A HIGH SPEED FUZZY SEMANTIC INFERENCE TECHNIC*

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ABSTRACT:
To introduce a fuzzy semantic inference technic in autonomous real time contral expert system, we have advanced a high speed fuzzy semantic inference technic which includes three parts.
(1) Limited fuzzy production relation (e.g. fuzzy knowledge representation)
(2) Limited fuzzy semantic inference.
(3) High speed inference technic.

1. FUZZY KNOWLEDGE REPRESENTATION.

The knowledge representation in our inference technic adopts a limited fuzzy production relation . As for information concerning the limitend fuzzy production relation, see reference (1). Our brief introduction is as follows. The so-called limited fuzzy production relation is the production which satisfying the following conditions.

1) The structure of the production is

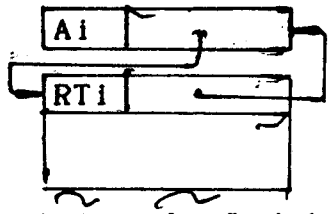
if <A1 (RT1) >...<Ai (RTi) > then <B1>...<Bi>.

( ), < >: the contents in the brackets may appear 0 or 1 time.

Ai, Bi: is the main word.

RTi: is fuzzy implicated relation table, its structure and linkage to Ai are shown in fig. below.

RTi			
Ai	B1	Bi	Bn
ai1	b11	bi1	bn1
aii	b1i	bii	bni
ain	b1n	bin	bnn



2) There is only one consequence in "if... then" (i=1for Bi).

3) There is only one fuzzy proposition in "if... then", and the others are all the binary logical.

4) The elements number fg of the ordered sets of fuzzy concepts of fuzzy language operator is limited for every proposition (max(fg) = 7).

5) The inexactness of probability could not be considered.

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2. LIMITED FUZZY SEMANTIC INFERENCE.

In our tecnic of high speed fuzzy semantic inference, the backward inference model is adopted. As the limited fuzzy production relation is used for knowledge representation, inference mechanism of this technic is almost the same as general production systems. But modifications are requird, i.e. if a goal is a fuzzy proposition, then searching of the goal is done in two steps. First to match main-words, if successful, match fuzzy language operator . This process is similar to the problem reduction of FRIL of Zhou Shanqiong and J.F. Baldwin. Bue these two are substantially different. They produce a reduction tree at first and then solve it. But in our method, the reducing and solving are proceeded simultaneously. Besides, relation composition operations and general mathematical operations are not necessary. Nor are the concerning theories of L.A. Zateh and bacic relation tablle of J.F. Baldwin (the possibility distribution of L.A. Zadeh in fact). And our efficiency is much higher than that of J.F. Baldwin and S.Q. Zhon .

3. HIGH SPEED INFERENCE TECHNIC

To factually apply the limited fuzzy semantic technic to autonomous real time control expert system, we, by making referenc of ideas of Reta algorithm and ES/KERNEL algorithm, advanced two kinds of high speed fuzzy semantic inference tecnic --R*FSI . E*FSI (R* fuzzy semantic inference E* fuzzy semantic inference). At the present, we are applying the two tecnics to the automated decision command expert system for the attack of submarine torped and to the autonomous real time expert system for accident idgnosis of neuclear power. We are now giving a brief introduction to the main idea of the high speed technic.

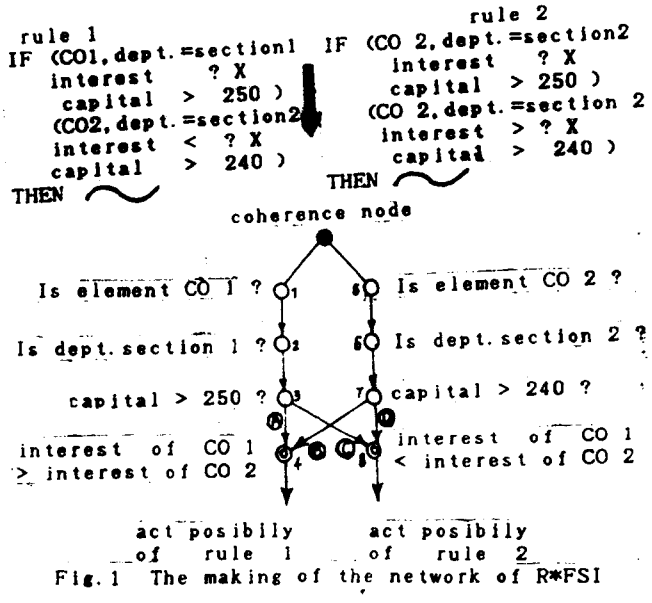


Fig. 1 The making of the network of R*FSI

(i) The High Speed of R*FSI

The factors causing the lowness of inference speed of production system are as follows:

(1) "large-Scalization" ie the augumentation of the scale of the rule number and elements of work memory.
(2) "complication" ie the following cases appear in rule condition: a) the augumentation of variables b) the augumentation of suject value comparation among various models c) the augumentation of "OR" coherence of subject value.
R*FSI particially solved th above stated two problems of fuzzy production system. The high speed of R*FSI inclodes two parts.

