The Adaptability of the Legal Expert System to CISG

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Legal reasoning floats between inorganic semantics and pure persuasion which appeals to the synthesized human evaluation. The construction of a legal expert system involves absorption of this complex process. It must determine the extent to which semantic logics may be maintained for each legal rule and how to interweave the application of general rules which override specific rules in each case. Where a mechanical application of several specific rules leads to more than one conflicting conclusion, the initial legal inputs must be reassessed in light of the overall objective of a rule in a given situation. Appropriate inductive and abductive reasoning is required. Meanwhile, for a legal expert system to operate efficiently, the use of certain default values is indispensable to prevent redundancy. However, the determination of a default value relates to the delicate question of the allocation of burden of proof, and even if an aspect is properly handled, an excessive use of default values may make the legal expert system impractical. The building of an expert system is a complex process often revolving around a pillar. The process also reveals many logical questions which the legal profession so far ignored.

The construction of an expert system would have been more feasible if the traditional legal positivism was in full swing. It would have been simpler if an expert system dealt with the application of more mechanical areas of laws such as traffic violation or tax rules. However, the present project ambitiously chose as its target the United Nations Convention on Contracts for the International Sale of Goods (CISG). CISG is popular for its dogma free nature and revolutionary in bringing in the unwritten norms of assessment by the society to the realm of law. Above all, in CISG, good faith is a prevailing standard for interpreting each rule. Thus, the room for dogma is minimum in CISG and its application is far more flexible when compared to the traditional codes of law. It was, therefore, quite natural that the construction of the expert system thereon encountered tremendous hurdles for lawyers, logicians and engineers. However, because of this challenge, the constant process of trials and errors provided profound insights even about the objective of the law in general which CISG implies, and contributed to providing a basis for the enhancement of this valuable set of rules at the truly global level together with other similar undertakings in other parts of the world.

The Clarification of the Logical Structure of Contract Law and Construction of CISG Knowledge Base System

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Abstract

It is necessary for a deductive legal knowledge base first to clarify the structure of the law as a deductive system from which a legal judgement can be justified as a conclusion of logical deduction together with relevant facts. As the logical state of affairs changes according to the time progress of an event, a clarified logical model of law is necessary to enable us to deduce changes among legal relationships over time from the beginning to the end of a case. This study presents such a model based on Logical Jurisprudence, in which the relationship between legal sentences and the meta-sentences regulating the validity of legal sentences plays a distinctive role. The model is applied to the United Nations Convention on Contracts for the International Sale of Goods (CISG) and a deductive knowledge base of the CISG is developed. The deductive structure of the contract law is clarified in the knowledge base so that appropriate answers are deduced to questions about legal states of affairs at any time point as a result of the application of CISG provisions to a concrete case.

1 Introduction

It is necessary for a deductive legal knowledge base as well as legal science at first to clarify the structure of the law as a deductive system from which a legal judgement can be justified as a conclusion of logical deduction together with relevant facts. We have developed a knowledge base of the United Nations Convention on Contracts for the International Sale of Goods (CISG) in the 'Legal Expert' Project.1 For a legal knowledge base of the CISG, it has been necessary for us first to clarify the logical structure of the contract law system as a whole because, to justify a legal judgement as a conclusion of logical deduction from a legal system of the CISG, together with a given fact by means of a legal expert system, we must make a deductive knowledge base of the CISG successfully and, for such a construction, we must to have a clear logical model of the contract law system to which the CISG belongs and upon which it is based, thus making it possible to justify the judgement as a result of logical deduction.

The legal state of affairs, which refers to the states of legal relations, changes according to the chronological progress of an event over time. We therefore must clarify such a logical model of law that enables us to deduce changes of legal relation according to time, regardless of any time point in given events from the beginning to the end, for example, before or after the contract conclusion, before or after fulfillment or non-fulfillment of an obligation on contract, before or after remedies for breach of contract, before or after cancellation of contract, before or after fulfillment or non-fulfillment of restitution, and so on. The present work contributes to this clarification.

The systematicatization of law, i.e., to present the law as a deductive system, has long been a central theme of legal theories, but remains obscure.2 Modern mathematical logic and the construction of a knowledge base system of law gives the opportunity to systematize this properly, succinctly and explicitly and demonstrates that the proposed systematization is correct.

I believe we have already clarified the logical structure of the contract law system in the above sense and have developed a knowledge base that demonstrates it appropriately. Our aim here is to present the essence of the clarification of the logical structure of contract law system by focusing on the CISG.

The study is based on Logical Jurisprudence.3 This paper

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demonstrates the basic structure of law from the point of
Logical Jurisprudence. In accordance with such a framework,
this study clarifies and demonstrates the structure of contract
law as a deductive system from which a legal decision may be
justified as a logical deduction when the CSG is applied to a concrete
case. This report considers the relationship between legal
sentences and legal meta-sentences that provide the validity of legal
sentences as the starting point for legal knowledge analysis and
modeling. From this point, a deductive model of the contract law
system is presented and applied to the CSG. The legibility of
the model is demonstrated in an example of the CSG
application to a concrete case.

