

# JOURNAL

## OF EQUIPMENT LEASE FINANCING

VOLUME 36 • NUMBER 2 • SPRING 2018

### **Headwinds and Tailwinds for Fintech In Equipment Financing**

*By Levon Goukasian, PhD, and Bill Ullman*

Financial technology, or fintech, has emerged as a sub-industry to the financial services industry. It offers marketplaces for financial transactions, alternative data collection and analysis, and much more. This article explains the factors and trends that have helped fintech evolve, discusses regulatory issues and developments, and offers various corporate strategies for incumbents.

### **Using Artificial Intelligence Technology to Remain Competitive in a Fintech Environment**

*By William S. Veatch*

Recent developments in mathematics, logic, and data science are leading to advances in artificial intelligence and the law. Speed and efficiency are paramount to the new breed of lessors and lessees, and data is king. This article explains the benefits to lessors that embrace the new technology to remain competitive. The appendix offers a primer on logic, both traditional and the Boolean lattice, to illustrate how leasing attorneys may be performing their jobs in the future.



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#### **The Equipment Leasing & Finance Foundation**

1625 Eye St NW,  
Suite 850  
Washington, DC 20006  
202.238.3400  
www.leasefoundation.org

# Using Artificial Intelligence Technology to Remain Competitive in a Fintech Environment

By William S. Veatch

Recent developments in mathematics, logic, and data science are leading to advances in artificial intelligence and the law. Speed and efficiency are paramount to the new breed of lessors and lessees, and data is king. This article explains the benefits to lessors that embrace the new technology to remain competitive. The appendix offers a primer on logic, both traditional and the Boolean lattice, to illustrate how leasing attorneys may be performing their jobs in the future.

This article examines how advances in mathematics, logic, data science, and artificial intelligence are beginning to impact the way attorneys draft equipment lease and loan documentation, and how those documentation changes in turn are affecting how parties do business in the finance world.

Without being overly technical, we review some of the latest developments in mathematics, logic, and data science that have enabled advances in artificial intelligence and the law. (The appendix goes into more detail, and the related endnotes provide references to extensive resources for readers interested in learning more.)

For those readers questioning the current sense of urgency, the answer is that we see a surge of interest in applying the latest technology innovations

to the finance world through a convergence of fintech, regulatory technology, and legal technology.

Whether we like it or not, the finance world is changing. Technology companies are partnering with financial institutions to develop innovative products and services that change the way we do business. As we proceed through the article, three trends emerge:

- New breed of lessees: A new generation of tech-savvy college and business school graduates is emerging, resulting in a new class of technologically demanding customers.
- New breed of lessors: New classes of competitors for equipment lessors have appeared. These include internet marketplace lenders that are expanding product offerings to include equip-

ment leases, and internet retail giants that are offering financial services.

- Data: Data is king. The predominant focus of fintech companies is the collection and use of data. Equipment lessors also have an opportunity to collect customer data, and by so doing create a new, potentially extremely valuable asset.

Those lessors that do not adapt and learn to use the new technology may wake up one day to find that a new hybrid fintech lessor has emerged and captured a significant portion of the equipment leasing market. The question is not, What can fintech companies do for us? but rather, How can traditional equipment lessors use artificial intelligence technology to avoid being rendered obsolete?

## WHO ARE THE LESSEES AND LESSORS OF THE FUTURE?

The world has changed in terms of how we contract for goods and services and how we pay for them. Consequently, electronic contracts and forms of electronic payment are continuing to evolve at a rapid pace.

As is often the case, a new generation of individuals brings with it a change in how business is transacted. Speed and efficiency are paramount to the current new generation of lessees: "I want it, and I want it now."

If the leasing industry can standardize the lease and loan boilerplate terms, lessees will be able to quickly enter into a lease or equipment loan and

trust they will be treated fairly. The negotiation then shifts to the material business terms, rather than interpretation of obscure lease agreement provisions. From a lessee's perspective, greater transparency is highly desirable.

There is a "new logic of the law" that has the potential to serve as a springboard for the development of artificial intelligence software applications.

The other radical change that we are seeing is the emergence of new classes of competitors to traditional equipment lessors. Now, in addition to bank-owned leasing companies and traditional nonbank equipment lessors, we are seeing internet marketplace lenders and other fintech companies expand their target asset classes from unsecured consumer loans to include small and medium business secured loans, auto loans, and equipment leases.<sup>1</sup>

Keeping in mind the changing profile of the lessee to a tech-savvy customer looking for

speed and simplicity, the new breed of fintech lessor offering almost instantaneous credit through a software application has considerable appeal.

The other class of financier to watch is the internet retailer. It has been projected that before long, some of the behemoth internet retailers will be the largest lenders in the world. We have already seen the impact on the consumer credit business, where a retailer acquires a bank in order to take deposits and offer consumer credit on a 50-state basis.

We are also seeing internet retailers purchase fleets of trucks, planes, and recently ships in order to enhance the flow of goods worldwide and capture the financing revenue. All signs indicate that this trend will continue, posing a greater threat to traditional financiers.

From both a lessee and a lessor perspective, moving to data-driven contracts would help the parties achieve their respective goals of speed, cost efficiency, and maintaining a competitive advantage. In fact, traditional equipment lessors have an opportunity to be technological leaders rather than followers.

## WHAT IS ARTIFICIAL INTELLIGENCE?

The term "artificial intelligence" is defined in different ways when used for different purposes. In the context of applying artificial intelligence to lease and loan documentation, we mean developing software applications that can (1) analyze legal issues under the Uniform Commercial Code (UCC) Article 2A and Article 9, and "think like a lawyer," and (2) assist with document origination, as well as modification, reporting, transfer, and securitization.<sup>2</sup>

Artificial intelligence is closely related to the study of logic, which is defined as the study of how we think and reason. Therefore, to develop artificial intelligence software applications in the law, we first need to understand how lawyers think and reason.

