ALGORITHMIC CONTRACTS

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Algorithmic contracts are contracts in which one or more parties use an algorithm as a negotiator to choose which terms to offer or accept, or as a gap-filler, allowing the parties to explicitly agree to the results of an algorithm as part of a contract. Such agreements are already an important part of today's economy. Areas where algorithmic contracts are already common are high speed trading of financial products and dynamic pricing in consumer goods and services. However, contract law doctrine does not currently have an approach to evaluating and enforcing algorithmic contracts. This Article fills this significant gap in doctrinal law and legal literature.

This article provides a taxonomy of algorithmic contracts. This task is required because different types of algorithmic contracts present different challenges to contract law. While many algorithmic contracts are readily handled by standard contract doctrine, some require additional interpretive work. Algorithms can be employed in contract formation as either mere tools or artificial agents. This distinction is based on the predictability and complexity of the decision-making tasks assigned to the algorithm. Artificial agents themselves can be clear box, when inner components or logic are decipherable by humans, or black box, where the logic of the algorithm is functionally opaque. While courts and policy makers should be mindful of the specific characteristics of algorithmic contracts in their interpretation and enforcement, traditional contract law provides adequate tools to address most algorithmic contracts.

The algorithmic contracts that present the most significant problems for current contract law are those that involve black box algorithmic agents choosing contractual terms on behalf of one or more parties. The classical interpretation of contract doctrine, which justifies contract as an expression of human will, finds that these algorithmic contracts are not properly formed at law and thus cannot be enforced in contract. This is because where algorithms serve as quasi-agents to principals

in making decisions the principals have not manifested the intent to be bound at the level of specificity that contract law requires. Algorithms are not persons, and so cannot consent beyond the scope of the principal's manifested objectives, as true agents can. Furthermore, policy considerations of efficiency and fairness in light of technological trends also supports presumptively excluding black box algorithmic contracts from contract law.

However, even some black box contracts may be enforceable. This Article proposes a model for determining whether such agreements may be enforced. The approach evaluates the fit between the black box algorithm's actions and the objectively manifested intent of the party using it to determine whether a contract can be implied. This approach draws inspiration from and contributes to the literature on artificial agents and implied-in-fact contract doctrine. Where a contract cannot be implied, restitution law and tort law allow justice to be done as between the parties. This offers a predictable approach to the enforcement of black box algorithmic contracts at law while promoting efficiency and fairness concerns in a manner traditional contract law cannot.

Common law courts and state legislatures should update their approach to algorithmic contracts. The American Law Institute and other groups that seek to promote best practices in state private law should update contract and commercial law statements to expressly address algorithmic contracts. Businesses should strengthen their positions in negotiations as well as in court by clarifying their objectives in using algorithms. Giving businesses the incentive to make their objectives clear will aid in ascribing liability in all areas of law and promote responsible use of algorithms.

I. INTRODUCTION

At 2:45PM on May 6, 2010, the Dow Jones industrial average dropped by 9%.[1] No market or political event presented a reasonable trigger.[2] Millions of dollars were lost in a matter of minutes.[3] A careful report by the Securities and Exchange Commission months later effectively admitted they did not understand exactly what caused the crash.[4] Despite years of study since, the exact mechanism that triggered the reaction is not fully understood, not least because many of the algorithms involved are proprietary.[5] And since nobody understands what causes flash crashes, they're happening more and more often. The Dow Jones had a flash crash of similar magnitude less than two years later, and similar events have dotted the global landscape.[6]

In the seconds leading up each of these flash crashes, securities were being bought and sold in milliseconds, with

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[1] U.S. SECURITIES & EXCHANGE COMMISSION, FINDINGS REGARDING THE MARKET EVENTS OF MAY 6, 2010, 1-4, September 30, 2010, available at https://www.sec.gov/news/studies/2010/marketevents-report.pdf.

[2] *Id.*

[3] *Id.*

[4] *See id.* at 6 (the lessons learned section was a general description of the current practices of the market. the many factors that may have caused the flash crash and a call for more transparency and honesty, conceding there were many things that they did not know about how the factors interacted).

[5] Tom C.W. Lin, *The New Investor*, 60 UCLA L. REV. 678, 682 (2013).

[6] *E.g.*, Pooja Thakur and Jonathan Burgos, *Singapore Strengthens Securities Rules After Stock Rout*, BLOOMBERG, Aug. 15, 2014 12:00PM (last visited Feb. 15, 2016), http://www.bloomberg.com/news/articles/2014-08-01/singapore-regulators-tighten-rules-after-penny-stock-rout.

prices being determined by algorithms. This is how securities trading is done today. But what's often missed in discussions of the growing influence of algorithms in trading is that contracts were at work here, too, enabling the formal alienation of the resources. Algorithms determined when the trades happened and at what prices. It's often said that algorithms shape our world. But it is contracts that give algorithms the authority to change our world, because it enables individuals and businesses to exchange resources and services.

Without legal reform, "flash crashes" could become endemic to any number of industries. And the results of such unexpected, undesired aberrations resulting from algorithms would not be so readily reversible in other subject matter areas. In areas such as, health care and safety measures, life and death literally will literally be dependent on the results of algorithms.[7] Ultimately, regulating the content of algorithms should be the subject, at most, of sector-specific reform. However, creating legal incentives for entities that use algorithms in contracting to understand and take responsibility for the actions algorithms take as agents will is required to preserve human responsibility and conscious choice in an increasingly automated society.

Contracts enable individuals demonstrate their preferences for one thing over another, while getting what they want. The freedom of contract allows individuals to express their valuations of property and services and make appropriate exchanges. Traditional contract law assumes that some individual is doing conscious evaluation, and through contracts, information about how society values things can travel about. Every contract contains a little bit of information about how parties valued the component terms of the contracts. But, when algorithms are introduced in institutional decision-making, individuals outsource their valuation processes to the algorithm. How does that impact contract law? That is the subject of this paper. Technology has advanced to the point where algorithms

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[7] *See generally* W. Nicholson Price II, *Black-Box Medicine*, 28 HARV. J.L. & TECH. 419 (2015) (describing the use of alogirthms in medicine and the legal and ethical problems posed thereby).

and machines are sophisticated enough to represent humans and make agreements on their behalf.[8]

Algorithmic contracts are contracts in which one or more parties use an algorithm as (1) a negotiator to choose which terms to offer or accept, or (2) a gap-filler, allowing the parties to explicitly agree to the results of an algorithm as part of a contract.

Some algorithmic contracts divorce critical aspects of decision-making in contractual agreements from conscious determination by any individual. Two major concerns arise from this divorce. First, the use of algorithms to determine terms in a contract creates the possibility for emergence, that is, results that are not and indeed could not be foreseen by the algorithm's creator. Furthermore, where an algorithm is created by one party and sold for use by another party for use in contract creation, it creates the potential for liability issues with no clear analogue in traditional contract law.

I argue that both contract law theory and pragmatic policy concerns require an approach to black box algorithmic contracts that differs from traditional contract law. This paper will proceed as follows. First, I will dig deeper into the definition of algorithmic contracts, categorizing the different types of algorithmic contracts and discussing significant existing examples of algorithmic contracts. Second, I will show that black box algorithmic contracts require a different approach from traditional contracts by examining how black box algorithmic contracts upend the assumptions behind the component parts of traditional contracts, that is, mutual assent and consideration. Finally, I will evaluate possibilities for legal reform of algorithmic contract I propose that approaching algorithmic contracts as implied-in-fact contracts in contract law, supported by restitution law and tort law where a contract cannot be implied in fact, offers a predictable approach to the

[8] Harry Surden, *Machine Learning and Law*, 89 WASH. L. REV. 87, 88 (2014) (discussing artificial intelligence technology and law).

enforcement of algorithmic contracts at law while promoting efficiency and fairness concerns in a manner traditional contract law cannot. In light of this proposed rule, I will also suggest ways forward for courts, state legislators, and companies and individuals who make algorithmic contracts and discuss the implications of my analysis for legal theory.

II. WHAT IS AN ALGORITHMIC CONTRACT?

Algorithmic contracts are contracts that contain terms that were determined by algorithm rather than a person. An algorithm is a process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.[9] The critical difference between an algorithm and a person determining terms is quite simply the fact that the rules are being implemented by a computer rather than a conscious human being. When we have more complicated algorithms, the ability of a human to anticipate the result of the algorithm is limited; indeed the reason why these algorithms are useful is because they can consider a breadth of data and number of conditions that no human could. Decision-making algorithms can have emergent properties, that is, the algorithms can yield results arising as an outgrowth of complex causes and not analyzable simply as the sum of their inputs. Emergence, or the

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[9] Defining algorithms is a difficult task, and the subject of scholarly inquiry, but there is broad consensus around a working definition similar to what I have stated above. *E.g.*, Yuri Gurevich, *What is an Algorithm? (revised)*, CHURCH'S THESIS: LOGIC, MIND AND NATURE (2014), *available at* http://research.microsoft.com/en-us/um/people/gurevich/Opera/209a.pdf; Solon Barocas, Sophie Hood, and Malte Ziewitz, Governing Algorithms: A Provocation Piece, unpublished manuscript, Mar. 29, 2013, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2245322; Rob Kitchin, Thinking Critically about and researching algorithms, unpublished manuscript, Oct. 28, 2014, http://papers.ssrn.com/sol3/Papers.cfm?abstract_id=2515786.

action of algorithms in manners not predictable by their developers, is a growing part of the algorithmic landscape, with significant moral and practical implications.[10]

Contracts are designed to reflect a "meeting of the minds" between two or more parties to alter the legal rights between them. As contractual doctrine evolved, it moved beyond attempting to evaluate whether or not the parties actually exchanged something fairly of value to whether or not there was a bargaining between the parties. The idea of the freedom of contract holds a special position in the American tradition.[11] Whether sophisticated or not, every competent party that is not under duress or one of one of the other very limited exception, has the power to choose what she sees bit to be bound by. But what happens when a human being is not doing the choosing? Do we lose a significant part of what it means to contract? The answer is, maybe. Unless a person is consciously agreeing to the contract, there is ordinarily no contract at all. After all, if someone signs a contract not knowing it's a contract there's no contract. The conscious choice to agree to terms is a critical

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[10] Ryan Calo, *Robotics and the Lessons of Cyberlaw*, 103 CAL. L. REV. 513, 532 (2015)(" The literature tends to refer to this exciting potential as "autonomy" or "true learning," but I prefer "emergence." Emergence refers to unpredictably useful behavior and represents a kind of gold standard among many roboticists for reasons I will describe. Finally, robots, more so than other technology in our lives, have a social valence. They *feel* different to us, more like living agents."); Zeynep Tufekci, *Algorithmic Harms beyond Facebook and Google: Emergent Challenges of Computational Agency*, 13 COLO. TECH. L. J. 2 (2015).

[11] *E.g.*, Richard A. Epstein, *In Defense of the Contract at Will*, 51 U. CHI. L. REV. 947, 953-54 (1984) ("Freedom of contract is an aspect of individual liberty, every bit as much as freedom of speech, or freedom in the selection of marriage partners or in the adoption of religious beliefs or affiliations. Just as it is regarded as prima facie unjust to abridge these liberties, so too is it presumptively unjust to abridge the economic liberties of individuals.)

element of a contract. In other areas of law, the awareness by a conscious person is thought to have different status than an observation or processing by a machine.[12] So, if a party uses a contract to make terms, is she consciously agreeing? It depends on what we think of the algorithm as doing.

We can consider an algorithm as a tool or as a servant. If an algorithm is a tool, then it should make no difference to whether not we have a contract. If the algorithm is simple enough that it is indistinguishable from a rule of thumb, that is, an ordinary person in the field would know more or less what the outcome would be knowing the inputs, it is a mere tool. The contract is still reflective of the will of the party that used it to create the contract. Let's say, for example, a woman decides to sell her car to a man. In order to draw up an agreement to sell the car, she looks online using a search engine and finds a form contract. She customizes the contract and they both sign. Even though the woman used a search engine and a form contract in helping her figure out the best way to write the agreement, she still consciously accepts these terms as her own when she makes the offer. This hypothetical is not an algorithmic contract.

The algorithms this paper addresses are those that must be understood as servants rather than mere tools. An algorithm is a servant when it has an objective that the person who entrusts it to achieve a given objectives, within certain parameters. The algorithm is as an agent for the person who uses it. It has certain objectives and conditions, but processes and "understands" details that the creator or user of the algorithm does not. It is comparable to human agents, and agency law provides clues as to how algorithmic contracts should be understood.[13] Agents

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[12] Priscilla J. Smith, Nabiha Syed, David Thaw, and Albert Wong, *When Machines Are Watching: How Warrantless Use of Gps Surveillance Technology Violates the Fourth Amendment Right Against Unreasonable Searches*, 121 YALE L.J. ONLINE 177, 181 (2011).

