BOOK REVIEW (for Minds & Machines)

BOOK INFORMATION

Eric Winsberg,
"*Science in the Age of Computer Simulation*",
The University of Chicago Press,
2010,
152 pages,
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REVIEWER INFORMATION

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REVIEW BODY

Science-Historical and Science-Philosophical Background of the Reviewed Book.
Before the advent of sufficiently powerful computing machinery, the practice of science took place on a *bi*-polar spectrum between rationalism and empirism, between theory and experiment. Theory commanded support from mathematics and ideal speculation; experiments commanded support from technical instruments and material skills. All the science-philosophical contributions and discourses prior to the actual availability of computers find their places somewhere on the line of that bi-polar spectrum – some of them more on the side of rationalism, others more on the side of empirism. After computers have equipped us with the new possibility of programming and executing computer simulations (or software simulations) as quasi-experiments "in silicio", a new "dimension" has *possibly* been "added" to the hitherto bi-polar spectrum between rationalism and empirism. In the new "universe of discourse" on this topic, the following philosophical positions can be conceived:

- **Conservative**: Computer Simulations do not add any new dimension to the classical bi-polar spectrum between rationalism and empirism. Consequently, the conservative thinker is ultimately forced towards one of the following two sub-alternatives:
  - **Rationalist:** Computer Simulations are, in spite of their "in silicio" execution, Gedankenexperiments on the speculative-mathematical side of the spectrum.
  - **Empirist:** Computer Simulations are, in spite of their "in silicio" implementation, genuine experiments on the technical-material side of the spectrum, such like experiments in physics or chemistry.

- **Progressive**: Computer Simulations are a genuinely new, third epistemological way of science between rational Gedankenexperiments and empirical experiments (though they might possibly share some properties with the other, classical ways).

Whether some philosopher of science occupies the conservative or the progressive point of view in this discourse will also depend on the finer details of the philosopher's definitions and concepts and notions of "theory", "model", "experiment", "simulation", "knowledge" (etc.), and on all these points we can already find large volumes of literature in publication with many subtle and finer details. Having thus roughly sketched the "universe of discourse" and the context of the book to be reviewed, a sketch of its contents can follow now.

Chapter One.
The introductory chapter of the book is concise and brief (pp. 1-6). It basically contains a piece of normative meta-philosophy, arguing why philosophers of science *should begin to* philosophize about new science-philosophical problems in the context of computer simulations.

Chapter Two.
The second chapter of Winsberg's book is dedicated to the discussion of the notions of "model" and "theory" and the conceptual relations between the two. Starting point of the discussion is the following simple linear epistemological schema:

[*Theory*] ➔ [*Model*] ➔ [*Treatment*] ➔ [*Solver*] ➔ [*Results*]

which captures much (though not everything) about how computer simulations are actually planned and carried out. The long workflow chain between "Theory" and "Results" requires a considerable amount of philosophical arguing and justification as far as the scientific *validity* of the "Results" is concerned; this also includes a sub-discussion on the notions of "validation" versus "verification". As far as the notion of "model" is concerned, Winsberg supported the contemporary "models-as-mediators" philosophy: *"Consequently, these models are best viewed not as mere solutions to theoretical equations; they are rich, physical constructs that mediate between our theories and the world"* (p. 28).

Chapter Three.
Under the title "Methodology for a Virtual World", the chapter explores the notions of "simulation" and "metaphor" whereby something is taken to stand for something else. Because there can be experimental simulations also *outside* the computer –think, for example, about simulating hot gas rocket propulsion with a water hose in your garden– it is necessary to be more specific about the characteristics of simulation *inside* a computer. Moreover one must ask if it is necessary for in-computer simulation to simulate in detail the state-transformation-steps of a simulated process, or if it sufficient for the notion of "simulation" if only the final results of the simulated process and the simulation are corresponding, (regardless of the computational path of the in-computer algorithm)? In this context Winsberg expressed his approval of Hacking's position regarding the

autonomy of experiments, who are said to have *"a life of their own"* (p. 44), more or less independent of their theoretical contexts. By analogy, also computer simulations would have to be regarded in such manner, which implies that *not all* elements of a successful and epistemologically credible computer simulation need to be theoretically grounded in all their details, as long as the metaphor by-and-large remains valid.