2. Logical Jurisprudence

Logical Jurisprudence ("Logische Rechtslehre") is a legally
theoretically developed discipline in jurisprudence
"legal logic" or "Juristische Logik".

Logical Jurisprudence tries to constitute the world of legal
discourse in terms of smallest unit of primitives. It starts from
three primitive "sentences", "validity" of a sentence, and "inference
rule." Logical Jurisprudence attempts to explain or model
the law using these three notions.

Logical Jurisprudence does not support the existence of
"legal norms as a meaning", which has traditionally been ad-
mited or presupposed in legal studies and practice. Logical Juris-
prudence presupposes the notion "sentences." Sentences exist,
as a form of written or spoken sign, cognizable or perceptible and
therefore communicable. In my opinion, legal norms as a
meaning belong to the world of images. It is what one imagined
when legal sentences are thought of. To communicate images to
other persons, they must be put them into sentential form, percept-
able by others. Logical Jurisprudence considers sentences in the
field of law as the direct and sound object of legal recognition.

The second basic concept in Logical Jurisprudence is "valid-
ity" of a legal sentence. The validity of a legal sentence is viewed
by Logical Jurisprudence as a "truth in the legal sense.". That
a legal sentence is valid means that the sentence is true in the world
of legal discourse, i.e. legally true. Logical Jurisprudence re-
resents this legal truth by means of a predicate (e.g.
"is_valid(sentence, legal_trueness)") which could be read as Fol-
lower: "The sentence is valid for a goal at time t." The represen-
tation of the validity concept by a predicate is characteristic of
Logical Jurisprudence that corresponds to the natural language

representation of knowledge in the real legal world.

The third basic concept in Logical Jurisprudence is the "inference
rule." The logical correct reasoning is based on inference
rules. The main inference rule is

Modus Ponens which is represented in the following schema
where A and B express propositions:

(A → B) ∧ A → B

This formula in is to be read: If "A then B" is true and A is true,
then follows B is true. Modus Ponens is the basic reasoning
schema for legal reasoning as discussed later.

In Logical Jurisprudence, legal reasoning is a process of the
development of legal sentences. In other words, legal sentences
are developed in the process of legal reasoning.

Logical Jurisprudence divides legal reasoning into reasoning
of justification and reasoning of discovery. Reasoning of legal
justification is reasoning through which a judgement is justified
from already justified legal knowledge. Logical deduction is the
type of reasoning in legal justification. The logical structure of
this reasoning is Modus Ponens. Judgement may not be deduced
from statements and facts alone, but may be shown to be deduced
from the whole body of legal knowledge, including statutes, facts
and additional legal sentences to the former as implicit legal
common sense or as a result of the reasoning of legal discovery.

Logical Jurisprudence makes these implicit or discovered know-
ledge clear and identifies it to make it explicit. Following are
such additional legal sentences: principles of law that unify stat-
utory legal sentences, common sense about legal terms, especially
historical relations between legal concepts, and the proposition
of interpretation of statutes that are produced by the reasoning
of legal discovery. Logical Jurisprudence analyzes legal knowledge
in detail, recognizes and demonstrates the implicit knowledge of
legal experts, and legal sentences created by the reasoning of legal
discovery, such that the reasoning of legal justification is formed
as logical deduction.

Reasoning of legal discovery is reasoning through which
judgements themselves or additional legal sentences are
discovered or created. This reasoning is based on legal deduction
because discovered legal sentences are to be set so that the whole
reasoning process including these additional sentences can be
represented as a logical deduction on the one hand and the reason-
ning of discovery is to be performed through a falsification iner-
ence on the other. Falsification has the logical structure of
Modus Tollens:

(A → B) ∧ ¬B → ¬A

This formula is read as follows: If "A (together with theorems accepted already) then B follows." and

it is proven that B is not true, then it follows that the hypothesis A
is not true. (The legal hypothesis cannot be proven as just but
only falsified as unjust.)

The reasoning of legal discovery, however, requires some-
thing more than deduction. To get hypothesis A in the schema
above, abductive or inductive reasoning are needed.

Figure 1: Legal Reasoning Structure

<table>
<thead>
<tr>
<th>Legal Rule Sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legal Principle</td>
</tr>
<tr>
<td>Statute</td>
</tr>
<tr>
<td>Interpretation 1 (general opinion)</td>
</tr>
<tr>
<td>Common Sense of Legal Concepts</td>
</tr>
<tr>
<td>Interpretation 2 (for a concrete case)</td>
</tr>
<tr>
<td>Fact Sentence</td>
</tr>
<tr>
<td>Confirmed fact</td>
</tr>
<tr>
<td>Described fact</td>
</tr>
<tr>
<td>Events</td>
</tr>
<tr>
<td>Legal Judgment Sentence</td>
</tr>
<tr>
<td>Legal Conclusion</td>
</tr>
</tbody>
</table>

Removing to get a hypothetical fact sentence is abduction and rea-
graining to generalize a rule is induction. Logical Jurisprudence
analyzes the legal reasoning process in two directions: (1) contradic-
tion (putting in concrete terms) and (2) systematization. This is also
true for legal reasoning of discovery. The study of legal interpreta-
tion or analysis is important to contrast. In systematization, it
is important to make legal principle sentences clear which will enable
us to bring more collections of legal sentences into a system, on the
one hand, and to analyze how legal principle sentences are to be
found as hypothesis on the other.

