Explaining with mathematical models: the contribution of systems engineering to biology

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Abstract

Session: The explanatory role of mathematical and dynamical models in molecular and cell biology (BAETU, BRAILLARD, GROSS, ISSAD and MALATERRE) Systems biology is known for its heavy reliance on dynamical modelling of molecular mechanisms and networks. Various mathematical and computational tools have been developed and different empirical data (partly coming from high-throughput methods) are used to build these models. They play different heuristic, explanatory and theoretical roles and one task of philosophical scrutiny of systems biology is to analyze and clarify these roles. In this paper, I will focus on dynamical analyses inspired by engineering methods. Traditionally, engineering's contribution to biology has been mainly technical (e.g. ultracentrifugation, the electroencephalograph), but engineering has also developed along more fundamental lines, with general analytical methods, theoretical results and peculiar explanatory concepts that might be relevant to explain biological systems. Many systems biologists have strongly argued for the transfer of methods and explanatory models from engineering to biology. My goal is to show the originality of these approaches in terms of explanatory strategies (decomposition methods) and models, stressing the differences with the classical mechanistic framework of molecular and cell biology, as it has been characterized in recent philosophical literature. There is more in these mathematical models than a way of representing the dynamics of biological mechanisms. Engineering offers new ways to look at biological systems, to decompose them, and to explain them. But of course, these transfers of methods and knowledge (partly based on analogies between natural and artificial systems) are not without limitations and dangers, as I will also discuss.

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