COS 116: The Computational Universe

Sanjeev Arora
COS116: 2/5/08
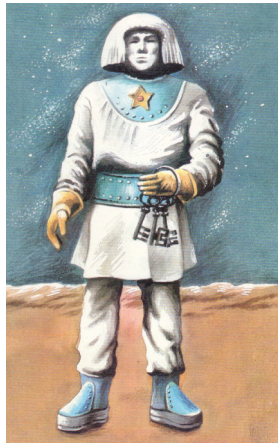
COS 116:
The Computational Universe

- Instructor: Sanjeev Arora
- Preceptors:
  - Ming-Tang Chen (mingchen@princeton)
  - Soner Sevinc (ssevinc@princeton)
  - Harlan Yu (harlanyu@princeton)
- Labs (room could still change)
  - Tues 7:30-10:30pm (Friend 007)
  - Wed 7:30-10:30pm (Friend 005)
- This week: Take-home lab (see handout)
- FILL OUT QUESTIONNAIRE

Ancient dream of man: "Breathe life into matter"

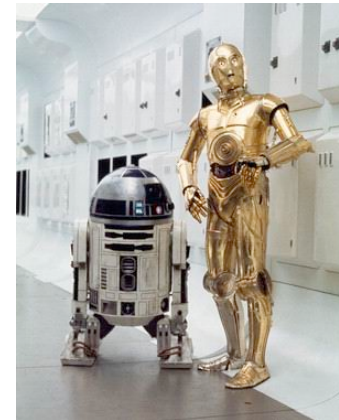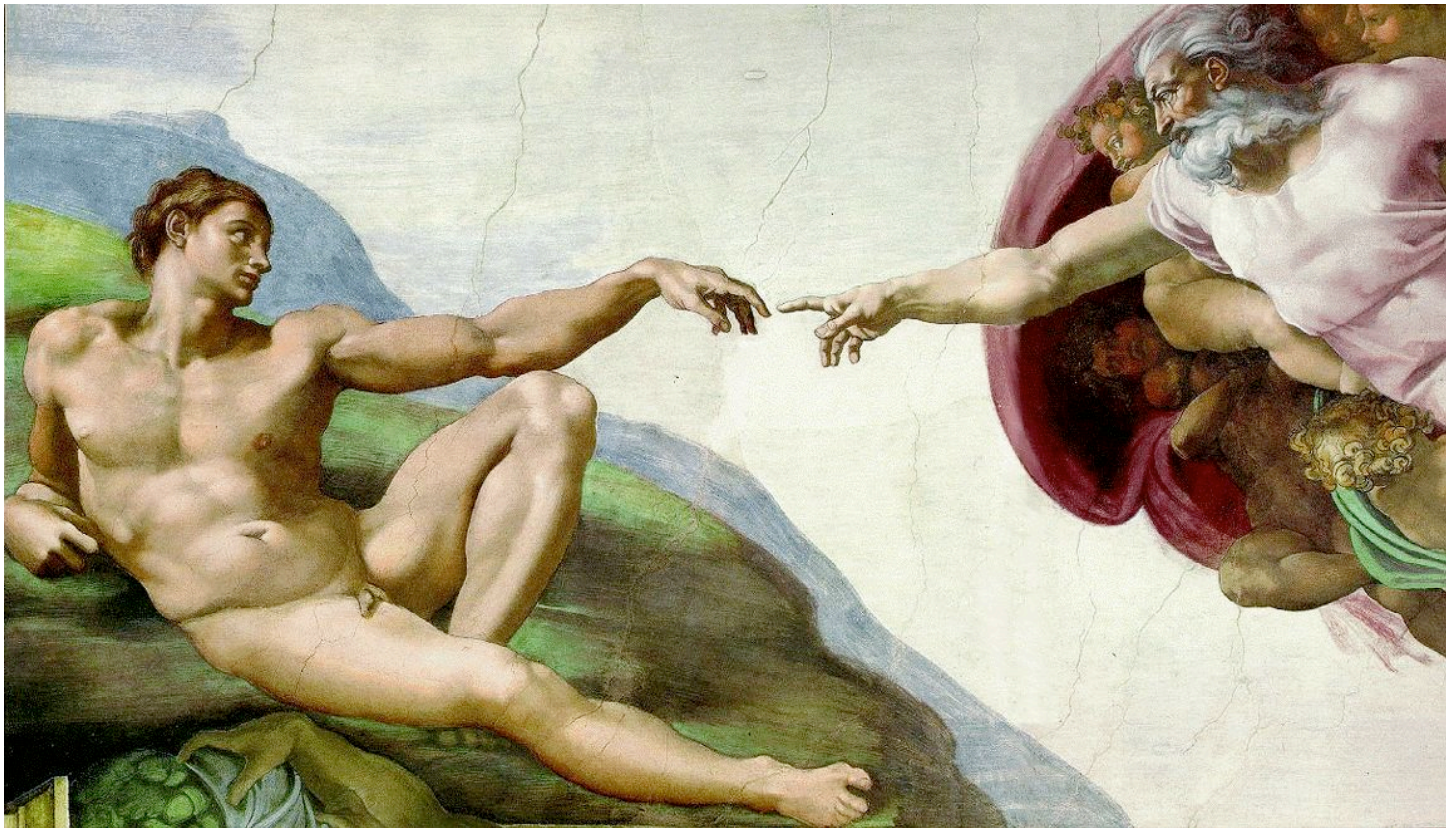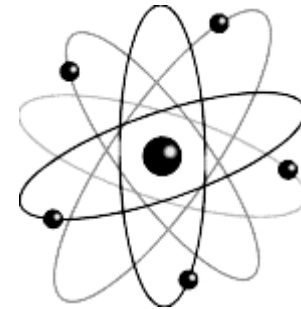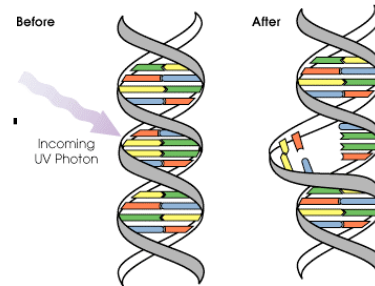|	
Golem (Jewish mythology)	"Automata", (South Germany or Spain, c. 1560) Also,chess automata
Frankenstein (Mary Shelley, 1818)	Robot (Karel Capek, 1921)

