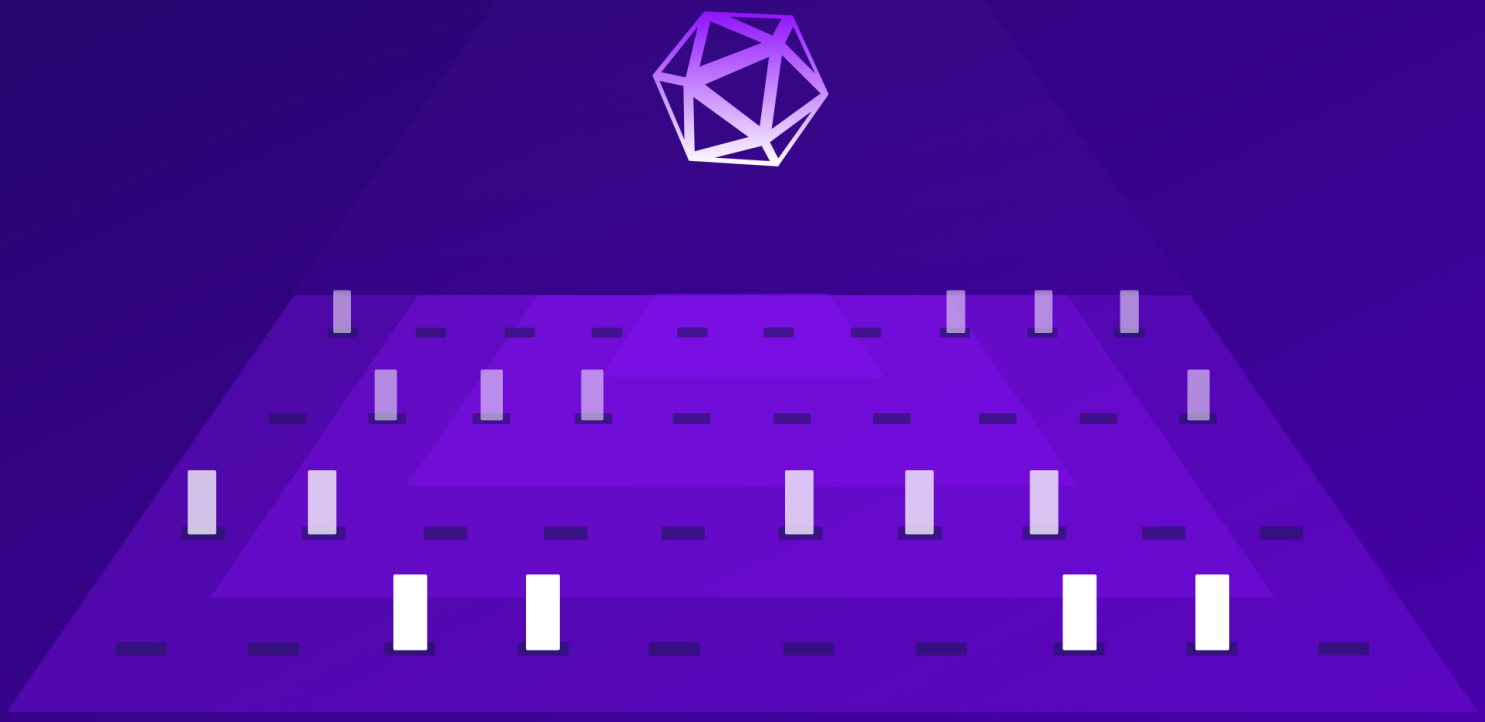
DISPUTE REVOLUTION



THE KLEROS HANDBOOK OF DECENTRALIZED JUSTICE

REVISED AND AUGMENTED EDITION

KLEROS.IO

DISPUTE REVOLUTION

THE KLEROS HANDBOOK OF DECENTRALIZED JUSTICE

A Foreword to the Augmented Edition

When it comes to civic innovation, writing software that works is only half the challenge. The other half is about convincing people that it can work.

A key part of our work at Kleros is clearly articulating and communicating our vision for the future of courts, arbitration and, generally speaking, dispute resolution.

It was in this spirit that, in March 2019, we published *Dispute Revolution: the Kleros Handbook of Decentralized Justice*.

Our goal was to provide readers with a one stop shop for a full account of the different aspects of the emerging field of decentralized justice, a place to learn about the history of the discipline, about cryptoeconomics, legal implications, business opportunities and the ever growing number of use cases that can be addressed by this novel approach to dispute resolution.

The first edition of our book organized our work into a six chapter structure. As the dynamic structure of this exciting field makes advances in a rapid pace, so must our book follow these evolving trends.

This revised and augmented version builds upon the structure of the first edition and contains some much needed updates.

In order to facilitate a wholesome look at our work at developing the academic field and the industry of decentralized justice, we expanded on both theoretical and practical tenets of Kleros.

From envisaging Kleros as a Supreme Court for the Internet, debating arbitration in the age of algocracy to the implications of collective and machine learning in the context of dispute resolution, the new edition maintains a broad look at how Kleros fits in the evolution of the legal industry.

Additionally, the augmented version of our book contains the Library of the Kleros Fellowship of Justice, which presents all the hard work done by our Fellows researching use cases of decentralized justice in the real world. Of course, no improved edition would be complete without the latest research updates and the presentation of the development of our platforms and applications.

This book represents the result of painstaking research into the underlying concepts of decentralized justice. It is an attempt to share our vision and motivate the right minds to think about the future of the legal industry and law as a whole. The world is rapidly changing and law will have to adapt to this rising tide.

We welcome you to a brave new edition of the *Dispute Revolution* and hope that this book will be a fine guide to you into this nascent and fascinating field.

Federico Ast

Buenos Aires, April 6th, 2020

Contents

Contributors

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Matheus Alencar is a software engineer passionate about governance and privacy. He was introduced to blockchain technology in 2017 while developing a decentralized voting system solution for his bachelor thesis. Before joining Kleros, Matheus worked on large scale enterprise software used by the brazilian Department of Justice and the Brazilian Air Force. When not working software, Matheus likes to practice rock climbing and calisthenics.

Federico Ast

CEO, Kleros

He graduated in economics and philosophy from the University of Buenos Aires. He holds a PhD in management from IAE Business School (Universidad Austral). He is passionate about exponential technologies such as artificial intelligence, crowdsourcing and blockchain for social innovation. He was a participant at Singularity University Global Solutions Program in 2016. He is host of "La Disrupción del Blockchain" the first Coursera course on blockchain in Spanish. He is a TEDx speaker. He is co-founder at Kleros.

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Luis is a JSD candidate at Stanford Law School and a professor of practice in the B.A. and M.L.S. programs at the University of Arizona College of Law where he teaches constitutional law. His JSM thesis—A Taxonomy of Investor-State Arbitration Cases Involving Party-Appointed Quantum Experts—has been distinguished with the 2017-18 Carl Mason Franklin Award for the most outstanding paper in international law presented at Stanford Law School. Outside the law school, Luis is a research assistant at the Hoover Institution.

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UX Design Lead, Kleros

Plinio is a multi-disciplinary UX Designer with a strong passion for technology and blockchain. He holds a Bachelor in Design from UFMG and the Karelia University of Applied Sciences, respectively. Plinio has a wide experience in delivering creative and engaging solutions across UX and UI Design, translating complex technical and business

requirements into usable and strong products. With 3+ years of experience designing for blockchain, he faced several challenges, always chasing innovation through empathy methods and data-driven decisions. His purpose-driven mindset and will to change the world through blockchain is his biggest source of motivation.

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Nicolas L. D'Agnillo graduated as an Accountant from the University of Buenos Aires, and completed a Specialization in Finance at UCEMA. Passionate about the financial markets, he has been trading since he was 17 and recently enrolled in UCEMA's Master in Finance while preparing for the CFA level II exam. He currently works in J.P Morgan as a business control analyst, covering fixed-income and interest rate derivatives trading desks.

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Rossana Deplano graduated in Law from the University of Cagliari (Italy). She holds a PhD in Law from Brunel University London (UK). She is lecturer in international law at the University of Leicester (UK). She has written extensively on the role of the United Nations in contemporary international organization. She is also passionate about law and technology, and how they may help achieve the goals of the United Nations. She is a Kleros Fellow of Justice.

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Daniel Dimov is an Internet law expert based in Belgium. Daniel Dimov is a fellow of the Internet Corporation for Assigned Names and Numbers (ICANN) and the Internet Society (ISOC). Daniel received a PhD in law from the Center for Law in the Information Society at Leiden University, the Netherlands. He has a Master's Degree in European law (The Netherlands), a Master's Degree in Law (Bulgaria), and a certificate in Public International Law from The Hague Academy of International law. Daniel has authored several peer-reviewed publications in the area of alternative dispute resolution. He presented his articles at conferences in Cyprus, Belgium, and the Netherlands.

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Mauricio Duarte is an attorney and notary graduated with honors from Universidad Francisco Marroquín. Before obtaining his LL.M. in US Law at the University of St. Thomas (Minnesota), he worked at one of Guatemala's most prestigious law firms, QIL + 4 Abogados, where he specialized in energy infrastructure investment, corporate governance, international investment, and commercial arbitrations.

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Primavera De Filippi is a permanent researcher at the National Center of Scientific Research (CNRS) in Paris, a faculty associate at the Berkman Klein Center for Internet & Society at Harvard University, and a Visiting Fellow at the Robert Schuman Centre for Advanced Studies at the European University Institute. She is a member of the Global Future Council on Blockchain Technologies at the World Economic Forum, and co-founder of the Internet Governance Forum's dynamic coalitions on Blockchain Technology (COALA). Her fields of interest focus on legal challenges raised by decentralized technologies, with a particular focus on blockchain technologies.

William George

Director of Research, Kleros

William George has a PhD in mathematics from the University of Toronto. His thesis was on number theory problems related to elliptic curve cryptography. Subsequently, during postdoctoral fellowships at the University of Toronto and at École Polytechnique (Palaiseau, France), he has done research on applications of blockchains. This work resulted in several scholarly publications, particularly in the use of blockchains in identity management systems. William is doing cryptoeconomics research for the blockchain-based dispute resolution platform Kleros.

Gillian Hadfield

Faculty Affiliate at the Vector Institute for Artificial Intelligence in Toronto and the Center for Human-Compatible AI at the University of California, Berkeley

Gillian Hadfield has served as a member of the World Economic Forum's Global Future Council on the Future of Technology, Values and Policy and Global Agenda Council on Justice and co-curates the Forum's Transformation Map for Justice and Legal Infrastructure.

She was appointed in 2017 to the American Bar Association's Commission on the Future of Legal Education and is a member of the World Justice Project's Research Consortium. She serves as an advisor to The Hague Institute for the Innovation of Law, LegalZoom, and other legal tech startups.

Peter Hunn

Founder, Clause.io and the Accord Project

Peter Hunn was a lawyer in the UK and settled on commercial law. He decided that there was going to be a big change in the legal industry, seeing how technology was changing finance, in particular consumer facing finance. Maintaining a keen interest in technology, Peter felt that it was the right time to begin building technology that would benefit the practice and the business of law. He explored the blockchain space for a few years and decided that this held a lot of promise, but the technology was not there to enable adaptation to commercial transactions. That is where the idea of Clause and the idea of the Accord Project came to fruition and what Peter has been building for three years.

Stuart James

Operations Lead, Kleros

Stuart James is the Communications lead of Kleros. He helped build and maintain the Kleros community and marketing direction from a very early stage. He has been involved in crypto since 2011, bought his first Bitcoins just in time to enjoy the MtGox fun and has followed the ecosystem ever since. He was co-host of Bitcoin.com podcast and has given talks at high level crypto events. In a not so previous life he was involved in the music and video industry winning 2 BAFTA awards and working on BBC documentaries and films shown at international festivals.

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Clément Lesaege is the CTO of Kleros. He has an engineering degree from UTC (France) and a Master of Science in Computer Science from Georgia Tech (US). He was introduced to Bitcoin in 2013 by fellow members of the pirate party and experienced with Bitcoin P2SH (rudimentary smart contracts). He worked as a smart contract security freelancer doing audits and finding vulnerabilities in smart contracts. At Kleros, he works on smart contracts and cryptoeconomics (CS, cryptography, game theory), designing mechanisms to make participants give honest answers in on-chain disputes (escrow, oracles, curated lists).

Damjan Malbašić

Communications Director, Kleros

Damjan Malbašić holds a B.A. in Communications from the Faculty of Media and Communications from Singidunum University in Belgrade and an M.A. in Geopolitics from the Faculty of Social Sciences from Charles University in Prague. He maintains a keen interest in foreign policy and the implications of technological innovations on international relations. Previously, he worked as the program coordinator of the Belgrade Security Forum and a researcher of European geopolitics, cyber security and disinformation in the media. He works at Kleros as the resident writer and social media manager.

Marco Mauer

Legal Engineer

Marco Mauer is a law student and software engineer based in Berlin, Germany. He works for a law firm that focuses on consumer protection and is involved in several legal tech projects. His research regarding Kleros revolves around court policies and governance - specifically, how rules can be formulated that allow everybody to participate and not just a handful of insiders and experts.

Joel Monegro

Partner, Placeholder

Joel Monégro is a partner at Placeholder, a venture capital firm he started with his close friend Chris Burniske in the summer of 2017. Before that, he spent three years as an analyst at Union Square Ventures developing the firm's early blockchain investment thesis and investment portfolio, and prior to that he managed the Digital Economy Department at the Ministry of Industry and Commerce of the Dominican Republic (where he's from), a government office in charge of developing the country's national and technology agenda. He fell down the crypto rabbit-hole in 2013 while researching alternative payment infrastructure technologies the Dominican Republic could promote across Latin America and since then it has occupied nearly all his mental space. He's driven by the opportunity to observe the re-structuring capitalism and governance in the age of information networks.

Alice Namuli Blazevic

Associate Partner, Messrs. Katende Ssempewba & Company Advocates

Alice Namuli Blazevic is an Associate Partner at Messrs. Katende Ssempebwa & Company Advocates in the Transactional & Advisory Department. She has over a decade experience in Commercial Transactions and Alternative Dispute Resolution with a keen interest in

Mediation and Arbitration. She always applies a business mind when resolving commercial disputes. She has been involved in a number of Mergers & Acquisitions and Anti-trust/ Competition Law matters. She has advised various large multinational ventures within Uganda, East Africa, South and West Africa, on regulatory compliance.

Sophie Nappert

International Arbitrator

Sophie Nappert is an arbitrator in independent practice, based in London. She is dual-qualified as an Avocat of the Bar of Quebec, Canada and as a Solicitor of the Supreme Court of England and Wales. Before becoming a full-time arbitrator, she pursued a career as an advocate and was Head of International Arbitration at a global law firm. Sophie pioneered scholarship on technology in arbitration with ground-breaking contributions in co-authorship on the impact of Artificial Intelligence and Blockchain on the arbitral process that are cited as a reference on the topic.

Dimitry Narozhny

Civil law attorney

Dmitry is a civil law attorney and project manager based in Russia. In the past couple of years, Dmitry has studied deeply the application of blockchain in dispute resolution. As a specialist in commercial litigation, civil and corporate law, Dmitry brought his experience as an attorney to Kleros. He has already been a long time follower of the project and has contributed with Kleros ethos. During his participation in the Kleros Fellowship of Justice program, Dmitry will conduct research on how to help integrate Kleros in the framework for online dispute resolution of the European Union.

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Josiah Ober, Mitsotakis Professor in the School of Humanities and Science at Stanford University, works on historical institutionalism and political theory, focusing on the political thought and practice of the ancient Greek world and its contemporary relevance. He is the author of a number of books mostly published by Princeton University Press, including ***Mass and Elite in Democratic Athens*** (1989), ***Political Dissent in Democratic Athens*** (2008), ***Democracy and Knowledge*** (2008). He has also published about 75 articles and chapters, including recent articles in American Political Science Review, Philosophical Studies, Hesperia, Polis, and Transactions of the American Philological Association.

Enrique Piqueras

Former Lead Developer, Kleros

Enrique Piqueras is a software engineer with a knack for breaking down complex topics into understandable parts. He has been programming since the age of 10 and worked in the vehicle telematics industry, where he led the development of a fleet management system for +700,000 users. Although only 20 years old, having the opportunity to build and lead a team has allowed him to gain experience in many areas of the engineering process. Most recently, he joined a blockchain startup that promises to revolutionize international justice and governance systems.

Orna Rabinovich-Einy

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Professor Orna Rabinovich-Einy is an associate professor at the University of Haifa. Her areas of expertise are online dispute resolution (ODR), alternative dispute resolution (ADR), and civil procedure, with research focusing on the impact of technology on dispute resolution, the relationship between formal and informal justice systems, and dispute resolution system design. She has published widely in these areas, and most recently has co-authored a book with Professor Ethan Katsh entitled *Digital Justice: Technology and the Internet of Disputes,* published by Oxford University Press. Rabinovich-Einy holds a J.S.D. degree from Columbia University. She was admitted to Israel (1998) and N.Y. (2001) Bar, and was certified as a mediator in New York (2003).

Joseph Raczynski

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Joseph Raczynski, legal technologist and futurist, is an innovator and early adopter of all things computer related. His primary bent is around the future of law and legal technology. He also focuses on several fields including blockchain, machine learning, mobile, cryptocurrency and robotics (drone technology). Currently he is with Thomson Reuters Legal managing a team of Technical Client Managers for both the Large Law and Government divisions. Joseph serves the top law firms in the world consulting on legal trends and customizing Thomson Reuters legal technology solutions for enhanced workflows.

Colin Rule

Vice President for Online Dispute Resolution, Tyler Technologies

Colin Rule is Vice President for Online Dispute Resolution at Tyler Technologies. Tyler acquired Modria.com, an ODR provider Colin co-founded, in 2017. From 2003 to 2011 Colin

was Director of Online Dispute Resolution for eBay and PayPal. He has worked in the dispute resolution field for more than 25 years as a mediator, trainer, and consultant. He is the author of *Online Dispute Resolution for Business* (2008), published by Jossey-Bass in September 2002, and *The New Handshake: Online Dispute Resolution and the Future of Consumer Protection* (2017), published by the ABA. He holds a Master's degree from Harvard University's Kennedy School of Government in conflict resolution and technology, a graduate certificate in dispute resolution from UMass-Boston, a B.A. from Haverford College, and he served as a Peace Corps volunteer in Eritrea from 1995-1997.

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Professor Amy J. Schmitz joined the University of Missouri School of Law faculty as the Elwood L. Thomas Missouri Endowed Professor of Law in 2016. Previously she was a professor at the University of Colorado School of Law for over 16 years, and had practiced law at two different law firms prior to teaching. Professor Schmitz is the co-author of the seminal book *The New Handshake*. She also created an Open Educational Resource for teaching Online Dispute Resolution, serves on the Association of American Law Schools Executive Committee on Commercial and Consumer Law, is a Fellow of the National Center for Technology and Dispute Resolution, is Co-Chair of the ABA Technology and Dispute Resolution Committee, and is an External Scientific Fellow of the Max Planck Institute Luxembourg. She also has taught in France, South Africa, and Oxford, England, and has been an expert and liaison for the United Nations working group seeking to create a global online dispute resolution mechanism (UNCITRAL WG III).

Abeer Sharma

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Abeer Sharma is an Indian dispute resolution lawyer working as a counsel in international commercial and investment arbitrations and is part of the Kleros Fellowship of Justice Programme. He is an active ADR advocate and frequently dabbles in dispute resolution research, with research interests including energy law, investment law, comparative contract law, and new technologies.

Kate Sills

Community Lead, Agoric

Kate Sills studied computer science at UC Berkeley and maintains a keen interest in politics, especially political philosophy. In 2017, she attended the cryptoeconomics conference at Berkeley and had a chance to hear a speaker from RMIT about institutional economics and its connection to the blockchain. Afterwards, she began research on Thomas Schelling and

Oliver Williamson, taking the lessons from institutional economists into smart contracts and contract law. She is currently the Communications Lead at Agoric, a company founded by pioneers in secure development and distributed systems, enabling object capabilities and smart contracts.

Santiago Siri

President, Democracy Earth Foundation

Santiago Siri is the founder of Democracy Earth Foundation, a Y Combinator backed non-profit building incorruptible digital governance for small and large communities; and the Partido de la Red (Peers Party), the first digital political party to run for elections. Partner of Bitex.la, a leading bitcoin fintech company in Latin America. Published *Hacktivismo* in 2015 with Random House. Co-founded Argentine Game Developers Association. World Economic Forum member.

Peter Stone

Associate Professor, Trinity College, Dublin

Peter Stone's doctoral dissertation was entitled *The Luck of the Draw: Revisiting the Lot as a Democratic Institution.* From 2003 to 2010 he was Assistant Professor of Political Science at Stanford University. He then spent a year as Faculty Fellow at Tulane University's Center for Ethics and Public Affairs before becoming Ussher Assistant Professor of Political Science (Political Theory) at Trinity College Dublin in fall 2011. Stone specializes in political theory, especially such areas as democratic theory, theories of justice, rational choice theory, and the philosophy of social science. He is particularly concerned with questions involving the scope and limits of human reason. He is the author of *The Luck of the Draw: The Role of Lotteries in Decision Making* (2011) and the editor of *Lotteries in Public Life: A Reader* (2011).

José Torres

Former Fellow at The Legal Design Lab - Stanford University

José Torres is a lawyer from Universidad de los Andes in Colombia and holds a Masters in International Economic Law and has experience of practice in different areas. He was an international trade and investment lawyer at the World Trade Organization and afterwards at the arbitration group at Skarren, Arps, Slate, Meagher & Flom in London. At Sergio Arboleda University in Colombia, he started the Center for Innovation in Law. In that program, he merged technology, design, entrepreneurship and law to prepare future lawyers for the 21st Century legal practice. The outcome of that work led him to become the first fellow of the Legal Design Lab at Stanford. At the lab, he dug deeper into the intersection of design, law and technology. In his work at Stanford he researched using design for online dispute resolution and access to justice and some of research on smart contracts.

Ferit Tunçer

DApp Developer, Kleros

Ferit Tunçer studied computer science at Marmara University, İstanbul. He has been programming for eight years as a hobby, as well as a profession. He worked on web services of a local bank in Turkey and on developing a thermodynamic cycle modeler and a simulator software project in a startup. Since 2018, he has been working on decentralizing justice at Kleros. Being a long-time chess enthusiast, he likes to spend his free time playing chess. Being a cypherpunk, he believes encryption and decentralized systems are key to protect privacy and freedom.

Sam Vitello

DApp Developer, Kleros

Sam Vitello is a software engineer based in Denver, Colorado. He has been working in the blockchain space since 2014. He holds a bachelor's degree in Mathematics and Computer Science from the University of Oregon. Sam joined Kleros because he believes in a world where truth and justice can be decentralized and universally accessible. Out of the office, Sam spends a lot of time climbing in the mountains and pursuing creative projects.

Barry Weingast

Ward C. Krebs Family Professor, Stanford University

Professor Barry Weingast, Ward C. Krebs Family Professor at Stanford University and Senior Fellow at the Hoover Institution is one of the world leading scholars in institutional economics, a field that studies how human institutions affect economic behavior. Throughout his career, Weingast has conducted extensive research in the application of rational choice theory to legal, legislative and constitutional institutions. His work was very influential in my thinking about decentralized justice, in particular, the seminal article titled "*The Role of Institutions in the Revival of Trade: the Law Merchant, Private Judges and the Champagne Fairs*" he co-authored with Nobel Memorial Prize laureate, Douglass C. North, and Paul Milgrom, an economist and game theorist at Stanford University.

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Silverzweig Professor of Economics, Hebrew University

Eyal Winter, Ph.D., is the Silverzweig Professor of Economics at the Hebrew University and Economics Professor at Leicester University. He is a member and a former director of the Center for the Study of Rationality, an elected council member of the International Game Theory Society and an elected fellow of the Economic Theory Society. He was awarded the Humboldt Prize for excellence in research by the German government in 2010. Winter has presented his work in more than 120 research institutes in 26 countries around the world including Harvard, Stanford, Princeton, Berkeley, Cambridge, and Oxford. His book Feeling Smart: Why our Emotions are More Rational Than We Think was published in January 2015.

Prologue

Building a Justice System for the Internet

By Colin Rule, Vice President for Online Dispute Resolution, Tyler Technologies

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Now we are engaged in a radical experiment: developing and inhabiting a new global online society, one built with electrons instead of bricks – enabling us to transcend time and space while connecting everyone, all the time.

But this new electronic space is still defined and shaped by the needs of living, breathing people. To make this online society work, we must create a new justice system, one that will provide the fairness online that humans have always demanded.

It is certainly true that we already have a justice system in place for our face-to-face world. We have courts and laws and judges and jails operating every day around the planet.

Why can't we just evolve that system to meet the needs for this new online society?

Many people are working hard to facilitate that adaptation, but it may be that their efforts are futile - the gap between the old justice system and the demands of the new online world is wide.

The face-to-face justice system is too tied to geography, too dependent on separate jurisdictions and too expensive and inefficient to scale to meet the needs of a wired world. When a $50 transaction can touch four continents in a millisecond, traditional judiciaries simply cannot respond. We need a new justice system that works the way the Internet works.

The concepts of judges and juries and laws arose at the same time as the nation state. But there are older ways of resolving problems that may be a better fit with the way the Internet works.

These older approaches don't rely on governments, jurisdictions and legal regimes. They aren't imposed from above by some powerful enforcement body. In fact, the majority of the world's population still uses these approaches to resolve disputes and provide fairness, even though they get far less attention than the formal justice system we hear about every day in the media.

That is what makes this book so exciting.

In these chapters, Kleros goes back to first principles to look at how justice systems have worked from ancient times until today, and then applies bleeding edge technology to sketch out where justice systems may be going.

We are at the dawn of a new era. The innovations we craft and hone today may shape the lives of generations to come. We have a lot of work to do, with many hard questions yet to answer, but I believe this book is an important contribution to the effort.

A Necessary (R)evolution?

By Sophie Nappert, International Arbitrator

International arbitration is facing an identity crisis: the trust historically placed in it by users is, if not waning, at least shifting. The system's polymorphous, flexible, lightly-regulated nature has long been praised as key to its success. These hallmarks of arbitration, long held as strengths, are showing signs of wear and tear. As international arbitration has ridden a wave of sustained popularity in modern times, more recently it has been the subject of criticism, substantively when dealing with public interest disputes, but also procedurally in being largely unable to come up with radical solutions to spiraling costs and delay, not to mention the lack of diversity on tribunals.

A stark illustration of where we were only twelve years ago and where we are now comes in the form of a quote by Professor Jan Paulsson at McGill University's Brierley Lecture in 2008: "[I]n the transnational environment, international arbitration is the only game. It is a de facto monopoly. (…) But as a matter of social policy the monopoly of international arbitration is not necessarily (…) a cause for celebration. It is a phenomenon to be evaluated continuously and critically. (…) If we do not deliver decent justice, if we do not close the door to abuse, we should understand that sharp reactions are likely – sharp reactions which may harm a very valuable tool."[1]

This statement is both prescient in its prediction of sharp reactions to abuse, and obsolete in that the world to which it refers, that of "the monopoly of international arbitration", is no more. As I am writing this at home in self-isolation, the Covid-19 pandemic paralysing the world threatens international arbitration in its historical practices of in-person hearings and regular practitioner gatherings.

Enter Kleros.

Kleros is a breath of fresh air in the dispute resolution space. Its blockchain-based concept of decentralised, transparent peer-to-peer justice aims at bringing tangible solutions to real problems of accessibility and affordability of justice. Kleros reasons that e-commerce transactions without boundaries need like-minded and equally varied jurors.

The dispensation with qualification standards to be a juror implies that disputes are resolved by lay peers, people just like the users, promising a mutual understanding of the world and winning trust. We must not forget that we are living in a world where the number of 'likes'

[1] Paulsson J., 28 May 2008, "*International Arbitration is not Arbitration*", John E C Brierley Memorial Lecture, McGill University

one receives as endorsement has more value for the validation of an idea or decision than does the reasoned output of three decision-makers appointed by word of mouth.

In a pandemic of unexpected proportions, Kleros brings a beacon of stability with a model of online dispensation of justice that can continue undisturbed by social chaos. It also matters that Kleros offers an open window to justice for those countries where the traditional justice system is unreliable, or saturated.

It is important to point out that Kleros, albeit it operates on the blockchain, relies on humans (not intelligent machines) to make decisions. There is a core underpinning of human trust in other humans in the Kleros model.

Kleros has important work ahead in its journey towards scaling up the development of its model of decentralised justice. Central issues on the legal front include the adaptability of the model to non-binary disputes, the treatment of precedent, and the place and role of due process and fairness in the game theory model. These are some of the legal challenges tackled by the talented Fellows of Justice, who are to be congratulated for their efforts and support of Kleros' vision.

Kleros and the Future of Democracy

By Santiago Siri, Founder, Democracy Earth

In order to implement fair democracies, we have found in our research that there are two main ways to subvert an outcome of an election.

One way is through false information, fake news or gossip, as it's often referred to by the mainstream media.

Another way is by having corrupt actors controlling the voter registry. If someone controlling the database can decide who gets to vote or delay voter registrations, this may have a very profound impact in the outcome of an election.

At Democracy Earth, we see the work being led by organizations such as Kleros as extremely relevant in the implementation of cryptographic lotteries and randomness over decentralized networks. When it comes to governance, having fair initial conditions matters and it's through randomization that fair conditions can be guaranteed.

After all, every game begins with a lottery to set initial conditions. In democracies, randomness can help disincentivize the bribing of nodes able to grant voter rights.

I have always been very inspired by Federico's view regarding how ancient democracy used to work for the Greeks, by implementing the kleroterion and electing public servants through lotteries.

I think a lot of those views that can be traced to the very origins of the idea of democracy are now being reborn with the rise of decentralized networks and the need for having fair and efficient governance mechanisms that cannot be gained in the way traditional democracies are being run today.

I'm very hopeful to see the work of Kleros grow and have a profound impact, as it's able to interact with the many different contexts where technology like this becomes relevant.

From Lex Mercatoria to Lex Criptographia

By Primavera de Filippi, National Center of Scientific Research (NCRS), Paris, Faculty Associate at the Berkman Center for Internet & Society at Harvard Law School

During medieval times, domestic trade was regulated by customary laws that were specific to a kingdom. Advances in transportation infrastructures expanded the reach of trade beyond a single kingdom. Domestic rules could no longer apply, and a new set of principles was therefore established to regulate trade within and amongst kingdoms.

This was achieved by means of private ordering, as merchants themselves established the rules that would regulate different types of transactions. Over time, some of these customs and best practices became recognized as a customary body of law for international (or interregional) commerce. This marked the advent of the so-called Lex Mercatoria.

Lex Mercatoria was not dictated nor recognized by any particular kingdom, it emerged organically from the interactions of merchants seeking to extend the reach and reduce the uncertainty of trade. It was not enforced by any sovereign authority, as royal courts generally avoided cases involving international trade or simply refused to acknowledge the validity of foreign contractual deals.

Hence, merchants developed their own courts to enforce their own legal framework stemming from voluntary contractual deals. Merchant courts progressively emerged along the main trading routes, recognizing Lex Mercatoria as a universal set of rules that is applicable to everyone regardless of the geographical location.

With the advent of the Internet and digital technology, an alternative normative system emerged, as a particular set of rules spontaneously and independently elaborated by an international community of Internet operators.

This system - sometimes referred to as Lex Informatica, by analogy to Lex Mercatoria - is an ideal toolkit for the regulation of online transactions, since its normative power arises directly from the technical design of the network infrastructure, which is used as a complement (or a supplement) to contractual rules.

Just like Lex Mercatoria, Lex Informatica ultimately relies on self-regulation: it is a system of customary rules and technical standards elaborated by those who interact on the global Internet network. The system operates transnationally, across borders, independent of national boundaries and domestic laws.

However, as opposed to Lex Mercatoria, which was elaborated by and for an international community of merchants, in order to respond to their own needs, Lex Informatica is unilaterally imposed by online service providers onto their users. Indeed, by restricting the type of actions that can be performed on a digital platform, Lex Informatica introduces a system of technical norms which are not a direct expression of the will of the people, but rather that of those in charge of maintaining the platform.

Blockchain technology enabled the emergence of yet another normative system, a new mechanism of coordination which also relies on technical means in order to coordinate behavior. Yet, as opposed to Lex Informatica, whose rules are ultimately dictated by a centralized operator, the rules established by the protocol of a blockchain network are established by the community and for the community, and must be enforced through a mechanism of distributed consensus involving all network participants.

The benefit of this new normative system - which I defined as Lex Criptographia in my book, **Blockchain and the Law** (2018) - is that it operates independently of any third party authority or intermediary operator. However, the flipside is that blockchain-based rules do not have the flexibility required to manage a large majority of social interactions and commercial transactions.

Hence, if such a system is to reach mainstream adoption, it is crucial to identify new mechanisms of conflict resolution capable of satisfying the basic requirements of transparency, accountability, accessibility, fairness and due process enshrined into our common understanding of the rule of law.

It is my hope that this book will constitute an important move in that direction.

Introduction

Through the ages, human communities have had to solve the ever present problem of social order. For this, they developed governance and legal systems. Of course, these were created with the technologies and beliefs of their time.

Athenians of the Classical period believed that all citizens had the right to participate in lawmaking and as jurors in popular trials. They used a sophisticated piece of civic technology called the *kleroterion* to randomly select jurors and help avoid manipulation of the system.

Modern legal systems were created in the 17th and 18th centuries, at a time of consolidation of nation states. An era dominated by the paradigm of the printing press technology.

These systems provided rule of law for many years, enabling industrial development and economic prosperity. But in the early 21st Century, the legal systems of the age of the printing press started to reach their complexity limits. The advent of the Internet and the creation of a global, digital, real-time economy are exposing the cracks in legal systems built in an era of paper contracts, horse transportation and national jurisdictions.

In today's economy, an increasing number of transactions are conducted online across boundaries. Clients from different countries hire contractors from all over the world for software development and other services. Investors from different countries participate in crowdfunding campaigns from everywhere.

In their book *Digital Justice* (2017), experts Ethan Katsh and Orna Rabinovich-Einy estimate that disputes arise in 3 to 5% of online transactions, totaling over seven hundred million in 2015 alone. (Katsh and Rabinovich-Einy 2017: p. 67)

Existing dispute resolution technologies are too slow, too expensive and too unreliable for an online real-time world. Even alternative methods like online dispute resolution (ODR) have failed to address this problem. ODR promised to bring resolution to this new type of disputes, but in the end it just streamlined existing court procedures, without bringing real innovation.

This can only get worse as we spend more time in online jurisdictions such as social media or virtual worlds such as those that were announced in Second Life and Steven Spielberg's *Ready Player One*.

Cars, not faster horses

Henry Ford famously said (although some people doubt the veracity of this): "If I had asked people what they wanted, they would have said faster horses".

The justice system of the Internet Age will not come from further streamlining existing processes but from fundamentally rethinking justice from a first principles perspective.

The last decades have shown the potential of collective intelligence to produce an encyclopedia like Wikipedia, a transport system like Uber, a restaurant rating system like Yelp!, and a hoteling system like Airbnb. These companies innovated by crowdsourcing value creation. Instead of having an in-house team of restaurant critics like the Michelin Guide, Yelp! crowdsourced ratings from users. Instead of a team of in-house writers, Wikipedia put content creation in the hands of its users.

Satoshi Nakamoto's invention of Bitcoin and the underlying blockchain technology are the next step in the rise of the collaborative economy. The Bitcoin network proved that, given the right incentives, anonymous users could cooperate in maintaining and updating a distributed ledger which could act as a monetary system. A nationless system, inherently global, and native to the networked age.

This system relied on cryptoeconomics, a new field of study that leverages cryptography, computer science and game theory to build secure distributed systems. It is the science that underlies the incentive system of open distributed ledgers. But its potential goes well beyond the financial applications of cryptocurrencies.

Kleros is a dispute resolution system based on cryptoeconomic incentives. It builds on governance ideas of random selection that can be traced back to Ancient Athens (Kleros is Greek for *randomness*) and the modern concept of *focal points*, developed by game theorist Thomas Schelling. Using a clever mechanism design, Kleros produces a set of incentives for randomly selected users to adjudicate disputes in a fast, affordable and secure way.

As Bitcoin was the first example of cryptocurrency, Kleros is the first working system of a new technology, industry and field of research we may call *decentralized justice*.[2] It leverages the wisdom of the crowd to resolve a large number of disputes in which existing methods fall short: e-commerce, crowdfunding and many types of small claims are among the early adopters.

As a pioneer in decentralized justice, we at Kleros face a threefold challenge.

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[2] We prefer the term *decentralized justice* to *distributed justice*, as the latter could be confused with the already existing concept of *distributive justice*. Distributive justice is a long standing tradition in political philosophy which refers to the socially just allocation of goods.

First, as a startup building a new industry, we need to solve real world problems in an economically sustainable way. This requires identifying customer segments, understanding their problems and designing business models that can address these needs. Some questions to answer in this regard: Does Kleros solve a real problem? Who has this problem? Is the solution adequate compared to other possible solutions?

Second, as researchers creating a new field, we need to understand whether Kleros' cryptoeconomic model can effectively create the right incentives for agents to collaborate while preventing attacks by malicious parties.

Some questions to answer here include: Can Kleros create the right incentives for agents? Specifically, are there incentives that will lead general users, whose behavior might deviate from mathematical models of rationality, to act in such a way that Kleros produces desirable outcomes, while nonetheless not allowing openings for sophisticated users or hostile parties to game the system? Namely, can cryptoeconomics create a decentralized justice system that is both effective and secure? Is Kleros the best system for decentralized justice or are there other mechanism designs that could work better?

Third, as social reformers, we need to push innovation in institutions that have not really changed in over two centuries (and in which some would prefer not to see any innovation at all). In this sense, Kleros is also a movement that needs to inspire people that a different justice system is possible. Building a perfect system of economic incentives is pointless if people do not want to use it. In this regard, some key questions to answer include: Is Kleros fair? If it is fair, will people understand it and choose to use it?

We tried to organize this book so as to address all these aspects throughout different chapters.

Chapter 1, *Genesis: When Greek Lotteries Meet Medieval Private Law* presents the two historical tenets on which Kleros' technology is envisaged. Through in-depth interviews with three political scientists, Josiah Ober, Peter Stone and Barry Weingast, we explore the roots of decentralized justice in Athens, in medieval Europe and how sortition fits into the tradition of Western political thought. Lastly, We implement these principles in thinking of Kleros as a potential Supreme Court of the DAOs.

Chapter 2, *Kleros Cryptoeconomics: Towards a Theory of Decentralized Justice* focuses on the technology behind Kleros. In it, experts on game theory, such as Hebrew University professor Eyal Winter and our cryptoeconomic researcher William George try to bring these concepts closer to the layman reader. It also consists of our latest research into social choice theory, different choices of voting mechanisms and their potential impact on Kleros. The remainder of the chapter focuses on helping expand the knowledge base of our expert

audience by sharing our experiences with smart contracts, oracles, as well as presenting proposals for Ethereum standards (or ERCs) and the basic policies on which Kleros is built.

Chapter 3, *Decentralized Justice in Action: From Doges on Trial to the Token Curated Registry* is an in-depth analysis of the "Doges on Trial" experiment, as well as early lessons from the implementation of our T2CR and a wide look at what has been learned about attack vectors, juror behavior and the foundational cryptoeconomics. In the second edition, the chapter is expanded with latest insights into the so-called 'challenger's dilemma' and the experiment we undertook comparing artificial and collective intelligence in the context of Doges on Trial.

Chapter 4, *Dispute Revolution: A New Justice Paradigm in an Old World* deals with the implications this technology might have for law and society. By sharing their experiences in online dispute resolution and research on blockchain law, industry and thought leaders such as Gillian Hadfield, Kate Sills and former Vice-President of the Ugandan Law Society, Alice Namuli give their opinion on how Kleros and decentralized justice might affect the future of law. A veteran international arbitrator, Sophie Nappert gives us a fantastic insight into the rise of algocracy and how humans can respond. In this chapter, particular care is taken to analyze the most critical points of any arbitration system - fairness and compatibility with existing legal frameworks.

Chapter 5, *The Business of Decentralized Justice* tries to paint an image of the way legal business is going to develop and change in the coming years. By bringing in decades of experience in future-centered thinking through conversations with Joe Raczynski, Thomson Reuters resident legal futurist, Colin Rule, the creator of eBay and PayPal's dispute resolution systems, the author of the seminal book *Digital Justice,* Orna Rabinovich-Einy, Accord Project founder, Peter Hunn and legal design expert José Torres, we discuss the opportunities and hurdles in building new legal systems for the 21st Century. As added flavour, our Design Lead, Plinio Braga gives us unique, practical insight into designing novel legal applications.

Chapter 6, *Scaling Up: The Applications of Decentralized Justice* focuses on the use cases of Kleros, where we combine the vision and practice to define the key ingredients which will make Kleros the dispute resolution system of the future. Experts from different fields present their research into Kleros as a solution for a plethora of use cases, ranging from decentralized freelancing, marketplaces, gas, energy markets and derivatives trading to fake news, social media and online gaming. This chapter also presents some of our coming platforms, as well as existing ones in the context of creating a thriving dispute resolution ecosystem.

Finally, in the second edition of our book we added ***The Library of The Fellowship of Justice***, which presents all the hard work done by our Fellows on researching and exploring the horizons of decentralized dispute resolution.

Our goal with this book is not to bring any definitive answers (which we don't have), but to share our learnings and try to pose the key questions to which we believe this discipline should answer. We would be happy if this became the beginning of a research and development roadmap for the emerging field of decentralized justice. We would be even happier if this book could kickstart a community of entrepreneurs and activists willing to push the ideals of this nascent discipline.

Political institutions are the result of trying to solve the practical problems of social coordination. Human communities of all times developed the institutions that were better suited to their problems, their technologies and their beliefs. Athenians of the Classical period built their court system on ideas of citizen participation with the aforementioned kleroterion for random selection. The founding fathers of the United States designed American courts based on the best knowledge of the political theory of their time.

In a time of globalization and digitalization, cryptoeconomics may become the pillar for building a decentralized justice system for the Internet Age.

Kleros, a Protocol for Decentralized Justice

Federico Ast, CEO, Kleros and Clément Lesaege, Chief Technical Officer, Kleros.

The world is experiencing an accelerated pace of the process of globalization and digitalization. A growing number of transactions are conducted online between people from all over the world. It is estimated that disputes arise in 3 to 5% of online transactions, totaling over seven hundred million in 2015 alone. (Katsh and Rabinovich-Einy 2017: 67)

Buyers at eBay claim that sellers failed to send the goods as specified in the agreement, guests at Airbnb claim that the rented house was not "as shown in the pictures" and backers in a crowdfunding campaign claim a refund as teams fail to deliver the promised results. As a larger part of commerce and social interactions move online, so do conflicts.

Existing dispute resolution technologies are too slow, too expensive and too unreliable for an online real-time world. A fast, inexpensive, transparent and decentralized claim adjudication system will be a key institution for the Internet Age.[3]

Existing dispute resolution technologies are too slow, too expensive and too unreliable for an online real-time world. A fast, inexpensive, transparent and decentralized claim adjudication system will be a key institution for the Internet Age.

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[3] In the article *The Crowdjury, a Crowdsourced Judicial System for the Collaboration Era* (2015), Federico Ast, one of Kleros founders, and Alejandro Sewrjugin presented some ideas on how a decentralized court system could work. Crowdsourcing, they argued, could enable faster, cheaper and more transparent judicial decisions. The key insight was that, as ancient Athenian courts, a judicial system could work on a p2p basis. The article laid out the big picture, but did not dig into details of how this technology could actually work.

The Acropolis at Athens (1846) by Leo von Klenze. *Oil on canvas, 103 x 148 cm. Neue Pinakothek, Munich.*

What the Greeks Knew About Justice

A court proceeding is an epistemic engine, a tool for ferreting out the truth from a confusing array of clues and indicators. Ability to reach true decisions is the critical feature of a court system. Courts that frequently convicted innocents and acquitted the guilty would fail to win the respect from those it governed[4]. However, other criteria are also to be considered, such as the cost and duration of proceedings. Reaching a true decision at a low cost is preferable to reaching a true decision at a high cost. Reaching a true decision sooner is preferable to reaching a true decision later.

Taking all of this into consideration, the key problem to solve is:

[4] *Legal epistemology* is a subfield of social epistemology that studies whether the rules that govern judicial proceedings are genuinely truth-conducive (Laudan 2006).

How to design a system that produces true decisions at the lowest possible cost and in the shortest amount of time?

In order to answer this question, we may find some inspiration in the ancient Greek. The Athenians developed a remarkable judiciary. Trials were conducted by a large body of ordinary citizens. On trial days, citizens wishing to serve as jurors went to the courthouse where a sophisticated jury selection procedure took place.

Each citizen inserted his *pinakion* (a bronze or wood ID token) into a slot of an allotment machine called *kleroterion*. After all citizens had inserted their pinakion, an official threw white and black *icosahedron* (20 faces) dice in a tube affixed vertically on a side of the kleroterion. The tube stopped at the bottom and held the dice in the random order in which they entered. Dice were then released one at a time. Candidates having a black dice on their row were dismissed for the day. Candidates with a white dice were drawn for paid jury duty (Boegehold 1995).

About 25 centuries ago, Athenians knew that courts could work as a peer-to-peer system without turning into mob justice, provided three conditions were met: jury duty was voluntary; jury duty was paid[5]; jury selection was done by sortition (*kleros*)[6].

Greek popular courts had no continuing existence or permanent personnel. They were decentralized organizations where jurors and officers changed from day to day following predefined rules. The pinakion, the kleroterion and the icosahedron dice were extraordinary pieces of civic technology that supported a basic concept of the Athenian polis: ordinary people had a right to judge.

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[5] In the 420s BC, jurors were paid three obols for a day's work. While it was not a grand sum, it was enough to make a difference in the way a man lived and more than enough to sustain mere existence.

[6] Kleros, the name of the project, comes from the use of sortition for jury selection. In governance, sortition (also known as *allotment* or *demarchy*) is a method of selection of political officials as a random sample from a larger pool of candidates.For more information, see the introduction to Chapter 1 - Genesis: When Greek Lotteries Meet Medieval Private Law, as well as the interview with Peter Stone.

A pinakion. *The token that Athenians used to be drawn as jurors in popular trials. Image: Bronze dikast ticket of Archilochos of Phaleron. About 370-362 BC, reused after 350 BC. Credit: British Museum Collection / CC BY-SA 3.0*

The kleroterion. *The allotment machine used in Ancient Athens to randomly select jurors for trials. Credit: The Ure Museum of Greek Archaeology*

An icosahedron dice. *Made of 20 faces of equilateral triangles, the Athenians used this type of dice in the kleroterion for random juror selection. Image: Twenty-sided die with faces inscribed with Greek letters. Credit: Gift of Hellen Miller Gould, Metropolitan Museum of Art.*

Athenian courts greatly contrasted with the legal systems that nation states started to develop in the 17th and 18th centuries. Instead of ordinary citizens, most modern judiciaries are based on professional judges and attorneys[7].

In the late 20th Century, following the advent of the Internet, national legal infrastructures became unable to cope with the complexity of a networked age. Limitations became clear, for example, when Google acquired YouTube in 2007 and had to comply with laws on privacy, intellectual property and defamation in over one hundred countries. Also in the case

[7] Notably, the United States judiciary kept some of the spirit of Athenian courts in using citizen juries. This participatory feature of the American political system was greatly admired by Tocqueville: "The jury, and more especially the civil jury, serves to communicate the spirit of the judges to the minds of all the citizens; and this spirit, with the habits which attend it, is the soundest preparation for free institutions (…) It invests each citizen with a kind of magistracy; it makes them all feel the duties which they are bound to discharge toward society; and the part which they take in the Government" (Tocqueville 1961: 336–37)

of Uber, which needs to deal with the laws of the thousands of local jurisdictions where the company operates.[8]

A new, global and real time economic reality requires a new, global and real time adjudication technology.

A Simple Website Dispute

Alice is an entrepreneur based in France. She contracts Bob, a programmer from Guatemala, to build a new website for her company. After they agree on a price, terms and conditions, Bob gets to work. A couple of weeks later, he delivers the product. But Alice is not satisfied. She claims that the quality of Bob's work is considerably lower than expected. Bob replies that he just did what was agreed. Alice is frustrated. She cannot hire a lawyer for a claim of just a couple hundred dollars with someone who is halfway around the world.

Now, imagine that, at the moment of their agreement, Alice and Bob had picked a standard off the shelf smart contract for website design freelancing[9]. The contract had a clause stating that, should a dispute arise, it would be arbitrated in the Kleros network. After Bob stops answering her email, Alice taps a button that says "Send to Arbitration" and fills a simple form explaining her claim.

Chief is a software developer who lives thousands of miles away in Nairobi, Kenya. While on the bus commuting to work, he is checking Kleros website to find some arbitration work. He makes a couple thousand dollars a year on the side of his primary job by serving as a juror in software development disputes between freelancers and their clients.

He usually works in the Website Quality court, which requires skills in html, javascript and web design. Chief deposits 2000 pinakion (PNK), the token used in Kleros to select jurors for disputes. The more tokens he deposits, the more likely it is that he will be drawn as juror.

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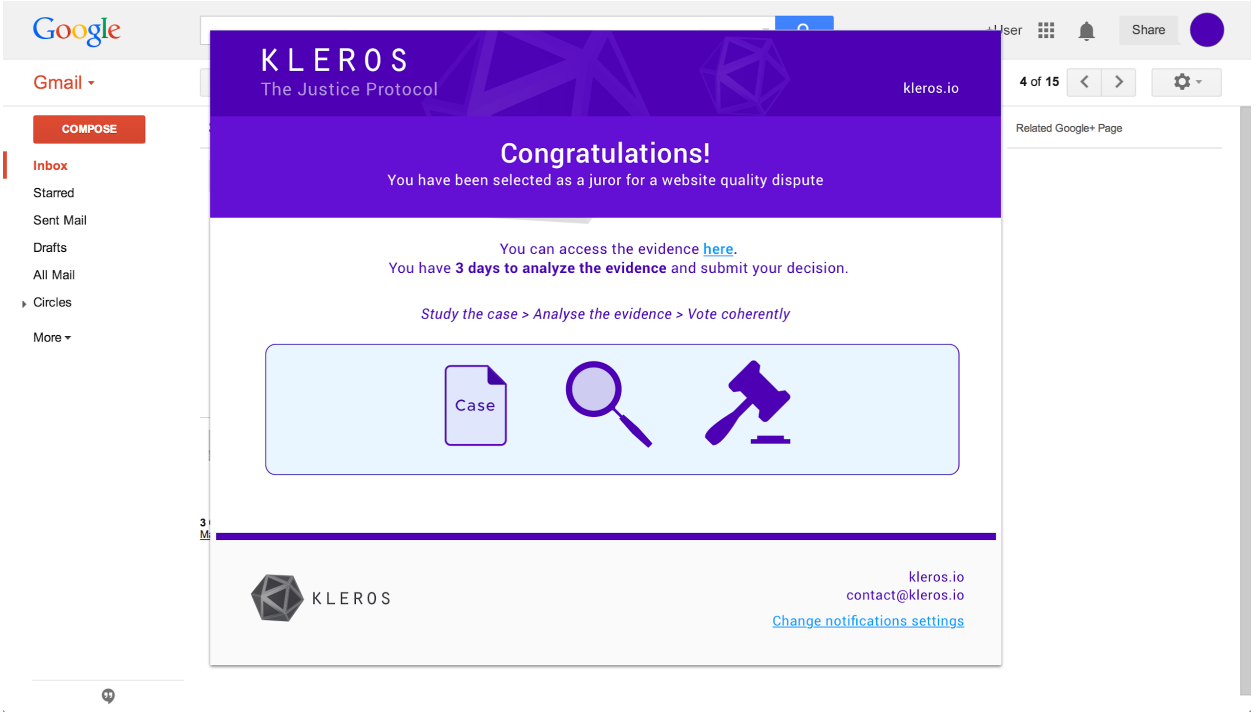
[8] The transition to a decentralized Internet is likely to make things even more complicated: "An ownerless network upsets many of the regulatory and legal frameworks now in place for our communication infrastructure. Clouds don't have a lot of geography. Whose laws will prevail? The laws of your domicile, the laws of your server's domicile, or the laws of international exchange? Who gets your taxes if all the work is being done in the cloud? Who owns the data, you or the cloud? If all your email and voice calls go through the cloud, who is responsible for what it says?" (Kelly 2016: 130). To learn more about this, read the interview with Gillian Hadfield in Chapter 4 - A New Justice Paradigm in an Old World.

[9] Previous attempts were made to use the bitcoin blockchain for arbitration with multi-signature (*multisig*) addresses. These addresses require more than one key to authorize a transaction. An initiative in this sense is Bitrated that leverages multisig transactions where a trusted third party is selected to solve disputes in case of fraud. However, the limited features of the Bitcoin blockchain are insufficient to handle more complex transactions.

About an hour later, an email hits Chief's inbox:



A similar email is received by Benito, a programmer from Cusco and Alexandru, from Romania, who had also deposited their PNK for the dispute. They were randomly selected from a pool of almost 3,000 candidates. They will never know each other, but they will collaborate in settling the dispute between Alice and Bob.

On the bus back home, Chief analyzes the evidence and votes on who is right.

Two days later, Bob receives an email saying he lost. Alice is refunded, jurors are rewarded for their work and the case is closed.

The Technology Behind Kleros

Crowdsourcing: Pulling Knowledge from the Crowd

Adjudication is, essentially, a task of information discovery and analysis. The exponential decrease of computing and communication costs have enabled this type of work to be done by crowds on a massive and global scale (Brabham 2013).

In the past, attempts were made to crowdsource dispute resolution. The Internet Corporation for Assigned Names and Numbers (ICANN) established an arbitration system with crowdsourced arbitrators for trademark claims. An early pilot was done in 1999 to

adjudicate disputes between buyers and sellers on eBay. In 2008, a community court scheme was built, where sellers disputing negative buyer feedback could submit their complaint to a randomly selected tribunal.

About 99% of the disputes arising in the Chineses e-commerce platform Alibaba are solved by a user-based jury system. In March 2016, 920,000 active jury members rendered 150 million votes. Jurors are rewarded with positive reputation which Alibaba uses for computing user credit scores (Katsh and Rabinovich-Einy 2017: 66).

Blockchain: Enabling Transparency

Transparency is a key feature of a justice system. Users need to trust that evidence is not tampered with and that the selection of jurors is not biased. Blockchains, open and distributed ledgers that can record transactions in a verifiable and permanent way, can fulfill the transparency requirements.

First, blockchains provide a cryptographic proof that evidence was not tampered with in any of the instances of the adjudication procedure. Second, decentralized autonomous organizations can guarantee that all the processes (handling and securing evidence, selecting and rewarding jurors) are fully automated and incorruptible. These features of blockchains guarantee that Kleros will be an impartial and incorruptible third party for adjudicating claims.[10]

[10] A smart contract is a set of self-enforceable instructions built on blockchain technology. To learn more about smart contracts, read Kate Sills' article on smart contracts. To learn more about the claim of Kleros being impartial and incorruptible, read Daniel Dimov's analysis of Kleros fairness, as well as William George's article about Kleros and mob justice.

SchellingCoin: Designing Incentives for the Truth

> "You are to meet somebody in New York City. You have not been instructed where to meet; you have no prior understanding with the person on where to meet; and you cannot communicate with each other. You are simply told that you will have to guess where to meet and that he is being told the same thing and that you will just have to try to make your guesses coincide" (Schelling 1960: 56).

While any place and time in the city could be a solution, game theorist Thomas Schelling found that the most frequent answer people would give is: "noon at the information booth at Grand Central Terminal". Nothing makes noon at Grand Central Terminal a location with a higher payoff (any other place and time would be good, provided that both agents coordinate there), but its tradition as a meeting place makes it a natural focal point. For each agent, it is the expectation of what the other expects him to expect to be expected to do.

Schelling called focal point a solution that people tend to use to coordinate their behavior in the absence of communication. Schelling points typically arise when communication is impossible, but also when, while communication is possible, parties do not trust each other.

Based on the concept of Schelling points, Vitalik Buterin has proposed the creation of the SchellingCoin, a token that aligns telling the truth with economic incentives. Paul Sztorc developed the concept of TruthCoin based on the Schelling point principles.

If we wanted to know if it rained in Paris this morning, we could ask every owner of a SchellingCoin: "Has it rained in Paris this morning? Yes or No". Coin holders vote by secret ballot. After they have all voted, results are revealed. Parties who voted as the majority are rewarded with 10% of their coins. Parties who voted differently from the majority lose 10% of their coins.

The SchellingCoin mechanism provides incentives to agents to tell the truth. Agents are expected to vote the true answer because they expect others to vote the true answer, because they expect others to vote the true answer… In this simple case, the Schelling point is honesty.

The majority votes \ You vote	YES	NO
YES	+0.1	-0.1
NO	-0.1	+0.1

Payoff of the SchellingCoin mechanism in the rain in Paris example.

SchellingCoin mechanisms have been used for decentralized oracles and prediction markets such as Truthcoin, Augur and Gnosis. The key insight is that voting coherently with others is a desirable behavior and has to be incentivized. The incentive design underlying Kleros is based on a mechanism similar to the SchellingCoin, slightly modified in order to answer challenges regarding scalability, subjectivity and privacy to encourage agents to engage in optimal behavior.[11]

The Kleros Adjudication Process

The Kleros decision procedure is made of the following elements: (i) Contract, (ii) Securing Evidence, (iii) Jury Selection, (iv) Analysis and Voting, (v) Appeal, (vi) Token Redistribution.

The Contract

Kleros is a voluntary opt-in system. In order to use it, the contract between the parties needs to have a clause stating that, should a dispute arise, it will be adjudicated in Kleros. When they started working together, Alice and Bob picked a freelancing contract template and modified a number of parameters to represent the specifics of their agreement (complexity of the product, delivery date, etc.). They also agreed that they would both pay the arbitration fee in case of dispute.

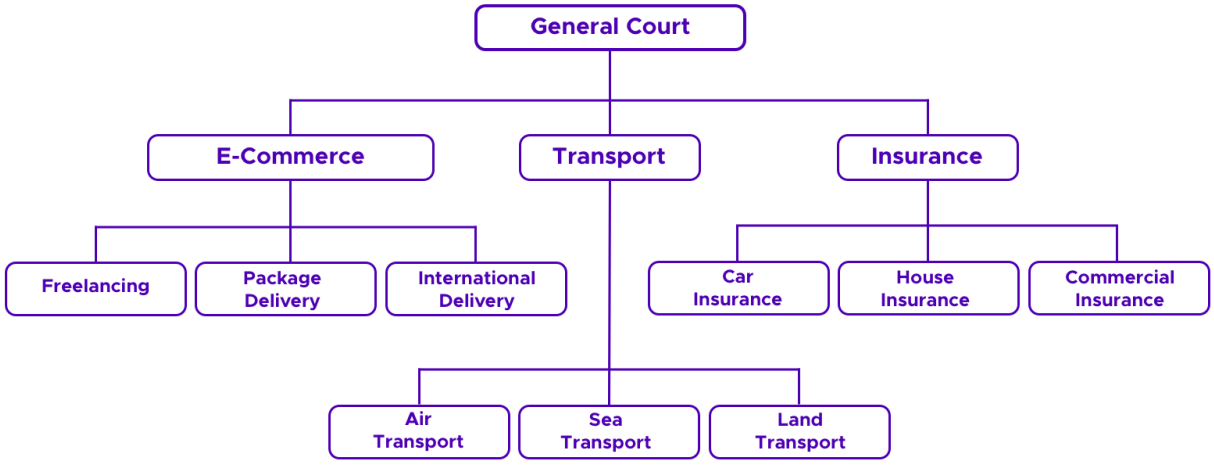
[11] To learn more, read the article Game Theory: the Cold War and How Reason Became Strategy by Damjan Malbašić in Chapter 2 - Kleros Cryptoeconomics: Towards a Theory of Decentralized Justice.

Parties don't need to know how to code in order to use one of these contracts. They don't even have to know what smart contracts are. From the point of view of users, signing the contract is just using a form to state the agreed upon terms in natural language. Projects already working in the development of such templates include Accord Project and OpenLaw. As the industry matures, more templates will be developed for contracts in e-commerce, finance, gaming, travel and so on.[12]

Court Selection: Where Will the Dispute be Adjudicated?

In traditional justice systems, courts are specialized in criminal, economic, civil law, etc. Kleros courts are also specialized in particular kinds of disputes such as freelancing, finance, consumer protection, online gaming, etc.

Each court has some specific features regarding policies, session time and cost, among other parameters.[13]



The Kleros court system resembles a tree with a root and branches. The root is a General Court, from where a number of branches (courts) are born. Each court adjudicates a specific kind of dispute.

Contracts between parties will specify the court where a dispute will be adjudicated, including the number of jurors that will be drawn for the first instance decision. The contract between Alice and Bob stated that the dispute would be solved in the E-Commerce/

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[12] To learn more about how contracts will be created, read the interview with Peter Hunn in Chapter 5: The Business of Decentralized Justice.

[13] This will be explained below in the section Court System.

Freelancing court using three jurors. As soon as the dispute arises, it is sent to the court specified in the contract.

Different disputes require different types of proceedings. Token holders will have the right to make a number of decisions affecting how courts work. These decisions include policies, session time, arbitration fees, maximum number of jurors drawn and minimum number of tokens staked.

Policies and Session Time

A dispute over a freelancing contract will be different from one about trolling on social media. Court policies will help adapt courts to the specific features of the disputes to solve.

Session time is the amount of time a specific court will give jurors to vote a decision. It may range from a few minutes to years, depending on the nature of the disputes. Simple cases, which may be solved in minutes, will have low session time. Complex disputes, which require more time to properly analyze evidence and come to a decision, will have high session time.[14]

Arbitration Fees

Jurors lend their time and expertise for analyzing evidence and voting. They offer a valuable service and will be compensated for every case they solve. Different courts will have different arbitration fees, depending on the complexity of the dispute and the scarcity of juror skills.[15]

Proceedings start after a deposit is made to cover jurors' fees. From the point of view of Kleros, it is irrelevant which party makes the deposit. It could be split equally between both parties, paid only by one party, paid by a third party with an insurance mechanism or by any other scheme.

The only thing that matters is that enough money is available to compensate jurors. As long as arbitration fees are paid, different models could work.

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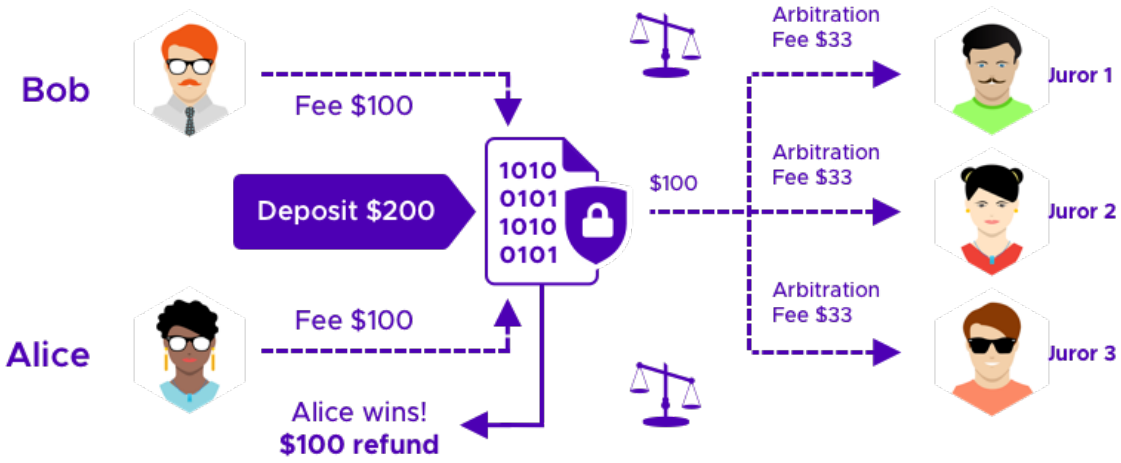
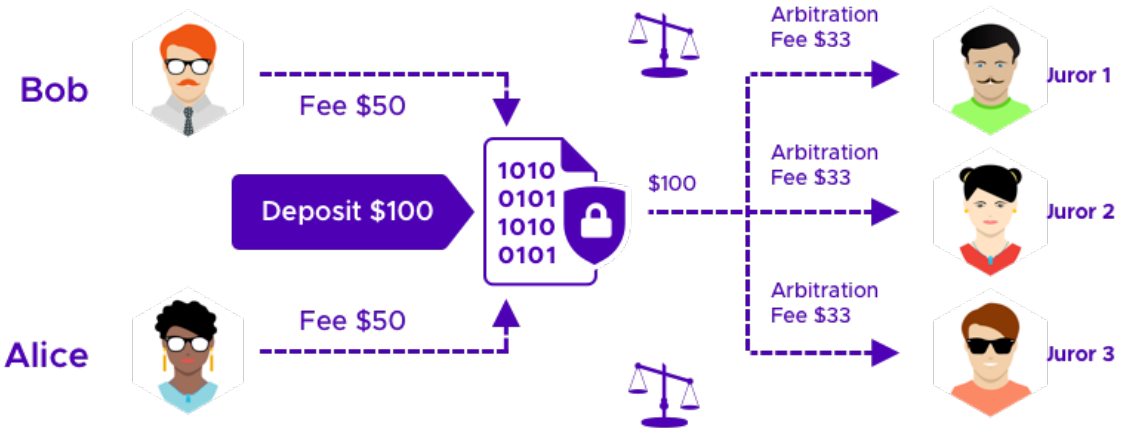
[14] To learn more about policies, see the Policies in Kleros: the Laws of Internet Courts article by Marco Mauer and Federico Ast in Chapter 2 - Kleros Cryptoeconomics: Towards a Theory of Decentralized Justice.

[15] Arbitration fees collected by jurors may range from a few pennies to millions of dollars, depending on the type of expertise required to solve a case. Simple disputes that do not require specific skills will probably have low arbitration fees. Complex disputes that require highly specialized (and scarce) skills will have high arbitration fees. Arbitration fees will be defined by users through Kleros' governance mechanism. More on this, below.



Model 1: Deposit and refund. *The total cost of the dispute is $100. The contract stipulates that both parties will make a deposit when the case goes to arbitration and that the winner will get a refund. Jurors vote Alice as winner. Money deposited by the loser is used to pay arbitration fees. Alice is reimbursed.*



Model 2. Both Parties Pay. *The contract stipulates that both parties will share the cost of arbitration and that no party will get a refund, regardless of who wins.*

Securing Evidence

Proceedings begin when at least one of the parties believes there was a breach of contract. When the party decides to send the case to arbitration, the contract in plain English (or the natural language chosen) and all relevant pieces of evidence are sent to Kleros secured by public key cryptography.

Relevant evidence will depend on the type of dispute at hand. In the Alice vs. Bob website suit, it may consist of the natural language agreement and the digital files delivered as a product. In an online gaming dispute where one party claims that the other has cheated, evidence could include a recording of the game. In a car crash insurance dispute, it could include the insurance contract and photos of the crashed car.[16]

Jury Selection

Jury selection relies on two basic elements: candidate self-selection and sortition. In order to avoid retaliation and intimidation, jurors are not required to provide proof of identity to be drawn.

The key challenge to be solved by Kleros is: how to create the right incentives for pseudonymous jurors to adjudicate claims in an honest way? This problem will be solved by using a system token and a random selection mechanism.

System Token: the Pinakion

Users have an economic incentive for serving as jurors: collecting arbitration fees. Anyone can self-select as a candidate to be a juror in a specific court by using a cryptographic token called *pinakion* (PNK).

Users must stake PNK in order to have the possibility of being drawn as jurors. The probability to be drawn as juror is proportional to the amount of tokens a user staked in a court. The higher the amount of tokens a user stakes, the higher the probability he will be drawn as juror.

Chief, the Kenyan software developer, often works in the E-Commerce/Freelancing court. This time, he staked 2000 PNK. Many other users from around the world (among them, Benito and Alexandru) have done the same.

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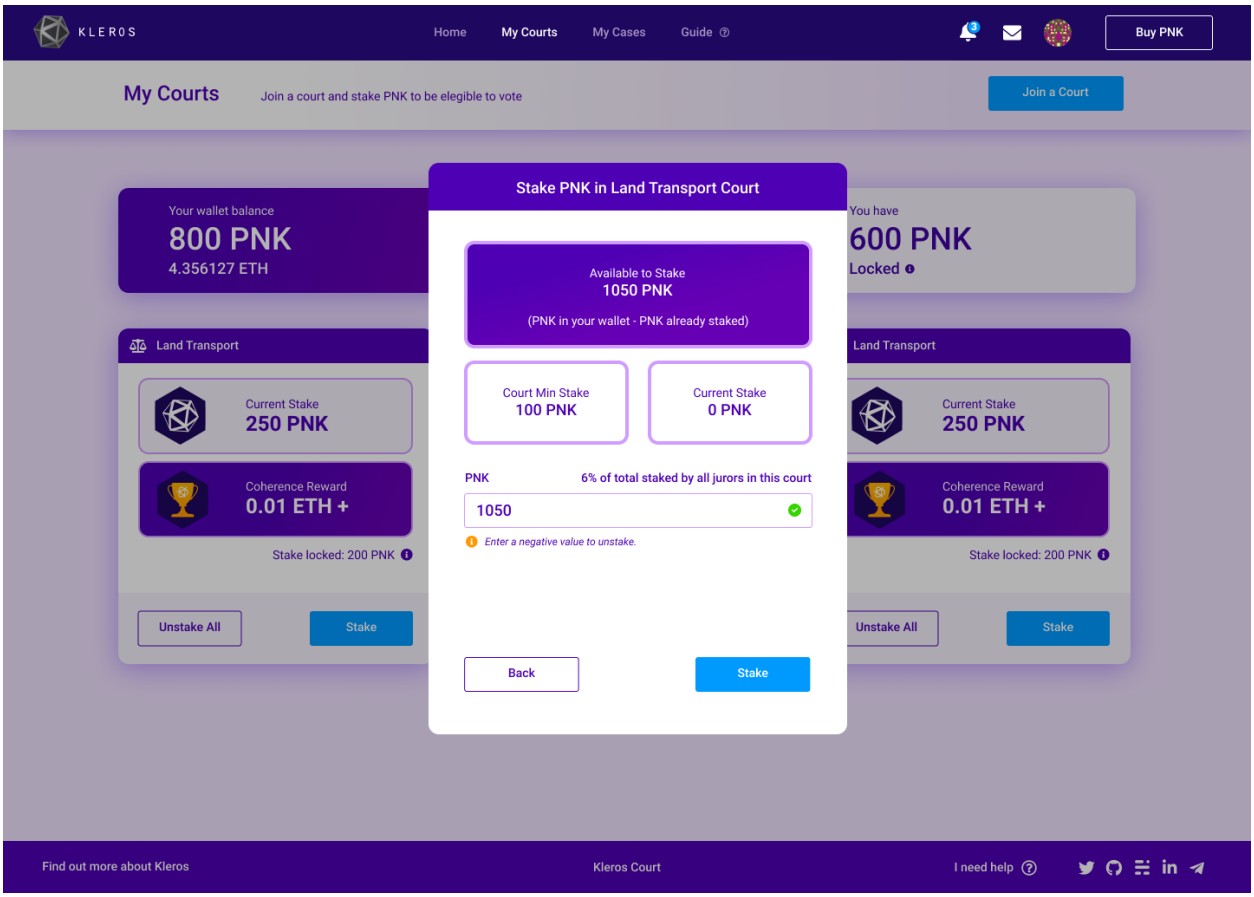
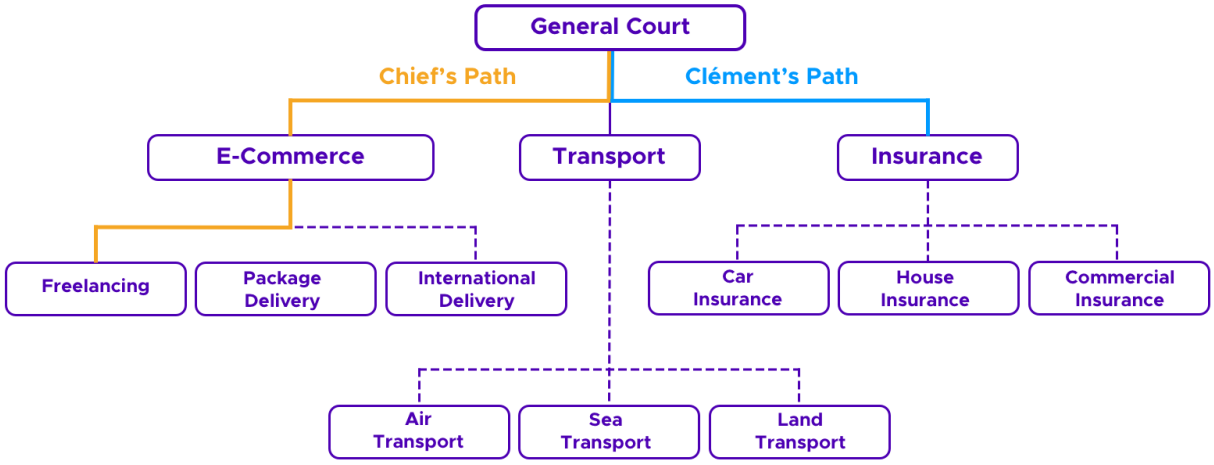
[16] To learn more about potential use cases, see Chapter 6 - Scaling Up: The Applications of Decentralized Justice.



When staking their tokens, users start in the General Court and follow a path to a specific court according to their skills. For example, Chief stakes his pinakion in the General Court and in the E-Commerce/Freelancing court. Clément, an insurance expert, stakes his tokens in the General Court and in the Insurance Court. This will allow him to be drawn for insurance disputes.

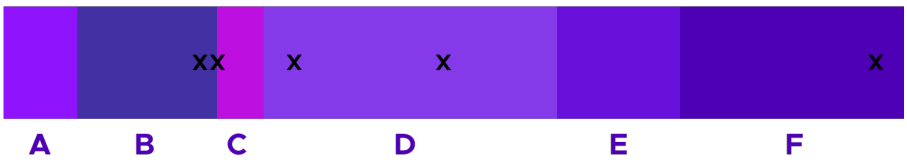


An example of paths chosen by jurors in the court system. Clément can be drawn as juror in the General Court and in the Insurance Court. Chief can be drawn as juror in the General Court, in the E-Commerce Court and in the Freelancing Court.

Jury Selection: Sortition

Jury selection is done randomly among all the users that staked their pinakion in a court. Theoretically, a candidate may be drawn more than once for a specific dispute. The amount of times a user is drawn for a dispute (called its *weight*) will define the amount of votes he will get in the dispute and the amount of tokens he will win or lose as a result of his vote. Imagine that 6 token owners signed up for the dispute and staked 10,000 in total with the following distribution:

Token Owner	Staked	Start	End	Weight
A	1000	0	999	0
B	1500	1000	2499	1
C	500	2500	2999	1
D	3000	3000	5999	2
E	1500	6000	7499	0
F	2500	7500	9999	1



Example of tokens staked and drawn jury members. *For simplicity, we are assuming that only 6 token holders exist. In practice, there will be many more. It will be extremely unlikely that a token holder will be drawn more than once for any specific dispute.*

For a dispute that requires 5 votes, 5 tokens are drawn out of the 10,000 that were staked.

The drawn tokens are number 2519, 4953, 2264, 3342 and 9531. The token owners B, C and F are drawn with a weight of 1. The token owner D is drawn with a weight of 2. Staked PNK will be frozen during the court session and will be unfrozen after the court has reached a decision.[17]

Analysis and Voting

Users that are drawn as jurors will have access to the evidence for analysis and will vote a decision. The specifics of this procedure may change in different courts. Courts will have

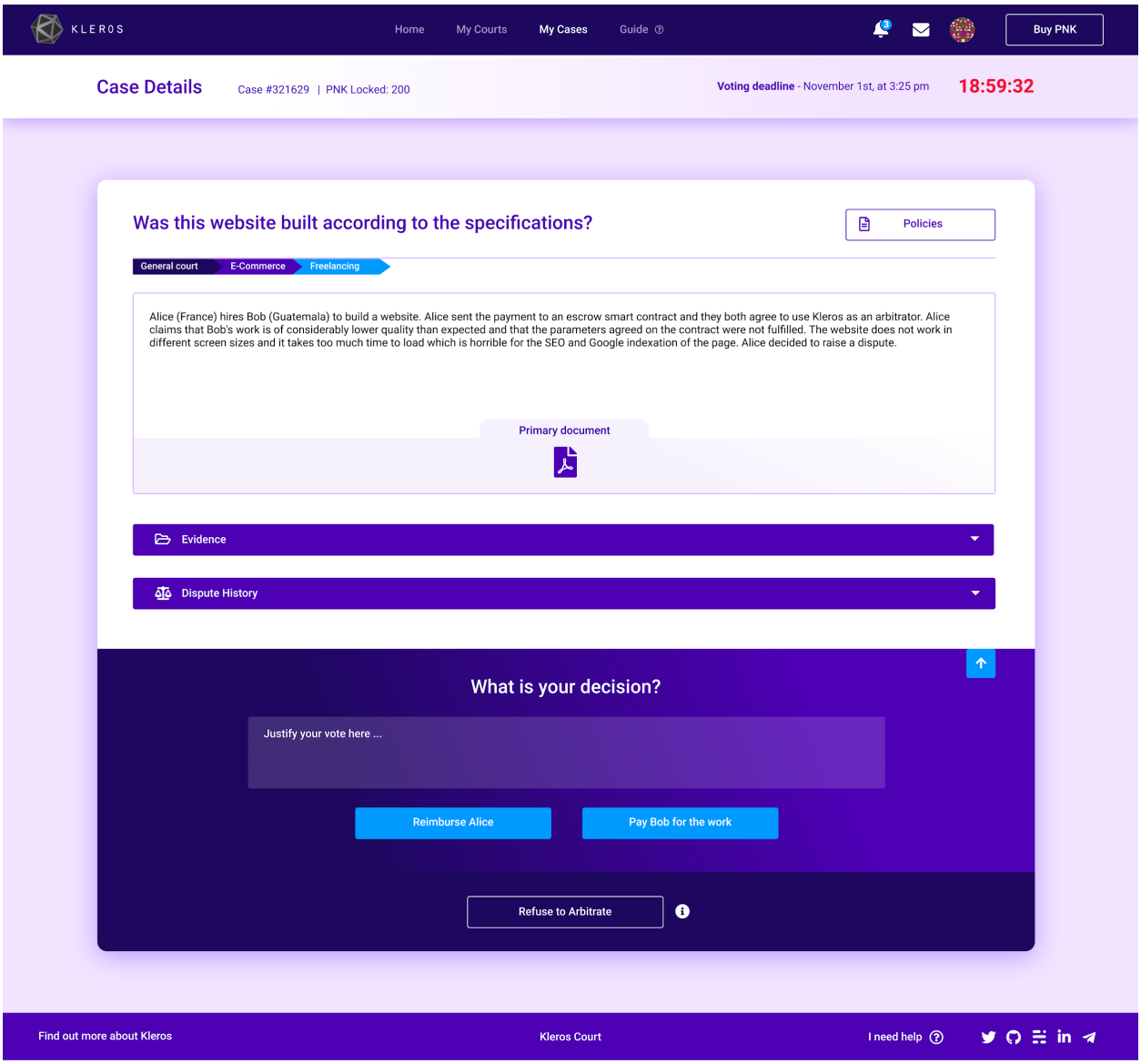
[17] Have a look here for a presentation by Clément on random number generation on the blockchain at Devcon3.

different parameters regarding issues such as the complexity of the voting options and the possibility of communicating with the parties.

In the early stages, Kleros will only be used for simple disputes involving only two parties and only two voting options. In the Alice vs. Bob dispute, the decision could be: "Who is right in the dispute? Alice or Bob?". The winner would receive the full payment and the loser would get nothing.[18]

After assessing the evidence, jurors commit their vote to one of the options. They are also required to provide a justification for their decision. After a juror has made a commitment, the vote cannot be changed. After all jurors have voted, the decision is produced.

[18] Over time, as technology improves, more complex disputes will be adjudicated. A slightly more complex option would be: "From 0 to 100, how guilty is Bob?". This would allow to split the payment in different parts. Further along the road, Kleros could potentially also adjudicate a contract where Alice hired Bob, Carl and Dave to build the website and the dispute requires defining different levels of responsibilities between parties.



Appeals

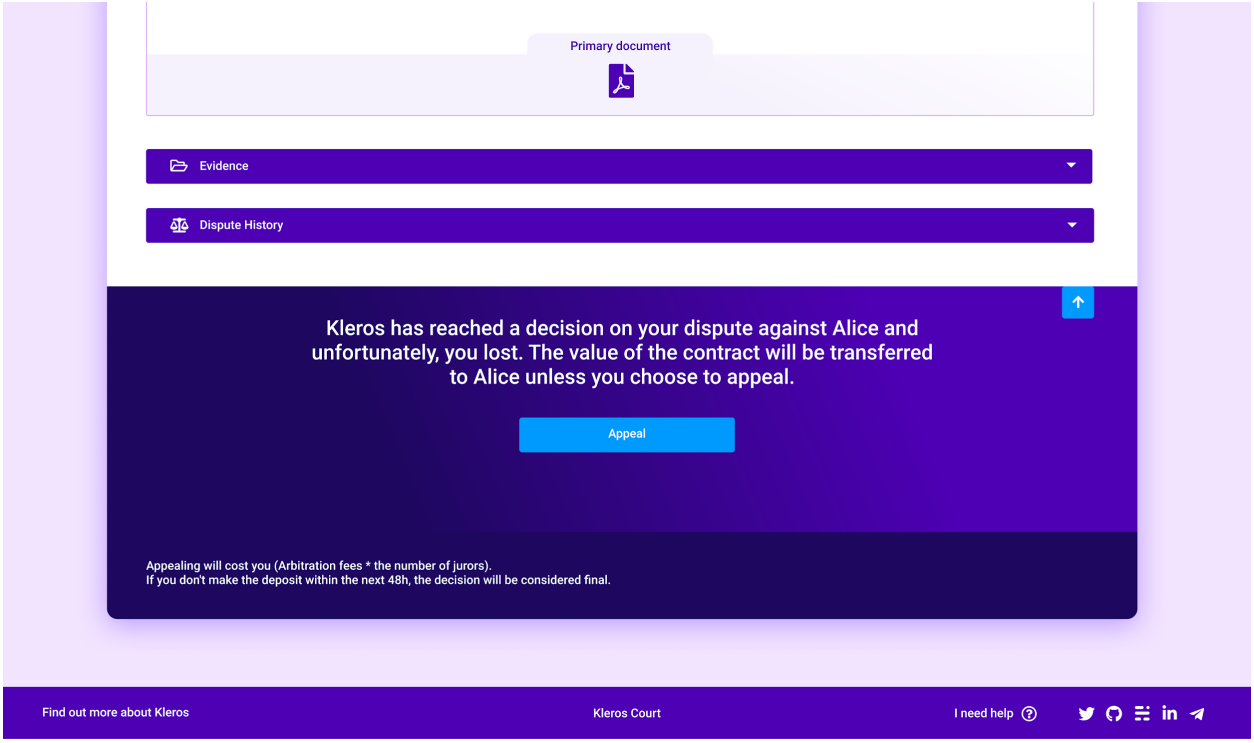
Appealing a court decision is a fundamental right recognized by most legal systems. If a party is not satisfied with a decision done in Kleros, it can have the case ruled again.

Decisions can be appealed several times. In each round, a new jury will be formed with twice as many jurors than the previous instance plus one. The appealing party will be required to make a new deposit in order to pay for arbitration fees.

The cost of appealing the decision is defined by:

Arbitration_fee*Number_Jurors

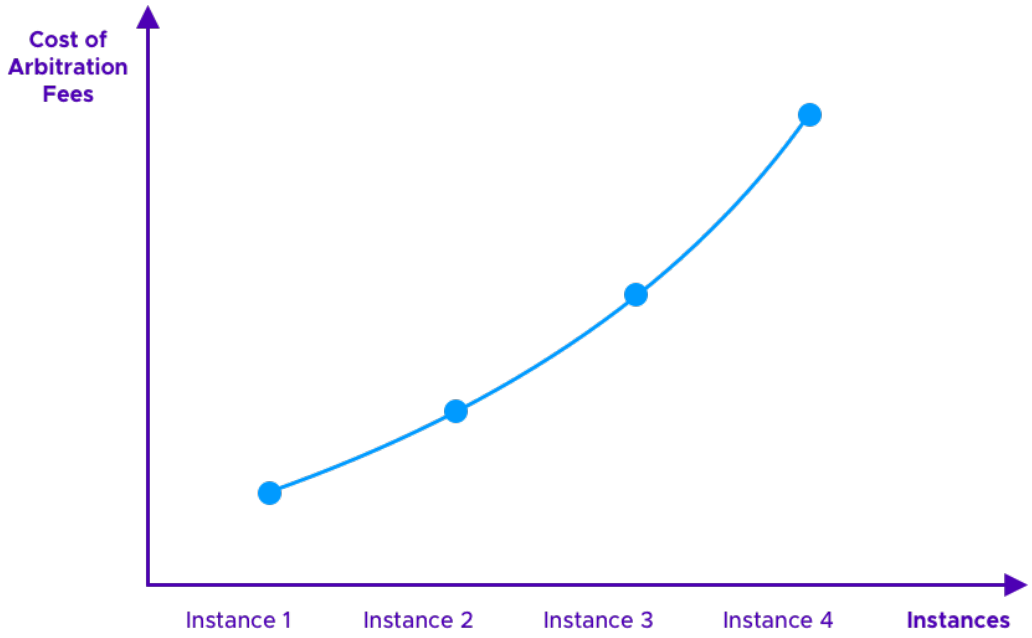
Imagine that, after the first instance arbitration, Bob receives the following message:



Bob thinks that the decision was unfair and decides to appeal. The second instance court will be formed by twice as many jurors plus one. Bob will have to pay for seven jurors to be drawn and pay:

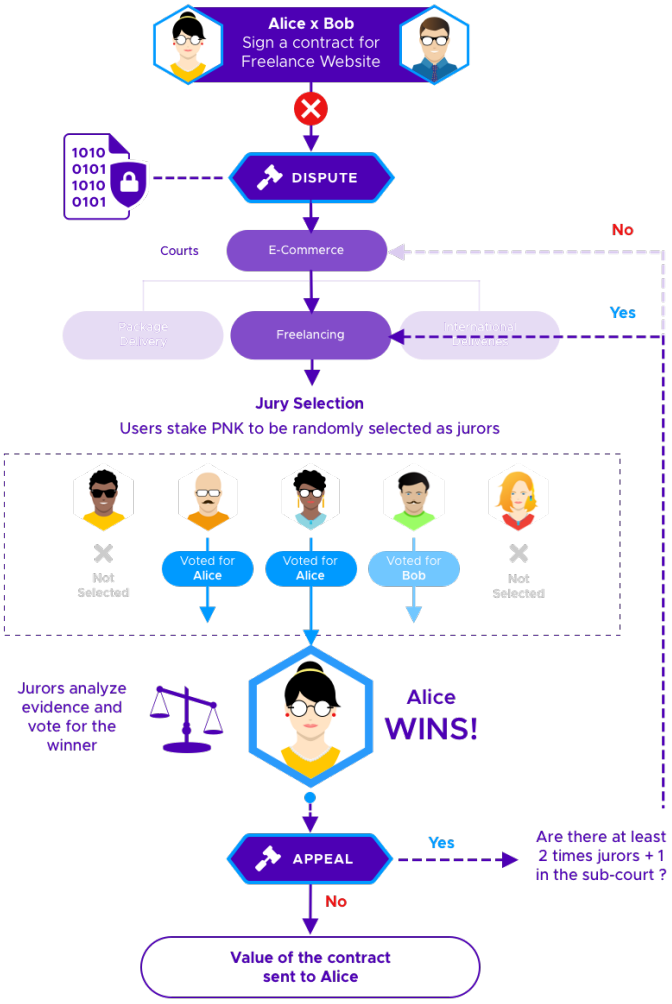
Arbitration_Fee*7

Again, the court votes Alice as winner. A new round of appeal would cost Bob the fee for 15 jurors. This time, he decides that the cost is too high and accepts the ruling as final[19].



The cost of appeal increases steeply instance after instance.

[19] Had Bob chosen to keep on appealing, the number of jurors would have doubled plus one again and again in each round. Generally speaking, appeals will be uncommon. However, the appeal system is an important mechanism against bribes. Bribing a small jury is relatively easy. But since the victim always has the right to appeal, the attacker would have to keep bribing larger and larger juries at a steeply rising cost. The attacker would have to be prepared to spend an enormous amount of money to bribe jurors all the way to the General Court and would very likely lose in the end. To learn more about this, read the article *Why Kleros Needs a Native Token* in Chapter 2 - Kleros Cryptoeconomics: Towards A Theory of Decentralized Justice.



The Kleros adjudication process.

As we can see, the focal point that jurors need to target in order to maximize their economic gain is the decision that would potentially be chosen by a hypothetical panel of a large number of jurors after a number of appeal rounds. As there is no way for the individual juror in the first round to collude or influence the vote of potential future jurors (who have not yet been selected), the individual juror in the first round can only try to mentally simulate the choice that would in all likelihood be made by that ultimate panel of jurors.

That hypothetical ideal decision is an "intersubjective truth", a consensus that captures the common sense of justice of that specific community (in this case, the community of website developers) applied to the specific conditions of the case at hand (in this case, the specific agreement between Alice and Bob). The "secret sauce" in the mechanism design is the way in which the economic incentive of each individual juror is aligned with their finding what the

community would select as consensual truth about the dispute.

Token Redistribution

After a decision has been made, there is an instance of PNK redistribution. Tokens are redistributed among jurors following a principle based on the SchellingCoin. Jurors will gain or lose tokens depending on whether their vote was coherent with the rest.

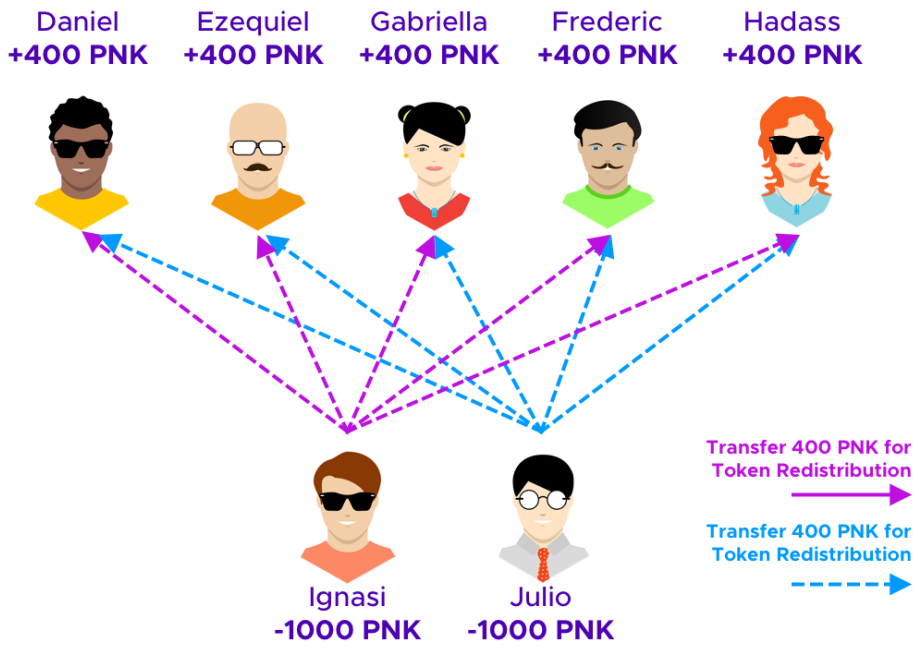
Assuming that jurors were properly selected, that they were correctly incentivized and that they had access to the same evidence, we would expect them to reach a similar verdict.

Following the Schelling point principle, Kleros assumes that jurors who voted incoherently with the rest were not properly qualified (they self-selected into a wrong court), that they did not conduct a proper analysis (they voted quickly just to collect the arbitration fee) or that their goal was not discovering the truth (they were bribed).

Jurors who vote with the majority are considered to have voted coherently and are rewarded with tokens. As of January 2020, the jurors are presented with cases in which they can select from a list of discrete options, typically making a choice between two options one of which will then necessarily receive majority support.[20] However, in the future, jurors will be able to rule in a way that produces a value in some range of real numbers. The mechanism that determines this output will transform the dispute into a series of binary disputes, and jurors are rewarded according to their decision in each of these binary disputes.

Imagine the dispute between Alice and Bob was solved with 7 jurors. Jurors Ignasi and Julio, who voted incoherently with the majority, have their tokens redistributed proportionally to the jurors who voted coherently. Token redistribution would look like the following:

[20] Strictly speaking, there is always an additional option as jurors can vote "Refuse to Arbitrate".



Token redistribution after the vote with seven jurors. *Tokens are redistributed from jurors who voted incoherently to jurors who voted coherently.*

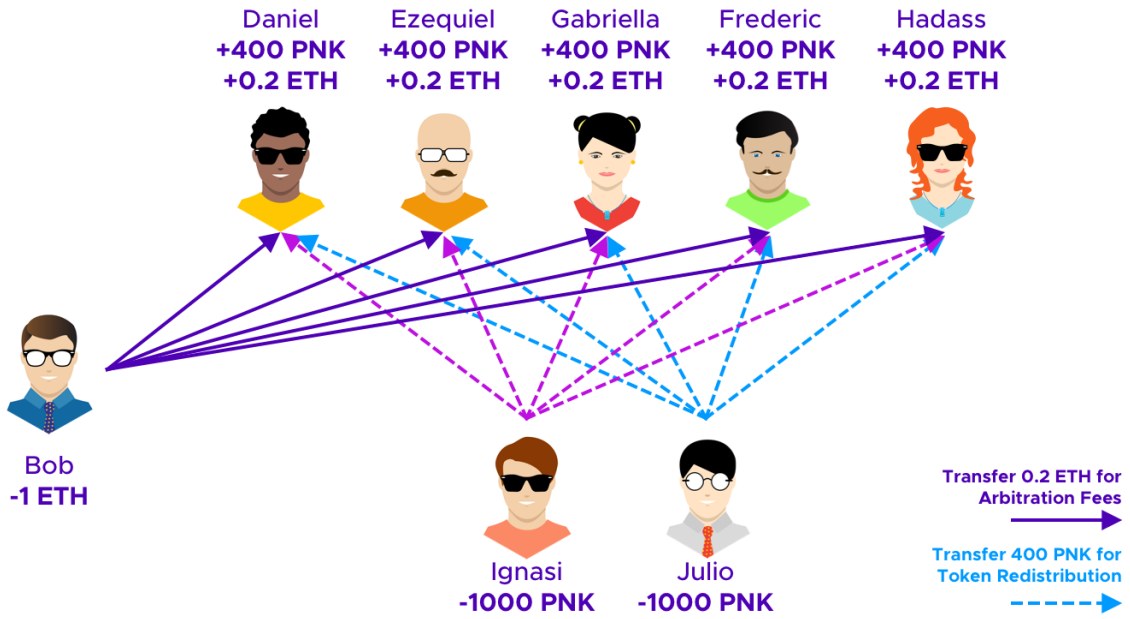
The PNK token is a critical part of the cryptoeconomic mechanism because it prevents sybil attacks and provides incentives for Kleros to produce true verdicts. The expectation of winning or losing tokens gives jurors the incentive to self-select into the courts where they truly have expertise, to analyze the evidence carefully and to vote honestly. A juror who chooses the wrong cases, who does not analyze the evidence carefully or who does not vote honestly is more likely to vote incoherently with others and, as a result, will suffer an economic loss.

Incentives Design: the Combined Effect of Arbitration Fees and Token Redistribution

Within the Kleros network, the incentives for jurors come from two sources: the payment of arbitration fees and the transfer of tokens.

Arbitration fees are payments from parties to jurors as a compensation for the time and expertise invested in analyzing evidence and voting. After the jury has reached a decision, the arbitration fees are divided between the jurors who voted coherently. Moreover, a transfer of PNK occurs from jurors who voted incoherently to jurors who voted coherently.

Hence, jurors voting coherently with the rest will experience a net economic gain (they will collect arbitration fees and tokens). Jurors voting incoherently will suffer an economic loss because the incoherent vote makes them lose tokens, which have an economic value.



Bob, the loser in the dispute against Alice loses his 100$ deposit, which is used to pay arbitration fees to all jurors. Ignasi and Julio, the two jurors that voted incoherently with the rest, lose their PNK, which are transferred to the jurors who voted coherently. Daniel, Ezequiel, Frederic, Gabriela and Hadass, the jurors who voted coherently, experience an economic gain in ETH and PNK.

As usual, some users will try to abuse the system. But Kleros cannot be gamed easily. Manny learnt this the hard way. He had always thought of himself as the smartest guy in the room. When he found out about Kleros, he saw it as an opportunity to make some easy money. He bought some PNK and started to stake them in courts with high arbitration fees. Of course that, when he was drawn as a juror, he would not even read the evidence. Manny just voted randomly, collected the fee and moved on to another dispute.

A couple of weeks into his 'brilliant scheme', he realized that he was suffering a net loss. Manny earned some money in arbitration fees. But, since his vote was often incoherent with

the rest, he systematically lost the PNK. After a couple of weeks, he realized the net effect was negative and he abandoned his intention of trying to game the system.[21]

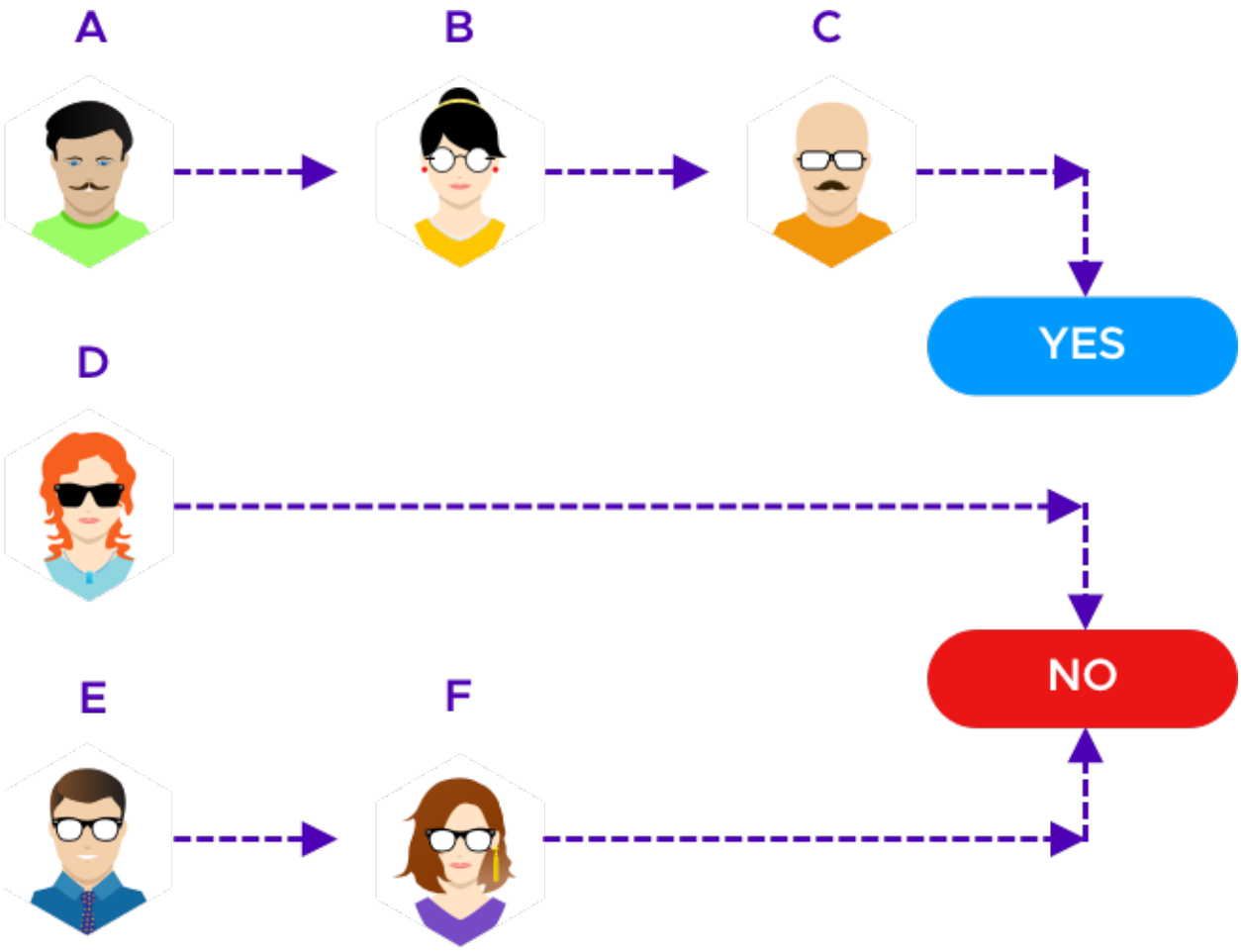
Governance

As Kleros reaches a critical mass of users and is adopted in a rising number of industries, new courts will have to be created, changes will need to be made in court parameters and the protocol itself will have to be updated to new versions.

