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Determinism

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Without Abstract

Definition

Determinism is the metaphysical doctrine that the whole of world history is uniquely fixed by laws of nature and initial conditions. In science, "deterministic" is an epithet of theories or of laws that describe the temporal behavior of physical systems as strictly regular.

Description of the Theory

What is Determinism?

To a first approximation, determinism is the claim "that there is at any instant exactly one physically possible future" ([*1*] p 3). As such, determinism is a metaphysical doctrine about the course of the world as a whole, rather than a scientific theory. The French mathematician P. S. Laplace famously and vividly formulated metaphysical determinism in the early nineteenth century:

"An intelligence that, at a given instant, could comprehend all the forces by which nature is animated and the respective situation of the beings that make it up, if moreover it were vast enough to submit these data to analysis, would encompass in the same formula the movements of the greatest bodies of the universe and those of the lightest atoms. For such an intelligence nothing would be uncertain and the future, like the past, would be open to its eyes." ([*2*] p 2).

In his appeal to a superhuman intelligence, later called *the Laplacean demon*, Laplace merged the idea that the future is definitely fixed with the idea that it can be predicted. Predictability, even predictability in principle, is an *epistemic* notion, which relates to the question what can be known, not to the question what is the case. It is advisable to disentangle the metaphysical claim of Laplacean determinism from the idea of predictability, because the latter poses additional problems. For example, the superhuman intelligence must not obtain his knowledge about the present state of the universe in the normal way. In the actual world, any detection of information involves the consumption of energy and thus would alter the physical data supposedly available to the demon. If the doctrine of determinism is not disentangled from predictability, then it can easily shown to be untenable, as Popper did for what he called "scientific determinism" [*3*].

The Laplacean idea that the course of the world is fixed once and for all can be reformulated in the jargon of possible worlds. Following Montague, determinism has been defined as the doctrine that two possible worlds which instantiate the same laws are alike throughout all of time or never, “The world W is *Laplacean deterministic* just in case for any (possible world W′ which satisfies the natural laws obtaining in the actual world), if W and W′ agree at any time, then they agree for all times” ([*4*] p 13; cf [*5*]).

Laplacean determinism makes a *modal* claim, i.e., a claim about what *must* be the case, not simply a claim about what will in fact be the case. In this respect, it differs from so-called *logical determinism*, as encapsulated in the formula “Que sera, sera.” Being a tautology, this dictum does not say what is *bound to* happen, as a matter of physical necessity. By contrast, Laplacean determinism does comprise an inevitability claim. It is taken to express a causal, physical or metaphysical kind of necessity, not a logical one. As to the question where its modal force stems from, there remains just one serious candidate. While *theological determinism*, i.e., the doctrine of divine predestination draws its modal force from God’s intentions or commands, scientifically minded Laplacean determinism takes it from the laws of nature. If determinism is true, it owes its truth to the existence of certain laws that “govern” everything. Given this bond between determinism and lawfulness, some philosophers apply the epithet “deterministic” primarily to some sets of laws and only derivatively to the course of the world. The following definition, which echoes Earman’s quoted above, reflects this idea: “A *deterministic* system of laws is one such that, whenever two possible worlds both obey the laws perfectly, then […] they are alike always or never” ([*6*] p 37). The connection between the world related and the laws related formulations of determinism is provided by the deductive-nomological account, according to which deterministic laws, taken together with complete antecedent conditions, *logically entail* a description of the total state of the world at any other time.

Laplacean determinism is sometimes called *causal* determinism. While this locution helps to distinguish the doctrine from logical and from theological determinism, it is infelicitous in that it takes for granted a contentious conception of causality. Some authors simply equate determinism with the principle of universal causation, i.e. with the thesis that every event has a cause. This equation rests on the preconception that causality is a deterministic relation. But since nondeterministic accounts of causation have been developed, such an identification is unadvisable. Laplace himself chose a causal formulation when he suggested “consider[ing] the present state of the universe as the effect of its previous state and as the cause of that which is to follow” ([*2*] p 2). This view assumes an unusual conception of causal relata, according to which causal relations do not hold between ordinary events, but only between total states of the universe.

