The Knowledge Structure of Legal Meta-inference and its Systematization*

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Abstract

"Legal meta-inference" is a legal inference for controlling a legal inference, in other words, an inference which decides the way to infer legally. The legal knowledge seems to be incomplete and therefore the contradictions might come out. In the author's opinion these seeming incompleteness of legal knowledge is remedied by appealing to legal meta-inferences in legal practice. Moreover, the whole legal reasoning is controlled by legal meta-inference. The whole law text is written under the supposition that this legal meta-inference will be done. This study shows, in an example of legal reasoning, what legal meta-inference is, clarifies the knowledge structure of the legal meta-inference in terms of legal meta-rules which regulate the validity of legal rules, and establishes the way to systematize legal reasoning which entails the legal meta-inference, formalizing the meta-inference as a logical deductive reasoning.

1 Introduction

"Legal meta-inference" is a legal inference for controlling a legal inference, in other words, an inference which decides the way to infer legally.

It seems that knowledge about our social life is incomplete, namely it contains contradictions at first glance, for knowledge is constantly changing, or increasing with time. Various studies on default reasoning, non-monatomic logic and so on, have tried to explore principles and methods of a system of inference applying such an incomplete knowledge[1]. But these approaches don't always seem to have succeeded in clarifying the principle sufficiently. In my opinion, they would not be useful for formalization of legal reasoning.

Contrary to those approaches, I start with thesis that knowledge about knowledge (or meta-knowledge) has been prepared in the field of law so that lawyers can control, willingly or unwillingly, their inference through legal meta-inference by applying this meta-knowledge in order to resolve the possible contradictions and to reach reasonable conclusions corresponding to dynamic changes of the knowledge.

This paper aims to clarify the knowledge structure of legal meta-inference in respect of the relation between knowledge and meta-knowledge, especially of the relation between legal rules and legal meta-rules which regulate the validity of the rules. Moreover, on that basis I establish the way to

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* This paper is based on [Yoshino 1992].

[1] Cf. [McDermott 1982], [McCarthy 1986], [Poole 1988], [Arima 1988]

systematize the legal meta-inference toward a legal reasoning system. The characteristic of my approach is to formalize legal meta-inference as a first order, classical logical inference.

2 An Example of the Legal Reasoning

Below, I examine an example of a legal reasoning in the field of Japanese contract law. In order to decide what kinds of obligations the contract parties have, one should solve whether the contract is concluded. In order to solve the latter problem, one should decide whether an acceptance of an offer becomes effective. Let's deal with a legal reasoning to decide this last problem. At first we assume certain facts, namely

Case 4:
f1: An offer by Anzai to Bernard reaches Bernard on November 7.
f2: Bernard dispatches an acceptance of the offer to Anzai on November 11.
f3: Bernard's acceptance of the offer by Anzai reaches Anzai on November 17.

Legal rules:
r1: A declaration of intention becomes effective when it reaches the other party. (Cf.: Japanese Civil Code Article 97-1)
r2: An acceptance becomes effective when it is dispatched. (Cf.: Japanese Civil Code 526-1)
r3: An acceptance is an declaration of an intention. (Common sense in law)

We suppose :
fv1: r1 becomes valid on October 1.
fv2: r2 becomes valid on October 30.
fv3: r3 becomes valid on October 1.
The time of the inference: December 16.

Let's resolve the following goal:
Goal: "When does the acceptance become effective?"

(a) Inference without a meta-inference

We get two answers by applying the above rules. One is "the acceptance becomes effective on November 17" and the other is "the acceptance becomes effective on November 11." The former is to be deduced as a result of applying rules r1 and r3 to the fact f1. The latter is to be deduced as a result of applying rule r2 to fact f2. These two answers contradict each other.

(b) Legal Reasoning (Inference with a meta-inference)

In the practical legal reasoning process, a lawyer gets a single answer "the acceptance becomes effective on November 11" by applying r2. It is the legal meta-inference that rejects applying r1 and applies only r2 to solve the goal to get the appropriate answer. I would like to clarify the logical structure of legal meta-inference in terms of the relevant knowledge.

