**Syllabus: PSYC 3503/5171 Introduction to Programming Complex Systems**

Last update 2021-01-27

This course provides an introduction to programming in Python by exploring a series of complex systems phenomena. It is open to undergraduates with Psychology, Language, Computing, Math, Engineering, Data Science, or related background and to all graduate students. A strong interest in learning to program is required but no prior programming experience is necessary. It is also open to people with extensive programming experience who want to work on more advanced aspects of the topics. Topics include a selection from dynamical systems, cellular automata, power laws, self-organization, fractals, neural networks, probabilistic grammars, synchronization, among others.

Spring, 2021 University of Connecticut, Storrs
Tu/Th, 12:30-1:45PM
Distance Learning

**Instructor:** Whitney Tabor, Email: whitney.tabor@uconn.edu
Office hours: Fridays 10-12 (Zoom---see end of syllabus)
Oliver McNeil Email: oliver.mcneil@uconn.edu
Office hours: Mondays 1:30-3:30pm (Zoom---see end of syllabus)

**Readings:**

**Homework:**
Weekly programming assignments up through Week 10
Larger program creation or analysis Week 11-13 (due in reading week)

**Week 1**
Intro: Complex Systems, Programming in Python
Reading: Downey, Think Python, Chapter 1
Reading: Downey, Think Complexity 2ed, Chapter 1
Programming: plotting functions, variables
Focus case: basic 2-d plots
Focus case: contour and 3-d mesh plots

**Week 2 (Exercise due midnight Tuesday, January 26 (on One-Drive): plotting)**
Complex systems: 1-d discrete dynamical systems 1st part
Programming: functions, loops, lists
Programming: 1-d discrete dynamical systems
Reading: Downey, Think Python, sections 3.1-3.9 (functions)
Reading: https://datagy.io/python-for-loop/#Python-For-Loops-Syntax
   (through the section called "Extending the python for-loop with the range() function") (for-loops)
Reading: Downey, Think Python, sections 10.1-10.6 (lists)
Focus case: 1-d discrete dynamical systems
Supplementary readings: Elman (1990) [neural network language processing], Bob (2008) [neural chaos and schizophrenia]

Week 3 (Exercise due: midnight, Tuesday, Feb 2, 1-d discrete dynamical systems 1)
Complex systems: 1-d discrete dynamical systems 2nd part
   Programming: debugging
   Focus case: lists
   Focus case: 1-d discrete dynamical systems
   Supplementary readings: see previous week

Week 4 (Exercise due: 1-d discrete dynamical systems 2)
Complex systems: Cellular automata: intro
   Programming: loops cont, arrays
   Focus case: 1-d cellular automata
   Reading: Downey TC2e Chapter 5

Week 5 (Exercise due: 1-d cellular automata)
Complex Systems: Power laws basic
   Programming: strings
   Focus case: Zipf’s Law
   Focus case: Barabasi & Albert’s generator
   Reading: Downey TC2e Chapter 4

Week 6 (Exercise due: power laws)
Complex Systems: Self-organized criticality (SOC)
   Focus case: Sand-pile (CA) model power law
   Supplementary readings: See previous week

Week 7 (Exercise due: SOC)
Complex Systems: Fractals
   Programming: recursion
   Reading: Barnsley excerpt from Fractals Everywhere
   Focus case: Drawing fractals
   Focus case: Fractal Dimension
   Focus case: Fractals in 1-d
   Supplementary Readings: Tabor (2015) [fractal language models]

Week 8 (Exercise due: fractal exercise)
Dynamical Systems: Neural networks---Perceptrons
  Focus case: Perceptron
  Focus case: Perceptron Learning Rule
  Focus case: Linear Separability

Week 9 (Exercise due: Neural networks---Perceptrons)
Dynamical Systems: Neural networks (Perceptron)
  Focus case: Backpropagation
  Focus case: Principle Component Analysis
  Focus case: Intro to Deep Learning
Supplementary reading: Elman (1990) [Neural network language models], Mehta & Schwab (2014) [Deep learning as renormalization]

Week 10 (Exercise due: Neural Networks---Backpropagation)
Language Processing: Grammatical generation
  Reading: Language Handout
  Focus case: Corpus analysis

Week 11 (Exercise due: Grammatical generation)
Special topics and techniques + working on final project

Week 12
Special topics and techniques + working on final project

Week 13
Special topics and techniques + working on final project

Week 14 Final Project due

Bibliography


Contact

**Professor Tabor Zoom for office hours** (Fridays 10-12):

Topic: Whitney Tabor’s Personal Meeting Room
Join Zoom Meeting  
https://us02web.zoom.us/j/7365349760

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Find your local number: https://us02web.zoom.us/u/kRa50bul7

**TA McNeil office hours location:** TBA