COS 116: The Computational Universe

Adam Finkelstein

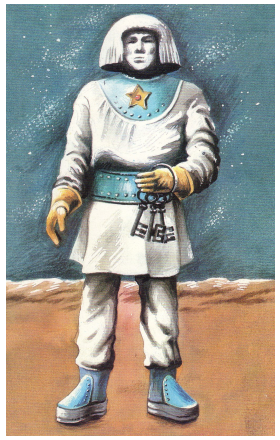
Spring 2010

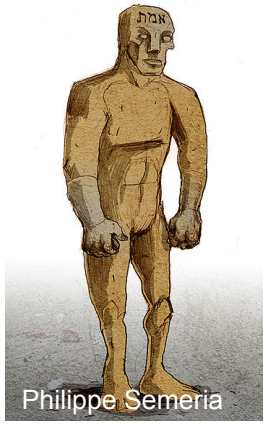
COS 116:
The Computational Universe

- Instructor: Adam Finkelstein
- TA: Vladimir Kim

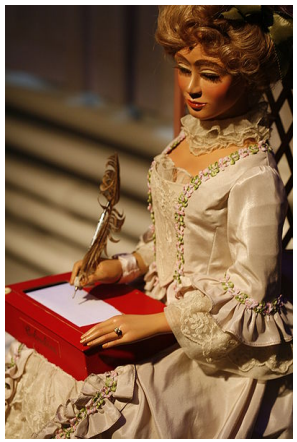
- Labs
  - Wed 7:30-10:20pm, Friend 007
  - This week only: take-home lab

Ancient dream: “Breathe life into matter”

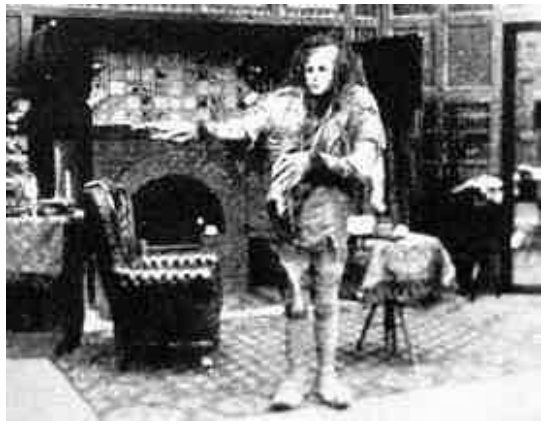




Golem (Jewish mythology)



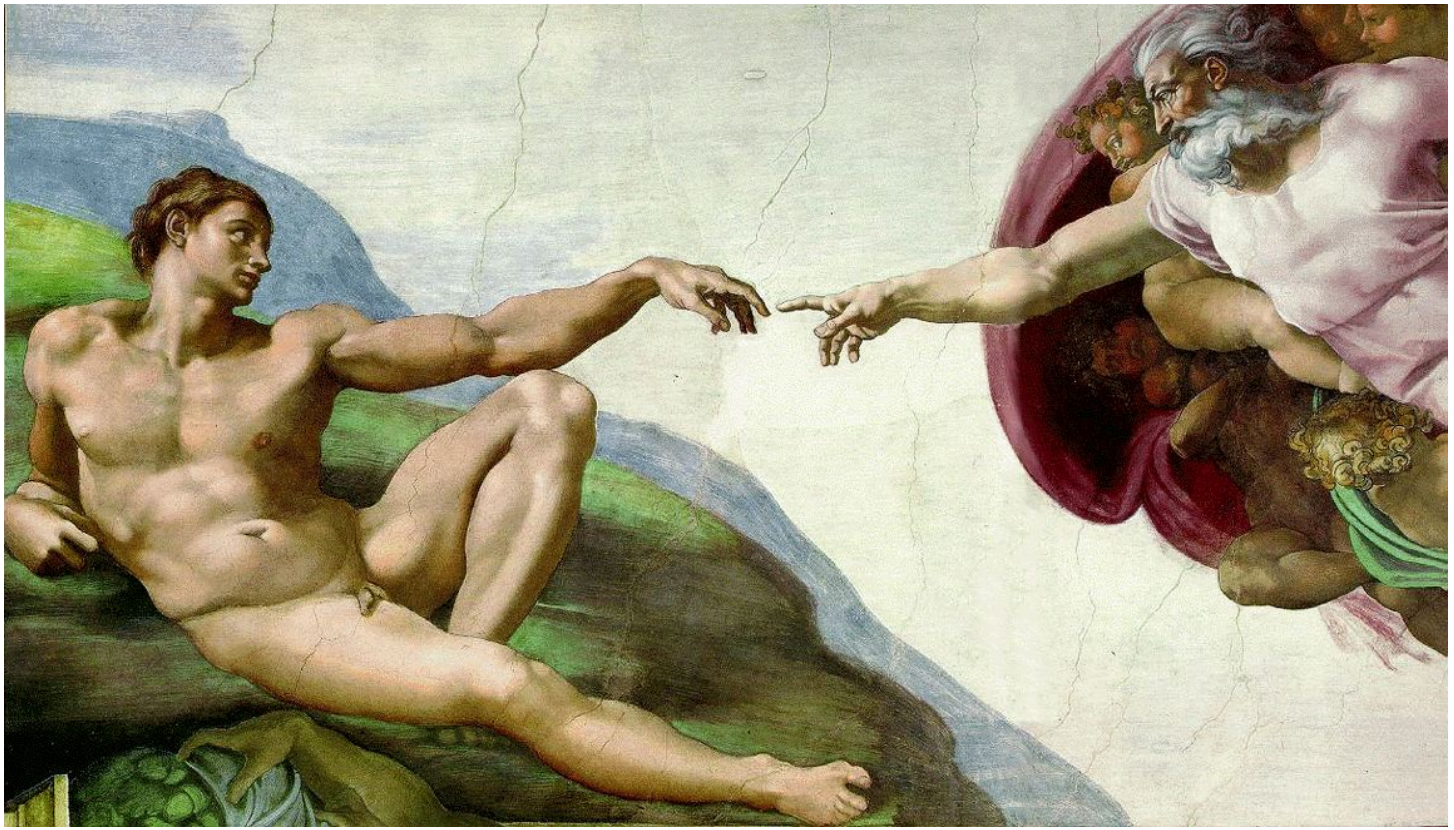
Automaton (Europe)