For those who are interested and have some background in logic, we review in the appendix, very briefly, the various forms of traditional logic and their limitations, and then introduce a new form of "logic of lattices" that is robust enough to

support the development of artificial intelligence in the law.

There is a "new logic of the law" that has the potential to serve as a springboard for the development of artificial intelligence software applications. These software applications include the development of a new breed of smart contract, including equipment leases and loan agreements in a new digital, data-based format.

It is not necessary for most readers to understand the logic in detail. Everyone should understand, however, that advances in legal logic have developed to the point that now we can create truly useful artificial intelligence software applications for use in the practice of law.

Just as you need not be an engineer to drive a car, you need not be a mathematician to use the new logic of the law in the everyday drafting and negotiation of contracts.

## VIEWING THE SUBSTANTIVE LAW AS DATA

In simple terms, the new logic of the law does two things: (1)

it breaks down ideas – legal concepts and rules in this case, into their component parts (a "partition") and (2) it helps us understand the relationships among ideas where there is an order to the ideas (a "chain").

As we become proficient in analyzing legal concepts by breaking them down and sorting them with partitions and chains, we begin to see that we can analyze the substantive law as fields of "data."

While due to space limitations we can provide only a few examples in the appendix, it is possible to interpret any provision of the UCC as a combination of partitions and chains.<sup>3</sup> In fact, efforts to create such a digitized map of the UCC are underway. We can store this data in a database in a "cloud" storage medium – that is, on a remote server – in a form that we refer to as a "knowledge representation structure."

Once we have the substantive law stored as data, we can create software applications using IF-THEN statements that reflect the logic inherent in partitions and chains.

## Creating a Map of the UCC to a Knowledge Representation Structure

There are two important points for the reader to remember about our ability to view the substantive law as data. First, we can create a map of the substantive law to a knowledge representation structure resembling a giant sphere of data. Second, there is a logic inherent in the knowledge representation structure that allows us to define legal terms, and create legal rules or tests that are defined with precision.

It is this internal logic and level of precision that opens the door to the creation of artificial intelligence software applications. Before long, for example, if you want to know how to perfect a security in a particular type of collateral, or what the elements are of the test for a finance lease, there will be a software application to guide you through the reasoning process.

## VIEWING CONTRACTS AS DATA

Just as we can analyze the substantive law as fields of data sorted by partitions and chains, we can do the same with a

contract. In fact, there are three relevant databases of information:

- boilerplate terms of the contract
- deal-specific contract terms
- data regarding modifications, transfers, and performance over the life of the lease or loan

In its most basic application, we use logic to help us draft documents with greater precision and clarity. With the new logic tools, however, we can also create artificial intelligence software applications that can sort and summarize the data contained in portfolios of contracts.

## Creating a New Form of "Smart" Lease Agreement

When we speak of "smart contracts" as a form of data, we are not talking about paper files scanned to electronic format, nor are we talking about electronic contracts that are organized as if they were paper contracts. Rather, we are talking about an entirely new way of viewing contracts. We can always choose to print the smart contract to paper or to an electronic file format, but

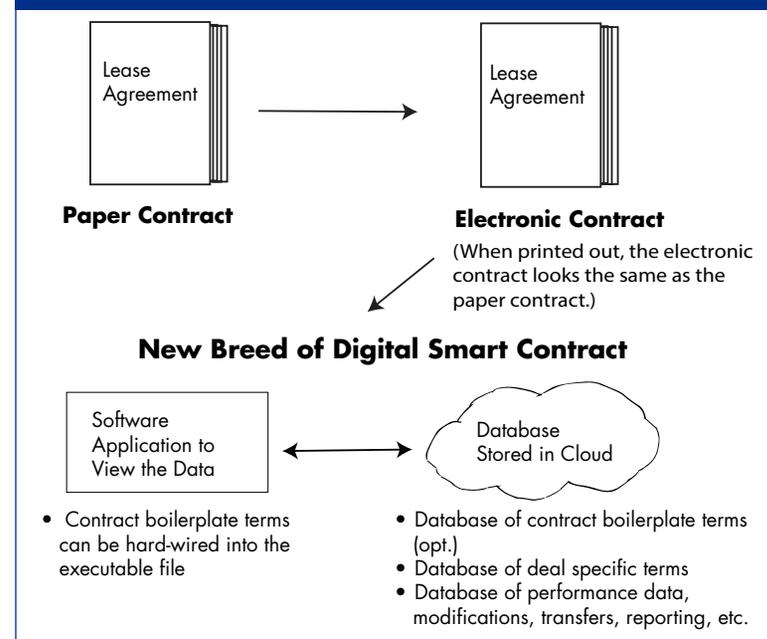
the contract terms are actually stored as fields of data (Figure 1).

