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Bridging Mechanism and Phenomenology in Models of Complex Systems

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The inherent complexity of biological systems gives rise to complicated mechanistic models with a large number of parameters. On the other hand, the collective behavior of these systems can often be characterized by a relatively small number of phenomenological parameters. I discuss how parameter reduction, specifically the Manifold Boundary Approximation Method (MBAM), can be used as a tool for deriving simple phenomenological laws from complicated mechanistic models. The resulting models are not black boxes, but remain expressed in terms of the microscopic parameters. In this way, we explicitly connect the macroscopic and microscopic descriptions, characterize the equivalence class of distinct systems exhibiting the same range of collective behavior, and identify the combinations of microscopic components that function as tunable control knobs for the collective behavior. I illustrate with several examples from from biology and compare to other common parameter reduction methods.