Award Abstract #1023875

Causal Learning As Sampling

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ABSTRACT

In the course of development, children change their beliefs, moving from a less to more accurate picture of the world. How do they do this when there are apparently an infinite variety of beliefs from which to choose? And how can we reconcile children's cognitive progress with the apparent irrationality of many of their explanations and predictions? In computer science, probabilistic models have provided a powerful framework for characterizing beliefs, and can tell us when beliefs are justified by the evidence. But they face similar questions: how can one actually get from

less warranted beliefs to more accurate ones given a vast space of possibilities? This project brings these threads together, suggesting a possible solution to both challenges. The solution is based on the idea that children may form their beliefs by randomly sampling from a probability distribution of possible hypotheses, testing those sampled hypotheses, and then moving on to sample new possibilities. This "Sampling Hypothesis" provides a natural bridge between understanding how children actually do learn and reason and how computers can be designed to learn and reason optimally. These experiments will provide an important first step in exploring the Sampling Hypothesis: how do evidence and prior beliefs shape the samples of possible beliefs that children generate and evaluate, and how do developmental changes lead to differences in the samples of possible beliefs generated and evaluated.

A relatively immediate contribution of this work will be to connect state-of-the-art methods from machine learning and data analysis in computer science and statistics with accounts of belief acquisition in developmental psychology and educational psychology. In the longer run, the proposed projects have the potential to inform education, early intervention programs, and the study of cognitive deficits; by precisely characterizing how learning should proceed in typically developing children, this project can illustrate when and how developmental limitations impact learning and suggest a framework of ways of helping children with such disorders. The research also supports an ambitious training plan for post-doctoral and graduate student researchers, requiring the development of a nuanced understanding of both computational approaches and developmental experiments.

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