## Modular Approach to Building a Smart Lease Contract

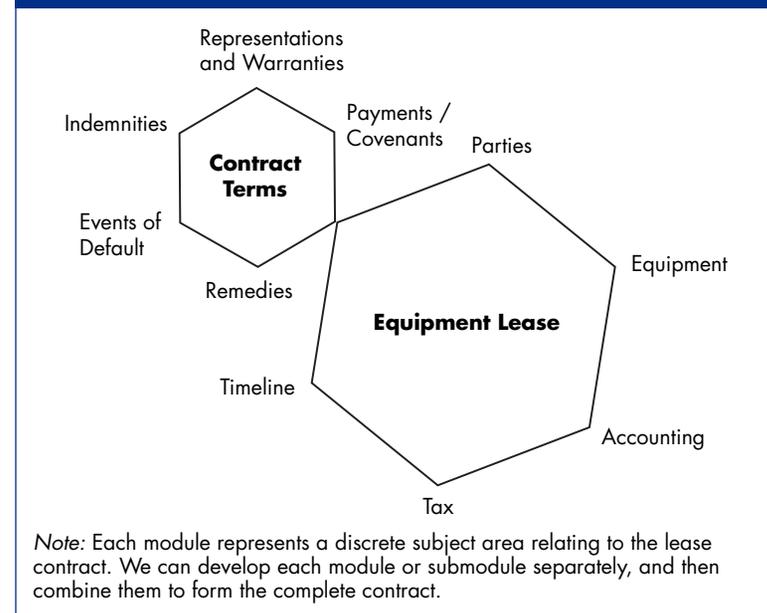
To create the "smart lease contract," the new logic of the law supports the concept of a "modular approach." This means that we can analyze each of the following as a separate module expressed in terms of partitions and chains: defined terms, representations, warranties, covenants, events of default, and remedies. Then, we can combine the modules to form a complete lease contract. Figure 2 illustrates the modular approach.

One of the advantages to a data-driven modular approach is that we can view on the screen, or print, the provisions that relate to any particular topic that we want to review. For example, if we want to view the payment, tax, insurance, default, or remedy provisions, we can retrieve the data relating to that particular topic. We no longer need to flip from one part of the contract to another in order to find the relevant definitions.

**Figure 1. Evolution of a Contract**



**Figure 2. Modular Approach to Building a Digital Smart Lease Contract**



Also, by storing lessee payment history in a related database, we can retrieve contractual payment terms and related actual payment history all in one report.

Portfolios of form contracts can be analyzed, compared, differences summarized, and reports generated without needing to scan and interpret the scan as is currently done.

The process of building smart lease contracts will likely be an iterative process. As lessors working with technology companies become more familiar with the artificial intelligence capabilities, more features can be added, with the end result that over time smart lease contracts will become more complex, offering more features.

## **BENEFITS OF "SMART" LEASE AGREEMENTS**

### **Automation and Speed of Origination of Equipment Leases**

#### *Automation of Document Origination*

The use of artificial intelligence techniques will lead to improved efficiency in the origination of leases through automation of processes. Greater efficiency means lower cost.

#### *Standardized Lease and Loan Terms*

Over time, conversion of lease and loan documents to a data format will likely lead to standardization of terms. Many lessors have observed that there is a tendency for lessees that contract electronically in consumer and small business transactions to not read the online contract as closely as they would have read a paper contract in the past.

Legal standards have yet to develop, but to avoid attack as a contract of adhesion, it would be prudent for the leasing industry to continue developing standard forms of lease and

loan documentation, which if adhered to will be deemed to be commercially reasonable. Conversion of lease and loan documents to a data format will make it easier to standardize legal documentation.

This does not mean that every lessor's form of lease needs to be identical. For example, two leases could contain exactly the same legal terms, but be drafted using a different style and wording in order to create a more competitive lease form.

Under the current approach, a lessee would ask its lawyer to review and compare two or more lease forms from different lessors and summarize the material differences. The attorney would bill for his or her time, and the end product would likely vary considerably depending on the skill and experience of the particular attorney who performed the review. The lessee could then decide which lease it prefers.

Under the new proposed data-driven approach to lease documentation, provided that standards have developed and are adhered to, a computer could compare the leases at

the idea level and generate a comparison of the two leases almost instantly.

An attorney would still need to review and interpret the data comparison, but much of the work of reviewing and comparing leases could be automated, resulting in lower cost to the lessee and, in many cases, a better quality work product.

### **Operational Efficiencies Over the Life of a Portfolio**

Perhaps the greatest economic benefit to a lessor would come as a result of operational efficiencies.

#### *Portfolio Management and Improved Reporting*

Portfolios of form contracts can be analyzed, compared, differences summarized, and reports generated without needing to scan and interpret the scan as is currently done. When we transform a contract to a data format, we no longer are restricted by the four corners of a piece of paper.

We can view the data, and sort and report on the content of the lease contract, in a variety of different formats. We can select

"print standard format to pdf" to create the electronic format that we are used to, or we can do something entirely different.

For example, if we are interested in insurance covenants and stipulated loss value, we can display only those provisions that relate to that topic. There is no limit to the number of possible reports or views of the data that we can create.

#### *Modifications and Amendments*

Currently, modifications and amendments to contracts can be a tedious and expensive process, particularly where a large portfolio of contracts has been securitized. With data-driven contracts, the amendment process could be simplified and reporting enhanced. Much more of the process of amending, summarizing, and reporting could be automated, resulting in lower cost, not to mention fewer errors.

#### *Litigation Support*

Data-driven contracts could be summarized almost instantaneously, since the logic inherent in the contract could be used to generate customized reports. With data-driven contracts, it becomes much easier to extract

whatever data is required in the litigation, whether the issue at hand relates to choice of law, choice of forum, waiver of jury trial, collection of fees, or some other provision in dispute.

### **Collection and Use of Data**

With the application of artificial intelligence techniques to lease and loan documentation, it will be possible to collect data relating to customers over the life of the lease or loan, creating a valuable asset in the process.

While many equipment lessors may not have explored this opportunity yet, with the growing “internet of things” and collection and storage of massive amounts of data about everything we do, data has become the primary focus of attention in the business world. It is important to understand that equipment lessors are also in a position to collect data about their customers.

