Non-probabilistic Causation without Necessitation[*]

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Abstract

This article introduces the notion of the directedness of a process, which underlies event causation as well as the persistence of things. Using this notion it investigates ₅ what happens in typical cases of active event causation. Causes never necessitate their effects because even non-probabilistic causes can be counteracted.

Keywords: causation, directedness, tendency, process.

1 How could the universe carry on?

₁₀ (1.1) In philosophy, when working on a particular problem in the way we were taught to work on it, we sometimes should take a step back and ask what really is the question and start again from

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scratch. In this article I want to have a fresh look in this sense at causation. May I thus ask you to put aside the idea that the
₁₅ philosopher's task concerning causation is to analyse the concept of a cause and to explore what all cases that fall under the concept of a cause have in common. Instead, I want to describe some cases of causation. I want to describe that which makes them cases of causation and the mechanism of causation, the causal
₂₀ connection. It will turn out that that mechanism is a special case of something that exists not only in cases of causation. Roughly, the kind of causation that I shall investigate is positive event causation; thus I shall not consider agent causation and causation by omission, absence, or preventing. But let me begin not by
₂₅ asking what causation is but by trying to convince you of the existence of a certain phenomenon.

(1.2) Imagine a universe U which is like ours except that (for simplicity's sake) it contains just two rocks in space, slowly moving away from each other. At time t, the rocks have been moving
₃₀ for a while. What will be there a short time later, at t_2? How will the universe carry on after t?[1] How *could* the universe carry on after t? On what, if anything, does it depend how it will carry on?

(1.3) We know that many states of the universe are *possible*,
₃₅ because we know that they have occurred. Possible is, for example, the state of the universe in which ours was at a certain time in 1816 AD, including the Pleiades, a planet with bears, honey bees, and the Principality of Liechtenstein. Therefore it seems possible that U would be exactly like that after t. Pos-
₄₀ sible is also an empty universe, or at least a universe without any bodies. It would also be possible that there is no universe at

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[1]By 'after t' I mean, unless I indicate otherwise, 'in a period of time as short as you wish beginning at t'; by 'before t', or 'until t', I mean 'in a period of time as short as you wish ending at t'; by 'at t' I mean 'before or after t'.

all.

(1.4) But we all believe that not all possible universes are equally likely to succeed U after t. Unless God ceases to sustain the universe, or God or some ghost interferes, U after t would contain just two rocks. U is heading in one direction. It is directed towards a certain development, it has a certain direction or directedness, it has an inclination, bias, propensity, or tendency to carry on in a certain way. Previously I used the name 'tendency'[2] for this, but too many associate with this term something probabilistic, which is here inadequate because U's heading in a certain direction is not probabilistic. Therefore I now use the term 'directedness'. We have no term in ordinary language which refers exactly to this directedness, except, as I shall explain below, the term 'force' which in the Newtonian sense refers to one kind of directedness. Let us investigate this phenomenon which I call 'directedness' further.

2 Directedness

(2.1) How the whole universe will carry on after t depends on the state of the whole universe at t. But we can also refer to parts or aspects of the direction of the universe. For example, 'The universe at t is directed towards the two rocks at t_2 being at positions x and y'. This directedness is based on the position and the velocity of the rocks at t, while their temperature is not relevant for that direction, it is not a part of the basis. So we can refer to certain properties of the universe at t_2 towards which

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[2]I used the term 'tendency' in Wachter 2003 and 2009, ch. 5. Popper (1974, 1990)) used the term 'propensity', Mellor (1995) uses 'chance' for something similar to tendencies. Freddoso (1986) speaks of natural propensities, tendencies, inclinations, and necessities, but none of these concepts is equivalent to my concept of directedness. John Stuart Mill (1843, p. 3.10.5) used the term 'tendency'.

the universe is heading, and to the properties of the universe at t which make the universe heading in this direction.

