Solving the problems of plurality of causes and of intermixture of effects in Mill's canons of induction

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Abstract. A novel solution to the problems of plurality of causes and of intermixture of effects in John Stuart Mill's canons of induction is proposed, which is based on two fundamental ideas. First, causal dependencies are defined in terms of causal relevance and irrelevance rather than in terms of necessary and sufficient conditions. Second, causal statements are relativized to dy-namically changing background conditions rather than a static causal field. The proposed solution improves on existing approaches in terms of both simplicity and adequacy for scientific practice.

Keywords: Mill's canons of induction · method of difference · INUS condition.

Mill's canons of induction (1843) remain one of the most influential inductive frameworks. Perhaps the crucial objection against these inductive methods is that they are not capable of dealing with certain widespread causal structures, in particular the *plurality of causes* and the *intermixture of effects*. Essentially, in a complex cause of the form $(A_1 \wedge A_2) \vee A_3$, the '$\vee A_3$'-part addresses the plurality of causes, while the '$\wedge A_2$'-part addresses the intermixture of effects. Mill believed that his inductive framework is mostly unable to deal with these issues.

The main attempts in the twentieth century to improve on Mill's canons of induction are due to Georg Henrik von Wright (1951), John Mackie (1980, appendix), and Brian Skyrms (2000, Ch. 5). These authors suggest a novel systematization of Mill's canons, which differs substantially from Mill's four (or five) methods. In particular, they attempt to solve the problems of plurality of causes and of intermixture of effects by delineating a range of methods tailored for specific types of causes. For example, Mackie proposes a two-dimensional system of different inductive methods, where the first number designates the allowed complexity of potential causes and the second number the type of method that is employed, e.g. method of difference or of agreement. However, the resulting systematization turns out to be rather complex. Furthermore, the approach does not align well with scientific practice. In particular, in typical experimental procedures, assumptions about the complexity of potential causes are rarely presupposed.

In the following, a solution to the mentioned problems is sketched which deviates in two crucial aspects. First, the proposed solution is based on causal relevance and causal irrelevance as fundamental concepts rather than on necessary and sufficient conditions. Second, causal statements are relativized to dynamically changing background conditions rather than a static causal field as in Mackie's approach.

Without being able to provide full detail in the limited space available here, essentially, 'causal relevance' of a condition A to a phenomenon C with respect to a given background B means: provided that the background conditions B are instantiated, then whenever A is present, C is present, and whenever A is absent, C is absent. Similarly, 'causal irrelevance' of a condition A to a phenomenon C with respect to a given background B means: provided that the background conditions B are instantiated, then C is always present, no matter if A is present or absent (for more precise formulations and a much more thorough analysis, see Pietsch 2022, Ch. 5).

The problem of *intermixture of effects* is tackled by defining: A is a 'causal factor' for a phenomenon C with respect to a background B, if and only if there exists an X such that A is causally relevant to C with respect to a background $B \wedge X$ and irrelevant to $\not C$ with respect to a background $B \wedge \not X$. For example, if a match and combustible material only in combination cause a fire, then the match is causally relevant to the fire with respect to a background, in which combustible material is present. By contrast, the match is causally irrelevant, when combustible material is absent, as the match alone cannot start the fire. Thus, the match is a causal factor for the fire according to the above definition.

The problem of *plurality of causes* is addressed by defining: A is an 'alternative cause' to C with respect to a background B, if and only if there exists an X such that A is causally relevant to C with respect to a background $B \wedge \not X$, but causally irrelevant to C with respect to a background $B \wedge X$. For example, if both lightning and an explosion are independent causes of a fire, then lightning is causally relevant to the fire as long as there is no explosion. By contrast, in the case of an explosion, lightning is causally irrelevant, since the explosion already causes the fire independent of the presence or absence of lightning. Thus, lightning is an alternative cause.

The above solution to the problems of plurality of causes and of intermixture of effects is simpler than the proposals by von Wright, Mackie and Skyrms. In particular, two fundamental methods suffice, one for determining causal relevance, the other for determining causal irrelevance. More complex causal dependencies can be defined based solely on these two fundamental methods. Furthermore, there is no need for any assumptions regarding the complexity of potential causes. Thus, the proposed solution more closely aligns with scientific practice, e.g. experimental procedures, but also machine learning methods (Pietsch 2021).

References

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