

The Adaptability of 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 overrides specific rules in each case. Where a mechanical application of several specific rules leads to more than one conflicting conclusion, the initial logical inputs must be reassessed in light of the overall objective of a rule in a given situation through induction and abduction. 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 this aspect is properly handled, an excessive use of default values may make the legal expert system unpractical. 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 applications 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 and 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 legal states of affair 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 legal meta sentences regulating the validity of legal sentences plays a definitive 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' Project¹. 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 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 status 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 systematization of law, i.e., to present the law as a deductive system, has long been a central theme of legal theories, but remains illusive.² Modern mathematical logic and the construction of a knowledge base system of law give us the opportunity to systematize this properly, succinctly and explicitly and demonstrate 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 Jurisprudence³. This paper

¹ 'Legal Expert' Project is Japanese project on development of 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. As regards the project and its study results cf. two special issues of *Journal of Advanced Computational Intelligence* Vol.1, No.2 1997, Vol.2 No.1 1998.

² The systematization of law has been endeavored especially in continental law countries. Scholars of modern natural law, such as H. Grotius, S. F. v. Pufendorf, and B. de Spinoza have tried to present a natural law system as a deductive system such as geometry. Legal scholars of general theory of law in Germany, such as F. R. Bierling and K. Bergbohm, have tried to explicate positive law as a deductive system. From a strictly logical point of view, however, they did not succeed in presenting a legal system as deductive. Cf. Ref. 9).

³ Cf. Ref. 2).

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 CISG 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 CISG. The legitimacy of the model is demonstrated in an example of the CISG application to a concrete case.

2 Logical Jurisprudence

Logical Jurisprudence ("ronri hogaku" "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 primitives: "sentence," "validity" of 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 admitted or presupposed in legal studies and practice. Logical Jurisprudence 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, perceptible by others. Logical Jurisprudence considers sentences in the field of law as the direct and sound object of legal recognition.⁴

The second basic concept in Logical Jurisprudence is "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 the sentence 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 a goal1 at time1." The representation of the validity concept by a predicate is characteristic of Logical Jurisprudence that corresponds to the natural language

⁴The difference between conventional and legal sentences and how these differ is discussed in section 5.2.1.

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:

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

This formula is to be read: If 'if A then B' is true and A is true, then follows: B is true. *Modus Ponens* is the basic reasoning schema legal justification 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*. Judgment may not be deduced from statutes 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 knowledge clear and identifies it to make it explicit. Following are such additional legal sentences: principles of law that unify statutory legal sentences; common sense about legal terms, especially hierarchical 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 logical deduction because discovered legal sentences are to be set so that the whole reasoning process including these additional sentences can be presented as a logical deduction on the one hand and the reasoning of discovery is to be performed through a falsification inference on the other. Falsification has the logical structure of *Modus Tollens*:

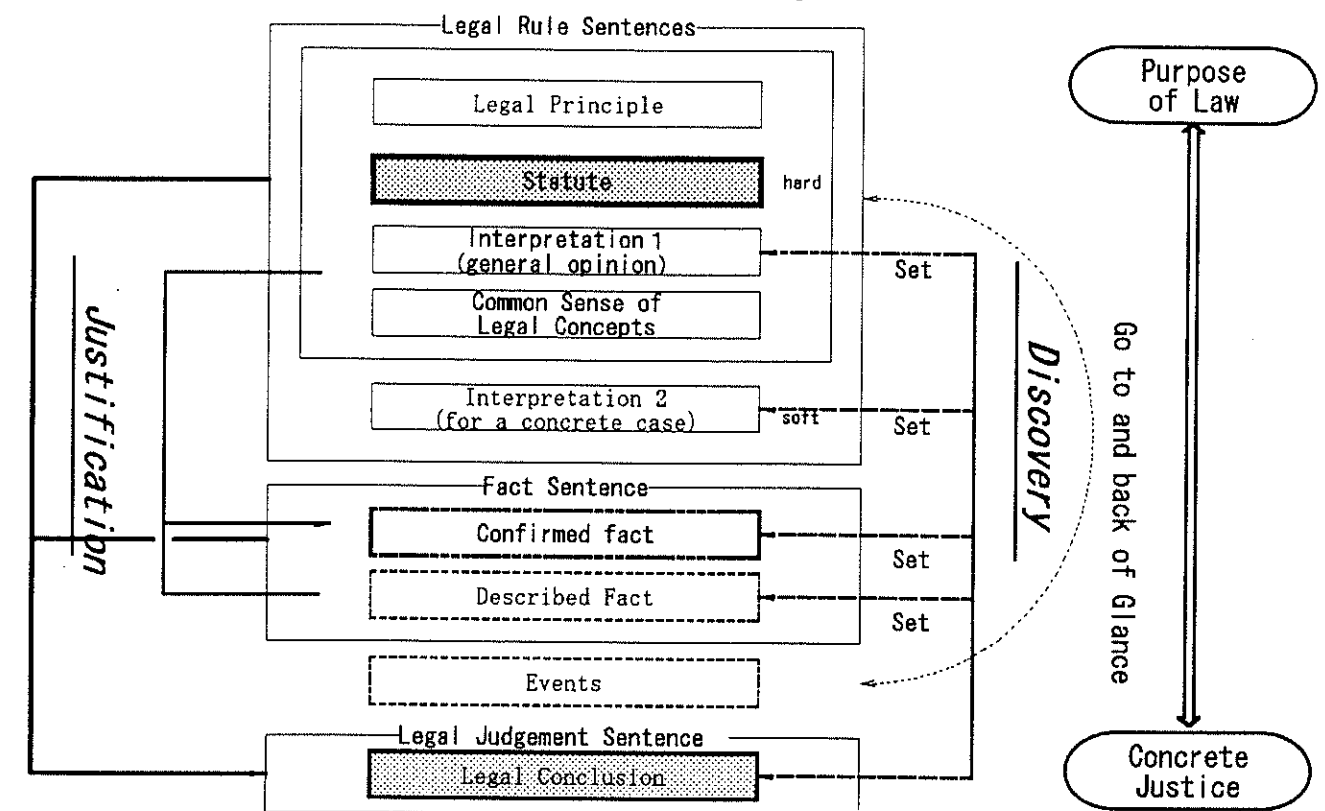
$$(A \Rightarrow B), \neg B \Rightarrow \neg A$$

This formula is read as follows. If 'if one sets a hypothesis 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 something more than deduction. To get hypothesis A in the schema above, abductive or inductive reasoning are needed.

Figure 1: Legal Reasoning Structure



Reasoning to get a hypothetical fact sentence is abduction and reasoning to generate a rule is induction. Logical Jurisprudence analyzes the legal reasoning process in two directions: (1) concretization (putting in concrete terms) and (2) systematization. This is also true for legal reasoning of discovery. The study of legal interpretation or analogy is important to concretization. In systematization, it is important to make legal principle sentences clear which will enable us to bring mere collections of legal sentences into a system, on the one hand, and to analyze how legal principle sentences are to be found as hypotheses on the other.

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

The study of legal discovery reasoning is important to the theory of legal reasoning, both in concretization⁵ and systematization⁶. Few engineers, however, study legal knowledge systematization itself, i.e. showing laws as a deductive system. This is because

⁵ Cf. Ref 15)

⁶ Cf. Ref 7)

engineers assume engineers that a theory of science has a deductive system, they are not interested in finding the deductive structure of law and, furthermore, legal knowledge is too specialized and complicated for engineers to deduce the structure. To construct a legal expert system, however, the deductive structure of law must be clarified to make a deductive knowledge base. It has long been desired in legal studies to clarify the deductive system of law and to systematize legal knowledge⁷. We focus on how to systematize the law of contracts as a logical deductive system⁸, leaving the reasoning of legal discovery in CISG to another time⁹.

3 The Basic Concept and Structures of Legal Sentences

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

⁷ Cf. Ref 4)

⁸ Interesting books on law and legal reasoning modeling have been published^{2,3,9}. Our study developed independently of them. Our approach is different from van Kralingen's approach, for example, in that it is not a conceptual or frame-based, but purely logical, especially in that we analyze and reconstruct the law intensively in 'legal sentences', 'their validity' and 'logical deduction'.