(2.2) We can call that with which we specify a directedness ₇₀ and its basis a 'state of affairs'. I mean by *a state of affairs* an instance of some property or properties at some thing or at some position at a certain time or during a certain period of time. So we specify a state of affairs by specifying which property (or properties) at which thing (or things) or position at or during ₇₅ which time we mean. This can be done by a phrase of the form 'x's being y at t' or 'that x is y at t'. Alternatively, we can use the term 'event', because the differences between events and states of affairs that are sometimes considered are not relevant here. It also does not matter here whether we refer to the thing by, for ₈₀ example, 'the Statue of Liberty', by 'that portion of bronce', or by 'at position x'.

Also concrete, i. e. ontologically complete, things, such as stones, are states of affairs. They are states of affairs that include all properties of the thing.

₈₅ (2.3) We can refer to directedness in this way:

State of affairs A at time t_1 is the basis of a directedness D towards state of affairs B at t_2.

Instead of 'a directedness' we can say 'a direction' or 'a tendency'. We can use the phrases 'A is directed towards B' or 'A ₉₀ has a direction towards B'.

(2.4) The *basis* of the directedness is that because of which there is the directedness towards B. It is that which makes the universe inclined to develop towards y. It is that which has the direction.

₉₅ A is the minimal basis: it is the complete basis of the directedness and contains nothing else, nothing that is not relevant for the tendency. B is the complete event towards which the directedness is directed. More precisely, y together with events at t_2

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which have to occur if B occurs, constitutes the complete event
towards which the tendency is directed. So B is not just a separable part of the event towards which the directedness is directed. The directedness towards B is the smallest directedness (the one with the narrowest basis) which is directed towards B.

(2.5) Some details and distinctions. By saying that 'the world' (or 'the universe') at t_1, is directed towards y at t_2 I mean that, although perhaps not everything at t_1 is relevant for that directedness, there is a directedness towards y and there is no directedness that counteracts it. Taking together all directednesses that there are, there is a directedness towards y. In this case I also say that there is a *total directedness* towards y.

(2.6) When I speak of directedness I always mean *singular* directednesses, as opposed to general statements like 'Iron tends to expand when heated' or 'Bees tend to be aggressive before a thunder storm'. Presumably sometimes singular directednesses are at least parts of the truthmakers of statements like 'Iron tends to expand when heated', but such statements play no role in my theory.

(2.7) The directedness based on A at t_1 towards B at t_2 is also a directedness towards a certain state of affairs at a certain time between t_1 and t_2. For each time between t_1 and t_2 there is a state of affairs towards which A is directed. That is, a directedness is about the world's carrying on after a certain time in a certain way, and that way can be specified by describing a state of affairs at some later time which would occur if nothing intervened before then. I individuate directedness so that directednesses towards different states of affairs (at different times) count as 'the same directedness' if they are based on the same state of affairs at the same time, because then they point in the same direction.

(2.8) By saying that the directedness based on A at t_1 towards B at t_2 was *realized* I mean that things carried on according to the

directedness so that B occurred. Further, I say in that case that B was the *result* of the directedness, that the directedness *led to* B, and, in short, 'A led to B'. By saying that the directedness based on A at t_1 towards C at t_3 was realized until B at t_2 I mean
that things carried on in accordance with the directedness until t_2 when it had led to B. In this case the tendency was *partially realized*, or *realized until t_2*.

(2.9) There can be two directednesses at a time whose realizations are incompatible. There can be at t_1 a directedness based on A towards B at t_2, as well as a directedness based on P towards Q at t_2 where B and Q are incompatible. The states of affairs meant by 'P' and 'Q', e. g. the apple's being at position r and the stone's being at position r, cannot both come to be realized. In that case, either one of the two directednesses overrides the other one, so that one is realized and the other one not, or both directednesses together constitute a third one, a *resulting directedness*. We can call this *superposition*.