Since Kleros is a decentralized organization, no central authority will be able to make these decisions. Users will control Kleros governance with a liquid democracy mechanism. Each user will have a number of votes equal to the amount of PNK he holds. In future releases, in addition to being able to vote directly, users will also be able to delegate their vote. Then, when a user fails to vote, his voting power will be automatically transferred to his delegate.

Imagine a decision about updating Kleros to a new version, with the following token holdings, voting behavior and delegation:

[21] To learn more about how the token economics work, see below the article, *Why Kleros Needs a Native Token* in Chapter 2 - Introduction to Kleros Cryptoeconomics: Towards a Theory of Decentralized Justice.



In this example, A delegates his votes on B. Then B has 1500 + 1000 = 2500 votes. B delegates his votes on C. This means that C has 500 + 2500 = 3000 votes. Since C votes Yes, the delegation chain stops and 3000 votes are Yes votes. D also votes Yes with his 3000 votes. This amounts to a total of 6000 votes for the Yes option (3000 + 3000 = 6000). E delegates his 1500 voting rights to F and F votes No. The No option gets 4000 votes (2500 + 1500 = 4000). The end result is 6000 votes for Yes and 4000 for No. The final result is Yes.

A Justice System for the Internet

A kleroterion in the Museum of the Ancient Agora, Stoa of Attalos, Credit: Joyofmuseums / CC BY-SA 4.0

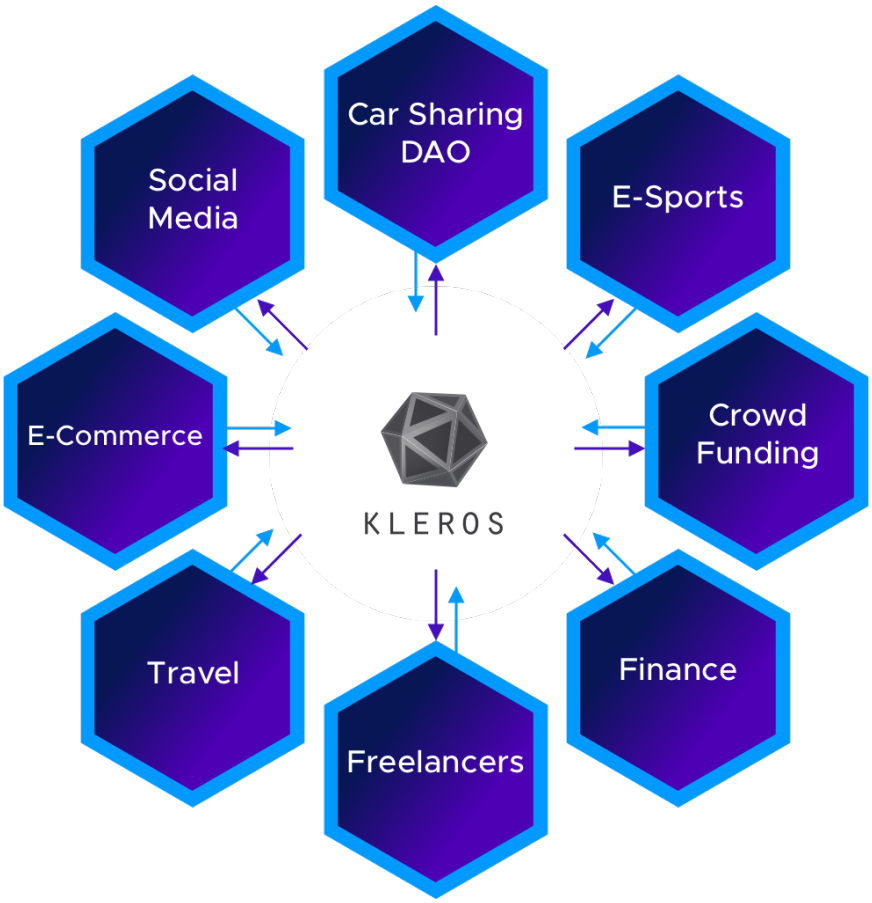
Our social and economic connections are increasingly intermediated by global Internet platforms connecting content producers, consumers and advertisers (Facebook and YouTube), buyers and sellers (Amazon and eBay), drivers and riders (Uber) and travelers and hosts (Airbnb).

If the blockchain promise holds true, the coming years will bring the disintermediation of centralized global platforms and their replacement by distributed models. People will transact goods in decentralized versions of eBay, will contract rides in a decentralized Uber, will stream music in a decentralized Spotify, will contract labor in a decentralized Upwork and will connect in decentralized Reddit platforms.

These platforms will use some shared building blocks. For example, they may all use IPFS for storing files and Golem for sharing computing resources. When disputes arise between

the users of decentralized platforms, efficiency considerations suggest that they should also use a single decentralized adjudication network.[22]

We do not need two separate networks for decentralized storage, for decentralized prediction markets, nor for claim adjudication.



Kleros will become the standard adjudication network for the decentralized Internet. Different courts will handle disputes coming from these different DAOs.

Smart contracts self-execute when the predefined conditions are met. However, automatic enforcement by code is at odds with a key principle of the philosophy of right: all contracts are incomplete.

At the moment it is signed, no contract could ever foresee every possible situation that could arise until the time comes for it to be enforced. Sometimes, strict enforcement may result in an unfair situation. And this cannot be solved exclusively by computer code.

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[22] To learn more about this, see Chapter 5: The Business Of Decentralized Justice.

The Greek had a term - *epikeia* for a moral principle that exempted a citizen of strict compliance with a positive law or contract in order to be faithful to its spirit. Modern legal systems also recognize that parties may be relieved of the obligation of compliance if such obligation has become unreasonable after a change in context.

Massive adoption of smart contracts require an 'escape hatch' mechanism for when strict compliance would produce undesirable or unfair consequences. But how to create a procedure for an escape hatch without using a centralized decision maker that introduces a new single point of failure into the system?

Kleros has the potential of becoming this decentralized escape hatch when strict compliance has become unreasonable. It can do it without reintroducing arbitrariness and corruption into the system.

In the past years, e-commerce has been growing at double digits and is expected to total a 2 trillion dollar market in 2020. Key components of the sharing economy (travel, car sharing, finance, staffing and streaming) are expected to reach $335 billion in spending by 2025. Around 2,000 platforms of equity crowdfunding exist in 2016 and the World Bank predicts that crowdfunding investments will be a $96 billion a year market in developing countries alone by 2025.

The legal systems of the nation state era were successful in creating an institutional framework for economic growth and social prosperity. In the wake of the digital revolution, however, they are reaching their complexity limits. While the new economy requires a deep institutional rethinking, few people are conducting research on legal infrastructure on a systemic level. Lawyers research what the law is. Economists study what the law should be in order to promote trade or improve incentives for, say, workplace safety. But hardly anyone studies how law works as a system, what determines the system's costs and efficacy (Hadfield 2016: 215).

The inability of legal systems to address the disputes of the Internet Age led platforms such as eBay or Alibaba to develop their own arbitration mechanisms. However, no horizontal system emerged to be used across the board and that could gain from increased specialization over time. Kleros seeks to become this system.

While Kleros relies on cutting edge technologies in blockchain, cryptography, game theory and collective intelligence, its fundamental logic is still based on a principle the Greek knew 25 centuries ago: justice can be served on a peer-to-peer basis. Bitcoin is helping advance the cause of financial inclusion. Justice inclusion is an equally important goal. Just as Bitcoin

is bringing banking for the unbanked, the Kleros promise is to bring justice for the *unjusticed*.[23]

[23] For a bit of visual stimulation of what Kleros is all about, have a look here at Federico's presentation at the Thomson Reuters Generate event in 2018.

Chapter 1

Genesis: When Greek Lotteries Meet Medieval Private Law.

"History never repeats itself but it rhymes".
- Attributed to Mark Twain.

Dice players. *Roman fresco from the Osteria della Via di Mercurio (VI 10,1.19, room b) in Pompeii*

Sortition, the use of random selection to allocate political decision making rights, plays a limited role in contemporary political systems. The most well known sortition mechanism in modern democracies is the selection of jurors in American trials.

Few people know that randomness was a key political technology throughout the history of democracy. In different times, thinkers and social reformers saw lotteries as a way to avoid concentration of power and corruption by special interests. Australian political scientist John Burnheim called demarchy political systems based on randomness.

Kleros uses sortition for jury selection. While we frequently talk about it as an innovation in the legal field, it can also be interpreted as part of a wider movement of governance innovation: the revival of demarchy.

Random Selection in Classical Athens

The Athenians never really trusted elections, which they mostly saw as an oligarchic feature all too often manipulated by demagogues. In Classical Athens, Randomly chosen citizens carried out most ordinary administrative duties in law courts, the police, public finance, etc. Voting was only used for choosing high rank military leaders and a few other officials.

Athenian political reformer Cleisthenes created many of the institutions of Ancient Greek democracy between 508 and 507 B.C. He pushed for demarchic political reforms that curtailed the power of the aristocracy and empowered the people. The use of randomness was a key part of these reforms. The kleroterion was an astounding piece of civic technology that allowed for transparent selection of citizens for public duties.

The Founding Fathers of America

The democratic revolutions of the 18th Century resulted in a fundamental rethinking of governance. When drafting the Constitution, the Founding Fathers of the United States had to figure out how to rule a large scale decentralized society. The Federalist Papers contain many of these discussions. Authored by James Madison, Alexander Hamilton and John Jay, they were published under the pseudonym Publius, recalling the first consul of the Roman Republic.

The Founding Fathers greatly admired the democracy of the Ancient. Thomas Paine wrote:

"What Athens was in miniature, America will be in magnitude. One was the wonder of the Ancient World; the other is becoming the admiration of the present".

Paine was a strong advocate of demarchy. He proposed that the delegations from each state to the Continental Congress be selected by lot, and that the Congress should elect the President from the members of the chosen delegation. In the end, however, random selection was only applied to the jury system.

This participatory feature of American democracy was greatly admired by Tocqueville:

“The jury, and more especially the civil jury, serves to communicate the spirit of the judges to the minds of all the citizens; and this spirit, with the habits which attend it, is the soundest preparation for free institutions (…) It invests each citizen with a kind of magistracy; it makes them all feel the duties which they are bound to discharge toward society; and the part which they take in the Government” (Tocqueville 1961: 336–37).

The Founding Father Thomas Paine was a strong advocate for the use of random selection during the days of the drafting of the Constitution of the United States of America. Image: A Portrait of Thomas Paine by James Watson, after Charles Willson Peale mezzotint, 1783. Credit: National Portrait Gallery, Smithsonian Institution.

Demarchy, Reloaded

These are times of discontent with representative democracy, a system many see as prone to be ruled by special interests and demagogues. In this context, some believe that sortition can help correct a number of flaws. After all, the Greeks used random selection precisely for its potential to curtail special interests and stop demagogues.

One of the pioneers was John Burnheim. In his book ***Is Democracy Possible? The alternative to electoral politics*** (1985) he advocated a political system based on randomly selected groups of decision makers. In ***The Principles of Representative Government*** (1997), Bernard Manin studied the potential of demarchy in modern democracies.

A number of experiments used random selection to increase the input of citizens into public policy making. These include the ***Citizen Juries*** of Ned Crosby (1995), the German ***Planning***

Cells of Peter Dienel (2005), and maybe the most famous of all, the *Deliberative Polls* of James Fishkin which extract political opinions from randomly selected pools of informed citizens. Large scale experiments were done in the randomly selected *Citizen's Assemblies* created in British Columbia and Ontario to reform their electoral systems.

There is a group of political scientists called **The Kleroterians**, who specialize in the study of sortition as a way to reform democratic institutions with principles of random selection.

Private Justice

The other tenet Kleros technology relies on is the concept of private justice. In a world that is quickly becoming flat, many transactions, in particular online ones, happen across jurisdictional boundaries. In this ever accelerating world, state legal systems with jurisdictional reach cannot hope to catch up without significant technological and regulatory advances.

Even though we are used to thinking of legal systems as government monopolies, this is not how it always worked and is probably not the way in which it will work in the future as we approach the age of personal sovereignty advocated by James Dale Davidson and William Rees-Mogg, *The Sovereign Individual: Mastering the Transition to the Information Age* (1997).[24]

The seminal work of economists such as Douglass North in institutional economics and Oliver Williamson in transaction cost economics teaches us that state legal systems are not the only way (and not even the most efficient way) to have agreements enforced. Another strong influence is certainly Bruce Benson, who advocated a justice system that would not rely on government coercion in his book *The Enterprise of Law: Justice Without the State* (1990), and the research by Edward Peter Stringham in *Private Governance: Creating Order in Social and Economic Life* (2015).

Throughout history, humans have relied on voluntary dispute resolution systems more often than on state legal enforcement. In the Middle Ages, merchants developed a private system of law which was enforced in courts in trading fairs in Europe. Currently, trading platforms such as eBay, Facebook and Alibaba have developed private legal systems to solve disputes and execute agreements.

These systems are proving to be more efficient than government courts (especially in China, where courts are not reliable), but have the problem of being completely privatized and not

[24] In that prescient book published as early as 1997, the authors predicted the widespread use of cryptographic currencies and even the use of the *kleroterion* for governance.

complying with basic conditions that we consider rule of law, such as publicity of how disputes are solved.

Can decentralized justice give us the best of both worlds? Can it give us coverage over disputes where state courts simply don't work but still covering all aspects of rule of law?

This chapter deals with the key concepts of private law and demarchy. The concept of private law is essential to face challenges of the global digital age, while sortition may be the way to govern and make decisions in this new system more fairly.

Josiah Ober on Greek Democracy

Interview by Federico Ast, CEO, Kleros

Josiah Ober, Mitsotakis Professor in the School of Humanities and Science, works on historical institutionalism and political theory, focusing on the political thought and practice of the ancient Greek world and its contemporary relevance. He is the author of a number of books mostly published by Princeton University Press, including *Mass and Elite in Democratic Athens* (1989), *Political Dissent in Democratic Athens* (2008), *Democracy and Knowledge* (2008).

One of the big questions we can ask is how does cooperation begin in the first place. How do humans manage to cooperate at scale in a complex society?

If we assume that human beings are to some degree self-interested, how is it that they ever manage to agree to obey rules?

This is one of the mysteries that the Greeks worried about. One answer to that is democracy. Another possible answer is monarchy, dictatorship, or tyranny.

The monarchy answer is the easy one: we agree to all cooperate, because there is some third party who will efficiently punish us if we don't cooperate. That's basically what Thomas Hobbes writes about in *Leviathan* (1651). The only solution is to create the third party tyrant who will force us to cooperate.

Democracy is the other solution. Instead of having a tyrant, we agree that we will be enforcing the rules on one another. That's, of course, harder. But, on the other hand, it gets us out of the problem of having a tyrant who may use his position to extract all kinds of resources from us.

That's the background question of democracy: how do we cooperate at scale without a tyrant?

Why did Athens have a democracy during the classical period, instead of a monarchy like most civilizations of their time?

The Greeks, in the period of emerging city states, had really two choices.

The first choice was to accept that the only way to have some kind of order was to have a tyrant or a very small group of people ruling everybody else (some kind of narrow oligarchy).

The other approach was to have the citizens rule themselves.

Both the Spartans, the other important city state in Greece, and the Athenians take this route that citizens rule themselves. But they take very different approaches.

The Spartans are convinced that the only way for this to work is for all of those who are in the citizen body to be essentially the same, or similar. They have to have the same education, to have the same military training, they have to live in similar houses and dress the same. This works, but at a really great cost. No Spartan had an opportunity to live a life that was anything but being a warrior and training all the time for combat.

For the Athenians, the challenge that they answer is: how to make a government for a large number of people who are different in the circumstances of their lives? Some are rich, some are poor, some are highly educated, some are less educated, so you have people who are genuinely diverse. And yet these people will treat each other as equals in the special circumstances of public decision-making.

Sorting that out is ultimately a matter of institutional design, coming up with the kinds of institutions that will allow those who are in various ways unequal and different from one another to treat each other as people who are equal in the special circumstances of public decision making.

How did the process work? Was there a group of people making a constitution for Athens? Or was it a longer, more informal process of institution building?

There are two important moments we can focus on in Athenian history.

The first one at the very beginning of the 6th Century BC. At that moment, it appeared that Athens was going to collapse into a civil war between wealthy Athenians and a much larger number of poor Athenians who were doing badly and being pushed into conditions of virtual slavery.

The few who were doing well were worried about a potential uprising by the many who were poor.

At this point in history, the two sides agreed on a single arbitrator, a man named **Solon** who is given the task of finding some kind of a compromise for the rich and poor to live together in the same community. Solon can't give everything to either side. He needs to find the right kind of compromise allowing Athens to go forward as a society and for the Athenians to live together.

Solon finds the right kind of compromise, a bargaining position that gives either side enough. Neither side is fully satisfied, but they realize they will live much better under the bargain that he offers than they would fighting a war.

A statue of Solon in the Main Reading Room of the Library of Congress of the United States. Solon was an Athenian statesman and lawmaker. He is credited with having laid the foundations for Athenian democracy. Credit: Carol Highsmith, Prints and Photographs, Library of Congress.

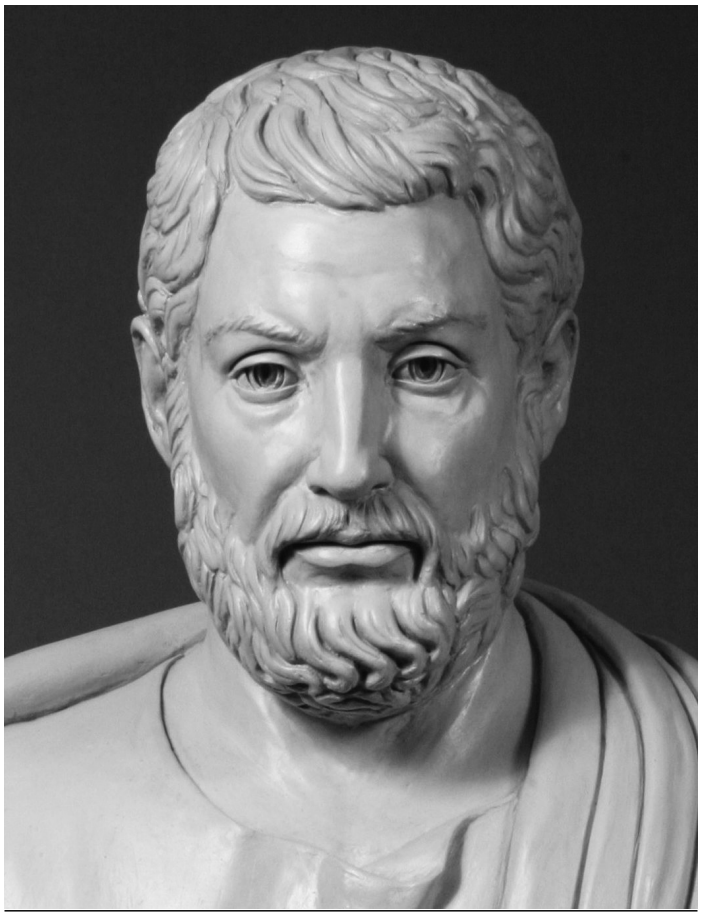
The next defining moment is about 75 years later, at the end of the 6th Century, when a tyrant had in fact taken over for a generation and then been expelled by the Spartans. The

Spartans, then, evacuated Athens, took their forces away and left Athenians to sort things out.

Two parties emerged - one preferring a closer alliance to the Spartans, the other wanting something else. The pro-Spartan side was initially more dominant, and then the leader of the other faction, a man called Cleisthenes, did something really radical.

Historian Herodotus tells us that Cleisthenes brought ordinary people into his coalition.

At that point, the pro-Spartan faction says: "We'll bring the Spartans in and create a narrow oligarchy that will be useful for us".



Cleisthenes, the father of Athenian democracy. Image: Bust at Ohio Statehouse by Anna Christoforidis, Columbus, Ohio. Credit: www.ohiochannel.org

The Spartans send threats saying that Cleisthenes, the leader of the popular faction should get out of town. He leaves, alongside his closest supporters. The Spartans arrive in Athens, they set up an oligarchy and put the pro-Sparta faction leader in power. Their first move is to abolish the ruling council of Athens.

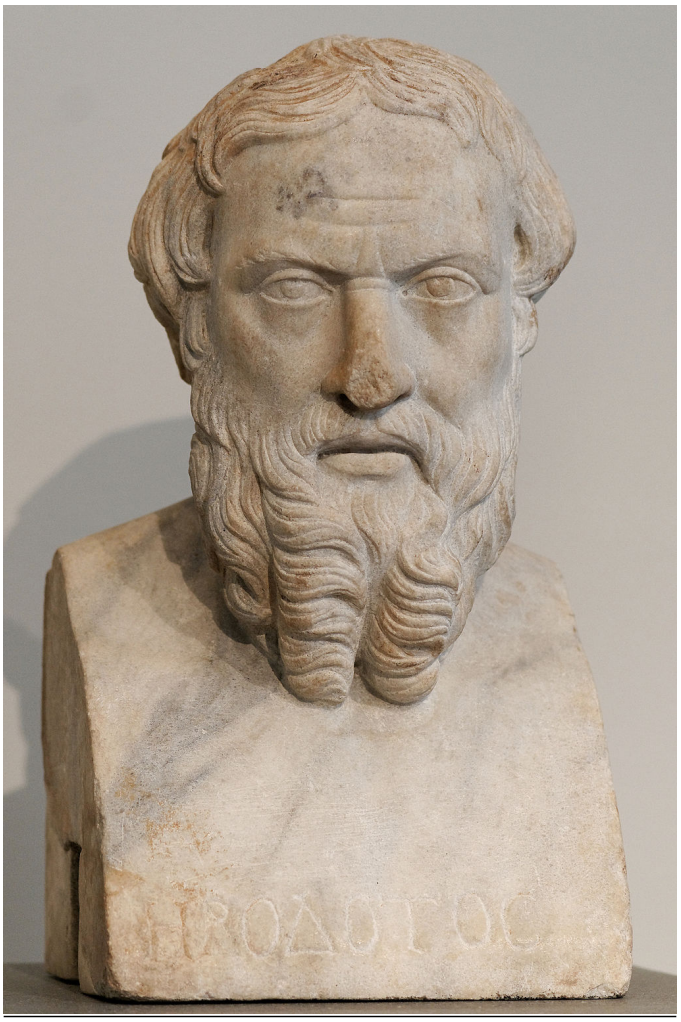
The council refused being abolished, but to no avail, given that the Spartans had an army. That was a key moment, because at that point, the rest of the Athenians besieged the Spartans and their Athenian allies on the Acropolis.

On the third day, the Spartans and their allies surrendered and departed from Athens. At that point the people were in charge of the city. They then recalled Cleisthenes, the man who had started this and told him it was time to deliver on everything he promised, to create some institutions that capture what they had just done together as a people.

That's the point at which the Athenian constitution was put in place. That's the origin of democracy.

Cleisthenes built on the earlier compromise that Solon had made, that allowed the Athenians to imagine living together without a boss. The real institutional structures were the result of this mass uprising of the people themselves, acting without formal leadership, but in recognition that people are going to need some kind of institutional structure, a formal way to get things done.

That's when we get the Athenian Constitution, the Council of 500, procedural rules for the assembly and soon thereafter, the structure of the people's court and so on.



***Head of Herodotus**; Greek inscription. Roman copy of the Imperial era (AD 2nd Century) after a Greek bronze original of the first half of the 4th Century BC. Herodotus (c. 484 BC – c. 425 BC) is considered the first writer to have treated historical subjects using a method of systematic investigation. For this, he is often referred to as 'The Father of History'. He is the author of The Histories, a detailed record of the Greco-Persian Wars. Credit: Metropolitan Museum of Art, © Marie-Lan Nguyen / CC-BY 2.5*

How did this compromise work between the classes which were in conflict for so long? What made Greek democracy successful?

One of the things is the fact that this democracy emerges, not as a gift from a benevolent elite to the huddled masses, but as the result of collective action, a reasonably coordinated collective action of many people doing something together.

That's a key point - institutions are really a designed system allowing people to do that thing that they have done spontaneously, accomplishing something together. The very fact that

the whole institutional design is not simply springing out of the head of some genius, but rather the result of this initial collective action is important. Everyone always remembered that this was where it all started.

A key thing is that leaders never had the opportunity to consolidate power and therefore rule in their own interest.

Leaders remained in the condition of advisors to the people, rather than becoming the rulers of the people. Athenian institutions were well designed so that nobody had the potential to seize control of central power and impose his will. The structure always pushes it back to a large body of citizens, in Athens it was 30.000 adult males. It pushes it back to the citizens themselves being the ultimate decision maker collectively.

The real trick, then, is to make institutions that allow a very large body of people to make decisions in a way that is efficient enough, that can make binding decisions quickly enough, so that Athens, as a democracy, can compete effectively with non-democratic states and other state actors.

Democracy can't be a solution to the collective action problem if it yields a very slow and inefficient way of doing things. It has to be not just democratic, but efficient. That's the real trick of institutional design.

Albumen print (taken circa 1865-1895) of carved speaker's staircase of the Pnyx, where the Athenian ekklesia (assembly) used to meet. Credit: A.D. White Architectural Photographs, Cornell University Library

What happened to Cleisthenes after the revolution?

That's a great question and the answer is - we don't know. One would expect the great hero to establish himself as the president of this new system, but he doesn't. There is no special place for Cleisthenes in the new system, so he disappears from history. We don't know what happens.

Cleisthenes designs the new constitution, history is clear about that. He's the guy who does in fact come up with these new institutions that are passed through the Assembly, but after that he is gone.

I've always found Cleisthenes fascinating, because it looks a bit like what Satoshi Nakamoto did. He built this new software and then left. He puts it in the hands of the people...

Yes! It's a fascinating thing. A very similar thing happened to Solon, the earlier compromiser. The story is that Athenians kept pestering Solon by saying: "Tell us how this compromise is supposed to go, you are supposed to give judgment on the new rules".

And Solon says: "No! I'm leaving, because you have to learn how to live with the rules yourselves. If I'm the only one who tells you, then it does not really work".

So Solon disappears as well. There is something about the disappearance of the hero-founder that may help democracies to work better.

George Washington also has a similar story...

Exactly! Washington is the one who is installed as president, but after his two terms says he's leaving. He went back to his farm.

I guess that's an important part of building peer to peer institutions. The leader should not stay long. If he stays, then it becomes just another monarchy.

I think that's right, the problem really is even if the leader is completely benevolent, then people would become dependent on that leader and they'll have this idea that they always have to look to the leader.

When the next leader eventually comes, because the previous leader dies or something else happens, there is no guarantee that the next one is going to be equally benevolent or equally competent.

Even with the best possible leader, he has to get out of the way if the organization is going to be a self-governing one, otherwise this kind of dependency will emerge.

Tell me about this very particular piece of Greek institutions, which is sortition or random selection. What role did it play in the Greek system and why was it important?

For the Greeks, elections were a fairly minor part of the way how democracy operated. They recognized that for certain roles they would need to use elections, that is they would have to identify people who were specially competent to hold certain roles. For example, they elected their generals to lead them in war.

For most other roles, including service in the Council, which has a very important overall position in Athenian democracy, they thought that any citizen should have the opportunity to take that role.

Each year, there were 500 citizens chosen by a very complicated lottery system which ensured that people from different parts of the Athenian territory were represented on the Council.

They would then be expected to handle the day to day business of the state and importantly - set the agenda for the citizens' Assembly to which any citizen could come. The Assembly would meet about every ten days in order to conduct public business.

The idea is that every citizen is assumed to bring something to the business of doing public work and that together a body of citizens, chosen by lottery, represent the collective competence of the community. That's essentially saying that a random sample of the population, given the job of public service, can efficiently accomplish the role of state governance.

What was the advantage of this system in Athenian democracy?

If you know that those on this very important governing Council are chosen randomly from across the population, you can quite readily say that they represent us - the people.

It's not a bunch of professional politicians, people who spent their life finding ways of getting to power and staying in power. The Council has a legitimacy, because it really is us. It is a miniature of us.

Furthermore, when this system of 500 people a year, chosen from a population of 30.000 citizens runs for a while, you get to the point that a large percentage of the population has had the experience of having served as a member of the Council, so you distribute the knowledge of how the city is actually run much more widely across the citizenry.

When we imagine all Athenians going to the Assembly, instead of thinking of a mob of 5000 to 8000 people making any kind of policy in a complex society as Athens - we should remember that a large number of them had the experience of a year serving on the governing Council. There is a lot of distributed knowledge of how things work across the population.

Let me ask you about another important piece of Athenian institutions: popular courts. How could a popular court work without becoming mob justice?

The court system was manned by citizens chosen by a lottery. In this case, about 6000 citizens would sign up for jury service each year and would take the oath of the juror.

Then, when there was the need for a trial, there was a selection process by lottery which determined which of those 6000 would be put on a particular jury. This was done in a very sophisticated way to make sure no one would know who would be on what jury ahead of time, so there would be no bribery or interference with the jurors.

The trick to this is to have the jurors recognize both that they are doing a very important piece of public business, and they have to do so in a way that is fair.

If you look at the oath that the jurors take, they swear to judge according to the laws, so they are meant to be judging according to the established laws. Where the laws don't pertain, they judge by their sense of equity. If the jurors don't do this, then it could devolve into mob justice.

Then we need to think about how the entire system develops into a kind of a political culture wherein the assumption is that being in a jury, you do take your oath seriously and you do try to judge according to the laws and you're not just carrying out some kind of mob vendetta.

If that were the case, the system would fall apart, people wouldn't trust the court system, they would try to solve their disputes by private vendettas and the system would fall apart.

But we don't observe that. Athens seems to be, in fact, a remarkably non-violent society, at least by the standards of pre-modern communities and especially for a community which had no organized police.

No organized police?

By lottery, they chose eleven men responsible for managing the prison and looking after public order, but there is no formal police.

Basically, the citizens have to be responsible for monitoring one another and carrying out judgements after the courts have given their decision. It really pushes a lot of weight to collective behavior by the citizens.

So, they make the laws collectively in the assembly, the existing body is selected from the people randomly, they monitor themselves, they go to courts and then they manage the prison...

Exactly, take for example the famous case of Socrates. Socrates is charged by one of his fellow citizens for various crimes, ultimately impiety and corrupting the youth and you can see in the story how this really goes.

In one of the earlier dialogues, Socrates meets a friend of his outside the magistrate's office, the magistrate who does the preliminary investigation when one citizen charges another and decides what court to send it to.

Socrates, having this conversation with his friend about the problem of piety says: "I have to go because I have an appointment with the magistrate". So, there is Socrates being a proper citizen. He is sent to the magistrate to have this preliminary investigation and there he is. There is no police to drag him in, he's done it because when you're summoned by the magistrate, you'll go as a citizen.

The magistrate sends him to court, Socrates appears in court, he conducts himself in the courtroom as a citizen would, he gives a speech of defense after the prosecutor has given a speech of prosecution.

And he loses, partly because he gives a peculiar kind of speech. He is then sent to prison. He accepts that. But his friend then shows up at the prison a couple of days later and says some of his friends have arranged to break him out of jail, they've bribed the jailor.

Socrates says: "I can't do that, because I've been convicted. I don't think I was actually guilty, I think the prosecutor made a mistake, but the jury convicted me. That's the way the laws go and I have to accept my punishment".

Plato tells this story as if Socrates is a moral saint, but actually it seems this was the case for many Athenians, who obey the rules because that's what a citizen does. In this case, we see Socrates being strikingly, for his own philosophical reasons, acting just as a loyal citizen of the state.

After his trial, Socrates (469–399 B.C.) had a final conversation in prison with his followers[25]. Painted in 1787 by Jacques-Louis David, shortly before the onset of the French revolution, this Neoclassical canvas is often interpreted as a resistance to unjust authority. Image: ***The Death of Socrates*** *(1787), Jacques-Louis David, Oil on Canvas. Credit: The Metropolitan Museum of Art, New York*

We're in the early 21st Century, we have a crisis of democracy. Is there anything we can learn from the Greeks?

I think that maybe the most important thing we can learn is that this kind of large and complex community can in fact organize itself democratically using lottery, using large scale citizen decision making and can do so over a long period, facing crises and addressing really serious problems and it can work.

It can work in ways where communities can be really effective, thrive in a very competitive environment in which other organizations are trying to advance their interests. It can create

[25] In the *Crito* dialogue, Plato tells the story of this final discussion about justice and the appropriate response to injustice, in the context of what was perceived as an unfair death sentence. After declining escape from prison, Socrates drank from the cup of poisonous hemlock and died willingly. His last words were: "Crito, we owe a cock to Asclepius. Please, don't forget to pay the debt".

very impressive things, such as the Western civilization, for example, or at least a good part of it.

History of Athens proves that it is not impossible that democracy, in this strong sense, citizens ruling themselves using institutions like the lottery can work. We know enough about it that we can say why it worked, why were particular institutions designed in the way they were, why they achieved this end.

I believe it is because they organized a lot of human knowledge and human capacity, organized skills in ways that were more effective than command and control, top down, pyramidal structures that hierarchical systems employ. That's the key, it's not just about the particular things we can learn, but I think the overall lesson is that we shouldn't believe when people say 'democracy is a nice idea, but it could never work'.

What can you recommend to people who want to learn more about Athenian democracy?

There is an excellent book by a wonderful Danish scholar, Mogens Herman Hansen ***Athenian Democracy in the Age of Demosthenes*** (1998), which gives a really great, very detailed account of the institutions of Athenian democracy.

I just edited a book with three colleagues from the University of Edinburgh called ***Ancient Greek History and Contemporary Social Science*** (2018) which has essays by twenty Greek historians and modern social scientists interested in Greek institutions where we try to address a wide range of questions, many of them directly about Athenian democracy.

That came out this year, and I think if you want to see where the state of the art is, that's what we were seeking to do, these are the people who like the idea of applying social science to Greek history, but also using Greek history to ask some questions that social scientists are asking, for example what is the relationship between democracy and economic development, what's the role of the rule of law, how does technology work within a democracy and so on.

Peter Stone on Randomness as a Political Tool

Interview by Damjan Malbašić, Communications Director, Kleros

Peter Stone's doctoral dissertation was entitled *The Luck of the Draw: Revisiting the Lot as a Democratic Institution.* He is the Ussher Assistant Professor of Political Science (Political Theory) at Trinity College Dublin. Stone specializes in political theory, especially such areas as democratic theory, theories of justice, rational choice theory, and the philosophy of social science. He is particularly concerned with questions involving the scope and limits of human reason. He is the author of *The Luck of the Draw: The Role of Lotteries in Decision Making* (2011) and the editor of *Lotteries in Public Life: A Reader* (2011).

Could you give us a short historical overview of sortition in political and legal systems, how did this technology come into being?

The idea of the use of sortition as a political technology goes back to at least the Athenian democracy. It would start to be used in a serious way by the 5th Century BCE. There is a debate about the origins of it. For example, was it originally regarded as a religious method of divination or something like that, but most scholars reject this idea. It was used in very critical ways by the Athenian system for the administrative council[26], it was used by most of the magistrates and it was used to fill the courts they employed. Through Athens it got exported to a lot of the democracies around the Greek world, that's why Aristotle famously says that election is the way that aristocracies select their officials and sortition is the way democracies do it.

After the eclipse of Athens as a democracy, the lineage dies out in a lot of ways. Sortition seems as a kind of technology that gets rediscovered, the direct connection to Athens is rather spotty, if there was any. There seems to be evidence that a lot of communities around

[26] Another excellent resource regarding sortition is Oliver Dowlen's *The political potential of sortition* (2009), which studies the use of sortition in ancient Athens and in late medieval and renaissance Italy, including descriptions of contributions to sortition made by Machiavelli, Harrington and Guicciardini, among others.

Europe employed sortition in various kinds of places, in particular city states in the Middle Ages.

There seems to be a lot of 'reinventing the wheel' happening in a lot of places. It was most famously associated with Renaissance Venice and Florence[27]. In different ways, sortition is employed into electoral procedures in a very complex manner, and then there is the Anglo-American development of the jury system which develops in the early Modern period and continues until today.

In 14th Century Florence, magistrates were drawn randomly from preselected lists of names established by electoral commissions. Credit: Pixabay

In the center of the political system, it's sort of on the fringes in actual nation-states until recently, probably until the last twenty-thirty years when anyone started taking this seriously again. Now you have large scale uses of it being developed, particularly the two constitutional conventions Ireland held in the last few years.

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[27] Niccolò Machiavelli was a proponent of random selection for public office in Florence. John P. McCormick's *Machiavellian Democracy* (2012) delves deeper into these ideas.

In *The Luck of the Draw*, you mention the concept of allocative justice. Could you tell us a little bit about what that means and how it is used?

I have in mind the idea that very often, when we are concerned with justice, we are concerned with some agent, it might be the public that faces a decision about how to allocate something, something people care about, something to which people might be said to have rights. That could be university submissions, public housing, all kinds of things. The political office in some situations might be construed in that kind of way. The idea is that sortition is in a way an appropriate way to respect those rights, the claims that people have to it in situations where there are many people with equal claims and not enough of whatever you are giving out to go around.

Kleros is trying to create a dispute resolution mechanism based on sortition for modern decentralized systems. Could you give us your view regarding how sortition could help democracies and justice and decision making in practice in this new digital age?

There are two facets of it. One is that you are selecting people in a manner that prevents anybody from 'stacking the deck', taking the selection process and manipulating it in a way that benefits them. Related to that is the factor of unpredictability, because random selection is all about unpredictability.

Of course, to the extent that you can predict who is one to be making the decision, even if you cannot control who selects them, you can suborn them. So, having the factor of unpredictability there together with the fact of preventing any control over the process is a really great way of ensuring a certain form of impartiality. That's essentially the concept of the jury as employed by the United States, Britain and other countries in the UK tradition.

Leonardo Loredan (or Loredano) (16 November 1436 – 22 June 1521) of the Loredan family was the 75th Doge of the Venetian Republic from 1501 until his death. His Dogeship was one of the most important in the history of Venice. Image: The ***Portrait of Doge Leonardo Loredan****, a painting by the Italian Renaissance master Giovanni Bellini, dating from 1501. Credit: The National Gallery in London.*

Do you see sortition as a mechanism for the 21st Century which can create a concrete impact on changing the power relations within the global system? Does it have the power to shift the relations?

I think it's a very useful tool. As with all tools, I think it's important to have a very well designed tool, you want to use it in the appropriate way. Like a lot of technologies, you can use it in ways that are very libertory and use it in ways that are less libertory, depending on the way you employ it.

A classic example of that is the way it was employed in Renaissance Venice, as Venice was most definitely not a democracy. It was concerned with preventing corruption and domination there, it was about preventing political monopolies from emerging, from keeping any of the big families from taking over, preventing the creation of their own Medicis, but it was most definitely not a tool for empowering poor people.

It was a mechanism that was entirely employed among the Great Council, which were all the well-born families, so it was used for a very particular purpose in that context and it worked well for that purpose. All by itself, it did not create a utopian move towards empowerment, justice or things like that. It was used in a particular way and that's how it's going to look in the future. It can be used in ways that are very disruptive to traditional ways of doing things, very empowering to different groups, or it can be used in other ways, how it's going to be used, time is going to have to tell.

Barry Weingast on Law Merchant and Private Justice

Interview by Federico Ast, CEO, Kleros

Professor Barry Weingast is one of the world leading scholars in institutional economics, a field that studies how human institutions affect economic behavior. Trained as a political scientist and an economist, he is a professor at Stanford University and a Senior Fellow at the Hoover Institution, a public policy think tank promoting the ideas of individual, economic and political freedom.

You wrote this great paper on how the Champagne Fairs enabled a revival of trade in the Middle Ages by providing a system of private law...

We were interested in the question about the rise of trade. In particular, why was trade so slow getting restarted after the fall of the Roman Empire? At the time we wrote, historians argued that an important role was played by the Law Merchant.[28] I think we wanted to have a sense of how trade could work in the absence of territorial-nation-states with extensive territories.

There were governments in the Middle Ages, but they were ineffective, what we today call 'low state capacity'. The king was up against the great lords, sometimes called 'the barons' in English history, and the barons were often almost as powerful as the king; and sometimes even more powerful than the king. So, the king could not impose his law on the land, thus property rights were subject to constraints and mischief by the great barons.

The set of institutions which arose back then had elements of private governance where a private group of merchants in different countries came to agreements on how to set the rules. In the 12th and 13th centuries, the private legal system of the Champagne Fairs enabled the revival of trade in Europe.

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[28] In recent years, modern legal historians have challenged the older view of the Law Merchant, questioning whether the phenomenon existed (see especially Kadens 2012). Regardless of that debate, merchants needed various types of institutions to underpin long-distance trade. Moreover the Law Merchant model – apart from whether the law merchant existed in practice – applies to such trading institutions as the Champagne Fairs, where merchants came to trade via contracts to deliver wares over the course of the coming years.

In the 12th and 13th centuries, the private legal system of the Champagne Fairs enabled the revival of trade in Europe. Image: An anonymous 19th Century graphic depicting Champagne Fairs in the 13th Century.

How did that system of private law work? Who created the rules? Who were the judges? How was enforcement done?

All long-lived constitutions have to be self-enforcing in the sense that those that live under them have to have incentives to abide by the rules. Part of what emerged in the early Middle Ages were mechanisms by which these traders devised to enforce long-distance trade where the opportunities for cheating, fraud, and malfeasance were legion.

In medieval northern Europe, trading cities were necessarily mindful of foreign merchants who sought to defraud local merchants and depart, never to be seen again. The home merchant might get a judgment in the home courts, but what good would that do if the defrauding merchant never returned?

Medieval trading cities developed a complex system that mitigated the problem of fraud/absconding in long-distance trade (as Grief 2005, Ch. 9, explains). These cities carefully controlled which foreigners were allowed to trade. Cities did not grant individuals rights to trade. An individual merchant from Cologne, Germany, could not show up in, say, London, England, and trade his goods.

Instead, England gave the rights to trade, not to an individual, but to an organization: a merchant guild comprised of the merchants from a given city. The guild was jointly liable for the behavior of their members – if one of them were to cheat and disappear, the other guild members were responsible for making good on his contracts, debts, and any judgments against the merchant who absconded after defrauding a local merchant.

This system of joint liability, in turn, gave the guilds the incentives to police who among them got to trade in their name. To trade, a merchant had to be part of a merchant guild and not everyone could do that. The guild closely controlled its membership. To become a member, a merchant had to have local property that could be confiscated; and typically the merchant's family would remain in the city, so there were consequences for that, as well.

This system is an example of self-organization, sometimes with the help of governments. In England, for example, the king was involved with the trading community. But the central idea is that merchants did not rely on the king and the state for enforcement. They developed a complex set of institutions that created incentives to trade honestly.

In principle, this system could be designed by and operated by merchants. Or it could be built in cooperation with local governments. The first approach is a purely private order, while the second involves one or two governments. What's the difference? As long as the system operated the same way, the result is the same public good.

What we would call these days a reputation system...

Yes, it was a reputation system, but one in which institutions were necessary to make it work. The nature of interaction among merchants had to be rigged in a way that mitigated the problem of enforcement in a complex environment where cheating is not observed.

Let me explain. In the 1980s, many political-economists began studying repeated games, especially the repeated prisoner's dilemma. This model attracted scholars because it suggested a way in which cooperation could be sustained even if the players had short-term incentives to cheat one-another.

In the single play prisoner's dilemma, both players had incentives to cheat rather than cooperate, leading to the failure of cooperation. But scholars discovered that when repeated infinitely, the prisoners' dilemma afforded cooperation. The reason is that, if player 1 cheated player 2 in this round, player 2 could retaliate against player 1 in the next round and forever thereafter.

Repetition combined with retaliation to force the would-be cheater to choose between: (i) cheating now and foregoing the benefits of cooperation forever, and (ii) refraining from cheating now and capturing the benefits of cooperation into the indefinite future.

The ‘folk theorem’ holds that when people do not discount the future too heavily, the benefits of ongoing cooperation exceed the short-term gains of cheating now but not cooperating thereafter. Defection today might be tempting, but if it leads to costly retaliation, the potential cheater will be deterred from cheating.

This illustration explains how the basic reputation mechanism works. But it is not the last word.

Consider a context of a merchant community whose members trade with one-another. If a given member of the community cheats, he gets a reputation as a cheater, and members of his community will avoid trading with him.

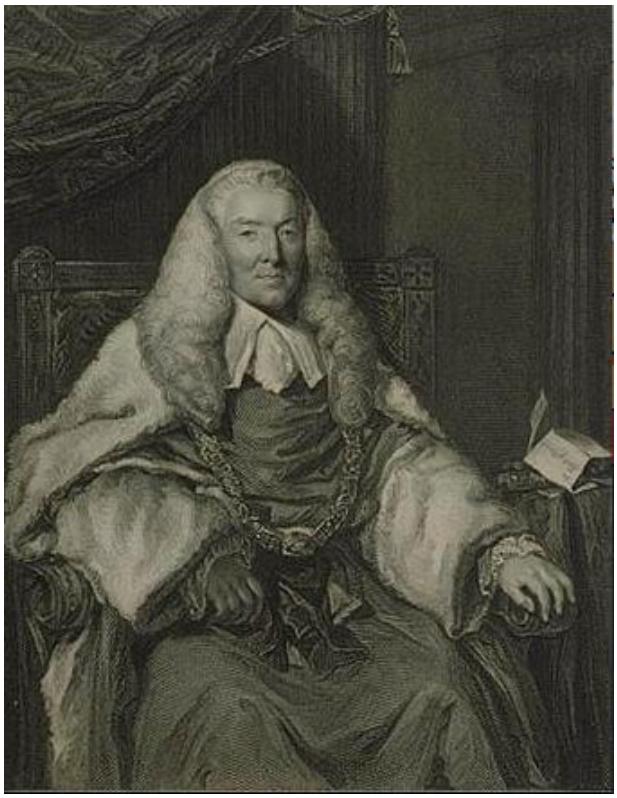
A fundamental but hidden assumption limits the applicability of the basic reputation model. The model assumes that behavior is common knowledge. Everyone knows who cheated, so they effortlessly focus their retaliation on the cheater. But what happens if members of the community do not costlessly observe who cheats?

Consider a merchant community whose members trade bilaterally. No one knows what goes on in an exchange between two merchants. Instead, members of the community typically observe a dispute in which both trading partners blame the other. Herein lies the problem: if members of a community observe disputes, not cheating, against whom are they to retaliate?

The problem is even worse because opportunist cheaters may engineer disputes that masquerade their subterfuge. The lack of knowledge about cheating disables the reputation mechanism.

This is where the Law Merchant model comes in, as a mechanism for preventing that kind of cheating by creating a centralized investigation, adjudicating the dispute, and then making a common knowledge announcement to the community about whether cheating had occurred.

In our paper, we show that, if the members of the community use this common knowledge signal for their retaliation decisions, they can sustain cooperation. But absent a mechanism like the Law Merchant, the community cannot sustain cooperation.



A portrait of William Murray, the 1st Earl of Mansfield by Henry Thomas Ryall, who integrated the Law Merchant into English Common Law in the 18th Century. Credit: National Library of Australia.

The Middle Ages taught us that both governments and private actors can play a role in providing a secure environment for trade and other social interactions. But, what's the difference between them? How do we know when we have a government? Take Facebook or eBay, for example. They are huge digital platforms with users from across the globe. They write the law of the land (terms and conditions). If a user violates this law, he can be banned, similar to how ostracism worked in the Middle Ages. And this decision is made by a moderator, a kind of private judge appointed by the 'platform king' to adjudicate on disputes which happen under this private system of law. Would you say that Facebook, eBay and other Internet platforms are states? Or is that going too far?

This is a deep question and I don't think anyone has a definitive answer. Part of the difficulty arises because the answer depends on the way you define a state.

Generally scholars think of the state as many components, such as sovereignty, the type of state (authoritarian, republican), etc.

A defining characteristic of a state is sovereignty: No legal authority exists above a sovereign state that can order the state to do something or prevent the state from doing something. If

we accept this premise that a state is a sovereign entity, then we get a syllogism that answers your question:

-Every state is a sovereign entity.
-Facebook is not a sovereign entity.
-Therefore, Facebook is not a state.

Facebook is subject to the host country's laws. It cannot set aside American commercial law or contract law or criminal law. Nonetheless, Facebook is a governance structure, to use Oliver Williamson's terminology.

What can we learn from these institutions that can function without a government?

A central lesson is that we have to look at the incentives of the actors, the ways they participate, and what they are willing to do. Another piece is the perspective Gillian Hadfield and I have developed which we call the 'what-is-law?' framework (Hadfield and Weingast 2012, 2014).

When does a body of rules constitute law? A related question is: what characteristics must a set of rules have in order to generate third party enforcement of the rules in a given community?

A range of 20th Century legal philosophers have thought deeply about this question. One of the things that emerges from literature dating from the ancient Greeks are characteristics of the rule of law. These include characteristics such as stability, feasibility, prospectivity, clarity, consistency, and impersonality. These characteristics are called 'legal attributes'.

Using a simple game, Hadfield and I show that legal attributes emerge as part of an equilibrium of third party enforcement of the rules. The reason is that individual A has no incentive to help punish a violation of the rule against person B if the rule in question applies to B, but not A. In a system of privilege, where each member of the nobility has a different set of privileges and in which commoners have few, a community finds great difficulties in sustaining law.

The 'what-is-law' framework has important consequences for projects like Kleros. Do the mechanisms underlying the products and services you're providing satisfy the conditions that people associate with the rule of law? I assume this is desirable. If so, how is Kleros attempting to implement and sustain the rule of law?

An example has to do with a characteristic we call 'impersonality', which means that the law treats like people alike. All citizens have the same rights. Your social position does not determine your rights as a citizen. In the rule of law, it corresponds to the idea that like cases

should be treated alike. Extraneous details about your personality, race, or circumstances should not enter into a decision judging you when you have been accused of wrongdoing.

This argument leads me to a question for you and Kleros – what kinds of thoughts you have about issues having to do with the rule of law?

Kleros seeks to provide rule of law for an environment which doesn't have it yet. For example, in today's global and digital economy, lots of disputes happen between agents across jurisdictional boundaries. Mostly small claims between freelancers and clients, etc. There is no court system able to solve a dispute for a couple hundred dollars between, say, a client in the United States and a contractor in India. It's simply not effective.

Kleros is a system of private law which provides small claim arbitration. When parties agree on the contract, they also agree on the jurisdiction for resolution in case a dispute happens.

In the Middle Ages, merchants agreed to have their disputes solved in fairs that had a reliable court system, which had some rule of law institutions that they could trust. The Champagne fairs were very successful because they managed to develop a legal system that provided rule of law. Merchants trading there knew that it was likely that contracts would be enforced.

In some way, Kleros is a digital age equivalent of this private court system. Parties can agree on using Kleros (and particular courts within Kleros) knowing that the dispute will be solved in a fair manner, by a panel of jurors selected in a transparent way. After the panel makes a decision, this is automatically enforced. It provides rule of law for a global society where there is no rule of law.

I would agree with everything you say, except for one piece. It is not clear to me you provide a rule of law in the sense of what legal scholars think of as law. In part, because it is not clear what mechanisms lead your system to treat like cases alike.

That is not to say you provide no value, you clearly have a system that is fair and that is not obviously biased towards either party. It is also a system of third party enforcement, meaning nobody making the decision is directly involved with the people in the case.

In that case, you have some important pieces of the rule of law, but it is not clear to me you have all of them, especially issues like precedence. Precedence is one of the central ideas underlying Anglo-American legal systems. What, if any, is the role of precedence in your system?

Jurist Oliver Wendell Holmes famously said: "The prophecies of what the courts will do in fact, and nothing more pretentious, are what I mean by law". Kleros also has this feature. After many cases are ruled in a specific court in the system (e.g., the website disputes court), we will start to observe a regularity on how cases that look alike are decided in a similar way. Then agents would know, even before going to arbitration, how a specific case is likely to be ruled by that court.

That is a very important piece to have, especially if you think about Kleros growing into a larger platform, one that moves beyond your initial focus. People are going to want to know how Kleros decides any given case, especially as you move into more complex interactions between businesses. This poses a challenge for any company trying to do these kinds of things.

I have been following TaoBao, the world's largest e-commerce platform, owned by Alibaba.

They are creating the legal system for their platform. A big difference between TaoBao and eBay or Facebook is that the latter have all of American law behind it.

Imagine you are an entrepreneur cyclist and you invent a new digital brake system, which you want to sell on the Internet. In the United States, three out of four people will create their own independent website. In China, only 10% of people would do that. Most of the people use platforms like TaoBao.

The reason for this is that America has a rule of law system which underlies commerce and exchange, so there exists mechanisms to deal with problems like intellectual property rights. In China, this backdrop of American law does not exist.

Part of what TaoBao is doing as a platform is creating a legal system in which disputes are resolved wholly within the system. eBay has that too, but it is truncated and if you exhaust the remedies, you can go to court and challenge any ruling made by eBay's system of adjudication. Whereas in China, no legal system and courts exist that can play this role.

Alibaba Group's public jury dispute resolution system works on par with state legislation. To pick up on our previous discussion: is TaoBao a state, then? It would seem like a type of monarchy which makes the laws and enforces them, and where there is no other place to go if you don't like a decision.

In the 17th Century, Louis XIV could overrule any ruling from his courts he didn't like. In modern democracies with rule of law, the executive power cannot overrule judicial decisions, because of the principle of the division of power.

But TaoBao's management would seem in a position to overrule any of their court's decisions. And it all happens within a walled garden. In the case of Kleros, there is no 'owner' who could overrule the rulings of a court. And also everyone knows how the system works: how jurors are selected, what are their incentives, how evidence is handled, etc. This is a big difference between a private law system like TaoBao's and Kleros, which is also a private law system, but operating with a procedurally fair framework.

In the end, users have to trust that TaoBao will be honest. Most of the time, it will probably be honest. But they still hold the monopoly of a key that can change rulings. That is a substantial difference. In Kleros, nobody holds that key and anyone can verify how the system works.

That is good, because one other characteristic of the rule of law is that it is transparent, that people understand how it works. Nonetheless, your system, like that of Taobao, is not free from potential biases. Part of your reputation growth will be trust that Kleros has not rigged the system, as you just pointed out with respect to Taobao.

One of the biggest problems in the evolution of law has to do with the arrival of unforeseen circumstances, when existing laws are inadequate to deal with it. This is a major reason why Hadfield and I argue a system of law must have some sort of legal steward, an individual or group that helps resolve disputes over how to extend the law into new areas and novel circumstances.

Kleros: a Supreme Court for the Internet

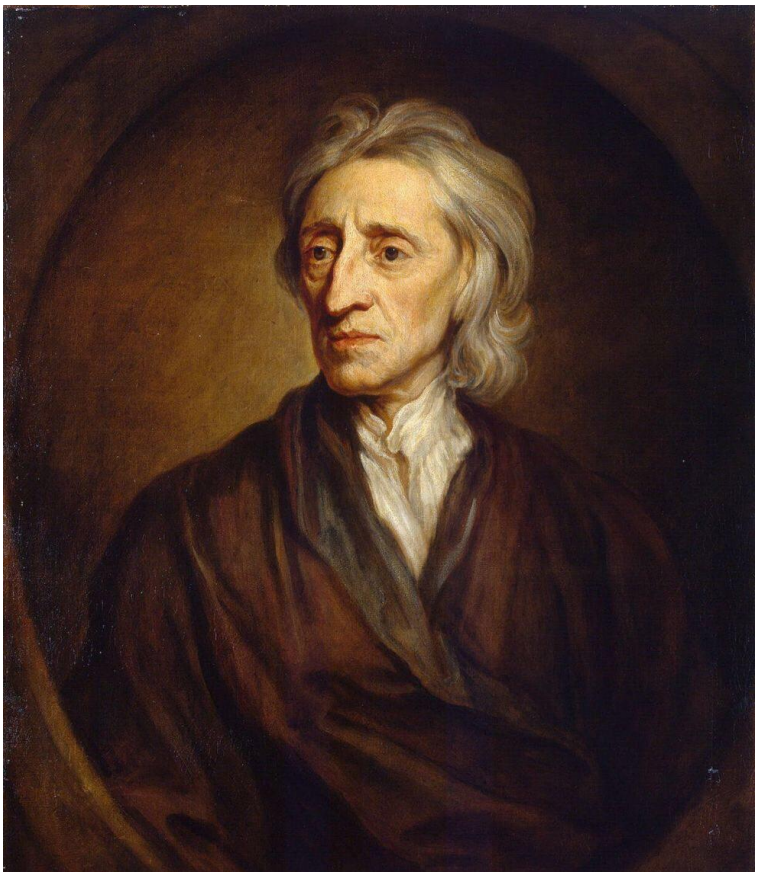
By Federico Ast, CEO, Kleros

From Cleisthenes and ancient Athens to DAOs, sortition historically enabled us to make important decisions in a just and transparent way. How can Kleros become a Supreme Court for the Internet?

Kleros as a dispute resolution protocol for online marketplaces, insurance and finance has been discussed at length since its nascent stage. These disputes, naturally, come from private contracts involving a few parties.

But, there is another type of agreement that philosophers dubbed "social contracts". They define in most general terms the basic clauses under which members of a society decided to live together.

Modern political philosophy has, in a large part, been based on the idea that the source of authority of every government comes from the consent of individuals to the social contract. This gives the government the right to make legitimate decisions on behalf of the whole political body, provided that they do not contradict the clauses of the social contract, as stated in the Constitution.



John Locke (1632-1704). In "Two Treatises of Government", Locke presents his theory of a limited social contract, where natural rights impose certain limitations on the authority of the government over its citizens. Image: Portrait of John Locke, Hermitage Museum

The Rise and Fall of Athenian Democracy

For a look at how social contracts have been constituted, let's have a look at ancient Athens. Between 561 and 510 B.C., Athens was ruled by a tyranny. In 510 B.C., a political leader called Cleisthenes led a popular revolution.

Between 508 and 507 B.C., after overthrowing the tyranny, he pushed a number of reforms that curtailed the power of the aristocracy and empowered the people. Cleisthenes empowered the Assembly as the sovereign organ in the Athenian government.

But the transition to democratic rule wasn't smooth. The early days of democracy were, in fact, quite tumultuous. The philosophers of that time saw the broad powers of the Assembly as problematic for a government of reason. Hence Plato's famous quote in the book VIII of Republic:
"And so tyranny naturally arises out of democracy, and the most aggravated form of tyranny and slavery out of the most extreme form of liberty."

Plato even coined the term of "theatrocracy" to refer to a government controlled by demagogues who target the majority's lowest passions. The Athenian experiment with radical democracy ended badly in the dictatorship of the Thirty Tyrants.

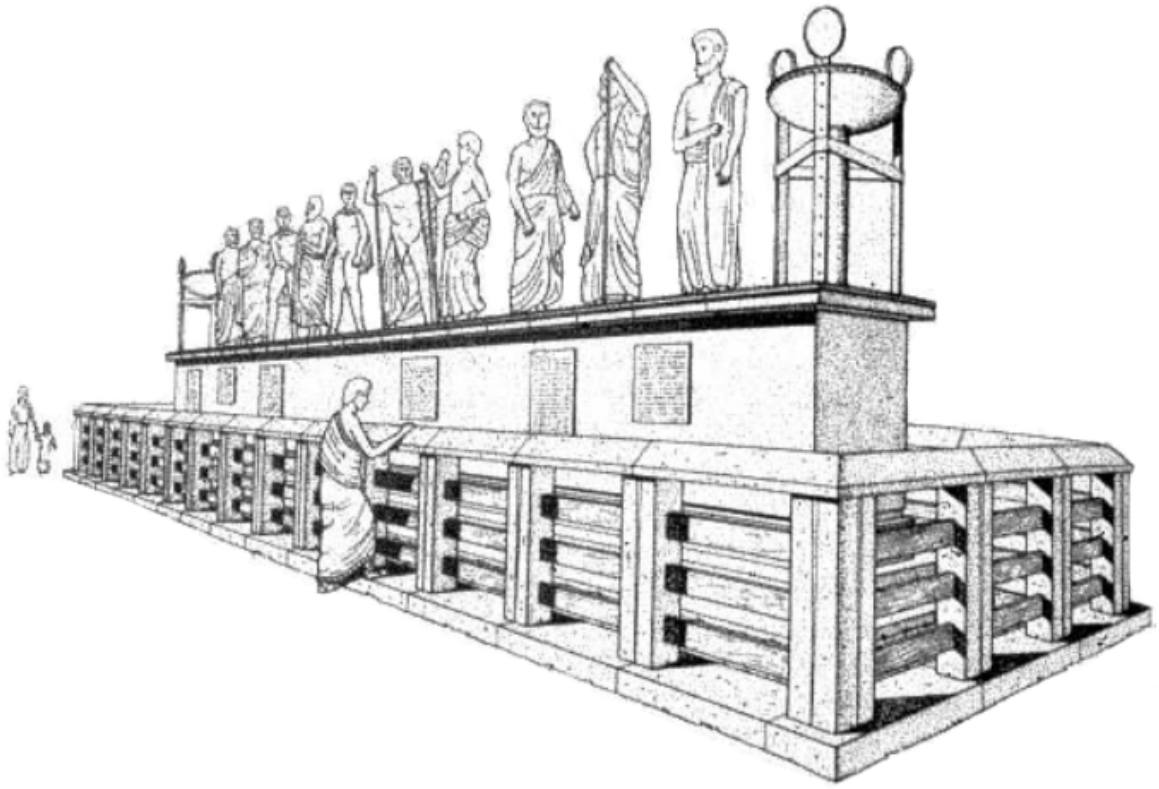
In less than a year, this regime massacred about 5% of Athenians and created wide ranging political turmoil before being overthrown by a coup, after which, in 403 B.C., came a period of democratic restoration.

Pericles' Funeral Oration *by Philipp Foltz (1852). This Athenian politician was seen by many, such as his opponent Thucydides, as a skilled demagogue.*

Democratic Innovation in Athens: the People's Supreme Court

The democratic restoration came with a key institutional reform that changed the power dynamics in Athens. A new body called the nomothetai was created. It was responsible for reviewing new legislation.

After the Assembly passed a law, this was written on a white board at the center of the agora for a week so all citizens could see it.



The Monument of the Eponymous Heroes. New legislation passed by the Assembly was posted in this place to be examined by all citizens.

If some citizen believed that some proposed piece of legislation could be contrary to the Athenian Constitution, he could start a procedure called graphe paranomon, which was basically sending the new bill to trial. The enactment of the new law was suspended until the matter was resolved.

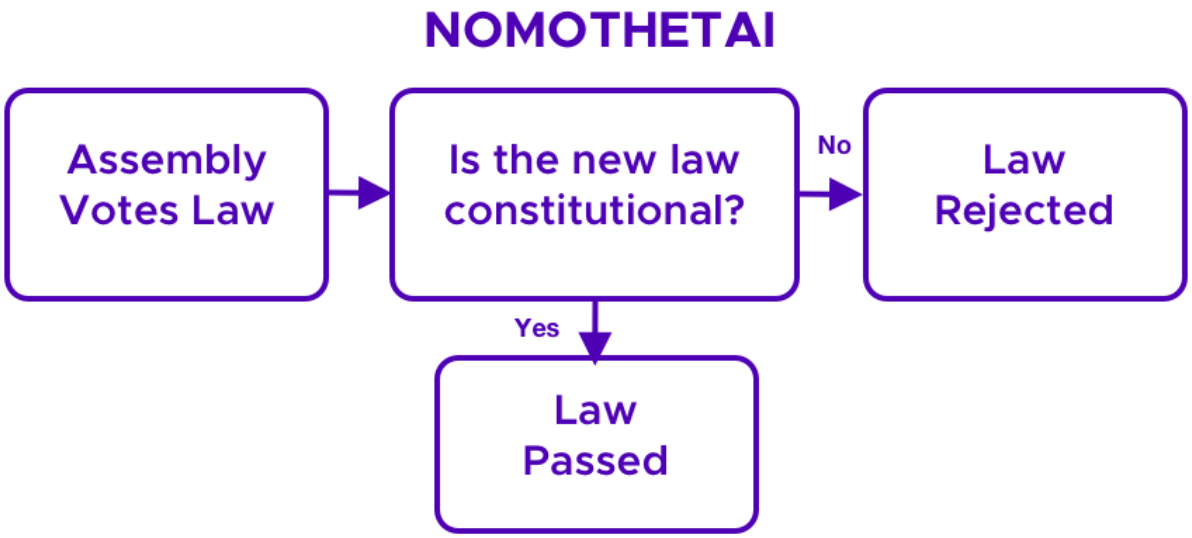
The suit was brought against the speaker who had proposed the motion in the Assembly. He was regarded as having misled the people and corrupted the law. On the appointed day, both parties pleaded their case in front of the nomothetai, a jury of randomly chosen citizens who would decide whether the new law was constitutional or not.

The losing party had to pay a fine. If the law was accepted, it was written on a marble stele. The nomothetai was a sort of a democratic brake on the legislative process. This procedure was important for reducing the power of the Assembly (and especially its vulnerability to the exhortations of demagogues).

The goal was to make democracy more rational and responsive to the needs of the polis as a whole, giving greater emphasis to the ideas of considered judgement, due process and impartiality. It was the equivalent of the checks and balances of modern democracy but with a direct recourse to an organ of the people.

The nomothetai became a cornerstone of Athenian democracy. Hence, Aristotle's famous quote:

> "Whoever controls the courts, controls the state".



Why We Need a Supreme Court for DAOs

As a larger part of our social interactions move to DAOs, communities need to make decisions about topics such as code updates or user fees. Different mechanisms have been proposed for making these decisions such as liquid voting, futarchy and quadratic voting among others.
[29]

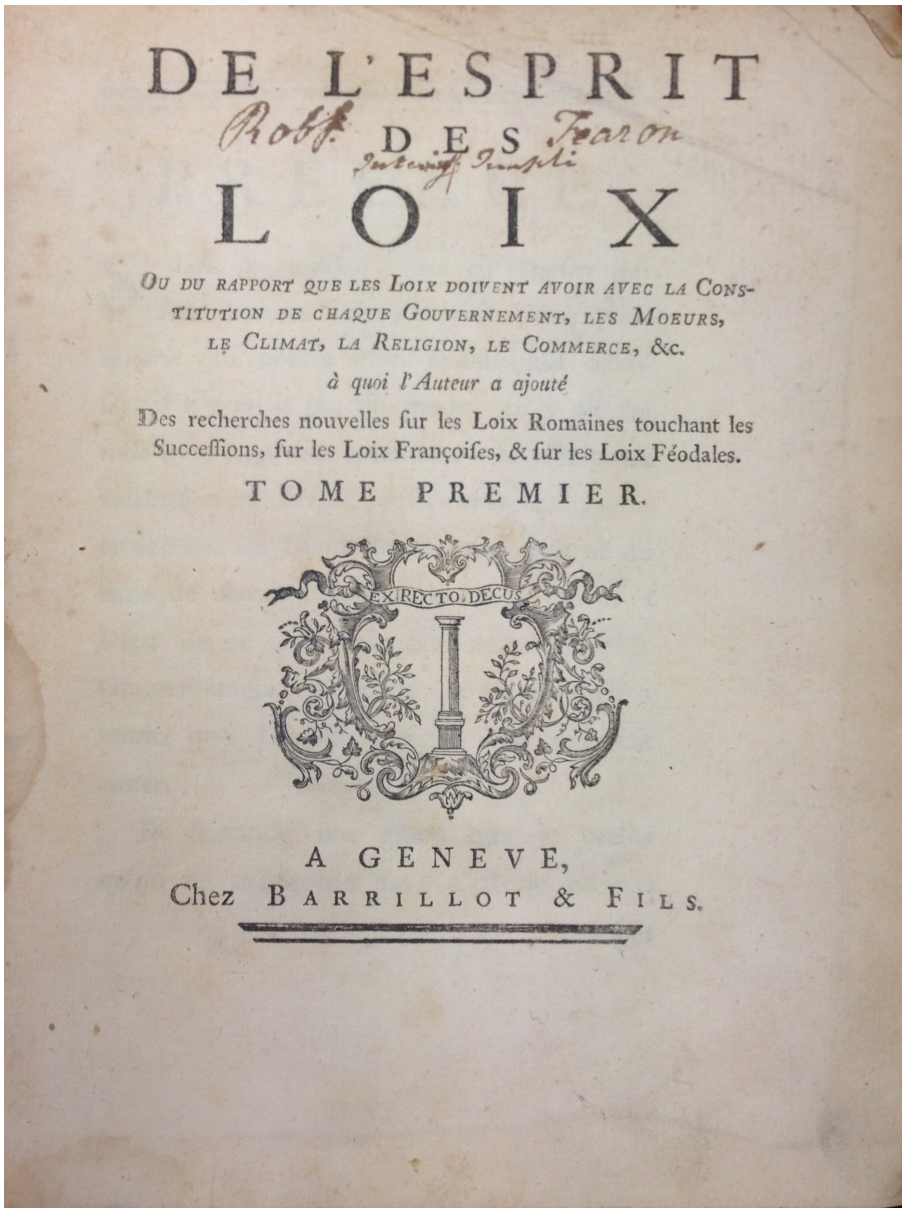
[29] To learn more, check this Tweetstorm by Jesse Walden on different models of DAO governance.

There's no one size fits all. Different platforms will probably end up having the system of governance better suited for their culture and practices (maybe in a similar way that Montesquieu thought that different societies had different optimal forms of government). However, regardless of the chosen model of governance, all platforms need a way to make sure that community decisions do not violate the social contract, the main principles that bind the community together in the first place.

In 2016, when **The DAO incident** happened, no decision mechanism was in place to address the situation. Was it acceptable to revert transactions? Or had the "code is law" principle to be respected no matter what?

The lack of a way to address this problem through the governance mechanism ended in a contentious fork and a division of the community. But forks are hard and expensive. In some cases, they may not even be possible.

This is why a type of a Supreme Court mechanism is a key part of blockchain governance. And Kleros can provide this layer, which makes sure that initiatives voted by a community comply with their Constitution.



DE L'ESPRIT

DES

LOIX

OU DU RAPPORT QUE LES LOIX DOIVENT AVOIR AVEC LA CONSTITUTION DE CHAQUE GOUVERNEMENT, LES MOEURS, LE CLIMAT, LA RELIGION, LE COMMERCE, &c.

à quoi l'Auteur a ajouté

Des recherches nouvelles sur les Loix Romaines touchant les Succeſſions, ſur les Loix Françoiſes, & ſur les Loix Féodales.

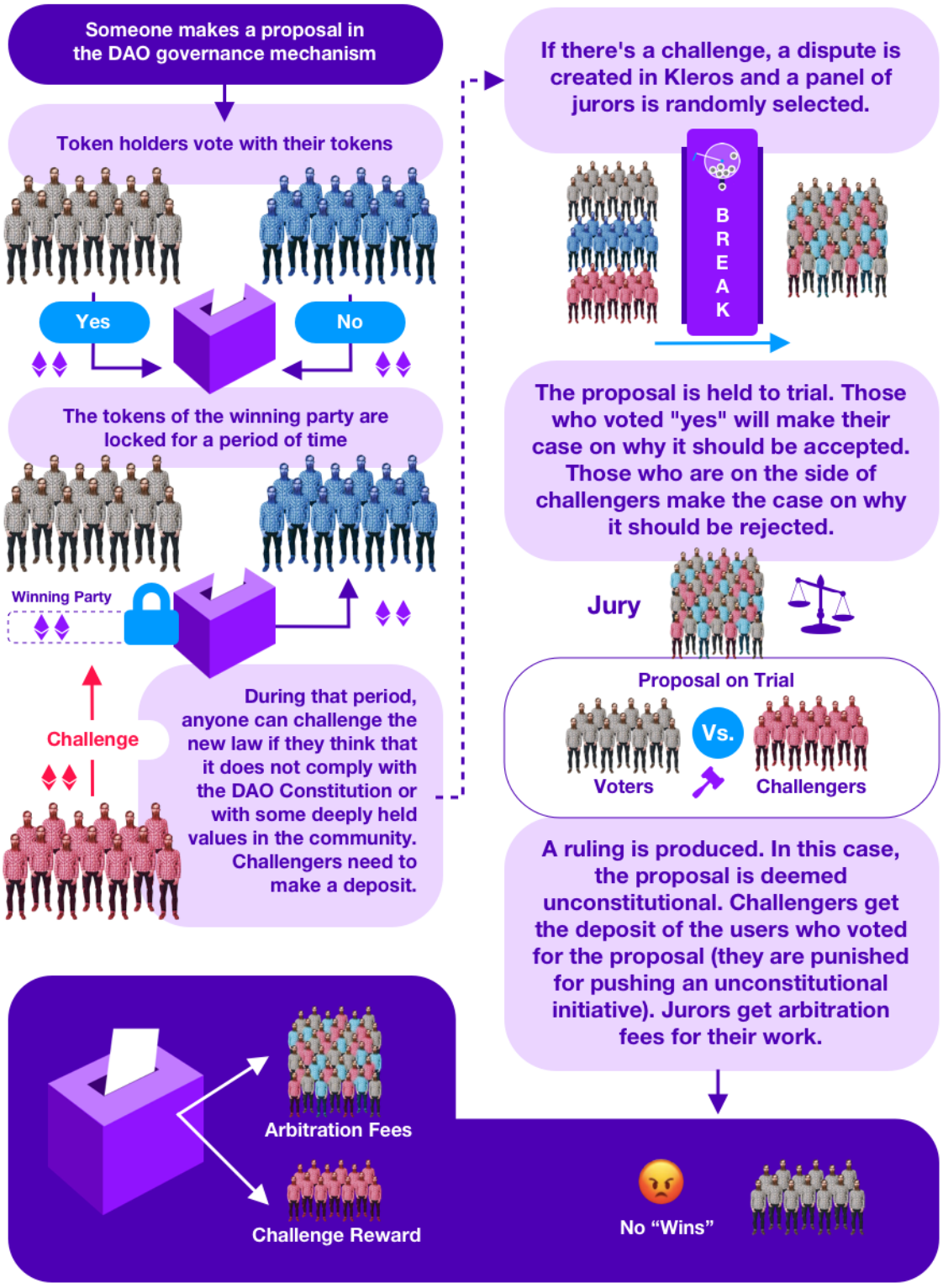
TOME PREMIER.

A GENEVE,

Chez BARRILLOT & FILS.

In his work "The Spirit of the Laws", Montesquieu argued that different countries had different optimal types of government.

Kleros as a Decentralized Supreme Court

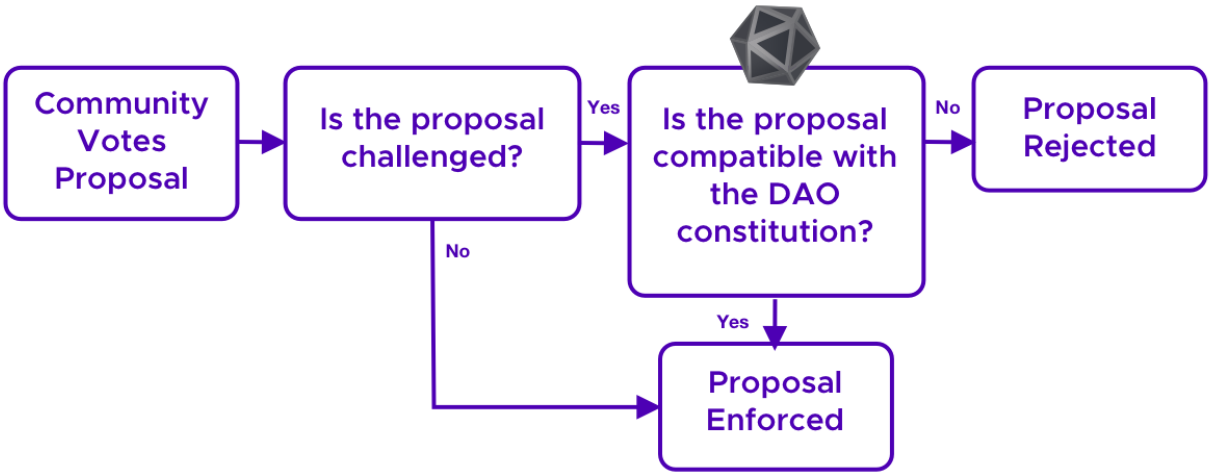


Moving forward, governance will be a key aspect of DAOs and blockchain scalability. In this context, the ability to define when a new law complies with the principles on which a community is built will be important.

This being such a new field, we have little experience in what works and what doesn't. But luckily we have history as a beacon on how human communities tried to solve their collective decision making problems in the past.

As Mark Twain famously said: "*History does not repeat itself. But it rhymes*".

The Ancient Greek and the tradition of social contract theorists teach us that a procedure is required to make sure that community driven initiatives comply with the fundamental values and norms that bind the group together.



Kleros can play this key role in the future of blockchain governance**: a Decentralized Supreme Court for the Internet.**

Of the people, by the people, for the people.

Chapter 2

Kleros Cryptoeconomics: Towards a Theory of Decentralized Justice

"If I have seen further it is by standing on the shoulders of Giants."
-Isaac Newton (1675).

Game theory is the study of interactions of decision makers. The choices that are made available to actors in these "games", the consequences that result from some set of participants' choices, and even the participants' manner of arriving at their decisions are all typically considered as obeying some mathematical model. These mathematical models are often inspired by economic interactions that are observed in the real world.

The field of mechanism design, which builds upon game theory, attempts to design new models that do not necessarily exist yet in the real world. Mechanism design is the study of choosing the rules of games in such a way that the expected behaviour of decision makers will result in desirable outcomes.

Governments, large corporations or other institutions are often able to structure people's lives through taxes, laws, company policies, contracts, etc, in such a way that the choices presented to actors and the consequences of those choices approximates a given game that has been determined to be likely to yield the institution's preferred behaviour. However, until recently, it was typically not possible to design these beneficial incentive structures without the intervention of some trusted third party.

Blockchains have introduced a new means for setting up incentive structures without the participation of a trusted third party. The structure of these games is defined via cryptography.

> The actions a player can take are limited, and taking some other action would require the player breaking some cryptographic system. The study of this mixture of cryptographic and game theoretic ideas, particularly in the context of trying to design games that will lead to desirable outcomes, is what we mean by *cryptoeconomics*.

For example, a Bitcoin miner can choose which transactions to put in a block or what block to mine on top of, but she cannot produce blocks faster than her hash power should allow

her to, unless she breaks a cryptographic hash function. Then, within what actions are available to the players, each with corresponding rewards and penalties, one can give a game theory analysis of how these players can be expected to behave. In the case of Bitcoin, one can prove that, under assumptions related to the rationality of players and the concentration of mining power, the structure of the game prevents double spending and leads to a consensus on which transactions are included.

Blockchains and cryptoeconomic ideas provide a new opportunity to create a crowdsourced dispute resolution platform like Kleros.

In order to be useful, a dispute resolution platform needs to be able to:

- Provide rulings that are perceived as fair, in accordance with the kinds of properties that are considered in the 'what-is-law' framework of Hadfield and Weingast.[30]
- Hold the disputed payment in escrow while a dispute is being processed and/or have the ability to oblige the losing party to comply with the dispute and pay the winner.

Kleros uses game theory to incentivize its ruling process. Many of the pure game theoretical tools it applies have existed for a long time. However, before blockchains and their ability to handle enforcement through smart contracts, we would have needed some mutually trusted party to enforce the incentives on actors and to handle the escrow.

Indeed, if there is a trusted entity that is willing to manage the escrow service, it is often the case that it would just make sense for that entity to provide rulings themselves. This is the model used by platforms such as eBay for their dispute resolution system.

Game theory based incentivization of the ruling mechanism is natural for a blockchain based system as blockchains themselves rely on game theoretic ideas to function. Hence, similar cryptoeconomic security properties underlie both the ruling and enforcement mechanisms of Kleros.[31]

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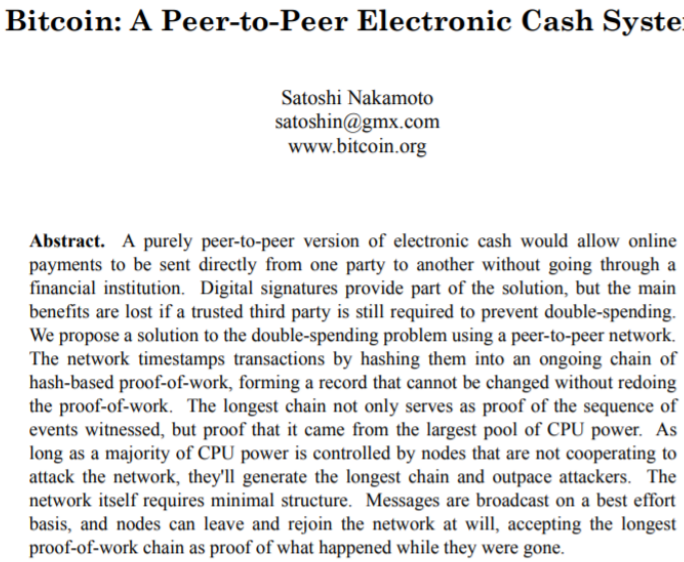
[30] See the Barry Weingast interview *On Law Merchant and Private Justice* in *Chapter 1 - Genesis: When Greek Lotteries Meet Medieval Law to* for more detail.

[31] For broad overviews of the kinds of cryptoeconomic tools available, see this introductory course into cryptoeconomics, as well as Vitalik Buterin's Introduction to cryptoeconomics.



Bitcoin: A Peer-to-Peer Electronic Cash System

Satoshi Nakamoto
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www.bitcoin.org

Abstract. A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.

A screenshot of the white paper of the first cryptoeconomic system - Bitcoin.

Cryptoeconomics in Kleros

In this section, we will briefly discuss a few specific examples of cryptoeconomic ideas that we are using in Kleros, or that we are researching towards the possibility of eventually including.

Schelling Points

Fundamental to Kleros is the concept of Schelling points. This is the idea that, if parties have an incentive to choose the same response to a question and they are unable to communicate, there are certain distinguished responses that they will gravitate towards.

In the context of Kleros, we expect that the honest answer to a dispute will be such a distinguished choice. Hence jurors, who vote in cases following a set of rules, will generally gravitate towards honest answers.

This will be explained in more detail in the article on Thomas Schelling and game theory, which delves deep into how game theory went from a purely theoretical critique of neoclassical economics to a key force which became used for military purposes, in

computer science, engineering, social sciences and other scientific fields.

Mechanisms Around Information Management

This chapter will also discuss mechanisms that help structure the flow of information between actors in Kleros. As Schelling points assume a lack of communication between participants, Kleros requires discouraging jurors from sharing their vote.

We envisage using 'commit and reveal'[32], where jurors each provide a cryptographic commitment to their vote before they are made public, potentially in combination with some kind of **anti-pre-revelation game**, which would impose an economic cost on jurors who reveal their vote prematurely.

Also related to encouraging an appropriate flow of information, our escrow system will allow parties to a contract to include a commitment to the text of that contract. During a dispute, a party that has a winning case would typically be incentivized to release (relevant parts of) that contract to the jurors, who can verify it against the commitment.

Going forward, we are also trying to imagine ways that *zero-knowledge proof systems*[33] can be potentially incorporated into Kleros so that the manner and timing of the release of information, such as the results of a given voting round, put participants in a situation where the economic game they play is likely to have desirable outcomes.

Sequential Proof of Work/Verifiable Delay Functions

Kleros is heavily inspired by the idea of random selection, a concept that can be traced back to the ancient Athenians and the city states of Florence and Venice in the Renaissance. The ancient Greek and the Italians of the *quattrocento* took great pain in making sure their random selection system was secure. This is also true at Kleros.

We expect to be able to use a random number generator for juror selection, such that one cannot know who the jurors will be within a fixed delay of when a party triggers a dispute. This way, a party cannot trigger a dispute at such a moment as to have particularly favorable jurors.

The idea is that jurors are determined by a process that involves taking information that only

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[32] Imagine a commit and reveal scheme like a quiz between a group of players. As players don't want their competitors to know the answers, first of all they hash their answer and submit it (the *commit*). Afterwards, everyone sumits their real answer (the *reveal*) and to prove that the answers are the same, it's possible to compare the hashes on-chain for validity.

[33] A zero-knowledge proof is a method by which one party can prove to another party that they know a piece of information 'x' without conveying any information except from the fact that they know 'x'.

becomes available the moment the dispute is triggered, such as a recent blockhash, and then takes a hash of this information. Then this hash is iteratively hashed a certain number of times.

The strength of the security guarantees which prevent the attacker from predicting which jurors will be drawn, as well as the integrity of proof of work mining would depend on the same kinds of hash power arguments. However, now even an adversary with a large degree of hash power will not be able to gain a large advantage over others because, as the hashes are computed on after another, calculating the result is a non-parallelizable task.

Appeal Mechanism

A key feature of Kleros is the use of an appeal mechanism. This allows for having cases judged by relatively small juries and avoiding unnecessary duplication of the effort. At the same time, the appeal mechanism provides security based on the costs and likelihood of success that an adversary would have if she attempted to attack some later appeal round. Indeed, an analysis of any of the cryptoeconomic components of Kleros has to be done in the context of how it interacts with eventual appeals.

In order to make appeal systems more accessible, it is sometimes useful to employ "crowdfunding" mechanisms. Here, third parties are incentivized to adopt part of the appeal fees of parties they believe to have winning cases, protecting honest parties that may not have the resources to trigger an appeal themselves.

Underlying Blockchain

As previously mentioned, the enforcement mechanisms in Kleros are handled by smart contracts executing on an underlying blockchain. So far, this is limited to the Ethereum blockchain, though building Kleros DApps on other smart contract platforms is a possibility in the future. As Ethereum is also a cryptoeconomic structure, one must keep in mind while designing Kleros how actions in Kleros will interact with the incentives of other actors (such as the miners) in the broader games on which Ethereum is based.

While building Kleros, we are always concerned with setting fees and making design choices in such a way that desirable equilibria arise – whether the game is played by rational players or whether we make more realistic assumptions about how rational the actors may be.

Particularly, we have studied how to make these choices in such a way that attacks have

acceptable griefing factors[34]. In case the attacker is willing to take a loss to harm another party, we seek that damage to the attacker is as large as possible compared to the harm done to the victim.

Finally, we expect to take the cryptoeconomic tool of Kleros itself and apply it back to other problems in blockchains. For example, the ability to build oracles and curated lists on top of Kleros enables new solutions to limitations that had been holding back applications of blockchain based systems in other areas.

This chapter focuses on exploring the game theoretical tenets of Kleros through a historic outlook of how game theory developed and an exclusive interview with professor Eyal Winter on the importance of game theory in distributed justice.

As core pieces of Kleros technology, we look at both the Kleros native token and the design, with an outlook on how legaltech applications should be made with users in mind and how policies should be shaped for ease of use. As a part of our research, we offer the basic structure of the policies surrounding Kleros and the way they are to be implemented in the system.

[34] To learn more, watch the talk *Griefing Opportunities in Kleros* by Kleros' CTO, Clément Lesaege, at the ETHCC 2018 conference.

Game Theory: the Cold War and How Reason Became Strategy

By Damjan Malbašić, Communications Director, Kleros

Lorraine Daston, Executive Director of the Max Planck Institute for the History of Science and her colleague, Michael Gordin, alongside her group of colleagues wrote a very interesting book titled *How Reason Almost Lost Its Mind* (2013) in which they studied how Cold War rationality came into being and the long-standing effects of a new understanding of what *reason* is.

In their Berlin workshop titled *The Strangelovian Sciences,* they note that:

> "Cold War rationality in all its variants was summoned into being in order to tame the terrors of decisions too consequential to be left to human reason alone, traditionally understood as mindful deliberation" (Daston 2013: 2).

In the times of the A-bomb, these 'terrors' became too apparent and this approach to understanding human rationality became a tool to comprehend and tackle this fear.

In their research, they studied something they called 'the silent club', a group of authors including John von Neumann, Oskar Morgenstern, economist and strategist Thomas C. Schelling, his pupil, economist Daniel Ellsberg and Edwin Paxson (the man who coined the term "systems analysis") at RAND to mathematical psychologist Anatol Rapoport, game theorist Martin Shubik to political scientist Albert Wohlstetter and many others.

Their work revolved around RAND, the Office of Naval Research, the Cowles Commission, the Center for Advanced Study in the Behavioral Sciences, Harvard's Laboratory of Social Relations and so on. (Weintraub, 2017)

As defined by MIT computer scientist Joseph Weismann, this group understood reason as "restricted to 'formal thinking, calculation and systemic rationality'" (Daston 2013: 29). With this definition of reason and their peculiar perception of human relations, they triggered a

revolution in fields as diverse as psychology, sociology, computer science, cybernetics and economics.

Game Theory: from Theory to Practice

This tale of human reason and utility as a computable element begins with 'the last great mathematician', Hungarian-born John von Neumann, who fathered game theory as a mathematical discipline.

In his now famous minimax theorem, proven in 1928, he established that in zero-sum games where each player knows all moves that have taken place so far, there are a pair of strategies for both players that allow each to minimize his maximum losses (hence minimax).

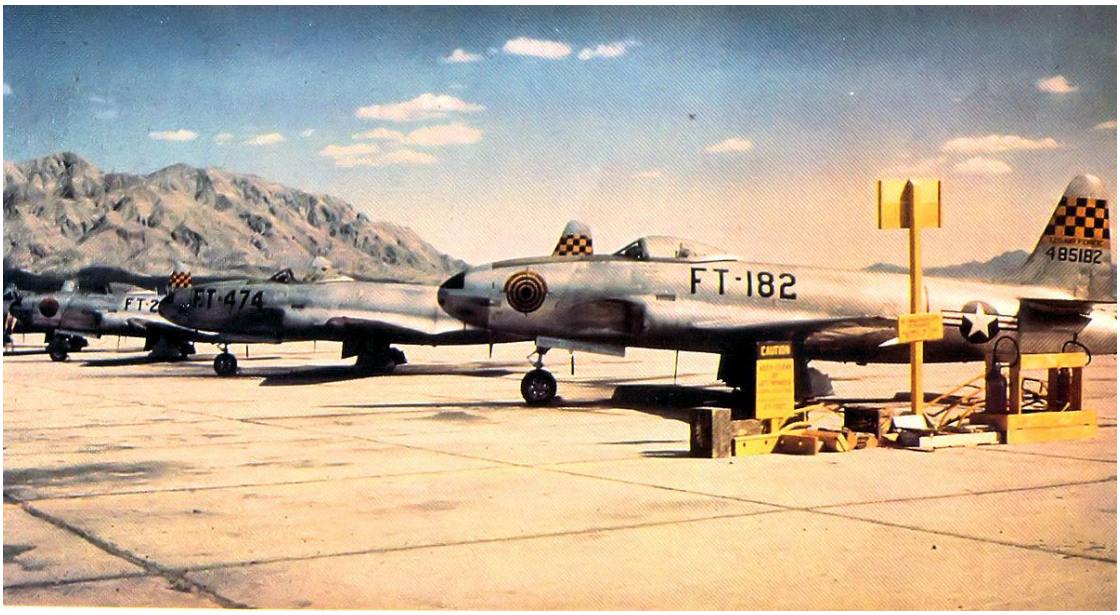
This seemingly simple concept was expanded upon greatly in 1944 when von Neumann published the ***Theory of Games and Economic Behavior***, coauthored with the German-born economist Oskar Morgenstern. In this book, they implemented the mathematical tenets of game theory into economics.

Oskar Morgenstern (left) with John von Neumann (right), Credit: Shelby White and Leon Levy Archives Center

During World War II, the US Applied Mathematics Panel, directed by mathematician Warren Weaver gathered a group of mathematicians to create an index of gains and losses in specific military operations.

Weaver himself stressed the importance of numerical theory of utility of the *Theory of Games and Economic Behavior* in his work and used it in their computations. After the end of the war, the AMP was revamped as the think tank we know now as RAND and thus effectively, game theory became an institutionalized area of research.

The work done by RAND focused in the first years on aerial warfare and the development of game theoretical models of aerial duels - dogfights, clashes between fighters and bombers and attacks on killer submarines.



USAF Fighter Weapons School F-80, around 1950. Credit: United States Air Force, Menard, David W. (1993) USAF Plus Fifteen: A Photo History, 1947-1962

The field quickly expanded with the work of the Cowles Commission in Chicago and their collaboration with RAND, as well as through the labour of the Office of Naval Research. It is exactly this office which funded academic research into game theory as a building block of a "science of warfare" to optimize the performance of the Air Force. (Hounshell, 1997: 244)

The RAND research teams delved deep into game theory and planted the foundations of future exploration of the field. This highly prolific group gathered top scholarly talent, such as John Forbes Nash Jr[35], among others.

With strong political backing and financial support from the Air Force, as well as private parties, such as the Ford Company, the impact of game theory on Cold War thinking

[35] John Nash was the author of the now famous equilibrium theorem in N person games. His name is often connected nowadays with the film *A Beautiful Mind*, but his research into what we now call the *Nash equilibrium* represents was key for future development of game theory. Taken simply, in the context of non-cooperative games, the Nash equilibrium is a situation where players make the best decision possible, taking into account the decisions of other players in the game, as long as the other parties' decisions remain unchanged. This understanding of the strategic interaction between decision makers paved the way for a better understanding of hostile situations like war and arms races, but also a better understanding of mitigating conflict by repeated interaction. (Nash 1950)

increased rapidly in the 1950s, especially with the entry of the Harvard economist and former member of the Executive Office of the President, Thomas Schelling.

The Great Strategist

Thomas Schelling came from a realist political background, deriving his rationale from the likes of Carl von Clausewitz and Niccolò Machiavelli. His background in working on the Marshall Plan in Europe and his strong political connections made him a perfect candidate for RAND. This is not accidental, as the postwar interplay between international economic policy and military policy was very strong. (Sent 2007)

Following the logic of Clausewitz that war is just an extension of diplomacy by other means, Schelling, a trade negotiator in international conferences saw war as a continuation of bargaining by other means.

Schelling's ideas during the 'golden age' of security studies in the period 1955-1965 were instrumental in the shaping of US government policies about nuclear deterrence. (Ayson 2004) In his own words, strategy's theoretical development had been hampered because "the military services, in contrast to almost any other sizable and respectable profession, have no identifiable academic counterpart". (1960: 8)

Thomas Schelling at the New America Foundation in 2010, Credit: New America Foundation, CC BY-SA 2.0

To understand the significance of Schelling's approach, it is important to understand the crisis in which the entire world found itself in the early 1950s. With the beginning of the Soviet testing of atomic bombs and the crumbling of American arms superiority, the central question in policy making circles in Washington was how to use nuclear weapons in a limited, coordinated manner without invoking Armageddon.

Before the Soviets developed their own Bomb, the Eisenhower administration envisaged a strategy of 'massive retaliation', which essentially meant using superiority of arms to deter initial attacks.[36]

In the context of the US-Soviet struggle, both states wanted to maximize their gains in the conflict, while at the same time avoiding nuclear war. These intermingled interests led to Schelling's theory of 'salience', where settlements between parties tend to occur at certain prominent points that focus the expectations of both parties, known as focal points. (Schelling 1960: 54-8)

In practical terms, this meant that the US and the Soviet Union could achieve bargains by means of deterrence and compellence. By deterring the opponent from acting in a certain manner, while persuading him to do something at the same time through threats and promises meant that equilibrium was achieved.

To make credible threats, Schelling proposed an adventurous approach - deliberately acting as an irrational actor and creating risk that leads to a bad outcome if other players failed to act as they are expected to. This approach meant that apparent recklessness or unreliability could help achieving credibility and that would, in a greater scheme of things, be strategically rational.

This paradoxical situation led to the idea that the ability to destroy populations was effectively conducive to peace, while the ability to destroy weapons increased the risk of war. This was coined as *the paradox of deterrence*. (Kavka 1978)

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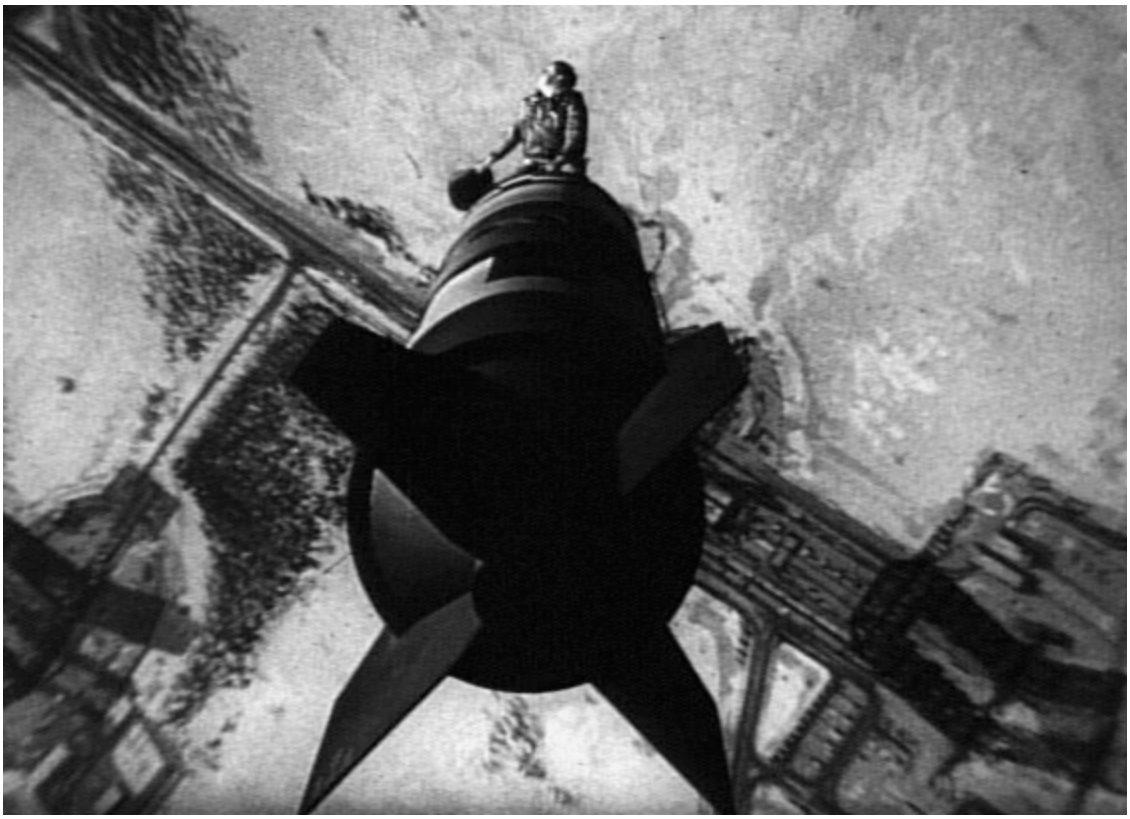
[36] This kind of an approach essentially meant that escalation of conflict could potentially be unlimited. What Schelling proposed was a focus on 'limited war'. (Mirowski 2002: 368) It is exactly this kind of an approach that was taken up by Lyndon Johnson and Robert McNamara at the start of the Vietnam War, which stands until today as a black mark on Schelling's biography, but that's another story.



The famous bomb riding scene from Stanley Kubrick's film Dr. Strangelove, on which Schelling was an advisor. According to Schelling, one of the only ways for a nuclear war to start was for military or state leaders to be a bit crazy. Credit: Major T. J. "King" Kong (Slim Pickins) riding the bomb in Stanley Kubrick's 1964 film, Dr. Strangelove.

The Application of Focal Points

In 1960, at the time he published the book *The Strategy of Conflict*, Schelling research focused on the clash between the great powers, but his concept of focal points resonated much further and had a significant impact on research on general decision making.

In his game theoretical experiments with students, the military and policy makers, Schelling found that there are certain points of consensus that humans get to without communicating between themselves. In his early experiments, Schelling discovered some of these points (Schelling, 1960):

- Name 'heads' or 'tails'. If you and your partner name the same, you both win a prize. 36 people chose heads and only 6 chose tails.

- You are to meet somebody in New York City. You have not been instructed where to meet; you have no prior understanding with the person on where to meet; and you cannot communicate with each other. You just have to guess where to go.

The majority selected Grand Central Station.

- You were told the date but not the hour of the meeting in the previous question. At what time will you appear?
  Virtually everyone selected 12:00 noon.

Schelling suggested that:

> "These problems are artificial, but they illustrate the point. People can often concert their intentions or expectations with others if each knows that the other is trying to do the same. Most situations… provide some clue for coordinating behaviour, some focal point for each person's expectation of what the other expects him to expect to be expected to do." (Schelling, 1960: 57)

This analysis of human behavior opened a plethora of questions for social scientists and led to further research into how humans reach collective decisions and how to apply this kind of incentivized thinking into action.

The New Strategy of Conflict: Blockchains, AI and the Future of Game Theory

Game theoretical concepts are important in the blockchain field. We know that Schelling points, or focal points, as a game theoretical example, in essence function as points of salience which are reached with specific kinds of incentives, influencing actors to reach certain strategic decisions in a coordinated manner.

Blockchain is envisaged as a decentralized system, a network of computers able to regulate itself. Having the ability to mathematically model human reasoning to shape networks that need no oversight and function for the common good, it becomes clear that game theory is core for blockchain social technology.

Cryptography gave the world the SHA 256 and a way to secure networks. Game theory gave us a tool to focus human reason on economic incentives, thus to be able to encourage positive behavior in these networks. This is what we call today cryptoeconomics.

