Synthetic biology and the functional meaning of noise

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In synthetic biology the use of engineering metaphors to describe biological organisms and their behaviour has become a common practice. The concept of noise provides one of the most compelling examples of such transfer. But this notion is also confusing: While in engineering noise is a destructive force perturbing artificial systems, in synthetic biology it has acquired a functional meaning. It has been found out that noise is an important factor in driving biological processes such as gene regulation, development, and evolution. What is the epistemic rationale of using the notion of noise in both of these opposite meanings? One philosophical answer to this question is provided by the idea of negative analogy. According to it not just similarities but also the differences found out in analogical comparison between two fields can further theoretical inquiry (e.g. Hesse 1966, Morgan 1997, Bailer-Jones 2009). But this is only part of the story. We will show how the notion of noise in the field of synthetic biology actually subsumes more heterogeneous interdisciplinary relations and influences: Despite the engineering connotations, the new functional meaning of noise had already emerged in statistical mechanics and complexity theory. The methods and techniques developed to study stochastic fluctuations in those fields have been transferred to synthetic biology. We will argue that one reason for the use of the notion of noise is the uncertainty concerning this transfer since the sources of the fluctuations in biological organisms are largely unknown. Noise functions both as an umbrella term and as a placeholder for the emerging research on different forms of fluctuations, their sources and consequences for the dynamics of the biological systems. The case of the concept of noise also shows, we suggest, that concepts are often accompanied by specific modeling methods. Yet they can undergo semantic transformations and subsume new kinds of research agendas employing novel modeling tools.