(2.10) For two conflicting directednesses there is an earliest time at which the states of affairs towards which they are directed are incompatible. That is the point at which the processes following the directednesses form an *intersection*. So that two processes, following directednesses S and T, form an intersection at t is to say that S and T both are towards states of affairs that begin at t and are incompatible, and that all states of affairs earlier than t towards which S and T point are compatible.

(2.11) If something impedes the realization of a directedness from the beginning then it remains entirely un-realized. The pen on the desk is directed towards moving downwards, but it does not move at all. Thus there are many directednesses that are entirely unrealized.

(2.12) A resulting directedness is a special case of what I call a 'complex directedness'. A complex directedness D is one whose

basis has parts that are bases of directednesses that constitute
D. A resulting directedness is a complex directedness that has
165 constituent directednesses that are conflicting. There are also
complex directedness that are not resulting directednesses.

(2.13) If the directedness based on A at t_1 towards B at t_2 is
realized, then there is what I call a *direct process* leading from
A to B, with A and B being stages of the process. A process is
170 a series of states of affairs: for each time between the beginning
and the end of the process there is a state of affairs that is a
stage of the process and the series, i. e. a state of affairs that
includes everything that belongs to the process and the series at
that time. *A direct process is a series of states of affairs each*
175 *stage of which is the result of a directedness that is based on an*
earlier stage. Each stage of it is the basis of a directedness the
result of which every later stage is. Each stage is the basis of a
directedness towards the later stages, and each stage before it is
the basis of a directedness towards it.

180 (2.14) An *indirect process* is a process a stage of which has a
part that is not the result of a directedness based on an earlier
stage. So it is a series of states of affairs each stage of which, or a
part of the stage, is the result of a directedness that is based on an
earlier stage. By a part of a state of affairs I understand a state
185 of affairs that, together with other states of affairs, constitutes
it. Each stage of an indirect process (except one with which the
process ends) is the basis of a directedness towards a later one
or towards a part of it, and for each stage (except for one with
which the process begins) there is an earlier one that is the basis
190 of a directedness towards it or towards a part of it. Consider,
for example, a billiard ball rolling between t_1 and t_3 which you
deflect from its straight line with your finger at t_2. There is an
indirect process between t_1 and t_3 whose stage at t_1 involves only
the ball and parts of the table. The process is indirect because

its stage at t_2 has a part that involves your finger and that is therefore not the result of a directedness based on the stage at t_1. About two states of affairs which are elements, or parts thereof, of the same process I say that they are *connected* (directly or indirectly) through a process.

(2.15) An indirect process can sometimes be re-described in terms of a direct process, by taking in more states of affairs as parts of the initial stage of the process. Assume A_1 and A_2 are states of affairs at t_1, B_1 and B_2 are states of affairs at t_2, and C_1 is a state of affairs at t_3. A_1 is the basis of a directedness towards B_1; B_1 and B_2 together are the basis of a directedness towards C_1; A_1 and A_2 together are the basis of a directedness towards B_1 and B_2. In that case there is an indirect process with A_1, B_1, and C_1 as stages; and there is a direct process with A_1 plus A_2, B_1 plus B_2, and C_1 as stages.

(2.16) When a directedness is being realized until some event occurs which is incompatible with an event towards which the directedness was directed, then I say that the directedness, or the process, was *interrupted* or *interfered with*, or that something *intervened*. An intervention may occur because of a conflicting directedness, but also because a poltergeist, or whatever agents you believe in makes it occur.

(2.17) There might exist directednesses of different strengths. A directedness can be unambiguous (or 'non-probabilistic') or probabilistic. I understand by an *unambiguous* (or 'non-probabilistic') directedness a directedness for which it is impossible that nothing interferes with it but nevertheless it is not realized. That is, an unambiguous directedness is one that necessarily will be realized if nothing interferes with it. The only possibility how it may fail to be realized is that something interferes (or God ceases to sustain the things involved). An 'probabilistic' directedness is one for which it is possible that it is not realized even

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though nothing interferes with it. So for a probabilistic directedness it is possible that it is not realized without there being any intervention; it can fail to be realized just by chance. Instead of ‘unambiguous’ one could use the term ‘deterministic’, but philosophers usually use this term in the sense of ‘necessitating’ (see § 6).