Of course, there are legal issues concerning who owns the data, and precautions must be taken to avoid violating a customer’s legal right to privacy. Still, with these caveats, data can be an extremely valuable asset that can be used for marketing

purposes or monetized in other ways.

### **Sale, Transfer, and Securitization**

#### **Monetizing Portfolios**

Sale, participation, financing, and securitization of lease and loan portfolios could be streamlined through the use of artificial intelligence technology. The diligence process for reviewing a portfolio of contracts can be a tedious process. Junior attorneys and paralegals spend significant amounts of time reviewing and summarizing material contracts, and verifying principal economic and legal terms, including negative covenants, restrictions on assignment, consent requirements, and confidentiality provisions.

Significant advances have been made in terms of developing artificial intelligence software that can scan and summarize legal contracts, but there are limits on how much a computer can do before escalating the process to review by a human. Depending on the type of contract, current artificial intelligence technology could be anywhere from 60% to 80% efficient before human intervention is required.

With data-driven contracts, however, the level of efficiency could begin to approach 100%, because the “logic” is inherent in the data format of the contract.

#### **M&A Diligence**

A similar diligence issue exists in mergers and acquisitions. Currently, there is either human review of contracts or semiautomated review using artificial intelligence software, where escalation to human review is required for nonstandard provisions, or where there are gaps in information in the contract.

Once again, with data-driven contracts the level of efficiency of portfolio review could be greatly enhanced, not to mention the fact that much more data would be available to sort and summarize.

## **ONE POSSIBLE VISION OF THE FUTURE OF EQUIPMENT LEASING**

No one can predict the future with certainty, but here is one possible vision of the future that incorporates many of the emerging new technologies.

### **Reformatting the UCC as Digital Data Content**

The UCC does a great job of codifying commercial law in a way that reflects the commercial reality of how people transact business in the real world. It is not always easy, however, for non-experts to understand the UCC and all of its intricacies. Reformatting the UCC in a data format using the new logic of the law would open the door to the development of software applications that could assist with the interpretation of the law.

In simple terms, if we use partitions and chains (which form the essence of the new logic of the law, and which anyone can learn) to define legal concepts and articulate legal tests, then we can create an artificial intelligence software program to assist with legal reasoning.

Examples of questions that an artificial intelligence software program could answer include: How do I perfect a security interest in a certain type of collateral? Given certain facts, what are the UCC remedies for a lessee default? and, Given certain facts, are restrictions on assignment enforceable?

The software would guide the user through a list of factual questions, then provide a preliminary answer to the legal question together with the backup reasoning. In the process, artificial intelligence software applications could make the law more accessible to non-experts.

Depending on the type of contract, current artificial intelligence technology could be anywhere from 60% to 80% efficient before human intervention is required.

### **Delivery of Legal Advice by Software Application**

Legal advice of certain types is well suited to the use of software applications. For example, a 50-state survey relating to a particular financial regulatory issue could be available as a web application backed by a database stored on a cloud server. The database could be updated for new developments in the law and would become available to the client automatically; 50-page memoranda would be a thing of the past.

Pricing could be based on a license fee, with a discount for clients meeting certain volume thresholds.

We urge industry leaders to begin the effort now to develop best practices for the application of artificial intelligence techniques to the equipment leasing and finance industry, and to develop open standards that can be applied by all.

### **Development of Standardized Lease and Loan Documentation in a New “Smart Lease/Loan Contract” Data Format**

With lease contracts transitioning to a data format, a likely consequence will be greater standardization of lease and loan terms. As a result, it is crucial that the legal profession focus more attention on best practices and standardization, along with options for “standard” exceptions to the form to meet special needs.

As discussed earlier, even with standardization of boilerplate contract terms at the data level, lessors may continue to customize the wording of their contracts for competitive reasons. Data-driven contracts will simply make it easier for a customer to compare contracts from different lessors and understand the substantive differences.

### **CONCLUSION**

Recent advances in mathematics, logic, data science, and artificial intelligence are about to transform how we document equipment lease and financing transactions. Often when writing about artificial intelligence, authors keep the discussion light and superficial.

In this article, we have attempted to take a very difficult subject and make it accessible by not including too much detail, but at the same time helping the reader understand the importance of some of the new developments in mathematics, logic, and data science.

The benefits to integrating artificial intelligence techniques into

the lease and loan documentation process are many, including greater efficiency in document origination, standardization and transparency of lease and loan terms, and more efficient management and reporting on lease and loan portfolios over the life of the portfolios.

Most importantly, however, those lessors and lenders that fail to keep up with innovation will be at a serious competitive disadvantage in a fintech environment. We urge industry leaders to begin the effort now to develop best practices for the application of artificial intelligence techniques to the equipment leasing and finance industry, and to develop open standards that can be applied by all.

Traditional equipment lessors have an opportunity to be leaders rather than followers in integrating new technology. We have a choice of either hoping for early retirement before the changes become mandatory, or embracing the new technology and using it to our collective advantage.

*The appendix to this article begins on the following page.*

# APPENDIX. PRIMER ON LOGIC

## OVERVIEW OF TRADITIONAL LOGIC

To truly understand what artificial intelligence is, and why it has taken so long to infiltrate the practice of law, we need to start with a brief overview of traditional logic as applied to the practice of law. By understanding the limitations of traditional logic together with the impact of new advances in mathematics, logic, and data science, it becomes obvious why we are on the verge of a flood of technological innovation in the legal profession.

### Classical Logic – The Categorical Syllogism

A categorical syllogism consists of two premises, together with a conclusion that flows naturally from those premises. When we think of the categorical syllogism of classical logic, we most often think of the classic syllogism set forth in Table 1.

