Weak Emergence and Systems Biology: The Reductive Potential

The discussion of emergent phenomena, and strong emergence in particular, has received significant criticism in the last two decades on epistemological and ontological grounds. Strong emergence is commonly described as a macro-level phenomenon that cannot be predicted from, yet is irreducible to, lower-level interactions. Conversely, weakly emergent phenomena are macro-level phenomena that cannot be predicted from, but are reducible to, lower-level interactions. Reduction in this case can be ontological and/or epistemological depending on context. Although some argue that strong emergence has a possible ontological reduction but not an epistemological one, weak emergence arguably can exhibit both. Therefore, many philosophers remain skeptical about the possibility of strong emergence (Kim, 2006), while ideas about the explanatory potential of weak emergence have grown. One increasingly popular idea is that while weak emergence might seem reducible at first, sometimes the only way to perform the reduction is to use computational analysis (Bedau, 1997 & 2013). My work advances the 'reduction by computation' argument. In this instance, computational analysis will aid in engaging philosophical theories of emergence to the scientific discourse surrounding systems biology.

The study of dynamic new paradigms in systems biology offers philosophers of science a means to practically apply their theories. I argue that systems biology, as a type of synthetic biology, supports the notion that weak emergence is compatible with reductionism because it models emergent properties and quantifies complex interactions that can ultimately be explained via computation. Ultimately, I highlight how the connection between weak emergence and the ability to be modelled creates an appreciation for complexity that does not necessarily exclude a holistic evaluation of macro and micro-level interactions. The inclusivity of weak emergence is paramount for current discussions in other areas such as genomics (Mazzocchi 2012) and ecology (Trepl & Voigt, 2011).

The construction of synthetic biology based systems is becoming an increasingly complex hybrid of bioengineering and synthetic chemistry that requires progressively more sophisticated computational models of organization and environmental acuity. Often conceived as a series or cluster of agents working simultaneously, agent-based modelling (ABM) has been a useful technique to model the interactions of these autonomous but symbiotic agents. For philosophy, the computer modelling potential of these individuals is crucial to testing whether they are genuinely weakly emergent phenomena by being reduced to micro-level interactions.

As an example of systems biology, I will use near-living architecture and its biomimetic responsive systems. Weakly emergent phenomena as found in near-living architecture installations occur in numerous examples but particularly when systems are built to accommodate and interact with occupants. As a case study, I will assess the work of computer modelling firm Aedas and the results from their mapping of nodal interactions in dynamic meshwork systems that stray far from equilibrium in near-living architecture installations. These robust meshwork systems initially use very simple behavioral micro-level rules to generate densely complex macro-level patterns in lattice neighborhoods. The trans-ordinal laws connecting higher and lower-levels of interactions (Chalmers, 2006) are philosophically rich for interrogation and I am able to provide a method to study the epistemological and ontological plausibility of weakly emergent phenomena.

There is of course the risk that by 'transcribing' biological features into synthetic systems there is a disingenuous representation of the phenomena; however, I demonstrate that systems biology remains a sustainable mechanism for investigating the likelihood of genuine weak emergence. Therefore, I show that the philosophical exploration of systems biology is advantageous because it encompasses biological models while extrapolating these concepts into domains like architecture, which offer paradigmatic examples for consideration.

References

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