(2.18) An unambiguous directedness can be said to have strength 1. The strength of probabilistic directednesses can be described with numbers between 0 and 1. However, an unambiguous directedness is only realized if nothing intervenes, and the strength of a probabilistic directedness corresponds to the *probability of outcomes only in situations where nothing intervenes.* This has to be taken into account if mathematical probability theory is applied to directedness.[3]

(2.19) A process during a certain period of time is an *unambiguous process* if and only if all directednesses that govern it (i. e. the directednesses leading from one stage of the process to another) are unambiguous directednesses. A process during a certain period of time is a *probabilistic process* if and only if some of the directednesses that govern it are probabilistic.

(2.20) One might object that one cannot understand what a directedness is or that directednesses are mysterious or that we know nothing about them. It is true that the concept of a directedness is not an ordinary concept. Introducing it requires an explanation such as the one I have given. Fortunately there is a kind of directedness about which we know quite much: Newto-

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[3]Tendencies differ here from Popper's ‘propensities’ (Popper 1959, 1974). Popper describes the strength of a propensity with a number between 0 and 1 which describes the relative frequency of how often the propensity is realized. I object that this is inadequate because of the possibility of intervention. The strength of a directedness only corresponds to the limiting relative frequency among cases where nothing intervenes.

nian forces.[4] That there is a certain force acting upon a body means that there is a directedness towards that body being at ₂₅₅ certain positions at certain later times. If the directedness is realized, then the object actually moves according to the directedness. But the directedness may remain unrealized, for example because of other forces acting upon the object. So forces are a kind of directedness. They can be represented by vectors. They are ₂₆₀ directednesses that concern the position of an object. Other directednesses concern other changes (or non-changes) than changes of position.

3 Causation

(3.1) In certain cases of directedness it is true to say that x ₂₆₅ caused y (if we stretch the ordinary concept of a cause a bit, as I shall explain in § 4):

A was a cause of B if A was, or was a part of, a state of affairs which was the basis of a directedness towards B, and the directedness was realized. In short, A was a cause of B if ₂₇₀ *A led to B.*

We can call this a 'theory of causation' or an 'analysis of causation', but it is not an analysis or definition of the *concept* of a 'cause'.

Two examples of such cases of causation: 'Billiard ball A's ₂₇₅ rolling at t_1 caused it's rolling at t_2'; 'the earthquake was a cause of the tsunami'. Thus the mechanism of these cases of causation is the realization of a directedness. An unrealized directedness is not a case of causation. So causation of this kind is a special case of directedness. Causation of this kind is in one sense not funda-

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[4]Massin (2009, § 1.3) gives an argument for the reality of Newtonian forces. Wilson (2007) refutes objections against the existence of Newtonian forces.

mental. One might say that causation is therefore in some sense reducible, if one wants to use the term 'reducible' for something other than conceptual reducibility.

(3.2) Some details and distinctions. A state of affairs A at t_1 was a *complete direct cause* (*indirect cause* respectively) of a state of affairs B at t_2 if A was an element of a direct process (*indirect process* respectively) of which B was a later element. State of affairs A was a *complete* cause of state of affairs B if A was the complete basis of a directedness towards B, and the directedness was realized. It was a partial cause if it was only a part of the basis. Speaking loosely one can also call a directedness that led to B a 'cause of B'. Sometimes it is easier to identify a directedness rather than its basis because it is difficult to know which state of affairs exactly is the basis of the directedness.

