

Legal Knowledge Based System and Legal Education

- Focusing on understanding Change of Legal Relation -

Hajime Yoshino

Meiji Gakuin University, Graduate Law School
1-2-37 Shirokanedai, Minato-ku, 108-8636 Tokyo, Japan
hyoshino@ls.meijigakuin.ac.jp
<http://www.meijigakuin.ac.jp/~yoshino>

Abstract

It is important for legal education to develop a student's capability to reason what kind of right and duty relations come to exist as a result of an application of law to a concrete case problem. A legal knowledge base system which logically infers the legal state of affairs as a conclusion from law together with the facts of a case and which clearly shows the reasoning process, is to be a useful tool for legal education. As the legal state of affairs changes according to the time-progress of an event, a clarified logical model of law is necessary to enable us to logically prove changes among legal relationships over time. This study presents such a model based on the concepts of legal sentence as well as their validity and applies it to a contract, i.e. United Nations Convention on Contracts for the International Sale of Goods (CISG) to construct its deductive knowledge base. As a visual representation to represent a legal state of affairs, we have introduced the belt figure of the validity of legal sentences in our legal knowledge base system in order that students can well understand the change in rights and duties relations.

Keywords:

Legal Knowledge Base System, Legal Expert system, AI, Legal knowledge, Legal Education, Legal Reasoning, Visual Representation, logical model of law, Logical Jurisprudence, right and duty relation, contract, CISG

1. Introduction

A legal knowledge base system (LKBS) is a computer system which contains knowledge and implies the possible legal result of the application of law to certain cases and explain the reasoning process as well as the legal knowledge that is applied.

It is an important for a lawyer to be able to explain the legal state of affairs that is connected with the case with which he deals. To identify what kind of legal state of affairs exists is to reason what kinds of rights and duties exist. For legal education, it is important to educate students so that they have the capability of performing such reasoning.

A legal knowledge base system, which infers the legal state of affairs as a conclusion from the facts of a case, and which clearly shows the reasoning process, will, therefore, be a useful tool for legal education.

In order to create a legal knowledge base system, it is necessary to clarify the structure of the law as a deductive system from which a legal judgment can be justified as the conclusion of the relevant facts. As the legal state of affairs changes according to the progress of an event, a clarified logical model of law is necessary to enable us to detect 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 legal meta-sentences regulating the validity of legal sentences, play a definitive role. The model is applies to a contract law, i.e., the United Nations Convention on Contracts for the International Sale of Goods (CISG), as well as a legal knowledge base system on a knowledge of the CISG¹. The deductive structure of the contract law is clarified in the basis of a knowledge that contains the appropriate answers to questions

¹ The legal knowledge base system LES5 was developed in 'Legal Expert' Project. It is a Japanese project on the development of a legal expert system, which has been funded by the Japanese Ministry of Education, Science and Culture. The author, as the representative, organized over 30 lawyers and computer scientists to clarify legal knowledge and develop legal expert systems. Regarding the project and its study results cf. two special issues of *Journal of Advanced Computational Intelligence* Vol1, No.2 1997; Vol.2 No.1 1998. The system is in the mean time through the new project developed to LES6.

about the legal state of affairs at any time, which are deduced as a result of the application of CISG provisions, to use a concrete example.

In this respect, a visual representation will be useful in represent the change in rights and duties relations that students will need to understand as regards the movement of the legal state of affairs. I have introduced, therefore, the belt idea of the validity of legal sentences which describe right and duty in aid of our legal knowledge base system.

In this paper, we want to demonstrate the basic concepts of Logical Jurisprudence, the visual representation of changes of legal relations, the legal meta sentences which decide the validity of legal decisions, a case-problem related to the CISG as an example for discussion, the representations of legal knowledge in Legal Knowledge base system LES6 and the applicability of the legal knowledge base system to legal education.

2. Basic concepts in Logical Jurisprudence

Logical Jurisprudence is our logical theory of law. Logical Jurisprudence tries to define the world of legal discourse in terms of the smallest unit of primitives. It starts from three primitives: “sentence,” the “validity” of a sentence, and the “inference rule.” Logical Jurisprudence attempts to explain the law by using these three notions as much as possible.

Logical Jurisprudence does not support the existence of “legal norms as a meaning,” which has traditionally been admitted or presupposed in legal studies and legal practice. Logical Jurisprudence starts from the notion of “**legal sentences**.” Sentences exist as a form of written or spoken signs and they are supposedly perceptible, and therefore, communicable. In my opinion, the meaning of legal norms belongs to the world of images. It is what one imagines when legal sentences are thought of. To communicate such images to other persons, they must be put into sentences that are comprehensible to others. Logical Jurisprudence considers sentences in the field of law to be the direct object of legal recognition.²

The second basic concept in Logical Jurisprudence is the “*validity*” of a legal sentence. The validity of a legal sentence is viewed by Logical Jurisprudence as a “truth in the logical sense.” That a legal sentence is valid means that it is true in the world of legal discourse, i.e., legally true. Logical Jurisprudence represents this legal truth by means of a predicate (e.g., “*is valid(sentence1, goal1,time1)*,” which could be read as follows:

“a sentence1 is valid for goal1 at time1.” The representation of the concept of validity by a predicate is a characteristic of Logical Jurisprudence that corresponds to the natural linguistic representation of knowledge in the legal world.

The third basic concept in Logical Jurisprudence is the “*inference rule*.” Logical reasoning is based on inference. The main rule of inference is in *Modus Ponens*, which is represented in the following schema, where A and B express propositions:

$(A \rightarrow B), A \vdash B$

This formula is to be read: If ‘if A then B’ is true and A is true, then it follows that B is true. *Modus Ponens* is the basic reasoning of legal justification as will be discussed later.

In Logical Jurisprudence, legal reasoning is the 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 the reasoning of justification and the reasoning of creation. The *reasoning of legal justification* is reasoning through which a judgment is justified from already-justified legal knowledge. Logical deduction is the type of reasoning of legal justification. The logical structure of this reasoning is that of *Modus Ponens*. Judgment may not be deduced from statutes and facts alone, but it may be deduced from the whole body of legal knowledge, including statutes, facts, and additional legal sentences to the former, as is implicit in legal common sense, or, as a result of the reasoning of legal creation. Logical Jurisprudence makes this implicit or created knowledge clear and identifies it so as to make it explicit. The following are additional legal sentences: principles of law that unify statutory legal sentences; common sense about legal terms, especially hierarchical relations between legal concepts; and the interpretation of statutes that are produced by the reasoning of legal creation. Logical Jurisprudence analyzes legal knowledge in detail, and recognizes and demonstrates the implicit knowledge of legal experts and legal sentences created by the reasoning of legal creation, such that the reasoning of legal justification is formed as logical deduction.

