LAW + TECHNOLOGY

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ABSTRACT

The classical "law & technology" approach focuses on harms created by technology. This approach seems to be common sense; after all, why be interested—from a legal standpoint—in situations where technology does not cause damage? On close inspection, another approach dubbed "law + technology" can better increase the common good.

The "+" approach builds on complexity science to consider both the issues *and* positive contributions technology brings to society. The goal is to address the negative ramifications of technology while leveraging its positive regulatory power. Achieving this double objective requires policymakers and regulators to consider a range of intervention methods and choose the ones that are most suitable.

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Introduction

Legal rules and standards typically focus on the problems created by technology. The Code of Hammurabi (1750 BC) first introduced this approach, providing that "[i]f any one open his ditches to water his crop, but is careless, and the water flood the field of his neighbor, then he shall pay his neighbor corn for his loss."[1] The Babylonians addressed technology as a cause of potential harm; after all, there is no need for regulation when technology does not cause any damage but benefits society. The rationale is now perpetuated under the label "law & technology."[2]

Another approach is possible. Perhaps a new legal way of considering technology is even desirable. Legal reasoning can go further by apprehending both the issues brought by technology *and* its positive contributions to society. The point is not to make lawyers evangelists or naïve. I do not suggest that policymakers and regulators embrace technological solutionism.[3] But I do suggest that policymakers and regulators escape legal solutionism—the recasting of all complex social situations in neatly defined problems legal rules can solve[4]—by looking at technology as a regulatory force that can contribute to increasing the common good.

Letting legal solutionism aside and actioning "law + technology" requires legal rules and standards to eliminate technology's negative ramifications while preserving the technology's benefits.[5] To be sure, the positive ramifications of technology are sometimes mentioned under "law & technology," but they are excluded from the analytical scope when tackling the negative ramifications. In short, "law & technology" expresses at best an "on-the-one-hand-on-the-other-hand-ism," but it fails to connect both

[1] CODE OF HAMMURABI, art. 55 (1750 BC).

[2] To be sure, "law & technology" is used as a general label to describe the study of digital laws (e.g., the Proposal for a Regulation of The European Parliament and of The Council Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, COM(2021) 206 final) or laws applied to digital matters (e.g., contract law applied to smart contracts, *see* Thibault Schrepel, *Smart Contracts and the Digital Single Market Through the Lens of a 'Law + Technology' Approach*, EUROPEAN COMMISSION, 22 (2021)). Not all scholars that use the label "law & technology" recognize themselves in the meaning I attribute to the label in this article. I, nonetheless, assign a specific meaning to the label "law & technology" to highlight the differences between the dominant legal approach to technology and the one I propose in this article.

[3] *See* EVGENY MOROZOV, TO SAVE EVERYTHING, CLICK HERE: THE FOLLY OF TECHNOLOGICAL SOLUTIONISM 5 (PublicAffairs, 2013) (describes technological solutionism as the recasting of "all complex social situations either as neatly defined problems with definite, computable solutions or as transparent and self-evident processes that can be easily optimized")

[4] Here paraphrasing Evgeny Morozov, *ibid*.

[5] Technology can exacerbate existing problems (e.g., discrimination and AI) or introduce new ones (systematization of risks), *see* Philipp Hacker, *Teaching Fairness to Artificial Intelligence: Existing and Novel Strategies Against Algorithmic Discrimination Under EU Law*, 55 COMMON MARKET L. REV. 1143, 1144 (2018) (describing algorithmic discrimination as "a key challenge for our algorithmic societies"); Sarah Myers West, Meredith Whittaker & Kate Crawford, *Discriminating Systems: Gender, Race, and Power in AI*, AI NOW INSTITUTE (Apr. 2019) https://perma.cc/B4WX-ZF9K.

positive and negative aspects.[6] The "law + technology" approach both mentions *and* considers how to preserve these positive ramifications. It connects technology with all its effects.

As a result, "law + technology" can further increase the common good than a classical "law & technology" approach because it better preserves technology that regulates society in ways legal rules and standards cannot. Indeed, law and technology are made of different materials whose combination creates synergies. Adding law and technology (+) rather than considering them separately (&) produces a combination of social and technical constraints that leverage their strengths.

"Law + technology" ends up better aligned with the constitutional aim of reducing "public misfortunes"[7] and "promote the general welfare."[8] The "+" approach is a positive contribution to the legal systems, not a concession to technology. Policymakers and regulators shall thus consider a range of regulatory methods and choose the ones that best achieve the dual objective of addressing the negative ramifications of technology while leveraging its regulatory power.

1. From "&" To "+"

Abandoning the "law & technology" approach in favor of "law + technology" requires first to define the scope (1.1.), formulate a hypothesis (1.2.), and explicit the aim (1.3.).

1.1. Scope

Law can help technology by creating a stable legal environment. This "code using law" aspiration is well documented and considered.[9] For example, Joe Biden's executive order on crypto-assets ambitions to use law for technological and economic growth.[10] The order aspires to "reinforce United

[6] Here quoting my colleague Anne de Hingh, capturing the idea behind Joseph Weizenbaum, *On the Impact of the Computer on Society: How Does One Insult A Machine?* 176 SCIENCE 609, 609 (1972) ("First there is an 'on the one hand' statement. It tells all the good things computers have already done for society (…) This is usually followed by an 'on the other hand' caution which tells of certain problems the introduction of computers brings in its wake"). Under "law & technology," the "other hand" ("problems") is addressed without considering the impact on "the one hand" ("good things").
[7] *See* DECLARATION DES DROITS DE L'HOMME ET DU CITOYEN DE 1789 [Declaration of the Rights of Man and of the Citizen 1789], pmbl.
[8] U.S. CONST., pmbl.
[9] EDMUND PHELPS, MASS FLOURISHING: HOW GRASSROOTS INNOVATIONS CREATED JOBS, CHALLENGE, AND CHANGE 206 (2013) (legal certainty makes entrepreneurs want to invest and innovate); Robert D. Cooter et al., *The Importance of Law in Promoting Innovation and Growth*, in RULES FOR GROWTH: PROMOTING INNOVATION AND GROWTH THROUGH LEGAL REFORM 9 (2011) (explores the connection between legal rules and growth).
[10] Exec. Order No. 14067 of Mar. 9, 2022, 87 Fed. Reg. 14143 (Mar. 14, 2022).

