Reasoning with Computer Code: a new Mathematical Logic

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Abstract

A logic is a mathematical model of knowledge used to study how we reason, how we describe the world, and how we infer the conclusions that determine our behavior. The logic presented here is natural. It has been experimentally observed, not designed. It represents knowledge as a causal set, includes a new type of inference based on the minimization of an action functional, and generates its own semantics, making it unnecessary to prescribe one. This logic is suitable for high-level reasoning with computer code, including tasks such as self-programming, object- oriented analysis, refactoring, systems integration, code reuse, and automated programming from sensor-acquired data.

A strong theoretical foundation exists for the new logic. The inference derives laws of conservation from the permutation symmetry of the causal set, and calculates the corresponding conserved quantities. The association between symmetries and conservation laws is a fundamental and well-known law of nature and a general principle in modern theoretical Physics. The conserved quantities take the form of a nested hierarchy of invariant partitions of the given set. The logic associates elements of the set and binds them together to form the levels of the hierarchy. It is conjectured that the hierarchy corresponds to the invariant representations that the brain is known to generate. The hierarchies also represent fully object-oriented, self-generated code, that can be directly compiled and executed (when a compiler becomes available), or translated to a suitable programming language.

The approach is constructivist because all entities are constructed bottom-up, with the fundamental principles of nature being at the bottom, and their existence is proved by construction.

The new logic is mathematically introduced and later discussed in the context of trans- formations of algorithms and computer programs. We discuss what a full self-programming capability would really mean. We argue that self-programming and the fundamental question about the origin of algorithms are inextricably linked. We discuss previously published, fully automated applications to self-programming, and present a virtual machine that supports the logic, an algorithm that allows for the virtual machine to be simulated on a digital computer, and a fully explained neural network implementation of the algorithm.

Keywords: AGI, emergent inference, mathematical logic, self-programming, virtual machine