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Automating Contract Law

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The study of contract law is undergoing a difficult transition as it moves from the theoretical to the empirical. The past few decades have focused largely on developing economic theories that offer a normative approach for setting the legal rules governing voluntary exchange. The time has now come to test whether these theories provide a meaningful basis for choosing our laws—and the only real way to do this is to ask whether empirical data supports the theoretical models posited by contracts scholars. Unfortunately, however, this type of empirical analysis has proven exceptionally difficult to conduct—and some commentators are beginning to question whether it will ever be possible to test and revise our economic theories of contract in a meaningful manner. Yet the problem of harnessing information to support complex decisions is not exclusive to those studying contract law. This Essay explores the possibility that recent technological developments from the field of organizational knowledge management—including advances in meaning based computing algorithms—will soon make it easier to conduct empirical work in contract law on a much larger scale.

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INTRODUCTION

Early one morning in 1958, Herbert Simon announced to his class of graduate students at Carnegie Mellon that “over Christmas, Al Newell and I invented a thinking machine.”1 His claim was a bit premature, but Simon did win the Nobel Prize in Economics twenty years later—not for creating a sentient computer, but rather for his “pioneering research into the decision-making processes within economic organizations.”2 Simon’s main contention was that all decisions had to be made under uncertainty because it was impossible to gather and process every bit of information that mattered.

But, importantly, Simon did not just throw up his hands and suggest that decision-makers should abandon the collection of information and resort to, say, flipping a coin—or some other arbitrary method for deciding. He concentrated, instead, on techniques that might improve our ability to muster information for complex decisions—perhaps by searching for patterns or organizational structures to manage data overload. Thus Simon famously studied master chess players to determine that they could keep about 50,000 “chunks” of information on chess positions in their mind and draw on these chunks to plan their moves.3 Or he told stories about the

3 Herbert A. Simon & K.J. Gilmartin, A Simulation of Memory for Chess Positions, 5
ability of master watchmakers to produce more watches by dividing up
tasks into modular subassemblies instead of trying to put a complete watch
together in one go.4

The concepts of “chunking up” information or modularizing
complicated systems are helpful frames, but ultimately Simon became
fascinated with the use of technology and computer simulation in complex
decisions—and in their potential for organizing information beyond the
human capacity. Simon was a polymath, and his interests were diverse—
spanning theories of artificial intelligence,5 the social implications of
computing,6 and philosophical problems in epistemology and intelligence.7
Yet, in all of these areas, Simon did have a unifying quest: the possibility
that our ability to process information might be augmented through
computing.

The design of contract law is similar to the boardrooms and chessboards
studied by Simon in that it also raises difficult and complex tradeoffs.8 And
just as the actors in those endeavors seek data to reduce uncertainty and
guide their choices, there has been a strong push by scholars toward
empiricism as a basis for selecting the rules to govern our agreements,
promises, and contractual bargains.9 This trend is not confined to contract
law of course; tangible data is sought to evaluate theories across the entire
realm of legal scholarship.10 But my interest in this Essay relates to the rules

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COGNITIVE PSYCHOL. 29 (1973).

Henry Smith recounts this story in more detail and relates it to contract design. Henry E.
Smith, Modularity in Contracts: Boilerplate and Information Flow, 104 MICH. L. REV.

5 SIMON, supra note 4. See also Byron Spice, Obituary, Herbert A. Simon / Father of
Artificial Intelligence and Nobel Prize Winner, PITTSBURG POST-GAZETTE, Feb. 10,

6 Herbert A. Simon, Prometheus or Pandora: The Influence of Automation on Society,

7 HERBERT A. SIMON, THE COMPUTER AS A LABORATORY FOR

8 See, e.g., Richard Craswell, In That Case, What is the Question? Economics and the
extremely difficult with lots of effects that we do not yet understand”); Smith, supra note 4
(describing contractual complexity and the use of modular design as a tool for simplifying
information interactions).

9 See, e.g., Ian Ayres, Valuing Modern Contract Scholarship, 112 YALE L.J. 881, 900
(2003); Russell Korobkin, Empirical Scholarship in Contract Law: Possibilities and
Pitfalls, 2002 U. ILL. L. REV. 1033; David V. Snyder, Go Out and Look: The Challenge

10 Over the last decade a wide range of legal scholars have cried out for more empirical
analysis. See RICHARD A. POSNER, OVERCOMING LAW 210-11 (1995); Lee Epstein & Gary
King, The Rules of Inference, 69 U. CHI. L. REV. 1, 2 (2002); Michael Heise, The
governing promise and exchange, and I will focus the discussion on contract.

Unfortunately, there are some real challenges in the use of empirical data to engineer the springs and wheels of contract law. It takes a long time to do this work, and anyone studying the written opinions of judges or the executed agreements of private parties must necessarily limit her sample size. This also makes it difficult to repeat or update the studies. Even more troubling are recent assertions that our theoretical models have grown so complex that the needed empirical information simply cannot be collected or processed in a meaningful manner. Eric Posner, for example, has argued that while we could “make complex and interesting predictions about contract law if we had sufficient information about empirical conditions … it is … unlikely that we ever [will].” And the fact remains: most everyone is eager to see an empirical revolution, but the volume of work that has

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11 In this Essay, I use the term empirical to refer to both qualitative and quantitative analysis—although some commentators seem to focus mostly on a lack of quantitative work. For more on the distinction here, see Epstein & King, supra note 10, at 2-3; Snyder, supra note 9, at 1012.

12 See Korobkin, supra note 9, at 1051-52 (“None of the empirical contracts articles reviewed in this study present data that makes up a truly representative sample of the population, (i.e., contracting parties or contract disputes generally) about which the author would like to suggest implications. Consequently, critics will usually be able to raise legitimate questions about the extent to which descriptive conclusions or policy prescriptions can be inferred from empirical results.”).


14 For a few representative comments along these lines, see Ayres, supra note 9, at 900 (“welcoming and predicting a shift from the theoretical to the empirical”); Russell Korobkin, Possibility and Plausibility in Law and Economics, 32 FL. ST. U. L. REV. 781, 785 (2005) (“I certainly support the widespread drumbeat for legal scholars to conduct more empirical analysis than our corner of the academy has produced historically.”); Snyder, supra note 9, at 1009 (“The opportune scholarly moment has arrived for empirical scholarship in contract law.”).
actually emerged in this area is surprisingly low.\footnote{See Korobkin, supra note 9, at 1036-37 (reviewing the volume of empirical contracts scholarship in 500 law journals from 1985 to 2000 and deeming “the empirical study of contract law … a very underdeveloped genre of legal scholarship”); Ulen, supra note 10, at 896-97; Russell J. Weintraub, A Survey of Contract Practice and Policy, 1992 WIS. L. REV. 1, 4 (“Despite this need for data, however, to date there have been only a handful of empirical studies focusing on particular contract problems and relationships . . . ”).}

Of course, as Simon’s work suggests, the problem of harnessing information to support complex decisions is not exclusive to those studying contract law. In the corporate world, an entire market has emerged around building knowledge management technology to help organizations deal with vast volumes of unstructured information.\footnote{For a collection of introductory articles related to knowledge management, see PETER DRUCKER ET AL., HARVARD BUSINESS REVIEW ON KNOWLEDGE MANAGEMENT (1999). For a more comprehensive synthesis of work in this area, see KIMIZ DALKIR, KNOWLEDGE MANAGEMENT IN THEORY AND PRACTICE (2005).} Some of these tools are as straightforward as more powerful databases, better search engines, or systematic processes for getting the right information in front of researchers and decision-makers. But there have been some intriguing recent developments in this field involving the use of computer algorithms that couple information theory with statistics. This is leading to more powerful systems for managing text, voice, and video information—and these methods are already being used with some success by large corporations, government security agencies, and others.\footnote{See infra Part II.} It is unfortunate that Simon died in 2001, for he would have been intrigued by the technological progress of the last six years.

This Essay explores the possibility that innovation in organizational knowledge management may soon make it easier to conduct meaningful empirical work in contract law on a much larger scale. I believe that contract law is especially well suited to take advantage of these recent developments for two reasons. First, the very choices that parties make in their formation of contracts often leave a data trail.\footnote{I say often because some contracts, such as implied-in-fact contracts or quasi-contracts, leave little permanent record. And it may be hard to assemble historical data for some types of contracts, such as verbal agreements. It is worth noting, however, that the knowledge management algorithms described in this Essay are successfully being used on voice recordings.} The principals typically record the terms of their agreement in a way that is less likely to happen with, say, tort or criminal law. Second, we are finally reaching a point where large repositories of centralized data are being amassed—including historically executed contracts, litigated case law, and other relevant sources. Each of these digital information troves might conceivably
be tapped and studied more systematically. In short, contract is unique because parties have the power to craft their own customized law, and in the very process of doing so they often leave behind data on their intentions.

My primary claim is that meaningful empirical work in contract law can, and soon will, be conducted using cutting edge knowledge management technology. Furthermore, much of this work can be automated in a way that allows constant updating and refreshing of the empirical studies. I want to remain cautious here because contract law is complex, and certainly I am not suggesting that we will reach uncontested results that allow us to make law without subjective judgment. But there are some intriguing possibilities, and it is worth discussing how the tools used by organizations to manage unstructured information can assist scholarly inquiry into the incentives and effects of contract law.

I have divided the Essay into four main parts. Part I briefly reviews the current state of contract law scholarship, with a focus on economic analysis and the thirst for empirical data. Part II turns to recent technological advances in organizational knowledge management, such as algorithms that blend information theory and statistical methods to process and synthesize unstructured information. Part III continues by illustrating some possible applications of this technology to empirical contract law research—including descriptive analysis, normative analysis, and predictive modeling. Part IV acknowledges some challenges and limits of this work, and a brief conclusion summarizes the Essay’s claims.

I. EMPIRICISM AND THE DESIGN OF CONTRACT LAW

Much of the scholarly work in contract law over the past few decades has focused on developing economic theories that offer a normative approach for setting the legal rules governing binding promises. The literature in this area is well-known and vast, and I will not try to review it here. Although the economic framework is not the only way to understand

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20 Some of this work also offers a descriptive understanding of contract laws, but more recent emphasis has been on the normative (either explicitly or implicitly). See Craswell, supra note 8, at 900-07.
21 For helpful discussions of economic analysis in contract law, see the relevant sections in ENCYCLOPEDIA OF LAW AND ECONOMICS (Boudewijn Bouckaert & Gerrit De Geest eds., 2000); ROBERT COOTER & THOMAS ULEN, LAW AND ECONOMICS, chs. 6-7 (2000); RICHARD A. POSNER, ECONOMIC ANALYSIS OF THE LAW, ch. 4 (2003); Benjamin E. Hermalin et al., The Law and Economics of Contracts, in THE HANDBOOK OF LAW AND ECONOMICS (A.M. POLINSKY & STEVEN SHAVELL eds.).
contract law, economics is powerful because it can conceivably provide lawmakers with a principled basis for preferring one rule over another.  