States leadership in the global financial system and in technological and economic competitiveness" through legal rules.[11] The AI Act of the European Commission similarly aims to "ensure legal certainty to facilitate investment and innovation in AI."[12]

But "code using law" is outside the "law + technology" scope, as the law only assists technology without creating a positive effect on law. "Law + technology" ambitions to maximize synergies between law and technology, not to use one for the sake of helping the other.

1.2. Hypothesis

Instead of the classical "law & technology" approach, this article proposes to adopt a "law + technology" approach to explore the synergies between law and technology. "Law + technology" is based on a simple postulate: technology and law can better increase the common good together than in a silo.

Law and technology are made of different materials: law is first and foremost a social constraint, technology is above all a technical constraint. These materials are complements, so one material must not erode the other.[13] The task assigned to lawyers under a "law + technology" approach is thus to regulate the negative ramifications of technology while preserving the positive ones. The approach requires policymakers and regulators to study and understand the technology's positive ramifications before regulating it. Under "law and technology," the risk of unintentionally reducing these positive ramifications is much higher.[14]

1.3. Approach

Technology can only play a role in "law + technology" if legal rules do not hamper it. Darwin's work helps understand what preserving technology entails. In his book *On the Origin of Species*, the father of modern biology concludes that animal species and varieties can only survive if they have

[11] *Ibid*.
[12] Proposal for a Regulation of The European Parliament and of The Council Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, COM(2021) 206 final.
[13] The erosion risk exists when the two materials (law and technology) collide. This risk does not always have to be avoided. When law and technology present irreconcilable interests, the law must prevail in a rule of law system. For example, freedom of expression must prevail over censorship technologies used by the Chinese and Russian governments.
[14] Under a "law & technology" approach, regulators are not comparing the effect of different intervention methods on the positive ramification of technology. They are not in a position to balance the effectiveness of the rule and its effect on the technology. Regulators may choose a regulation with comparable efficiency to others but a more negative impact on the technology.

unique characteristics they can put to good use in their environment. It follows that the natural or brutal change in the environment causes species extinction.[15] The same is true if man's hand changes the characteristics of these species.[16]

Darwin's work introduces what will later be called "complexity science."[17] Complexity science is interested in how systems react to the context they create. The relationships between agents create a dynamic that changes the environment in which they evolve. The new environment impacts its agents, which modify their relationships, etc.

Complexity science is not well explored in the "law & technology" literature, although its teachings are fundamental.[18] The related literature body has two main lessons for regulators acting in the digital space. First, one must be careful not to remove—by legal rule—what distinguishes one technology from another, for example, not to force a single point of access in blockchain governance or constrain deep learning's reliance on activation functions.[19] The changed technology will disappear in favor of others otherwise.[20] A technology appears and remains among others only because it creates value in a singular way. Removing the element(s) that differentiate the technology from others impacts that value and thus makes it disappear. Second, one shall be cautious when changing the (legal, technical, etc.) technology environment. The technology shall remain in a position to exploit its singularities.

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[15] CHARLES DARWIN, ON THE ORIGIN OF SPECIES, 69 (1859, John Murray) ("if these enemies or competitors be in the least degree favoured by any slight change of climate, they will increase in numbers, and, as each area is already fully stocked with inhabitants, the other species will decrease").
[16] CHARLES DARWIN, ON THE ORIGIN OF SPECIES, 38, 84 (1859, John Murray) ("Man can hardly select, or only with much difficulty, any deviation of structure (…) How fleeting are the wishes and efforts of man! How short his time! And consequently how poor will his products be, compared with those accumulated by nature during whole geological periods. Can we wonder, then, that nature's productions should be far 'truer' in character than man's productions; that they should be infinitely better adapted to the most complex conditions of life, and should plainly bear the stamp of far higher workmanship?").
[17] For an introduction, *see* JOHN H. HOLLAND, COMPLEXITY: A VERY SHORT INTRODUCTION (Oxford, 2014); STEFAN THURNER, RUDOLF HANEL & PETER KLIMEK, INTRODUCTION TO THE THEORY OF COMPLEX SYSTEMS (Oxford, 2018); M. MITCHELL WALDROP, COMPLEXITY: THE EMERGING SCIENCE AT THE EDGE OF ORDER AND CHAOS (Simon & Schuster, 1992); MELANIE MITCHELL, COMPLEXITY: A GUIDED TOUR (Oxford, 2009).
[18] HeinOnline lists only 87 articles mentioning "complexity science" or "complexity theory" in the "Science, Technology, and the Law" literature between 1960 and 2020, *see* (all_topics_ms: "Science, Technology, and the Law" ("complexity science" OR "complexity theory")) in Law Journal Library, section type "articles", 1960 to 2020.
[19] Chigozie Enyinna Nwankpa, Winifred Ijomah, Anthony Gachagan & Stephen Marshall, *Activation Functions: Comparison of Trends in Practice and Research For Deep Learning* (2018) (explains that activation functions manipulate the data and produce an output for the neural network).
[20] This proposition is only valid if what differentiates one technology from another allows for value creation. If this is not the case, technology can create value in the same way that another technology can. It may also mean that the technology survives only because of its ability to reduce the common good while benefiting a few individuals. Policymakers can therefore suppress the technology.

In practice, regulators face two scenarios. One, the technology needs to be regulated because it creates negative ramifications for reasons (technical, governance, etc.) that are not related to differentiating characteristics. Regulation can address the problems without endangering the technology's survival. Two, the technology creates negative ramifications precisely because of the characteristics that differentiate it from others. Regulation will endanger technology's survival, which entails addressing the issue while maintaining sufficient differentiation from other technologies.

