
Discussion about Causation and Correlation

Chenhao Zhou
Yuanpei College
Peking University
zhouch@stu.pku.edu.cn

Abstract

Causation and inductive inference have been linked in the philosophical literature since David Hume. The opinions on causation and causal discovery over the past two decades are having influence not only within philosophy, but also in computer science, statistics and cognition. Among those views, there are different understandings of the relationships between causation and correlation. So we may stand on both theoretical and practical perspective to rethink their relations. In this essay, we try to give a brief summary of causation and correlation based on the views in different domains, and finally focus on the cognitive AI's causality perception.

1 Introduction

Causality is the logical relationship between cause and effect, which humans get from the perception of environment. Causality was originally proposed to understand the scientific explanation in philosophy [1]. While talking about how to explain the multiple phenomenon perceived by our humans perceptual system, considering as the theory of explanation, an opinion suggest that "maybe we explain something when we identify what caused it".

Before using causality to understanding the explanation of phenomenon around us, we have to figure out its derivation and mechanisms, which would be crucial to interpreting the essence of causality. Apparently, considering correlation and causation's bind is an intuitive and empirical view, as we personally experienced such perception processes. Thus there has been a number of discussions about causation and correlation in different domains. And one of the representative views in philosophy is Hume's regularity theory. In Sec. 2 through Hume's perspective, we would discuss the relationships between correlation and causation in domains of philosophy, psychology, statistics and cognitive AI. In Sec. 3 we propose an idea about causality perception from temporal and spatial correlation, try to build an engine in cognitive artificial intelligence.

2 Think about Causation and Correlation's Relationships

2.1 Philosophy

We can notice the phenomenon combining causation and correlation: the height of the flagpole **causes** the length of the shadow, but not vice versa; disease causes symptoms, but not vice versa. From empirical perspective, Hume argued that causes occur temporally prior to their effects, and are either contiguous with them in space and time or else connected to them by a contiguous chain of causation. The view suggests we never actually see one event cause another, but simply see one event followed by another. Therefore the idea that causation as a sort of hidden connection between thing is wrong to Hume's perspective.

Further indicative view involving the causal explanation is explaining something is giving information about how it was caused. There are some events which we explain without saying what caused it: The big bang, which can be explained with quantum behavior, has no cause but explains. That opinion

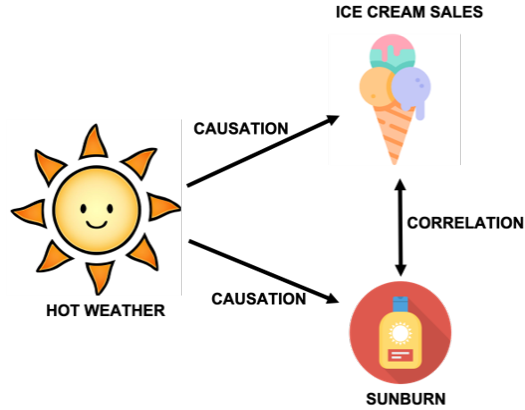


Figure 1: Typical case of causation and correlation

further suggests perception of correlative information may also enhance the ability of explanation in AI.

2.2 Psychology

Considering the causal perception in psychology, one of the most important and controversial questions queries its origin [3]: do we learn to see causality, or does this ability derive in part from innately specified aspects of our cognitive architecture? Newman et al. [2] explore causal perception in 7-month-old infants and demonstrate that even infants' visual systems process information in temporally extended chunks. Usually the instantaneous moment-by-moment construction is probably not our way for causal perception. The result indicates us giving temporally extending and spatially bounded information about events' correlation for causal perception in cognitive AI may be more efficient.

2.3 Statistics

Statistics define correlation as a statistical association between variables, and causation as a change in one variable causes a change in another variable, which equal to the cause-and-effect relationship between variables. But the co-variation isn't necessarily due to a direct or indirect causal link. Otherwise it may lead to some misconception, and the third variable problem and the directionality problem may occur. Statistics suggests respectively using correlational research and experimental designs to demonstrate correlational links between variables and test causation.

Spirtes et al. [4] showed that causal discovery converges to the truth under certain conditions. It is not accurate to say that given sample size one can infer how it is close to the truth. Causal links between variables can only be truly demonstrated with controlled experiments, in which cause-and-effect relationships can be demonstrated with reasonable confidence. Furthermore in cognitive AI, we think the test process can be transfer to the causal perception in AI.

3 Causal Perception from Correlation: with Self-Test Mechanism

Integrating all of the previous points, we propose a naive idea about building a causal perception module. The Hume's regularity theory provides the theoretical basis on perceiving causality from correlation. The scenarios containing single or multiple causality can be treated as the premise of the causality perception. The perspective in psychology suggests that we can use 4D scenarios data to give temporally extending and spatially bounded information about events' correlation. There are still problems about the noisy variable and directionality reverse accompanied by the process of parsing correlations into causality. To solve this problem, thus enhancing the explainability of causality perception, we suspect a self-test mechanism for cognitive AI. Based on the data combining multiple temporal and spatial correlations, AI could spontaneously design controlled experiments to test the previously perceived causation. A sketch of self-learning framework in causality perception can be generated through the mechanism.

4 Conclusion

The essay is mainly organized with Hume's perspective of causality perception, which is simply obtain the causation from correlation. While there are other different views such as "the ability of causality perception derives from innately intrinsic architecture". Although different philosophical views correspond to different perception paradigms, the self-test mechanism can be transferred between different process. Also we expect further discussion about causation and correlation.

References

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