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Scientific perspectivism: A philosopher of science's response to the challenge of big data biology

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ABSTRACT

Big data biology—bioinformatics, computational biology, systems biology (including ‘omics’) and synthetic biology—raises a number of issues for the philosophy of science. This article deals with several such: Is data-intensive biology a new kind of science, presumably post-reductionistic? To what extent is big data biology data-driven? Can data ‘speak for themselves’? I discuss these issues by way of a reflection on Carl Woese’s worry that “a society that permits biology to become an engineering discipline, that allows that science to slip into the role of changing the living world without trying to understand it, is a danger to itself.” And I argue that scientific perspectivism, a philosophical stance represented prominently by Giere, Van Fraassen, and Wimsatt, according to which science cannot as a matter of principle transcend our human perspective, provides the best resources currently at our disposal to tackle many of the philosophical issues implied in the modeling of complex, multilevel/multiscale phenomena.

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Those researching the cancer problem will be practicing a dramatically different type of science than we have experienced over the past 25 years. Surely much of this change will be apparent at the technical level. But ultimately, the more fundamental change will be conceptual.

—Hanahan and Weinberg (2000, p. 57)

We simply cannot transcend our human perspective, however much some may aspire to a God’s eye view of the universe. Of course, no one denies that doing science is a human activity. What needs to be shown in detail is how the actual practice of science limits the claims scientists can legitimately make about the universe.

—Giere (2006a, p. 15)

1. Introduction

1.1. Beyond the flat earth perspective in big data biology

In many sciences and elsewhere, the data trickle of old has recently become an ‘avalanche,’ ‘deluge,’ or ‘torrent,’ which is

steadily accelerating and amplifying. According to one estimate, mankind created 150 exabytes (1 exabyte = 10^{18} bytes) of data in 2005; it was expected to create 1200 exabytes in 2010 (The Economist (London), 2010). Krawetz (2009) guessed that at the time of his writing the rate of data acquisition was approaching 2 terabytes (1 terabyte = 10^{12} bytes) over the course of 5 days.

High-throughput technologies as first used on a massive scale in biology in the Human Genome Project raise great expectations within the scientific community and far beyond, including

...discoveries of new drugs, a better understanding of the earth’s climate, and improved ability to examine history and culture. The growth of data in the “big sciences” such as astronomy, physics, and biology has led not only to new models of science—collectively known as the “Fourth Paradigm”—but also to the emergence of new fields of study such as astroinformatics and computational biology... (Borgman, 2010, p. 2).

The “Fourth Paradigm” envisioned by Jim Gray, a software designer for Microsoft, calls for a new scientific methodology based on the power of data-intensive science, understood as the capturing, curation, and analysis of large data (Hey, Tansley, & Tolle, 2009). Its more

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