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FORMAL PROOF-VERIFICATION AND MATHEMATICAL INTUITION: THE CASE OF UNIVALENT FOUNDATIONS

Session 4F

Congress section(s): C1

The idea of formal proof verification in mathematics and elsewhere, which dates back to Leibniz, made important advances since the beginning of the last century when David Hilbert launched the research program called today after his name. In the beginning of the present century an original contribution into this area of research has been made by Vladimir Voevodsky (b. 1966 Moscow - 2017 Princeton) who proposed a novel foundations of mathematics that he called Univalent Foundations (UF). UF involves an interpretation of Constructive Type theory with dependent types due to Per Martin-Löf by means of Homotopy theory (called Homotopy Type theory or HoTT for short) and is designed to support an automated, viz. computer-assisted, verification of non-trivial mathematical proofs [1].
The present paper analyses the epistemic role of mathematical intuition in UF. The received view on the role of intuition in formalized mathematical theories stems from Hilbert. Hilbert stresses the importance of human capacity to distinguish between different symbol types, identify different tokens of the same symbol type and manipulate with symbols in various ways. He qualifies this cognitive capacity as a form of intuition and claims that it plays a major epistemic role in formal logic and formalized mathematical theories. All other forms of mathematical intuition, in Hilbert's mature view, have significant heuristic and pedagogical values but play no role in the formal representation and justification of ready-made mathematical theories (see [2], section 3.4 and further references therein).
Unlike Hilbert Voevodsky didn't write a philosophical prose but he expressed his vision of mathematics and explained motivations of his projects in many public talks, which are now available in record via his memorial web page maintained by Daniel Grayson in Princeton Institute of Advanced Studies [3]. In a number of these talks Voevodsky stresses the importance of preserving in the framework of formalized computer-assisted mathematics an "intimate connection between mathematics and the world of human intuition" . Using a simple example of classical theorem in the Algebraic Topology formalized in the UF setting [4], I show how a spatial intuition related to Homotopy theory serves here as an effective interface between the human mind and the computer, and argue that it plays in UF not only heuristic but also a justificatory role.
Bibliography:
1. D.R. Grayson, An Introduction of Univalent Foundations for Mathematicians, arXiv: 1711.01477
2. A. Rodin, Axiomatic Method and Category Theory (Synthese Library vol. 364), Springer, 2014
3. http://www.math.ias.edu/Voevodsky/ (Voevodsky's memorial webpage)
4. M. Shulman and D. Licata, Calculating the fundamental group of the circle in homotopy type theory. arXiv:1301.3443
(The accompanying Agda code is available from Dan Licata's web site at http://dlicata.web.wesleyan.edu)

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RATIONALITY PRINCIPLES IN PURE COORDINATION GAMES

Session 16B

Congress section(s): A2

We analyse so-called pure win-lose coordination games (WLC games) in which all players receive the same playoff, either 1 ("win") or 0 ("lose"), after every round. We assume that the players cannot communicate with each other and thus, in order to reach their common goal, they must make their choices based on rational reasoning only.
We study various principles of rationality that can be applied in these games. We say that a WLC game G is solvable with a principle P if winning G is guaranteed when all players follow P. We observe that there are many natural WLC games which are not unsolvable in a single round by any principle of rationality, but which become solvable in the repeated setting when the game can be played several times until the coordination succeeds.
Based on our analysis on WLC games, we argue that it is very hard to characterize which principles are "purely rational" - in the sense that all rational players should follow such principles in every every WLC game.

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TECHNOSCIENCE AND PHILOSCIENCE

Session 26K

Congress section(s): B1, C8

According to the traditional views science and technology are definitely different from each other: while the former deals with facts, the latter deals with artifacts. Because of the radical changes in the recent forms of technological and scientific practices the validity of this traditional position has became uncertain, and a new view has emerged - to rethink the science-technology relations using the concept of technoscience.
The term "technoscience" became an essential component of discussions on the science- technology-society complex following the appearance of Latour's Science in action (Latour 1987). In the last decades number of studies were published on the history, philosophy and sociology of technoscience e.g. by Latour, Ihde, Barnes, Klein, Pickstone, Nordmann, Bensaude-Vincent and others (see the references below).
In this lecture I try to contribute to this discussion introducing the concept of philoscience as an alternative concept to technoscience. While the concept of technoscience expresses the entanglement of the traditional forms of science and technology in a given socio-historical environment, the concept of philoscience expresses the entanglement of science and philosophy in a given socio-historical environment.
On the account proposed in this lecture, all science is technoscience in its any historical forms; there is no science without technological components. On the other hand, at the same time all science is philoscience in its any historical forms as well; there is no science which would not include philosophical components.
When we speak about "science", unqualified, this inner structure of scientific knowledge remains obscured. It is always a fusion of technological and philosophical components that results in the formation of a "scientific matter", i.e., a concrete socio-historical form of science. The relative weight of technological and philosophical components in the mixture, and the level of their integration are challenges to be taken up by the history and philosophy of science and technology, and by further studies on the interrelatedness of technology, science, and philosophy.
References
Barnes, B.: Elusive Memories of Technoscience, Perspectives on Science 13, 142–165, 2005