[13] Several authors have discussed algorithms as agents. Samir Chopra & Laurence White, *Artificial Agents and the Contracting Problem: A Solution Via an Agency Analysis*, U.

can be authorized to make some decisions, and not others. They might go outside their purview. When they do, it cannot be presumed that their judgment reflects the judgment of the master. People who use human agents must be careful to authorize them carefully to manage their liability. So too with

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ILL. J.L. TECH. & POL'Y 363, 402-03("Our examination of the other solutions to the "contracting problem" led us to argue that its most satisfying resolution--along the legal and economic dimensions--lies in granting artificial agents a limited form of legal agency. Such a move is not only prompted by the ever-increasing autonomy and technical sophistication of today's artificial agents but also by the better liability protection it enables for the human and corporate principals of artificial agents. Furthermore, while a number of the existing legislative responses to electronic contracting appear to embrace a "mere tool" doctrine of electronic agents, the most important international texts--the Model Law and the Convention--are consistent with the agency approach."); Anthony J. Belia, *Contracting with Electronic Agents*, 50 EMORY L.J. 1047 (2001) (arguing that there are both formational and enforcement concerns when electronic agents are used to make contracts). Earlier conceptions of algorithms as mere tools led some in the early information age to be more skeptical of the potential for algorithms to create remoteness from the intent of parties employing them as agents. See Jean-Francois Lerouge, *The Use of Electronic Agents Questioned Under Contractual Law: Suggested Solutions on a European and American Leve*l, 18 J. MARSHALL J. COMPUTER & INFO. L. 403, 417 (1999) (suggesting that under objective theory user of electronic agent is contractually liable for exchanges arranged by agent); see also Ian R. Kerr, *Spirits in the Material World: Intelligent Agents as Intermediaries in Electronic Commerce*, 22 DALHOUSIE L.J. 190, 214 (1999) (suggesting the same, at least where electronic agents are not operating autonomously). *But see* Tom Allen & Robin Widdison, *Can Computers Make Contracts*, 9 HARV. J.L. & TECH. 25, 43-45 (1996) (suggesting that to hold users liable under objective theory would require extension of doctrine).

people who use artificial agents, algorithms, to help them determine how they will bind themselves in contract.

This language is intentionally calling upon the language of principal-agent relationships. The Uniform Electronic Transactions Act, adopted by 47 states, includes an understanding of algorithms as agents.[14] UETA facilitates the creation of algorithmic contracts by allowing for such contracts to be formed through electronic records and signatures, thereby giving electronic records and signatures the same legal equivalence as traditional paper records and manual signatures.[15] There is consensus around the notion of some algorithms being able to act as agents, as many scholars have addressed, and the actions of algorithms out in nature confirm.[16] However, as Professor Anthony J. Bellia observed soon after the adoption of the UETA in 2001,

> Legislative initiatives have addressed the use of "electronic agents" in contract formation, but have not resolved the difficult enforceability questions. By and large, current initiatives require either a pre-existing agreement between persons to arrange transactions electronically, or some direct manifestation of human intent, for exchanges arranged by software agents to be

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[14] UNIF. ELECTRONIC TRANSACTIONS ACT (1999), *available at* http://uniformlaws.org/Act.aspx?title=Electronic%20Transactions%20Act.

[15] Patricia Brumfield Fry, *Introduction to the Uniform Electronic Transactions Act: Principles, Policies and Provisions,* 37 IDAHO L. REV. 237, XX (2001).

[16] *E.g.,* Samir Chopra, Laurence White, *Artificial Agents and the Contracting Problem: A Solution Via an Agency Analysis*, U. ILL. J.L. TECH. & POL'Y, Fall 2009; Juliet M. Moringiello & William L. Reynolds, *From Lord Coke to Internet Privacy: The Past, Present, and Future of the Law of Electronic Contracting*, 72 MD. L. REV. 452, 483-87 (2013); Anthony J. Bellia Jr., *Contracting with Electronic Agents*, 50 EMORY L.J. 1047, 1048 (2001)

> enforceable. The initiatives, like the common law, provide no clear answer to the question of enforceability when these conditions are not fulfilled. The question thus arises whether a person who willingly uses an electronic agent to arrange transactions should be bound to arrangements made thereby. This question is one that courts and legislatures presently must confront.[17]

Unfortunately, since 2001, courts and legislatures have come no closer to a workable solution for an approach to enforcing algorithmic contracts. I disagree with Professor Bella that current law provides a clear answer on the formation of algorithmic contracts.[18] To understand why the formation of an algorithmic contract is a hard question, we must understand the possible roles algorithms can play in contract formation. First this section will distinguish between two types of algorithmic contracts. Then, it will discuss notable types of algorithmic contracts in action, for illustrative use in later parts of this Article. In showing the role algorithmic contracts really play in contract formation, the emergence that characterizes many modern algorithms and will only continue to do so, this section ultimately reveals the notion that a principal using an algorithm automatically assumes the risk of anything and everything an agent might do to ultimately be naïve. Ultimately, humans making contracts must expressly account for the question of who takes responsibility for emergent acts by artificially intelligent entities. To fail to do so is inefficient and unfair in the distribution of costs.

A. Defining Algorithmic Contracts

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[17] Anthony J. Bellia Jr., *Contracting with Electronic Agents*, 50 EMORY L.J. 1047, 1048 (2001)

[18] Although I agree, ultimately, that algorithmic contracts should be taken to be formed in equity as will be made clear by discussions in Part III (problematizing the formation of algorithmic contracts) and Part IV (proposing how to interpret algorithmic contracts).

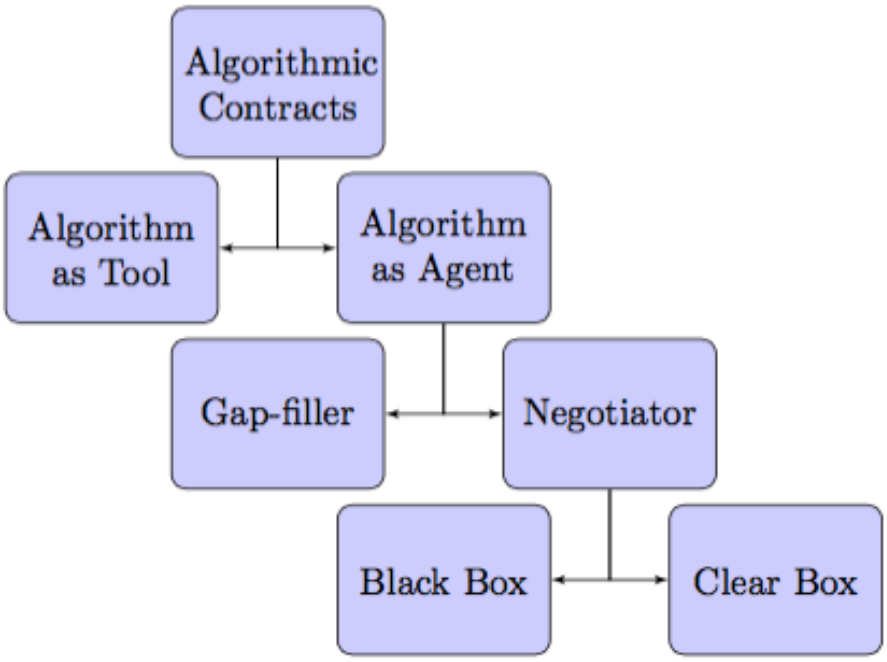
We have already started to define algorithmic contracts. They are contracts in which one or more parties use an algorithm to determine whether to be bound or how to be bound.

There are several ways that a party can use an algorithm in contract formation. Depending on how the parties use algorithms, algorithmic contracts can be easy cases for contract law, or very difficult cases.

This section provides a taxonomy of algorithmic contracts. This task is required because different types of algorithmic contracts present different challenges to contract law. While some algorithmic contracts are readily handled by standard contracts doctrine, some require additional interpretive work for contracts law to apply. Algorithms can be employed in contract formation as either mere tools or artificial agents. This distinction is based on the predictability and complexity of the decision-making tasks assigned to the algorithm. Artificial agents themselves can be clear box, when inner components or logic are decipherable by humans, or black box, where the logic of the algorithm is functionally opaque. While courts and policy makers should be mindful of the specific characteristics of algorithmic contracts in their interpretation and enforcement, traditional contract law provides adequate tools to address most algorithmic contracts.

A simple chart illustrating the relationship between the different categories of algorithmic contracts is pictured below. Algorithmic contracts can be distinguished first by the role of the algorithm (tool or agent), then by the task assigned to the algorithm (gap-filling or negotiation), and finally, for negotiating algorithms, whether the algorithm is a black box algorithm or a clear box algorithm.

Fig. 1: A Flowchart for Algorithmic Contract types



There is a gradient of "fit" between algorithmic contracts and existing contract doctrine.

Contracts where the algorithms helping the parties are mere tools typically do not present any new issue for contract law. They are no different from a party using a calculator or a basic excel program to determine what to offer or accept.

Agent algorithmic contracts acting as gap-fillers have clear analogues in existing contract law, such as agreements to pay market price on a given date. This type of algorithmic contract may enable and encourage excessively broad gaps. Existing doctrines such as incomplete contracts and illusory contracts can cabin this tendency.

When algorithms act as negotiators, more interpretive work is required to show the fit with contract law. Black box algorithmic contracts inherently introduce a gap between the

objectively manifested intent of the party using the algorithm and what the artificial agent does. Unlike in typical contracts, where we assume that a "sophisticated party" especially knows what they are doing enough to bound, black box algorithms by definition engage in emergent behavior that cannot be anticipated by its principal. So that presumption of deference to general acts showing an intent to be bound even of a sophisticated party using must be relaxed in the case of black box algorithmic contracts and we have a contract that may not be enforceable. A discussion of why black box algorithmic contracts are a particularly big problem for contract law is the subject of Part III. Part IV shows a roadmap to enforcement for black box algorithmic contracts. Clear box algorithmic contracts are an intermediate case, because principals using clear box algorithms could anticipate their behaviors. Clear box algorithmic contracts present no formational impediments if their behavior is foreseeable and limited in scope; using a clear box algorithm to negotiate a contract may, in such cases be enough to show intent to be bound to a reasonably firm universe of outcomes.

B. Algorithmic Contracts in Action

When described in general terms as in Part A, it can seem like algorithmic contracts are creatures of the future. However, they are already in use, have been for over a decade, and are growing ever more automated and sophisticated. [19] Commentators have discussed the limits of property law to address the complex problems presented by a digital, information age.[20] This section describes three examples of

[19] Anthony J. Bellia Jr., *Contracting with Electronic Agents*, 50 EMORY L.J. 1047 (2001) ("The use of computer technology to "make contracts" for humans is no longer mere prospect but reality.").

[20] Christopher J. Cifrino, *Virtual Property, Virtual Rights: Why Contract Law, Not Property Law, Must Be the Governing*

algorithmic contracts in action: high speed trading, online pricing, and Ethereum's "smart contracts."

1. High Frequency Trading

Faster is better, when you're a trader of financial products. Faster is better because algorithms can make rapid decisions to exploit changes in the market that move in the milliseconds; the faster the response rate, the theory goes, the more potential to profit.[21] These concerns have lead to the widespread adoption of high speed trading. As much as 75% of the volume of trading is high frequency trading. What is HFT, and how does it differ from traditional trading?

High frequency trading, or algorithmic trading, is computerized trading using proprietary algorithms.[22] There are two types of high frequency trading. "Execution trading is when an order (often a large order) is executed via a computerized algorithm. The program is designed to get the best possible price. It may split the order into smaller pieces and execute at different times. The second type of high frequency trading is not executing a set order but looking for small trading opportunities

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Paradigm in the Law of Virtual Worlds, 55 B.C. L. REV. 235, 254-64 (2014)

[21] Nick Baumann, *Too Fast to Fail: How High-Speed Trading Fuels Wall Street Disasters*, MOTHER JONES, Jan./Feb. 2013 http://www.motherjones.com/politics/2013/02/high-frequency-trading-danger-risk-wall-street (last visited Jan. 25, 2016).