**Table 1. The Classic Syllogism**

	<b>"Socrates Is Mortal"</b>	<b>Generic form</b>
Major premise	All men (M) are mortal (P).	All M are P
Minor premise	Socrates (S) is a man (M).	<u>All S are M</u>
Conclusion	Therefore, Socrates (S) is mortal (P).	$\therefore$ All S are P

There are, in fact, 19 valid forms of the categorical syllogism, although the example in Table 1 is by far the most common.<sup>4</sup> Whether attorneys realize it or not, the form of reasoning represented by the categorical syllogism is used commonly in the practice of law.

### Propositional Logic

In propositional logic, logicians study generic propositions  $p$ ,  $q$ ,  $r$ , ... and their negatives (NOT)  $\neg p$ ,  $\neg q$ ,  $\neg r$ , ... connected by "AND" and "OR" to form a "well-formed formula." These three basic logic operations, along with the "implication" operation, are defined in Table 2.

**Table 2. Propositional Logic**

Logic operation "OR"			"AND"			"NOT"		Implication "IF x THEN y"		
x	y	$x \vee y$	x	y	$x \wedge y$	x	$\neg x$	x	y	$x \rightarrow y$
T	T	T	T	T	T	T	F	T	T	T
T	F	T	T	F	F	F	T	T	F	F
F	T	T	F	T	F			F	T	T
F	F	F	F	F	F			F	F	T

A proposition "p" represents a sentence that is either true or false, but beyond that, the logician does not care what the sentence is about. The subject and predicate of the sentence are irrelevant. The theory is that the truth value of the well-formed formula is determined by the truth values of the component propositions. The following is an example of a well-formed formula and the resulting truth values:

$$\frac{T}{p = \text{"The sky is blue."}} \rightarrow \frac{T}{q = \text{"Equipment is a type of goods."}} = \frac{T}{p \rightarrow q}$$

We use an absurd example on purpose, in order to illustrate that the meaning of the sentence is irrelevant. Clearly, it makes no sense to reason: If "the sky is blue," then "equipment is a type of goods." This example highlights the primary limitation of propositional logic — that is, that the meaning of the premises is irrelevant; any appearance of a causal connection in an "if-then" statement is coincidental.<sup>5</sup>

The principal limitation of propositional logic, from the perspective of a lawyer, is that as lawyers we are interested in the relationships among the subjects and predicates of the propositions, but propositional logic looks only at whether the proposition is "True."

### Compound Arguments

One of the most pervasive forms of argument is *modus ponens*: If  $x$  is true, then  $y$  is true.  $x$  is true. Therefore,  $y$  is true.

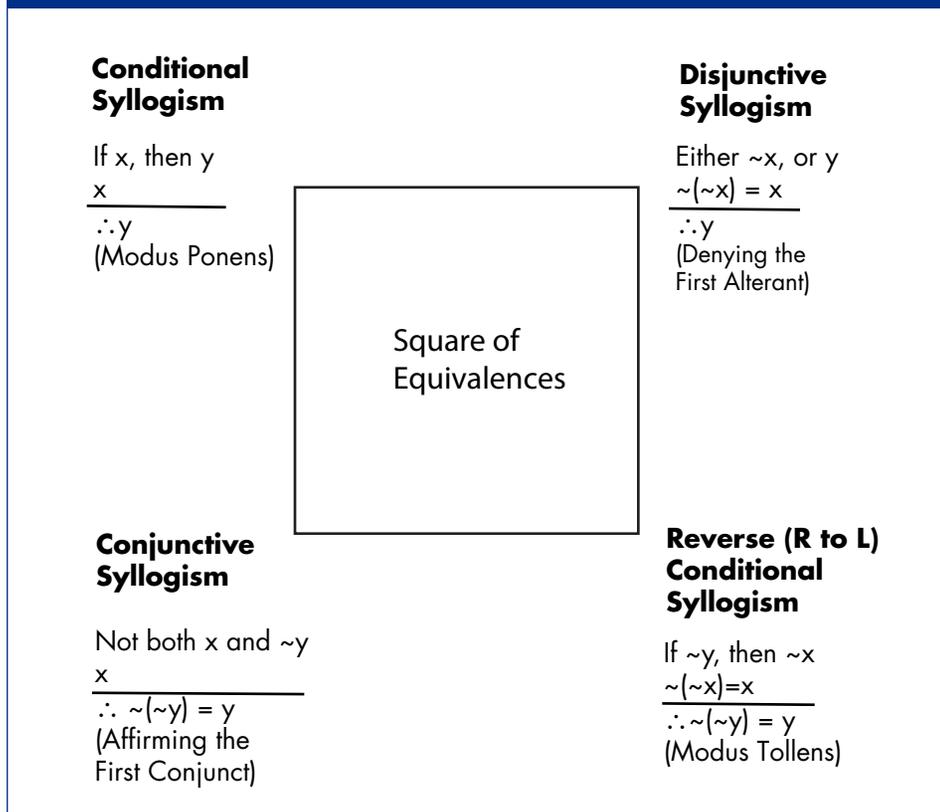
*Modus Ponens*:

$$\begin{array}{l} x \rightarrow y \\ x \\ \hline \therefore y \end{array}$$

Compound arguments like *modus ponens* are also a form of propositional logic, meaning that “x” and “y” in the example are propositions. The only relevant attribute is the truth value; the subject and the predicate are irrelevant. Figure A.1 illustrates four equivalent forms of argument. *Modus ponens* is equivalent to each of the disjunctive syllogism, conjunctive syllogism, and reverse (right to left) conditional syllogism — that is, “if x, then y” = “either not-x or y” = “not both x and not-y” = “if not-y, then not-x.”