The *reasoning of legal creation* is reasoning through which judgments themselves or additional legal sentences are either discovered or created. This reasoning is related to logical deduction because legal sentences are formulated so that the whole reasoning process, including these additional sentences, can be presented as a form of logic.. Such reasoning is performed through falsification, which has the logical structure of *Modus Tollens*:

²The difference between conventional and legal sentences and how these differ is discussed in section 4.2.1.

$$(A \rightarrow B), \neg B \rightarrow \neg A$$

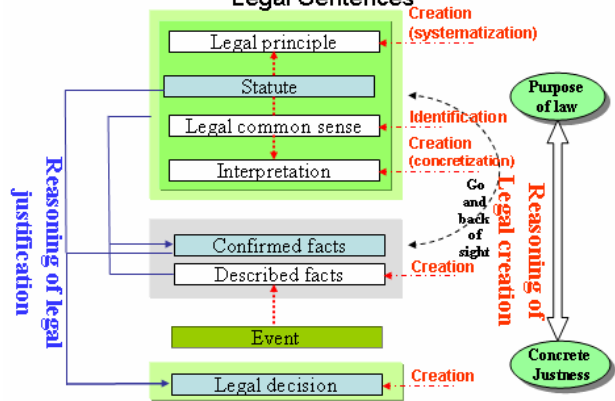
This formula is read as follows. ‘If one sets hypothesis A (together with already accepted theorems), then B follows’ and it is proven that B is not true. Thus, it follows that the hypothesis A also is not true. (The legal hypothesis cannot be proven as just but can only be falsified as unjust.)

The reasoning of legal creation, however, requires something more than deduction. Reasoning to get a sentence of hypothetical fact is abduction and reasoning that constitute induction.

Logical Jurisprudence analyzes the legal reasoning process in two ways: (1) concretization (putting it into concrete terms) and (2) systematization. This is also true for the legal reasoning of creation. The study of legal interpretation or analogy is important for concretization. In systematization, it is important to make sentences in legal principle clear which will enable us to bring mere collections of such sentences into a system, on the one hand, and to analyze how such sentences as hypotheses on the other hand.

The study of reasoning in legal creation is important to the theory of law, both as regards concretization³ and systematization⁴. Few engineers, however, study the systematization of legal knowledge itself, i.e., the process of showing laws as a deductive system. This is because engineers assume that a theory of science is deductive, so they are not interested in finding the deductive structure of law. Moreover, legal knowledge is too specialized and complicated for engineers to identify deductive relationship of legal knowledge. To construct a legal knowledge based knowledge base system, however, the deductive structure of law must be clarified to develop a deductive knowledge base. Clarifying the deductive system of law and systematizing legal knowledge⁵ have long been desired in legal studies. We focus on the process of systematizing the law of contracts toward a logically deductive knowledge-base⁶, leaving the reasoning of legal creation in the CISG for another time.⁷ What has been explained about the structure of legal reasoning can be shown visually in Figure 1.

Figure 1: Legal Reasoning as Developing Process of Legal Sentences



I would like to clarify the concept of legal sentences more precisely. Sentences in the legal field, referred to here as *legal sentences*, are starting points, as above explained. We introduce the basic kinds of sentences, according to which all legal sentences are classified, so that laws can be systematized as logical deduction.

Legal sentences consist of two types: legal rule sentences and legal fact sentences. It is important to distinguish between the two legal sentences. *Legal rule sentences* have the following syntactic form: “ $X\{a(X) \rightarrow b(X)\}$ ”. This formula is read as: “For all X, X is a, if X is b.” In legal sentences, the consequence of the sentence, which is the portion on the left in the formula $a(X)$, is called a “legal consequence,” and the antecedent portion on the right- $b(X)$ is called a “legal requirement.” On the other hand *legal fact sentences* have the following syntactic form: “ $b(x1)$,” which is read as: “x1 is b.” Note that the difference between legal rule sentences and legal fact sentences is purely syntactic in Logical Jurisprudence, as mentioned above.

Second, legal sentences are to be further classified in terms of elementary legal sentences or complex legal sentences. An *elementary legal sentence* is the smallest unit of legal sentences. Statutes or contracts are composed of elementary legal sentences, e.g., “one must drive a car under 65 miles per hour on a highway” or “A may require B to pay the price of \$10000.” A *complex legal sentence* is a group of legal sentences, e.g., an entire legal document, such as “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, 2004.” A code, and parts or sections of an article of a statute are complex legal sentences. In most cases, the fact that a certain legal sentence belongs to a complex legal sentence is represented

³ Cf. Ref. 15

⁴ Cf. Ref. 7

⁵ Cf. Ref. 4

⁶ Interesting books on law and legal reasoning modeling have been published.^{2, 5, 6} Our study developed independently of them. Our approach is different from van Kralingen’s approach, for example, in that it is not conceptual or frame-based but purely logical, especially in that we analyzed and reconstructed the law logically intensively in ‘legal sentences’, ‘their validity’ and ‘logical deduction’.

⁷ We have already done this to in a certain extent, i.e. ref.15.

by the placement of the sentences and the space where it is printed. The relationship is represented in Logical Jurisprudence by a sentence describing the unified relationship of grouped sentences. The concept of a complex legal sentence enables us to treat the validity of all legal sentences at once. Namely, if one has described the validity of a complex legal sentence, then all legal sentences that belong to it are also valid. The advantage of the complex legal sentence is that it contributes to 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 “B must pay A the price of \$10000” is a legal object sentence. A *legal meta sentence* describes legal sentences. More precisely, it describes the validity of a legal sentence. Some legal meta sentences describe the validity of other legal 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 laws in Japan (HOUREI)]. Another example is the following: (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).