Let's take three examples. A blockchain smart contract is immutable. It cannot be deleted, stopped, or changed.[21] Immutability constrains the creator of the smart contract and the regulator, which is problematic when the smart contract automates an illegal transaction. In reaction, the draft version of Data Act Article 30 proposes implementing a "mechanism (...) to terminate the continued execution of transactions."[22] It would put smart contract immutability in check, thus challenging technology's survival.[23] Immutability indeed differentiates smart contracts from other contractual methods; it creates value. The characteristic creates trust between the parties by preventing unilateral non-execution. It also lowers transaction costs related to monitoring and enforcement.[24] And it helps combat corruption by blocking malicious changes after one puts the smart contract on the network, etc. Users are unlikely to want to use a "stoppable smart contract" rather than another transactional means. This singular characteristic must therefore be regulated, but maintained.[25]

Similarly, blockchain immutability is problematic when courts identify past transactions as illegal, when a user sends a token to the wrong address, etc. But immutability serves the probity of the information on the blockchain. For example, if an AI system—that runs on top of a blockchain—malfunctions, the company operating the system cannot delete entries from the database to hide the reasons explaining the misbehavior.[26] Here again, the same feature is the source of both negative and positive ramifications.

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[21] Thibault Schrepel, *Smart Contracts and the Digital Single Market Through the Lens of a 'Law + Technology' Approach*, EUROPEAN COMMISSION, 22 (2021) (explains smart contracts' immutability).
[22] The Proposal for a Regulation of The European Parliament and of The Council on Harmonised Rules on Fair Access to and Use of Data (Data Act), COM(2022) 68 Final, art. 30 only applies to smart contracts automating data sharing.
[23] Thibault Schrepel, *The Theory of Granularity* in BLOCKCHAIN + ANTITRUST: THE DECENTRALIZATION FORMULA, 247 (Edward Elgar, 2021) (explores how to make immutability practicable without hampering smart contracts' survival chances).
[24] *Ibid*., 95-96 (smart contracts' automatic execution reduces costs compared to using an intermediary).
[25] Thibault Schrepel, *Smart Contracts and the Digital Single Market Through the Lens of a 'Law + Technology' Approach*, EUROPEAN COMMISSION (2021) (applies the "law + technology" approach to smart contracts).
[26] *Ibid*., 56 ("blockchain visibility ensures the transparency of the data used in AI systems").

Last, one sees the duality of technology at a more general level. A facial recognition system can discriminate against minorities poorly represented in the database used to train the system using deep learning.[27] But law enforcement can use facial recognition to identify human trafficking victims, in which case AI imperfections—if AI performs better than humans—shall be tolerated.[28] Researchers also use deep learning systems in medicine to discover new pathologies, improve diagnoses[29] and treatments.[30] The same goes for metaverses and virtual reality, also used in medicine.[31] Regulators shall consider the impact on positive ramifications instead of simply looking at a way to address the risks. The Darwinian take on regulating technology preserves these positive ramifications and thus forms the cornerstone of "law + technology."

2. "Law + Technology" Methodology

There are different intervention methods at the regulator's disposal (2.1.). "Law + code" is under-used to date but has unique characteristics that policymakers and regulators may want to consider (2.2.).

2.1. Overview of Regulatory Methods

The "law + technology" approach aims to maintain the potential of technology while providing an answer to the issues it creates. Different methods are possible to achieve the aim. These methods must be evaluated in light of a ratio between (i) eliminating (partially or totally) the negative ramifications and (ii) maintaining (partially or totally) the positive ramifications of the technology ("EM ratio," as in *E*liminating and *M*aintaining).

There are three families of regulatory methods. Law expressed in natural language is the only regulatory tool of the former. Computer code (the language of technology) stands by itself in the second. The third combines law and code.

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[27] Joy Buolamwini & Timnit Gebru, *Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification*, 81 PROC. OF MACH. LEAR. RES. 1, 12 (2018) (links error rates with datasets); Karen Hao, *This Is How AI Bias Really Happens—And Why It's So Hard to Fix*, MIT TECH. REV. (Feb. 4, 2019) https://perma.cc/6QDV-WXDQ.

[28] OSCE Office of the Special Representative and Co-ordinator for Combating Trafficking in Human Beings and Tech Against Trafficking, *Leveraging Innovation to Fight Trafficking In Human Beings: A Comprehensive Analysis of Technology Tools* (Vienna, May 2020).

[29] Nan Wu et al., *Deep Neural Networks Improve Radiologists' Performance in Breast Cancer Screening*, 39 IEEE Trans Med Imaging. 1184 (2020); Charlotte Jee, *Deepmind Has Made a Prototype Product That Can Diagnose Eye Diseases*, MIT TECH. REV. (Apr. 1, 2019) https://perma.cc/3QLZ-78SH.

[30] Anne Trafton, *Artificial Intelligence Yields New Antibiotic*, MIT News Office (Feb. 20, 2020) https://perma.cc/3QPR-7FT4.

[31] Children's Hospital Los Angeles, *A Game Changer: Virtual Reality Reduces Pain and Anxiety in Children* (Aug. 25, 2021) https://perma.cc/2BZ4-KA65.

	Law	Code	Law + Code
Observation	**Law is Code**: Law is a "system of rules (law "programs" society)	**Code is Law**: Code regulates like the law ("lex informatica")	**Law needs Code**: Law and code regulate better together
Method	**Code of Law**: Codification of legal rules and standards	**Law of Code**: What the code says equals the law	**Code as Law**: Code embodies the law-of-the-land **Law as Code**: Translate law into a machine-consumable version

The **first** method simply relies on law; it assumes the law is self-sufficient to provide answers to the problems created by technology. The General Data Protection Regulation,[32] the EU Artificial Intelligence Act,[33] the Digital Markets Act,[34] the Digital Services Act,[35] the Data Act,[36] the Data Governance Act,[37] the California Consumer Privacy Act,[38] the Open Apps Market Act,[39] etc., rely on this way of regulating that derives from the maxim "**Law is Code**."[40] The law is conceived as a positivist "system of rules"[41] which govern all subjects (i.e., law "programs" society). Law directs society; it reduces the number of behaviors sanctioned as illegal.

