Chapter 18
Computer Simulations and Traditional Experimentation:
From a Material Point of View

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ABSTRACT

In this work I expect to revisit Francesco Guala's paper Models, simulations, and experiments in order to cast some doubts upon the so-called 'ontological account' of computer simulations and experiment described in his work. Accordingly, I will develop my argument in three (plus one) steps: firstly, I show that Guala's conception of 'experiment' is too narrow, suggesting a more accurate version instead. Secondly, I object to his notion of 'simulation' and, following Trenholme, I make a further distinction between 'analogical' and 'digital' simulations. This distinction is also meant to enrich the concept of 'experiment'. In addition, I suggest that Guala's notion of 'computer simulation' is too narrow as well. All these arguments have the advantage of moving the 'ontological account' into a new ontological map, but unfortunately they cannot get rid of it. Hence, as a third step I discuss cellular automata as a potential solution of this new problem. Finally, I object to his conception of 'hybrid simulations' as another way of misrepresenting computational activity.

INTRODUCTION

Computer science has undoubtedly introduced a new, possible radical, way of performing scientific research. Many philosophers, consequently, tend to refer to certain computational practices, such as computer simulations, as the 'third pillar' of scientific practices, along with theory and experimentation. This is a strong claim that has been philosophically questioned on different grounds: epistemological, ontological, methodological, semantic, among others. Each one of this raises new and revives old philosophical issues. In this work I will narrow down the possible set of discussions, focusing myself specifically on the differences and proximities between computer simulations and traditional experimentation. The general idea is to understand if there exists a clear

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division line that divorces computer simulations from experiments, or the distinction is so abstruse that any attempt is condemned to fail.

Probably, one of the most controversial discussions today is about the so-called 'materiality' of computer simulations. Briefly, the claim goes as follows: an experiment differs from a computer simulation in terms of the causal relations present in each; and since the materiality (i.e. the causal relations) of the experiment is expected to be similar to those of the phenomena, then a computer simulation must be epistemically defective. The bare bones of this argument consist in claiming for an ontological difference that authorizes drawing conclusions on epistemic grounds. The advocates for this argument, that from now on I will be referring to as the 'ontological account'[1], usually try to kill two birds with one stone: they pretend to solve the controversy with the 'epistemological account', and to settle the dispute about computer simulation once and forever.

The general idea behind this work consists in raising some questions on certain assumptions that rest in the heart of the ontological argument. In order to achieve this task, I will be discussing Francesco Guala's paper *Models, simulations, and experiments*. This work on computer simulations and experimentation has the benefit of presenting the ontological account in a radical way such that it is possible to deal with a clean, general picture, free of subtleties.

One of Guala's main motivations for writing his paper was his rejection to the 'epistemological account'. Briefly, the epistemological account establishes a degree of epistemic 'fertility' or 'reliability' to the outcome of a computer simulation; therefore what matters is finding epistemic credentials that will increase the perspectives of a computer simulation to become a real experiment. It is interesting to follow the different philosophical positions attached to this epistemological account: the more devotees believe, not without a lot of controversy, that we could fully rely on computer simulations for our understanding of the world insofar our access to the world is, ultimately, through models. In the end, these same philosophers may also suggest that, sometime soon we could just completely depend on computer simulations and leave experimentation out of the realm of scientific activity once and for all. They recognize, however, that before this could happen, a proper epistemology and metaphysics must be in place. On the other hand, a more conservative follower, but still a confident one, would suggest that computer simulation do not need to compete with experiment in such a radical way; instead it is possible to deal with each activity in its own domain, making no differences in their (comparable) epistemological power. Their favorite example is the understanding of astronomical phenomena, where experimentation can hardly be performed (if it can be performed at all). However, when this philosopher is asked about the many cases where computer simulations and experimentation are somehow competing on the same domain, his choice is usually inclined to favor experimentation over simulations. This reaction is based on the philosophical assumption that there exists a deep, possibly causal, relation that experiments maintain with the world. Finally, there is a third category of philosophers that believe that computer simulations are nothing but some sort of huge *abacus* for helping the scientist make his calculations quicker and more precise. It follows, according to this philosopher, that computer simulations are not epistemically important *per se*, but only as a tool, just in the same way a microscope or a pipe is a tool in the scientist's lab.

Independently of the epistemological position, all these philosophers agree that the question about the differences between computer simulations and experimentation can be solved on epistemological grounds, namely, on the degree (positive or negative) of 'reliability' of the knowledge obtained by running a computer simulation. On the contrary, Guala believes that this difference cannot be answered from pure epistemological grounds, but instead from an ontological one. In Guala's

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