

The Systematization of Legal Meta-inference

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Abstract

"Legal meta-inference" is legal inference for controlling legal inference. The legal knowledge is constantly increasing with time and a conclusion from the knowledge at a former time might contradict a conclusion from the knowledge at a later time. These seeming incompleteness of legal knowledge is remedied by appealing to legal meta-inferences in legal practice. Therefore, in order to build a legal knowledge-base system, it is necessary to clarify the structure of the legal meta-inference and systematize it, and to construct it on that basis. This study shows, in examples 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 logical deductive reasoning. This paper concludes with suggestions for constructing method of a knowledge-base system of law, where knowledge increases constantly with time.

1. Introduction

"Legal meta-inference" is legal inference for controlling a legal inference, in other words, inference which

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decides the way to infer legally.

It seems that knowledge about our social life is incomplete and may lead to contradictions. The knowledge is constantly increasing with time and a conclusion from the knowledge at a former time might contradict a conclusion from the knowledge at a later time. In classical logic, the proved theorem should still be a theorem in the increased knowledge. However, we should get an different appropriate resolution according to the increase of knowledge with time, without leading to a contradiction with the existing knowledge. How can we do this? This is the problem 'non-monotonic reasoning'.

Various studies on default reasoning, non-monotonic logic and so on, have tried to explore principles and methods of the inference applying such incomplete knowledge¹. Contrary to those approaches, I start with a thesis that meta-knowledge has been prepared well enough in law so that lawyers can control their inference through legal meta-inference by applying meta-knowledge to lead to an appropriate conclusion corresponding to the increase of knowledge. If we describe legal meta-knowledge exactly, then we need not have any other special inference method than classical first order logic.

Moreover, I would like to emphasize that legal meta-inference is extremely widespread in the legal reasoning. In my opinion, the whole legal reasoning is controlled by legal meta-inference. All law text is written

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

on the supposition that this legal meta-inference will be done.²

This paper³ aims to clarify the knowledge structure of legal meta-inference in respect to 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. Based on it I establish the way to systematize legal meta-inference toward a legal knowledge-base system on the basis of legal meta-inference. Characteristic of my approach is that legal meta-inference is formalized as a first-order, classical logical inference and the control of legal reasoning is based on only knowledge, meta-knowledge.

2. Examples of Legal Reasoning

Below, I examine two examples of legal reasoning in the field of Japanese contract law. In order to decide what kinds of obligations the contract parties have, one should resolve whether the contract is concluded. In order to solve the latter problem, one should decide whether an acceptance of an offer becomes effective. The following examples concern this last problem. They are very simple, but representative of a larger class of typical legal reasoning.⁴ At first we assume two cases and the relevant rules:

Case 3:

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.

f3.3: Bernard's acceptance of the offer by Anzai reaches Anzai on October 17.

Case 4:

f4.1: An offer by Anzai to Bernard reaches Bernard on November 7.

f4.2: Bernard dispatches an acceptance of the offer to Anzai on November 11.

² This is one of the target theses of my logical jurisprudence. The further investigation would be necessary for me to demonstrate this thesis.

³ This paper is a revision of [Yoshino 1992], [Yoshino 1994d] and [Yoshino 1994e].

⁴ As it will become clear later, these examples are examples of legal problems, where the reasoning about the validity of legal rules is necessary and therefore to be done. The examples concern the change of the validity of legal rules with time on the one hand and the priority relations of the validity of rules, which contradict each other, on the other hand. These problems are typical legal problems to be solved where legal rules are applied.

f4.3: Bernard's acceptance of the offer by Anzai reaches Anzai on November 17.

Legal rules:

r1: An indication 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 Article 526-1)

r3: An acceptance is an indication of intention. (Common sense in law)

r4: An offer is an indication of intention. (Common sense in law)

We suppose :

fv1: r1 becomes valid on October 1.

fv2: r3 becomes valid on October 1.

fv3: r2 becomes valid on October 30.

fv4: r4 becomes valid on October 1.

The time of the inference: December 17.

Let's resolve the following goal:

Goal: "When does the acceptance become effective?"

(1) Inference without meta-inference

(1-1) As regards case 3:

As the time of the inference is December 17, r2 must have been installed already in the knowledge-base, so that the inference system could get two answers by applying the above rules r1 together with r3 and r2.

answer 1.1.1:

"the acceptance becomes effective on Oct. 17"

answer 1.1.2:

"the acceptance becomes effective on Oct. 11."

