Data-driven methods for modeling and control of complex biological systems

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Controlling biology with spatiotemporal precision has the potential for significant impact in biomedical applications. Controlling biology refers to the achievement of an intended and predicted response in a biological system. However, generating predictive models to adequately direct behavior through a mechanistic approach remains a challenge due to limited observable states in a complex system. Biological systems are notoriously high dimensional, noisy, and nonlinear. In order to direct cellular response, we consider data-driven methods to controlling biology. We present NN-based predictors and feedback controllers in order to direct cellular response with no model a priori and no offline training. The algorithms learn in real-time as information is received. The control algorithm adapts according to the difference between the desired response and actual response. Hence, we must also consider careful design of the desired response in real time to achieve the intended end response. To this end, we also introduce efforts towards data-driven models of complex biological processes in order to identify and drive systems towards desired reachable states via our NN-based controller. We propose that combining a robust controller with an abstract model that maps reachable states allows one to bypass the need for a predictive model.