(3.3) I only call *particular* states of affairs causes. In ordinary discourse as well as in science we sometimes say things like 'Smoking causes cancer'. Such generalisations have to be distinguished from claims about what a particular event was caused by. John's cancer was not caused by smoking in general, it was (partially) caused by his smoking. Presumably 'Smoking causes cancer' is true if some people's smoking causes them to have cancer. However, I am concerned only with singular causation, i.e. causation between particular states of affairs.

(3.4) A is an *unambiguous cause* of B if and only if A is a cause of B, and A and B are connected through an unambiguous process. I call A a *probabilistic cause* of B if and only if A is cause of B and A and B are connected through a probabilistic process.

(3.5) An *uncaused event* is an event that occurs not as the result of a directedness nor as the result of the free choice of an agent. Presumably an uncaused event cannot occur where it would conflict with a directedness. It can occur only in an area of

reality where there are no directednesses. So where an uncaused event U occurs there was no directedness towards U nor towards an event which is incompatible with U. There may well be no uncaused events, but we can make sense of the idea.

(3.6) According to the directedness theory, directednesses are in a certain sense ontologically more fundamental than causation. Directedness is that which is at work in every case of active event causation. The realization of directednesses is the mechanism through which an effect is brought about by its cause. But not every directedness is a case of causation; not every directedness can make a causal claim true. If A is the basis an unambiguous directedness towards B but something prevents B from occurring, then A is not a cause of B. There are directednesses that are not realized, not even partially. The term 'cause' applies only to directednesses that are realized. It is what we may call a *success term.* When we say 'A caused B', part of what we claim is that A and B occurred. 'Cause' is a success term because it refers to a certain phenomenon and singles out only some cases where the phenomenon occurs, cases where there is success of a certain kind.[5] According to the directedness theory, this phenomenon that underlies event causation is directedness.

(3.7) According to the directedness theory two events are causally related if they are different stages of the same process. And a process is not to be defined as a series of events that are connected through causal relations – it is not defined as a 'causal chain'

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[5]In the same sense it is sometimes said that 'perceive' is a success term. Someone who says 'John perceived that p' implies that p. But Peter may be in a mental state exactly similar to John's although p is false. We may say then that Peter and John have the same 'perceptual experience'. 'Perceive' is a success term because it refers to perceptual experiences and singles out only some cases of them, namely cases where things are as represented in the perceptual experience and where the object of the perception caused the experience.

– but in terms of directedness. One can in this sense say that processes are more basic than causal relations. The label 'process causation' would therefore be a good substitute for 'event causation' (as opposed to agent causation). There cannot be causally related events that are not connected through a process. Directednesses are about how things carry on. Where a directedness is realized there is a process. A stage of a process, then, can be called a cause of a later stage. For it to be true that A caused B things must have carried on after A in a certain way, following the directedness of which A was the basis. So I agree with John Venn who said in 1866: 'Substitute for the time honoured "chain of causation", so often introduced into discussions upon this subject, the phrase a "rope of causation", and see what a very different aspect the question will wear.'[6]

4 Not a definition of 'cause'

(4.1) However, my statement about causation is not a definition of the term 'cause' and not a theory of the concept of a cause because I am not trying to capture all cases of causation (i.e. all cases to which the word 'cause' applies) and only cases of causation according to ordinary language. It is a description of certain cases of causation: active, positive process (event) causation. My account does *not* apply to the following cases of true causal statements:

- Negative causation (causation by absence), e.g. 'The boiler exploded because there was no safety valve.'

- Causation by omission, e.g. 'Churchill's house burned down because he had not turned off the stove.'

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[6] John Venn, *The Logic of Chance* (London, 1866), 320, quoted in (Salmon 1980, p. 171).

- Agent causation, e. g. 'Churchill raised the glass.'

365 - Reasons, e. g. 'He took the umbrella because the weather forecast had predicted rain.'

- A matter a debate would be 'She killed him out of jealousy', 'She was the cause of his sadness.', and 'The eagle built a nest in order to brood.'

