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On the Formalization of Scientific Theories

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The general concept of the formalization is considered. Five levels of the formalization of scientific theories are noted and described.

The general concept of the formalization is connected with the systematization and the specification of human knowledge. The formalization of some branch of knowledge is defined as a representation of knowledge in this branch by means of another branch when this representation is connected with systematization and specification of knowledge; as a rule such a representation is approximative and estranged from the initial branch. The formalization of different branches of science is typical for such sciences as, for example, mathematics and physics, but it takes place also in the humanities. For example, the criminal and the civil law may be considered as a formalization of the human morals. The written natural language may be considered as a formalization of the oral one.

We shall study some levels in the formalization of scientific theories. Below five levels of such kind will be described.

The first of them is the *"descriptional"* level. The creation of any scientific theory begins from the observation of facts. A collection of the observed facts is the content of the descriptional level. It gives a basis for the development of the theory in future. On this level only the collection of facts is present; the theory (in the own sense of this term) yet does not exist.

The second level may be characterized as a *"linguistic"* one. It is performed when the observed facts are numerous and multiform, and it is necessary to systematize them and to introduce some system of notions giving a classification of the observed facts and of the relations between them. On this level the *language* of the theory is created.

The third level may be characterized as an *"intuitive logical"* one. It is performed when it is necessary to specify and systematize the statements of the theory and to establish relations between them. On the highest stage of this level some central statements of the theory sometimes are formulated such that all the statements in the considered theory can be deduced from them. Such central statements bear different names in different sciences. They are, for example, *axioms* and *postulates* in the geometry, laws (for example, Newton's laws) in the physics. Sometimes such central statements are *equations* (for example, Maxwell's equations in the electrodynamics, Schr†dinger's equation in the quantum mechanics). But the methods of logical deduction on this level are typical only for a considered theory; we have, for example, the "geometrical thinking" in the geometry, the "mechanical thinking" in the mechanics.

The fourth level of the formalization may be characterized as a *"formal logical"* one. It is performed when the methods of the intuitive logical thinking used on the previous level

become not satisfactory from the point of view of the exactness and the reliability of the statements obtained by the deduction. The intuitive logical deduction is replaced on this level by the formal logical one. For example, the passing of the geometry to the forth level was performed in 19-th century [1].

The fifth level of the formalization may be characterized as a *"syntactical"* one. It is performed when the formal logical deduction is reduced to transformations of combinations of formal symbols (defined only by their formal structure). Such a level is essential from the point of view of some directions in the mathematics (for example, formalism [2]); it is essential also for applications of the computer science to the investigations of peculiarities of the human thinking. The predicate calculus [3] gives a general method for passing to the fifth level from the fourth one.

Some higher levels of the formalization may also be considered, but they are yet not implemented, and we do not consider them here.

References

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