A Fuzzy Judgement Approach to Inference of Case in CISG

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Abstract

In a legal expert system, legal experts interpret the article rule on the basis of precedent. Because the judgement of the interpretation involves the vagueness and uncertainty, the representation and inference of such cases can't be handled by the same means used for crisp cases. In our legal expert system, on the basis of the facts of precedent, the statute rule is interpreted as case rule. The judgements of the elements of case rule are represented by fuzzy membership functions. They are stored in the case base by means of fuzzy frames. An inference based on case rule is made from the YES/NO judgement of element of case rule. The target law of the system is the United Nations Convention on Contracts for the International Sale of Goods (CISG).

Keywords: Legal Expert System, CBR, Fuzzy, CISG

1 Introduction

Law is applied to represent and handle various ever-changing real events. But the number of statute rule is limited. Law has a precise definition only for those individual cases that have come to court and been decided. Therefore, in order to deal with the various real situations, case-based reasoning (CBR) is also used in law[eg. Edwina L. Rissland, Kevin D. Ashley,1987]. By applying precedents that are similar to a new case, a conclusion for the new case can be reached.

In CBR, in order to apply law to cases, statute rule is interpreted on the basis of facts of precedent. Then judgements as to whether the facts of the case are true to the elements of the interpreted statute rule or not are made. But, there are fuzziness in the judgement. Such fuzziness is caused by the adaptation of a legal concept which is written in limited words applying to a given fact, and the uncertainty of knowledge. Therefore, it is necessary that the representation of a case be described using fuzziness.

Conventional case based reasoning involves the crisp representation of case[Janet Kolodner,1993], and it can't deal with the representation of cases involving fuzziness.

In order to represent the case with fuzziness, and infer the conclusion, fuzzy theory is applied. A judgement with fuzziness is described by concepts of membership and vagueness. Moreover, a method for judging the correspondence of fact and the element of rule by YES and NO from membership function is suggested.

Considering the judicial precedent of CISG (United Nations Convention on Contracts for the International Sale of Goods) as a precedent, an experiment on legal fuzzy inference employing CBR is undertaken.

The CBR for legal inference in CISG is introduced in 2. The representation of case with fuzziness is described in 3. The method of inference is presented in 4. The result of the experiment is illustrated in 5.

2 CBR for Legal Inference in CISG

Legal inference consists of the recognition of facts and interpretation of laws.

CISG is used as an example to be discussed here. In CISG, when "the conclusion of contract" is judged, it is necessary first to judge whether the offer has effect or not. Once the effect of the offer has been judged, it is necessary to judge whether the offer is effective or not. Once this has been judged, it is essential that the proposal be sufficiently definite, this being defined in statute 14(1) of CISG.

The definition can be also expressed as :

The proposal is sufficiently definite =

{Indicating the goods} #a#r#d

{Fixing the quantity #c#r making provision for determining the quantity}

#a#r#d {Fixing the price #c#r making provision for determining the price}

The fact of case seldom clearly comes under the statute rule. For example, the criterion of judgement for " Fixing the price " is not written in the statute rule. The statute rule can't be used directly. But legal experts can, by analogy, apply the statute rule to the cases. A new case can thus be inferred.

As for the point of argument to be inferred, the precedent is described by the interpretation of the application of statute rule on the basis of the facts of the case. The application of statute rule is that the connections between the facts of the precedent and the statute rule are spread out so that the facts of the precedent satisfy the legal requirements of the statute rule. The connections made from the precedent and statute rule are called a "case rule".

The Malev v. Pratt Whitey affair is taken to be a precedent. The main contents are described below:

There was a sale of an aircraft engine by Pratt Whitey (PW), a subsidiary of United Technologies In-

ternational, to Malev Airlines (Malev), the Hungarian National Airline.

The alleged contract has two parts:

(1) PW supplies replacement engines to Malev for its Soviet-built TU-154 jet airliners.

(2) PW supplies both original and replacement engines for Malev's soon-to-be-purchased wide body planes.

During the PW negotiations, Malev was negotiating with both the U.S.'s Boeing and Europe's Airbus for the purchase of aircraft. PW offered to supply the engines that would serve as original equipment on these jets and spare engines, and service, maintenance, warrant, financial support.

On November 9, 1990, PW 's original offer provided for the sale of one of three types of engines to Malev:

If Malev chose the Boeing aircraft: PW 4056

If Malev chose the Airbus aircraft: PW 4152, PW 4156/A

On December 4,1990, PW and Malev signed a letter of intent on (1), but (2) was still contingent on the aircraft purchase portion.