Another child of von Neumann spread its wings at the beginning of the 21st Century - algorithmic game theory. The Internet, according to Noam Nisan, is a “ubiquitous and quintessentially organic computational artifact” that transformed, informed and accelerated markets, while creating new and unimaginable kinds of markets - in addition to being itself, in important ways, a market. (Nisan 2007)

This twist turned computer scientists to thinking in the terms of game theory when envisaging these interactions. As Scott Schenker, a pioneer in this field, once said "the Internet is an equilibrium, we just have to identify the game". This fusion of ideas of game theory and algorithms came to be used to unravel the mysteries of the Internet.

What stands as an open question and is intriguing to think about is - will this reduction of human reasoning to mathematical models function as intended? We find ourselves at a very exciting time, with promises of decentralized money, decentralized courts, decentralized governance, but we still have a long way ahead of us until these promises are fulfilled.

This is exactly why it is of utmost importance to understand the history of the basic concepts from where this brave new world comes and comprehend that, however ingenious they might seem, theories that lack in “the mud, blood and local political determinants of real history” (Ayson 2004; Williams 1991) might turn out more problematic than expected.

Eyal Winter on Game Theory and the Challenge of Decentralized Justice

Interview by Federico Ast, CEO, Kleros

Eyal Winter, Ph.D., is the Silverzweig Professor of Economics at the Hebrew University and Economics Professor at Leicester University. He is a member and a former director of the Center for the Study of Rationality, an elected council member of the International Game Theory Society and an elected fellow of the Economic Theory Society. He was awarded the Humboldt Prize for excellence in research by the German government in 2010. Winter has presented his work in more than 120 research institutes in 26 countries around the world including Harvard, Stanford, Princeton, Berkeley, Cambridge, and Oxford. His book *Feeling Smart: Why our Emotions are More Rational Than We Think* was published in January 2015.

How did you start researching the connection between game theory and legal systems?

Legal systems, to some extent, can be portrayed as a game. I have several joint works with people who work in law in Israel, both on theoretical works on how to design constitutions: how to design a legal system that is economically optimal? How do you draft a bill that will have the maximal ability to deter at minimal cost? How do you allocate cost in tort law?

These issues require a game theoretical insight. These collaborations are with legal people that need my expertise in game theory and I enjoy doing it.

On the other hand, my PhD supervisor, Bezalel Peleg[37], made some of the most important contributions to the theory of voting.

He made most of his career in what we now call social choice theory, a branch of game theory which deals with collective decision making. This field was started by mathematicians like Condorcet and Borda in the period of the French Revolution. They introduced some of

[37] Bezalel Peleg is a professor emeritus of mathematics and the author of *Game Theoretic Analysis of Voting in Committees*, published in 1984. He is one of the world most renowned experts on voting theory and social choice.

the most important concepts in social choice theory, like the Borda Voting Count and the Condorcet Principle.

The other person who influenced me was my good friend, Kenneth Arrow[38]. He is probably the greatest economic theorist of the 20th Century.

His main contribution, which got him his Nobel Prize in 1972, is known as the ***Arrow Impossibility Theorem***. He pointed out a very crucial difficulty that we face whenever we are trying to design a well-behaved voting system. He found that there is an inherent problem in achieving desirable properties for voting rules that you must compromise if you want to create such a system.

It's a fundamental theorem that is now being taught across the world in economics, in mathematics, but also in fields such as social science, computer science. There is a lot of work being done on the Arrow Theorem by people doing algorithmic game theory at computer science departments.

[38] Kenneth Arrow was awarded the Nobel Memorial Prize in Economic Sciences in 1972 with John R. Hicks for his contribution to general equilibrium theory and welfare theory

Marquis de Condorcet was a French philosopher and mathematician who pioneered the application of mathematics to social sciences. He is the author of the famous Condorcet voting method that elects the candidate that would win a majority of the vote in all of the head-to-head elections against each of the other candidates, whenever there is such a candidate. Image: Portrait of Marquis de Condorcet, circa 1789-1794, Credit: Salles des peintures XIXe Attique Chimay, Versailles

It's quite interesting that you mention Condorcet and how they researched voting in the early days of the French Revolution. Projects like Kleros and others working on blockchain governance are like the Federalists in the United States who were trying to find out what are the best institutions to scale democracy: what should be the best voting system in a time where there was no previous experience in designing voting systems? In the case of Kleros, we are trying to find out what is decentralized justice, how it should work when there hasn't been any previous experience in this...

Decentralized justice is potentially a new area on which we didn't put too much thinking in the past, just because the technology wasn't available. Sometimes really big ideas come up

in science because some technology is making us conscious of things that were not relevant in the past, as we could not use them.

It's an opportunity to design a new legal system that, at its' first steps, would only involve clearly civil cases and not criminal cases, because there is still a lot to do to put people in jail as a result of people fighting online. That stage may potentially also appear, who knows, but clearly only in the future.

These pioneering engagements in this world are very important, it's very mind boggling and you should be very fortunate to be engaged in it.

What are these new technologies that made this the right time for decentralized justice? Why now?

To some extent, the main thing is the size - the ability to get a lot of opinions together, the crowd wisdom effect that we couldn't get from juries in the past, the easiness of handling juries. We don't have to get juries together in a room and lock them up until they make a decision.

We have a better way to control what kind of information we want them to know. We have a better way to affect the thing which they will be influenced by. In traditional courts, you hear a piece of evidence from the defendant's side or from the prosecution side, the judge decides this piece of evidence was not generated legally and instructs the jury not to take account of this piece of information.

This is very hard to do for the jury when members know that the evidence is there. With decentralized justice, we can control what we want the jury to be influenced by and what not. It's about size, it's about the screening, a more rigorous control of information and it's about the speed at which decisions are being made.

These three aspects have been changed due to the advances in computer technology. The fact that we can make this kind of decision online facilitates all these properties that we couldn't achieve in the past.

What are the main challenges this emerging field has to overcome to become a reality?

The big challenge is to convince the public and the policy makers that what we are doing is not repugnant. Many people will treat decentralized justice as unfair.

People fear technology in all corners of life. But this fear gets stronger when we get to justice. Justice is a very elementary right, something that we don't want to see violated. It's very much like health, people are still very reluctant to be diagnosed by a computer.

“You can’t let a computer decide justice” - that is a very difficult attitude that we will have to fight against.

We will have to convince the public and the policy makers that this technology is not only for making things faster and less expensive, but it’s also making the decisions better.

It’s also providing an outcome with a higher quality than the past. This is going to be a very difficult task, because what we are lacking with decentralized justice is the counterfactual: what would have been the decision if we did things the old way?

The other aspect is that we cannot ever know *ex-post*, even when we get a very smart jury, a very qualified bunch of people who exert a lot of effort at making a decision, we will never know after they decide whether they decided correctly.

This is a huge obstacle to convincing policy makers that they should use it. But I think that gradually, with the mistakes that traditional juries make and with AI influencing other fields of life, we will be able to convince them that we should also change the justice system.

The way to do it is not by going against the conventional legal system, but rather to recruit the classical justice system into this new technology. To convince judges, courts, lawyers, policy makers in governments that this is something to help the public.

Not to compete with them, but to help them implement it gradually and eventually maybe develop some way, a hybrid system which uses the classical courts together with some sort of a decentralized component in it. This will ease things in ways of introducing it into practice.

In my talks with government officials, they do understand what decentralized justice can do for traditional justice systems. Small claims, like disputes for a couple of hundred dollars, cannot be handled by these systems. There is no other solution than decentralized justice. That’s maybe a good way of collaborating with conventional justice systems: by helping them reduce the saturation of disputes and cut costs.

It’s not just saturation. When it gets to $1000 or $5000, you ease the standard justice systems by taking some of these cases into your territory. But when it gets to $100 or $200, you don’t reduce the burden on them, but you generate more justice, because these people who find themselves in disputes over a couple of hundred dollars never go into the standard court systems. It’s just too expensive to engage yourself in a case.

The outcome of this is that these people are left without justice. What decentralized justice can do is actually offer them this right of justice even when the amount of money in a dispute is marginal. This is how decentralized justice can make a contribution to the world.

Why Kleros Needs a Native Token: Security and Incentives in Decentralized Justice

By William George, Director of Research, Kleros

An essential part of Kleros mechanism design is the native pinakion token (PNK).

For each dispute that is arbitrated by Kleros, a certain number of jurors are required. A jury as small as three people may provide an initial ruling of a dispute. Then if one of the parties decides to appeal the ruling, the number of jurors in subsequent rounds increases.

PNK holders can stake their token in a Kleros court to indicate their availability to serve as jurors. In order to select the jurors for a case, random PNK are drawn from among those which have been staked, and the people who hold these PNK will become jurors.[39]

Why Does Kleros Need its Own Token?

First and foremost, PNK is a protection against sybil attacks[40]. In order for an attacker to flood the juror pool, it would need to buy enough PNK so that it is selected enough times to be a juror for the same case in order to change the outcome. Generally, this means that the attacker would need more than 51% of the total staked tokens in the court under attack.

In rare circumstances, an attacker may get lucky and be selected for two of three juror spots with only a minority of the PNK. However, in order to maintain the attack through the appeal process, it would need to be selected for the majority of the juror spots on larger and larger juries. This will only be possible if the attacker actually has a majority of the PNK that is staked. Hence, substantial economic resources are required to perform a 51% attack.

So far, this would still be true if we had potential jurors stake ETH instead of PNK. However, using a native token offers several key advantages for minimizing the risk of 51% attacks versus using an external cryptocurrency.

PNK Makes Attacks Hard

If would-be jurors were drawn based on how much ETH they had staked (rather than PNK), it would be much more viable for an attacker to try to buy enough ETH to outspend the rest of the market. If an attacker wants to obtain 51% of PNK, market liquidity will dry up.

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[39] For a general view on how Kleros mechanism design works, see *Kleros, a Protocol for Decentralized Justice*.

[40] A sybil attack in computer security is an attack in which a reputation system is subverted by the attacker forging identities.

As the attacker keeps buying PNK, the token will become scarcer and each additional PNK will cost more and more. The attacker may not even be able to find 51% of PNK for sale on the open market at any given time.

In contrast, consider the situation of an attacker who wants to buy enough ETH to make a stake that is greater than whatever would be already staked in Kleros courts at a given time. There is a much larger quantity of ETH in the market, and Kleros will presumably only represent a part of the broader Ethereum ecosystem.

In 2019, 24 hour market volumes for ETH are hovering around 3 billion USD with all time highs near 10 billion. If someone wanted to buy enough ETH to overwhelm whatever is staked in Kleros, it probably wouldn't take them all that long. Moreover, the market for ETH is much deeper than the market for PNK. So, while a large purchase of ETH might move the price of ETH a bit, market liquidity effects wouldn't come to Kleros' defense in the same way as they do by having a native token.

PNK Makes Attacks Expensive

Imagine that someone does buy 51% of the PNK in an effort to attack Kleros. Maybe their attack will be subtle and go unnoticed. However, the community will more likely realize that it is under attack, particularly if the attacker uses her new PNK to commit obvious miscarriages of justice.

In this case, Kleros would lose credibility as an arbitration platform, people would stop using it, and the value of PNK would decrease. Then the attacker would take a substantial loss on the PNK she bought, representing a high economic cost to carry out the attack.

On the other hand, an attack on Kleros would presumably not have that large of an impact on the price of ETH. So, if stakes were made in ETH, an attacker could perform her attack. After this was successful, she could sell her ETH in the open market without taking a significant loss.

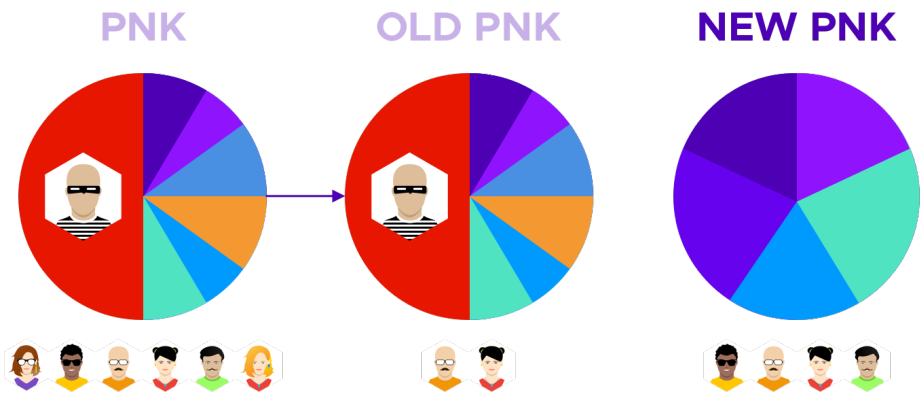
The price of Bitcoin Gold (BTG) over a recent period in 2018 where it suffered a 51% attack. In Kleros, performing a 51% attack requires holding 51% of the tokens, so the attacker should take a hit in value on each one of her tokens.

PNK Makes Kleros Forkable

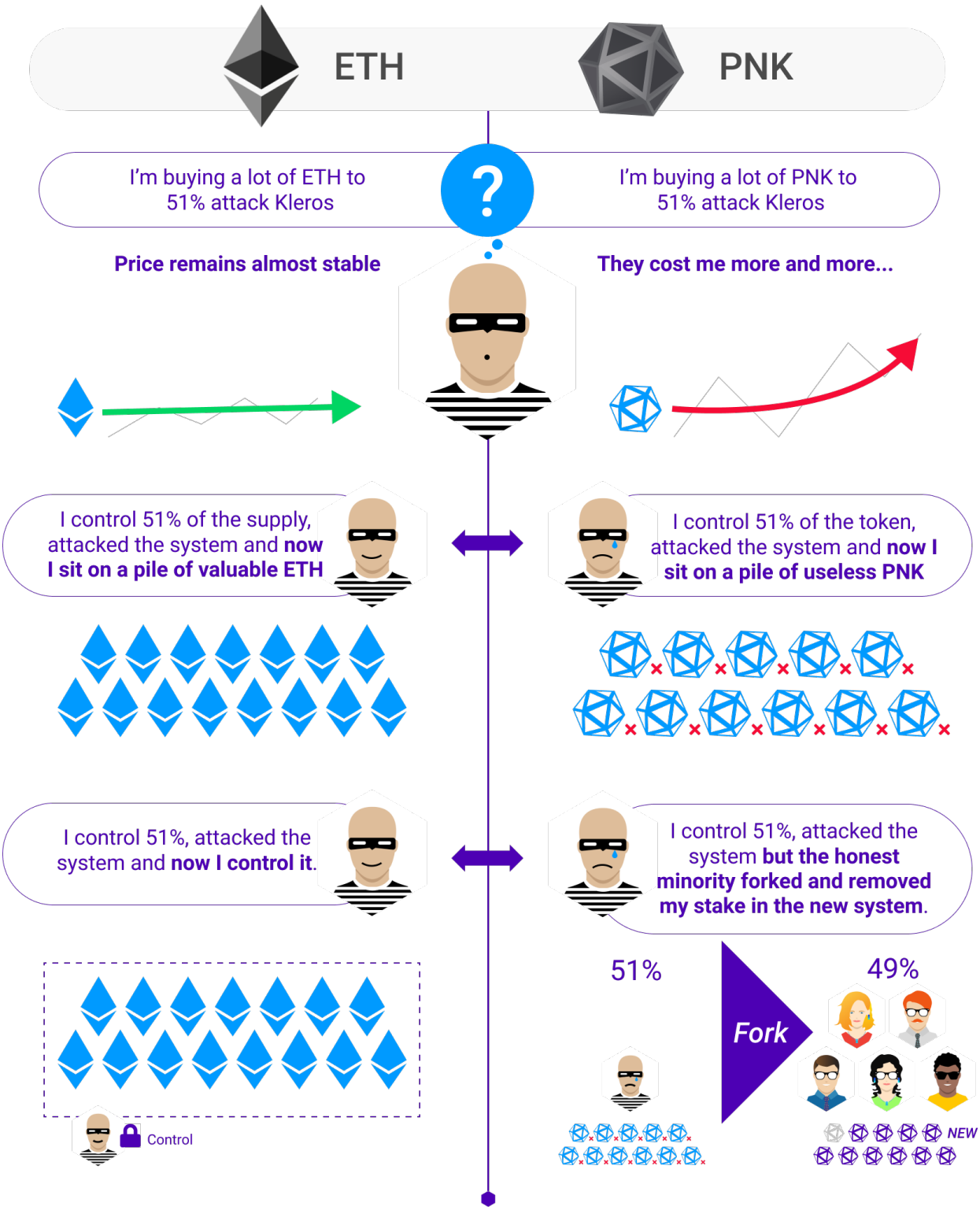
In the extreme case of a successful 51% attack, by having a native token, it is still possible to perform a last-ditch defense of forking the system to remove the attackers' holdings. Then the market would sort out which version of PNK should be used going forward.

This would of course be highly disruptive as any pre-existing contracts designating Kleros as their arbitrator would continue to use the old version of PNK by default. Still, it would offer the community a path forward out of disaster that would not be available without a native token.[41]

[41] This defense mechanism is similar to the ultimate appeal mechanism of Augur. An example of a fork that resulted from a divergence of the needs of a part of a blockchain community is the split between Ethereum and Ethereum Classic that followed the DAO attack.



On the left, an attacker has managed a 51% attack and starts carrying out obvious miscarriages of justice. The community decides to fork the token removing the attackers' holdings, and most of the users migrate to the new version of PNK.



To summarize, Kleros needs its own token as a defense against 51% attacks. This token gives users the ability to be selected as jurors. As such, users should have an interest in holding

PNK tokens because of the opportunity that these tokens represent to receive fees and rewards for coherence for arbitrating disputes.

Kleros and Mob Justice: Can Wisdom of the Crowd Go Wrong?

By William George, Director of Research, Kleros.

Twelve Angry Men is an American courtroom drama film which tells the story of a jury as they deliberate the conviction or acquittal of a defendant. Image: Twelve Angry Men, Sidney Lumet, 1957.

In Kleros, we resolve disputes through crowdsourcing. Specifically, we randomly select a group of jurors that rule on the case. To incentivize the jurors to be honest, they are rewarded or penalized based on whether or not they are coherent with the vote of others.

The basic idea is that, if you don't have any information on how the other jurors are going to vote, you think that they are more likely to be honest than not. You might reason that this is the case if only because honesty is a distinguished choice that the juror population is likely to gravitate to. Namely, we expect voting honestly to be a Schelling point for rational, self-interested jurors.

There are two basic situations where jurors may not reach the 'right' decision:

- The natural Schelling point of the case (the decision that an infinitely large group of jurors that are not communicating among each other would arrive at) is the 'right outcome,' but the chosen jurors nonetheless don't arrive at that outcome.
- The natural Schelling point of the case is 'wrong,' namely it would result in an unjust outcome. This might be due to systematic biases in the juror population.

Kleros has a number of built-in defenses against the first failure case. Principally, our appeal system makes it difficult for such deviations to persist. We have done a more detailed analysis of these defenses in other places.[42] Here we will focus on the second kind of failure case.

Biases in Justice Systems

In the film classic *Twelve Angry Men*, a single juror blocks what would otherwise be a unanimous decision of a twelve person jury in a case carrying the death penalty. With this extra time to reflect, the jury more carefully considers the evidence and concludes that it is not sufficient to convict.

In the film, each of the eleven jurors who initially vote guilty has his own motivations, among them biases against the defendant's racial and economic background, as well as merely a simplistic analysis of the available evidence leading to confirmation bias.

Similar effects could apply to Kleros juries as well. In traditional courts, the primary defense against juries falling into simplistic reasoning is convincing arguments from lawyers during the proceedings. In Kleros, the parties can submit evidence, and it is not unreasonable to imagine that someday there will be an industry of crypto-lawyers that counsel parties on what evidence to provide in high-stakes Kleros cases.

Blinding Jurors Against Information Generating Biases

An initial defense against jurors falling into biases based on irrelevant information such as the demographics of the parties is that Kleros cases are 'blinded' against such information. When you create a contract (a real-world contract, written in English or some other human language) that designates Kleros as the arbitrator in case of eventual dispute, you include a cryptographic commitment to that contract in an Ethereum smart contract.

For this, it would have been sufficient to include the hash of the contract text. However instead, the contract is split into clauses and a Merkle tree is formed out of the hashes of these clauses. Then the root of this tree is included in the Ethereum smart contract.

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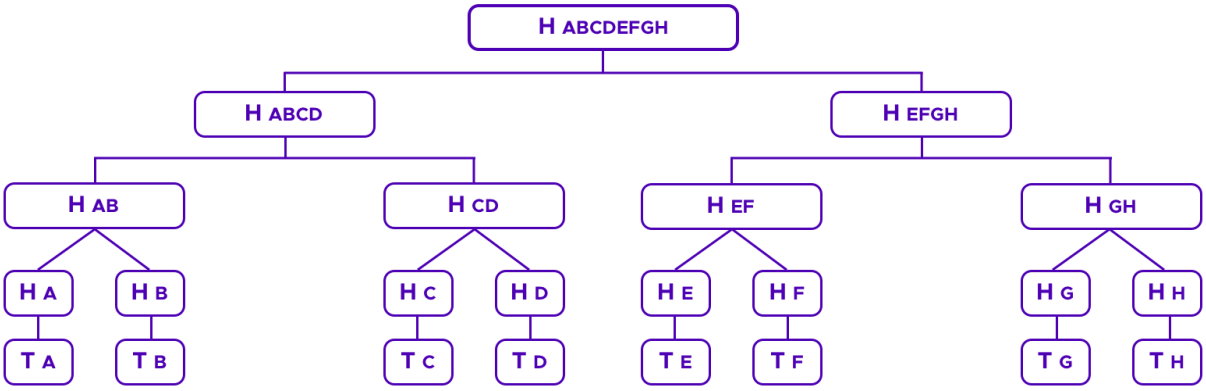
[42] To learn more about this, read the article *Why Kleros Needs a Native Token:Security and Incentives in Decentralized Justice* by William George.

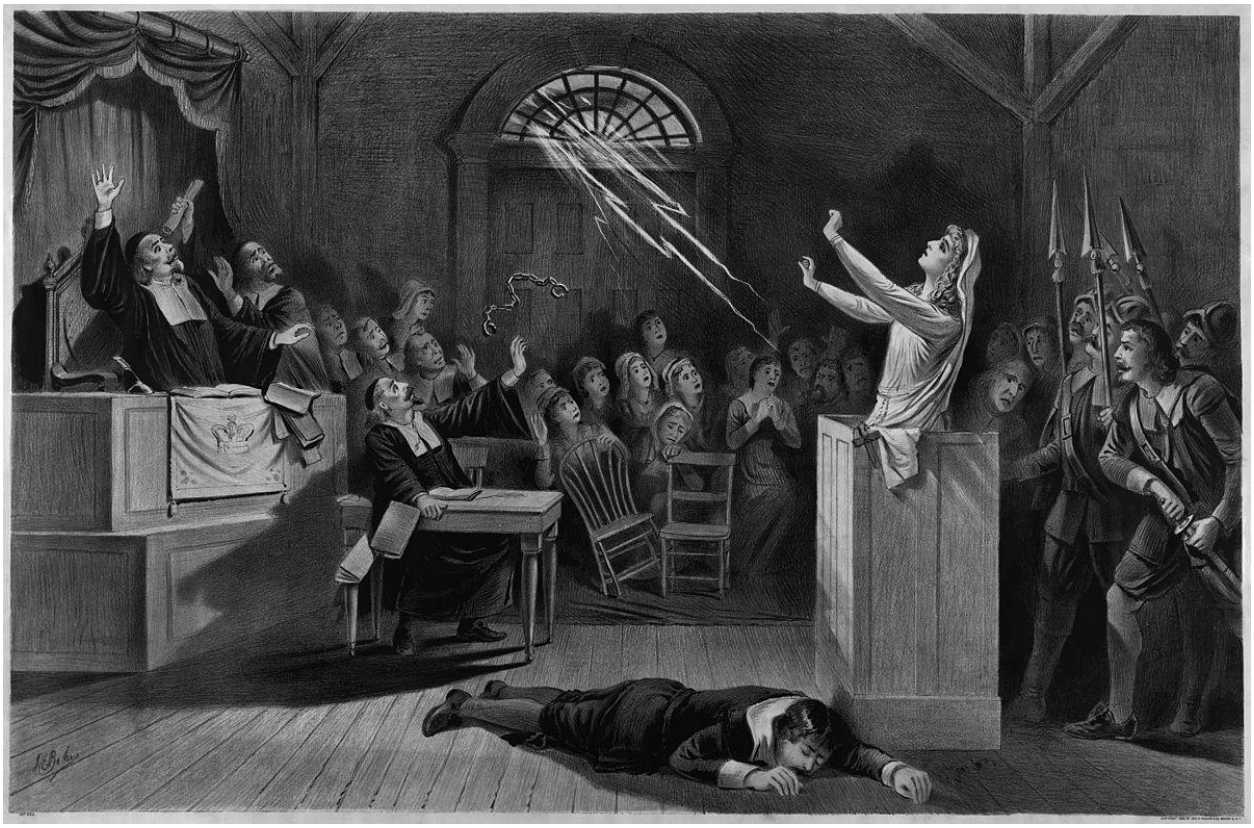
Hence, the clause(s) that are relevant to the dispute can be revealed to the jurors without showing them the rest of the contract. Then, if the full contract would make clear, for example, the national origins of the parties, this might be able to be nonetheless concealed from the jurors. Note that this idea is similar to the double blind peer review used by many academic journals, where authors' names and affiliations are not shown to reviewers to avoid biases.



The use of the Merkle Tree structure enables Kleros to only show to jurors the information from the contract that they need to know, to avoid unnecessary biases.

This is, of course, an imperfect defense. Often, the nature of the case will require that demographic information of the parties be revealed. In a dispute where a small business owner is unhappy with a website for her business designed by a freelancer and wants a refund, the jurors will have to be provided with the website as evidence, which will presumably reveal a lot of information about the small business.

Moreover, as both parties possess the full contract, either could publish it in its entirety if they thought that would give them a tactical advantage. Nonetheless, a party might not want to publish information on the other party that is clearly irrelevant to the case for fear of appearing too blatant and causing a backlash among the jurors.



Arthur Miller's play The Crucible tells the story of the witchcraft trials in Salem, Massachusetts, in 1692/1693. A different case of a justice system gone awry. Image: ***The witch no. 1*** *litograph, Joseph E. Baker, circa 1837-1914, Credit: Library of Congress Prints and Photographs division.*

Is There Any Such Thing as a Unbiased Justice System?

It is true that there will sometimes be situations where jurors will gravitate towards Schelling points that are unjust. However, these kinds of biases are also present in other justice systems.

According to the United States Sentencing Commission, there are important differences in judicial outcomes in traditional courts based on such demographic characteristics of the defendant as race, gender, and immigration status when controlling for the type of crime committed. In some cases, sentencing has even been seen to be substantially more or less severe depending on whether the sentencing hearing is before or after the judge has had lunch (Danziger, Levav, Avnaim-Pesso 2011).

Part of the reason *Twelve Angry Men* is such a compelling film is that the premise of a jury rushing to a hasty judgment is tragically believable, while the idea that a lone voice of reason can change the tide is something we want to believe in.

In Kleros, we envisage penalizing jurors if they provably communicate their votes with each other, as a defense against such communication altering the Schelling point. So admittedly, a lone Kleros juror would not be able to gradually convince the others of his or her point of view as Juror 8 does in *Twelve Angry Men*.

However, the film should not necessarily be taken as representative of the role of deliberation in the traditional justice system. Indeed, studies show that, for better or for worse it is, in fact, quite rare for jury deliberations to end in a result that had minority support on the jurors' first vote, particularly when this support is below a critical threshold of around one fourth to one third of the jurors. (Devine, Clayton et al. 2001)

In fact, game theoretical work modeling juror utility in traditional settings has concluded that, due to strategic voting, juries requiring unanimity can counterintuitively result in higher conviction rates of innocent defendants than juries not requiring unanimity. (Feddersen, Pesendorfer 2014)

Further work in this vein shows that in the model of not requiring unanimity, at least for small juries, better outcomes are reached if jurors do not deliberate as this avoids issues where jurors free-ride on the efforts of others and do not rigorously examine the case for themselves. Note that non-deliberative juries are used in the Brazilian legal system and were used in ancient Athens. (Guha 2018) (Leib 2008) (Boegehold 1963)

Indeed, the degree to which the result of Twelve Angry Men is exceptional is highlighted to the viewers by a dialogue between the characters, where it is pointed out the uphill battle Juror 8 faces in convincing any of the other jurors to reconsider, and the high likelihood that in case of a retrial any other jury will fall into the same biases as the first and convict:

> "Juror 7: What do you think you're gonna accomplish? You're not gonna change anybody's mind. So if you wanna be stubborn and hang this jury, go ahead. The kid'll be tried again and found guilty sure as he's born.
> Juror 8: That's probably right."

This discussion should not be interpreted as a slight against the traditional court systems. We at Kleros have a lot of respect for the legal system. However, providing just outcomes is a thorny problem. Kleros aims to provide affordable and fast dispute resolution, most notably for the kinds of small claims that it is not worth taking to the existing justice system. One can not reasonably expect Kleros to also be more rigorous than that of the expensive and slow traditional justice systems of countries with a well-established rule of law.

Ultimately, we see that when facing situations where a juror population gravitates toward an unjust decision, Kleros has many of the same challenges as existing justice systems.

To quote Atticus Finch from To Kill a Mockingbird:

> "I'm no idealist to believe firmly in the integrity of our courts and in the jury system — that is no ideal to me, it is a living, working reality. Gentlemen, a court is no better than each man of you sitting before me on this jury. A court is only as sound as its jury, and a jury is only as sound as the men who make it up".

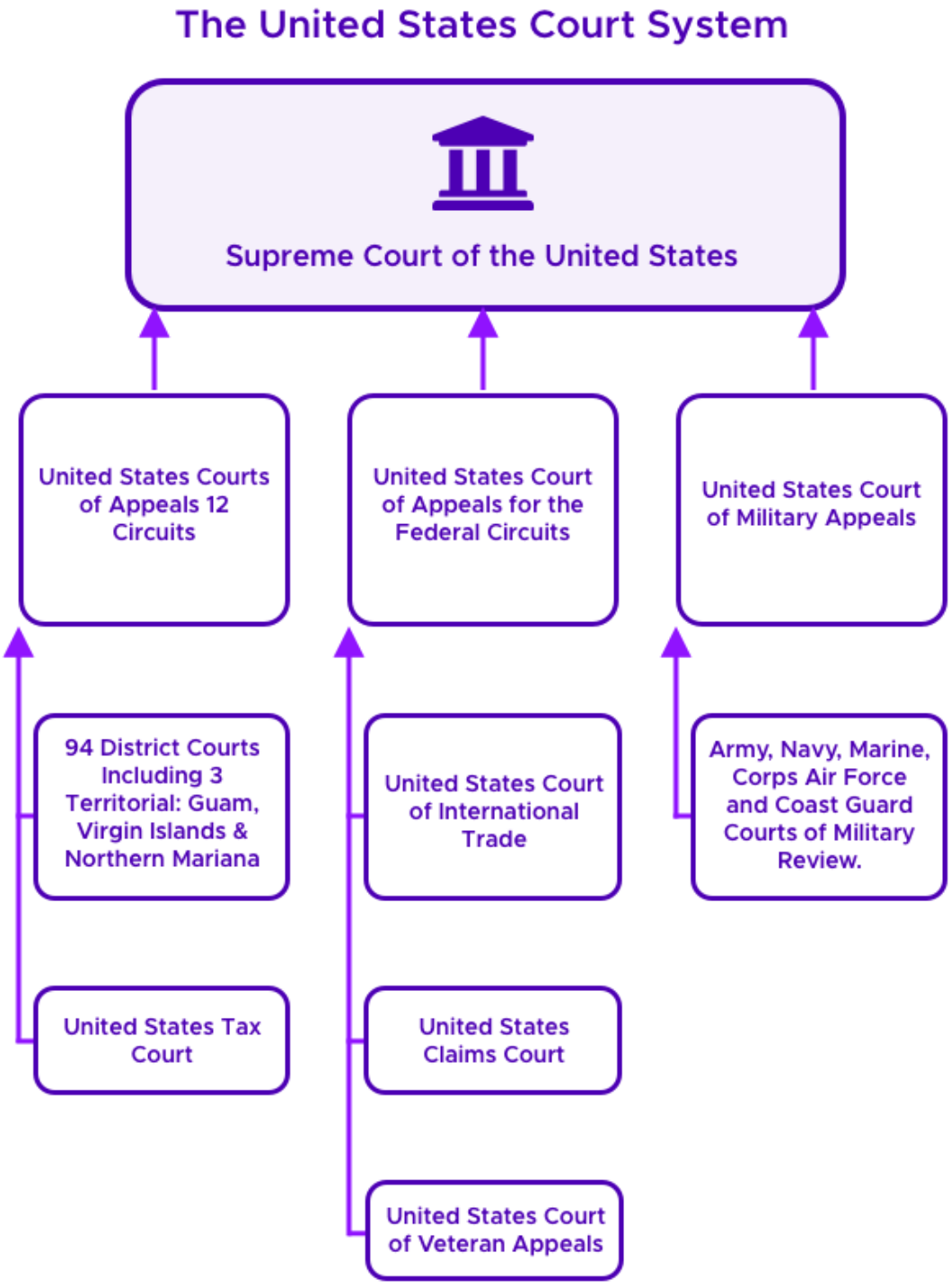
At Kleros, we seek to expand this 'living, working reality' to offer dispute resolution in cases that are not adequately addressed by the existing system.

Policies in Kleros: the Laws of Internet Courts

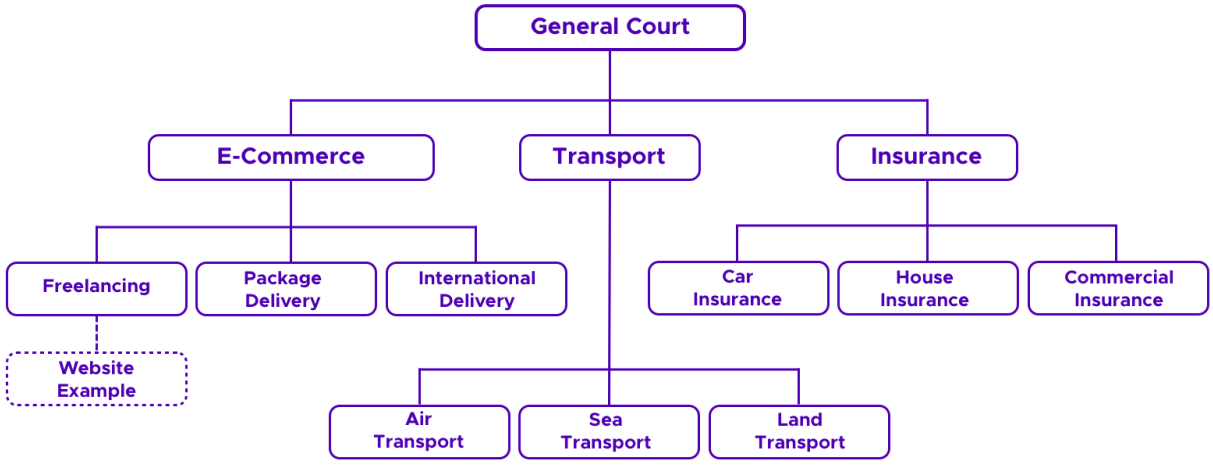
By Marco Mauer, Legal Engineer and Federico Ast, CEO, Kleros

Kleros is a general purpose arbitration system which can be used to solve a large number of disputes. In this sense, it's no different from traditional government courts, which were also designed with a multi purpose intent.

Traditional justice systems have courts specialized in different topics: commercial, civil, criminal, etc. In the same vein, Kleros has courts specialized in different types of disputes. Each of them has a policy that provides guidance to jurors on how they should evaluate evidence and adjudicate cases.



The Structure of the US Court System. Courts specialize in different types of disputes using special rules which determine how cases should be adjudicated. The appeal process goes from lower level courts all the way up to the Supreme Court, whose decisions are considered final.



Kleros court tree. As in traditional justice systems, appealed cases move up the ladder to higher level courts.

In the next section, we will review an example of a court policy concerning website disputes. The website court will very likely be the court of an e-commerce court. This could shorten the policy in practice as many rules it creates are applicable to most e-commerce cases and can therefore be part of a superior e-commerce policy that applies in the website court as well. Court policies can go from very simple descriptions (only a few lines) to more complex sets of rules.

A Policy on Website Disputes

Alice hires Bob to build a website. Bob does so. Alice is not satisfied with the delivered product. She claims a page is missing. Since Bob refuses to acknowledge this, she creates a dispute in Kleros. As was agreed in the contract, the dispute will be solved by three jurors in the Website Disputes court. The court policy may look something like this:

§ 1 Purpose of the Court

(1) The court rules on disputes in which a customer (plaintiff) refuses to pay the creator of a website they ordered (defendant) because it allegedly does not meet the requirements set out in a contract.

(2) Furthermore, the court rules on disputes that can be decided by applying this statute respectively and that a hypothetical average juror of this court is qualified to decide.

(3) The court decides whether it has jurisdiction. If it finds that it does not have jurisdiction jurors refuse to arbitrate.

§ 2 Agreements of the Parties

(1) If the parties have a written agreement regarding the specifications of the disputed website, it is the plaintiff's obligation to submit it into evidence and convince the court that it is genuine.

(2) When there is no written agreement, the plaintiff can present communication with the defendant prior to the agreement to prove that the defendant did not meet the requirements agreed upon.

(3) The court considers the evidence on the agreement provided by the plaintiff as genuine even when the plaintiff cannot prove it as long as the defendant does not claim it to be false.

§ 3 Website

It is the defendant's obligation to provide the court with access to their work.

§ 4 Defect

(1) When the court finds the website to have a defect, it decides in favor of the plaintiff.

(2) A website is considered free from defects if it is delivered as agreed. When there is no agreement on a relevant aspect, it is considered to be delivered free from defects:

1. if it is suitable for the use intended under the contract,
2. if it is suitable for the customary use and its quality is as the plaintiff may expect it.

(3) The website has a defect when it does not meet the expectations the defendant creates through his advertisement of his service.

§ 5 Non-binary Decisions

(1) When the arbitrable contract allows the jurors to vote on more than two possible outcomes and the court finds the website to have a defect, it considers what verdict is appropriate for the kind of defect.

(2) When the defect can be fixed and the plaintiff cannot prove that he has no interest in a delayed delivery of the website the court allows the defendant to fix the website.

Structure of the Policy

This policy guides jurors through the disputes arbitrated in the court, from their very creation to the rendering of a verdict. Let's go through it step by step.

Section 1. Court Purpose.

Section 1 defines the purpose of the court. In Kleros there are several courts for special types of disputes. This ensures that jurors are only dealing with cases they are qualified to decide. Therefore, the very first question the jurors have to consider is whether the submitted dispute is actually in the right court.

The Website Court is for website disputes, obviously. The policy allows it to deal with disputes that are not about websites but about similar products, as well. If Alice had submitted an insurance case, for instance, jurors would have refused to arbitrate as it has nothing to do with websites. Alice would then have to find another court. In our example, however, Alice has submitted her dispute to the right court so the jurors can decide on the case.

Section 2. Proof of Agreement.

In order to make a decision, jurors need evidence. As Alice is claiming that Bob has failed to fulfill some obligations he had, it is her obligation to prove what the agreement was. This is stated in Section 2. Alice can provide the jurors with a plain-text agreement or some e-mail correspondence. The evidence must show what features Bob agreed to implement.

Usually, it is not hard to prove the agreement. When Alice and Bob create the smart contract that selects Kleros as arbitrator, they can store the hash of their agreement on chain. Then Alice just has to reveal the contract to the jurors and they can verify its genuineness with this hash. Bob could reveal the contract as well but if no contract is revealed at all, Alice's claim shall be rejected.

Section 3. Access to Evidence.

Once the jurors know what the parties agreed on they have to check whether the website actually meets the requirements. In order to do so, they have to be able to see it. As Bob was required to create one, it is his job to show it to the jurors. This is specified in Section 3.

Section 4. Decision Rules.

Section 4 helps jurors decide whether a website is as it should be when the requirements that are stated in the contract are not clear enough to decide. In our example, Alice decides that a certain page that should have been provided is actually missing. When the contract that Alice submitted clearly states that Bob has to deliver the said page, it is clear that she should win the dispute.

If it is not stated explicitly, however, Bob wins, unless it is clear that the missing page would be reasonably expected to be delivered in a website development contract.

Section 5. Decision Alternatives.

In our example, the arbitrable smart contract gives jurors just two options: they can either make Alice pay or allow her to refuse payment. More complex arbitrable contracts could allow jurors to grant Bob some more time or reduce the price Alice has to pay. Section 5 deals with these special types of contracts.

As you can see there are just five quite simple rules that help make the arbitration process go smoothly and provide the jurors with objective requirements they can check.

Other Policies

The court policy in this article provides procedural guidance for jurors to adjudicate disputes in the Website Court. But there are other policies that prohibits jurors from ruling on immoral cases like those concerning assassination markets. Other policies define how policies shall be formatted. You can find all policy drafts **here**. Feel free to contribute so we can pass the first policies as soon as the Kleros governance mechanism is deployed.

Policies are in some way unknown territory. We are looking forward to spectating what ideas the users come up with. This article is supposed to give the readers an idea of what policies are and motivate interested token holders to participate in the upcoming discussions revolving around them.

The Oracle of the Kleroterion

By William George, Director of Research, Kleros

*Image: **Consulting the Oracle** by John William Waterhouse, Credit: Tate Gallery, Britain*

A classic obstacle in applying smart contracts to many common problems is that most useful contracts in the real world require access to values that cannot be verified by computation. A smart contract that sells rain insurance to farmers needs to be able to determine whether it rained. Many financial contracts that one would like to implement on the Ethereum network require the price of 1 ETH in USD, but this is not a value that natively lives on the chain.

An "oracle" is a mechanism that can be consulted to provide this outside, real-world information. Many major blockchain projects have built oracles designed for their specific applications. The stablecoin created by MakerDAO uses an oracle to ensure that sufficient collateral is held to cover the DAI in circulation. Prediction markets like Augur and Gnosis require oracles so that the blockchain knows the result of the market.

The resulting oracles are often well adapted to the specific needs of these projects. Indeed, the proposed oracle of Augur offers a fully decentralized solution that works particularly well when the real-world value one is trying to determine takes discrete outcomes. However,

there still has not been an oracle capable of providing a fine-grained estimate of a price of a generic asset, as for use in a financial contract, in a satisfying, fully decentralized way.

At Kleros, we are building a platform for crowdsourced justice. On our platform, disputes are decided by randomly selected jurors who are incentivized to vote honestly through game theory. Already such a dispute resolution platform is a kind of oracle; it brings onto the blockchain the external information of who is the honest party in some dispute. We propose to leverage this ability for use in more general oracles.

In this vein, we are sharing the current state of some of our research on how to apply Kleros to create an oracle that estimates a real number value. Thus, this proposition could be used as a price oracle, such as in the applications discussed above. Even more general oracles are a subject of **future work**.

For our proposed real number valued oracle, in addition to the jurors who are always present in Kleros, we have actors called respondents. They provide the initial input estimates of the value to the system. Potentially, the respondents will provide conflicting information. In this case, they become parties to a dispute that Kleros will resolve in order to determine the value.

The oracle at Delphi / Credit: Pixabay

Roughly, respondents will submit an interval — a lower and an upper bound — where they think the true value lies. As they do so, they also place a deposit. Those whose interval contains the ultimate value that is output by the system are rewarded while respondents whose intervals don't contain the output value are punished.

Of course, respondents could try to place a really large interval to ensure that the output value will be within the limits. Imagine a respondent who submits an interval for the price of ETH from 1 USD — 10 million USD. While likely true, this wouldn't be very useful. But the rewards and punishments are weighted so that correct respondents who submitted smaller intervals receive higher rewards than those who submitted large intervals.

One could imagine that whoever needs an oracle (e.g., for a hedging contract), would pay the respondents for their work. However, this poses several challenges:

- A widely used oracle such as for the value of ETH in USD may be paid for by one party, but nothing prevents a parasitic party from pointing its contract at that value without paying for it (see similar concerns in the work of Augur).

- If you let anyone submit a response for a reward, users will tend to submit the same response many times to get a large reward while only performing the required work to determine the value once. On the other hand, if you restrict who can submit a response, it can become difficult to ensure with high probability that someone will submit an honest response at all.

For now, we assume that the respondents are not, on average, compensated. Instead they only receive rewards drawn from other respondents' penalties. In this model, someone may nonetheless submit (honest) responses through self-interest if they have a financial interest in the oracle producing honest results. In future work, we will consider how to properly compensate the respondents for their efforts in a way that is resistant to attack.

Using a sort of modified binary search, we ask Kleros jurors a repeated number of times whether the true value is higher or lower than some test value. Rather than test against the median of the list of responses, as one would do in a typical binary search, we detect points in the list of responses that are preventing the system from coming to a consensus answer. Then we test against the median of the list of these 'points of incoherence'.

This ultimately allows us to prove that our proposal has some nice properties. Particularly:

- The number of times Kleros must be called scales with the square of the log of the resources of parties that are ultimately ruled to be wrong. Thus, even if there are many, many responses, they will only cause extra appeals to Kleros to the degree that they disagree with each other. In fact, if all the responses are coherent (no one's

lower bound is bigger than someone else's upper bound) then no calls to Kleros are required at all.

- The amount of precision of the final output is tuned in accordance with how large or small the intervals of the respondents are. In particular, we prove that if a user submits an interval that contains the true answer, and if we assume that Kleros itself works in an ideal way — that the decisions of the jurors are accurate — then the output of the oracle is in the user's interval. So a single user that is confident in the value she is submitting and that wants to make sure that the oracle produces a very precise answer can simply submit a very small interval.

So far, we have described a mechanism by which Kleros can be used as an oracle to determine the price of an asset. This is already an essential tool for building financial contracts on a smart contract platform.

As Kleros matures and technology improves, Kleros could be used to bring many different types of information on chain. As the pool of Kleros jurors grows to the point where even niche courts can attract a robust group of experts, Kleros could be used to handle very specialized disputes such as oil price reviews.

As the underlying blockchains on which Kleros is deployed scale their capacity and reduce their latency, Kleros could be used as a live, decentralized means of reviewing contentious plays in sporting events, in place of traditional referees. In the following sections, we will explore some of these aspirational, longer-term possibilities. [43]

[43] For additional information on oracles and their implementation in Kleros, have a look at William George's presentation as part of the Tokenomics International Conference on Blockchain Economics, Security and Protocols here.

Kleros and Augur: Using Game Theory to Find Truth

By Clément Lesaege, CTO, Kleros and William George, Director of Research, Kleros

Augur is a decentralized oracle and peer to peer protocol for prediction markets. The vision of Augur is for people to have the ability to trade in prediction markets at a very low cost, while keeping the system trustless and frictionless.

Kleros and Augur have some underlying similarities. Both projects are deployed on Ethereum, and in both cases, information external to the blockchain needs to be used.

This makes it interesting to analyze similarities and differences between the mechanism design in both projects. Both were heavily influenced by the Truthcoin white paper and the SchellingCoin mechanism as means to keep voters honest. Thus, it is interesting to compare how the two systems have evolved and the choices they are making to address similar problems.

Purpose

Augur is an oracle for prediction markets while Kleros is a general purpose dispute resolution mechanism. In both cases, information external to the chain needs to be used.

For Augur, this is the true outcome of a prediction market. For Kleros, this is the honest decision about some dispute.

In both cases, there is a mechanism for people to vote on submitted information depending on how many tokens they have — REP in the case of Augur and PNK in the case of Kleros.

Prediction market oracles and general dispute resolution systems face different opportunities and constraints, which are determined by their purpose:

- A general dispute resolution system may involve non-fungible assets (for example, one could have a dispute over a contract holding a cryptokitty) and even assets without a clear monetary value (for example, an entry in an ENS blacklist). In a prediction market, bets are generally placed in a given currency such as USD or ETH.

- Prediction markets have a more severe problem with parasitic markets.[44] It is reasonable to expect a prediction market that is issuing bets on well-known events to have competition from other markets speculating on the same event, and there is the risk that this competitor will reuse the result of an Augur market without paying for

[44] Markets that use the result of the oracle without paying appropriate fees.

reporting costs required to obtain this result. In contrast, in most of the day-to-day disputes that would be handled by a general purpose dispute resolution system (such as a contract dispute between a freelance web developer and a client) one would not expect outside parties to have a significant interest in creating a secondary market on how the dispute is resolved.

- There is greater uncertainty in how a given honest juror will vote on general disputes. A general dispute mechanism needs to be able to handle the fact that sometimes there will be judgement calls on which reasonable people would disagree. This is not really the case for prediction market oracles, where one is reporting on some established fact in the world.[45]

Appeal Mechanism

Truthcoin did not have an appeal system which posed serious scalability issues. As each VoteCoin holder must vote on each case, the total amount of work was O(amount_of_disputes * amount_of_holders), which can't scale.

Truthcoin's proposed solution to this was for the system to subdivide itself into "branches". Then, a given case was considered by a single branch where all of the VoteCoin holders vote. Then as the branch gets too big, there is a process to further subdivide it. The problem with this is that the VoteCoins, as described in the Truthcoin paper, are not transferable between branches.

Thus, you either wind up with a few giant branches where the coin holders are overworked or many small branches that are vulnerable to having an attacker buy up the coins of that branch.

Even if the current (12 July 2018) version of the Augur paper does not explicitly talk about "appeals", their proposal for disputing a tentative outcome is an "appeal". This allows only requiring input from a subset of token holders.

Kleros handles appeals explicitly, by drawing the jurors which need to solve the dispute. In Augur, this is implicit, token holders could look at all markets to find some to stake their tokens.

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[45] Although there can be rare edge cases such as the TradeSports market Augur mentions in their white paper. In this market, bets were placed on whether North Korea would launch a missile that landed outside of their airspace before the end of July 2006. North Korea successfully launched such a missile, but the event was not recognized by the US Department of Defense as was required by the contract creating a controversy between the spirit and the letter of the betting market.

In the Augur appeal system, rational token holders should adopt a mixed strategy and randomly choose markets in which to stake their tokens. However, this leads to cartels (voting pools) or to large actors having an advantage. They would be able to stake their tokens with less work as they only need to determine the result of a given market a single time.

We could argue Kleros has the same issue with jurors drawn more than once in a dispute who only need to do their arbitration work once. With large courts it is unlikely that even a relatively large voting pool would be chosen enough times to have meaningful work savings, but for small courts or very large cartels, this becomes an issue. Both projects would benefit from some additional work to deal with, or at least reduce, this issue.

Ultimate Appeal Mechanism

Augur proposes an ultimate appeal mechanism for markets that are disputed beyond a fixed percentage of all REP. In this case, the network is forked creating parallel sets of REP based on the result of the disputed outcome. This is an interesting approach as it lets the market sort out very contentious cases.

However, we note that having users irrevocably bet their holdings by migrating to one of the two forks (as in Augur) would not necessarily be viable for a general dispute resolution system such as Kleros.

In a general purpose dispute resolution mechanism, jurors will find themselves often in a situation where they have to make a judgement call, even while the right solution is not obvious. In this setting, a forking-based appeal would be much more likely to result in multiple versions of the token with non-negligible value.[46]

We find Augur's proposed fee determination system interesting. This system reacts to the amount of ETH at stake in active markets and automatically pushes the market cap high enough to deter rational attackers. Kleros could potentially draw inspiration from this idea. This may be difficult as it would require knowing the value at stake in smart contracts arbitrable by Kleros.

However, as we noted above, the assets at stake do not necessarily always have clear monetary values. Conceivably, we could use the Kleros-based oracle for real number values

[46] Nonetheless, the Kleros community might want to fork PNK at some point as a last-ditch defense against an attack by social consensus; however, this does not need to be written into the smart contracts in advance.

that could be used to determine these amounts. But it remains a subject of future research to determine in what circumstances this would be viable.[47]

So, to recap, we summarize a few of the differing choices made by the two systems in the following table:

	augur	KLEROS
Purpose	**Oracle for prediction markets**	**General dispute resolution mechanism**
Appeal Mechanism	**Implicit: appeal by disputing outcomes**	**Explicit appeal**
Ultimate Appeal	**Fork into multiple chains, one for each outcome to disputed case**	**Kleros general court**
How arbitrators are chosen	**Self-select**	**Self-select into sub-courts, then randomly chosen**
Fees	**Automatically adjusts to current value of Augur markets**	**For now, not adaptive to value at stake in Kleros contracts (which can be hard to determine)**

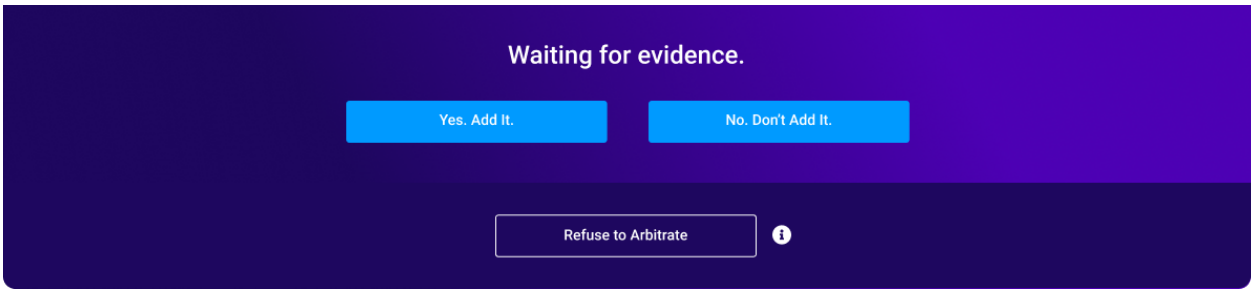
[47] To learn more about this, see the article *The Oracle of the Kleroterion*, by William George in Chapter 2 - Kleros Cryptoeconomics: Towards A Theory of Decentralized Justice.

Kleros and Social Choice Theory: Research Paths for the Future

By William George, Director of Research, Kleros.

Up to this point, the disputes handled by Kleros have largely been binary. Jurors have been presented with options such as "Yes, add this to a list" versus "No, do not add this to a list" or "This is fake news" versus "This is not fake news".

To the degree that jurors have been given more than two options (e.g. strictly speaking jurors also always have the option to vote "Refuse to arbitrate" if the case does not adhere to court policies), the other choices have generally been marginal to the point of de-facto binarizing the dispute.



The choices before a Kleros juror in a typical dispute in Kleros' Token Curated Registry.

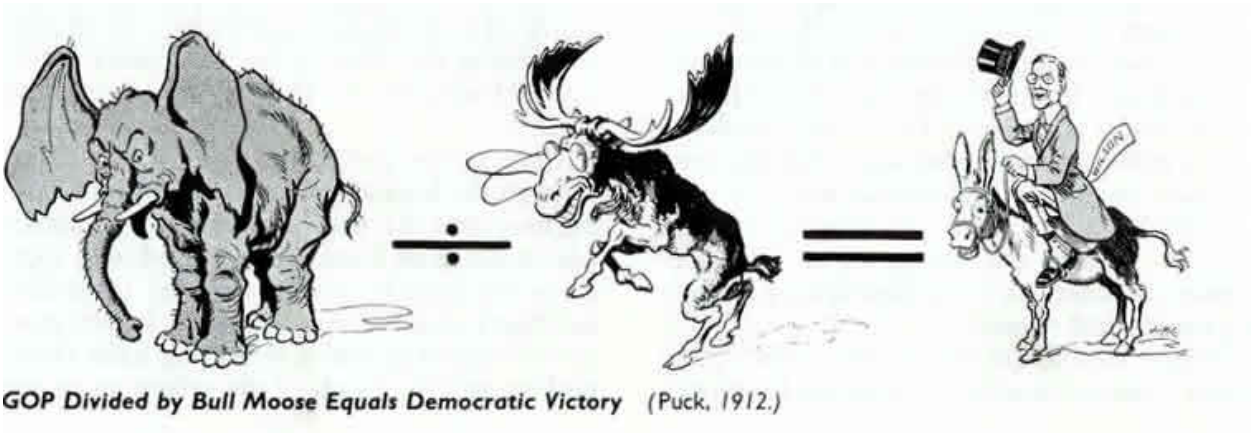
However, many potential use cases do not fit into the model of having only two possible outcomes. When parties enter into an economic relationship, agreeing to use Kleros in case of dispute, they need to define the options that eventual jurors would choose between if a dispute ultimately happens. In many cases, they would want to provide jurors the flexibility to decide outcomes that are not as simple as ruling for one side or the other. For example, we could have cases where:

- In a Kleros escrow contract where small business owner Alice has hired freelancer Bob to make her a website, outcomes could include paying Bob, refunding Alice, as well as options to give Bob more time to make improvements to the website.
- In a Kleros based insurance system, when Alice claims a certain value of insurable damages, options could include paying her the full requested amount, rejecting her claim, or paying her some partial amount.
- In Kleros based social media content moderation, when a problematic piece of content is flagged, jurors could have options to maintain the piece of content, to remove the content without deleting the offending user's account, and to remove the content and delete the offending user's account.

In this article, we will review some ideas from social choice theory which influence our design choices as we build Kleros so that it can handle disputes with many outcomes in a secure way.

First Past the Post and Its Problems

Modern elections have taught us that voting can become complicated when there are more than two candidates. Particularly, in the United States and the United Kingdom, there have been several famous elections marked by warnings of "vote splitting" and suggestions of "tactical voting".



In the 1912 US presidential election, the progressive vote was split between the Republican candidate and incumbent president William Taft and the Progressive Party candidate and former Republican president Theodore Roosevelt, who received 23% and 27% of the popular vote respectively (8 and 88 electoral votes respectively). The Democratic candidate Woodrow Wilson was elected with 42% of the popular vote and 435 electoral votes. Cartoon by Louis Glacken (1866-1933) for Puck Magazine, 1912.

Both the United States and the United Kingdom use an electoral system called "First-past-the-post" or, in the language of social choice theorists, Plurality. In this system, voters select a single candidate and the candidate with the single largest number of votes wins (even if no one candidate receives a majority of the votes because there are many candidates). Then:

- If there are two similar candidates that would appeal to the same group of voters, each of them can be expected to receive fewer voters that they would if the other candidate was not in the race. Then it is possible that neither of them wins even if one of them would have won had the other not been present. This is the concept of "vote splitting". This is what happened in the 1912 US presidential election.
- Suppose a voter thinks that candidate A is great, candidate B is not as good but is acceptable, and candidate C is terrible. If the voter decides to vote for candidate B

instead of candidate A because she thinks candidate B is more likely to be able to beat candidate C, she is said to be making a "tactical vote".

See, for example, the tool created by www.tactical.vote for the recent December 2019 UK election which suggests which tactical vote people should make in order to prevent a Conservative majority government based on where they live.

Borda and Condorcet: Alternative Voting Systems

In the 18th century, the French philosophers and mathematicians Jean-Charles de Borda and Nicolas de Condorcet realized the issues with Plurality voting and proposed alternative systems.

- Borda proposed the following system when there are N candidates. Each voter submits a list of as many candidates as she wishes to rank, ranked from her first choice up to the last choice. Her first choice receives N points, her second choice N-1 points, etc. After all votes have been counted, the candidate with the most points wins.

A statue of French mathematician Jean-Charles de Borda (1733-1799) in Dax, South West of France.

- Condorcet proposed simulating pair-wise election "duels" between every two candidates in an election. For example, if voters rank the candidates from the first to last choice, for each pair of candidates A and B one can check if the majority of voters ranked A higher than B or if the majority ranked B higher than A in their lists. Then if a candidate wins head-to-head against every other candidate that candidate should win the election. However, it is possible that there is no such candidate; for example, in an election between candidates A, B, and C one can have majorities of voters prefer A to B, B to C, and C to A. This is called a "Condorcet paradox"; as Condorcet did not specify what to do in the event of a Condorcet paradox, this is not considered a voting system in the sense of modern social choice theory. Rather, it is a property a voting system can satisfy; a system is said to be "Condorcet" if it elects a candidate that would win head-to-head against every other whenever there is one. Prominent examples of Condorcet systems include Schulze, Ranked Pairs, Kemeny-Young, Copeland, and Dodgson (invented by Charles Dodgson, better known as Lewis Carroll).

If ever the Kingdom of Hearts decides to become a republic, Lewis Carroll designed a voting system they can use. Illustration by Sir John Tenniel for "Alice's Adventures in Wonderland", 1865.

In the ensuing centuries, many other different voting systems have been developed. A notable example is:

- Instant-runoff – Voters submit a list of candidates, ranked in order of preference. The number of first place votes each candidate receives is counted, and whichever candidate receives the fewest first place votes is eliminated. The eliminated candidate's first place votes are reattributed to the candidates whom those voters placed second. One continues in this way, each round eliminating the candidate who is the top remaining choice of the fewest voters until one candidate is the top remaining choice of a majority of the voters. Note that this is equivalent to having a series of runoffs with the number of rounds being one less than the number of candidates.

Variants of the Borda system are used in the parliamentary elections of Nauru, for the MVP award in Major League Baseball, and for the winner of college football's Heisman Trophy. The Schulze system, a Condorcet method, has been used for board of trustees elections for the Wikimedia Foundation and some internal elections in various chapters of the Pirate Party. The Instant-runoff system is used in Australian parliamentary elections and in the Academy Awards.

In all of the voting systems discussed above, voters are asked to rank their candidates in order of preference.

A typical filled-in ballot in a voting system where voters rank their choices in order of preference.

Voting Paradoxes

In 1950, Kenneth Arrow (Nobel Laureate in Economics 1972) showed that any voting system with three or more candidates where voters only submit a ranked list of preferences will have some pathological behaviour, at least in some cases. Specifically, he proved :

Theorem 1 (Arrow's impossibility Theorem).

Suppose one has a voting system where voters choose between three or more candidates by submitting ranked lists of their preferences. Suppose for all possible sets of preferences expressed by voters and all candidates X, Y that

- ***if every voter prefers candidate X over candidate Y, then candidate X finishes higher than candidate Y.***
- ***if voters change their preferences in such a way that every voter's relative order between X and Y remains unchanged, then whether X or Y finishes higher remains unchanged. (I.e. if voters change their minds on whether they prefer X vs Z, Z vs Y, or Z vs W, this should not change how X does relative to Y).***

Then there must be a "dictator"; i.e. there is a single voter who determines the order in which the candidate finish.

So for any ranked-preference voting system that isn't completely trivial (one person deciding) with three or more candidates, there is inevitably a possibility that a "voting paradox" will arise where the votes are translated into results in a way that fails natural properties we would want/hope for a voting system to have.

Gibbard and Satterthwaite built on Arrow's Theorem to show that in any such voting system, there will be situations where a rational voter would vote tactically.

Voting paradoxes, including a voting paradox in an instant-runoff voting system.

While Arrow's Theorem tells us that some pathological behaviour is inevitable in any ranked choice voting system, one can nonetheless design voting systems to satisfy some good properties. A few examples that have been considered by social choice theorists are:

- Monotonicity – Suppose that voters cast a set of votes so that the candidate A wins. If some voters had changed their vote to move A up while no other changes are made

then A will still win. (One also has a similar condition about moving candidates down not causing them to win.)

- Clone independence – A set of candidates are considered to be clones if all voters rank them consecutively. Then deleting a clone from every voter's list should not change whether any other candidate outside the set of clones wins or loses.
- Participation – Suppose that if Charles does not vote, the candidate A wins, and Charles prefers A to B. Then Charles voting should not result in B winning.

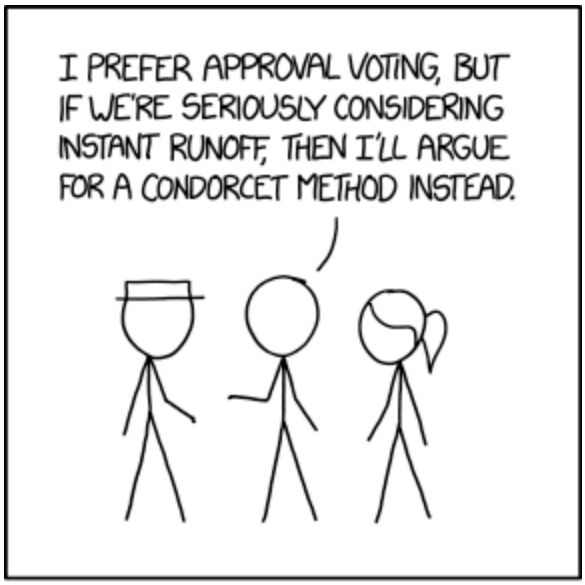
They have found that ranked preference voting systems can have some of the properties but not all one would want.

Comparison of Preferential Electoral Systems																
	Monotonic	Condorcet	Majority	Condorcet loser	Majority loser	Mutual majority	Smith	ISDA	LIIA	Clone independence	Reversal symmetry	Participation, Consistency	Later-no-harm	Later-no-help	Polynomial time	Resolvability
Schulze	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Yes
Ranked pairs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
Alternative smith	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes
Alternative schwartz	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes
Kemeny-Young	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes
Copeland	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	No
Nanson	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No	No	Yes	Yes
Instant-runoff voting	No	No	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No	Yes	Yes	Yes	Yes
Borda	Yes	No	No	Yes	Yes	No	No	No	No	No	Yes	Yes	No	Yes	Yes	Yes
Baldwin	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes
Bucklin	Yes	No	Yes	No	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	Yes
Plurality	Yes	No	Yes	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Contingent voting	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Coombs[1]	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes
MiniMax	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes
Anti-plurality[1]	Yes	No	No	No	Yes	No	No	No	No	No	No	Yes	No	No	Yes	Yes
Sri Lankan contingent voting	No	No	Yes	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Supplementary voting	No	No	Yes	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Dodgson[1]	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	Yes

A table of properties for different ranked-choice voting systems, from https://en.wikipedia.org/wiki/Ranked_pairs

The good news is that, for many of these voting systems, the paradoxes and failures of good properties only occur on relatively rare edge cases. So one can reasonably hope to pick a voting system that has less problematic tactical voting that Plurality does. Then, the voting system one selects is a question of which 'good' properties one prioritizes.

Finally, note that other voting systems have also been proposed where voters provide more information than a simple ranking of votes, such as Approval Voting and Range Voting. These systems have a different set of challenges with respect to tactical voting.



https://xkcd.com/1844/

Why This Matters for Kleros

The situation of Kleros is somewhat different. Above, we considered elections where voters have some intrinsic preference for which candidate wins. They vote for candidate A because they want A to become president. If, due to some weird voting paradox, voting for candidate B is a more useful vote for the goal of making A president, rational voters would vote for candidate B.

In Kleros, jurors want to vote in the way that maximizes their economic return. Hence, based on the idea of Schelling points, jurors want to vote with the consensus in order to earn arbitration fees and not lose their stakes. While jurors,While, jurors as they hold PNK, might have a general desire that Kleros produces honest outcomes so that the system remains credible and PNK does not lose value, we expect this motivation to be secondary as jurors decide to vote on any given case.

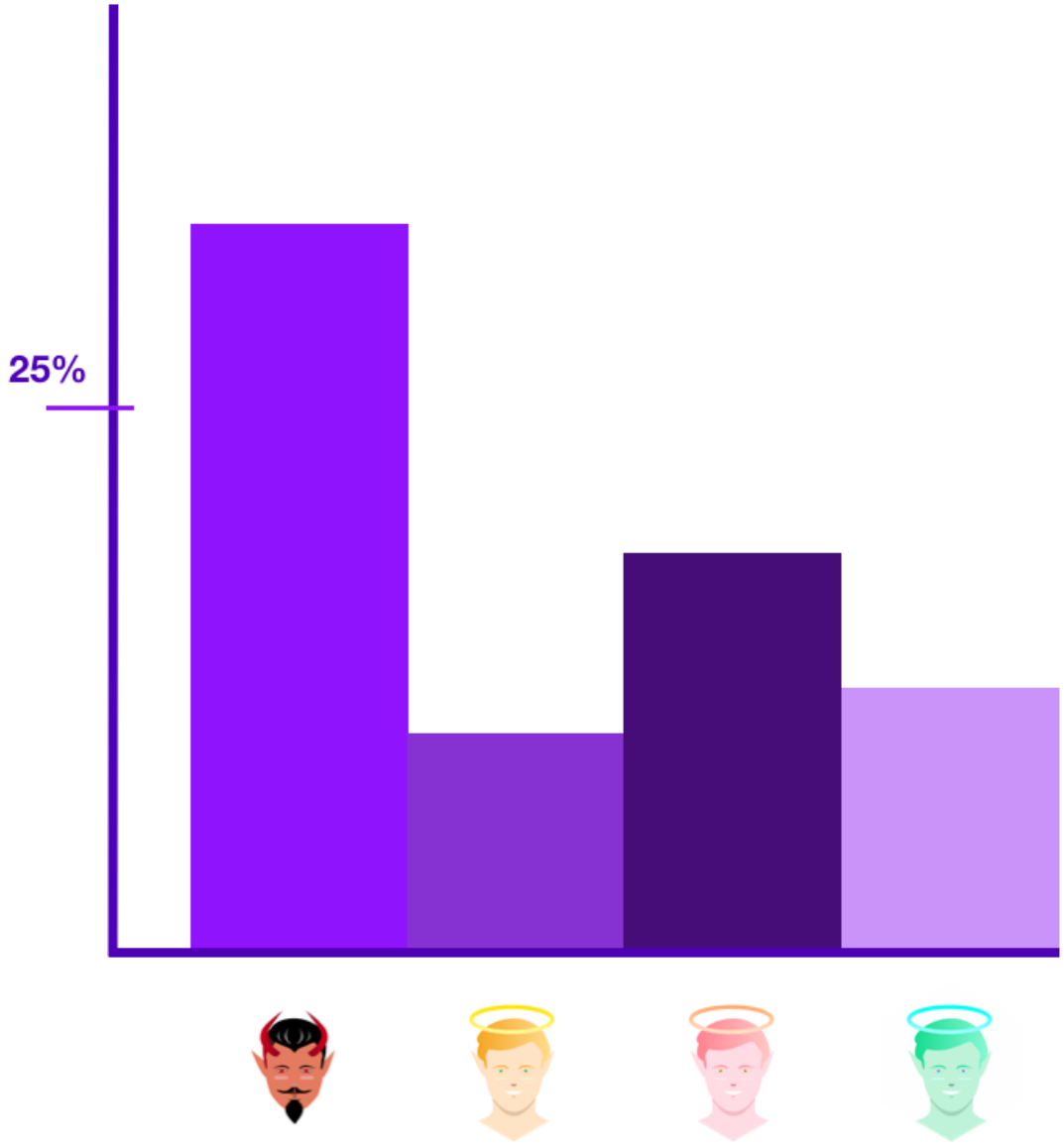
Nevertheless, Schelling point based voting has some issues related to the phenomena we saw above. For example, using Plurality for a Schelling point based vote with three or more choices has the following consequences:

- If there are many very similar honest options (or "clones", paralleling the clone independence property considered above), they will divide the votes of jurors that are

attempting to vote honestly, decreasing the probability that any one of them wins. Anticipating this effect, jurors might instead vote for a distinguished but dishonest choice. For example, again imagine that we have a small business owner Alice that hires a freelancer Bob to build her a website. If jurors can choose between "refund Alice", "pay Bob" and "give Bob another week to finish the project", they might vote to give Bob more time. However, suppose instead there are several different options that gave Bob another week, another eight days, or another nine days respectively. Then the jurors might avoid all of the "give Bob more time" options expecting the vote to be too split between them for any of them to win.

In the Plurality voting system, jurors can only submit one choice and can't, for example, vote "take one of the more time options, it doesn't matter which". However, then a dishonest choice among a collection of similar, honest choices may seem distinguished and become the Schelling point.

- To the degree that no single option is likely to receive more than 50% of the votes, this lowers the bar for the number of votes that attackers need to corrupt to pass a dishonest result.



If the votes are split between several "honest" options, the attacker does not need to corrupt 50% of the vote in a Plurality system to have a malicious option adopted.

As jurors' motivations are economic, considering the incentive system of rewards and penalties is essential to analyzing the voting system. In general, we want a voting and incentive system that:

- Incentivizes jurors to vote for outcomes they think are correct.
- Aggregates the information provided by the jurors' votes into an outcome that reflect what the group of jurors thinks is correct.

Now, for example, consider the following incentive system for use with ranked choice voting systems. Suppose each juror has a stake of d PNK which represents the maximum she can lose for an incoherent vote. Then suppose that (based on whatever voting system we wind up using) the winning outcome is w. Then, based on her vote, a juror Alice loses:

$$\frac{\text{\# options Alice ranked ahead of } w}{\text{total \# of options - 1}}\, d$$

from her stake, and receives:

$$\text{Arbitration Fees} \cdot \frac{\text{\# of options Alice ranked ahead of } w}{\sum_i \text{\# of options } i\text{th juror ranked ahead of } w}$$

ETH in arbitration fees and:

$$\text{Lost Stakes} \cdot \frac{\#\text{ of options Alice ranked ahead of } W}{\sum_i \#\text{ of options } i\text{th juror ranked ahead of } W}$$

PNK in redistributed stakes. Note that, unlike the binary situation, it is now not necessarily the case that jurors are entirely coherent or entirely incoherent. They can be "partially" right. Then one can show :

Theorem 2

Consider the above incentives system. Suppose that a given voter has a probabilistic prior for the outcome of the dispute resolution process such that

- ***she believe that the outcome is independent of her own vote.***
- ***she assigns to the possible outcomes $a_1,\dots,a_n$ probabilities $prob(a_1),\dots prob(a_n)$ of ultimately winning.***

Then a weakly dominant strategy for this juror is to rank the outcomes a_j from highest to lowest by their chance of winning $prob(a_j)$.

The perspective of a juror thinking of the ultimate outcome of a dispute being independent of her vote is certainly idealized, but not completely unreasonable for Kleros if jurors expected incorrect decisions to be appealed.

			My estimate for % chance of winning
2	Alice		30%
1	White Rabbit		40%
4	The Mad Hatter		5%
3	Cheshire Cat		25%

Theorem 2 says that if jurors think that the outcome is independent of their vote (e.g. because of future appeals), they will be incentivized to rank choices by how likely they think they are to win. Then, the jurors' votes should provide a good, if perhaps "noisy", "signal" of honesty that a voting system can aggregate into an honest collective outcome.

Now, similar to the tradeoffs in voting system properties that we saw above, when choosing a voting system for a Schelling point based model there are a number of properties that we might want.

Clone Independence

The standard property of clone independence that we already looked at above is even more important in the context of Schelling point based voting, as we saw in our criticisms of Schelling point Plurality voting. By choosing a clone independent voting system, parties

drafting a contract that designates Kleros as its arbitrator can worry less about whether the choices they include will cause "vote splitting".

Easy to Understand

When a country chooses its leaders via a democratic election, it is important that its citizens understand the voting system so that they can fully engage in the democratic process. However, a Kleros juror may need an even better understanding of the voting system than she is using as she is tasked with mentally simulating how a vote is likely to play out to maximize their chance of being coherent with its output. Hence, it is better to choose a voting system that prospective jurors do not need to spend a lot of effort to understand.

Voting as a Maximum Likelihood Estimator

If the incentive system succeeds in incentivizing jurors to provide their honest opinion of a dispute, one might think of the jurors' votes as indicating the "true outcome" with noise, namely that which outcome(s) jurors think deserve to be ranked high is probabilistic based on some distribution that is conditional on the "true outcome" being a certain option.

This model is similar to the framework considered in work such as that of Conitzer and Sandholm. They study which voting systems can be thought of as maximum likelihood estimators when the jurors vote distributions are independent and identically distributed; namely, which voting systems return the outcome that is most likely to be the "true outcome" given the noisy votes and assuming a uniform prior over the outcomes.

This is a good measure of whether the voting system is doing a good job of transforming the "noisy signal" of the jurors' votes into correct outcomes.

Conitzer and Sandholm consider two points of view; they say a voting system is MLEWIV if it is a maximum likelihood estimator when the "honest" answer is thought of as being a single outcome, and MLERIV if it is a maximum likelihood estimator when the "honest" answer is thought of as being a full ranking of the possible outcomes. While it may be that in some Kleros cases one can think of there being an "honest ranking" of all options, the MLEWIV model is more relevant for Kleros.

Attack Resistance

Possibly the most important property for a voting system on a blockchain, a world in which for example one can have smart contract enforced bribes, is that it is resistant to attacks. This is essentially economic.

We want the number of votes that would need to be changed to result in a "dishonest" outcome winning to be high, with the rationale that this increases the cost of attacks, such as bribes that would be necessary to change those votes.

We already discussed reasons why Plurality is not as attack resistant as one would want in Schelling point based systems. For another example, in the Borda system, an attacker that wants B to win where A is the "honest answer" can perform a "burying attack" where a relatively small number of attacker controlled votes put B first and A last.

In contrast, in instant-runoff a successful attack requires that in at least one of the "runoffs" that B receives more votes than A, which should require corrupting a much larger percentage of the jurors. Note: with the incentive system described above, the total economic cost in lost deposits if these two attacks narrowly fails are actually comparable; just the attack on instant-runoff requires that a large number of jurors lose a small amount, whereas in the attack on Borda a small number of jurors lose a lot. We have a version of the above incentive system that weights based on which outcomes are "narrowly defeated" and under that incentive system instant-runoff seems to perform better than Borda according to the measure of lost deposits for narrowly failed attacks.

	Clone Independent	Difficulty to Understand	Maximum Likelihood Estimator	Attack Resistance
Plurality	**No**	**Easy**	**MILEWIV+MLERIV**	**Bad**
Borda	**No**	**Easy**	**MILEWIV+MLERIV**	**Not great**
Instant-runoff	**Yes**	**Medium**	**MLERIV**	**Better?**

Tradeoffs in Schelling point voting systems. The results in the MLE column are due to Conitzer and Sandholm and use their notation, with the positive results corresponding to specific but reasonable noise models.

We have summarized how different voting systems fare on some of these properties in the above table.

Conclusion

We have been using Plurality voting for Kleros, which has worked well because the disputes we have considered so far generally were de-facto binary, namely they only had two plausible outcomes. As Kleros addresses more complex, non-binary disputes we want a voting and incentive system that handles well some of the challenges that that presents.

As social choice theory has seen for standard elections, this involves accepting tradeoffs. Instant-runoff voting with a (weighted) version of the incentive system that we present above is a promising choice, but we will continue to research these questions.

Chapter 3

Decentralized Justice in Action: From Doges on Trial to the Token Curated Registry

"Much test, very wow, such Dogenomic."
-Doge

In order to test the cryptoeconomic incentives of Kleros in a low stakes context, in July 2018 we launched the "Doges on Trial" pilot. This experiment is based on Kleros' **curated list application**, which is a key area of research within the decentralized ecosystem.[48] This curated list aimed to collect images of 'Doges'.[49] As non-Doge images should be prevented from being included on the list, Kleros was used to rule on disputes over whether a given image was or was not a Doge.

There are three basic roles that users may take in this setting. They can be (i) submitters, (ii) challengers and/or (iii) jurors.

Submitters provide candidate images to the list. Generally, a submitter in a curated list will be motivated by the fact that the list has some external use or prestige. In our case, as being on the list of Doges would not a priori provide significant value in and of itself, Kleros provided an incentive by distributing an amount of Dogecoin between all images that were ultimately accepted to the list before a deadline.

Also, in curated lists that have some external uses, attackers will generally have natural incentives to try to place false submissions (e.g., have a low quality restaurant included in a list of high quality restaurants). To simulate these incentives, rewards were offered for participants who submitted images of cats that were ultimately accepted onto the list, subject to certain restrictions as described in a payout policy.

Submitters had to send a deposit of 0.06 ETH (the average stake was between $13-$16) that they received back if and when their image was accepted to the list, and which they could lose if their image was ultimately rejected.

Challengers could flag images that they did not believe belonged on the list. Like submitters, challengers also placed a deposit of 0.06 ETH. If their challenge was ultimately successful, then the image was rejected from the list and the challenger received back 0.09 ETH. If their challenge failed and the image was deemed to be a Doge image, the challenger lost their deposit, the submitter was paid 0.03 ETH as compensation for having their image delayed, and the picture went back to a 'pending' state.

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[48] To learn more about how curated lists work and Kleros applications in them, have a look at Curated Lists as a Solution to Decentralized Freelancing in Chapter 6 - Scaling Up: the Applications of Decentralized Justice.

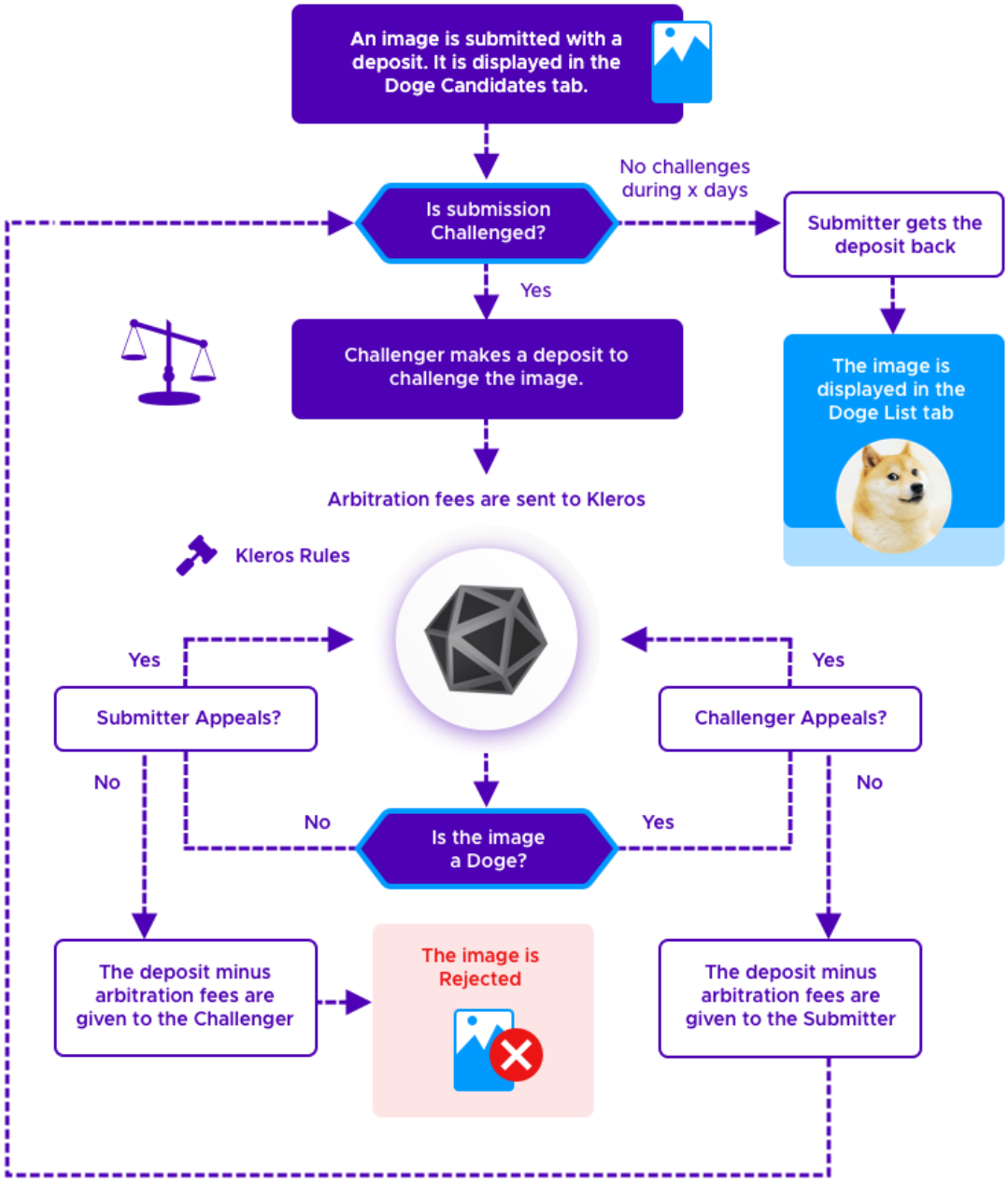
[49] Doges are a widespread Internet meme of images of Shiba Inu dogs, typically with some kind of humorous text representing the dog's internal monologue in broken English. This meme has been closely linked to the cryptocurrency community since the invention of Dogecoin in 2013. Dogecoin was designed as a cryptocurrency to be used to provide tips for people who created Doge meme images, and subsequently accumulated actual economic value.

If an image was 'pending' for more than 24 hours (either because it was never challenged or because it survived a challenge and was not subsequently challenged again for 24 hours), then it was accepted to the list.

Jurors ruled on challenges. Namely, when a challenger flagged an image, some number of randomly selected jurors were chosen and were asked the question, "Does this image show a Doge?" Their decision, which could be appealed up to five times, determined whether the challenge was successful or not.

The 0.03 ETH difference between what the 0.12 ETH that the submitter and challenger collectively paid in deposits and the 0.09 ETH that was returned to them paid jurors arbitration fees in the first dispute round. Arbitration fees for later rounds were paid by appealants. In addition to receiving arbitration fees, jurors were rewarded or penalized based on whether they were coherent with the eventual majority outcome.[50]

[50] Submitters and challengers could perform their roles at any time. However, in this first version of Kleros, jurors could only stake PNK and be drawn in discrete periods. Hence, images facing challenges were gathered into 'sessions' and jurors were drawn for all of the images of a session at the same time. Each such session, from the drawing of jurors for one set of cases through giving time for jurors to rule on those cases and for parties to appeal their decisions up to drawing jurors for the next set of cases, lasts roughly 3.5 days. For more information on how this works read this in-depth guide to the pilot. The dataset of the experiment can be found here.

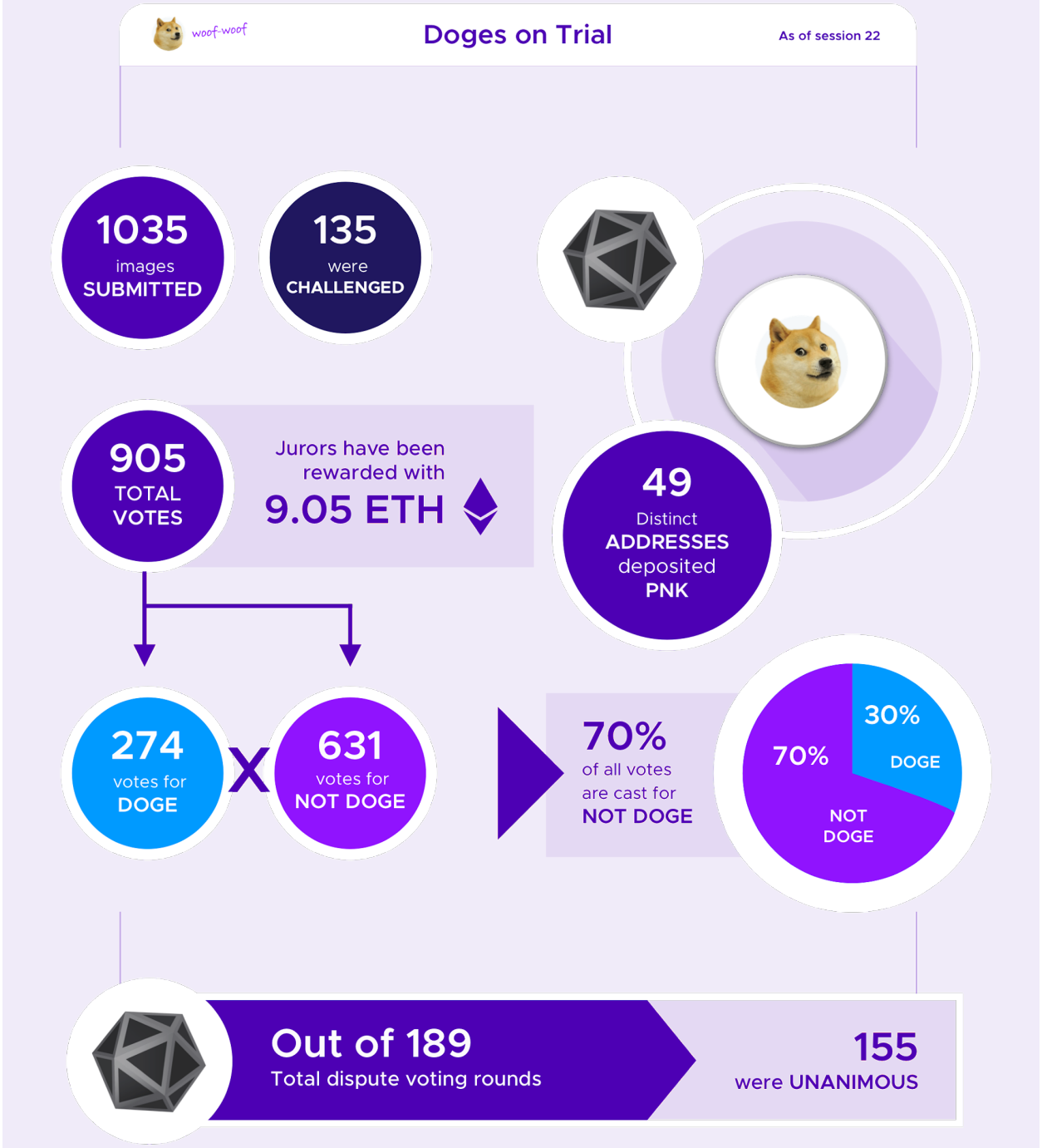


General Observations

The "Doges on Trial" experiment was divided into court sessions, each of them lasting 84 hours. As of session 22, (which ended on 23 October 2018), 49 total distinct addresses had

deposited PNK, 1035 images had been submitted to the list of which 135 were disputed. In total, 905 votes were cast. Jurors were rewarded with 9.05 ETH in total.

There were 274 votes for "Doge", 631 for "not Doge" - so 70% of all votes are cast for "not Doge". Thus, the images the challengers flagged as not being Doges received mostly votes of "not Doge" from jurors. This should be seen as evidence that the challengers had a good sense of juror voting patterns and they only challenged cases they were likely to win. Out of 189 total dispute voting sessions (counting each appeal of a given case separately), 155 were unanimous.

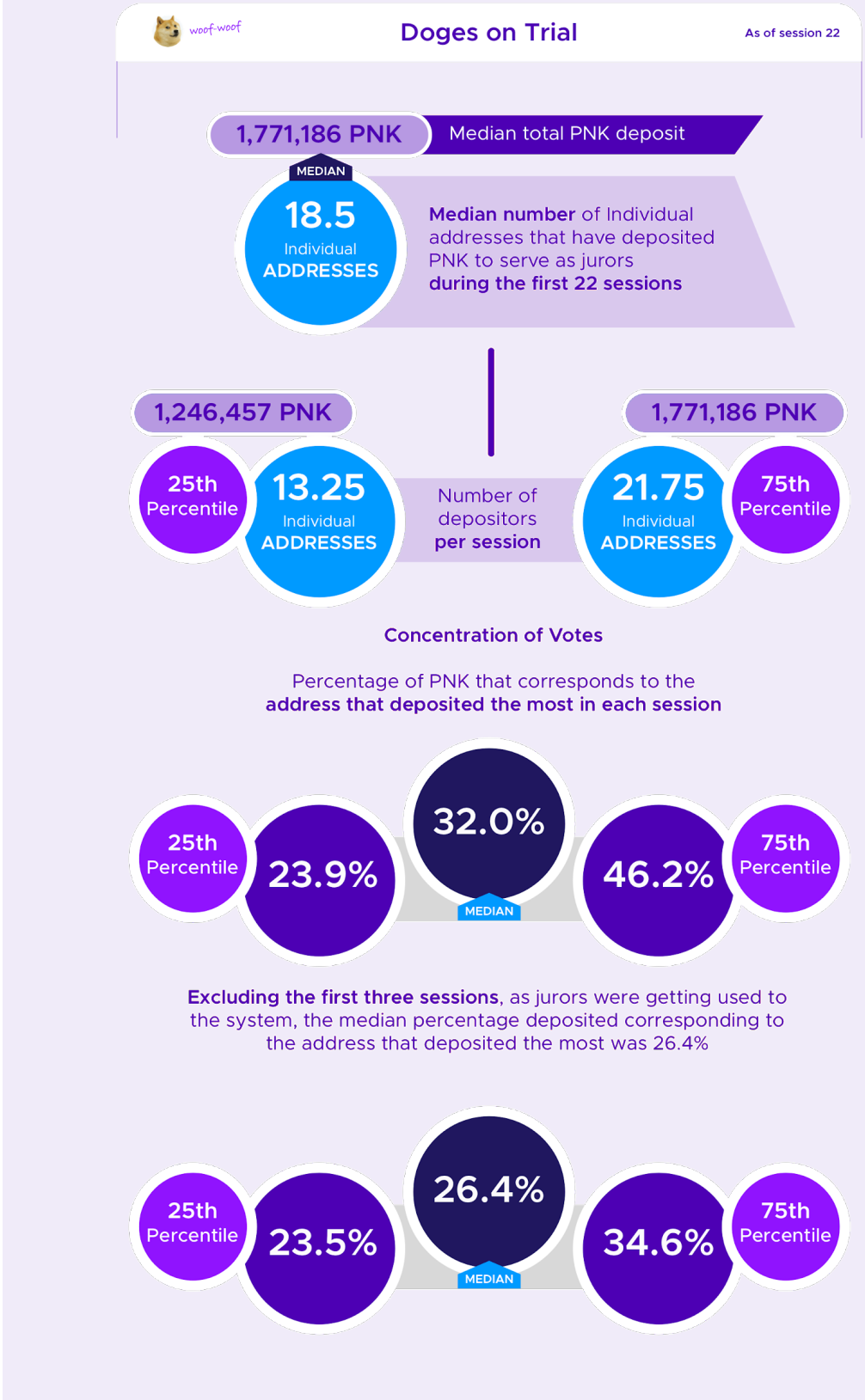

woof-woof
Doges on Trial
As of session 22
1035
images
SUBMITTED
135
were
CHALLENGED
905
TOTAL
VOTES
Jurors have been
rewarded with
9.05 ETH
49
Distinct
ADDRESSES
deposited
PNK
274
votes for
DOGE
X
631
votes for
NOT DOGE
70%
of all votes
are cast for
NOT DOGE
30%
DOGE
70%
NOT
DOGE
Out of 189
Total dispute voting rounds
155
were UNANIMOUS

Analysis of 51% Attack Resistance

One of the key measures of the security of Kleros against potential attackers is the percentage of PNK that is actively being deposited in the court that is controlled by a single actor (and to a lesser degree by a small number of actors).

If more than 51% of PNK in a court is controlled by a single party, by appealing a sufficient number of times this party can ensure with high probability that she has a majority of the votes on any given case, allowing her to choose the outcome she wants.[51]

[51] To learn more about attack resilience of Kleros, see *Why Kleros Need a Native Token* by William George in Chapter 2: Kleros Cryptoeconomics: Towards a Theory of Decentralized Justice.


woof-woof
Doges on Trial
As of session 22
1,771,186 PNK
Median total PNK deposit
MEDIAN
18.5
Individual
ADDRESSES
Median number of Individual addresses that have deposited PNK to serve as jurors during the first 22 sessions
1,246,457 PNK
25th Percentile
13.25
Individual
ADDRESSES
Number of depositors per session
1,771,186 PNK
21.75
Individual
ADDRESSES
75th Percentile
Concentration of Votes
Percentage of PNK that corresponds to the address that deposited the most in each session
25th Percentile
23.9%
32.0%
MEDIAN
46.2%
75th Percentile
Excluding the first three sessions, as jurors were getting used to the system, the median percentage deposited corresponding to the address that deposited the most was 26.4%
25th Percentile
23.5%
26.4%
MEDIAN
34.6%
75th Percentile

The median number of individual addresses that have deposited PNK to serve as jurors during the first 22 sessions of the Doge Pilot has been 18.5; the 25th and 75th percentiles for the number of depositors per session were 13.25 and 21.75 respectively.

This has corresponded to a median total PNK deposit of 1,771,186 PNK, with 25th and 75th percentiles of 1,246,457 PNK and 1,771,186 PNK respectively.

To get a sense of the concentration of votes, we look at the percentage of PNK that corresponds to the address that deposited the most in each session. The median percentage was 32.0%, with 25th and 75th percentiles of 23.9% and 46.2%.

Excluding the first three sessions, as jurors were getting used to the system, the median percentage deposited corresponding to the address that deposited the most was 26.4% with 25th and 75th percentiles of 23.5% and 34.6%.

Bribes

Kleros is based on the idea that complicated and lengthy disputes can be resolved in a way that reflects the opinions of a large pool of token holders – and is hence as difficult to attack as it is to corrupt a majority of the whole pool – while not excessively duplicating juror time and effort. This is done by randomly choosing an initial small panel of jurors and allowing appeals that pull in more and more jurors, if necessary.

While it may not seem to be hard to bribe two out of three jurors in an initial round, actually changing the outcome of the case requires being able to maintain such an attack with more and more jurors during the appeal rounds.

In this part, we will look at various efforts to bribe the jurors of "Doges on Trial".

Simple Non-Smart Contract Based Bribes

There were a number of 'traditional' bribes offered to jurors over the course of the "Doges on Trial" pilot. Would-be attackers typically put a text in their submitted image promising a portion of the payout they would receive to jurors who voted with them.

These attacks did not manage to buy the votes of very many jurors. This is perhaps unsurprising as their payouts were not guaranteed by smart contracts. These attacks required the jurors to trust that the attacker would actually pay them (would you trust an anonymous internet user that he will keep his word in paying you the promised bribe?).

Dispute 8 (0-3) - i.e. 0 votes for "Doge" and 3 votes "not Doge". A failed bribe attempt.

What is more interesting is how the jurors responded to a series of p+epsilon attacks, a number of which were launched on the "Doges on Trial" pilot with payment guaranteed by smart contracts.

Analysis of p+epsilon Attacks

A *p+epsilon attack* is a special kind of bribe, paid out on the condition that the attacker loses, thus warping the incentives of Schelling point-based systems.[52]

[52] See the discussion of Vitalik Buterin's The P+Epsilon Attack that introduced this attack vector.

	Majority X	Majority Y
Vote X	p	0
Vote Y	0	p

	Majority X	Majority Y
Vote X	p	0
Vote Y	p + ε	p

Let's suppose an attacker wants choice **Y** to win. In the simplest possible Schelling point system, voters are rewarded with **p** if they are coherent and get nothing if they are incoherent. Then the attacker offers p+epsilon to voters who vote **Y** if **X** wins.

This way, if a voter thinks **X** will be the majority decision, she will be better off voting **Y** to get the bribe. If she thinks **Y** will be the major decision, she is better off voting **Y** to be coherent and get **p**.

So, either way she gets at least as much by voting **Y** as by voting **X**. This means that voting **Y** is a 'can't lose' strategy. It is important to note that if the majority votes **Y**, then the attacker does not have to pay out any bribes. So, in a context of perfectly economically rational voters, the attack should always succeed and an attacker would have a free way of hijacking the incentives of the system.[53]

In Kleros, the payoff table is slightly more complicated because the amounts jurors are rewarded for coherence depends on how many jurors are incoherent:

[53] If a voter with a single vote knows that their vote is decisive, then they get p either way they vote by being coherent. If a juror has many votes that she knows include the decisive vote - or if many jurors that have the decisive vote between them work together in a way that they can trust each other to vote in certain ways, such as by committing large deposits to a smart contract that are slashed if they do not vote as instructed – then it is profitable to split up these votes in a way such that the attacker loses narrowly. However, note if a juror believes that a case will be appealed, then there is no one in that round whose vote decides the ultimate outcome, so it is always strictly in that juror's interest to accept the bribe.

Take a given juror with one vote. Imagine that:

- There are M total votes,
- There are x other votes for X and
- y = M - x - 1 other votes for Y.

	Final ruling X	Final ruling Y
Vote X	$\frac{(M - x - 1)d}{x+1}$	-d
Vote Y	-d	$\frac{(M - y - 1)d}{y+1} = \frac{xd}{M - x}$

	Final ruling X	Final ruling Y
Vote X	$\frac{(M - x - 1)d}{x+1}$	-d
Vote Y	$\frac{(M - x - 1)d}{x+1} + \varepsilon$	$\frac{xd}{M - x}$

If the number of other votes for "not Doge" is zero (if everyone in a given round accepts the bribe except you, but "not Doge" eventually wins anyway in appeal), then the coherence payout for being the lone voice of reason in your round is the sum of all the other jurors in that round **(M-1)d**.

If an attacker wants to incentivize jurors to accept the bribe, she must lock up enough PNK that in the worst case for her (where in every round except the last jurors unanimously vote **Y** but then **X** is voted narrowly in the last round), she can pay each of the jurors in these non-ultimate rounds enough so they are not encouraged to defect in hopes of getting the **(M-1)d** lone voice of reason bonus. Hence the attacker must lock up **O(M^2)** PNK; as **M**, the number of votes per round grows exponentially in the number of rounds, thus the attacker required lockup quickly becomes unviable.

A solution to this problem from the perspective of the attacker is to only offer the bribe to jurors who vote in the round that winds up being decisive. This way, there is no subsequent round to prove that a 'lone voice of reason' from this round was right.

Such an attack was conducted in Dispute 94.

The limitation of such an attack is that jurors are only incentivized to accept the bribe if (i) they believe they are in the last round or (ii) they think the attack will ultimately succeed and they should vote with the attacker to be coherent.

If a juror thinks that there is likely to be an appeal and that the attacker will ultimately lose, they will not accept the bribe. In particular, voting with the attacker ceases to be a can't lose strategy in rounds that are not guaranteed to be terminal.

