[EE381V] Programming with Molecules  
Graduate Course :: Spring 2016  
Prof. David Soloveichik

Lecture: T, TH 12:30-2pm in JES A303A  
Office Hours:  
T 2:30-3:30pm in POB 3.434

TA: Boya Wang  
Office Hours: W 2-3pm in NMS 3.104

Description
We will discuss paradigms for programming complex behavior in (bio)chemical systems. Similar to how digital circuits and automata (e.g., finite state machines) are fundamental abstractions for electronic computation, we are interested in models of computation as embedded in the chemical world. The motivating natural phenomena include biological self-organization and information processing in chemical pathways in cells. Applications of rationally designed molecular systems will be introduced from synthetic biology, and DNA bioengineering and nanotechnology. Topics will include algorithmic tile-assembly and cellular automata, discrete and continuous chemical reaction networks, population protocols, and strand displacement cascades. We will study chemical computation by reasoning, simulation, and formal proofs about these and other models. Besides chemistry, we find applications in distributed computing settings where weak computational agents must operate in a disordered environment (e.g., sensor networks). The course will consist of a combination of lectures, paper discussions, and group projects.

Prerequisites
No biology or chemistry background is assumed.

Necessary background:

- Digital circuits and automata models (e.g., Turing machines)
- Familiarity with formal proof techniques
- Programming experience
- Undergraduate course in probability
- Elementary differential equations

Grading
Homework (40%), Mid-term project (25%), Final project (25%), Class participation (10%)

Homework policy
Homework is due at the beginning of class. Late homework will be accepted only until the time when solutions are posted. The penalty will be –20% per 24 hour period. This penalty is assessed after normal grading and is cumulative with any points lost (e.g. a homework that would normally receive 80% of total points would receive only 40% if handed in within 48 hours). Late homework must be submitted via e-mail to the instructor and TA.
Collaboration policy

You may discuss homework problems with other students, but the solutions turned in must be written entirely by you. You must write the names of all the students you collaborated with at the top of your homework. Copying on homework assignments will result in an automatic zero for the assignment for both students as well as other consequences (e.g., failure and disciplinary action). Close collaboration is expected for group projects, with all students meaningfully contributing.

Textbook / reading materials

There is no textbook for this course. You are strongly urged to attend all classes and participate during discussions. Where possible, PDF copies of optional reading materials will be provided.

Major Topics

1. Chemical Reaction Networks
2. Algorithmic Self-Assembly
3. Strand Displacement Cascades
4. Synthetic Biology

University policies

Religious holy days. By UT Austin policy, you must notify me of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, I will give you an opportunity to complete the missed work within a reasonable time after the absence.

Students with Disabilities. The University of Texas provides on request appropriate academic accommodations for qualified students with disabilities. At the beginning of the semester, students who need special accommodations should notify the instructor by presenting a letter prepared by the Service for Students with Disabilities (SSD) Office. Disabilities range from visual, hearing, and movement impairments to Attention Deficit/Hyperactivity Disorder, psychological disorders (bipolar disorder, depression, Obsessive Compulsive Disorder, etc.), and chronic health conditions (diabetes, multiple sclerosis, cancer, etc.). These also include from temporary disabilities such as broken bones, recovery from surgery, etc. For more information, contact Services for Students with Disabilities at (512) 471-6259 [voice], (866) 329-3986 [video phone], via e-mail at ssd@austin.utexas.edu, or visit: http://ddce.utexas.edu/disability/.