The engine base prices varied with the type: PW 4056 was quoted at $5,847,675; and the PW 4152 was quoted at $5,552,675; the PW 4156/A was quoted at $5,847,675. The offer's terms further provided for a support package (involving service, maintenance, credit and so on) to be tailored to the type of aircraft ultimately chosen by Malev. The engines for the Airbus option were properly referred to as a " jet engine system." In contrast, the engine for the Boeing option only included the engine.

The situation concerning "The proposal is sufficiently definite" is as follows:

Event: proposal

Description of event:

The goods are jet engine systems.

The quantity of engine systems can be calculated by the number of planes that will be purchased.

About the price:

There is no description concerning the prices of the Boeing jet engine systems.

The price of the Boeing jet engine is fixed.

The jet engine system includes a support package, services and so on.

In accordance with statute 14(1) of CISG, the Hungarian Supreme Court declared that the proposal was not sufficiently definite because the price of jet engine systems was not fixed, and the jet engine systems have no market prices.

In this case, it is clear that the goods have been "indicated." It is also clear that the "quantity"has been "fixed." It is the "fixing" of the price of entity, consisting of several parts, that needs expert interpretation.

The method for verifying the price of the entity is interpreted as follows:

Initially, the entity price of parts is judged. If the entity price doesn't exist, it is necessary to verify whether there is a part that the price is fixed. If there is no part that the price is fixed, it is considered that "The proposal is not sufficiently definite." If there is a part that the price is fixed, the importance of this part for the entity needs to be verified. If this part is not important, it is considered that "The proposal is not sufficiently definite." If this part is important for the entity, it needs to be determined whether the other part, namely, the part that the price is not fixed , has a market price or not.

The process for the verification of market price is as follows:

If there is a market for this part, it is considered that there is a market price for this part. If there is no market for this part, it needs to be verified whether there is a market for a product that can substitute for this part or not. If there is a market, it is considered that there is a market price for this part . If there is no market, then, it needs to be verified whether there is a price for the product that is similar to this. If there is a market price, it is considered that there is a market price for this. If there is no price, it is considered that there isn't a market price for this.

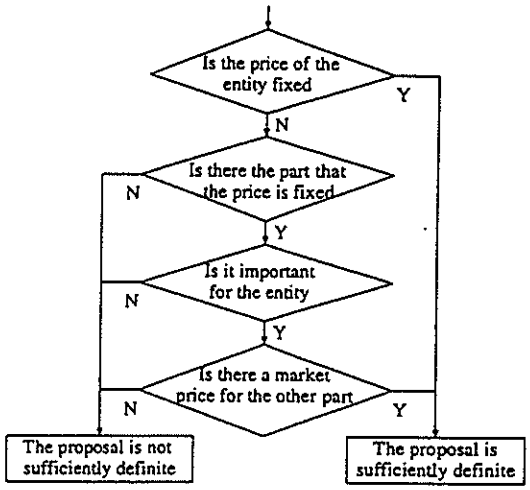

Figure 1: The case rule for the verification of price of entity

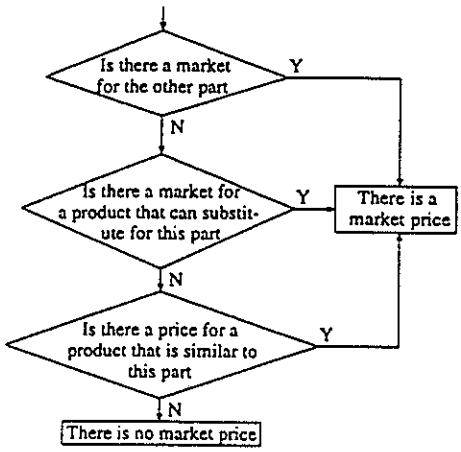

Figure 2: The case rule for the verification of market price

The process of interpretation about the price of en-

tity is shown in Figures 1 and 2. They are the case rules about the verification of the price of entity in Malev affair.

The hierarchy of case rule consists of several stages.

According to the YES/NO judgement of the element of case rule, an inference based on case rule can be made.

3 Representation of Judgement with Fuzziness for the Element of Case Rule

In the inference by case rule, it is sometimes difficult to clearly judge the elements of case rule. For example, "Is there a market for other part." This kind of fuzziness is caused by the fact of a choice of limited words, and the uncertainty of knowledge. It can be considered that there is fuzziness in the judgement of element above.

In order to deal with the fuzziness in the judgement of elements, fuzzy theory is introduced.