[22] *High Frequency Trading*, NASDAQ FINANCIAL GLOSSARY, http://www.nasdaq.com/investing/glossary/h/high-frequency-trading#ixzz3xkqhACe4 (last visited Jan. 25, 2016).

in the market."[23] Many scholars have highlighted the contrast between high frequency trading and traditional trading.[24]

High speed trading presents many market efficiency and fairness concerns, with several commentators within the industry noting that HFT merely enables practices that otherwise would be illegal to proceed under cover of sophisticated proprietary algorithms. [25] "The level of sophistication required makes it difficult for regulators around the world to catch those traders who are not operating legally, said Peter Castellon, a partner at Proskauer Rose in London. "That's what's evil about high-frequency trading," Castellon said, "and it's very hard to catch because of the sophistication of the algorithms.""[26]

Left to their own devices, the widespread use of HFT has made financial markets less effective at their function of distributing information, and has moved the actions of big players closer to pre-industrial age behavior of "closeness to a resource," in this case, access to the internet, rather than more sophisticated methods of wealth generation.[27]

Algorithmic trading has decreased the information-distributing function of the financial markets. The Flash Crashes are just the most extreme illustration of this general

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[23] *High Frequency Trading*, NASDAQ FINANCIAL GLOSSARY, http://www.nasdaq.com/investing/glossary/h/high-frequency-trading#ixzz3xkqhACe4 (last visited Jan. 25, 2016).

[24] *E.g.*, Andrew J. Keller, *Robocops: Regulating High Frequency Trading After the Flash Crash of 2010*, 73 OHIO ST. L.J. 1457, 1461-64 (2012) (describing the unique features of HFT in contrast to traditional trading).

[25] Merritt B. Fox et. al., *The New Stock Market: Sense and Nonsense*, 65 DUKE L.J. 191, 226-261 (2015)

[26]Maureen Stapleton, *Laws Need to Catch Up to High-Speed Trading,* ABA J., August 2015, at 66, *available at* http://www.abajournal.com/magazine/article/laws_need_to_catch_up_to_high_speed_trading/.

[27] cite for the behavior of companies, hopefully linking it to exploitation of natural resources

phenomenon. The very purpose of HFT is to conceal information about the market from some actors in order to profit from their ignorance. While this tends to enrich some actors in the market, it does not promote efficiency, and in fact can lead to dangerous mistakes that no individual party intended. As practitioner Wallace C. Turbeville wrote in a recent Maryland Law Review article:

> Properly measured, the financial markets have become less efficient in the era of deregulation even though conventional wisdom dictates that advances in information technology and quantitative analysis should have caused the opposite result. Enormous sums of money are extracted from the capital intermediation process causing the financial sector share of the economy to grow at the expense of the productive manufacturing and service sectors and public finance. This trend must be reversed if the U.S. economy is to prosper and compete successfully in the world markets.
> Several factors contribute to this result. Contrary to commonly held beliefs, advances in information technology and quantitative analysis have actually created asymmetries in information among trading market participants. While up-to-date information related to fundamental value (for example, corporate financial reports, crop yields, government policies)[11] is widely known today, these advances have been used by the more sophisticated and better-funded market participants to detect, analyze, and often influence activities by other market participants, and to then exploit advantages derived from this market non-fundamental information.[12] In addition, complex instruments--primarily derivatives--are better understood by the financial institutions that market them than by their customers. As a result, the financial

> institutions profit far more from the sale of these instruments than their customers realize.[28]

Ironically, the use of algorithms has reinvigorated the importance of physical space in trading.[29] The trend towards using algorithm has led to the increased importance of location. One interesting issue that has arisen out of high-frequency trading is the co-location of computer servers that give traders an advantage.[30]

Professor Chris Brummer has observed that "Nowhere has disruptive technology had a more profound impact than in financial services--and yet nowhere do academics and policymakers lack a coherent theory of the phenomenon more, much less a coherent set of regulatory prescriptions."[31] The overwhelming nature of the change in the way trading happens and the difficultly of regulatory responses stems in part from the technocratic approach that has dominated securities regulation in particular. Technocratic approaches can in fact be less effective than generalist approaches where the pace of technological development is so fast and so proprietary as to preempt true expertise on what is actually happening in the field to develop in government. By contrast, corporate law is still strongly influenced by common law, which has allowed corporate law to adapt to changing situations. While this Article's approach to algorithmic contracts does not purport to

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[28] Wallace C. Turbeville, *A New Perspective on the Costs and Benefits of Financial Regulation: Inefficiency of Capital Intermediation in A Deregulated System*, 72 MD. L. REV. 1173, 1177-78 (2013)

[29] Andrew J. Keller, *Robocops: Regulating High Frequency Trading After the Flash Crash of 2010*, 73 OHIO ST. L.J. 1457, 1461-64 (2012)

[30] Frank Pasquale, *Law's Acceleration of Finance: Redefining the Problem of High-Frequency Trading*, 36 CARDOZO L. REV. 2085, 2110 (2015).

[31] Chris Brummer, *Disruptive Technology and Securities Regulation*, 84 FORDHAM L. REV. 977 (2015)

be a substitute for sector-specific financial regulation, making sense of the background private law of contract that governs algorithmic contracts will (1) provide guidance when rules fail and (2) aid in developing sector-specific approaches by describing a general approach that comports with the actual realities and potentials for contracting with algorithms. Professor Charles Korsmo has observes that any regulatory strategy for high frequency trading should involve ensuring that "reliable information regarding HFT is generated in close to real time," "an evolving body of best practices regulation desired to reduce the systemic risks posted by HFT' and "strengthen liability for HFT and those who sponsor their access to the markets."[32] A clear backstop of contract rules would help achieve these goals even in absence of specific regulation. Specific regulation is very difficult in an environment of constant innovation and proprietary algorithms.

Furthermore, the need for general rules is particularly acute where innovation moves trading outside of traditional trading structures. "Dark pools" are non-public markets where orders are executed without the scrutiny for regulated exchange trading.[33] They are anonymous trading platforms for trading stock listed on public markets.[42] Orders placed through an exchange are visible to the public and all other market participants, but an order or an indication of interest entered on a dark pool is revealed only to other dark pool participants.[34] This gives dark pool participants access to information unavailable to the public."[35] Far from being the province of

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[32] Charles R. Korsmo, *High-Frequency Trading: A Regulatory Strategy*, 48 U. RICH. L. REV. 523, 530 (2014)

[33] Luis A. Aguilar, *Shedding Light on Dark Pools*, U.S. SECURITIES AND EXCHANGE COMMISSION, Nov. 18, 2015, https://www.sec.gov/news/statement/shedding-light-on-dark-pools.html.

[34] *Id.*

[35] Jerry W. Markham, *High-Speed Trading on Stock and Commodity Markets-from Courier Pigeons to Computers,* 52 SAN DIEGO L. REV. 555, 563 (2015)

marginal actors, mainstream banks such as Golden Sachs participate in dark pools.[36]

Even the basic characteristics of the entity to be regulated has changed. As Tom C.W. Lin has put it : "changes in finance have transformed prevailing understandings of financial regulation's main character, "the investor"" the investor has evolved from a person or group making a decision to a human-cyber hybrid, and regulation should reflect the particular challenges presented by this reality.[37]

High speed trading, as alluded to above, is merely so many term algorithmic contracts. Algorithms, acting as agents for investors, will determine the best way to make money pursuant to general objectives, and will enact their objectives in such a way as to cover their tracks. The algorithms are sophisticated, but ultimately, what happens at each moment of trade is that the algorithm either offers a price based on its program and the current environment, or decides whether or not to accept an offer based on the same. The algorithm's programming is hidden from whatever person or algorithm on the other side is trying to achieve. All that the other party sees is the offer of a price, or a rejection of an offer.

Agent algorithmic contracts are less common in HST. The major part of the market is term algorithmic contracts, because the idea is to hide from other traders the grounds on which decisions are being made. If algorithms were being agreed to, the situation would be more transparent. The idea that HST is just a fancy way to confuse and conceal information from the market is the reason why many industry insiders who are no fans of government regulation are calling for regulation of HST. There is limited case law on HST, because disputes arising from HST tend to end in settlement. On January 31 But they may do well to focus their fire on term algorithmic contracts.

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[36] Justin Baer & Scott Patterson, *Banks Draw Trading Scrutiny*, WALL ST. J., May 10, 2014, at B2.

[37] Tom C.W. Lin, *The New Investor*, 60 UCLA L. REV. 678, 682 (2013)

Despite the prevalence of HST and the huge amount of damage the practice has done to investors, case law about contract law is practically nonexistent.[38] On January 31, a huge SEC settlement forcing many top industry players to pay out in a record deal, saw the players admitting guilt in deceiving participants in dark pool by lying to them about whether the HST would serve to mislead them when trading in the dark pool.[39] The teachable lesson for crafting policy solutions for algorithmic contracts is that contract rules have impacts on the behaviors of , and those of us who think about how contract law should work would do well to be mindful of this.[40]

2. Dynamic Pricing

Dynamic pricing uses information about the market, product, and consumer to set prices at the highest price a given consumer is willing to pay.[41]

A classic example of dynamic pricing is the purchase of airline tickets. If I plan to visit my parents in Atlanta this June, the cost of the ticket that I will be offered will vary based on

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[38] Leading corporate law scholar Tom C. W. Lin did not cite a single case in his article describing high speed trading and its legal discontents in 2013. Tom C.W. Lin, *The New Investor*, 60 UCLA L. REV. 678, 682 (2013)

[39] Sarah N. Lynch, *Barclays, Credit Suisse strike record deals with SEC, NY over dark pools*, REUTERS, Jan. 31, 206 9:01M, http://www.reuters.com/article/us-sec-new-york-darkpools-idUSKCN0V90UE.

[40] Avery W. Katz, *Contract Theory-Who Needs It?*, 81 U. CHI. L. REV. 2043, xx, 2044 (2014) (discussing the underrated importance of considering contract theory for transactional lawyers).

[41] Robert M. Weiss & Ajay K. Mehrotra, *Online Dynamic Pricing: Efficiency, Equity and the Future of E-Commerce*, 6 VA. J.L. & TECH. 11, 1. (2001) (defining dynamic pricing and discussing its rise in the digital economy through reference to Amazon.com).

variable factors, such as how close to the date of departure I decide to buy the ticket, whether or not there are major events happening in the city at the time I choose to go, and more fixed factors, such as how many flights there are between New York and Atlanta and the distance between the two cities. The airline, or the third party vendor selling the ticket, will use an algorithm to take these factors into account when offering me the ticket price. This example takes place online, but dynamic pricing is spreading to the brick and mortar context, too.[42]

Since as early as 2000, a feature of dynamic pricing is the use of personal information to even further customize the price term to what a business's algorithm suggests a consumer might accept.[43] Contract is liminal feature of interactions between consumers and businesses. Regardless of how intellectual property rights, or intellectual quasi-property rights, such as privacy[44] set defaults, contract can still control the rights and responsibilities that most consumers face.[45] While there are some limits to what can be agreed to, by and large "While the enforceability of these contracts is sometimes contested, the law seems fairly settled in most jurisdictions that these contracts are relatively immune to challenge so long as certain notice and other procedural requirements to satisfy judicial concerns over aggressive "fine print" tactics are met."[46] A consumer protection

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[42] Greg Bensinger, Amazon Plans Hundred of Brick-and-Mortar Bookstores, Mall CEO Say, Wall St. J., Feb. 2., 2016 (noting that the prices for goods in the brick-and-mortar stores will be the same as the online prices, which are known for dynamic pricing techniques).

[43] Akiva A. Miller, *What Do We Worry About When We Worry About Price Discrimination? The Law and Ethics of Using Personal Information for Pricing*, 19 J. TECH. L. & POL'Y 41, 48-49 (2014)

[44] Lauren Henry Scholz, *Privacy as Quasi Property*, 101 IOWA L. REV. (2016)

[45] Jonathan M. Barnett, *Is Intellectual Property Trivial?*, 157 U. PA. L. REV. 1691, 1705-06 (2009)

[46] *Id.*

concern arises where we begin to think that algorithms may allow businesses to set price terms to squeeze the maximum profit out of each consumer.[47] Some have the intuition that violence is being done to basic principles of fairness, where one party has an algorithm that allows them to know the lowest price that an individual will accept, and the average consumer is operating with much less information about what price the company would accept.[48]

The fairness of and potential for price discrimination in dynamic, digital pricing from data mining and processing has

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[47] David A Hoffman, From Promise to Form: How Contracting Online Changes Consumers, (January 29,2016), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=272466.("I hypothesize that different experiences with online contracting have led some consumers to see contracts — both online and offline — in distinctive ways. Experimenting on a large, nationally representative, sample, this paper provides evidence of age-based and experience-based differences in views of consumer contract formation and breach. I show that younger subjects who have entered into more online contracts are likelier than older ones to think that contracts can be formed online, that digital contracts are legitimate while oral contracts are not, and that contract law is unforgiving of breach. I argue that such individual differences in views of contract formation and enforceability might lead firms to discriminate among consumers. There is some evidence that businesses are already using variance in views of contract to induce consumers to purchase goods they would not otherwise have. I conclude by suggesting how the law might respond to such behavior.)