⁹ We have already done this to in a certain extent, i.e. 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: " $\forall X\{a(X) \leftarrow b(X)\}$ ". This formula is read: "For all X, X is a, if X 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: " $b(x)$ ", read: "x is b". Note that the difference between legal rule and fact sentences is, in Logical Jurisprudence, purely syntactic, as mentioned above.

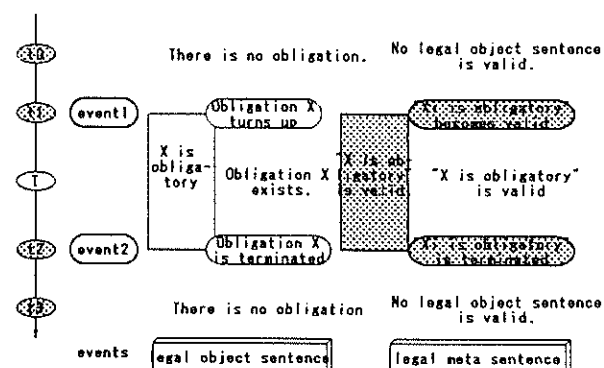
Second, legal sentences are to be further classified in terms of **sentence**, the smallest unit of legal sentences. Statutes or contracts are composed of elementary legal sentences, e.g., "one must drive a car under 100 km /hour on a highway" or "A may require B to pay the price of \$10000." A **complex 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 advantage of the 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 "B must pay A the price of \$10000" is an legal object sentence. 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 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(HOURED)) 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 them by 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. The

Figure 2: The Existence of an Obligation and the validity of the object legal sentence



relation of the existence of an obligation and the validity of a legal object sentence describing the obligation are shown in Figure 2.

The validity of legal meta sentences that prescribe legal object 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 the final, highest legal meta sentence is set as fact¹⁰.

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

¹⁰ Cf. Kelsen 1960, p.102. He proposed the concept of "basic norm (*Grundnorm*)". It is to be noted that my basic legal rule sentence does not always coincide with Kelsen's conception. They differ in the following points: Kelsen starts on legal norms as a meaning, while I start on legal rule sentences; Kelsen's basic norm is conceived of as a norm which gives the ground of the validity of constitution or convention 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 at any case where the validity of a legal sentence is to be decided. This has become the case of our logical analysis of legal system and legal reasoning.

4 Case and Solution

This section describes an example of a dispute relevant to CISG, presents questions on 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.

[Case 7f]

- (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.
- (2) On April 8, the letter reached B, the branch office in Hamburg.
- (3) On April 9, B made a telephone call to A. "The offer is accepted." Then B said to A. "I would like to withdraw my offer."
- (4) On May 1, A finally handed the farming machine over to a Japanese container ship at the port of 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 estitute 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
- damages by exercising his right to other remedies.
Article 46

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

- 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 offeree.
(2) An offer, even if it is irrevocable, may be withdrawn if the withdrawal reaches the offeree 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 offeree before he has dispatched an 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 consists:
(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;
- 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 of 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 with this requirement.
- (2) 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 fix an additional period of reasonable length 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 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 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 right to require B to pay the price to A by 10 May.
- 4) On August 15th, A has a duty to recover the damage, while B has right to claim from A the damage and B has 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 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 damage and the duty to restate the price paid by B, and B has the duty to restate the machine delivered by A, while B has the right to claim damage from 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.

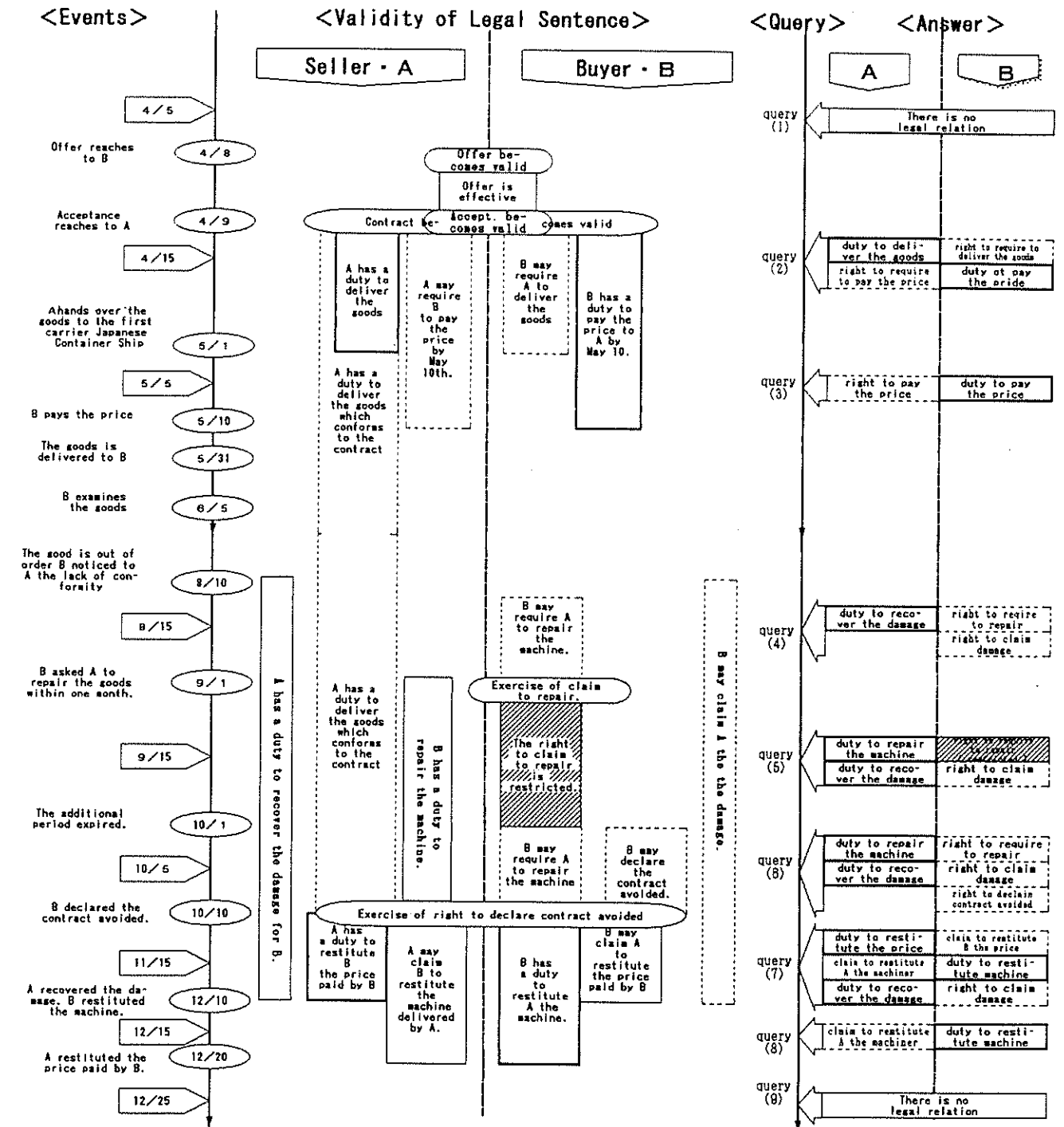
The changes of legal relation according to the time progress in case 7f are shown in Fig 3.

The above solutions correspond to obligation and right. In this chart, the existence of legal relations is indicated by the rectangle zones of the validity of legal sentences which describe obligations and rights in the figure. The knowledge structure which enabling deduction of the above solutions, or enabling the formation of rectangle zones of legal relations 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 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

Figure 3: The Changes of Legal Relation



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 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 Rule Sentences Deciding that Legal Sentences are Valid.

The following fundamental legal meta rule sentence is valid to confirm that legal sentences are valid¹¹:

(mr1) "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."