The former is to be deduced as a result of applying rules r1 and r3 to the fact f3.3. The latter is to be deduced as a result of applying rule r2 to the fact f3.2. The first answer is correct but the second is not so, because r2 has not become valid at the time of the event of Oct. 11 so that r2 should not be applied to the case 3. In order to get the correct answer, one has to delete r2 in the knowledge-base for the case 3. Or one has to prepare separately two different knowledge before and after October 30. However, to delete certain knowledge in a knowledge-base for each older case is difficult and not a good method as a system. It is also difficult to build a number of knowledge-bases according to the change of knowledge with time.

(1-2) As regards case 4:

The system could get also two answers here by applying the above rules as follows:

answer 1.2.1

"the acceptance becomes effective on Nov. 17"

answer 1.2.2

"the acceptance becomes effective on Nov. 11."

The former is to be deduced as a result of applying rules r1 and r3 to the fact f4.3. The latter is to be deduced as a result of applying rule r2 to the fact f4.2. These two answers contradict each other. As the time of the event is Nov. 11 and r2 has become valid Oct. 30 already, r2 must be valid at the time of the event so that it is not to be deleted.

(2) Legal Reasoning (Inference with meta-inference)

(2-1) As regards case 3

Japanese lawyers get only one answer

answer 2.1:

"the acceptance becomes effective on Oct. 17"

applying r1 together with r3. They do not apply r2, even if they have the knowledge of r2 in the brain as a knowledge-base. It is legal meta-inference that excludes applying r2 to the case 3.

(2-2) As regards case 4

In the practical legal reasoning process, Japanese lawyers would get here a single answer :

answer 2-2:

"the acceptance becomes effective on Nov. 11"

by applying r2. It is 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 understood 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"⁵. A legal system prescribes legal obligations of

people to do a certain conduct or refrain from doing it. The legal obligations exist if the legal rule which describes the relevant obligations is legally valid. There are a series of legal rules which describe the validity of the rule. These are to be called legal meta-rules, as above mentioned. There is also a meta-rule, which prescribes the validity of legal meta-rules. (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 rules 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, only valid rules can be applied, as axioms of 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 Prescribing the Scope of the Validity of Rules

Unlike rules of natural science, in the legal world, the valid rules are not always valid for every time or for everywhere or for everyone or for everything. Every legal rule has its scope of validity. A legal rule is valid only in a given scope, and applicable in a given range. A legal rule is not valid outside of its specified range and therefore not applicable. The scope of the validity of legal rules is limited in terms of "time", "place", "person" and "matter". 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 in reference to what matter. 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:

⁵ Cf. [Yoshino 1988] p.52.

(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 Prescribing the Priority of Rules

To avoid contradictions, 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 principles are introduced as below⁶:

- 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 r1 is derogated for scope G by rule r2, if rule r2 is a particular rule to rule r1 and the scope G of the validity of rule r2 overlaps with the scope of the validity of rule r1.*
- pr2'-1: A rule is a particular rule to the other rules, if and only if the scope of the validity of the rule in terms of time, place, person and matter is the subset of the other.*

In the above legal meta-rules pr1, pr2 and pr3, legal rules with higher priority 'derogate' legal rules with 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 legal 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.

⁶ Cf. [Yoshino 1986a] p.38f., [Yoshino 1988] p.52f. and [Yoshino 1989] p.47f.

3.5 General Principles to Determine the Validity of Rules

I have analyzed the validity relationships of legal rules and endeavored to extract general principles to determine the validity of rules for a legal meta-inference system. The present results are following two rules⁷. In order to make the description of this paper more simple, the scope of the validity of rules is taken account of only in terms of matter and time here, and terms of place and person are eliminated. The matter which a rule regulates is conceived of in this case as a goal to be solved by the rule in the inference.

mr1:

Rule R is valid for goal G at the time of T, if R becomes valid at the time of T1 before T for goal G1 including G, and R does not become null between T1 and T for goal G2 included in G1.

mr2:

*Rule R is valid for goal G at the time of T, if R becomes valid at the time of 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.*⁸

⁷ 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 1990] pp.49-55). These concepts were a little too complicated and the viewpoints 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.)