[48] Aniko Hannak et. al, Measuring Price Discrimination and Steering on E-commerce Web Sites, 2014 CONFERENCE ON INTERNET MEASUREMENT CONFERENCE, 305-218, available at http://www.ccs.neu.edu/home/cbw/pdf/imc151-hannak.pdf. (empirical study confirming the role of price discrimination online, finding that there are "numerous instances of price steering and discrimination on a variety of top e-commerce sites")

been examined in the literature from several perspectives. Some take it to be as an issue of competition and antitrust law.[49] Some scholars address it as a fundamentally an ethnical issue.[50] It does not enter into our analysis of whether algorithmic contract constitute contract formation. Exposing an unknowing consumer to a sophisticated algorithm tailoring its terms to the worst terms that consumer would accept would tend to remove all consumer surplus from transactions. This may justify intervention based on a policymaker's interpretation of efficiency and justice. However, some, notably Professor Matthew A. Edwards, have argued that price discrimination actually could be desirable for consumers. As he observes, "vigorous anti-equality stance is neither inimical to consumer rights nor incompatible with progressive critiques of laissez faire approaches to contract law."[51] This is a rich area of analysis that ultimately is an application of justice concerns about what contract law should do and how it should distribute

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[49] Rory Van Loo, *Helping Buyers Beware: The Need for Supervision of Big Retail*, 163 U. PA. L. REV. 1311, 1330 (2015) (analyzing how sophisticated institutions capitalize on consumer limitations and considering what might be done about it); Akiva A. Miller, *What Do We Worry About When We Worry About Price Discrimination? The Law and Ethics of Using Personal Information for Pricing*, 19 J. TECH. L. & POL'Y 41, 45 (2014); Nathan Newman, *Search, Antitrust, and the Economics of the Control of User Data*, 31 YALE J. ON REG. 401, 405 (2014).

[50] Amy J. Schmitz, *Secret Consumer Scores and Segmentations: Separating "Haves" from "Have-Nots"*, 2014 MICH. ST. L. REV. 1411, 1414-15 (2014); Akiva A. Miller, *What Do We Worry About When We Worry About Price Discrimination? The Law and Ethics of Using Personal Information for Pricing*, 19 J. TECH. L. & POL'Y 41, 103 (2014).

[51] Matthew A. Edwards, *Price and Prejudice: The Case Against Consumer Equality in the Information Age*, 10 LEWIS & CLARK L. REV. 559 (2006)

power in society.[52] Except for the considerations of policy justifications for algorithmic contracts in part III.B., this Article will bracket this issue as not relevant to the issue of contract formation. Consumer facing term algorithmic contracts are simply another application of the general weakness of the "unequal bargaining power" defense to a fair contract where a consumer has willingly entered into the contract.[53]

Dynamic pricing provides a fairly clear example of term algorithmic contracts. Retailers use algorithms that take into account information about the market, and increasingly often, information about the particular potential buyer, to determine what price to offer. In most retailing situations, the price is a "take it or leave it offer" but one can imagine an algorithm that responds to an individual with a "counteroffer price," a price which takes in account the consumer's counteroffer in addition

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[52] Duncan Kennedy, *Distributive and Paternalist Motives in Contract and Tort Law, with Special Reference to Compulsory Terms and Unequal Bargaining Power*, 41 MD. L. REV. 563 (1982).

[53] Some law and economics oriented scholarship has been skeptical of unequal bargaining power as an argument against contract in the absence of true duress. *E.g.*, Richard A. Epstein, *In Defense of the Contract at Will*, 51 U. CHI. L. REV. 947, 953 (1984) (defending contract at will between employers and employees, that is, contracts to work that essentially provide for dismissal at will for almost any reason, a classic case of unequal bargaining power in the American economy). Another kind of argument against interfering with consumer contracts in the social media mediated climate has it that current technology has actually made it easier for consumers as a class to bargain with companies in the creation of form contracts than ever before, which into question the argument that legal intervention is necessary. *E.g.*, Wayne R. Barnes, *Social Media and the Rise in Consumer Bargaining Power*, 14 U. PA. J. BUS. L. 661, 671 (2012).

to the other factors the algorithm already weighed.[54] An algorithm does not appear to the consumer, only the term which is determined, in real time, by an algorithm.

One could imagine a type of dynamic price where a consumer agreed to the result of an algorithm, but this has not really taken off in consumer to business transactions. People probably find it creepy, which presents the question of whether it's ethical or different in some way to mask the use of an algorithm by offering a term. Ultimately, as my distinction between term and agent algorithmic contracts would suggest, I do think it matters. When parties agree to an algorithm, the visibility of the algorithm is important and the algorithm will serve as an agent to both parties. In the average case of consumer pricing, what's important to the consumer is the price, not how the offering company arrived at it. This in in evidence in business to business transactions, however. [55]

3. Ethereum and "Smart Contracts"

The first two examples this section has discussed have reached the mainstream, but it is the third, "smart contracts" that truly begins to indicate the level of automation that is possible in creating contracts and lays bare the inadequacy of the assumptions of traditional contract law in addressing algorithmic contracts. As Joshua Fairfield has discussed in recent work, decentralized applications could lead to widespread consumer usage of sophisticated algorithms to select for price and conditions.[56] Thus, the failure of the market to provide consumers with algorithms to help them make rational choices in a complex market because of the lack of

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[54] Find example/hypothetical to place here[and there is probably a hypo i could find]

[55] [Add example here]

[56] Joshua Fairfield, *Smart Contracts, Bitcoin Bots, and Consumer Protection*, 71 WASH. & LEE L. REV. ONLINE 35, 40-45 (2014)

incentive for companies to create and distribute such an application[57] could be corrected by a decentralized body.

Underlying Bitcoin, which has been defined by its creators as a "decentralized currency based on a cryptographic ledger."[58] Bitcoin has been the subject of debate and regulation as a cryptocurrency, but much of the discussion has centered around Bitcoin in its current form. In fact, block chain technology, which enables Bitcoin, has far broader implications that are not commonly debated outside of the debates about Bitcoin.[59]

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[57] Rory Van Loo discusses this problem in some detail in a recent article.

The second way in which technologies have failed to live up to their potential is in their ability to enable consumers to gather and analyze all market prices available. To see the theoretical potential for this to happen, consider a shopping application in which consumers input location, means of transportation, and a shopping list. The application would aggregate prices from all relevant brick-and-mortar and online retailers and run sophisticated algorithms to create optimized shopping itineraries from which the consumer could choose.[69] Importantly, the application would be immune from irrational decisions such as being more likely to purchase a product ending in "9" and being influenced by exposure to an advertisement for an overpriced $799 television. It would be able to determine rationally which retailer had the best price on like items.

Rory Van Loo, *Helping Buyers Beware: The Need for Supervision of Big Retail*, 163 U. PA. L. REV. 1311, 1330 (2015)

[58] Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, https://bitcoin.org/bitcoin.pdf(last visited Jan. 29, 2016).

[59] Especially within the past two years, there are notable exceptions that prove the rule. *E.g.*, Trevor I. Kiviat, *Beyond Bitcoin: Issues in Regulating Blockchain Transactions*, 65 DUKE L.J. 569, 574 (2015); Joshua Fairfield, *Smart Contracts,*

Blockchain technology, which can roughly be described as a decentralized database, enables "trustless" transactions: value exchanges over computer networks that can be verified, monitored, and enforced without central institutions.[60] The blockchain can be described as a public ledger that records every transaction that has ever been made and will ever be made on the bitcoin network, and a copy of this is distributed to every single user connected to the network, which all agree to abide to a certain set of procedures, the Bitcoin protocol.[61] The blockchain is an authentication and verification technology, enabling automated title transfers and ownership verification based on conditions.[62] No trust is needed, and these functions can be performed without trusted intermediaries subject to government regulation such as banks.[63] The borderless, frictionless nature of the blockchain enables it to provide a cheap, fast infrastructure for exchanging units of value.[64]

Ethereum builds upon the technology of bitcoin to form a next generation smart contract and decentralized application platform.[65] On top of decentralized database, digital tokens, and

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Bitcoin Bots, and Consumer Protection, 71 WASH. & LEE L. REV. ONLINE 35, 40-45 (2014).

[60] Trevor I. Kiviat, *Beyond Bitcoin: Issues in Regulating Blockchain Transactions*, 65 DUKE L.J. 569, 574 (2015)

[61] Primavera de Flippi, *Ethereum: Freenet or Skynet?,* BERKMAN CENTER FOR INTERNET AND SOCIETY, Apr. 15, 2014, https://cyber.law.harvard.edu/events/luncheon/2014/04/difilippi (last visited Jan. 31, 2016).

[62] *Id.*

[63] *Id.*

[64] *Id.*

[65] Vitalik Buterin, et al., *A Next Generation Smart Contract and Decentralized Application Platform*, Ethereum White Paper, https:// github.com/ethereum/wiki/wiki/White-Paper (last visited Jan. 10, 2016). The term "platform" implies a level of neutrality by the creators that may or may not reflect reality. This Article will largely bracket the influence that third parties might have on the type of algorithmic contracts that are created,

encryption, it builds a Turing-complete scripting language which allows anyone to deploy their own application on town of the blockchain.[66] This enables the development of autonomous applications that operate autonomously on the blockchain.[67]

A smart contract removes the need for trust between parties. Smart contracts are self-enforceable. This means that the contract and the code are matching to one thing, the contract is defined by the code and is also automatically being enforced by the code that defined it. This creates the possibility of one decentralized application interacting and agreeing with another application.

What distinguishes smart contracts from other areas of algorithmic contract is the ability of Ethereum to create what are known as decentralized autonomous organizations (DAOs). DAOs implement a constitution that basically stipulates the for governance of organization. DAOs also implement a system of equity allowing people to invest by purchasing some of their shares to help the organization achieve its objective. Instead of trusting an organization to operate by rules, you can encode a series of rules for behaviors for an organization that will then be bound to operate according to those principles because it has no choice but to do otherwise. For an investor, this may be in some ways more desirable than investing in actual founders. As the Ethereum website aptly puts it, the platform enables "applications that run exactly as programmed without any chance of downtime, censorship, fraud or third-party interference."[68]

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while flagging its potential significance. *See* Tarleton Gillespie, The Politics of 'Platforms', New Media & Soc'y (2010), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1601487 (discussing the use and significance of the term "platform").

[66] *Id.*

[67] *Id.*

[68] ETHEREUM, https://www.ethereum.org/ (last visited Jan. 29, 2016).

Term algorithmic contracts predominate in the first two case studies this section has described. The case of smart contracts is particularly valuable in that it provides several examples of agent algorithmic contracts. Consider the case of an investor in a DAO. They agree to invest in an algorithm programmed to achieve certain objectives. They know the kinds of thing the algorithm is programmed to do, so they invested wanting certain particular objectives, but they did not agree to those objectives. They agreed to the algorithm.

Smart contracts can also involve term contracts. A DAO, in attempting to achieve an objective, might offer another application a price for a good or service. That transaction would transpire via a contract, where the other party agrees to a term offered by the DAO. Smart contracts are so sophisticated that we see, as in this example, term algorithmic contracts being agreed to by an algorithm that is executing an agent algorithmic contract.

III. BLACK BOX ALGORITHMIC CONTRACTS REQUIRE A DIFFERENT INTERPRETIVE APPROACH FROM TRADITIONAL CONTRACTS

Both theoretical and practical justifications are required to justify why existing contract law cannot apply to black box algorithmic contracts. I will address both in turn. This Part will consider how algorithmic contracts demand a different approach from traditional contract law due to deficiencies in formation. First, I will analyze three points of tension in contract formation doctrine presented by term or agent algorithmic contract: mutual assent, consideration, and performance. Then, I will discuss the potential for defenses to contract formation available uniquely for individuals who would contest an algorithmic contract. Finally, I will discuss the policy reasons to weaken the presumption that black box algorithmic contracts should be evaluated solely, as in traditional contracts, with reference to the four corners of the contract. Part IV will go on to discuss possible interpretive methods for black box algorithmic contracts.

A. Theoretical justification

Contract theory and case law shows major differences between traditional contract and algorithmic contracts.