This rule is represented in the CISG knowledge as follows¹²

```
sen('mr1', [
  is_valid(_[obj:sen(SEN,[cnt:[S]]),goa:G,tim:T])
  <-
  be-
  come_valid(_[obj:sen(SEN,[cnt:[S]]),goa:G,tim:time_before(T1,[t1:
  o:T])])
  &
  not(is_terminated2(_[obj:sen(SEN,[cnt:[S]]),goa:G,tim:T2]) &
  time_after(T2,[tfr:T1]) & time_before(T2,[tfo:T])
  ])).
```

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, in 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 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 satisfied¹³.

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 rule 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'.)

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:

(r01) 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.

The above rule is installed in the CISG Knowledge base as a CPF as follows:

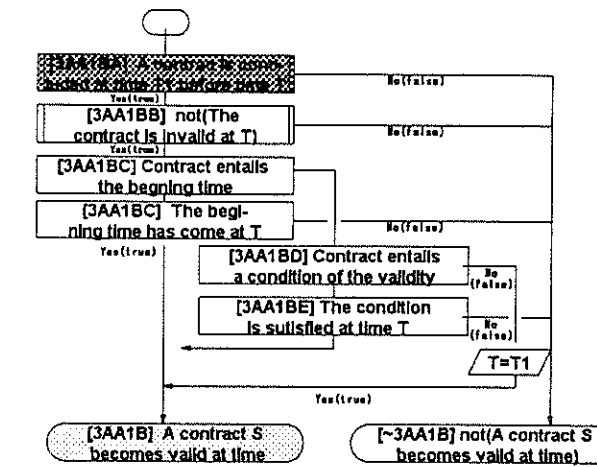
```
sen('01', [
  become_valid(_[obj:sen(SEN,[cnt:[S1]]),goa:G,tim:T])
  <-
  be-
  come_valid(_[obj:complex_sentence(B,[cnt:CNT_COMPLEX_SE
  NTEENCE]),goa:G])
  &
  ele-
  ment_sentence(_[obj:sen(SEN,[cnt:[S1]]),obj:complex_sentence(B,
  [cnt:CNT_COMPLEX_SENTENCE]),tim:T])
  ]).
```

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.

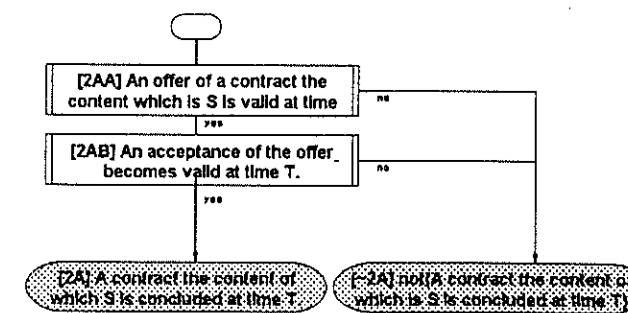
Figure 4 is a logical flowchart of the legal rule sentence that decides the accrual of validity of contract 3AA1BA in Fig. 4¹⁴ means that the contract is concluded. The "conclusion" of the contract means that it is formed as a legal sentence named contract. Legal sentences differ from conventional sentences 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: 3AA1B A contract becomes valid.



Part 2 of the CISG regulates in detail the conclusion of contract 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

¹⁴ As regards the method of knowledge representation of law by logical flow charts, refer to: Yoshino 1994a.

must be met. This legal rule sentence therefore [2A] (Fig. 5) is a legal principle of contract law¹⁵. (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 subrule of the first requirement [2AA] of this legal rule sentence. Articles 18 through 22 and 24 in part 2 are systematized as a subrule of the second requirement [2AB].

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 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:

(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.

¹⁵ As to the identification of this legal requirement and the formalization of the inference process of the discovery, we have discussed in: Sakurai & Yoshino 1993.

¹¹ 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

¹² This formula is based on CPF as a representation method of legal knowledge. As regards CPF, conf. Ref. 26.

¹³ We could say, therefore, that all legal meta rules in this sense contribute to regulating the validity of legal sentences.

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 an 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 an legal object 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 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.

```
sen('02',[
'is_terminated2'(BECOME_VALID,[obj:sen(SEN,[S1]),
goa:GOA_VALID,tim:T])
<
'is_terminated2'(BECOME_VALID,[obj:'complex_sentence'(S,[
cnt:CNT_COMPLEX_SENTENCE]),goa:GOA_VALID,tim:T])
&
'element_sentence'(ELEMENT,[obj:sen(SEN,[S1]),
obj:'complex_sentence'(S,[ cnt:CNT_COMPLEX_SENTENCE]),
tim:T])
]).
```

Complex legal sentences lose their validity on the day when a fixed term is expires, when the termination condition is met or when contract avoidance becomes effective. Regulations con-

cerned with these factors can be integrated as a legal rule sentence, which makes concrete the second requirement of the fundamental legal meta rule sentence *mr1* as its 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" 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 buyer¹⁶.

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 meta rule sentence is valid:

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

(The relevant CPF is eliminated here to introduce.)

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 CISG 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 expert system is composed. Here I would like to describe shortly about the CISG 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 CISG is represented at first in terms of the logical flow chart. Such example have shown already in Figure 4 and 5 in this paper. This approach

¹⁶ 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.

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 himself. These are advantages of the use of logical flow charts. The logical flow charts written are converted then to a kind of predicational 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 CISG articles and its interpretations are represented in terms of CPF (Compound Predicate Formula) in the knowledge base. CPF is an extend form of the first order predicate logical 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 represent.
- (2) It contains Case List which is a list of pairs and each pair 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 an example of legal rules represented in terms of CPF in the CISG knowledge base the rule 2a which corresponds in principle to the logical flow chart of Figure 5 is shown below.

```
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,
obj:offer(OFFER_ID,[
nam:OFFER,
agt:OFFEROR,
cnt:CNT_CONTRACT,
]),
tim:time_after(T1,[fr:T1])
]),
]),
&
```

```
goa:OFFEREE,
imp:IMP_OFFER,
obj:conclude(CONCLUDE_ID,[
nam:B,
agt:[OFFEROR,OFFEREE],
obj:contract([
nam:CONTRACT,
agt:[OFFEROR,OFFEREE],
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,
obj: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(T1,[fr:T1])
]),
]),
]),
&
```

6.3 CISG knowledge base system

We have developed a legal expert system LES4 and LES5 as a CISG knowledge base system. LES4 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. LES5 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. LES4 and LES5 can be used being connected with each other. The LES5 system is 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.

I would like to introduce the leader 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 7f, which is described earlier in this paper. In the LESS menu, if we click 'Do Inference', we are given the 'inference'