3. Visual Representation of Changes of Legal Relation

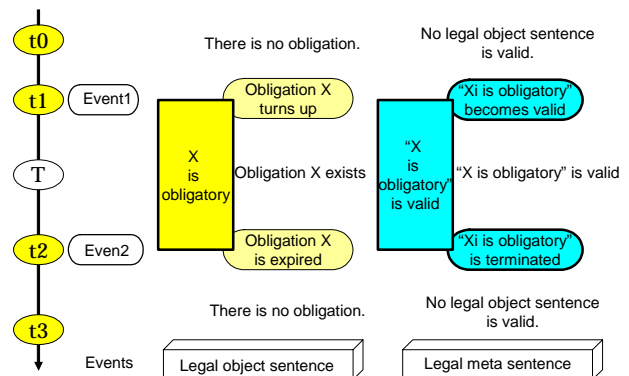
Law ultimately prescribes the obligations of persons. In other words, people’s conduct is ultimately regulated by obligations given them by law. What legal obligations exist depend upon the legal sentences that describe the obligations, or more precisely, on the validity of the sentences of the law. The validity of legal object sentences is prescribed by meta sentences. In Logical Jurisprudence, the existence of A’s obligation to Z means that legal sentences, such as “A has an obligation to do Z” or “It is obligatory for A to do Z” are both valid. The relation of the existence of an obligation and the validity of a legal object sentence describing the obligation are represented visually in Figure 2.

The same is the case for the existence of the right. What legal rights exist means that legal sentences describing the right are valid. The validity of a legal sentences is prescribed by legal meta sentences. The Figure 2 applies also to the concept of

rights, if the word “obligation” is replaced with “right” and “obligatory” with “entitled”. Using this belt figures which represents the validity of legal sentences that describe a duty or a right, we can visually represent the existence of rights and duties relations as well as the change in legal relations.

The validity of legal meta sentences that prescribe legal sentences is prescribed by other legal meta sentences. A legal meta sentence that prescribes the validity of a legal meta sentence is called a *higher* or *upper* level legal meta sentence. The validity of each legal meta sentence is prescribed by a higher level of legal meta sentence. The highest, final level of legal meta sentence is called a “basic” or “fundamental” legal sentence. The validity of his final, highest legal meta sentence is described with a fact sentence⁸.

Figure 2: Visual Representation of Changes of an Legal Relation



It should be noted that legal sentences describing rights are not legal object sentences, which describe obligations. They do not belong to an object level of legal language but to a meta level. Logical Jurisprudence considers the sentences, which describe rights as a kind of legal meta sentences, make it possible to set forth a new legal object sentence. This will be discussed again later.

⁸ Cf. Kelsen 1960, p. 109. Kelsen proposed the concept of “basic norm (*Grundnorm*)”. It is to be noted that my basic concept of the legal rule sentence does not always coincide with Kelsen’s conception. They differ in the following points: Kelsen depends on legal norms as a basis for meaning, while I depend on legal rule sentences; Kelsen’s basic norm is conceived of one as which takes for granted as a given positive law, while my theory presents not only such a basic legal rule sentence but also fundamental rules which are always applied in any case where the validity of a legal sentence is to be decided. This has become the case of our logical analysis of legal systems and legal reasoning.

4. Case-Problem and Solution

It is an effective way for legal education to develop students' reasoning capability, to give them case-problems which they should be able to solve and explain.

This section describes an example of a case-problem relevant to the CISG. It describes the circumstances of a particular example of that problem, asks questions about that example and introduces legal solutions to those questions in order that the deductive knowledge structure of contract law by which solutions may be deduced are clarified.

[Case 8f]

- (1) On April 3, A, a farming-machine maker in New York sent a letter to a branch of a Japanese trading company in Hamburg. 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. B was to pay fee to A by May 20.
- (2) On April 8, the letter reached B at the branch office in Hamburg.
- (3) On April 9, B made a telephone call to A, saying, "The offer is accepted."
- (4) On May 1, A finally handed the farming machine over to a Japanese container ship at a port in New York.
- (5) On May 31, the machine was delivered to the branch office in Hamburg.
- (6) On June 5, B examined the machine.
- (7) On May 10, B paid the price of \$50,000 to A.
- (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.
- (9) On September 1, B asked A to repair the problem within one month. A did not repair it until October 1.
- (10) On October 10, B declared the contract void.
- (11) On December 10, A recovered damages and B restituted the machine delivered by A.
- (12) On December 20, A restitutes the price paid by B.

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 5th
- 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 client.
- (2) An offer, even if it is irrevocable, may be withdrawn if the withdrawal reaches the client before or at the same time as the offer.

Article 16

- (1) Until a contract is concluded, an offer may be revoked if the revocation reaches the client before he has negated the contract.

Article 18

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

Article 23

A contract is concluded at the moment an acceptance of the 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 particular place other than the designated one. His obligation to deliver consists of nothing more than handing the goods over to the first carrier for transmission to the buyer;

Article 38

- (1) The buyer must examine the goods, or cause them to be examined, within as short a period as is practicable in the circumstances.

Article 39

- (1) The buyer loses the right to rely on a lack of conformity in the goods if he does not give notice to the seller specifying the nature of the lack of conformity within a reasonable time after he has discovered it 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) exercise the rights 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 damages by exercising his rights to other remedies.

Article 46

- (1) The buyer may require the performance of the seller's obligations unless the buyer has resorted to a remedy which is

inconsistent with this requirement.

(2) If the goods do not conform to the contract, the buyer may require delivery of substitute goods only if the lack of conformity constitutes a fundamental breach of contract, and if a request for substitute 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 to the contract, the buyer may require the seller to remedy the lack of conformity by repair, unless this unreasonable having in regard to all the relevant 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 fix an additional period of reasonable time for performance by the seller of his obligations.

Article 49

(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 this 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 if he declares that he will not deliver within the period so fixed.

The solution of the above case is as follows.

[Solution]

1) On April 5th, there is no longer any 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 \$50,000 to A by May 20th, while B has the right to require A to deliver the goods to B and A also right to require B to pay the price to A by May 10th.

3) On May 5th, B has a duty to pay \$50,000 to A by 20 May, while A has the right to require B to pay to A by 10 May.

4) On August 15th, A has the right to recover damages, while B has the right to claim damages against A, and B has the right to require A to repair the machine.

