

# On how string diagrams unify underdeterministic and probabilistic causation

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Two kinds of causes have captured most of philosophical imagination: deterministic causes, which necessitate their effects, and probabilistic causes, which change the probability of their effects. However, it has recently turned out that there are non-deterministic causes, which, rather than changing the probability of their effects, change their effects' modal status. For instance, the meteor that killed dinosaurs is an underdeterministic (token) cause of our existence because big mammals, including humans, wouldn't have evolved if dinosaurs kept roaming the earth. As there seems to be no determinate probability of our evolving on an Earth free of dinosaurs, this causal relation cannot be analyzed in probabilistic terms. A new concept is needed, and indeed, a new concept has been provided (Wysocki 2023a, 2023b).

Here, I will introduce a framework that allows for modeling underdeterministic causation. However, instead of the standard framework of causal models (Wysocki 2023b), I will use the category-theoretical framework of string diagrams (Otsuka & Saigo 2023). Why this nonstandard tool? While string diagrams allow for modeling situations that violate the Causal Markov Condition (as shown by Otsuka in his presentation) and hence are more expressive than causal models, the main benefit of using string diagrams is that they can represent deterministic, underdeterministic, and probabilistic causation in a unified way. This framework captures the differences between these three causal species with a single requirement on the string-diagrammatic representation (specifically, a requirement on the columns of the matrices that the string-diagrammatic boxes are mapped onto). This fact shows, first, that the three types of causes are manifestations of a single causal concept; second, that string diagrams are superior to causal models in representing causation.

First, I will motivate the concept of underdeterministic causation, as it's still new to the literature: we need it whenever non-deterministic causal relations cannot, in principle or in practice, be described probabilistically. I then will introduce an interpretation of string diagrams that can model underdeterminism: specifically, a functor from string diagrams to the category representing variable values and conditional causal modalities. Finally, I will discuss how different concepts are represented with different types of matrices; I will also mention the prospects of representing situations where different causal relations—underdeterministic and probabilistic—occur.

The talk will be given in English.

Otsuka, J. and Saigo, H. (2023). Process theory of causality: a category-theoretic perspective. *Behaviormetrika*

Wysocki, T. (2023a). An event algebra for causal counterfactuals. *Philosophical Studies*. Forthcoming.

Wysocki, T. (2023b). The underdeterministic framework. *British Journal for Philosophy of Science*. Forthcoming.