Although understanding compound arguments is useful when formulating arguments, this form of logic, without more, is not robust enough to support artificial intelligence in the law.<sup>6</sup>

**Figure A.1.** Square of Equivalences — Modus Ponens



## Predicate Logic

In predicate logic, we use symbols to represent ideas, together with “ $\forall$ ” meaning “for every” and “ $\exists$ ” meaning “there exists.”<sup>7</sup> Therefore, when representing propositions in predicate logic notation, we use “ $\forall$ ” to represent “all” and “ $\exists$ ” to represent “some.” In this way, we can write the A, E, I, and O propositions of classical logic as follows:

- A:  $\forall x: (Rx \rightarrow Sx)$ : All R are S.
- E:  $\forall x: (Rx \rightarrow \sim Sx)$ : No R are S.
- I:  $\exists x (Rx \wedge Sx)$ : Some R are S.
- O:  $\exists x (Rx \wedge \sim Sx)$ : Some R are not S.

Predicate logic is more powerful than the other three forms of traditional logic that we have examined so far, but it has not gained wide acceptance by practicing lawyers. Its usefulness in the practice of law, arguably, is dwarfed in comparison to the new logic of lattices that we examine below.

The problem with the various forms of traditional logic is that they are not robust enough to support our desired form of artificial intelligence. They are all valid forms of reasoning insofar as they go, but they do not go far enough. With advances in logic and data science, we will soon see that a new, comprehensive form of logic is emerging that subsumes the four that we have reviewed so far and goes much further. With the new logic, we have a foundation for artificial intelligence in the law.

## INTRODUCTION TO THE EMERGING NEW LOGIC OF THE LAW

Now that we have a basic understanding of traditional logic as applied in the law, we turn to the latest developments in mathematics, logic, and data science that open the door to a new, exciting form of logic that lays a foundation for the development of artificial intelligence software applications.

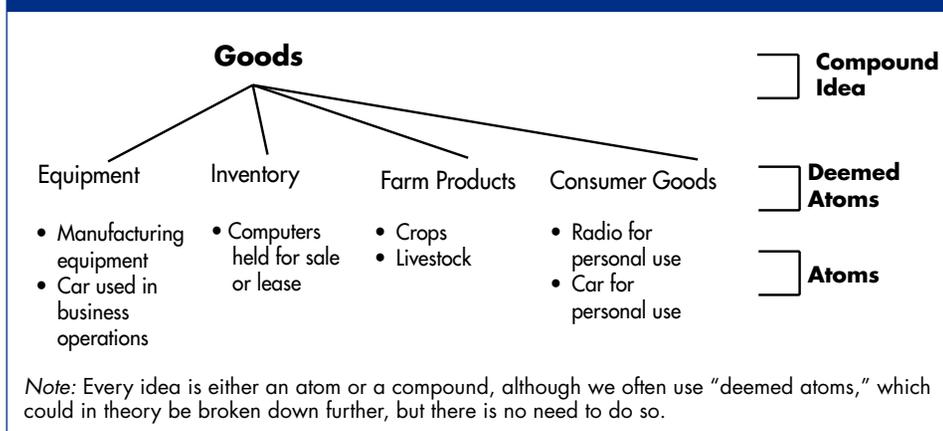
### The Logic of Lattices

With advances in mathematics, particularly in the fields of lattice theory and formal concept analysis,<sup>8</sup> a new “logic of lattices” is emerging. While the underlying mathematics is complicated, it is possible to distill the mathematics of ideas into a handful of key principles that are easy to apply.

## Every Idea Is Either an Atom or a Compound

The starting point in our new logic is the concept that every idea that we are capable of thinking (an “idea”) is either an “atom” or a “compound.” In Figure A.2, the idea “goods” is a compound, and each of equipment, inventory, farm products, and consumer goods is an atom (or “deemed atom”). (Often, we use deemed atoms, if we do not care about breaking down an idea into smaller parts.)

**Figure A.2. An Idea Is Either an Atom or a Compound**



## Every Idea Can Be Defined by Examples of the Idea (Objects) and Properties of the Idea (Attributes)

Another fundamental principle is that we can define any idea by listing examples of the idea, which we call “objects,” or by listing properties of the idea which we call “attributes.” In our example of “goods,” examples or objects would be equipment (e.g., manufacturing equipment), inventory (e.g., computers held for lease), farm products (e.g., crops), and consumer goods (e.g., car held for personal use); and properties or attributes would include movable, personal property, not real property, and tangible.

## A “Partition” Breaks Down an Idea Into Its Object Parts

A “partition” breaks down an idea into its component “object” parts, provided that two rules are adhered to: (1) the component parts must be mutually exclusive, and (2) the partition must be exhaustive, meaning that the component parts make up the whole with nothing left over. In our goods example, we have the following partition:

$$\text{goods} = (\text{equipment} + \text{inventory} + \text{farm products} + \text{consumer goods})$$

$$(abcd) = (a) + (b) + (c) + (d)$$

The power of partitions from an artificial intelligence perspective results from the fact that there is a binary logic inherent in the structure of a partition. This binary logic allows us to create IF-THEN statements that we can use in a software program. For example, we can convert the above partition into the following:

IF goods,  
 AND NOT inventory  
 AND NOT farm products  
 AND NOT consumer goods,  
 THEN equipment.