5) On September 15th, A has the right to recover damages and a duty to repair the machine, while B has right to claim the damages against A, and B has the right to require A to repair the machine, which is suspended to exercise.

6) On October 5th, A has a duty to recover damages and a duty to repair the machine, while B has right to claim the damages against A, and B has right to require A to repair the machine, whereas B has the right to declare the contract voided.

7) On November 15th, A has the duty to recover damages and the duty to restate the price B has paid, and B has the duty to restate the machine delivered by A, while B has the right to claim damages against A and the right to require A to restate the price, and A has the right to require B to restate the machine.

8) On December 15th, A has the duty to restate the price paid by B, while B has the right to require A to restate 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 8f are shown in Fig 3.

The above solutions correspond to obligation and right. In this chart, the existence of legal relations is indicated by the belt of the validity of legal sentences which describe obligations and rights in the figure.

5. Legal meta rule sentences to decide the validity of legal sentences

In Logical 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" or "It is obligatory for A to deliver a farming machine to B" is valid. 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 meta rule sentences that regulate the validity of the legal object sentences of the contract. Below, we show what kind of legal meta rule sentences work to prove the validity of the legal object sentences related to the contract and how they do so.

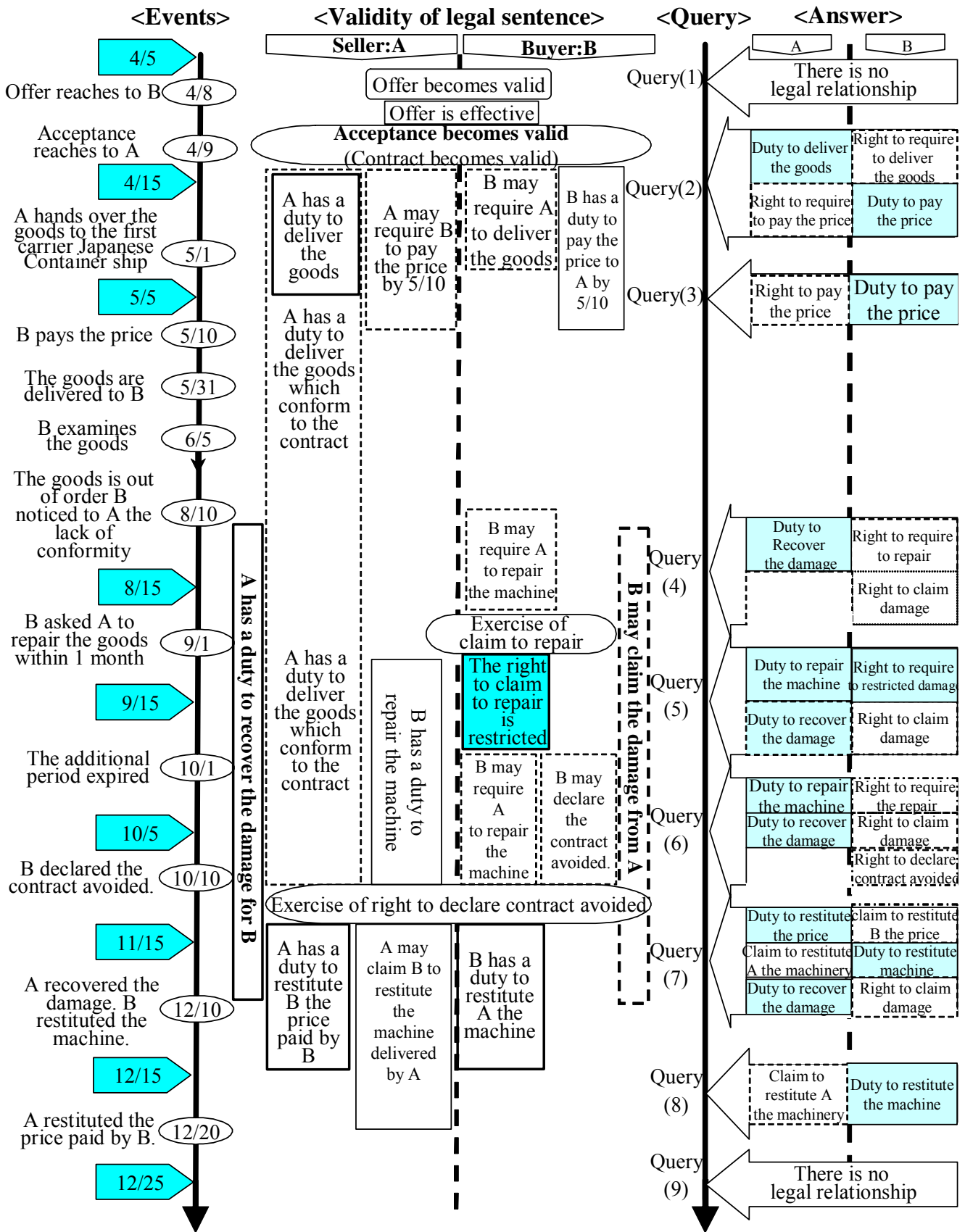
5. 1 Legal meta rule Sentences deciding th at Legal Sentences are Valid.

The following fundamental legal meta rule sentence is valid for deciding that legal sentences are valid⁹:

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

⁹ The validity of this fundamental legal meta rule is presupposed. In the CISG knowledge base a sentence which describes this validity is set as a legal fact sentence.

Figure 3: The changes of Legal Relation



This legal rule sentence cannot be found as a statutory text in the CISG or other regulations. This is a fundamental legal meta rule sentence implicitly taken for granted by the CISG and all other regulations. Without this rule, no statutory legal sentence works when it comes to application. This rule is the most fundamental among legal meta rules enabling us to put a mere 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 15” is valid, we apply this rule and examine its two specified requirements: “A has an obligation to deliver the machine to B’ becomes valid before April 15” and “A has an obligation to deliver the machine to B’ is not terminated until April 15”. If both requirements are satisfied, then the legal object sentence is valid, on April 15. 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 sub-rules 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 ¹⁰.

Now, we shall clarify the structure of legal knowledge deciding these two 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 logical structure of legal knowledge regulating changes of legal obligation clear. Here, note 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 rule 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 ‘mr1’¹¹.

¹⁰ We could say, therefore, that all legal meta rules in this sense contribute to regulating the validity of legal sentences.