The structure of legal reasoning in the application of law, in which
two reasoning of justification and discovery interact with a concrete
case is shown in Figure 1.

The study of legal discovery reasoning is important to tie the theory
of legal reasoning, both in contrastion1 and systematization.

Few engineers, however, study legal knowledge systematiza-
tion itself, in showing laws as a deductive system. This is because
engineers assume that a theory of science has a deductive
structure, they are not interested in finding the deductive structure
of law and, furthermore, legal knowledge is too specialized and compli-
cated for engineers to deduce the structure. To construct a legal expert
system, however, the deductive structure of law must be clarified
in order to make a deductive knowledge base. It has long been desired in legal
studies to clarify the deductive structure of law and to systematize legal
knowledge.2 We focus on how to systematize the law of contracts
as a deductive logical system, leaving the reasoning of legal
discovery in CSG to another time.3

3 The Basic Concept and Structures of Legal Sentences

Sentences in the legal field, referred to here as legal sentences,

1 Cf. Ref. 6
2 Our study developed independently of theirs. Their approach is different from von K hnig's.
For example, it is not a systematic and logical method, but partly legal, especially in that we analyze reasoning as follows in "legal sentences," "their structure," and "legal deductions."
3 We have already showed this in a previous paper, namely, Ref. 15.
are starting points. We introduce legal sentence, basic concept, according to which legal sentences are classified so that laws can be systematized as a deductive system of legal sentences.

First, it is important to distinguish between legal rule and fact sentences. Legal sentences consist of two types: Legal rule sentences have the following syntactic form: \( \forall x (N(x) \rightarrow L(x)) \). This formula is read: "For all x, N is a, L is b." In legal sentences, the consequence of the sentence, which is the formula at left in the implication, is called a "legal consequence" and the antecedent, which is the formula at right, is called a "legal requirement." Legal fact sentences have the following syntactic form: \( \text{\textit{b}}(\text{\textit{e}}) \), read: "\( \text{\textit{b}} \) is \( \text{\textit{e}} \)." Note that the difference between legal rule and fact sentences is, in Logical Jurisprudence, purely syntactic, as mentioned above.

Second, legal sentences are to be further classified in terms of sentences, the smallest unit of legal sentences. Statutes or contracts are composed of elementary legal sentences, e.g., "one must drive a car under 100 km/hour on a highway" or "A may require B to pay the price of $10,000." A complex legal sentence is a group of legal sentences, e.g., "the United Nations Convention on Contracts for the International Sale of Goods," or "A contract for sale of a farming machine between A and B on October 8, 1997." A code, and parts or sections or an article of a statute is a complex legal sentence. In elementary and complex legal sentences, in most cases, the fact that a certain legal sentence belongs to a complex legal sentence is represented by the place and the space where they are printed. The relationship is represented in Logical Jurisprudence by a sentence describing the united relationship of grouped sentences. The concept of a complex legal sentence enables us to treat the validity of legal sentences at once. Namely, if one has described the validity of a complex legal sentence then all legal sentences that belong to it have been regulated. The validity of a complex legal sentence is that it contributes to producing economical description.

It is also important for the deductive systematization of legal knowledge to distinguish between legal object sentences and legal meta sentences. A legal object sentence describes the object itself. In the legal domain, the object is an "obligation." Legal object sentences prescribe the obligations of a person. The sentence "one must drive a car under 100 km/hour on a highway" or "A must pay the price of $10,000." A legal meta sentence prescribes legal sentences. More precisely, it describes the validity of a legal sentence. Some legal meta sentences describe the validity of meta sentences. An example of a legal meta sentence is: "A law is enforced 20 days after the day of its promulgation" (Article 1 of the law governing the application of law (JOURNAL) or "(1) This Convention applies to contracts of the sale of goods between parties whose places of business are in different states: (a) when states are contracting states; or . . . " (Article 1 of the CISG).

Law ultimately prescribes the obligation of persons. In other words, people's conduct is ultimately regulated by obligations given by them to law. What legal obligations exist depend on the legal sentences that describe the obligations, or more precisely, on the validity of legal object sentences. The validity of legal object sentences is prescribed by legal meta sentences. In Logical Jurisprudence, the existence of A's obligation to do Z means that "A has an obligation to do Z" or "It is obligatory for A to do Z" is valid.

Figure 2: The Existence of an Obligation and the Validity of the Object Legal Sentences

4 Case and Solution

This section describes an example of a dispute relevant to CISG, presents the example, and introduces legal solutions to questions so that the deductive knowledge structure of contract law by which solutions may be deduced are clarified.