⁸ These rules are not logical rules. But they should be presupposed unconsciously by lawyers and all legal meta-rule provisions, which are issued in the statutes, must have these as tacit axioms of the rule system. There is no positive law provision which describes directly when a rule is valid. The positive law provisions describe when rules become valid or when rules become null. In order to decide whether a legal rule is valid, we have to presuppose that there are rules whose consequence is made of the predicate 'is-valid' and whose requirement is made of 'become-valid' and/or 'become-null'. The mr1 and mr2 have been found through these consideration. Mr1 and mr2 are necessary presupposition for law or legal science to cognize legal rules as a system of valid rules. The validity of mr1 and mr2 must be presupposed. Man could

There is no other rule, which regulates directly that a rule is valid, than *mr1* and *mr2*. We could unify the above two rules into one rule in which the condition and the consequence are connected by not 'if' but 'if and only if'.

The *mr1* concerns the case that the rule has become valid already for the problem to be solved, which conceptually (or extensionally) includes the problem in question, and it does not become null yet for any goal conceptually included in the former. The *mr2* concerns the case that the rule has become null for a goal included in the goal for which the rule had become valid.

I will illustrate later what the rules means with the meta-inference examples concerning the given cases 3 and 4 on my developed inference engine.

Under these two rules there are many meta-rules. Here I introduce only one rule which connects the above two rules with *pr2*:

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

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 legal meta-inference is 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 the event". 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

call this kind of rules as 'basic rules' in comparison to Hans Kelsen's 'basic norm' (Grundnorm).

meta-goal is logically proved by the application of the meta-rule.

5. Systematizing Legal Meta-Inference

5.1 Formalization of Legal Knowledge by CPF

I have developed and used CPF as a knowledge representation method of law since 1985⁹. CPF is an abbreviation of 'Compound Predicate Formula'. I have applied CPF to implement the model of legal meta-inference and to construct the present legal knowledge-base.

I show an example of CPF, which represents the above fact *f3.3*:

"Bernard's acceptance of the offer by Anzai reaches Anzai on October 17."

```
reach(reach3,[
  obj:acceptance(acceptance3,[
    agt:'Bernard',
    obj:offer(offer3,[
      agt:'Anzai',
      obj:obj_offer3,
      goa:'Bernard'])
    goa:'Anzai'])
  tim:10_17,
  goa:'Anzai'])
```

This formula is equivalent to the following 'flat CPF' (FCPF).

```
reach(reach3,[obj:acceptance3,tim:10_17,goa:'Anzai'])&
acceptance(acceptance3,[agt:'Bernard',obj:obj_acceptance3,goa:'Anzai'])&offer(offer3,[agt:'Anzai',obj:obj_offer3,goa:'Bernard'])
```

⁹ 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 and defined exactly in 1990 (Cf. [Yoshino 1990a], pp. 27f.). It was used also for LES-3 (Cf. [Yoshino 1992], pp.1ff.) as well as for a legal analogical reasoning system ([Yoshino 1993] 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. To this system CPF is applied, too.

An FCPF is an abbreviation of a compound formula of first order logical formulas connected by conjunctions. We can define this by a following example:

```
reach(reach3,[obj:acceptance3,tim:10_17,goa:'Anzai'])
```

is abbreviation of:

```
reach(reach3) & obj(acceptance3, reach3) &
  tim(10_17,reach3) & goa('Anzai',reach3)
```

The latter logical formula is to be read:

“reach3 is ‘reach’ and object of reach3 is acceptance3 and time of reach3 is 10_17 and goal of reach3 is ‘Anzai’.”

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

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

A legal meta-rule is also represented in the same way. The following is a CPF representation for the above legal meta-rule mr1:

```
mr1:
rule(mr1,[
  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(become_null(BN,[obj:R,goa:G2,tim:T2])) &
  (between(T2,[tim:T2,tfr:T1,tto:T]) &
  include(G1, G2))))).
```

A goal of legal meta-inference, which matches 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 ‘RuleID’ is a variable for a rule-identifier and ‘Goal’ is a variable for a goal solved in the under level inference.

5.2 Legal Meta-Inference Engine

The legal meta-inference engine enhanced the classical inference engine in two ways. First, it has a function to interpret a CPF. This interpretation can be done by two alternative ways:

- a) flattening 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 both types of inference engine.

Second, the legal meta-inference engine has the ability to decide the validity of the rule applied to solve a goal. The inference function of meta-level inference itself does not differ from that of the original level inference.