¹¹ The negation as failure is a concept in logic programming, where the negation of a sentence is considered true if it is failed to prove that the latter is true.

5.2. Legal rules sentences deciding accrual of obligation

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

5.2.1 Accrual of validity of elementary legal sentences with accrual of contract validity

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

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

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 obligation 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 A by May 20th." The main part of contract law is legal meta rule sentences regulating changes of validity of the contract itself as a complex legal sentence, i.e., the accrual and termination of its validity.

Figure4:3AA1B A contract becomes valid

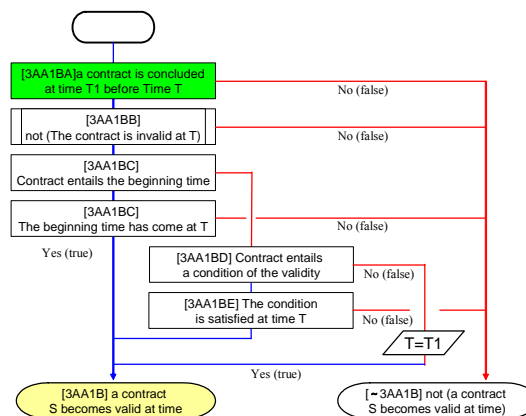


Figure 4 is a logical flowchart of the legal rule sentence that decides the accrual of validity of contract. 3AA1BA in Fig. 4¹² means that the contract is concluded. The “conclusion” of the

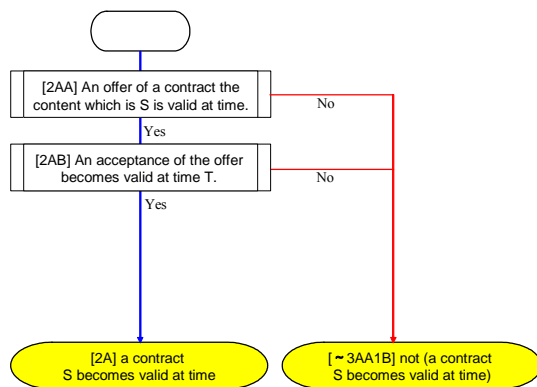
¹² As regards the method of knowledge representation of law by logical flow charts, refer to: Yoshino 1994a.

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 .

Part 2 of the CISG regulates in detail the conclusion of contract from Articles 14 through 24.

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 law¹³. (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 2 are to be systematized as a sub-rule of the first requirement [2AA] of this legal rule sentence. Articles 18 through 22 and 24 in part 2 are systematized as a sub-rule of the second requirement [2AB].

Figure5 : [2A] Contract is concluded



5.2.2 Accrual of a legal object sentence by exercising rights

In some cases, the accrual of validity of the elementary legal sentence by itself, not as a result of the accrual of contract validity, is regulated. An obligation accrues, for example, along with exercise of the relevant right. In Figure 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

¹³ As to the identification of this legal requirement and the formalization of the inference process of the creation, we have discussed in: Sakurai & Yoshino 1993.

of the machine on September 1st.

Logical Jurisprudence does not consider sentences describing rights as a legal object sentence as 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.

(3AA2) "A legal sentence 'X has an obligation to do Z' becomes valid at time T, if a legal sentence 'Y has a right to require X to do Z' is valid, at time T, and Y exercises the right to require X to do Z at time T."

The accrual of seller A's concrete obligation to repair the machine on September 1. For example in Fig. 3, for the present case is deduced by the application of this rule. 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 1. The instantiated first requirement "Buyer B has a right to require seller A to remedy the lack of conformity by repair on September 1, is valid ." is proved by applying the fundamental meta rule *mr1*. 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 10" is proved by applying the following legal rule sentence representing Article 46 of CISG:

(rCISG46): "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 *rCISG46* is satisfied by the fact (8) on August 10. The instantiated second requirement of the applied *mr1* "'B has a right to repair the machine' is not terminated until September 1." is proven because the proof of "'B has a right to repair the machine' is terminated until September 1st" is false.

The deductive system of legal knowledge to deduce an accrual of the validity of a legal object sentence by exercising a right of claim is explicated in an example of the claim to repair the goods delivered. Legal meta rule sentence *3AA2* 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 rule sentences regulate the accrual of validity of legal object sentences directly. In such a case, one needs not to apply rule 3AA2.

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. There are 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 is terminated if the complex legal sentence to which they belong is terminated. That is also the case in the contract. The following meta rule sentence is valid:

(02): The validity of elementary sentences of a contract is terminated if the validity of the contract as a complex legal sentence is terminated.

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 *mrl* as its sub-rule 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" is 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, i.e. 'B has the right to declare the contract avoided' is valid.

The right to declare the contract void resulted from the fact that the seller had not fulfill an obligation to repair the machine within the additional period of time (one month) fixed by the

buyer¹⁴.

5.3.2 Termination of validity of 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 meta rule sentence is valid:

(mr4b) "The validity of elementary legal object sentences is terminated when the obligation is fulfilled."

For example, Because of the delivery 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 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 *mr4b*.

6 The Legal 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 CISG and made a CISG knowledge base of which our legal knowledge based system is composed. Here I would like to describe shortly about the CISG knowledge base 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 CISG 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 law, represent it and communicate with other people especially with lawyers. Lawyers or law students can use also this method for themselves, what is an advantage of the use of logical flow charts. This visual approach is also effective for students to analyze and understand the logical structure of

¹⁴ This reasoning can be done through the analogical application of article 49 (1)(b). I would like discuss about this analogical reasoning in another occasion.

law. The logical flow charts written are converted then to a kind of predicate 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

Legal knowledge which is composed of fundamental legal meta rule sentences, the CISG articles and its interpretation are represented in the legal knowledge base in terms of CPF (Compound Predicate Formula) in the knowledge base. CPF is an extend form of the first order predicate logical formula.

It en-tails the extension in the following characteristics:

- (1) It introduces identifiers of predicates to designate the entity which a term through the relevant predicate represent.
- (2) It contains Case List which is a list of pairs and each pairs represents case role and filler.
- (3) It has compound structure by that each filler may be a compound predicate term.

CPF has so strong knowledge representation capability that it can represent complex relations of legal state of affairs.