"Breathe life into matter" – Another perspective

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

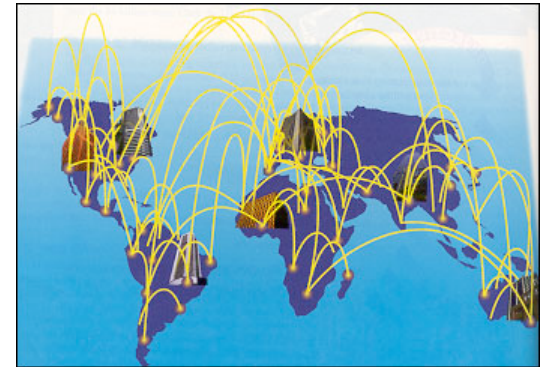- "Matter": Atoms, molecules, quantum mechanics, relativity …

- "Life": Cells, nucleus, DNA, RNA, …

- "Breath life into matter": Computation

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

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 significant advantage to those who have prior programming experience
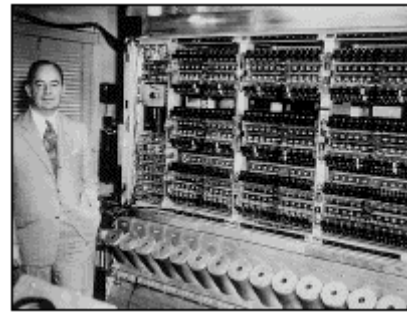
Some labs/lectures use "pseudocode"

Brief history of computers / computation

- **Technological:**
  - Clocks
  - Clockwork "Automata"
  - Mechanized looms, steam engines (18th century)
  - 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?"
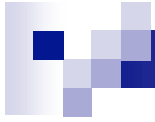
Computer Science:
# A new way of looking at the world

