Computational Neuroscience of Elemental Cognition NEURL-UA 302-005/ NEURL-GA-3042-003

Professor Xiao-Jing Wang Center for Neural Science, Office: Meyer 752 (xjwang@nyu.edu)

Objectives: this is an advanced undergraduate/graduate course. It covers the basic ideas and methods of modeling single neurons, recurrent neural networks, synaptic plasticity and learning. The focus is on the neural circuit mechanisms of core cognitive functions such as decision-making and working memory, both in local neural networks and multi-regional large-scale brain systems.

Prerequisites: Introduction to neuroscience, Calculus or linear algebra; or permission of instructor.

Time: Friday 2-4pm, the first class is on September 6th, 2019 **Location**: Room 760, Meyer building, 4 Washington Pl, New York

Readings: Materials from a book to be published by MIT Press, papers (2 per week).

General references: Theoretical Neuroscience, by P. Dayan and L. F. Abbott, MIT Press, 2001.

Neuroscience: exploring the brain, by M Bear, B. Connors and M. Paradiso, Lippincott Williams and Wilkins, 2006.

Nonlinear Dynamics And Chaos: With Applications To Physics, Biology, Chemistry, And Engineering, by S Strogatz, CRC Press, 2018.

Evaluation: Homework (50% of grade); Final: model simulation project (30%); reading and in-class participation (20%).

Tentative schedule:

Week 1 (9/6): introduction and dynamical systems theory
Week 2 (9/13): models of single neurons
Week 3 (9/20): models of synapses and short-term plasticity
Week 4 (9/27): network dynamics and population coding of information
Week 5 (10/4): learning, memory and synaptic plasticity
Week 6 (10/11): working memory
Week 7 (10/18): decision-making
Week 8 (10/25): selective attention and task switching
Week 9 (11/1): categorization and deep networks/deep learning
Week 10 (11/8): reinforcement learning and value-based economic choice
Week 11 (11/15): executive control, rules and behavioral flexibility
Week 12 (11/22): multi-regional, large-scale brain circuit theory
Week 13 (11/29): distributed cognition in the global brain
Week 14 (12/6): computational psychiatry
Week 15 (12/13): interplay between brain science and artificial intelligence