The "**Code of Law**" method derives from this observation.[42] Handwritten legal rules are effective when all regulated subjects know them. The rules come primarily from the policymaker in a civil law system and the courts in

[32] Regulation (EU) 2016/679 of the European Parliament and the Council of 27 April 2016 on the Protection of Natural Persons with Regard to the Processing of Personal Data and on the Free Movement of Such Data, and Repealing Directive 95/46/EC (General Data Protection Regulation), 2016 O.J. L 119/1.
[33] Proposal for a Regulation of The European Parliament and of The Council Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts, COM(2021) 206 final.
[34] Proposal for a Regulation of the European Parliament and of The Council on contestable and fair markets in the digital sector (Digital Markets Act), 2020/0374 (COD).
[35] Proposal for a Regulation of the European Parliament and of The Council on a Single Market for Digital Services (Digital Services Act) and amending Directive 2000/31/EC, COM/2020/825 final
[36] Proposal for a Regulation of the European Parliament and of The Council on Harmonised Rules on Fair Access to and Use of Data (Data Act), 2022/0047 (COD).
[37] Proposal for a Regulation of the European Parliament and of The Council on European data governance (Data Governance Act), COM/2020/767 final.
[38] California Consumer Privacy Act of 2018 [1798.100 – 1798.199].
[39] S.2710 To Promote Competition and Reduce Gatekeeper Power in The App Economy, Increase Choice, Improve Quality, and Reduce Costs For Consumers ("Open App Markets Act"), 117th Congress (2021-2022).
[40] William Li, Pablo Azar, David Larochelle, Phil Hill & Andrew W. Lo, *Law Is Code: A Software Engineering Approach to Analyzing the United States Code*, 10 J. BUS. & TECH. L. 297, 298 (2015) (provides an innovative way to analyze the code created by law since Code of Ur-Nammu).
[41] See HERBERT LIONEL ADOLPHUS HART, THE CONCEPT OF LAW 8 (Oxford, 1961) (makes the point that "a legal system consists (…) of rules").
[42] Codification, 12 CAPE L.J. 16, 21 (1895) (explains that Napoleon Bonaparte appointed five jurists in 1800 to frame a Code of Law).

a common law system. Policymakers and regulators must gather them in one place (a "Codex") to help their dissemination. The consolidation of rules in a Codex requires coding them, meaning extracting the principles and transcribing them into natural language.

Codification has several merits: it increases the accessibility of the law, it highlights possible inconsistencies, it encourages rationalization, and finally, it increases the understanding of the legal system. French codes illustrate the importance of the codification process, where lengthy judgments are summarized in just one sentence.[43]

The **second** method comprises using only code. This method posits the self-sufficiency of code *and* incentives to change code to address the problems created by the technology.

The method derives from Lawrence Lessig's famous "**Code is Law**,"[44] according to which the code regulates *like* the law.[45] His point is not that code can replace law, but that code produces a similar effect by regulating users' behaviors. The design of any digital thing (software, platforms, social networks, operating systems, etc.) influences its use, which explains why the coder acts as a regulator.

Going one step further, some have pushed a "**Law of Code**" method according to which code *equals* law.[46] "Law of Code" advocates demand that code be read as one reads the law. The strict interpretation of code determines what is legal and what is not. The infamous "The DAO attack" captures the ins and outs of this method.[47] The (poorly designed) code of a smart contract allowed a user to extract over 3.6 million Ether (at the time around 50 million dollars, today around 9,65 billion dollars) against the will of its creator. Proponents of the "Law of Code" method argued the behavior was not theft because the attacker did not hack the code, but simply exploited it.[48]

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[43] For an example, *see* here, CODE DE COMMERCE, Art. L. 225-231 (2022).

[44] Lawrence Lessig, *Code is Law – On Liberty in Cyberspace*, HARV. MAG. (Jan. 2000) https://perma.cc/47CK-4ZRC.

[45] The concept of "Lex Informatica" also describes this approach, *see* Joel R. Reidenberg, *Lex Informatica: The Formulation of Information Policy Rules through Technology*, 76 TEX. L. REV. 553, 555 (1998) (describes Lex Informatica as "set of rules for information flows imposed by technology and communication networks").

[46] See *Code is Law*, ETHEREUM CLASSIC (Feb. 22, 2022) https://perma.cc/6SEF-U7YR (defends this point of view according to which "no one has the right to censor the execution of code" that shall be read as one reads the law, but uses the wrong label to describe it); Aaron van Wirdum, *Ethereum Classic Community Navigates A Distinct Path To The Future*, BITCOIN MAGAZINE (Aug. 19, 2016) https://perma.cc/6ZYP-K8NF (details the logic of this point of view).

[47] David Siegel, *Understanding the DAO Attack*, COINDESK (Mar. 9, 2022) https://perma.cc/88NW-YCVY.

[48] *See* the attacker's letter, A Guest, *An Open Letter*, PASTEBIN (Jun 18, 2016) https://perma.cc/6J4X-47XP ("I have carefully examined the code of The DAO and decided to participate after finding the feature where splitting is rewarded with additional ether. I have made use of this feature and have rightfully claimed 3,641,694 ether, and would like to thank the DAO for this reward. (…) I am disappointed by

The third method combines law and code on the premise that "**Law needs Code**." Three reasons explain why there is such a need. First, "Code of Law" has inherent limits that 3.772 years of legal evolution—since the Code of Hammurabi first appeared—have not fixed. The law is often ignored, and infringements are difficult to detect.[49] Second, law and code are made of different materials. Combining them creates synergies.[50] Third, "Code is Law" is becoming ever relevant, if only because digital infrastructures, products, and services support an increasing number of offline activities.[51] Regulators can size the momentum and leverage the regulatory power of technology.