<table>
<thead>
<tr>
<th>Case 70</th>
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<tbody>
<tr>
<td>(1) On April 3, 1997, A, a farming machine maker in New York, sent a letter to the branch office in Hamburg of B, a Japanese trading company. The letter indicated that A was to sell B a set of farming machines for $50,000, and that A was to deliver the machine to B by May 10 and that B was to pay the price to A by May 20.</td>
</tr>
<tr>
<td>(2) On April 8, the letter reached B, the branch office in Hamburg.</td>
</tr>
<tr>
<td>(3) On April 9, B made a telephone call to A. &quot;The offer is accepted.&quot; Then B said to A, &quot;I would like to withdraw my offer.&quot;</td>
</tr>
<tr>
<td>(4) On May 1, A finally handed the farming machine over to a Japanese container ship at the port of New York.</td>
</tr>
<tr>
<td>(5) On May 31, the machine was delivered to the branch office in Hamburg.</td>
</tr>
<tr>
<td>(6) On June 5, B examined the machine.</td>
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<tr>
<td>(7) On May 10, B paid the price of $50,000 to A.</td>
</tr>
<tr>
<td>(8) On August 10, the machine proved to be operating out of order because of a faulty connection gear. B immediately notified A specifying the nature of the problem.</td>
</tr>
<tr>
<td>(9) On September 1, B asked A to repair the problem within one month. A did not repair it until October 1.</td>
</tr>
<tr>
<td>(10) On October 1, B declared the contract void.</td>
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<tr>
<td>(11) On December 10, A recovered damages and restored the machine delivered by A.</td>
</tr>
<tr>
<td>(12) On December 20, A estopped the price paid by B.</td>
</tr>
</tbody>
</table>

The following questions are set as examples:

**Question**

At each of the points in time below, what is the legal relation that exists between A and B?

1. April 26th
2. April 15th
3. May 5th
4. August 15th
5. September 15th
6. October 5th
7. November 15th
8. December 15th
9. December 25th

The following CISG articles apply:

**Article 15**

(1) An offer becomes effective when it reaches the offeror.

(2) An offer, even if it is irrevocable, may be withdrawn if the withdrawal reaches the offeror before or at the same time as the offer.

**Article 16**

(1) Until a contract is concluded an offer may be revoked if the acceptance reaches the offeror before he has dispatched his acceptance.

(2) An acceptance of an offer becomes effective at the moment the indication of assent reaches the offeror.

**Article 23**

A contract is concluded at the moment an acceptance of an offer becomes effective in accordance with the provisions of this Convention.

**Article 31**

If the seller is not bound to deliver the goods at any other particular place, his obligation to deliver comprises:

(a) if the contract of sale involves carriage of the goods - in handing the goods over to the first carrier for transmission to the buyer;

(b) otherwise - in delivering the goods to the buyer.

**Article 39**

(1) The buyer loses the right to rely on a lack of conformity of the goods if he does not give notice to the seller specifying the nature of the fault within a reasonable time after he has discovered or ought to have discovered it.

**Article 45**

(1) If the seller fails to perform any of his obligations under the contract or this Convention, the buyer may:

(a) rescind the contract provided in articles 46 to 52;

(b) claim damages as provided in articles 74 to 77.

(2) The buyer is not deprived of any right he may have to claim with this requirement.

(3) If the goods do not conform with the contract, the buyer may require delivery of substitute goods only if the lack of conformity constitutes a fundamental breach of contract and a request for substi-
tute goods is made either in conjunction with notice given under article 39 or within a reasonable time thereafter.

3) If the goods do not conform with the contract, the buyer may require the seller to remedy the lack of conformity by repair, unless this is unreasonable having regard to all the circumstances. A request for repair must be made either in conjunction with notice given under article 39 or within a reasonable time thereafter.

Article 47
1) The buyer may declare the contract avoided:
   (a) if the failure by the seller to perform any of his obligations under the contract or the Convention amounts to a fundamental breach of contract; or
   (b) in case of non-delivery, if the seller does not deliver the goods within the additional period of time fixed by the buyer in accordance with paragraph (1) of article 47 or declares that he will not deliver within the period so fixed.

[Solution]
1) On April 5th, there is no legal relation between the seller A and the buyer B.
2) On April 15th, A has a duty to deliver the farming machine to B by May 10 and B has a duty to pay the price $50,000 to A by May 20th, while B has the right to require A to deliver the goods to B and A has the right to require B to pay the price to A by May 10th.
3) On May 5th, B has a duty to pay the price $50,000 to A by 20 May, while A has the right to require B to pay the price to A by May 10th.
4) On August 15th, A has a duty to recover the damage, while B has the right to claim from A the damage and B has the right to require A to repair the machine.
5) On September 15th, A has a duty to recover the damage and a duty to repair the machine, while B has the right to claim from A the damage and B has the right to require A to repair the machine which is restricted to exercise.

6) On October 5th, A has a duty to recover the damage and a duty to repair the machine, while B has right to claim from A the damage, B has right to require A to repair the machine and B has a right to declare the contract avoided.

