

Philosophy term paper: Critically evaluating Hume's skepticism of causality

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1 Introduction

This short survey on the skepticism of causality is divided into roughly three parts: We begin by surveying Hume and his arguments on why we must be skeptical of causality. We then move on to see certain arguments against this thesis.

First, we consider Karl Popper's notion of falsification, and how the scientific method (as is broadly understood), truly allows us to gain access to scientific truths.

Secondly, we consider the Bayesians and the statistical method, who take Hume to heart and encode the notion of "habit" in terms of "probability". We examine the ramifications of taking this perspective to the extreme, and how we lose sight of the distinction between correlation and causation — precisely as anticipated by Hume.

Lastly, we rebutt the Bayesians by considering the bleeding edge science of causality, initiated by Judea Pearl, starting from the 1980's, which provides an alternative definition of causality in terms of *counterfactuals*. While this definition appears useless, we provide a short introduction for how this allows us to regain a reasonable notion of causality which can be mathematically dissected, thereby triumphing over the anarchy of Hume's definition.

2 Hume and Causal skepticism

David Hume (1711-1776) was a contemporary of John Locke and George Berkely. While all of them advocated using empiricism to arrive at knowledge, Hume was the only consistent empiricist among the three, who applied his empirical standards rigorously and unflinchingly. This allowed him to arrive at oftentimes counter-intuitive results, such as challenging the very existence of causation.

Since Aristotle, there was thought to be a difference between *belief* and *scientific opinion*. Scientific knowledge consisted of providing explanations in terms of necessary causes for an effect to manifest. As an example, smoke is

caused by fire, since for smoke to exist, there must *necessarily* exist fire that causes this smoke.

2.0.1 Convention and Causality

The crux of Hume's argument is that of convention. All that we suppose to be "causal", is in fact simply convention, that we as humans have gotten used to due our experience. He provides a famous example of billiard balls: When we see that the motion of one billiard ball follows another, we are only observing conjunction, not their connection. Indeed, his definition of "cause" is this:

A **cause** is an object, followed by another, where all the objects similar to the first are followed by objects similar to the second.

3 Karl Popper and falsification

These problems of causation and their relation to science were eventually resolved (in a sense) by Karl Popper(1902-1984), who gave an account of scientific knowledge in terms of a strictly empirical account driven by falsification, instead of one driven by induction. Roughly, his solution relates to the adage:

All models are wrong, some models are useful.

Where he views the entirety of science, and as an extension, our model of causality, as precisely that: a model. No knowledge that we possess, not even that of obvious causality, is certain. Knowledge is correct, insofar as it provides a useful model of the world. A model, or a notion of causation can be discarded as soon as it does not align with the reality. In this way, the notion of *falsifiability* takes center stage.

In short, Popper's theory can be summed up as:

- There is no correct way to perform induction, given access to any amount of experimental data. This agrees with Hume's skepticism.
- Our theories (including our notion of causality, which is governed by our theory), is just a conjecture. We must attempt to falsify these conjectures. If we are unable to falsify a conjecture, then we have greater faith in the conjecture. However, we can never truly establish a fact (such as causality). All we can do is to attach a *probability* to causality.

3.1 Bayesians and Hume

The bayesians were a school who took as fundamental Bayes' theorem, a general theorem about the structure of probabilities which describes how to *incorporate* experimental knowledge (observations) into our current knowledge of the world (the prior) to arrive at an updated knowledge of the world (the posterior). The famous formula is:

$$P(B) = \frac{P(B|A) \times P(A)}{P(A|B)}$$

Far too much ink has been spilled analyzing the above formula, so I will not repeat that here. The basic point is that this theory provides us with the *best possible way to update our beliefs*, if our beliefs about the nature of the universe are purely probabilistic.

Thus, bringing this back to Humian terms, bayesian theory allows us to decide *which conventions we should choose*, given raw experimental data.