There are two "Law + Code" methods. The first is "**Code as Law**;" it comprises using the regulatory force of code to maximize the application of the legal rule.[52] The law is translated into computer code to facilitate or automate compliance.

There are three kinds of translations. One, the translation can be literal. For example, assuming real estate sales contracts must include a withdrawal provision, a storage platform can refuse to register the contract when the provision is not detected. Two, the translation can be non-literal. For example,

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those who are characterizing the use of this intentional feature as 'theft'. I am making use of this explicitly coded feature as per the smart contract terms and my law firm has advised me that my action is fully compliant with United States criminal and tort law. (…) A soft or hard fork would amount to seizure of my legitimate and rightful ether, claimed legally through the terms of a smart contract. Such fork would permanently and irrevocably ruin all confidence in not only Ethereum but also the in the field of smart contracts and blockchain technology. Many large Ethereum holders will dump their ether, and developers, researchers, and companies will leave Ethereum. Make no mistake: any fork, soft or hard, will further damage Ethereum and destroy its reputation and appeal. I reserve all rights to take any and all legal action against any accomplices of illegitimate theft, freezing, or seizure of my legitimate ether, and am actively working with my law firm. Those accomplices will be receiving Cease and Desist notices in the mail shortly. I hope this event becomes an valuable learning experience for the Ethereum community and wish you all the best of luck. Yours truly, 'The Attacker'").

[49] For example, the annual probability that a cartel would be detected, conditional on being detected, is between 13 and 17 percent, *see* Peter G. Bryant & Edwin Eckard, *Price Fixing: The Probability of Getting Caught*, 73 REV. ECON. STAT. 531, 531 (1991). Confirming the study, *see* Emmanuel Combe, Constance Monnier & Renaud Legal, *Cartels: The Probability of Getting Caught in the European Union*, Bruges European Economic Research Papers (2008).

[50] LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE, VERSION 2.0, 126 (Basic Books, 2006) (deplores that the use of code regulatory features by lawyers is not on the radar: "Law-talk typically ignores these other regulators and how law can affect their regulation. Many speak as if law must simply take the other three constraints as given and fashion itself to them").

[51] Organisation for Economic Co-operation and Development, *OECD Digital Economy Outlook 2020*, (OECD Publishing, 2020), https://perma.cc/Q43X-6PYV (documents how much the COVID-19 pandemic has amplified all aspects of the digital transformation).

[52] Lessig explores this approach, *see* LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE, VERSION 2.0, 127 (Basic Books, 2006) (explores how law can "change the regulation of architecture"); Marco Goldoni, *The Politics of Code as Law: Toward Input Reasons*, *in* Jane Reichel & Anna-Sara Lind (eds.), *Freedom of Expression, the Internet and Democracy* 119 (Brill, 2015) (argues that "code as law is normative in the sense that it regulates and guides human behaviour"); LAURENCE E. DIVER, DIGISPRUDENCE: CODE AS LAW REBOOTED, 232 (Edinburgh, 2022) (makes the point that code is not "an abstract medium or 'regulatory modality', but (…) a mechanism that is embodied in very real, very particular artefacts whose design affects individuals and communities in concrete ways at identifiable moments in time").

Digital Rights Management ("DRM") in MP3 files prevents playing the music purchased on another computer.[53] DRM enforces copyright laws. Three, code can indirectly translate legal rules.[54] New technical advances coupled with innovative architectures and business models have enabled the emergence of streaming services, such as Spotify and Netflix.[55] These platforms have contributed to reducing piracy of protected content.[56] The emergence of public permissionless blockchains — whose governance is horizontal and non-coercive[57] — eliminates a large majority of leveraging practices. These practices comprise using technical control of an infrastructure to impact compatible products.[58] Public permissionless blockchains therefore reduce the number of violations of antitrust law.[59]

Regardless of the translation method, "Code as Law" can have different degrees of coercion. Code can convey legal information. For example, when a third-party computer plays an MP3 file, the code can display a pop-up window showing the potential penalty. Twitter uses code this way by displaying "Headlines don't tell the full story; you can read the article on Twitter before Retweeting" when a user wants to retweet an article they have not opened.[60] But the code can also be more coercive. The code can prevent a behavior; for example, code can require opening the news article and staying on the webpage for two minutes before retweeting. The least coercive degree creates false negatives, while the most coercive degree creates false positives.

[53] Frank Hartung & Friedhelm Ramme, *Digital Rights Management and Watermarking of Multimedia Content For M-Commerce Applications*, 38 IEEE COMMUN. MAG. 78, 78 (2000) (explains how DRM controls and restricts multimedia data access).
[54] *See* Thibault Schrepel, *What to Make of "Business Models Eat Law*, NETWORK L. REV. (Apr. 28, 2022) https://perma.cc/LJ52-67NN.
[55] Nicolas Petit & Thibault Schrepel, *Complexity-Minded Antitrust* 13 (2022) https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4050536 (highlights the history of Netflix in the 2000s).
[56] Joao Pedro Quintais & Joost Poort, *The Decline of Online Piracy: How Markets—Not Enforcement—Drive down Copyright Infringement*, 34 AM. U. INT'L L. REV. 807 (2019) (shows that online piracy is declining because of the "increasing availability of affordable legal content, rather than enforcement measures").
[57] Thibault Schrepel, *The Theory of Granularity* in BLOCKCHAIN + ANTITRUST: THE DECENTRALIZATION FORMULA, 111-122 (Edward Elgar, 2021) (explores the horizontality of blockchain governance).
[58] *See* Thibault Schrepel & Vitalik Buterin, *Blockchain Code as Antitrust*, 35 BERKELEY TECH. L.J. 1 (2021) (introduces "blockchain code as antitrust" as a derivative of "code as law").
[59] *See* Thibault Schrepel, *The Theory of Granularity* in BLOCKCHAIN + ANTITRUST: THE DECENTRALIZATION FORMULA (Edward Elgar, 2021) (explores the lack of leveraging power in public permissionless blockchains).
[60] James Vincent, *Twitter Is Bringing Its 'Read Before You Retweet' Prompt to All Users*, THE VERGE (Sept. 25, 2020) https://perma.cc/DFA4-KMD4.