3 The Structure of Legal Knowledge

3.1 Legal Rule and Meta-Rule

Legal knowledge consists of legal rules. A legal system can be taken as a logical connection of legal rules. We can distinguish two kinds of legal rules. One is the rule that prescribes obligations

of people as the addressee of the law which I call legal object rule. The other is the rule that prescribes rules, to be accurate, the validity of rules, which I call "legal meta-rules"[2]. A legal system prescribes ultimately legal obligations of people to do a certain conduct or refrain from doing it. The legal obligations are conceived to exist if the legal rule which describes the relevant obligations is legally valid. In order to decide whether a rule is valid, there is a series of legal rules which describe the validity of the rule. These are to be called legal meta-rule, as above mentioned. There is also a meta-rule, which prescribes the varidity of legal meta-rule. (In my opinion the greater part of Japanese contract law consists of this kind of legal meta-rules, which prescribe the validity of a contract as a set of legal rule prescribing legal obligations of the parties. In order to decide whether a contract is valid, we have to decide at first the problem whether the contract is concluded, which is concerned with the above case and rules.)

3.2 Validity of Rules

Legal rules are either valid or invalid. The validity of a rule is to be conceived as a truth value in the logical sense. Just as only true rules are to be applied to solve a problem, so only valid rules can be applied, as axioms of the legal reasoning, to solve a legal problem. Legal meta-rules control legal reasoning on the way they prescribe what rule is applicable to solve the relevant problem. Legal meta-rules prescribe the validity of rules in these two ways: a) prescribing the scope of the validity of rules and b) prescribing the priority of rules.

3.3 Rules Prescribing the Scope of the Validity of Rules

Unlike the world of natural science, in the legal world, the validity of rules is relative. Every legal rule has its scope of validity. The scope of the validity of legal rules is limited in terms of "time", "place", "person" and "matter". A legal rule is valid only in the range of the scope. It is applicable only in the range. A type of legal meta-rules prescribes the scope of the validity of rules. They determine when the rules become valid or null, where, to whom and to what matter. For instance, Article 1 of Law Concerning the Application of Laws in General of Japan determines the enforcement date of laws.

And, article 1 (1) of the United Nations Convention on Contracts for the International Sale of Goods describes that the convention applies to a certain matter as below:

(1) This Convention applies to contracts of sale of goods between parties whose places of business are in different States:
  (a) when the States are Contracting States; or
  (b) when the rules of private international law lead to the application of the law of a Contracting State.

It is also to be noted here that the scope of the validity of legal rules changes according to the progress of time.

3.4 Rules Prescribing the Priority of Rules

To avoid contradiction, which might come out as a result of the application of legal rules, there are legal meta-rules which determine the priority relation of rules. The principle rules are introduced as below[3]:

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[2] Cf. [Yoshino 1988] p.52, [Yoshino 1989] pp.41ff.
[3] Cf. [Yoshino 1986a] p.38f., [Yoshino 1988] p.52f. and [Yoshino 1989] p.47f.

pr1: An upper law derogates a lower law,
pr2: A particular law derogates a general law,
pr3: A new law derogates an old law.

It is the meta-rule pr2 that remedies the seeming contradiction between the above legal rules to solve case 4. This meta-rule is to be formulated accurately as follows:

pr2': The validity of rule 1 is derogated for scope G by rule 2, if rule 2 is a particular rule to rule 1 and the scope G of the validity of rule 2 overlaps with the scope of the validity of rule 1.

pr2'-1: A rule is a particular rule to the other rule, if and only if the scope of the validity of the rule in terms of time, place, person and matter is included by the other.

In the above legal meta-rules pr1, pr2 and pr3, legal rules of higher priority 'derogate' legal rules of lower priority. In my opinion, the derogation of a rule by another rule means that the validity of the former is derogated by the validity of the latter rule. In other words, the former becomes null by the latter (cf. mr2-2). If a rule is null, i.e., invalid or false, then it cannot be applied as a premise of the inference.

Among above legal meta-rules from pr1 to pr3, there are also priority relations. Pr1 is prior to pr2 and pr2 is prior to pr3.