The standard way to conduct this analysis is to model a project where there are potential benefits for both buyer and seller. In other words, the buyer’s valuation exceeds the seller’s cost of production in at least some future states of the world. There may also be relationship-specific investments that can be made at a future time by one or both parties to increase the gains from trade. An economic model is then set up to consider various contingencies and contract terms—and to explore how, and whether, the parties will trade and invest under different legal default rules. Ultimately, the author may suggest that a particular rule is economically superior to the alternatives under the theoretical framework that is offered or under the assumptions used in the model.

For example, Judge Richard Posner recently considered how economic analysis might aid courts in the task of contract interpretation. He starts by stating an objective function for our legal system: “to minimize contractual transaction costs, broadly understood as obstacles to voluntary efforts to shift resources to their most valuable use.” Posner then goes on to model a cost function for contract formation, which includes initial efforts to draft an agreement, the probability that litigation over an ambiguous or missing term will ensue, the costs of litigation, and the costs of judicial error (broadly defined). After further analysis, he concludes that a formalist approach to contract interpretation, requiring that parties “do whatever is necessary” to avoid ambiguity, is inefficient because it will lead to excessive up-front drafting costs. Moreover, Posner’s economic analysis informs the appropriate use of the indefiniteness doctrine (which is sometimes used to invalidate half-baked agreements). Similar use of economic theories and models to advance normative claims permeates the contracts literature.

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23 This step provides additional justification for legal enforcement of time-deferred commitments in order to counter post-reliance opportunism by the other party. See Schwartz & Scott, supra note 22, at 559-62.
24 Economic superiority is usually defined in terms of welfare maximization through Pareto efficiency. Posner, supra note 13, at 832-34 & n.8.
26 Id. at 1583.
27 Id. at 1583-84.
28 Posner does not explicitly say this, but a natural extension of his work might contend that courts should enforce vague contracts only when parties make efficient tradeoffs between the various costs of contract formation.
29 Much of this work deals with economic analysis of contract remedies. See, e.g.,
The challenge, of course, is to determine whether these economic models are accurate reflections—or at least partial reflections—of the way that the world really works. Are the variables complete enough? Are all incentives identified? Are the assumptions reasonable? And so on. In other words, while economic analysis offers a powerful theoretical basis for evaluating contract law, it must be tested in due course to determine whether normative assertions comport with real world observations—and thereby provide a meaningful basis for making choices about our laws.

In field after field of the social sciences, scholars have been able to make intellectual progress by creating, testing, revising, and retesting their theories in this manner. Many academic commentators believe the time has now come to follow the same path in contract law. Professor Thomas Ulen has nicely captured this sentiment: “The newer theorizing in law tends to make predictions about the real world consequences of legal rules and standards … ultimately, their worth turns on the extent to which they are borne out by careful empirical and experimental work.”

And this cry is taken up by other scholars, who eagerly herald the promise of a new wave of empirical analysis in contract law.

Yet I think it is fair to describe this work as underdeveloped. Professor Russell Korobkin surveyed the literature a few years back and found “a surprising dearth of empirical research in contract law scholarship.” To be sure, his analysis focuses on quantitative empirical work and excludes the large body of doctrinal analysis that might also be considered empirical. And there is a growing collection of work, often conducted outside the legal academy, that empirically studies executed contracts. This work typically examines how parties structure their agreements when the law is taken as a given, however, and focuses less on empirical analysis as a basis for deciding what the law should be.

While it is an important question, I do not want to spend too much time


31 See sources cited supra note 14.

32 Korobkin, supra note 9, at 1061.

33 Id. at 1035.

asking why there has not been more empirical work in contract law. Plenty of other thoughtful articles explore the challenges—which include the need for training in statistics and quantitative methods; time delays arising from data collection or from painstaking efforts to code and analyze this data; and other institutional and logistical factors.35

Seizing upon the slow rate of progress in this area, Professor Eric Posner raises another pessimistic thought: maybe this type of work just can’t be done. In a provocative and widely read essay in the Yale Law Journal, Posner argues that the empirical data needed to assess economic theories of contract law are unlikely to be available.36 And even if it is possible to get this information, he contends that it will be difficult to sum up the various effects into probabilistic choice models that might coherently suggest whether one legal rule is superior to another.37 Ultimately, Posner claims that these problems render economic models of contract law indeterminate—a damning accusation.

I agree with Posner that this work is taxing—and that it can be difficult to gather and aggregate the information necessary to reach sound conclusions about contract law.38 But I am concerned here with a different problem, one that has received less treatment in the contract law literature: there is an extraordinary amount of data out there on the collective choices that we make in our contractual trades. As the volume of information grows, it is becoming harder to whittle the noise down to what really matters. In a sense, Posner is concerned that there is too little empirical data; I am concerned that there is—or soon will be—too much of it.39

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35 See sources cited supra note 10.
36 See Posner, supra note 13, at 837 (“[T]he relevant variables are too complex and too hard to determine. We do not observe doctrine incorporating them, nor do we have enough empirical data to be able to guess which rule is based on assumptions that are closer to reality.”).
37 Richard Craswell nicely synthesizes Posner’s concerns as follows: “[W]e cannot decide which remedy is “best” in any overall sense . . . unless we have some way of measuring the relevant effects, both good and bad, and then summing them to come up with a combined score for each of the possible remedies. But if we lack empirical data to measure the magnitudes of the various effects, any such sum will be difficult—or even impossible—to construct, so we will never know which remedy is truly the most efficient. Craswell, supra note 8, at 908.
38 I have tried to conduct some of it myself and have had to qualify most of the conclusions because certain variables are grounded in assumptions. See George S. Geis, Empirically Assessing Hadley v. Baxendale, 32 FL. ST. U. L. REV. 897 (2005) [hereinafter Geis, Empirically Assessing Hadley]; George S. Geis, An Experiment in the Optimal Precision of Contract Default Rules, 80 TUL. L. REV. 1109 (2006) [hereinafter Geis, Optimal Precision].
39 And I think both of us would agree that the real problem is obtaining relevant data that can be brought to bear on economic models of contract law.
Of course, fears that decision-makers might drown in a sea of information overload are not new. Limits on human cognitive ability to absorb information have led to interesting experiments in bounded rationality, 40 and behavioral decision theorists take up this notion to argue that we are forced to resort to “mental shortcuts” in our decisions. 41 Problems of information overload also get some play in the popular press. 42 Much of the emphasis here is on consumers and how too much information—often in the form of mandated regulatory disclosures—can actually backfire and doom decision-makers to less meaningful choices, or even to decision paralysis.43

I am skeptical of this “freezing-up” phenomenon. 44 But I do worry about the ability of organizational decision-makers—including lawmakers tasked to choose rules for governing contract law—to make the best use of all the information that is out there. There are an awful lot of economic theories about contract law and millions of contracts that might be examined to measure the impact of our laws. Similarly, as the volume of published legal opinions grows exponentially, we might ask whether it is still possible to determine how courts are really applying a given rule in contract law.

Fortunately, the challenge of managing unstructured information arises in many different contexts, and some well-funded organizations have profit motives for inventing sophisticated tools to aid in the pursuit of sound

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40 For some helpful collections of this work, see DANIEL KAHNEMAN & AMOS TVERSKY, CHOICES, VALUES AND FRAMES (2000); JONATHAN BARON, THINKING AND DECIDING (2000).
42 E.g., BARRY SCHWARTZ, THE PARADOX OF CHOICE: WHY MORE IS LESS (2004) (bemoaning, among other things, the modern-day stress of choosing a pair of jeans at the Gap—“I just want regular jeans, you know the kind that used to be the only kind.”).
43 See, e.g., Naresh K. Malhotra, Reflections on the Information Overload Paradigm in Consumer Decision Making, 10 J. CONSUMER RES. 436 (1984) (“[L]imited processing capacity can become cognitively overloaded if [consumers] attempt to process ‘too much’ information in a limited time, and this can result in confusion, cognitive strain, and other dysfunctional consequences.”).
decisions. It is therefore worth asking whether some of the recent innovations in organizational knowledge management might also be helpful for studying and testing our theories of contract law.

II. RECENT TECHNOLOGICAL ADVANCES IN KNOWLEDGE MANAGEMENT

We live in an uncertain world, and every day we are bombarded with information related to our decisions. Some of this information is structured—that is, placed in a database or other format that can be readily defined, accessed, and manipulated at an atomic level. But, more and more, we must wade through unstructured information: the management memo from last month, the video news clip from Tuesday night, this morning’s phone call, or the collection of emails lingering in our inbox.

By gathering, processing, and synthesizing this information—both structured and unstructured—we can conceivably make better decisions by reducing uncertainty and risk to a collection of probabilistic assessments. Difficult questions cannot be answered with mathematical certainty, of course, and there will always be a need for social context, subjective judgment, and intuition. But the disciplined tools of decision analysis—and their focus on identifying relevant variables and gathering the empirical facts necessary to attach probabilities and payoffs to these variables—can help us seek sound results.45 Furthermore, the last five years have led to some remarkable innovation in knowledge management technology. This Part considers how these new tools are changing the way that decision-makers can harness unstructured information.

A. The Challenge Presented by Unstructured Information

We have been using technology for a long time now to organize and process structured information—that is, database fields or tabular data that can be manipulated in a predetermined manner. This is the type of information accepted by ancient punched card computers, with each punched-out chad corresponding to a predefined data format. Similarly, address fields in a contact management program, or billing records in a firm’s financial software, are good examples of structured data. Both

45 The use of probability theory to make choices under uncertainty dates back, at least, to Pascal’s expositions on whether to believe in God. See BLAISE PASCAL, PENSEES (1670) (the expected payoff from God’s existence is so large, that one is better off believing in God even if the probability of his existence is actually quite small). For helpful overviews of more recent work in the area, see PAUL GOODWIN & GEORGE WRIGHT, DECISION ANALYSIS FOR MANAGEMENT JUDGEMENT (2004); HOWARD RAIFFA, DECISION ANALYSIS: INTRODUCTORY READINGS ON CHOICE UNDER UNCERTAINTY (1997).
contain singularly defined fields specifying an enforced composition of relationships—and these data fields can easily be manipulated to print mailing labels or compile financial reports.

