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KNOWLEDGE REPRESENTATION AS A TOOL OF SUPPORTING THE PLANNING OF EXPERIMENTS IN MACHINE EXPLOITATION RESEARCH

Summary. The paper introduces an idea of using some means and method of the Knowledge Engineering in order to support the Planning of Experiments which are carried out in a general field of machine exploitation. In particular the method of the knowledge representation which bases on the so-called *semantic networks* is introduced. In conclusions the possibilities of using this tool for the needs of particular tasks in the above mentioned general field are discussed.

1. Introduction

In a systematic approach to analysis and synthesis of the technological processes of production, control-information management, machine exploitation and other labor systems the problem of investigations appears as the important element of the obtaining information about technical objects. Consequently the need of formulating rules exists for the specific area of engineering which can be described as the Planning of Experiments in Machine research. In this area one can observe the connection between man (man observation) and machine (as an observed object).

The mentioned area concerns various categories of particular problems like:

- identification of the object and the goal of investigations
- fitting the method of the investigations
- planning and arranging the laboratory or 'in situ' measurements
- analysis of results of the measurements
- drawing final conclusions from the investigations.

Every element of the above shown list implies the necessity of using the specific area of knowledge. Thus the idea of supporting the mentioned actions by means of the methods of the Knowledge Engineering seems to be reasonable. If so, the problem becomes of finding the adequate tool for the mentioned purpose.

The analysis of the fixed area of problems push us to a certain formalization which must take account with [1]:

- Consideration of the expedient man's behavior;
- The presence of both algorithmic and heuristic components in the fixed activities;
- The necessity to have an unified formalism for defining both man knowledge and his means of action;
- The presence of stochastic elements such as malfunctions or errors in the mentioned area of activity.

Knowledge representation in such a class of problems must allow us to describe, design and estimate the quality of functionning object for various application. In this paper authors propose the *semantic networks* as such a tool. Semantic networks called also Conceptual Dependency Networks are a form of graph data structures which combined with AI techniques, encode real-world knowledge data sets and the relations between them.

2. What is the semantic network?

Semantic network is a directed graph whose nodes represent individuals and whose arcs represent relationships between individuals. An arc is labeled by the name of the relationship it represents. Several arcs can have the same label. However, each individual is represented by only a single node.

Information about semantic network links may be kept in a Relational Database Management System. We can define new link types by filling in the necessary fields. It is possible that a 'concrete' groups of links can have properties such as security levels or hours of activation, which involve a limit access to linked objects. We have as the consequence the possibility to type specific links or groups of links as 'read-only'. The ability to combine read-only and read-write links offers the exciting possibility of seamlessly integrating CD-ROM data with a user's own local information [2].

3. Structure of knowledge in semantic networks

A cognitive agent interprets the external world in terms of conceptual attributes and their associated values, and his factual knowledge is represented using these attributes and values. In addition to the conceptual attributes such as 'has-color' (with values: RED, BLUE, GREEN, etc.), 'has-texture', 'has-odor', knowledge-structuring relations such as IS-A and PART-OF are also considered to be conceptual attributes. Attributes need not be unstructured entities, for instance [3], 'has-color' may be defined in terms of 'sub-attributes' such as 'has-brightness' and 'has-saturation'.

Concepts are labeled collections of [attribute,value] pairs. The values of attributes are also concepts, and hence, concepts may be arbitrarily complex.

Attributes may be classified into two broad categories: properties and structural links. Structural links provide the coupling between structure and inference. They reflect the epistemological belief that world knowledge is highly organized and that much of this structure can be factored out to provide general domain independent organizational strategies that in turn lead to efficient inference.

Each structural link embodies one such organizational strategy. If we map knowledge onto a data structure (or a physical device) so that structural links get represented explicitly as arcs in the data structure (or interconnections in the physical device), then these arcs (or interconnections) provide hard-wired, and hence, efficient inference paths. The most of representative structural link is the IS-A link that is used for inheritance in semantic networks. We can extend the notion of inheritance to include other structural links such as the is-a-part-of, and occurs-during links. For example, is- a-part-of links may be used to infer values of attributes 'has-location', while occurs-during links may permit inferences pertaining to time.

4. Object analyses and the choice of identification method

The choice of a method of identification is hardly connected with information about the object before starting the identification process [4]. Such information concern the structure of the object, stochastic interference and stochastic object parameters. Usually, object structure is known and we assume a similar structure for the model. The role of identification in such case is to determine the unknown object parameters. Sometimes the structure is unknown, in such case we assume a certain alternative of structures arbitrarily proposed and then studying the identification of all variants structure, we choose the optimal proposedo-ne. Qualitative information about the identified object have a great meaning for the choice of structure.