3.5 General Principle to Determine the Validity of Rules

I have analyzed the validity relationships of legal rules and endeavored to abstract general principle rules to determine the validity of rules for a legal meta-inference system. The present results are following two rules[4]. In abstraction the scope of the validity of rules is taken account of only in terms of matter and time, and terms of place and person are eliminated.

mr1: Rule R is valid for goal G at time T, when
R becomes valid at the time T1 before T for goal G1 including G, and
R does not become null between T1 and T for goal G2 included in G.
mr2: Rule R is valid for goal G at time T, when
R becomes valid at the time T1 before T for goal G1 including G, and
G is included in goal G3 where G3 is the intersection of G1 and the complement to goal G2, if R becomes null for G2 between T1 and T where G2 is included in G1.

Under these two rules there are amount of meta-rules. Here I introduce only a rule which connects the above two rules with pr2':

mr2-2: Rule R becomes null for goal G at time T, when
its validity for G is derogated by the other rule at T.

[4] I tried to formalize principal legal meta-rules in terms of concepts 'applicable', 'formal relationship of application', 'formal applicable', 'be valid' and 'become valid' in 1990 (Cf. [Yoshino 1990a] pp.49-55). These concepts were a little too complicated and view points were not enough definite. Especially the concept of 'application' as a conduct was confused with the concept 'validity'. Since 1991 I have excluded the concept 'application' from legal meta-rule to formalize legal meta-knowledge only in terms of the concept of 'validity', which is composed of 'be valid', 'become valid' and 'become null'. (Cf. [Yoshino 1991b] p.22ff.)

4. Logical Nature of Legal Meta-Inference

Legal reasoning is controlled by determining the validity of rules, for only valid rules can be applied to cases as premises (axioms) of the legal reasoning. A Legal rule must be valid to solve a problem at the time of the inference, i.e., the time of the judgment, as well as at the time of the event. to which legal rules are applied. It can be said, that a legal meta-inference is an inference which deduces a valid legal rule to solve a problem.

Legal meta-inference solves the meta-goal "the rule is valid for the goal to be solved at the time of inference as well as the event". The nature of this inference is to be conceived as a logical inference. This inference can be formalized in terms of the first order predicate logic. In this meta-inference, meta-rules prescribing the validity of the rule are conceived as axioms - in other words, premises of the meta-inference - and the above meta-goal is logically proved from these axioms together with the goal and the facts of the case to which the rule is applied, where the goal is logically proved by the application of the rule.

5. Systematizing Legal Meta-Inference

5.1 Formalization of Legal Knowledge by CPF

As law sentences prescribe the complex state of affairs in our social life, it is necessary for a formal language of a legal reasoning system to be able to represent the complex state of affairs precisely as it is described in natural language. The language should be also easy to read and write for lawyers who make or check a legal knowledge base. From this point of view, the author has developed and used CPF as a legal knowledge representation since 1985[5]. CPF is an abbreviation of 'Compound Predicate Formula'. Here I would like to apply CPF to formalize the relevant legal knowledge explaining what CPF is.

A unit of CPF is a compound predicate formula, which is composed of two terms as follows:

predicate(predicateID, CaseList)

'predicate' is a predicate name. The term 'predicateID' is an identifier of the predicate. The term 'CaseList' is a list of pairs, which represents case role of the predicate and its fillers. Each filler can be also a compound predicate formula. I show an example, which represents the above fact f3:
"Bernard's acceptance of the offer by Anzai reaches Anzai on November 17."

```
reach(reach1,[
  obj:acceptance(acceptance1,[
        agt:'Bernard',
        obj:offer(offer1,[
            agt:'Anzai',
            obj:obj_offer1,
            goa:'Bernand'])
      goa:'Anzai'])
  tim:11_17,
  goa:'Anzai'])
```

[5] CPF was used at first for constructing LES-2 (Legal Expert System-2) in 1985 (Cf. [Yoshino 1986a], pp.36ff.; [Yoshino 1988], p.56). It was improved in 1989 (Cf. [Yoshino 1989a], pp. 52f.) and defined exactly in 1990 (Cf. [Yoshino 1990a], pp. 27f.). It was used also for LES-3 (Cf. [Yoshino 1992a], pp.1ff.) as well as for a legal analogical reasoning system ([Yoshino 1993b] p.111f.). The formal semantic foundation was given in 1994 (Cf., [Yoshino 1994b] p.154f., [Yoshino 1994c] p.134f.). We are now developing LES-4 which is funded by Grant-in-Aid for Scientific Research. To this system CPF is applied, too.