Here, as examples of legal rules represented in terms of CPF in the CISG knowledge base, the fundamental meta rule sentence (0) and the legal rule sentence (2a) which corresponds in principle to the logical flow chart of Figure 5 is shown below.

```
sen('0',[
is_valid(_[abj:sen(SEN,[cnt:[S]]),goa:G,tim:T])
<-
become_valid(_[abj:sen(SEN,[cnt:[S]]),goa:G,tim:time_b
efore(T1,[tto:T])])
&
not(is_terminated2(_[abj:sen(SEN,[cnt:[S]]),goa:G,tim:T
2]) & time_after(T2,[tfr:T1]) & time_before(T2,[tto:T])
]).
```

```
sen('2a',[
% A contract is concluded
is_concluded(IS_CONCLUDED_ID,[
nam:IS_CONCLUDED,
agt:[OFFEROR,OFFEREE],
obj:contract(CONTRACT_ID,[
```

```
nam:CONTRACT,
agt:[OFFEROR,OFFEREE],
cnt:CNT_CONTRACT,
imp:IMP_OFFER,
obj:OBJ_CONTRACT
]),
tim:T
])
<-
% An offer becomes effective at the time T1.
become_effective(BECOME_EFFECTIVE_ID,[
nam:BECOME_EFFECTIVE,
abj:offer(OFFER_ID,[
nam:OFFER,
agt:OFFEROR,
cnt:CNT_CONTRACT,
goa:OFFEREE,
imp:IMP_OFFER,
obj:conclude(CONCLUDE_ID,[
nam:B,
agt:[OFFEROR,OFFEREE],
obj:contract(_[
nam:CONTRACT,
cnt:CNT_CONTRACT,
imp:IMP_OFFER,
obj:OBJ_CONTRACT
]),
tim:_
]),
src:SRC_OFFER,
tim:TIM_OFFER
]),
tim:T1
])
&
% The acceptance of an offer becomes effective at the time T
after the time T1.
become_effective(BECOME_EFFECTIVE_ID2,[
nam:BECOME_EFFECTIVE2,
abj:acceptance(ACCEPTANCE_ID,[
nam:ACCEPTANCE,
agt:OFFEREE,
cnt:CNT_ACCEPTANCE,
goa:OFFEROR,
```

```

imp:IMP_ACCEPTANCE,
obj:OFFER_ID,
src:SRC_ACCEPTANCE,
tim:TIM_ACCEPTANCE

```

```

}),
tim:time_after(T,[tfr:T1])

```

```

)})

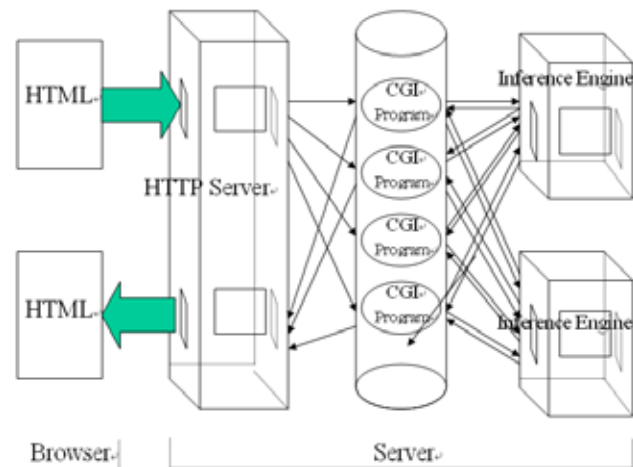
```

6.3 Legal knowledge based system on CISG

We have developed a legal knowledge based system LES5 and LES6 on CISG. The 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 far as his computer has a browser and is connected to a LAN or internet.

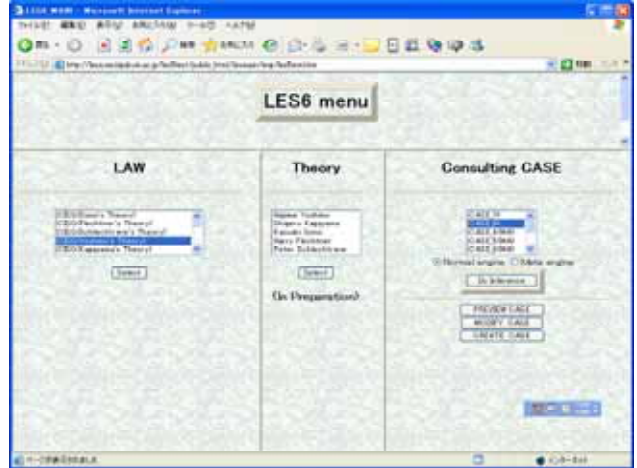
The LES5 and LES6 systems are composed of an HTTP server, Inference gateway (CGI program), server with inference engines and main machine interface (Figure 6). The inference engine is a meta-interpreter written in Prolog to perform CPF directly. A CPF rule file, a goal file and board numbers of socket are given in it at the beginning and it is permanently stationed after starting. The meta-interpreter is called for requirements from the process on network through socket communication and it can return the results of the inference. The inference engine is separated from the CGI program (gateway) and the inter-face is composed of socket communication, so that the independence of the programs is promoted. The program source is written in SICStus prolog, so that it is valid independently on special platforms.

Figure 6



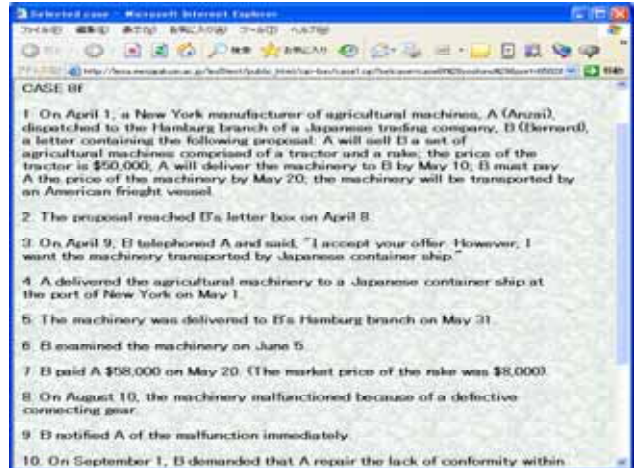
I would like to introduce the leader to the system, showing and explaining pages of the system. The system has a Japanese version as well as an English version. Figure 7 is the main menu of the LES6 system.