While determinism, in making a stronger claim about lawfulness, should not be identified with the principle that every event has a cause, it does exclude uncaused events, miracles and interventions by immaterial soul substances. Thus determinism is intimately linked with the principle of the causal closure of the physical domain (see also completeness of the physical domain). This association is due to the demand that one set of laws describe happenings completely and uniquely. If a miracle is defined as a violation of the laws of nature (Hume), it follows immediately that determinism rules out miracles. Whether determinism rules out *mental causation* is more difficult to decide. Accounts of mental causation that do not contest the claim that one set of physical laws fixes the course of events uniquely, e.g., supervenience theories of the mental, should be compatible with determinism.

Determinism is closely linked with the physicalistic assumption that whatever happens must supervene on the lawful behavior of microphysical entities. While the principle of the nomological primacy of the microlevel as it may be dubbed, is arguably not part of the *meaning* of "determinism," it is hard to see how it could work the other way round, i.e., how higher level laws could uniquely fix the behavior of microphysical entities. Note, however, that microphysical laws do not *causally determine* the behavior of the systems they describe. Laws are abstract entities; they do not make anything happen. Causal determination is a relation in time, which holds between events or states that follow each other. To say that laws "govern" events is already metaphorical.

Hard determinism and *soft determinism* are not further variants of determinism, but views about the compatibility issue in the free will debate. Soft determinism holds that determinism and free will are compatible. Hard determinism denies it. It is widely agreed that no kind of determinism is compatible with one core element of a "strong" conception of freedom, the principle of alternative possibilities, according to which the agent could have acted otherwise under the same circumstances.

Is Determinism True?

Is determinism a scientific or a metaphysical theory? The issue hinges on the kind of evidence available. The natural assumption is that any scientific evidence for Laplacean determinism must come from physics, the most fundamental science. Now the determinism problem is by no means a dead issue in the philosophy of physics. In recent years, long established assumptions have been called into question. It is no longer uncontroversial that classical mechanics is a deterministic theory, nor that quantum mechanics is indeterministic [*4*,*8*]. Since Newtonian mechanics knows no upper bound on the velocities of moving particles, it does not rule out objects which "escape to infinity" nor the inverse phenomenon of "space invaders." The latter at least violate determinism. Moreover, Newtonian mechanics does not yield empirically correct solutions for a number of collision phenomena. As for quantum theory, its orthodox interpretation is indeterministic, but in recent years, deterministic interpretations have been developed which also seem to be consistent.

How could physics prove or disprove Laplacean determinism? The main obstacle to a scientific test is the global character of the doctrine. Laplacean determinism says something about the course of the world as a whole. Now take the laws related formulation that a deterministic system of laws is one such that whenever two possible worlds both obey these laws, they coincide throughout all of time or never. The question whether determinism is true then seems to boil down to the question whether the fundamental laws of physics or the theories of which they form part are deterministic in character or not. A law of physics is deterministic if it is strict, i.e., if it admits no exceptions, is not probabilistic and does not contain open ended *ceteris paribus* clauses. Given that the book of nature is written in mathematicalese, as Galileo proclaimed, a physical law's being deterministic is a mathematical property of certain sets of equations (roughly, the property of having a unique solution for future times). In quantum mechanics, for example, the Schrödinger equation, which describes the evolution of the wave function, is taken to express a deterministic law. However, the deterministic character of fundamental laws and the theories to which they belong does not by itself license the inference that the *world* is deterministic, i.e., that Laplacean determinism is true. The problem with this inference can been described as follows: "The best approach to the question whether a world is deterministic is to analyze the laws or theories that pertain to it. The claim that not only the theory but also the world it pertains to is deterministic (or indeterministic) is however a further claim that needs to be established separately, e.g., by arguing that the relevant theory describes the whole universe in all its detail" ([9] p 12). A deterministic theory would have to tell the *whole truth* about the course of the world. It would have to be a final "theory of everything." Unless it is such a complete theory, any regular succession of phenomena predicted by the theory is susceptible to interferences that are due to the superposition of physical forces about which the theory is silent. As Russell puts it: "All causal laws are liable to exceptions, if the cause is less than the whole state of the universe" ([10] p 230). Lacking an all-encompassing theory, deciding whether certain laws of a physical theory are deterministic or not is immaterial to the question of whether Laplacean determinism is true. There is "a large gap between the determinism of a given physical theory and the bolder, vague idea that motivated the traditional formulations, the idea that the world in itself is deterministic" ([8] p 33).