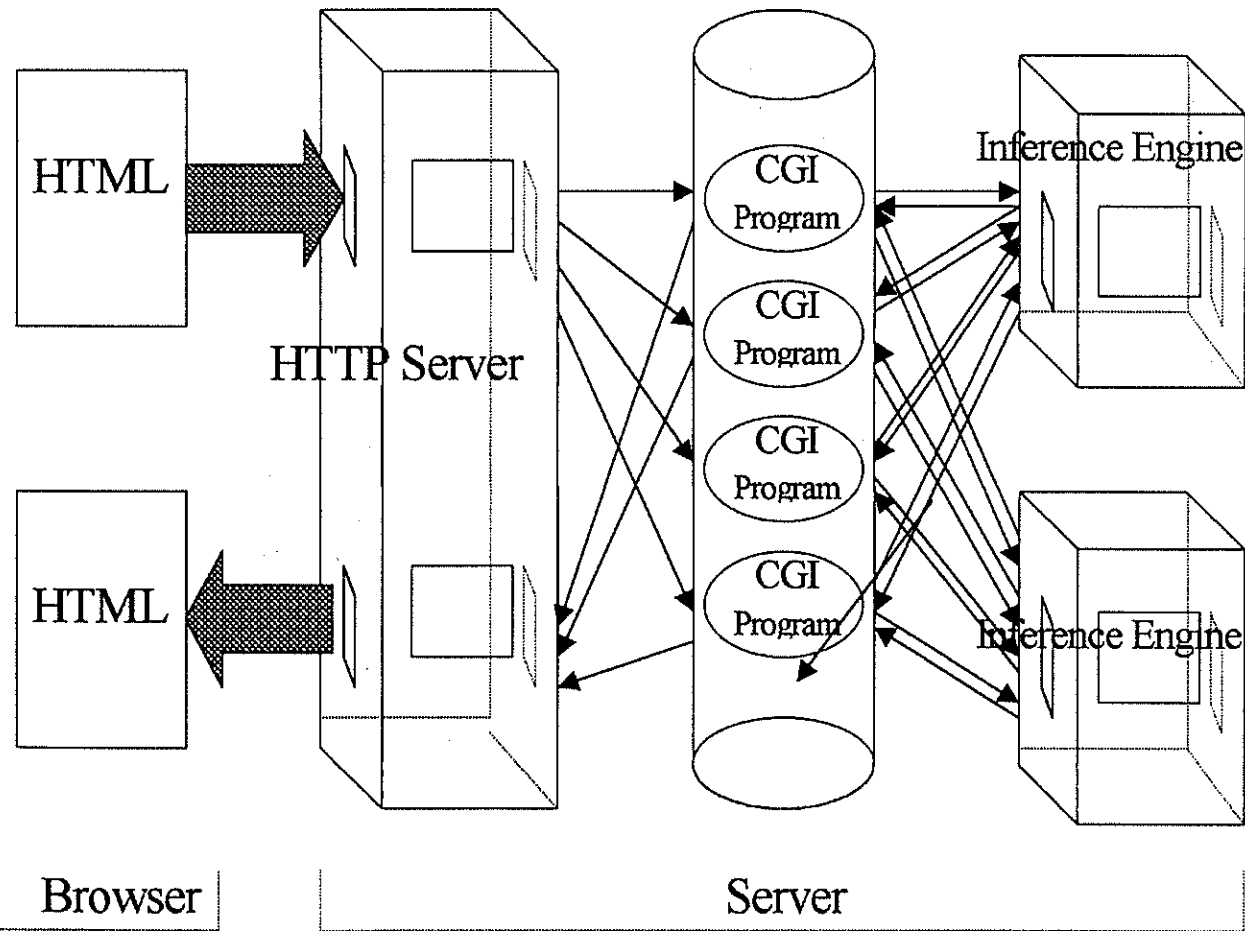


Figure 6

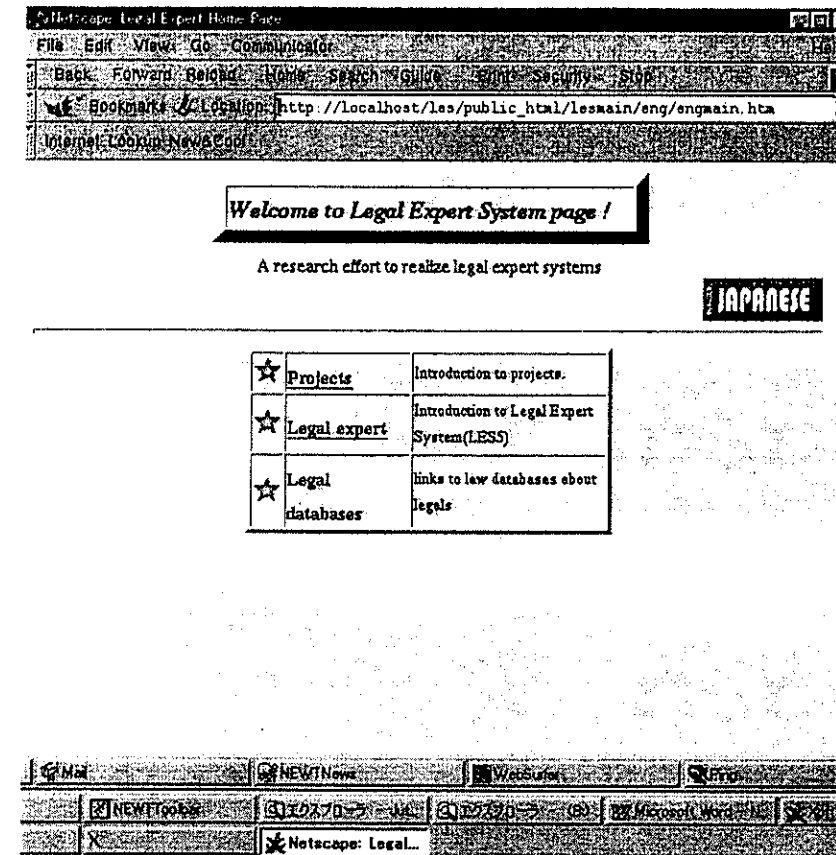


Figure 7

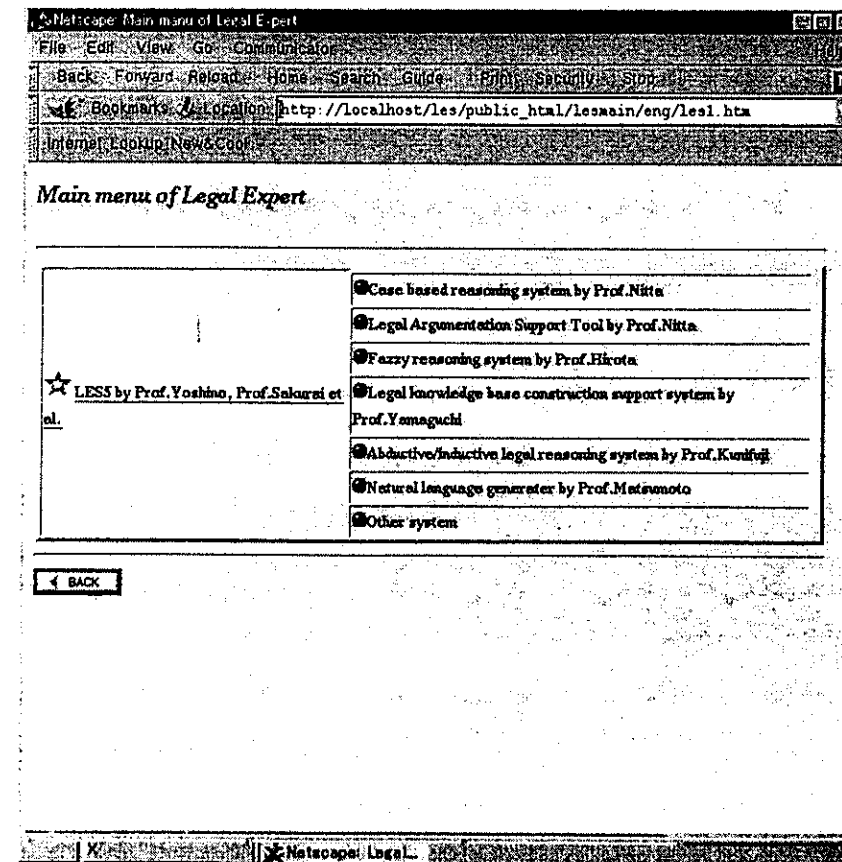


Figure 8

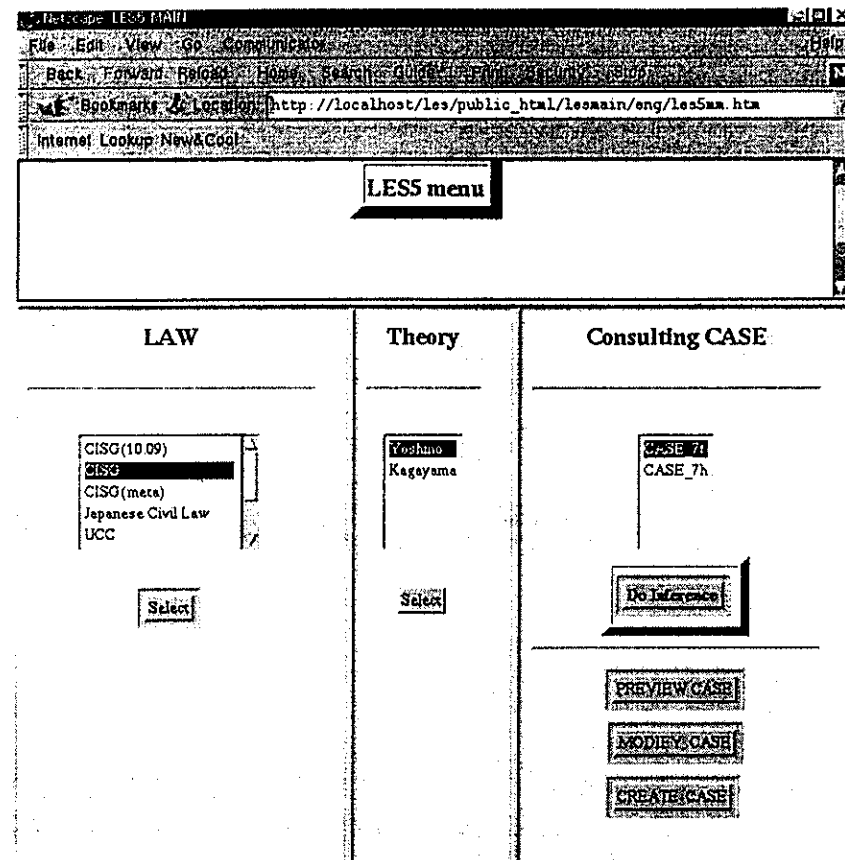


Figure 9

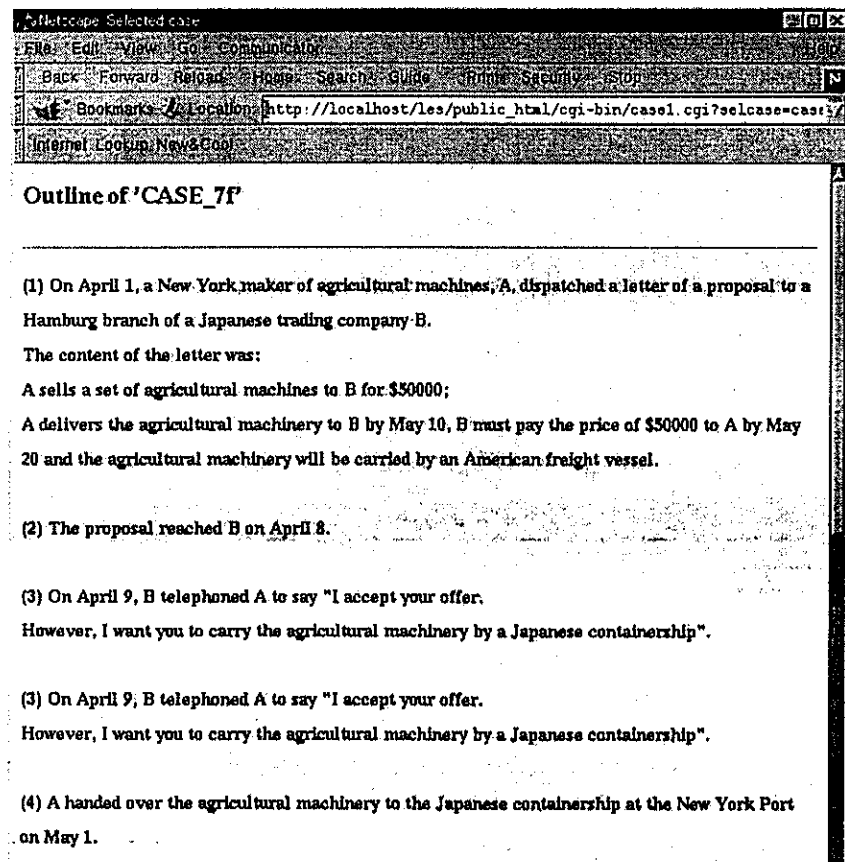


Figure 10

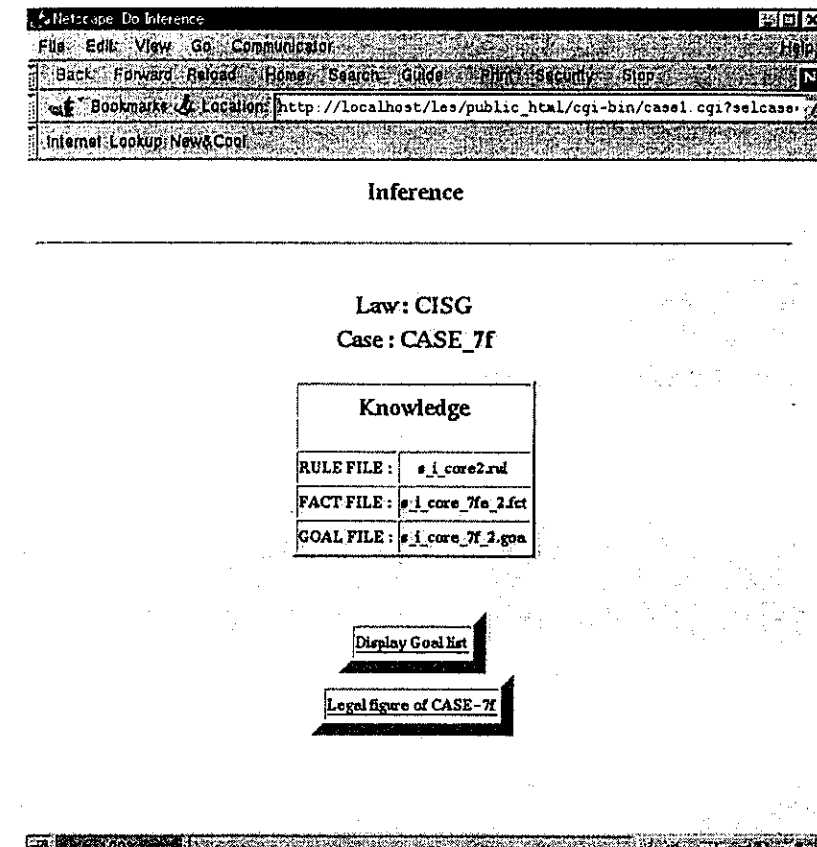


Figure 11

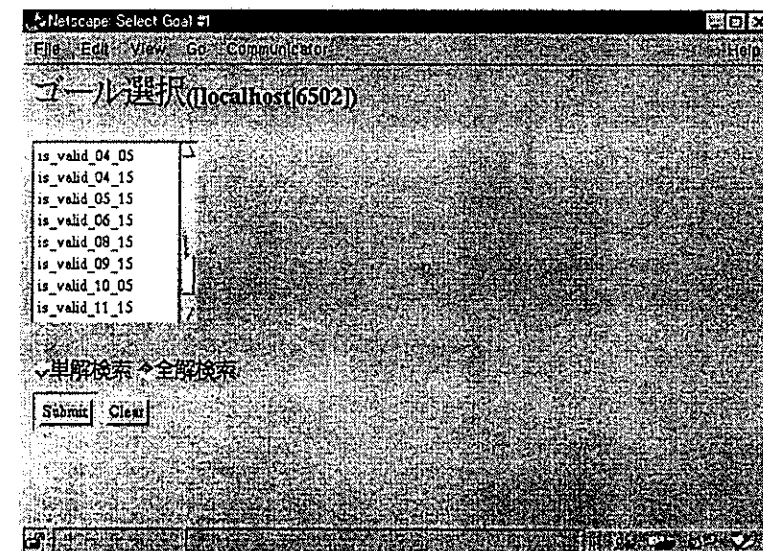


Figure 12

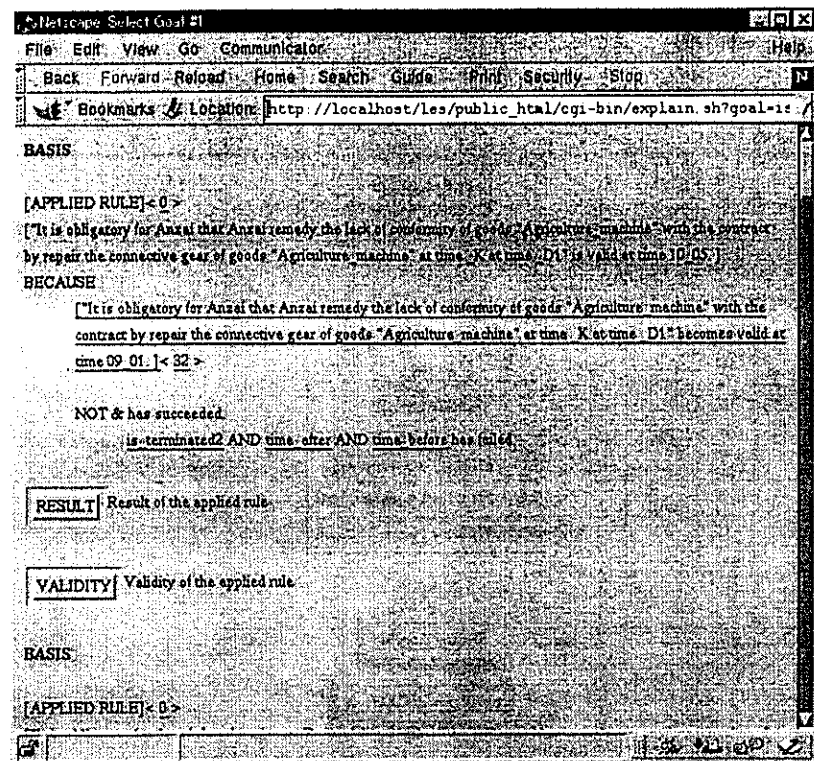


Figure 13

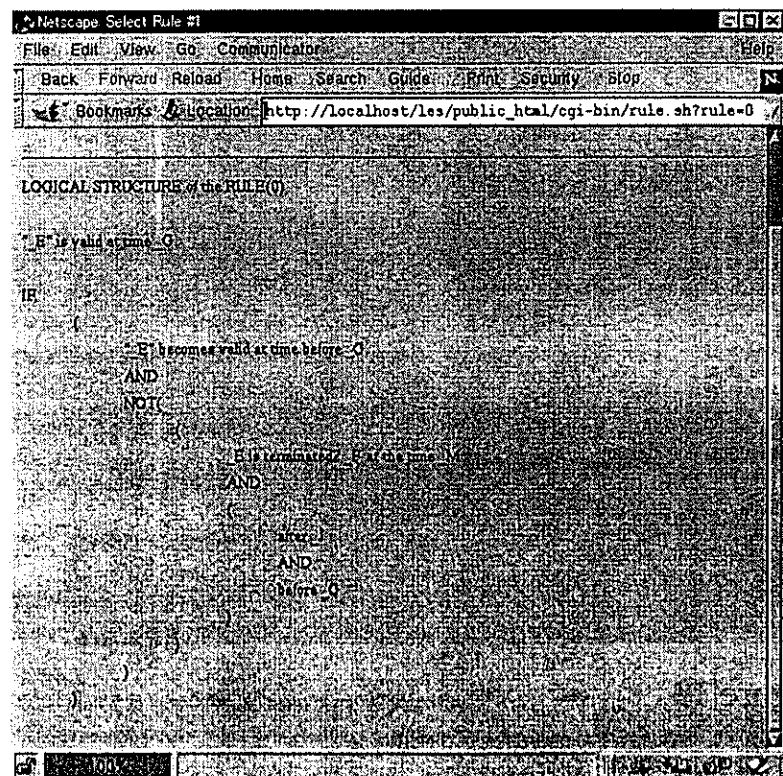


Figure 14

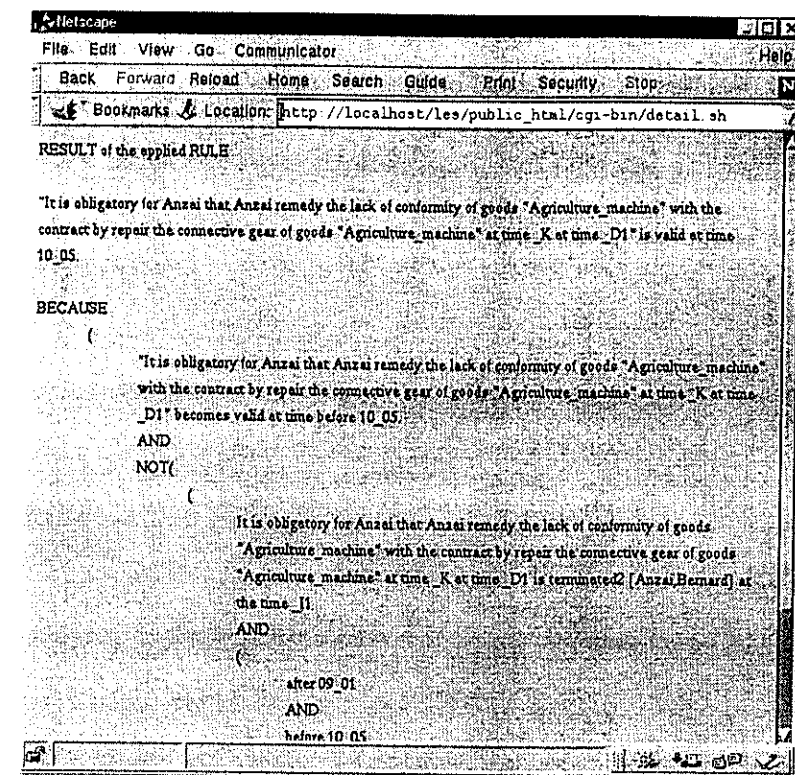


Figure 15

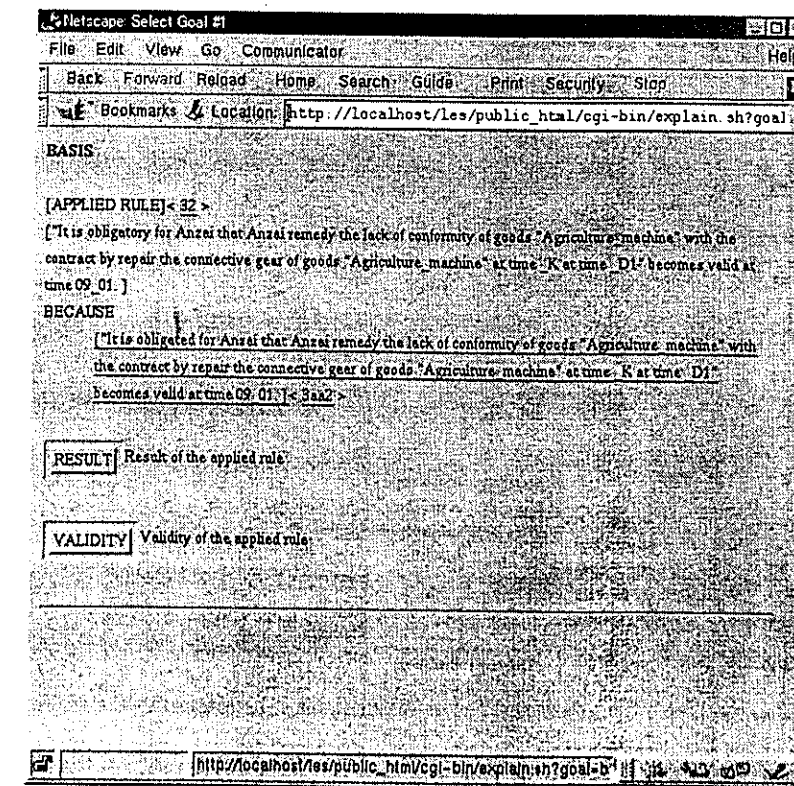


Figure 16

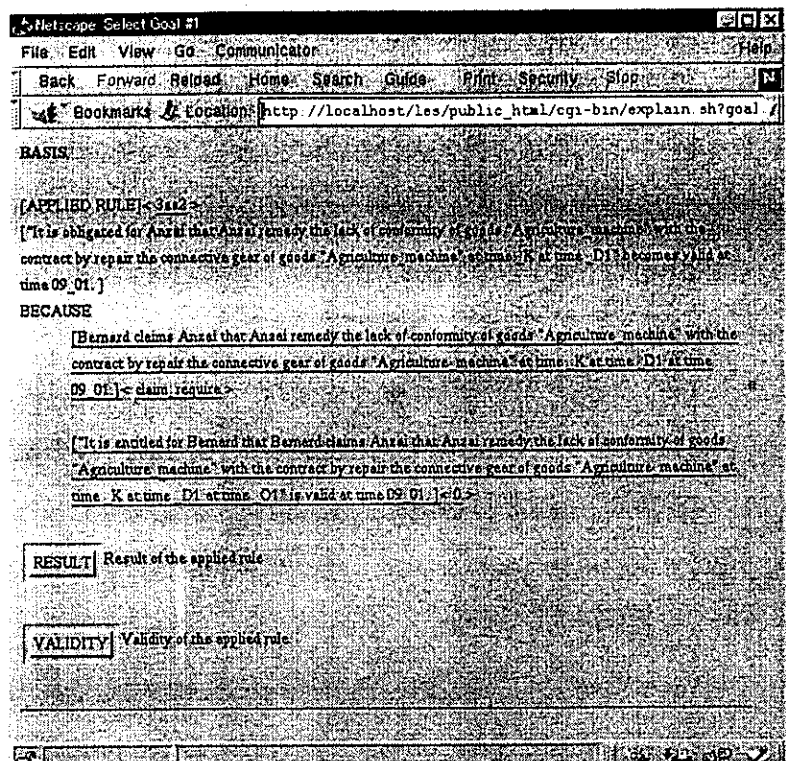


Figure 17

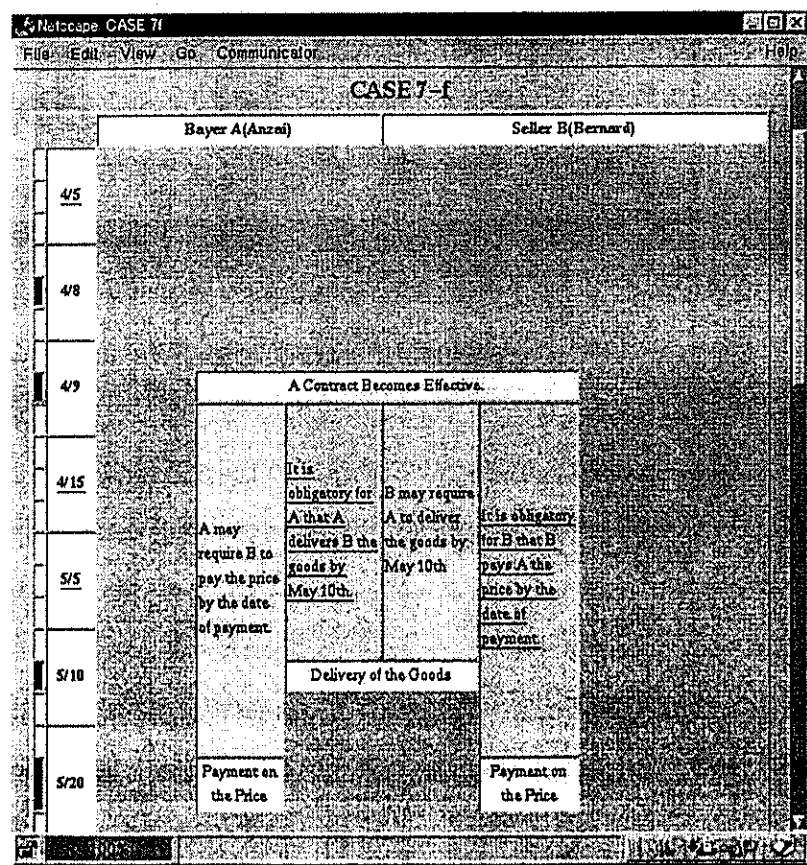


Figure 18a

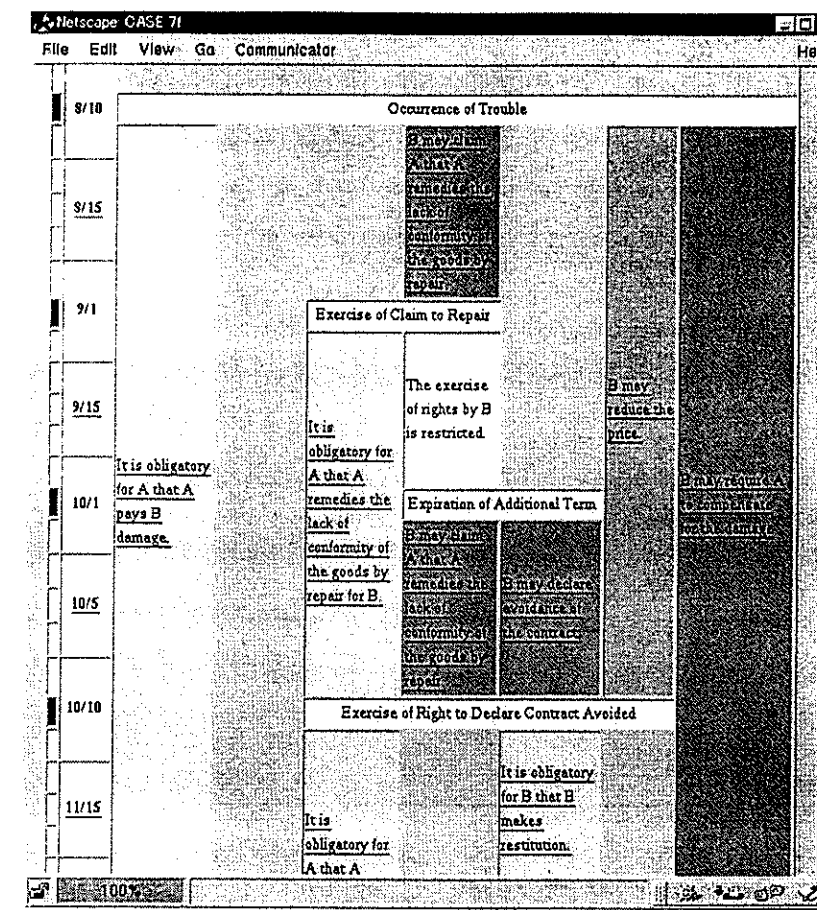


Figure 18b

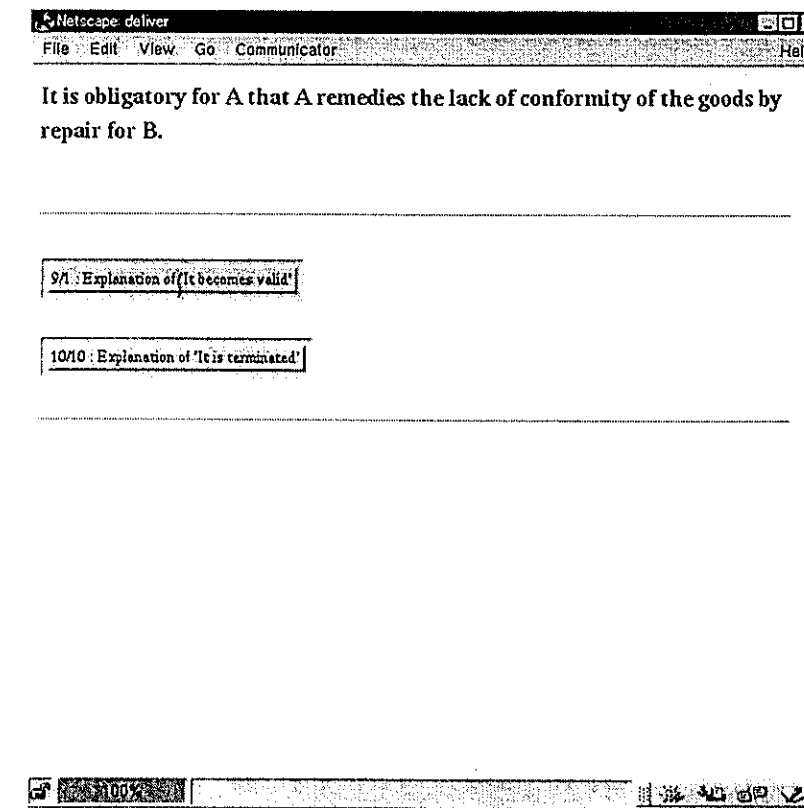


Figure 19

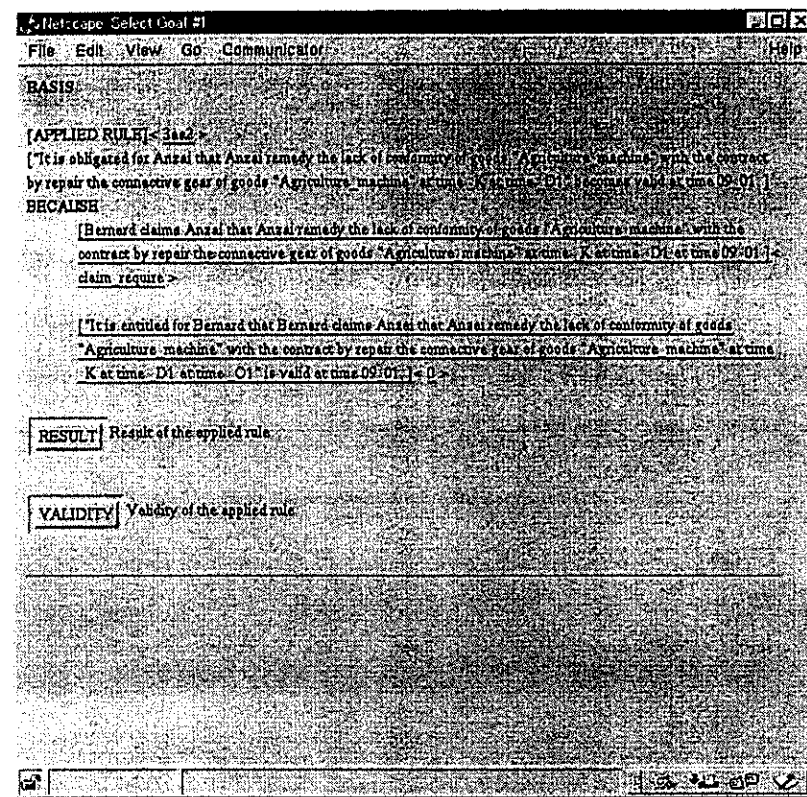


Figure 20

page (Figure 11) where we may choose the "goal list" or the "Legal Figure of the Case". If one chooses the former, then Figure 12 is turned out, where a list of goals which should be resolved by the system is shown. In Figure 12, the goals to be solved are the validity of the legal sentences at each time given in query. If we choose here what kind of legal sentence is valid on October 5, for example, and choose the "all solutions" possibility, then we are given the applicable conclusion and the basis for such conclusion. Therefore, Figure 13 shows that the sentence "It is obligatory for Anzai that Anzai remedy the lack of conformity of the goods with the contract