Frankenstein (Shelley 1818)

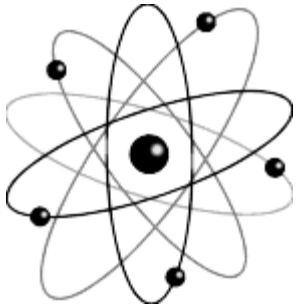
Robot (Capek 1920)

“Breathe life into matter” – Another perspective

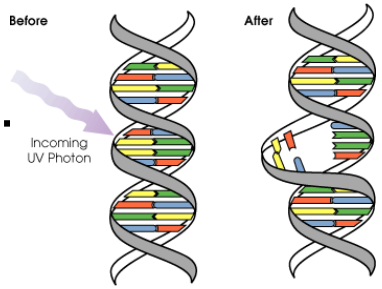


"Breathe life into matter" – A 20th century perspective

- "Matter": Atoms, molecules, quantum mechanics, relativity …

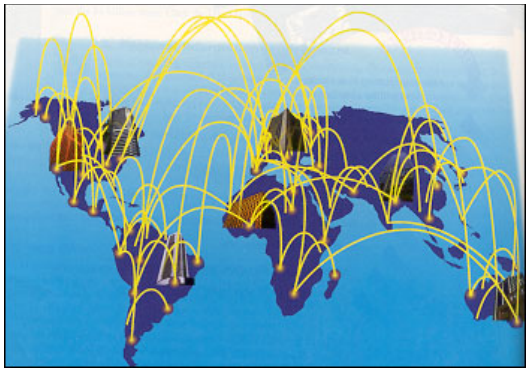


- "Life": Cells, nucleus, DNA, RNA, …



- "Breathe life into matter": Computation

One interpretation: Make matter do useful, interesting things <u>on its own</u>



Computational Universe

Google™

Some important distinctions

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

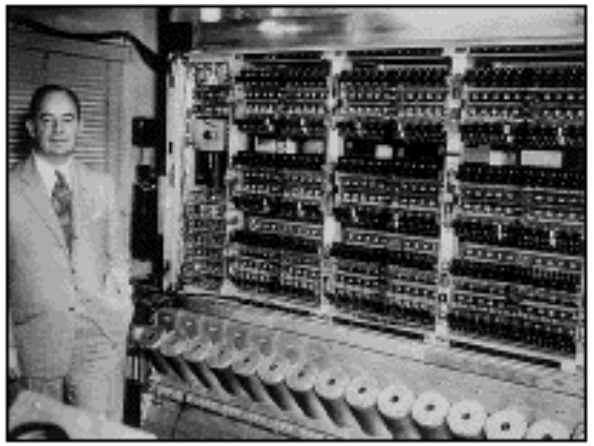
Notion of computation vs. Specific implementation (Silicon, robots, Xbox, etc.)