Fuzziness can be represented by several methods. We shall use the concepts of membership of fuzzy theory, and vagueness that is presented by the extended fuzzy expression of probabilistic sets to represent fuzziness [Hirota K. et al. 96][Hirota K. 79]. The adaptation that the specific knowledge is described by limited words is represented by the concept of membership. The uncertainty of knowledge is represented by the concept of vagueness.

There are five values for the input of the membership concept, and three values for the input of the vagueness concept. The membership value is m, and the vagueness value is v. The correspondence between numerical representation and fuzzy linguistic representation is shown in figure 3.

A triangular membership function can be used to represent the membership function of the fuzziness. The vertices can be defined as:

$$mL = m - mv, \tag{1}$$

$$mH = m + (1 - m)v, \tag{2}$$

where mL and mH show the lower limit and upper limit of m, respectively. For example, suppose there is an element of case rule, the judgement is : "probably yes, roughly." The membership function of the judgement of this element is shown in Figure 4. Fuzziness is represented by a fuzzy membership function.

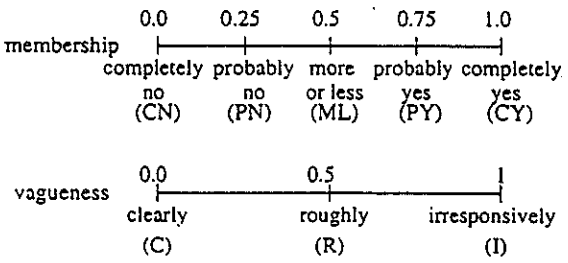

Figure 3: Values of Linguistic Variables

When "clearly" is selected from the linguistic variables of vagueness, we can get:

$$mL = mH = m. \tag{3}$$

It means that the membership function becomes a singleton.

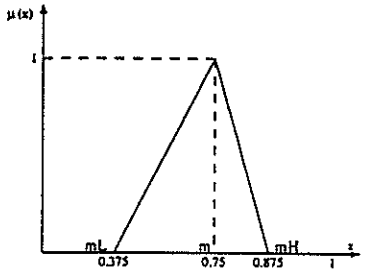

Figure 4: A Triangular Membership Function

The case rule can be represented by a frame, where the name of the frame is the name of a legal requirement, the slots are the elements of case rule, the values of slots are the judgements of elements. The frame is saved in a case base.

4 Inference Based on the YES/NO Judgement

The judgement on the correspondence of fact of the new case and element of rule is represented in fuzzy membership. According to the case rules of Figures 1 and 2, a Yes/No judgement is necessary for inference by case rule. Here the judgement YES or NO is determined by the center of gravity of fuzzy membership.

Let C_i be the fuzzy set that describes the judgement of the element of case rule for the new case.

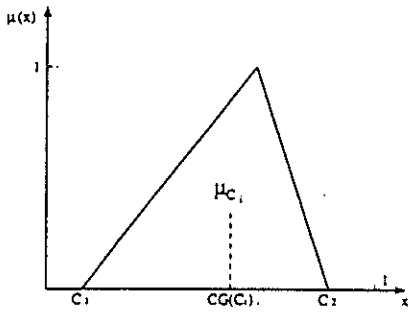

Figure 5: The Center of Gravity of Membership Function

The membership function of C_i is μ_{C_i}. The center of gravity of μ_{C_i} can be calculated by

$$CG(C_i) = \frac{\int_{c_1}^{c_2} x\mu_{C_i}(x)dx}{\int_{c_1}^{c_2} \mu_{C_i}(x)dx}. \tag{4}$$

The center of gravity of μ_{C_i} belongs to [0, 1]. When the value of the center of gravity is near 1, it can be considered that the judgement is YES. When the value

of the center of gravity is close to 0, it can be considered that the judgement is NO. The value 0.5 is selected as the threshold. When the value of the center of gravity is greater than 0.5, the judgement is YES. When the value of center of gravity is less than or equal to 0.5, the judgement is NO.

After the correspondences of the elements of case rules and facts of new cases are judged, the conclusion as to whether the legal requirement occurs or not is inferred according to the case rule.

5 The Inference Experiment Based on Case Rule

Two reference cases are made for the experiment based on case rule.

The reference case (I) is as follows:
1) On April 1, A in New York dispatched a letter of an offer to the business branch of a Japanese company B in Hamburg, the content of which was that A sells a set of farming machinery (the price of the tractor itself is \$50,000 to B. The tractor should be equipped with a rake, which is a product of company C. The farming machinery is delivered by a U.S. cargo ship).
2) The letter reached B on April 8.
3) On April 9, B telephoned A to say"I accept your offer, but you should transport the machinery by a Japanese container."