Figure 7



In this page, we can choose the law to be applied under the theories according to which the knowledge is formalized. Here we can also choose the consulting case-problem. We may preview the chosen case, modify it or create a new case. Figure 8 shows an outline of the chosen Case 8f, which is described earlier in this paper.

Figure 8



In the LES6 menu, i.e. in the Figure 7, if we click 'Do Inference', we are given the 'inference' page where we may choose the "goal list" or the "Legal Figure of the Case". If one chooses the former, then a list of goals is given which should be resolved by the system is shown. If we choose the latter, Figure 9 and 10 appear. This figure is a belt figure which represents movements of the validity of legal sentences which describe duties or rights of both parties of the contract. This represents thus changes of legal duty and right relations between parties in the given case-problem according to time progress. If we look at what kind of belt with sentences are represented at the right

side of the date, for example “4/15”, then we can identify what legal sentences are valid at the time point, that means what kind of right and duty relation exist between A and B on the date. Clicking a date of the left column, we can let the system explain the reason why such legal sentences are valid on the date.

Figure 9

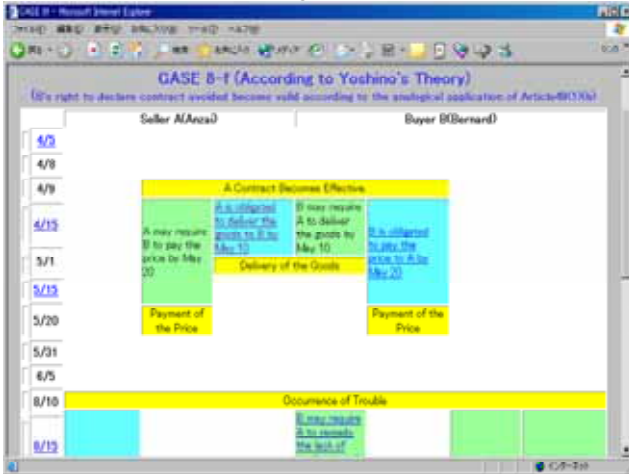


Figure 10

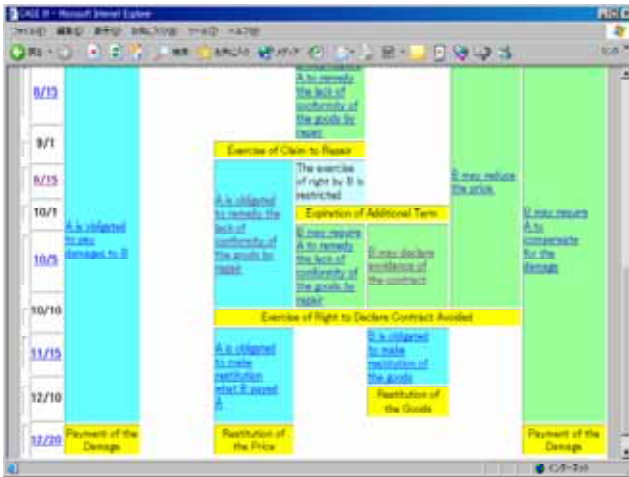
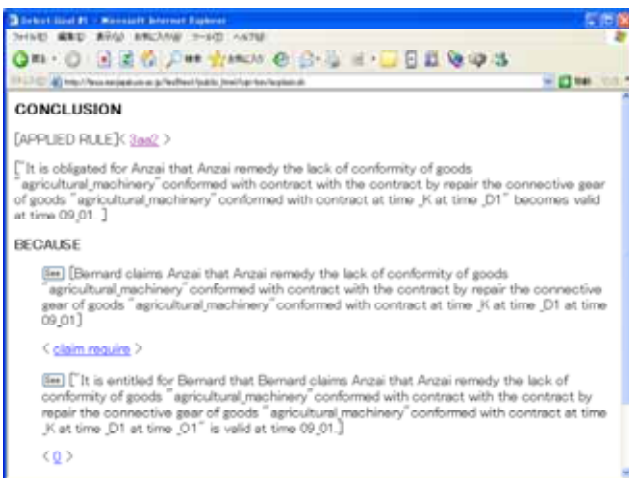


Figure 11

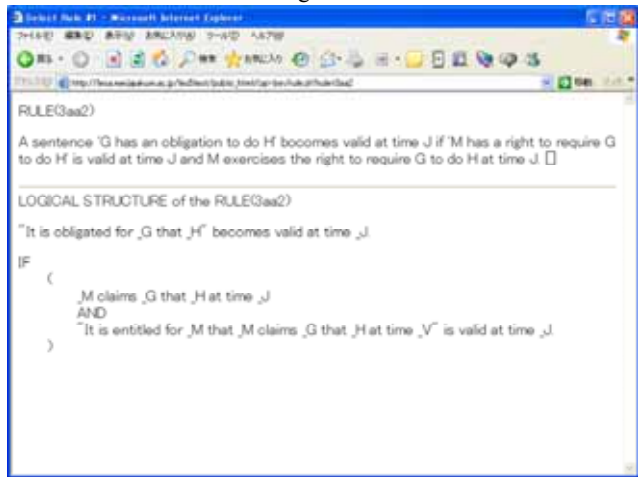


If we click, for example, the belt figure which represents the validity of the legal sentence “A (Anzai) is obligated to remedy the lack of conformity of the goods by repair”, then we can confirm the reason why the sentence becomes valid on September 1 and is terminated at time October 10.

Figure 11 shows that the legal sentence “A is obligated to remedy the lack of conformity of the goods by repair” become valid on September 1, because B (Bernard) claims A that A remedy the lack of conformity of goods by repair at time September 1 and the legal sentence “It is entitled for B that B claims A that A remedy the lack of conformity of goods by repair” is valid at time September 9.