No programming in this course!

- Not necessary for understanding
- More time for to cover computer science (broader than COS126!)
- No advantage to those who have prior programming experience

Brief history of computation

- Technological:
  - Clocks
  - Clockwork “Automata”
  - Mechanized looms, steam engines
  - Vacuum tubes, electronic calculators (1910-1930’s)
  - ENIAC (1945)
  - von Neumann Computer (1949, Princeton)

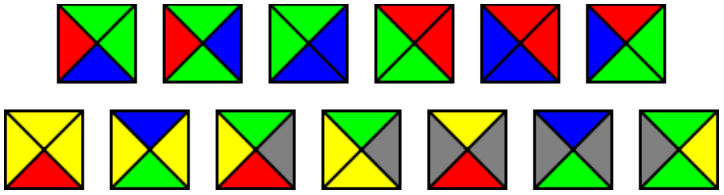


Brief history of computation

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

} Both at Princeton;

First clear notion of
“What is computation?”



Wang tiles 1961

Computer Science:
A new way of looking at the world

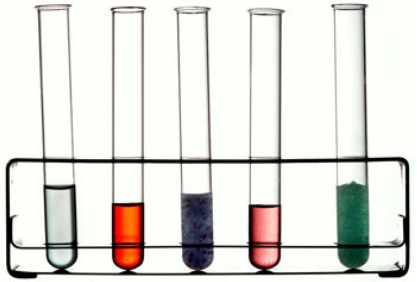
Example 1:

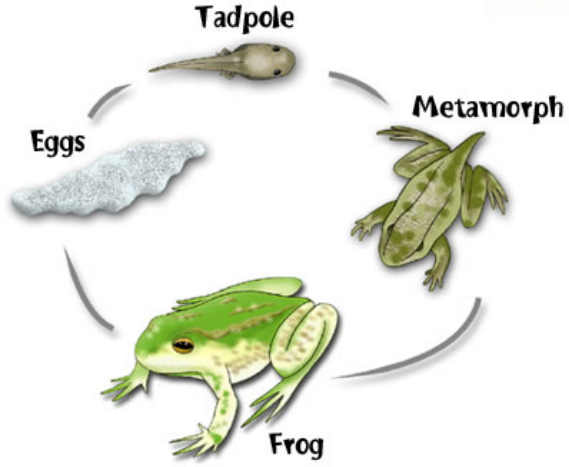
Example 2: Public closed-ballot elections

- Hold an election in this room
  - Everyone speaks publicly (no computers, email, etc.)
  - End: everyone agrees on who won and margin
  - No one knows how anyone else voted
- Is this possible?
  - Yes! (A. Yao, Princeton)

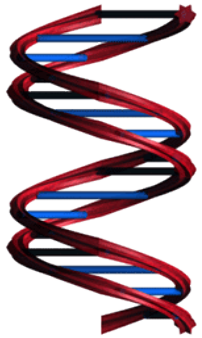
Example 3: Computational Biology

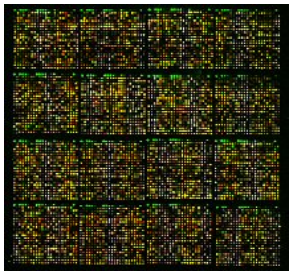
Old Biology



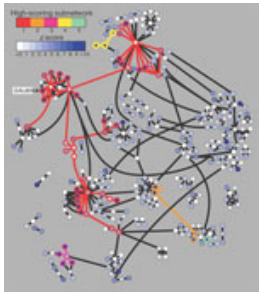


New Biology





Microarrays



Pathways

COS 116

- First 10 lectures:
  - Cool things computers do and how
- Next 8 lectures:
  - What's inside, internet, silicon chips
- Last 6 lectures:
  - Complexity, cryptography, viruses, search engines, artificial intelligence

This week's reading:
Brooks
pp 12-21, pp 32-51.

This week's lab: Web 2.0

(Take-home lab – will be posted by Wed afternoon)

Grading

- Midterm: 15%
- Final: 35%
- Lab reports: 35%
- Participation (class, blog): 15%

- Attendance expected at lectures and labs

Next couple labs: Scribbler. What determines its behavior?