But as we empower computers to handle richer forms of content, more and more of our information is becoming unstructured. This might include free form text with no data type definition, such as an email or a memo drafted in a word processing software. This Essay itself is another example of unstructured—perhaps very unstructured—information. And digitized voice and video are still other forms of unstructured information.46

The proliferation of unstructured information is not necessarily a bad thing; we enjoy using this richer content. But it does make life more difficult for organizational decision-makers who want to draw upon this data to reduce uncertainty and risk. A string of old emails, for example, is harder to process and synthesize than a financial database. A collection of research papers scattered throughout remote corporate outposts is hard to incorporate into new product design decisions. There are various ways to finesse the problem, such as tagging unstructured data elements with keywords or other descriptive features in an attempt to “force” the data into more structured formats. But these classification schemes present some obvious concerns because they may misclassify data or exclude important information.47

In response to these challenges, researchers are developing new algorithms—using blends of information theory, statistical inference, and other ideas—to provide decision-makers with better tools for taming unstructured information. This field is a close cousin to Internet search, which also faces the daunting task of organizing and categorizing unstructured information (although the two disciplines can be distinguished). It is helpful background, therefore, to briefly consider how Web search algorithms have evolved over the past fifteen years.

B. Search Versus Knowledge Management

As the rapid expansion of the Internet in the mid 1990s led to an exponential increase in unstructured information, a real need was raised for search engines to navigate this universe of data. Early products were crude, focusing on webpage titles or URLs for content-based classification and

47 See infra Part II.C.2.
retrieval. But next generation search engines were able to improve results by using web crawlers to scan the entire text of a webpage and score the document on various keyword relevance metrics. This worked well for a while, but spammers soon started to sabotage these search engines by embedding unrelated words throughout their pages.

Search engines grew more sophisticated, in response, and they began to rely on webpage links and cross-references in order to increase accuracy and relevance. Lycos, a popular search engine from about 1995 to 1998, analyzed the anchor text around a webpage’s outbound links in order to determine that referring page’s content. For example, if I publish a website with the phrase “here is a terrific academic article discussing contract law:” next to a hyperlink, then Lycos might use that information to infer that my site deals with contract law scholarship.

Google’s celebrated PageRank algorithm took this concept one step further by looking to linking sites—instead of just scanning the internal contents of a page—as a way to retrieve meaningful results. In a nutshell, Google crawls the web to determine how many other sites link to a given webpage. Furthermore, not all links are created equal: Google has devised a mathematical formula for weighing the importance of each linking site—based, in turn, on the number of links attached to that site. Each webpage

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49 AltaVista and Excite were two pioneers in this type of search technology. Notably, Excite conducted statistical analysis of word relationships to evaluate a Webpage’s underlying concepts. Id. at 45-46, 55.
50 As search expert John Battelle describes, “spammers … could capture traffic for high-traffic keywords like ‘cars’ by hiding those keywords all over their sites (often in small white letters on a white background, for example).” Id. at 104.
51 Id. at 53-54.
53 Brin & Page, supra note 52; BATTELLE, supra note 48. This is a slight simplification of the PageRank algorithm, but the main focus is on the number and quality of inbound links. For example, after setting up a webpage, I might wonder, “How many people link to my site?” Before Google, there was no way to know the answer. But with access to Google’s internal data, I could now find out—because Google has crawled the entire web to determine who is linking to every site. Furthermore, Google will assign weights to the linking sites based, again, on the number of links coming in to that site. So my high school friend’s website linking to my site might get a low hypothetical score of 10 (no one links to him), my home city newspaper linking to my site might garner a score of 1000, and the U.S. Supreme Court linking to my site might earn an additional score of 10,000. My total score could then be compared against all other sites dealing with, say, contract law, and the results would be served up in order (after any paid search ads) to an
can then be assigned a ranking score for keywords in Google’s index, and this whole exercise has famously produced highly relevant search results.54

The ability to search and classify a linked system of information, like the relation of one website to another, is useful for knowledge management.55 And organizations are successfully adapting web search technologies to manage information in a closed organizational system.56 But unstructured information often stands alone, independent from a web of interlinking documents like the Internet. The broader field of knowledge management seeks to organize and muster both discrete and linked information in an effort to improve organizational decisions.

And one of the most recent innovations in knowledge management involves meaning based computing. The general idea here is to organize unstructured information in a way that does not depend on keyword tagging, anchor-text references, or linking citations. In other words, meaning based computing goes beyond most search algorithms in that it tries to estimate—I won’t say understand—what the information actually means. How is this possible? Let me turn to the theories underlying meaning based computing.

54 Of course, it has also produced a cottage industry focused on farming links and using other methods to boost a site’s PageRank score, one reason why Google constantly updates its algorithms to exclude certain parts of the Internet.

55 And, as an aside, there is a very interesting research (and perhaps business) opportunity involving the “Googleization” of all U.S. published court opinions and legal scholarship. As discussed above, Google’s PageRank algorithm relies on linked citations—and on the differing importance of the citing source—to return the most relevant pages for a given keyword. Intriguingly, this is the exact same format used in our case law: court opinions cite (or link) to one another to support their claims, and the linking opinions are then, in turn, cited with differing frequency in support of various legal doctrines. Thus, it should be possible to create a program that crawled the entire digital collection of published court opinions and used Google’s algorithm to calculate a “CaseRank” for each case. This would allow scholars, practicing lawyers, or other researchers to type in search keywords and presumably retrieve the most relevant cases on point (although the accuracy of the search results is an empirical question that would need to be tested). I will return to some similar ideas infra Part III.A, but Googleization is different because relies on the networked web of legal citations—instead of on the use of meaning based computing to “understand” and cluster court opinions. Either approach is likely to be better than our current, awkward framework for legal research.

56 For example, Google offers a corporate appliance where its search technology can query and retrieve organizational information from multiple business applications. See The Google Search Appliance, http://www.google.com/enterprise/gsa/#utm_medium=et&utm_source=bizsols&utm_campaign=gsa .
C. Meaning Based Computing Algorithms

1. Theoretical Underpinnings

Many path-breaking firms are working to create technology that can help organizations manage unstructured information. The primary goals involve forming contextual understandings of the key ideas contained in a given unit of communication—and relating disparate units of information to each other in an effort to uncloak important data and improve decisions. The complex algorithms in this field draw upon ideas from linguistics, information theory, statistics, and other disciplines. But two of the most important concepts are Shannon’s Information Theory and Bayesian inference.

a. Shannon’s Information Theory

In 1948, Claude Shannon, a mathematician in AT&T’s Bell Labs, wrote an important paper on the efficient communication of information. His main contention is counterintuitive because it equates information with disorder. But this work forms a foundation for the field of information theory, and it has been used to analyze topics as diverse as psychology, philosophy, biology, physics, and economics.

The easiest way to understand Shannon’s ideas is to consider his diagram of the essential elements in a communication system (portrayed in

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Figure 1). Any communication stream might be broken down into four main steps: the information source, the transmitter (encoding and dispatching the information along a channel of communication), the receiver (obtaining and decoding), and the destination. Along the way, there might also be a noise source that threatens to corrupt the signal carrying the information.

Figure 1. Elementary Communication System

Working within this model, the challenge for Shannon was to encode information in a manner that could be communicated accurately and efficiently—meaning that a message might still get through when noise alters the signal. Certainly a great deal of information is redundant. We can get the gist of a newspaper article by skimming a few sentences. Students can keep up with a law school class without hanging on the professor’s every word. More generally, Shannon wondered whether certain units of communication could be quantified as more important than others for conveying meaning. The surprising answer: the most disordered, or unexpected, term will often denote the most meaning.

Suppose, for example, you are standing in the middle of a room at a noisy cocktail party trying to decide which of several conversations sounds like the most interesting one to join. The room is buzzing, and you can only hear snippets of three different conversation circles:

“Yesterday ... Iraq ... disheartening”
“Believe ... NASDAQ ... lately”

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61 This channel might involve a phone line, but it could also refer to letters on a piece of paper, laser signals in an optical network, or any other medium for sending a message. The term communication unit is used broadly to refer to text, voice, video, fingerprints, or other encoded symbols of meaning.
62 For further discussion of this insight, see Durham, supra note 59, at 73-92.
With these fairly limited—and distorted—units of communication, you can still probably get a decent sense of the conversation topic in each group. Sure, you don’t know exactly what they are talking about—does the second speaker, for example, believe that the stock market will rise or fall? But even though noise tattoos the full communication, you can quickly orient yourself towards a discussion on politics, business, or sports.

Furthermore, within these snippets of conversation, a few words seem to convey more meaning than others. The words Iraq, NASDAQ, and Super Bowl each present strong clues. According to Shannon, this is true because infrequently occurring words convey greater meaning than common ones. His work goes on to provide a basis for quantifying the level of meaning provided by a given unit of communication.

So how does this idea help programmers write knowledge management algorithms? Essentially—and without getting into more complicated mathematical details—they can weigh rarer words more heavily when determining a communication’s meaning. For example, in the sentence *I’m flying to Miami tomorrow to see the Super Bowl*, the words “Miami,” “Super,” and “Bowl” are probably the most infrequently occurring words—and therefore the ones that would be treated as likely to be more indicative of this sentence’s meaning. Knowledge management software uses this concept, on a much grander scale, to estimate the most important terms in a given piece of unstructured information.

But even infrequently occurring words can be ambiguous and subject to multiple meanings. In the sentence above, for example, is the speaker talking about a football game or her grandmother’s terrific china? To help with this problem, meaning based algorithms use a second important concept: the statistical notion of Bayesian inference.

b. Bayesian Inference

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63 SHANNON & WEAVER, supra note 60.

64 Although this would need to be determined in the overall context of the body of information under analysis.

65 To take a related example, Amazon.com employs technology to identify “statistically improbable phrases” that may convey a sense of a book’s subject matter. See Amazon.com Statistically Improbably Phrases, http://www.amazon.com/gp/search-inside/sipshelp.html.

