Classification Of Intelligence By Meta-models

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Abstract

We propose a novel classification of artificial intelligence based on computational problems vs. learning problems that builds up from traditional algorithmic methods to general meta-models.

Computational methods are defined by traditional function execution, which implicitly hold the model of the problem to solve. Computational problems are straightforwardly solved by exploiting an algorithm with, generally, input and output data. Examples include calculation tasks, functions that return data, and symbolic processing. We call these processes first order intelligence.

In contrast, learning processes are characterized by the algorithmic production of the methods used in first order intelligence. Learning problems arise when there are no appropriate methods available to solve a computational problem. In this case, exploration of model space, in opposition to exploitation of a particular model, yield candidate algorithms. Interestingly, learning problems are computational meta-problems in the domain of computational problems, i.e. exploration of model-space is equivalent to exploitation of a meta-model. Examples include neural-network-training algorithms, machine code generation by genetic algorithms, reinforcement learning, and, in general, functions that return references to other functions. These processes are called second order intelligence.

Subsequent orders reveal meta-models of previous orders to form an infinite sequence of classes of intelligence whose discontinuation is plausible, yet problematic, by using self-referential meta-models. Third order intelligence builds from second order intelligence by taking over when there are no appropriate meta-models to generate algorithms, that is, when exploitation of model space is not viable, resorting to exploration of meta-model space. Intuitively, third order intelligence is understood as learning to learn. Higher orders of intelligence are reached inductively in a similar manner, with every order increasing in abstraction, complexity, difficulty to grasp intuitively, and no guarantee to stop at any order. To remedy this situation, we propose to use a self-referential meta-model as a general meta-model, i.e. an algorithm that modifies itself, in order to break the infinite escalation of orders. However, such a general meta-model is impossible in formal systems due to the restrictions imposed by Gödel incompleteness theorems, which show that axiomatic systems able to represent their own axioms are not complete.

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