Dispute 94 was appealed five times, which was the maximum number of appeals that was possible in the Doge pilot (in more meaningful situations, the maximum number of appeals parameter will likely be set to be much larger). Jurors in the sixth round of Dispute 94 knew

that they were in the last round, so in that round this attack functioned like a standard 'can't lose if you accept the bribe' p+epsilon attack.

To summarize, the p+epsilon attacks were launched for Disputes 70, 71, 73, 74, 75, and 76; smart contracts were deployed offering the bribe to jurors in rounds one and two for various choices of epsilon.

In Dispute 94, the bribe was offered to jurors in the last round, which was unknown in advance, but in the sixth round it was impossible to appeal further, so jurors in that round knew the bribe was offered to them.

In some of the rounds there were relatively high rates of no-show jurors who were selected but didn't vote.[54]

Dispute 70 (0-3, 0-6) - i.e in the first round – 0 votes "Doge," 3 votes "not Doge" and in the first (and only appeal) 0 votes "Doge" and 6 votes "not Doge"

[54] In round 5 of Dispute 94 this was due to a technical problem in the Kleros juror interface. In the second round of Disputes 70, 71, 73, 74, 75, and 76 (which were conducted in parallel), this seems to have been due to abnormally high gas prices on the Ethereum network.

55

Attention jurors! There is a possibility of a bribe for voting that this image is a Doge. See https://forum.kleros.io/t/p-epsilon-10-attack/64 for details.

Dispute 71 (1-2, 0-4)

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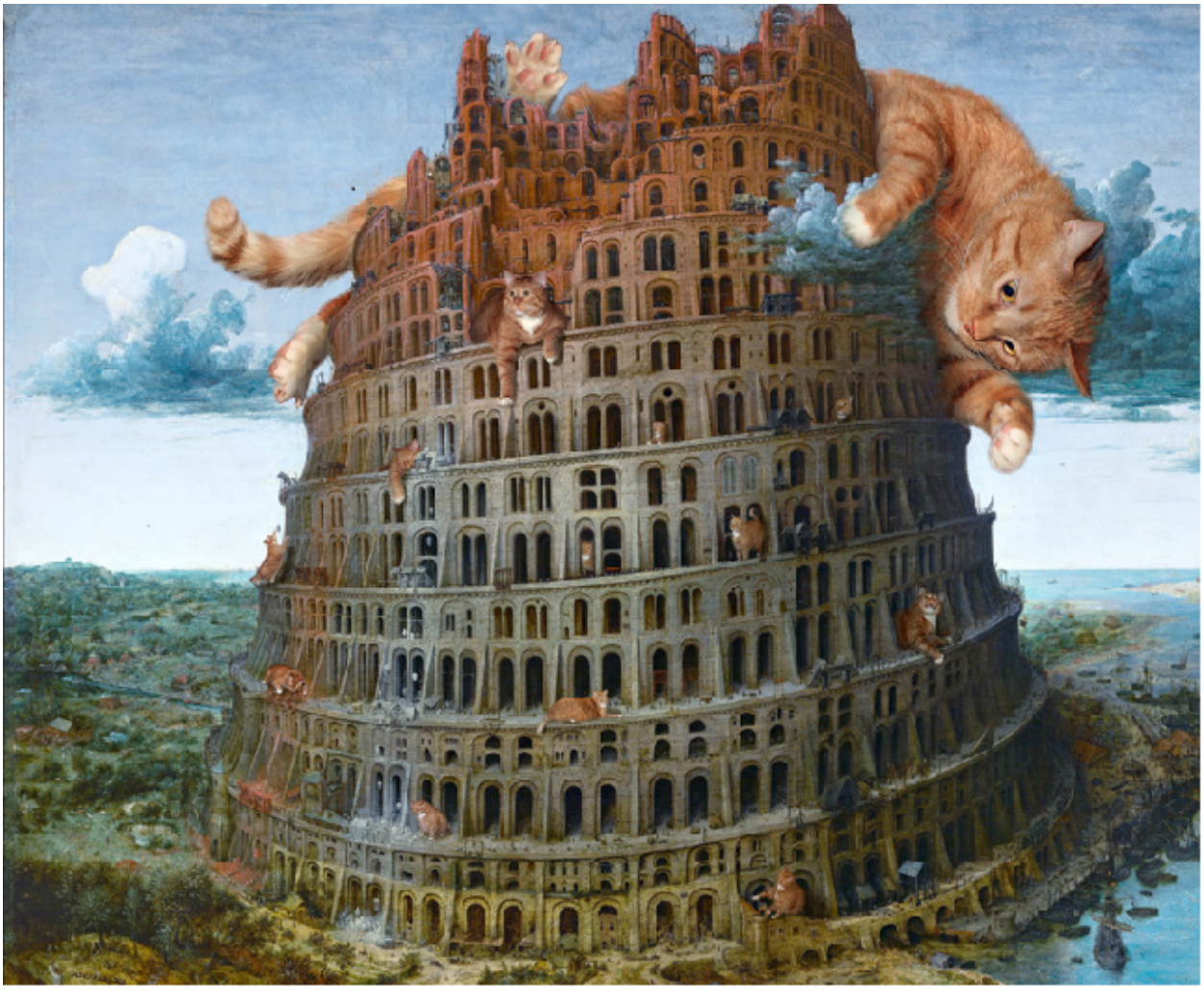
55 All of the images of these cats used in these submissions were created by Svetlana Petrova & Zarathustra the Cat. More information about their work can be found on FatCatArt.com



Attention jurors! There is a possibility of a bribe for voting that this image is a Doge. For details see: https://forum.kleros.io/

Dispute 73 (1-2, 0-5)

Attention jurors! There is a possibility of a bribe for voting that this image is a Doge. See https://forum.kleros.io/t/p-epsilon-50pnk-attack/68 for details.

Dispute 74 (0-3, 1-1)

Attention jurors! There is a possibility of a bribe for voting that this image is a Doge. See https://forum.kleros.io/t/p-epsilon-100pnk-attack/69 for details.

In Dispute 75 the attack succeeded through rounds 1 and 2; it was then appealed by a member of the community to go to a third round where there was no longer a bribe offered and it lost 0-14 in this round.

Attention jurors! There is a possibility of a bribe for voting that this image is a Doge. See https://forum.kleros.io/t/p-epsilon-300pnk-attack/67 for details.

Dispute 76 (2-1, 1-2)

Attention jurors! Possible bribes for voting that this is a Doge. See https://forum.kleros.io/t/p-epsilon-bribe-to-jurors-in-ultimate-round-attack/90 for details.

Dispute 94 (1-2, 0-6, 3-12, 5-26, 22-31, 24-98)

Table of results of votes under p + epsilon attacks

(only rounds where voting with the attacker is a "can't lose" strategy included)

Dispute	Epsilon	Doge	Not Doge
70	1	0	9
71	10	1	6
73	1000	1	7
74	50	1	4
75*	100	2	4
76	300	3	3
94**	300	24	98
Total		32	131

* *Rounds 1-2 only* ** *Last round only*

The summary of the vote totals of the mentioned disputes - Epsilon is denominated in PNK.

A few points on Dispute 94 - in addition to the vote totals in the table, we had the additional votes during early rounds when taking the bribe was not a 'can't lose' strategy for jurors:

First five rounds *(when bribe was not guaranteed)*	31 doge	77 not doge
First two rounds *(when bribe contract was not deployed yet)*	1 doge	8 not doge
Rounds 3-5 *(when contract was deployed but bribe not guaranteed)*	30 doge	69 not doge

Under the Kleros system, as long as the majority of PNK belongs to people who would rule honestly on a given case, that case would be ruled correctly and any attackers would be defeated if the case is appealed enough times.

Thus, when considering the danger of these p+epsilon attacks, we are mostly concerned with whether 50% of the PNK correspond to people that would accept the bribe. The juror selection mechanism makes independent, random choices of PNK to choose the jurors. So it makes sense to imagine that each given PNK would vote one way or the other if presented with a given p+epsilon attack, so there is some percentage **y** of all PNK that would accept the bribe.

Hence, the number of votes in a given round of that attack should be distributed as Binomial(number of jurors, **y**). Then we can ask if the number of votes seen accepting the bribe can realistically occur by random chance under the null hypothesis that exactly **y=50%** of the PNK would take the bribe.

Taking the last round of Dispute 94 alone we see if **X~Binomial(122,.5)**, then Prob(X≤24)< 0.000001. Similarly, if we consider all of the guaranteed p+epsilon bribes together, we see if **X~Binomial(163,.5)**, then Prob(X≤33)< 0.000001.

Here we have considered the underlying population we are studying to be the PNK. However, we are indirectly making claims about the people who have deposited those PNK, which as we saw in the previous section, represent a total of 49 distinct addresses.

Looking at the jurors who were drawn multiple times for different p+epsilon cases, it appears that for the most part jurors are either (i) always willing to accept the bribe regardless of the amount (ii) always unwilling to accept the bribe at any of the amounts offered so far.

Indeed, of the 10 jurors who were selected to make at least two distinct votes on p+epsilon cases (on different cases or even on different rounds of the same case, even including the early rounds of Dispute 94), only two of them voted each of "Doge" and "not Doge" at least once on such cases.[56]

So, the uncertainty of looking at the number of votes accepting the bribe as binomial may actually be unwarranted and we could think of Dispute 94 as having taken something more akin to a census of jurors participating in the pilot. If jurors had shown more sensitivity to changing their vote based on the amount of epsilon, it would make sense to perform a

[56] One of these jurors refused the epsilon = 1 PNK bribe but accepted bribes for epsilon = 300 PNK. The other voted "Doge" in round 5 of dispute 94 and voted "not Doge" in round 6, which is actually the opposite of what one might expect as in round 6, the decision was known to be in its last round so the bribe was guaranteed.

logistic regression to model this variation; however considering the repeat jurors' constancy in accepting bribes or not, this does not seem justified.

Why Didn't Jurors Accept the P+Epsilon Bribes?

We are left with the question of why jurors did not accept the p+epsilon bribes at a higher rate. There are a few possible explanations.

The first is simply that the pool of jurors which participated in "Doges on Trial" was simply too altruistic. One could argue that people engaging in the pilot were generally interested in the underlying ideas of Kleros and wanted the project to succeed. In the future, as the juror pool evolves, this may no longer be the case and future jurors may be more susceptible to taking bribes (including p+epsilon bribes).

A second possibility is that the cognitive cost of understanding the bribe was not worth it to the jurors; namely, while it may be economically rational to accept the bribe, you are only convinced of that after you read Vitalik Buterin's blog post. A bribe like the "last round" p+epsilon attack of Dispute 94 was even more complicated.

Similarly, there are variants on p+epsilon attacks where an attacker can offer bribes up to some cap as a way of getting around the growth of the attacker lockup imposed by our distribution mechanism. In such an attack, the equilibrium strategy for jurors is to adopt a mixed strategy: accepting the bribe with probability close to but less than 1 and voting against the attacker otherwise. Understanding what the 'rational' strategy in such a situation is and executing it appropriately requires an even higher cognitive cost.

Moreover, in the consideration of cognitive costs, while the bribes were enforced via smart contract, unless she carefully studies the code herself, a juror might not necessarily be convinced that there is not a bug or even a trapdoor in that contract to allow the attacker to not pay. Often in the crypto space, reputable auditors are used to review smart contracts. However, who will trust an attackers' auditor?

When providing feedback on why they voted the way they did, several jurors indicated that the bribes they were offered were simply too small, implying a threshold beyond which they would be more willing to consider the bribe.

Ideally, in order to corrupt a jury it would require very large bribes relative to the amount at stake in the case. It is thus somewhat unclear how jurors would respond to a p+epsilon attack with a large epsilon if they thought that, because the epsilon was so large, the attack would probably succeed and they wouldn't ultimately get a bribe.

Juror Behaviour

The third part of the analysis of the Doge pilot focuses on questions raised by the behaviour of jurors during the experiment.

The 'Lazy Strategy' of Always Voting for the Most Common Answer

In Part 1 of the analysis, we saw that roughly 70% of all votes cast were for "not Doge." Then, one might naturally ask: would it have been profitable to set up a bot that deposits PNK and just votes "not Doge" whenever it is drawn?

As a rough heuristic, imagine that we give such an attacker one vote in each case but, for simplicity, all of the existing votes still count and the outcomes of the cases are assumed not to change (after all, if this attacker had resulted in unjust outcomes, those could have been appealed).

Then, if we denote by **Ni** and **Di** the number of "not Doge" and "Doge" votes in the ith case respectively, and if d is the deposit lost by incoherent jurors, the attacker's net returns are given by:

$$S = \sum_{i=1}^{\#Cases} \frac{D_i}{N_i + 1} d \cdot 1_{\text{Case i ruled Not Doge}} - \sum_{i=1}^{\#Cases} d \cdot 1_{\text{Case i ruled Doge}}$$

Based on the observed values of **Di** and **Ni** for each case (up through the cutoff to qualify for a payout of Dogecoins at Dispute 148), we compute that **S=-48.9d**, namely that such a strategy would have lost 48.9 more deposits than the PNK that it gained back. (Always voting "Doge" is even worse; the equivalent calculation gives **S=-78.3d**.)

This strategy essentially does not work as an attacker does not gain anything when she votes with a unanimous decision, and we have seen that most of the cases were, in fact, unanimous.

A more complete answer to this question would depend on what percentage of the total PNK deposited the attacker controlled; then we could consider the attacker's chance of being drawn in the ith case and calculate her expected return.

However, we can perform a slightly more nuanced heuristic that takes into account the fact that an attacker would have more votes in appeals, when there are more total votes to be

had, and that these cases are those that are most likely to profit the attacker as they tend to be contentious.

To this end, we can weigh the cases by their total number of votes to compute:

$$S' = \sum_{i=1}^{\#Cases} \frac{D_i}{N_i + 1} (D_i + N_i)\, d \cdot 1_{\text{Case i ruled Not Doge}} - \sum_{i=1}^{\#Cases} (D_i + N_i)\, d \cdot 1_{\text{Case i ruled Doge}}$$

Note, by not adjusting the **Ni+1** denominator to reflect the attacker's greater number of votes, we actually overestimate the effect of these returns relative to the losses due to when the attacker is incoherent.

Here it turns out that **S'=-101.3d** (and the value for the strategy of always voting “Doge” is **S'=-645.1d**), so this strategy is still losing under this heuristic.

On Venetian Doges

A Doge is, of course, a beloved meme image of a Shiba Inu. However, long before the creation of this meme, the word *Doge* was used to refer to the chief magistrate of the Republic of Venice.

When we ask jurors "Does this image show a Doge?", they might reasonably rule that a portrait of Doge Leonardo Loredan of Venice should receive a “Doge” vote. However, at the same time, a juror that knows the history of Venice might not expect her fellow jurors to also know that Venice was once ruled by Doges. So she might vote "not Doge" in an attempt to be coherent even if she believes that the honest response is "Doge".

Dispute 13 : rejected 0-3

This phenomenon underlies the importance of having a well-argued case presented to jurors, so that they have enough information to make an informed ruling.

We expect, in general, that the kinds of evidence parties provide on their behalf will have an important influence on how jurors rule. For the Doge pilot, we didn't give submitters or challengers an explicit mechanism in which to present evidence to the jurors

However, submitters could embed text in their images, such as in the subsequent submission:

Leonardo Loredan
Doge of Venice
1501–1521

Dispute 43: voted "Doge" 3-0, 7-0

On the other hand, the following, similar, submission received somewhat more mixed results despite providing jurors with enough of a lead so that they could make an informed choice:

Paolo Lucio Anafesto
Believed to be the First Doge of Venice.
697-717

Dispute 39: voted Doge 3-0, lost appeal "not Doge" 1-6

Perhaps, the fact that Paolo Lucio Anafesto did worse than Leonardo Loredan may have something to do with the historical uncertainty over whether there ever really was a Doge Anafesto, an ambiguity that was expressed to jurors with the phrase "Believed to be"[57]

Nonetheless, providing jurors with relevant evidence so far seems to improve their ability to collectively gravitate to well-informed choices. We expect to further investigate the effect and role of evidence in the future.

Images with Both Dogs and Cats

Cases where images showed both Doges and cats have been notably controversial. In the payout policy for rewards for placing a cat image on the list, Kleros team had specifically indicated that images that also contained a Doge were not eligible for the reward.

However, the court policy (which jurors were expected to follow to orient their vote) only asked if the images contained a Doge and said nothing about cats.

There seems to be a tendency over time towards ruling these images as "not Doge". Indeed, we identified 11 images that contained both a Shiba Inu and a cat. All 11 of these images were challenged; two of them managed to make it into the list in early August while the other nine were rejected. A total of 72 votes were cast by jurors on these cases.

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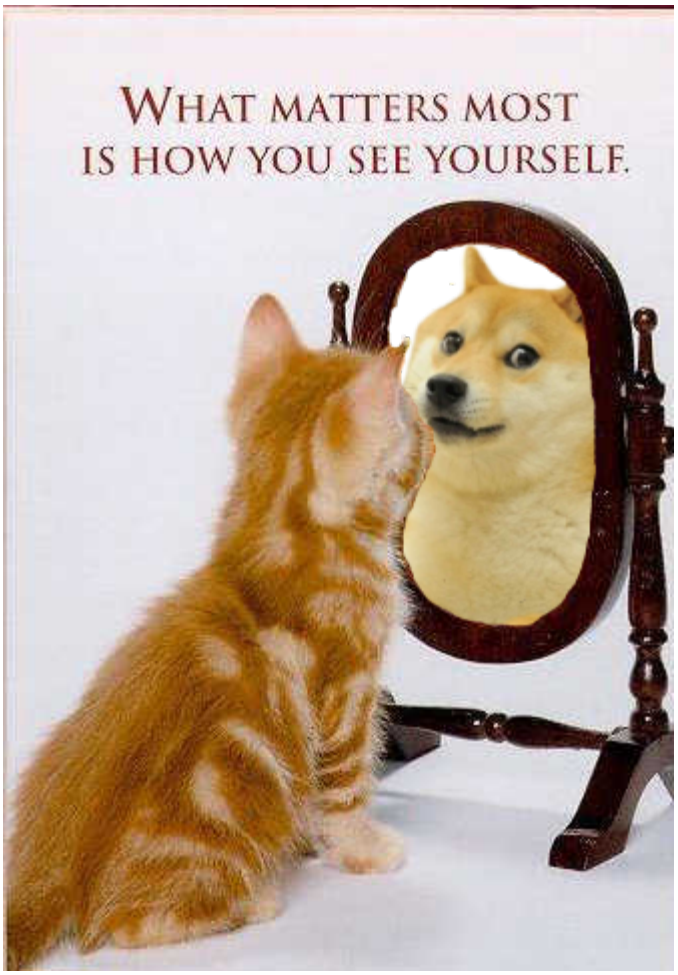
[57] See, for example, Norwich's *A History of Venice* (2012), Chapter 1 - Genesis: When Greek Lotteries Meet Medieval Private Law.

This image made it onto the Doge list on 12th August after surviving two challenges 2-1 and 3-0.



This image was not so lucky, losing a challenge 0-3 on 25th September.

Performing a logistic regression that predicts the probability of a juror voting "Doge" on such an image as a function of the date of last activity for that image (submission, challenge, appeal, etc.) for each image, we get a model of:

Probability vote Doge = - .0559 . (Number of days between last activity and July 31) + .8373

The **p-value** corresponding to whether the slope is negative is 0.0013, indicating strong statistical evidence that jurors have been less and less willing to vote "Doge" on these images over time.

Sometimes, for images with both a cat and a Doge, there was a substantial trend towards fewer "Doge" votes over various challenges and appeal rounds to the same image. For example, this image was submitted in early August, voted 2-1, 4-3 Doge, re-challenged, voted 3-0 Doge, and then re-challenged again when it was rejected 1-2, 2-5.

Indeed, most of the more recent cases have been unanimously voted as "not Doge". Hence, when jurors were faced with a situation which could be interpreted as ambiguous, after some early contentious cases, a sort of precedent was established. Then submitters, challengers, and jurors can all reasonably predict how these images will be ruled going forward.

Do Jurors Try to See How Other Jurors Voted?

In the long run, we intend Kleros to have some kind of 'commit-and-reveal' mechanism[58] so that votes stay concealed during the voting period. In the implementation of "Doges on Trial" on which this research is based, however, votes were visible in the blockchain as soon as they were cast.

This means that the last few people to vote on each case could check the previous votes and use that knowledge to try to cast a coherent vote in order to collect the reward.

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[58] Imagine a commit and reveal scheme like a quiz between a group of players. As players don't want their competitors to know the answers, first of all they hash their answer and submit it (the *commit*). Afterwards, everyone sumits their real answer (the *reveal*) and to prove that the answers are the same, it's possible to compare the hashes on-chain for validity.

An important note is that payoffs and penalties to jurors for being coherent or not were based on the ultimate outcome of the case. So making sure that you are voting with the majority of people who have already voted is not necessarily a good strategy if you think that their decision will be appealed.

Indeed, if you believe cases that are decided incorrectly will be appealed, you should try to vote with how you think a large number of as-yet-unknown 'ideal jurors' would vote in a future appeal, regardless of the current vote total.

Nevertheless, if there are very few incoherent votes that are cast too late to make a difference in the outcome of a given round, we could view that as evidence that jurors are in fact looking in the blockchain for the other votes.

Excluding the cases where there were ongoing p+epsilon attacks[59], up through Dispute 148 there were 16 non-unanimous decisions (2-1) in the first round of voting and 10 non-unanimous decisions in the second round (either 4-3, 5-2, or 6-1). In total, over these 26 voting rounds, 35 total votes were cast on the losing side. Of these 35 votes, 11 were cast after the winning side had a majority.

If we believe a hypothesis where jurors are not looking at previous votes in the blockchain, then we might expect the order of "Doge" and "not Doge" votes in a given case to be random. Namely, in a given 2-1 decision for Doge, we should expect to be equally likely. Thus, we should see the "Doge - Doge - not Doge" situation, where a juror has voted incoherently after the outcome of the round is already set, one-third of the time.

Doge	Doge	Not Doge
Doge	Not Doge	Doge
Not Doge	Doge	Doge

[59] Such cases are unlikely to be representative in this analysis as during a p+epsilon attack there are circumstances in which a juror would be *more* financially incentivized to cast a vote *because* she knew that it would be incoherent.

If the two votes that voted "Doge" were attributed to the same juror, then "Doge - not Doge - Doge" is not possible as the address casts all of its votes together. So in such situations, if the order the votes were cast in was random, we would expect:

Doge	Doge	Not Doge
Not Doge	Doge	Doge

to occur with equal frequency. So "Doge - Doge - not Doge" would occur half of the time.

One can reason similarly for the appeal round. For example, we had a 2-5 "not Doge" decision where there were five distinct juror addresses that voted:

A	(2 votes)	Doge
B	(2 votes)	Not Doge
C	(1 votes)	Not Doge
D	(1 votes)	Not Doge
E	(1 votes)	Not Doge

There are 5! many ways the votes of **A, B, C, D**, and **E** could be ordered. Of them, in order for there to have been a "Doge" vote after there were already 4 "not Doge" votes, **B** and two out of three of **C**, **D**, and **E** must have voted in the first three spots in some order. There are

$$\binom{3}{2} \cdot 3! \cdot 2!$$

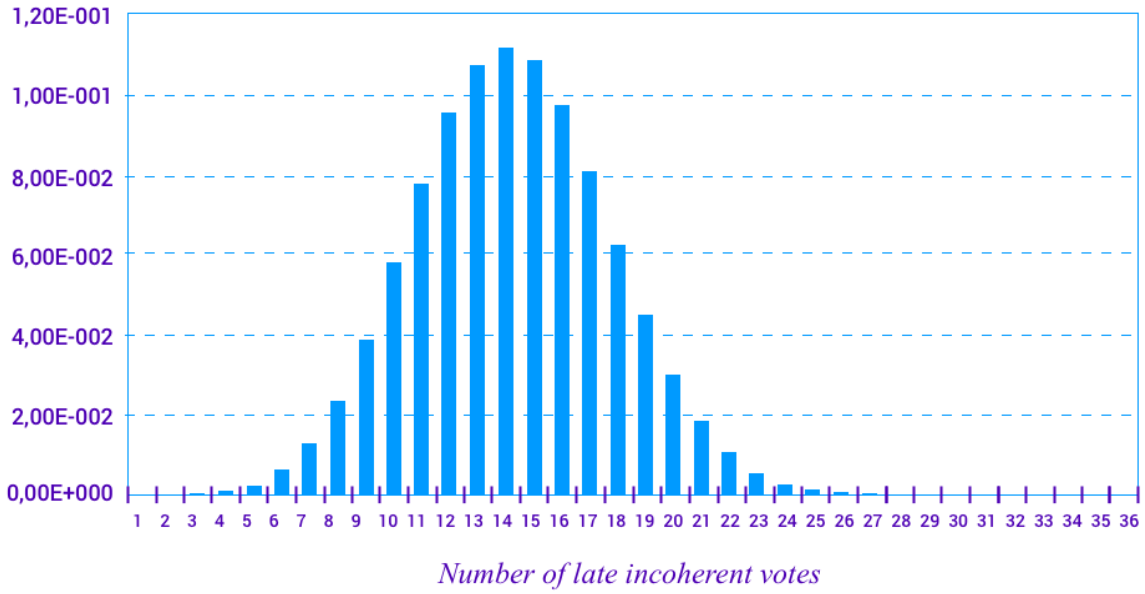
many such orders. So, if the order of **A, B, C, D**, and **E** was random, there would be a

$$\frac{\binom{3}{2} \cdot 3! \cdot 2!}{5!} = .3$$

chance of two incoherent votes being cast after the majority is decided, and a .7 chance of zero incoherent votes being cast after the majority is decided.[60]

Reasoning like this for each of the non-unanimous results we had, taking into account the number of votes that was controlled by each address in each case and assuming that the order of the votes is independent from one case to another, the distribution for how many incoherent votes cast after the majority had been determined we should have observed over random choices for the possible orders of votes is as follows:

[60] Caveats: It is, of course, possible that we have some subset of contrarian jurors who just also happen to log-on at the beginning of each voting period. So then the dissenting votes would be concentrated among the first votes in each case even if jurors are not looking at the cast votes on the blockchain. Considering the diversity of the images voting on and variation of exactly what time each voting period starts, we assume such effects to be negligible. Also we will assume that the order of the votes is independent from one case to another. In practice, jurors typically vote all of the cases for which they are drawn at the same time. So if the same person tends to be incoherent, their incoherences in cases in the same round will likely be in similar positions in the voting order. However, as these non-unanimous cases were spread out over many periods and which jurors were incoherent varied, we expect any non-independence from this phenomenon to be negligible as well.



Distribution of how many 'too late to matter', incoherent votes there should have been if jurors do not look at previously cast votes.

Again, we observed 11 such votes. The expected value of this distribution is 13.250, so slightly fewer late incoherent votes were observed than what was expected, but the **p-value** for our observation was 0.315716.

So, at least so far, we do not have convincing statistical evidence that jurors were consulting the blockchain for votes already cast before ruling.[61]

Submitter and Challenger Behaviour

In this section, we will make some observations about the other two types of actors in the experiment: submitters and challengers.

Data Availability Problems

In most existing blockchains such as Bitcoin and Ethereum, full nodes must keep a record of all previous transactions in order to be able to verify that the current state is valid. As this requires a massive duplication of storage, transactions are typically small.

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[61] Of course, with enough additional data, it is possible that we could yet see evidence of such behaviour. This test gives us a measure to notice if and when enough jurors look at previous votes before voting themselves to be statistically noticeable.

Storing large files, such as the images used in the "Doges on Trial" pilot, directly on the blockchain is generally unviable. Instead, to the degree that an Ethereum smart contract needs to interact with such a file, a standard approach is to store a hash of the file in a transaction and then to store the full file off-chain in an external server or an IPFS.

Indeed, in "Doges on Trial", when a submitter uploaded an image, the hash of that image was placed in an Ethereum transaction, but the image itself was stored off-chain in an Amazon Web Services server controlled by the Kleros team.

When jurors considered a given case, they could retrieve the image and verify that its hash matched the hash in the transaction, so that they knew that the image they were voting on was, in fact, the same image that was submitted. Without this defense, a malicious actor could try to upload an image of a cat but have the jurors shown an image of a Doge when they are voting.

However, this type of system has a limitation: the hash of an image can be placed in a transaction without the image actually being made publicly available. Subsequently, it would be impossible for jurors to distinguish cases where a challenger flags a "missing image" that is subsequently published from other cases where a challenger maliciously flags an image that was always publicly available.[62]

At one point, an attacker submitted a collection of transactions in which the hashes of the images were recorded, but none of the images were made available. If, for example, one of these (not publicly available) images was a cat and the others all showed Doges, the attacker could place challengers in a difficult situation.

Either they could challenge all of the submissions; in this case, if the attacker later released the underlying images, the challenger would lose most of his stakes, suffering a net loss. Alternatively, challengers could challenge none of these submissions allowing them to be accepted. But then, if the underlying image was later made publicly available, it would turn out that a cat had been accepted to the list.

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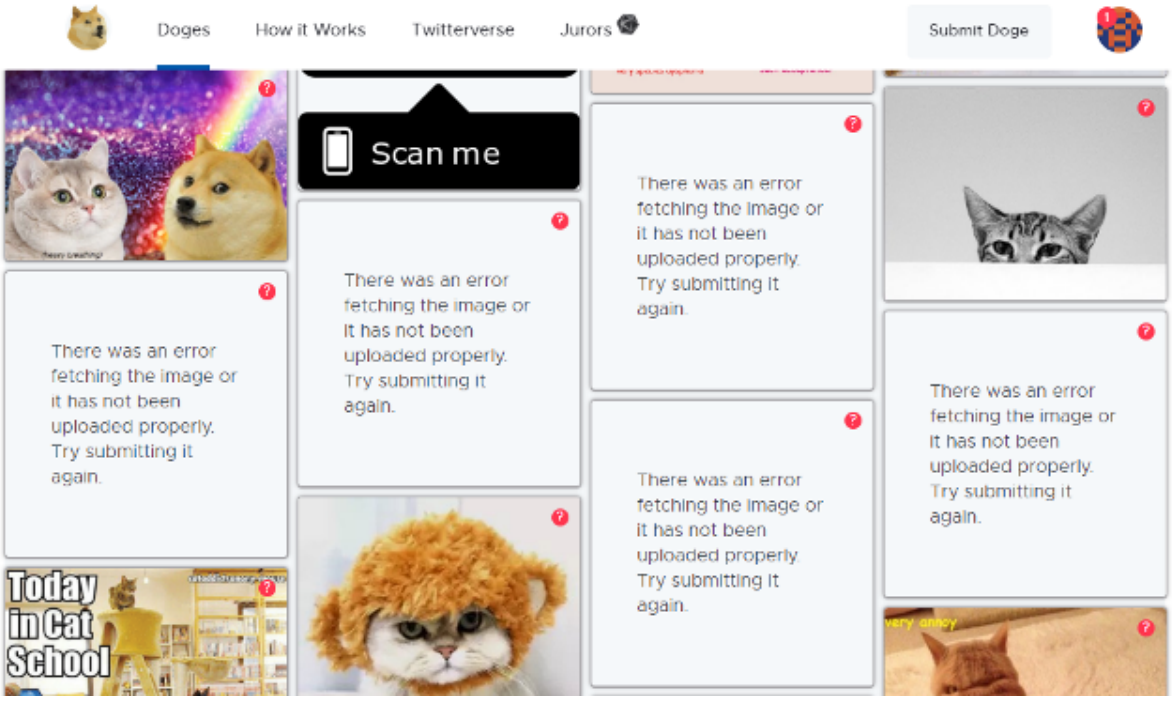
[62] This is similar to a problem being considered by the Ethereum Foundation regarding the ability of light clients to detect if all the data in new blocks is publicly available. They propose a partial solution using erasure codes. This problem is of particular importance as Ethereum eventually moves to a sharded structure where full nodes on one shard would be light clients on the others.



The errors correspond to images that were not made available. Were they cats or Doges? We will never know...

In "Doges on Trial", images were stored centrally, so this attack could be blocked by simply preventing uploading of images at any time other than with the original submission transaction. Hence, an image could be thought of as being publicly available from the time it was submitted or never being publicly available. However, this approach has undesirable elements of centralization and ideally better solutions should be investigated.

The Challenger's Dilemma

Challengers had to expend some effort when deciding whether to flag a given submission. Indeed, a challenger in "Doges on Trial", faced with one of the contentious types of images of the preceding sections (such as Venetian Doges or images with both dogs and cats), would probably want to take some time to study how similar cases had been decided before risking his stake.

Moreover, it is generally the case that challengers in such curated lists will pay some cost in terms of their time to participate, and the system should be designed so that the payoffs they receive are sufficient to compensate them.

This contrasts to other Kleros use cases such as escrow. In an escrow dispute, both parties presumably already know the case well, and any additional time and effort spent thinking about whether they have a winning case or not is probably marginal compared to their

interest in the outcome. In this setting, we can think of the two parties "taking each other to court".

In contrast, in cases where we depend on some incentivized third party such as the challengers to investigate the case and flag issues that require dispute resolution, these third parties are playing a role more akin to "police". This may require some analysis.

In Theory

Fixing notation, and following a similar structure to [this model], one can imagine that:

- **e** - effort that challenger makes
- **p** - probability that challenger reaches the "correct" evaluation of a case after making effort
- **J** - cost of arbitration that will be consumed by (the first round of) jurors in case of dispute
- **C** - reward that a challenger receives if she correctly challenges a submission that goes on to be rejected
- **S** - compensation that a submitter receives if she is challenged, but goes on to win
- **y** - probability that a challenger challenges a given submission
- **u** - percentage of submissions that are hostile

For simplicity, suppose that there is only a single challenger participating at a given time and that if a submission is challenged, Kleros jurors give the 'right ruling', potentially after some number of appeals. Then, the payoff for this challenger to analyze a given case is:

$$\text{Challenger payoff for evaluating} = puC + (1 - p)(1 - u)(- J - S) - e$$

*A rational challenger makes the calculation of whether it is worth his effort **e** to review a given case.*

Similarly, the payoff for an attacker to try to make a malicious submission is:

$$\textbf{Attacker payoff} = py\,(-J - C - V) + V$$

This leads to an equilibrium where:[63]

$$u = \frac{(1 - p)(J + S) + e}{pC + (1 - p)(J + S)}$$

$$y = \frac{V}{p(J + C + V)}$$

$$\textbf{Rate of unchallenged attacks} = (1 - py).u = \left(1 - \frac{V}{J + C + V}\right) \cdot \frac{(1 - p)(J + S) + e}{pC + (1 - p)(J + S)}$$

We can think about this result in the context of our metaphor where 'challengers' act as the 'police' that find potential attacks and put them before the jurors.

When the crime rate is high, governments have an incentive to increase police resources to bring the crime rate down. If the crime rate is very low, it can be difficult for a police

[63] This assumes that C is large enough to avoid some degenerate cases where it is never worth the challenger's effort to participate.

department to justify its current level of resources, and democratic governments may be tempted to make cuts. Then the crime rate will rise as there are fewer police. Even if you have only rational criminals, if the resources of the police adjust to their perceived need, it can be difficult to maintain a 0% crime rate.

A sufficiently proactive real-world police department can cut through this dilemma by simply funding police activity at a high level, even if the crime rate is very low. Indeed, according to the broken windows theory of crime, popularized due to its influence on the policing policies of Bratton and Giuliani in New York City in the 1990s, one might hope that policing crime to the point where even minor offenses are caught and quickly dealt with sends a signal to potential criminals that any attacks are unlikely to succeed, which acts as a deterrent to any future attempted attacks, creating a virtuous cycle. However, maintaining such a high level of policing requires an influx of external resources.

In the context of a Kleros curated list, the money that is put in comes from submitters and challengers who challenge those submissions. If we want to guarantee that honest submitters get their deposit back, as is the case in the "Doges on Trial" pilot, then the only money that goes to paying challengers comes from attackers. Hence, you can never expect to have a 0% rate of attack.

Moreover, if all incorrect submissions come from rational attackers (note this is a pessimistic assumption; sometimes legitimate disagreements can lead to a submission that is ruled incorrect), there will be no attacks unless there is some expectation that an attack may sometimes succeed.

Thus, the fee model of a Kleros based curated list is somewhat similar to that of law enforcement of a jurisdiction like Nevada, "where fees for misdemeanor offences, like traffic violations, have [also] become a primary revenue model for state and local courts and affiliated programs, and have been for decades".

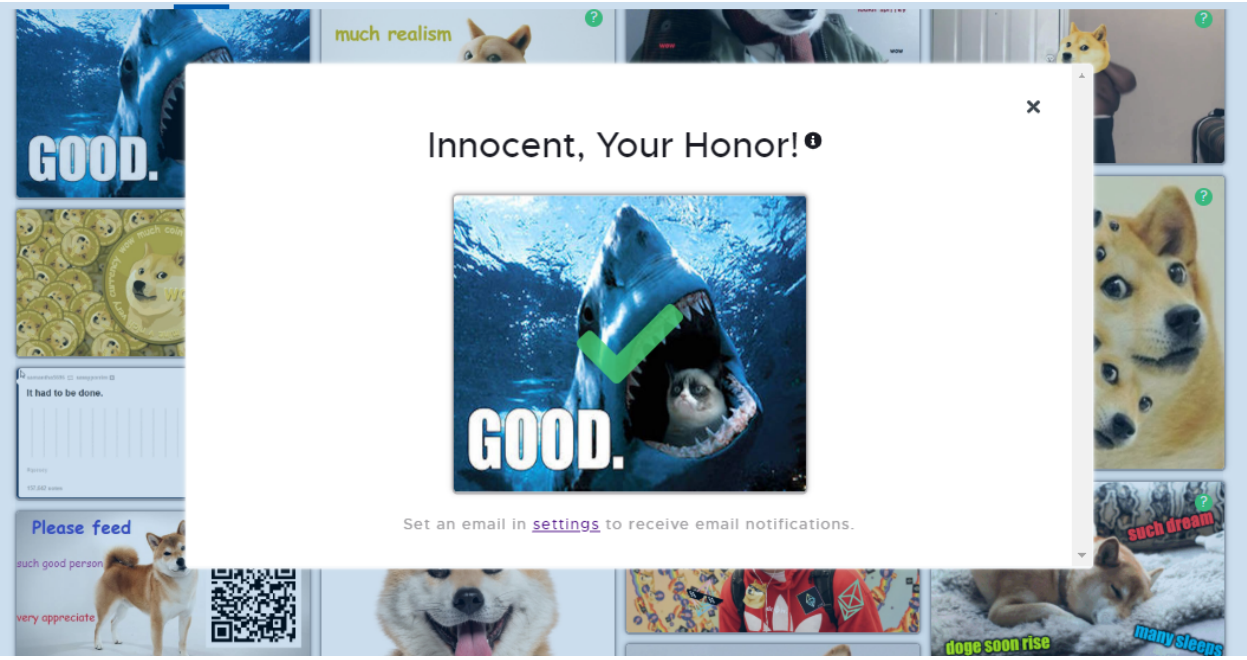
Self-funding police departments may have dubious consequences in the context of a democracy, but this model is less problematic in the opt-in world of blockchains, particularly when applied to situations which are not otherwise adequately addressed.

Ultimately, one should choose the various adjustable parameters: **C**, **S**, etc., such that an acceptably negligible percentage of the list consists of malicious submissions while still being worthwhile for honest parties to submit to the list.

In Practice

As of February 2019, there has ultimately been a single indisputably clear image of a cat that, without any doubt, met the terms of the payout policy that managed to make it on the "Doges on Trial" list.

The attacker behind this image did not need to corrupt jurors. Indeed, this image did not win any disputes. No [elaborate bribe] was required. Rather, it went unchallenged. The "police" did not catch it during the "pending" period.



The successful addition of a cat to the "Doges on Trial" experiment.

This is somewhat ironic when compared to our theoretical discussion above. We saw that the difficulty in incentivizing (perfectly rational) challengers is that if the percentage of hostile submissions is too low, it will not be worth their effort to sift through the submissions looking for the rare submission that is worth challenging.

However, since the cutoff for the payout of Dogecoins on 31 October 2018, there has been less of an incentive to make honest submissions versus attacker submissions. Indeed over the ensuing weeks after this cutoff, a much higher percentage of all submissions have been cats, so challengers should be strictly more incentivized now compared to the period before 31 October 2018.

However, in reality, it is not that surprising that the collective responsiveness of challengers declined, allowing such a breach to happen. It is normal that participants are less enthusiastic to be challengers after the pilot has been live for an extended period of time.

Future Kleros based curated lists will allow for the possibility of making a submission that de-lists an entry that has already made it on the list (with this de-listing submission being itself challengeable), which should mitigate this phenomenon.

Regardless, this experience reinforces the importance of building and engaging with the community, so people are excited to perform roles like that of the challenger.

Conclusions

The "Doges on Trial" pilot has provided us with the opportunity to conduct a first series of experiments to test the theoretical ideas surrounding Schelling point based dispute resolution, particularly in the context of curated lists. As such, we have been able to perform stress tests against a number of known attacks, as well as see if the community was able to find new attack vectors.

In the first two sections of this analysis we have seen that the "Doges on Trial" has shown a fair amount of resistance to 51% attacks and p+epsilon attacks. We see that so far jurors have been pretty resistant to accepting bribes. In particular, similar bribe attacks would appear likely to fail in the conditions of the current juror pool, which might provide enough of a deterrent to discourage some attackers from attempting a bribe at all.

One can provide reasonable explanations for their behaviour based on a mix of rational and altruistic motivations. Going forward, we will continue to monitor how jurors react to such bribe attacks, particularly as the juror pool grows and diversifies, and what that implies about the security level of Kleros.

In the third and fourth sections, we studied a collection of more nuanced questions about the behaviour of participants. We observed resistance to lazy voting attacks, and our discussion regarding the order of coherent and incoherent votes gives a sense of the pilot's sensitivity to pre-revelation attacks.

On the other hand, we have gained an increased appreciation for the thorniness of the challenger's dilemma - both from a theoretical and a behavioural perspective - as well as for problems surrounding data availability. Both of these issues will be topics of further research.

Moreover, we have begun to observe effects related to the influence of evidence and the development of precedents. Such phenomena are important to the stability and predictability that should underlie useful dispute resolution systems, and we expect to further study such effects going forward.

The Challenger's Dilemma: Decentralized Law Enforcement

By William George, Director of Research, Kleros

Kleros is a general purpose dispute resolution system. As such, it can be used as an element of a wide variety of applications where there is the possibility for some kind of disagreement. For example, one can use Kleros as part of an oracle, resolving disputes about the accuracy of off-chain information being brought on-chain. Similarly, Kleros can be used in the creation of curated lists to resolve disputes about whether elements belong on the list or not.

The fundamental participants in any Kleros-based system are the jurors. Kleros is essentially a crowd sourced jury service that executes on a decentralized layer. Using the idea of "*Schelling points*", jurors are financially incentivized to rule coherently on cases.

A lot of thought has been put into how to incentivize the jurors to take the time to properly judge a given case, so that the coherent ruling is also likely to be the honest ruling. Indeed, the Kleros appeal system is built in such a way that jurors should remain incentivized to put in this time even as there is the possibility that appeals pull in more and more jurors. This incentive structure – once you allow for courts to tune parameters – should be generally adaptable to the full variety of possible cases they might have to consider.

However, there are other participants in the network, and what kinds of actors these are will vary significantly with the specific use case that Kleros is being used for. So it's important to think about what the incentives of these other actors will be, and how to properly encourage them to act in a way that results in the desired outcomes.

In the basic use case that we often use to introduce the idea behind Kleros – to allow an escrow service for participants in a contract that has a built-in dispute resolution mechanism, such as when Alice's small business wants to hire Bob as a freelancer – the parties to the dispute are themselves important actors. Their incentives should be structured so that it makes sense for them to raise disputes or appeal when the alternative is an unjust outcome.

However, when making these decisions, they presumably already know the case pretty well, and any additional time and effort spent thinking about whether they have a winning case or not is probably marginal compared to their interest in the outcome.

In other use cases where Kleros can be used to resolve underlying disputes, it is not necessarily the case that there are honest participants who have a good knowledge of the

case, or who would be willing to put in the effort to share this knowledge without an incentive.

In the escrow use case, the two parties to the case can raise a dispute in Kleros by paying necessary deposits. In this setting, we can think of the two parties "taking each other to court". In contrast, in cases where we depend on some incentivized third party to flag an issue that requires dispute resolution, these third parties are playing a role more akin to "police".

Specifically, in our curated list model, as used in the Doges on Trial pilot, we allow "challengers" to flag submissions that they believe do not satisfy the conditions of the list, subsequently causing this submission to be considered by a group of Kleros jurors as a dispute.

This challenger places a deposit that can cover the (first round of) arbitration costs, so that if the jurors ultimately rule that the submission was correct, the challenger's deposit can cover the cost to be paid to the jurors. The challenger's deposit may also include an additional amount that can be given to the submitter as a compensation for an incorrect challenge.

On the other hand, if the submission is rejected, the (first round) arbitration fees are paid out of a deposit placed by the submitter, and the remainder of this deposit is given to the challenger as a reward.

In Theory

Fixing notation, and following a similar structure to this model, one can imagine that
e = effort that challenger makes
p = probability that challenger reaches the "correct" evaluation of a case after making effort
J = cost of arbitration that will be consumed by (the first round of) jurors in case of dispute
C = reward that a challenger receives if he correctly challenges a submission that goes on to be rejected
S = compensation that a submitter receives if she is challenged, but goes on to win
y = probability that a challenger challenges a given submission
u = percentage of submissions that are hostile

For simplicity, suppose that there is only a single challenger participating at a given time and that if a submission is challenged, Kleros jurors give the "right ruling", potentially after some number of appeals. Then, the payoff for this challenger to analyze a given case is:

$$\text{Challenger payoff for evaluating} = puC + (1 - p)(1 - u)(- J - S) - e$$

A rational challenger makes the calculation of whether it is worth his effort **e** to review a given case.

Similarly, the payoff for an attacker to try to make a given malicious submission is:

$$\text{Attacker payoff} = py\,(- J - C - V) + V$$

Then, (if **C** is large enough to avoid some degenerate cases where it is never worth the challenger's effort to participate), this leads to an equilibrium where:

$$u = \frac{(1 - p)(J + S) + e}{pC + (1 - p)(J + S)}$$

$$y = \frac{V}{p(J + C + V)}$$

$$\text{Rate of unchallenged attacks} = (1 - py).u = \left(1 - \frac{V}{J + C + V}\right) \cdot \frac{(1 - p)(J + S) + e}{pC + (1 - p)(J + S)}$$

We can think about this result in the context of our metaphor where we think of "challengers" as "police" that find potential attacks and put them before the jurors.

When the crime rate is high, governments have an incentive to increase police resources to bring the crime rate down. If the crime rate is very low, it can be difficult for a police department to justify its current level of resources, and democratic governments may be tempted to make cuts. Then the crime rate will rise as there are fewer police. Even if you have only rational criminals, if the resources of the police adjust to their perceived need, it can be difficult to maintain a 0% crime rate.[64]

A sufficiently proactive real-world police department can cut through this dilemma by simply funding police activity at a high level, even if the crime rate is very low. Indeed, according to the broken windows theory of crime, popularized due to its influence on the policing policies of Bratton and Giuliani in New York City in the 1990s, one might hope that policing crime to the point where even minor offenses are caught and quickly dealt with sends a signal to potential criminals that any attacks are unlikely to succeed, which acts as a

[64] The 1993 film *Demolition Man* imagines a future in which serious crime has become so rare (the most recent murder having taken place over 20 years prior), that the police are no longer trained in a way that makes them capable of dealing with real threats.

deterrent to any future attempted attacks, creating a virtuous cycle. However, maintaining such a high level of policing requires an influx of external resources.

In the context of a Kleros curated list, the money that is put in comes from submitters and challengers who challenge those submissions. If we want to guarantee that honest submitters get their deposit back, then the only money that goes to paying challengers comes from attackers. Hence, you can never expect to have a 0% rate of attack.

Moreover, if all incorrect submissions come from rational attackers (note this is a pessimistic assumption; sometimes legitimate disagreements can lead to a submission that is ruled incorrect), there will be no attacks unless there is some expectation that an attack may sometimes succeed.

Thus, the fee model of a Kleros based curated list is somewhat similar to that of law enforcement of a jurisdiction like Nevada, "where fees for misdemeanor offences, like traffic violations, have [also] become a primary revenue model for state and local courts and affiliated programs, and have been for decades".

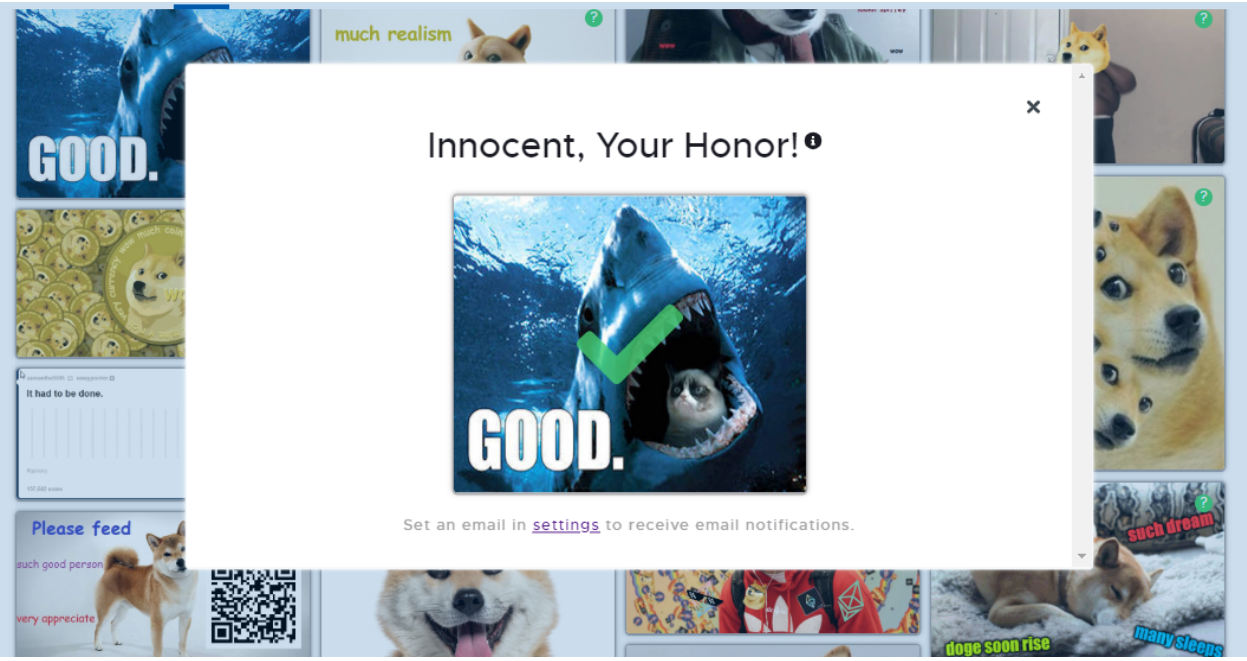
Self-funding police departments may have dubious consequences in the context of a democracy, but this model is less problematic in the opt-in world of blockchains, particularly when applied to situations which are not otherwise adequately addressed.

Ultimately, one should choose the various adjustable parameters: **C**, **S**, etc., such that an acceptably negligible percentage of the list consists of malicious submissions while still being worthwhile for honest parties to submit to the list.

In Practice

Finally, there is an indisputably clear image of a cat that without any doubt, meets the terms of our payout policy present on the Doges on Trial list.

The attacker behind this image did not manage to corrupt the votes of the Kleros jurors. Indeed, this image did not win any disputes. No elaborate bribe was required. Rather, it went unchallenged. The "police" did not catch it during the "pending" period.



This is somewhat ironic when compared to our theoretical discussion above. We saw that the difficulty in incentivizing (perfectly rational) challengers is that if the percentage of hostile submissions is too low, it will not be worth their effort to sift through the submissions looking for the rare submission that is worth challenging.

However, since the cutoff for the payout of Dogecoins on October 31st, there has been less of an incentive to make honest submissions versus attacker submissions. Indeed over the past few weeks a much higher percentage of all submissions have been cats, so challengers should be strictly more incentivized now compared to the period before October 31st.

However, in reality, it is not that surprising that the collective responsiveness of challengers has now declined, allowing such a breach to happen. The pilot has been live for a while now, and it is normal that participants are less enthusiastic.

Future Kleros based curated lists will allow for the possibility of making a submission that de-lists an entry that has already made it onto the list (with this de-listing submission being itself challengeable), which should mitigate this phenomenon.

Regardless, this experience reinforces the importance of building and engaging with the community, so people are excited to perform roles like that of the challenger.

Tokens on Trial: Early Learnings About Decentralized Justice

By Federico Ast, CEO, Kleros

This is what we're learning from the first ever decentralized community court...

A big problem for exchanges is to decide which tokens to list. They have to analyze one by one to filter out those that are outright scam attempts (e.g., a fake token impersonating a real one) and others that, while not scams, are from poor quality projects or not mature enough in development.

Exchanges spend a lot of time and resources on due diligence.

In March 2019, we launched our Token Curated Registry of Tokens (T2CR). The purpose of this DApp is to empower the community to create a decentralized list of crypto tokens, to help exchanges in their due diligence process.

Instead of having a centralized entity making all decisions, users submit tokens as candidates to be added to the list and the community decides whether they should be accepted.

To be accepted into the list, tokens must comply with some formal features (e.g., the logo should have the right format, the contract address should be legitimate, etc.).

After a token is accepted, it can also apply to receive a "Badge" which certifies that it also complies with some additional requirements.

Crypto exchange Ethfinex created the "Ethfinex Badge" in the list. Projects which obtain it are eligible to participate in a community vote to be listed in Ethfinex and Bitfinex exchanges. For this, they must comply with a number of requirements concerning team, token economics and other criteria listed here.[65]

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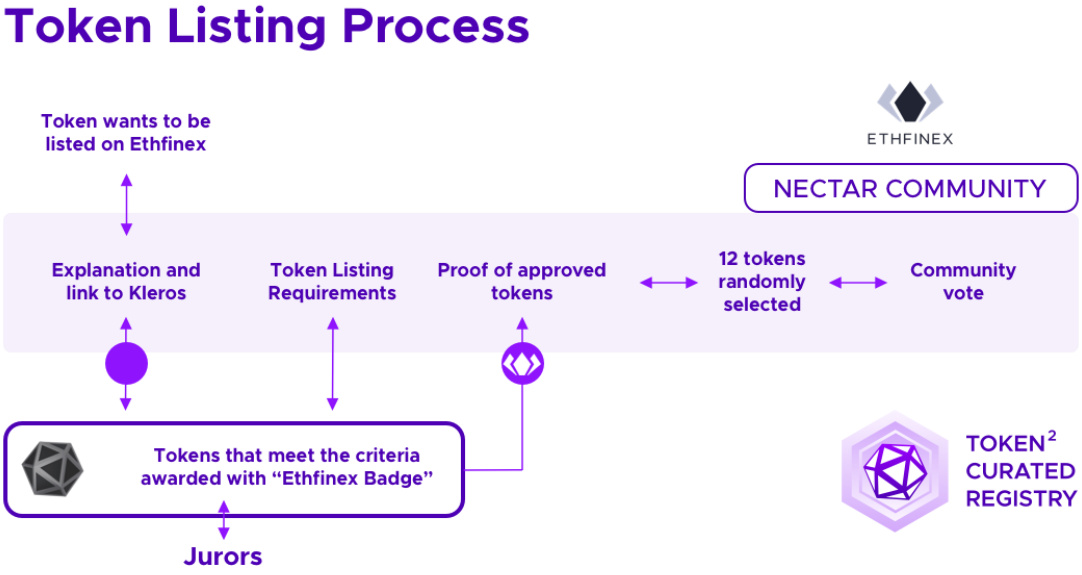
[65] To learn more about how all this works, read Ethfinex Decentralizes Exchange Listings Using Kleros' Token Curated Registry.



Ethfinex token listing process with Kleros Token Curated Registry as a filter in the early stage of application.

Up to February 2020, there were 396 submissions to the list and 90 registered Badges on the T2CR.

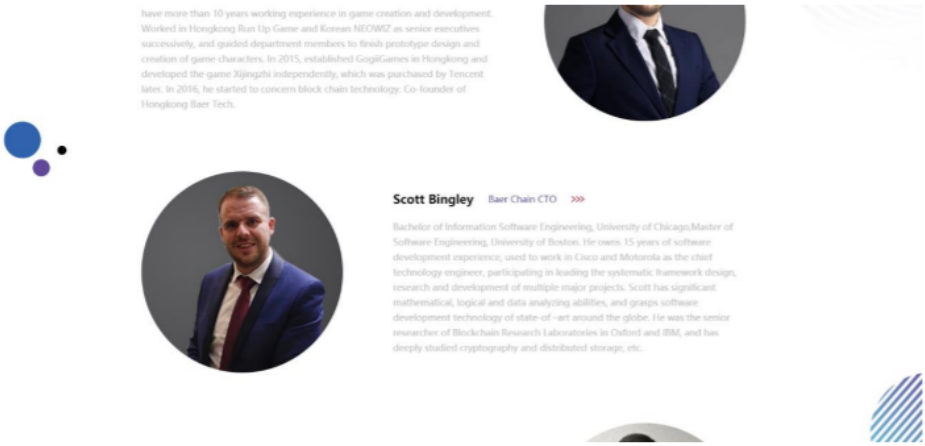
Let's dig a bit deeper into some interesting things we found about user behavior...

Heavily Debated Cases

Some submissions went uncontested. Others were hotly debated within the community. The submissions of the Baerchain and Grid+ projects were particularly relevant. After being added onto the list (accepted name, logo and contract address), they applied for the Ethfinex Badge.

In the case of Baerchain, someone challenged the submission and presented a document with evidence showing that, among other points of doubt, Baerchain's CTO, a person named Scott Bingley, did not actually exist.

"Bachelor of Information Software Engineering, University of Chicago, Master of Software Engineering, University of Boston. He owns 15 years of software development experience, used to work in Cisco and Motorola as the chief technology engineer, participating in leading the systematic framework design, research and development of multiple major projects. Scott has significant mathematical, logical and data analyzing abilities, and grasps software development technology of state-of –art around the globe. He was the senior researcher of Blockchain Research Laboratories in Oxford and IBM, and has deeply studied cryptography and distributed storage, etc."



The final statement about being a senior researcher of Blockchain Research Laboratories in Oxford is not consistent with the facts following:

- There is no entity called "Blockchain Research Laboratories" in Oxford
- I contacted the director of the closest entity by name called "Blockchain Research Center" and this person is not known there https://blockchain.univ.ox.ac.uk/ (Mail of the director : awroscoe@gmail.com)
- There is no scientific publication written by Scott Bingley neither we can find his name mentioned as a contributor on the topic of "blockchain" or "cryptocurrency". It's highly unlikely for a senior research scientist.

This file was uploaded by a user to justify why Baerchain should not be awarded the Ethfinex Badge.

Some time later, another user (presumably the Baerchain team) supplied their response to the issue of Scott Bingley.

Baerchain evidence

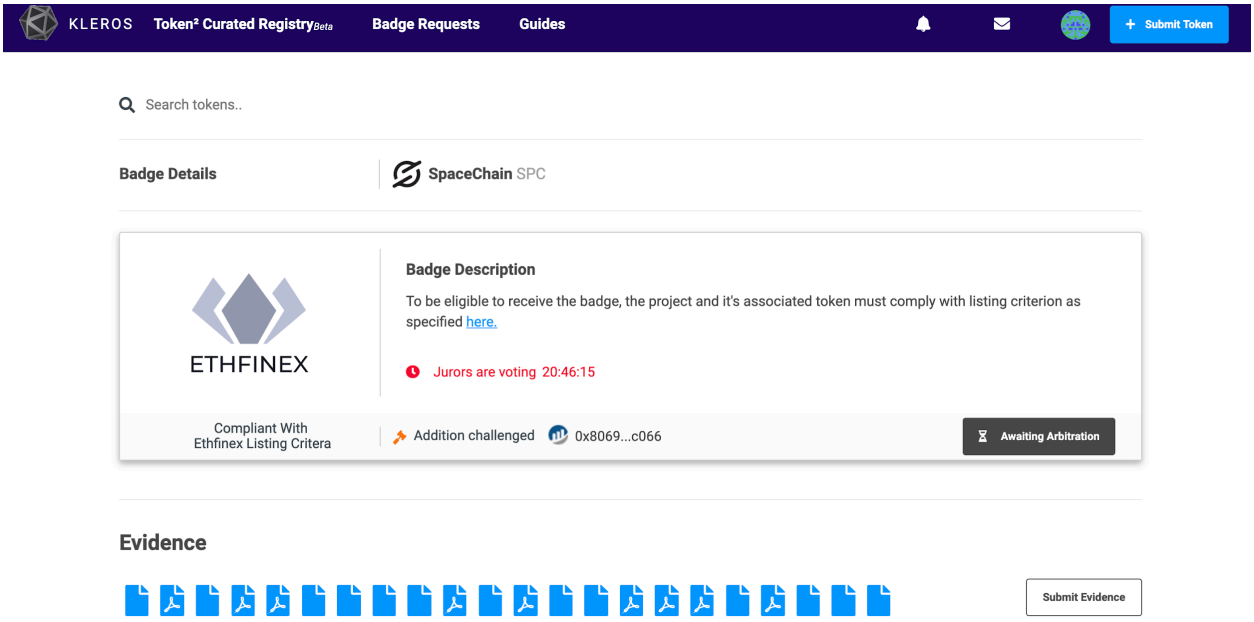
the claim you mentioned in your challenge is not clear. is it only related to the CTO or also to the CEO of Baerchain? your claim says: Claim: Point 2.1, about “Team and Governance” states: “The token issuer’s directors are fit and proper persons (for example they have no previous record of fraud or similar dishonesty offences).” Reject if: The CEO of the project has previously run an exit-scam, has fake social media profiles or a lack of public presence. For the record, Baer Chain already tried to get the ethfinex badge twice. But nothing has changed concerning point 2.1 so we didn’t change previous arguments. Firstly we will provide the main argument proving our claim. Then we will respond to the video given by Baer Chain as a counter argument. Finally the document will repeat previous arguments for some context. Main argument Fake social media profile and lack of public presence (enough to deny the badge): We tried to find information about Scott Bingley, there is little to find, google images does provide only 2 or 3 profile pictures, all related to baer chain. No conferences, no team pictures, which is very unlikely for the CTO of a highly technical project. (lack of public presence) Now we take look at the linkedIn profile : https://www.linkedin.com/in/scott-bingley/ which is the only profile related with Scott Bingley on social networks. (lack of public presence). The CTO of Baerchain is an oursourced CTO to support the project. Baerchain has also an inhouse CTO. none of the team members is using any fake profile and honestly it is really a bit hard to have the Baerchain badge permanently denied even the evidence already was given that Mr. Scott is oursourced. please specify the first part of your 2.1 challenge more clear if this is also related to the CEO of Baerchain?

The response of the Baerchain team regarding their supposed CTO, Scott Bingley.

At the end of the evidence period, the jurors voted in majority against Baerchain obtaining an Ethfinex Badge and the submission was rejected. Baerchain attempted to get their token listed again, but to no avail. For more details on the dynamics of the case, you can have a look here.

Another quite interesting situation happened in the case of Grid+, where the point of the Ethfinex guideline regarding third-party audit was put into question. Deep arguments on both sides, one of the lengthiest discussions in the history of Kleros and a dispute that went into two appeal rounds.

Here are some pieces of evidence: evidence 1, evidence 2 and for an overview of the entire discussion, have a look here. This case also saw the birth of the first decentralized lawyer office, Heliast, which was a very interesting response to this newly established system of incentives.



Spacechain Badge request and all the pieces of evidence uploaded.

Why Crowdsourcing Matters

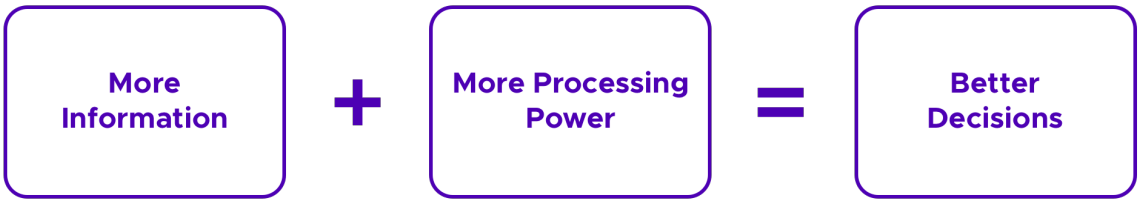
Crowdsourcing is the process of getting work done online from crowds. This work involves finding and processing information.

Centralized procedures, such as those traditionally conducted by exchanges, only produce limited information. Exchange managers typically only have access to the version of the story submitted by the team.

The wisdom of crowds substantially increases the amount of information available for decision making. This became clear in several instances of the T2CR, when users submitted evidence about quality of code on GitHub, data on token supply and on the quality of teams of different projects.

Secondly, crowdsourcing also increases the processing capacity of the system. If crowds generated more information but the processing capacity was static, a bottleneck would occur in decision making.

But Kleros' cryptoeconomically incentivized hive mind system also scales the processing power with the available amount of information.



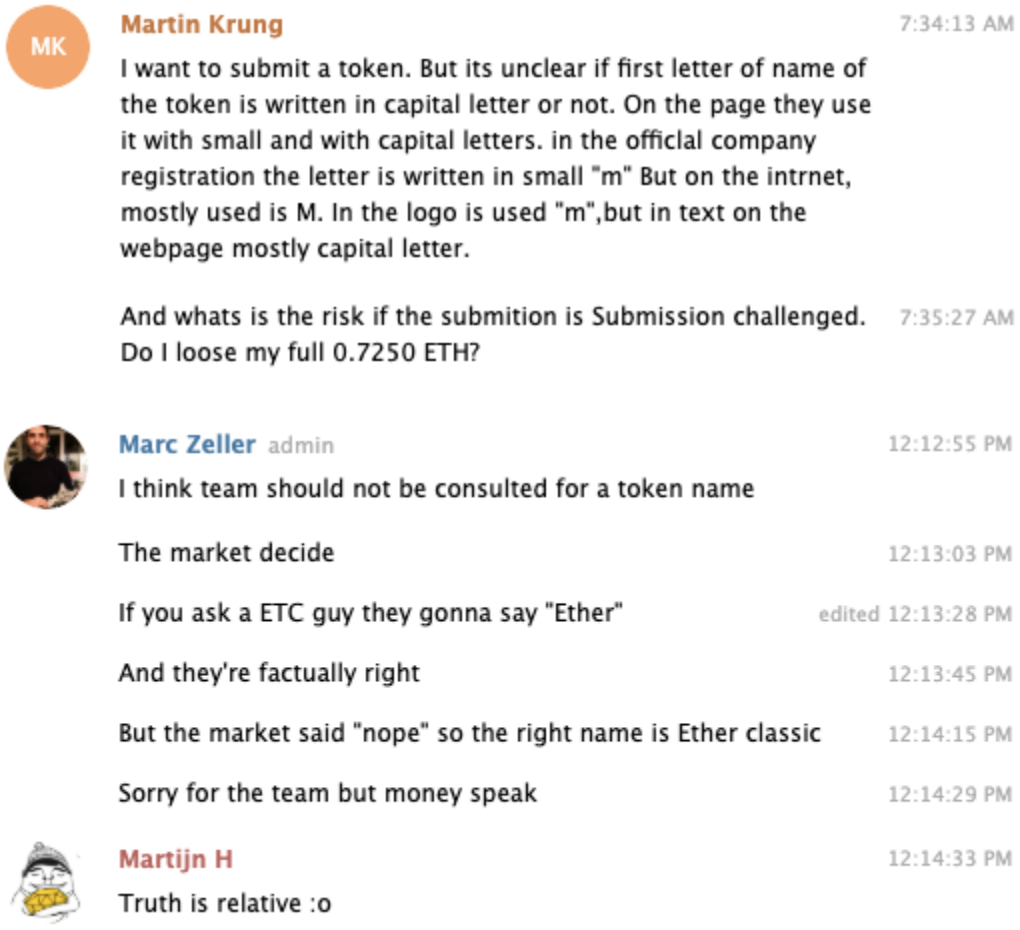
A Rulemaking Community

Crowdsourcing does not only add to available information and processing power. It also engages the community in rule-making as to better define how the process should work and the goals it ought to achieve.

When the T2CR product was launched, we just had some simple rules about what information was to be considered in order to have a token accepted into the list.

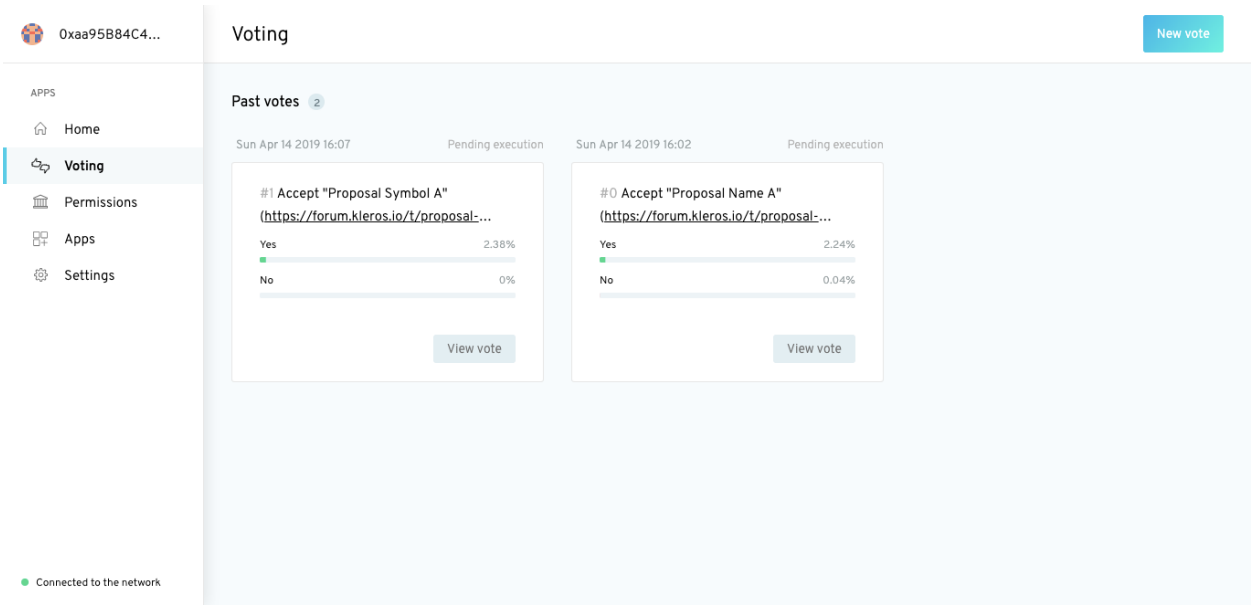
But even something apparently as simple as the criteria for accepting token names and logos proved to be challenging. Should a token be submitted with the name of the token (pinakion, in the case of Kleros) or the name of the project (Kleros)?

Many discussions happened on Telegram about these topics.



And what about the logo? Should submitted logos comply with some quality guidelines? What if an old logo was submitted?

This also was cause for discussion and for rule changing proposals in the [Kleros Forum](#).



A voting session live about policy changes for logos and token names.

Collective vs. Artificial Intelligence: What We Learned by Sending Dogs to Court

By Federico Ast, CEO, Kleros

Is there a future for the legal profession? Will lawyers be replaced by artificial intelligence tools that can do legal work faster and at a fraction of the cost?

Early attempts to use artificial intelligence in law go back to the 1960s, when Hugh Lawford, a professor at Queen's University from Toronto, developed the QUIC/LAW database.

But the real explosion of AI only came in recent years, as the digital economy enabled us to build larger datasets to train algorithms. A number of corporate projects and startups are making extraordinary progress in the use of machine learning in the legal industry.

Some highlights:

- JP Morgan's COIN (short for Contract Intelligence) is a program which can read 360,000 hours worth of documents in just a few seconds. This quick and low-cost process significantly cut costs in the bank's lending due diligence procedure.
- In February 2018, the Israeli company LawGeex organized a challenge where their AI algorithm faced 20 US lawyers for detecting problematic clauses in 5 confidentiality contracts. The level of accuracy of lawyers was 85%. The accuracy of the AI was 94%. It took lawyers 92 minutes on average to analyze the contracts. The AI did it in 26 seconds.
- A number of startups are developing machine learning technologies to predict the result of trials and optimize litigation strategies. Some of the leaders in the field of legal analytics include Luminance, Premonition and Lex Machina.

The work of lawyers basically revolves around pattern recognition. It's about seeing how some situation fits into some pattern described by the law. Since AI also excels in pattern recognition (but much faster and cheaper than humans), some believe it will kill off lawyers.

The experience we've had at Kleros with our Doges on Trial pilot and our Token Curated List DApp may give us some insight about the need for human involvement in dispute resolution.

Is This Clearly a Doge?

Our Doges on Trial pilot rewarded users who submitted non-repeated images of the Doge meme onto a list. Jurors would decide whether an image should be accepted or not. This is a sample of the submitted pictures.

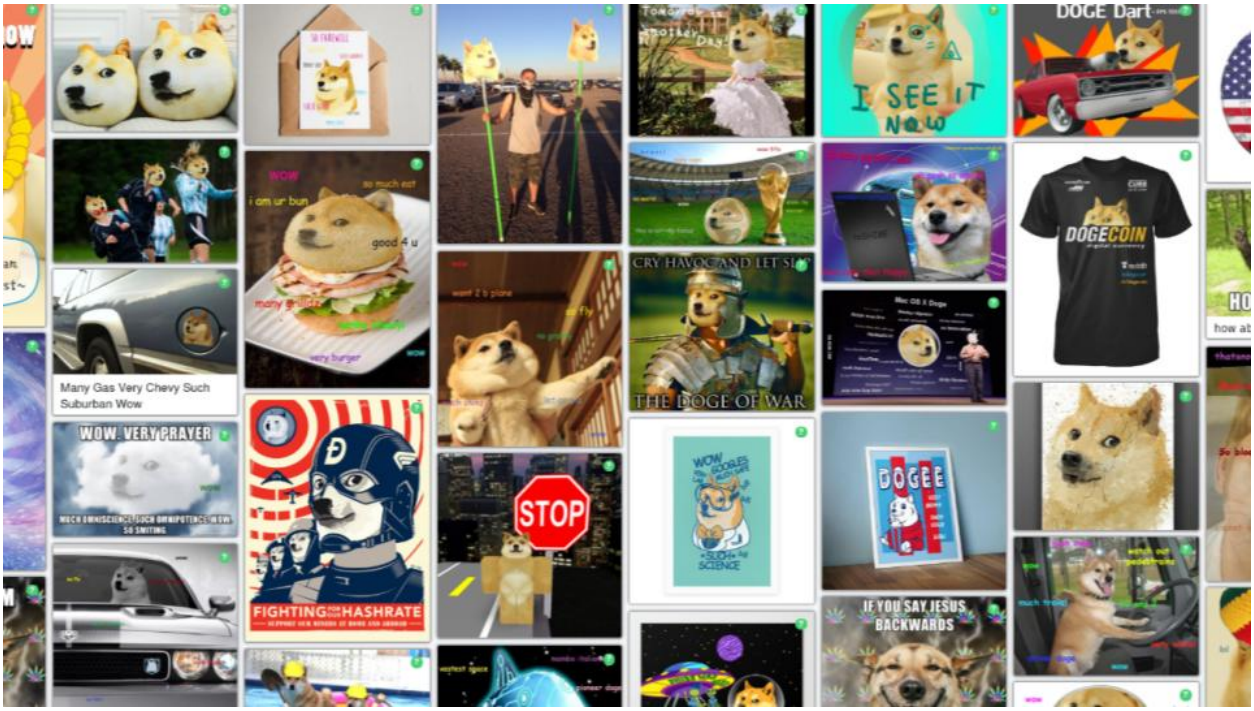
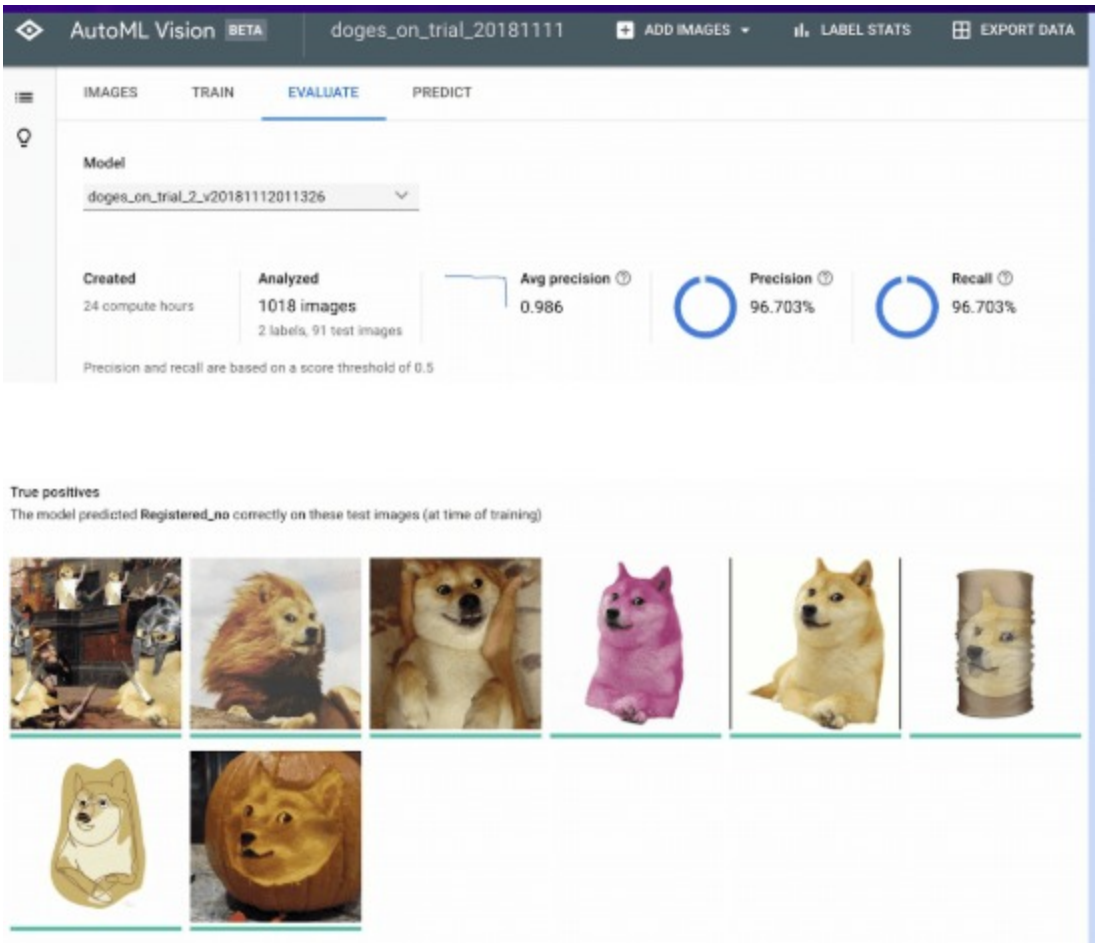


Image recognition technology has made huge progress over recent years and a big part of the decision-making process of accepting images could be automated.



A test with image recognition software over the images submitted in the Doges on Trial experiment.

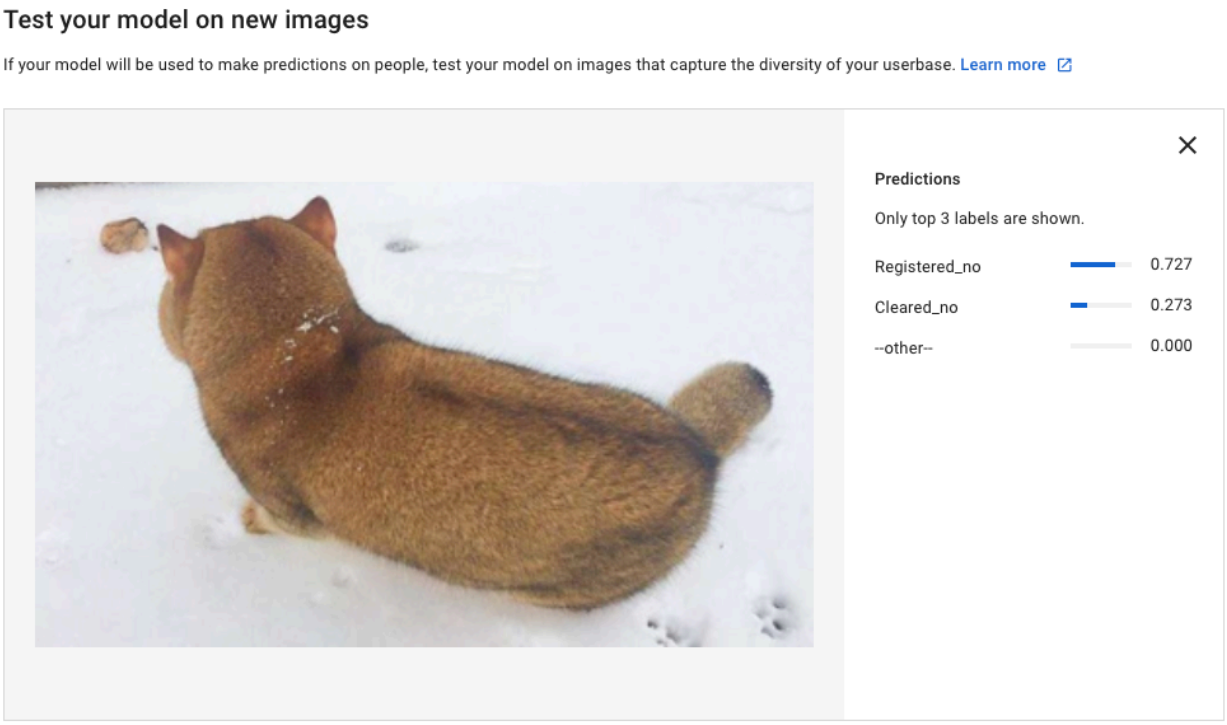
The experiment also rewarded 50 ETH to whoever was able to sneak the image of a cat past Kleros' jurors. Users submitted a large number of cat images which were correctly identified by jurors (to learn more about these attempts, see [this post]). Many of these could also be identified by algorithms.

And then someone sent the following:

The image went unchallenged past the jury (hey, it looks like a Doge, right?). The submitter then sent the picture below and argued that the animal in the previous image and the one below are the same. Hence, he continued, as he had succeeded in sneaking a cat into the list, he was eligible for the 50 ETH reward.

The payout policy expressed that, to be eligible for the reward, the image had to "clearly display" a cat. It could be argued, of course, that the initially submitted image didn't "clearly display" a cat.

Image recognition software was pretty confident that this was a Doge:



However, one could argue that the image was actually from this dog (instead of a cat) taken from this angle:

Since we couldn't find an agreement on this, we decided to make a Kleros escrow trial for the 50 ETH between Coopérative Kleros (which held that the image didn't comply with the payout policy) and the submitter (who argued that it did).

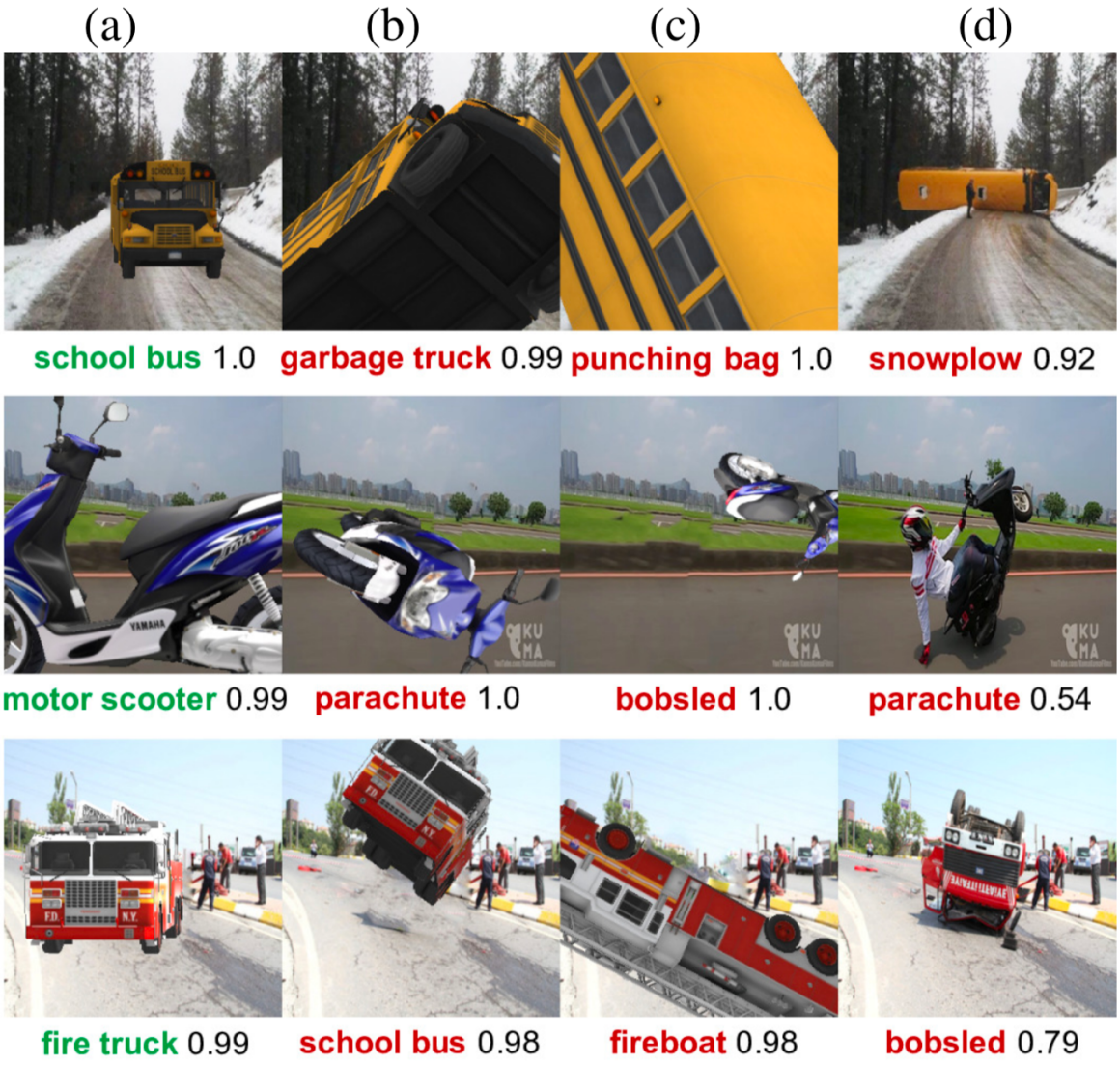
Jurors were asked to answer the question: does the image comply with the payout policy of "clearly" displaying a cat?

Jurors ruled that the image did not comply with the policy. Coopérative Kleros won.

The Limits of AI

The "apparently silly" case of the "Doge in the Snow" dispute highlights some critical points about the limits of AI in a context of digital disruption of the legal industry.

It is beyond doubt that AI is immensely useful for processing large amounts of data. However, it also has limitations. For example, researchers found that Google's image recognition AI could be [fooled by something as trivial as ordinary objects] placed in unusual positions, as shown in the following image:



The limits of artificial intelligence have already been tested by big Internet platforms in the context of content moderation.

YouTube uses algorithms to identify videos potentially infringing copyright. Social media companies use AI to detect comments which violate terms and conditions of service. E-commerce platforms use AI to identify fake reviews and to take down listings that violate conditions of service.

But a large number of situations generate false negatives or positives in identification algorithms.

No matter how far technology goes in rooting out fake reviews, AI could always fall short of detecting all the tricks played by scammers without the helping hand of a human to discern borderline cases. In addition to their algorithms, YouTube also employs over 10,000 human content moderators. Facebook has around 30,000 human reviewers, surveying a whopping 510,000 comments, 293,000 statuses, and 136,000 photos being uploaded every 60 seconds.

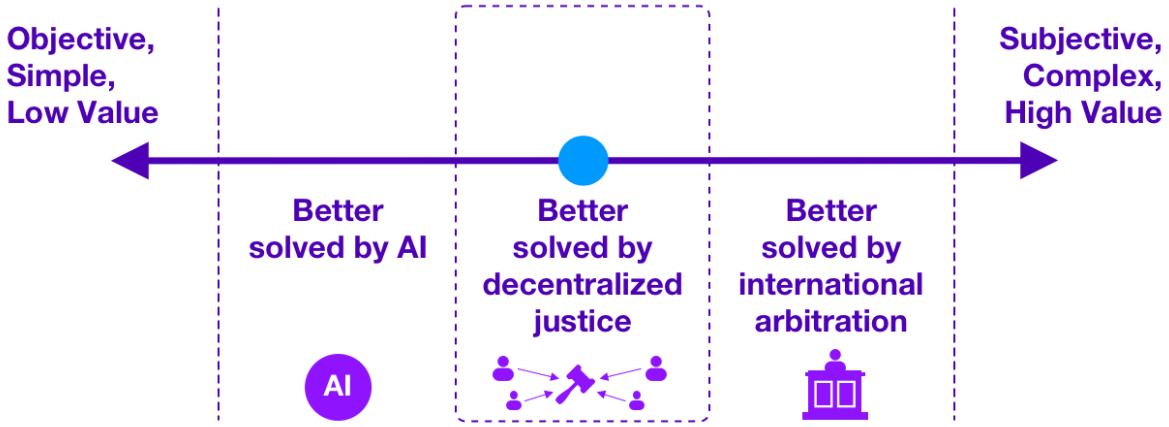
The coming big challenge is "deep fake content". Deepfake is a "technique for human image synthesis based on artificial intelligence. It is used to combine and superimpose existing images and videos onto source images or videos using machine learning. Deepfakes have been used to create fake celebrity pornographic videos or revenge porn".

AI tools are being developed for automated Deepfake detection. But this kind of validation may also require some type of human participation.

"President Trump is a total and complete dipshit". Did Obama ever say that? No, that was a Deepfake video impersonating him.

The Boundaries of Collective and Artificial Intelligence

The experience of big tech platforms solving user disputes and moderating content can be a preview of how artificial intelligence may impact the future of law.



The limits between artificial intelligence and collective intelligence.

Over time, AI will probably be unbeatable in simple and objective decisions. Automation will lead to a cheaper and faster decision making than any human based procedure could ever provide.

Collective intelligence methods such as Kleros will be especially useful for decisions where a great deal of transparency is needed (because of conflicting interests of parties) but which is too complex to be handled by AI. When human intervention is needed to appreciate the nuances of a situation, collective intelligence trumps artificial intelligence.

And then, there are other situations involving even higher levels of subjectivity and complexity. For example, disputes where a conflict of values is present or where stakes are extremely high may not be a fertile terrain for the use of artificial or collective intelligence. People may accept the algorithm or the crowd for settling an e-commerce dispute over a couple hundred dollars, but are unlikely to have them decide over disputes that affect fundamental rights (e.g., sending someone to jail). This is probably where traditional dispute resolution systems and lawyers will still have an edge, at least in the foreseeable future.

Of course, these systems may have digital enhancements such as incorporating online communication for increased efficiency and reduced need for physically going to court. But, essentially, the procedure will still look like traditional court proceedings.

The disruption in the legal industry is just starting and new technologies are coming into play, each addressing a specific type of problem: AI solves mechanical and repetitive tasks, crowdsourcing resolves cases with higher complexity and traditional methods are always there when stakes are really high.

Chapter 4

Dispute Revolution. A New Justice Paradigm in an Old World.

"The legal world will change more in the next 20 years than it has in the past two centuries." -Richard Susskind

The first written legal code we know of was the Code of Ur-Nammu[66], dating back to the 21st Century BC. But written rules represent an exception, as throughout most of human history, laws were established through oral tradition. Oral law, however, had many disadvantages. It was ambiguous and could be abused by those having the knowledge to hack the system.

For the weak, the outcome of a trial was hard to predict. The powerful party could bribe judges to achieve a desired outcome, while it was easy for the judge to justify any decision. In this context, a poor person could not afford going to court and risk losing everything. Even if there wasn't ill intention, lack of clarity about what the law was could also lead to undesirable outcomes.[67]

In the early days of the nation state era, some thinkers started to express their concern about 'justice inclusion' (although, of course, it was not called like that back then).

In the 17th Century, philosopher and mathematician Wilhelm Leibniz sought to reduce the weight of interpretation and human error in judicial decisions. In his book, *Disertatione de arte combinatoria* (1666), he developed a logic for reducing subjectivity by articulating the general principles of legal science. (Leibnitz, 1666)

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[66] This legal code is three centuries older than the Code of Hammurabi, written during the reign of the king Ur-Nammu of Ur in Mesopotamia.

[67] Much of the legal jargon of today's courts can be traced back to 1066, after the invasion of William the Conqueror. This resulted in the use of French in Britain's legal proceedings. That language stayed in use in courts, under the name of Law French, much after the Normans were expelled from England. Many legal words survived to our days such as defendant, *force majeure*, mortgage (dead pledge), parole (word), torts (civil wrongs), or plaintiff (complaining).

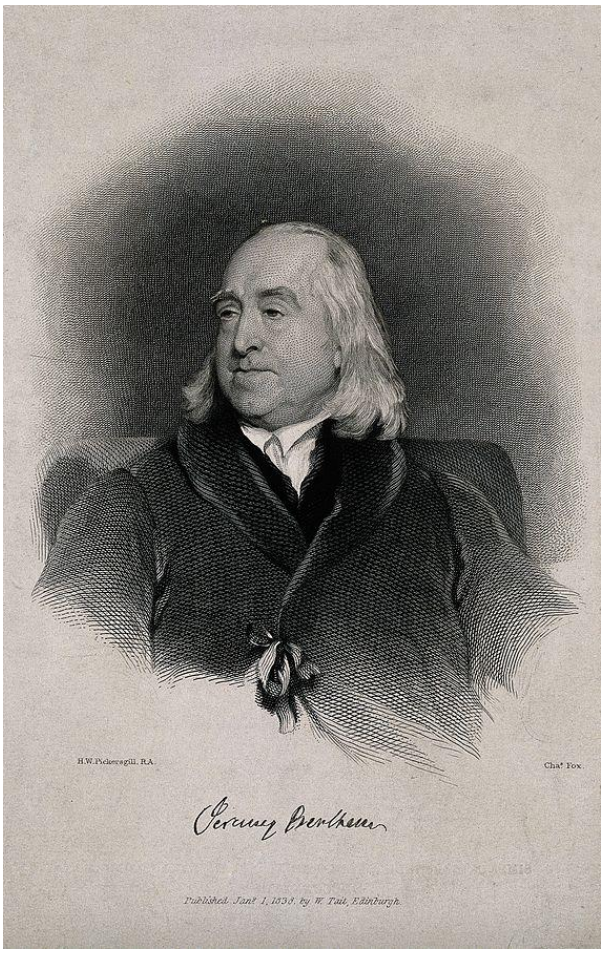
Portrait of Gottfried Wilhelm Leibniz by Andreas Scheits, circa 1710, collection of Museum Herrenhausen Palace.

Jeremy Bentham, mostly known as a moral philosopher and creator of utilitarianism, was probably the greatest legal reformer of the modern age. Concerned with the difficulty which ordinary people had in having a fair trial, his lifelong struggle was about fostering justice inclusion. Between 1776 and 1827, he published a great number of works to push legal reform, the most famous of which is *Rationale of Judicial Evidence* (1827).

Bentham advocated the use of natural language in courts (as opposed to legal jargon), pushed for the codification of the oral tradition into written law (in fact, he is credited with inventing the word *codification*) and for the **publicity of judicial proceedings**.[68]

[68] In 1811, he wrote to President James Madison to volunteer writing a complete legal code for the United States. His offer was declined and Bentham made the same proposal to all nations in his book Codification Proposal. It's no coincidence that by the same time Napoleon was writing the Code Civil.

Bentham's struggle for justice inclusion is still alive two centuries later. Over one million disputes remain unsolved every year in civil justice in Great Britain. The 2017 Justice Gap Report of the Legal Services Corporation in the United States notes that a whopping 86% of civil legal problems of low income Americans remained unaddressed, with citizens receiving little or no legal aid.



Portrait of Jeremy Bentham, line engraving by C. Fox, 1838, after H.W. Pickersgill, Iconographic Collections, Credit: Wellcomeimages.org, CC-BY-4.0

In 2015, the United Nations adopted justice inclusion in their Sustainable Development Goal 16 for the 2030 Agenda for Sustainable Development. There's a perception that courts don't work, both in developed and developing economies. The system is too expensive, too slow and too hard to understand for the layman. It's becoming obvious that the technologies on which traditional justice systems are built have reached their complexity limits.

As Bentham's struggle was at the turn of the 18th to the 19th Century, our time is also a time of transition - to the network society, a new legal system and the new age of codification.

From East Coast Code to West Coast Code

In his seminal 1996 article Smart Contracts: Building Blocks for Digital Markets, Nick Szabo argued that the Internet society would require a completely different legal system, based on a different type of code.

Law is the East Coast Code. It's the Atlantic facing Europe, the old economy of traditional finance (Wall Street), traditional law schools (Harvard and Yale) and Big Law firms. East Coast Code is built on natural language which is ambiguous and where the power of interpretation lies in the hands of lawyers and judges.

Computer language is West Coast code. It's Pacific facing, towards the rising powers of Asia. It's software, Silicon Valley and Stanford. It's computer language, objective and readable by machines. Smart contracts, the core of the legal system of the Internet Age, bring objectivity and automatic enforcement.

But West Coast Code has a problem.

Automatic enforcement by code is at odds with the key principle of the philosophy of right that maintains a position that all contracts are incomplete. When it is signed, no contract could ever foresee every possible situation that could arise until the time it is to be enforced. Sometimes, strict enforcement may result in an unfair situation and this cannot be solved exclusively by computer code.

The Greek had a term - *epikeia* for a moral principle that exempted a citizen of strict compliance with a positive law or contract in order to be faithful to its spirit. Modern legal systems also recognize that parties may be relieved of the obligation of compliance if such obligation becomes unreasonable after a change in context. Mass adoption of smart contracts requires an 'escape hatch' mechanism. The question is - how to create such a mechanism without introducing a centralized decision maker that becomes a new single point of failure into the system?

Kleros can provide this decentralized escape hatch to revoke agreements when strict compliance has become unreasonable and it can achieve this without reintroducing arbitrariness and corruption.

Smart contacts are coming to fulfill Bentham's dream of a law completely clear in its formulation and transparent in its enforcement, impossible to be hacked by a corrupt judiciary. Bentham spent half of his life struggling for the codification of oral tradition in written law. The battle of our time is the process of coding written law into computer code.

Arbitration and the Transition to the Digital Age

The emergence of global commerce already created a number of responses by legacy legal systems. As it became increasingly clear that national jurisdictions were insufficient for dealing with a globalized and digital economy, different initiatives tried to construct the institutional framework for this new world.

In 1958, the United Nations pushed the Convention on the Recognition and Enforcement of Foreign Arbitral Awards. This was a recognition of the growing importance of international arbitration as a means of settling commercial disputes. The goal was to provide common standards for the recognition of arbitration agreements and court enforcement of foreign arbitral awards.

In 1966, the UN created the United Nations Commission on International Trade Law (UNCITRAL) to promote the progressive harmonization and unification of international trade law. This further cemented the UN framework for international dispute resolution. Within UNCITRAL, rules for mediation and arbitration were developed, as well as model laws for different industries and use cases such as construction services, electronic commerce, secure transactions and records.

The main advantage of arbitration over court litigation is that arbitration awards are enforceable in most countries in the world. However, the UN arbitration framework was built with businesses in mind and with nation states as basic units. It did not foresee the exponential growth of low value cross border consumer disputes of the digital age.

At the beginning of the 21st Century, the UN arbitration framework has evident shortcomings for dealing with this type of disputes. A growing number of experts have become skeptical of the potential of UNCITRAL to provide solutions to these challenges.

In parallel to the UN arbitration framework, Internet platforms like eBay, PayPal, Amazon and Alibaba have put in place their own services to address consumer disputes. It is more efficient for, say, a buyer in France to rely on eBay's dispute resolution service for a dispute with a seller in the Philippines than going to court or committing to international arbitration over a couple hundred dollars.

Blockchains are the new evolution of this idea of international arbitration as they provide decentralized automatic enforcement as an alternative to judicial enforcement. Moreover, blockchains have the advantage of also providing this enforcement in countries with weak institutions, which are unable to enforce arbitral awards.

The Challenges of Decentralized Justice

The new paradigm of decentralized justice poses a number of challenges in the interplay between traditional law and smart contract law. If smart contracts can enforce arbitral awards in an automatic and decentralized way, then why do we need the whole framework of the New York Convention and UNCITRAL?

Ultimately, the point of that framework was about guaranteeing the recognition of arbitral awards by courts in every country. The key question to answer here is whether the existing legal frameworks would accept decentralized justice as a valid arbitration method.

To a great extent, the answer to this question may depend on decentralized justice systems being able to prove without a doubt that they comply with critical conditions for fairness in dispute resolution. This leads us into the field of moral philosophy: is decentralized justice moral?