66 Another problem arises when there are no rare words in a search phrase. A famous way to test the power of a search engine, for example, is to type “to be or not to be,” and see if the results return information on Shakespeare’s soliloquies. BATTELLE, supra note 48.
I will not spend as much time discussing Bayesian inference, as it should be more familiar.\(^{67}\) In a nutshell, this is a statistical technique used to update the probability that a prior belief is true in light of newly received information. One obvious application of Bayesian inference is in the law of evidence. If a jury is sixty percent sure that a criminal defendant is guilty, how should it update this belief when new physical evidence is presented showing the defendant’s fingerprints at the victim’s apartment? Bayesian inference provides a mathematical framework for answering this and other questions—though not one that is free from controversy.\(^{68}\)

In the field of knowledge management, Bayesian inference can be used to calculate probabilistic relationships between multiple variables and to determine the extent to which one variable impacts, or relates to, another.\(^{69}\) These relationships are important in two different ways. First, within a bundled communication, such as a letter or phone call, they can be used to help refine or deduce the meaning of the message. Second, across a larger universe of data, Bayesian inference provides a basis for estimating which parcels of unstructured information are more likely to deal with similar concepts or messages.

Let me illustrate each of these applications of Bayesian inference by returning to our earlier sentence: *I’m flying to Miami tomorrow to see the Super Bowl.* We might have a prior belief that any time the word “bowl” is used, it refers to something you use to eat soup or cereal sixty percent of the time, a form of casual recreation involving ten pins and a heavy ball thirty percent of the time, and a forum for a football game just ten percent of the time.\(^{70}\) But using Bayesian inference, we might modify that prior belief from a 60-30-10 split to a 10-10-80 split once we discover that the word “super” occurs in close proximity to “bowl.” And the split might be modified still further, perhaps to 1-1-98, indicating a high probability that the communication involves football, when the word “Miami” (the 2007 location of the contest) appears in the same sentence.

Similarly, once it has been determined that this message likely relates to a championship football game, Bayesian inference can be used to find other

\(^{67}\) For more background on Bayesian inference, see ANDREW GELMAN ET AL., *BAYESIAN DATA ANALYSIS* (2003). For a discussion on the uses of Bayesian inference in legal scholarship, see Ulen, *supra* note 10, at 888-93.


\(^{69}\) See *Autonomy: Technology White Paper*, *supra* note 57.

\(^{70}\) These numbers are merely illustrative—I have no idea how often “bowl” refers to each of these three concepts.
parcels of unstructured information that probably relate to the same concept. By examining the multivariate relationships across many documents, the algorithm can determine that communications relating to the NASDAQ or Iraq are less relevant than ones discussing the quarterback prospects of the Chicago Bears or the Indianapolis Colts in early 2007.

2. Knowledge Management Applications

Assuming that this technology really works—and that a combination of Shannon’s information theory, Bayesian inference networks, or other techniques can be used to estimate the meaning of unstructured information—what is it good for anyway? One likely application is the creation of a better search engine. Imagine how much more relevant search results might become when users query on the meaning of the data—instead of on another measure such as keywords or the frequency of inbound links.71

But the applications transcend search. Once a universe of data is processed, it becomes possible to conduct clustering analyses or obtain especially relevant information without asking for it. If I am writing an article on contract remedies, for example, my computer can scan everything I have ever downloaded on the topic and automatically present the most relevant results in a sidebar window as I type.72 Or I might ask my computer to cluster all previous academic articles on the topic in order to determine the different approaches to remedy selection (for example, economic analysis, doctrinal review, philosophical arguments, and the like). This type of knowledge management is proving useful in fields as diverse as automotive manufacturing, pharmaceutical drug discovery, corporate finance, and government national security.73

Another reason why organizational decision-makers are starting to adopt meaning based computing in earnest is because the technology offers some distinct advantages over other methods for processing unstructured information. The primary benefit over keyword search (Boolean query) is accuracy. Most keyword search engines simply scan an information index—one that must often be seeded and updated manually with topic taxonomies—looking for documents where the keyword occurs

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71 There is a potential concern, however, in using meaning based technology to build a search engine in an open universe like the Internet. Because there are commercial incentives to attract attention, spammers may again seek to undermine the algorithm by hiding irrelevant keywords throughout a Webpage. Fortunately, I suspect that this problem is less likely to emerge in the analysis of information related to contract law.

72 Several recent Microsoft projects—codenamed “Stuff I’ve Seen,” “PowerScout,” and “Watson,” seek to accomplish this type of implicit search. See Mostafa, supra note 57.

73 See sources cited supra notes 16, 57.
frequently.\footnote{See Autonomy: Technology White Paper, 
\emph{supra} note 57.} And with these systems, users are typically required to write more complex, and syntax-specific, queries in order to weed out irrelevant results. Another common approach to managing unstructured information is to manually tag each document with various, predefined taxonomies.\footnote{Technology standards such as XML facilitate this sort of information tagging.} This can help force some structure around information, but human inconsistency may lead to problems with the accuracy of these tagging schemes. They also take a lot of time and do not scale.

These relative advantages of meaning based computing offer some intriguing possibilities for empirical legal research. Yet I am unaware of any previous attempt to use this technology to study the law. And contract law, in particular, may lend itself to this sort of analysis, because private agreements generate a great deal of unstructured information and because more and more of this data is becoming available for examination.

\section*{III. SOME POSSIBILITIES FOR THE EMPIRICAL ANALYSIS OF CONTRACT LAW}

Where might we begin to gather unstructured information for a project to automate empirical analysis of contract law? Two data sources are close at hand: collections of published court opinions, and digital aggregations of executed contracts. Processing this information will not allow us to test every economic theory underlying the rules of contract law,\footnote{See \emph{infra} part IV.A.} but it is a good place to start.

The availability of full text court opinions through Westlaw, Lexis, or other avenues is familiar, and I will return to some ideas for using this information shortly. Some may be less aware, however, of recently compiled digital databases of executed contracts. As the cost of data storage decreases, more organizations are building central repositories of these contracts for public research. For example, the Digital Contracts Library, hosted by the Contracting and Organizations Research Institute (CORI) at the University of Missouri, has amassed an impressive collection of over 440,000 contracts.\footnote{Contacting and Organizations Research Institute Digital Contracts Library, \textit{available at} \url{http://cori.missouri.edu/pages/ksearch.htm}.} CORI gathers these contracts from both public and private organizations (much of the data comes from filings with the Securities and Exchange Commission\footnote{Public firms will file material contracts with the SEC, and these agreements can easily be accessed through Edgar, Lexis, or, increasingly, through third-party aggregators who collect, update, and host full text contract databases. One organization, ONECLE (\url{http://www.onecle.com/}), lists over ten thousand business contracts from SEC filings, sorted by industry and transaction type. This information is worth studying, but it is}}
research purposes. The breadth of coverage is impressive—sports stadium leases, container shipping agreements, physician/HMO provider agreements, and so on—and CORI continues to add thousands of contracts daily. Moreover, there are many other contract collection initiatives underway. Some of the contracts are tagged with simple descriptors, such as the date and type of contract, or the industry involved. But these tags do not always cluster contract types precisely, nor do they typically provide enough structure to easily analyze and compare key terms.

How, then, might this data be combined with knowledge management algorithms to better study contract theory and contract law? There are three broad ways to think about the possibilities. First, we might use meaning based computing to improve our descriptive analysis of contract doctrine. Second, we might use the technology to gather data that can help operationalize or revise normative economic theories of contract law. And finally, we might use some of the resulting information to conduct what I will call predictive modeling—that is, to run massive computer simulation on various economic models of contract law in an attempt to derive a pretty good—though not necessarily perfect—rule.

Hopefully these ideas will become clearer as we go. I will take them on in order of difficulty—starting with the least ambitious and moving through to the most ambitious (although this is a matter of degree, and a fair-minded critic might still term all three sections “excessively ambitious”).

A. Descriptive Analysis

1. Super-Charged Doctrinal Analysis (Without Tagging)

Doctrinal research involves the examination of published court decisions in order to determine how judges implement legal principles. A
contracts scholar, for example, might read several hundred cases on the mistake doctrine to study how courts really differentiate unilateral from bilateral mistake—and to clarify the conditions required under either branch to excuse contractual liability.\[^{81}\]

There are a variety of approaches to doctrinal scholarship. The most ambitious work seeks to glean legal principles from an analysis of the cases.\[^{82}\] Less ambitious work simply conducts doctrinal analysis as a legal reasoning exercise where various cases are harmonized, distinguished, or criticized in light of earlier precedent. Still a third approach uses doctrinal analysis to present a puzzle, that is, to show a situation where courts are deciding cases in a manner inconsistent with prevailing conventional wisdom.

As an example of this last type of doctrinal analysis, consider a recent article by Professor Robert Scott on the indefiniteness doctrine.\[^{83}\] After gathering, coding, and analyzing 238 indefiniteness cases in state and federal court, Scott concludes that the conventional wisdom—which condemns the indefiniteness doctrine as dead letter law—is entirely wrong.\[^{84}\] According to his analysis, courts often continue to invalidate agreements when contracts are “too uncertain to be legally enforced.”\[^{85}\] Having offered this evidence that the indefiniteness doctrine persists as a meaningful bar to contract formation, Scott then goes on to explore why parties might continue to make indefinite agreements in light of this annulment risk.\[^{86}\]

All three types of doctrinal research present some methodological concerns,\[^{87}\] and doctrinalism seems to have fallen out of favor in recent years.\[^{88}\] After all, just because a lot of courts are actually deciding cases in a certain way does not necessarily mean that this is the way contract law

\[^{82}\] One example of this is Farnsworth’s derivation of a “dependence” principle in contract law. See E. ALLAN FARNSWORTH, *CHANGING YOUR MIND: THE LAW OF REGRETTED DECISIONS* (1998).
\[^{84}\] Id. at 1662-60.
\[^{85}\] Id. at 1653.
\[^{86}\] His hypothesis is that some parties may be motivated by a behavioral sense of reciprocal fairness and that an ambiguous agreement can serve as a type of signal. Id. at 1660-63.
\[^{87}\] For example, there is a potential problem with selection bias because the analysis is based only on the results of decided and published cases. All data on settled or unpublished disputes are excluded by necessity—even though inclusion of this information might change the results. See Epstein & King, supra note 10, at 110-12.
\[^{88}\] See Craswell, supra note 8, at 904-07; Posner, supra note 13, at 877-78.
But criticisms here can be overstated; as Scott’s work shows, it is important to know what courts are really doing in order to develop and test hypotheses on the incentives imposed by contract law. Or, as Stephen Smith puts it: “Legal scholarship is done with various purposes in mind, but the basic aim of legal scholarship is to understand the law better. Even if our ultimate goal is law reform, we need first to understand what it is we are trying to reform.”

