Summary: What Are Intelligence? And Why? by Randall Davis

03 October 2019 - Paul Meierling (6.844)

Overall summary of the paper

Davis gives an overview of the concept of intelligence, arguing that it depends on multiple fields. He goes through the fundamental elements of intelligence (what) as well as the history of intelligence (why).

Structure of the argument

Fundamental Elements: Davis argues that four behaviors are used to separate intelligent behavior from purley stimulus driven ones, namely prediction, response to change, intentional action and reasoning. He then dives deeper into reasoning showing answers from different fields. The mathematical view describes reasoning as a form of logic that can be described in a formal way ("a calculus of thought"). The psychological view instead argues that reasoning is something innately human. These two views put the field of AI either into mathematics or natural science. The societal view takes the viewpoint that the sum is larger than its parts and reasoning comes from the combination of different disciplines. Davis believes that these different fields can be combined by looking at the design space of intelligence. Where instead of trying to assign the research in AI to one field it can be seen as a continuous space.

History of intelligence: Having discussed the different elements of intelligence Davis tries to uncover how and why intelligence developed. This is notoriously difference since our data of the evolution is very incomplete. He argues that evolution is using blind/random search instead of search with a clear goal. It tries to find good enough improvements instead of an ideal goal. This has a number of consequences: 1. Search space is explored in parallel instead of ascent/descent 2. Explored solutions may not be useful at all (e.g. redundant metabolic cycles) 3. Search may double back to previous solutions (e.g. eye of a mammal and octopus) 4. Nature build adequate systems instead of optimal ones (e.g. bird lungs) 5. Structures can be used for different use-cases (e.g. feathers being used for flights) 6. Evolution is very conservative and proceed incrementally instead of redesigning from scratch. All these points result in a very convoluted and complex final system (e.g. a human brain that has been designed for 400,000 years), which is very hard to untangle like trying to read 400,000 year old legacy code. Davis then elaborates several different theories how humans evolved the capabilities they have now. These include: making incrementally better tools, developing better throwing techniques, adapting to changing climate, changing the diet, developing a psychology model or learning how to communicate . These theories suggest that our brain may not be legacy code but instead be a tool, which has been used for something different.

Inhuman problem solving: Davis discusses the different levels of animal intelligence (birds and primates), showing that there may be design space continuity from intelligence in birds to primates and humans. Further discussing the design space he argues that having a mental image of pictures can be considered as reliving an experience (e.g. thinking whether or not an elephant fits through a door). Arguing that visual reasoning maybe a crucial part of intelligence.

Discussion and implications

The paper gives a lot of clarification of the multiple avenues of the meaning and development of intelligence. For a practitioner of current AI techniques it is hard to apply this knowledge in practice, however it contains crucial information to push the field further towards Artificial General Intelligence.