This chapter seeks to address the different challenges brought by the dispute revolution into existing legal and moral frameworks.

To address the issue of future law, the chapter begins with an article by Kate Sills who gives an explanation of smart contracts to a layman audience and why they matter. Gillian Hadfield, on the other hand, gives her view of a number of technological changes that are making traditional legal frameworks obsolete.

To see how traditional legal systems interplay with modern technological trends, the chapter turns to CNRS and Harvard researcher, Primavera de Filippi who speaks of the rise of decentralized autonomous organizations.

As Kleros is a rare breed of a legal creature, ODR expert Daniel Dimov gives his take at Kleros as a system based on fairness, while Dmitry Narozhny argues that the Kleros dispute resolution process is fully compliant with the framework set forth by the New York Convention and UNCITRAL.

Furthermore, an expert in UN law and lecturer at the University of Leicester, Rossana Deplano unravels the tale of how Kleros could help reach the goals of justice inclusion set forth in SDG 16. Finally, Uganda lawyer Alice Namuli-Blazevic takes a practical look at the importance of decentralized justice in countries with weak judicial institutions, particularly Africa.

The Promise of Smart Contracts

By Kate Sills, Community Lead, Agoric

STAN: Jerry, we're not just going to give you seven hundred and fifty thousand dollars.
WADE: What the heck were you thinkin'? Heck, if I'm only gettin' bank interest, I'd look for complete security. Heck, FDIC. I don't see nothin' like that here.
JERRY: Yah, but I — okay, I would, I'd guarantee ya your money back.
WADE: I'm not talkin' about your damn word, Jerry.
— Fargo (1996)

Fargo is primarily a movie about promises, implicit and explicit. It asks whether we will keep our promises to others, even against our own self-interest. What makes the movie fascinating is that many of the promises aren't backed by the court system, for very good reason — the deals are illegal. Fargo asks if we can trust each other even if there is no government force making us comply. In other words, can we make contracts in the state of nature?

In 1651, Hobbes argued that we couldn't:

“If a covenant be made wherein neither of the parties perform presently, but trust one another, in the condition of mere nature (which is a condition of war of every man against every man) upon any reasonable suspicion, it is void: but if there be a common power set over them both, with right and force sufficient to compel performance, it is not void. For he that performeth first has no assurance the other will perform after, because the bonds of words are too weak to bridle men’s ambition, avarice, anger, and other passions, without the fear of some coercive power…”

The frontispiece of the book "Leviathan" (1651) by Thomas Hobbes, engraving by Abraham Rose.

In other words, we need some external mechanism to enforce our promises, to make it so that other people can depend on our commitment. Making credible commitments is the foundation of business, and society in general. Like Hobbes, we tend to assume that the government's coercive power is the only way to create contracts. Nobel Prize-winning economist Oliver Williamson called this view *legal centralism*, the assumption that "the legal system enforces promises in a knowledgeable, sophisticated, and low-cost way" (Williamson, 1996, 121).

Williamson and other Nobel laureates, such as Elinor Ostrom, built their careers on proving this assumption wrong. In many instances, the court system is costly and time-consuming, and sometimes corrupt. Moreover, people are often surprisingly able to enforce promises and maintain order in their own communities without government.

Trust is the bedrock of society. Without it, life would look a lot like Hobbes' state of nature — constant suspicion, backstabbing, and insecurity. A person might make a promise, but given the opportunity, they might break it and pursue their own self-interest, a scenario which Williamson calls *opportunism*.

Oliver Williamson, Nobel Prize laureate for economics in 2009 for "his analysis of economic governance, especially the boundaries of the firm". Photo: US Embassy Sweden, CC-BY 2.0

However, business deals depend on being able to trust that a promise will be kept, otherwise our society would be limited to instantaneous exchanges. Fortunately, there are a

number of mechanisms that can be used to secure a promise, all of which have advantages and disadvantages.[69]

For instance, we might depend on personal ethics and only make promises with people who have a strict moral code. The advantage of relying on personal ethics is that they don't require institutions or outside coercion, but ethics also have a severe limitation: it's difficult to know very many people well enough to trust them to do the right thing, and even the best people might break their promises.

Another enforcement mechanism is reputation. Before making a contract with someone, we can ask around and find out how their previous interactions went. Reputation is extremely useful in small communities with repeated transactions, since if someone breaks their promise, they will be labeled untrustworthy and will be excluded from future interactions.

However, reputation is more difficult to apply when interacting with strangers. Other enforcement mechanisms for promises include strategies like vertical integration in business (where opportunism is curbed through the alignment of incentives) and the use of collateral.

But the Internet, currently a state of nature if there ever was one, presents new difficulties. Personal ethics, of course, are always helpful, but there is no guarantee that a random stranger will be ethical. Reputation is more difficult because pseudonyms like email addresses and usernames are often used instead of true names. When a person breaks their promise, they can simply erase their history by creating a new pseudonym with a clean reputation.

Being able to cheaply create a new pseudonym in order to dodge a bad reputation is called *whitewashing* (Nisan 2007, 682). There are various ways to handle the problem of whitewashing. One is to distrust all newcomers, since they could have a new identity to hide a bad reputation. Another possibility is to ensure that any pseudonym is tied to a real person or business, so that a bad reputation can't be escaped.

So why don't we just create a global reputation system connected to our real-life identities? China is doing just that. As Wired explains in an article from 2017, people with low ratings (including those who speak out against the government) will be punished in nearly every aspect of their lives: slower Internet speeds, restricted access to restaurants, and the removal of the right to travel. They will have extreme difficulty being hired, renting

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[69] In *Order Without Law: How Neighbors Settle Disputes* (Ellickson 1991), Yale Law Professor Robert C. Ellickson studied how cattle ranchers in rural Shasta County, California enforced their promises, and categorizes some of the constraints on behavior thusly: personal ethics, contracts, norms, organization rules, and law. Anthony T. Kronman, also a Yale Law Professor, wrote about the ability to make contracts without using court enforcement in *Contract Law and the State of Nature* (Kronman 1985). He describes a number of devices, such as "hostages," collateral, hand-tying, and the alignment of incentives by union.

apartments, and getting loans. In other words, a global reputation system can become less about trustworthiness and more about allegiance to authority.

It's clear that many of the enforcement mechanisms are hard to apply to the Internet. Personal ethics are ideal, but unreliable. Reputation systems that attempt to enforce societal or organizational norms must be carefully designed lest they turn into "basically a big data gamified version of the Communist Party's surveillance methods" (Botsman 2017).

Lastly, law cannot be easily applied to people in different countries, since each geographic jurisdiction has its own separate legal system, and there's little chance of forcing a person from the Internet (especially if they are anonymous) to appear in court in a different country.

It's important to realize that all of our enforcement mechanisms are merely tools to be used when helpful. Like a hammer or a screwdriver, each tool might apply in a different situation. Moreover, like tools, our enforcement mechanisms are subject to innovation. For hundreds of years, since Hobbes, we've tended to think of contracts as legal agreements that must be enforced by the court system.

However, court enforcement is only one of many ways to enforce promises, and we need to hold open the possibility that we can improve on it. As public choice economist Gordon Tullock pointed out, "We tend to forget that there is such a thing as technological progress in contracts. People discover new ways of making agreements, and over a period of time we obtain considerable benefit from this sort of technological progress" (Tullock 1970).

One such example of technological progress is the invention of smart contracts. Smart contracts are a new mechanism for enforcing promises, allowing us to make credible commitments with each other on a blockchain, including commitments with strangers in other countries. To be clear, smart contracts are not legally enforceable, but that's part of their unique advantage. Smart contract commitments are enforced outside of the law, outside of legal jurisdictions, without government enforcement.

Given that our legal jurisdictions are primarily tied to our geographic location, and many countries have frail or unreliable legal institutions, this is a huge societal advance. It means that given an Internet connection, someone from one of the poorest countries in the world can make business deals and credible commitments with someone in the US as easily as if they were American. By creating trust where there was none, the world will be opened like never before.

The idea of smart contracts originated in the mid-90s, when programmer and legal scholar Nick Szabo published a series of articles explaining their potential.[70] Like a vending machine, smart contracts rely on machinery for enforcement. However, instead of using physical machinery, smart contracts are literally code that runs on a blockchain, a kind of open, distributed ledger that runs on the computers of thousands of users, and which has no central authority.

As Nick Szabo explained, smart contracts rely on machine enforcement, precisely like vending machines. The user introduces a coin and the mechanism automatically delivers the product. Image: A Lego vending machine in Munich, Germany / Sarah-Rose, Flickr / CC-BY-ND 2.0

Contrary to their name, smart contracts have nothing to do with artificial intelligence. 'Smart' refers to the self-enforcing quality. Smart contracts are immutable, meaning that the code by default cannot be changed. For the purposes of contract, this is a good thing, since it's impossible to break a promise if you have no opportunity to do so.

However, for programmers, immutability presents a special challenge. All code has bugs, and code that cannot be altered needs to be written carefully to try to minimize the number

[70] One of the primary pieces is *Formalizing and Securing Relationships on Public Networks* (Szabo 1997).

of mistakes, since the bugs can't be fixed after the fact. Thus, writing a smart contract is like trying to write code for NASA — correctness matters a great deal, and the consequences of bad code can be dire.

A smart contract might be as simple as a transfer of money from one account to another after a certain time, or it might be very complicated. However, one major limitation is that smart contracts can only transfer digital assets that are defined on a blockchain, such as cryptocurrencies. This might seem like a show-stopper given that cryptocurrencies aren't yet widely accepted, but transferring money subject to certain conditions is all that many contracts do.

Also, even contracts that include actions with physical objects can potentially be enforced by putting up bonds that will be lost if the promise isn't kept. Another limitation is that smart contracts cannot access outside information, unless it is written to the blockchain. For instance, a smart contract by itself has no access to weather data. To condition a contract on the temperature, for example, there must be a third party that takes the data from a weather API and writes it to the blockchain in a way that is accessible to other users. This trusted data source is called an *oracle*.

Smart contracts have many limitations. However, we tend to forget that the courts have limitations as well. We shouldn't compare smart contracts to an idealized version of court-enforced contracts. When we view both critically, it becomes clear that court-enforced contracts have intrinsic flaws.

First, access to the court system is rationed, and there are many people waiting for their turn simply to use the service. This means that cases may take years or even decades. Because of the slowness of the courts, businesses often use private arbitration clauses in their contracts that allow them to settle out of court.

Another often overlooked limitation of the court system is that because the court is an external third party, it can only guess at the true damages if the contract is breached. This is problematic because the court system determines what will be given to the aggrieved party. Unfortunately, simply asking the aggrieved party how much the performance of the contract was worth to them isn't going to work — they have no incentive to be honest in reporting their damages.

Therefore, the court system tries to use its best judgment to determine what the damages are, but as Georgetown Law Professor Randy Barnett points out, "Any assessment of legal damages attempts to quantity or objectify that which is actually subjective and essentially unmeasurable…" (Barnett 2010).

The solution is for the parties to write their valuations explicitly in the contract, as liquidated damages. However, the courts may decide not to enforce these if they think they are unfair. Thus, even in countries with the best institutions, court-enforced contracts have intrinsic limitations and paternalistic aims.

Smart contracts are not legal contracts, and in many cases may not be a good replacement for legal contracts. However, they are a valuable new tool in our limited toolbox. They allow us to make commitments — even with strangers — without government enforcement, something many, for hundreds of years, have assumed was impossible. In the next few decades, smart contracts will give people around the world the power to make agreements with each other despite corrupt and broken institutions, and so transform the lives of millions.

Gillian Hadfield on Rules for a Flat World

Interview by Federico Ast, CEO, Kleros

Gillian Hadfield is a Faculty Affiliate at the Vector Institute for Artificial Intelligence in Toronto and the Center for Human-Compatible AI at the University of California, Berkeley. She has served as a member of the World Economic Forum's Global Future Council on the Future of Technology, Values and Policy and Global Agenda Council on Justice and co-curates the Forum's Transformation Map for Justice and Legal Infrastructure. She was appointed in 2017 to the American Bar Association's Commission on the Future of Legal Education and is a member of the World Justice Project's Research Consortium. She serves as an advisor to The Hague Institute for the Innovation of Law, LegalZoom, and other legal tech startups.

How did you become interested in technology and the flat world?

It was a very long evolution. I got involved in a family law matter 25 years ago. What I discovered was that it was phenomenally expensive and did not seem to be doing much to help our family. As I struggled with it, I started to ask myself as an economist - how can it be working like this, how can it be so expensive?

This is how I started thinking about the structure of the legal markets and legal institutions.

On an unrelated path, I started talking to companies in Silicon Valley about how the legal system was affecting their ability to innovate. I started hearing from the general counsel, people like Mark Chandler at Cisco and Kent Walker at Google. Even though they were at the peak of the legal market and they had huge wealth to buy the best of the best, they were saying pretty much the same thing - it is incredibly expensive and it's not doing much to help us.

That connection led me to rethink what is going on in law: what is law? Where does it come from? Why aren't there private companies offering law competitively? That would put some pressure to come up with better solutions at better prices.

All these things converged into thinking about going back to basics - what law is really about and what are the ways in which we can restructure our systems for producing law and running legal systems, so that they are more responsive to what people, businesses and communities need from them.

What changed in the world that is making law obsolete?

Human societies have always had some structure of rules. When they work well, we get increasing specialization and division of labour. As communities grow bigger, their ways of doing things and rules stop working.

In a small community, you can meet around the fire and talk about what's going on. Things move very slowly, and everybody has similar needs and interests. As a community becomes more complex and diverse, a particular way of coming up with the rules doesn't work very well, so we develop other systems.

Law is the evolution of the process of building the rules for any group.

Because we were very successful at establishing law at one stage in our history, we moved forward with specialization and our existing systems became more complex. This changed the environment and what works in terms of ways of coming up with rules.

As societies become ever more complex, so do the rules that govern them. Image: A 26 segment × 3 exposure (78 frames in total) panoramic view of the Hong Kong skyline taken from a path around Victoria Peak, 2007. / David liliff / CC BY 3.0

The environment changed. How can we adapt to creating new rules for this new context?

The most important thing that we need to figure out is how to generate more creativity and innovation in the way we solve these basic problems of developing rules that will give us all the confidence we need to live together, work and feel safe together.

We need to figure out how to innovate and solve that problem.

The key thing we have seen is how to get our existing systems (law being made, adjudicated and enforced by governments) supplemented, so we can have a greater capacity for private actors such as non-profits (collectives, unions, etc.) and also for-profit companies.

We need to figure out how to get more of those kinds of processes in coming up with the correct rules. And these processes need to be responsive to concerns about accountability and legitimacy, which is what our governments give us.

We need to figure out how to get more money and brains building a better legal system and doing so in a way that's responsive to public interest and our communities.

This reminds me of the section of your book *Rules for a Flat World* on how Google handles the process of the right to be forgotten. Users submit a claim and Google decides that in a completely private process. That's maybe something that will come up if we don't think of some new legal processes. Eventually, corporations will give us law, but not in an open way...

That's really important. I talk about this concept of how we can build regulatory markets and called it *super-regulation* in the book.

The idea is - we can have private organizations develop systems for building rules, regulatory systems and adjudication systems. But, can we do that in a way that those private organizations are responsible?

We are at the limits of what our governments can handle - and our governments know that.

In many cases, they had to leave it to private organizations to come up with the rules, implement and adjudicate them. But, because we don't have this intermediary layer, this market layer of private organizations that are independent of the regulated entities, we end up as in the Google example - with governments telling the company they are trying to regulate: "Here's the rules. Now regulate yourself in accordance with those rules".

We need to add a new layer of independent, private regulators that we can delegate the job to instead of Google itself.

That's a shift we need in order to build incentives and systems that can manage the high levels of complexity we are looking at, the great rates of speed, the challenges of artificial intelligence, the challenges of globalization and so on.

Are there attempts of trying to create these super-regulators?

There's at least one model that I can point to: the regulation of lawyers in the UK.

The UK government set out a number of principles (the Legal Services Act) and created a government board called the Legal Services Board. The body does not regulate lawyers, it regulates regulators of lawyers.

So, it regulates the Solicitors Regulatory Authority, the Bar Regulation Organization and so on. It tells those regulators how they have to carry out the job of regulating lawyers.

There are a lot of things that are close, Google's right to be forgotten is an example. There is a delegation to a private company, but it is not an independent private company. We have food certification standards in Europe where governments set out principles and private organizations certify if companies are in compliance with those systems. We have lots of things that get close, but we haven't built really vibrant markets for regulators.

I would like to figure out how to build these markets for regulators. But these regulators in turn need to be regulated by governments.

People often point out the credit rating agencies in the United States as an example of why this couldn't work, saying they contributed to the 2008 crash because they did such a bad job. That's true, but they were not regulated and they were not obligated to generate results that were established by government and accountable bodies.

We have examples that are coming close, but other than the UK legal services market, I haven't encountered another very clear example of the full model that I'm talking about.

There's another challenge. Lots of transactions happen across borders and jurisdictions… For example, when Google bought YouTube, they had to harmonize over 100 national regulations on copyright…

Another example to think of is Uber. They are operating in probably thousands of jurisdictions, because taxi ride services are regulated often at the city level and they are operating globally.

The model I am proposing has an answer to the globalization challenge, that is to say, you could have private regulators that are operating on the global market, offering their services on two sides.

On the one side, they offer their services to the entities we want to regulate, like a ride hailing service company like Uber. Then they go around the world to different countries and seek approval as regulators in specific jurisdictions. These regulators could be licensed in Europe, Latin America and North America, for example.

In these jurisdictions, they would be able to regulate Uber, imposing the same regulatory system across all those places. These jurisdictions would have to agree on regulation; they would just have to decide whether the offered system meets their standards.

Following this system, we could have multiple regulators operating in all those jurisdictions; those jurisdictions can approve multiple regulators. Private regulators could regulate in different ways.

Regulator A could regulate using one model, such as traditional rulemaking perhaps, and Regulator B could regulate using a different model - using a lot of data oversight and technology, for example. Uber could choose Regulator A and that would satisfy any governments that approve Regulator A. Lyft could choose Regulator B and that would satisfy any governments that approve Regulator B. Uber and Lyft could be operating in all the same jurisdictions, but choosing regulatory systems that work best for them but all of which meet the government's standards wherever they operate.

This creates a vibrant and competitive market.

With the rise of platforms such as Uber and its competitors, like Lyft, the question that arises is how these new concepts would be merged into the regulatory sphere. Image: Lyft

Arbitration in the Age of Algocracy: Who Do You Trust?

By Sophie Nappert, International Arbitrator

Technology up to now has been at the service of the arbitration process, assisting with the accuracy and speed of procedurally repetitive or voluminous tasks, such as the review and classification of documents; and the development of matrices for the calculation of quantum (jargon for the monetary outcome of the dispute), typically involving the analysis of future profits on a discounted cash flow basis.

By now, one would have expected technology to have had a real, positive impact on bringing down the procedural time and costs of arbitration. The reality is that, if anything, time and costs are on the rise. One reason for this apparent mismatch might be that, in attempting to draw a parallel between the use of technology in proceedings and the time and costs of those proceedings, we are drawing the wrong parallel.

The right parallel to draw is between the use of technology and the processing of instantaneous information. And we must not confuse the immediacy of acquiring information with our capacity to sift through that information, digest it, and use it to inform our decision-making.

There is no technology to accelerate that latter process when it is carried out by humans. The immediate communication and information does not necessarily translate into faster, more accurate decision-making. This may go some way towards explaining why international arbitration has been slow to embrace technology.[71]

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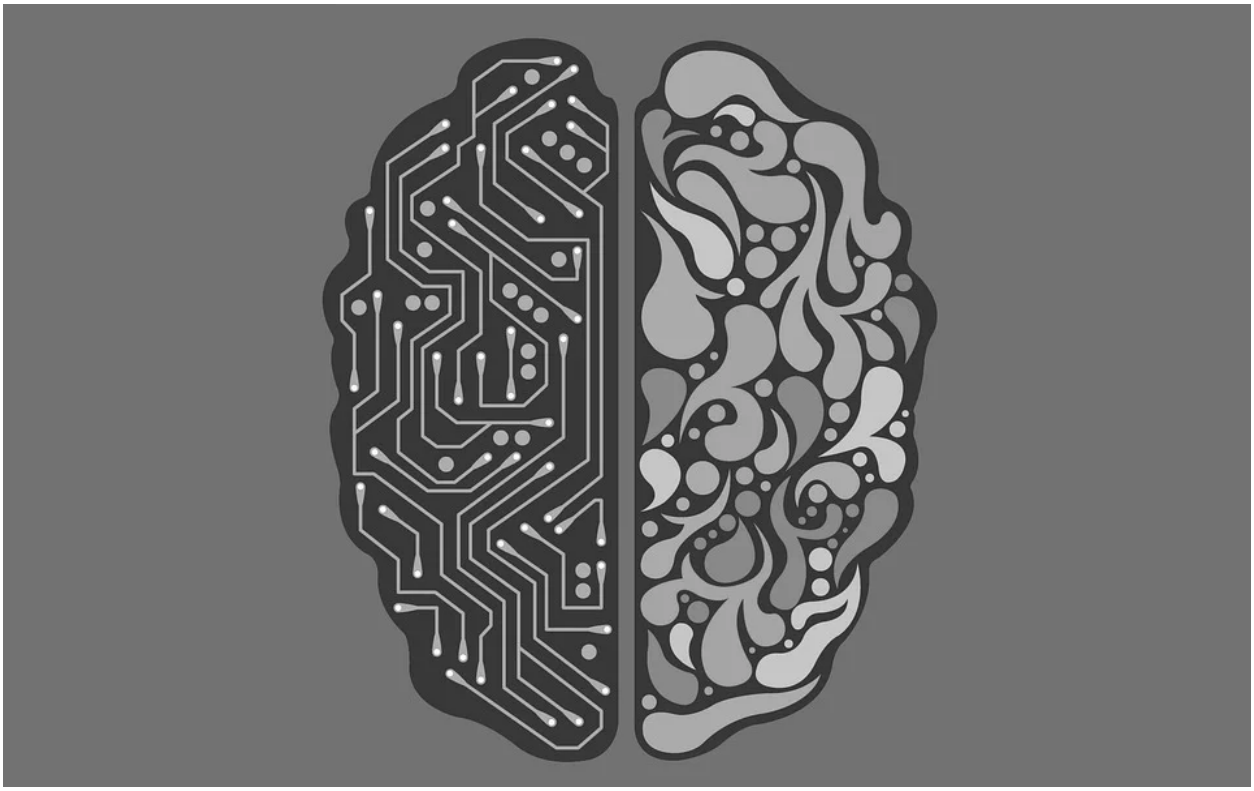
71 (…) a system in which algorithms are used to collect, collate and organise the data upon which decisions are typically made, and to assist in how that data is processed and communicated through the relevant governance system. This can be done by algorithms forcing changes in the structure of the physical environment in which the humans operate (…). Such systems may be automated or semi-automated. Or may retain human supervision and input." J Danaher, "The Threat of Algocracy: Reality, Resistance and Accommodation" (2016) 29:3 Philosophy & Technology 245-268, available here.



We are now at a stage where technological development enters the realm of the substantive, hitherto the preserve of human decision-makers: assessing the truth of a witness's testimony on the basis of an analysis of her voice intonations and facial micro-expressions; or generating in record time a reasoned decision that takes into account prior precedent, as illustrated by the Prometea initiative, an algorithm devised to assist the Public Prosecutor's Office in Buenos Aires to clear the backlog of administrative law and fiscal cases.

We are, in other words, entering the age of what has been aptly described as "Algocracy", or governance by algorithms. The challenge that this presents, for arbitration as for many other processes currently dominated by human decision-making, is whether, in allowing algocracy to flourish, we are creating decision-making processes that will constrain and limit opportunities for human participation.[72]

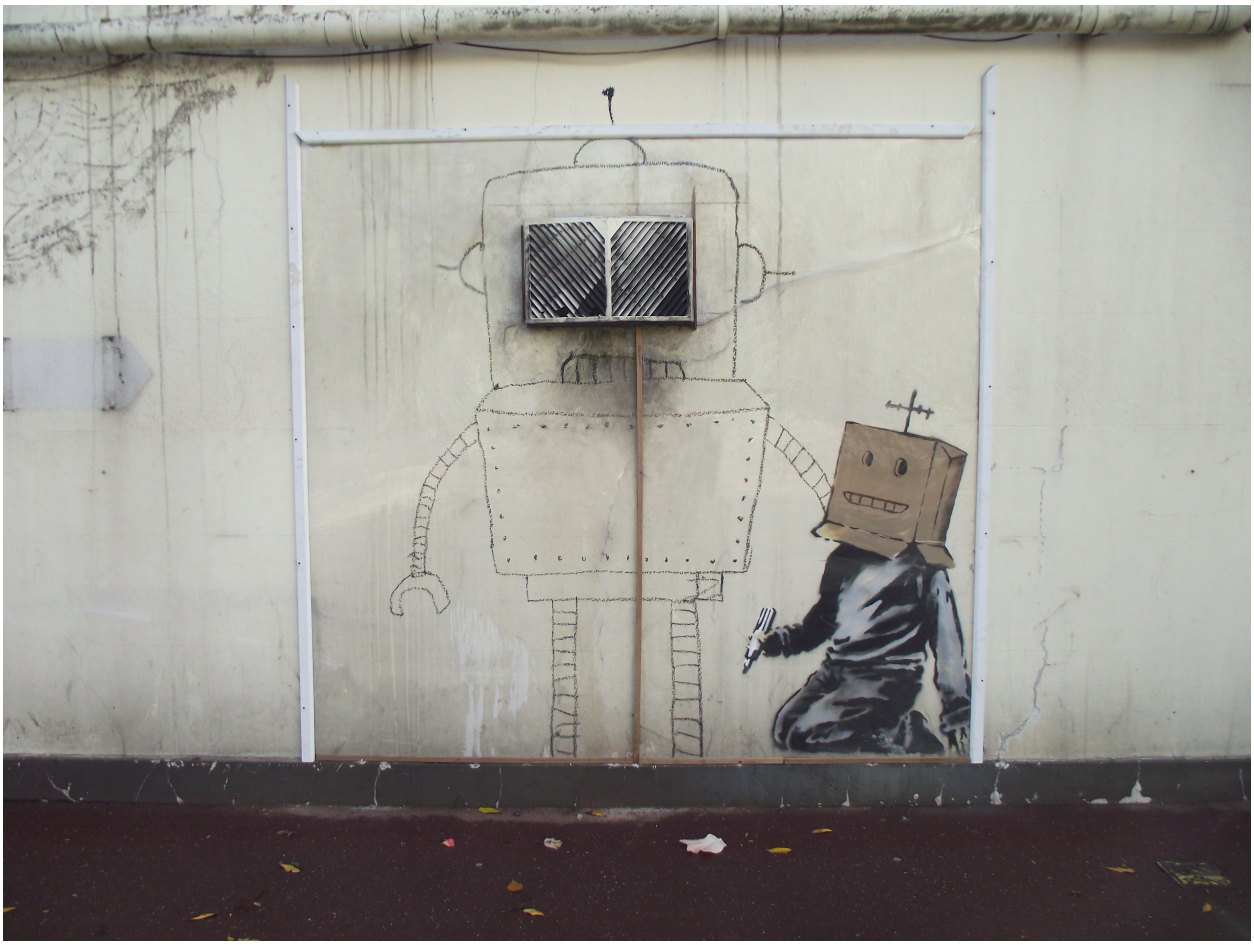
The list of questions that threaten soon not to be hypothetical is illuminating. Here are a few:

- If technology exists that could determine a witness's veracity with unerring accuracy, would we be forced to use it?

- Would arbitrators face a challenge from a party for using that technology because the party felt that the arbitrators were abdicating their responsibility to adjudicate the case to a machine?
- Would arbitrators face a challenge for not using that technology because the party felt that arbitrators ought to use every tool at their disposal to determine the truth?
- Would counsel hesitate to put forward certain witnesses on the basis that they might not survive the scrutiny of technology?
- Would arbitrators draw an adverse inference from a witness willing to testify but unwilling to use the machine?

Returning to arbitration, the answer to the above questions leads to more core questions about what we want from the arbitral process, and what it can deliver: A flawlessly logical, entirely dispassionate outcome? Unanswerable legal reasoning (and if so, query the need for appeal or review in tomorrow's dispute resolution world)? A search for the truth? What is the place of equity in the technological world?

Does technology need to be kept in check and confined to its current role as assistant to the decision-making process; or do we allow it to take the process over and, by shepherding the human part of it through those areas where the mind is eminently fallible (e.g. areas involving complex mathematical calculations or areas involving cognitive bias), confine the humans to decide only those issues where humans can still have an edge, such as issues involving equity, fairness or empathy? Would this amount to a better process in the end?



Painting on wall of Grosvenor Hotel in Torquay, England. Said to be the work of Banksy. Source: Pinterest

Technology also causes us to rethink the tenet of the individual nature of the arbitrator's mandate, and how much of it can be relinquished without delegating the function altogether – much like it has been said that writing one's own awards is the safeguard of intellectual integrity, what happens if technology gets ahead of you, leads you by the hand through true or false witness testimony or algorithmic computation and presents you with an inevitable conclusion?

By way of a practical illustration of this last challenge, I am currently co-chairing a task force looking at the treatment of allegations of corruption in international arbitration. We plan to examine whether arbitrators could derive assistance from an algorithm programmed to recognise red flags (indicators of corruption) in a given set of factual circumstances, and to determine the percentage chance of corruption being, or not being, present.

Something along those lines has already been conceived by researchers at the University of Cambridge, who developed a series of algorithms that mine public procurement data for

signs of the abuse of public finances (e,g, an unusually short tender period; low number of bidders in a competitive industry; unusually complex or inaccessible tender documents). If the algorithm returns, say, a result showing a 65% probability of corruption being present, what scope remains for the human arbitrator to disagree, and on what basis?

One thread running through these important questions is that of trust, a most intangible, and most human, attribute. In selecting arbitration as an alternative to the judicial system, disputants make an active choice based on the trust that they place in arbitration to provide a process and outcome suited to their industry, or values.[73]

Legal sociology scholarship posits that trust is built upon the perception of the fairness of a dispute resolution system, which itself is based on a belief that the system is neutral, respectful, representative and demonstrates care towards the litigant. This necessarily implies that human trust is earned over time, by the repeated demonstration of accuracy and fairness.

Historical notions of trust have been upended by the decentralization underpinning blockchain and smart contracts. It has been said that the advent of smart contracts raises a new set of trust issues, re-allocating the trust traditionally placed in institutions (and, for arbitration, "trusted third parties"), to a system premised on code and the powerful actors within this system.[74]

It has also been stated that smart contracts may be ill-suited to long-term contractual relationships that "entail the possibility of greater uncertainty due to the natural limitation of human foresight and a greater number of permutations, including external factors beyond the control of the parties. Such relationships entail high levels of interpersonal trust."[75]

The resolution of disputes over these long-terms relationships also typically involves consideration of appropriateness, fairness and equity (one classic example is gas price

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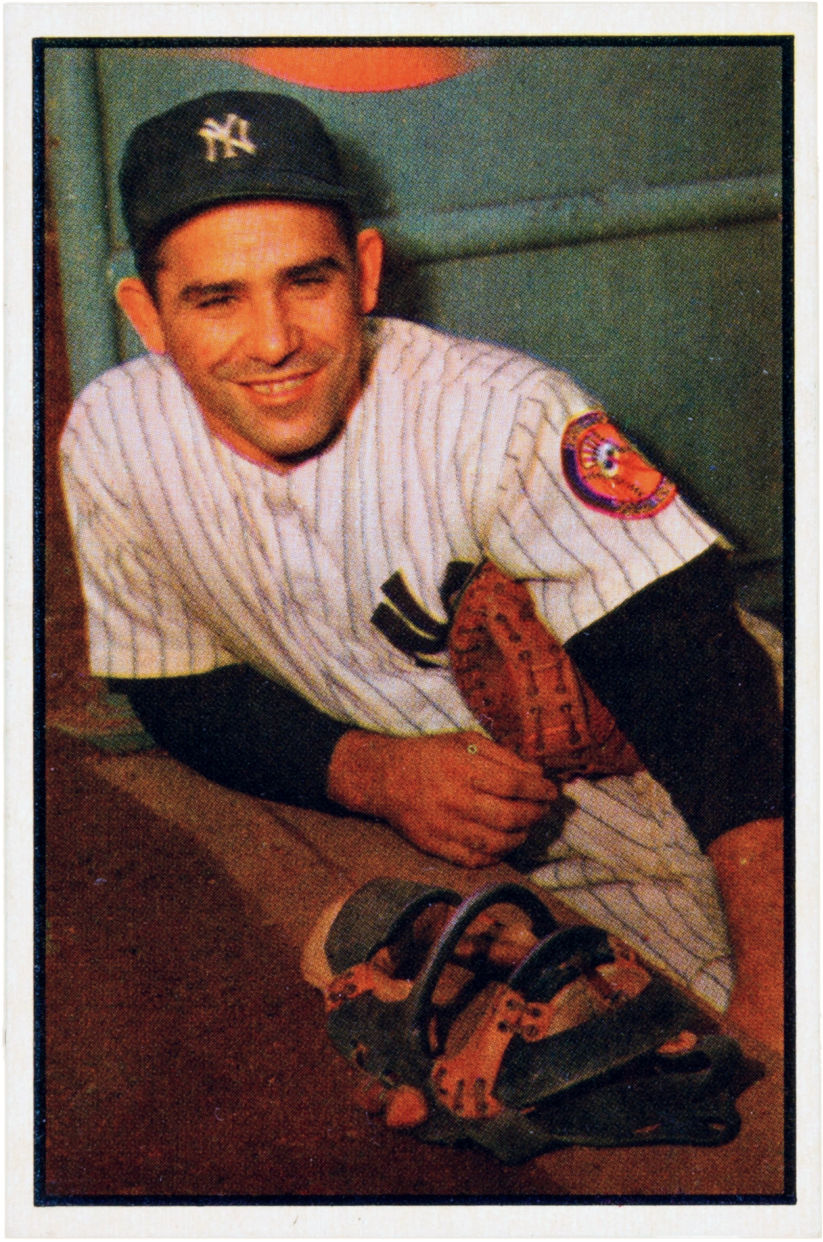
[73] The concept of arbitration "is a simple one. Parties who are in dispute agree to submit their disagreement to a person whose expertise or judgment they trust. They each put their respective cases to this person – this private individual, this arbitrator – who listens, considers the facts and the arguments, and then makes a decision. That decision is final and binding on the parties; and it is binding because the parties have agreed that it should be, rather than because of the coercive power of any State." N Blackaby and C Partasides with A Redfern and M Hunter, Redfern and Hunter on International Arbitration (OUP, 2015).

[74] Mimi Zou, Grace Cheng, Marta Soria Heredia, "In Code(r) We Trust? Rethinking 'Trustless' Smart Contracts", 7 June 2019, available here.

review disputes)[76], falling squarely within those areas identified above as particularly suited to the human mind rather than to intelligent machines.

Yogi Berra, the baseball player and inadvertent apostle of the statement of the obvious, once quipped that "predictions are hard to make -- especially about the future."

[76] "(…) most price review clauses in Asian LNG contracts are general in nature and say very little (…), if anything, about the factors which should be taken into account in a price review. Industry evidence suggests that some Asian price reopeners refer to 'various factors' or broader economic considerations (like 'levels and trends in the price of oil and gas in Asia-Pacific region') which should guide price review discussions. In addition, or in the alternative, some Asian LNG contracts require that the price adjustment shall be 'appropriate', 'reasonable', 'equitable', 'fair and justified', or apply a combination of these, or similar, thresholds." Agnieszka Ason, "Price Reviews and Arbitration in Asian LNG Markets", The Oxford Institute for Energy Studies (April 2019), available here.



Yogi Berra, catcher and later manager of the Yankees and the Mets (1925-2015).

At this stage, however, we can say with some certainty that, as the blockchain and smart contract ecosystem develops with a view to becoming more mainstream, human disputants will continue to trust other humans – Kleros' jurors - to decide the disputes that arise in this new ecosystem.

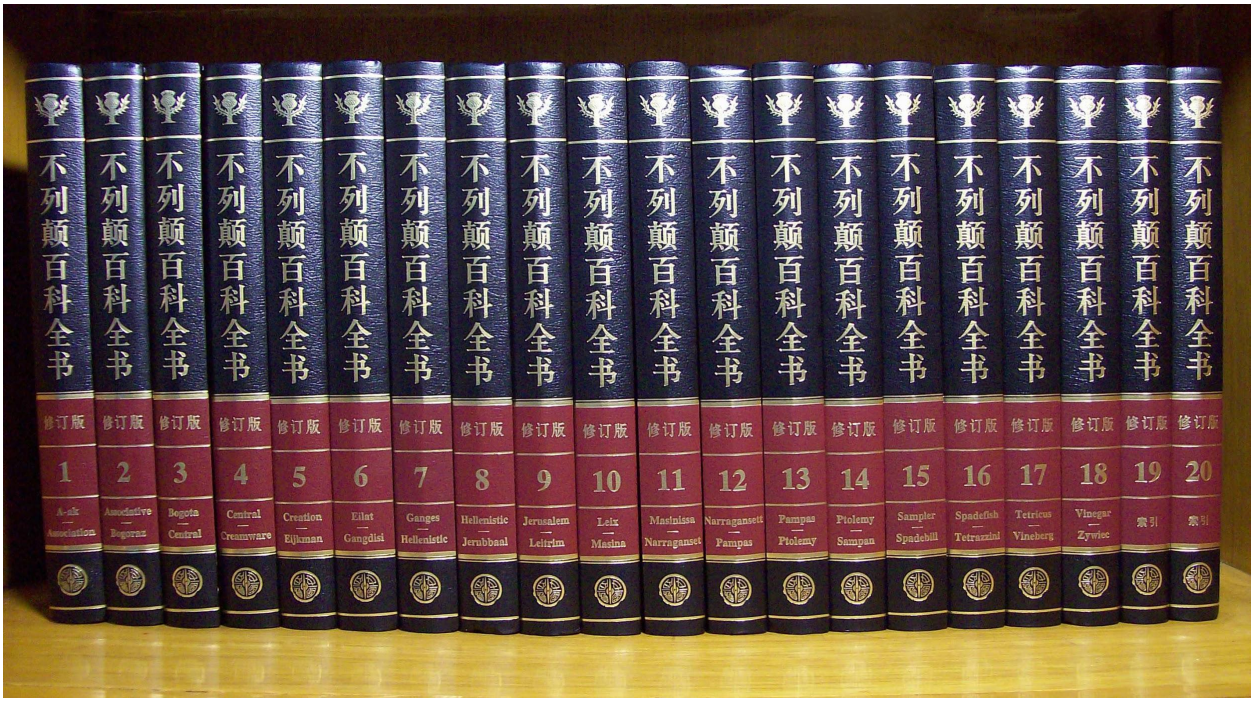
As greater familiarity with the disintermediation of human interaction sets in, there is a good case to be made for a fruitful partnership between intelligent machines and the human mind, keeping the perils of algocracy in check.

Is Kleros Fair?

By Daniel Dimov, Dimov Internet Consulting, and Federico Ast, CEO, Kleros

Kleros' approach to arbitration is radically different to traditional court systems and alternative dispute resolution methods. Relying on cryptoeconomics[77], it provides crowdsourced jurors the incentive to arbitrate on various types of disputes.

Kleros promises to transform the field of dispute resolution in a way similar to how Wikipedia revolutionized encyclopedia publishing. Back then, few people expected that an encyclopedia written by anonymous people on the Internet could compete with traditional encyclopedias. Nevertheless, Wikipedia ultimately triumphed and forced Microsoft to shut down its paid product Encarta. It also brought the end to the venerable Britannica, 242 years after the first edition.



A Chinese edition of Encyclopedia Britannica. Credit: Hawyih / CC BY 3.0

Sceptics believe that Kleros does not provide a fair method for dispute resolution and that this will become an obstacle for mass adoption. Our goal in this article is to address this concern: can Kleros resolve disputes in a fair manner?

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[77] For more information on how cryptoeconomics work, see the introductory article to Chapter 3: Decentralized Justice in Action: From Doges on Trial to the Token Curated Registry.

Assessing Fairness in Crowdsourced Online Dispute Resolution (CODR)

In order to assess the fairness of Kleros, first we need to identify reliable fairness criteria. Daniel Dimov (one of the coauthors of this article) has worked extensively on the development of a model for assessing procedural fairness in the context of CODR.[78]

Procedural fairness refers to a set of criteria for determining whether a given procedure contributes to a fair outcome. Dimov examines two types of procedural fairness, namely, objective procedural fairness and subjective procedural fairness, and merges them in a combined framework.

Objective procedural fairness is defined as the extent to which the procedure complies with the fairness standards defined by the Directive on Alternative Dispute Resolution (ADR), an EU law applying to the entire European Union.

Subjective procedural fairness is defined as: "an individual's subjective perception of the fairness of a procedure". This is based on empirical studies about people's subjective perceptions regarding various aspects of procedures. It falls under the domain of psychology as it relates to human behaviour and mental processes (and not to objective normative frameworks).

The combination of objective and subjective procedural fairness is important to assess the overall fairness of a dispute resolution procedure. A procedure may be legally fair, but subjectively regarded as unfair by the disputants.

Let's see how Kleros scores with regard to the criteria of Dimov's framework of procedural fairness.

Evaluating the Procedural Fairness of Kleros on the Basis of Dimov's Framework

Expertise

The third neutral party should have (i) the necessary knowledge and skills in the field of alternative or judicial resolution of consumer disputes and (ii) a general understanding of the law.

Kleros jurors self-select into the court where they wish to conduct arbitration. Kleros does not ask for the jurors' real identity or to prove they are qualified to arbitrate disputes in the court where they want to work.

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[78] To learn more, read Dimov's PhD dissertation: *Crowdsourced Online Dispute Resolution*.

The expertise requirement is conducted via economic incentives. Kleros generates for users the incentive to self-select for the courts where they have expertise. Users who self-select into the courts for which they have the right skills will, on average, make money over time. Users who self-select into courts where they don't have the right skills will lose money and tend to abandon the system.

Even though, in theory, jurors may not have subject matter expertise (anyone can participate in the court), in practice, users without adequate expertise would suffer an economic loss and exit the court (unless they wish to lose money while they work, in order to gain those skills).

This works similarly to Wikipedia in the sense that a user who does not have expertise in a field to which an article edited by him/her relates, may still edit the article but will likely be sanctioned by Wikipedia.

Independence

Jurors should have personal and functional independence. Personal independence refers to guarantees that are built into the position of third neutral party regarding the duration of appointment, pay and dismissal. Functional independence means that the third neutral party should feel free to freely give his judgements.

Smart contracts guarantee personal independence in the sense that no authority could affect the duration of the appointment (jurors are drawn for the whole court session), pay (arbitration fees are written in the smart contract) and dismissal (there is no way to dismiss a juror before the end of the court session).

Pseudonymity favors functional independence. The fact that jurors do not need to reveal their true identity makes them less vulnerable to attacks or intimidation. However, token redistribution (which gives jurors the incentive to vote in coherence with the final decision) lowers functional independence. Functional independence may be retrieved by forking, in case the results would be significantly different from what users consider as a fair outcome.

Impartiality

The third neutral party must not have any internal prejudices, prejudgments or predisposition toward some parties or some of the elements of the subject matter of the dispute.

The procedure for random selection of jurors among those who staked tokens in a court makes it hard to attack the court.

It is extremely hard for a juror to be able to be drawn into a court where he has a vested interest. In practice, it would be extremely unlikely for jurors having a vested interest in a case to compose a significant part of the drawn jurors.

It is possible that internal biases still exist in jurors. There are some ways within Kleros to present information in such a way that it minimizes this bias. However, it could be also argued that no system can be completely free of biases.[79]

Transparency

The dispute resolution process should be understandable and, if necessary, possible to replicate.

Kleros' dispute resolution procedure is documented in many places. All cryptoeconomic research is public and the code is open source. A fully working version of Kleros could be replicated in a matter of minutes by anyone with technical skills in blockchain.

Fair Hearing

Parties should be provided with (i) a notice informing them about the commencement of the dispute resolution process and (ii) an opportunity to present their cases and rebut the cases of their opponents.

The start of a dispute is public. Any party having set a way to get informed (this can be done by just providing an email address) can be informed about the commencement of a dispute. Parties have the opportunity to present arguments on their defense.

Counterpoise

Pre-existing imbalances in the financial status of parties and the computer skills of the disputants should be neutralized.

As Kleros early use cases are connected to disputes within the blockchain ecosystem, arguably there are not high imbalances in computer skills.

Kleros could make a better job of balancing financial inequalities than competitors such as customer support services. The customer support service of an Internet platform such as eBay is more likely to favor the wealthier party, as it is the one generating more revenue for the platform. Furthermore, customer support services are usually provided in a limited

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79 For an in depth discussion about biases in juror decision making, read *Kleros and Mob Justice: Can Wisdom of the Crowd Go Wrong?* in Chapter 2 - Kleros Cryptoeconomics: Towards a Theory of Decentralized Justice.

number of languages. This puts foreign language speakers at a disadvantage compared to native language speakers.[80]

Reasonable Length of Procedure

The outcome of the dispute resolution procedure should be available within a period of 90 calendar days from the date on which the provider of the dispute resolution service has received the complete complaint file.

While the length of procedure in Kleros would depend on the type of dispute, it would be arguably faster than many other alternative dispute resolution methods. The reason is that the amount of users from which jurors are pooled is much higher, which generates a large supply of arbitration services.

In theory, the number of appeals could lead to a lengthy procedure. But, in practice, frivolous appeals in order to delay a final ruling are expensive and lead to compensation that will be paid to the victim of those appeals.

Providing Reasons

Jurors must give parties a statement of the grounds on which the decision is based. In Kleros, jurors are required to provide a short text explaining their vote.

Voluntary Participation

The participation of parties in the dispute resolution procedure should be voluntary.

As in traditional arbitration, parties have to agree on Kleros as a dispute resolution method before the dispute happens.

Process Control

The increase of control over the development and selection of information that will constitute the basis for making a decision strengthens the perceptions of procedural fairness.

The information that jurors will evaluate for making a decision depends on the type of case and the court. When parties agree to a specific court to settle a dispute, they also agree to the type of evidence that will be used for resolution.

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[80] Imbalances in the financial status of parties could lead to inequality in the appeal process. Parties with lower financial resources will have less opportunity to appeal (as the losing party needs to pay for appealing). The post-dispute insurance process is designed to neutralize this imbalance. This allows for external agents to pay the appeal fee of a party they think is right.

Decision Control

Decision control refers to the extent to which the parties are free to reject or accept a decision rendered by a third party. The increase of the extent to which the participants in a procedure can reject or accept a decision rendered by that procedure strengthens the perceptions of procedural fairness.

Parties can appeal to decisions they disagree with and have their case ruled again. This gives them control over the decision.

Consistency

The consistent application of a procedure across persons and across time strengthens the perceptions of procedural fairness.

Kleros fully complies with this condition. All cases within a court are settled with the same court policy. The procedure maintains consistency across time, as any change to the court policy needs to be approved by users through the governance mechanism.

Accuracy

Individuals view procedures based on accurate information as more fair than the procedures based on inaccurate information.

Information used in the resolution process is agreed beforehand by the parties. Blockchain immutability guarantees that parties cannot tamper with the evidence.

Correctability

The opportunity to correct a decision strengthens the perceptions of fairness of the procedure used for making the decision.

Kleros allows for participants to appeal decisions that they consider unfair. Such decisions will be reviewed again by a new jury that will consist of twice as many jurors plus one.

Ethicality

The increase of the extent to which a procedure conforms to personal standards of ethics and morality increases the extent of the perceived fairness of the procedure.

Using Kleros as an arbitrator is a choice. Parties with different standards of ethics and morality are not required to use Kleros. Besides, the creators of different court policies will be able to implement ethical principles in their court to which most disputants will adhere, thus ensuring a high-level of ethicality.

Is Kleros Fair?

Kleros seems to comply with most of the points of Dimov's framework for fairness in online dispute resolution systems. Furthermore, the fairness of Kleros is enhanced by the use of blockchain technology. Most other CODR procedures are centralized. This means that the operator may interfere with the procedure and breach Dimov's fairness framework.[81]

In centralized systems, the owner can decide to stop the procedure at any time and for any reason. As Kleros replaces the operator of the CODR procedure with a decentralized autonomous organization, it removes the centralized trusted operator and guarantees a high level of procedural fairness.

[81] This may have happened when, on the 31st of January of 2012, eBay decided to stop its CODR procedure called *Community Review Forum*.

Is Kleros Legal?[82]

By Dmitry Narozhny, Civil Law Attorney

"Shylock.
Is that the law?
Portia.
Thyself shalt see the act:
For, as thou urgest justice, be assured
Thou shalt have justice, more than thou desirest."
William Shakespeare, The Merchant of Venice,
Act IV, Scene I. Venice. A court of justice.

Shakespeare's "The Merchant of Venice" climax scene takes place in a Venice court of law, where financier Shylock demands that his contract be enforced against Antonio, a merchant who defaulted on his loan. Image: An illustration in Shakespeare's comedy of the Merchant of Venice by Sir James D. Linton R.I., 1914.

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[82] This article is the result of the Fellow's work as part of the Kleros Fellowship of Justice Program. To see all reports done by our Fellows, have a look at the The Kleros Fellowship of Justice Library.

Two simple questions should be answered for the sake of confidence in Kleros as an arbitrator. Does Kleros dispute resolution conform to the law? Would a court recognize Kleros jurors ruling? I will argue here that the answer is “yes” to both.

Legal Definition: is Kleros Arbitration?

Currently, a general pattern among state regulators is to encourage implementation of alternative and online dispute resolution (ADR, ODR) in commercial and consumer disputes.

The following well-known lawmaker’s blessings should be quoted in this regard: U.S. Alternative Dispute Resolution Act (28 U.S. Code §651), EU Directive on Consumer ADR and Regulation on Consumer ODR (Directive 2013/1/EU and Regulation 524/2013 of 21 May 2013) and UNCITRAL Technical Notes on Online Dispute Resolution (2017).

These regulations provide ‘umbrella’ definitions for a variety of ADR and ODR ‘out-of-court’ techniques, such as mediation, negotiation, arbitration, etc., which are conducted through the use of electronic communications.

Kleros is a blockchain-based platform and provides arbitration by means of information and communication technology. This clearly matches valid legal terms of alternative and online dispute resolution.

Under the clauses of international law, the Kleros dispute resolution process is an arbitration scheme. Namely, the UNCITRAL Model Law on International Commercial Arbitration adopts that “arbitration” means any arbitration, administered or not by a permanent arbitral institution.

Some could argue that, in its traditional understanding, arbitration has little to do with Kleros random selection of crowdsourced jurors, cryptoeconomic incentives, or the fact that the procedure is conducted by an automated blockchain protocol.

However, these arguments do not exclude Kleros from the definition of arbitration. The specific details of Kleros may differ from arbitration methods that were tried before, but its general framework is still recognizable as alternative dispute resolution.

UNCITRAL principles explicitly preserve parties' full freedom to determine the rules of arbitration procedure on their own. Building on this, it is evident that Kleros conforms to the law.

But this isn't yet enough to conclude that Kleros is capable of producing a lawful and internationally recognizable ruling. For this, the dispute resolution procedure itself must be compliant to substantive due process principles of international arbitration.

Due Process: is Kleros Compliant with Substantive Arbitration Principles?

A procedure's compliance/non compliance with a set of substantive principles is what makes its rulings valid/invalid. The compliance to these principles is what would be examined by a state court when evaluating *pro et contra* of endorsement of each and every ruling at stake.

To distill applicable international rules to Kleros' procedure, this examination may be conducted around these four layers: (i) Scholarly research on general principles of international due process; (ii) International conventions and model laws; (iii) Best practices and recommendations; (iv) Laws and regulations.

Beside the resources mentioned above, the following legislation should be listed here: Article V of the New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards; Article 6 of the European Convention on Human Rights; ALI/UNIDROIT Principles of Transnational Civil Procedure (this list is far from being exhaustive).

The design of the Kleros dispute resolution process complies with all core principles of due process. In particular: independence, impartiality, jurisdiction, effectiveness, accessibility, liberty, legality, expertise and, to be emphasized, procedural fairness.

Indeed, Kleros is a decision protocol ("accessibility") for a general purpose opt-in court system ("liberty", "jurisdiction/competence"). It is decentralized ("independence"), allowing arbitration of smart contracts by crowdsourced jurors relying on economic incentives ("impartiality"). It is an autonomous organization ("independence") that works as a decentralized third party to arbitrate disputes in every kind of contract ("impartiality").

Every step of the arbitration process (securing evidence, selecting jurors, etc.) is fully automated ("procedural fairness" and "transparency"). Kleros does not rely on the honesty of a few individuals but on game theoretical economic incentives ("expertise").

Smart contracts are smart enough to automatically execute as programmed, but not to render subjective judgments or to include elements from outside the blockchain ("data confidentiality and security"). Each court should have some specific features regarding policies ("legality", "non-contradiction to public policy"), session time and cost ("effectiveness"), number of drawn jury members and tokens staked.[83]

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[83] To learn more, read Daniel Dimov and Federico Ast's article *Is Kleros Fair?* in Chapter 4 - Dispute Revolution: A New Justice Paradigm in an Old World.

Recognition: Could Kleros Rulings be Overturned by Courts?

The New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards expressively reduces compliance requirements to the following common denominator: the grounds for a refusal to recognize and enforce an award.

It is important to make a reservation here: Kleros is a self-enforceable arbitration method.

Thus, the discussion is not about recognition and enforcement (because smart contracts would be enforced anyway), but rather about subsequent judicial review of an already executed ruling, made on the grounds of The New York Convention.

In international commercial arbitration, there is a strong presumption that awards are valid and that they should be enforced. The New York Convention's 'pro-enforcement bias' prevents any court from reviewing the merits of the underlying dispute. The review emphasizes due process and public policy concerns.

In this regard, it is to be noted that the procedural grounds to refusal (incapacity, lack of jurisdiction, lack of proper notice, tribunal not composed according to arbitration agreement, non-arbitrability of subject-matter, right to present a case, right to be heard and right to present an evidence and defences) are mitigated in advance by Kleros' protocol design.

In fact, the whole dispute resolution process would not commence until the smart contract receives pre-determined evidence of mutual unequivocal consent of the parties to arbitrate and if the subject-matter of their dispute fits into the Kleros platform.

Furthermore, compliance to due process requirements is a built-in feature of the protocol: stages such as proper notice of the parties, the composition of the jurors tribunal, exchange of evidence and comments of the parties are executed automatically by smart contracts. As a result, Kleros rulings are a hard target for judicial review.

Kleros' technique, elegant in its simplicity and efficiency, provides more consistent procedural protection and thus a more predictable judicial outcome. In short, Kleros fits within the structures and frameworks for a legally binding arbitration protocol.

Kleros and the United Nations Sustainable Development Goals[84]

By Rossana Deplano, Lecturer, University of Leicester

In 2015, the United Nations adopted the 2030 Agenda for Sustainable Development. Aimed at eradicating poverty in all its forms and dimensions, this agenda contains a plan of action articulated into a set of 17 Sustainable Development Goals (SDGs) and 196 targets to be achieved by 2030.

SDGs include achieving food security and promoting sustainable agriculture, ensuring minimum standards of well-being and education, promoting gender equality, protecting the environment as well as fostering peaceful and inclusive societies.

SDG 16 aims at promoting peace, justice and strong institutions. Particularly, target 16.3 refers to the need of strengthening the rule of law at the national and international levels and of ensuring equal access to justice, especially in undemocratic and corrupt societies.

[84] This article is the result of the Fellow's work as part of the Kleros Fellowship of Justice Program. To see all reports done by our Fellows, have a look at the The Kleros Fellowship of Justice Library.

United Nations Sustainable Development Goal 16 aims, among other things, to strengthen rule of law and participation of developing countries in the institutions of global governance.

The SDG 16 Progress Report reveals that there is an endemic problem of corruption, facilitated by inefficient regulations and procedures. It is estimated that nearly 20% of firms worldwide receive at least one bribery payment request when engaged in regulatory or utility transactions (the share is 25% in low and middle-income countries, compared to 4% in high-income countries).

Kleros is designed to create a fair, affordable and fast dispute resolution system. Its mission is to provide access to justice to those left outside the traditional judicial system, as well as the various alternative dispute resolution systems, such as arbitration, mediation and online dispute resolution.

While it does not replace the traditional court system, one can think of at least two use cases in which Kleros could directly contribute to the achievement of the SDG 16 and Target 16.3.

First, it could create a culture of honesty and transparency among ordinary citizens. Disagreement is part of life, and so is the natural reaction of the offended person to seek redress to the perceived injustice.

The vast majority of disputes arising between people is of such a small value that it does not warrant recourse to the slow and expensive court system. The unmet demands of justice create friction and foster a culture of suspicion. Kleros offers a cheaper and faster redress system, thus increasing access to justice for those whose demand for legal services is currently unmet.

Youth is the segment of society particularly affected by such negative trends, especially in developing countries. At the same time, it is the segment most exposed to the influence of the new technology.

If the youth were aware of the social and monetary worth of their technological skills, they could turn their interest in technology into being a responsible citizen. For example, a jobless young person could make a small profit by adjudicating small claims from her phone.

A freelance website designer based in a developing country could sell her competence – hence, her services – to, potentially, the world market. The technology behind Kleros creates the necessary confidence for both parties in a dispute. Once the dispute is adjudicated, the smart contract safely distributes the funds held in escrow to the relevant participants.

By incentivizing the acquisition and constant improvement of skills and knowledge, a blockchain dispute resolution system would eliminate the dependence of vulnerable persons from others, thus fostering the sense of inner worth and self-respect that underpins the concept of human dignity. It would also eliminate gender stereotypes that often lead to discrimination, especially against girls and women.

In this sense, Kleros could have an educative function for the youth and civil society in general. As a result, it could make markets work better and even help the United Nations achieve other SDGs, such as poverty reduction (SDG 1) and equality of opportunity in employment (SDGs 5 and 8).

Second, as an open source protocol, Kleros can be looked at as a source of inspiration, a model for implementing the Secretary General's Strategy on New Technologies.

Aimed at accelerating the achievement of the SDGs, the Strategy calls for fostering participation and transparency about the use of new, 'disruptive' technologies such as blockchain. To that end, it encourages the work in partnership across a range of actors –

governments, businesses and civil society – to consolidate dialogue, build collective knowledge and test new ideas about the promise and peril of disruptive technologies.

As a business proposition, Kleros has the capacity and the authority to become one of the UN partners in the digital cooperation sector and partake in the international standard-setting function that is going to shape the role of technology for peaceful uses in the 21st Century.

Alice Namuli Blazevic and the Power of Blockchain for Common Good

Interview by Damjan Malbašić, Communications Director, Kleros

Alice Namuli Blazevic is an Associate Partner at Messrs. Katende Ssempebwa & Company Advocates in the Transactional & Advisory Department. She has over a decade experience in Commercial Transactions and Alternative Dispute Resolution with a keen interest in Mediation and Arbitration. She has been involved in a number of Mergers & Acquisitions and Anti-trust/Competition Law matters. She has advised various large multinational ventures within Uganda, East Africa, South and West Africa, on regulatory compliance.

Could you give us some background on what is currently happening in Africa regarding initiatives about blockchain?

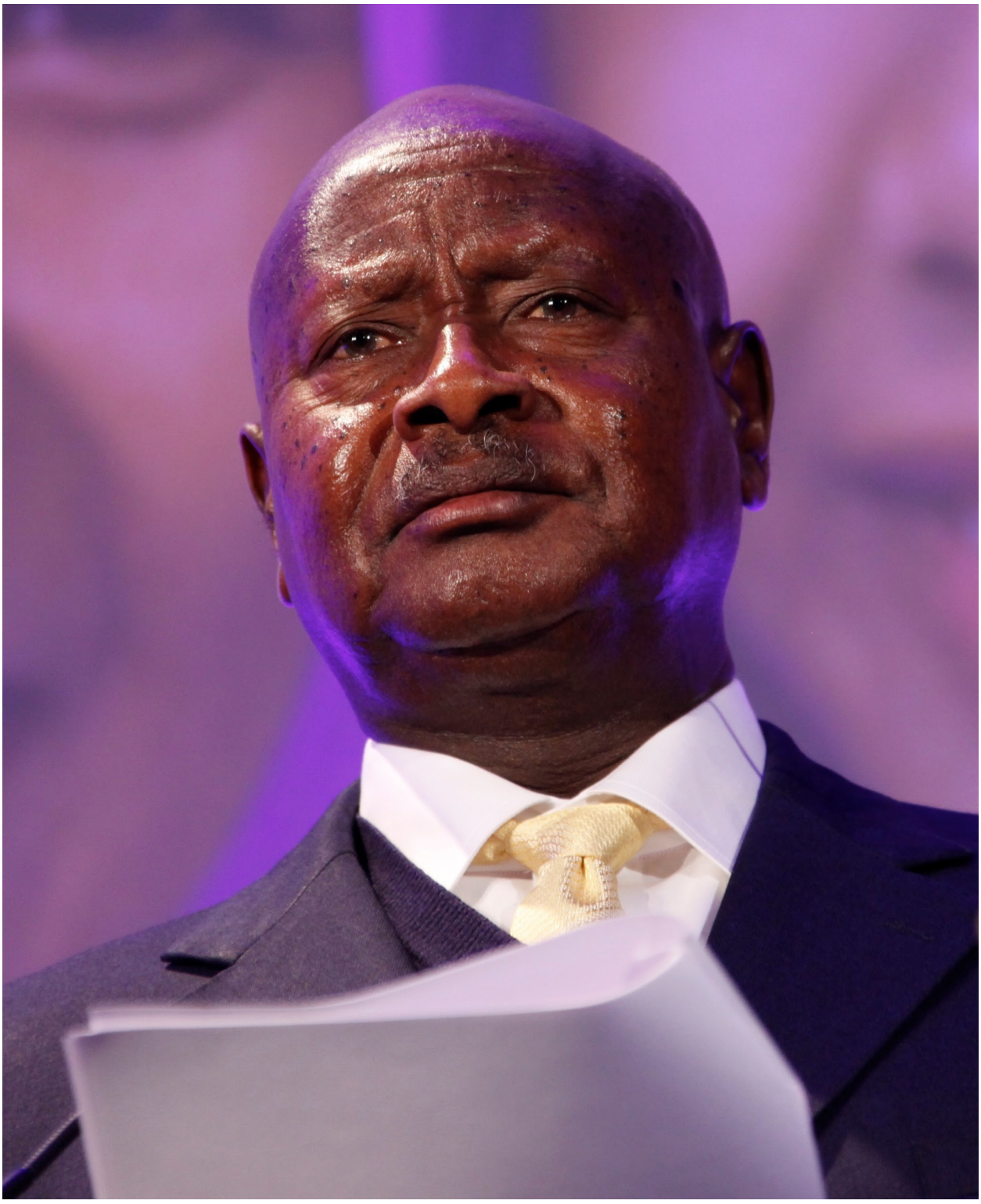
There are many blockchain technology-based businesses that are coming up on the continent, especially in the financial sector. Most African countries face a lot of difficulties with cost ineffective financial systems due to the various currencies, regulatory systems and exchange rates among African countries. However, blockchain has enabled, for example, flows of assets across borders at the lowest rates.

Blockchain has enabled African businesses to access global markets by removing barriers, such as intermediary banks, with their high costs and waiting periods, and regulatory restrictions. It has also enabled access to financial services by the so-called 'unbankable' which are a majority on the African continent.

It has created a kind of liberalism among citizens. Of course, there are restrictions from the government, but there is some kind of freedom in doing business without too many restrictions. With blockchain, I am able or free to transact with a community that appreciates independence and transparency - as opposed to slow-moving, non-transparent services offered by our governments.

Yet, there is so much blockchain technology can offer aside from cryptocurrencies. Smart contracts, for instance, can enormously affect the legal profession. The blockchain industry

is not regulated, but most regulatory authorities are following with a keen eye what is going on. We hope that soon they will appreciate the benefits of blockchain technology and embrace it.



President Museveni of Uganda called the Bank of Uganda governor 'dogmatic' and unwilling to adapt to new technology at the Africa Blockchain Conference in Kampala in May. Image: Russell Watkins/Department for International Development, CC BY-SA 2.0

When you mentioned this sense of liberalism and how it is connecting certain communities, I remembered a quote of a philosopher who said that it was not the invention of gunpowder which brought down the walls surrounding European city-states, it was the invention of free trade. This story rings in a similar way. What can blockchain do to help in not just economic, but social transformation?

There are many blockchain technology-based ventures that are causing socio-economic transformation on the continent. We have initiatives in the agricultural sector using blockchain that are helping farmers in rural areas to have a direct connection with businesses in urban centres without middlemen.

We also have social entrepreneur schemes in the health sector which are able to connect patients to doctors and pharmacies. Pharmaceutical companies which are able to track the movement of drugs from the manufacturers to the patients tackle the serious problem of pharmaceutical counterfeits.

Another application is the registration of property titles on the blockchain. I believe that embracing such a quick, transparent and cost effective system in Uganda will get rid of most land disputes, the biggest source of conflict in Uganda, which contribute to the majority of cases filed in our courts. A reliable system based on blockchain would also greatly reduce fraud and corruption.

How do you see this rise of AI and smart contracts, in what way do you see this change in the legal industry happening? What are the tipping points?

I see two tipping points. Firstly, a change in dispute resolution. Our current judicial system is still based on the laws of the 18th Century, yet the people who need the services of the judiciary are changing every day in the way we communicate, relate, transact and do business.

With the rise of online or virtual businesses like Uber, Airbnb and Facebook, a change in the mode of dispute resolution becomes inevitable. For example, in the case of a dispute arising out of an Initial Coin Offering (ICO), it would be a total waste of time and resources to file such a suit in our mainstream courts. It will be a painful experience for both the judicial officers and the litigants.[85]

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[85] Kleros can be used as a tool for dispute resolution in such circumstances, you can read more about it in *Kleros: a Tool Against Abuse in Crowdfunding* in Chapter 6 - Scaling Up: the Applications of Decentralized Justice.

The second tipping point is the change in the way lawyers deliver legal services. Clients are changing day by day. Clients are using more AI solutions to carry out business. They want fast, inexpensive legal solutions. Inevitably, lawyers will be forced to change and embrace dispute resolutions mechanisms to meet the high demands of tomorrow's clients.[86]

Indeed, the key ingredient in creating change needs to be moving from low hanging fruit and being able to solve disputes that fall under the jurisdiction of these state and powerful non-state actors.

Collaborations can be built between technologists and lawyers. I have a strong interest in alternative dispute mechanisms that can effectively serve or meet the demands of the new technology sector like online dispute resolution and arbitration on the blockchain.

Without a doubt, arbitration on the blockchain will become the next big thing in dispute resolution because of what it offers - fast, efficient and transparent systems. Platforms like Kleros will become the norm. They will be able to solve peer to peer, business to business disputes but in future we hope our court systems will embrace blockchain systems.

You mentioned representing exchanges. How was it dealing with the legal systems? How did this 19th Century vs 21st Century clash go about?

The good thing is that this new technology creates a lot of liberalism and independence from the government. Many transactions are concluded without the interference of regulators due to the virtual nature of the transactions and the absence of regulation. Therefore the chances of clashing are rare.

The main challenge we are facing now is helping our clients to find a safe regulated space to operate. Engagements with regulators have been positive but very slow. We are fully aware that being a new industry it will take some time for our regulators to fully appreciate the blockchain industry.

We are yet to have a dispute arising between a blockchain technology based business and the government of Uganda. Disputes are inevitable in a human society. Very soon these types of disputes will arise and they will need a platform to resolve them.

And Kleros might be the answer!

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[86] For more information about how the law will develop in the coming years, read the interview with Joe Raczynski on the future of law in Chapter 5 - The Business of Decentralized Justice.

Chapter 5.

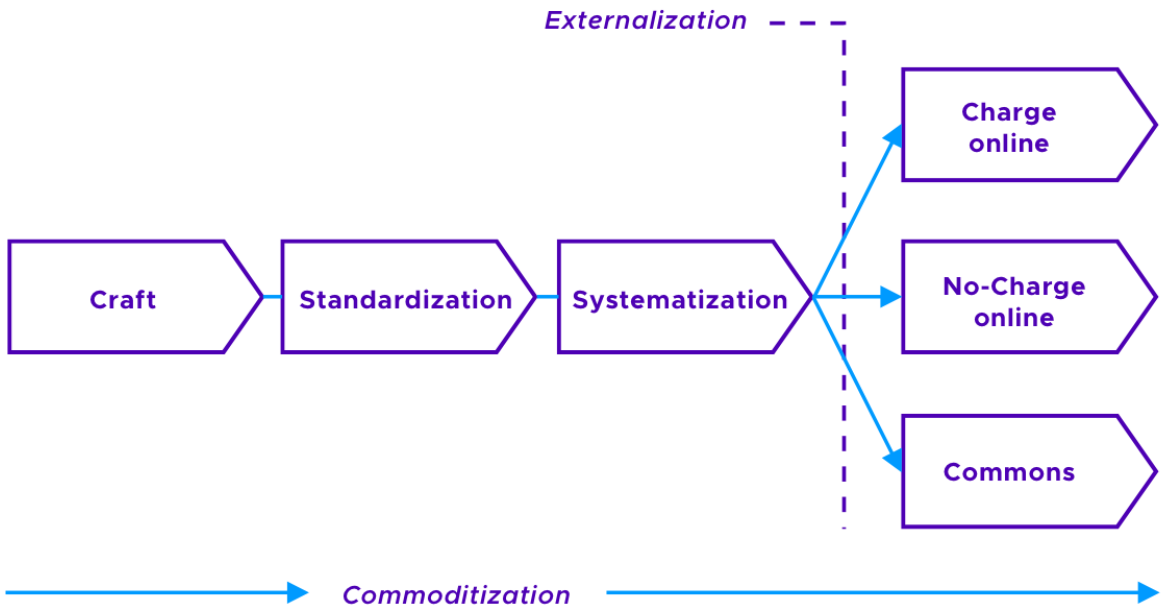
The Business of Decentralized Justice.

"If I had asked people what they wanted, they would have said faster horses."
-Henry Ford

In the book *Tomorrow's Lawyers* (2013), Richard Susskind argues that the legal industry is facing three key trends: cost reduction, deregulation and increasing competition by information technologies. Since the beginning of the economic crisis in 2008, lawyers have had to face clients ever more willing to turn to technology to solve their legal problems faster and at a lower cost.

This can be done by participating in legal communities such as AVVO (where thousands of users share their experiences) or as simply as just googling answers to legal questions (instead of consulting with an attorney).

The business of law, Susskind explains, is moving steadily towards commoditization. Activities that used to be done in a bespoke way by lawyers are becoming standardized and systematized, and are moving to the cloud. The legal industry is facing the same "[software is eating the world]" pressures that affected media, record labels and encyclopedias in the early days of the Internet.



What Can Lawyers Learn from Wikipedia?

When Microsoft launched Encarta in 1993, some declared the beginning of a new age in the encyclopedia business. Soon after, the venerable Encyclopedia Britannica also launched its digital version. But the dawn didn't come.

From the perspective of innovation theory, Encarta and Britannica only brought about incremental innovation. Yes, their digital versions had audio and video and were distributed as a CD-ROM instead of printed books, but they were still traditional products.

The company would hire a team of expert writers to produce an encyclopedia. At a fundamental level, the model was not different from the one Diderot and D'Alembert had created in the 18th Century. Encarta was a digital immigrant.

The game really changed with Wikipedia, which introduced the wisdom of the crowd into the content creation process. Wikipedia was not a digital immigrant. It was the first encyclopedia native of the Age of Collaboration.[87]

Back in the day, many were skeptical. "How can an encyclopedia be produced by anonymous people on the Internet?", they asked. "How can you make sure it is actually written by experts that know what they are talking about?".

But it worked. The wisdom of the crowd proved better than the expert curation model which had been used for nearly 300 years. It turned out that anonymous people from the Internet could indeed produce a high quality encyclopedia faster and at a lower cost than what had been possible before and this, in turn, democratized access to knowledge.

Eventually, the digital versions of Encarta and Britannica were shut down. That was ultimately the result of seeing the Internet as an opportunity to create faster horses in a traditional model. Wikipedia was the automobile that brought massive disruption.

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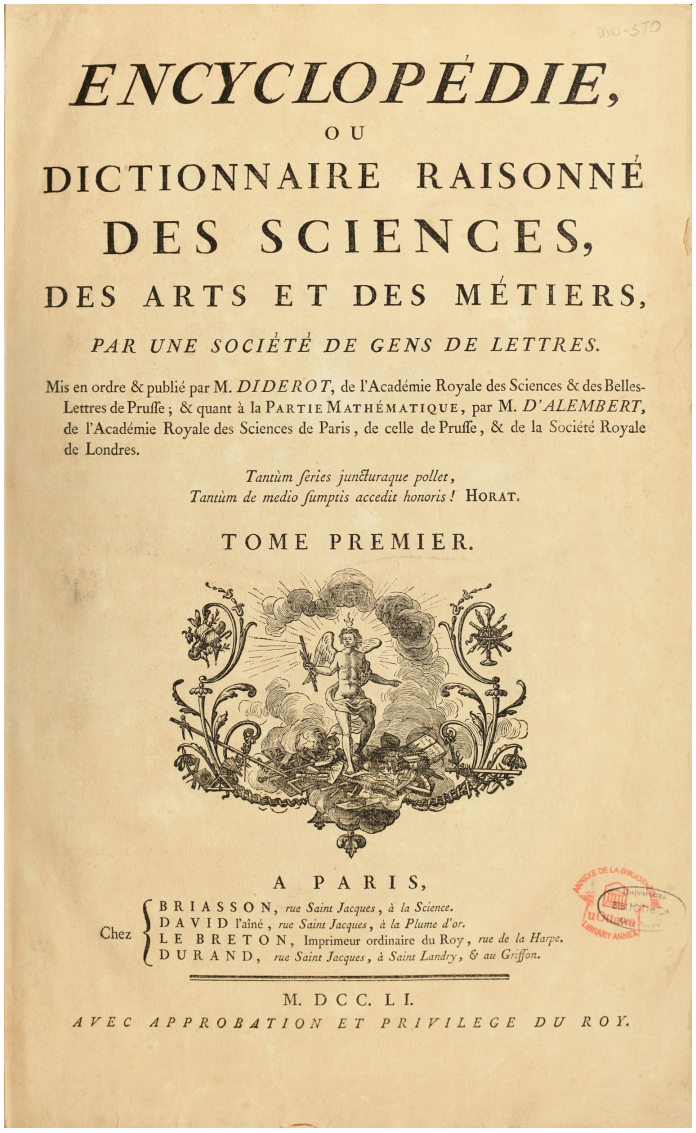
[87] Marshall McLuhan observed that the first version of a new medium imitates the medium it replaces (McLuhan, 1970). This is why in the early age of computing, screens were organized as a metaphor of the office. We had "desktops", "folders" and "files". In the second age of computing, we moved forward to the organizing principle of the web. The basic unit was no longer files but "pages". In the third age, the prime units are flows and streams.



ENCYCLOPÉDIE,

OU

DICTIONNAIRE RAISONNÉ

DES SCIENCES,

DES ARTS ET DES MÉTIERS,

PAR UNE SOCIÉTÉ DE GENS DE LETTRES.

Mis en ordre & publié par M. DIDEROT, de l'Académie Royale des Sciences & des Belles-Lettres de Prusse; & quant à la PARTIE MATHÉMATIQUE, par M. D'ALEMBERT, de l'Académie Royale des Sciences de Paris, de celle de Prusse, & de la Société Royale de Londres.

Tantùm series juncturaque pollet,
Tantùm de medio sumptis accedit honoris! HORAT.

TOME PREMIER.

A PARIS,

Chez { BRIASSON, *rue Saint Jacques, à la Science.*
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M. DCC. LI.

AVEC APPROBATION ET PRIVILEGE DU ROY.

Nothing really changed in 300 years. Image: Cover of the first edition of the "Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers". Edited by Denis Diderot and Jean le Rond D'Alembert (1751).

Online dispute resolution is not a new industry. In the early days of the Internet, people saw the potential of digital technologies for settling disputes. As early as the 1990s, companies like iCourthouse experimented with collective intelligence to resolve civil cases. In the 2000s, eBay implemented a crowdsourced panel to decide whether a contested review had to be deleted.

Early applications of ODR, however, failed at having a massive impact. These attempts, even though they tried to apply digital tools, ultimately didn't bring an innovation which could

represent a breakthrough over the status quo. Generally speaking, early players in ODR just took existing court procedures, streamlined them and put them online.

The legal industry has much to learn from the encyclopedia business. Just moving the court online will not bring radical change. We need to rethink the logic of the resolution process from a first principles perspective.[88]

Rethinking Justice With Cryptoeconomics

Instead of taking existing arbitration procedures, streamlining them and putting them online, Kleros uses cryptoeconomics to enable a completely different logic in the dispute resolution process. This approach makes possible the application of a model imported from sharing economy companies such as Uber or Airbnb.

These platforms operate as coordinators of supply and demand of services within user networks.

Uber matches the demand of transportation services (people willing to pay for transportation) with the supply of transportation services (people willing to provide transportation services). By quickly scaling the amount of drivers that can potentially participate (people can easily turn their cars into a Uber if demand is high) the supply of transportation services goes up when prices signal an increase in demand. This makes the cost of transportation adjust down.

In a similar vein, Kleros matches the demand of arbitration services (users willing to pay for having disputes resolved) with the supply of arbitration services (people willing to use their skills and spend their time in resolving disputes). As the network grows, a larger pool of potential jurors increases the supply of arbitration services, which dramatically lowers the cost of arbitration. This results in many disputes that were not arbitrable before (e.g., consumer disputes for a few dozens dollars) become arbitrable.

This logic opens a huge "bottom of the pyramid" market that was never addressed before by any other dispute resolution service. In a world where cryptocurrencies become the enabler for a new global economy, a reliable service for the adjudication of micro disputes becomes an essential piece of public infrastructure.

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[88] According to Clayton Christensen, there are two main types of innovation: incremental and disruptive. Incremental innovation represents the continuous technological improvement happening within an industry. Disruptive innovation represents a completely different working logic for value creation within the industry. While the digital version of Britannica was an incremental innovation within the encyclopedia industry, Wikipedia came as a disruptive innovation to completely transform the logic of value creation and capture. To learn more, read Christensen, C.M. et al, (2015) *"What is Disruptive Innovation?", Harvard Business Review*

The introduction of cryptoeconomics to arbitration can become the 'Wikipedia moment' in the ODR industry.

The Dark Side of Silicon Valley

It is undeniable that the big tech companies coming out of Silicon Valley brought enormous progress for most people, especially those with least opportunities. With Google, anyone could obtain access to all of the world's information. With Facebook, every person could communicate with almost anyone in the world at near zero cost.

But the rise of big tech also had a dark side.

Venture capitalist Chris Dixon argues that big tech companies typically follow a similar evolution.

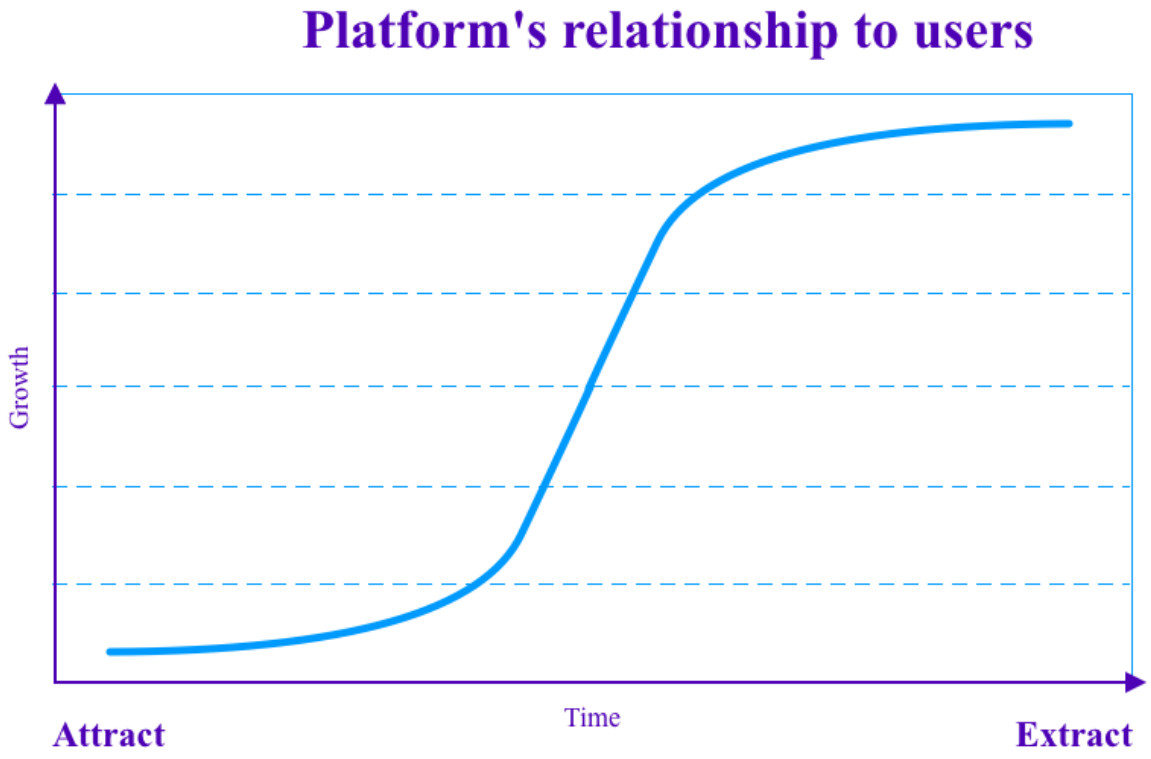
In their early stages, they gain market share by onboarding as many users as possible as fast as possible. This is typically done by subsidizing the supply side of the market (high rates for drivers, in the case of Uber, for example). At some point, network effects start to pick up.

When the company feels it is in a secure position, subsidies stop and the opposite starts to happen: the platform starts to heavily tax users. This is evident in the case of Facebook, for example.

In the early days, companies saw Facebook as an effective communication channel and invested in creating large followings. As Facebook became a near global monopoly, the only way to have something seen by users is by buying advertisements. Organic reach isn't effective anymore.

This means that most communications from a company to their audience will now be taxed by a monopolistic agent. Users cannot easily leave to a competing platform, because network effects are very strong. And they already have much sunk costs for all the time and money invested in building a reputation and a following in that platform.

This is how big tech collects monopolistic rents from their global network of users.



Chris Dixon uses this curve to explain the relationship of big platforms with their users through the different stages.

Why Decentralization Matters

Does the curve above mean that, after gaining global preeminence, Kleros will collect monopolistic rents from its network? Will jurors be required to work more for less pay? Will the cost per dispute solved go up as the platform collects high arbitration fees for the use of the network?

Kleros differs from the centralized big tech business model and the cycle that goes from attract to extract. Kleros is not a company but a decentralized cryptonetwork that isn't owned by anyone.[89] Cryptonetworks rely on cryptographic tokens to generate incentives for users to engage in the desired behavior (which, in this case, is providing arbitration services).

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[89] Even though, for legal reasons, a legal entity called *Coopérative Kleros* is in charge of the development of the project. In this respect, cryptonetworks (including Kleros) look more like a kibbutz or a country, where members have a say in decision making and that they can also leave when they see fit.

Kleros doesn't have an owner in the same sense that countries don't have owners (Who owns the United States?). It's just a group of people that collaborate, under a given set of rules, in order to achieve some goals. And these rules also include mechanisms for collective decision making.

In a seminal blog post, Joel Monegro coined the concept of **fat protocols** to describe the workings of the rising decentralized Internet. Protocols are public pieces of infrastructure that nobody owns (in contrast to the current web, where networks are owned by companies wishing to maximize return on investment). Users have voting rights to decide about the policies to be applied in the network.

Since they make a living as users in the network, they have a vested interest in seeing it prosper and remain a good place to work. In particular, they have an interest in avoiding the kind of rent seeking behavior of the centralized big tech (because they, as users, would be paying for those monopolistic rents).

Monegro's thesis also holds that on top of the fat protocols, a layer of thin applications will be built. This means that, over time, many entrepreneurs will build companies on top of Kleros juror cryptonetwork. These companies will adapt Kleros to different use cases in different industries.[90]

They can confidently build their businesses on top of Kleros, as the decentralized nature of the protocol gives them the reassurance that they will not be kept as hostages of some centralized platform that will someday seek to heavily tax them.

The success of Bitcoin and Ethereum was based on building an ecosystem. The same will be true for Kleros. This requires offering a compelling value proposition, not only to jurors and end users, but also to the entrepreneurs and developers who will build companies on top of the protocol. This is where decentralized business models of the blockchain age interact with legal tech.

This chapter addresses the aspects of Kleros as a business and of decentralized justice as an industry, covering a wide spectrum of topics.

Joe Raczynski, Thomson Reuters legal futurist, discusses some key trends about the legal industry and how Kleros fits in this large scale transformation.

Then come a number of articles specifically about the ODR industry.

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[90] More on this in Chapter 6 - Scaling Up: The Applications of Decentralized Justice.

Colin Rule, the creator of the dispute resolution system of eBay and PayPal and founder of Modria, brings his immense industry experience to discuss the past, present and future of ODR.

Amy Schmitz, Professor at the University of Missouri, comments on the limitations of existing consumer dispute frameworks and the possibility of building a global platform.

Then, Professor Orna Rabinovich-Einy spoke to us about the radical change initiated by the emergence of the Internet in consumer disputes and gave us a unique look at the type of mechanisms put in place by e-commerce platforms to address this change.

José Torres, former fellow at Stanford's Legal Design Lab introduces this discipline aiming at building better legal products and bringing law closer to the people by improving the friendliness of interfaces. Additionally, this chapter contains an in-depth look at the legal design processes of Kleros, written by our Design Lead, Plinio Braga.

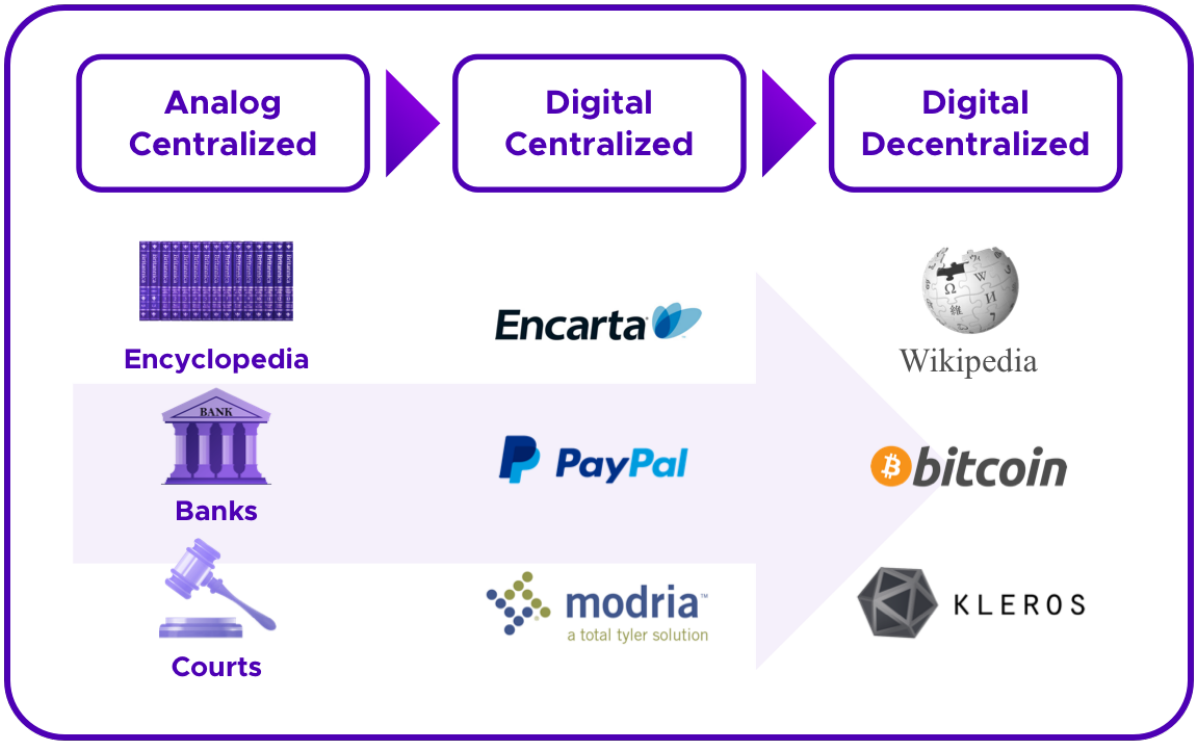
Then, Joel Monegro introduces his concept of fat protocols and how they will impact the evolution of decentralized industries.

Peter Hunn, founder of the Accord Project, explains the need of having new legal standards for the reinvention of contract law in the digital age.

Finally, we present the smart contract standards ERC 792 and ERC 1497 which look into how smart contracts should be written and evidence presented for building an ecosystem of interoperable arbitration providers.

As Richard Susskind explains, the legal industry is going through significant change and the rise of decentralized platforms is a part of that change. This time the innovation is real. Advanced cryptoeconomics and decentralized incentives usher the future of dispute resolution.

And this is the business.



Joe Raczynski on Artificial Intelligence, Blockchain and the Future of the Legal Industry

Interview by Federico Ast, CEO, Kleros.

Joseph Raczynski spent a lot of time working on the core pieces of technology, either building computers, working on networks, white hat hacking systems and delving into how businesses processes work by studying sociology and nature, which inevitably impacts how we interact and develop. He holds an undergraduate degree in economics and sociology, combining understanding of the business world and how humans think and work in groups.

You don't have a background as a lawyer, but in business and social science. How did you become interested in the legal industry?

I see the legal industry as one of the spaces with the greatest opportunities. You know this is growing because of all of the startups that have infiltrated the industry. There are so many startups that are looking at the legal space right now, because there are two parts to it - the business of law and the practice of law. Both of these are ripe for great efficiency across the board.

These startups are looking at different aspects of these two facets, thinking of how to make it more efficient, to make it a bit easier for the clients to better serve themselves, or to work with law firms and have law firms better service their clients.

I see AI and blockchain leading the way - the AI algorithms making things faster and more efficient and blockchain saving this information and hopefully making it so that the trusted third party is now a computer network.

The perfect example of this is what you guys are doing with Kleros. I honestly think this is one of the best examples out there in terms of how we can create better efficiency in a 'trustless' environment, working with blockchain to be able to save information, secure it, but also have people leveraging this tech to create a better environment for all parties involved in a dispute.

Since you mention Kleros, what caught your attention about our project?

What I find the most fascinating about Kleros is the idea that you are going to leverage blockchain as a space in the ether that allows people to file a complaint, process that complaint, and eventually resolve it, using a system based on blockchain, and wisdom of the crowds.

Crowdsourcing enables the expansion of the pool of people making the decision. This makes a lot of sense, as it can greatly enable efficiency and reduce costs in a large number of dispute resolution processes.

The economic model that aligns individual incentives with honest decision making is a great innovation within the legal industry.

How do you see a new technology like blockchain interacting with traditional government courts and regulation? Are legacy legal systems going to adapt to blockchain or are they going to be disrupted?

That is a great question and I think the answer depends on where you are in the world.

In time, I think blockchain will absolutely disrupt the way the government interacts with information and the way they verify it. I was in Dubai some weeks ago and met with government officials working on a full-on blockchain enabled verification system that, when decisions are made, puts everything on the blockchain.

Anyone will be able to look up that decision with ease and they want to have this up and running within the next 18 months without having to go through a proprietary company. In Dubai, it is the government who is pushing law firms in this direction. The government is leading there.

In the United States, on the contrary, you find that traditionally it is the corporations that lead change. Law firms tend to follow, then eventually, a little bit further down the road, you may see the government starting to get involved in the space.

Depends on where you are and how this works, but clearly some changes are afoot in the next five years.

What about AI? How is it likely to impact the legal industry?

All we see in the news is how AI is going to disrupt law firms or the legal industry in general. There is so much talk about this every single day, how the robot attorney is coming...

I had the good fortune to meet the preeminent legal technologist, Richard Susskind last year in London, one thing he says is that, in the short term, we are probably overestimating the power of AI. But in the long run we are probably underestimating it. We're at a stage that AI is in the news and most of the attorneys, partners, and managing partners of law firms that I meet ask - is this really happening?

It's clearly cresting atop Gartner Hype Cycle, similar to what is happening with blockchain, there is a lot that may happen with both of them. On the AI front, you are seeing companies that come along and have very smart ideas about how they can change a section of how the practice or business of law works.

For example, let's say there is a merger between two massive organizations, both have 50,000 employees. One of the core things they want to look at are the employees they have for both organizations to see if they mesh well. In order to do this, they need to review all 100,000 employment contracts identifying golden parachute language… For example, if anyone got a $50 million bonus if the merger took place.

Currently, many global law firms do this due diligence. They put 100-200 attorneys on it by having them read every single contract and making sure that those documents are standardized - not containing that golden parachute.

Increasingly there are algorithms and associated programs on the market that go through all the contracts, looking for all the standard language, kicking out those contracts that don't have the common phrases or terminology. Those kick-outs are then reviewed by a human, resulting in a massive increase in efficiency and less people hours.

These startups who are creating these applications, are pushing the bar in the legal industry. They are devising better ways to get the job done using AI - in an incremental way. Will we see a robot attorney in the next few years, no. But these types of tools leveraging some AI will ramp up quite considerably across the board.

What is the result of all this? In the world of AI and blockchain, in fifteen years, say, what's the place of lawyers? What does the legal system look like?

Ten years out, and these are just guesses, all of the lower tier work that we traditionally see law firms doing, be it the e-discovery, some of the contract work, all of that will probably go away.

E-discovery still has a lot of human eyes looking at a lot of these documents, after a first pass that maybe a computer completes. In time, that will probably be all computer. The documents that are out there right now, the normal contracts, that will all go away.

It's that very top level where you need human imagination, human thought, collaboration that will be the furthest out to be disrupted. But there are a lot of attorneys that are doing just day-to-day work, canned phrases that you use to build up that document, a lot of that stuff will be impacted in the next, say, five years. In ten ten years, I'd say it'll definitely be impacted. That's the direction that I personally see it going in.

Law firms that don't change the way in which they work will probably go away.

Lastly, what we are starting to see in Europe, as well as Australia and New Zealand, is that the Big Four of auditing and accounting are starting to take away some of the business from law firms.

Not only can they now handle law firm work, they can handle everything else - they have full-on accounting, the business processes, all of that is going to be fulfilled by these massive organizations. That will absolutely impact law firms. This will come to the US soon, it is inevitable.

What advice would you give to a law student preparing for this world that is coming?

Don't practice law. (Laughs) I'm kidding.

I think it's still a fantastic profession which requires a great deal of talent and unique thought processes. The advice that I actually gave to a few people who were interning here this summer, who were looking at law school, spend as much time on understanding the basics around law. If your passion is around helping people and the love of law, go to law school.

In preparation for your studies, look at some of the startups like Kleros and try to work there to see what a lawyer will be doing in the future. Understand the growing relationship between technology and the law. Clearly law rules the roost, but technology will continue to play a role in how it is practiced, and frankly what will be done by the future attorney.

I think companies should bring in a few aspiring attorneys to help them understand where we are going as a society, as a business. The future student should work with startups, work with bigger companies that are involved with e-discovery or anything in the legal technology world to help them get an understanding of how the technology works, how the vendors work and how this stuff may impact the way they practice law. Getting a full-rounded perspective of where the world is heading is essential - especially if you are dropping 300K USD on education.

One last thing I'll mention about this is - I don't know who originally thought of this concept, but there is a phrase called a T-shaped attorney[91]. It's literally like the letter T. Across the top of the letter T, those aspiring attorneys are learning everything they can about the business and the practice of law. They are learning a bit about project management, maybe they're learning a bit about how to code or how vendors work.

More and more we are hearing about attorneys learning to code in different languages, so they have a better understanding of how that works. Understanding how vendors work, how startups work in the legal tech space. That's the top of the letter, and the deep part, the extension of the letter T is the practice area they're in, litigation, automotive practice or any other which they know almost as an expert. We are really talking about a well rounded attorney[92].

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[91] The idea was first proposed by R. Amani Smathers at the ReInvent Law NYC 2014 Conference.

[92] To hear more about how innovation is disrupting the legal space, check out Joe Raczynski's recent talk at the World Bank on the topic.

Colin Rule on the Past, Present and Future of Online Dispute Resolution

Interview by Federico Ast, CEO, Kleros

Colin Rule is Vice President for Online Dispute Resolution at Tyler Technologies. Tyler acquired Modria.com, an ODR provider Colin co-founded, in 2017. From 2003 to 2011 Colin was Director of Online Dispute Resolution for eBay and PayPal. He has worked in the dispute resolution field for more than 25 years as a mediator, trainer, and consultant.

At Kleros, we're building software for online dispute resolution (ODR). But I always say: it's not just about computer software. It's also about updating mental software. What is your perception of your experience in eBay, almost 20 years later?

There is a quote from Gandhi which says: "First they ignore you, then they laugh at you, then they fight you, and then you win". That's been my experience with ODR. When you put out new ideas, everybody goes: "wow, these ideas are so futuristic, they're never going to happen".

And then slowly but surely history catches up with you. The thing about being a visionary is that people think you're nuts at the beginning, but slowly people come around. So, I think it's important to let people come to the realization on their own timeline.

I agree with you: the obstacle is not the technology. You can make the code do whatever you need it to do. It is often the human resistance that is the bigger challenge.

When we first introduced the concept of the Community Court at eBay, people thought: "That's an interesting idea, but it will never work". Once we started to scale it up to do thousands and thousands of cases, people said: "Wow, maybe it will work after all".

There is a lot of unforeseen sand traps that you can get caught in. You gotta figure those out, and (as they say in lean startups) fail forward. Create your concept, get it out there, and then discover all the problems that you didn't foresee in your original design.

Gameability is a problem. There are going to be a lot of smart people out there who are going to try and find ways to manipulate the process to their own ends. Those aren't fatal errors, you just need to continually innovate and explore -- figure out seams in your design and then patch the seams.

What were the main challenges you faced in the process of building the Community Court?

When we started the Community Court at eBay, we needed to get jurors, so we put out a call for volunteers. We weren't sure how many people we would get, but we were absolutely overwhelmed. It was amazing how many people wanted to be jurors.

We actually created a slush fund of $5000, because we thought we would need to pay people incentives, to give them gift cards to have them serve as jurors. It turned out that we never spent one dollar of that, because there were so many users that were eager to be jurors, they didn't need incentives. We had more jurors than we knew what to do with. We actually didn't have as many cases as we thought we were going to get, so we started putting extra people on juries, because we didn't want them to feel we were ignoring them.

But then when we started the Community Court at PayPal, we had the opposite problem. We couldn't get jurors, no one wanted to serve.

I think it had a lot to do with the communities. eBay was talking about the community a lot; anybody who was a part of eBay felt they were a part of something. Users wanted to give back, because they had a connection to the marketplace and they were making money in the marketplace. So they wanted to donate some service to help keep eBay safe.

Whereas in PayPal, the community of users was just a bunch of different people paying for things. So, if I paid for something with PayPal and you paid something with PayPal, there is no real implied connection between the two of us. It's not like we would have a reason to hang out. There was less of a feeling of community. Whereas at eBay, we would have a reason to hang out: we are both eBay members, we love eBay.

In the cryptocurrency community there is a community there, but is it more like the PayPal community or more like the eBay community? I think, to a certain extent, your success in your initial target market is dependent on the way users see other users within that community.

That is a very interesting concept: people volunteering as jurors because they believe in the idea and want to keep the community clean...

If you get your jury summons in the mail, you feel like you have an obligation – "I live in this community, I'm gonna do this active community service, even though it is a sacrifice for me, I'm gonna do it because I'm bought in". John Locke wrote about the social contract: do I feel like I'm a member of something and does that membership obligate me to do something?

I guess that is one of the determinants of the success of these crowdsourced dispute resolution systems, because it defines the mindset of your users. It defines the way that they think about their membership in the community and then also defines whether they feel they have any kind of obligation to give back.

I'm curious to see with your experiments, especially in different target communities, how that works.

How do you see the future of ODR, since we have these technologies, in particular AI and blockchain?

I am actually writing an article with my friend, Amy Schmitz, who is a law professor at the University of Missouri, on smart contracts, blockchain and ODR. I think these are powerful technologies and there is no question about their importance moving forward.

For a lot of the ODR work I am doing, I can see a very clear role for blockchain and for smart contracts. When we're working with the courts, if the parties can reach an agreement with each other, it should be an easy option for them to memorialize their settlement agreement in a smart contract and drop that on a blockchain.

A lot of the online (and even offline disputes we are tackling with ODR) can definitely benefit from the use of these technologies in terms of creating an automatic enforcement mechanism. So, I am very interested in that side of it.

The side of it where we build in online dispute resolution to every smart contract, I think that is very interesting too, where every smart contract created, just like in person contracts, we have an ADR clause. I can see smart contracts having an integrated ODR clause.

Now that LegalZoom and RocketLawyer are starting to craft smart contracts and put them onto the blockchain, I think it would be very interesting for those providers to automatically include a dispute resolution process. And then we can talk about how that would exactly work -- though I think it could be something like Kleros.