The predominant approach to contracts at law considers a contract as fundamentally an expression of will, the conscious, objectively manifested intention by two parties or more to be bound to terms.[69] Note that, properly understood, the term of art "objective assent" requires a level of intersubjective awareness that blurs the line between the ordinary understanding of objective and subjective assent.[70] Under Randy Barnett's will-

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[69] *E.g.*, CHARLES FRIED, CONTRACT AS PROMISE: A THEORY OF CONTRACTUAL OBLIGATION (1981); Randy E. Barnett, *A Consent Theory of Contract*, 86 COLUM. L. REV. 269 (1986). The alternative theory of contract, which finds that contractual obligation springs at law from the right of one who has justified reliance on another to a remedy. *E.g,*. P.S. ATIYAH, THE RISE AND FALL OF FREEDOM OF CONTRACT (1979); Daniel A. Farber & John H. Matheson, *Beyond Promissory Estoppel: Contract Law and the "Invisible Handshake"*, 52 U. CHI. L. REV. 903, 927 (1985). There are also theories that mix these approaches for a social theory of contracts, arguing that contract springs from trust arising between individuals; an act of will is relevant but not determinative. *E.g.*, JOHN FINNIS, NATURAL LAW AND NATURAL RIGHTS 307, 323-24 (1980) ("Suffice it to observe here that although promissory obligations do not come into being without some voluntary and intentional act such as might be said to manifest an 'act of will' on the part of the promisor, the occurrence of that act is only one of the several facts relevant to the emergence of the necessity which we call obligation, and has no special role in explaining the obligation of the performance promised."). Part IV.E. will discuss the implications of algorithmic contracts for contract theory. As this section is focused on doctrine,

[70] BRIAN H. BIX, CONTRACT LAW: RULES, THEORY, AND CONTEXT 24-25 (2012); *see also* Avery W. Katz, *Contract Theory-Who*

oriented and permissive view of form contracts, consenting to form contracts is not about making a promise that a party would need to have actually understood. Instead it is "about manifesting consent to be legally bound."[71] Conscious intent is on the non-corporate side of the form contract even when the individual chooses not to read lengthy terms and conditions; the person who agrees to the form contract has just determined rational ignorance is appropriate.[72] Barnett finds that there are limits on what can be consented to in a form contract; terms which "exceed some bound of reasonableness" should not be considered part of the contract.[73] Recently, several scholars have proposed a more limited scope for the enforceability of form contracts,[74] but Barnett's reflects the conventional view on this matter.

Needs It?, 81 U. CHI. L. REV. 2043, 2049-53 (2014) ("For purposes of contracts, law, or indeed any aspect of human communication, it is the interpersonal definition that is relevant. In order for words to have communicative effect, the listener and hearer must speak the same language; functionally, they must share the same conventions regarding what sounds are used to refer to what concepts. Such conventions constitute what the literary and legal critic Stanley Fish has labeled an "interpretive communit[y]." Once one recognizes this point about the way that language works, the distinction between subjective and objective interpretation loses much of its bite, because whether two people share the same linguistic convention is a social fact that can be determined by interpersonally objective criteria.").

[71] Randy E. Barnett, *Consenting to Form Contracts*, 71 Fordham L. Rev. 627, 629-30 (2002).

[72] *Id.* at 640.

[73] *Id.* at 639.

[74] Kenneth K. Ching, *What We Consent to When We Consent to Form Contracts: Market Price*, 84 UMKC L. REV. 1 (2015)(" My argument is not just that form contracts should be enforced at market price. It is that consent to form contracts should be construed as consent to pay market price."); Andrew Tutt, *On*

Algorithmic contracts present a different type of problem than form contracts. The problem here is that, unlike in form contracts, where those who accept form contracts can be said to be "rationally ignorant," in algorithmic contracts there is no fixed set of things of which a party can be said to be ignorant. What the algorithm is going to do is unknown, varying based on a variety of factors. Agreements to agree, or to pursue an objective only when profitable, have never been considered. While the algorithm itself is making more granular choices, the idea that automated choice has legal standing different from conscious choice by some person undergirds many areas of law, such as the law governing government surveillance and autonomous weaponry. [75] The doctrine does not support considering algorithms agents or persons, so while it is useful to

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the Invalidation of Terms in Contracts of Adhesion, 30 YALE J. ON REG. 439 (2013) ("judges should invalidate terms in contracts of adhesion that place the risk of loss on the costlier cost-avoider or that grant an option to one of the parties to impose non-reciprocal costs on the other"); Andrew A. Schwartz, *Consumer Contract Exchanges and the Problem of Adhesion*, 28 YALE J. ON REG. 313, 363-66 (2011) (arguing that consumer exchange contracts should be excluded from the doctrine of adhesion).

[75] Several authors have discussed the rise of autonomous weapons, and sources are remarkably consistent in their awareness that a choice made by an artificially intelligent agent. A. Michael Froomkin & P. Zak Colangelo, *Self-Defense Against Robots and Drones*, 48 CONN. L. REV. 1, 6 (2015); Rebecca Crootof, *The Killer Robots Are Here: Legal and Policy Implications*, 36 CARDOZO L. REV. 1837, 1844-45 (2015). The question of how machine learning in the context of NSA surveillance is different from reading by a human government is also a live debate. Priscilla J. Smith, Nabiha Syed, David Thaw, and Albert Wong, *When Machines Are Watching: How Warrantless Use of Gps Surveillance Technology Violates the Fourth Amendment Right Against Unreasonable Searches*, 121 YALE L.J. ONLINE 177, 181 (2011).

think about agency law as an analogy for understanding the gap between the principal and algorithms help humans make contracts, agency law does not actually govern these cases.[76]

Like agents, Algorithms must not be understood as mere extensions of the will of an individual or company. Robotics law expert Ryan Calo defines emergence as "unpredictably useful behavior and represents a kind of gold standard among many roboticists[]."[77] If the instructions given toe an algorithm-agent instructions by its principal vague, they cannot be a ground for the level of intent necessary to ground a contractual promise. Furthermore, algorithms have the potential for emergence, so the law must have a coherent and descriptive account of the liability profile in the case of algorithmic emergence.[78] As this Part makes clear, many contracts made with algorithms can meet the requirements of regular contracts. The concern is, unless the law incorporates an accurate view of the role algorithms play relative to their human principals, agreements that do not reflect the actual theoretical grounding of contract law will be swept into contract law. What's more, the gap between the role of contract law and improperly formed algorithmic contracts has important negative policy effects, which will be discussed in part III.B.

Algorithmic contracts present theoretical problems for mutual assent and consideration. They also are susceptible to defenses under the heading of "failure of a basic assumption of the contract." This Section will go over each of these issues in turn.

1. Mutual Assent

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[76] See Anthony J. Belia, *Contracting with Electronic Agents*, 50 EMORY L.J. 1047, 1059-1067 (2001) (finding no support for algorithms as agents or persons in the common law).

[77] Id.

[78] Ryan Calo, *Robotics and the Lessons of Cyberlaw*, 103 CAL. L. REV. 513, 532 (2015).

Mutual assent is agreement by both parties to a contract, usually in the form of offer and acceptance.[79] In modern contract law, mutual assent is determined by an objective standard — that is, by the apparent intention of the parties as manifested by their actions.[80] But the objective intent at issue in the formation of a contract is not the general intention to make some kind of contract, or to come to some kind of terms with another party to reach an objective.[81] It is objective manifestation of intent to be bound by a contract with particular terms.[82] And that is where algorithms complicate matters for standard contract theory.

In a standard contract, one party makes an offer, the other party evaluates it and then chooses to accept or deny.[83] In the case of a term algorithmic contract, where one party uses an algorithm to choose, for example, price and who to ask to contract with, the offeror (that is, the company or individual using the algorithm) is not directly offering. Rather, an automated agent is offering on behalf of the offeror, in a combination that the offeror may or may not have consciously thought of.[84] The question is, is the manifested intent of a party

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[79] RESTATEMENT (SECOND) OF CONTRACTS § 1 (1981) (defining contract as "a promise or a set of promises for the breach of which the law gives a remedy, or the performance of which the law in some way recognizes as a duty.")

[80] K. N. Llewellyn, *Our Case-Law of Contract: Offer and Acceptance, II,* 48 YALE L.J. 779, 783 (1939); K. N. Llewellyn, *On Our Case-Law of Contract: Offer and Acceptance, I*, 48 YALE L.J. 1 (1938).

[81] *See* Robert A. Prentice, *"Law &" Gratuitous Promises*, 2007 U. ILL. L. REV. 881, 909 (2007); Melvin Aron Eisenberg, *Donative Promises*, 47 U. CHI. L. REV. 1 (1979).

[82] *See* Joseph M. Perillo, *The Origins of the Objective Theory of Contract Formation and Interpretation*, 69 FORDHAM L. REV. 427, 428-29 (2000).

[83] RESTATEMENT (SECOND) OF CONTRACTS (1981).

[84] For the purposes of this discussion we will take the perspective that the contracting party is the offeror. The same

to use an algorithm to select prices and contractual terms for them, the same thing as actually objectively, manifestly assenting to the actual contracts the algorithm selects? Not necessarily. The algorithm as agent mediates between the intent of the creator of the algorithm, and the acts of the algorithm. If the algorithm is acting within the parameters of what the offeror specifically planned for it to do the algorithm acting on behalf of the offeror is acting as a conduit for the objective intent of the offeror to be bound. To put it another way, it is possible that the extent to which the offeror can be said to be agreeing to an algorithmic contract, it is possible that it is merely an illusory promise. When illusory promises are all that support a purported bilateral contract, there is no mutuality of obligation, and therefore, no contract. A new technology should not enable contracting party to end-run around the bedrock principle of contract law; that parties agree to be bound by mutual promises, not just any promise (gratuitous and illusory promises are out).[85]

Simply because there has been an agreement on price, does not mean that there is agreement on other finer points of the contract; in fact there is a theoretical and doctrinally grounded "taboo" against using the price to interpret other contract terms.[86]

The instinct of many operating with more limited knowledge of algorithms in society is that of course, a party using an algorithm has an idea of what it will do on its behalf. However, this is based on the idea of algorithms as mere tools, similar to a

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analysis holds for when an algorithm serves as the agent of the accepting party to a contract; that is, determining who to contract with, which terms to accept and whether to counteroffer.

[85] *See* Robert A. Prentice, *"Law &" Gratuitous Promises*, 2007 U. ILL. L. REV. 881, 909 (2007); Melvin Aron Eisenberg, *Donative Promises*, 47 U. CHI. L. REV. 1 (1979).

[86] Donald J. Smythe, *Consideration for A Price: Using the Contract Price to Interpret Ambiguous Contract Terms*, 34 N. ILL. U. L. REV. 109, 110 (2013).

calculator. As has been discussed earlier in this paper, algorithms have progressed far beyond this point, to the point when they are far more similar to artificially intelligent agents. The potential of Ethereum and the inscrutable sources of the Flash crashes, as discussed in Part II.B are real world examples of how far the behaviors chosen by algorithms can stay from the intentions of any conscious person. In agency law, principal is not always bound by the actions of their agents, the agents might act in a way that goes directly contrary to the stated goals and interests of the principles. But the principal is usually liable for the mistakes the agent makes; this is because the principal assumed such a risk by opting to use an agent in the first place. But assumption of risk is a concept from tort, and should be analyzed as such. If the offeror using an algorithmic contract is bound by a contract that goes beyond the scope reasonably anticipated by the offeror, or the offeror gave the algorithm so broad an objective, such as "do X it if it is within my business interest" that it demonstrates no intent to be bound by a particular type of contract, there is a strong argument that there is no objective manifestation of intent to contract in any particular algorithmic contract. The person who used the algorithm is still liable for the actions of the algorithm in tort. The broad sense that "a party used an algorithm to make a contract, but they basically knew what was going to happen" does not rise to the level of mutual assent in traditional contract. One may argue that the law should include this way of assenting as a way of mutual assent to the way one might assent but it does not fit into the current approach.

2. Consideration

The second area of contractual formation that algorithmic contracts call into question is consideration. Consideration is something (such as an act, a forbearance, or a return promise) bargained for and received by a promisor from a promisee; that which motivates a person to do something, especially an

agreement to engage in a legal act[87]. Consideration, or a substitute such as promissory estoppel, is necessary for an agreement to be enforceable. So, even if an algorithmic contract can be said to be grounded on mutual assent, if there is no consideration, the contract is non-enforceable. [88]

Modern contracts scholars have adopted the "bargain theory of contract" above the benefit-detriment model.[89] That is, as long as there was a bargaining process between the two parties, then what arises from it is a contract. [90]

In term algorithmic contracts, consider in what sense is there a bargain between the two parties if one party is using algorithm as an agent. It goes back to my previous analysis. The algorithm's machinations might represent it's principal's objective intent to be bound, or it might not. There should only be said to be a bargain where the former is true. It is a doctrinally relevant fact, in the bargained-for agreement theory, that offeror isn't bargaining, it is the algorithm bargaining. In agent algorithmic contracts, the issue is somewhat attenuated. This is because both parties can talk about what should be in the algorithm, what it should do, when to accept results, etc. So a bargain is being done between humans here. However, a different problem in deeming it a bargained-for agreement

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[87] RESTATEMENT (SECOND) OF CONTRACTS (1981).