370 (4.2) On the other hand the directedness (or tendency) theory calls some cases causation which ordinary language tends not to call causation. While the directedness theory entails that one temporal stage of a thing is a cause of its later stages, in ordinary language we do not always say that. We would not usually 375 say that 'Stone A at t_1 was the cause of Stone A at t_2'. Rather, in ordinary language we call only changes and triggering causes, such as the spark that caused the explosion, 'the cause' of the event in question. But I suggest that for the purpose of philosophical research to stretch the meaning of 'cause'by calling a 380 stage of a thing the cause of its later stages because there is the same mechanism as in typical cases of causation. The only difference to the ordinary cases of causation is that the cause is more or less similar to the effect.[7]

(4.3) Further, in ordinary language we tend not to call an event 385 A that is connected to a later event B by a probabilistic process a 'cause' of B,[8] whereas the directedness theory does call A a

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[7]The Polish philosopher Roman Ingarden expressed most clearly the alternative view. He held that a thing's carrying on in time consists in something's persisting identically in time and that one phase of a thing is not causally connected to the earlier phases. (Ingarden 1974, p. 74) Further, Ingarden held that a cause is simultaneous with its effect and that only the last factor that makes a sufficient condition of event y complete is the cause of y. (53) So he called only triggering causes 'cause', explained all temporal progress in terms of identity, and held that a phase of a thing is not caused by its earlier phases.

[8]Lowe 2013, p. 159 for that reason says that in cases of chance, such as

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'probabilistic cause' of B. My reason for doing so is that there is the same mechanism as in ordinary cases of process causation, the only difference is that in the one case the directedness is
390 unambiguous while in the other case it is probabilistic.

(4.4) Having said that my statement about causation is not a *definition* of the concept of a cause, in my view it is still adequate to call it an 'analysis' or 'theory' of event causation.[9] Although philosophers need to pay attention to how certain words
395 are used and often need to specify what they mean by a certain term, providing definitions that really capture how the words are used in ordinary language is the task of linguists. How we use words like, for example, 'cause', 'know', 'reason', 'faith', or 'miracle' in different cases cannot be captured by a formula of
400 the standard form of a definition that philosophers use. Besides that, the boundaries of the set of cases to which we apply a certain term are often vague, and different people use terms differently.[10] If the philosopher's task concerning causation is not to provide a definition but to *describe* certain cases of causation,
405 then it is adequate to call such a description a 'theory of causation'. Such a theory of causation is not to be tested by looking for counter-examples which show that the term 'cause' usually is used differently than the definition has it, but by looking at that to which the term 'cause' refers in certain cases. Back to
410 things in themselves! Philosophy is not about concepts. How-

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radioactive decay, 'there is no causation at all'.

[9]Others have offered 'theories of causation' that are not theories of the concept of a cause: Armstrong 1997, ch. 14 argued that causation is a non-supervenient second-order relation holding between first-order states of affairs, Mumford and Anjum 2011, p. 11 offer 'a theory of causation in terms of real dispositions or powers'.

[10]Cartwright 2004, p. 805 points out that 'there is a great variety of different kinds of causes and that even causes of the same kind can operate in different ways' and: 'The term 'cause' is highly unspecific. It commits us to nothing about the kind of causality involved nor about how the causes operate.'

ever, what matters for this article is just that I am not claiming that my description of process causation in terms of directedness is not designed to be a definition of the term 'cause', and that one cannot understand what directedness is just by investigating ₄₁₅ our concepts, but only by thinking about things in themselves.