It could be a crowdsourced approach, or it could be an algorithmic approach, like an AI. There are a lot of people hard at work creating these "digital judges".

ODR is just the use of technology to help resolve disputes. These are powerful new technologies and there is no question they are going to be applied to disputes at scale in the near future.

The real question is: where are we going to hit scale first? There is a lot of infrastructure that needs to be built around ODR in order for smart contracts to operate.

The reason why we are having traction in crypto initially is because most of the players in these transactions have publicly accessible key performance indicators (KPIs) that you can use for smart contracts to trigger off those data sources.

For other things, RocketLawyer or LegalZoom are talking about running smart contracts for wills or employment contracts, and a lot of the KPIs for those types of contracts are not necessarily visible yet. So, we have to build a lot of new infrastructure to get these new technologies to really be useful.

But, I think we are getting there. There is so much momentum behind these technologies, so much enthusiasm; the traction that you're making is a great example. We are going to make the investments necessary to open up other categories of agreements to these types of technologies and that's going to mean that their applicability is going to skyrocket.

I've been talking about ODR for years and now it's actually happening, all over the world. I kind of feel like the dog that caught the car. There are big challenges in bringing it all live, but it's exciting. It can be a little overwhelming, but I truly feel this is the biggest opportunity we've had to expand global access to justice in the past 100 years. But we have to do it right.

Towards a Global Online Dispute Resolution Platform: Amy Schmitz and *The New Handshake*

Interview by Federico Ast, CEO, Kleros

Professor Amy J. Schmitz is an Elwood L. Thomas Missouri Endowed Professor of Law at the University of Missouri School of Law faculty. Previously she was a professor at the University of Colorado School of Law for over 16 years, and had practiced law at two different law firms prior to teaching. Professor Schmitz is the co-author of the seminal book *The New Handshake*.

What was your motivation for writing *The New Handshake*?

That was after the UNCITRAL[93] working group ended and they didn't really have a platform, a clear procedure or anything. There was still a huge momentum for ODR for consumer disputes, so Colin Rule and myself teamed up to work on the book. Colin being the technologist, and me being a professor, looking at the theory and practice, especially consumer remedies.

The idea was to envision the way this process could work and how it could still remain in the confines of international process for ODR for consumer disputes on an international level. But it didn't necessarily have to be something done by the United Nations, it could be something that was created privately.

Why do we need this platform? What is the problem it solves?

Right now, there are a lot of problems when it comes to consumer rights - arbitration clauses often preclude consumers from joining together to bring a class-action suit, which is the only way that it would be feasible to bring a small valid claim.

Otherwise, it would be too expensive if I had to pay an arbitration fee or travel somewhere in order to bring a claim for even $5000. It's not cost-effective and does not make sense from a

93 UNCITRAL or the United Nations Commission on International Trade and Law is the core legal body of the United Nations system in the field of international trade law.

consumer standpoint. When they have purchase problems, consumers typically give up and don't do anything.

It's very important to open up access to remedies and access to justice in the consumer space where you have a lot of low dollar claims, many of which are international.

So, you have this platform where anyone can log in to submit a claim against a seller and this platform is going to arbitrate the dispute between the buyer and the seller, right? And how are rulings going to be enforced?

We propose a multi-step process, starting with negotiation and, if necessary, mediation. This flows from the research that Colin conducted at eBay, because 9 times out of 10, the problem will be resolved by negotiation.

As for enforcement, we propose banking on good will. There is a very clear business case for creating an ODR platform that will increase your good will.

We have seen that on eBay, on Amazon, on Etsy. A lot of platforms selling goods and services have actually become popular because they provide remedies in case something goes wrong. For example, I feel comfortable buying on Amazon, because I know if it doesn't arrive or there is some kind of problem with the purchase, they have an ODR program. There is a way to get a remedy if something goes wrong.

Imagine if all the sellers and merchants who actually abide by this ODR platform can post a seal or trustmark that shows they comply with *The New Handshake*. And this helps them attract more buyers.

This could be especially useful for small companies in developing nations which typically don't have the means of setting up their own ODR process. They would benefit greatly by having something like *The New Handshake*, because then buyers from all over the world would access their site and feel more comfortable making purchases.

How do you envision selecting the arbitrators for disputes in *The New Handshake*?

In many cases, this won't be needed. Most consumer disputes get solved through negotiation or mediation, and they don't need to go to arbitration.

But, if you get to that level, consumer unions or non-profit consumer groups could get involved, those that would have time and offer their arbitrators for a low cost. That would be one way to do it very cheap or free, so it doesn't end up costing a lot for the consumer.

Businesses would be able to chip in together, as well, and have a pool of money to pay for these arbitrators. This sort of ODR process through *The New Handshake* would be cheaper for companies than paying an army of customer service representatives, who may or may not abide by company practices. Indeed, companies' reputations are often harmed by the inconsistency of the service provided by individuals in their call centers.

Something like this could derive in a single system. You would have arbitrators who would work with the Consumers Union or with another, like Consumers International or other consumer groups in Latin America, in South Africa, in all different parts of the world.

I even brought up the idea that students who want to get a little bit of legal experience could do it for free as part of their class. You could allow them to obtain experience while arbitrating consumer issues under the supervision of a professor.

What do you see happening in the next five years with regards to challenges to build this platform?

I think private industry and companies are moving in the direction of siding along the lines of The New Handshake, but I think there is a problem of self-interest. I see that based on my experience with the United Nations.

What led to the breakdown of Working Group 3[94] was that everybody was trying to protect their own turf. This is why they ultimately never created this global platform for e-commerce disputes.

I think that self interest comes into play and makes it difficult for any sort of collective ODR of the sort we were envisioning with The New Handshake.

Do I still hope it would happen?

I really do, and I hope that companies will join forces to do something like this for the good of consumers, and to assist their own good will. I think the book sets up a blueprint that is ambitious, but I think it would be really helpful for the consumers and the companies as well, especially smaller companies and those in developing nations.

To answer your question on challenges - I also think there are some really big challenges for ODR in the next few years.

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[94] UNCITRAL Working Group III was an initiative of the United Nations to undertake work in the field of online dispute resolution relating to cross-border electronic commerce transactions, including business-to-business and business-to-consumer transactions and formulate a common framework in this field.

What are those?

I'm intrigued by what's going on in e-courts and ODR in the courts. For years, courts were slow to embrace technology and we were working overtime to educate courts on the value of ODR for access to justice.

However, we woke up one day and suddenly every court thinks that technology is the shiny, new toy they want to play with. But, they don't really know what they're doing and they don't necessarily have clarity about what they want to achieve.

They're not clear if they're trying to save money as an austerity measure or if it's a part of increasing access to justice. We have to think in terms of dispute system design, and proper functional analysis. I'm a little worried about what's going with the rush to digitize in that courts are not necessarily stopping to ensure that they are building processes that "fit the forum to the fuss" as we say in the dispute resolution world. I want to be sure that courts are not running into it just to say they have ODR and e-courts.

That's one thing, the other thing I'm excited about is what Kleros is working on as well and that's ODR for smart contracts.

It's awfully hard to actually use a court for resolution of smart contract claims. It's nonsensical for a number of reasons. Thus, we have to create sound ODR systems for smart contract disputes and that, of course, is very near and dear to my heart right now.

Could you recommend some readings for people who want to learn about the new trends in ODR?

There are new things that come out every day. Start by going to odr.info, as it includes many new articles and links to interesting resources on ODR. Also, the Open Educational Resource that I created for teaching and learning in the ODR space is freely available here.

Orna Rabinovich-Einy on the Internet of Disputes

Interview by Federico Ast, CEO, Kleros

Professor Orna Rabinovich-Einy started her journey into online dispute resolution almost twenty years ago. She arrived in the United States in 1999 to study towards her LLM at Columbia University. For her thesis, she combined two booming areas - the Internet and dispute resolution, which were at the time going in parallel paths and intersecting in a very narrow area, in e-commerce. She researched this field up to 2005, when she returned to Israel and joined the University of Haifa, which emphasized both the technology and dispute resolution as a part of its work. Since then, she has been an academic researching the field and building quite the community, both internationally and locally.

What changed in dispute resolution with the coming of the Internet?

One of the main challenges is the fact that things are changing at a pace that is much faster than we were used to in the pre-digital era.

The institutions and processes we talk about in research are constantly undergoing change themselves. In that respect, alternative dispute resolution processes have an advantage, because they have always been touted as being more flexible and more adaptable to the circumstances, to the characteristics of a dispute, the parties and the context.

In an environment that is constantly changing, these processes have the capability of adapting. Part of what they've had to adapt to is a change in technology, but also a change in premise that dispute resolution processes are no longer uniquely offered face to face and we might be actually entering a phase in which they might be primarily (but not exclusively) offered online or through digital media.

It has been a challenge across different levels.

It has been a professional challenge for lawyers and for judges, but also a challenge for software designers - to think about ethical, legal and dispute resolution types of questions they are not accustomed to thinking about.

It's also a technological challenge which cuts across axes - socio-economic, age, location.

It's a huge challenge to the legal field, an institution which is used to regulating the pace of change and that now needs to adapt to an environment that is fast changing, in which its' authoritative nature needs to find avenues to exert authority. Not necessarily through a face to face, structured process, but in different ways.

Tell us about your book, *Digital Justice* (2017)? It's a comprehensive overview of the new types of disputes in the time of the Internet: AirBnB, e-commerce... What are these disputes like and what are the methods that have been developed to solve them?

Digital Justice was co-authored by Professor Ethan Katsh[95]. We feel it came out at the right time, as there are so many things going on.

We tried to do several things in the book.

First of all, we tried to provide some kind of a historical background, a description of what's out there and what's not out there, but also to provide a framework for analyzing what's out there and thinking about future developments.

The principle for doing that was an access to justice prism. In many ways, these developments are posing new challenges to access to justice.

These are new types of disputes for which there are no effective avenues of redress, resolution and prevention. But also, on the other hand, new types of processes are emerging and allowing us to do things that were never possible before. Now we can deal with large quantities of low value disputes. In the past, people just had to move on and not do anything about them.

In many ways, technology is enhancing access to justice. But in yet another twist, many of these processes are offered selectively, by private entities or not necessarily transparent and open to research and study and in that respect might operate in ways which are not necessarily accessible or not necessarily just.

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95 Ethan Katsh is Director of the National Center for Technology and Dispute Resolution and Professor Emeritus of Legal Studies at the University of Massachusetts Amherst. He is the coauthor of the book Digital Justice.

After this conceptual framework, we look at five different areas. We look at new types of disputes that are out there and we try to locate new avenues to address them.

In some areas, we have many, like e-commerce. In others we have some, like social media. And yet in others we have practically none, like in digital health records. We also talk about another major area in dispute resolution - the prospects of dispute prevention.

I find it interesting that you mention that some disputes are being solved in private courts. When you have a dispute with another user of a platform for e-commerce, it is solved by the customer service. In traditional legal systems, there are some procedural rules and some requirements of publicity of what happens inside the dispute resolution process. But these private systems are not accountable to anyone. The decision made by the AirBnB team is final and there is nothing you can do about that.

Exactly. Part of the problem with a private entity is that we don't really know what the standards are for addressing disputes and we have no way of comparing the ways different types of disputants are being handled.

We want to believe that the systems they have developed are fair, effective and legitimate and that they follow what we believe are basic standards of dispute systems design, but we need indication that they indeed operate in these ways.

Tell me about how you see the impact of technologies like blockchain on developing new ODR systems.

I find blockchain very interesting. Firstly because of the initial aura that surrounded it, that of being disputeless.

In the early days, people thought they could pre-design everything so that there would be no problems. They thought all contracts would self-execute.

But engineers quickly found out that, when humans are involved, you cannot predict everything. You are bound to have problems and disputes, even absent fraud, even when everyone is well meaning, things are bound to raise certain problems.

You have to have mechanisms in place for addressing such problems. The tension here lies in the fact that blockchain is an environment that hails decentralization, and in order for an environment to inculcate dispute resolution you need some kind of a central authority to create incentives, or sometimes even enforce and motivate parties to use dispute resolution mechanisms.

I think that part of the challenge will be to see how we think about incentivising the participants. We need to see where the mediating entities in the blockchain setting are, and think about how we can motivate them to motivate anyone using a smart contract to include a clause that would refer the parties to a dispute resolution provider.

One of the initiatives at Kleros is the development of smart contract standards for arbitration. Anyone implementing these standards can unplug Kleros as the preferred dispute resolution platform and plug in another one, so all providers can become interoperable.[96]

That's a big issue and very important - there is also an educational need. Disputes are a factor in every human interaction, whether or not they are computer or software mediated, and we are bound to need processes and entities that would assist us in addressing such disputes.

Ideally, the information gained, the data gained from dispute resolution efforts would be used later to improve not just, for example, how a system like Kleros solves a dispute, but ideally that data would be used to improve the design of smart contracts to begin with, to improve the design of the blockchain environment so that less disputes of that type will emerge.

Tell me about mechanism designs you have seen in the area, what projects are interesting for you in how they design mechanisms for ODR?

When you look at the different designs that have emerged, the word *arbitration* is striking. Most of the platforms turn towards arbitration, and you see several who have designed an environment that is based on jurors and some kind of tokenization.

Those are emerging as sort of dominant designs, each with their own schemes and differences among them.

It's interesting to ask ourselves if there is an advantage in designing a multi-step process that has been the practice in other areas of dispute system design, both online and offline. Tiered systems start with consensual party based dispute resolution and then move up to some kind of decision based, authoritative process that could be called *arbitration*.

If you think about designing it in a tiered way, in which each stage is timed and has an expiration date at which you move to the next stage, this could still gradually develop into a process that could be automatically executed, even if one of the parties is not collaborating.

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[96] To learn more about smart contract standards for arbitration see the article *A Smart Contract Standard for Lex Cryptographia* in Chapter 5 - The Business of Decentralized Justice.

One final question - for people who want to start working or researching ODR, what books could they start reading?

A good read to start with is Colin Rule and Amy Schmitz's *The New Handshake*, which relates to e-commerce.[97]

I think it's important for people in the ODR arena to be well versed in dispute system design literature. There is a wonderful book which is going to come out written and edited by Janet Martinez and others and there is a great book by Nancy H. Rogers and others.

Of course, there is the International Journal of Online Dispute Resolution, which is available online and free of charge and is hosted by the National Center for Technology and Dispute Resolution. That's a great resource to find articles, new developments and conferences around the world. It's a very exciting time for ODR, there is much going on, there is a real sense that things are happening.

[97] To learn more, see the interviews with Colin Rule and with Amy Schmitz in Chapter 5 - The Business of Decentralized Justice.

José Torres on Legal Design and the Impact of Technology in Law

Interview by Federico Ast, CEO, Kleros

José Torres is a lawyer from Universidad de los Andes in Colombia and holds a Masters in International Economic Law and has experience of practice in different areas. He was an international trade and investment lawyer at the World Trade Organization and afterwards at the arbitration group at Skarren, Arps, Slate, Meagher & Flom in London. At Sergio Arboleda University in Colombia, he started the Center for Innovation in Law. In that program, he merged technology, design, entrepreneurship and law to prepare future lawyers for the 21st Century legal practice. The outcome of that work led him to become the first fellow of the Legal Design Lab at Stanford. At the lab, he dug deeper into the intersection of design, law and technology. In his work at Stanford he researched using design for online dispute resolution and access to justice and some of research on smart contracts.

Tell us about your experience at Stanford and the type of legal research that is being conducted there...

Stanford has two centers on legal innovation - the first one is CodeX, a joint venture between School of Engineering and the School of Law. In that center, they do research on the application of technology on the practice of law. For example, how you can use technology to automate legal reasoning, how to do better research and enhance legal capabilities.

The other center (where I was a fellow) is called the Legal Design Lab, a joint venture between Stanford's Hasso Plattner School of Design and the Law School.

Its goal is to embed design thinking into law and to reimagine how legal services can be provided. It seeks to instill an innovation and creativity mindset into the students and to conduct research into a variety of areas. One of them is access to justice, the other being how to create innovative legal organizations in law firms and legal departments and also how you can innovate government services in general.

Why have we not seen much innovation in legal services in the past years compared to other sectors of the economy?

You are completely right. We have just started to see innovation in law in the past ten years or so. There are a couple of reasons for this.

The first is that, in general, lawyers are conservative and have been educated to become risk averse. Lawyers are educated to caution clients against legal risks. This ends up being translated into everything we do as lawyers, so we become risk averse ourselves.

The fact that law has been a regulated profession has inhibited innovation significantly, as well. Regulation has protected the profession from competition. It has prevented other disciplines to get into legal practice or legal services.

That is the very reason why we have started seeing engineers getting interested in creating startups in legal services, or in your case - creating a system like Kleros, given that you are not lawyers.

Law has also been very insulated as a profession, even though in legal doctrine we might have areas of research such as law and economics or law and sociology. In general, even though we studied the substance of law, we haven't studied very deeply how to become better lawyers and how to provide a better service.

If you look at other industries, usually companies have a percentage of their revenue dedicated to R&D and innovation. That has not been the case in legal services at all.

Unfortunately, it is this lack of innovation that has been travelling across borders. When you look beyond the US and the UK, the profession has been even more conservative, there is less access to knowledge, and in the case of Colombia we also tend to copy the US or the UK law firms and their lack of innovation.

In the last five years we have seen some innovations in the legal field, like RocketLawyer or LegalZoom and others applying AI. What has sparked innovation in this traditionally conservative profession?

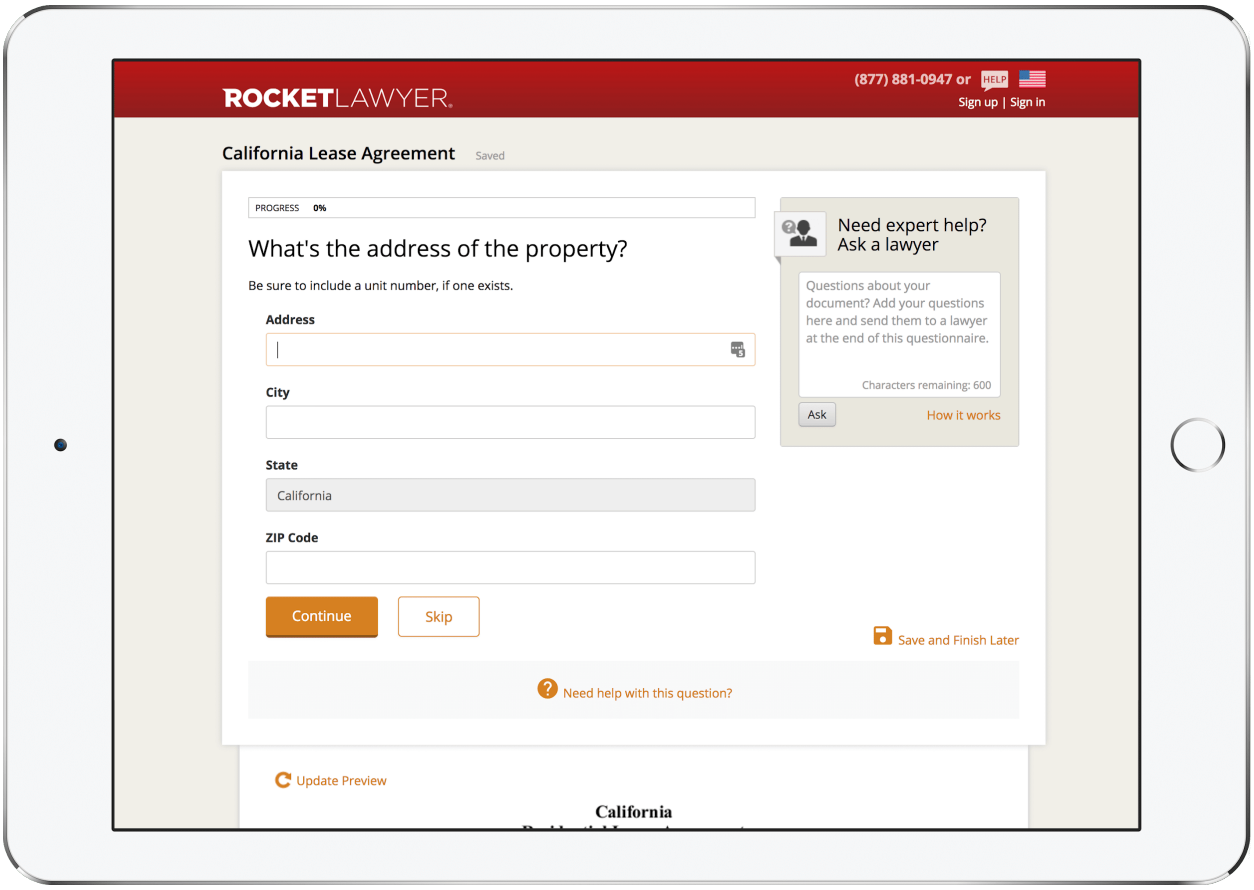
The fact that the industry has never faced competition from startups has been viewed as a huge opportunity - the legal market is quite big in the US and worldwide. Some individuals have just decided to go straight on and challenge the profession, which is the case of LegalZoom and RocketLawyer, for example. They have issues with the American Bar Association because of that.

The general driver in the last ten years has been that the citizens in general have become very displeased with the profession and there is a worldwide crisis in access to justice. In whichever country you go, courts just don't work. That's irrespective of whether you are a developed or a developing country, rich or poor, large or small. Legal services have become more complex and more expensive, contrary to other areas of the economy.

The way legal services are developing has caused the people to cry out and demand that lawyers get out of the way and bring in different professions that can add a lot of value, because lawyers have a limited skillset. We already know what that skillset can do - it has not led us to create good courts. This discomfort has caused other areas of the economy to jump in.

In some countries, innovation in law is also viewed as a factor of competitiveness of the economy. In the case of the UK, for instance, the legal system has historically been very attractive to business. The system became ever slower and that had a huge impact on the economy, effectively making the UK legal system less attractive for business.

The area of seeing law as a competitive advantage of a country has moved countries like Canada, the UK and Singapore forward to become more innovative, so they continue to be attractive economies for business.



RocketLawyer and LegalZoom were the pioneers making strides in challenging the existing legal order. Image: RocketLawyer

Tell us about legal design. What is this new discipline?

Legal design is a combination of design driven innovation applied to different areas of the law. You can apply the design process to law firms, to government services and to legal departments.

There is a certain fetishism around which is 'the right' design process to follow, but in general, what human-centered design strives for is to make sure that the user is put at the center of the service or the product and make sure that whatever it is that you are designing is usable and engaging from a user perspective.

This is a very new concept in the legal field. Law has been produced historically by lawyers for lawyers, without keeping the citizens in mind. If you go through any piece of legislation, they are drafted to be complex, not for us as regular citizens to understand.

By putting the user first, legal design seeks to produce regulation, contracts, legal pieces of information in a manner that anyone can understand, which is the whole purpose of a democracy.

Another big area of the design process is just making sure that you are synthesizing information with different research methods, doing tons of prototyping and conducting experiments to figure out really quickly what works and what does not.

If you think about the courts, for instance, we have run very few experiments, so no one knows what a 21st Century court should look like. If you look at the area of design, we have run loads of experiments with software, with hardware, even with furniture - you can have a million different types of chairs for different types of services.

If you think about it, a court has historically been viewed as a physical place that you have to go to. If you apply creativity to this and start reframing what a court might be, you can come up with different types of courts.

In my research at Stanford, I designed a court for low claim labour disputes in Colombia only using text. In your case, you are using blockchain and game theory to also imagine what a concept of a court could be like.

Another area that has been growing significantly has been visualising and simplifying legal information.

A key example is privacy policies. No one reads privacy policies online. If you reimagine what a privacy policy is and stop thinking about it as a legal document, but instead start thinking of a privacy policy as a core part of the user experience in a service, that changes dramatically how you design a privacy policy and how you show it to a user. With a good privacy policy, you want to make sure that the user actually trusts your product and that the communication is transparent.

Another core idea in design is just having a bias toward action and building to learn. In law, usually, we like to reflect and think a lot, but there is not a bias towards action. We like to write a lot, but we don't like building and creating stuff. Just the fact of creating different types of artifacts, they can be digital or paper-based, physical or online, just building to learn how a system might work better is also a core area where design can bring a lot of value to the law.

This is a challenge we usually face at Kleros. Some old time lawyers are skeptical about our approach to dispute resolution. They say "this is not a legal service" or "this is not how the law could evolve". How do you think this skepticism can be bridged, are there any quicker wins that we could seek?

I think you just have to have a rough skin and really believe in whatever it is you are doing and realize that history is on your side. There hasn't been a profession in history that hasn't changed and I think it is the time for law to change.

In terms of getting quick wins, the key driver is to engage very closely with the private sector and companies that are fed up of having to use the same legal services that aren't providing any value.

I think that the private sector is going to be the key driver in legal innovation, both in terms of policy and in terms of new types of services. So, in the case of Kleros, for instance, instead of trying to convince the governments to make this is an integral part of their court system, where you are going to find tons of resistance, it is better to go to a bank or an insurance company and figure out how you can use Kleros to help them solve much of the consumer disputes that they have which they know they cannot solve in courts. They are also fed up of solving those disputes in a very old fashioned way.

There is also another core tenet of design which is beautifully demonstrated by Kleros - the idea of radical collaboration between disciplines. If you look at the system of Kleros, you have game theorists, you have philosophers, you have economists, you have lawyers, you have the crypto community and you have technologists working together.

That is as radical as it can get. I think it is hard to find a legaltech startup that was created by someone who is very deep into philosophy, for instance, or where game theory is a key driver.

That's a direction in which law needs to evolve.

Building User Experience in Legal Technology

By Plinio Braga, UX Design Lead, Kleros

Legaltech innovation aims to revolutionize the legal industry, which has typically been considered conservative and resistant to change. New ideas, products, and concepts being developed in the field are trying to simplify complex law processes and generate more affordable and engaging solutions for end users.

Design represents a fundamental tool for promoting the changes that will benefit both lawyers, legal departments and individual consumers. By taking a design-driven approach to problem-solving, the legal system can be innovated in ways that were unimaginable in the past.

Design Thinking Meets the Legal Industry

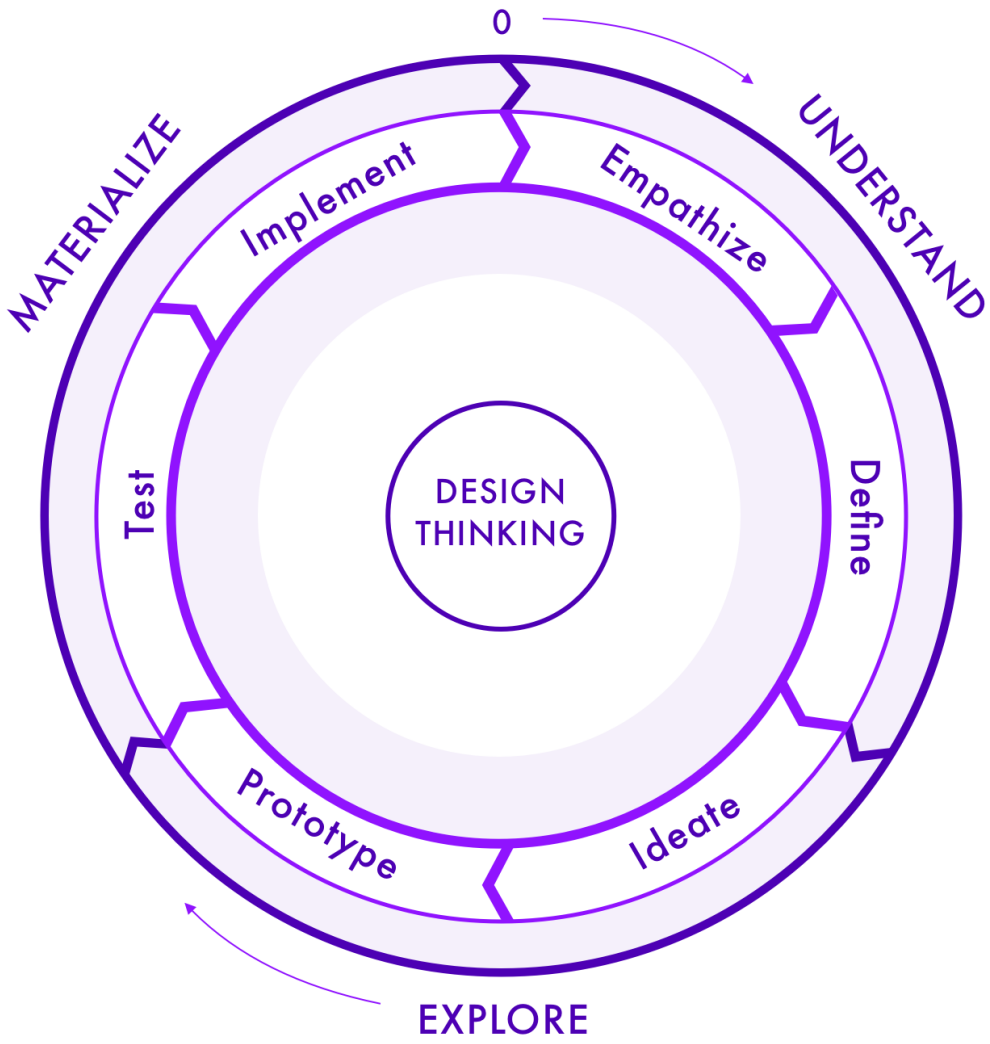
In recent years, a great deal of work was done in applying methodologies that merge law, design, and technology. The Stanford Legal Design Lab, directed by Margaret Hagan has become a world-renowned center in the field, while other centers and projects developing research and teaching on legal innovation through design methods include the NuLawLab, Innovation for Justice and the Legal Design & Innovation Project.

The application of design based thinking in the legal sector contributes to identifying new possibilities, and enhancing the efficiency, user-friendliness and usability of the legal products of the future. More than just a methodology, it is a framework that can be used to identify and solve problems.

Design thinking follows a cyclical flow with 3 major steps:

- Understanding the users and defining the problem
- Exploring ideas that address the user needs
- Materializing the solution into real products

The process can be described by following 6 phases: empathize, define, ideate, prototype, test, and implement. The whole process is iterative and cyclical, allowing and inviting team members to always come back to previous phases, as long as the product evolves.



The six phases of the design thinking process.

Design thinking leverages the probability of success and the positive impact the products have over the users. For that reason, defining the real problem you are trying to solve is vital for the success of this methodology.[98]

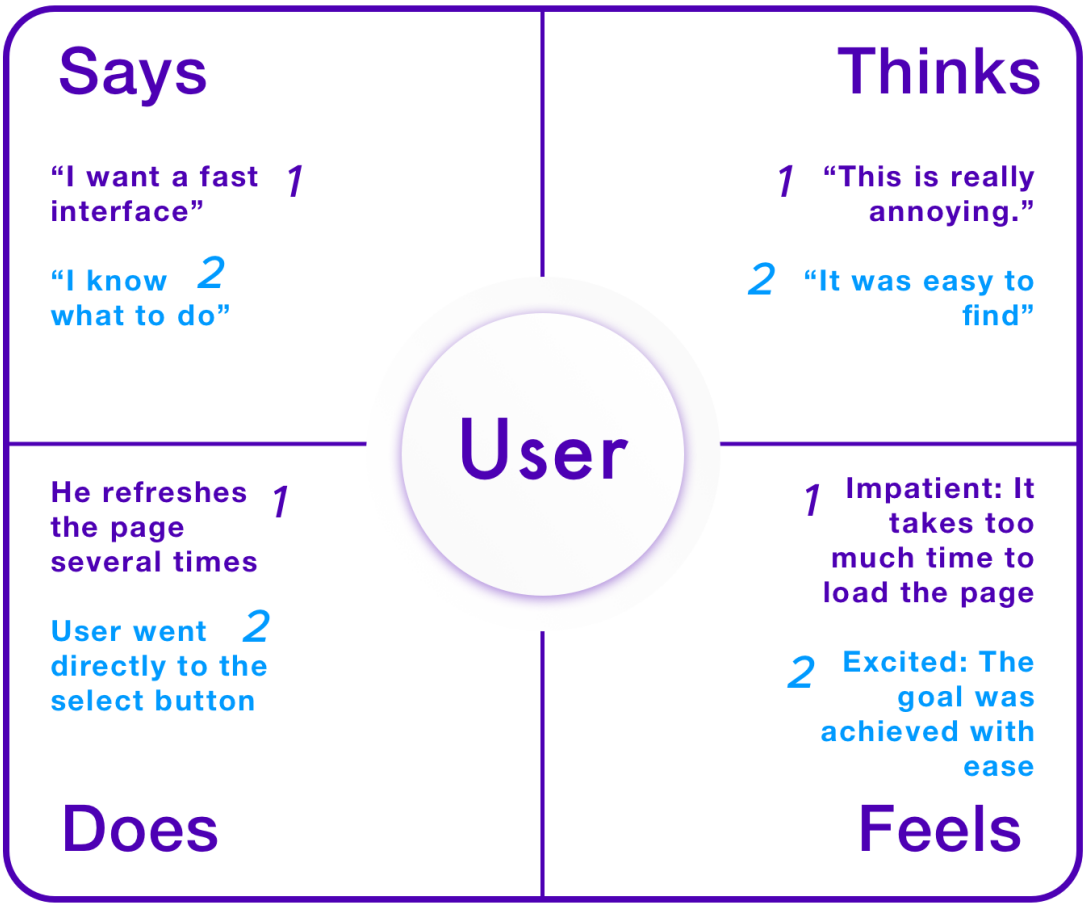
[98] A good reference about methods that can be used in the initial phases of the process is the Law+Design Workbook. Another great resource to get into the field of legal design is the interview with José Torres in Chapter 5: The Business of Decentralized Justice.

> “A wonderful interface
> solving the wrong problem will fail."
> Jakob Nielsen

Designing a New Justice

Imagining the legal services of the future is not easy. But we can start with the right foot by asking the right questions: what do people need? What are the current pain points? How can we do it simpler and more efficiently? Asking the right questions will take us to the root of the problem.

Empathy maps are a useful tool to explore and validate the data we have about the users. In particular, to understand user needs and behaviors in the early stages of the design process. Based on user personas, empathy maps explore four attitudinal aspects: what the user says, thinks, does, and feels.



The four aspects of empathy maps: what the user says, thinks, does and feels.

Design Principles

When designing the user experience for a legal product, is important to follow some basic design principles:

- Consistency - Communicate with the users using one coherent language. Keep similar elements of the design with a consistent look, function, and feel.
- Simplicity - Simplify the UI, avoid distractions and unnecessary information. Keep clear and objective communication.
- Efficiency - Optimize workflows. Anticipate mistakes, and enhance the process of achieving the user goals, making users work faster, better, and smarter.
- Learnability - Make it fast and easy for new users to understand how to use the interfaces. Work to create intuitive experiences.

User Research and Data-Driven Decisions

User research helps gather relevant data about the users, and the problem we are aiming to solve with design. Different research methods may be applied, depending on the aspects and the development stage of each product. A good approach is to mix qualitative with quantitative methods.

Qualitative methods, such as usability testing, contribute to identifying the factors that affect a specific area under investigation, and are normally based on open-ended questions, observation, and user behavior. Examples of qualitative methods are:

- Usability testing
- User interviews
- Small-sample surveys
- Ethnographic studies
- Contextual inquiry
- Focus groups

Quantitative methods contribute to validating assumptions or hypotheses pointed out by the qualitative research. It's normally based on statistical data and metrics, helping to identify user preferences. Examples of quantitative methods are:

- A/B testing
- Analytics
- Large-sample surveys

It's also important to understand the difference between attitudinal and behavioral methods. Attitudinal relates to 'what people say', their stated beliefs, while behavioral relates to 'what people do', or how they interact with the product.

For the exploratory phase, we need to understand the personas and stakeholders on a deeper level, as well the challenge we are trying to solve. Creating wireframes, low and high-fidelity prototypes are essential to validate the initial ideas the team comes up with and identify points of improvement as soon as possible.

Nielsen's 10 Usability Heuristics for User Interface Design is a useful framework, as well as performing user testing called *Heuristics Evaluation* that helps to identify usability problems in the user interface (UI) design. This test examines the product's interfaces against a set of usability principles.

Redesigning the Legal System

Kleros uses blockchain technology to rethink the justice system and propose solutions that can cause a positive impact on people's lives. Decentralized applications (DApps) can help us propose a more efficient legal process by automating the enforcement of rulings through smart contracts, effectively reducing cost and increasing transparency.

As a designer, one of my goals is to introduce a more visual approach to processes normally dominated by boring plain text and legal-bureaucratic documents. Getting to the core of the problem helps to identify inefficiencies of the traditional system, and propose new solutions that can make it more usable, inclusive and accessible.

Kleros latest release, Athena, is an interface that allows users to join as a juror and to be randomly selected to adjudicate disputes in different courts. For that purpose, we need to understand what users are willing to accomplish and define the main actions to be done on the platform:

> "I want to be a juror, arbitrate a case and win the rewards." (User Persona goals)

We can organize the main user's actions this way:

- Join as a juror and choose a court where you have the competency to arbitrate
    - Onboarding
    - Choose the courts you have competency for
    - Stake PNK

When randomly selected as a juror for a case:

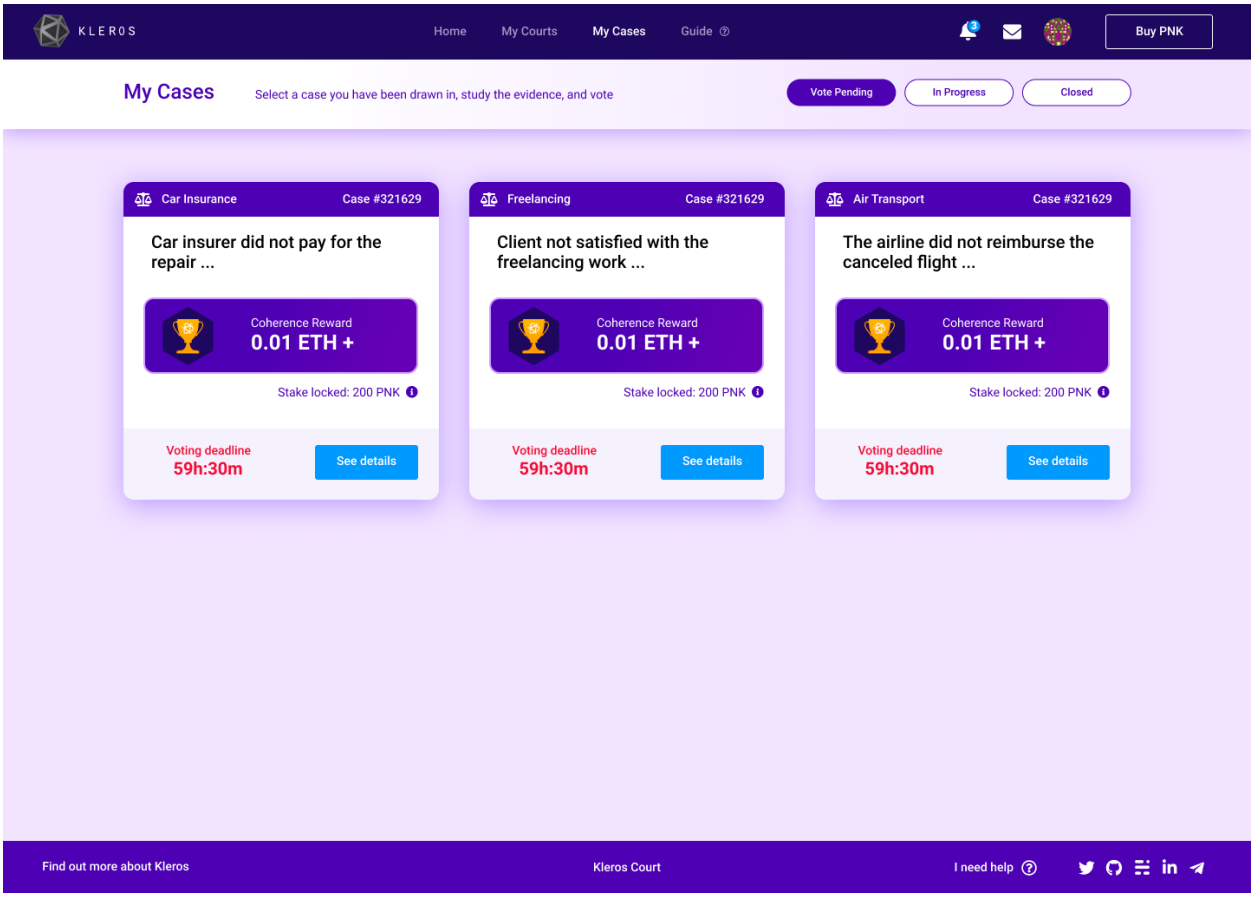
- Analyze evidence and vote when drawn as a juror for a case
    - Read the case details and evidence (photo, documents, video, audio...)
    - Make a decision and vote

As a consequence, the juror can win rewards in ETH and PNK, or lose staked PNK, depending if he/she voted coherently with the majority or not.

With this in mind, we decided to create the interfaces by focusing on the user goals and guided by the main actions they need to do in order to achieve them. This way, we present a top navbar, where the users can find everything they need, the main pages as well as a guide link, notifications, and EtherScan icon.

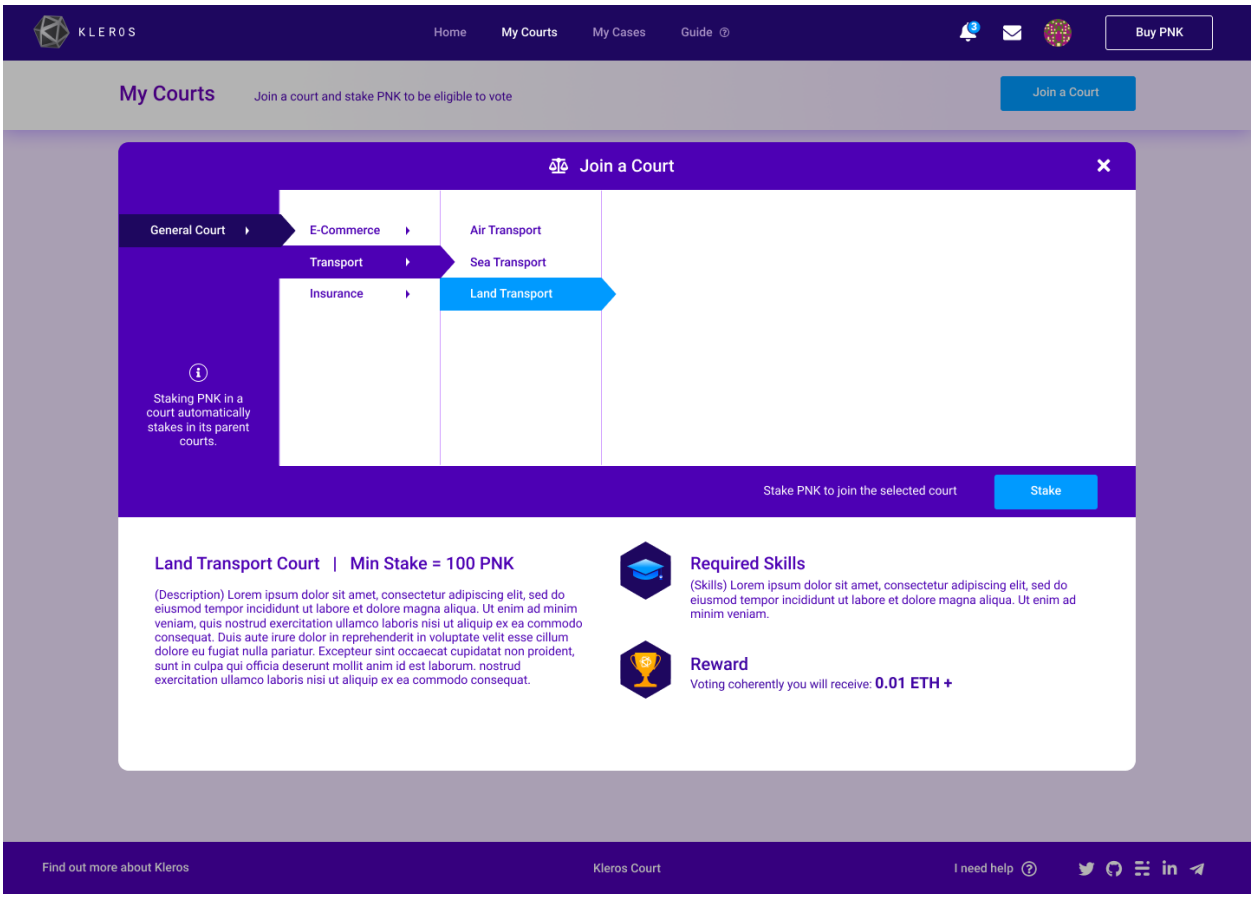
A sub navbar displayed in all screens with the title of the page and guidance directs the users to what they need to do to proceed, and cases are presented as cards, instead of lists or tables.

The goal here is to present an overview of the basic information about the case: the short description of the case, the court, the staked PNK, possible reward and the voting deadline as a timer, so the user can select the card and see its full details.



Cases screen - cases for which a juror was drawn and still require voting.

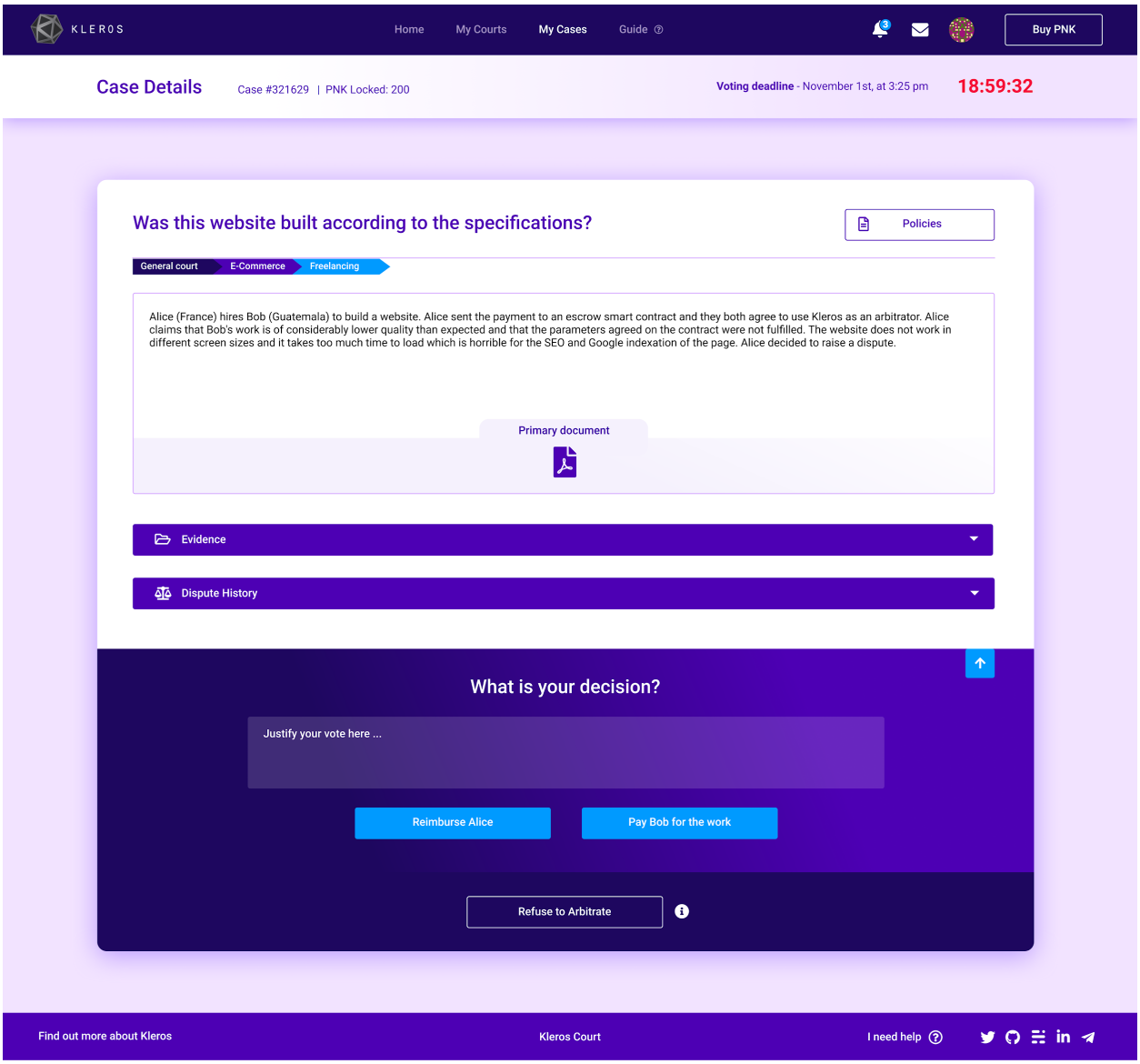
In order to choose the court the user wants to apply for as a juror, we displayed the Merkle Tree on a modal, allowing the users to navigate into multiple items of the tree from the General Court. This approach enables displaying more items (courts) on the same screen while keeping the tree easily navigable.



Courts selection modal - Users can select the courts they have the competency to arbitrate, see the details and requirements as well as examples of disputes at that court and the rewards associated with it.

Cases can be evaluated by the selected jurors on the case details screen. The jurors can find all the information required to properly evaluate the dispute: the title of the case, description, a primary document with general information about the case, a link for the policy page, as well as clear indicators of the parties involved in the litigation or dispute and the evidence attached by each of the parties. At the bottom of this screen the juror can vote.

The case details screen aims to bring a more visual approach to the evidence, and to the documents involved in the dispute, allowing the juror to easily navigate through all the items necessary to evaluate the case and vote coherently.



Case details screen - Here the juror can evaluate the case details and evidence and vote.

One challenge we face when designing DApps for the legal industry is understanding how to demystify the idea that tokens are something complex and geek related and bring a more intuitive and natural approach to their use.

Tokens are usually there to serve a specific function, to have a utility within the product. It is important to make it clear for the users, explaining why they need a token, and how it will be used.

It is always good to avoid using excessive technical terms and jargons, commonly used in blockchain solutions and communicate with the users in the most simple way possible, avoiding unnecessary friction, and doubts.

Another point of attention is the time a transaction can take on blockchain processes. It's important to construct the user experience in a way that the users will not get anxious about the pending states, keeping them informed at all times in which part of the process they currently are.

Designing the user experience and user interfaces is a constant work in progress. The work is never finished and there's always room for improvement. The more we get to know your users, the more insights you have about how to improve the product, how to make it more engaging and valuable for them.

By cultivating a multidisciplinary collaboration and gathering inputs from the different fields involved helps to identify different points of view about the problem you are trying to solve through design.

The legal insights brought by law experts and researchers are fundamental for the process of creating a DApp for legal tech and all the data gathered in the design process, as well as the rich feedback received from the users interaction with the prototypes leverage the possibilities to build wise solutions that resonate with the users core needs.

A user-centered approach is essential to guarantee that the products are being crafted for real users. We need to understand the user, who they are, what they need, and what they expect from our products.[99]

[99] For some great insight into the link between blockchain and legal design, have a look at Plinio Braga's talk about the topic as part of Devcon5.

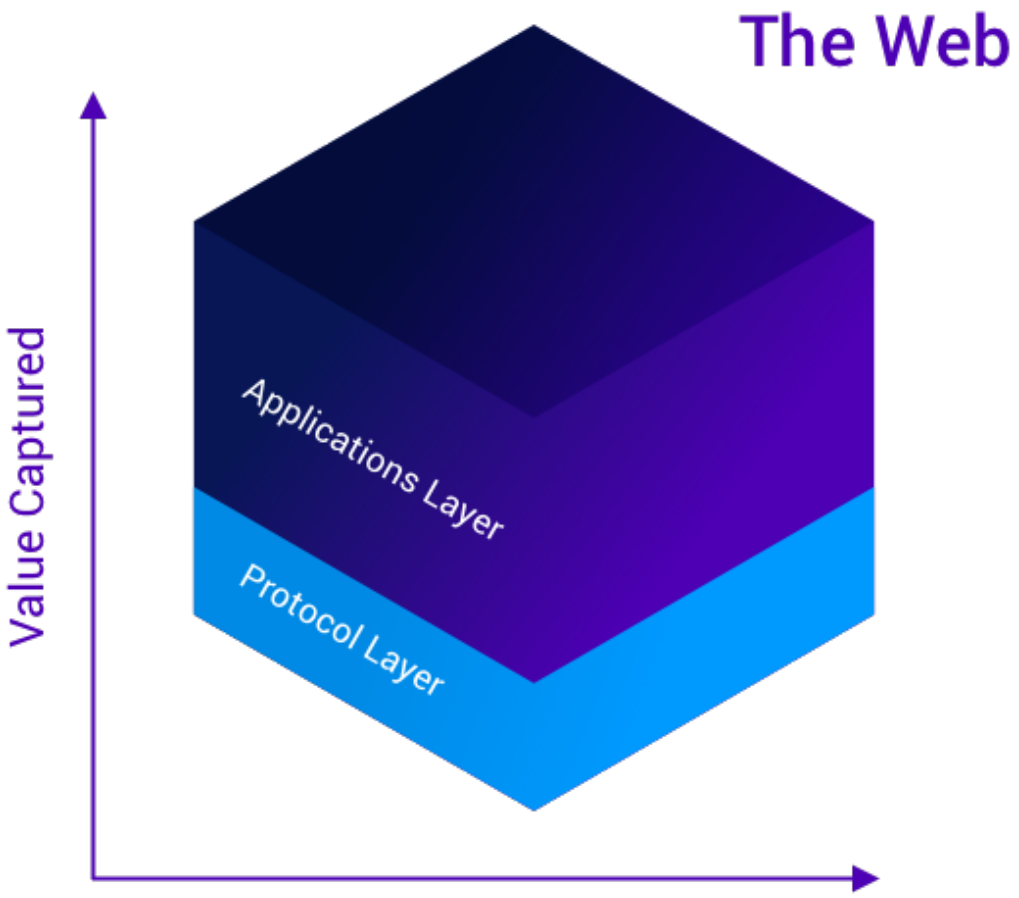
Fat Protocols, the New Business Model of the Decentralized Internet

By Joel Monegro, Partner, Placeholder

Joel Monégro is a partner at Placeholder, a venture capital firm he started with his close friend Chris Burniske in the summer of 2017. Before that, he spent three years as an analyst at Union Square Ventures developing the firm's early blockchain investment thesis and investment portfolio, and prior to that he managed the Digital Economy Department at the Ministry of Industry and Commerce of the Dominican Republic (where he's from), a government office in charge of developing the country's national and technology agenda. He fell down the crypto rabbit-hole in 2013 while researching alternative payment infrastructure technologies the Dominican Republic could promote across Latin America and since then it has occupied nearly all his mental space. He's driven by the opportunity to observe the re-structuring capitalism and governance in the age of information networks.

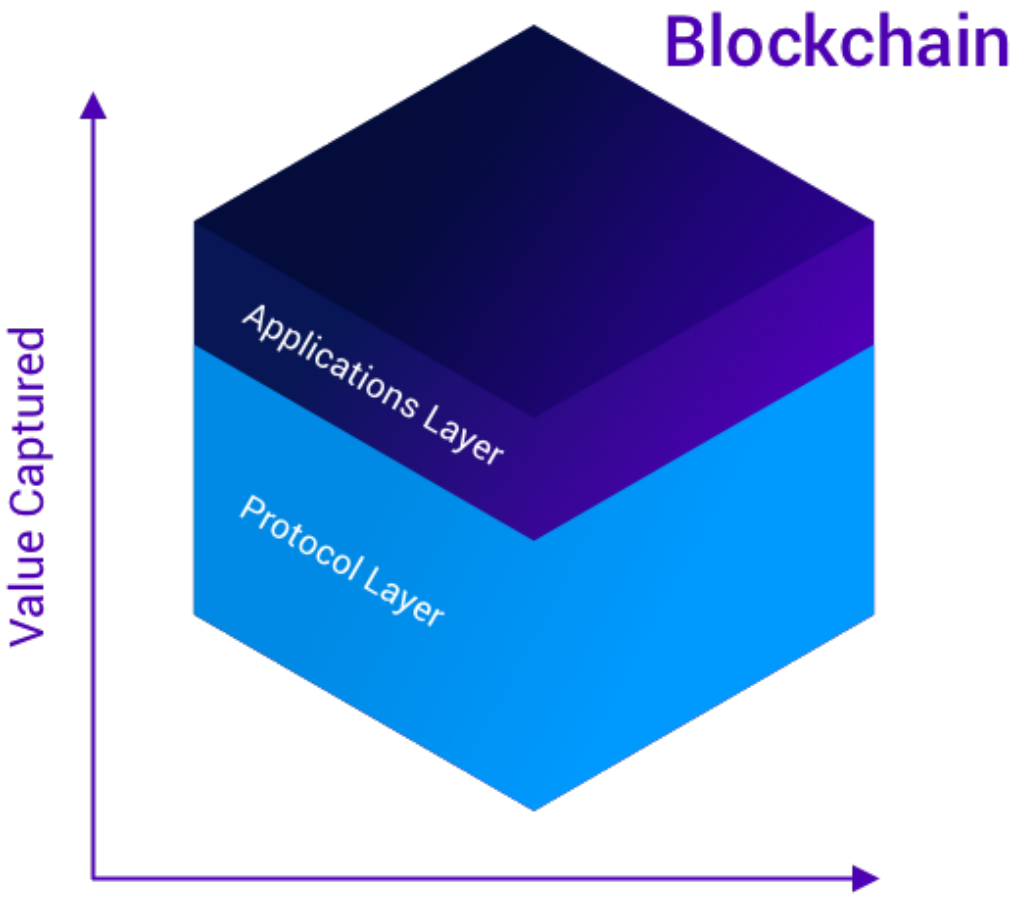
Here's one way to think about the differences between the Internet and the Blockchain. The previous generation of shared protocols (TCP/IP, HTTP, SMTP, etc.) produced immeasurable amounts of value, but most of it got captured and re-aggregated on top at the applications layer, largely in the form of data (think Google, Facebook and so on).

The Internet stack, in terms of how value is *distributed,* is composed of "thin" protocols and "fat" applications. As the market developed, we learned that investing in applications produced high returns whereas investing directly in protocol technologies generally produced low returns.



This relationship between protocols and applications is reversed in the blockchain stack. Value concentrates at the shared protocol layer and only a fraction of that value is distributed along at the applications layer. It's a stack with "fat" protocols and "thin" applications.

We see this very clearly in the two dominant blockchain networks, Bitcoin and Ethereum. The Bitcoin network has a $10B market cap yet the largest companies built on top are worth a few hundred million at best, and most are probably overvalued by 'business fundamentals' standards. Similarly, Ethereum has a $1B market cap even before the emergence of a real breakout application on top and only a year after its public release.



There are two things about most blockchain-based protocols that cause this to happen: the first is the shared data layer, and the second is the introduction of cryptographic "access" tokens with some speculative value.

I wrote about the shared data layer about a year ago. Though the post has gathered some dust since, the main point remains: by replicating and storing user data across an open and decentralized network rather than individual applications controlling access to disparate silos of information, we reduce the barriers to entry for new players and create a more vibrant and competitive ecosystem of products and services on top.

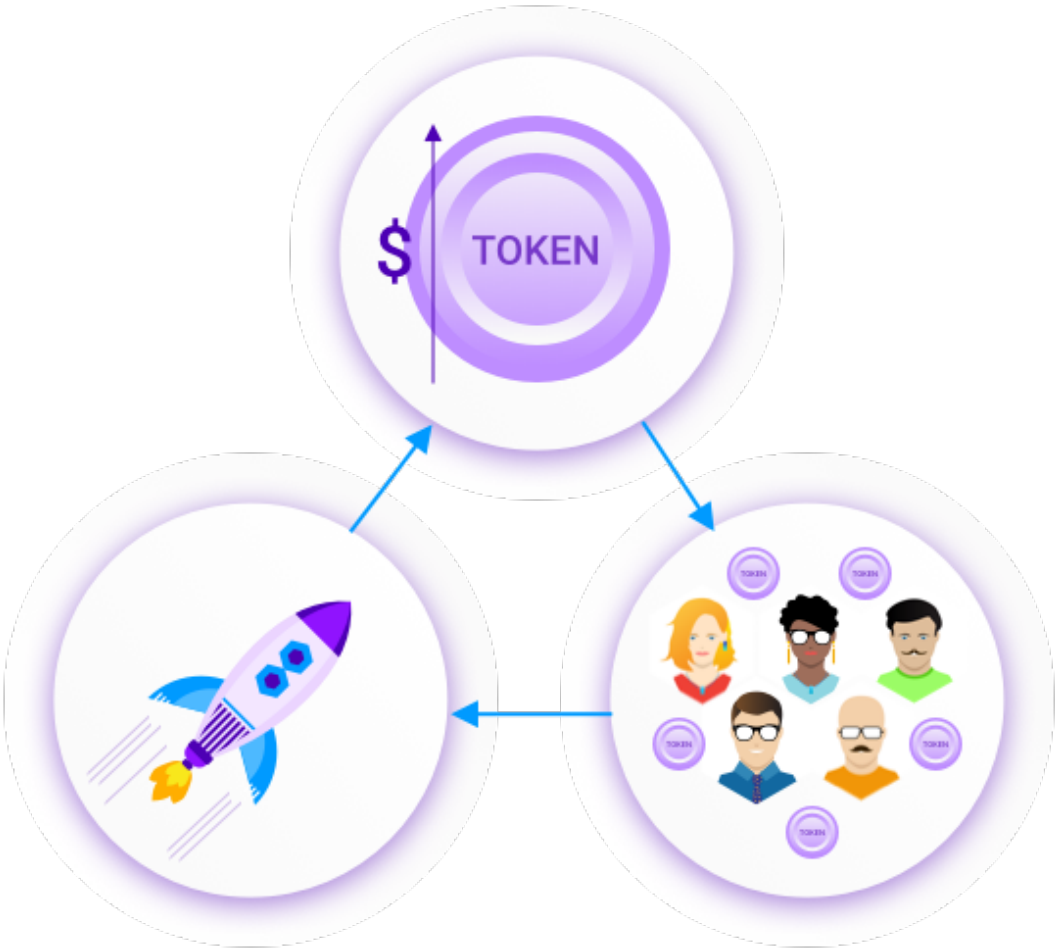
As a concrete example, consider how easy it is to switch from Poloniex to GDAX, or to any of the dozens of cryptocurrency exchanges out there, and vice-versa in large part because they all have equal and free access to the underlying data, blockchain transactions.

Here you have several competing, non-cooperating services which are interoperable with each other by virtue of building their services on top of the same open protocols. This forces the market to find ways to reduce costs, build better products, and invent radical new ones to succeed.

But an open network and a shared data layer alone are not enough of an incentive to promote adoption. The second component, the protocol token (also known as App Coins), which is used to access the service provided by the network (transactions in the case of Bitcoin, computing power in the case of Ethereum, file storage in the case of Sia and Storj, and so on) fills that gap.

Albert Wenger looked at protocol tokens from the point of view of incentivizing open protocol innovation, as a way of funding research and development (via crowdsales), creating value for shareholders (via token value appreciation), or both.

That post will help you understand how tokens incentivize protocol development. Here, I'm going to focus on how tokens incentivize protocol adoption and how they affect value distribution via what I will call 'the token feedback loop'.



When a token appreciates in value, it draws the attention of early speculators, developers and entrepreneurs. They become stakeholders in the protocol itself and are financially invested in its success.

Then some of these early adopters, perhaps financed in part by the profits of getting in at the start, build products and services around the protocol, recognizing that its success would further increase the value of their tokens. Then some of these become successful and bring in new users to the network and perhaps VCs and other kinds of investors. This further increases the value of the tokens, which draws more attention from more entrepreneurs, which leads to more applications, and so on.

There are two things I want to point out about this feedback loop. First is how much of the initial growth is driven by speculation. Because most tokens are programmed to be scarce, as interest in the protocol grows so does the price per token and thus the market cap of the

network. Sometimes interest grows a lot faster than the supply of tokens and it leads to bubble-style appreciation.

With the exception of deliberately fraudulent schemes, this is a good thing. Speculation is often the engine of technological adoption.[100] Both aspects of irrational speculation — the boom and the bust — can be very beneficial to technological innovation.

The boom attracts financial capital through early profits, some of which are reinvested in innovation (how many of Ethereum's investors were re-investing their Bitcoin profits, or DAO investors their Ethereum profits?), and the bust can actually support the adoption long-term adoption of the new technology as prices depress and out-of-the-money stakeholders look to be made whole by promoting and creating value around it (just look at how many of today's Bitcoin companies were started by early adopters after the crash of 2013).

The second aspect worth pointing out is what happens towards the end of the loop. When applications begin to emerge and show early signs of success (whether measured by increased usage or by the attention or capital paid by financial investors), two things happen in the market for a protocol's token: new users are drawn to the protocol, increasing demand for tokens (since you need them to access the service — see Albert Wenger's analogy of tickets in a fair), and existing investors hold onto their tokens anticipating future price increases, further constraining supply.

The combination forces up the price (assuming sufficient scarcity in new token creation), the newly-increased market cap of the protocol attracts new entrepreneurs and new investors, and the loop repeats itself.

What's significant about this dynamic is the effect it has on how value is distributed along the stack: the market cap of the protocol always grows faster than the combined value of the applications built on top, since the success of the application layer drives further speculation at the protocol layer.

And again, increasing value at the protocol layer attracts and incentivises competition at the application layer. Together with a shared data layer, which dramatically lowers the barriers to entry, the end result is a vibrant and competitive ecosystem of applications and the bulk value distributed to a widespread pool of shareholders. This is how tokenized protocols become "fat" and its applications "thin".

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[100] Edward Chancellor writes a thorough and entertaining history of financial speculation and its place in society and Carlota Pérez describes the important role of bubbles in the development of new technologies by attracting financial capital to research and development.

This is a big shift. The combination of shared open data with an incentive system that prevents 'winner-take-all' markets changes the game at the application layer and creates an entire new category of companies with fundamentally different business models at the protocol layer.

Many of the established rules about building businesses and investing in innovation don't apply to this new model and today we probably have more questions than answers. But we're quickly learning the ins and outs of this market through our blockchain portfolio and in typical USV fashion we're going to share that knowledge as we go along.

Peter Hunn on Building the Standards of the New Legal World

Interview by Federico Ast, CEO, Kleros

Peter Hunn was a lawyer in the UK and settled on commercial law. He decided that there was going to be a big change in the legal industry, seeing how technology was changing finance, in particular consumer facing finance. Maintaining a keen interest in technology, Peter felt that it was the right time to begin building technology that would benefit the practice and the business of law. He explored the blockchain space for a few years and decided that this held a lot of promise, but the technology was not there to enable adaptation to commercial transactions. That is where the idea of Clause and the idea of the Accord Project came to fruition and what Peter has been building for three years.

Tell me about Clause. What's the problem you're trying to solve with this company?

Clause is building infrastructure for contract life cycle management. None of the existing contract life cycle management platforms enable you to use what we would call *smart legal contracts*.

A smart legal contract is essentially a contract that has computable elements within it. That is really important, because it enables you to have some semblance of the state of the contract.

Today you typically sign a contract with the likes of DocuSign or HelloSign. That then gets stored in Dropbox if we're lucky, sometimes it gets stored in people's inboxes in their email, or even printed out and put in hard copy storage. This means we have no knowledge of the state of that contract after it was signed.

What we're doing is using the contract as a record of the state of that agreement at the point of signature. Whereas we all know that not all contracts follow that happy path. And even if they do, you have all these business processes that have to take place in order for you to manage that contract effectively.

A very basic example is a dynamic pricing clause. These appear all the time in supply agreements and basically require you to take data about stocks of the physical world and how it affects the agreement.

It can be things like late delivery, for example. If a package under that supply agreement is delivered after the stipulated date on the contract, then the terms of that contract may say that the price is reduced by a certain amount. We then need to calculate all of that.

Who's the typical customer for this service?

It could be anyone who manages contracts. Just like DocuSign and e-signature providers focus on making parts of the contract smart (which is essentially signing it) we are looking at extending that functionality into anything that happens past the point of signature.

You can then begin to reconcile that contract with your accounting systems in real time, calculate the price in real time, send notifications in real time when the state of the contract changes. All of that is possible with stateful contract management or, as we call it, *connected contracting*.

It's not just a blockchain specific product, it can be used for payments through Stripe, for example. We don't necessarily need a blockchain infrastructure to enable that.

However, there are some elements of the contract life cycle where it is useful to have a blockchain infrastructure. You can hash the state of the agreement and put it on chain, which reports the state of the contract at given events.

What if we added self-enforcing capabilities to those contracts with an arbitration platform like Kleros?

Absolutely. Something that we built within Clause is this notion of smart clauses. A smart clause is really, to use the DocuSign analogy again, like an e-signature block. You can instantiate drag and drop that smart clause provision into a contract and that will automate some function within that contract.

Payment is an obvious example. Almost every contract has some form of consideration or payment provision within it. What we're enabling to do is then use that for any arbitrary operation.

One of those could be dispute resolution clauses. We think that's particularly powerful. The idea that you could automatically dispute a state of the contract through an online dispute resolution platform without needing to go through traditional dispute resolution procedures.

That's where Kleros could come in. You could have Kleros smart clauses that the user can, when building a contract, simply drag and drop that Kleros smart clause into their contract and then, whenever there is a dispute, it would be rooted to Kleros to resolve that.

It brings that contract from a static record of an agreement into the real world, where you can interact with a contract, you can provide its state to the dispute resolution platform for the resolution procedure to take place. That's a really powerful proposition.

Tell me a bit about the Accord Project, how did that come into being?

About six months into the Clause journey, we were building the foundational infrastructure - things like templates for contracts so they can use external data, binding natural language and logic together. All of these foundational things that are not a product per se, but they are really important to have a solid foundation for everyone to be able to utilize in an agnostic way. That's when the Accord Project came into being.

Without some standard elements, we would run into a fragmentation of approaches. If we get a fragmentation of approaches, it can drive up transaction costs, instead of reducing them.

Today we have natural language, we don't have any data in our contracts. We can share that document and anyone can open it in any word processing platform. It is easy to share and agree on the technical foundations of that contract.

Once we start to use data and executable elements within contracts, it is very important that we can use it, first of all, in an agnostic manner, across blockchain infrastructures like Hyperledger[101] or Ethereum.

We don't want to have to agree on the technical foundations of a contract before we agree on the substantive terms and conditions of that contract. Having to agree to agree would greatly raise transaction costs.

It's really important to have this kind of agnostic approach.

This is what the Accord Project is about, it is about open sourcing a lot of this technology. We didn't want this to be under the Clause banner, we wanted this to be essentially for the industry, so we created a non-profit, contributed a bunch of the code that we have developed over a period of time and got a lot of organizations to come and support it.

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[101] Hyperledger is a collaborative project hosted by the Linux Foundation with the goal of reducing complexity of blockchain systems by creating a distributed peer-to-peer ledger. This system should work sort of as an operating system for marketplaces, data-sharing networks, micro-currencies, and decentralized digital communities.

At Kleros we have developed a smart contract standard that we expect all smart contracts to use when they need to use arbitration. The way in which you build the contract, the way in which you present the evidence should be interoperable for all arbitrators so you can plug and play any arbitrator you want.

That's exactly the same approach with the Accord Project. We really need this, we are transitioning from static natural language contracts to this whole new world of computable contracts.

If we don't have a universal way, or at least a common way of expressing how we use that data within that contract to how we bind natural language and logic together, how we can run it on chain, how we can run it on chain, how we can interface with all the leading DLT platforms, then we can struggle to find adoption around that. Lawyers and enterprises don't want to bet on one particular technology and indeed in our opinion lawyers can't do that, they need to remain agnostic.

You are absolutely right, we need that not just for the way the contract will look like, but also the subsidiary elements within it - how do we go from this common specification of a contract to common interfaces for dispute resolution and other things as well.

So, that's where Kleros is valuable, for creating this open source standard, because it's not just used by you, it's used by others as well and that means it's more likely to get actual adoption on the market.

In the end, I think we are defining what due process means in this new world. How a contract should be written to be valid, how evidence should be presented to be valid to the online court, so we need everyone to be on the same page to increase adoption. Legacy legal system has all this developed, it took a lot of time, but it works (laughs).

That's why this transition point is so important, to get these universal specifications and approaches and get the stakeholders engaged with that process. If we don't do that, we risk the classic 'well, this isn't worth the effort' kind of mentality. If we don't develop this new technological stuff to make it viable in the real world, we're just going to revert back to what we currently have.

Even though it's more hassle down the line, if the unhappy part of the contract is taken, it's not worth the effort up front to specify all of these technological interfaces and expressing that in a computable contract now, because it may not happen in the future. So we have to avoid that kind of adverse incentive issue in which it just becomes more complex now for something that may not be beneficial in the future.

We need to make it very quick and easy to use those smart clauses for dispute resolution in a contract now and also accrue the benefits in the future, rather than having this situation that is very complex now for the hope of avoiding some bit of complexity down the line.

A Smart Contract Arbitration Standard for *Lex Cryptographia*

By Clément Lesaege, CTO, Kleros; Enrique Piqueras, Former Lead Developer, Kleros; Sam Vitello, DApp Developer, Kleros and Federico Ast, CEO, Kleros

The late Middle Ages saw a rapid expansion of long-distance trade. English wool, Italian textiles, German beer, French wine and Greek wax were bought and sold in fairs in cities such as Venice, Florence and Genoa. Merchants started to experience the need of a reliable system ensuring that debts were paid, goods were delivered and property was safe.

As merchants spent most of their time traveling in foreign lands, a critical concern was how to create a set of common rules and contract standards which could be adjudicated in courts of different fairs and cities.

Lex Mercatoria (merchant law) was born to provide fast arbitration and reliable enforcement for that age of growing international trade. It was formed by a number of generally accepted merchant practices concerning the use of bills and notes, insurance, banking, shipping, suretyship, and agency. The main source of the law were merchants and their guilds, not governments. It was based on principles of contract freedom and alienability of property.

Adjudication was done by merchant courts across Europe's fairs. Thanks to the common standards, a contract signed in Genoa could be adjudicated by a court in Paris or Antwerp. Enforcement was done by the community via a reputation system. Those who failed to comply with the decision of a merchant court were ostracized by their guild. Other merchants wouldn't do business with them.[102]

The Internet Age poses a number of similar challenges. As a larger part of the economy starts to operate online across jurisdictional boundaries of state courts, a new body of law is emerging. It is not created by governments but, as the medieval *Lex Mercatoria*, by e-commerce merchants and the platforms where they conduct business.

The emerging *Lex Cryptographia* would greatly benefit from a set of common rules and contract standards allowing for the interoperability of arbitration services.

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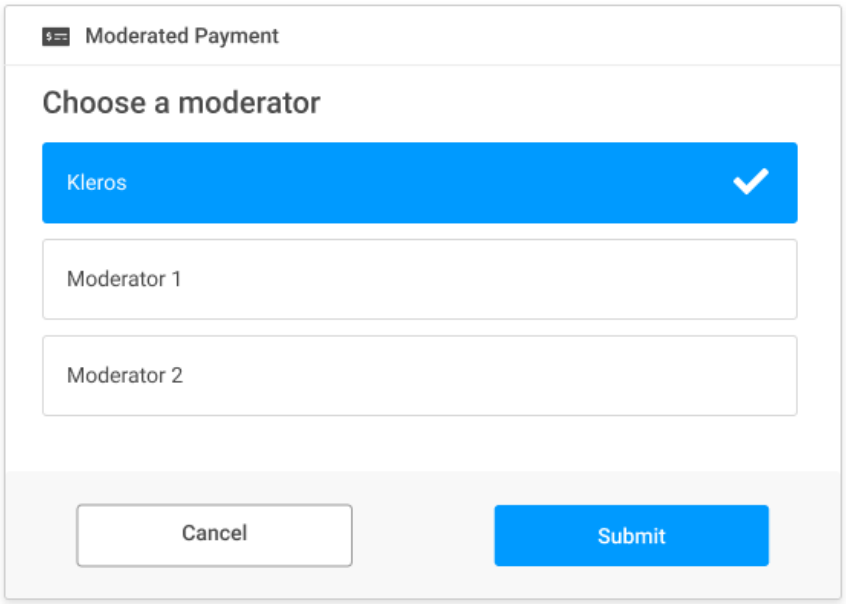
[102] Economists Paul Milgrom, Douglass North and Barry Weingast argued that the private law system of *Lex Mercatoria* explains the revival of trade in the Middle Ages. Some towns and fairs became wealthier because their institutions did a better job in supporting trade than their neighbors, in particular those allowing for commercial disputes to be adjudicated by merchant courts, instead of government officials or priests. This was the case of the Champagne fairs of the 13th Century and the city state of Venice.

Kleros has proposed a number of guidelines for building this standard for blockchain smart contracts. Any smart contract following these guidelines should be able to be adjudicated by any court.

This standard is made of two proposals submitted to the Ethereum community: ERC 792, explaining how smart contracts should be written, and ERC 1497, on how evidence should be presented to jurors.



A case where a user can select the adjudication service provider among a set of different options complying with the standard.

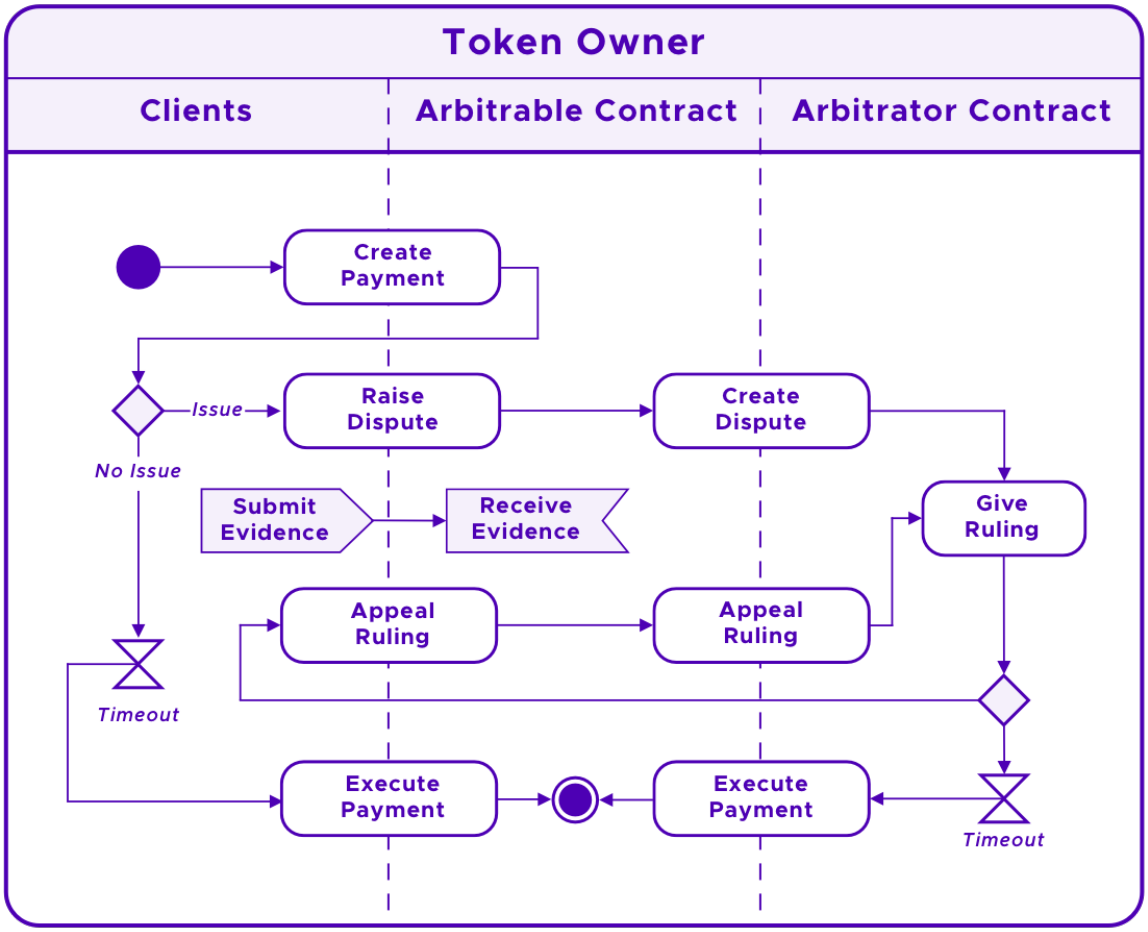
ERC 792: Arbitrable and Arbitrator Contracts

In arbitration, the arbitrable party is the one that demands the service of arbitration from the arbitrator, the supplier of the service. Arbitrators give rulings to arbitrable parties.

The goal of the ERC 792 proposal is to try to emulate this construct in code by standardizing the way the demand side of dispute resolution (the *arbitrable* side) interacts with the supply side (the *arbitrator* side).

This seeks to provide a minimal interface by which any two conforming contracts can interact with each other to execute dispute resolution, regardless of implementation details.

This way, DApps and their smart contracts can plug and play any contract that implements the standard.



This is a diagram of the flow between clients, arbitrable contract, and arbitrator contract for the simple use case of an arbitrable escrow payment. To start, the client creates a payment which involves sending the funds to be escrowed and agreeing on the potential arbitration. If there are no issues between the parties involved during the time out, the payment can be executed. Otherwise a dispute is raised on the arbitrator via the arbitrable contract. The parties can start submitting evidence, and eventually the arbitrator gives a ruling with a time out for appeals. Once the time out passes, the arbitrator can execute the ruling on the arbitrable contract.

The standard consists of two kinds of contracts: Arbitrable and Arbitrator contracts, such that every Arbitrable contract can be adjudicated by every Arbitrator contract.

Arbitrator: Interface

```
contract Arbitrator {
    function createDispute(
        uint _choices, bytes _extraData
    ) public requireArbitrationFee(_extraData) payable returns(uint disputeID) {};

    function arbitrationCost(bytes _extraData) public view returns(uint fee);

    function appeal(
        uint _disputeID, bytes _extraData
    ) public requireAppealFee(_disputeID,_extraData) payable {
        emit AppealDecision(_disputeID, Arbitrable(msg.sender));
    }

    function appealCost(uint _disputeID, bytes _extraData) public view returns(uint fee);

    function appealPeriod(uint _disputeID) public view returns(uint start, uint end) {}

    function disputeStatus(uint _disputeID) public view returns(DisputeStatus status);

    function currentRuling(uint _disputeID) public view returns(uint ruling);
}
```

These are all the methods that an arbitrable contract should need to execute a dispute resolution flow. Let's go over each method one by one.[103]

We have:

- A way of creating a dispute.
- A way of getting the cost of creating a dispute.
- A way of appealing a ruling.
- A way of getting the cost of appealing a ruling.
- (Optional) A way to see the time window you have for appealing a ruling (Useful for multi-party fee payments.).
- A way of getting a dispute status.
- A way of getting a dispute's current ruling (You might want to appeal it before it's final.).

[103] Note that we've removed the Doxygen comments for simplicity.

Arbitrator: Types and Events

```
contract Arbitrator {
    enum DisputeStatus { Waiting, Appealable, Solved }

    event DisputeCreation(uint indexed _disputeID, Arbitrable indexed _arbitrable);

    event AppealPossible(uint indexed _disputeID, Arbitrable indexed _arbitrable);

    event AppealDecision(uint indexed _disputeID, Arbitrable indexed _arbitrable);
}
```

For types we just have an enum that tells you if the dispute is waiting for a ruling, in an appeal period, or already resolved.

Events are like immutable logs that can be efficiently indexed and queried by clients.

We have:

- One for when a dispute is created.
- One for when a dispute ruling becomes appealable.
- One for when a dispute ruling is appealed.

Arbitrable: Interface and Events

```
contract Arbitrable {
    event Ruling(Arbitrator indexed _arbitrator, uint indexed _disputeID, uint _ruling);

    function rule(uint _disputeID, uint _ruling) public onlyArbitrator;
}
```

This is all that an arbitrator contract should need to execute a dispute resolution flow.

We have a way for the arbitrator to give a final ruling and an event to notify clients when that happens.

This interface is much simpler than the arbitrator one. But, that doesn't mean that arbitrable contracts are always easier to implement. There is a lot of complex logic involved with

evidence submission, multi-party and crowd-insured fee payments, and then there is what the contract does after a ruling is given.

In order to address this, we have proposed the ERC 1497 for standardizing evidence.

ERC 1497: Towards Evidence Standardization in Decentralized Justice

The Evidence Standard ERC 1497 seeks to create a standard way for DApps that are part of the dispute resolution process to share context and information. This standard allows DApps that have disputes they need arbitrated a way to provide the details of the dispute to the Arbitrator. Conversely, for an Arbitrator interface to be able to display a dispute to be ruled on, there needs to be a standard way for the interface to fetch evidence from the Arbitrable contracts.

Let's consider an example where a developer is asked to create an e-commerce website. The contracting party locks up the payment for the website in an escrow smart contract.

Unfortunately, once the developer submits her work, there is a disagreement on whether the terms have been met and a dispute is raised in the smart contract. Now the case will go to an arbitration service, but in order for the arbitrators to make a fair ruling, they need to understand what the dispute is about and to take into consideration the arguments from both parties.

In essence, there are two kinds of evidence needed for the arbitrators to be able to make a ruling.

The first type of evidence, called *MetaEvidence*, provides the story behind the dispute. In this case, it could be the original off-chain contract or agreement, as well as important information regarding what consequence(s) an arbitrator's ruling will have. MetaEvidence is used to convey this information to the chosen arbitrator.

The second type is the *material evidence*, such as emails, screenshots, contracts and testimony, provided by each party to try to prove that the dispute should be ruled in their favor. In the above case, the programmer might submit the code as evidence, while the contracting party submits screenshots of what is missing.

MetaEvidence is an impartial landscape of the dispute context while Evidence is the proof provided by each party.

How it Works

In order to provide flexibility for all different types of disputes, and to try to keep minimal information on the chain; we decided to create standardized JSON objects that can be

hosted anywhere and fetched by an interface to display a dispute. Below we provide some examples. For more information on what each field does, take a look at the [standard specification].

MetaEvidence

We have already discussed what MetaEvidence is, so let's take a look at how a piece of MetaEvidence might actually look and how it would be used. Each dispute has one piece of MetaEvidence that is used to give all of the contextual information for a contract that might be disputed.

MetaEvidence should be created at the same time as the agreement so that it can be impartial. The only restriction on MetaEvidence is that it must be created before a dispute can be raised in the smart contract.

Here's an example of MetaEvidence JSON:

```
{
    "fileURI": "/ipfs/QmUQMJbfiQYX7k6SWt8xMpR7g4vwtAYY1BTeJ8UY8JWRs9",
    "fileHash": "QmUQMJbfiQYX7k6SWt8xMpR7g4vwtAYY1BTeJ8UY8JWRs9",
    "fileTypeExtension": "pdf",
    "category": "Escrow",
    "title": "Alice Builds an e-commerce webpage for Bob",
    "description": "Alice is hired by Bob as a contractor to create an e-commerence website for
his company. When completed, the site will be hosted at https://my-site.com.",
    "aliases": {
        "0x56b2b5C88C9AC1D0E5785ED1A7c7B28173F5eE1b": "Alice",
        "0x8961286757C764a4a6Be9689649BA9E08DBaca4a": "Bob"
    },
    "question": "Is the website compliant with the terms of the contract?",
    "rulingOptions": {
        "titles": ["Yes", "No"],
        "descriptions": [
            "The website is compliant. This will release the funds to Alice.",
            "The website is not compliant. This will refund Bob."
    ]},
    "evidenceDisplayInterfaceURL": "https://my-site.com/evidence-display/escrow",
    "evidenceDisplayInterfaceURLHash": "QmUQMJbfiQYX7k6SWt8xMpR7g4vwtAYY1BTeJ8UY8JWRs9",
    "selfHash": "QmUQMJbfiQYX7k6SWt8xMpR7g4vwtAYY1BTeJ8UY8JWRs9"
}
```

Evidence

It is also essential in many types of disputes that the participants have a chance to show their viewpoint and give reasons why they believe they are right. Therefore there needs to be a way for an Arbitrator to receive Evidence. The Evidence JSON file includes the following properties:

```
{
    "fileURI": "/ipfs/QmWQV5ZFFhEJiW8Lm7ay2zLxC2XS4wx1b2W7FfdrLMyQQc",
    "fileHash": "QmWQV5ZFFhEJiW8Lm7ay2zLxC2XS4wx1b2W7FfdrLMyQQc",
    "fileTypeExtension": "pdf",
    "name": "Email clarifying the terms of the contract.",
    "description": "This is an email sent to Alice from Bob that clarifies that the recommendation
page that was expected",
    "selfHash": "QmUQMJbfiQYX7k6SWt8xMpR7g4vwtAYY1BTeJ8UY8JWRs9"
}
```

How to Use These JSON Files

Now we have JSON files with our two types of evidence, but we still need a way to link them to our smart contracts. MetaEvidence and Evidence are submitted and looked up via smart contract event logs.

The standard specifies some new events for your smart contracts. When a new piece of is Evidence is submitted, an event is raised that includes a URI to the JSON file. This way we can leverage the immutability and availability of the blockchain to create a permanent log of submission that any interface can look up and use to access the Evidence JSON.

Keeping the Data Safe with Hashes

In contentious disputes, it is crucial that Arbitrators can be sure that they receive accurate Evidence and MetaEvidence. For example, if MetaEvidence is tampered with, one of the participants can switch the labels on the ruling options, and an Arbitrator might send funds to the wrong party thinking they are voting the opposite way. To protect against Evidence or MetaEvidence being modified, a series of hashes are used.

The JSON for both MetaEvidence and Evidence contains hash fields for things such as linked files. The standard also allows for the hash to be used as the name of the file, like the format IPFS uses, so that files hosted on distributed platforms that guarantee data integrity don't require any extra work. The arbitrators can use these hashes that are provided when Evidence or MetaEvidence is submitted to verify that nothing has been changed.

We also created a Javascript library called Archon[104] which we built to make following our standards easier. You can use Archon to hash, fetch and validate evidence as well as interact with any smart contract that follows these standards.

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[104] In ancient Greece, an archon was the chief magistrate (or magistrates) in many city-states. For example, in Athens, by the middle of the 7th Century BC, executive power was in the hands of nine archons who controlled all state functions once held by the king alone.

By applying this standard to all envisaged DApps in the ecosystem, it will allow for complete interoperability by all arbitrators and create a common framework for all jurors to be able to read and understand the evidence in the same way.

The New Contract Law Standard for the Internet

As argued by Milgrom, North and Weingast, the rise of trade in the late Middle Ages and the transition to early capitalism were enabled, at least in part, by a better protection of property rights resulting from the law merchant. This was facilitated by a set of common standards, which allowed contracts to be adjudicated in a network of private merchant courts on the main trade routes.

At the dawn of the decentralized economy, the time has come for the development of standards for securing property rights. The smart contract standard we propose here is a key step in this direction, since it enables interoperability of courts.

As the merchants of the Middle Ages once chose the best cities and fairs to adjudicate disputes, e-merchants of our time will be able to choose from a variety of adjudication services, all using the same contract standard. Users will be able to select their preferred arbitration service at the moment of doing a transaction which will result in wider choice, better arbitration services and faster growth for the ecosystem.

This will create a competitive market for arbitrators, which in turn will lead to better services at lower prices for consumers, all without additional development costs for any of the parties involved. Collaboration will make the ecosystem stronger.

Chapter 6

Scaling Up: the Applications of Decentralized Justice.

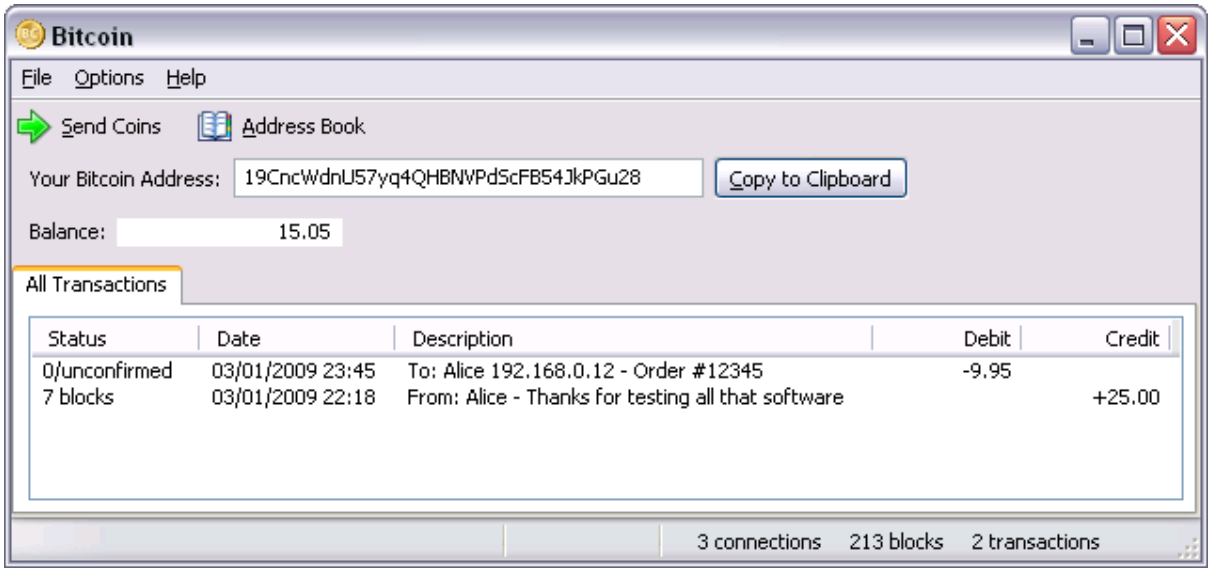
"A journey of a thousand miles begins with a single step."
-Confucius

In Chapter 5, we presented Kleros as a protocol for dispute resolution, a cryptonetwork of users organized by a set of economic incentives which allows for a faster and less costly dispute resolution than in any other previous method.

So, what types of disputes can be expected to be solved in this cryptonetwork? And how will this mechanism evolve over time? There is plenty to learn from the evolution of the Bitcoin ecosystem, the longest running experiment of a blockchain protocol.

What We Can Learn from the Bitcoin Ecosystem

Satoshi Nakamoto launched the Bitcoin network on January 3, 2009. The first Bitcoin client (v. 0.1.0) was released a few days later, on January 9, 2009. This piece of software was intended to provide users a simple way to interact with the protocol.



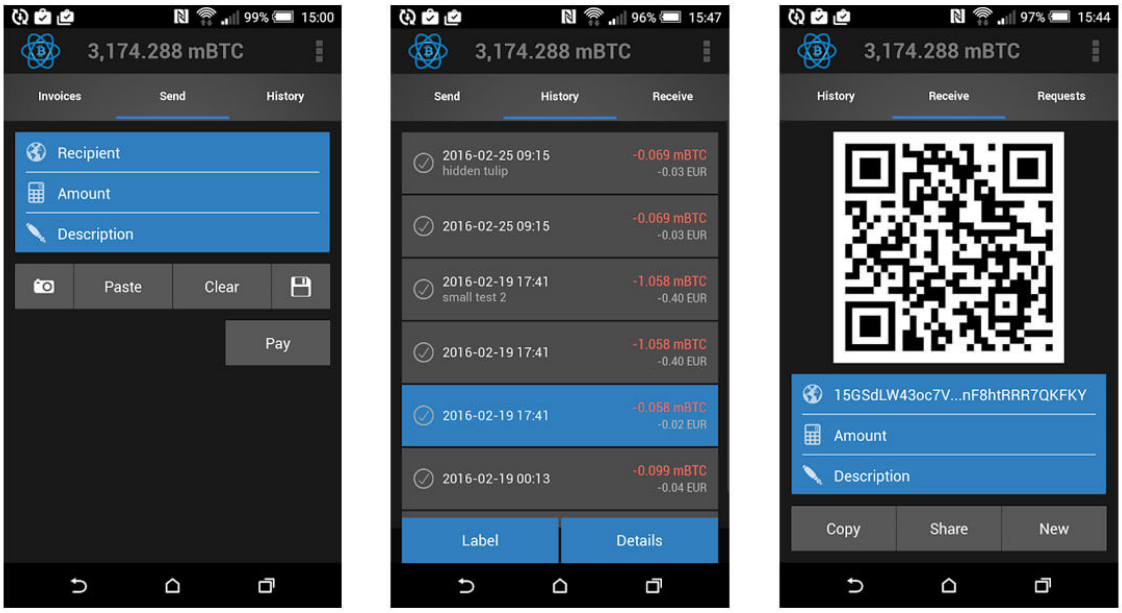
An early version of the Bitcoin Core wallet, 2009. The first version only worked on Windows.

Early versions of the Bitcoin Core client were not very user friendly (let alone aesthetically pleasing), but they were the only (more or less) user friendly way to access the Bitcoin cryptonetwork. However, Satoshi's vision wasn't that all transactions would go through that wallet. In the future, users would have the choice to access the network through software developed by third parties. The Bitcoin blockchain was an open protocol on top of which many entrepreneurs would build new applications.

This contrasted with the traditional Internet architecture, where network, protocol and application are controlled by the same entity. Users need the Facebook client to access the Facebook network and the Uber client to access the Uber network.[105]

As the network started to grow, other companies entered the industry. Founded in 2011, Coinbase was a key milestone as it gave users an easy way to buy, send and store bitcoin. Its sleek interface was especially friendly to non technical users.[106]

Soon thereafter, other companies joined as well, giving users more options to use cryptocurrencies (Xapo, Jaxx and many others). What they all had in common was the fact that they were built on top of the Bitcoin protocol. They competed between themselves by offering better interfaces, the most responsive customer service and by focusing on specific segments or use cases.



As an example of how wallets developed, the Electrum wallet is mobile and has many extra features compared to the early version of Bitcoin Core, such as the ability to use multiple accounts and a much sleeker interface. Credit: electrum.org

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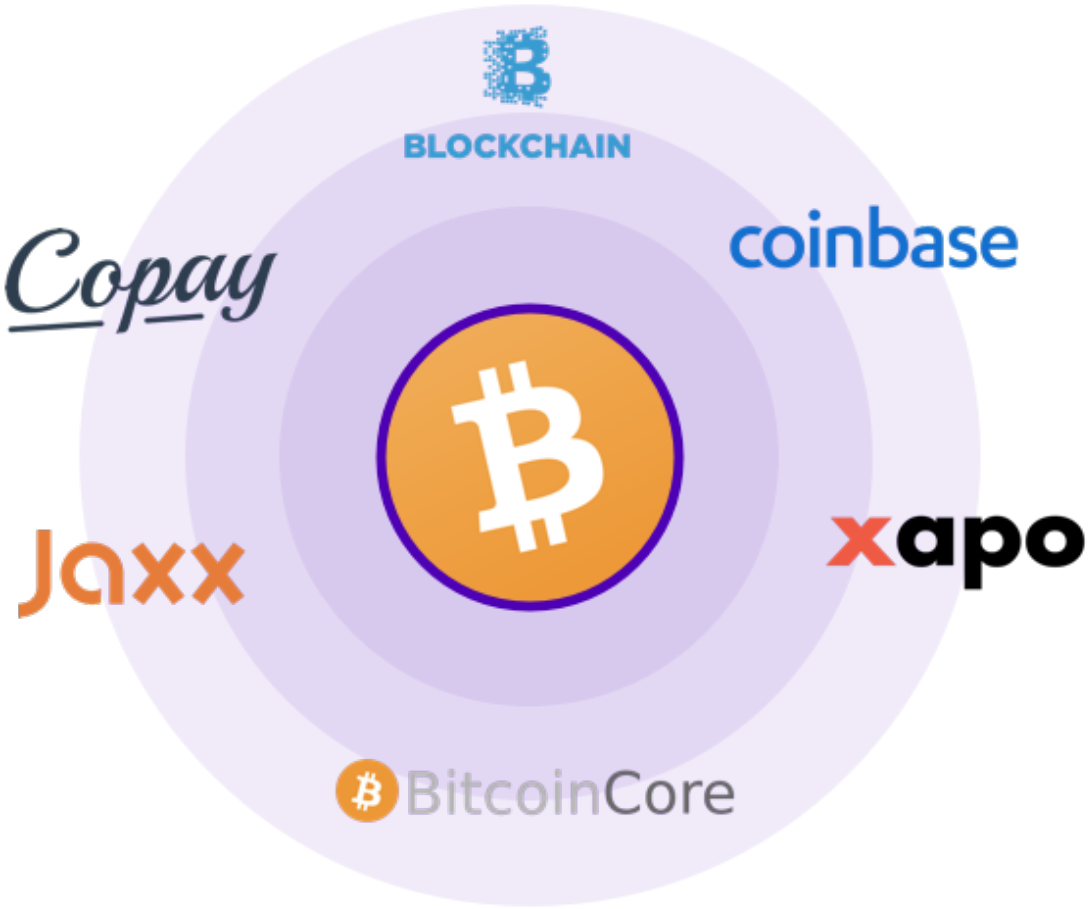
[105] Eventually these companies may allow third parties to access the network. But they charge for that service and they can revoke access at any moment.

[106] The effect was similar to the creation of the Mosaic and Netscape browsers by Marc Andreessen, in the 1990s. By putting a friendly graphical interface on top of the HTTP open protocol, they enabled web access to mass users, and not only to computer scientists as was the case before, when the web had to be browsed from the command line.