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

Tadpole

Metamorph

Eggs

Frog

New Biology

Microarrays

Pathways
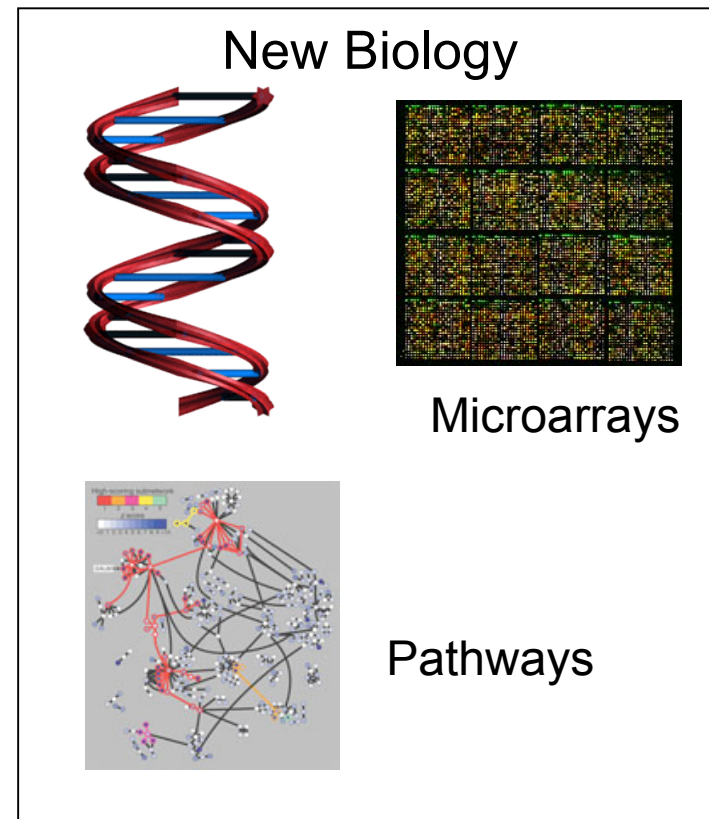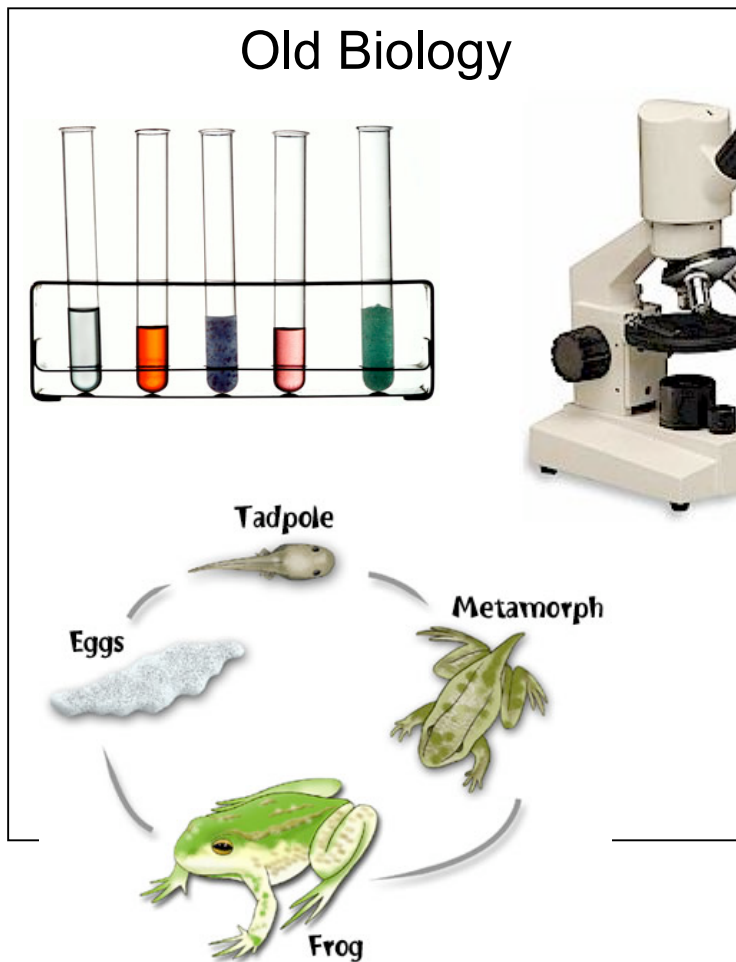
COS 116 : Course structure

- **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

Text

This week:
Read pp 3-31
(handout)

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; attendance compulsory:
  - Tue 7:30-10:30p, Wed 7:30-10:30pm
- Precepts will be (as needed) at start of labs. Arrive on time!
- This week's lab is take-home: Web 2.0

Not enrolled yet? Got questions? See instructor.

Grading

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

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