5 Laws of Nature

(5.1) The directedness theory of causation also gives us a theory of causal laws of nature (as explained in more detail in Wachter 2009, ch. 6 and Wachter 2015). Causal laws of nature say ₄₂₀ what directednesses there are in what kinds of situations. The law of gravity, for example, tells us that there is a certain force when two things having certain masses are at a certain distance from each other. There is a debate what laws involve besides regularities, but there is a wide agreement that they do involve ₄₂₅ regularities of succession, i.e. that they say what kind of event is *always* followed by what kind of event.[11] They say something of the form 'All Fs are G' or 'All Fs are followed by Gs'. But this is not true, because what actually happens depends on what other factors there are in the situation. All sorts of things may ₄₃₀ intervene and counteract, e.g. other forces or ghosts. This could only excluded by saying 'All Fs are followed by Gs if nothing prevents G from happening'. But this conditional regularity does not include many cases to which the law applies. John Stuart Mill wrote therefore in 1843 rightly:

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[11]For example David Armstrong, although he strongly rejects the regularity theory of laws, assumes in his book *What is a Law of Nature?* (1983, p. 77) that laws have the form 'It is a law that Fs are Gs'. However, later in the book he considers the possibility of 'oaken' laws. If N(F,G) is an oaken law, then it does not entail that all Fs are G, but only that 'all uninterfered with Fs' (149) are G.

All laws of causation, in consequence of their liability
to be counteracted, require to be stated in words af-
firmative of tendencies only, and not of actual results.
(Mill 1843, 3.10.5, p. 319)

6 Causes are not sufficient for their effects

(6.1) I do not call an unambiguous cause 'deterministic' be-
cause, due to the what philosophers usually mean by 'determin-
istic', that would make the reader think of an event that neces-
sitates its effect, and there are no such causes. Likewise, I do not
call an unambiguous process 'deterministic' because that would
make the reader think of a process that cannot be stopped, and
there are no such processes. Every process can be stopped by
something which intervenes.

(6.2) Because a directedness can be prevented from realization,
causes do not necessitate their effects, causes are not 'sufficient'
for their effects. Many authors hold that an unambiguous cause
taken together with the 'circumstances' and the laws of nature is
'sufficient' for its effect. By this they mean not that the cause is
complete or strong enough[12] to cause the effect, but they mean
that the cause 'necessitates' the effect.[13] But that is false. If one

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[12]Christian August Crusius (1744, p. 9) pointed out against Leibniz that
the ordinary meaning of 'sufficient' is not 'necessitating' but being 'enough'
or being 'strong enough' and that he should call his 'principle of sufficient
reason' (which Crusius rejected) instead 'the principle of determining reason'.
Already Hobbes had failed to distinguish these two meanings. His argument
for determinism in his 'Elements of Philosophy' (Hobbes 1655, p. 2.9.5) is
based on this confusion: he derived from the claim that every event had a
sufficient cause in the sense of one that is strong enough and complete the
claim that every event has a sufficient cause in the sense of being necessitated
by a preceding event.

[13]Mellor, for example, holds that there are causes which are in this sense
'sufficient' for their effects. He writes: 'By causes that determine their effects

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billiard ball rolls at time t_1 towards another one, then it will hit the other one at t_2 unless something intervenes, but *it is possible* that something intervenes between t_1 and t_2. Other billiard balls, cats, ghosts, or who knows what may intervene. If A at t_1 was the complete cause of B at t_2, then it could have happened that A occurs and B fails to occur; that is, the occurrence of A does not exclude the non-occurrence of B. B 'could have' failed to occur not just in the sense of logical possibility but also in any ordinary sense of 'could have'. 'A caused B' entails that A and B occurred, but this does not mean that a cause necessitates its effect.

(6.3) Even keeping the laws fixed does not help: B could have failed to occur even though A occurred and the laws never changed. What is impossible is that B does not occur even though A occurs, the laws do not change, and nothing intervenes. Whether something intervenes depends on whether there are things that can and do intervene, for example non-living things, animals, ghosts, gods, etc. That nothing intervenes is not a fact about the nature of the cause, and therefore it is in no sense true to say about a cause that it is sufficient (in the sense of necessitating) for its effect.

