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**Purely stochastic binary decisions in cell signaling models without underlying deterministic bistabilities** MAXIM N. ARTYOMOV, Massachusetts Institute of Technology, JAYAJIT DAS, Ohio State University, MEHRAN KARDAR, ARUP CHAKRABORTY, Massachusetts Institute of Technology — Detection of different extra-cellular stimuli leading to functionally distinct outcomes is common in cell biology, and is often mediated by differential regulation of positive and negative feedback loops that are a part of the signaling network. For cellular responses stimulated by small numbers of molecules, the stochastic effects are important. Therefore, we studied the influence of stochastic fluctuations on a simple signaling model with dueling positive and negative feedback loops. The class of models we have studied is characterized by single deterministic steady states for all parameter values, but the stochastic response is bimodal; a behavior that is distinctly different from models studied in the context of gene regulation. For small numbers of signaling molecules, stochastic effects result in a bimodal distribution for this quantity, with neither mode corresponding to the deterministic solution; i.e., cells are in “on” or “off” states, not in some intermediate state. For a large number of molecules, the stochastic solution converges to the mean-field result. When fluctuations are important, we find that signal output scales with control parameters “anomalously” compared to mean-field predictions.

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