A second approach consists of using "**Law as Code**" (also called "Rules as Code,"[61] or "Computational Law"[62]). The computer interprets the legal rule to arrive at a legal diagnosis. Code can show how to comply with the law. For example, code can compute the amount owed to the Internal Revenue Service to comply with tax laws.[63] Code can show whether and how the construction of a building complies with planning regulations, etc.[64]

There are different degrees of "Law as Code" integration. The diagnosis made by computer code can be communicated to a human decision-maker. Techniques such as "boxing methods" can create a barrier between the diagnosis and its implementation in the real world.[65] These methods prevent the automatic execution of a law violation, but they slow down the decision-making process and (re)insert (more) human cognitive limits. Conversely, the diagnosis produced by code can be directly implemented in the real world. For example, software that calculates taxes can automate transfers to the tax authorities. The absence of barriers allows for efficiency gains by reducing intermediary costs and increasing execution speed. But there is a greater risk that the limitations of the code will lead to infringing the law.

2.2. Exploring "Law + Code"

Methodological approaches under "law + code" can achieve a positive EM ratio. Policymakers and regulators shall consider "law + code" methods and evaluate whether, in a given case, they allow for a better ratio than other methods. There are several reasons to believe this will more than occasionally be the case.

First, and most importantly, "law + code" methods are more **integrative** than "law" methods. "Law + code" forces lawyers and coders to work together. "Code as Law" is only effective if lawyers understand code. "Law as Code" is only effective if those who program the system understand the law.

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[61] Government of Canada, Rules as Code, Canada School of Public Service's Rules as Code project (Nov. 27, 2020) https://perma.cc/VF3Z-JJ22; James Mohun & Alex Roberts, *Cracking The Code: Rulemaking For Humans And Machines*, OECD Working Papers on Public Governance No. 42 (2020) (explores the creation of legal rules in a machine-consumable form across public sectors); Jason Morris, *Blawx: Rules as Code Demonstration*, MIT COMPUTATIONAL LAW REPORT (2020) https://perma.cc/9DWR-8ZVD; Laurence Diver, *Interpreting the Rule(s) of Code: Performance, Performativity, and Production*, MIT COMPUTATIONAL LAW REPORT (2021) https://perma.cc/8JU4-L6VS.

[62] Michael Genesereth, *What is Computational Law?*, STANFORD LAW SCHOOL, CODEX (Mar. 10, 2021) https://perma.cc/SDK9-BGBL; Nathaniel Love & Michael Genesereth, *Computational Law*, in Proceedings of The Tenth International Conference on Artificial Intelligence And Law, 205 (Association for Computing Machinery, 2005).

[63] *See*, for example, Intuit Turbotax.

[64] Stanford University, Computational Law, *Portico*, https://perma.cc/6KAU-NEC4.

[65] NICK BOSTROM, SUPERINTELLIGENCE: PATHS, DANGERS, STRATEGIES, 129, 130 (Oxford, 2014) (one can, for example, prevent the code from accessing communications networks).

Bringing together legal and coding expertise not only affects how the law is executed but also the substance of legal rules. "Law + code" prevents a strong disconnection between law and technology because both need to understand and rely on one another. The disconnection is problematic when legal rule imposes obligations that are technically difficult to comply with or endanger technology. For example, imposing the integration of smart contracts' kill switch functions amounts to sanctioning the smart contracts already on-chain.[66] Mandating interoperability of messaging services is tantamount to introducing data security problems.[67] Prohibiting "Proof of Work" within layer-one blockchains forces the use of other consensuses that are criticized for their security or centralization.[68] And besides the intrinsic qualities of these mandatory changes, there is a risk that programmers could poorly implement them because of a lack of technical expertise.

These legal rules would be rightfully abandoned under a "law + code" approach because programmers would put technical limitations front and center. "Law + code" thus protects technological survival more vividly.

Second, "law + code" approaches allow for **effective** interventions. "Law + code" effectiveness lies in the automatic execution of code when the conditions are met. For example, copyright law can prohibit the use of protected content, but the deterrent effect of "Code of Law" solutions is limited to the ability to detect the practice. "Code as Law" is more effective because it technically prevents the sharing of protected content. Instagram, YouTube, and other aggregators have adopted this method where code forces users to comply with copyright laws. Legal content is thriving without hampering these aggregators' survival chances.[69]

Third, "law + code" methods are **granular** because of the computational capacity they leverage. Regulators can design expert systems with many inferences or detailed decision trees. They also rely on machine learning ("ML") techniques to analyze large data sets and find the legal rule that best applies. For example, supervised ML can help policymakers better simulate

[66] The Proposal for a Regulation of The European Parliament and of The Council on Harmonised Rules on Fair Access to and Use of Data (Data Act), COM(2022) 68 Final, art. 30 shall be closely monitored. As it stands, there are two ways of reading it. First, smart contracts *with* a kill switch function will be presumed legally compliant, while smart contracts *without* a kill switch function will not benefit from the presumption. Second, only smart contracts *with* a kill switch function are legal, while the others are not.

[67] Casey Newton, *Three Ways the European Union Might Ruin WhatsApp*, THE VERGE (Mar. 29, 2022) https://perma.cc/XS6A-T8C4.