There are several points of argument as to whether the contract is concluded. Whether the proposal from A is effective or not is one of them. On the condition that "The proposal is sufficiently definite," the proposal is effective.

The description of "The proposal is sufficiently definite" is as follows:
Event: proposal
Description of event:
The goods are farming machinery.
The quantity of farming machinery is one.
About the price:
The price of the tractor is fixed.
The price of a set of farming machinery is not fixed.
The farming machinery contains the rake.

The reference case (II) is as follows:
CompNet Inc. made a proposal to LexData Inc. to sell a computer system on May 4. The price of the computer hardware is 1,000,000 dollars. The computer system is installed with a new operation system of SysSoft Inc.. LexData Inc. accepted the proposal on May 8. But soon after, LexData Inc. claimed that the contract was not concluded because the proposal was not definite.

In this case the description about "The proposal is sufficiently definite" is as follows:
Event: proposal
Description of event:
The goods are a computer system.
The quantity of the computer system is one.
About the price:
The price of the computer hardware is fixed.
The price of the computer system is not fixed.
The computer system contains an operation system.

In the two reference cases above the goods are indicated, and the quantity is fixed. The price of the entity is not clearly definite. Therefore, statute rule 14 of CISG can't be directly applied.

In order to judge whether the proposal is sufficiently definite or not, the Malev affair is selected as the precedent which is similar to these two cases. By quoting the case rule (Figure 1, 2) that is applied to verify the price of entity of goods, and referring to precedent, the conclusion of reference cases about the point of argument can be derived.

By means of Figure 3, users can select the fuzzy linguistic variables to answer the elements of case rule in terms of the fact of case.

In the proposed fuzzy legal expert system, selection of the user by figure 3 is the input. By using the equations (4), the Yes/No judgement is made. The determination of whether the proposal is sufficiently definite or not is the output of this system.

The price is fixed or made provision for determining the price			
	m1	v1	yes/no
Is the price of the entity fixed	0.25	0.0	no
Is there the part whose price is fixed	1.0	0.0	yes
Is it important for the entity	1.0	0.0	yes
Is there a market price for the other part			

There is a market price for the other part			
	m1	v1	yes/no
Is there a market for the other part	0.25	0.0	no
Is there a market for a product that can substitute for this part	0.5	0.5	no
Is there a price for a product that is similar to this part	0.5	0.5	no

Figure 6: The inference of reference case(I) concerning "The proposal is sufficiently definite"

The price is fixed or made provision for determining the price			
	m2	v2	yes/no
Is the price of the entity fixed	0.0	0.0	no
Is there the part whose price is fixed	1.0	0.0	yes
Is it important for the entity	1.0	0.0	yes
Is there a market price for the other part			

There is a market price for the other part			
	m2	v2	yes/no
Is there a market for the other part	1.0	0.5	yes
Is there a market for a product that can substitute for this part			
Is there a price for a product that is similar to this part			

Figure 7: The inference of reference case(II) concerning "The proposal is sufficiently definite"

In reference case(I), the rake of C is probably considered as the exclusive use of the tractor of A, that is not sold as a separate piece of equipment. The $m1$

and $v1$ in figure 6 represent the value of fuzzy linguistic variables selected by the user.

In reference case(II), it is probably considered that SysSoft's operation system is sold on the market. The input $m2$, $v2$ are shown in Figure 7.

In reference case(I), the conclusion from the YES/NO judgement is the same as the precedent, namely, the proposal is not sufficiently definite.

In reference case(II), by the YES/NO judgement the conclusion is not the same as the precedent. Thus, the proposal is sufficiently definite.

6 Conclusion

We analyzed an actual decided case in CISG, namely, the Malev case, and were able to formulate the case rule. The judgement of element of case rule was represented by the concepts of membership and vagueness in fuzzy theory. An inference based on case rule is made by the YES/NO judgement. The judgement of YES or NO is made by the center of gravity of the membership function. This method can also be applied in other laws containing such fuzziness.

Our case base is currently still small. Therefore, it should be extended. Further, a method for retrieving a precedent which is similar to a new case from the case base should be developed in terms of fuzzy theory.

Acknowledgment:

The case (Malev v. PW), which we analyzed and applied, was introduced to us by Prof. Kanl Branting in 1995. We thank Prof.Brant for drawing our attention to it.

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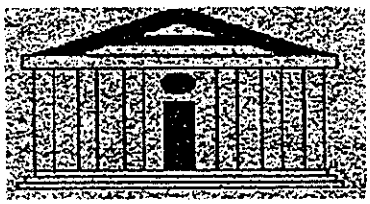

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