This formula is equivalent to the following 'flat CPF' (FCPF). Compound predicate formula is to be converted into FCPF's for an inference.

reach(reach1,[obj:acceptance1,tim:11_17,goa:'Anzai']) &
acceptance(acceptance1,[agt:'Bernard',obj:obj_acceptance1,goa:'Anzai']) &
offer(offer1,[agt:'Anzai',obj:obj_offer1,goa:'Bernard'])

The filler for object-case of predicate 'reach', namely 'acceptance1', in the above first FCPF is defined as a member of set 'acceptance' in the second FCPF. The filler for object-case of 'acceptance' in the second FCPF, which is 'offer1', is defined as a member of set 'offer' in the third FCPF. By the introduction of predicate identifiers and case lists, CPF can represent precisely a complicated state of affairs of social events which law prescribes.

As far as the semantic foundation of CPF is concerned, two ways are available:
1) a formal semantics for a conservative extension of first order language
2) a definition as an abbreviated representation (syntax sugar) of first order language.
I have tried the first approach in the previous works[6]. In this paper I would like to try the second way of the foundation.

i) A CPF which has a compound predicate formula (CPF) as a filler of role of case of predicate is an abbreviation of a compound formula of FCPF's connected by conjunctions like the above example.
ii) An FCPF is an abbreviation of a compound formula of first order logical formulas connected by conjunctions, where one formula is one-term predicate logical formula whose term is a predicate identifier and the other formulas are two-terms predicate logical formula whose predicate is a case role and whose terms are fillers of the role and a predicate identifier. We can define this by a following example:

reach(reach1,[obj:acceptance1,tim:11_17,goa:'Anzai'])
is abbreviation of:
reach(reach1) & obj(acceptance1, reach1) & tim(11_17, reach1) & goa('Anzai',reach1)

The latter logical formula is to be read:
"reach1 is 'reach' & object of reach1 is acceptance1 & time of reach1 is 11_17 & goal of reach1 is 'Anzai'."

Therefore the above whole CPF is to be conceived as an abbreviated formula of the following first order logical formula:

reach(reach1)&obj(acceptance1, reach1)&tim(11_17, reach1)&goa('Anzai',reach1) &
acceptance(acceptance1)&agt('Bernard',acceptance1)&obj(obj_acceptance1,acceptance1)&
goa('Anzai', acceptance1) &
offer(offer1)&agt('Anzai', offer1)&obj(obj_offer1, offer1)&goa('Bernard', offer1)

CPF's can be connected with each other by a propositional operator to represent a compound proposition. A legal rule can be formalized by connecting at least two CPF's, which represent a legal requirement and a legal effect, by a material implication or equivalence.

In the knowledge base a fact sentence is loaded in the following form:
fact(factID,factInfo,factItself).

'factID' is an identifier of a fact, 'factInfo' is information about the fact and 'factItself' is CPF describing the fact.

A rule is loaded in the following formula in the knowledge base:

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[6] [Yoshino 1994b] and [Yoshino 1994c]

rule(ruleID,ruleInfo,ruleItself).

'ruleID' is an 'identifier' of a rule, 'ruleInfo' is information about the rule and 'ruleItself' is CPF describing the rule.