7) On November 15th, A has the duty to recover the damaged goods and the duty to resubmit the price paid by B, and B has the duty to resubmit the machine delivered by A, while B has the right to claim the damage from A and the right to require A to resubmit the price, and A has the right to require B to resubmit the machine.

8) On December 15th, A has the duty to resubmit the price paid by B, while B has the right to require A to resubmit the price.

9) On December 25th, there is no legal relation between A and B on the contract.

The changes of legal relation according to the time progress in case 7 are shown in Fig. 3.

The above solutions correspond to obligation and right. In this chart, the existence of legal relations is indicated by a solid line on the axis of legal sentences which describe obligations and rights in the figure. The knowledge structure which enables deduction of the above solutions or enabling the formation of legal sentences is to be clarified below.

5. The logical Structure of Contract Law - Regulating Changes in Legal Relation and the Representation in the CISG Knowledge Base

In Legal Jurisprudence, the existence of an obligation means that a legal object sentence describing the obligation is valid as mentioned above. The existence of A's obligation to deliver a farming machine to B means that "A has an obligation to deliver a farming machine to B" is true. If the parties have an obligation to deliver a farming machine to B based on a contract, it is so because the sentences in the contract describing the obligation (that is, legal object sentences) are valid as proved. The contract law is a set of legal object rule sentences that regulate the validity of the legal object sentences of the contract. Below, we show what legal object rules sentences work to prove the validity of the legal object sentences related to the contract and how they do so.

5.1 Legal Rule Sentences Deciding that Legal Sentences are Valid.
The following fundamental legal meta rule sentence is valid for confirming that legal sentences are valid:

(see "A legal sentence is valid for a goal G at the time T if only if it becomes valid for G at time T before T and S is not terminated for G after T1 and before T."

This rule is represented in the CSG Knowledge as follows:

\[
\text{sentence} \{ \text{has_valid_sentence} \} \text{sentence}(\text{sentence}(\text{time_before}(T1,T2)))
\]

\[
\text{be}(\text{sentence} \{ \text{has_valid_sentence} \} \text{sentence}(\text{sentence}(\text{time_before}(T1,T2))) \& \text{terminate} \{ \text{sentence} \{ \text{has_valid_sentence} \} \text{sentence}(\text{time_before}(T1,T2))) \}
\]

This legal meta rule cannot be confused as a static test in the CSG or other regulations. It is a fundamental legal meta rule sentence implicitly taken for granted by the CSG and all other regulations. Without this rule, no legal sentence works when it comes to application. This rule is the most fundamental among legal meta rules enabling us to put a more collection of legal sentences into a legal system. This rule applies to every case, where the validity of legal sentences is considered.

In deciding, for example, whether legal sentence "A has an obligation to deliver the machine to B on April 15th" is valid, we apply this rule and examine its specified requirements: "A has an obligation to deliver the machine to B becomes valid before April 15th." A has obligations to deliver the machine to B if it is not terminated until April 15th. If both requirements are satisfied, then the legal sentence is valid, in April 15th. Therefore, A's obligation to deliver the machine exists in the prevailing usage of legal language, if not, it is not valid, and therefore the obligation does not exist.

How are legal sentences to be systematized under this fundamental legal meta rule sentence? All other legal meta rule sentences are systematized as subrules of this sentence, as rules to decide whether the two different requirements of this fundamental meta rule sentence, i.e., "the legal sentence becomes valid" and "the legal sentence is not terminated," are satisfied. 12

Now, we shall clarify the structure of legal knowledge deciding these factors, i.e., "the legal sentence becomes valid" and "the legal sentence is not terminated," focusing on the validity of legal object sentences to make the legal structure of legal knowledge governing changes of legal obligations clear. Here, the following: "The legal sentence is not terminated" means "it is not the case that the legal sentence is terminated." In the real legal world, there is no rule that decides directly "a legal sentence is not terminated," but there exist many legal rules sentences which decide "a legal sentence is terminated." (The legal rules sentences that decide "a legal sentence is terminated" play their role through "Negation as a Failure" for the second requirement of the fundamental meta rule "sentence."

5.2 Legal Rules Sentences Deciding Acquittal of Obligation

Legal obligations occur because legal object sentences become valid as mentioned above.

5.2.1 Acquittal of Validity of Elementary Legal Sentences with Acquittal of Contract Validity

The acquittal of validity of a complex legal sentence follows the acquittal of validity of elementary legal sentences belonging to it. The following legal meta rule sentence is presupposed:

(901) An element sentence becomes valid at the time T if it is an element sentence of complex sentences at the time T and if the complex sentence becomes valid at the time T.

