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EXPERT SYSTEM AS A PART OF INFORMATION SYSTEM

To use computers effectively in man-machine interactive environments one has to create proper algorithms and construct a user-friendly environment in a computer system.

Our special interest lies in cases of scarce and incomplete information for control. Industrial processes serve as our example, where physical and chemical processes are so complex that mathematical modeling is out of the question. At the same time the general principles of their control are well known and already in practical use.

For these problems we need formal tools to collect, represent and use knowledge of human experts.

In practice an expert concentrates on parameters of the controlled object which are influencing the control goal. From the observed values he makes necessary fuzzy conclusions and changes the values of control parameters.

We are searching a type of expert's inference model that would define the sets of conditions which should be satisfied to start a set of actions. Therefore, we have to use a model which would check conditions that hold and knows what real actions comply with them. That brings us to a natural way of describing the experts's knowledge. One has to construct a set of conditional productions, each of them having the form

IF (set of conditions) THEN (set of actions).

It is easy to understand the semantics of that production representing the dependence between the set of conditions to be fulfilled so that the specific actions can be taken.

To create all conditional productions needed for expert actions, we use the theory of monotonic systems [2].

TABLE 1

Parameters

conditional					decisional	
1	2	3	4	5	6	7
1	1	2	2	1	2	4
1	1	2	2	1	2	4
2	1	2	2	2	2	3
2	1	2	3	2	2	3
2	2	2	3	2	2	3
2	2	2	3	4	2	3
2	2	2	2	2	2	3
2	2	2	2	2	2	3
1	2	2	2	1	2	4
1	1	2	2	1	2	4
1	1	2	2	1	2	4
1	1	1	2	1	2	4
1	1	2	2	2	2	4
1	1	2	2	2	2	4
2	1	2	3	1	2	2
2	2	2	3	3	2	2
3	2	2	3	1	2	2
3	2	2	4	2	2	1
3	2	2	4	2	2	1
3	2	2	4	2	2	1
3	3	2	4	1	2	3
2	3	2	2	2	2	3
2	2	2	2	2	2	3
2	2	2	2	2	2	3
1	1	1	2	4	1	4
1	1	1	2	4	1	4
1	1	1	2	4	1	4
1	1	1	2	4	1	4
1	1	2	2	1	2	4
2	1	2	2	2	2	3
1	1	2	2	1	2	4
1	1	2	2	1	2	4

2	1	2	2	2	2	3
2	1	2	3	2	2	3
2	2	2	3	2	2	3
2	2	2	3	4	2	3
2	2	2	2	2	2	3
2	2	2	2	2	2	3
1	2	2	2	1	2	4
1	1	2	2	1	2	4
1	1	2	2	1	2	4
1	1	1	2	1	2	4
1	1	2	2	2	2	4

Taking data from [1](see table 1) and using the algorithm from [3] we get a full cover of the data table by conjunctive sentences:

1.2 & 3.2 & 6.2 & 7.3 = 15 cases (the value of the first, third and sixth parameters is two and the value of the seventh parameter is three).

1.1 & 3.2 & 4.2 & 6.2 & 7.4 = 14

1.1 & 2.1 & 3.1 & 4.2 & 5.4 & 6.1& 7.4 = 4

1.1 & 2.1 & 3.1 & 4.2 & 5.1 & 6.2 & 7.4 =2

1.3 & 3.2 & 4.4 & 5.2 & 6.2 & 7.1 = 3

Two objects are alone and are of no statistical interest

1.3 & 2.3 & 3.2 & 4.4 & 5.1 & 6.2 & 7.3 = 1

1.2 & 2.1 & 3.2 & 4.2 & 5.1 & 6.2 & 7.4 = 1.

An interesting and complicated case of conjunctive sentences is given by a triad

1.2 & 3.2 & 4.3 & 6.2 & 7.2 = 2

3.2 & 4.3 & 5.1 & 6.2 & 7.2 = 2

2.2 & 3.2 & 4.3 & 6.2 & 7.2 = 2

Those three pairs (seemingly 6 objects) are in reality creating a cover only for 3 objects.

All conjunctions in that list give us a full and non-doubling cover for the data table.

Therefore, having 1-to-1 correspondence between all condition sets and action sets we can reverse the covering sentences and get the so-called conditional productions [1]

1. IF (1.2 & 3.2) OR (1.3 & 2.3 & 3.2 & 4.4 & 5.1)
   THEN (6.2 & 7.3)
2. IF (1.1 & 3.2 & 4.2) OR (1.1 & 2.1 & 3.1 & 4.2 & &5.1) OR (1.2 & 2.1 & 3.2 & 4.2 & 5.1)
   THEN (6.2 & 7.4)
3. IF (1.1 & 2.1 & 3.1 & 4.2 & 5.4) THEN (6.1 & 7.4)
4. IF (1.3 & 3.2 & 4.4 & 5.2) THEN (6.2 & 7.1)
5. IF (1.2 & 3.2 & 4.3) OR (3.2 & 4.3 & 5.1)
   OR (2.2 & 3.2 & 4.3) THEN (6.2 & 7.2)

We have to mention that the author of [1] did not use the rule No 3 at all, although its covering value in the data table is 9 %.

So we have built up an alternative expert system for data table 1 from [1].

Creation of expert systems, using the method of monotonic systems gives us some interesting possibilities.

First, its speed allows us easily to implement new knowledge and practical follow-up results into an expert system. One can even talk about self-instructing expert system. Why? All rules will almost automatically be generated from a given data base. If new data are added, the represented method works directly on the same base and creates new conditional productions.

To characterise the speed of our algorithms we generated all conditional productions for a discrete 3000*7 data table (the first six parameters had 8 categories, the last one (0,1)). It takes only three minutes on IBM PS/2-50 personal computer.

References

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Abstract

Expert system development, based on the theory of monotonic systems is described in this paper. Automatic generation of facts and rules for an expert system with a full coverage of a data table is estimated.

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EKSPERTSÜSTEEM KUI INFOSÜSTEEMI OSA

Kokkuvõte

Artiklis kirjeldatakse montoonsete süsteemide teooria rakendust ekspertsüsteemides. Reaalsel andmetabelil esitatakse ekspertsüsteemi reeglistiku genereerimise protsess. Näidatakse, et seejuures jääb jõusse infosüsteemide üks põhinõudeid - kirjeldada uuritav andmekogum vähima arvu parameetritega.