The above legal rule r1 is to be formalized as follows:

```
rule(r1,RuleInfo,[
become_effective(BE,[
    obj:IOI,
    tim:T])
<-
reach(REACH,[
    obj:declaration_of_intention(IOI,[
        agt:AGT_IOI,
        obj:OBJ_IOI,
        goa:GOA_IOI]),
    tim:T,
    goa:GOA_REACH])
]).
```

A Legal meta-rule is represented also in the same way. A legal meta-rule represented by CPF has a rule identifier (rule name) as a term (constant or variable) in it, to be accurate, as a filler of object-case of a predicate designating legal validity. The following is a CPF representation for the above legal meta-rules:

```
mr1:
rule(mr1,MRuleInfo1,[
be_valid(BV,[obj:R,goa:G,tim:T])
<-
(becomes_valid(BV1,[obj:R,goa:G1,tim:before(T1,[tim:T1,tfr:T])]) & include(G1, G])) &
(not(beome_null(BN,[obj:R,goa:G2,tim:T2])) &
(between(T2,[tim:T2,tfr:T1,tto:T]) & include(G, G2])))
]).

mr2:
rule(mr2,MRuleInfo2,[
be_valid(BV,[obj:R,goa:G,tim:T])
<-
(becomes_valid(BV1,[obj:R,goa:G,tim:before(T1,[tim:T1,tfr:T])]) & include(G1, G)) &
((become_null(BN,[obj:R,tim:T2,goa:G2]) & between(T2,[tim:T2,tfr:T1,tto:T])) &
(intersection(G3,(G1 & (~(G2))) & included(G,G3)))
]).
```

A goal of a legal meta-inference, which I call meta-rules mr1 and mr2, is to be formalized as follows:

```
be_valid(BV,[obj:RuleId,goa:Goal,tim:Time])
```

This formula is to be read:
"RuleId is valid for Goal at Time"
Here 'Goal' is a solved goal in object level inference.

5.2 Legal Meta-Inference Engine

The legal meta-inference engine enhanced the classical inference engine in two features. First, it has a function to interpret a CPF. This interpretation can be done by two alternative ways:
a) flattenization of CPF or
b) an extended unification.
In the former way only syllogism is to be applied to infer appealing to the conceptual hierarchy, while in the latter an order sorted, extended unification of a concept to its sub-concept is to be done. I have

developed the both types of inference engine. Second, the legal meta-inference engine has a function to call an inference to decide the validity of the rule applied to solve a goal. I would like to show the second feature below:

```
1 demo(A):-fact(A).
2 demo(not(A)):-not(demo(A)).
3 demo(A&B):-demo(A),demo(B).
4 demo(A;B):-demo(A);demo(B).
5 demo(A):-
6       rule(R,I,A<-B)),
7       demo(B),
        .....
11    get_time_of_event(A,T2),
12    demo(be_valid(_,[obj:R,tim:T2,goa:A])).
```

(Here I eliminate the part of the meta-inference for the validity of the rule in terms of the time of inference, which should be written in line 8-10.)

5.3 Verification of Legal Meta-Inference by Example

I would like to demonstrate the logical structure of a legal meta-inference by describing the inference process to solve the above example case 4 step by step.

Because, the concept 'acceptance' is a subset of the concept 'declaration of intention' as rule r3 also shows, we can conclude (also through a meta-inference, which is not explained here):

fmrv4a: "Rule r2 is a particular rule to rule r1."

Our inference engine follows the steps below to prove the goal.
Rule r1 becomes a candidate to solve the goal "the acceptance becomes effective" (6 - this notation refers to the line number of our inference engine listed in section 5.2). When rule r1 is applied to this case, it is provable through r3 together with the fact 3 that;

"the acceptance of the offer becomes effective at the time November 17" (in lines 7-6).

CPF of this proved goal is:

```
become_effective(BE,[
    obj:acceptance(acceptance1,[
        agt:'Bernard',
        obj:offer(offer1,[
              agt:'Anzai',
              obj:obj_offer1,
              goa:'Bernard'])
        goa:'Anzai'])
    tim:11_17])
```

The inference engine executes the goal 'get_time_of_event' in line 11 to get the time of the event from the proved goal by applying the relevant knowledge. '11_17' is to be the time of the event. Then, the meta-inference is invoked to prove the meta-goal "the rule r1 is valid at the time of the event on November 17 for the goal 'the acceptance of the offer becomes effective on November 17'" (Cf. line 12), whose formula is:

```
be_valid(BV,[
    obj:r1,
    goa:become_effective(BE,[
        obj:acceptance(acceptance1,[
                agt:'Bernard',
                obj:offer(offer1,[
                    agt:'Anzai',
                    obj:obj_offer1,
                    goa:'Bernard'])
            goa:'Anzai'])
        tim:11_17]),
    tim:11_17])
```

