

[EE381V] Unconventional Computing

Graduate Course :: Spring 2020

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There is a world of computation outside of electronic devices: in every biological cell, in your head, in cutting-edge laboratories trying to create DNA computers and quantum computers. Such unconventional computation inspires new models of computing beyond traditional models of boolean circuits and automata. This class exposes you to new perspectives on computation: models of highly distributed and unstructured computation such as that occurring in chemical reactions, models in which building is equivalent to computing, models that address the ultimate limits of low energy computation, and models that compute by relaxing to the lowest energy state. If time permits, we will cover the basics of neural computation (not learning), and quantum computing. The course will consist of a combination of lectures, paper discussions, and group projects.

Prerequisites

Experience with mathematical proofs (e.g., discrete math, algorithms)

Helpful: undergraduate course in probability, basic differential equations

No physics, chemistry, or biology background needed

Grading

Homework (65%), Project (30%), Class participation (5%)

Major Topics

1. Extreme distributed computing: Population Protocols, Chemical Reaction Networks, Cellular Automata
2. "To build is to compute": Algorithmic Tile Assembly Model
3. Computing without using energy: Reversible Computing
4. "You'll get there, don't worry how": Hopfield networks, Protein Folding, Thermodynamic Binding Networks
5. (if time permits) Basics of Quantum Computing, Neural computation (not learning!)