[88] *Id.*

[89] Id. **(**"An agreement is a manifestation of mutual assent on the part of two or more persons. A bargain is an agreement to exchange promises or to exchange a promise for a performance or to exchange performances.")

[90] Roy Kreitner, *The Gift Beyond the Grave: Revisiting the Question of Consideration*, 101 COLUM. L. REV. 1876, 1878-79 (2001); Val D. Ricks, *The Sophisticated Doctrine of Consideration*, 9 GEO. MASON L. REV. 99, 104 (2000); Melvin Aron Eisenberg, *The World of Contract and the World of Gift*, 85 CAL. L. REV. 821, 825 (1997); Melvin Aron Eisenberg, *The Principles of Consideration*, 67 CORNELL L. REV. 640, 641 (1982); Lon L. Fuller, *Consideration and Form*, 41 COLUM. L. REV. 799 (1941);

arises for agent algorithmic contract. The agreement to an algorithm presumes that the algorithm will reach results that are amenable. So, in an agent algorithmic contract, it may be that the bargaining has not occurred yet. Rather, there is an agreement to agree rather than the fruit of the bargain. Agreements to agree have long be deemed insufficient to ground contracts. However, they may be sufficient for the "bargaining" behind a bargained for agreement.

Consideration is a particularly thorny problem for algorithmic contracts that feature algorithms on both sides of the negotiation. When algorithms are doing the bargaining rather than the offeror and accepting party, it's less clear that we can say that it is a bargained for agreement. Perhaps there is a rational benefit and detriment, but the law has already moved away from that approach to consideration. In business to business transactions, this type of contracting is rising in import.

Ultimately, there are serious concerns about whether the bargain theory of contract can be applied to algorithmic contracts. Just running through a suite of examples above creates the provocation that it might not. Given that algorithmic contract as a class creates the potential that the very low bar of bargaining not be met in a large range of business to business agreement, this supports the idea that the theoretical infrastructure for traditional contract law needs tweaking to be relevant for algorithmic contracts.

3. Defenses

There are several defenses to contractual formation that might arise in the case of an algorithmic contract. These include the excuses for non-performance (mistake, misrepresentation, frustration of purpose, impossibility, impracticability, illegality, unclean hands, unconscionability, accord and satisfaction) and the defenses against formation (lack of capacity, duress, undue influence, and non est factum).[91] The purpose of this paper is to

[91] RESTATEMENT (SECOND) OF CONTRACTS (1981)

evaluate whether algorithmic contracts are contracts, and if they are, how they should be interpreted, if in a different manner from traditional contracts. To this end, I will not consider defenses to contract at this time, because my aim is to understand the prima facie case of contract in the context of algorithmic contract.[92] I will, however, discuss and ultimately dismiss the approach to contract law that would shoehorn the burden of raising issues with algorithmic contracts on defending parities in the part IV, when I discuss the affirmative approach to contract law for which this article advocates.

B. Practical Justification

Courts, legislators, and society are motivated to alter the law so that it leads to results that are efficient and just. Contract scholarship has been critiqued on the grounds that it is too theoretical and divorced from the realities of contracts in

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[92] Pragmatically, concentrating on defenses has proven less successful than attacking from formation in the context of consumer contracts for a number of reasons explored deftly by other scholars. Anne Fleming, *The Rise and Fall of Unconscionability As the "Law of the Poor"*, 102 GEO. L.J. 1383, 1395 (2014) (chronicling the decline in success of the use of the unconscionability from a legal historical perspective); Edith R. Warkentine, *Beyond Unconscionability: The Case for Using "Knowing Assent" As the Basis for Analyzing Unbargained-for Terms in Standard Form Contracts*, 31 SEATTLE U. L. REV. 469, 523 (2008); John P. Dawson, *Economic Duress--An Essay in Perspective*, 45 MICH. L. REV. 253, 288 (1947)(commenting on the "conflict and confusion" in economic duress doctrine). But see Grace M. Giesel, *A Realistic Proposal for the Contract Duress Doctrine*, 107 W. VA. L. REV. 443, 451 (2005); Melvin A. Eisenberg, *Mistake in Contract Law*, 91 CAL. L. REV. 1573, 1575-76 (2003)
(both theoretical arguments for expansionary roles for defenses).

action.[93] The previous section has shown that algorithmic contracts cannot, theoretically speaking, be evaluated in the same way as traditional contracts. This is significant because, if reform is conducted through the courts, by adoption of changes in the restatement and the adoption of general rules by state legislature, algorithmic contracts due to the particular way common law courts reason in the modern ear.[94] One need only look at the widespread theoretical concerns about form contracts, and their prevalence in real life to see this gap.[95]

In an automating world, rules that create incentives for companies to clarify intent and objectives of algorithms will encourage human involvement in the development and quality control of algorithm. It creates a space for technical writers and policy people on board with communicating the to the "big picture" folks in legal and C-level suites. This, to put it bluntly, spells more jobs for humans. This is significant in an economy where, thanks to innovation, will be hemorrhaging jobs over the next several decades.[96]

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[93] Avery W. Katz, *Contract Theory-Who Needs It?*, 81 U. CHI. L. REV. 2043, xx, 2044 (2014); Allan Farnsworth, *A Fable and a Quiz on Contracts*, 37 J. LEGAL EDUC. 206, 208 (1987) ("The urge to have a 'theory' of contract law has tended to increase the distance between contracts scholarship and practice. In particular, it has led to an excessive emphasis by scholars on why promises are enforced.").

[94] David Rosenberg, *The Path Not Taken*, 110 HARV. L. REV. 1044, 1046 (1997) (discussing the tradition role common law courts have changed and modern attitudes towards the limitations of courts and the rise of faith in a technocratic, specialist state).

[95] Randy E. Barnett, *Contract Is Not Promise; Contract Is Consent*, 45 SUFFOLK U. L. REV. 647, 664 (2012); Randy Barnett, Consenting to Form Contracts, 71 FORDHAM L. REV. 627-645(2002).

[96] WORLD ECONOMIC FORUM, *The Future of Jobs: Employment Skills and Workforce Strategy for the fourth digital revolution*,

As Melvin Eisenberg put it, "[I]nterpretation cannot possibly be more accurate with less information and less accurate with more information. Accordingly, if literalism is to be supported, it cannot be on the ground that it leads to more accurate interpretation. Instead, it must be supported, if at all, on other grounds."[97] Formation theory gives us reason to doubt that algorithmic contracts are properly formed at law. The evaluation of practical considerations in this section adds to the argument against enforcement of algorithmic contracts without consideration of their context.

1. Valuation principle

Algorithmic contracts are uniquely able to destroy the use of contracts as a principle for evaluating the demonstrated preferences of people beyond market price valuation. [98] Contracts show how people value items. If A contracts to sell a house to B for 1000 units, it shows that A values the 1000 units more than the house. A and B bring their own impressions, biography, and context to the transaction. 1000 may represent the market value, but that is likely not the sole reason B chose to

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http://www3.weforum.org/docs/Media/WEF_FutureofJobs.pdf (last visited Jan. 29, 2016).

[97] Melvin A. Eisenberg, Foundational Principles of Contract Law (2015)

[98] *See* Kevin E. Davis, *Contracts As Technology*, 88 N.Y.U. L. REV. 83, 89-90 (2013) (discussing contracts as distributors of information and innovation in society in their own right aside from market interaction, noting "the value of a contract to its parties will reflect the net effect of the behavior it induces, taking into account enforcement costs and the levels of reading costs, investigation costs, and residual uncertainty the parties have chosen to incur. A rational actor should decide whether to adopt one contractual document or another based on a rational assessment of these costs and benefits. In practice, this calculation will require a fair amount of guesswork.");

buy that house. Perhaps B strongly prefers brick houses, and this house was one of very few brick houses in the area, or she liked the particular community because of access to hiking. A may strongly value the house, perhaps at even more than 1000 units, but may have to leave the area for other reasons.

This classic, intuitive illustration shows that contracts mean more than just an indication of what market prices are.[99] Contracts are a venue through which individuals can express preferences that are not grounded in "rationalist" market pricing, and in this way promote information sharing in society.[100] Contract doctrine reflects this in its transition from the benefit-detriment theory of contract, in which courts used to try to objectively analyze whether the deal was "fair" to an acceptance of the fact that contract law is all about accepting the actual preferences of individuals. There is a presumption among non-specialists that algorithms are typically right, but that is far from true, at least in the ordinary sense of "rightness."[101] Algorithms are, by definition, bound by the terms and context and limitations of their human programmers. To put it another way, if the question the algorithm is told to solve is "wrong" the

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[99] See Henry E. Smith, *Law and Economics: Realism or Democracy?*, 32 HARV. J.L. & PUB. POL'Y 127, 127-28 (2009) ("Law and economics and democracy are not enemies, but I contend that legal realism--or its lingering aftershocks--causes aw and economics to be more technocratic and less democratic than necessary. While legal realism as a movement itself may be dead, it rules us from the grave.").

[100] *See* Richard Craswell, *Taking Information Seriously: Misrepresentation and Nondisclosure in Contract Law and Elsewhere*, 92 VA. L. REV. 565, 566-67 (2006); Melvin A. Eisenberg, *Disclosure in Contract Law*, 91 CAL. L. REV. 1645, 1648-49 (2003); Anthony Kronman, *Mistake, Disclosure, Information, and the Law of Contracts*, 7 J.LEG. STUDIES 1, 13-14 (1978). (on the information distributive functions of contracts).

[101] Tarleton Gillespie, *Can an algorithm Be wrong?*, 1 LIMN 1(2012).

algorithm will not necessarily be able to correct the question, and thus will produce a "wrong" answer. The law needs to make provisions in line with how algorithms really work.

When we take the accountability to the conscious preferences of individuals out of the equation, as with algorithmic contract, we lose the use of contracts as an indicator of what humans or companies consciously prefer. It becomes just another predictor of actual preferences (like price) rather than the real thing. Contracts are a unique area of law where individual's objective acts to reveal a preference are given precedence. The concept of e-governance is based on the idea that understanding the experiences and opinions of the public will allow for better policy decision-making;[102] contract law has the same function in the private sector. To uphold what an algorithm agreed to, especially when it is in conflict with or unrelated actual objective intent of the principal, is not just ethically questionable, but also robs society of a valuable, unique source of information about social and business norms.

2. Uncertainty

The use of algorithms creates a great deal of uncertainty. Sophisticated algorithms can quickly find connections that humans would be less likely to see, but can also create problems that humans are unlikely to foresee.[103] This is a rational,

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[102] *E.g.*, Beth Simone Noveck & David R. Booth, *The Future of Collaborative Governance* , GOVERNMENT 2.0, NGENERA REPORTS (Fall 2008).

[103] SIVA VAIDHYANATHAN, THE GOOGLIZATION OF EVERYTHING (AND WHY WE SHOULD WORRY) 174- 198 (discussing the limitations to how algorithms can help us to know things, including discussion of uncertainty) (2012); Jenna Burrell, How the Machine 'Thinks:" Understanding Opacity in Machine Learning Algorithms, unpublished manuscript, Sep. 15, 2015, *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2660674 (identifying three types of opacity associated with algorithms "1)

calculated risk on the part of any person or business who decides to use an algorithm in making decisions. It is certainly not the aim of this paper to argue that business stop using these algorithms or should be regulated when they use algorithms for internal-decision-making. [104] Businesses and individual can manage their own risks, and when their risk-taking impacts others, tort law can allow people to recover in some cases.

The reality of how many firms use algorithms internally is best described by the much maligned algebra method "guess and check." Instead of having any idea of how a database may be used, they just poke around looking for patterns. And once patterns are found, they operate based on them.[105] It's unlikely

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opacity as intentional corporate or state secrecy (2) opacity as technical illiteracy, and (3) an opacity that arises from the characteristics of machine learning algorithms and the scale required to apply them usefully. The analysis in this article gets inside the algorithms themselves."); Ian Bogost, *The Cathedral of Computation*, THE ATLANTIC, January 15, 2015, available at http://www.theatlantic.com/technology/archive/2015/01/the-cathedral-of-computation/384300/(discussing the rightness of algorithms as an article of faith in modern society and their fallibility in reality).