The above rule is installed in the CSG Knowledge base as a CFP as follows:

\[
\text{sentence}(\text{valid}(\text{sentence}(\text{time_before}(T1,T2))) \& \text{sentence}(\text{time_before}(T1,T2)))
\]

\[
\text{become_valid}(\text{sentence}(\text{sentence}(\text{time_before}(T1,T2))) \& \text{sentence}(\text{time_before}(T1,T2)))
\]

\[
\text{element_sentence}(\text{sentence}(\text{sentence}(\text{time_before}(T1,T2))) \& \text{sentence}(\text{time_before}(T1,T2)))
\]

Consider, for example, the change in the legal relation on April 9 in Fig. 3. As the contract as a complex legal sentence has become valid, the following two obligations sentences (legal object sentences) as elementary legal sentences of the contract, become valid: "A has an obligation to deliver the machine to B" and "B has an obligation to pay the price by May 20th." The main part of contract law in legal meta rules regulating changes of validity of the contract itself as a complex legal sentence, i.e., the acquittal and termination of its validity.

Figure 4 is a logical flowchart of the legal rule sentence that decides the acquittal of validity of contract. 3AA1BA in Fig. 4 means that the contract is concluded. The "termination" of the contract means that it is formed as a legal sentences named contract. Legal sentences differ from conventional sentences because legal sentences is made satisfying the requirements of legal meta rules prescribing the formation of the relevant legal sentences such as contracts, judgments, statutes, constitutions, and conventions.

Figure 4: 3AA1BA A contract becomes valid.

Part 2 of the CSG completes the detailed description of conclusion from Articles 14 through 24.

Figure 5: [2A] Contract is concluded

This rule is related to Article 23, but is not the same. The article does not refer to the effectiveness of an offer directly. For Articles 14 through 17 to be systematized, the first requirement must be met. This legal rule sentence therefore [2A] (Fig. 5) is a legal principle of contract law. (This rule would be valid for the case of the CISG and also for other contract laws.) Articles 14 through 17 and 24 in part 1 are to be systematized as a subrule of the first requirement [2A] of this legal rule sentence. Articles 18 through 22 and 24 in part 2 are systematized as a subrule of the second requirement [2A].

5.2.2 Acquittal of a legal object sentence by exercising rights

In some cases, the acquittal of validity of the elementary legal sentence by itself, not as a result of the acquittal of contract validity, is regulated. An obligation arises, for example, along with the exercise of the right relevant. In Fig. 3, the legal sentence "B has an obligation to repair the machine for A" becomes valid because A exercised the right to require the repair of the machine on September 1st.

Logical determinism does not consider sentences describing rights as a legal object sentence in the prevailing opinion in legal theories, but as legal meta rule sentence, as described above. That a person has a right to require another person to do Z, for example, means, in our opinion, that the person may arrive at a legal object sentence concluding that the other person is obligated to do Z.

The legal meta rule sentence below must be valid.

(143-24) "A legal sentence X has an obligation to do Z becomes valid at time T if a legal sentence X has a right to require Y, to do Z at time T and Y exercises the right to require Z at time T."

The acquittal of seller A's concrete obligation to repair the machine on September 1st. For example, in Fig. 3, for the present case is decided by the application of the CFP. The proof is as follows. The second requirement of the rule "Y exercises the right to require X to do Z at time T" is satisfied by buyer B's exercise of the right to require seller A to remedy the problem by repair on September 1st. The instantiated first requirement "Buyer B has a right to require seller A to remedy the lack of conformity by repair on September 1st, it is valid." is proved by applying the fundamental meta rule sentence. The instantiated first condition of the latter rule "Buyer B has a right to require seller A to remedy the lack of conformity by repair" becomes valid on August 10th is proved by applying the following legal rule sentence representing Article 46 of CISG:

(CISG46): "The buyer has a right to require the seller to remedy the lack of conformity by repair" becomes valid, if the goods do not conform with the contract.
The requirement of the rule CSG046 is satisfied by the fact (8) on August 10. The instantiated second requirement of the applied norm "It has a right to repair the machine not terminated until September 1st." is proven because of "It has a right to repair the machine not terminated until September 1st" is false.

The deductive system of legal knowledge to deduce an accrual of the validity of an legal object sentence by exercising a right of claim is exemplified in an example of the claim to repair the goods delivered. Legal meta rule 14.42 applies to many other cases, such as accruals of the seller's duty to perform his obligations (Article 46(1)), to deliver substitute goods (46(2)) and so on.

Many statutory legal rules regulate the accrual of validity of an legal object directly. In such a case, one need not to apply rule 14.42.

5.3 Legal Rule Sentences Deciding the Termination of Obligations

The termination of obligations means that the validity of legal object sentences describing obligations is terminated. It is accomplished in two ways to terminate the validity of elementary legal object sentences: the termination of their validity along with the termination of the complex legal sentence and the termination of their validity by themselves.