By the same token, the existence of counterinstances to alleged deterministic laws or theories does not by itself *refute* Laplacean determinism. In order to put Hume's principle "same cause, same effect" to the test, the antecedent conditions of the entire system, i.e., of the universe, would have to be the same on two occasions: "As long as it is not the case that the entire universe was in perfectly identical states t and t', [an object] O's different behavior at those two points in time can always be attributed to different causes acting on it. […] Thus we could suggest that the doctrine of determinism implies that if the total state of the universe was ever identical with a state that had obtained at any time in its past, the universe would from then onward go through eternally recurring cycles" ([7] p 341 f). This intimate connection between Laplacean determinism and the ancient doctrine of eternal recurrence was already acknowledged by J. S. Mill, who framed the hypothetical principle: "If the whole prior state of the universe could again recur, it would again be followed by the present state". Now as far as is known, history does not repeat itself. And worse yet, the more precisely the antecedent of an alleged law is specified, the less probable it is that such a state will be instantiated more than once. There is an inverse relation between exactness and repeatability, as described by Russell: "As soon as the antecedents have been given sufficiently fully to enable the consequent to be calculated with some exactitude, the antecedents have become so complicated that it is very unlikely they will ever recur" ([11] p 188). This being the case, the deterministic idea that like states follow like states after definite time intervals can only be preserved in a counterfactual version, as in Mill's principle, if a state of the universe *were* ever to recur, history *would* repeat itself down to the last detail.

Science has no option but to study systems that are not causally closed. Within the actual world, no physical system is completely isolated. The very procedures of taking measurements and making observations constitute causal interactions between the observed system and its environment. The above mentioned principle that the physical domain as a whole is causally closed does not change the situation, for even if the physical realm were a deterministic system, this property would not be passed on to partial systems within the physical. As a remedy, it has been suggested "to formulate determinism in terms of completely isolated systems," thinking of theories as "describing single completely isolated systems, each alone in the universe" ([8] p 36 f). This move is however just another version of Mill's escape to counterfactuality. Restricted to isolated systems, determinism would become a counterfactual claim and perhaps even a counter*legal* one, in devising worlds which are nomologically impossible. The salient point is that positing physical systems that are each alone in the universe would deny the existential presuppositions of the remaining laws of physics, thus making it impossible for all of the laws to hold in the same actual world ([12] p 778).

In sum, evidence from physics can neither conclusively verify nor falsify Laplacean determinism. Its assertion transcends empirical evidence and this is precisely what makes determinism a metaphysical doctrine.

Now what about the whole array of domain-relative determinisms? Talk of psychological, biological, genetic, historical, economic or cultural determinism carries the suggestion that these respective factors strictly determine say, the nature and the behavior of human beings. Genetic determinism, for instance, has been described as the view that "human lives and actions are inevitable consequences of the biochemical properties of the cells that make up the individual and these characteristics are in turn uniquely determined by the constituents of the genes possessed by each individual" ([*13*] p 3). Now it is simply not the case that genetic factors fix human behavior uniquely. In order to make a domain-relative determinism true, strict, exceptionless laws would have to exist that link say, the genetic set up of individual organisms with their behavior. No weaker correlation would do. In particular, making the system *disposed* to react in a certain way does not constitute a deterministic relation. In the absence of such strict laws, either all these domain-relative determinisms are plainly false, or a weaker reading of "determinism" must be developed.