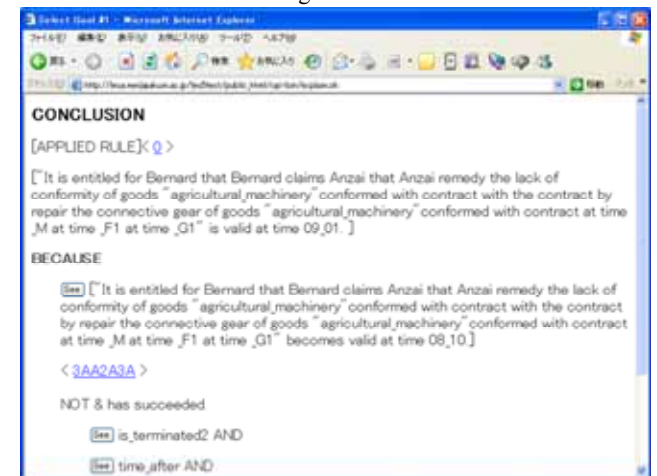
In the Figure 11, if we click rule ID “3aa2”, then we can confirm the legal rule sentence applied, that is shown in Figure 12. This rule regulates the relation between right and duty as mentioned above.

Figure 12



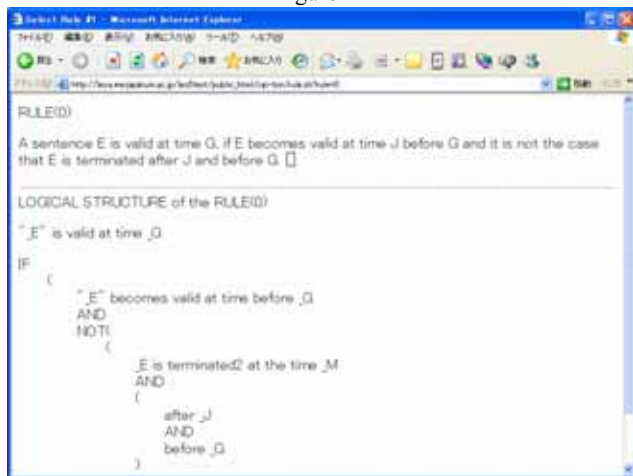
If we click “See” in front of the sentence “‘It is entitled for B that B claims A that A remedy the lack of conformity of goods by repair’ is valid at time September 9”, then we can confirm the reason why this is proved as true, in Figure 13. This is the result of the application of rule 0.

Figure 13



Clicking rule id “0” in figure 13, we can confirm the rule applied, which is the fundamental meta rule sentences mentioned above. Figure 14 shows it.

Figure 14



In Figure 15, we can confirm the reason why the first requirement of rule 0 “It is entitled for B that B claims A that A remedy the lack of conformity of goods” becomes valid at time August 10, if we click “See” in front of the sentence. On this way, we can confirm the reasoning processes as well as the legal knowledge applied to solve the problem step by step precisely.

7. The applicability of legal knowledge based system to Legal Education

Our system just explained has the capability to show the legal knowledge and legal reasoning process 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 through which right and duty relation is correctly represented. The system is, therefore, useful for law students to understand legal knowledge in its details as well as its systematic structure. It is also useful to analyze knowledge and to develop individual systematizations of the knowledge.

Here I would give a list of the dimensions where this legal knowledge based system is applicable to legal education. The system is applicable to legal education in general in two directions: student’s acquisition of fundamental as well as concrete legal knowledge or skills of law on the one hand and promoting student’s creative legal thinking on the other hand.

I would like to give a list explain at first in the first direction and then in the second direction.

(1) As an acquisition of fundamental knowledge/skills of law, the following dimension can be listed:

- (1.1) Understanding general logical structure of legal knowledge and legal reasoning,
- (1.2) Understanding concrete knowledge structure of positive law and reasoning of legal problem solving,
- (1.3) Simulation of legal reasoning and legal problem solving and
- (1.4) Developing skills to write the reason why the problem is to be solved so.

(2) Promoting Creative Legal Thinking

- (2.1) Comparison of theories or cases through problem solving
- (2.2) Simulation of hypothesis generation and falsification
- (2.3) Learning of systematization of legal knowledge

We have tried to apply our legal knowledge based system to our practical teaching in the classes of “Legal Methods”, “Legal Informatics” and “Law and Artificial Intelligence of Law” at Meiji Gakuin Graduate Law School, where the education for professional lawyers are to be developed. The purposes of the application of the system to the classes are:

- (a) To understand the general structure of legal knowledge and the reasoning process.
- (b) To understand the concrete content and the structure of legal knowledge and reasoning process to solve given problems.
- (c) To exercise to write the reason why the conclusion is deduced.

As regards (a) it was confirmed that the application works to let student understand the general structure of law more clearly than traditional oral lectures. As regards (b), It worked to let students catch the real function of legal knowledge to solve concrete given problems. As regards (c), it worked for students to get the way of writing the syllogistic reasoning structure and contents more clearly, precisely and effectively than traditional exercising methods.

I would like to add some comments on the efficiency of use of visual representation above introduced. It is in deed the case that the visual representation of changes of legal relations of cases as the belt figure of the validity of legal sentences and reasoning processes step by step in the explanation windows help students to understand the knowledge and exercise the skills to use it.

It can be said that our results confirmed the use of the legal knowledge based system for (1.1)-(1.4) and (2.3) above mentioned.

8 Conclusion

In this paper, we demonstrated basic concepts in Logical Jurisprudence, Visual Representation of Changes of Legal Relations, Legal meta sentences which decide the validity of legal sentences, a case-problem related to the CISG as an example for our discussion, the representations of legal knowledge in Legal Knowledge Based System LES6 and the applicability of LKBS to legal education. It is convinced that our logical model of law and its implementation in LKBS (LES6) is useful for legal education, including its visual representation

We would like to conclude this paper giving some comments on our present and future tasks.

In this paper, we have discussed legal knowledge as well as reasoning mainly in terms of the reasoning of justification. We should discuss also about the reasoning of legal creation. Our present project is to develop legal education methods for creative legal minds, where reasoning of creation must play much important role. The knowledge structure of legal creation and the methods of education for it will be in another occasion discussed more precisely. However, it is to be noted that for such works it is indeed needed as their necessary condition to clarify and reconstruct the deductive structure of legal knowledge and legal reasoning, for the legal creation is performed in the framework of the legal justification which is constituted of deductive reasoning.

The present visual figure of changes of legal relations is not automatically drawn but with cording. The content of the legal sentence and the beginning point as well as the terminating point of the validity of the sentences can be inferred automatically. Therefore, it is possible to make a program to display the belt figure of the validity of legal relations automatically. In order that each belt can be allocated understandable as much as possible, a certain rules for the allocation must be found. These are our future tasks.

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