5.3.1 Termination of elementary legal sentence validity through contract termination

The validity of elementary legal sentences are terminated if the complex legal sentence to which they belong is terminated. The validity elementary sentences of a contract are terminated if the validity of the contract as a complex legal sentence is terminated. The following rule sentences is set in the knowledge base.

\[
\text{sentence}(\text{element}\_\text{sentence}(\text{ELEVEMENT}[\{\text{deny}(\text{SEN}(\text{S}))\}], \text{go}(\text{GOA}(\{\text{valid}, \text{time}(T)\})) < \text{element}\_\text{sentence}(\text{ELEMENT}[\{\text{deny}(\text{SEN}(\text{S}))\}], \text{deny}(\text{SEN}(\text{S})) [\text{ECOMPLEX}\_\text{SENTENCE}]), \text{go}(\text{GOA}(\{\text{valid}, \text{time}(T)\})) < \text{ECOMPLEX}\_\text{SENTENCE}])
\]

Complex legal sentences lose their validity on the day when a fixed term is expired, when the termination condition is met or when contract avoidance becomes effective. Regulations concerned with these factors can be integrated as a legal rule sentence, which makes concrete the second requirement of the fundamental legal meta rule sentence not as a subrule sentence.

In Fig. 3, two legal object rule sentences, "A has an obligation to B that the machine delivered to conform the contract" and "A has an obligation to B to repair the machine" are terminated on October 1, because the validity of the contract as a complex legal sentence was terminated owing to B's exercise of the right to declare the contract avoided when he has the right. It is B's right to declare the contract avoided is valid. The right to declare the contract invalid resulted from the fact that the seller had not fulfilled an obligation to repair the machine within the additional period of time (one month) fixed by the buyer.

5.3.2 Termination of validity elementary legal object sentences with fulfillment of its obligation

In some cases, the validity of one article of the contract is terminated independently of the validity of the whole contract. The following legal rule sentence is valid.

\[
\text{valid}(\text{element}\_\text{sentence}(\text{ELEMENT}[\{\text{deny}(\text{SEN}(\text{S}))\}], \text{deny}(\text{SEN}(\text{S})) [\text{ECOMPLEX}\_\text{SENTENCE}]), \text{go}(\text{GOA}(\{\text{valid}, \text{time}(T)\})) < \text{ECOMPLEX}\_\text{SENTENCE})
\]

(2) For example, the delivery of the package by A on May 1, for example, the validity of the legal object sentence "A has an obligation to deliver the machine to B" is terminated May 1, and because of payment by B on May 20, the validity of legal object sentence "B has an obligation to pay the price by May 20" is terminated May 20. These terminations of obligations are deduced by applying the above legal meta rule sentence validly.

6. The CSGK Knowledge Base System

The results of the clarification of the logical structure of the contract law system is applicable to construct a legal knowledge base on contract law. We have tried this application in the field of the CSGK and made a CSGK knowledge base of which our legal expert system is composed. Here I would like to describe shortly about the CSGK knowledge base system developed by us.

6.1 Representation of legal knowledge in terms of the logical flow chart

The logical structure of the contract law system and the CSGK is represented at first in terms of the logical flow chart. Such examples have shown already in Figure 4 and 5 in this paper. This approach is useful for knowledge engineers to analyze the logical structure of laws and communicate with other people especially with lawyers. Lawyers or law students can use also this method for themselves.

The extension of the use of logical flow charts. The logical flow charts written are converted then to a kind of predication formula CPF, which is to be explained just in the next section, for the knowledge base.

6.2 Legal Knowledge representation in terms of CPF

The systematizing rules above mentioned, the CSGK and its interpretation are represented in terms of CPF (Compound Predicate Formula) in the knowledge base. CPF is an extension of first order predicate logic formula. It entails the extension in the following characteristics:

(1) It introduces identifiers of predicates to designate the entity which a term through the relevant predicate represents.

(2) It contains Case List which is a list of pairs and each pair represents case rule and filter.

(3) It has compound structure by that each filter may be a compound predicate term.

CPF has no strong knowledge representation capability that it can represent complex relations of legal state of affairs. Here, as an example of legal rules represented in terms of CPF in the CSGK knowledge base the rule 2a, which corresponds in principle to the logical flow chart of Figure 5 is shown below.

\[
\begin{align*}
&\text{become_effective}(\text{BECOME_EFFECTIVE}_2) \iff \\
&\sigma(\text{BECOME_EFFECTIVE}_2, \text{execute}(\text{EXECUTE}_2)) \land \\
&\sigma(\text{EXECUTE}_2, \text{null}) \land \\
&\sigma(\text{null}, \text{known}) \\
&\text{become_effective}(\text{BECOME_EFFECTIVE}_2) \iff \\
&\text{become_effective}(\text{BECOME_EFFECTIVE}_2) \land \\
&\text{execute}(\text{EXECUTE}_2) \land \\
&\text{null} \land \\
&\text{known} \\
&\text{become_effective}(\text{BECOME_EFFECTIVE}_2) \iff \\
&\text{become_effective}(\text{BECOME_EFFECTIVE}_2) \land \\
&\text{execute}(\text{EXECUTE}_2) \land \\
&\text{null} \land \\
&\text{known}
\end{align*}
\]

6.3 CSGK knowledge base system

We have developed a legal expert system LESS and LESS as a CSGK knowledge base system. LESS system is a system to support knowledge base construction and has a function to infer the results of the application of installed knowledge to concrete cases as well. LESS system is so made that a user can use it to know the results of the application of the law to concrete cases and their reason through WWW browser via internet. Any user can use the system as his computer has a browser and is connected to a LAN or internet. LESS 4 and LESS 5 can be used being connected with each other.

