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Commentary on: David Hitchcock's "Material consequences and counter-factuals"

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1. INTRODUCTION

David Hitchcock argues that a good argument is one where the corresponding material and counterfactual conditionals are such that their universal generalizations have no false substitution instances. Further, he proposes adopting Pearl's structure equation modelling (SEM) analysis of counterfactual conditionals vs. Lewis and Stalnaker's "closest world" approach, on the grounds that it is easier to determine the truth-value of counterfactuals using Pearl's approach. Although I tend to agree with Hitchcock's account of what a good deductive argument is, the account does not apply to non-deductive arguments, thereby lacking generality. In addition, Hitchcock's endorsement of Pearl's SEM semantics makes a lot of sense, though perhaps not for the reason that Hitchcock suggests. I shall argue that verifying counterfactuals is just as difficult if not more difficult using SEM semantics as for closest-world semantics. However, one advantage that SEM semantics has over closest-world semantics is that it is more general in the sense that it can be applied to non-recursive models. On the other hand, the distinction between "endogenous" vs. "exogenous" variables in structural equation modelling is not always so clear, which poses a real difficulty for the SEM approach. Finally, possible world semantics fares much better than SEM semantics with respect to evaluating counterfactual conditionals in mathematics and logic.

2. THERE ARE ARGUMENTS AND THEN THERE ARE ARGUMENTS

Although an account of implicitly deductive arguments, empirical or otherwise, in terms of covering generalizations is as good as any other, not all arguments are amenable to such an account. There are many non-deductive arguments that cannot be evaluated using the covering generalization approach. For example, if a group of researchers are conducting a study on the effectiveness of an experimental drug, their arguments will not be such that the conclusions of the study "follow" in any sense of "follow" from the premises. At best, all they can hope for is that a statistical analysis such as analysis of variance, chi-square, etc. will help make sense of their results. In no scientific paper that I have read, and I have read many as a biologist in training, is there a claim that the conclusions of the study follow from the data. Yet we wouldn't want to say that the researchers are bad arguers.

Mohammed, D., & Lewiński, M. (Eds.). *Virtues of Argumentation. Proceedings of the 10th International Conference of the Ontario Society for the Study of Argumentation (OSSA), 22-26 May 2013.* Windsor, ON: OSSA, pp. 1-4.

There is already an account of what constitutes a good non-deductive argument such as those that appear in scientific arguments, viz., inferential statistics. Or at least, this is the best we have to date. The call for a "logic of induction" is at this point in time best answered by the statistician and probability theorist. If I am a researcher who claims that drug X is better than the alternatives on the market, then instead of consulting a logic text on how to argue, I would consult a statistician, a statistics text, or a program such as SPSS.

3. SEM SEMANTICS IS NO CLOSER TO PROVIDING A RELATIVELY EASY MEANS OF EVALUATING COUNTERFACTUALS THAN CLOSEST WORLDS SEMANTICS

Hitchcock claims that Pearl's SEM semantics provides an easier method for evaluating counterfactuals than closest world semantics. Consider the counterfactual conditional discussed by Hitchcock, viz., "if Putin lived in the White House, then he would live in Washington." According to Hitchcock, this conditional is difficult to evaluate using Lewis' possible worlds semantics since if one thing changes, many other things will too. Then exactly how close will the world in which Putin lives in the White House be to the actual world? And in fact, suggests Hitchcock, there may be no closest world to the actual world where Putin lives in the White House, meaning that the conditional cited above is only vacuously true. Hitchcock's reservations regarding closest world semantics are spot on, but the situation with SEM is no better.

According to Pearl's SEM semantics for counterfactuals in terms of structural equations, to evaluate "if Putin lived in the White House, he would live in Washington" it would be necessary to change structural equations in the model. But how many would we have to change? In SEM causal models, endogenous variables may be related to any number of other variables, and causation may be bidirectional in non-recursive models, so that changing an equation relating two variables could have major effects on other equations, ad infinitum. Further, as Hitchcock acknowledges, there are many different causal paths leading to Putin's living in the White House. But he excludes such paths as Putin's having a relationship with Michelle Obama as being a remote possibility. This seems somewhat arbitrary, since as unlikely as it may be, this could happen and thus it can't be entirely discounted. Further, perhaps there was a major war, and Putin took over the United States. There are countless variables that need to be considered, and countless structural equations relating these variables that may need to be changed.

An additional practical difficulty with SEM semantics is that is it not always clear whether a variable is endogenous or exogenous. Presumably, an exogenous variable is such that it is not changed by the endogenous variables in the model. For example, if a farmer raises their crop production in a given season, this will not have a noticeable effect on the market price of the crop, so that price is treated as exogenous. On the other hand, if all the farmers in the province of Ontario were to increase their crop production, this may indeed influence the price of the crop. (http://academic.reed.edu/economics/course_pages/red_spots/endogenous_and_exogenous_v.htm) Similarly, if Russia went to war with the United States, and Russia

won, this may influence the location of the White House. In a Russian victory, the White House might be moved to Moscow.

On the good side, an SEM semantics for counterfactuals has the distinct advantage that it is more general than a Lewisian possible world semantics since it applies not only to recursive causal models, but to slightly more general kinds of causal models where equations have unique solutions and finally to non-recursive models where two endogenous variables may causally influence one another (Halpern, 2010). According to Halpern, this possibility was not even recognized by Pearl himself since he restricted himself to only recursive causal models (Halpern, 2010). If Hitchcock is to endorse an SEM semantics for counterfactuals, it should be on grounds of generality vs. ease of evaluation of counterfactuals.

4. MATHEMATICALLY SPEAKING

One serious limitation of an SEM semantics for counterfactual conditionals is that it does not straightforwardly apply to conditionals in mathematics. Consider Fermat's Last Theorem (http://en.wikipedia.org/wiki/Fermat's_Last_Theorem):

> No three positive integers x, y, z can satisfy the equation $x^n + y^n + z^n$ for any integer value of n greater than 2.

Now, consider the following counterfactual conditional: If x = 2, y = 4, z = 12, then the equation $x^n + y^n + z^n$ would have a solution for n = 3. It is not clear how one could demonstrate the falsity of this conditional using SEM semantics, since there are no structural equations causally relating endogenous variables. In fact, what would count as an endogenous or exogenous variable in this case? Are numbers causally related? However, Lewis' possible worlds semantics would provide us with a method of evaluating this counterfactual conditional. Consider the closest mathematically/logically possible world to the actual world where x = 2, y = 4, z = 12. In such a world, there would be no solution for $x^n + y^n + z^n$. Thus, the conditional cited above is false.

5. CONCLUSION

While I agree with Hitchcock's account of good arguers re: deductive arguments in terms of covering generalizations, the account does not apply to non-deductive arguments amenable to evaluation from the perspective of inferential statistics. Further, although his endorsement of SEM semantics for empirically-based counterfactual conditionals makes sense from the perspective of generality, a Lewisian closest-world semantics is the only way to go with respect to evaluating counterfactuals in mathematics.

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