[104] This is a rich and growing area of research, with spirited empirical and theoretical arguments about whether and how internal usage of algorithms should be regulated. *See generally e.g.*, FRANK PASQUALE, THE BLACK BOX SOCIETY: THE SECRET ALGORITHMS THAT CONTROL MONEY AND *INFORMATION* (2015); Zeynep Tufekci, *Algorithmic Harms beyond Facebook and Google: Emergent Challenges of Computational Agency*, 13 COLO. TECH. L. J. 2 (2015). It is important to note here that even the most extreme arguments for data as constitutionally protected speech, *see* Jane Bambauer, *Is Data Speech?*, 66 STAN. L. REV. 57, 64 (2014), do not limit the analysis here; it is settled law that contracts are not speech, but "legal acts." *E.g.*, *Coghlan v. S. Carolina R. Co.*, 142 U.S. 101, 111 (1891) (referring to contracts as legal acts).

[105] Charles Vaccaro, *Look Before You Leap into Predictive*

that this way of using data and algorithms will change given that so many successful results have come from it.[106] This true of the algorithms in algorithmic contract in trading.[107] Algorithms are increasingly being used to develop culture,[108] an area where it is less obvious than in finance when a "crash" has occurred, and how to fix one if one were to happen.

The uncertainty problem becomes untenable when many actors are using algorithms to conduct transactions. *In Property as the Law of Things*, Henry Smith makes the argument that the reason why property works so well is that it allows the law leaves to the owner's discretion many aspects of use and enjoyment, and the law only steps in on the borders, where individuals seek to sell their property, or one of the sticks that compose it (like, access to a piece of land). The law can come in and regulate at the borders.

When an algorithm has unpredictable results because a business isn't sure what causes it to have positive results, they can manage the risk internally. The problem with using algorithms at the borders is that since the algorithms aren't operating within anyone's domain, no one person is keeping track of and minimizing potential risks for the unanticipated

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Coding: An Argument for A Cautious Approach to Utilizing Predictive Coding, 41 RUTGERS COMPUTER & TECH. L.J. 298, 318-19 (2015) (discussing "garbage in garbage out" and the principle that most lawyers and non-quantitative business people don't understand the predictive limitations of algorithms) .

[106] Astrid Mager, Algorithmic Ideology How Capitalist Society Shapes Search Englines, Info., 15 Comm'ns & Soc.

[107] Cite sources on on HST supra

[108] Tarleton Gillespie, *#trendingistrending: when algorithms become culture*, ALGORITHMIC CULTURES: ESSAYS OF MEANING, PERFORMANCE AND NEW TECHNOLOGIES (forthcoming 2016), *available at* http://www.tarletongillespie.org/essays/Gillespie%20-%20trendingistrending%20PREPRINT.pdf (last visited Feb. 2, 2016).

negative results of the use of algorithms. When nobody is responsible for managing the risk, the risk continues unabated.

And that can lead to crises where nobody understands what went wrong. The classic example of this is are the Flash Crashes, but there is a potential for this everywhere algorithmic contracts are found. Everything makes sense and everyone's objectives can be met until they're not. Someone needs to have responsibility. The place to insert regulatory liability and incentives is at the borders where transactions between parties are being made.

3. Repository of responsibility

More and more significant tasks are being delegated to algorithms, and these are tasks not just of increasing complexity, but tasks that require judgment (both financial and moral). It needs to be made clear who has responsibility for judgments made by artificial agents.

Delegating moral responsibility has meaning in society. This is true not just of criminal law, but also tort law.[109] Even when we

[109] John C.P. Goldberg & Benjamin C. Zipursky, *Torts As Wrongs*, 88 TEX. L. REV. 917, 918-19 (2010) ("As the law of private and privately redressable wrongs, tort law is rightly treated as a cornerstone of legal education along with criminal law (the law of public and publicly redressable wrongs) and contract law (the law of consensually defined duties). Looked at through the lens of litigation, Torts is about the wrongs that a private litigant must establish to entitle her to a court's assistance in obtaining a remedy and the remedies that will be made available to her. Looked at through the lens of daily life, Torts is about which duties of noninjury owed to others are counted as legal duties and what sorts of remedial obligations one will incur for failing to conduct oneself in accordance with those duties. In turn, the places to look for contemporary extensions of tort law are not the compensation systems with which tort law is frequently coupled. Rather, they are found in the rules governing 10b-5 suits, civil RICO actions, Title VII

move beyond the responsibility that can legitimately be claimed in a contract, the way that we understand algorithms at law must be compatible in lodging the responsibility specific individual or company in a way that makes intuitive sense.

The use of algorithms in agreement present unique incentives and mechanisms for avoidance of accountability by institutional actors that use them.[110]

4. Social welfare

Algorithmic agreements can enable price discrimination (both in the consumer context and in the business to business financial market), that allows companies with market power to gain more and more consumer surplus (in the consumer case)

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claims for workplace discrimination, constitutional tort claims, and intellectual-property-infringement actions. To study torts is to learn what sort of conduct our legal system defines as wrongfully injurious toward another such that, when committed, the victim is entitled to exact something from the wrongdoer. This is the domain of law that was born centuries ago with the recognition of the writ of trespass vi et armis and that today is defined by state and federal common law, as well as state and federal statutory and constitutional law.")

[110] E.g., Bryant Walker Smith, *Proximity-Driven Liability*, 102 GEO. L.J. 1777, 1779 (2014) ("[T]hese tools also raise concerns about privacy and autonomy as against companies, governments, and malicious actors.... Legal regimes can support this design by clarifying rights and responsibilities with respect to information, access, and control. Tort law, contract law, and the hybrid that is products liability will confront some of the failures of this design. As this Article has argued, the result could be expanded duties for sellers. "); Michael Mattioli, *Disclosing Big Data*, 99 MINN. L. REV. 535, 577-83 (2014) (evaluating the sufficiency of intellectual property as an avenue for encouraging "big data" producers to disclose how they collect, organize, and transform valuable sources of data).

and more . It also, as discussed above, can allow such companies to avoid taking responsibility for external harms "Flash Crashes" cause.[111] They also can enable consumer contracting contexts that would enable companies to take a lot of consumer surplus.[112] Furthermore, as Andrea M. Matwyshyn's recent article, illustrates, there's a strong, reinforcing connection between contract law norms and the law's ability to protect consumer privacy against the interest of sophisticated business actors.[113]

While conceiving contact law as mechanism for distributive justice has fallen out of fashion,[114] there is a tradition of strong

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[111] Dennis D. Hirsch, *The Glass House Effect: Big Data, the New Oil, and the Power of Analogy*, 66 ME. L. REV. 373, 375-76 (2014) (comparing the management of big data to the management of big oil due to the common features of high negative externalities and high market power in both fields).

[112] Michael L. Rustad & Thomas H. Koenig*, Wolves of the World Wide Web: Reforming Social Networks' Contracting Practices*, 49 WAKE FOREST L. REV. 1431, 1436 (2014)(" Based on our statistical findings in Parts I, II, and III, which demonstrate that TOUs are systematically unfair and imbalanced, we propose procedural and substantive reforms in Part IV that will fortify the rights of consumers entering into these adhesive TOUs."); Larry A. DiMatteo & Blake D. Morant, *Contract in Context and Contract As Context*, 45 WAKE FOREST L. REV. 549, 552 (2010); Omer Tene, Jules Polonetsky, *Judged by the Tin Man: Individual Rights in the Age of Big Data*, 11 J. TELECOMM. & HIGH TECH. L. 351, 352-53 (2013)

[113] Andrea M. Matwyshyn, *Privacy, the Hacker Way*, 87 S. CAL. L. REV. 1 (2013)(" It challenges three commonly held misconceptions in privacy literature regarding the relationship between contract and data protection--the propertization fatalism, the economic value fatalism, and the displacement fatalism--and argues in favor of embracing contract law as a way to enhance consumer privacy.").

[114] See Eyal Zamir, *Contract Law and Theory: Three Views of the Cathedral*, 81 U. CHI. L. REV. 2077, 2118 (2014)

works in that vein that would support being critical of a type of contract that systemically allows powerful parties to systematically consume surplus and impose negative externalities on society.[115] However, recently, there has been a reemergence of interest in using other parts of common law as a method to correct for the unjust potential of some powerful parties in society using sophisticated algorithms and big data to extract rents from less sophisticated parties.[116]

It seems that the use of algorithmic contracts could enrich powerful parties and disempower the weak under the guise of "objective" algorithms. To the extent that we don't want the law to do that, and we want to create a fair rules of play that don't effectively take from A to give to B, this justifies government action in the form of law-changing. The good thing about altering contractual interpretation is no command and control legislation is needed here; indeed it would be futile given the fast development of algorithms and their proprietary nature.

Algorithms also do not evolve to changing circumstances in the same way humans do. It may be that the use of algorithms could lead to a functional freezing of today's social hierarchies

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(commenting on the lack of analysis of distributive justice and feminist perspectives in three influential new contracts treatises).

[115] *See e.g.*, *Passing On the Costs of Legal Rules: Efficiency and Distribution in Buyer-Seller Relationships*, 43 STAN. L. REV. 361 (1991); Duncan Kennedy, *Distributive and Paternalist Motives in Contract and Tort Law, with Special Reference to Compulsory Terms and Unequal Bargaining Power*, 41 MD. L. REV. 563 (1982); Richard Craswell, Anthony T. Kronman, *Contract Law and Distributive Justice*, 89 YALE L. J. 472 (1980).

[116] *E.g.*, Irina D. Manta & David S. Olson, *Hello Barbie: First They Will Monitor You, Then They Will Discriminate Against You. Perfectly.*, 67 ALA. L. REV. 135, 179-187 (2015) (arguing that than discouraging the use of restrictive software licenses, the law should adapt to better facilitate such licenses, noting that perfect price discrimination will likely help the poor).

and perceptions in a more neutral-seeming package. Making the aims of algorithms explicit, as part IV's proposal incentivizes.

VI. REFORM FOR ALGORITHMIC CONTRACTS AT LAW

This section will describe an approach to algorithmic contracts at common law, describe ways forward in light of this approach for legislatures, courts, and stakeholders, and suggest some implications of this Article for legal theory.

A. Private Law for Algorithmic Contracts

The previous Part has been negative in nature. It rejected the ability of traditional contract law to address the particular problems presented by algorithmic contracts, and suggested policy reasons why this approach would not be desirable.

This Part will sketch the approaches available at law for algorithmic contracts. Disputes regarding contract law can be handled in contract, restitution, or tort. The suitability of each of these approaches depends on the facts at play. Algorithmic contracts cover a broad space. Notable distinctions include agent versus term algorithmic contracts, and commercial contracts versus consumer contacts.

The policy concern at play in algorithmic contracts is their particular ability to muddy the question of responsibility, and in this way enable some actors to acquire unjust rents through being able to avoid liability for the harms they cause. Furthermore, one party is using an algorithm and the other is not, or if one party has a better algorithm than the other, this enables the advantaged party to withhold more information from the outside than they otherwise would be compelled to in bargaining. This leads to substantial negative externalities for the public. As Robert Cooter and Ariel Porat put it in a recent paper: "When internalization is the legal goal of private law, the appropriate remedy is compensation for harms and disgorgement of benefits. Besides internalization, another goal of private law is to stop injurers from harming others (deter), and more rarely, to spur people to benefit others (encourage).

The law minimally deters a harmful act when the injurer neither gains or loses from acting."[117]

Each of these three approaches for handling algorithmic contracts does a better job at achieving the goals of reducing externalities and preserving fair play in commerce than the status quo of ignoring algorithmic contract as a special category of agreement. They do this while doing justice to the actions and risks assumed by the parties to the agreement. Put another way, this multi-pronged approach to algorithmic contracts allows the law to uphold algorithmic agreements when they are fairly made, but rightfully give relief when they are not. While existing tort law can already address some algorithmic contract disputes, for algorithmic contracts to be handled in contract and restitution, state legislatures, courts, and organizations that advise them on private law such as the American Legal Institute, should update their approach to the law to reflect this view of algorithmic contracts. This modern problem requires renewed interest in and clarification of areas of private law that, up until recently, has been considered arcane.[118]

1.Implied-in-fact contracts

Contract law includes implied-in-fact contracts. Implied-in-fact contracts are those that parties presumably intended as

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[117] Robert Cooter & Ariel Porat, Internalization and Deterrence in the Law of Torts and Restitution, unpublished manuscript, Jan. 6, 2016, *available at* http://www.law.uchicago.edu/files/file/restitution_1-8-16_002_0.pdf.