In order to prove this goal, the present inference engine is invoked again and the goal matches meta-rule mr1 at first (Cf. line 11). The first requirement of mr1 "r1 becomes valid at the time of November 17 for goal 'the acceptance becomes effective on November 17'" is on the basis of the fact fv1 provable, but the second requirement "r1 does not become null between October 1 and November 17 for goal" is not provable, because it is to be proved that:

"r1 becomes null for goal 'acceptance becomes effective' at the time of October 30 between October 1 and November 17'" and
"'becomes_effective of acceptance' is included in 'become_effective of declaration of intention".

The proof process is as follows:
Rule r2 is a particular rule to rule r1 as above described and the validity scope for 'become_effective of acceptance' of r2 overlaps with the validity scope for 'become_effective of declaration of intention' of r1. Therefore it is provable, through meta-rule pr2', in the meta-inference:
"The validity of r1 is derogated for goal 'acceptance becomes effective' by r2 at the time of October 30." (On the basis of fv2).
Consequently it is also, through mr2-2, provable that:
"r1 becomes null for goal 'acceptance becomes effective' at the time of October 30."
As 'acceptance' is subset of 'declaration of intention', it is also provable that:
"'becomes_effective of acceptance' is included in 'become_effective of declaration of intention'".

After the trial of the application of mr1 failed, the inference engine tries mr2. Here also the second requirement cannot be satisfied, for r1 becomes null for goal 'becomes_effective of acceptance' which is included goal 'become_effective of declaration of intention' at the time of October 30 between October 1 and November 17, and there cannot be any goal G which is included in 'becomes_effective of acceptance' and at the same time included in the intersection of 'become_effective of declaration of intention' and the complement of 'becomes_effective of acceptance'. As the both application of meta rules mr1 and mr2 fails, the system cannot prove the meta-goal "the rule r1 is valid for the goal 'the acceptance of offer becomes effective on November 17' at the time of the event on November 17". That means that rule r1 cannot be applied to prove the goal "the acceptance becomes effective". Consequently as the result of the application of r1, the answer 'the acceptance of the offer becomes effective on November 17' is abandoned.

Then the engine finds the second candidate, namely rule r2 (Cf. line 6). When the rule is applied, it can be proved that "the acceptance becomes effective on November 11" on the basis of f1 (Cf. line 7). Thereby the meta-inference is invoked to prove the new meta-goal "the rule r2 is valid for the goal 'the acceptance becomes effective on November 11' at the time of November 11"(Cf. line 12). In this meta-inference the engine follows the proof steps below. Applying meta-rule mr1, "rule r2 becomes valid for the goal at the time of October 30 before November 11 for the goal" is to be proved (Cf. fv2), and "r2 becomes null for a goal included in the goal 'the acceptance becomes effective' between October 1 and November 11" fails to be proved. Therefore it is proved that "the

rule r2 is valid for the goal 'the acceptance becomes effective' at the time of November 11. (This means that the application of the mr1 succeeds). Therefore the answer "the acceptance becomes effective on November 11" is accepted as proved (Cf. line 5).

The same analysis could apply to the other case. If the case, where the event happened one month before the case 4, was supposed:

case f3:
f3.1: An offer by Anzai to Bernard reaches Bernard on October 7.
f3.2: Bernard dispatches an acceptance of the offer to Anzai on October 11, and
f3.3: Bernard's acceptance of the offer by Anzai reaches Anzai on October 17,

then the answer for the same goal would differ from the present one as follows:

"The acceptance of the offer becomes effective on October 17."

Namely, the acceptance becomes effective not at the time of the dispatch (October 11) but at the time of the reach (October 17).

This is so, because r2 becomes valid for the goal 'acceptance becomes effective' on October 30 (fv.2), so that r1 has not become null for the goal until the time of the event, October 17. This legal reasoning can be formalized and demonstrated in the same way as done above.