I would like to show the abstract listing of the legal meta-inference engine written in Prolog 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,[A<-B]),
7 demo(B),
.....
11 get_time_of_event(A,T2),
12 demo(be_valid(_,[obj:R,goa:A,tim:T2])).
```

At every step of the success of the application of the rule to the problem to be solved,¹⁰ the meta-inference engine calls meta-goal¹¹

```
‘be_valid(_,[obj:R,goa:A,tim:T2])’
```

to decide whether the rule is valid for the present problem at the time when the event is occurred, which the engine gets,¹²

5.3 Verification of Legal Meta-Inference by Examples

I would like to demonstrate the logical structure of legal meta-inference by describing the inference process to solve the above examples case 3 and 4 step by step.

¹⁰ Cf. Line 7 of the listing.

¹¹ Cf. Line 12 of the listing.

¹² Cf. Line 11 of the listing.

Before the demonstration, the above supposition fv1, fv2 and fv3 are to be reformed more exactly in terms of the scope of the validity of rules described in the chapter 3.3 as follows:

fv1: r1 becomes valid for 'an indication of intention becomes effective' on October 1.

fv2: r3 becomes valid for 'an indication of intention' on October 1.

fv3: r2 becomes valid for 'an acceptance becomes effective' on October 30.

5.3.1 Meta-inference from Case 3

Our inference engine follows the steps below to prove the goal :

"When does an acceptance become effective?"

1) Rule r1 becomes a candidate to solve the goal (Cf. 6 - this notation refers to the line number of our inference engine listed in section 5.2).

2) When rule r1 is applied to this case, it is provable through r3 together with the f3.3 a tentative answer (in lines 7-6):

"Bernard's acceptance of the offer by Anzai becomes effective on October 17."

CPF of this proved goal is:

```
become_effective(be3,[
  obj:acceptance(acceptance3,[
    agt:'Bernard',
    obj:offer(offer3,[
      agt:'Anzai',
      obj:obj_offer3,
      goa:'Bernard'])
    goa:'Anzai'])
  tim:10_17])
```

3) The inference engine executes the goal 'get_time_of_event' to get the time of the event from the proved goal by applying the relevant knowledge (in line 11). '10_17' is to be the time of the event.

4) Then, the meta-inference is invoked to prove the meta-goal *"the rule r1 is valid on October 17 (at the time of the event) for the goal 'the acceptance of the offer becomes effective on October 17'"* (Cf. line 12), whose formula is:

