COS 116: The Computational Universe

- Instructor: Adam Finkelstein
- Head TA: Umar Syed
- Preceptors: Forrester Cole, Ari Feldman
- Labs will be held in (Friend 005)
  - Tues 7-10p, Wed 7-10p
- This week: Take-home lab
Ancient dream of man: “Breathe life into matter”

<table>
<thead>
<tr>
<th>Golem (Jewish mythology)</th>
<th>“Automata”, (South Germany or Spain, c. 1560)</th>
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<tbody>
<tr>
<td><img src="image1" alt="Golem" /></td>
<td><img src="image2" alt="Automata" /></td>
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<td>Also, chess automata</td>
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<tr>
<th>Frankenstein (Mary Shelley, 1818)</th>
<th>Robot (Karel Capek, 1921)</th>
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<tr>
<td><img src="image3" alt="Frankenstein" /></td>
<td><img src="image4" alt="Robot" /></td>
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“Breathe life into matter” – Another perspective
“Breathe life into matter” – A 20th century perspective

- “Matter”: Atoms, molecules, quantum mechanics, relativity …

- “Life”: Cells, nucleus, DNA, RNA, …

- “Breath life into matter”: Computation

One interpretation: Make matter do useful, interesting things on its own
Computational Universe
Some important distinctions

Computer Science vs. Computer Programming (Java, C++, etc.)

Notion of computation vs. Concrete Implementations of Computation (Silicon chips, robots, Xbox, etc.)
No programming in this course!

- Not necessary for conceptual understanding

- Gives us more time for a broader coverage of computer science (broader than COS126!)

- No advantage to those who have prior programming experience
Brief history of computers / computation

- Technological:
  - Clocks
  - Clockwork “Automata”
  - Mechanized looms, steam engines
  - Vacuum tubes, electronic calculators (1910-1930’s)
  - ENIAC (1945)
  - von Neumann Computer (1949, Princeton)
Brief history of computers / computation (cont’d)

- Intellectual
  - Ancient Greeks, philosophers (“How to formalize thought?”)
  - Boolean logic (G. Boole, 1815-1864)
  - Crisis in math
    - Hilbert: Call to axiomatize math
    - Gödel: Incompleteness theorem
  - Lambda calculus (A. Church, 1936)
  - Turing machines (A. Turing, 1937)

Both at Princeton; First clear notion of “What is computation?”
Computer Science: A new way of looking at the world
Example 1:
Example 2: Public closed-ballot elections

- Hold an election in this room
  - Everyone can speak publicly (i.e. no computers, email, etc.)
  - At the end everyone must agree on who won and by what margin
  - No one should know which way anyone else voted

- Is this possible?
  - Yes! (A. Yao, Princeton)
Example 3: Computational Biology

Old Biology

New Biology

Microarrays

Pathways
COS 116 : Course structure

- First 10 lectures:
  - Cool things computers do and how

- Next 8 lectures:
  - What’s inside computers, Internet, silicon chips

- Last 6 lectures:
  - Complexity, cryptography, viruses, search engines, artificial intelligence
This week’s lab: Web 2.0

(Take-home Lab; pick up “manual” today)
Lab in Weeks 2 and 3: Scribbler. What determines its behavior?

(Each student gets one robot)
Some details

- 3 hour lab sessions:
  - Tue 7-10p, Wed 7-10p
  - Wed is CLOSED (may only switch Wed->Tue)
  - Not assigned a session yet? Come see us today after class!

- Precepts will be (as needed) start of labs

- This week’s lab is take-home: Web 2.0
Grading

- Final (in-class): 35%
- Lab reports (including questions): 35%
- Participation (in class, on blog): 15%
- Midterm (take-home): 15%

- Attendance at lectures is expected:
  - Homeworks / lab assignments are handed out and due in lecture
  - Will experiment with clickers