Modeling of NON-Factors as the Basis for Constructing an Intellectual Modeling Technology

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Abstract.*This paper describes the problems of modeling systems that contain poorly defined properties named NON-factors. It defines which negative properties can be difficult to formalize and explains why this makes a system more complicated to define. The so called "poorly defined situation" in modeling of complex objects is introduced. It is stated that the factors being specific to the investigated process (object, phenomenon) should be identified.In conclusion, the authors ask if a system that does not model non-factors can be called intellectual.*

Keywords

NON-factors,Im-In-Un-knowledge,negative properties,poorly defined situation, identification, predictive modeling.

1 Introduction

The term NON-factors has been proposed more than thirty years ago by A. Narinyani [1] to refer to the complex of negative properties (*indetermination*, *uncertainty*, *incompatibility*, *fuzziness*, *inaccuracy*, *incompleteness*, *incorrectness*, *inadequacy*etc), that are characteristics of real knowledge systems but poorly represented in formal systems. In the western literature, these factors are calledIm-In-Un's [2].

In other words, NON-factors is an attempt (often on the linguistic level) to record our Im-In-Un-knowledge during abstraction, transition to the formal systems and interpretation of the conclusions at a formal level.

Therefore, development of technologies for predictive modeling is impossible without identifying these factors in each case (with respect to some specifics), their analyzing and implementing appropriate methods and tools.

2 Classification and modeling of NON-factors

Applied to the different categories of data, information and knowledge, NON-factors are *treateddifferently* [3]. For example, fuzziness of the data is the first case, fuzziness of the conclusions is the second one, fuzziness of the problem statement is the third, etc. Therefore, it is advisable to consider the NON-factors as the definition of any processes, objects and phenomena. And when it comes to modeling, the NON-factors also characterize the relationship between an object and a model**.**

It seems to be natural to consider the classification of NON-factors in a conditional five-dimensional system of coordinates <*NON-factors*; *methods of its modeling*; *tools for modeling them in a computing environment*; *simulated objects* (*properties, relationships, and operations*); *subject* (*problem*)*domains*>.

Below we will build and analyze this classifier in some more details.

Relationships of NON-factor problematic and mathematical instruments, the problem of scaling of NON-factors, NON-factors in the exploratory design (and modeling) of complex technical systems, NON-factors in creative thinking are considered in [3]. There is also an overview of articles of known authors on the subject.

3 NON-factors as significant characteristics of a poorly structured situation

Among the management tasks in the socio-economic, institutional, political and other fields related to the life of society, the most complicated are complex tasks aimed to change the situation as a whole in a desired way [4]. In this case, the object of control is the whole problem domain that is seen as a dynamic situation consisting of a set of heterogeneous interacting factors. Some of these factors are directly dependent on the decisions of the decision maker, the others depend on the decision-maker indirectly (through a chain of other factors), while others are independent of the decision-maker at all (such as the weather, the harvest expectations, changes in legislation, etc.).

What is a "poorly defined situation" in modeling of complex objects? We usually look for knowledge of the situation as a function

$$y = f(x_1, x_2, \ldots, x_n),$$

where x_1, x_2, ..., x_n are the factors affecting y.

Our initial NON-knowledge can take many forms:

- we may not know what and how many factors are present;
- we may know the factors but not sure that only these are influencing on output y;
- the range of the factors may not be known;
- it may be known nothing about the function f;
- we may have some parametric conception of f, for example, be sure that f is a weighted sum of factors but without knowledge of the factor weights in this sum, etc.

When attempting to use traditional information technology to solve such problems, generally we have to face the fact that, unlike most of the technical systems, the object of control (i.e. situation) is not only unformalized but poorly structured.

It is expressed as follows.

1. The system of notions (factors, concepts) and relations between them is not defined with sufficient completeness. Of course, the main factors are known, but many factors, relations and parameters are clarified only during the problem statement.
2. The main parameters of the situation (the factor values, the extent of influence of some factors on the others) are not quantitative but qualitative, i.e. they are not represented as numbers but either as intervals characterizing accuracy of the estimate, or as fuzzy values, or linguistic evaluations, forming a linearly ordered scale.
3. The values of the situation parameters are obtained mainly by interviewing experts, thus representing their subjective assessment. This also applies to those factors and relationships that are expressed quantitatively as a result of the statistical data analysis, opinion polls etc., because the same factors are estimated by various sources differently. The final values of the parameters introduced by experts into the model are the result of their subjective processing the data, including the choice of one of the estimates (or their weighted convolution) taking into account the data reliability, the source reputation etc.
4. Pre-formulated alternatives of the control decisions in such cases are rather few and often obvious; the unobvious alternatives, where the best ones tend to belong, occur only during the analysis of the situation.
5. When evaluating the identified alternatives one must take into account the dynamics of the situation, i.e. it is required to forecast of its evolution when influencing on various factors, the occurrence of side effects, etc.

Because of these specifics, the approaches of imitational modeling that are focused on the use of quantitative objective assessments, and methods of the traditional decision making theory based on methods of selecting the best alternative from a variety of well-defined alternatives are often inadequate when making decisions in such problem domains. The materials used for decision making in such domains will inevitably contain a significant portion of

qualitative, fuzzy, subjectively evaluated data and represent essentially an expert knowledge (or a group of experts) on the situation describing the problem domain.

The use of formal methods and appropriate information technologies for control of situations in poorly structured problem domains should be preceded by preparatory work consisting of the following steps:

1. Structuring a problem domain, i.e. forming a system of factors and relations between them.
2. Parameterization of the resulting system of factors and relations, i.e. describing the acceptable ranges of values, mostly qualitative and fuzzy.
3. Formalization of the domain, i.e. selection of a model that is characterized by the form of functions determining the impact of relations on the factors, and methods of their calculation.

As a result of these three stages of the research, the factors that are specific to the investigated (simulated) process (object, phenomenon) should be identified.

4 Conclusion

The up-to-date intellectual systems are focused on the development of computing technologies for subject and problem domains of knowledge that are often referred to as "*semi-structured*","*poorly structured*","*weakly structured*". It is impossible to model such knowledge without accounting for the NON-factors. These problems are starting to attract attention of "traditional mathematics" and "classical logics". Apparently, these problems will soon take an appropriate central place in artificial intelligence. And then it will be proper to ask:

Can a system be called intelligent if it does not model any NON-factors?

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