```
be_valid(BV,[
  obj:r1,
  goa:become_effective(be3,[
```

```
obj:acceptance(acceptance3,[
  agt:'Bernard',
  obj:offer(offer3,[
    agt:'Anzai',
    obj:obj_offer3,
    goa:'Bernard'])
  goa:'Anzai'])
  tim:10_17]),
  tim:10_17])
```

5) In order to prove this goal, the present inference engine is invoked and the goal matches meta-rule mr1 at first (Cf. line 6).

6) The unified first requirement of mr1 is proved as *"r1 becomes valid on October 1 before October 17 for the goal 'an indication of intention becomes effective' which includes the goal 'the acceptance becomes effective on October 17'"* on the basis of the fact fv1' together with r3 which describes that 'indication of intention' is a super concept of 'acceptance'.

7) And the second requirement *"r1 does not become null between October 1 and October 17 for any goal which is included in the goal 'an indication of intention becomes effective'"* is also proved, because it cannot be proved that : *"r1 becomes null between October 1 and October 17 for the goal."*

8) Therefore it is proved that *"the rule r1 is valid for the goal 'the acceptance becomes effective' on October 17."* (The same meta-inference is done for the validity of the rule r3, whose explanation is eliminated here.)

9) Therefore the answer *"the acceptance becomes effective on October 17"* is accepted as proved (Cf. line 5).

10) If a redo of inference is done, then the engine finds the second candidate, namely rule r2 (Cf. line 6). If r2 is applied, it is proved that *"the acceptance becomes effective on October 11"* on the basis of f3.2 (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 October 11' on October 11"* (Cf. line 12). In this meta-inference it cannot be proved the goal, for the first requirements of the both meta-rules mr1 and mr2 are not satisfied because r2 becomes valid only on October 30, which is not before October 11. Therefore it is concluded that r1 is not valid for the goal and the result of the application of r1 is abandoned .

11) Thus it is proved only one answer:

"The acceptance becomes effective on October 17."

5.3.2 Meta-inference from Case 4

It is to be noted at first that the concept 'acceptance' is a subset of the concept 'indication of intention' as rule r3 also shows, so that we can conclude (also through a meta-inference, which is not explained here):

fmr4a: "Rule r2 is a particular rule to rule r1."

Our inference engine follows the steps below to prove the same goal.

As regards the case 4 the inference steps go like above, but the final conclusion is different.

1) Rule r1 becomes a candidate to solve the goal "the acceptance becomes effective" (in line 6). If r1 is applied to this case, it is proved through r3 together with the f4.3 that;

"the acceptance becomes effective on November 17"
(in lines 7-6).

2) The inference engine gets the time of the event '11_17' from the proved goal.

3) Then, the meta-inference is invoked to prove the meta-goal:

"The rule r1 is valid on November 17 for the goal 'the acceptance becomes effective on November 17'"
(Cf. line 12).

4) In the application of the meta-rule mr1 (Cf. line 11), the unified first requirement of mr1 is proved as *"r1 becomes valid on October 1 before November 17 for the goal 'an indication of intention becomes effective' which includes the goal 'the acceptance becomes effective on November 17'"* on the basis of the fact fv1' together with r3 which describes that 'indication of intention' is a super concept of 'acceptance'.

5) But the second requirement *"r1 does not become null between October 1 and November 17 for the goal 'the acceptance becomes effective on November 17' included in the goal 'an indication of intention becomes effective'"* is not provable, because it is to be proved that:

"r1 becomes null for the goal 'acceptance becomes effective' on October 30 between October 1 and November 17" and

"'become_effective of acceptance' is included in 'become_effective of indication of intention'".

The proof process is as follows:

5-1) Rule r2 is a rule, particular to rule r1 as above described and r2's validity scope for 'become_effective of acceptance' overlaps with r1's validity scope for 'become_effective of indication of intention'. 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 on October 30." (On the basis of fv3').

5-2) Consequently it is also, through mr2-2, provable that:

"r1 becomes null for goal 'acceptance becomes effective' on October 30."

5-3) As 'acceptance' is subset of 'indication of intention', it is also provable that:

"'becomes_effective of acceptance' is included in 'become_effective of indication of intention'".

6) 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 indication of intention' on 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 indication of intention' and the complement of 'becomes_effective of acceptance'.

7) As the both applications of meta rules mr1 and mr2 fail, 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".

8) Consequently, the answer *'the acceptance of the offer becomes effective on November 17'* as the result of the application of r1, is abandoned.

9) 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 f4.2 (Cf. line 7).

10) 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.

11) Applying meta-rule mr1, *"rule r2 becomes valid for the goal at the time of October 30 before Novem-*

ber 11 for the goal" is to be proved (Cf. fv3'), 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 and that the application of the rule r2 to the goal '*an acceptance becomes effective*' is correct.

12) Therefore the answer "*the acceptance becomes effective on November 11*" is accepted as proved (Cf. line 5).

5. 3. 3 Legal Inference System dealing with the Change of the Validity of Rules

If we compare the inference in case 3 with the inference in case 4, we notice that it is not necessary for a legal system to modify the old rule (r1) in spite of adding a new rule (r2) according to the progress of time. This is because a legal system entails meta-rules concerning the validity of rules and 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 -- the both levels of inference and meta-inference -- is formalized as first order deductive inference.

In this way, the conclusion of 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 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'.

On the basis of the above described principles and methods, we can develop a legal meta-inference system with the legal knowledge-base which entails legal meta-rules¹³. The approach of this study takes could, in

¹³ 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

my opinion, produce a sound foundation of the knowledge-base system of law where new knowledge (or simply provisions) is constantly added without removing old knowledge (provisions).

6. Conclusion

This paper has shown what legal meta-inference is, in examples of legal reasoning. The knowledge structure of the legal meta-inference has been clarified with 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 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-rules. 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, without contradictions, corresponding to the dynamic change of social life in the progress of time, not removing old legal rules but only adding new rules. This study of systematization of legal meta-inference could produce a sound foundation of a knowledge-base system of law where knowledge increases constantly with time.

As a further task I would like to formalize legal meta-inference in the change of time more accurately and systematically. My final target is to formalize the total system of legal rules from a constitution through statutes to contracts logically, in terms of the validity of rules.

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Sequential Prolog) on PSI-II, both of which are developed by ICOT (Institute for the New Generation Computer Technology). Tokuyasu Kakuta (Tokyo Institute 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.

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