by repair" is valid at the time of October 5. The basis shows that the sentence has become valid at the time of September 1 and it is not proved that the sentence has been terminated. This is a result of the application of Rule <0>, which represents fundamental meta-rule (mr1) described in Chapter 5.1 of this paper. If one clicks the rule number <0>, then the window changes to Figure 14, which shows the rule itself. If one clicks a "result" in the same window, Figure 13, then one comes to Figure 15 to see the results of the applied rule to the present case. The "Validity" button of each page is used to show the basis for proving the validity of the applied rule to the case. If one clicks each of the proved requirements one can see the basis for the proof of the requirements further. For example, if one clicks the proved first requirement of rule <0> in Figure 13, then the system shows the basis of the proof (Figure 16). If one clicks the proved requirement of rule <32>, then Figure 17 turns out. Figure 17 shows that the object sentence that describes the obligation of Anzai to remedy the lack of conformity of the goods with the contract by repair becomes violated at the time of September 1 because Bernard claimed against Anzai that Anzai must remedy the lack of conformity by repair on Sep. 1 and, at that time, Bernard has the right to claim against Anzai that Anzai remedy the lack of conformity by repair. This is based on rule <3aa2> which represents the relationship between duty and right described in the section 5.2.2. In this way one can inquire into the basis of legal reasoning according to the logical structure of legal knowledge up to the final corresponding facts. If we choose "Legal Figure of the Case" in Figure 11, then the system will display a chronological figure of the legal relationships between the parties, which are represented as the validity of the legal object sentences, which describe the obligations of the parties (Figure 18a; Figure 18b). If we click, in Figure 18, the relevant object sentence (for example, A's obligation to remedy lack of conformity of the goods in Figure 18b), then Figure 19 displays the beginning point and ending point of the validity of the object sentence, which corresponds to rule <0>. If one clicks the former the system

shows the basis for the proof that the sentence becomes valid. In this case Figure 20 turns out, which is the same as Figure 16. If one clicks the latter, the system shows the basis for the proof that the sentence is terminated. 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 CISG as an example and focusing on the systematization of law from the view of Logical Jurisprudence. 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 frame to cases (case 7f here), 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 every 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 CISG. 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 the CISG to a given international trade case.

