

Equation-free Modeling for Complex/Multiscale Systems

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In current modeling practice for complex systems, including agent-based and network-based simulations, the best available descriptions of a system often come at a fine level (atomistic, stochastic, individual-based) while the questions asked and the tasks required by the modeler (parametric analysis, optimization, control) are at a much coarser, averaged, macroscopic level. Traditional modeling approaches start by deriving macroscopic evolution equations from the microscopic models. I will review a mathematically inspired, systems-based computational enabling technology that allows the modeler to perform macroscopic tasks acting on the microscopic models directly in an input-output mode. This equation-free approach circumvents the step of obtaining accurate macroscopic descriptions. I will discuss applications of this approach and its linking with recent developments in data mining algorithms, exploring large complex data sets to find good “reduction coordinates”.