Instructor: Alessandro Flammini, aflammin@indiana.edu

Office Hours: by appointment

Session: 13 weeks session

Course Format: 100% Online through Synchronous instruction. For more information visit https://fall2020.iu.edu/learning-modes/

Time: Tuesday and Thursday, 9:25a – 10:40a

Description: This course is about describing, modeling and reasoning in quantitative terms about Complex Systems. We will learn to recognize how macroscopic ordered/organized behavior emerges/derives from the local (possibly non-linear) interactions of a large number of simple "agents." Inspired by real world examples that range from ecosystems to financial markets, we will learn to abstract the common features, mechanisms, and principles that underlie the evolution of such systems. We will come to appreciate how the study of complex systems is an inherently interdisciplinary enterprise.

Topics: Cellular Automata; Fractal Geometry; Mean-Field Models: Epidemics and Population Dynamics; Game Theory; games, iterated games, evolutionary game theory; Collective Behavior: Information Cascades, Networks Effects, Cascading Behavior; Optimality: Traffic, Transportation Networks, Rivers; A bit of Statistics: Central Limit Theorem, Power Laws, Rich-get-Richer; Neural Networks: Perceptron, (Deep) Learning

Material: We will use a variety of sources, including selected chapters of *The Computational Beauty of Nature* (Links to an external site.), by G. W. Flake and *Networks, Crowds and Markets* (Links to an external site.), by D. Easley and J. Kleinberg.

Tools: We will use Netlogo [https://ccl.northwestern.edu/netlogo/ (Links to an external site.)] to illustrate the behavior of some of the systems of interests for this class. Some of the assignments will require simple numerical calculation (or simulation.) You are free to use the software of your choice for those. R [https://www.r-project.org/ (Links to an external site.)] and Python have been popular choices for this purpose in the past.

Prerequisites: This a graduate-only class. There are no specific prerequisites, but to enjoy the class basic concepts of Linear Algebra, Calculus and Probability Theory are needed.

Grading: Assignments 75%; Class Participation: 25%