Determinism in the Neurosciences

In the neurosciences, "determinism" is not a well-defined theory. Theories in the neurosciences can be called "deterministic" if they treat their objects of research, i.e., the brain or the neural system, as deterministic systems. What does it mean that the brain "works deterministically" or that it is a "deterministic automaton"? A deterministic automaton is one whose computational output is completely determined by the starting state, the input and the program. If the brain is such a system, its causal output must be fixed uniquely by these three factors. This could only be the case if the operation of the brain were causally isolated, i.e., if after the processing of some input begins, no further factor could ever disturb the dynamics of the brain from outside. Now surely more things can happen between brain input and output than are dreamt of in our neuroscientific textbooks. This is why neuroscience is hardly ever concerned with finding strict causal laws, i.e., causally sufficient conditions for the occurrence of a certain phenomenon. For example, the readiness potential, which "initiates" voluntary acts in the brain, according to B. Libet, is not a causally sufficient condition for the onset of movement and no one argues that it is. Just like any other physical system, the brain is susceptible to interferences of many kinds, including the sudden death of the organism that houses it, which ends all brain activity. Now systems that are not causally isolated cannot exhibit local determinism unless global Laplacean determinism is also true. (There is however one sense in which domain-relative determinisms could be true while Laplacean determinism is not; physical systems can be described at different levels and with different degrees of precision. If there is genuine randomness at the quantum level, this quantum indeterminacy may average out at the macro level. In that restricted sense, the world could contain deterministic systems even if the course of events is fundamentally indeterministic.)

It has been suggested that biological systems, while not being causally or energetically closed, are "operationally" or "organizationally closed" (Maturana/Varela). Operational closure means that certain relations and processes define the system as a unity, in determining the dynamics of interaction and transformations that the system may undergo. This kind of closure is however, immaterial to the issue of determinism. It is one thing to identify principles that restrict the number things that can happen within the system unless it is destroyed. It is another thing to reduce the number of possibilities to one. In order for the brain to be a deterministic system, its initial state, its input and its *modus operandi* would have to fix its causal output *uniquely* and as a matter of physical necessity.

The observation that neural activity is neither completely predictable nor purely random has led a number of authors to invoke the notion of deterministic chaos to describe the dynamics of the brain. Deterministically chaotic systems are extremely sensitive to initial conditions, which makes their dynamics unpredictable in the long run, while they still instantiate deterministic laws. In such systems, same causes still have same effects, but similar causes do not have similar effects. The response of nerve cells to periodic stimulations for instance, has been described as such a deterministically chaotic process. The philosopher Robert Kane invokes chaotic neural processes sensitive to quantum events in order to explain the possibility of free, undetermined decisions [*14*].

In the life sciences, the notions of determinism and determination are often used in a loose, informal sense. For example, talk of "neural determinants" of thought and behavior typically does not commit the speaker to determinism proper. But while the verb "to determine" is an ordinary English term that is not associated with a particular philosophical or scientific theory, it is questionable whether a weak sense of "determinism" really exists or should be introduced. Insisting that the brain "works deterministically" often just has the function of indicating that no causal gaps, no miracles and no intrusions by immaterial soul substances should be expected. These views are better expressed without the notion of determinism. In particular, the view that all mental phenomena are physically *realized* in the brain has nothing to do with determinism, the latter describing a *temporal* relation. One can believe in the causal closure of the physical, reject Cartesian dualism and repudiate obscure pseudo-explanations without adhering to Laplacean or neurobiological determinism. Consciousness, thought and behavior arguably have neural correlates and even neural "determinants," even if determinism is not true.

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