Unfortunately, any scholar launching a doctrinal study soon runs into some hurdles: there are an awful lot of court decisions out there, and it is hard to unearth all the cases that matter. Furthermore, because this information is primarily unstructured, any comprehensive analysis typically requires intensive tagging, coding, and interpretation. Random sampling offers a possible basis for reducing the caseload, and thereby simplifying this work, but this introduces questions of statistical significance, accuracy, and replication. Said differently, this type of research does not scale efficiently.

Meaning based computing algorithms can conceivably help doctrinal scholars with these problems in two different ways. First, they might make it easier to identify relevant cases. Come back, for a moment, to Professor Scott’s indefiniteness study. To identify cases involving the indefiniteness doctrine, Scott queried a Westlaw key number related to the requirements for contractual certainty. I am sure that West does a pretty good job tagging legal cases with subject matter descriptors. But some cases involving this rule might use different terms or concepts—such as “preliminary agreements,” “incomplete contracts,” “partial deals,” or “agreements to agree”—and West employees may have missed relevant court opinions. It would be more powerful to scan every single case involving contract law with meaning based algorithms that look for

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89 As Richard Craswell puts it, it is hard to find a useful null hypothesis to test empirically with descriptive analysis. Craswell, supra note 8, at 905-06.
91 For example, a recent search in Westlaw’s ALLCASES database for every state and federal opinion in the past 90 days containing the term “contract” returned 7922 results (search conducted Mar. 7, 2007).
92 Specifically, Scott used Westlaw’s 95k9(1) database Contracts: Requisites and Validity: Nature and Essentials in General: Certainty as to Subject Matter: In General. He then chose a random subset of these cases in order to construct a manageable dataset. Scott, supra note 83, at 1652-53.
93 This concern is less important for Scott’s claim that a meaningful number of courts still use the indefiniteness doctrine. His analysis clearly demonstrates this. But missing cases would be potentially more damaging to any work asserting a more comprehensive claim on the exact contours of a rule in contract law.
94 Or, taking this idea to its extreme, researchers might conceivably scan every single court opinion ever published in the United States with a meaning based computing
annulment by indefiniteness—even when this concept is expressed in an unorthodox manner. This technology might also be used to find relevant cases for legal questions or concepts where West has not yet established a key number taxonomy.

Second, meaning based computing can help synthesize the key factors that influence courts in their adjudication of borderline cases. Every human conducting this type of research ultimately needs to simplify large amounts of unstructured information down to manageable distinctions—and prior contextual understanding will usually shape this synthesis. Compounding this problem, cases might be analyzed in a slightly different manner when work is divided among research assistants or professors.

By contrast, unleashing the statistical objectivity of meaning based computing on all relevant cases might lead to a more consistent synthesis of contract doctrine. How would this work? In theory, we might add every contracts case to a centralized database and process each case with a meaning based algorithm in order to develop an initial subject matter impression. This sounds like a lot of work, but organizational knowledge management systems routinely process hundreds of thousands or millions of documents. From here, researchers could cluster the information according to key concepts, and, perhaps, work to tune the results by “teaching” the algorithm which connections are the most important.95

After that, there are multiple ways to proceed. One option is to seed an analysis with a leading case or treatise discussion on, say, indefiniteness and ask the computer to return all relevant cases. These results could then be clustered on two, three, or more dimensions, and we might use this analysis to refine theories on how and why courts are deciding cases. Continuing the previous example, this sort of analysis might suggest, hypothetically, that courts often enforce indefinite agreements when it would be hard to specify clear, verifiable metrics for a key contingency, and rarely enforce them when this sort of task, in hindsight, would have been easy.96 Thus, by automatically clustering all relevant court opinions across many dimensions, scholars might be able to rely on computer systems to aid

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95 By teaching, I mean updating the Bayesian networks that reflect the strength of links between words and concepts (either through human understanding and intervention or through automated review of additional, related content). Many knowledge management programs allow users to tune systems in this manner. For example, after scanning all court opinions on contract law, I might tell the computer that “consideration” is less likely to be associated with “kindness” and more likely to involve bargained-for contractual requirements of detriment and benefit. Or, even better, I might scan several dozen casebooks and treatises on the topic—and use this information to retroactively update the Bayesian linkages between words and concepts in the case database.

96 I borrow here from Professor Scott’s musings on the topic. See Scott, supra note 83.
Let me try a more concrete illustration of how this would work in the context of a familiar event: the circuit split.

2. Jurisdictional Splits

Descriptive scholars can often identify interesting problems by locating situations where the same issue receives disparate legal treatment across two or more jurisdictions. The hallmarks of this work include identifying the parameters of a circuit split, discerning key doctrinal differences, evaluating various approaches, and, perhaps, advocating one solution as superior.

Consider an example. The elusive concept of unconscionability, sometimes used to invalidate outrageously lopsided contracts, is implemented unevenly across the United States. Many courts require the demonstration of both procedural and substantive unconscionability before a contract can be annulled. Procedural unconscionability represents a flaw in the bargaining process, while substantive unconscionability goes to the outrageousness of specific terms. E. ALLAN FARNSWORTH, CONTRACTS § 4.28 (4th ed. 2004). For the origins of the procedural / substantive distinction, see Arthur Leff, Unconscionability and the Code: The Emperor’s New Clause, 115 U. PA. L. REV. 485 (1967).

Other jurisdictions, however, seem to be satisfied with a showing that just one type of unconscionability—either substantive or procedural—corrupts the agreement. But how extensive is this schism? And why are courts coming out differently?

One possible way to answer these questions is to gather every historical case on unconscionability and manually code the facts of interest—including the judicial test (procedural, substantive, both, something else), the holding (contract voided, contract upheld, contract reformed), the parties’ demographics (sophisticated, educated, poor), and so on. This might convey useful information, but it is unlikely to capture everything that matters. A recent study, for example, attempts this sort of exercise by coding unconscionability cases across ten different dimensions. But

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98 E.g., Maxwell v. Fidelity Fin. Servs., 907 P.2d 51, 58 (Ariz. 1995) (holding that unconscionability can be established without procedural flaws but also recognizing that many courts require both).

99 Other factors might include whether the contract involves a consumer or commercial transaction, the nature of the disputed term (price, an arbitration clause, or something else), the term of the contract, and many other pieces of data. For one recent study presenting some variables to consider, see Larry A. DiMatteo & Bruce Louis Rich, A Consent Theory of Unconscionability: An Empirical Study of Law in Action, 33 FL. ST. U. L. REV. 1067 (2006).

100 Id. at 1116 App. A. These factors include the ones mentioned above, along with whether the parties were represented by an attorney, whether other legal doctrines such as
certainly there might be other factors that courts consider in these decisions.

Now, imagine how knowledge management technology might improve the analysis. With a meaning based algorithm in place, it would be possible to run a consistent review of every single case. After completing this review, we could automatically sort and cluster the unstructured cases on any number of dimensions—including jurisdiction, date, outcome, legal test, contractual subject matter, and anything else—to clarify the scope and substance of the circuit split. Furthermore, we could ask the algorithm to aid our judgment by searching for notable factors relating to the doctrinal split that we may have overlooked. And, importantly, there would be no need for human re-coding if it became necessary to extract another variable from the cases. In other words, a significant benefit of automated analysis is the elimination of the need to predetermine which factors will be included in the tagging taxonomy for doctrinal review.

To be sure, this work will still not yield normative conclusions; we don’t know which court is doing it best. But it would certainly be useful to have this information to better understand the contours of unconscionability—or any other rule of contract law receiving incongruent judicial treatment.

Let me finish this discussion of computer-aided descriptive analysis with one final application involving the replication—or even the automation—of doctrinal research over multiple periods in time.

3. Time Series Analysis

In 1969, Professor Stanley Henderson completed a landmark study on promissory estoppel—an alternative legal basis for enforcing promises in the event of reasonable detrimental reliance. Henderson decided to examine every single case involving Section 90 of the Restatement (famously setting out the requirements for promissory estoppel) over the past decade in order to determine how courts were handling these claims. His work led to a surprising set of insights, perhaps the most important being that this theory of contractual liability was still used primarily for bargain promises—and not in a broader set of circumstances that seemingly also met the rules of Section 90.
These results were puzzling, and Professors Daniel Farber and John Matheson decided to update Henderson’s analysis sixteen years later.\textsuperscript{104} As before, the authors examined every single case involving promissory estoppel for the past ten years. Their work led to a very different set of conclusions: by 1985, they argued, courts were now much more comfortable applying promissory estoppel to a wider range of contexts, and they were no longer using it merely as a fallback provision for consideration.\textsuperscript{105} More recent work by Richard Craswell, Robert Hillman, and others has continued the analysis.\textsuperscript{106} But we still have not reached consensus on the scope and limits of promissory estoppel, and it will clearly be necessary to continue doctrinal work in this area.

These studies demonstrate a familiar perception of contract law as an evolving creature. And they highlight the benefits of repeating doctrinal projects over time to refine earlier analysis and assess the breadth and pace of adaptation. Yet repeated time series analysis is an arduous task, and it is hard to know whether scholars are reading the cases consistently across the decades.

Fortunately, meaning based computing again offers a way to assist scholars—this time by providing a technological framework for automatically replicating and updating intertemporal doctrinal analysis. The first step is to build a database of historical cases, as described above, and use knowledge management algorithms to process, cluster, and synthesize cases across a variety of dimensions. After that, as courts issue new opinions on, say, promissory estoppel, scholars can feed these into the same system and process the cases with the same algorithms to unleash a constant stream of doctrinal studies. In fact, once a framework, or project structure, is established, standing studies might be refreshed automatically every one,


\textsuperscript{105} More specifically, they argued that reliance was becoming less important in promissory estoppel claims and that estoppel was being used to enforce many promises that were made in furtherance of economic activity. Id.

two, or five years—or even in real time to get immediate feedback on judicial treatment of the rule.

In this manner, meaning based computing algorithms might help us conduct time series studies across many different areas of contract law—even when the number of cases is voluminous. If this type of work is successful, it might lead to recurring insights that confirm or challenge our conventional understanding of the ways that courts are implementing contract law. For practitioners and judges, this might prove a potent legal research tool. And for academics, it offers an intriguing methodological framework for understanding, critiquing, and comparing case law on an unprecedented scale.\textsuperscript{107}

Of course, as mentioned earlier, doctrinal analysis—even what I have called super-charged doctrinal analysis—can only go so far in helping us reform contract law. Careful examination of many cases—or even of every case—will not necessarily lead to a normative theory of contract. Just because courts are deciding cases in a certain manner does not mean that this is what they should be doing. For this reason, I believe that descriptive applications of meaning based computing will ultimately be less important than normative applications. Let me turn, then, to some possibilities for using knowledge management technology to support normative analysis in contract law.