(6.4) The idea that a cause necessitates its effect if the laws remain constant might have arisen from the Humean idea that laws of nature are, or at least entail, regularities of succession. But laws of physics do not entail regularities of succession. Probably there are no regularities of succession of the type 'All events of type x are followed by events of type y', because if an event

I shall mean ones that are in the circumstances both sufficient and necessary for them.' (Mellor 1995, p. 133) Similarly Hausman 1998, p. 33. Cf. also Swinburne 1994, p. 52, Bigelow and Pargetter 1990, p. 290 and Handfield 2009, p. 4. Schrenk (2010) argues that the modality in causation cannot be Kripke-style a posteriori modality. Mumford and Anjum (2011, ch. 3) and Wachter (2012) argue that there is no necessity in causation.

of type x occurs and there are a few x-events, probably x-event will not be followed by a y-event because something prevents the y-event.[14] The possibility of an intervention does not require a change in any laws of nature. It happens all the time that processes are stopped. No law of motion changes if a rolling billiard ball is stopped by another ball or by a cat or by an angel.

(6.5) Packing more circumstances into 'A' does not help the believer in causal sufficiency: the world could have gone exactly as it did until any time after t_1 and before t_2, and still B could have failed to occur because something intervened before or at t_2. It is true that it is impossible that B fails to occur if A occurs, all relevant states of affairs at the time of A obtain, 'and nothing intervenes'. But as 'nothing's intervening' cannot reasonably be taken to be an event that can be included in the 'complete cause', this truth is not adequately expressed by saying that 'the complete cause necessitates its effect'. 'Nothing's intervening' cannot reasonably be included in the 'complete cause' for two reasons. First because 'nothing intervenes' is not a state of affairs but only a phrase saying that something does *not* happen. Secondly, because 'nothing's intervening' does not take place at the time of the cause but refers also to the time after A until B. So on any reasonable interpretation the statement 'the cause necessitates its effect' is false because of the possibility of something intervening after A. We should stop saying that causes are sufficient for (or 'necessitate') their effects.[15]

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[14]For a longer defense of the claim that laws do not entail regularities of succession, see Wachter 2019, Wachter 2009, ch. 6.1. and Wachter 2015.

[15]Let me state the differences betweeen my directedness theory and the contemporary approaches to causation that are closest to it. Alfred Freddoso's theory of 'natural necessity' (Freddoso 1986) has much in common with my theory. However, one difference is that he says of the world that it has a certain tendency but not of events or states of affairs (p. 225). Another difference is that he thinks that a deterministic tendency can only be impeded

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by 'free causes' (p. 225), not by other processes. A third difference is that he says of an event that occurred as the result of a deterministic directedness that it occurred 'by natural necessity'. I reject the view that a cause necessitates its effect. Karl Popper, in his *A World of Propensities* (1990), proposes to understand causation in terms of propensities. Causation, for him, is 'just a special case of propensity: the case of a propensity equal to 1, a *determining* demand, or force, for realization' (p. 22). For Hugh Mellor (1995) a cause raises the 'chance' of the effect. Both Popper and Mellor assume that a propensity of the strongest sort, one with strength 1, entails or necessitates the effect; it cannot fail to be realized. 'The existence of the cause ensures [...] that its effects also exist.' (Mellor 1995, p. 13). I have argued that there are no such propensities and no such causes. Every causal process can be stopped if there is something strong enough to stop it. This I object also to Richard Swinburne's (1994, ch. 3) theory, which is (like Harré and Madden 1975) based on powers of substances. He understands 'by a full cause one whose active causal operation is sufficient for the production of the effect' (p. 52). Mumford and Anjum 2011 and Bird 2010 have argued that causation is the manifestation of powers. One difference between these power theories and my theory is that powers are borne or had by substances whereas directions are based on states of affairs. Onother difference is that on my theory a thing's persisting in time is a matter of a direction being realized.

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