Modeling the dynamics of life systems: a multidimensional research journey

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ABSTRACT
Computational models are essential tools that can be used to simultaneously explain and guide biological intuition. With increasingly high-resolution, high-throughput, and dynamic experimental data, computational biologists are better equipped to develop informed models that aim to characterize complex cellular responses and direct experimental design. My lab operates at this evolving interface between chemical engineering and biology; we employ machine learning, dynamical systems, and agent-based modeling strategies to help explain biological observations, and to elucidate design principles that drive both individual cellular decisions and cell populations. In this presentation, I provide an overview of how machine learning can be used to resolve cell signaling pathways. I also introduce an agent-based model as an intuitive, modular, and flexible framework to study emergence of heterogeneous cell populations in context of solid tumor microenvironments. We use this framework to interrogate the inherent multiscale nature of cells—reinforcing how “the whole is greater than the sum of its parts”—and to predict cell population dynamics from the composition of simpler biological modules.

ABOUT DR. BAGHERI
Neda Bagheri’s research lab at Northwestern University seeks to identify engineering ‘design principles’ that underlie, explain, and rationalize complex biological function, and to understand how extrinsic factors can be used to optimize therapeutic interventions. Toward these goals, her interdisciplinary team of engineers, basic scientists and applied mathematicians combine experimental data with computational strategies derived from statistical analysis and control theory to address problems from creative angles not possible with single discipline methods.

In recognition for her research accomplishments and vision, Bagheri was awarded a National Science Foundation CAREER Award in 2017. She serves on three scientific advisory boards and two editorial boards, and she has helped direct investments of government agencies through leadership at three grand challenge workshops. Bagheri was honored as a Distinguished Speaker for the Accelerated Discover Forum at IBM Research-Almaden in 2018 and as the Keynote Speaker at the 15th International Conference on Molecular Systems Biology in 2017. Bagheri is also invested in mentorship, outreach, and citizenship. After having designed a new science policy course to mobilize engineering students and reinforce best practices in communicating science with general audiences, she is eager to take on her next project: a children's STEM book series targeting K-5 students.