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Emergent evolutionism, determinism and unpredictability

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ABSTRACT

The fact that there exist in nature thoroughly deterministic systems whose future behavior cannot be predicted, no matter how advanced or fined-tune our cognitive and technical abilities turn out to be, has been well established over the last decades or so, essentially in the light of two different theoretical frameworks, namely chaos theory and (some deterministic interpretation of) quantum mechanics. The prime objective of this paper is to show that there actually exists an alternative strategy to ground the divorce between determinism and predictability, a way that is older than—and conceptually independent from—chaos theory and quantum mechanics, and which has not received much attention in the recent philosophical literature about determinism. This forgotten strategy—embedded in the doctrine called "emergent evolutionism"—is nonetheless far from being a mere historical curiosity that should only draw the attention of philosophers out of their concern for comprehensiveness. It has been indeed recently revived in the works of respected scientists.

1. Introduction

If, during the dawn of modern science, it was once firmly believed that the behavior of deterministic systems was in principle predictable, things have now changed. In the light of the frameworks that are chaos theory and (some deterministic interpretation of) quantum theory, it has been extensively and convincingly shown over the past decades that some systems can be conceived of as deterministic, and yet be radically unpredictable.

The prime objective of this paper is to identify and describe an alternative strategy, embedded in the doctrine of "emergent evolutionism", which is older than—and conceptually independent from—chaos theory and quantum mechanics, and which is also able to ground the divorce between determinism and predictability.

In Section 2, I begin by setting the stage in a twofold movement. First, I propose a conceptual analysis of the notion of determinism through four different theses, namely "ontological determination", "state determinateness", "epistemic determination" and "state determinability". On this basis, I then lay down the overall structure of what I will refer to as the "Laplacean argument", according to which some minimal form of determinism necessarily entails predictability. This argument will be purposively framed in a way that renders explicit its dependence on three controversial inferences I_1, I_2 and I_3. In Section 3, I concisely mention the way in which chaos theory and (some deterministic interpretation of) quantum mechanics constitute proper places to object to the Laplacean argument, namely through the idea of algorithmic incompressibility (to the effect that I_1 is denied) and the impossibility of performing non-disturbing (position) measurements (to the effect that I_2 is denied), respectively. Finally, in Section 4, I turn to the original, older framework that is emergent evolutionism, which, as its name suggests, rejects the Laplacean picture by invoking the existence of "emergent" entities and laws through evolution (to the effect that I_3 is denied).

While the first two strategies have received much attention over the last decades in the philosophical literature, the third one is often overlooked as a consistent—though metaphysically heavy—alternative way of grounding the idea that determinism and unpredictability can peacefully coexist. Emergent evolutionism is however more than just a historical curiosity. It has been recently revived in the works of respected scientists, coming essentially from the field of condensed matter physics, and this should constitute a sufficient clue that it deserves renewed attention from the community of philosophers of science.

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2. The Laplacean argument

In order to set the stage for the subsequent discussion, let us begin by analyzing the very general and somewhat ambiguous notion of determinism through four different theses.[1] First:

> (L_o) *Ontological determination*. There exists a uniform and univocal determinative relationship between successive states of a given system, to the effect that two similar systems in the same state and the same conditions at time t are in the same state at all times t^*.

Extended to the whole universe, L_o states that when two worlds agree at t, they agree at all t^*. Second:

> (S_o) *State determinateness*. There is a fact about the state in which a given system is at each time t.

This second ingredient, which is seldom explicitly stated but often tacitly endorsed, is required for L_o to hold, insofar as for two systems (or two worlds) to be able to agree at any time t, there must at least be something to agree on at t.

Both theses L_o and S_o, which are primarily *ontological* claims about systems in the world and the way they evolve through time, can be given *epistemological* counterparts—L_e and S_e, respectively—which are claims about the access that cognitive beings can have to the states of these systems and the determinative relations between these states. Thus:

> (L_e) *Epistemic determination*. The uniform and univocal determinative relationship that exists between successive states of a given system can be decrypted by a cognitive agent and captured under the form of a predictive algorithm. A predictive algorithm is a formal device (*e.g.* a set of equations) that allows in principle a cognitive agent to determine the state of the system at any time t^* from complete knowledge of its state at t (provided that, between t and t^*, nothing changes in the nature of the system that renders the algorithm obsolete).
>
> (S_e) *State determinability*. The fact about the state in which a given system is at each time t can be known and specified by a cognitive agent.

