CMSC 828Q: Nature-Inspired Computing  
Syllabus - Fall 2019 (Draft June 16)

Time and Place: Tuesdays and Thursdays, 12:30 – 1:45 pm, CSI 1122

Instructor: James Reggia, AVW 3233, 301-405-2686, reggia@cs.umd.edu  
Office Hours: Th. 1:45 – 2:45 pm, or by appointment

Class web page: http://www.cs.umd.edu/class/fall2019/cmsc828Q  
Gives exam dates, homework assignments and their due dates, lecture slides, reading assignments, and links to other useful information.

Prerequisites: graduate status in computer science, math, engineering, or permission of instructor.

Objective: The primary objective of this course is to examine nature-inspired computational methods in artificial life, evolutionary computing, and related fields, with an emphasis on understanding the basic computational principles involved.

Content:

Conceptual Framework  
Definitions, terminology, introduction to different paradigms, core concepts such as self-organization and emergence, history, overview

Evolutionary Computation  
Genetic Algorithms: biology, method, variants, schema theorem, applications  
Genetic Programming: evolving computer programs, tree/linear/graph based genomes  
Evolution Strategies: method, variations, optimization  
Issues: preferred operators, co-evolution, speciation, creative evolutionary systems, network representations and genetic operations, spatially-distributed populations

Artificial Life  
Dynamical Systems: fixed points, limit cycles, chaotic attractors, etc.  
Cellular Automata: basics, life-like properties, environments, self-replicating machines, adaptation, applications  
Multi-Agent Artificial Life Worlds: flocking, swarm intelligence, particle swarm optimization, ant colony optimization  
Developmental Systems: L-systems, morphogenesis, self-assembly, pattern formation

Neural Computation  
Feedforward Networks: gradient descent learning, error backpropagation, deep learning  
Recurrent Networks: neurocontrollers, coupled oscillators, rhythmic behavior, attractor networks, self-organizing maps, radial basis function networks, echo state networks, BPTT and LSTM  
Topics: neurocognitive systems, reverse engineering the brain, GANs  
Immunological Computation: principles, artificial immune systems, applications

Evolution and Adaptation of Intelligent Agents  
Evolving Rule-Based Systems: classifier systems, GABIL, cellular automata, L-systems  
Evolving Neural Networks: weights, architectures, recurrent networks, cellular coding, etc.  
Evolving Multi-Agent Systems: cooperative/competitive behavior, communication

Advanced/Research Topics in Nature-Inspired Computation (as time permits)  
reinforcement learning in multi-agent systems, imitation learning, biologically-inspired
robotics, multi-SOM systems, DNA/molecular computing, artificial consciousness, models of attention, language and language acquisition, optical/photonic computing, quantum computing, nanotechnology, physarum machines, binding problem, simulated annealing, biologically-plausible supervised learning, machine creativity, etc.

**Grading:** Grading will be based on homework assignments, worksheets, and class participation (collectively 10%), a semester project (20%), and two exams (35% each) given during the semester.

**Textbooks:**
2. Additional readings from several sources (pdf’s will be provided).

**Disabilities:** Any student eligible for and requesting reasonable academic accommodations due to a disability needs to provide the instructor with a letter of accommodation from the Office of Disability Support Services (DSS) within the first two weeks of the semester.

**Class Absence Policy:** The campus has an established policy governing class absences. This policy requires instructors to provide the following information. For this class, the “major scheduled grading events” are the exams and the semester project. A maximum of one self-signed medical excuse for other grading events will be accepted.

**Academic Integrity:** All homework assignments are to be done individually and independently; all submitted work must be your own. All students are expected to be familiar with and to uphold the Code of Academic Integrity administered by the Student Honor Council at UMCP (please see [http://www.shc.umd.edu](http://www.shc.umd.edu)).