1) To popularize the intercovering part of the parttern of rules. As there is so large a part of intercovering, the times for matching are reduced substantially. See fig. 1 (for narration covenience, we didn't give the examples of fuzziness. The same follows below)

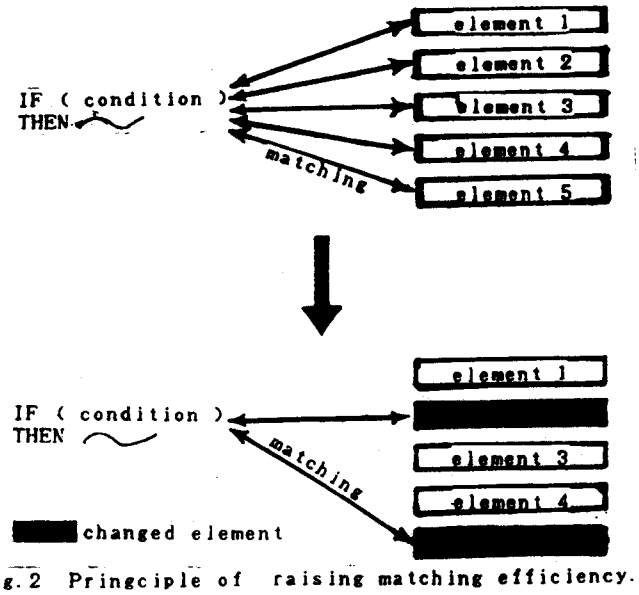


Fig. 2 Pringciple of raising matching efficiency.

2) When infering, it is unnecessary to match every timeall rule condion part with all state elements in work memory, only changed variables as matching object. As, in every cognitive cycle, state changing in work memory is limited, the times for matching are reduced substantially. See fig. 2.

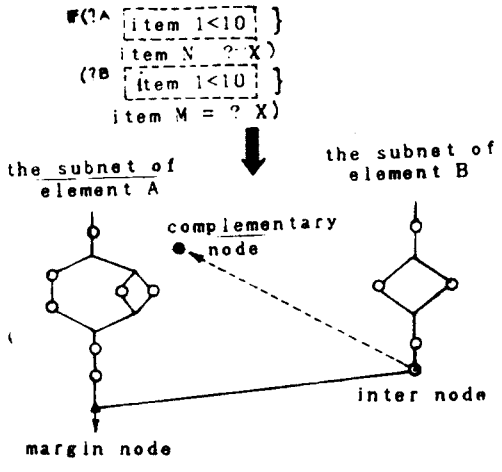
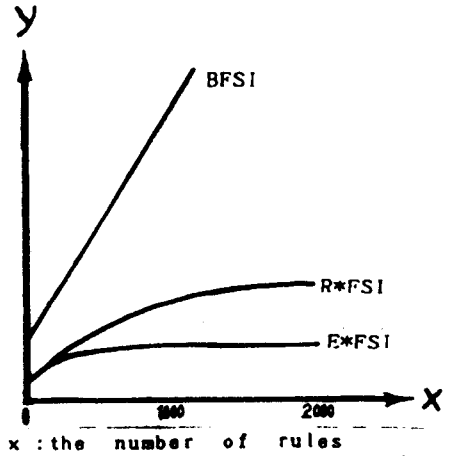


Fig. 3 The making of the network of E*FSI.

(ii) The high speed Technic of E*fsi
In R*FSI, if the more complex the rules are, the more conditions of logic "OR" are and if avriables are used in the rules, then the larger the net composition of R*FS is and therefore the superiority of R*FSI is greatly reduced.

In E*FSI, through the adoption of the method of complementary nodes, the above-stated problems of R*FSI are solved effectively. See fig. 3. By Rete emthod, under the condition of fig. 3, cohere subnet with internodes immediately. But here it is not done like this. Instead, in the subnet of the condition nodes whose indicating value is introduced(it is the subnet of element A, here), relative hypotheticol nodes are added. Internodes and complementary nodes are implicit. thus, logically the swell of network can be prevented.



x : the number of rules
y : the act time concerning rules
Fig. 4 The rule scale and the time of act in high speed FSI

(iii) The Effectiveness of High Speed Technic

See fig. 4.

REFERENCE:

(1) Zhou Faqiàng et al., Fuzzy production relation and the applicatino, (to appear).

(2) Funehashi et al., The high speed inference technic of EUREKA-II, NIKKEI COMPUTER, 1986.