Trezor emerged as a solution for storing bitcoin over the long term. Credit: Trezor



The Bitcoin Ecosystem. A number of thin applications built on top of the Bitcoin protocol.

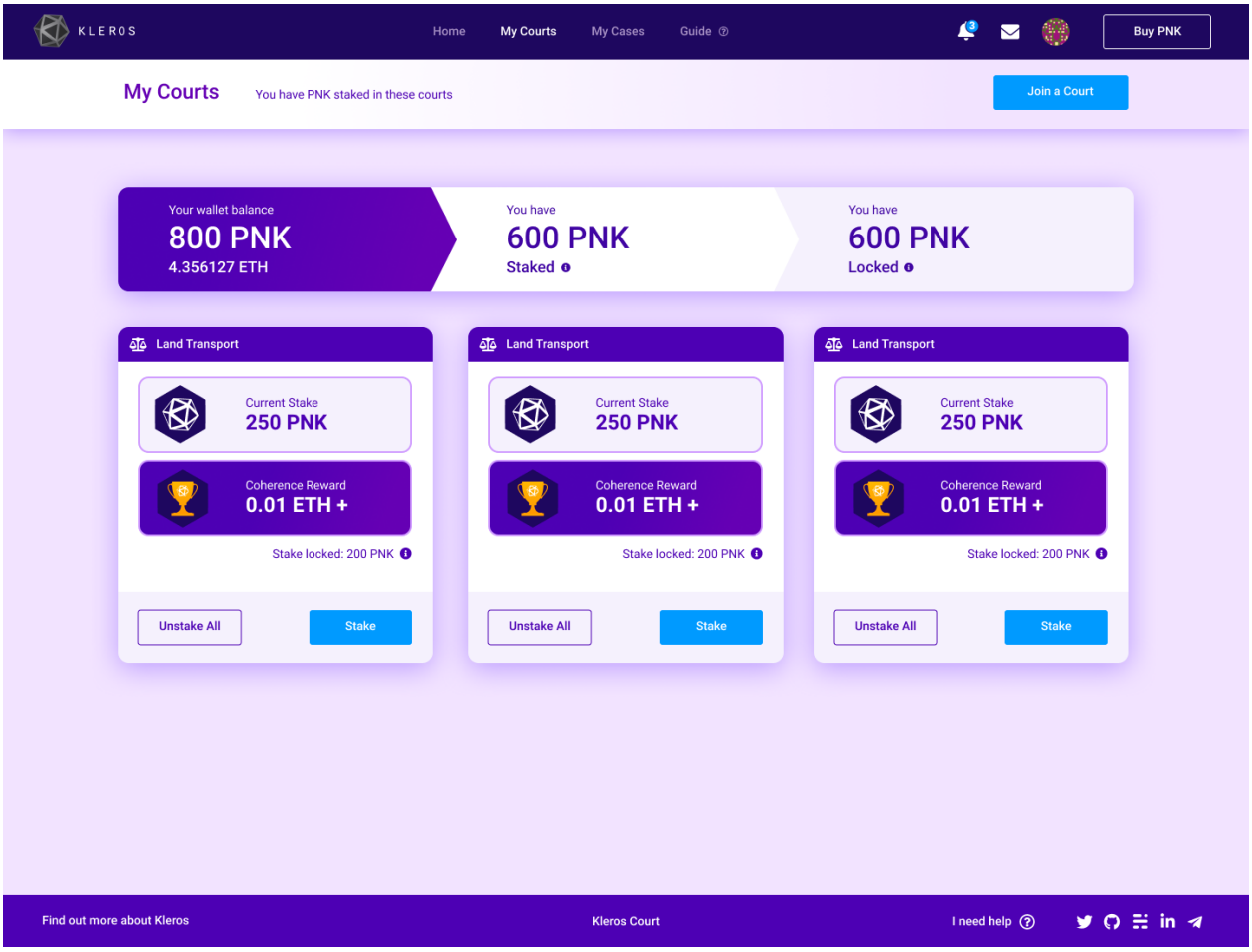
What Can We Expect of the Kleros Ecosystem

The history of the Bitcoin ecosystem may give us some clues about the likely evolution of the Kleros ecosystem.

Kleros is a general purpose cryptoeconomic protocol which provides incentives for users to use their time and skill to adjudicate disputes.

Just as Satoshi Nakamoto developed the Bitcoin Core client as a friendly way to use the network in the early days and as the Ethereum team developed the Ethereum wallet, the Coopérative Kleros is in charge of developing some applications.

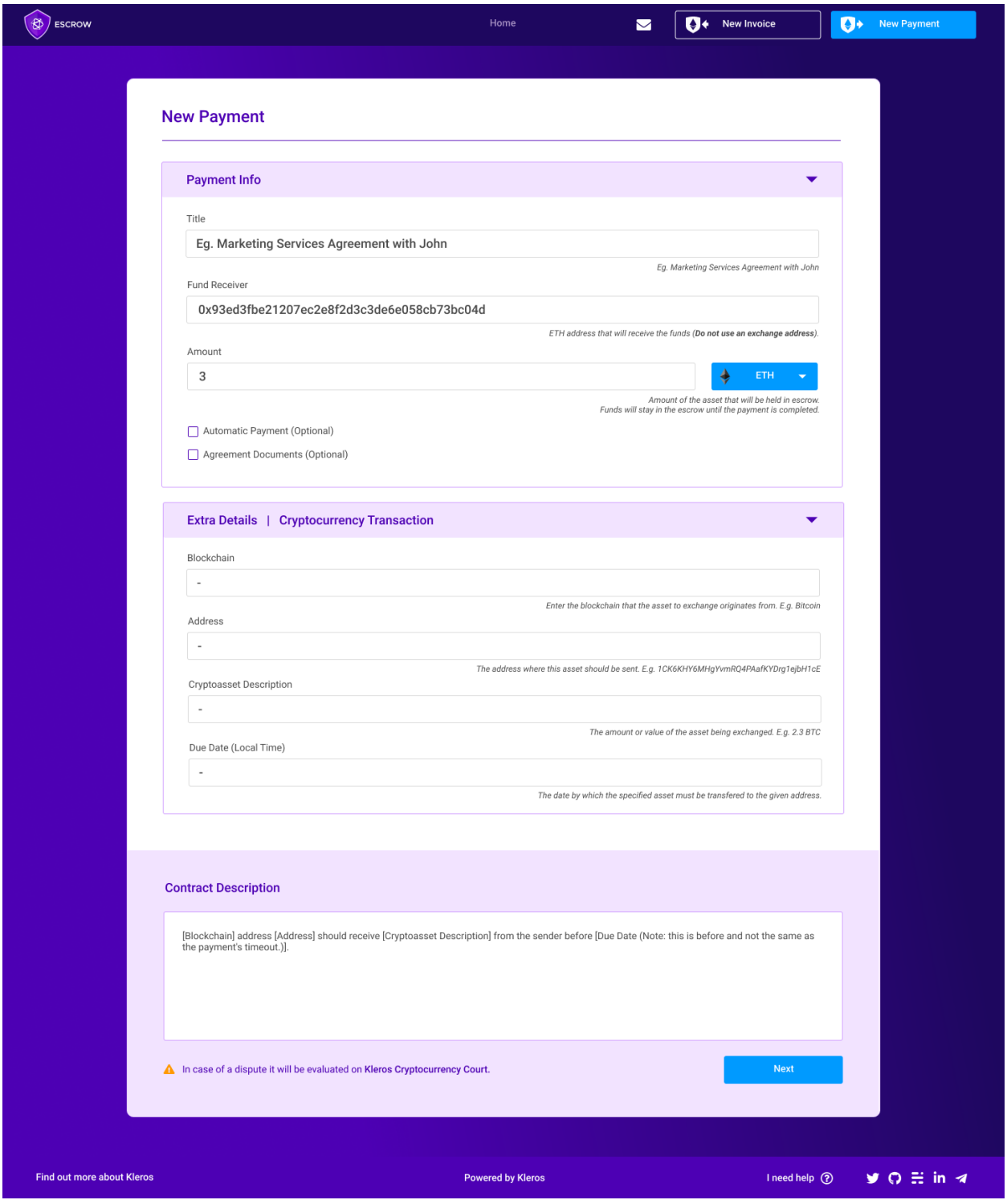
One of them is an interface which users can utilize to stake their tokens and rule on disputes.



Kleros juror front interface in which jurors can choose the court in which they wish to participate in, stake their PNK to be drawn for cases and when drawn, adjudicate cases, bring decisions and collect rewards for their work.

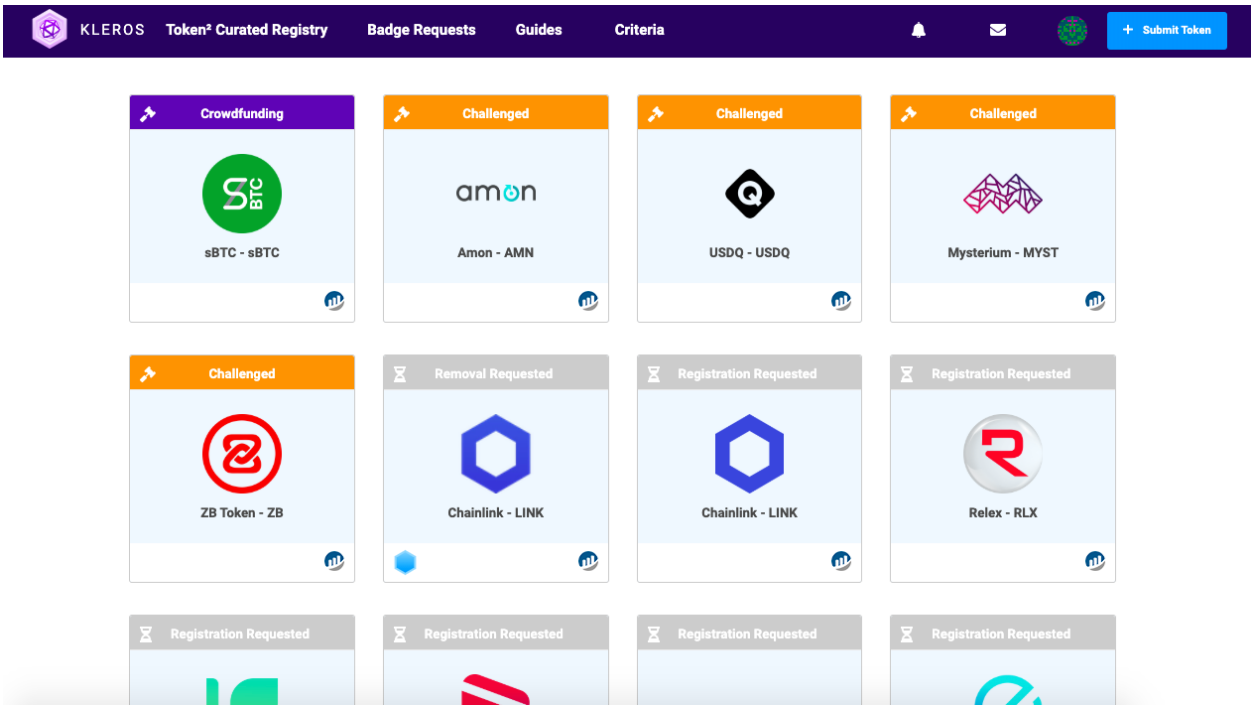
Coopérative Kleros is also building applications for three general types of use cases where Kleros can be used as adjudication protocol:

- An escrow application for helping users make transactions having Kleros as arbitrator in case a dispute happens.



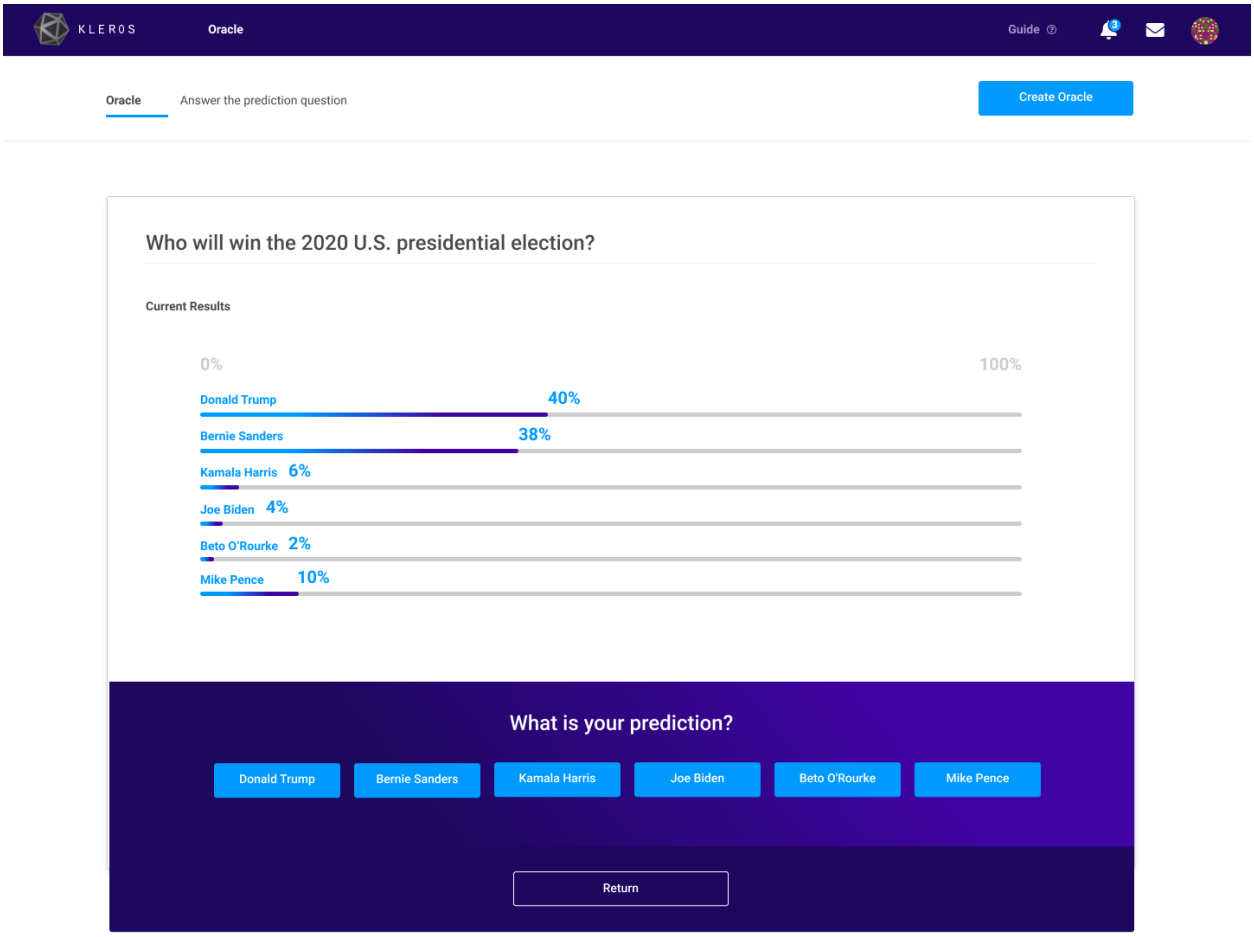
The escrow DApp allows for any financial transaction to be put into an arbitrable smart contract and if certain conditions of the smart contract are not met, the contract allows the signatories to dispute elements of the contract and send them to Kleros for adjudication.

- A token curated list application that can be used for deciding the content of a list in a decentralized way.



The Token Curated Registry is a curated list DApp which allows users to list valid tokens and dispute scam tokens in a decentralized way. This is a key use case in securing decentralized finance platforms.

- An oracle application that can be used for bringing external information on chain.



The Kleros Oracle DApp determines the real number value by collecting information from respondents. It is the first dispute based oracle of this kind in development to date.

These interfaces are still clunky. And it's normal that they are. They're the equivalent to the Bitcoin Core client for decentralized justice. The goal isn't that these particular apps will be used in the long run. They are just intended to bring the early use cases to bear and for testing the system.

The growth of the Kleros cryptonetwork will come from entrepreneurs building ODR applications on top of the protocol, addressing different use cases and customer segments.

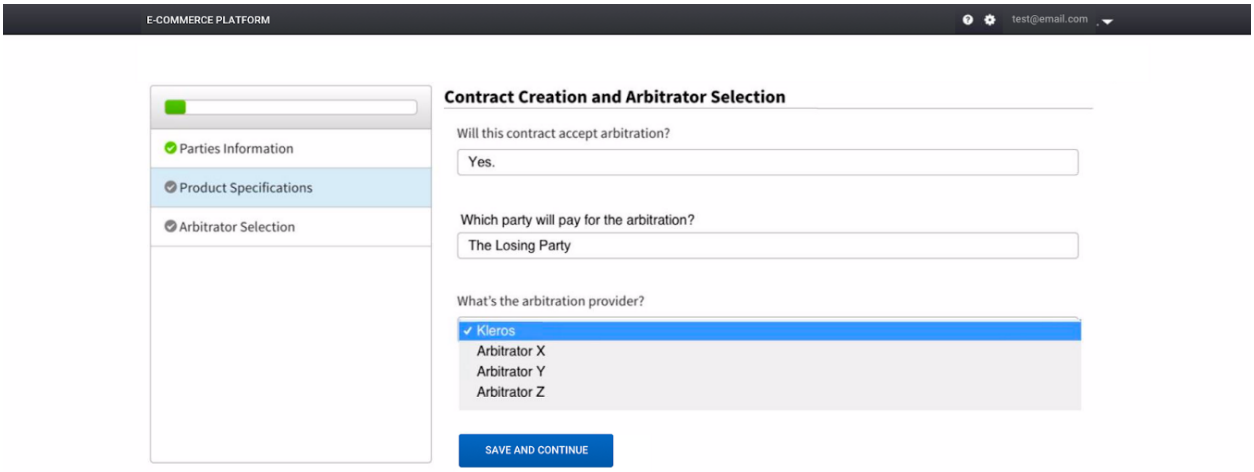
Justice as a Service for the Global Economy

In years to come, a number of decentralized platforms will start to replace Silicon Valley's big tech. These platforms will handle e-commerce, freelancing, social media and many

other use cases. But they will all have something in common. They will need dispute resolution services to replace the job that is currently done by the customer care department of centralized companies.

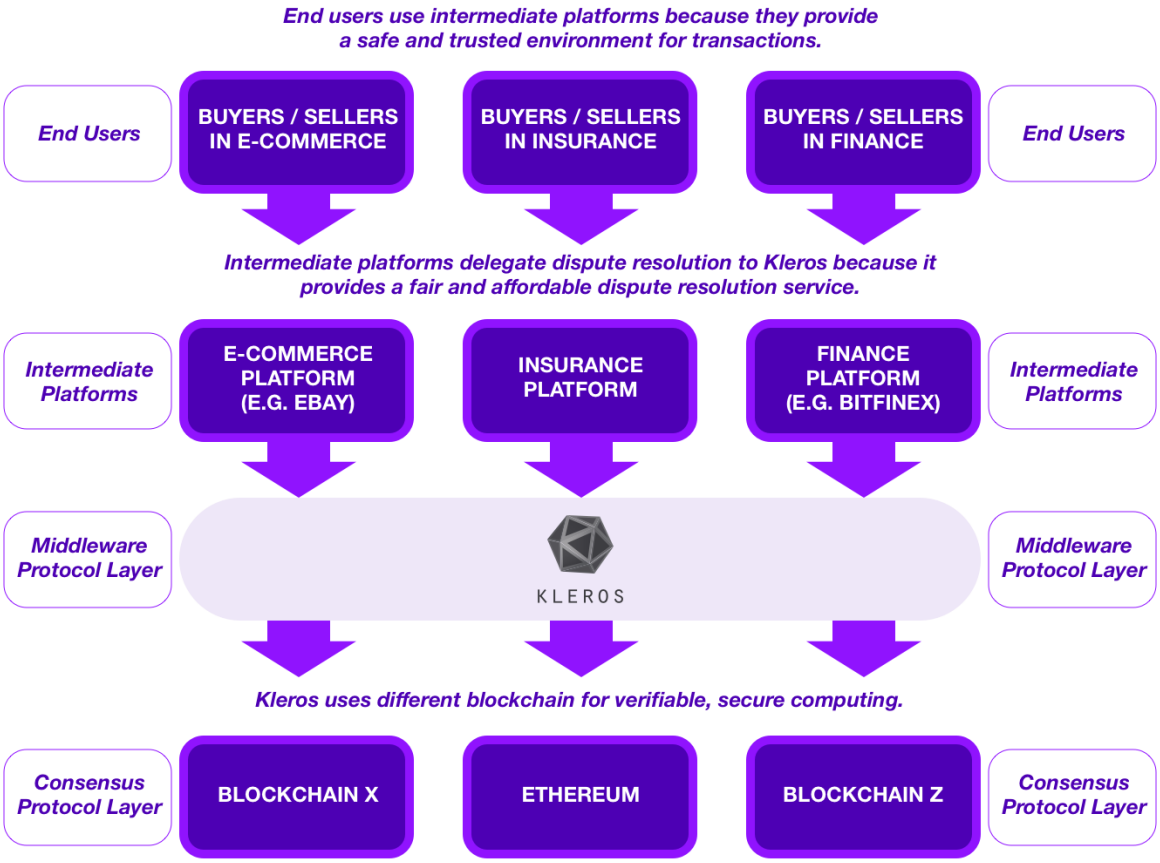
These services include content moderation, fact checking, review of plagiarism claims, a dispute over defective goods among many other applications.

The long term vision is that Kleros will become a protocol that will be massively used as backend for generating the incentive system that will enable millions around the world to use their skills to adjudicate all types of disputes.



We can imagine this to be the interface of an e-commerce platform where both parties of the contract choose an arbitration provider among all of those who comply with the smart contract standard. Platforms that integrate the ERC 792 Arbitration Standard and the ERC 1497 Evidence Standard in their smart contracts will be able to give users the possibility of choosing among different arbitrators as they will all be interoperable.

The current version of Kleros is built on the Ethereum blockchain, which is the most advanced smart contract platform to date. But, Kleros is a middleware protocol in the blockchain stack. Potentially, it could operate on top of other chains with smart contract capabilities. On top of Kleros, many different applications will plug into Kleros juror cryptonetwork for dispute resolution.



Within the blockchain stack, Kleros may be seen as a middleware protocol. A layer between the consensus mechanisms and the user facing applications.

How Deep Does the Rabbit Hole Go?

The success of Bitcoin and Ethereum was based on building an ecosystem. The same will be true for Kleros. The truth is that not even the Coopérative Kleros team knows what are all the possible use cases which could arise.

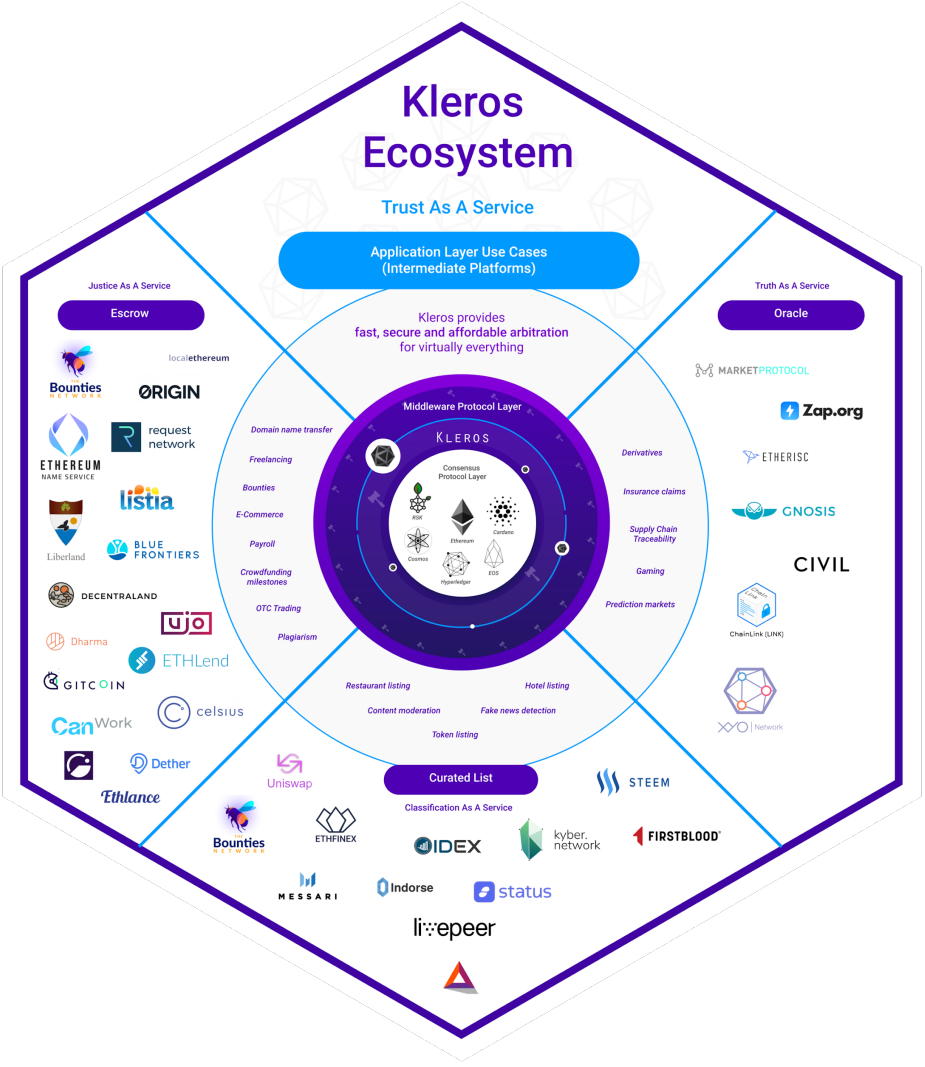
With a three-pronged approach, the chapter covers escrow use cases, with solutions to decentralized freelancing, token abuse in crowdfunding and derivative trading. List curation focuses on a general approach to curating content, from fake news to social media and as a tasteful addition, the chapter delves into oracle use cases through an analysis of gas price review disputes, using crowds as VAR in football matches and finishes with a long look at all the potential use cases of Kleros.

As the ecosystem matures, Kleros will prove that it can deliver fast, affordable and transparent justice in a growing number of use cases. More customers bring more entrepreneurs, more jurors, more developers and an increasing number of use cases. The

community will build the ecosystem on top of an open protocol. And this is how decentralized justice takes over the world.

In an article published in 1878 in the North American Review, Thomas Edison listed a [number of possible use cases] for his invention of the phonograph. Some of them came to materialize, such as the reproduction of music. Others were completely off. Edison thought that one of the key applications would be the recording of dying people's last words.

At Kleros, we wonder, 20 years from now, which will be the ones we predicted and which will be our biggest mistakes. We can only propose. The community will find the way.



As the ecosystem matures, many companies will use Kleros as a dispute resolution partner while others will build applications on top of the Kleros protocol. This infographic shows a number of companies from the decentralized ecosystem that could use Kleros for dispute resolution.

Escrow

By Federico Ast, CEO, Kleros

In the first chapter of the book, Barry Weingast argued that institutions and rule of law are key for economic development. This was true in the Middle Ages, when merchants created *Lex Mercatoria*, it was true during the industrial revolution and it still holds true in the Internet Age[107].

In the early days of e-commerce, people were reluctant to shop online for fear of fraud. Few had the courage to enter their credit card number into a website for fear of it being stolen by hackers. Also, few were willing to buy some good or service from a seller halfway around the world.

Fears eventually vanished thanks to the creation of e-commerce platforms such as Amazon and eBay, and payment systems such as Paypal. Today, users feel comfortable buying a t-shirt on Amazon because they know they can return it and get a refund. They feel comfortable renting a house on Airbnb because they know there is a dispute resolution system in place that will help them in case a problem happens.

These platforms, besides connecting buyers and sellers, offer escrow and reputation systems which provide a secure environment for transactions. Buyers know that, should a problem arise, they will get their money back. Sellers, on their side, know that the platform handling the payment will protect them in case of malicious behavior from the buyer.

In exchange for providing these governance mechanisms, these platforms take big cuts from each transaction.

With the coming of the blockchain era, a number of decentralized organizations are attempting to create networks of buyers and sellers. These organizations lack a dispute resolution system that is common in traditional e-commerce platforms. Failure to provide a secure and friendly commercial environment is one of the big obstacles to adoption of decentralized platforms.

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[107] For more information about *Lex Mercatoria,* see the interview with Barry Weingast on Merchant Law and Private Justice in Chapter 1 - Genesis: When Greek Lotteries Meet Medieval Law.

An important use case of Kleros is to provide dispute resolution for escrow services. Escrow can be used in applications as varied as freelancing, derivatives trading and crowdfunding, among many others.

Kleros strives towards becoming an important piece of infrastructure for fostering security in online commerce.

Kleros Escrow: Crowdsourced Justice for Secure Online Commerce

By Federico Ast, CEO, Kleros

**In the last decades, the world economy has gone through an accelerated process of globalization and digitalization. Clients hire freelancers from other countries and backers participate in crowdfunding campaigns from teams distributed around the globe.
As work and capital become transnational, cross-border disputes become more frequent. In particular, small claims which can't easily be solved by courts or traditional dispute resolution systems.**

As cryptocurrencies gave us the infrastructure for a global and seamless financial system, smart contracts will provide the legal infrastructure for these transactions to happen securely.

Let's take an example: Alice hires Bob to conduct a job online. But they only met on an online forum and don't really know each other's real identity. How can they trust each other?

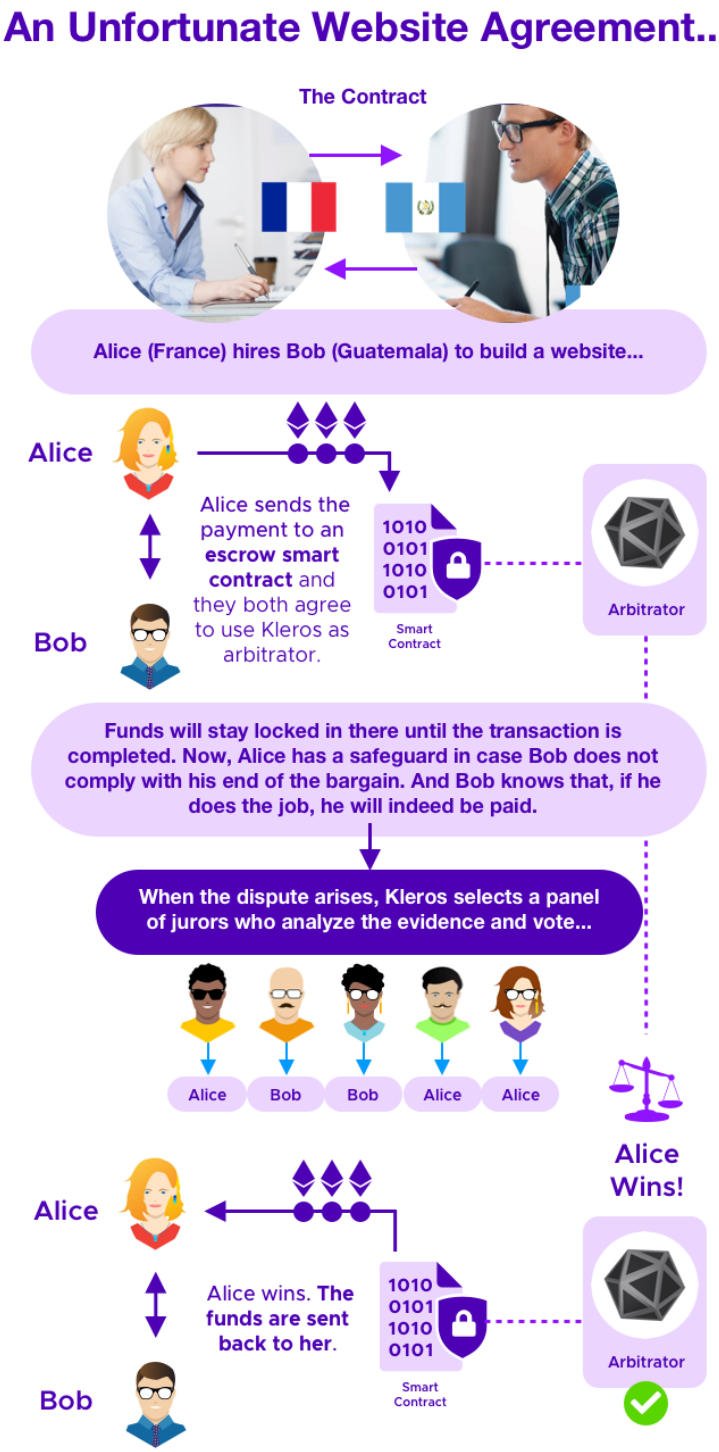
Should Alice send the payment and then wait for Bob to deliver the job? But what if he vanishes with the money? If Bob delivers the service first, how can he make sure that Alice will send the payment?

And what if Bob does deliver the service, but Alice deems that it was of lower quality than agreed?

Situations like this are extremely common in today's online economy. The only solution so far was using some e-commerce platform with an expensive escrow service, and these companies usually charge up to 15 or 20% of each transaction.

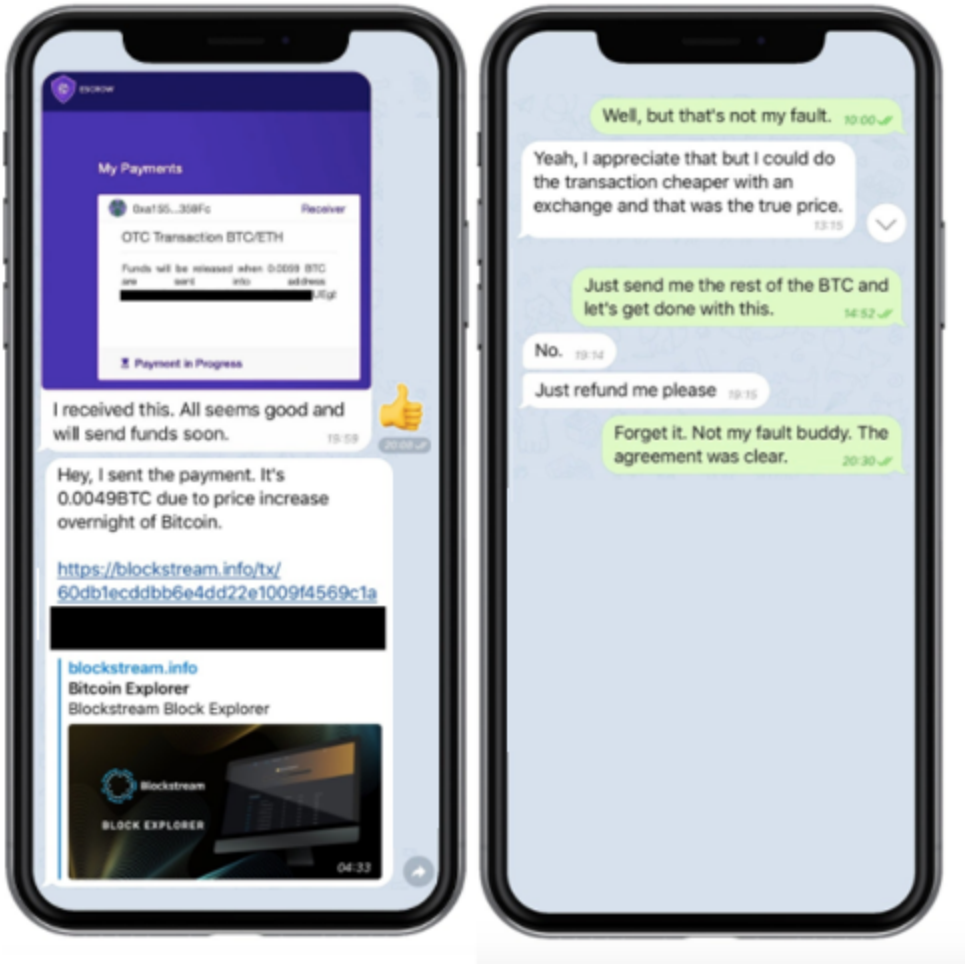
A trustless system to create escrow transactions backed by dispute resolution is a fundamental part of this new piece of global infrastructure. That is why I'm happy to introduce our new product: Kleros Escrow.

Let's see how it works...



An Unfortunate Cryptoasset Transfer...

Federico and Stuart have agreed to make an over-the-counter exchange BTC for ETH. This is what happened...



The Sky's The Limit

These are but two simple examples of how Kleros Escrow can become a fundamental tool for securing online transactions.

Other notable immediate use cases for the Kleros escrow are:

- Marketing services. A PR company promises to have a client mentioned in The New York Times. The client sends the money to Kleros Escrow, which will be released only if the PR agency delivers on its promise.

- Video production. A freelancer promises to do a review of a blockchain project. They agree with the client on parameters of editing quality, resolution and length. A dispute arises when the freelancer sends the video and claims the payment. The

agreement stated that the length had to be at least 1 minute 30 seconds, but the delivered piece was only 59 seconds long. Funds are sent back to the client.

- Written content. A freelance writer promises to write a press release for a blockchain project. The client requires that the press release meets some quality standards specified in the contract. If the quality of the delivered product is not up to standard, the dispute goes to Kleros jurors.

- Exchange listings. An agent promises a project that it will have its token listed in X exchange. The client sends the money to the escrow, which will be released if the coin is indeed listed where promised.

These are the initial use cases of the Kleros escrow, seen as the lowest hanging fruit. These are, of course, not final, or even close. Our escrow solution can cover a wide range of cases, notable being:

- Website integrated payment. Websites can display payment buttons allowing their customers to make escrow payments. If customers do not receive goods and services as they should have, they can request a refund. The decision is made by Kleros jurors.
- Milestones in crowdfunding campaigns. Project managers pledge to develop a product and set up milestones. Each milestone releases a specific part of the funds raised in the crowdfunding. If milestones are not reached after a deadline, funds are reimbursed to contributors. Kleros solves claims based on milestone completion. Should the next payment be released or not? To learn more about this use case, read **this post**.
- Car Insurance: Bob rents Alice's car for the weekend. Bob sends $1000 into an escrow which will be refunded after the car is returned in good condition. Alice claims the car was damaged. Jurors estimate the damage at 300$. That amount is then sent to Alice from the funds deposited in escrow and the remaining $700 are refunded to Bob.

OTC exchange, freelance production, crowdfunding, e-commerce... What all these cases have in common is that they are disputes about how funds held in escrow should be awarded between parties claiming to have rights to them.[108]

[108] Start using Kleros Escrow today!

Linguo - Making Freelance Translation in a Trustless Environment a Reality

By Ferit Tunçer, DApp Developer, Kleros

After the success of Kleros Escrow in securing freelancing transactions, the Kleros team announces the coming of Linguo, a fully decentralized and trustless translation application.

Translation is a special sub type of freelancing, where the customer receives a service, but cannot easily verify its quality. Since the customer lacks knowledge of the language, how can she or he verify that the translation was done properly?

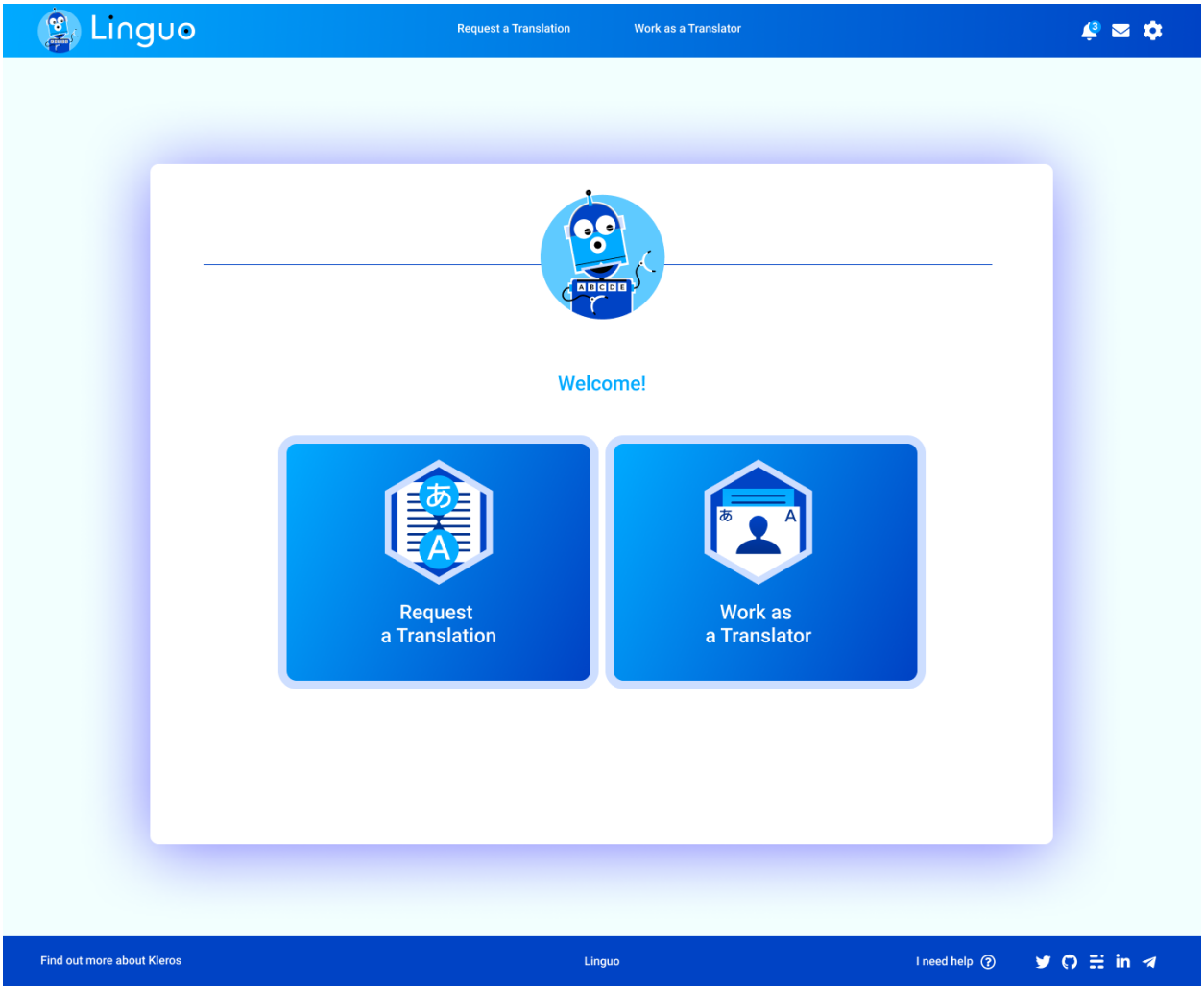
Up to now, the hard-to-verify nature of this type of work was solved by hiring trusted translators. Knowing someone who has significant knowledge of the target language or a professional in the field meant that you would use their services. Otherwise, the customer would have to turn to a certified translator, which is a more expensive option.

Then again, the customer still needs to trust the certifying authority (be it a government or a company) and assume that the certified translator did an efficient job in order to protect their reputation and livelihood.

But, is there a better and trustless way to handle translation work?

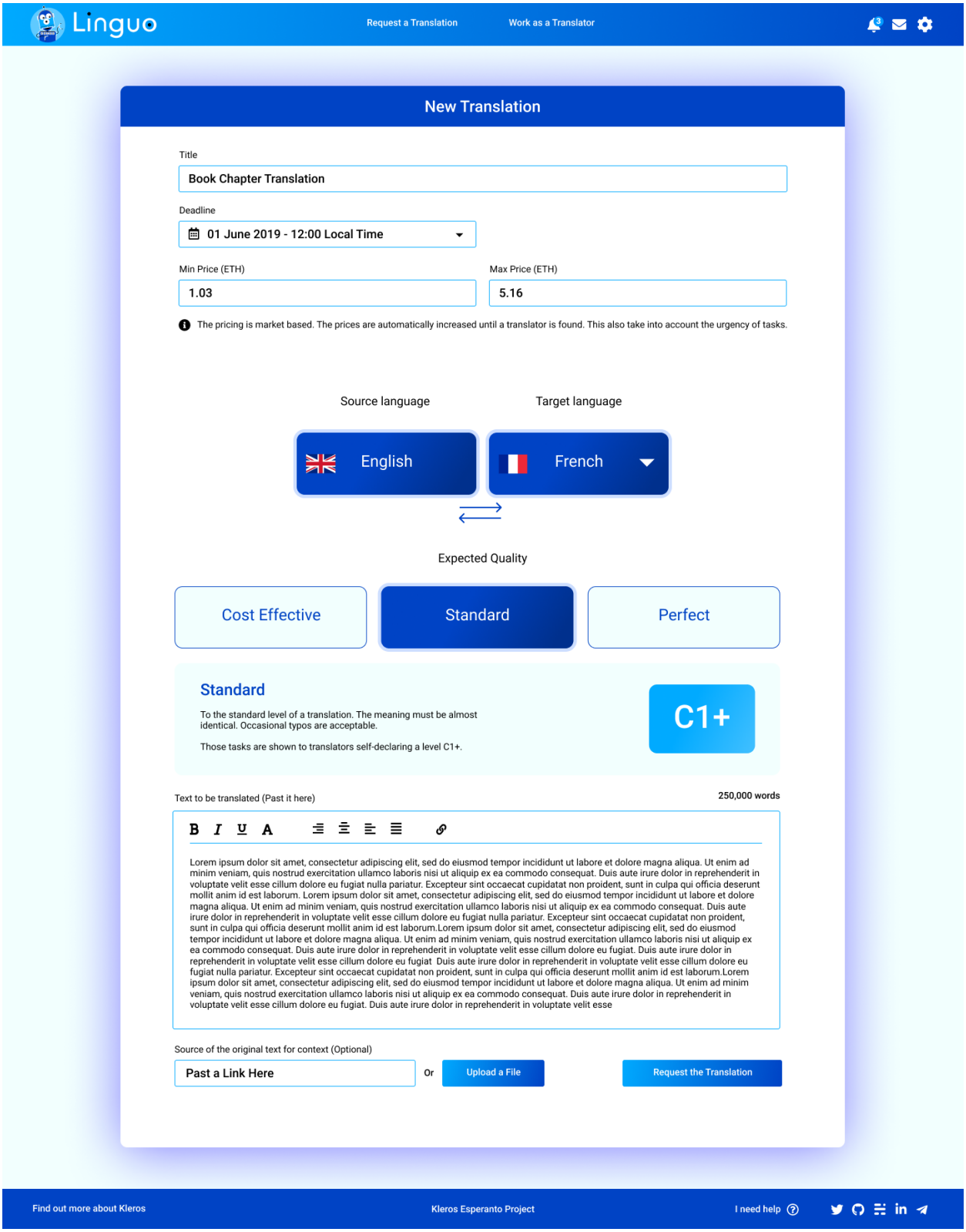
Enter Linguo, a Trustless Translation DApp

To fully overcome any obstacle in having a perfect translation, we are developing Linguo, a trustless app for customers to hire translators. Linguo relies on the working logic of the Kleros Escrow, which guarantees the security of all transactions between two parties that do not trust each other.



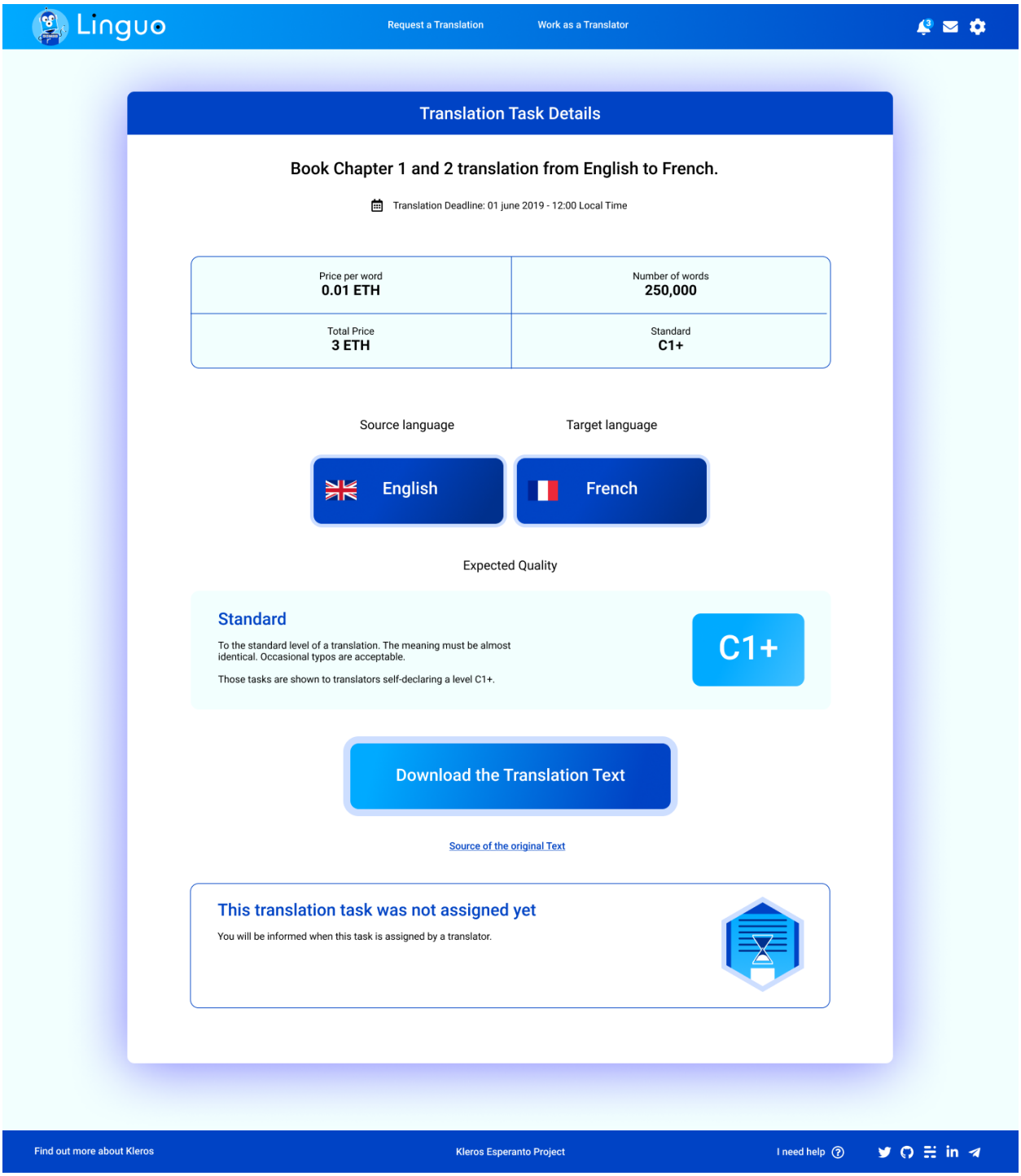
Welcome page

Alice decides that she wants a book chapter translated from English to French. She opens Linguo and specifies the translation level as at least C1. She also specifies a translation deadline, and a minimum of 1.03 ETH and maximum of 5.16 ETH she is willing to pay.



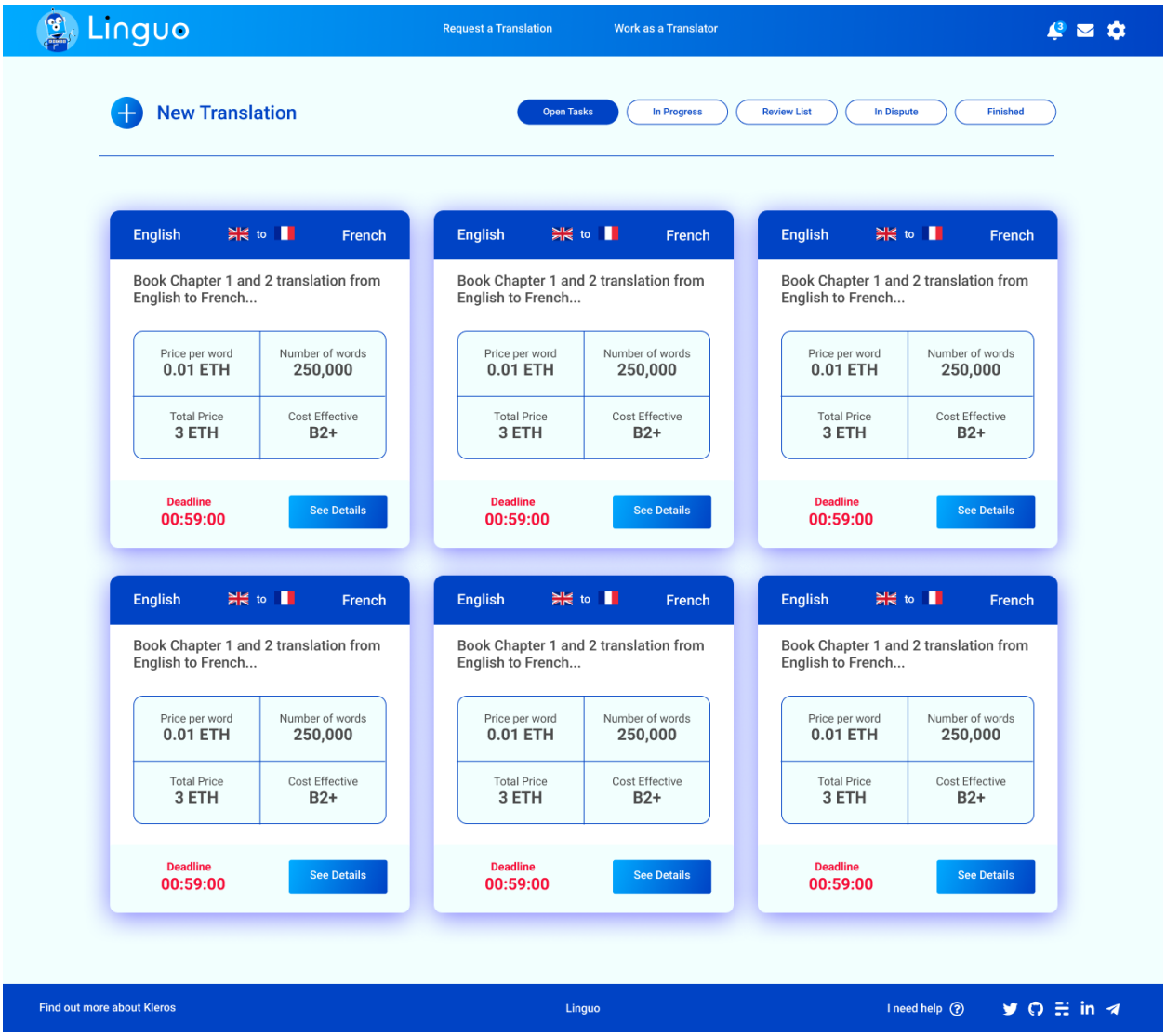
In the task submission form, Linguo allows users to choose the quality of the expected translation and how much they are willing to pay.

Alice needs to submit the request by escrowing the maximum payment amount and wait for a translator to take the job. The task first goes live with a promised 1.03 ETH fee. While she waits, the price linearly increases as the deadline draws near, to a maximum of 5.16 ETH.



A translation task was posted and is awaiting a translator to take the task.

Bob is an experienced translator between English and French. He spends some time every day looking for translation work on Linguo. He just noticed a 2 ETH promised payment for Alice's task. He escrows a stake as collateral and picks up the translation.



List of open translation tasks

After Bob finishes his translation, he submits it for a review. All translations are open for review for a time and anyone who notices mistakes can challenge the translation and get rewarded the translator's stake.

Since Bob did an excellent job, no one challenges his work and he is rewarded with a payment of 2 ETH. Alice gets the rest of her funds (5.16 ETH - 2 ETH = 3.16 ETH) back.

But let's imagine that Bob did not manage to do a good translation. Eve, another regular use of Linguo, notices mistakes in his work and believes it doesn't meet the requirements. She challenges the translation by escrowing a stake as collateral and the dispute goes to Kleros. Depending on who Kleros says is right, either Eve gets Bob's stake and Alice gets refunded or Bob gets Eve's stake and gets his regular payment from Alice.

In a case where the translation is not submitted in time, Alice receives Bob's stake as payment for time lost.

The basic idea behind the Linguo project is simple, as it is genius - crowdsource wisdom to help create a more efficient and seamless process of communication across borders and continents. Everything done in a trustless environment, where the written word gets the respect and attention that it needs.

Kleros, the Missing Link to Decentralized Freelancing

By Stuart James , Director of Operations, Kleros

Freelancing has changed the modern workforce irrevocably. Few other innovations in the business sphere have had such an impact in such a short time frame. According to a Forbes article from 2017, freelancers now make up a staggering 35% of the US workforce. That's almost 55 million in the US alone.

In little over a decade, the number has risen from 10 million (or 7.3%) to one in three of the US working populace. UpWork, which is one of the 'Big Three' freelancing platforms, deals with more than $1 billion worth of job postings annually with Freelancer.com and PeoplePerHour in similarly valued territory.

Having worked for many years as a freelancer, I've seen the continued erosion of workers earnings toward running costs, development, support and profit of the respective sites. The companies in question would argue that, without their existence, sellers would receive less income (or no income at all) and thus justify their right to the large cut (up to 30%) taken from the final invoice. Be that as it may, it seems inevitable the freelancing ecosystem will move to a blockchain based environment as and when the infrastructure is complete.

However, as it stands, much like the rest of the tech economy, the big players have firmly entrenched themselves and look unlikely to be usurped by the crypto pretenders in the near future. The competitors in the decentralized sphere are still far behind making inroads to the main platforms user base.

Let's take EthLance, a perfectly acceptable decentralized freelance marketplace. It's well designed, looks pretty, functions well, offers 0% fees and has no restrictions on membership.

However, it currently suffers from a few major flaws.

The first one is lack of volume. A quick scan on the 'Find Work' page shows a grand total of four job postings made in the last week. UpWork on the other hand, probably counts closer to four job postings a second.

The second one is the lack of a reliable dispute resolution system. From the comment made by EthLance dev Mavdas, it's clear the lack of dispute resolution and functional escrow is hampering the greater adoption of decentralized freelancing services.

Should EthLance or any other decentralized platform solve this issue, the end user benefits are vast.

upwork™ formerly oDesk	Ethlance
Employees = 250 - 500 people	14 smart contracts
Total funding = $168 million	Unknown Likely to be < $100k
Freelancer fees 20% for the first $500 billed with the client (after extra cost and transfer fees it's closer to 30% before	0% other than your residing countries relevant tax.
Dispute resolution = Potentially hundreds of support staff costing millions per year, buyer bias.	None as of yet.
Payment transfer time = 2-3 days	Around 15 seconds after successfully submitting your work or, until the next block confirms.

Conditions on the two respective platforms as of 2018.

How Kleros Can Help

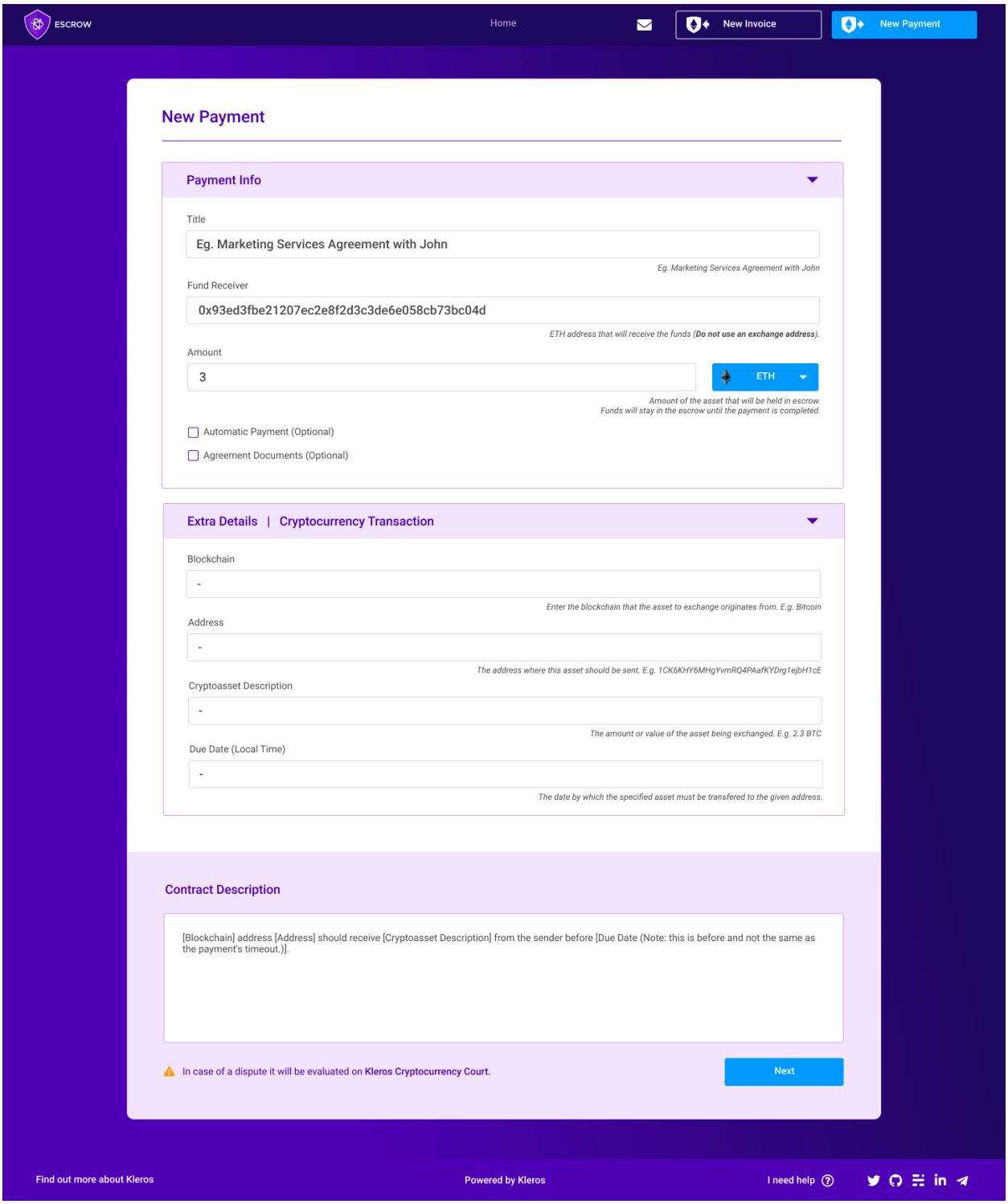
Kleros can provide the low cost dispute resolution necessary to allow decentralized freelance platforms to flourish. In doing so, they can offer the same level of security and efficiency their centralised peers do. Kleros can provide the 'trust as a service' necessary to bring confidence to both buyer and seller in this brave new blockchain world.

Decentralizing arbitration brings with it another huge benefit, namely, levelling the buyer / seller bias when disputes arise.

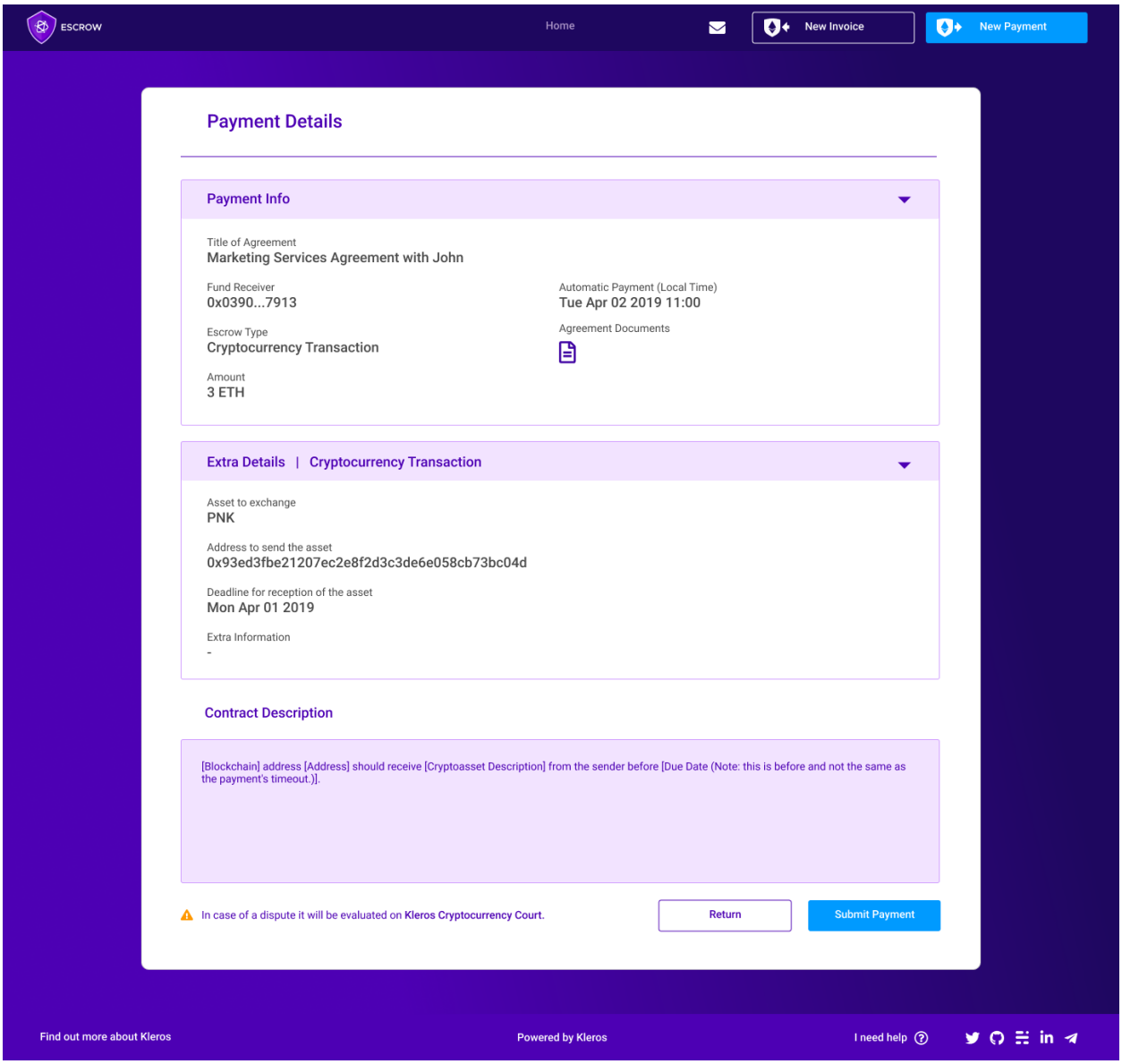
In the case of a dispute, centralized freelance platforms will on most occasions side with the buyer. It's no real surprise, since buyers are ultimately funding the platform. With decentralized platforms using Kleros as the arbitrator, this is no longer true. Both buyer and seller start on an equal footing should a dispute arise.

Kleros can be tailored through to cater to any market no matter how large, or niche it may be. From the more commonly expected disputes such as the example below, to very rare cases with few experts in the field.

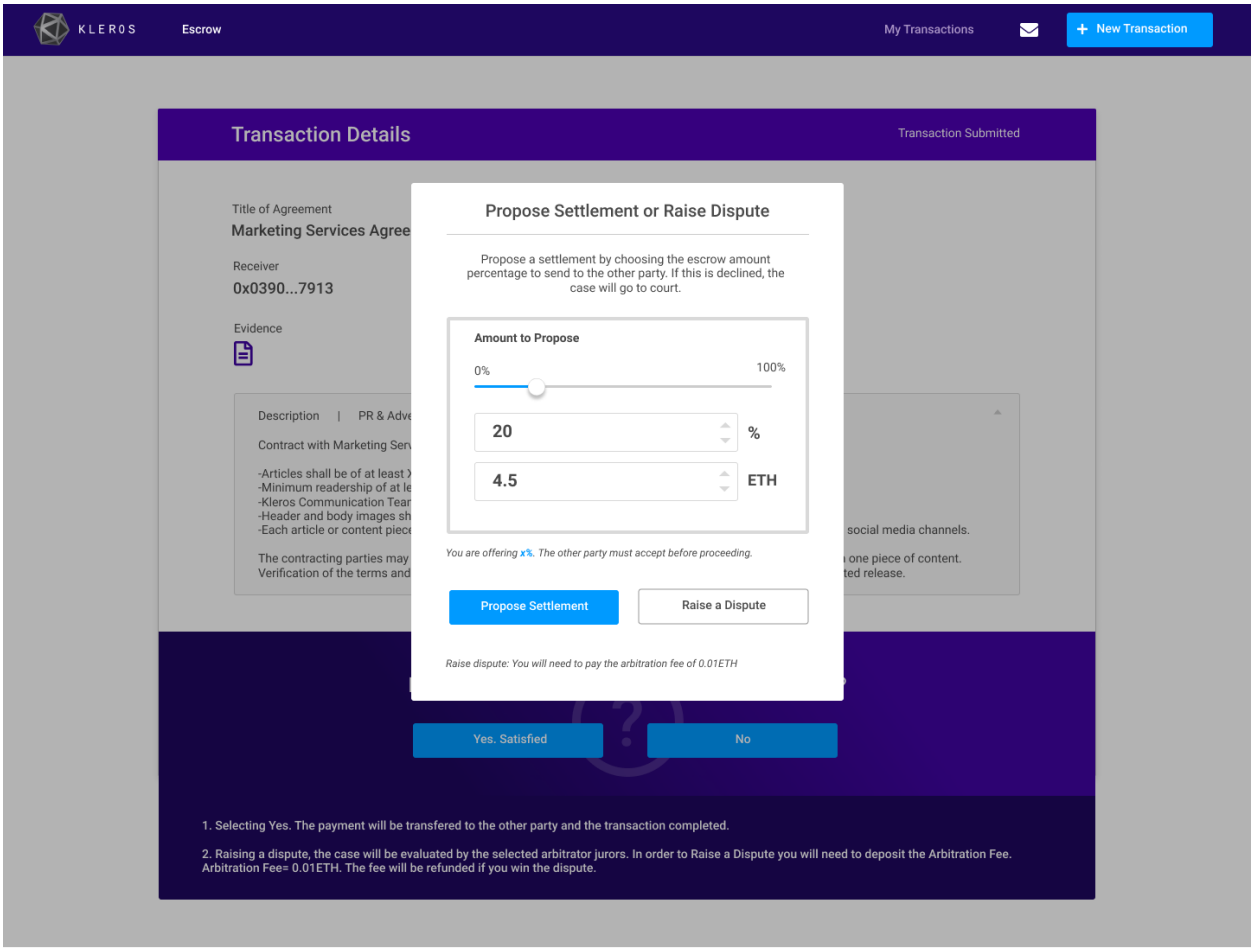
Decentralizing arbitration opens the door to every single person on earth contributing their knowledge about any subject. You could reside in California, whilst a leading expert on your topic picks through the evidence of your dispute from the Outer Mongolian Steppe.



The creation of a new transaction on the Kleros escrow for the buyer.



A review of the escrow contract on the buyer's side.



A proposal for settlement or the creation of a new dispute by the buyer if the conditions of the contract were not met.

To Conclude

The large freelancing platforms have provided income to many, a second job or the ability to operate in foreign markets thousands of miles from their own. Some 20 years ago, it would have been unthinkable to contract a reputable and skilled Korean translator from the comfort of your own home at an incredibly cheap price point within minutes of searching.

Finding a reputable web developer at urgent notice to fix a malware your website contracted was a tough ask, not to mention expensive.

Now, we're blessed by the ability to do both, cheaply, easily and all whilst still in our pyjamas. The price to pay however, has been complete centralization over policy making, high fees,

buyer bias all in the name of expansion, greater profit and increasing overheads from centralised actors.

Kleros' utility towards freelancing is only the tip of the iceberg, there are a myriad of possible use cases which could benefit from our dispute resolution, each bringing with them significant benefits for the end user.

Kleros and the Future of Crowdfunding

By Federico Ast, CEO, Kleros and Clément Lesaege, CTO, Kleros

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The rise of token sales is unstoppable. According to PwC, in just the first half of 2018, over 17.7 billion dollars were raised with this mechanism, surpassing investment by traditional venture capital firms.

Crowdfunding is one of the key economic trends of our time. The rise of *security tokens*[109] will empower small investors from everywhere to finance projects from halfway around the world.

However, as is usually the case with new economic practices, situations of abuse have occurred, including companies vanishing with backer's money.

Financial regulators are monitoring this new phenomenon closely. But, the development of a framework for crowdfunding can be challenging for governments having to tackle a 21st Century problem with 18th Century tools.

When traditional, state legal systems were developed, nobody was able to foresee that some day they would have to deal with crowdfunding. Jurisdictional boundaries don't play well with a practice where thousands of participants from dozens of countries enter into a contract with a startup team which is also distributed around the world.

The decentralized global economy requires a global and decentralized institutional framework native to the Internet Age. Kleros may contribute to this framework by creating a safer environment for crowdfunding and token distribution events.

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[109] Security Tokens (STO) are cryptographic tokens that represent tradable assets such as bonds, options or company stock.

*Image: **Greed**, engraving by Jacques Callot, France, circa 1621 ,Los Angeles County Museum of Art.*

How it Works Now

A team starts a project. They build a website, define milestones for the product and set a date for a token sale.

Backers from all over the world send payments in crypto to the team. In exchange, they receive some tokens. Backers funds stay in an address controlled by the team.

After the token distribution, different things may happen. In the best case scenario, the team executes the plan as promised and develops the product. In the worst case scenario, they simply vanish with the backer's money.

But things can go wrong even if the team behaves honestly. Running a successful crowdsale (and raising millions of dollars) does not necessarily mean that the team is qualified to run a software company. Even absent ill intention, they may end up misallocating that money because of incompetence.

The traditional startup world has a set of practices and legal safeguards to minimize such risks. There are laws dealing with scammers and specialized investors that are usually good at spotting rotten apples. Besides, teams don't get all the VC money upfront. Funding

follows a predefined sequence (seed, Series A, Series B, etc.) where founders have more control over resources as they prove their ability to reach product/market fit and to run the company.

A team failing to reach product/market fit (maybe because their product was based on a wrong market hypothesis) or that is unable to manage the company will not make it to Series A. If it fails, then damage will be contained to seed round investors, usually amounting to a couple hundred thousand dollars.

The big question is: how can risk be reduced in crowdfunded projects with distributed backers and teams?

The blockchain ecosystem needs a framework against predatory behavior. Credit: George Hodan, publicdomainpictures.net

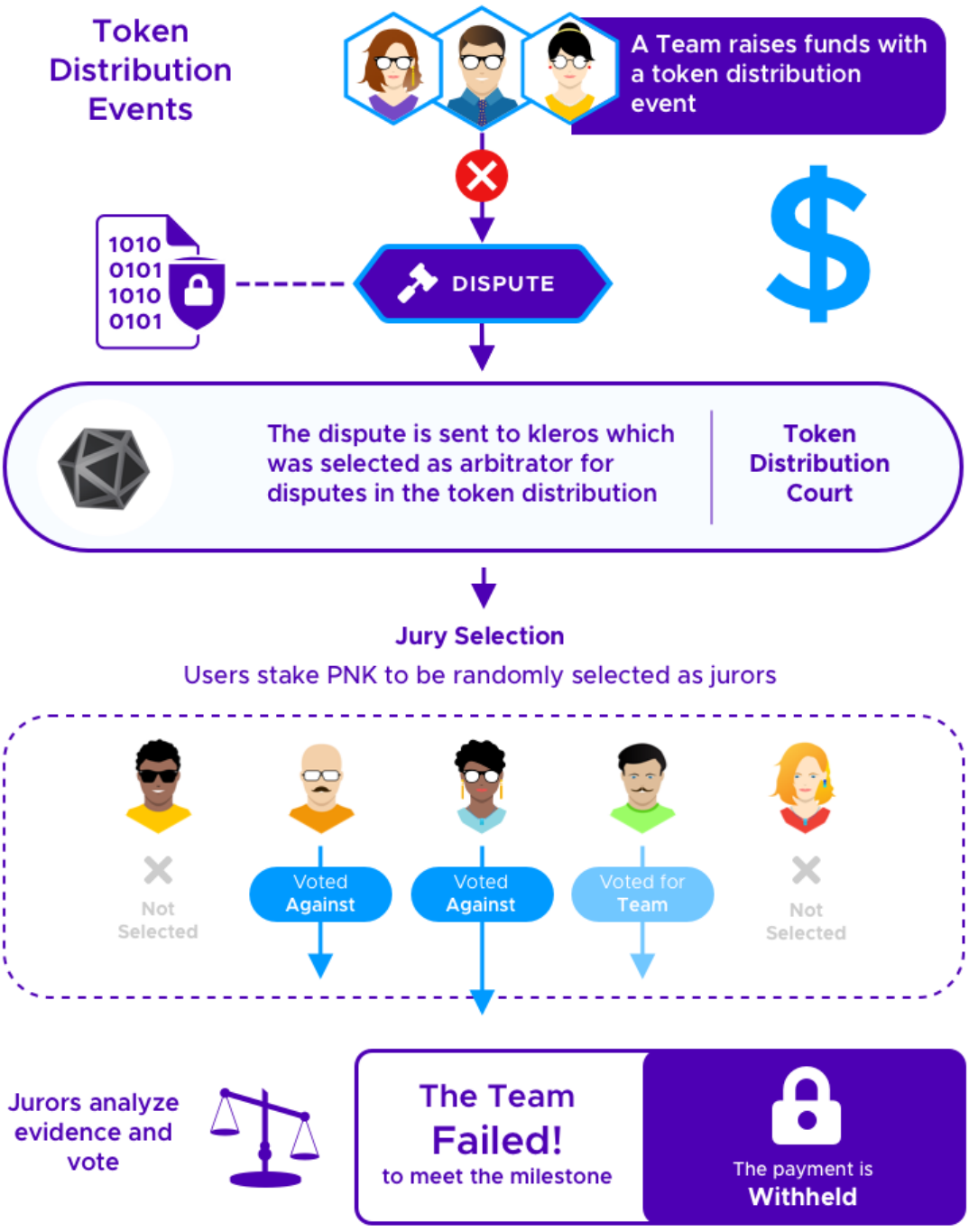
How it Should Work

A team starts a project. They build a website, they define milestones for the product and set a date for a token sale.

During the crowdsale, backers from all over the world send payments into a smart contract which will release funds to the team as some predefined milestones are met. For example: "Next payment will be done when the team releases a new version of the software with substantial improvements".

When the team claims a milestone is reached, token holders have some period of time to dispute it. If a sufficient amount of token holders reject the milestone completion claim, a dispute arises between the team and the token holders (Was the milestone met? Should the money be released?). Kleros is brought in as the dispute resolution mechanism.

Kleros selects jurors to evaluate the agreement along with the evidence and vote a decision: "Conditions are met/not met for releasing the payment".



How Kleros can help in token distribution events.

It's important to note that Kleros acts as a safeguard both for token holders and team members. The token sale is an agreement that works in two ways. Team members make a commitment to the token holders that they will build the product following a predefined timeline. Backers promise that funding will be available for the team, provided it meets the milestones that were agreed upon.

It is important that the token holders do not simply have the choice of voting to be reimbursed. Even if the team reaches the milestones, backers could ask for their money back if the amount of ETH locked is worth more than the tokens. In this case, Kleros works as a protection for the team.

In these times, there are plenty of people claiming that token sales should be forbidden because it's a fertile ground for scams. But crowdfunding has a *raison d'être*: it can help finance important projects.

We wouldn't want to forbid selling apples just because some happen to be rotten. Instead, we need better methods to detect the bad ones and prevent them from poisoning the system.

Kleros may give backers a high degree of control over the funds committed to support the project. If a team fails to produce the expected results, token holders may claim their money back, and the decision would be made by a decentralized jury.

Kleros, Bringing Fairness to Financial Markets[110]

By Nicolas D'Agnillo, FInancial Analyst, JP Morgan

James Harvey, an interest rate derivatives trader in a regional bank, had to execute a trade of an IRS in order to hedge the risk of his portfolio against potential losses due to expected market fluctuations.

Therefore, he decided to enter into a 60mm 10Y USD IRS to exchange a cash flow based on LIBOR + 50 bps for another cash flow based on a 3.0115% fixed rate.

James logged the transaction in a SEF platform (*Swap Execution Facility*, an electronic platform for this kind of derivatives trading) and executed the trade against the first counterparty to reply the RFQ (request-for-quote, one of the protocols used to trade in these platforms).

Just a few minutes after the trade was accepted, he noticed that he entered a fixed rate of 3.1015% instead of the intended 3.0115%. By the time he realized, the market had already moved adversely and his book PnL was deep into red numbers. Those 10 bps were crucial to save the day.

Hastily, James reached to the counterparty and asked to amend the trade to the original price, but they refused. He then turned to the SEF representative. He replied that the trade could only be amended with the agreement of both parties.

James finished that day with a significant trading loss, all because of a mere typo and a dispute (amend the trade vs. do not amend it) that wasn't resolved.

Why Trading Disputes Matter

Over-the-counter derivative markets are by far the largest in volume of all financial markets. They are used by hedgers, arbitrageurs and speculators alike. These markets comprise a wide range of products, from swaps (a universe in their own) repos, forwards, to IR options, FX options but also exotic and structured products or even CDOs (sound familiar?).

These are the markets where traders, just like James Harvey, operate. According to the Futures Industry Association, the total nominal volume negotiated in SEF platforms amounted to a total of 180.691.690.967.244 USD (180 T for short, but note the length of the number to understand the magnitude of these markets).

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[110] This article is the result of the Fellow's work as part of the Kleros Fellowship of Justice Program. To see all reports done by our Fellows, have a look at the The Kleros Fellowship of Justice Library.

The percentage of trade cancels and amends is estimated at a 1.5%. The figure for trades never settled because disputes during the process of confirmation can represent over 5% of the transactions in some markets.

The total volume negotiated in SEF platforms amounts to 180 trillion dollars. The percentage of trade cancels and amends are estimated at 1.5%. Credits: Pixabay

Most trading operations take place in electronic platforms like the SEF used by James Harvey.[111]

Even though automation has increased over the years, execution errors (human or machine caused) and conflicts persist, which demand both human resolution and a great deal of good judgement by representatives appointed by trading venues.

Conflicts include trades cancels, trades amends, trades executed at off-market prices, debates around the clauses of the agreement details (some of them are particularly

[111] The regulators designated them by a plethora of names to refer to each specific instance and player of the ecosystem. Lots of acronyms were born: ATS, ECNs, MTFs, OTFs and so on.

complex in nature, like the ones in some types of swaps), and the verification of credit events.

Trading platforms usually provide their own set of rules to solve any issues that may arise and are responsible for guaranteeing an environment conducive to fair trading. They carry the burden of conflict resolution themselves.

While electronic trading and channeling of transactions via this kind of platforms might increase transparency compared to the classic bilateral or broker-dealing trading (some trades are even mandatory to be reported to regulators i.e TRACE), the risks of their autonomy and self-regulation are deemed to remain high.

The Problems with SEF Platforms

These platforms have been under increasing regulatory scrutiny, due to different violations of regulatory practices, industry standards, or conflicts of interests.

Many experts have pointed out several problems (still to be addressed):

- Trading venues have incentives to favor the clients with higher traded volumes (in some fee schemes they are the principal income generators).
- Rulebooks might have gaps and their application and may become subjective. Any subjectivity in judgement isn't very appreciated.
- ATS sometimes are owned by market participants themselves, which is a conflict of interest in and of itself and creates a potential bias in judgement.
- Conflict resolution demands resources, and ATS have to allocate resources specifically for that purpose, hiring specialized staff with the ability to apply their specific knowledge to a set of sophisticated trades.

A plausible solution to these issues would be to eliminate any conflict of interest by delegating the conflict resolution authority to an independent third party. This already happened, for example, with another specific source of conflict: the calculations sustaining the value of certain derivatives contracts, which were delegated to calculation agents.

This solution would also eradicate any reputational risk for both the trading venue and its clients associated with the system of resolution of conflicts, or any regulatory risk that might arise.

It would even reduce litigation costs in case of gaps in rulebooks or conflicts concerning contract clauses.

And it would be even better if the system put in place by this third party to pass judgement was absolutely inviolable, by its very definition impossible to corrupt and its decisions resting upon the ability of the best available court of financial experts.

What if the system was based on blockchain technology and absolutely confidential? What if it could be embedded into the very code of the traded contracts? It would certainly improve the quality of conflict resolution, as it would improve the fairness, cost efficiency and trust in the financial markets.

Kleros, a First Step Towards Fair Resolution in Financial Markets?

Kleros could be embedded into the trading platforms as a way to channel any dispute between the registered counterparties. Every trader (or trade desk support on his behalf) would be able to submit a trade for review by a Kleros specialized court in case a conflict had arisen and she didn't reach an agreement with her counterparty.

Kleros' unique combination of blockchain technology and game theory would make it possible to draw a qualified jury among a pool of experts and guarantee they reach a fair decision (and to determine, for example, if the trade has to be corrected, or should remain the way it was entered into the platform) based on the trading venues' rulebook, laws and regulations, industry conventions or by applying the experts' judgement case by case.

This solution would be by far more efficient than the current negotiations among multiple counterparties' back offices, trading desks (or even legal counsel) and would certainly contribute to the reduction of the number of trades not being settled because of misunderstandings, execution errors or other conflict factors.

List Curation

Have you ever wondered how importants lists really are? Many things we see online are organized into lists, from our eBay product listings, Facebook and Instagram feeds, Google searches, places like Booking and AirBnB - we use lists every day, as they are the most effective way of organizing reliable information.

All of the systems named above use some kind of curation to separate relevant information from irrelevant information. As centralized entities, algorithms and human moderators are used to a great effect in order to organize and sort quality information. Moderators, human or otherwise, leverage user inputs such as reviews and reports about violations of terms and conditions in order to promote and demote, include and exclude and order items on the lists.

This gives the centralized owner considerable power. It is the administrator who will ultimately decide which websites will be allowed into the search engine, which restaurants will be accepted into the list or in which way you'll be able to scroll through your feed.

Decentralized platforms, on the other hand, require a different mechanism in order to facilitate this process. They require curated lists where users themselves can efficiently organize information and protect it from not just irrelevant submissions, but also malicious behavior.

Cryptoeconomic mechanisms represent the key to decentralizing lists in the form of token curated lists. They are called this, because users, or token holders, are cryptoeconomically incentivized to participate in creating healthy lists, while security is assured by using advanced cryptographic techniques.

There are many different ways to organize decentralized curated lists and in the case of Kleros, our dispute resolution system acts as a powerful tool to create secure lists of this kind.

In this section, you can see the example of our Generalized Token Curated Registry of how our platform can be used in a plethora of use cases, as well as an overview of how curated lists can be used for addressing the problem of fake news.

Generalized Token Curated Registries: The World of Lists

By Matheus Alencar, DApp Developer, Kleros

TLDR: Generalized TCRs lower the costs of construction and deployment of TCRs. This optimization can spawn a large number of use cases where the community is empowered to decide which information should be listed in a fair and transparent way.

Most apps we use are lists. Messages, videos, torrents, pictures, news and search results are pieces of information ordered and displayed as lists according to a set of rules.

Some list apps accrue so much influence that item listing rules become tools of economic and political warfare, steering public opinion and election results by simply hiding or displaying certain items.

This became clear in the 2016 US Election, when personal data was mined on Facebook to display targeted ads which allegedly swayed voter opinion. Controlling the list of which information is (and isn't) displayed on Facebook is a phenomenal tool to influence public opinion.

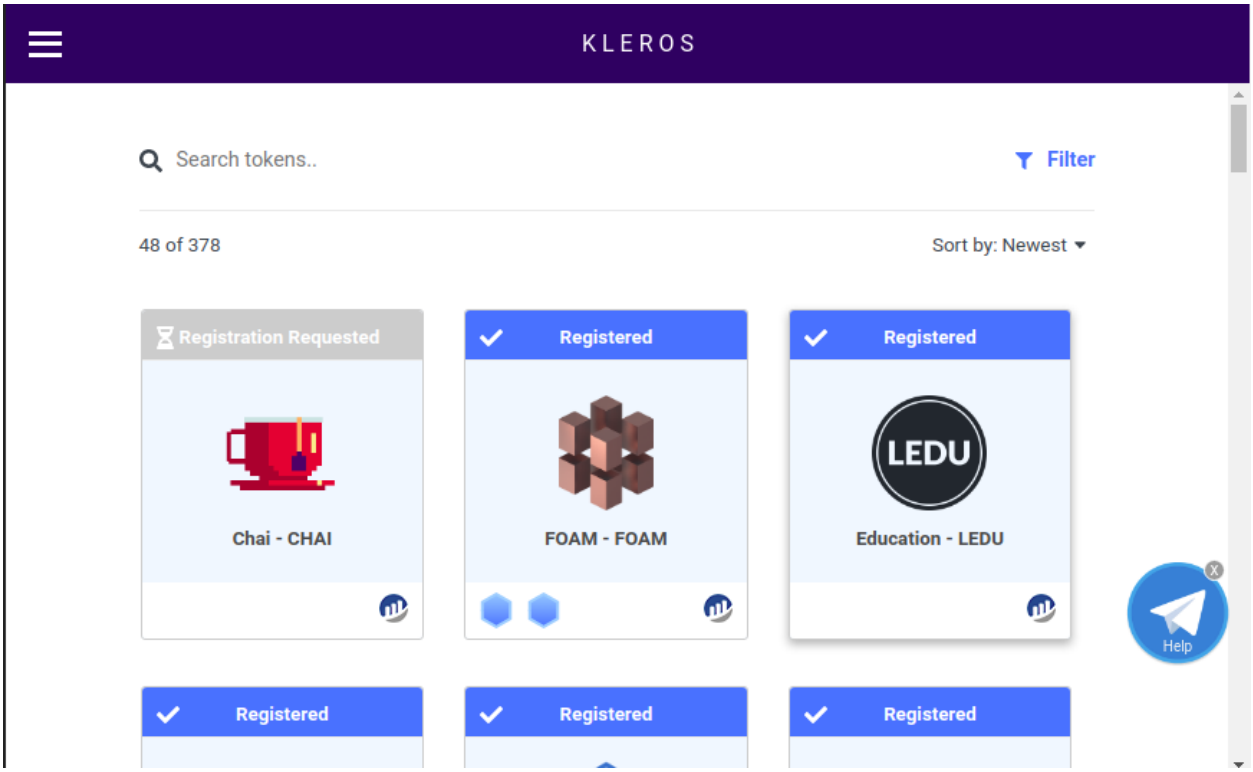
Furthermore, the use of closed-source, black box algorithms (such as YouTube's content ID) for content curation makes it impossible to properly understand how content makes it to the trending topics or the criteria that determines which pieces will get flagged for removal. Users are expected to simply trust the middleman despite past breaches of that trust. The power of centralized listing became evident again at the end of 2019, when Google removed a number of crypto related apps (including MetaMask) from its app store.

In the information age, whoever controls the list, controls the power. If we want the power to be in the hands of the people, we need a decentralized and transparent method to empower the community to decide which items should be accepted in the list.

This is precisely the problem that Token Curated Registries seek to resolve. Decentralized arbitration coupled with the right economic incentives can create a powerful tool for community curated information.

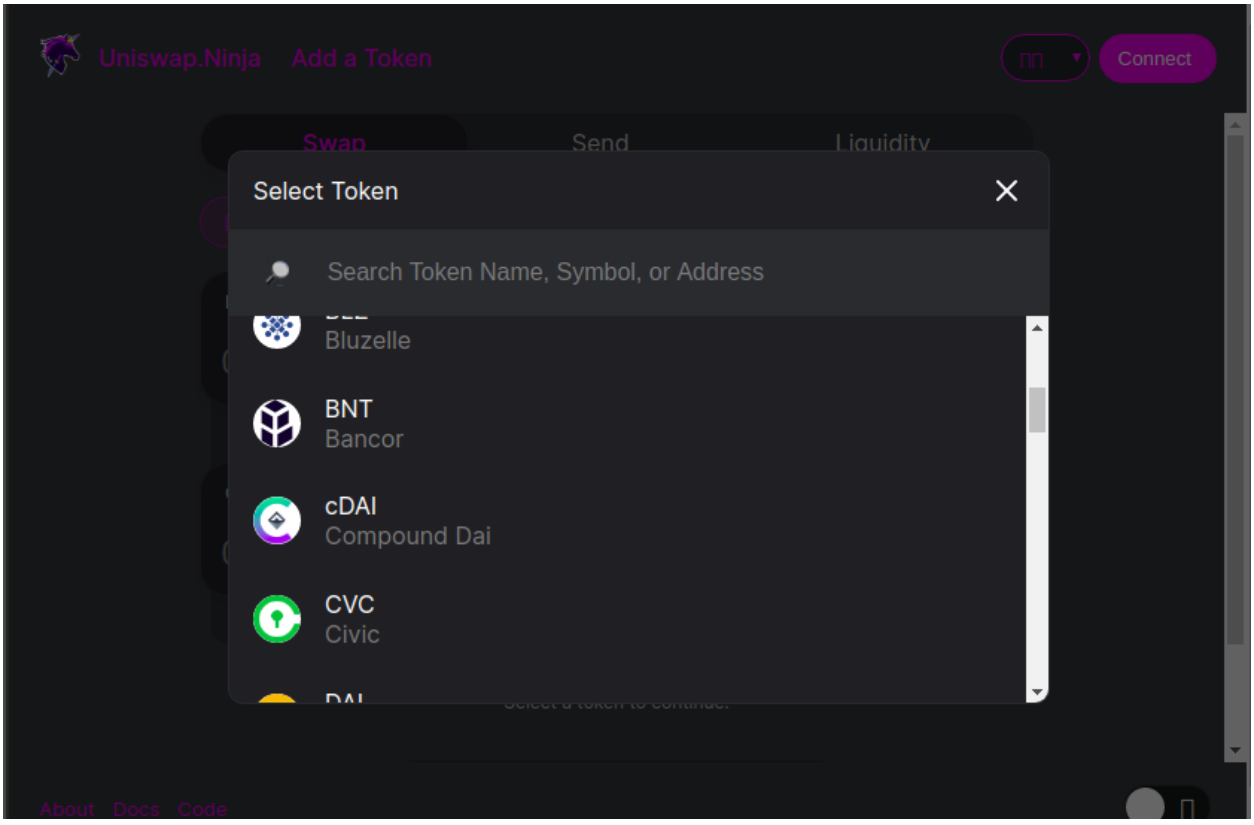
Kleros' Token Curated Registries

In 2019, Kleros deployed six TCRs related to token listings, which were used to ensure code quality, exchange compliance and fraud detection. The T^{2}CR and its Badges demonstrated that the space can self-regulate and punish projects which attempt to violate listing rules.



An interface of Kleros' Token² Curated Registry, where the community decides which tokens should be accepted into the list.

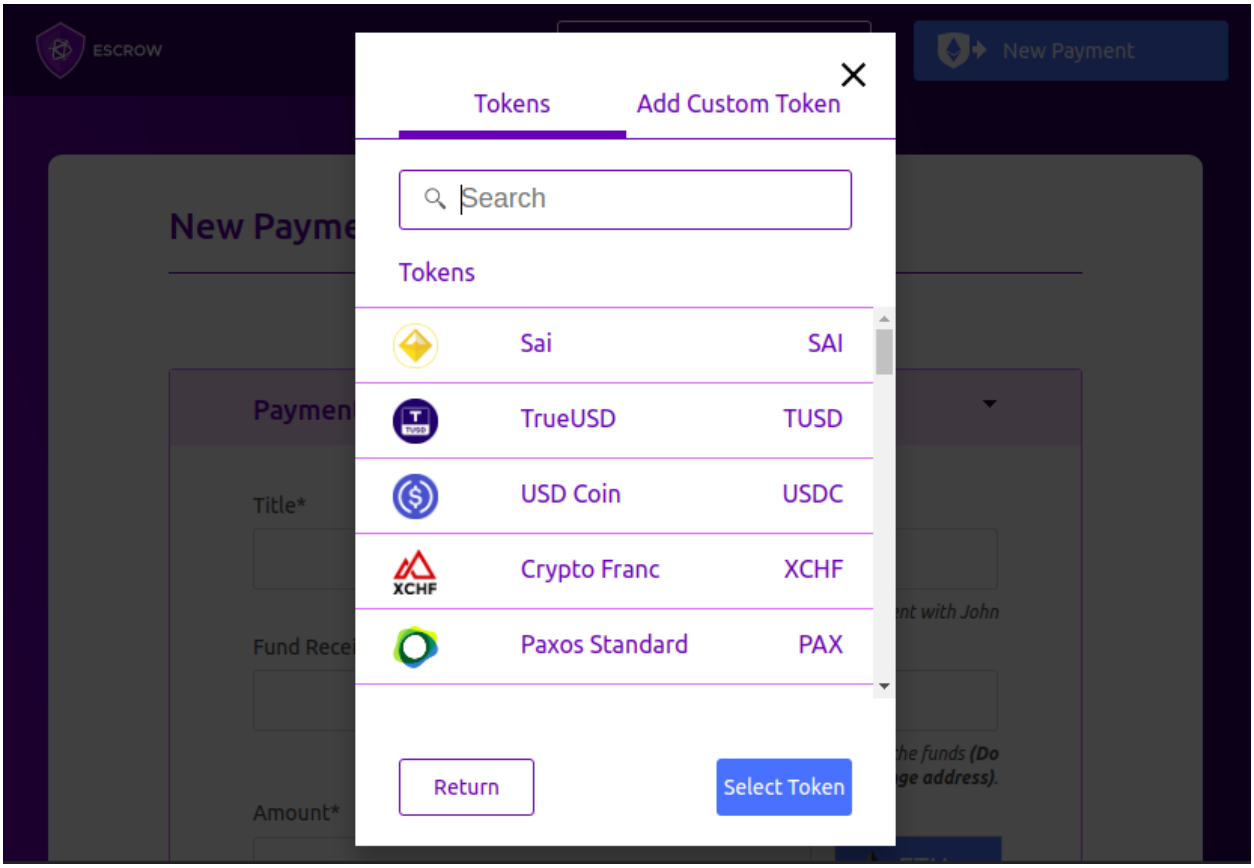
Over $350.000 dollars moved through Kleros's contracts, as projects participated in the decentralized listing process of the Ethfinex (now Deversifi) and uniswap.ninja exchanges.



The Uniswap.Ninja exchange, displaying tokens with the ERC20 Badge.

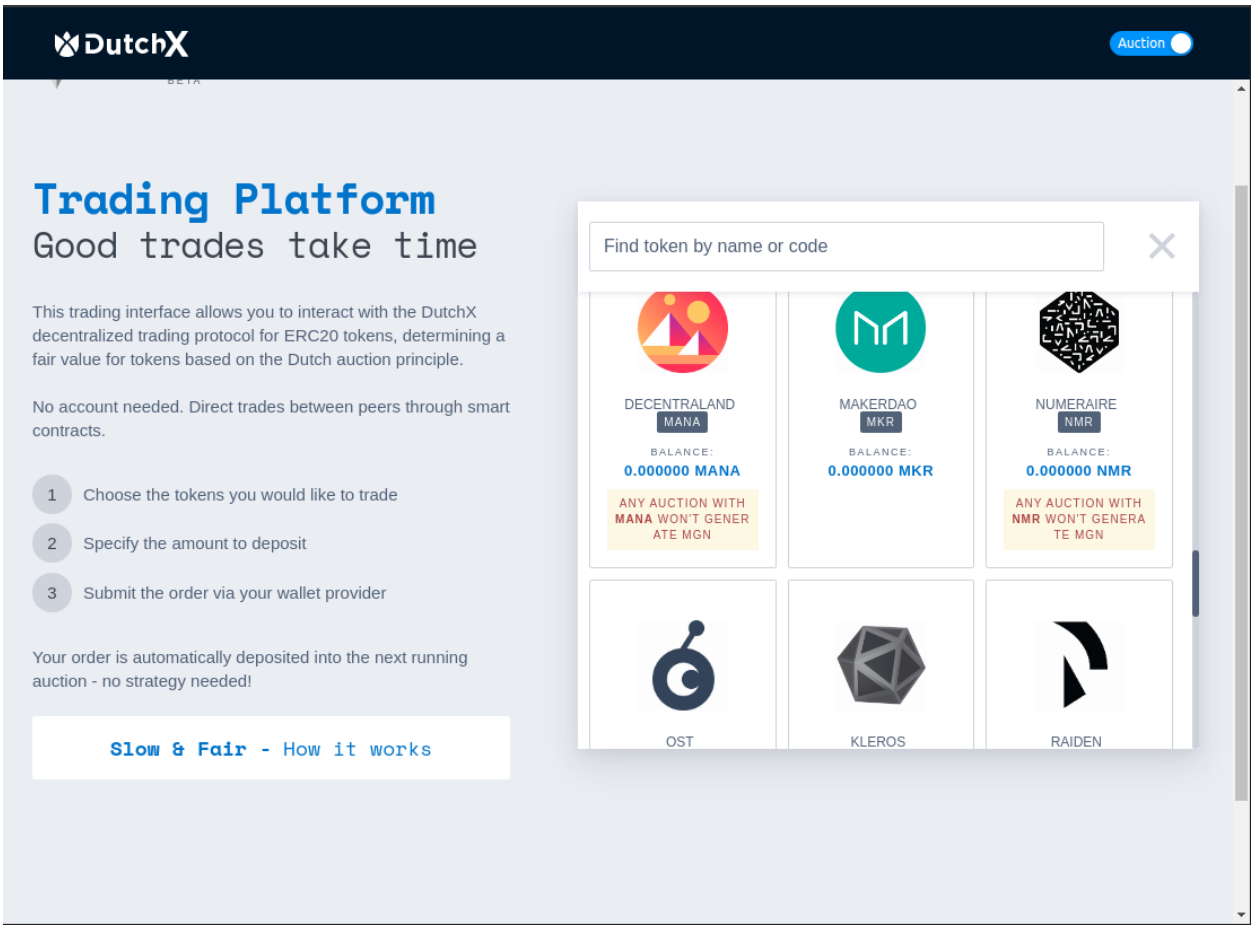
Since the list is public, other DApps can simply plug into it to benefit from this community curation process. Examples of this are:

- Kleros Escrow. This DApp uses three TCRs powered by Kleros: The T^{2}CR for token information, the ERC20 Badge and the Stablecoin Badge to display and sort tokens for payment.