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Construction of Legal Knowledge Base on the Maritime Traffic Laws and Regulations in Japan

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[Abstract] The existing laws and regulations function as a social engineering system in the vertically-structured society. However it is difficult for nonprofessionals to understand the legal knowledge which has abstract expressions for provisions, the hierarchy structures of legal systems, the richness of legal text, the deficiency of laws, and so on.

In this paper, I discuss, through a jurimetrics approach, the possibility of the systematization of legal knowledge (maritime traffic laws and regulations in Japan; a kind of public law) which is complicated in its structures and nature. Also, I propose, for the purpose of legal norm sentences analysis, the model of logical flowgraph and the method of logical formalization on steering and sailing rules.

Keywords: Legal reasoning, Legal knowledge, Jurimetrics, Logical formalization, Maritime traffic laws and regulations

1. Introduction

Laws and ordinances are generally written using abstruse words and technical terms to pursue exactness and conciseness and are described abstractly to facilitate their application to various legal phenomena. Laws and ordinances involve three different structures, preferential, conceptual and logical, making legal applications complicated. Furthermore, legal knowledge can be 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 stipulates the maritime customs and the empirical rules. They are characterized by a judicial norm rather than by a maneuver 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 logic, legal logic and information science. Furthermore, it forms one province of jurimetrics ¹⁾ aiming at a scientific approach towards law by an empirical method. The idea of jurimetrics can be

applied to the systematization of legal knowledge such as laws and ordinances.

In past research ²⁾, I proposed the systematization of laws and cases by the intelligent computer system, and I discussed theoretical problems based on the formalization of legal norm sentences by predicate logic. The use of symbolic logic to analyze the syntax of legal norm sentences has been suggested by ALLEN ³⁾. The direct application of classical mathematical logic to legal norm sentences has been suggested by YOSHINO ⁴⁻⁶⁾. On the other hand, some ideas of consultation or decision-making systems in law were suggested by MEHL ⁷⁾. Since then, research and development (R&D) of law 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 teams, such as the TAXMAN project ⁸⁾, the LEGOL project ⁹⁾, the HYPO project ¹⁰⁾, the Oxford project ¹¹⁾ and the LES project ¹²⁻¹³⁾. In advanced workshops ¹⁴⁾ or conferences ¹⁵⁻¹⁹⁾, some computer scientists and jurists studied various possibilities of computer assistance in the field of law ²⁰⁻²²⁾.

The idea of the systematization of legal knowledge is fundamentally based on these studies of the modeling of legal reasoning ²³⁻²⁶⁾, expert systems in law ²⁷⁻³³⁾, and the other computer-aided