If we compare the inference on case 3 with the inference on case 4, we can notice that it is not necessary for a legal system to change the old rule (r1) in spite of adding new rule (r2) according to the progress of time. This is so, because a legal system entails meta-rules concerning the validity of rules and a legal reasoning is performed under the control of the validity of the legal rules by the legal meta-rules.

By these cases, we can get the single adequate answer. Any step in the process of deriving this answer -- both object level inference and meta-level inference -- is formalized as a first order deductive inference.

In these way, the conclusion of an inference is checked by a meta-level inference applying the legal meta-rules to prove that the applied rule in the inference is valid for the problem. To speak exactly, the meta-inference and the inference belong to the different levels of inference. A transition is done here between the meta-inference to prove the validity of the applied rule and the inference to prove the goal by applying the rule. The application of the valid rule, i.e., the true rule, is a presupposition of an inference for a practical purpose, or is a conduct to do the inference itself. Therefore this transition is necessary for every inference. (The inference engine does it.) We could admit the transition, the transition of the meta-inference to the inference, as a rule, which is to be called a 'transition rule'.

We can develop a large scaled legal expert system which can perform the legal reasoning in the above meaning by loading the described meta-inference engine as well as legal meta-rules.[7]

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[7] We have already developed an experimental legal expert system with legal meta-inference, i.e., LES-3.3 (Cf.[Yoshino 1992], pp. 4ff.). This system is described with ESP(Expanded Sequential Prolog) on PSI-II, both of which are developed by ICOT (Institute for the New Generation Computer Technology). Tokuyasu Kakuta (Tokyo Instate of Technology) has contributed to install it. I am now analyzing and formalizing the whole legal system in terms of the validity of the legal rules. The present developing system will load the result.

6. Conclusion

In this paper it has been shown, what legal meta-inference is, in an example of a legal reasoning. The knowledge structure of the legal meta-inference has been clarified in respect of the relation between legal rules and legal meta-rules which regulate the validity of the rules. The legal reasoning, which entails the legal meta-inference, has been formalized in the language of CPF. An inference engine was introduced and the process of the legal reasoning was demonstrated accurately on it. Thus the legal reasoning, which entails legal meta-inference, was analyzed and formalized on the basis of first order language, so that the way of systematization of a legal reasoning system was established.

In this study, I have dealt with only two examples of the legal reasoning. However, we can find such a legal meta-inference everywhere in the legal reasoning praxis. A legal system is composed under the control of the validity of legal rules by legal meta-rule. By appealing to legal meta-inference and applying legal meta-rules, a legal system controls the validity of its rules so that it regulates human social life consistently corresponding to dynamic change of social life in the progress of time, not removing old legal rules but only adding new rules.

I have discussed only legal reasoning in this paper. However, the clarified principles and the produced methods could apply not only to a legal expert system but also to a knowledge base system in general. I would like to suggest that the validity control of rules by meta-rules and meta-inferences could make a solution of so called 'incomplete knowledge' problem or 'common sense reasoning'. I do suggest also that it would produce a sound basis for a development of large scaled knowledge base system in general which must load increasing new knowledge, which comes out in the change of time, without leading to contradiction. As a future task I would like to formalize legal meta-inference in the change of time more systematically.

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ページ：13
【妥当範囲というのは、どの対象の範囲に向かって妥当するかということ。このコメントは末尾に移動して、保存。】
【goalに対する効力が破られる、というより、validityのスコープが破られるとした方がよい。このコメントは末尾に移動して残す。】

【mr2はいらないかも？というわけは、特別法の妥当範囲が一般法のそれと重なると妥当範囲がその分なくなるとすれば、最初からその無効になる部分の補集合に属する範囲という者はないのではないか、とも思われるからである。要検討！このコメントは末尾で保存。り】

【ｒ１，ｒ２，ｒ３が効力発生した時点を入れる。これに応じて無効になる時点なども入れる。】
【推論時点の違いによる結論の違い、すなわち、ｒ２が効力が発生する前と後と。これは次の論文で発表するか。末尾に移動して保存。】
【ルールの例を入れる：rule(A<-B)にマッチするように】

（これより１９９４年１１月３０日、教授自筆の追加分を入力：ワープロ入力は鴨下による）