[68] *See* Sandali Handagama, *EU Parliament Scraps Proof-of-Work Ban Following Backlash*, COINDESK (Mar. 1, 2022) https://perma.cc/GS9E-4X7J; Casey Wagner, *New York Bill Banning Proof-of-work Crypto Mining Poised to Advance*, BLOCKWORKS (Apr. 25, 2022) https://perma.cc/38G2-GWY7.

[69] Similarly, integrating DRM within MP3 files has not eliminated MP3 singular features: small size, relatively good audio quality, etc.

the effect of a merger and impose effective remedies by computing billions of entry points.[70] Natural language processing ("NLP") can help policymakers better understand the case law and adapt their rules and policies.[71]

That being said, "law + code" methods are not without limitations. The first limitation relates to our ability to **understand** the technology. Using machine learning systems through unsupervised learning, for example, creates transparency and accountability issues.[72] While waiting for technical answers to these concerns, policymakers and regulators must find constructive solutions.[73]

The second limitation is "law + code" **accuracy**. One cannot always translate legal rules with 0's and 1's (i.e., Boolean values). Even if policymakers use an indirect translation method, code cannot systematically express the law. A maximalist approach that would only use "law + code" methods in all circumstances would, therefore, be misguided. Policymakers and regulators must consider "law + code" methods to expand their range of intervention modes, but they must always prefer the method with the best EM ratio.

The third limitation ties to the potential **effects** of "law + code" methods. Code is effective because it executes as soon as the conditions are met. This feature can be a bug when the effects of code are not well anticipated. Code systematizes false positives; its efficiency is double-edged when code is poorly designed.

[70] Anthony J. Casey & Anthony Niblett, *Micro-Directives and Computational Merger Review*, 1 STANFORD COMP. ANTITRUST 132 (2021) (makes the point that ML can help compute past merger decisions).
[71] Felix B. Chang, Erin McCabe et al., *Doctrinal Implications of Computational Antitrust*, 1 STANFORD COMP. ANTITRUST 117 (2021) (explores how NLP can help better analyze the case law).
[72] Thomas Nachbar, *Algorithmic Fairness, Algorithmic Discrimination*, 48 FLA. ST. U. L. REV. 509, 545 (2021) (makes a distinction between "transparency—the ability to view the working of a system—and accountability, an explanation for why the system is operating as it does"); Daryl Lim, *Can Computational Antitrust Succeed?*, 1 STANFORD COMP. ANTITRUST 38, 48 (2021) (making the point that accountability is a more realistic and helpful goal that transparency).
[73] Ben Green, *The Flaws of Policies Requiring Human Oversight of Government Algorithms*, 45 COMPUT. LAW SECUR. REV. 1 (2022) (discusses the limits on human oversight and argues for institutional oversight instead)

3. "Law + Technology" institutional framework

"Law + Technology" calls for a new decision-making framework at the institutional level.[74] The aim is to achieve the highest possible EM ratio.

(1.) **Approach**: A technical and practical analysis of the technology shall precede new regulation and enforcement action. The aim is to identify the stakes of each regulation.

(1.1.) Policymakers and enforcers shall ask how the targeted technology *is* improving the common good. Doing so entails investigating the technology's singular features and governance mechanisms.[75] Policymakers and enforcers shall also consider *potential* improvements, such as expressed in scientific writing.

(1.2.) Then, policymakers and regulators shall study the potential connection between the features that increase the common good and those that call for regulation.[76] There are two scenarios.

(1.2.1.) There is no connection between features with positive ramifications and features with negative ones. Problematic features can be removed, changed, limited, or prohibited without reducing the ability of the technology to generate value. For example, one might require software that sends personal data to use modern encryption techniques, such as Secure Hash Algorithm SHA-2 or SHA-3, instead of relying on SHA-0. Similarly, policymakers may require companies that use machine learning to document all changes they make to the learning model. Requiring to inform these changes does not jeopardize the usefulness of the technology.[77]

But regulation has a cost.[78] For example, when specific standards are imposed on car manufacturers, this represents a cost passed to the consumer. The same

[74] Institutional issues, including public choice theory (e.g., regulatory capture) are little discussed in the law & technology literature. Only 490 articles mention these issues between 1960 and 2020 according to HeinOnline, *see* (all_topics_ms: "Science, Technology, and the Law" "public choice") in Law Journal Library, Section Type "Articles," from 1960 to 2020.

[75] Once more, technology increases the common good because of singular characteristics. In the absence of singular characteristics, the technology disappears.

[76] There are different points of view regarding these negative aspects. Some think technology is neutral: the effects of technology are created by its intrinsic characteristics. Others, on the contrary, believe technology is not neutral: the effects of technology depend entirely on the social context. For a discussion of these different views, *see* Thibault Schrepel, *Law and Technology Realism*, MIT COMPUTATIONAL LAW REPORT (2020) https://perma.cc/59CP-AE68.

[77] This proposition is only *true* if regulation does not unnecessarily eliminate the features that differentiate the technology.

[78] Robert W. Hahn & John A. Hird, *The Costs and Benefits of Regulation: Review and Synthesis*, 8 YALE J. ON REG. 233, 233 (1991) (introduces a way to measure the costs of doing business created by regulations).

goes for documenting changelogs, the use of new databases, etc. Regulators must balance costs and opportunities. The cost/opportunity balance does not challenge technology survival, but questions technology accessibility by making it expensive to implement, use, change, etc.[79]

(1.2.2.) The features of a technology that create negative ramifications are also the ones that create value. Policymakers and regulators will challenge the technology's survival chances when addressing the issue.[80] They must consider different methodologies to achieve the best EM ratio (*see* 2. "Method").[81]

(2.) **Method**: policymakers and regulators can modulate the EM ratio depending on the need of each regulation. They may prefer to eradicate entirely negative ramifications in some situations or maximize the survival chances in others. The following elements will move the needle on the EM ratio.

(2.1.) Policymakers may prefer rules or standards. Rules differentiate between legal and illegal behaviors, while standards provide guidelines that regulators can interpret *ex-post*.[82] Standards pose a lower risk to technology survival but prove less efficient when regulators face a specific problem.