## A “Chain” Breaks Down an Idea Into Its Attribute Parts

A “chain” breaks down an idea into its component parts in terms of “attributes,” provided that two rules are adhered to: (1) the component parts must be ordered by inclusion (i.e., each element in a chain is a subset of the element above it in terms of sets of objects), and (2) the sorting of attributes by the chain must be exhaustive, meaning that the component parts make up the whole with nothing left over. In our “goods” example, we have the following chain:

$$\text{equipment} \subset \text{goods} \subset \text{personal property} \subset \text{property}$$

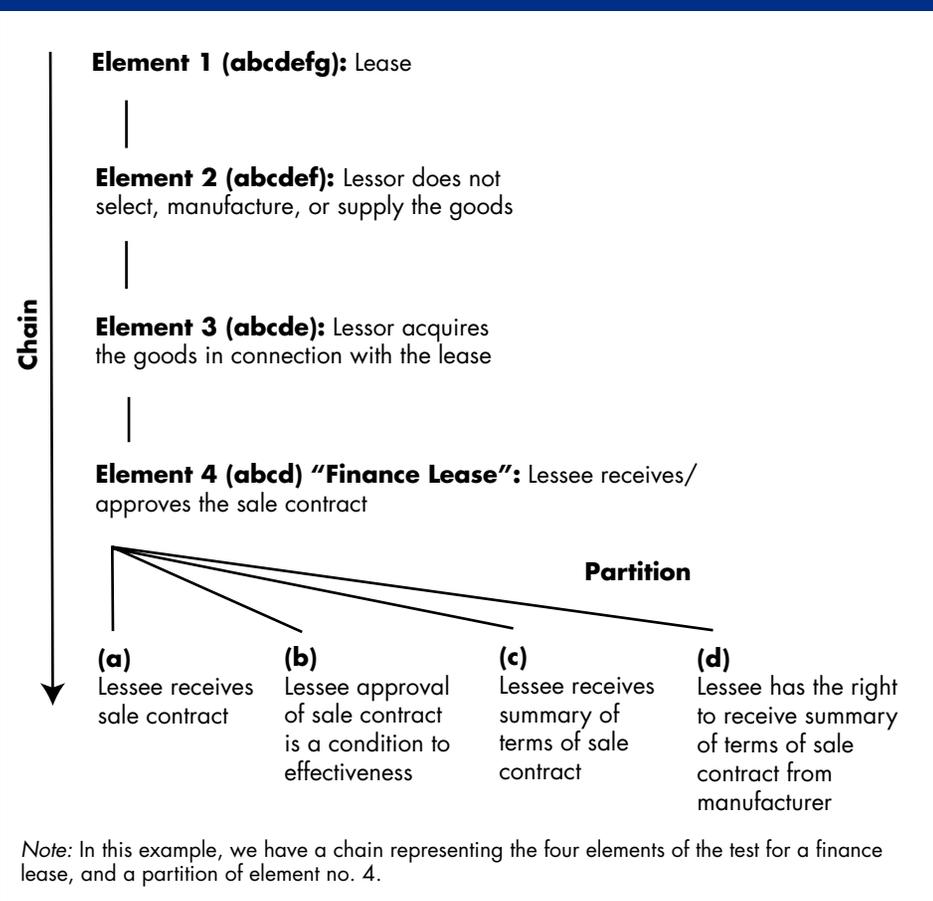
$$(a) \subset (ab) \subset (abc) \subset (abcd)$$

We can also use a chain to represent the elements of any “legal test” or “cause of action,” often in combination with partitions. Figure A.3 provides an example of such a chain for the definition of “finance lease,” taken from UCC Article 2A.

As with a partition, there is a binary logic inherent in the chain structure. For example, we can convert the above chain into the following:

IF lease,  
 AND lessor does not select, manufacture, or supply goods  
 AND lessor acquires the goods in connection with the lease  
 AND lessee receives/approves the sale contract:  
 {lessee receives sale contract  
 OR lessee approval of sale contract is condition to effectiveness  
 OR lessee receives summary of terms of sale contract  
 OR lessee has right to receive summary from manufacturer  
 }  
 THEN finance lease.

**Figure A.3.** Using a Chain to Represent the Test for a Finance Lease

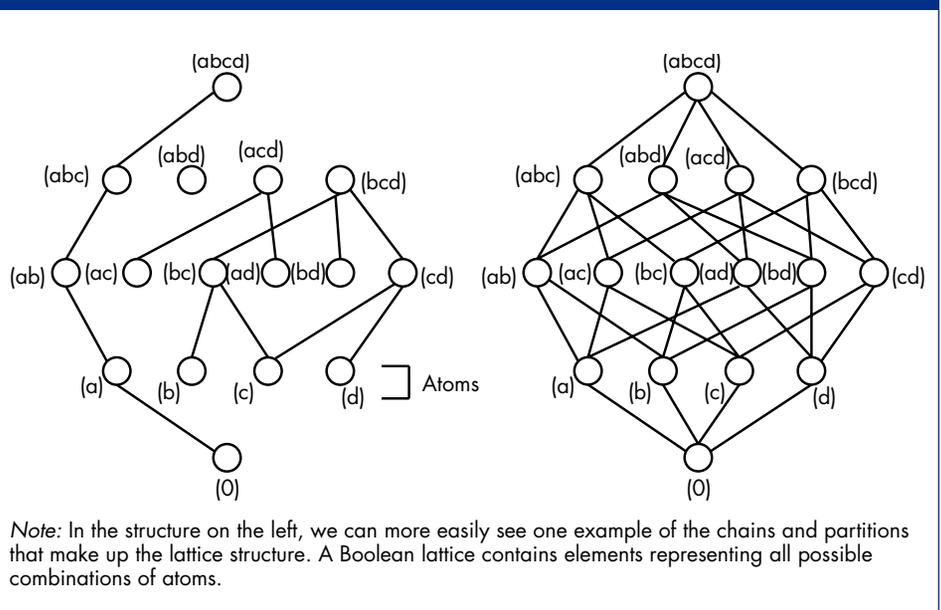


**Partitions and Chains Together Comprise a Boolean Lattice Structure**

Together, partitions and chains combine to form a Boolean lattice (Figure A.4).