The Kleros Escrow DApp displays tokens with the Stablecoin Badge first in the list.

- DutchX: To simplify and speed up its token listing process, the DutchX exchange simply plugs into the already populated T^2CR of ERC20 tokens. No one needs to ask for Kleros or dxDAO permission to get their tokens listed or open pull requests. Likewise, there is no one that can be compelled to censor or prevent a token from making it into the exchange. Additionally, a token that complies with the DutchX listing criteria can request the DutchX Badge to be displayed first in the exchange.



The DutchX Auction UI pulling tokens with the ERC20 Standard Badge.

Moving Forward: Generalizing the Token Registry

The Kleros Token[2] Curated List brought remarkable results, and also a lots of questions from our community:

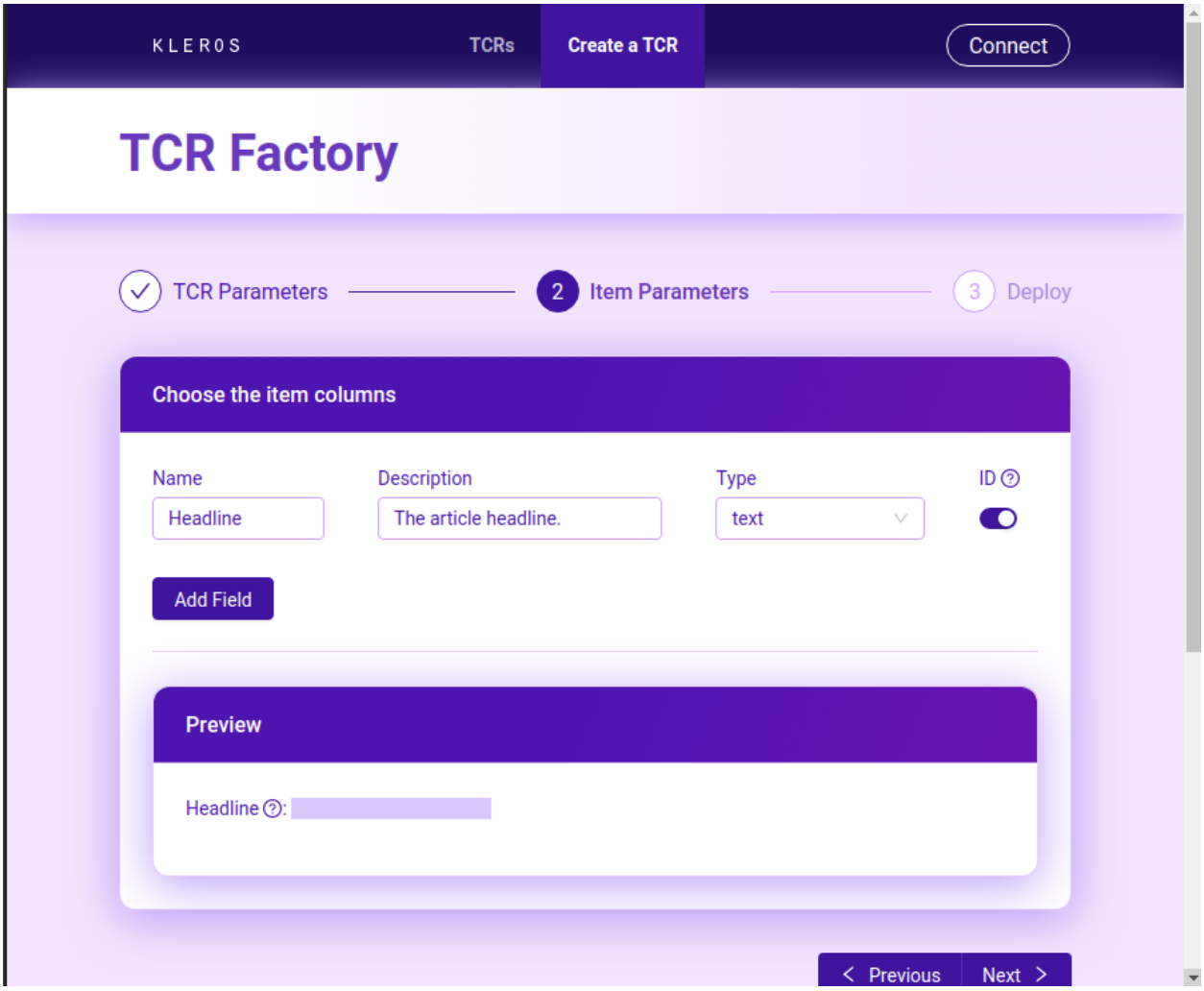
- Politics: “Could you make a token curated list of politicians that have no history of involvement with corruption?”
- Business Ethics: “Please make a curated list of companies that don't use sweatshops? That are eco friendly? Can we do Badges for companies that lobby congress and spread false information on CO2 and climate change?”
- News Media: “Can you please make a TCR of news articles that do not contain fake news? Actually could we make a decentralized YouTube?”
- Government Transparency: “How hard would it be to make one that accepts evidence of dubious actions by governments? Like a Wikileaks that only accepts legit evidence? Could we deploy a DAO to reward successful submitters?”
- Content Addressing: “What if we make a torrent registry of malware free files? Torrents on the blockchain would be quite hard to take down right? Could we make

one that accepts IPFS links for other DApps as well? Also how about a TCR of TCRs to make navigating the whole thing easier?"
- App Discovery: "Can we make a list of open-source, safe apps? Like a Google Play or App Store that is resistant to centralized hammers?"

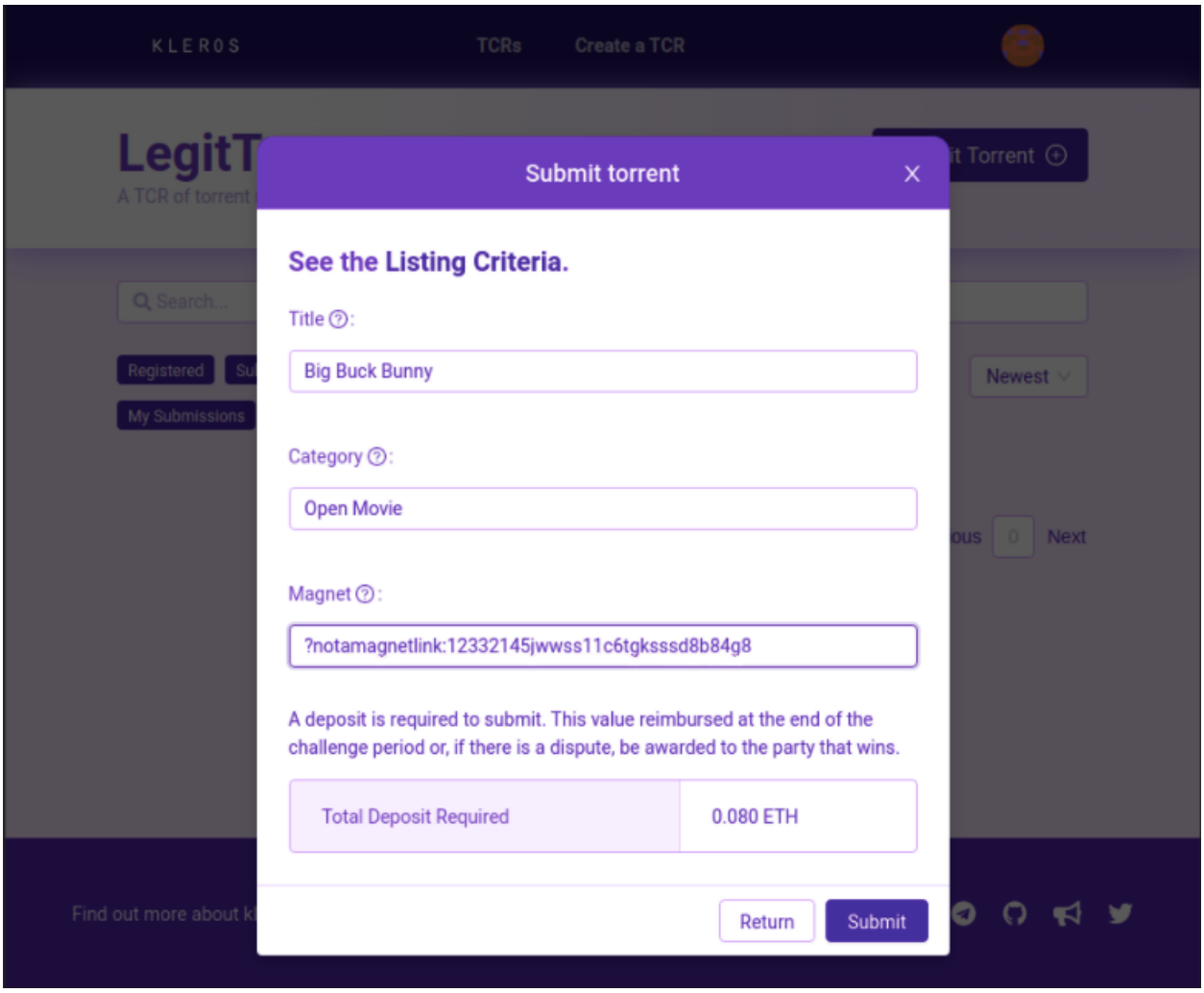
Imagination was running wild. However, it is not our job at Kleros to build the whole stack of software for each specific case. Our job is to build the tools which empower the governance of communities. In this case, by providing them the infrastructure to address the use cases they need.

This is the goal of Kleros' Generalized Token Registry: a way for anyone to easily deploy a curated list with any combination of fields, listing criteria and deposit values.

We set out to build a protocol such that a smart contract adhering to a set of rules could be displayed by a user interface that did the same. This way, users can have a single UI to view, submit, challenge items, consume evidence and so on.



A screenshot of Kleros' TCR Factory.



The submission form for a TCR of torrent magnets.

The GTCR is a powerful tool, enabling anyone to create registries in a decentralized, trustless fashion, while maintaining the highest level of integrity. With it, the power of Kleros will be unleashed, as use cases which will arise from the community and active usage will enable grand scaling of the Kleros ecosystem.[112]

[112] To hear more about the GTCR, see this video presentation of Matheus presenting the platform as part of ETHCC 3.

Can Kleros Beat Fake News?

By Damjan Malbašić, Communications Director, Kleros

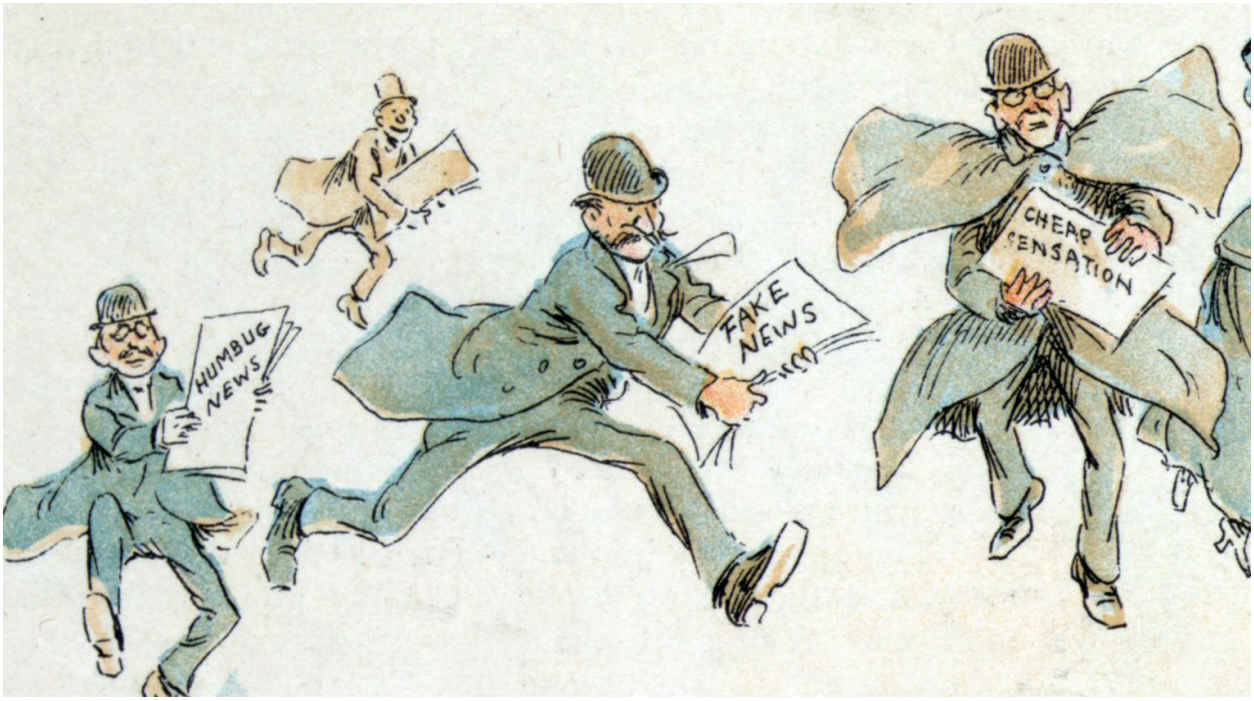
Damjan Malbašić holds a B.A. in Communications from the Faculty of Media and Communications from Singidunum University in Belgrade and an M.A. in Geopolitics from the Faculty of Social Sciences from Charles University in Prague. He maintains a keen interest in foreign policy and the implications of technological innovations on international relations. Previously, he worked as the program coordinator of the Belgrade Security Forum and a researcher of European geopolitics, cyber security and disinformation in the media. He works at Kleros as the resident writer and social media manager.

> “The untested truths spun by different interests continue to churn and accumulate in the sandbox of political correctness and value systems. Everyone withdraws into their own small gated community, afraid of a larger forum. They stay within their little ponds, leaking whatever "truth" suits them into the growing cesspool of society at large. The different cardinal truths neither clash nor mesh. No one is invalidated, but nobody is right. The world is being engulfed in ‘truth’.”
> -Metal Gear Solid 2, Col. Roy Campbell (2001)

The Internet revolution connected us. But, it created echo chambers, huge ghettos in which we live and discuss within groups of people we agree with, while being less and less able to understand those we disagree with. As we now know **from many examples**, this was used by political actors (and others) to sway opinions by appealing to emotions, rather than discussing ideas. This diversionary tactic, among others, brought us to the advent of the modern concept of fake news.

This has happened because our elites have become free of the yoke of citizen oversight. The end of the Cold War allowed money and power to seamlessly cross all state borders, effectively ripping the social contracts that held the Western world in place since the Enlightenment. Revolution has become impossible.

As Ivan Krastev, the Bulgarian political theorist put nicely in his book ***In Mistrust We Trust*** (2013), revolutions of the 21st Century stopped being ideological (socialist, capitalist, communist) and became tied to the medium: the Twitter revolution, the Facebook revolution, the Internet revolution for that matter. Content is no longer important. This is one of the seminal reasons why trust in the media, our institutions and our societies is eroding and continuing to erode.



Reporters with various forms of "fake news" from an 1894 illustration by Frederick Burr Opper.

Then how is blockchain as a technology, or Kleros for that matter any different?

The basic problem with fact checking these days is bias. Whoever does the checking, as a centralized entity, be it a social media platform, such as Facebook or Twitter, an NGO or an international/government body, can be seen as observing "their own" version of the truth. This can at times just muddy the water even more and make debate impossible. This is fertile soil for a crowdsourced, blockchain-based solution.

Blockchain technology is a twist in how mistrust is managed. By being built on the concept of natural human uncertainty and lack of trust, through a secure and verified network, blockchain is bolstered by the exact same things which make traditional institutions lackluster. Blockchain reduces uncertainty and actually gains power through mistrust.

This is where Kleros comes in.

One Kleros use case is the creation of curated lists (Kleros has already conducted **the first test of this kind** on the Ethereum mainnet), which is the perfect stage for creating a decentralized tool for fighting fake news.[113] The envisaged blacklist of fake news could be a crowdsourced, non-bias way of listing not just the singular pieces of fake news, but could open the path to dredging and analysis of entire networks of how fake news is created and distributed.

Nuts and Bolts

Let us imagine a curated blacklist of potential fake news which belongs to a Fake News Court of Kleros. Parties are free to submit pieces of news for which they believe belong here by placing an appropriate deposit. There could be a form in which the submitter would have to check certain items for more precise listing (e.g. country of origin, the source, type of news...).

There could also be **a guide** written to help users in checking whether the news they are submitting is indeed fake. If the piece goes unchallenged for a time, the piece is put on the public blacklist as is. However, if the piece is indeed challenged, the challenger puts in a security deposit and the case goes to the Kleros court.

The jurors are selected at random per deposited PNK tokens in the court. Consequently, when the jury selection is finished, the jurors are presented the evidence by the original submitter and the challenging party and vote according to their conscience.

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[113] To learn more about how such a list might function, have a look at *Lessons Learned from the "Doges on Trial" Experiment* by William George in Chapter 3 - Decentralized Justice in Action: From Doges on Trial to the Token Curated Registry.

After the voting is over, the majority rules on whether the piece is indeed fake news or not. The votes that dissented from the majority would lose their PNK, which would then be distributed to other jurors.

This list could be nested, thus creating its' own 'spin-offs' by language or region. Sub-lists could be graded, so outlets who publish fake news could be better seen, as their articles would be larger in number. The list could be organized by topics as well, which would allow for a better understanding of how fake news spreads.

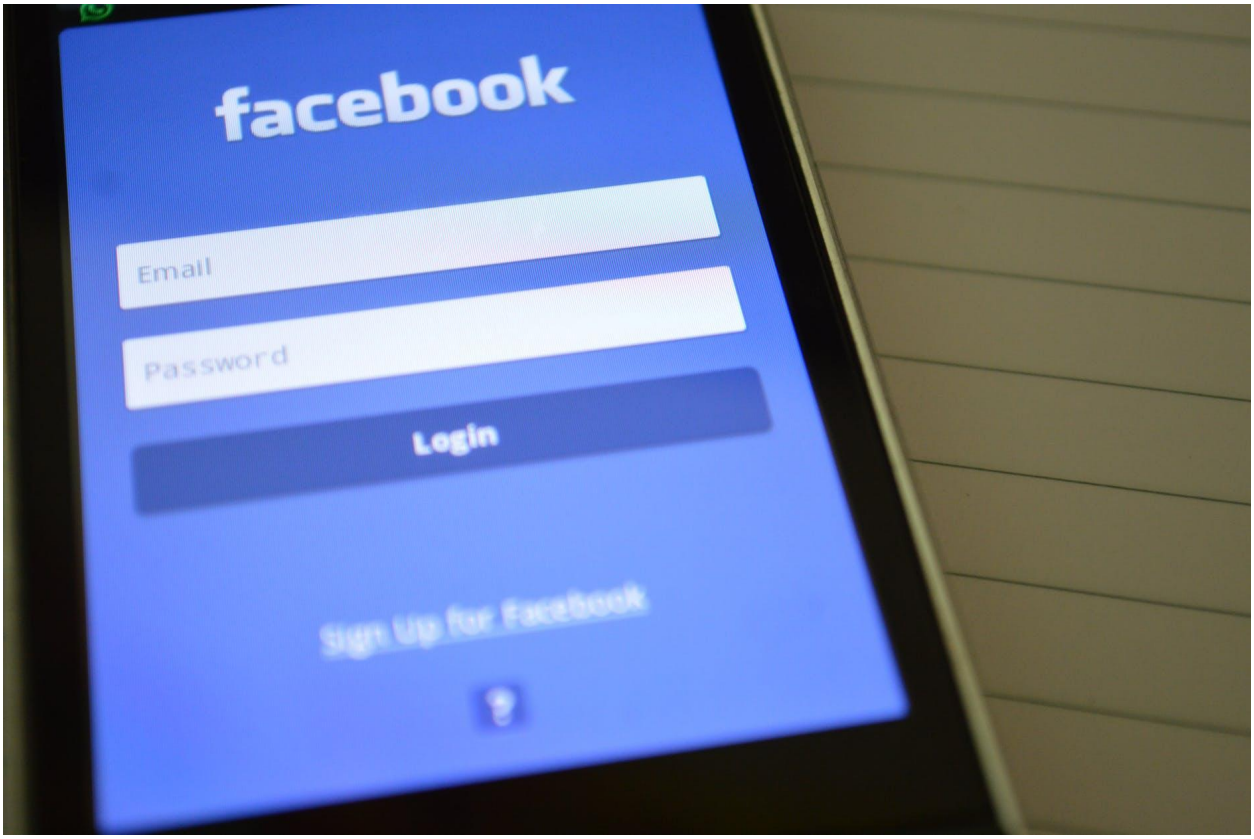
The Social Network

The beauty of such a fake news detection framework lies in the fact that this approach can be taken towards news outlets as the source of information, but also as towards their distribution side and in the end, direct communication between users of social media could be mediated by a court of Kleros jurors.

We've become painfully aware of the effect social media has in exacerbating this malignant form of communication, effectively poisoning dialogue between individuals and groups at the very root. What furthers this grievance is the fact that social networks **often censor material in accordance with their priorities** and terms and conditions, which just alienates further the people using them.

Decentralized social media platforms function on the basis of establishing relevance of their members and content through reputation systems. These systems reward 'good' content by distributing reputation tokens to their producers. For a decentralized network of this kind to be truly decentralized, the control mechanisms of this platform must also be decentralized.

Let's take a practical example: Michael and Uri have an argument over an article Michael shared, which Uri sees as fake and racist on a social media platform. Uri reports Michael to Kleros, the watchdog of this network. The article is quickly sent to the Kleros court, where jurors weigh in. A decision of peers is made, Michael's post is analyzed and he is punished by losing 20 reputation tokens for spreading falsities on the network.



Platforms like Facebook have entire systems dedicated to content moderation. While keeping the social order on their feeds, the platforms also may choose what type of speech is allowed on the network. To protect the freedom of speech in its' true form, this kind of moderation must be done in a decentralized way.

To Observe and Punish

The mixture of active citizens and technology is today seen as a tool for fighting for a better world, but there is a hitch to this technological approach.

Let's imagine this two pronged approach to solving the problem of fake news and abuse on social media. There are a vast number of users on the Kleros platform, scouring the net for fake news outlets and dispensing justice on decentralized social media. The system works flawlessly.

Mainstream media outlets and investigative journalists pick up on what's submitted to Kleros and analyze bulks of data. Patterns are formed and it's getting more difficult to spread fake news online. Users of decentralized media are more aware of 'what doesn't fly' and adjust their behavior accordingly. Sounds like a dream turned reality.

But the system is built on the absolute condition of mistrust. Mistrust is a key ingredient in every democracy, this is a game that has gone on since the conception of the state. But transparency is not a bridge towards trust. In fact, it is a political tool to manage mistrust. If we reverse this game of openness and we become the ones who control the political system, how different is it from a dystopian scenario where the state controls the system in the same way?

Before we delve deep into the methods of control of our nascent Internet democracy, we need to establish the basic rules that will govern this system, especially with regard to values to be upheld. Without reaching a consensus on what should be the foundations of our common framework, we are at a risk of pushing towards creating further rigidity not just towards those that hold the reins of power and try to manipulate us, but also between ourselves. This could have an effect of breaking the creative links between citizens, making our echo chambers even bigger and spilling over into the 'IRL' and consuming us.

It is exactly what makes the system work that can, if successful and unmanaged, be its' greatest pitfall.

Oracle

As we've discussed in previous chapters, smart contracts have a plethora of use cases on the blockchain, but the application of smart contracts in the real world often requires the blockchain to be informed of events happening outside, since these variables are incomputable. The most effective way to gather data about the real world and put them on the blockchain are oracles.

"Oracles" are mechanisms designed to provide the blockchain with information either through sensors, software or human input. One of the most famous examples of oracles in use is MakerDAO, where the oracle ensures sufficient collateral is held to cover the circulating DAI stablecoin. One other example of an oracle is Augur, which uses oracles in prediction markets, of which we speak in this section of the book.

Many, if not all oracle solutions are adapted to specific use cases. Up until now, there has not really been a full proof generalized solution for oracles, and it still remains a research topic for many developers and mathematicians.

How does Kleros fit into all of this?

Kleros is building a crowdsourced dispute resolution system. In this system, jurors vote through a game theoretically incentivized system to come to an honest decision concerning a particular dispute. This could be seen as a sort of an oracle - jurors bring external information onto the blockchain via a consensus mechanism in a decentralized, but in a game theoretically controlled fashion.[114]

This section of the book paints an image of Kleros in action as an oracle through our work with Realitio, as well as presenting some early research into using Kleros for resolving disputes in the gas and energy markets done by our Fellows.

The underlying incentive structure of Kleros may be a way to resolve the oracle problem, and below you can find our latest insight into the matter.

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[114] If you're interested in more technical aspects of our approach, have a look at the section about our research into oracles in Chapter 2 - Kleros Cryptoeconomics: Towards a Theory of Decentralized Justice.

Kleros-Realitio Oracle Service - Getting Real Information On-Chain

By Federico Ast, CEO, Kleros

Smart contracts are smart enough to self-execute as written in the code. But they face severe limitations when enforcement requires information from the outside world.

How can a smart contract trigger an agricultural insurance payment if that execution depends on the amount of rainfall in a season?

In order to work, smart contracts often need information that lies outside the chain. This requires having a trustworthy way to introduce this information on-chain, a way able to resist attempts by malicious agents trying to subvert the system by submitting false information. This is known as “the oracle problem”.

Realitio's Oracle

Realitio is a project building a cryptoeconomic mechanism for verifying real world events and introducing them on-chain.

Users can access the Realitio platform to ask any question with a publicly verifiable answer. For example:

- What was the average daily price of BTC in 2018?
- Who won the gold medal in the individual kata category in the Karate World Championship in 2004?
- In which month and year was the first version of the game ‘The Curse of Monkey Island’ released?

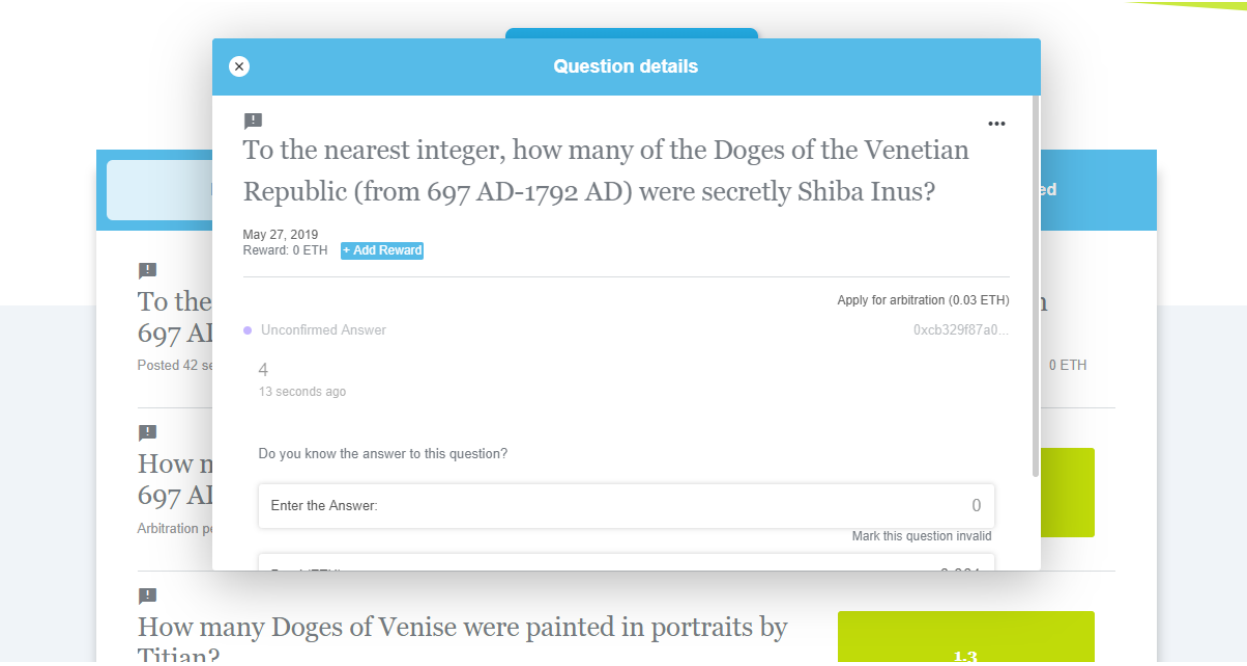
When submitting a question, users need to send a reward, in order to incentivize people to provide answers. The reward will be collected by the user giving the final answer.

But there's a problem…

How to ensure that the answer provided is the right one? How to avoid malicious users submitting false answers to subvert the execution of the contract? How to prevent lazy users from giving a random answer without even doing the required research?

In order to create the right incentives, when answering the question, users are also required to post a bond. If other users believe that the answer is wrong, they can challenge it by doubling the bond and providing a new answer.

After each answer, a countdown period begins during which others can submit a different answer. When the countdown period expires, the last person to have posted an answer receives the bond, as well as the reward posted by the asker.[115]



The initial challenge for the Kleros "last appeal"

Realitio Meets Kleros' Dispute Resolution[116]

At any point of the answering process in Realitio, anyone can "apply for arbitration" to bring in an external arbitrator to resolve what the right answer is.

The arbitrator will either confirm the current answer (in which case, the party who provided the final answer receives the bond) or it will provide a different answer (in which case, the new answer is considered definitive and the party who paid the arbitration fees receives the bond).

So, how is the arbitrator selected?

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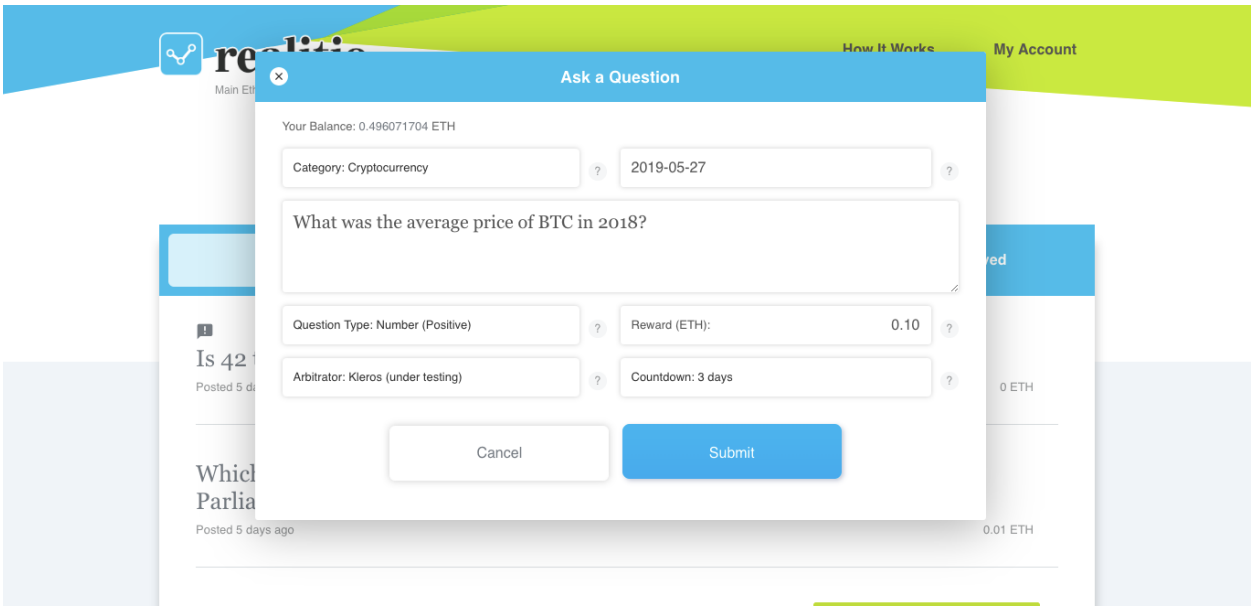
[115] For more details about how the system works, see Realitio's documentation.

[116] Have a look at The Kleros-Realitio Oracle Explainer for more information.

When submitting a question, the asker needs to choose an arbitrator in case of a dispute. And one of these arbitrators is Kleros.



When asking the initial question, the user can choose Kleros as arbitrator in case a dispute arises.

In case of a dispute, a large pool of jurors is called (currently 500) to the General Court to adjudicate the case. The party who triggers the external arbitration in Realitio has to pay the arbitration fees. This decision will be considered final.

Kleros acts as a "last resort" for Realitio when there is a question to which many different answers were submitted and where the bond already doubled several times. At some point, it eventually becomes profitable to pay the arbitration fee to win that bond.

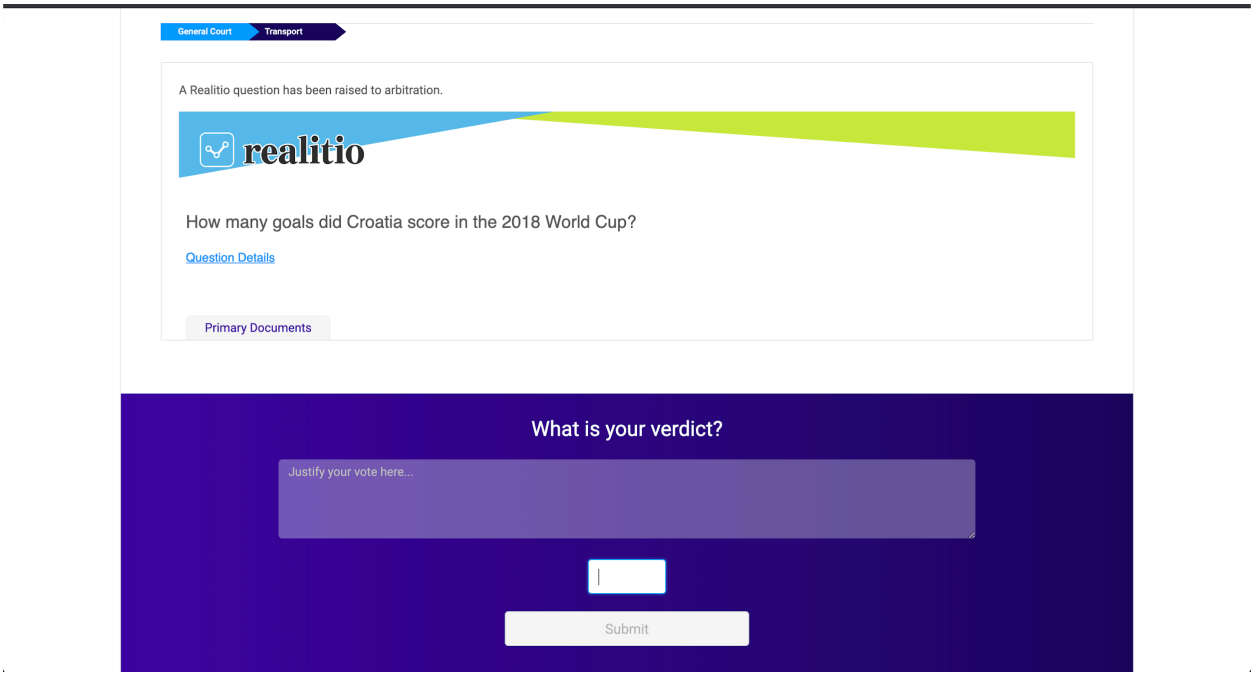
Kleros Court, Reloaded

From the point of view of Kleros jurors, the situation is not too different from other uses such as the escrow or the T2CR. Jurors vote and the answer that gets most votes wins. Incoherent jurors lose their PNK deposit, while all coherent jurors split the arbitration fees and the lost deposits.

What's novel in this new application of Kleros is the introduction of questions that might have more than two answers. Realitio questions can have answers that are binary (Yes/No), single-choice (one answer from a list), multiple choice (multiple answers from a list), a date or a number.

Oracles often require more sophisticated structures, such as inputting a number, a price (e.g., what was the price of Dogecoin in US dollars on May 21st, 2019 at 3pm UTC?) or a discrete answer from a set of given options (e.g., which team won the Football World Cup in 1954?).

In order to resolve these types of disputes, we just launched a new version of the Kleros Court which is able to handle multiple options in voting.



The option to insert a number as an answer in the juror interface has been added as well.

Oracles also have an advantage compared to other Kleros use cases: questions tend to be less subjective and even if there are multiple options to choose from, one choice is likely to receive overwhelming support.

Thus, situations where no option gets 50% of the votes - which can lead to tactical voting and unstable equilibria - are largely avoided.

We are actively researching Kleros applications with multiple choice outcomes in more subjective cases. For this purpose, we are adapting ideas from social choice theory to research what kind of voting systems will tend to produce just outcomes in a Schelling point, non-binary choice framework.

Once these ideas are implemented, we will be able to apply them to make future releases of the oracle even more robust.

A Contribution to the Decentralized Infrastructure of the Future

Solving the “oracle problem” will be a key part of the construction of the financial and legal infrastructure of the future.

The use cases are everywhere, encompassing gambling (e.g., betting on the result of a sporting event), trading (e.g., inputting settlement prices on-chain) and insurance (e.g., rainfall to trigger the payment of an agricultural contract), among many others.

With our oracle application, at Kleros we're happy to contribute to the construction of the infrastructure of the future.

Kleros: A Solution for Gas Price Review Disputes?[117]

By Abeer Sharma, Lawyer, Supreme Court of India

Drafting effective contracts is a tricky affair. Parties contracting in good faith desire that their relationship remains legally enforceable and aim to ensure that the text of the contract reflects their mutual intentions, factoring in any potential loophole or change of circumstance that may upset the existing commercial balance.

However, it is impossible to anticipate every event or circumstance which may affect the performance of the contract, even if the document numbers thousands of pages.

This problem is especially relevant in the case of lucrative, long-term commercial relationships where the contractual obligations performed by both parties are spread over years. No rational contracting party would like to see an entire contract repudiated because of an unforeseen hiccup which gives rise to a material breach or a *force majeure* defence.

Therefore, certain long-term contracts incorporate 'contract adaptation clauses' that anticipate a revision of the contract's terms in response to external changes that may render the original terms too onerous for the parties to perform.

Contract adaptation clauses may envision an obligation to renegotiate or adapt certain contractual obligations based on the fulfilment of certain conditions or (more commonly) provide a procedure to review the ongoing contractual remuneration periodically payable by one party to the other.

The latter, known as price review clauses, are a mainstay in contracts used in the energy production and supply industries.

Long-term energy supply contracts are typically set in the context of a niche market with very few buyers and sellers. For instance, in the liquefied natural gas (LNG) industry, the sellers tend to be gas producers that have a natural monopoly over their gas producing fields.

The buyers tend to be gas wholesalers who subsequently supply gas to the end-user market and have a regional or national monopoly over the areas supplied.

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[117] This article is the result of the Fellow's work as part of the Kleros Fellowship of Justice Program. To see all reports done by our Fellows, have a look at the The Kleros Fellowship of Justice Library.

Entering into such a commercial relationship requires heavy upfront capital investment and necessitates guaranteed long-term supply to ensure the investment's profitability – a goal which may take decades to achieve. The periodically-payable contract price is negotiated at the beginning of the contract, and is accompanied by a formula which allows the price to be adjusted in accordance with inflationary pressures and market changes in the regional oil and gas sector.

However, no matter how sophisticated the contract price indexation gets, it cannot anticipate every unforeseen event that may impact economic conditions in either the buyer or seller's local market.

For instance, the seller may require a higher price because certain national regulations increased its operating costs. Or perhaps the buyer may require a lower price because of recessionary pressures in the end-user market making marketing the gas at old prices uneconomical.

This is where price review clauses step in.

Gas carrier Hoegh Gandria during Operation Desert Shield, Credit: picryl.com, Combined Military Service Digital Photographic Files

The Need for Arbitrated Price Reviews

Price review clauses are usually drafted vaguely in order to leave wiggle room for drastic, unique and unanticipated circumstances (known as *trigger events*). For example, with respect to trigger events, the price review clause in one famous price review dispute stated simply that:

> "If at any time either party considers that economic circumstances in Spain beyond the control of the parties... have substantially changed as compared to what it reasonably expected when entering into this Contract (...) and the Contract Price (...) does not reflect the value of Natural Gas in the Buyer's end user market..."

Price review clauses generally lay down a structured procedure for price adaptation. For instance, a party requesting a price review is required to give sufficiently long notice to the counterparty, after which they are required to negotiate in good faith for a new price.

Of course, given the high risk/high reward nature of investing in the oil and gas industry, even well-intentioned parties are generally reluctant to agree to a price that would disadvantage them. The price review clauses therefore provide for an externally-imposed, binding solution if a voluntary agreement is impossible. In essence, the failed negotiations are treated like a dispute.

Given the high-stakes, international nature of gas supply agreements, the dispute settlement process needs to be internationally enforceable, confidential, not subject to unnecessary delays and appeals and delivered in a neutral jurisdiction by individuals who have an intimate understanding of the relevant commercial context.

These requirements eliminate options such as national courts or expert determination, thus leaving international arbitration as the only feasible method for determining whether the price must be reviewed and, if so, by how much.

While this standard use of having arbitrators essentially rewrite the LNG supply contract to more 'commercially appropriate' terms has attracted a fair deal of controversy, with critics claiming that this function is at odds with the purpose of arbitration.

There is undoubtedly a pressing need to finally settle price disagreements between the parties as soon as possible, for they cannot simply walk away from the supply contract merely five years after entering into it. Doing so would irreparably injure not only the parties, but also a wider pool of stakeholders dependent on the success of the agreement such as taxpayers, manufacturing industries, and consumers.

It therefore makes sense that if amicable resolution methods fail, the solution will be imposed by a third party.

Station Wildervank of the the Groningen natural gas field in the Netherlands, Credit: Skitterphoto

Evaluating the Suitability of Arbitrators for Price Review Disputes

Despite conventional wisdom dictating that arbitrators are more commercially-minded than judges, their main job description is ultimately to decide the outcome of a legal dispute. But gas price review arbitrations are quite far-removed from conventional legal disputes.

Whereas legal disputes concern controversies regarding whether a party has breached its legal obligations towards the other, this is rarely an issue in price review arbitrations.

In fact, a successful price review arbitration commences with the premise that neither party is 'at fault'.

Legal disputes are 'backward-looking' in the sense that the tribunal has to consider only the events leading up to the alleged breach of contract and award damages accordingly. Arbitrators do not generally concern themselves with events happening after the alleged breach, much less events that happen after the issuance of the arbitral award. The role of an arbitrator in a legal dispute is to restore the parties' relationship as best as possible to the balance that existed before the purported breach.

Price review arbitrations, on the other hand, are both backward and forward-looking. They are backward-looking because tribunals need to ascertain whether a trigger event affecting the price has truly taken place. They are forward-looking because after ascertaining the existence of a trigger event, the arbitrators have to adjust the contract's price for all future transactions between the parties – or at least until the next foreseeable price review.

In fact, arbitrators function more like commercial advisers than judges in price review arbitrations, attempting to ascertain a mutually acceptable and economically sustainable solution for both parties.

In order to determine whether a specific pricing solution makes commercial sense, it helps to have a diverse panel which can impartially evaluate factors such as different business sensibilities, risk appetites, and negotiation practices to come as close as possible to an 'objectively reasonable' solution.

However, there is a limit to how representative or diverse conventional arbitration tribunals can get. Tribunals usually consist of a panel of three arbitrators; a tribunal manned by more than three arbitrators tends to get unwieldy and prohibitively expensive.

It appears then that in most cases the 'objectively reasonable commercial solution' to price review disputes is really just the consensus of at least two out of three hand-picked individuals. Despite these glaring shortcomings, international arbitration is the only viable method to finally settle unsalvageable price review disagreements.

Indeed, the popular quote for democracy seems apt here: "Conventional international arbitration is the worst process for settling a stalled voluntary price review dispute, except of all other processes that have been tried before."

However, what if there was a process that has not been tried before? One that contains or even improves upon several of the advantages of arbitration while at the same time lacking some of its weaknesses?

Kleros: A New Solution for Price Review Disputes?

Kleros' dispute resolution system offers several of the same procedural benefits as arbitration.

For instance, contracting parties have control over the procedure by which their dispute will be judged. They can mutually determine what kind of evidence is permissible. They can opt-in to the rules of a specific court - feasibly one that has been created especially for oil and gas transactions.

As far as costs are concerned, using Kleros could result in substantial savings. While the hourly fees charged by party-appointed experts or counsel are unlikely to decrease, a blockchain-based arbitration procedure would eliminate sundry expenses such as travel, accommodation and the hire of hearing facilities.

Coming to the enforcement of the jury's verdict, this should not be a problem from a technical perspective, as smart contracts could be programmed to automatically adjust the payable contract price to cover the pendency of the price review proceedings as well as subsequent payments in accordance with Kleros decision.

Of course, it is true that blockchain-based crowdsourced awards would not constitute a 'foreign arbitral award' for the purposes of qualifying under the robust enforcement framework provided by the New York Convention 1958, but research on this topic has already started.

Importantly, Kleros may outperform conventional arbitration in the context of substantive fairness. The majority of international arbitrators are legal professionals. This may be an acceptable situation for legal disputes, but it is counterproductive for disputes which require commercial solutions.

A diverse jury is more comfortable with assessing commercial reasonability from different perspectives. For instance, accountants or commodity traders may have different risk appetites that would shape their perception of a sensible solution due to their professional training.

All of these variegated perspectives come together to ensure that the ultimate verdict is as 'objective' as possible.

Kleros allows for more operational flexibility than offline hearings and thus will eliminate the expenses and logistical hurdles involved with hosting large, diverse tribunals.

The Kleros platform's reliance on cryptoeconomic solutions to ensure fair decisions guarantees that jurors will not only vote according to their own subjective values and priorities, but will also consider the perspectives of their peers due to the Schelling point principle. Given the high monetary value of gas price review disputes (ranging from hundreds of millions to billions of dollars), the jurors could be required to stake a sufficiently high amount of PNK to ensure that they have more 'skin in the game' and do not vote carelessly.

Looking Ahead

The adoption of Kleros in price review disputes has the potential to bring substantive fairness, procedural efficiency and lower costs in a sector where billions of dollars of public money are at stake.

Despite these potential advantages, there are several adoption challenges that lie ahead. Some of these challenges are technological – such as scalability of the underlying Ethereum blockchain.

However, other key challenges lie with the attitudes and values of the targeted end-users.

Inertia and technological suspicion are some deeply-ingrained cognitive barriers that will need to be steadily broken down. The ultimate roadblock – ensuring that national judiciaries respect Kleros jury awards as final – will have to be addressed with a concerted transnational effort.

While Gas Price Review arbitrations collectively happen to be the highest-value commercial disputes in the world, price review mechanisms are also found in lower-value, comparatively mundane long-term contracts (i.e. land leases or the supply of services).

These 'low-hanging fruit' (in a relative sense) are appropriate candidates to test the viability of leveraging Kleros' oracle and escrow use cases in price review arbitrations before the platform can set its sights on the bullseye of long-term Gas Supply Agreements.

A natural gas pipeline in Alaska.

Could Kleros Be Used To Solve Disputes in a Peer-To-Peer Energy Market?[118]

By Mauricio Duarte

Blockchain has been suggested as the next big technological advancement, impacting everything in our daily lives. The potential effect of blockchain extends far beyond its potential use in payments, finance, and smart contracts. Blockchain blends several existing concepts including peer-to-peer networks, public-private key, cryptography, and consensus mechanism, to create a highly resilient and tamper-resistant technological advancement. This new technology has enabled the transfer of digital currencies, the management of valuable assets, and-perhaps most profoundly, facilitating the trade of surplus electricity.

According to the Energy Market Barometers conducted by Grenoble Ecole de Management (GEM)[119] in December 2018 "[p]eer-to-peer energy trading and electric vehicle charging and sharing[120] are the most promising applications of blockchain technology." Blockchain technology is providing decentralized energy systems a new way to organize themselves and is steadily becoming a central part of electricity markets of the future. In a peer-to-peer market in the energy industry, consumers will increasingly move into the focus as market participants. Blockchain technology will allow consumers to become "prosumers"[121], as they will become involved in the generation of energy and trade that energy in the market via small-scale interactions[122].

In a decentralized market, transactions are executed on smart contracts, while smart meters provide the data necessary to execute those transactions. In these smart contracts, the

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[118] This article is the result of the Fellow's work as part of the Kleros Fellowship of Justice Program. To see all reports done by our Fellows, have a look at the The Kleros Fellowship of Justice Library.

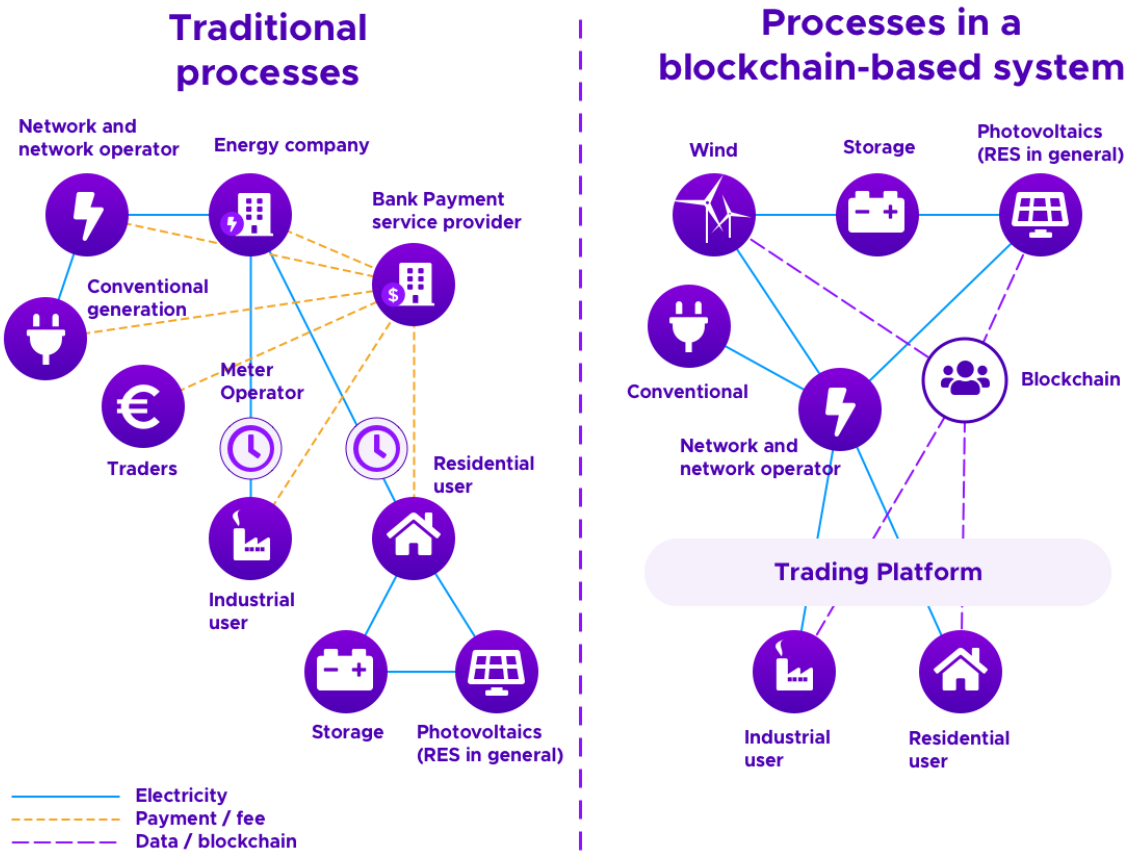
[119] Grenoble Ecole de Management, (2018), The Winter 2018 Edition of the Grenoble Ecole de Management (GEM) Energy Market Barometer, accessed August 25, 2019.

[120] For example, BlockCharge by RWE and Slock.it are developing a mobile phone app, which links to a blockchain based network that allows electric vehicle (EV) owners to charge their car via any charging station network and to be billed for the energy consumed.

[121] Alvin Toffler in his book The Third Wave (1980), proposed the notion that consumers are a phenomenon of the Industrial Age. As society moves toward the Post-Industrial Age, so will the number of pure consumers decline. Consumers will be replaced by "prosumers," that is, people who produce many of their own goods and services.

[122] Mylrea M. Gourisetti SNG. (2017), Blockchain for smart grid resilience: Exchanging distributed energy at speed, scale and security. In: Proceedings of the Resilience Week (RWS) 2017, IEEE, 2017, pp. 18–23.

parties agree when they will trade electricity at what price and how the energy will be paid. This new trend is providing an automated secure way to buy and sell electricity.



However, for a full implementation of this technology, the users must rely on adequate mechanisms to solve disputes effectively. Disputes relating to the energy sector may occur with a great diversity of stakeholders who will all opt for different solutions.

Across the supply chain, consumers are being hit the hardest as a result of energy disputes. Most of the time, consumers are the ones that suffer the most and do not have any recourse to solve their disputes. According to a 2017 study for Ombudsman Services[123], it was reported that consumers experienced more than 173 million issues with products and services, yet only 27% of the claims were raised with the provider. For energy consumers, disputes may be caused by i) problems related to the price or charges to the bill; ii) an excessive price due to a hardware problem in the meter; or, iii) an irregular supply of

[123] Mylrea M. Gourisetti SNG. (2017), Blockchain for smart grid resilience: Exchanging distributed energy at speed, scale and security. In: Proceedings of the Resilience Week (RWS) 2017, IEEE, 2017, pp. 18–23.

electricity. If the world is trending towards a distributed and collaborative economy, a decentralized system to solve the disputes could be useful.

In its most basic concept, Kleros is a decentralized court system that adjudicates disputes using smart contracts. Moreover, Kleros is a decentralized autonomous organization (DAO) that uses economic principles to incentivize users to become jurors and solve disputes on a basis of what is fair, equitable and according to the evidence submitted by the parties.

Kleros uses blockchain technology to promote a decentralized justice system, creating efficient legal recourse. In fact, Kleros' method of blockchain-based arbitration has the potential to become one the most appropriate mechanisms to settle decentralized market electricity disputes in the following ways:

- Prosumers will have direct recourse for disputes, rather than relying on a centralized mechanism.

- Kleros substantially reduces the expenses involved with initiating an ordinary dispute mechanism.

- Jurors will have the technical knowledge and understanding to solve disputes in a complex matter. Using Kleros incentive structure, jurors that are skilled and qualified will have a reason to serve as jurors and solve disputes.

- The decentralized energy projects that use smart contracts are compatible with the infrastructure of Kleros. Furthermore, Kleros infrastructure is philosophically compatible with a decentralized market in the energy industry.

- Given the infrastructure of Kleros, automatic execution of the judgment embedded in a smart contract is expected. This could promote efficiency in the decentralized energy markets, creating additional incentives for the expansion of the industry.

Final Thought

It is quite difficult to put into a few pages a wonderful experience as a Fellow for Kleros. I learned new ideas and suggested solutions to improve the future of justice.

Blockchain, smart contracts and smart meters are drastically changing the way electricity is generated, distributed and transacted. These new technologies are enabling the increase in energy prosumers as participants of distributed and decentralized energy markets.

Consumers have been affected deeply, sometimes not even attempting to pursue a claim due to the costs, time and frustrations associated with a centralized dispute resolution mechanism. The infrastructure of Kleros and its economic incentives is compatible with a peer-to-peer market. Moreover, Kleros is a decentralized application powered by blockchain that can be perfectly integrated to other decentralized applications in the energy industry.

For every skeptic about the potential of Blockchain, there are futurists, innovators, programmers ready to move forward a new culture of innovation. Rather than fantasizing about the future, this is an open invitation to become part of creative and innovative projects. Regardless of the industry, anyone can become an integral part of the future. The Kleros Fellowship Program is a starting point and invite you to become a member of a phenomenal community and a component of the future of justice.

Kleros, the Referee of Tomorrow

By Federico Ast, CEO, Kleros

The Russia World Cup was the first to implement VAR technology for assisting referees, a step towards higher transparency in a FIFA organization often accused of match fixing, corruption and other nefarious deeds.

But even if VAR tends to reduce the likelihood of referee mistakes, the decision is still made by just one person.

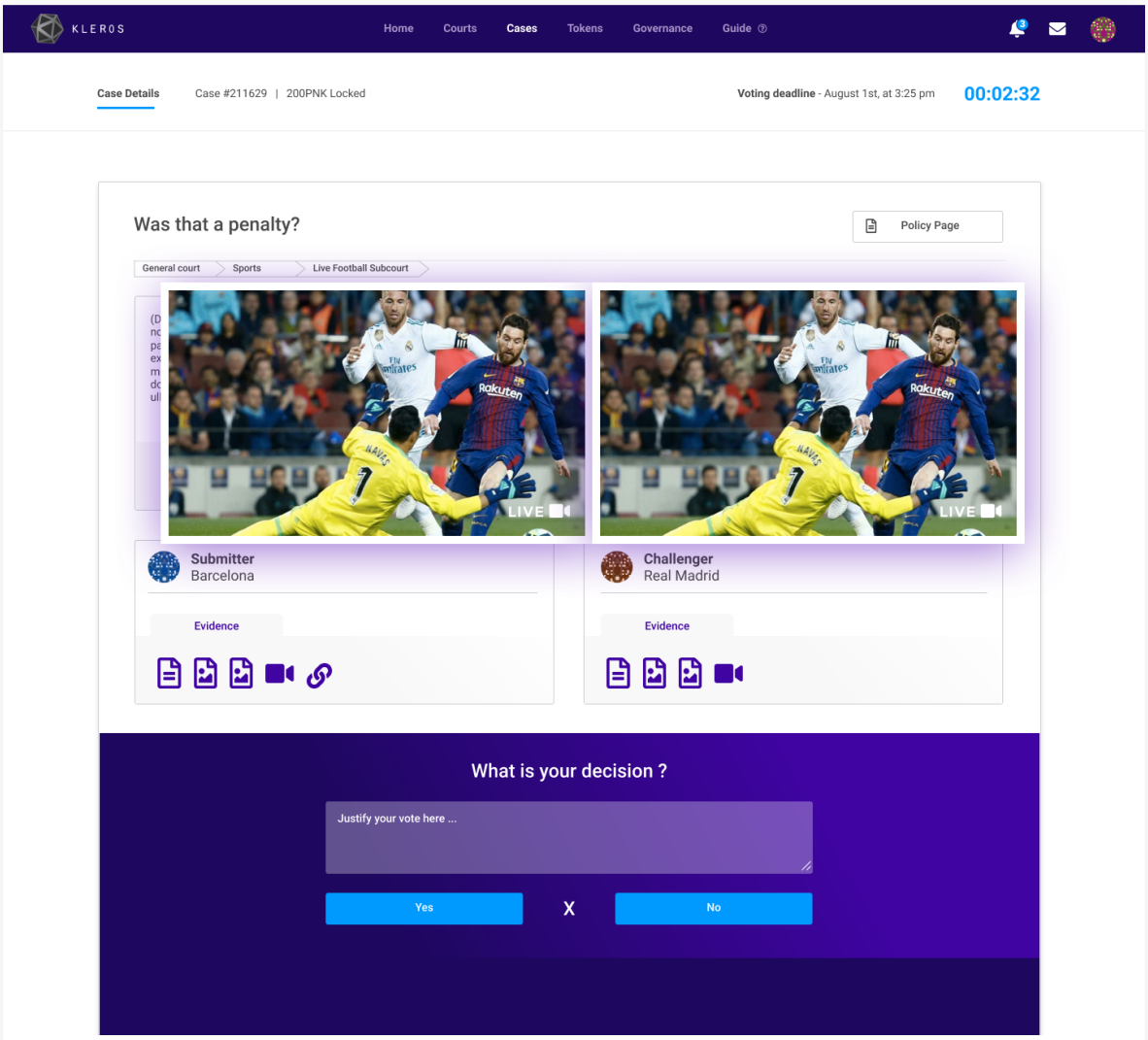
Kleros proposes the use of collective intelligence as a neutral third party for dispute resolution. Could it also become a 'crowd referee' enabling transparency in football?

VAR, the Video Assisted Referee being used for the first time in the Russia 2018 World Cup. Credit: Corwin of Amber, CC BY-SA 4.0

How it Would Work

Some features of professional football make it, at least at first glance, suitable for a crowdsourced referee approach. Games are usually broadcasted, which means that potential jurors from all over the world could access the same evidence that referees see in VAR. The rules of football are well known and are the same in every country. Any fan could tell if a specific play was or not a penalty.

In order to be drawn as jurors, users would have to stake PNK into, say, a Live Football Court. A predefined number of jurors would be randomly drawn. After the selection is done, jurors would be shown the evidence and would have to make the decision ("Was that a penalty? Yes/No").



A juror interface in the CrowdVAR

Those voting coherently with the majority would keep their PNK, while those voting incoherently would lose theirs.

The beauty of a “live court” is two fold:

- Jurors would have a constant stream of cases to arbitrate quickly. This creates an ecosystem of permanent work hours potentially giving users something that resembles 'Full Time' employment.

- End users would be guaranteed a quick turn around in 'simple' cases where a human decision is all that's needed to confirm the outcome.

Both of these factors produce a steady liquidity which keeps the protocol turning efficiently.

Preventing Attacks

National 51% Attacks

Say Brazil (207 million people) is playing against Iceland (334,000 people). Brazilian supporters could try to do a 51% attack on the court. Since they want their team to win and they hold the vast majority of the tokens, they could try to vote for Brazil in every CrowdVAR decision.

But there is a defense against this.

In Kleros, users can only select the court where they want to participate as jurors. But they cannot select the specific game. The Live Football Court could have, say, 1000 simultaneous CrowdVAR decisions and only one of them would be the Brazil vs. Iceland game.

If Brazilian fans wanted to flood the court, lots of them would be sent to decisions in Danubio-Nacional from the Uruguay League or Erchim-Bayangol from the Mongolia First Division.

On average, a large country's fan base would not be able to overwhelm the system unless it had 51% of the total juror pool. If there is an arbitration decision involving the Brazilian national team and, say, 10% of the total juror pool consists of Brazil fans, that may tilt the results in the case of a particularly difficult arbitration decision, but it would likely not be enough to result in blatantly bad calls.

Bribes

One might think that there is so much money floating around on sports bets, that bettors could pirate such a system by offering bribes that dwarf whatever internal incentives Kleros uses.

In practice, however, it would likely be difficult for groups of bribers to coordinate themselves to make a common attack in real time. So real threats would only be likely to

come from individual parties with very large stakes in the outcome of the match. Nonetheless, using jury sizes in early round voting much larger than what Kleros normally uses would be necessary to combat this[124].

Is FIFA Ready for CrowdVAR?

The crowdVAR may not be the lowest hanging fruit for Kleros applications. Because of scalability concerns, blockchain technology still isn't ready for real time applications. And one would need to figure out how to avoid Kleros appeal system, one of the main defenses against malicious actors, to avoid ruining the game experience (imagine having to wait for solving the appeals in the middle of the game).

Perhaps the main challenges are not technical, but cultural and organizational. Even though VAR seems to allow for better referee decisions in Russia 2018, some have decried its use as 'taking the randomness' out of football. And FIFA is notoriously slow in adopting new refereeing technology.

It's worth pointing, however, that just as any other human practice, refereeing has evolved throughout the ages. And the trend was always towards adding more eyes and brains in decision making. In the 19th Century, in the early days of football, there was only one referee (imagine how hard it was to rule an offside). Linesmen came later, adding two extra pairs of eyes. The fourth referee was introduced in 1991, and the fifth referee debuted in Germany 2006 World Cup.

There's no reason to stop there. Evolution seems to keep moving in the direction of the crowd referee. Under the right incentives, 10,000 eyes assisted by AI can make better decisions and bring more fairness and transparency into the beautiful game.

Decentralized Refereeing for E-Sports

Even though the CrowdVAR may not be a low hanging fruit in professional football, the e-sport industry could indeed be one of the early adopters for decentralized justice.

E-sports have been growing fast over the last decade. According to the World Economic Forum, the global e-sports audience has reached 380 million people in 2018, made up of 165 million dedicated e-sports followers and 215 million occasional viewers. It is projected that in 2018, the industry generated $905 million in revenue.

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[124] To learn more about how the Kleros system defends itself from attack, see *Why Kleros Needs a Native Token: Security and Incentives in Decentralized Justice* by William George in Chapter 2 - Kleros Cryptoeconomics: Towards a Theory of Decentralized Justice.

League of Legends is a very popular online battle video game with over 100 million players every month. The 2016 World Championship had a total prize pool of over 6 million dollars.

Just as the eBays and Facebooks have created their dispute resolution systems to provide users a safe environment for transacting and interacting online, so have gaming companies like Valve built their own systems for detecting and punishing cheaters.

Such companies have already experienced crowdsourced systems using tribunals formed by other players. An example of this is the system **Overwatch** created by Valve for detecting cheaters in their game Counter Strike. In this system, a panel of players reviewed recorded videos where some player was accused of cheating and decided whether there was indeed a violation or not.

In the era of an ever expanding internet and with the rapid rise of online gaming, decentralized justice solutions might offer a cheaper and more efficient way to solve the problem of cheaters and violators in the field.

Kleros Layer 2: Decentralized Justice in the Mainstream World

By Federico Ast, CEO, Kleros

We usually present our vision of Kleros as an arbitration layer for the decentralized ecosystem. A protocol to which all DAOs can delegate dispute resolution.

Quite often, we are asked the following question: can you use Kleros to resolve disputes in the mainstream world? Could it be used, say, by eBay to solve user disputes? Or by governments to handle small claims? Or by insurance, finance and other companies to implement higher fairness standards when handling customer claims?

The answer is yes.

As a decentralized protocol, for Kleros it doesn't make a difference whether the case comes from the crypto or the non-crypto world. The main challenge in mainstream use cases is about implementation details.

Decentralized platforms can easily integrate with Kleros by implementing the ERC 792 arbitration standard into their smart contracts. But this can be challenging for non-crypto companies.

Mainstream businesses typically don't handle cryptocurrencies (and may even have regulatory constraints for doing so). Also, they may be unable or unwilling to deal with the complexity of Kleros (e.g., learning how the incentive system works, etc.).

Corporates and institutions just want to delegate dispute resolution to a business process outsourcing (BPO) provider and pay a fee (in fiat!) for the service rendered. And this is exactly the problem that Kleros Layer 2 comes to solve.

Kleros Layer 2: Bringing Decentralized Justice to the Mainstream World

Alice is Customer Claims Manager at the e-commerce platform MuchTrade. She's in charge of the resolution process for thousands of customer disputes.

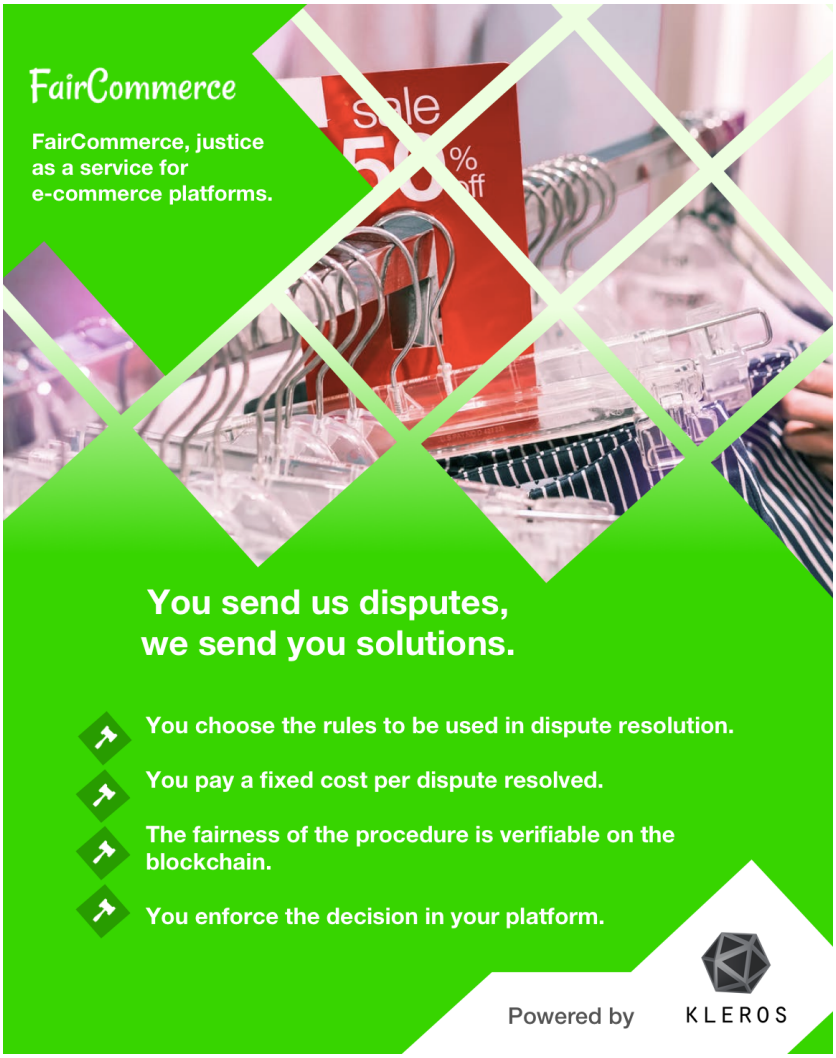
The process is currently handled by an internal team that solves claims by following a set of predefined rules.

Alice is under pressure by different agents.

On the one hand, the CEO demands that she cuts costs in the resolution procedure, which is slow and expensive. On the other hand, customers usually complain that the resolution process tends to be biased in favor of larger users.

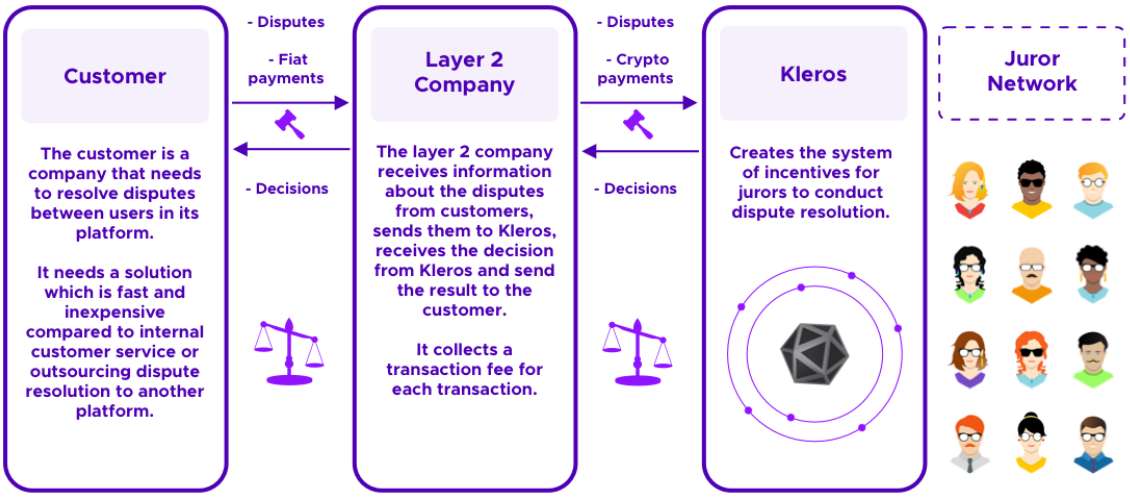
Alice gets in touch with Bob, business developer at FairCommerce, a BPO built on Kleros that provides dispute resolution services for e-commerce platforms.

Bob sends Alice a brochure explaining their services:



From the point of view of MuchTrade, it's no different than contracting any other BPO such as a contact center or one that handles administrative tasks.

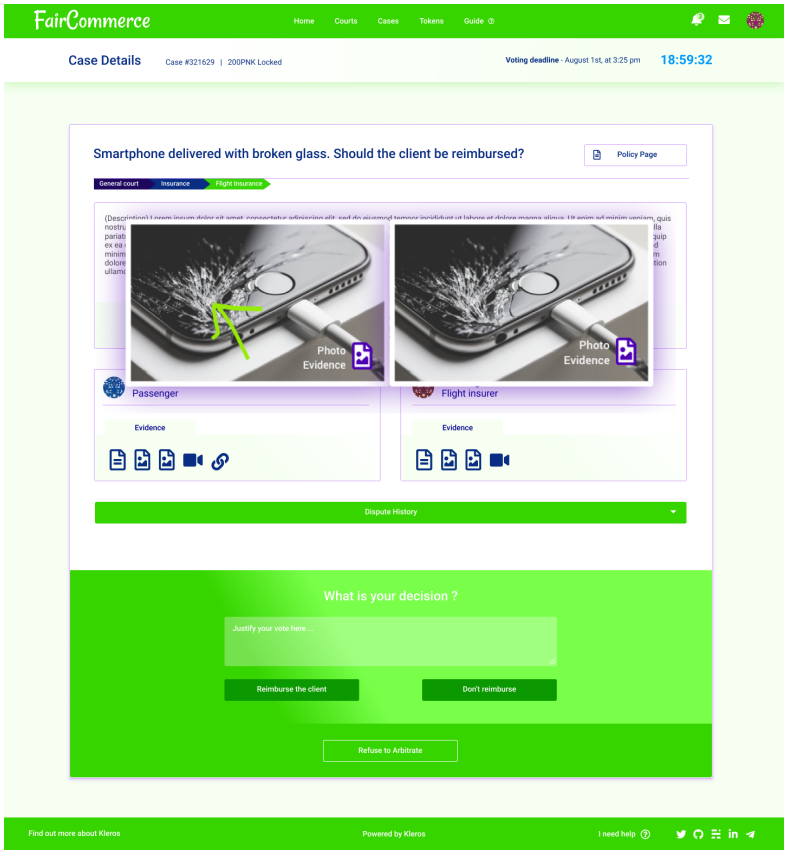
FairCommerce will handle all the complexities of Kleros and of dealing with crypto. In exchange for this, it will collect a fee per case resolved.



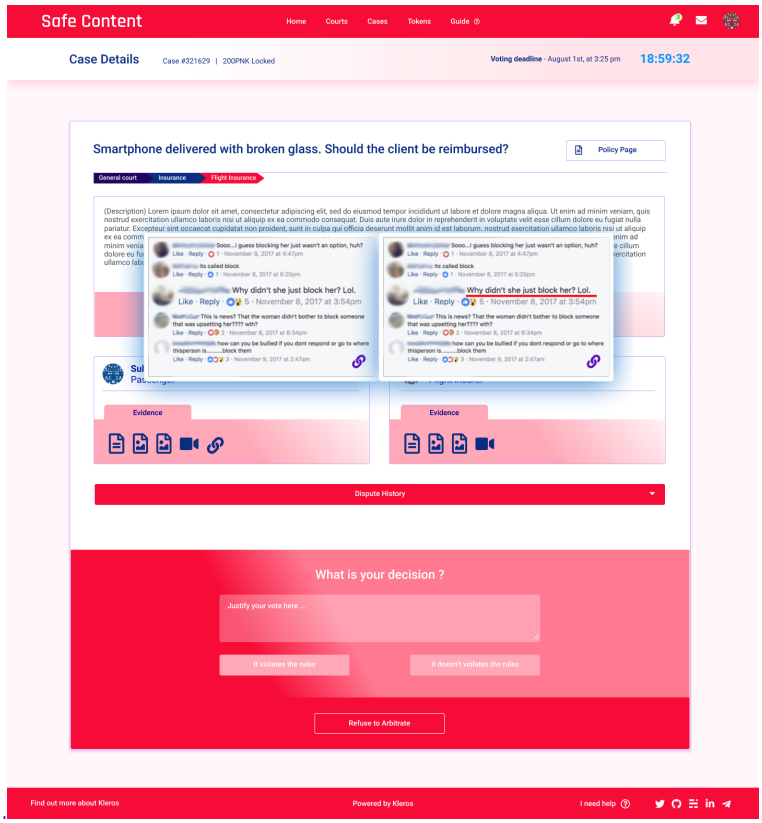
Layer 2 companies mediate interactions between customers and Kleros' cryptonetwork. From the point of view of the customer, the experience is no different than dealing with any other BPO.

Different Layer 2 companies will address use cases in different industries. Some will specialize in e-commerce, others in insurance, others in finance and so on. They will all tap into Kleros juror cryptonetwork for resolving disputes.

Kleros protocol (and the fact that it's built on a blockchain) will provide verifiability and guarantee of a transparent procedure. Customers know that the decision-making is verifiable on the blockchain.



This is what an interface could look like for FairCommerce, a Layer 2 company specializing in e-commerce disputes



This is what an interface could look like for Safe Content, a Layer 2 company specializing in fair content moderation.

The Early Use Cases

Kleros Layer 2 isn't a vision for the far away future but a reality being shaped in the present. Entrepreneurs are already building Layer 2 products on top of Kleros.

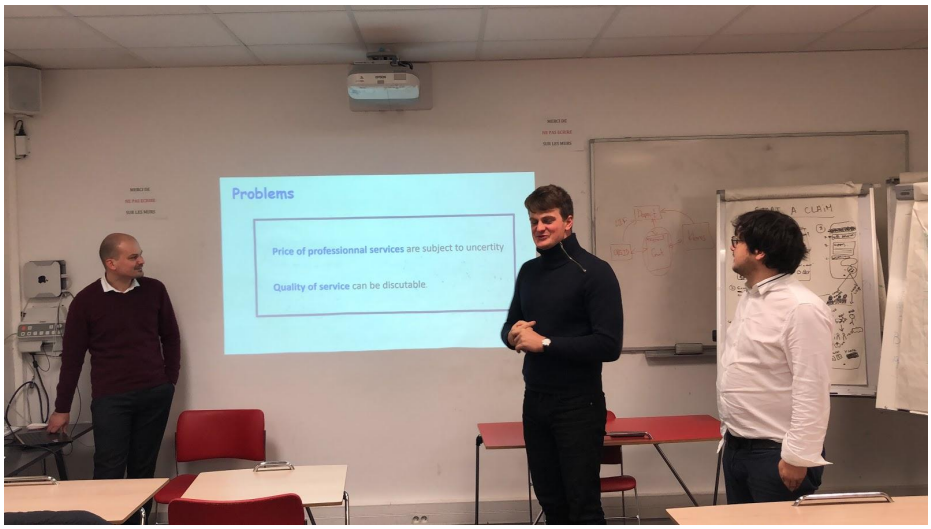
Sahele Felicio and Flavio Gouvea, Kleros Fellows presenting an app for dispute resolution in the construction industry at a meetup in Brazil.

Kleros is an academic partner at the program in [Legaltech and Digital Transformation of Law at Paris 2 Panthéon-Assas University](). Lawyers who participate in this postgraduate program are required to use legal design principles to build Layer 2 products based on the Kleros protocol.

These are the products they've built:

Start a Claim. An app based on Kleros for dispute resolution in sharing economy platforms.

S.Y.D. An app based on Kleros for resolving disputes between landlords and tenants.



An app based on Kleros for dispute resolution in professional services agreements.

Justice as a Service

Companies need to focus on what they do best and then try to delegate other processes to agents that are able to do them faster, cheaper and better.

MuchTrade needs to focus on attracting users and optimizing revenue per user, instead of managing a dispute resolution team.

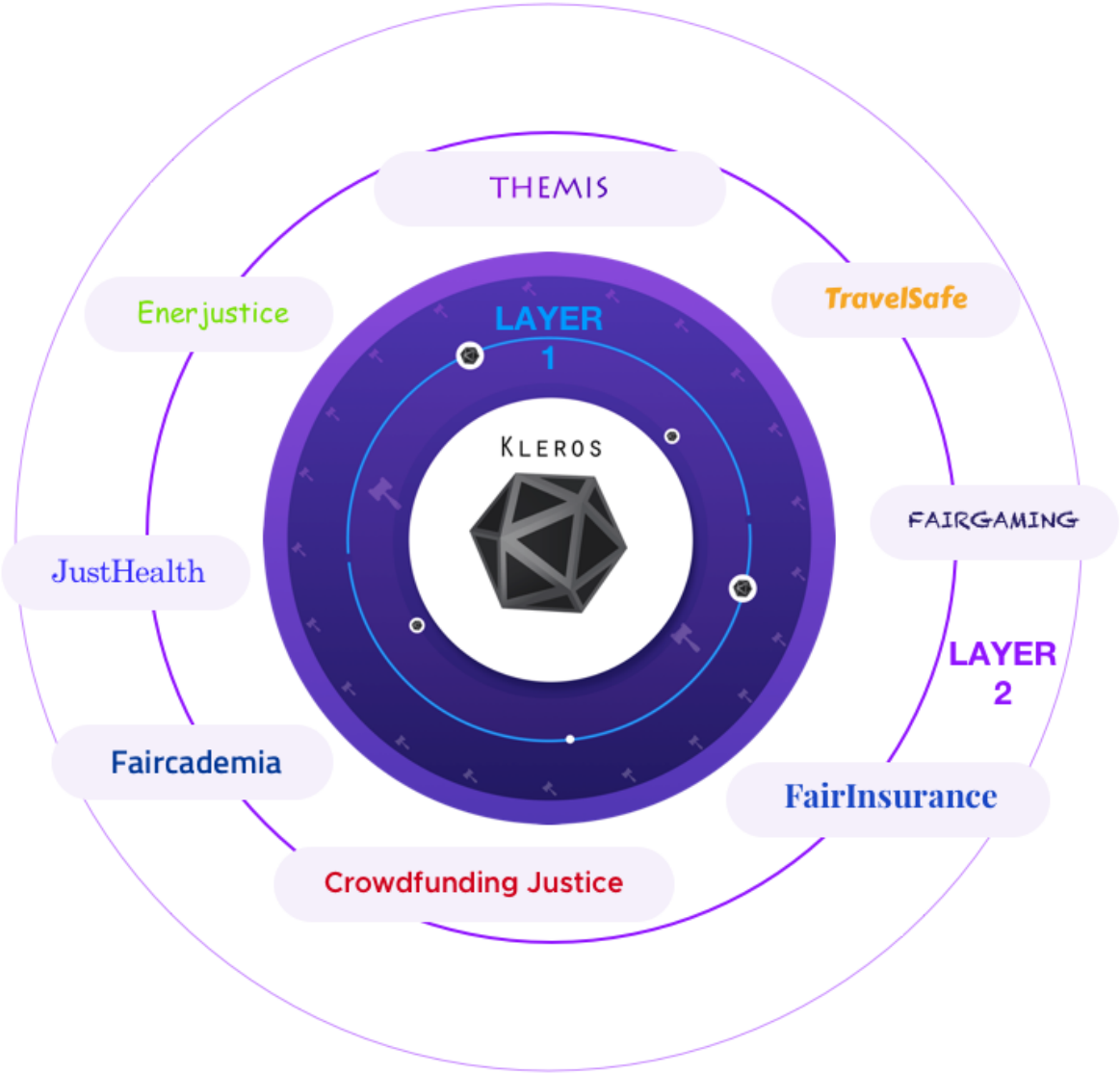
Companies are already used to delegating customer service processes into lower cost providers such as contact centers.

Kleros enables a process that is radically more efficient in producing fair decisions in a wide variety of customer claim scenarios. Many Layer 2 companies will be created for addressing these customer needs.

Layer 2 entrepreneurs will experiment and learn. And they will find the answer to a number of questions: What is the best way to sell "justice as a service"? What is the best way to charge for the resolution procedure? How should the business model work?

In the crypto ecosystem, Coinbase played the important role of making Bitcoin accessible to the masses. It abstracted complexity and provided a friendly process for people to use crypto.

Kleros Layer 2 will have the same effect on decentralized justice. It will bring justice as a service into the mainstream world.


THEMIS
Enerjustice
TravelSafe
LAYER 1
KLEROS
FAIRGAMING
JustHealth
LAYER 2
Faircademia
FairInsurance
Crowdfunding Justice

Kleros: A World of Possibilities

1. **Freelancing disputes.**

   A client deposits funds for a task to be completed by a freelancer. In the case of disputes, the job would be sent to Kleros for arbitration. Kleros jurors decide and the contract is executed dispersing funds to the winning party.

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2. **Video encoding quality**
   A network provides rewards to participants for encoding videos. A participant challenges the quality of a video. Jurors watch the original and the newly encoded video and determine who was right. The contract is executed and funds are disbursed to the original challenger or the encoder.

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3. **Development bounties.**

   A dev team lists bounties to reward developers who build specific features or find bugs. A developer claims he developed the requested feature or found a bug. The dev team denies it. The evidence goes to dispute resolution. The jury decides who is right and the payment is executed accordingly.

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4. **Milestones to release funds in crowdfunding campaigns.**

   Project managers pledge to develop a product and set up milestones. Each milestone releases a specific part of the funds raised in the crowdfunding. If milestones are not reached after a deadline, funds are reimbursed to contributors. Kleros solves claims based on milestone completion.

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5. **Website integrated payment.**

   Websites can display payment buttons allowing their customers to make escrow payments. If customers do not receive goods and services as they should have, they can request a refund. The decision is made by Kleros jurors.

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6. **Micropayments for attention.**

   Users can install a special plug-in and fund their account. Websites on the network don't display ads to these users. Users of the network make automatic micropayments to the websites they visit. Websites can enter the network by making a deposit. When a user notices that a website he paid for still displays ads, he can report it and claim the deposit of the violating website.

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7. **Inheritance.**

   The will maker uses an inheritance smart contract account to store his assets (ETH, Bitcoin, collectibles). He designates heirs to receive the funds upon death. If he doesn't interact within a predetermined time, heirs can claim that the will-maker is dead. Anyone can counterclaim that the will-maker is in fact alive. Kleros can rule on the death of the will maker (for example, by looking at the death records). Funds are transferred to the heirs if the will-maker is considered dead.

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8. **Car Insurance.**

   Bob rents Alice's car for the weekend. Bob sends $1000 into an escrow which will be refunded after the car is returned in good condition. Alice claims the car was damaged. Jurors estimate the damage at 300$. That amount is then sent to Alice from the funds deposited in escrow and the remaining $700 are refunded to Bob.

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9. **Auto-promises.**

   Users can make promises with themselves by depositing a stake. If a person makes a commitment to lose weight, quit smoking, exercise more, they put funds into an escrow. If they do not comply with the promise given, funds in the escrow are burnt. A panel of Kleros jurors defines whether the promise was indeed kept.

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10. **Moderate social media for profanity, illegal content or NSFW content.**

    Bob makes an unsavory comment on social media. The comment is flagged as profanity. Jurors vote that the comment violated terms and conditions of the platform. Bob loses reputation points or is suspended / banned.

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11. **Avoid plagiarism in content platforms.**

    Bob uploads a video to a video sharing platform. Alice claims that he plagiarized a previous video of hers. Kleros jurors decide that the video was indeed plagiarized.

The offending video is deleted.

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12. Removing fake files from torrent networks.

When a user sends a file to a torrent network, he needs to make a deposit. If the content in the file does not match the title description, other users can challenge it. Any dispute then goes to Kleros.

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13. Mail antispam.

Email senders set up a deposit proportional to the amount of emails they want to send per month. Emails sent this way are never filtered through spam filters, but in the case the recipient considers a message as spam, he can create a dispute. The challenger wins part of the sender deposit if the email is ruled as spam by Kleros jurors.

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14. Securing Decentralized Finance Platforms

Users can submit tokens with their name, address, ticker and logo. Incorrect submissions can be challenged. Applications (wallets, decentralized exchanges, etc) use this list of tokens to allow their users to select tokens without having to type their addresses and to display user balances.

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15. Sport betting.

Gamblers place their bets on sporting competition results. Bettors who bet on the right result split the money lost by other bettors. If there is a dispute between parties over who actually won, that information is obtained through a Kleros based jury decision.

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16. Price Oracle.

An oracle giving the price of a currency (like ETH) in another currency (like dollars or BTC). Submitters submit price ranges and Kleros remove price ranges not containing the real value. The final value is given by taking the mean of the intersection of all remaining intervals. This can be used to update prices or to make financial contracts.

The Kleros Fellowship of Justice Library

We explore and experiment with the concept of decentralized law, more precisely decentralized dispute resolution. This is a grand endeavor, which requires the creation of a strong community of computer scientists, mathematicians, economists, legal experts, social scientists and businesspeople.

In August 2018, we launched the Kleros Fellowship of Justice, a program directed at experts to foster this community. Since our first batch, we welcomed 47 applicants to the fellowship. Here, we would like to present the outstanding and inspiring work of our Fellows.

In this 2–6 month long remote program, participants from the fields of computer science, cryptoeconomics, law and business get exposed to the cutting edge of civic technology we're building at Kleros.

For the duration of the Fellowship, candidates collaborate with core members of the Kleros team by doing work or conducting research relevant to the advancement of decentralized justice.

Tracks

The Program is composed of four tracks covering the key fields involved in Kleros: DApp Development, Cryptoeconomics, Law & Society and Business.

Candidates have to apply to their field of choice and the specific skills to be accepted will depend on the chosen track.

The goal of the Fellowship is to bring brilliant people into the decentralized justice conversation and to create a vibrant research community. Over time, its graduates will be recognized as world experts in the field of decentralized justice. In this Library of the Fellowship of Justice, you can see all the completed work of our Fellows until now.

Incorporating Kleros in Long-Term Energy Supply Contracts

Abeer Sharma, Lawyer, Supreme Court of India

Long-term contracts are a special category of contracts where the obligations of the contracting parties are spread over many years – sometimes up to decades. While used in a range of different transactions, they are most famously used in lucrative supply contracts in primary resource industries such as coal mining, liquified natural gas, electricity, and nuclear power supply contracts. This report focuses on an analysis of feasibility of using Kleros as an oracle to resolve disputes arising from such a high-stakes market.

Link to full report.

Due Process in Kleros Consumer Dispute Resolution

Dmitry Narozny, Civil Law Attorney, Russia

This report focuses on the analysis of how Kleros corresponds to internationally recognized due process requirements. The main purpose of this Report is to deliver a model of Kleros' consumer redress scheme which is compliant to any identifiable regulatory coordinate system for conducting dispute resolution procedures.

Link to full report.

My Kleros Fellowship Experience as a Digital Product Designer

Tian Zhao, UX Designer, Canada

"I chose to work with Kleros because it was a great opportunity for me to learn and contribute more as a blockchain-focused product designer who's passionate about social impact. What's incredible about all of this is that prior to encountering Kleros, I had no interest in law." A personal story and details of improvements to our system of our Fellow combined in this touching testimony.

Link to full report.

Application of Kleros decentralized dispute resolution technology in cases of civil liability derived from parental responsibility to Argentinian courts.

Julieta Fernandez Tineo, Digital Law Specialist, Argentina

The Kleros decentralized dispute resolution technology has already proven its worth in the private sector as an effective alternative arbitration method, which is why in this paper the

case will be made for its application in the public sector. Because the public order of a country – in this case Argentina – will be at stake when testing this protocol in the Courts, it is important for the matter being discussed to be as straightforward as possible in order to avoid any undesired rights violations. That is why this paper studies the possible extrapolation of the Kleros protocol from the private to the public sector in Argentine Family Courts in cases where the existence of a civil liability of the parents, derived from their parental responsibility duties, is being investigated.

Link to the full report.

Labor Certification on the Blockchain

Elliot Talbert-Goldstein, Assistant Director for Digital Marketing, Division of Professional Studies, University of Maryland

Certification and regulation frameworks that reduce risks for each party in a food supply chain, while increasing transparency make a major impact on food production and consumption by protecting consumers, workers, and companies. Those frameworks today can be drastically improved using blockchain technology. The following case study analyzes a real-world example of designing a blockchain application that improves the confidentiality, integrity, and availability of data for the certification for food growers, processors, sellers, and, ultimately, consumers. The research is designed to inform key challenges and opportunities in using blockchain for regulation in the supply chain and regulatory frameworks more broadly.

Link to full report.

Kleros and the Alabama Arbitration Act

Eric Martin Scott, Public Law & Cyber Security, University of Alabama

This article will discuss generally the arbitration laws in the United States and how the state of Alabama's laws favoring commercial arbitration, could make the state a favorable locus for blockchain based arbitration. As one researcher into blockchain and U.S. state law suggests, "Like any contract, smart contracts should contain a dispute resolution clause, which specifies, among other things, choice of law and choice of jurisdiction."10 Thus, Alabama, once referred to sarcastically as the "Arbitration State"11 could earnestly find itself as the "Blockchain Arbitration State."

Link to full report.

Mauricio Duarte

Attorney and Notary, Specialist in Energy Infrastructure Investment Law. Guatemala

This report covers the potential application of Kleros to peer-to-peer energy markets. The energy industry is rapidly transforming, and the “millennial” generation will demand technologies that enable the integration of distributed energy resources. Blockchain, smart contracts and smart meters are drastically changing the way electricity is produced. These new technologies are enabling the increase in energy prosumers as participants of a distributed and decentralized energy market. Blockchain adoption in the energy sector will benefit markets and consumers.

Link to full report

Conclusion

Alice wakes up one morning with her VR set quietly buzzing on her head. She stretches her arms, stands up from her bed excitedly and steps into the spacious dressing room of her virtual mansion. She is looking for her latest acquisition - a new dress she bought from Bob, a designer of grand reputation. The dress cost quite a lot of coins to tailor precisely according to her taste.

But her excitement quickly turns to disappointment as she finds out that the dress was absolutely not what she expected. She writes a strongly worded letter to Bob immediately, but to no avail. His prompt answer is that he did his job exactly according to her preferences. In addition, he demands that she releases the second part of the payment from the escrow.

Not shaken by this act of defiance, she logs into the wall console, connects to the resident dispute resolution system and talks with a bot about her claim. After answering several standard questions, the case is swiftly sent to Kleros for resolution.

Carl is a self-aware bot earning his living by processing thousands of disputes in design. A small bleep on his internal display shows a new case to be adjudicated. He optimizes the amount of coins necessary to become a juror, feeds the coins into the platform and quickly swoops in to solve the case of the erroneous dress. The case was solved in Alice's favour. Two of the jurors were bots. Only one was human.

This is not science fiction. This is what currently happens in the customer services of big tech companies such as Alibaba and Facebook, where algorithms and crowdsourcing are already used for dispute resolution. But, since they are private companies, we don't consider such processes as governance and justice. We just see them as business processes and customer service.

As the decentralized economy grows, however, these procedures will be seen as what they really are: the governance framework of the Internet Age. As such, they will require the same thoughtful consideration that the Greek gave to their democratic procedures and that the Federalists gave to building the institutions of the United States.

For most of history, the only form of government that humanity had known was despotism. Pharaohs, tsars, emperors and kings enjoyed a centralized position of absolute power. The world had known of but a few democratic experiences in the Athenian polis, the Roman Republic, Florence and Venice of the Renaissance.

In the 17th and 18th centuries, revolutions in Great Britain, France and the United States triggered a process of decentralization of power. Politicians and intellectuals of that time debated how the government of a great republic should be structured. There were no previous experiences of large scale democracies. A representative democracy with a division of powers was the best answer to build a system that would be able to avoid concentration of power..

At the end of the 20th Century, the Internet was born with a liberating ethos. Silicon Valley entrepreneurs, many of whom are contemporaries and heirs of the San Francisco´s hippie movement of the 1960s, were fighting for the democratization of information and knowledge. That generation published the Declaration of Independence of Cyberspace and the Cypherpunk Manifesto.

Even though they were concerned about avoiding governments becoming too powerful (and for that they advocated the use of cryptographic tools) they failed to see that the technology they developed would actually end up creating another type of behemoth, shaped as big tech companies that quickly became the largest concentration of power that mankind has ever known.

West Coast big tech (Google, Amazon, Facebook, Apple and Microsoft) became global oligopolies. Even though they are business organizations, from a political point of view, these huge governance structures can be considered as virtual states. Absolute monarchies with hundreds of millions of users as subjects. Management writes the law (terms and conditions), controls the administration of justice (dispute resolution system), appoints judges (moderators) and enforces sanctions (suspension and expulsion of users).

As the big platforms increased their power, early voices like Aaron Schwartz, Julian Assange and Edward Snowden sparked a movement to put the Internet back in the hands of the people. Their struggle was for democratizing access to information and avoiding surveillance.

At the dawn of the 21st Century, still in the early days of the digital revolution, we face a new disjunctive, in some way, analogous to the 18th Century democratic revolutions: the transition from big tech platforms to a decentralized Internet era.

As entrepreneurs from all over the world build decentralized cryptonetworks for e-commerce, social media, the sharing economy, file sharing, among many others, the old governance dilemmas of the Athenians and the Federalists start to emerge again: without a monarch to make unilateral decisions (software updates, pricing policy, revenue distribution), users have to make decisions together. They go from virtual subjects to virtual citizens.

How do we govern these organizations? What tools should we use for our collective decision making?

In the 18th Century, attempts to solve these practical dilemmas of social organization in nation states gave birth to new sciences such as economics, political theory and new tools such as statistics (which derived its name, of course, from the governance of a state). By then, researchers such as Condorcet were trying to apply mathematical models to advance a voting theory.

In the early 21st Century, the new dilemmas involve online platforms and the rise of the new science of cryptoeconomics, a combination of computer science, economics and cryptography to deal with the governance issues of the digital age. Such as the Internet poses new problems, it also enables new forms of government which were not possible before.

As Hobbes, Locke and Montesquieu in the 18th Century (who speculated on the advantages and disadvantages of monarchy, aristocracy and democracy), researchers have in recent years started to speculate about what should be the best system of governance for decentralized organizations.

Some proposed *liquid democracy*[125], a combination of direct and representative democracy. In representative democracy, citizens delegate their voting power to a representative, who assumes the responsibility to vote for them on all issues. In case he's not happy, the citizen can only change the representative in the next election.

In liquid democracy, citizens can delegate their voting power to representatives on specific issues. For example, delegate decisions about software updates to one user, and decisions about revenue distribution to another. If we are not satisfied with the representative, we can immediately revoke our delegation of the vote, without waiting for the next election. Projects exploring liquid democracy include Democracy Earth and DAO Stack.

Another idea is *futarchy*, a form of government first suggested by economist Robert Hanson in the article ***Futarchy: Vote Values, But Bet Beliefs***. In this case, users do not vote for representatives or policies. They vote for a metric that defines how well the political community is working. Then, with a technology known as prediction markets, incentives are generated to implement policies that optimise the metric chosen by citizens. Prediction market projects such as Augur and Gnosis are already being developed, and improve the

[125] Liquid democracy, or delegative democracy has strange origins. One of the earliest proponents of the idea was Charles Dodgson (or Lewis Carroll) in his writing, but the idea reappears since the end of the 19th Century in the writings of Gordon Tullock, James C. Miller and Martin Shubik.

availability of information for decision making. Aragon is a project exploring the application of futarchy in governance processes.

Finally, Kleros proposes another form of government for decentralized organizations. It is based on the old concept of demarchy, the Athenian idea of random selection of representatives for government and courts, enhanced by the collective intelligence concepts of the Internet Age.

Liquid democracy, futarchy or demarchy? What is the best form of government for decentralized organizations?

It is likely that the answer will be - all of them. Athenians used random selection for the Council of 500 and popular courts, but not for selecting generals (for which they used standard voting procedures). The Founding Fathers of the United States kept random selection for jury duty, but decided to select government officials by voting.

It is yet to be seen how the new political technologies of liquid democracy, futarchy and Kleros will be combined into effective governance tools for decentralized organizations. And it is likely that Kleros will fulfill a key role in dispute resolution and maybe also in other governance processes where a neutral third party is required. A decentralized arbitration platform will be a critical piece of governance infrastructure for the years to come.

Social order was always established through the development of ever more complex legal systems. These systems arose from ever more complex societies that built them and the technological advances that followed.

Athenians from the Classical period used popular trials. The Middle Ages in Western Europe brought with them ordeal trials for witchcraft, where people would be burned at the stake if they floated on water. The coming of the 17th and the 18th Century brought with it the formation of modern nation states and with them the legal systems we know today.

In the decades to come, our children may see early 21st Century justice systems as we see medieval ordeal trials today: as bizarre proceedings causing extreme and unnecessary pain.

This, of course, is a long look at the possibilities that might arise in the times ahead of us. When we look at the short term effects of this new era - the Internet has already brought with it complexities and wonders which unravel before our very eyes.

Unlimited access to information, e-commerce transforming trade and cryptocurrencies transforming finance. The coming of AI and smart contracts marks the beginning of a new wave of changes with the potential to transform law and democratize access to justice.

In this context, these new governance tools are already used to explore and eventually transform a number of existing businesses and business practices, from international arbitration, handling of customer claims, protection of consumer rights to content moderation.

That is why it is already not difficult to imagine a world where platforms such as Kleros offer cheaper, efficient and more equitable access to resolving small scale disputes, which represents a seed from which so many things can grow.

As Cleisthenes in ancient Athens and the Hamiltons and the Madisons in 18th Century America, we are trying to lay the foundations of sustainable and prosperous peer-to-peer communities online.

Like them, we are creating powerful social technology in uncharted territories. This book gives you, the reader, a look at what we have learned at the beginning of our journey. We hope it will inspire you to join us in this venture of bringing citizen justice to the world.

Join us in this dispute revolution.

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