If we now consider that a given system is *predictable in principle* (P) when its states at all times t^* can, as a matter of principle, be predicted by a cognitive agent at a previous time t, then we may lay down the structure of an argument that expresses a belief—*viz.* that deterministic systems are predictable in principle—that has been part of our scientific tradition since its advent in modernity. The argument—to which I will from now on refer as the "Laplacean argument"—runs like this (where theses P_i are the basic premises, I_i additional entailments traditionally taken for granted, and C the overall conclusion):

(P_1)	L_o
(P_2)	S_o
(I_1)	$L_o \rightarrow L_e$
(I_2)	$S_o \rightarrow S_e$
(I_3)	$L_e \wedge S_e \rightarrow P$
(C)	P

In a nutshell, the argument expresses the idea that, given the assumptions that the state of a system at t^* is univocally determined by its state at t (P_1) and that the system has well-defined states at t^* and t (P_2), then an absolutely competent cognitive being (*e.g.* a Laplacean demon) should be able to capture the determinative relationship between these states under the form of a predictive algorithm (I_1), as well as specify precisely what the state of the system is at t and plug this specification into her algorithm (I_2). As a result, such a demonic calculator should be able to predict what the state of the system at t^* will turn out to be (I_3), and hence the system would be predictable in principle (C).[2]

It may be pointed out that $L_o \wedge S_o$ constitutes what can be referred to as "ontological determinism", whereas $(L_e \wedge S_e) \wedge P$ rather constitutes "epistemological determinism".[3] While the former consists of a claim about the determinative relations holding *in the world*, the latter pertains to the way in which cognitive agents can come to *know* these relations and exploit this knowledge to make predictions. According to the Laplacean argument presented above, ontological determinism entails epistemological determinism, and hence predictability.

3. Around the Laplacean argument: contemporary strategies

That the Laplacean argument is mistaken—to the effect that there exist ontologically deterministic, yet unpredictable systems—has been massively vindicated over the last few decades from two different scientific perspectives, namely chaos theory and (some deterministic interpretation of) quantum mechanics. In this section, I briefly mention how these theories indeed provide adequate frameworks to argue against the Laplacean picture by rejecting either I_1 or I_2, respectively. In Section 4, I will turn to the real core of this paper by showing how a different, older framework—emergent evolutionism—is able to object to the Laplacean picture in yet another fashion, namely by denying the truth of I_3.[4]

But before turning to this, it is worth stressing the fact that chaos theory, (some deterministic interpretation of) quantum mechanics and emergent evolutionism have in common that they *object to*—rather than merely *circumvent*—the Laplacean argument. Accordingly, these approaches take the conclusion of the argument (P) as false while taking both its premises (L_o and S_o) as true. With that in mind, the obvious strategy one can adopt in order to argue for in-principle unpredictability through ontological *in*determinism, defined as $\neg L_o \vee \neg S_o$, is not to be considered here.[5]

[1] The first one, L_o, corresponds to a metaphysical way of framing determinism that can be found, for example, in Boyd (1972), Schurz (1995) or Earman (2007) (under the name of "Laplacean determinism"). Adding the second thesis, S_o, to the picture is not an unusual move; see for instance Glymour (1971) or Bishop (2003).

[2] In what follows, I will regularly use the metaphor of the demon to capture the idea of a "perfectly competent cognitive being". In order to be philosophically useful, such a metaphor should be understood in the following sense: a "Laplacean demon" is an idealized scientist whose cognitive and technological powers consist in infinite *extensions* of the powers of real human scientists. Accordingly, a "Laplacean demon" is *not* an omnipotent god that could overtly *transgress* what turns out to be physically possible according to our best scientific theories.

[3] For early uses of this distinction—albeit with slightly different terminologies –, see for instance Popper (1956), Hunt (1987) or Redhead (1987).

[4] I acknowledge the heterogeneity of the three frameworks envisioned here as strategies to object to the Laplacean argument (the first is something like a set of scientific models, the second some interpretation of a scientific theory and the third a philosophical doctrine). Nonetheless, this heterogeneity is not detrimental to the project of the present paper, insofar as identifying the possible options to oppose an argument doesn't *a priori* require these options to be related in a certain way. I thank an anonymous reviewer of this journal for having drawn my attention on this.

[5] Such a strategy is often put forward through an appeal to the so-called "orthodox" interpretation of quantum mechanics (see for instance Popper & Eccles, 1977, p. 33). It ultimately rests on the two following facts (Maudlin, 1998): in some circumstances—typically when a "measurement" occurs, whatever that means –, the determinative relationship between successive quantum events—the "collapse"—is intrinsically chancy (denial of L_o), and/or quantum events themselves are not determinate (denial of S_o).