\section*{B. Normative Analysis}

How should we decide which rules work best in contract law? And might knowledge management algorithms assist in this endeavor? If we accept that economic efficiency is normatively relevant to the design of contract law (and while I do, some people certainly do not), then the issue really becomes how to use meaning based computing to help uncover the incentives and economic effects of alternative rules.

To this end, it is helpful to consider two different philosophies on the design and role of contract law. The first approach, incomplete contracting theory, is pursued by economists who treat contract law as a simple regime for specifically enforcing verifiable terms in an agreement. Work in this

\textsuperscript{107} It might be powerful, for instance, to cluster contract law cases with tort, property, or agency cases in order to look for previously undeveloped linkages in the common law. Or it might be useful to cross-check the various ways that courts or agencies deal with key constitutional or administrative principles. Or still a third idea might involve meta-studies—or a study of all contract law studies—similar to work that is conducted in clinical studies of drugs or medical devices. See, e.g., U.S. Department of Health and Human Services et al., Draft Guidance for Industry and FDA Staff: Guidance for the Use of Bayesian Statistics in Medical Device Clinical Trials, May 23, 2006 draft, available at \url{http://www.fda.gov/cdrh/osb/guidance/1601.pdf}.
area considers how parties can write intelligent contract terms to maximize the economic benefits of trade and investment. The second approach, pursued more often by legal scholars, takes a very different tack: it assumes very simple contracts, and asks instead what legal rules will promote efficient outcomes. This approach is often termed default rule theory, because it asks how contractual gaps should be plugged in the absence of stated intent.

Both philosophies often simplify reality—incomplete contracting theory assumes simple law, and default rule theory assumes simple contracts. But they provide useful bookend frames for thinking about how meaning based computing might assist in normative analysis of contract law. I will start with the incomplete contracting approach.

1. Incomplete Contracting Theory

The full scope of incomplete contracting theory is beyond this Essay, but the goals here are very similar to those pursued by default rule theorists. In short, how can parties form agreements that provide efficient incentives to trade and invest? For efficient trade, the parties should only go through with the deal if the buyer's valuation exceeds the seller's cost at the time of exchange. For efficient investment, the parties should invest to maximize their payoffs from performance—the classic example involves a seller building her factory next door to the buyer—while also recognizing that there is a chance of breach (and thus avoiding inefficient over-investment in reliance on the contract).108

Economists in this area have come up with a variety of creative contracting solutions for promoting efficient trade and investment.109 The typical trick is to ignore most substantive contingencies (such as factory fires or rising interest rates) and focus instead on bargaining procedures that go directly to changes in a buyer's valuation or a seller's cost—whatever the cause. For example, the parties may set up a process, ex-ante, where the buyer will make a price offer, at the time of performance, which the seller can accept or reject. Under this regime, and assuming (perhaps strongly) that the buyer can observe the seller’s cost, the buyer will set a low price to avoid the trade if the cost exceeds her valuation (recognizing that the seller

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108 These two goals are often in tension. For instance, a remedy that fully compensates the buyer's valuation in the event of breach (thus giving the seller incentives to trade when efficient) may cause the buyer to ignore the probability of breach and over-invest. See Posner, supra note 13, at 834-36, 856.
will not perform below cost) and set a price equal to the cost if her valuation
is higher (in order to induce trade and capture all surplus above seller
cost). This procedural framework should also encourage efficient
investment because the buyer knows, again ex-ante, that the contract will
only be performed if her valuation winds up exceeding the seller’s cost.

Incomplete contracting theory can quickly grow complicated in a world
of asymmetrical information, two sided investment, or third party effects.
But it is a thriving literature, and economists have pursued a number of
interesting methods for channeling efficient trade and investment. Importantly, if there are procedural bargaining mechanisms that the parties
themselves might install to avoid post-execution opportunism, then the role
of contract law and the normative need for an extensive array of default
rules becomes much more limited. A court would simply need to enforce
the agreements as written.

Unfortunately, there is a potential problem: it has been suggested that
these types of contracts do not commonly exist in the real world. This is
somewhat of a puzzling observation given the theoretical promise of the
incomplete contracting scholarship. Yet these models are sometimes
dismissed as too complex for ordinary contracting parties, and the work is
starting to drift into the realm of bounded rationality.

I wonder, however, whether these types of efficiency-inducing contracts
are completely fictional. Some agreements do employ a variety of
procedural contingencies or structures, and it is plausible that these terms
may be roughly approximating some of the theoretical processes advocated
by economists. Consider, for example, venture capital contracts, used by
investors to fund entrepreneurial endeavors. Venture capitalists likely care
little about underlying legal default rules because their contracts provide
structural self-help protection in the event of entrepreneurial
opportunism. Other agreements also provide procedural mechanisms for

\[ \text{110} \text{ See Posner, supra note 13, at 834-35.} \]
\[ \text{111} \text{ For a recent collection of work in this area, see BOLTON & DEWATRIPONT, supra note 109.} \]
\[ \text{112} \text{ Some legal scholars have argued as much for certain groups of contracting parties. See Schwartz & Scott, supra note 22.} \]
\[ \text{113} \text{ See Posner, supra note 13, at 859.} \]
\[ \text{114} \text{ I will pick up on some concerns and possibilities presented by bounded rationality infra Part IV.C.} \]
\[ \text{115} \text{ This self-help is typically executed via preferred stock contracts and involves techniques like increasing board representation, manager stock vesting, liquidation preferences, and other procedural events that are often tied to manager performance. For further discussion of venture capital contracts, see Robert P. Bartlett, Managing Risk on a $25 Million Bet: Venture Capital, Agency Costs, and the False Dichotomy of the Corporation, 54 UCLA L. REV. 37 (2006); Kaplan & Stromberg, supra note 34; Gordon Smith, The Exit Structure of Venture Capital, 53 UCLA L. REV. 315 (2005).} \]
terminating contractual relationships, often at a price and without substantive cause.

Here, then, is where the power of meaning based computing might be used to shed some light on an empirical question. If parties actually do erect bargaining procedures to channel efficient investment and trade, then under what circumstances will this typically occur? Meaning based algorithms might conceivably be used to directly analyze thousands of contracts to determine if parties use procedural mechanisms for dealing with future events—as predicted by incomplete contracting theorists. How, for example, do the contracts cluster in their treatment of exit rights? Are there similar patterns involving the use of take-or-pay terms? Do some agreements provide mechanisms for benchmarking the seller’s cost and allowing the buyer to offer a price that the seller can take or refuse? As meaning based algorithms improve our ability to process the unstructured information in these contracts, we may be able to compare and evaluate terms on a massive scale. I suspect that this work would prove complicated, but my hypothesis is that it would reveal some areas where parties have restructured the axis of their contracts from the substantive to the procedural.

If we can uncover clusters of these contracts, then one powerful normative implication might follow: lawmakers should simply enforce these contracts as written. To be sure, there is a granularity problem here. If, for example, eighty percent of venture capital contracts have procedural bargaining mechanisms—but a specific contract under dispute does not—then what approach should be taken? Should courts enforce the agreement as it stands or look to default rules to plug gaps? Said differently, at what level of precision should contract law operate? One approach for everyone? One approach for all venture capital contracts? One approach for each contract? These are thorny questions, and I will discuss them a bit more below in relation to default rule theory. Assuming, however, that some sort of judgment can be made to establish a workable approach to granularity (as we have really had to do all along), then meaning based computing might help provide a principled basis for hiving off a subset of agreements where default rules become less important—and where courts should just specifically enforce the agreements as drafted.116

116 It is an open question whether this subset should comprise a large or small portion of our economy. Schwartz and Scott have argued, for example, that courts should take this exact approach for all agreements between commercially sophisticated entities. See Schwartz & Scott, supra note 22. Furthermore, an argument can be made that conditioning legal treatment on the content of contracts puts the cart before the horse; perhaps it would be better to simply enforce all sophisticated party contracts as written, and let individuals adjust their agreements to such a regime.
Yet even a quick glance through CORI, or other databases of historical contracts, suggests that many agreements do indeed lack the sort of procedural bargaining mechanisms prescribed in the incomplete contracting literature. They are simple fixed price deals, or they focus more on substantive contingencies. What about these contracts, the ones failing to establish internal mechanisms for channeling efficient trade and investment? This question brings us into the world of default rule theory.

2. Default Rule Theory

According to default rule theorists, contract law is primarily tasked with providing background rules to govern situations where parties do not explicitly define some aspect of their agreement in advance. An effective default rule regime might theoretically provide a number of benefits, including transaction cost savings for parties freed from specifying the minute details of their deal. How, then, might we use meaning based computing to inform the legal default rules that should operate when parties’ contractual intentions remain silent?

Here, unfortunately, the path is much steeper. Twenty years ago, I might have argued that we could simply examine a million contracts to glean the popular preferences of contracting parties across a wide variety of terms. For example, do most contracts require that delivery of bulk goods comes all at once, or will they permit a seller to deliver small lots of the product over time? Do most agreements limit damages for breach, and, if so, in what manner? In essence, each contract could serve as a ballot, and the most-voted-for term could just be imported as a majoritarian default rule—under the premise that this approach would reduce the greatest amount of transaction costs in the future. Meaning based computing would simply be a machine for faster tallying of the votes.

But work over the past two decades suggests that the selection of contract default rules is much more difficult than this. There are at least three major complications: how to count silence; when to adopt penalty defaults that convey information as parties contract around disliked rules; and how to deal with the above-mentioned granularity problem. Let me touch briefly on each of these concerns.

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118 Some commentators have argued, for example, that the Hadley default rule limiting unforeseeable consequential damages is often replaced by a rule prohibiting all consequential damages for breach. Douglas G. Baird et al., Game Theory and the Law 281 n.16 (1994); Richard A. Epstein, Beyond Foreseeability: Consequential Damages in the Law of Contract, 18 J. Legal Stud. 105, 118 (1989).
The first problem is that we cannot always infer that failure to change a default rule constitutes approval. It is, after all, not costless to strike a disliked default rule. The parties must negotiate and draft a replacement, and if the transaction costs of these efforts exceed the likely benefit from the new legal term, then they may not bother to make the change—even when both parties would be better off with a different term. Moreover, some commentators have argued that default rules are sticky, meaning that parties are loathe to change a term even when the benefits may exceed the costs of doing so. And even when parties love a default rule, they may not bother to write it into the contract—that’s the point, after all, of having popular defaults. For these reasons, it can be hard to know how to “count the votes.”

