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Modificated repertory grid procedure for attribute problem domains

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Abstract

Knowledge acquisition is always seen as a difficult task during the construction of a knowledge based systems. The Repertory Grid technique is the acknowledged leader in the field of constructive eliciting procedures. Some formal lacks of repertory grids are accounted for the possible incomparableness of considered triples of decisions. Recently proposed approach aims at getting rid the marked lack and, at the same time, making knowledge acquisition procedure more friendly for the expert.

Knowledge acquisition research supports the generation of knowledge–based systems through the development of principles, techniques, methodologies and tools. The main purpose — is to elicite conceptual structures underlying expert performance and represent it in the form of adequate computational structures. The person which does all these things and in general is responsible for creating of knowledgesbased system is called knowledge engineer. Knowledge engineer is analogous to the system analyst in traditional computer systems design.

Knowledge acquisition is difficult and time consuming process, in the course of which knowledge engineer faces many problems, and, in particulary, the problem of eliciting of concepts to describe the examining problem domain. From the point of view of programmer, it is necessary to ascertain a finite set of facts allowing the expert to make correct decision for any problem situation. In the role of decisions, for example, some objects or medical diagnoses would be implied. Assume, that all names of decisions are already known.

The Repertory Grid technique is the acknowledged leader in the field of constructive procedures. The main idea was adopted from psychology and assumes that knowledge engineer demonstrates triples of different decisions and asks the expert to fulfil following task. Expert must tell the charasteristic feature, which separates three decisions on two similar ones and one different. Expert's answers are placed in the special table — repertory grid. Special procedures analyze obtained repertory grid and elicite expert's knowledge.

During the work with repertory grids we have faced the formal lacks of that method. One of them is accounted for the possible incomparableness of decisions, and causes, at least, two undesirable consequences:

- often triples of decisions is nonsense, therefore the request to separate decisions discomforts the expert;
- the order of presenting triples for examination isn't taking into account, although it is known, that it directly influences the effectiveness and quality of elicited concepts.

Trying to avoid that lacks and, at the same time, to make knowledge acquisition easier for expert, we have modificated classical Repertory Grid method. Features of our approach are following:

- it modificates the main question for expert;
- it separates examination of triples from attribute's eliciting;
- it ensures friendly dialogue with Expert.

Approach consists of two stages: stage of decision making and stage of documentation. During the stage of decision making a special sequence of elements from the initial set of decisions is forming:

- at the begining expert arbitrary fixes first two elements from the initial sequence;
- then he adds elements (decisions) to the end of the sequence in according with the following rule: "there is some characteristic

(classificatory) feature, which separates the last but one decision of the sequence from the choiced decision and from the last decision at the same time".

Accent three principal moments. In the first place, unlike classical Repertory Grids method, the classifying feature is not specificed on the stage of decision making. It will be named later — on the stage of documentation. Obtained "rough" name are only for "inward using", it may has not the real name of the attribute, which is usual, for example, for qualitative attributes.

In the second place, notice that we have modificated the main request to expert. Now we permit him to select the third decision without assistance.

In the third place, because of dividing the main task into sub–tasks, we can bring about dinamics into the first stage of the procedure. Attractive computer game was created to mask the creating of special sequence of decisions.

Here we focus our approach on sub–class of cognitive models, where concepts are represented in the form of "attribute: value". From the point of view of such models, examination of each triple allows to elicite the name of attribute (as the name of characteristic feature) and names of two attribute's values (as concrete manifestations of that feature for separated decisions accordingly). The pair "attribute: value" wil be called "fact".

On the stage of documentation expert is explaining his decisions made on the first stage. He looks over the sequence and choices any three neighbouring elements. In accordance with the first stage's rule, there is some classificatory feature, which separates first element of the triple from two last elements. Expert must explain:

- what is it the same for two last decisions and
- what is it the difference between two last and the first decisions.

As a result, we have two expert's answers for each triple of the sequence. Expert's answers will be called short sentences. It is difficult to determine the attribute's name and names of its values directly

from short sentences. For this goal the special procedure — the name's polishing procedure was created. It consists of three steps. Consider it in detail.

At the first step expert formulates one common question for given short sentences. By another words, he must formulate such question, for which given short sentences have been presented two different answers. Such step is necessity, because the attribute's name may be absent in the short sentences. Then without fail it will be in the text of the question.

At the second step, special procedure forms full answers on the base of the question and short sentences. The answer is full if it has subject and predicate. Notice, that if at the first step expert had answered by full sentences, then short sentences and full sentences are coincided. In any case, obtained information can be edited by the expert.

On the third step using that:

(1) attribute's values are presented in the short sentences,

(2) attribute's name is presented in the question and

(3) both attribute's name and attribute's values are presented in the full sentences it is possible to clear up the name of the attribute and names of two attribute's values.