(2.2.) When policymakers choose rules over standards, they can exploit different degrees of coercion. Policymakers may prefer low coercion, for example, by providing "Law as Code" solutions to help draft contracts (e.g., an insurance contract, a real estate sale, a purchase of financial assets) that

[79] Chinchih Chen, Carl Benedikt Frey & Giorgio Presidente, *Privacy Regulation and Firm Performance: Estimating the GDPR Effect Globally*, Oxford Martin School Working Paper No. 2022-1, 1, 2 (argues that firms exposed to the GDPR experienced an 8% decline in profits, and that "the decline in profits of small companies is almost double the average"); Rebecca Janßen, Reinhold Kesler, Michael E. Kummer & Joel Waldfogel, *GDPR and the Lost Generation of Innovative Apps*, NBER Working Paper 30028 (May 2022) ("Using data on 4.1 million apps at the Google Play Store from 2016 to 2019, we document that GDPR induced the exit of about a third of available apps; and in the quarters following implementation, entry of new apps fell by half"); Garrett A. Johnson, Scott K. Shriver, & Samuel G. Goldberg, Privacy & Market Concentration: Intended & Unintended Consequences of The GDPR (2020) (argues that GDPR increased digital markets concentration); Benjamin Mueller, *A New Study Lays Bare the Cost of the GDPR to Europe's Economy: Will the AI Act Repeat History?*, CENTER FOR DATA INNOVATION (Apr. 9, 2022) https://perma.cc/MAT5-4R4E.

[80] The impact will be greater or lesser depending on the number of other features that differentiate the technology.

[81] Choosing between alternatives can be straightforward. For example, a regulator shall prefer 70% effectiveness in eradicating problems with 90% maintaining positive features over 70% effectiveness in eradicating problems with 50% maintaining positive features. Other alternatives leave more room for the preferences of each regulator. For example, a regulator could prefer 70% effectiveness in eradicating problems with 90% maintaining positive features *or* 90% effectiveness in eradicating problems with 70% maintaining positive uses.

[82] Louis Kaplow, *Rules Versus Standards: An Economic Analysis*, 42 DUKE L.J. 557, 560 (1992) (holds that "the only distinction between rules and standards is the extent to which efforts to give content to the law are undertaken before or after individuals act").

comply with legal rules under the law-of-the-land.[83] When policymakers and regulators have higher confidence in legal rules' accuracy, they will impose higher coercion. Coercive interventions could mandate kill switch functions for smart contracts or prohibit anonymous blockchain transactions.[84]

(2.3.) Policymakers and enforcers can use different conversion methods between code output and actual implementation. For example, "boxing methods" that confine code to a "box" set up a barrier between code and the so-called real space.[85] Human intervention is necessary to implement the output. Similarly, code can simply flag potential issues—to users or regulators—rather than implementing "compliance by design" solutions that try to eliminate problems before they occur. When they are confident in legal rules' accuracy, policymakers will allow the automatic implementation of code output. They may, for instance, mandate coded solutions to the trolley problem for driverless cars.

(2.4.) Policymakers and regulators can adapt parameters 2.1. to 2.3. using feedback loops that document, evaluate, and change legal rules and standards. First, policymakers can modulate regulations depending on their effectiveness. "Law + code" methods offer flexibility because regulators can change code and immediately measure the effects on the technology. Second, policymakers can measure the effect of legal rules on technology survival. For example, one can measure adoption curves, external investments, filed patents, etc., and adapt regulation.

Conclusive Thoughts

One plus one equals three using a "law + technology" approach. Instead of relying solely on law to increase the common good, "law + technology" combines the two and explores their synergies.

The combination of law and technology requires maximizing the EM ratio. When legal rules reduce technology's chances of survival, policymakers and regulators deny one of "law + technology" two pillars. The "law +

[83] *See* Harry Surden, *Computable Contracts*, 46 U.C. DAVIS L. REV. 629 (2012) (explains how to represent contractual obligations as computer data); Mark D. Flood & Oliver R. Goodenough, *Contract as Automaton: The Computational Representation of Financial Agreements*, Office of Financial Research Working Paper No. 15-04 (2020) (shows that financial contracts can be represented as rules).
[84] Report on the proposal for a regulation of the European Parliament and of the Council on information accompanying transfers of funds and certain crypto-assets, 29a (COM(2021)0422 – C9-0341/2021 – 2021/0241(COD)) ("In cases of a transfer of crypto-assets made from or to an unhosted wallet, the provider of crypto-asset transfers should collect information from its customer both on the originator and the beneficiary").
[85] NICK BOSTROM, SUPERINTELLIGENCE: PATHS, DANGERS, STRATEGIES, 129 (Oxford, 2014) (makes a distinction between physical and informational boxing methods).

technology" approach thus requires considering different methods to reach an optimum EM ratio.

Scholars contribute to the "law + technology" approach by teaming up with computer scientists to develop new solutions.[86] But there is room for more scholars, policymakers, data and computer scientists, practicing lawyers, students, etc. New problems will appear as the "law + technology" approach develops. They will require innovative solutions.

But in fact, one can already highlight two lines of research. The first comprises creating a database of all regulations that fit the "law + technology" approach. Researchers will need to document the method and EM ratio for each of these regulations. The second line of research involves proposing new "law + technology" regulations that achieve a better EM ratio than the existing and forthcoming ones.

Meanwhile, a handful of law schools that teach computational law, complexity science, etc., contribute to the "+" approach. These law schools are scattered all over the world. Those interested in this approach may want to join forces and move forward.[87]

[86] *See* CodeX, The Stanford Center for Legal Informatics, https://perma.cc/R3ZN-Z6GM. Also, Stanford Computational Antitrust, https://perma.cc/89DW-WFHW.
[87] Join the "+"at https://bit.ly/lawplustech.