The theory of penalty default rules further complicates the analysis by offering an economic reason why lawmakers may wish, in some circumstances, to impose a default rule that very few parties would prefer. The basic point here is that penalty defaults can theoretically provide a way to reduce information asymmetries by forcing parties to reveal data that is personally disadvantageous but socially desirable for the counterparty to know. The classic example involves the Hadley rule, requiring high value buyers to reveal unforeseeable consequential damages so the seller can take efficient precautions against breach. For this reason it may be economically efficient to choose a default rule that is actually disliked by a majority of contracting parties.

Finally, default rule theory presents a granularity problem because lawmakers are free to set different default rules for different groups of contracting parties. The notion of writing unequal laws may seem offensive

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120 Although some parties preferring the default rule may still incur the costs of explicitly inserting that term into their agreements simply to avoid taking the time and expense to determine how the law will handle contractual silence—or because they are worried that courts might make mistakes. See Ian Ayres, Preliminary Thoughts on Optimal Tailoring of Contractual Default Rules, 3 S. CAL. INTERDISC. L.J. 1 (1994); Louis Kaplow, Rules Versus Standards: An Economic Analysis, 42 DUKE L.J. 557 (1992).


122 See infra notes 144-145 and accompanying text.
at first, but it should really not be that troubling because the parties can presumably just change the disliked terms. And while there are additional costs to write and administer granular default rules, this price may potentially be worth it under some circumstances. Unfortunately, selecting a level of granularity for contract default rules is a byzantine problem. Into how many groups should we splinter our society? The Uniform Commercial Code, for example, famously enacts different default rules for consumers and merchants. Similarly, common law default rules occasionally differ from those of the UCC. But it is not self-evident that bifurcating contract law between consumer and merchant—or between goods and services—presents an optimal segmentation. Why not three different groups? Why not ten? And what are appropriate parameters for ex-ante segmentation of the contracting population?

For all of these reasons, I am skeptical of any project that aims to select an optimal default rule. Yet, exactly because this task is so hard, it is worth asking whether we might use powerful computing technology to assist with these problems. After all, lawmakers cannot abandon the job; there must be some legal rule or standard that takes effect in the absence of stated contractual intentions. Even a decision to eschew default rules—or, analogously, to strike contracts void for indefiniteness when unplanned contingencies arise—is itself a default rule. So, let me offer a few tentative thoughts on how meaning-based computing might help with the selection of default rules.

One possibility is to use knowledge management algorithms to conduct natural experiments on change and effect in contract law. The basic idea here is to find a situation where there has been a doctrinal change—perhaps due to a landmark court decision or statutory enactment—and measure the impact of the change on subsequent contract terms in that jurisdiction. Parallel jurisdictions might also be included as a form of control. This would be analogous to an event study in finance or economics, and might help to shed light on the incentives and effects of differing legal default

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123 This is true because more precise default rules offer some potential benefits, such as reduced transaction costs and reduced error costs. I have explored the tradeoffs elsewhere. See Geis, Optimal Precision, supra note 38.
125 Richard Craswell puts the problem this way: “If different rules would be efficient for different contracting pairs, the law must also to decide the extent to which its default rules should be ‘tailored’, or customized to match the rule that would be most efficient for each individual contracting pair.” Richard Craswell, Contract Law: General Theories, in 3 Encyclopedia of Law and Economics § 4000, at 4-5 (Boudewijn Bouckaert & Gerrit De Geest eds., 2000).
126 Id.
rules.

For example, Ian Ayres has recently suggested that a state law imposing a low interest rate on loans—in the absence of a different specified rate—acts as a sort of penalty default.\footnote{Ayres, supra note 121, at 590.} In essence, it forces a lender to clearly disclose the interest rate governing the contract in order to avoid punishment by a low rate. It would be interesting to ask how long this law has been in effect and whether it is achieving these predicted aims. For instance, we might gather a collection of loan contracts formed both before and after the statutory default rule. We could then use computer algorithms to assess the frequency and manner with which the interest rate is reported—and compare the results across times and jurisdictions. This may not afford a complete basis for preferring one rule over another, but it could help us understand the impact of changes on contractual behavior, while also yielding data on whether default rules are working as expected.

A second, related idea would involve studying hundreds of thousands of contracts to identify and cluster standard boilerplate provisions.\footnote{The topic of contractual boilerplate has received some attention lately. See “Boilerplate”: Foundations of Market Contracts Symposium, 104 MICH. L. REV. 821 (2006).} We might then assess how and when this boilerplate changes and try to link this evolution to default rule changes in contract law. Again, this sort of work may not provide a complete normative basis for choosing one default over another, but it would speed the partial analysis of incentives and effects.

Third, if we decide that it is appropriate to enact different default rules for different contracting segments, then it might be possible to use computer-aided clustering to help determine a meaningful segmentation. As mentioned above, one of the hardest problems here is identifying appropriate ways to classify parties into different treatment groups—who gets default A, who gets default B, and so on. It might be powerful to run knowledge management clustering analysis on many different types of contracts in order to gather evidence on the dimensions where salient characteristics diverge. These clues could then suggest whether to segment groups—and if so, whether these segments should be defined by industry, by the size of the agreement, by the nature of the transaction, or by some other dimension.\footnote{In order for this to work, there would need to be relative homogeneity within the sub-classes. Otherwise, the results would tell us little about individual members in each class, and we might conclude that we are better served by simple, one-size-fits-all rules.} Related to this, we might study term outliers or build a taxonomy of what features best define a contract type.

Regrettably, these problems are difficult, and I am not sure how far these ideas can take us toward normative reform. But there is one other
possibility that I want to discuss in greater detail—that of simulation and predictive modeling.

C. Predictive Modeling

Let me try a completely different angle on the default rule problem, one that illustrates another potential way to use meaning based computing. A likely criticism of the discussion thus far is that this sort of normative analysis will prove too difficult to conduct. Even if we can cut through the noise to pull out information that is relevant to our choice of contract default rules, it may be impossible to sum up the analysis into an optimal array of legal prescriptions. After all, what are the full costs and benefits of a given default rule? And how granular should our default rules be? We may never be able to answer these questions with absolute certainty.

But there is a response: We may not have to get it perfect. There might still be benefits from using knowledge management technology to conduct predictive modeling that can help determine which legal rules will “do a good job” most of the time—even if they’re not flawless. I think the easiest way to introduce this idea is through an analogy.

In 1997, IBM stunned the world by beating the current chess champion, Gary Kasparov, with its Deep Blue supercomputer. The victory was seen as a signpost in the gradual march toward artificial intelligence because chess provides the perfect setting to test concepts like pattern recognition, learning, and planning. More recently, computers have become the undisputed champions in other arenas of the parlor—including Othello, backgammon, Scrabble, and bridge.

The success of computers in these games comes as more sophisticated processors enable programmers to design “brute force” strategies, similar to the one that Deep Blue used to defeat Kasparov. Essentially, the computer trees out all possible moves, counter-moves, counter-counter-moves, and so on until it has enough information to pick the move with the highest probability of success. Brute force often amounts to complex decision trees with millions and millions of branches.

But there is one game where computers have never been able to give humans a good fight: the East Asian game of Go. This game requires players to take territory by placing black and white stones on the

130 See supra notes 36-38 and accompanying text.
132 Winning Ways: Computers Have Started to Outperform Humans in Games They Used to Lose, ECONOMIST, Jan. 25, 2007.
133 Id.
intersections of a grid to surround their opponent. It is a very complex
game, with some stones appearing “dead” until the very end when they may
spring back into life at a critical moment. A computerized brute force
strategy simply does not work here because Go has many more potential
moves than chess—and because it is very tricky to evaluate any given
position in Go.134

Quite recently, however, programmers have starting using a different
sort of algorithm to give human Go players a tougher match. Instead of
drawing comprehensive decision trees, the computer uses Monte Carlo
simulation, a method of statistical sampling with random number
generation.135 In a nutshell, the computer will pick one move and randomly
play out thousands or millions of games to the finish. If the computer wins
often with this move, say 75 or 80 percent of the time, then it will stop
analyzing the position—even though there may be a better move out there—
and take its chances with this move. Otherwise, it goes on, selecting
a second move, re-running the Monte Carlo simulation, and recording the
probability of success. The process is repeated only until an acceptable
move is found; there is no attempt at perfection. This strategy is intriguing
(and apparently successful) because programmers are able to mitigate
complexity by replacing a search for the optimal move with a search for one
that is just good enough.136

In this same way, we may not need to solve, via brute force, for the
perfect contract law default rule. Instead, we might think about the problem
like the computer programmer seeking a win at Go. In some cases, it may
be possible to use unstructured information to form probability distributions
for the parameters that are critical to economic models of contract law. We
might then use Monte Carlo simulation to run millions of different iterations
on our predictive model to find a default rule structure that seems to
produce high pareto outcomes.137 In other words, we could populate
economic theories of contract law with empirically-derived assumption
bands for the most critical variables and run arrays of simulated transactions
until we find a pretty good rule.138

134 The Economist newspaper reports that the fastest computers can assess just 50 Go
positions in a second, compared with a half million positions per second in chess. Id.
135 See, e.g., Savvakis C. Savvides, Risk Analysis in Investment Appraisal, 9 PROJ.
to conduct Monte Carlo simulation).
136 Perhaps surprisingly, it is also much faster for computers to play many repeated
random games than to tree out and evaluate all possible moves. See Winning Ways, supra
note 132.
137 For some simple examples of this, see sources cited infra note 38.
138 Said another way, the correctness of a decision should be based on both (1) the
adequacy of results that are obtained; and (2) the efficiency with which the decision is
In order to run these predictive models, we would first need to set an objective function—similar to defining a “win” in chess or backgammon. This is a little tricky in contract law, since there is no natural end-game, but we might characterize the objective in terms of a high pareto outcome (primarily trade and investment gains net of transaction costs). After that, we could build a model economy that includes all key variables related to the contract default rule under examination—such as buyer valuations, cost functions, investment opportunities, breach precautions and probabilities, and other contingencies. Finally, we would use Monte Carlo analysis to vary these parameters (within empirically grounded assumption bands) and analyze the results under alternative contract default rules. In short, we would split our model economy into two or more parallel universes, give each universe a different default rule, and run millions of random iterations to see which rule typically leads to higher pareto outcomes.