However, this again loses a notion of causation, since we are again making probabilistic statements about the world. In theory, a causation would be represented as a *perfect correlation*. However, this has its own can of worms. A simple problem with this model is that we lose the **directionality** of cause and effect.

For example, we might have the readings on a thermometer, and the real temperature of that day. Using this data, we would create a formula $r = \alpha t + \beta$, where r is the reading of the thermometer, t is the real temperature, and α, β are constants. This gives us a model for the relationship between the thermometer reading and that of temperature, and indeed these two variables are perfectly correlated. However, crucially, there are *two* possible interpretations of the formula: one saying that the temperature governs the reading of the thermometer ($r = \alpha t + \beta$), and the other saying that the reading of the thermometer governs the temperature ($t = (r - \beta)/\alpha$). The structure of mathematical equations is such that both of these are entirely valid views.

What we really need is a new form of mathematics, that allows us to depict ($r \leftarrow \alpha t + \beta$) where the \leftarrow indicates that the r is determined by t and not the other way round.

This was believed for roughly a century since the birth of statistics to be impossible, by (fundamentally), an appeal to Popper and Hume: how, indeed, can we establish such a directionality, if all we have is the data at hand?

4 Judea Pearl, Causal models, and the do-calculus

Here enters the fascinating study initiated by Judea Pearl into what are now called *Causal Models*.

The insight is that one can provide a definition of causality, provided *counterfactuals* are available. One can *define* causality as follows. For the sentence:

The billiard ball A colliding with billiard ball B **caused** billiard ball B to move.

We assign the meaning of the word **caused** as the meaning of this equivalent sentence:

In all universes where the billiard ball A **not** collided with billiard ball B, the billiard ball B **would not move**.

This sentence does not seem to improve our state of affairs by much. It has managed to provide a definition of causality. However, this definition relies on universal quantification of an all universes, which is a tad unrealistic to test.

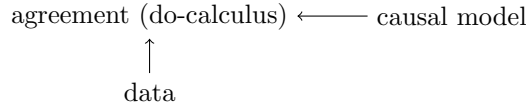
Note that this is a different notion of causality than that of Hume, in that it is verifiable, provided access to an infinite number of universes, and the ability to perform experiments.

Luckily for us, due to the structure of mathematics, *once we fix some causal model*, for example, (A collided with B \rightarrow B moved), we can test how well the *data* agrees with the model.

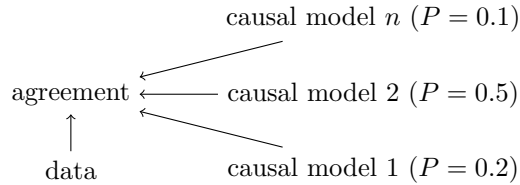
While as bayesians, we had: (data \longrightarrow correlations)

Note that there is no human-in-the-loop. From the data, we compute, plug and chug to arrive at correlations. To a statistician, this is all that we can say, and indeed, all that we need to say. Unfortunately, this is a disastrous position to hold. After all, as we all know, "correlation does not imply causation". We have yet been unable to escape the long shadow cast by Hume. "correlation" is simply a fancy mathematical encoding of "convention", is it not?

Now as users of do-calculus, we have:



Notice that we *explicitly* require a model to even begin applying do-calculus. However, the upshot is that we can now discuss how well our proposed model of reality agrees with the data that we have. Indeed, our process of "doing science" can be now viewed as:



The takeaway is that *relative to a model i*, we can judge how well this model captures the causality of the data!

This is *both subjective*, or bound by convention (in terms of the choice of model), but also objective *relative to a model*. Once we choose a model, we can check its "causal agreement" with the data.

5 Conclusion

I argue that do-calculus and our 21st century understanding of causality has settled Hume's arguments to a far greater degree than Hume believed was ever possible: under an intuitive definition of causality (counter-factuals), we can build an edifice of mathematical machinery which allows us to test models of

reality against data. While this choice of model is non-canonical, and this is where the human enters the loop, beyond this choice, we have objectivity.

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