Classical repertory grids method allows to elicite only two values of attribute, so we complete our procedure with the eliciting of full spectrum of attribute's values. We were asking the expert about the values of attribute for all possible decisions.

The domain of cardiology is used to illustrate proposed approach. For example, there are six possible decisions:

MYOCARDIAL INFARCTION,
INFARCTION OF LUNG,
PLEUROPNEUMONIA,
SHARP TRACHEOBRONCHITIS,
PLEURISY and
SPONTANEOUS PNEUMOTHORAX.

Here we don't discuss the first stage in detail. To introduce game elements in dialogue with expert we used the posibility of easy "jumping" from stage of decision making to stage of documentation and back. The goal of the game bases on attempt to classify all given decisions by introducing the minimal set of attributes. To achieve such goal expert must quess the most favourable moment for "jumping" to the stage of documentation. At the same time, the game program can control and evaluate expert's actions, because it know the initial task (task of classification) and has information about all examined triples.

Now assume, that on the first (game) stage expert had created the following sequence of decisions:

MYOCARDIAL INFARCTION $\longrightarrow$ SHARP TRACHEOBRONCHITIS $\longrightarrow$
$\longrightarrow$ SPONTANEOUS PNEUMOTHORAX $\longrightarrow$ PLEURISY $\longrightarrow$
$\longrightarrow$ PLEUROPNEUMONIA $\longrightarrow$ INFARCTION OF LUNG $\longrightarrow$
$\longrightarrow$ MYOCARDIAL INFARCTION.

Looking at the sequence we can see five possible triples:

1)	MYOCARDIAL INFARCTION	SHARP TRACHEOBRONCHITIS SPONTANEOUS PNEUMOTHORAX
2)	SHARP TRACHEO-BRONCHITIS	SPONTANEOUS PNEUMOTHORAX PLEURISY
3)	SPONTANEOUS PNEUMOTHORAX	PLEURISY PLEUROPNEUMONIA
4)	PLEURISY	PLEUROPNEUMONIA INFARCTION OF LUNG
5)	PLEURO-PNEUMONIA	INFARCTION OF LUNG MYOCARDIAL INFARCTION

Below we will describe the protocol of our procedure for examination of the first triple.

First step:

- What is it the same for SHARP TRACHEOBRONCHITIS and SPONTANEOUS PNEUMOTHORAX?
- What is it the difference between them and MYOCARDIAL INFARCTION?

Expert's answer:

DECISIONS	SHORT SENTENCES
SHARP TRACHEOBRONCHITIS SPONTANEOUS PNEUMOTHORAX	Strengthening of pain when breathing or cough.
MYOCARDIAL INFARCTION	No

Knowledge Engineer:
Please, formulate a common question for these short sentences.
Expert:
Is the pain strengthing when breathing or cough? (Question number 1)

Special procedure forms full answers (may be edited by the expert):

FULL SENTENCES
In the case of myocardial infarction the pain isn't strengthening when breathing or cough.
In the case of sharp tracheobronchitis and spontaneous pneumothorax the pain is strengthing when breathing or cough.

The procedure forms attribute's name and two values:

OBJECTS	NAME OF ATTRIBUTE	VALUE
MYOCARDIAL INFARCTION	The pain is strengthing when breathing or cough	No
SHARP TRACHEOBRONCHITIS, SPONTANEOUS PNEUMOTHORAX	The pain is strengthing when breathing or cough	Yes

For another decisions:

MYOCARDIAL INFARCTION	SHARP TRACHEO-BRONCHITIS	SPONTA-NEOUS PNEUMO-THORAX	PLEU-RISY	PLEURO-PNEUMONIA	LUNG INFARC-TION
No	Yes	Yes	No	No	Yes

And such process was repeated for all triplexes. As a result we have the next final table, which could be used for decision rules creating.

N	DECISIONS					
	MYOCARDIAL INFARCTION	SHARP TRACHEO-BRONCHITIS	SPONTA-NEOUS PNEUMO-THORAX	PLEU-RISY	PLEURO-PNEU-MONIA	INFARC-TION OF LUNG
1	No	Yes	Yes	No	No	Yes
2	Left part of thorax	Center of thorax	Left or right part of thorax	Left or right part of thorax	Center of thorax	Left or right part of thorax
3	Weak breathing	Pleura noise	Weak brea-thing	Pleura noise	Pleura noise	Weak brea-thing
4	Good	Bad	Bad	Bad	Good	Good
5	Suddenly	Gradually	Sud-denly	Gradu-ally	Gradu-ally	Sud-denly

where

N	NAME OF ATTRIBUTE
1	Strengthening of pain when breathing or cough
2	Localization
3	Percussion
4	X–ray photography
5	Begining of disease

Described procedure was welcomed by experts. Such circumstance was a very pleasant surprise for us, because it is known that many peoples prefer to hide his routine work for searching of definitions. Perhaps this is the rare case, when the help of inanimate computer is more preferable than the service of knowledge engineer.

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