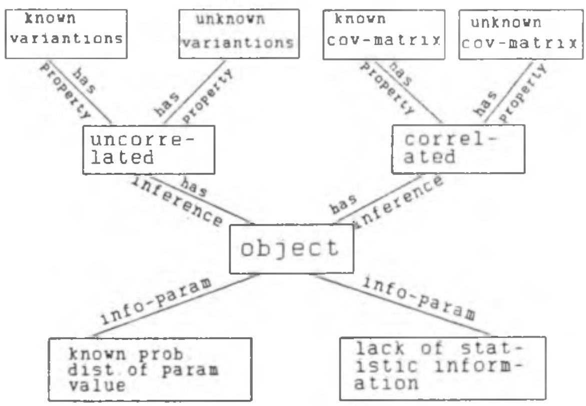

Fig.1. Simple representational information about object

In order to resolve the problem of choosing the suitable identification problem, we can use the power of semantic networks which extended with a clausal form of logic guides the search for deduction and solution. The extended semantic network, not only can be regarded as a syntactic variant of the clausal form of logic, but it can also be regarded as an abstract data structure, the semantic network provides an indexing scheme [5] which can be used for guiding the search for a solution.

An indexing scheme is a method of organizing information for the purpose of accessing it efficiently. It is the characteristic feature of semantic networks that, given a term, direct access is provided to all atoms (both conditions and conclusions) containing that term. This is called *indexing on arguments*. It is also possible to *index on predicate symbols*: given a predicate symbol, direct access is provided to all atoms containing that predicate symbol. Indexing on predicate symbols is employed in almost all predicate logic implementations.

5. The plan of result-analyses

For the result-analysis during experiment's measurements, we have to control their completeness and the existence of errors. The source of such errors may be the malfunction of measurement apparatus or human mistakes (man is playing a dual role of making and correcting mistakes as being a 'generator' of mistakes and a 'corrector' of the sequals of the faults.

A good method for detecting mistakes is to analyse diagrams, the evaluation of average or variance. We can also mention another kind of mistake's elimination such as filtration and 'smoothing'.

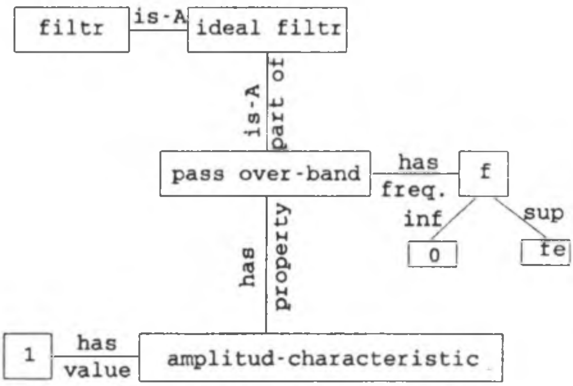

Fig.2. Simple example of supporting errors detection by filtration

6. About programming-tools

Object-oriented languages, especially commercially-targeted languages such as C++, allow relations to convey some semantic information by the technique known as 'inheritance'. When a new object of a certain class is created, the creating function automatically assigns links from that object to others. Each object class can be assigned its own inheritance characteristics. While this simplifies the construction of semantic networks, these languages do not inherently support link typing. Programming languages or language extensions which incorporate SN manipulation through primitive functions have yet to be developed [5].
Object-oriented languages, which are becoming increasingly popular, present considerable advantages in designing Sns. The limitation mentioned earlier, that links inherent to these languages cannot be types - can be circumvented fairly easily by defining links as objects themselves. In other words, every link becomes once removed, with the data object first pointing to another object defining the link. A language with good support for record-like structures, such as C++, is ideal for this solution. A set of structures for representing various classes of links may be defined along with inheritance properties, since links are like objects in this method. The task of building a semantic network toolbox for C++ becomes very straightforward with this recipe.

7. Conclusions

To propose the tool there is a first step in the task which has been formulated in the introduction to this paper. Now it would be necessary to fix the areas in which the tool might be used. Between the listed above particular tasks of the Planning of Experiments there are undoubtedly areas which can be supported by use of this tool with success. In particular the authors of this paper have undertaken trials to apply the method of semantic networks: first of all for supporting the planning of investigations and data analysis because the description of every technology is equivalent to a description of corresponding logical-functional network which takes account with both: the description of logical-temporal sequence of accomplishing elementary operations (by man, machine, robot, etc...) and the characteristics of the quality of the quality of their performance: average and dispertion of time of operation fulfilment. The first results seem to be promising.

'Semantic networks are not a natural mode of description for a person. But the computer doesn't care about that. As an internal data structure they're great. But they have too much representational power for users to build them' /Barr.A/.
[2].

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