Using these same techniques, we can convert any statute, case, or contract into partitions and chains from which we can build a Boolean lattice that we refer to as a “knowledge representation structure.” In the process of creating the map to a knowledge representation structure, we convert the statute, case, or contract into data governed by a specific binary logic inherent in the Boolean lattice structure.

**Figure A.4.** Partitions and Chains Together Form a Boolean Lattice



Traditional logic covers relatively simple scenarios with typically one to five atoms, whereas the new logic of lattices relates to scenarios that are orders of magnitude more complicated with potentially very large numbers of atoms. As the knowledge representation structure grows in size, it begins to resemble a giant sphere of data when viewed in three dimensions. The binary logic that is inherent in the Boolean lattice structure makes artificial intelligence possible.

One of the features of the new logic of lattices is that all of the existing forms of logic remain valid, are subsumed by the new logic, and can still be used. Therefore, we lose nothing when we move to the logic of lattices, since we can continue to use categorical syllogisms, propositional logic, compound arguments, and predicate logic.

We gain a lot, however, because the Boolean lattice structure is scalable to handle much more complex factual and legal scenarios, and lends itself to the development of artificial intelligence techniques.

## Endnotes

1. See, for example, Brett Boehm and Patricia M. Voorhees, "FinTech Pressure on Equipment Finance Companies Serving SMB Markets," *Law Journal Newsletters' Equipment Leasing Newsletter* (March 2017).

2. For more information about artificial intelligence generally, see: Ertel, Wolfgang, *Introduction to Artificial Intelligence*, 2<sup>nd</sup> ed. (Weingarten, Germany: Springer, 2017); Brachman, Ronald J., and Hector J. Levesque, *Knowledge Representation and Reasoning* (San Francisco: Elsevier, 2004); Sowa, John F., *Knowledge Representation* (Pacific Grove, CA: Brooks/Cole, 2000); and Jackson, Philip C., *Introduction to Artificial Intelligence*, 2<sup>nd</sup> ed. (New York: Dover, 1985). For more information about artificial intelligence and the law, see: *Legal Knowledge and Information Systems, JURIX 2000–2016: Annual Conference, Foundation for Legal Knowledge Systems* (Washington, DC: IOS Press, 2000–2016); and *Artificial Intelligence and Law*, Springer, vol. 1 (1992) – vol. 26 (2018).

3. From time to time, the author intends to post on his website more examples of the application of artificial intelligence to lease and loan documentation, as well as applications to the UCC generally.

4. For more information about classical logic, see: Kreeft, P., *Socratic Logic* (South Bend, IN: St. Augustine's Press, 2010); and Aldisert, Ruggero J., *Logic for Lawyers – A Guide to Clear Legal Thinking* (South Bend, IN: National Institute for Trial Advocacy, 1997).

5. For more information about propositional logic, see: Smullyan, Raymond M., *A Beginner's Guide to Mathematical Logic* (New York: Dover, 2014); Burris, Stanley N., *Logic for Mathematics and Computer Science* (Upper Saddle River,

NJ: Prentice Hall, 1998); and Langer, Susanne K., *An Introduction to Symbolic Logic* (New York: Dover, 1967).

6. For more information about compound arguments, see: Shenefelt, Michael, and Heidi White, *If A, Then B: How the World Discovered Logic* (New York: Columbia University Press, 2013); and Cothran, Martin, *Traditional Logic – Advanced Formal Logic* (Louisville, KY: Memoria Press, 2000).

7. For more information about predicate logic, see: Tall, Aliou, *From Mathematics in Logic, to Logic in Mathematics: Boole and Frege* (Boston, Docent Press, 2014); and Quine, Willard Van Orman, *Methods of Logic* (Cambridge, MA: Harvard University Press, 1982).

8. For more information about lattice theory, see: Grätzer, George, *General Lattice Theory*, 2<sup>nd</sup> ed. (Boston: Birkhäuser, 2003); and Davey, B.A., and H.A. Priestley, *Introduction to Lattices and Order*, 2<sup>nd</sup> ed. (London: Cambridge University Press, 2002). For more information about formal concept analysis: see Ganter, Bernhard, and Rudolf Wille, *Formal Concept Analysis* (New York: Springer, 1999); and also the website of Uta Priss at <http://www.upriss.org.uk/fca/fcaintro.html>.



## William S. Veatch

[wveatch@reedsmith.com](mailto:wveatch@reedsmith.com)  
[www.reedsmith.com](http://www.reedsmith.com)

William S. Veatch is a partner in the San Francisco office of the law firm Reed Smith LLP. In addition to his debt, equipment leasing, and receivables finance/securitization practice, he works with the technology innovation team at the global law firm of Reed Smith LLP. He wrote *Math Without Numbers – Vol. 1. Foundations* (2016), describing a new mathematics of ideas; *Propositional Logic as a Boolean Algebra – A New Perspective, Vol. 1*, describing a new "logic of lattices"; and *The New Logic of the Law – Building a Foundation for Artificial Intelligence in the Law* (expected in 2018). Examples of the application of artificial intelligence will be posted on the author's webpage from time to time. Mr. Veatch welcomes anyone interested in the application of artificial intelligence to the law, and legal tech and innovation generally, to contact him by email. He earned an LL.B. from the University of Manitoba and a BA from the University of Winnipeg, both in 1985. He holds a JD (1987) from the University of California, Hastings College of the Law, San Francisco. The ideas and conclusions in this article do not necessarily reflect the views of Reed Smith LLP.