

Center for Theoretical Biological Physics

Northeastern University

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177 Huntington Avenue, 13th Floor, Boston, MA 02115
<https://northeastern.zoom.us/j/93428254350>

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Some Control Theory and Dynamical Systems Ideas in Systems Biology

Abstract. A central concern of systems and synthetic biology is that of identifying, and understanding the roles of, signal transduction pathways and feedback loops, whether in natural systems or as an aid to engineer networks that exhibit a desired behavior. This talk will discuss how certain types of network qualitative information can be gleaned from "dynamic phenotypes", a term that we take as encompassing transient characteristics of temporal responses, particularly when using richer classes of probing signals than step inputs. Examples of dynamic phenotypes include fold-change detection (scale invariance), non-monotonic responses, and induced subharmonic oscillations. We will present theorems that relate different behaviors to circuit motifs, and touch upon biological applications at multiple scales, including enzymatic mechanisms, chemosensing, the generation of certain stress responses, and the kinetic recognition of self vs non-self by the immune system.

Biography. Eduardo Sontag's major current research interests lie in several areas of control and dynamical systems theory, systems molecular biology, cancer and immunology, and computational biology. He received his Licenciado degree from the Mathematics Department at the University of Buenos Aires in 1972, and his Ph.D. (Mathematics) under Rudolf E. Kalman at the University of Florida, in 1977. From 1977 to 2017, he was with the Department of Mathematics at Rutgers, where he was a Distinguished Professor of Mathematics. In 2018, Sontag was appointed as a University Distinguished Professor of Electrical and Computer Engineering and of BioEngineering at Northeastern University, where he is also an Affiliate Professor of Mathematics and Chemical Engineering. He is also in the faculty of the Laboratory of Systems Pharmacology at Harvard Medical School and an Affiliate at MIT/LIDS. Sontag has authored over five hundred research papers and monographs and book chapters in the above areas with over 60,000 citations and an h-index of 105 and is in the Editorial Board of several journals; in addition, he is a co-founder and co-Managing Editor of the Springer journal MCSS (Mathematics of Control, Signals, and Systems). He is a Fellow of IEEE, AMS, SIAM, and IFAC. Sontag was awarded the Reid Prize in Mathematics in 2001, the 2002 Hendrik W. Bode Lecture Prize and the 2011 Control Systems Field Award from the IEEE, the 2022 Richard E. Bellman Control Heritage Award from IFAC, the 2002

Board of Trustees Award for Excellence in Research from Rutgers, and the 2005 Teacher/Scholar Award from Rutgers.