Chapter Four.
This chapter under the heading "*A Tale of Two Methods*" is a revised version of a paper which Winsberg had published under the same title in Vol.169/3 of the journal *Synthese* (Springer-Verlag), pp. 575-592, 2009. Its summary can thus easily be retrieved from the Internet (DOI 10.1007/s11229-008-9437-0), whereby I must criticize that the book's References section (p. 145) does not list that paper as pre-existing.

Chapter Five.
This chapter, under the title "When Theories shake Hands" discusses the analysis and modeling of complex phenomena for which one unified theory is not available. By means of some kind of divide-and-conquer tactics, such complex phenomena could be seen from various partial viewpoints at various ontological levels, and the resulting set of disparate partial models of the whole can still be combined reasonably for the purpose of a working computer simulation. Motivating examples in this chapter are taken from the contemporary techno-science of Nanotechnology, which stands –so to speak– with one leg in the world of quantum physics and with the other leg in the world of classical physics. In this context, Winsberg also discussed some theoretical "fictions" (simplifications, etc.) the purpose of which it is to make a computer simulation work properly (rather than to depict accurately the physical reality). Tacitly, the chapter conveys between its lines an *instrumentalist* attitude w.r.t. the role and function of scientific theories.

Chapter Six.
This long chapter (pp. 93-119) contains the discussion of typical contemporary application scenario of an for computer simulations, namely climatology. Changes in the global weather are so complex that they are *"analytically impenetrable"* (p. 93), i.e.: cannot be adequately captured by a finite system of differential equations. The need to deal with the related *uncertainties* has also some science-*political* and science-*ethical* implications, which are discussed in a sub-section (pp. 97-100) of that chapter. Winsberg also used this chapter as a battle ground for some arguments against the science-methodology of Richard Jeffrey (1956) on valuation and the acceptance of scientific hypotheses, thereby often deviating from the dedicated topic of the chapter, global climate change. This chapter has a strong confessional sub-text, and the phrase *"I believe"* can be found in it remarkably often.

Chapter Seven.
This chapter comes under the philosophically provocative heading "Reliability without Truth". This refers to the built-in *"fictions"* in computer simulation programs (which are related to the experimental "autonomy" of Chapter 3) which can challenge our belief in the validity of such computer simulations. Nevertheless, there is some "success" to be

found in such fictions-in-application (p. 127). In this context, Winsberg has analyzed different notions of reliability, such as *"generally"* versus *"broadly"* reliable (p. 134) and associates so-called "fundamentalist thinkers" versus so-called "anti-fundamentalist thinkers" with those different notions of truth and reliability: *"Rather than taking theories and laws to be universally true and delimiting the character of all possible worlds, the anti-fundamentalist sympathizer takes them to be broadly reliable for a wide array of practical and epistemic tasks"* (p. 134), whereby the question about the ultimate reason for the occurrence of such reliability remains not only un-answered but also un-asked. At this point, philosophically versed readers will have noted the proximity of such a position to the classical position of *instrumentalism* (as far as the interpretation of scientific theories is concerned) in conjunction with a *coherence* theory (instead of correspondence theory) of the notion of truth. In this context, Winsberg's speaking of *"tasks"* (instead of "knowledge") might *perhaps* also be deciphered as a –however tacit– turn away from a classical notion of science itself, towards a post-classical notion of techno-science.

Chapter Eight.
Also the book's conclusion chapter is brief and concise (pp. 135-138). In this chapter, Winsberg rejected the conservative position according to which computer simulation would be nothing more than theory-application. On the other hand, Winsberg also avoided to assert firmly the progressive position according to which computer simulations would trail-blaze a completely new path to scientific knowledge production: *"Is it true that simulations are, after all, a particular species of experiment? I have tried to argue against this claim, while at the same time insisting that the differences between simulation and experiment are more subtle than some of the critics of the claim have suggested"* (p. 137).

Apparatus.
The book's References section contains 128 literature references dating back to the years 1913-2009 (whereby Henri Poincaré's "*La Science et l'Hypothese*" from 1902 is listed as of "1952" in its English edition), and also includes one reference to this journal, *Minds & Machines* (1995). The book's Index section, which mixes personal names and impersonal objects, contains 321 alphabetical entries.

Reviewer's Opinion.
Winsberg's book is quite easily readable, however –and this is only the reviewer's opinion– somewhat too colloquial in its literary style: in some parts of it the book reads almost like a spoken conversation printed to paper. A more "austere" academic language might have helped to "sharpen" the discussed concepts even further; on the other hand any decision of the book's author in favour of a more "austere" academic presentation might have decreased the readership numbers of this interesting and thought-provoking book.