The LESS system is composed of an HTTP server, "Inference
I would like to introduce the reader to the system, showing pages of the system and explanations of the pages. The system has a Japanese version as well as an English version. Figure 7 is the Homepage of the whole project. If we click "Legal Expert" in this page, then we are taken to the main menu of the Legal Expert (Figure 8). By choosing "LESS" we are given the LESS menu, which will allow us to choose the law to be applied and the theories under which the knowledge is formalized. Here we may also choose the consulting case. We may preview the chosen case, modify it or create a new case (Figure 9). Figure 10 shows an outline of the chosen case, which is described earlier in this paper. If we click "Do Inference", we are given the 'inference'...
On April 1, a New York maker of agricultural machinery, A, dispatched a letter of a proposal to a Hamburg branch of a Japanese trading company B.

The context of the letter was:
A sells a set of agricultural machines to B for $30,000;
A delivers the agricultural machinery to B by May 15; B must pay the price of $30,000 to A by May 20 and the agricultural machinery will be carried by an American freight vessel.

The proposal reached B on April 6.

On April 9, B telephoned A to say "I accept your offer. However, I want you to carry the agricultural machinery by a Japanese carrier ability.'

On April 9, B telephoned A to say "I accept your offer. However, I want you to carry the agricultural machinery by a Japanese carrier ability.'

On April 9, A handed over the agricultural machinery to the Japanese carrier ability at the New York Port on May 1.
Figure 20

In this case, Figure 20 turns out, which is the same as Figure 16. If one clicks on the latter, the system shows the basis for the proof that the sentence becomes valid. The further explanation process is the same as above described. Here we have to confess that this chronological figure of the relationship is not automatically produced yet, but is theoretically possible.

This system has the capability to show the legal knowledge in its details on the one hand and systematically on the other hand, especially in terms of relationships between the legal requirements and legal effects in each legal rule and relationship of legal rules, including meta-levels of rules. The system is, therefore, useful for law professors to analyze knowledge in their favored fields and to develop individual systematizations. It is also useful for law students so that they may know and understand legal knowledge in its details as well as the system of legal knowledge.

7 Conclusion

In this research, we confirmed the structure of contract law by taking up CSG as an example and focusing on the systematization of law from the view of logical reasoning. By using three standards of legal sentences—that is, legal fact sentences and legal rule sentences, complex legal sentences and elementary legal sentences and legal object sentences and legal meta-sentences—we explicated the basic structure of legal knowledge enabling us to systematize contract law. Applying the framework to cases (case 7), (case 8), (case 9), we formalized the change of legal relation as a change of the validity of legal sentences that describes obligations. On formalization, we found the fundamental legal meta-rule sentence under which other legal meta-rules are systematized. We thus clarified the logical structure of contract law system that deductively proves the change of legal relation along with the progress of events in a concrete example.

The results of this study have been introduced to the knowledge base of the CSG; we have developed a knowledge base system by which solutions about legal states of affairs can be deduced at any time as a result of applying CSG to a given international rule case.

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1. Introduction

Laws and ordinances are generally written using abstract words and technical terms to pursue exactness and conscientiousness and are described abstractly to facilitate their application to various legal phenomena. Laws and ordinances involve different structures, preferential, conceptual, and logical, making legal applications complicated. Furthermore, legal knowledge is categorized as laws, regulations, ordinances, precedents, legal theories, legal common sense, and so on. Especially, maritime traffic laws and regulations in Japan are legislated as a legal norm which stimulates the maritime customs and the empirical rules. They are characterized by a judicial norm rather than by a renewer norm (a behavior norm). Therefore, it is essential to systematize laws and regulations through analyses of the richness of legal knowledge, because it is difficult for nonprofessionals to understand the legal applications and the legal reasoning.

This research is interdisciplinary in that it requires a wide coverage of traditional jurisprudence, analytical jurisprudence, symbolic search of the Legal Expert System, and logic and information science. Furthermore, it forms one province of jurisprudence. The idea of jurisprudence can be applied to the systematization of legal knowledge and laws and ordinances.

In past research, I proposed the systematization of laws and cases by the intelligent computer system, and I discussed the theoretical problem based on the formalization of legal sentences by predicate logic. The use of symbolic logic to analyze the syntax of legal norm sentences has been suggested by ALEPH. The direct application of classical mathematical logic to legal norm sentences has been suggested by YOSHIMI. On the other hand, ideas of consultation or decision-making systems in laws were suggested by MNL. Since then, research and development (R&D) of laws machine or so-called legal expert systems has progressed in the scientific trends of jurisprudence.

R&D of legal expert systems has been generally carried out in terms, such as the IMABAI project, the LEGED project, the HYPO project, the Oxford project, and the LEX project. In advanced workshops or conferences, some computer scientists and jurists studied various possibilities of computer assistance in the field of law. The idea of the systematization of legal knowledge is fundamentally based on these studies of the modeling of legal reasoning, expert systems in law, and the other computer-aided