To be sure, this method will not let us empirically solve for the optimal, or most efficient, answer. It may not be very satisfying to concede that we can’t know which rule of law is best. But, if the Chinese game of Go is complicated, how much more so are the collective choices of billions of people across a diverse range of economic settings. Adding to this complexity, parties are free to change many disliked rules in contract law—and there are theoretical benefits, in some cases, from forcing them to make these changes. Optimal precision in contract law is probably beyond our grasp right now, but partial economic analysis can still be used to inform—and perhaps reform—our legal rules. This may not be easy, but we are closer than many might think to securing helpful information through predictive modeling.

IV. LIMITS OF THIS WORK

These ideas are exciting (at least to me), but now it is time to let some air out of the balloon. Throughout this paper I have cautioned that meaning based computing and economic empiricism will never enable lawmakers to abandon subjective judgment. The techniques described in this Essay are unlikely to prove helpful for all avenues of empirical inquiry, or for all problems related to the design of contract law, and I want to finish by acknowledging some limits of this work.

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139 See supra notes 121-122 and accompanying text.
140 See Craswell, supra note 8, at 910-15 (describing the benefits of partial economic analysis in contract law).
A. Economic Models Requiring Different Data

The first problem relates to data availability. Thus far, I have focused primarily on how the unstructured information found in published court opinions and historically executed contracts might inform contract law. This data may indeed prove useful—in ways previously described—but these sources will be irrelevant to key parameters in some economic models of contract law. Accordingly, for meaning based computing to be of any use in these situations, we will need to find other sources of empirical data.

Let me give two short examples. First, recall the lost-volume seller problem: should a breached-against seller maintain a valid claim for lost profits even if she is able to mitigate the breach by reselling the product to someone else?141 The argument against recovery is that she eluded harm by reselling. The argument for lost profits damages is that she missed an incremental sale—she might have enjoyed both sales if the initial buyer had not breached.142

The problem quickly becomes more nuanced when we consider the relation of sales volume to profit margin. If selling more products leads to cheaper marginal (or average—depending on your point of view) costs, then actual damages should exceed lost profits on the initial sale.143 Conversely, if the seller faces a rising cost function, then damages are less than foregone profits because the seller avoids the need to make a higher cost product. Moreover, lawmakers may want to choose a default rule to expose a seller’s cost structure so buyers will efficiently internalize the cost of breach. For example, a penalty default awarding no lost profit damages might force some retailers to come forward and contract for a nonrefundable deposit or liquidated damages.

Ultimately, then, the best default rule for the lost-volume seller problem involves empirical evidence about seller cost functions. But this empirical data is rarely found in executed sales contracts—sellers often want to keep their profit margins secret. And while a few courts may hear evidence on seller cost curves, this will probably not yield sufficient data to successfully model the problem. Scholars will need to look elsewhere for the information.

For a second example of this external data problem, consider the Hadley rule barring unforeseeable consequential damages. Economic models pitting this rule against one allowing full damages for breach are complex—and

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142 See FARNSWORTH, supra note 97, at § 12.10.
would require an extended discussion. But ultimately, the best rule turns on a host of variables, including contracting transaction costs, the probability of successful performance with greater seller precautions, and the overall distribution of buyer valuations in a contracting population. Unfortunately, even if we could collect several thousand contracts for the exact same product, these variables cannot be measured from this data. For example, a contract’s price term tells us little about the buyer’s valuation. Again, we would need to find data from different sources to investigate which damages rule is more likely to lead to the better economic result.

If this all sounds somewhat familiar, that is because I am echoing earlier concerns raised by Eric Posner, who doubts whether decision-makers will ever be able to gather data on, say, seller cost functions or buyer valuation curves. I am more optimistic than Posner on the possibility of obtaining information for some of these variables through other means—perhaps via experimental methods or through the mining of organizational information. I have also argued elsewhere that data from the field of marketing might prove useful to contract law scholars. But it will be necessary to tap into other data sources. None of the unstructured information discussed earlier in this Essay will go very far towards implementing normative theories of the lost-volume seller problem, the Hadley rule, or other economic theories of contract law that rely on more nuanced variables.

**B. The Social Meaning of Contractual Promises**

More generally, contract law is a social and linguistic construct, as well as an instrument for the regulation and promotion of exchange. Since no computer on earth—not even one adept at grandmaster chess—can plumb the depths of human society or language, there will always be limits on the use of computer-aided empiricism to survey the contours of contract.
Consider one example. Richard Brooks, in an interesting and thoughtful essay, has recently challenged the economic justification for the efficient breach hypothesis.\textsuperscript{150} Recall that this hypothesis claims that a promisor need not keep a contract—but rather that she must simply perform or pay expectation damages to the promisee. In other words, the option of nonperformance is awarded to the promisor.\textsuperscript{151} Brooks questions why the entitlement should run this way and proceeds to demonstrate that an alternative rule—one allowing the promisee to demand performance or to compel breach and receive the promisor’s cost of performance—is also economically efficient.\textsuperscript{152}

Without an efficiency basis for preferring one remedy over the other, the better approach may therefore depend on a different empirical question: what did the parties really mean by their promise? By promising, did they intend the exchange to include an implicit option to breach and pay damages—or was this simply a naked promise to perform? Brooks regrets that scholars have made little effort to empirically identify the social meaning of contractual promises—because this leaves us with no intention-based grounds for preferring an efficient breach or an efficient performance hypothesis. Given this efficiency toss-up, he goes on to advocate the efficient performance hypothesis by turning to moral and philosophical reasoning.\textsuperscript{153}

Such an empirical undertaking, into the social meaning of contractual promises, is possible.\textsuperscript{154} But it is hard to imagine how anything I have discussed in this Essay would directly help with such an effort. Likewise, computer-aided empiricism may not have much to add when a moral or philosophical framework is advanced as a basis for selecting the rules of

\textsuperscript{151} For further implications of the options framework in contract law, see Robert E. Scott & George G. Triantis, Embedded Options and the Case Against Compensation in Contract Law, 104 COLUM. L. REV. 1428 (2004).
\textsuperscript{152} Brooks, supra note 150, at 581-84. This is true because both rules cause one party to internalize the marginal costs and benefits of performance. It is interesting to ask, however, whether distortions from a promisee’s incentive to over-rely with expectation damages (because he sets the probability of breach at zero) might differ from distortions caused by promisor incentives to take inadequate precautions against breach (because she sets the probability of actually performing at less than 1).
\textsuperscript{153} Id. at 591-95. An alternative approach, in the face of these multiple equilibria, might be to conduct further inquiry into the relative administrative costs of each alternative—will it cost more, for example, to figure out seller cost or buyer valuation.
\textsuperscript{154} Lisa Bernstein, for example, has explored the underlying intentions of promise-makers in the diamond industry. See Lisa Bernstein, Opting Out of the Legal System: Extralegal Contractual Relations in the Diamond Industry, 21 J. LEGAL STUD. 115 (1992).
contract law.

C. Bounded Rationality and Contract Theory

A third potential problem relates to the perfect rationality assumption underlying many economic theories of contract law. We usually expect that contracting parties will respond rationally to the incentives imposed by legal rules, and this belief forms the crux of normative arguments that a given rule will outperform alternatives.

Yet experiment after experiment suggests that our actual behavior does not come close to perfect rationality. Indeed, I have argued throughout this Essay that it is rarely possible to gather enough information to lift decisional ambiguity like a stage curtain and reveal the “rational” decision. If so, this poses some concerns—both for economic models of contract law, and for any empirical work seeking to reform these models. In short, how can we form a basis for advancing a given rule when the parties may not respond as expected to the incentives imposed by that rule?

Here, however, I think there is room to move forward. One possibility, as Eric Posner has again discussed, is to figure out how to estimate and model the range of cognitive capabilities existing within a relevant population of contracting parties. For example, we may think that one group of people will process substantial information, a second group will process some information, and a third group will process little information. Admittedly, it may be difficult to derive assumption bands for the various cognitive abilities of a population. But predictive modeling and Monte Carlo simulation, as described above, is perfectly structured to handle this type of analysis. We can construct decision rules or logic branches that incorporate various stages of bounded rationality and rerun these predictive models millions of times in order to observe the efficiency impact of different legal rules under conditions of imperfect rationality. Ultimately, the results will only be as good as the assumptions—and we will probably never know when an optimally efficient rule is reached. This type of exercise could, however, conceivably form a basis for revising the rationality assumption underlying many economic theories of contract law with empirically grounded models that are closer to reality. Like the algorithms powering computerized Go, there is no attempt at perfection.

155 See sources cited supra notes 40-41.
156 Posner, supra note 13, at 875-77.
157 The analogy reported by Posner relates to unraveling in the beauty contest game in game theory. Id. See also Teck-Hua Ho et al., Iterated Dominance and Iterated Best Response in Experimental Beauty Contests, 88 AM. ECON. REV. 947 (1998).
158 See supra note 135 and accompanying text.
But this approach might nevertheless lead to meaningful insights into the practical effects of the rules governing contract law.

CONCLUSION

Perhaps I am too much of an optimist. Certainly it would be easier to say that large-scale empirical work cannot be done in contract law—and that we should move on or just accept what we have. But I don’t really think that offers much of a choice. Even in the absence of perfect information, lawmakers need to make decisions about the default rules that govern the creation, interpretation, and enforcement of contracts. Economic theory offers a principled way to make these choices, but it must somehow be combined with empirical facts.

Furthermore, I do believe that we are on the edge of innovation in the fields of search and organizational knowledge management. Recent advances in information theory, statistical inference, and other technologies are helping organizations draw upon unstructured information to make better decisions. These algorithms are not perfect. No computer has passed the Turing test, and artificial intelligence is a distant dream (or nightmare). But the technology of organizational knowledge management is getting better at estimating meaning, and it is worth considering how it might be used to assist descriptive and normative projects in contract law.

Finally, just to be clear, I am not advocating the substitution of computer algorithms for human choices. As I have argued all along, contract law is a social construct, as well as an economic one, and we will never be able to set our rules without subjective judgment. Until a supercomputer comes along that can simultaneously mimic the mental activity of seven billion brains, we will probably have to settle for contract laws that are good enough—instead of demanding ones that are perfect. Ultimately, however, we must make granular choices about what rules to adopt, and we must continue to ask how contract law shapes human action. We should take up every available tool to conduct the partial empirical analysis that might help with these complex problems.

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159 In 1950, Alan Turing suggested an enduring test for artificial intelligence: can a person holding two natural language conversations—one with a computer and one with a human—distinguish the two correspondents? Alan Turing, Computer Machinery and Intelligence, 59 MIND 433 (1950), available at http://www.abelard.org/turpap/turpap.htm.