[118] *See* George S. Geis, *Gift Promises and the Edge of Contract Law*, 2014 U. Ill. L. Rev. 663, 666 (2014) (defining and discussing the "edges" of contract law and their increasing import to shore up the argument that that third-party beneficiary law should receive independent legal significance).

their tacit understanding, as inferred from their conduct and other circumstances.[119]

One potential objection to Part III's analysis is to observe that some of the actions of sophisticated companies in using algorithms may imply the intent to be bound, so there is a contract. The problem with this "objection" is that it is entirely compatible with Part III's analysis. Where this is the case, there will be a valid contract implied-in-fact. Under this standard many business-to-business transactions will be upheld.

Even when taking into account the actions of the parties, it is possible that contracts may be incomplete as to the terms of agreement. Algorithmic contracts are particularly likely to be incomplete. Scholars and courts differ as to how incomplete contracts should be handled. The classic view, and the one that still prevails in the courts, is that such contracts are unenforceable. [120] Several scholars have discussed the significance of acknowledging the reality of incomplete agreements at law.[121]

Specifically, some have found that courts should interpret incomplete contracts in a way that would have the most efficient

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[119] George P. Costigan, Jr., *Implied-in-Fact Contracts and Mutual Assent,* 33 HARV. L. REV. 376 (1920).

[120] Ian Ayres & Robert Gertner, *Filling Gaps in Incomplete Contracts: An Economic Theory of Default Rules*, 99 YALE L.J. 87, 89 (1989) (arguing for default rules that neither party would want in order to encourage parties to reveal information).

[121] Subha Narasimhan, *Of Expectations, Incomplete Contracting, and the Bargain Principle*, 74 CAL. L. REV. 1123, 1130 (1986) ("Under this theory, if the value of the contract at the time of dispute is outside the agreed-upon range, the parties are entitled to their expectations based on that range, leaving an excess to distribute. Next I suggest some possible criteria for allocating that excess. Viewed in this light, the current doctrines of impossibility, mistake, and modification merge into the enforcement question of whether the value of the contract at the time of enforcement is within the range of values assented to.")

consequences in terms of information sharing.[122] The power to modify contracts based on legal objectives arises not in contract, but quasi-contract, more commonly called restitution, which I will discuss in its own right next.

However, even squarely within contract, when considering contracts implied-in-fact, fairness in business dealings should be a factor. There is some consideration of the public interest in every contract. As Bertram Lomfeld put it, "Every contract has an implicit public dimension of reasoning."[123] In algorithmic contracts, when the individual or collective acts of algorithms tend to have a costly effect, the actors that avoided liability need to be disgorged.[124] For repeat players what goes around comes enough may be enough in the many settlements that occur in this space, but for many others adversely effected (pensioners for example), it may be harder to replace the one-time loss if

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[122] *See generally* Lucian A. Bebchuk & Omri Ben-Shahar, *Precontractual Reliance*, 30 J. LEGAL STUD. 423, 452-57 (2001)("Suffice it to observe here that although promissory obligations do not come into being without some voluntary and intentional act such as might be said to manifest an 'act of will' on the part of the promisor, the occurrence of that act is only one of the several facts relevant to the emergence of the necessity which we call obligation, and has no special role in explaining the obligation of the performance promised. The need for a voluntary assumption of duty requires some independent justification. Indeed, recent scholarship suggests that imposing no liability for precontracutal reliance (i.e., reliance before there is a voluntary assumption of a duty) may lead to inefficient outcomes."); Ian Ayres & Robert Gertner, *Filling Gaps in Incomplete Contracts: An Economic Theory of Default Rules*, 99 YALE L.J. 87, (1989) (arguing for default rules that neither party would want in order to encourage parties to reveal information).

[123] Bertram Lomfeld, CONTRACT AS DELIBERATION, LAW & CONTEMP. PROBS., 2013, at 1, 2.

[124] Melvin A. Eisenberg, *The Disgorgement Interest in Contract Law*, 105 MICH. L. REV. 559, xx (2006)

liability is uncertain. Interpretations of areas of contract law subject to special rules could be instructive.[125]

2. Restitution

Restitution is the disgorgement of improperly acquired gains.[126] The type of restitution most relevant to algorithmic

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[125] For example, the law handles form contracts as contracts despite their notable differences from traditional contracts. Randy Barnett has written an influential and persuasive argument as to why this is and should be so. Randy E. Barnett, *Consenting to Form Contracts*, 71 FORDHAM L. REV. 627, 637 (2002) (theorizing the nature of consent in the context of form contract, and arguing for a broad scope for their enforcement, to wit, that applies to all terms in the form except the "radically unexpected").
The concerns about the form contracts advantaging one party are handled in the interpretation to which form contracts are subject. There is broad agreement on the point that form contracts should not be enforced as written because of how they were formed. I argue that, similarly, the algorithmic contracts should be handled in law and society as contract, but a type of one that should be interpreted with reference to the context in which the algorithmic contracts were made, that is, with consideration of objectively manifested evidence of the intent of the parties to the contract with respect to the terms of the contract that involved algorithmic agents. Put another way, how algorithmic contracts are interpreted should correct the limitations in their formation. This way, the law does not have to wholly disregard the actions and intent of the private parties in contract.

[126] Restitution is also sometimes called unjust enrichment. Eric J. Konopka, *Hey, That's Cheating! The Misuse of the Irreparable Injury Rule As A Shortcut to Preclude Unjust-Enrichment Claims*, 114 COLUM. L. REV. 2045, 2047-48 (2014)

contracts is implied-in-law contracts, or quasi-contracts. These contracts interpret contracts in such a way as to prevent unjust enrichment, regardless of the real intentions of the parties.[127] Restitution should play an important role in the enforcement of algorithmic contracts. Contract law and restitution are so closely linked that Joseph Perillo has argued that quasi-contract restitution actions of the should be considered as part of contract law given their shared goals.[128]

What factors might courts take into account when implying a contract in law? The policy considerations from Part III that lent themselves to holding algorithmic contracts to a higher level of scrutiny for enforcement than traditional contracts could prove instructive. Considerations may include transparent dealing incentives, reducing uncertainty, creating a repository of responsibility in the face of a harm, and social welfare.

Restitution should be a particularly important action in the case of algorithmic contracts because the value of the ability to acquire information and deal on the basis of that without disclosing one's position may well be more valuable than the loss to the person whose information is acquired and the resultant agreement. An example of such a case is the disgorgement of rents associated with data security or information privacy.

3. Torts

Torts are the inverse of restitution, and provide for compensation for wrongs by another. Naturally, negligence is a

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(an introduction to unjust enrichment, noting its influence has flagged due to widespread misunderstanding of the action, and arguing for a resurgence in its use where appropriate).

[127] FREDERIC CAMPBELL WOODWARD, THE LAW OF QUASI CONTRACTS § 1, at 1–2 (1913).

[128] Joseph M. Perillo, *Restitution in A Contractual Context*, 73 COLUM. L. REV. 1208, 1210-11 (1973).

cause of action where applicable, but the specific type of tort that is most relevant to algorithmic contracts is promissory estoppel, an action seeking compensation for harm arising from detrimental reliance.

The dividing line between contract and tort is not as bright as first year contract and tort law classes make it appear. Promissory estoppel, particularly calls the division into question.[129] Promissory estoppel implicates similar issues as the above two methods, except the focus is on the harm to the plaintiff as opposed to the gain to the defendant, as in restitution, or what behaviors suggest was objectively agreed to, as in implied-in-fact contracts. Furthermore, the role of promissory estoppel is protecting reliance on a promise, which amounted to a representation of future intentions rather than one of existing fact.[130] Where the facts lend themselves particularly strongly to this interpretation for plaintiffs, such as when a plaintiff has lost more than the defendant gained, this cause of action could be useful.

B. Ways forward for Stakeholders

The law and policy changes should follow from the forgoing analysis are as follows. Common law courts should begin handling the case in line with one or both of the theories I described for how algorithmic contracts should be handled at law. State legislatures should adopt statutes that compel courts to evaluate algorithmic contracts in this manner. To facilitate winning in causes of action involving algorithmic contracts (and

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[129] Mark P. Gergen, *Negligent Misrepresentation As Contract*, 101 CAL. L. REV. 953, 953-54 (2013) (arguing that negligent misrepresentation is a part of contract, rather than tort due to its resemblance to promissory estoppel).

[130] Charles Calleros, *Cause, Consideration, Promissory Estoppel, and Promises Under Deed: What Our Students Should Know About Enforcement of Promises in A Historical and International Context*, 13 CHI.-KENT J. INT'L & COMP. L. 83, 102 (2013)

in negotiations outside of court), businesses should make their objectives in their use of algorithms as agents or terms clear in a discoverable paper trail.

Creating a legal incentive for companies to make sure that they make their intentions for use of an algorithm clear would add another barrier to companies harming high risk populations without a paper trail showing intent.[131]

One way to hasten this project would be incorporating this proposal in an American Law Institute restatement of law and model legislation. This proposal is germane to the ongoing process of updating the restatement of contract law for consumer contracts and updating the Universal Commercial Code.[132]

C. Implications for contract law and scholarship

This paper proposes that algorithmic contracts are contracts, but are subject to different formational and interpretative standards from traditional contracts. Algorithmic contracts play a large and growing role in our economy. Several other areas of contract law are subject to their own tailored rules, including insurance contracts, landlord-tenant contracts, real estate contracts, and more. Form contracts, another special category,

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[131] Danielle Keats Citron & Frank Pasquale note the same problem but consider constitutional due process as a potential solution. Danielle Keats Citron & Frank Pasquale, *The Scored Society: Due Process for Automated Predictions*, 89 WASH. L. REV. 1 (2014).

[132] CONSUMER CONTRACTS, AMERICAN LAW INSTITUTE, https://www.ali.org/projects/show/consumer-contracts/ (last visited Jan. 30, 2016); UNIFORM COMMERCIAL CODE, AMERICAN LAW INSTITUTE, https://www.ali.org/publications/show/uniform-commercial-code/ (last visited Jan. 30, 2016).

make up about ninety-nine percent of contracts made in the United States.[133]

Algorithmic contracts add to the chorus of inconvenient empirical evidence against the traditional theoretical account of contract law. It may give support to less traditional theories of contract, such contract as grounded in trust and reliance. It also may provide another argument for contract law to take into account the increasing amount of empirical research calling into question many of the theoretical underpinnings of the traditional account of contract law. Algorithmic contracts are a call to action for contract theorists: how do we create a theory of contract that incorporates the contracts of the future, rather than forcing it to be sidelined to an atypical case of contract, as the scope of traditional contract gets ever-smaller and less relevant to social and business practices?[134]

This Article has focused on private law as a method of contending with technological change. Notably, the role of areas of private law that up until recently have thought of as somewhat marginal, have been coming to the fore in scholarship and case law as a way to solve problems.[135] Scholars should examine why that may be the case, and whether doctrine and legislation should embrace more expansive and flexible methods

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[133] *See* W. David Slawson, *Standard Form Contracts and Democratic Control of Lawmaking Power*, 84 HARV. L. REV 529, 529 (1971); Robert A. Hillman and Jeffrey J. Rachlinski, *Standard-Form Contracting in the Electronic Age*, 77 NYU L. REV. 429, 431 (2002); Russell Korobkin, *Bounded Rationality, Standard Form Contracts, and Unconscionability*, 70 U. CHI .L REV. 1203, 1203-04 (2003).

[134] Eyal Zamir, *Contract Law and Theory: Three Views of the Cathedral*, 81 U. CHI. L. REV. 2077, 2122-23 (2014) (noting with skepticism the "traditionalist inclination of contracts scholarship).

[135] *See e.g.*, Lauren Henry Scholz, *Privacy as Quasi-Property*, 01 IOWA L. REV. 1113 (2016); George S. Geis, *Gift Promises and the Edge of Contract Law*, 2014 U. ILL. L. REV. 663, 666 (2014); Caprice L. Roberts, *The Restitution Revival and the Ghosts of Equity*, 68 WASH. & LEE L. REV. 1027 (2011).

in order to free itself to conform to technology and social trends in a changing world.

VI. CONCLUSION

Algorithms have important implications for how individuals bind themselves in contracts. And because algorithmic contracts will increasingly become the norm for business-to-business and business-to-consumer transactions it is important to think about where and how law can and should come into play when thinking about how algorithms are used on the ground, and making appropriate distinctions between what type of algorithms are used and for what purpose. This article contends that courts should relax formational requirements to permit algorithmic contracts to be recognized at law, but relax the parole evidence requirement for terms that were determined by algorithm. This allows courts to determine if the algorithmic decision-making coincided with the objective intent to be bound by the parties. The legal context in which algorithms work is as significant a part of the environment as any other factor, and one that individuals working on algorithms should be thinking about during the development of algorithms, not after the fact. The legal framework proposed by this paper offers incentives for relevant actors to make decisions that clarify responsibility and ensure that contracts are enforced in a way that reflects human valuations and intent.