A COURSE ON PROGRAMMING AND PROBLEM SOLVING

Swapneel Sheth, Chris Murphy, Ken Ross, Dennis Shasha

University of Pennsylvania
Columbia University
New York University

http://programming-and-problem-solving.github.io/

PROGRAMMING AND PROBLEM SOLVING

- Originally taught by Donald Knuth at Stanford in the 1970s
- Later taught by Ken Ross at Columbia since 1999
- Taught by Swapneel Sheth and Chris Murphy at Penn since 2013
- Taught by Dennis Shasha at NYU since 2001

- NO exams
- NO homework
- NO (expensive) textbooks
- NO lectures

- 4 open-ended projects
- No “correct”answers

WHAT IS COMPUTER SCIENCE?

Computer Science is an activity in which we **create**, **implement**, **analyze**, and **communicate** solutions to algorithmic problems

EDUCATIONAL OBJECTIVES

- Emphasize four aspects of problem solving:
  - Create/Think about an approach (develop intuition, identify algorithms, data structures)
  - Implement a solution (programming, reuse and modify code, team collaboration)
  - Analyze the results (understand behavior)
  - Communicate your solution to others (group discussion, written reports, presentation, incorporate feedback from others)

EDUCATIONAL OBJECTIVES (2)

- Using Bloom's taxonomy:
  - A lot of courses focus on "knowledge" and "comprehension"
  - This course focuses on "analysis," "synthesis," and "evaluation"
- Problem-Based Learning (PBL)

COURSE DETAILS

- Intended Audience
  - Upperclassmen and graduate students
  - Prerequisites: Data Structures, Algorithms, 2+ years of programming experience
  - Recommended: Machine Learning, Artificial Intelligence, etc.
- Class Size and Teams
  - 20-30 students; teams of size 3-4
  - New teams for each project; two students cannot work together more than once

COURSE DETAILS (2)

- Course Structure
  - 4 projects, roughly 3 weeks each
  - Start: introduce problem; provide simulator, GUI, API; team formation
  - Students work with their groups outside of class time
  - Subsequent Class Meetings: discuss students' insights and ideas; demonstrate progress; demos; cooperative problem solving
  - End: Tournaments run by TA

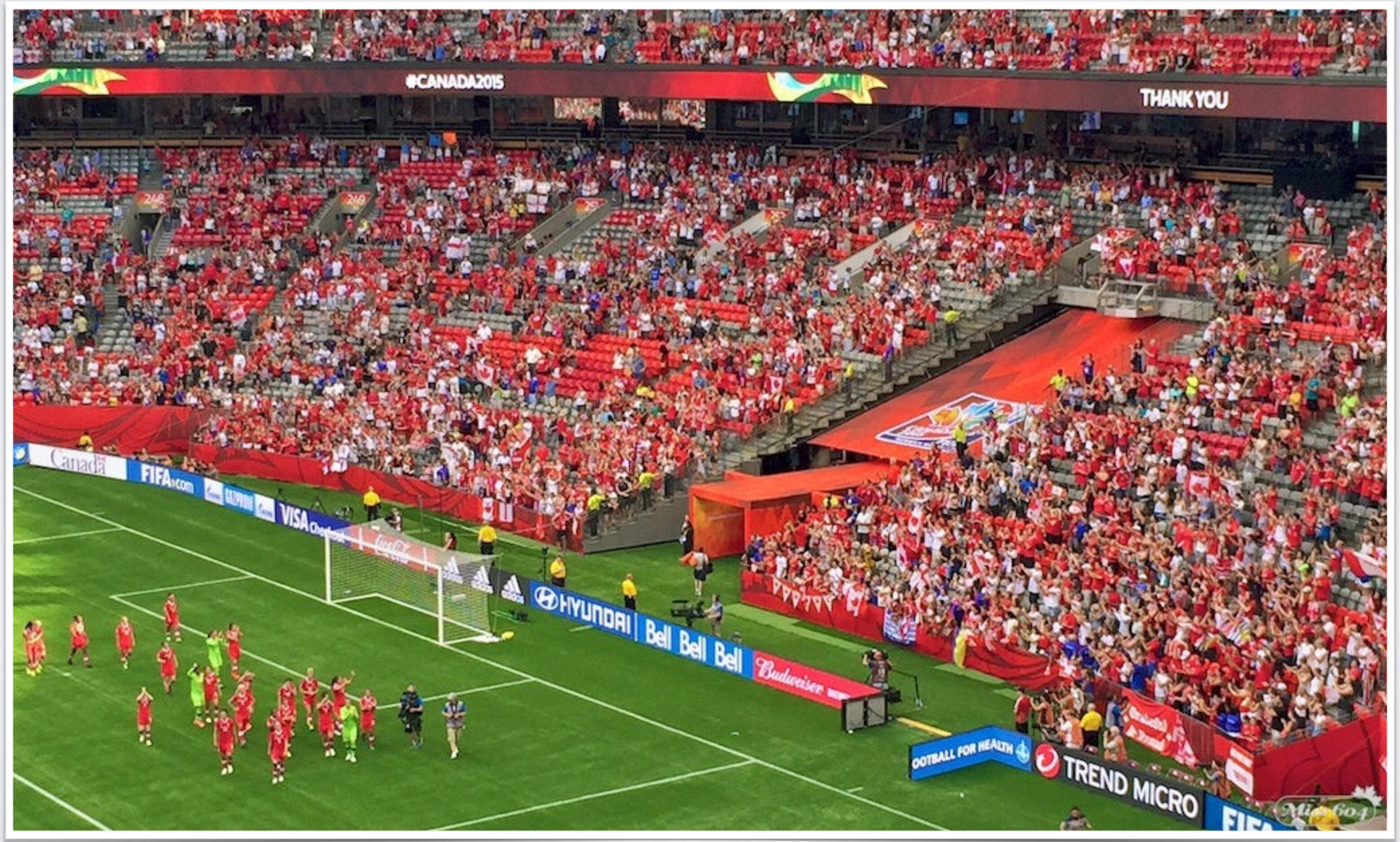
COURSE DETAILS (3)

- Open Source Nature
  - Steal other people's ideas/code!
  - But you must attribute/cite it
- Communication and Presentation
  - Final report containing details of solution, analysis of approach, overview of implementation, analysis of tournament results
  - 10 minute presentation in class

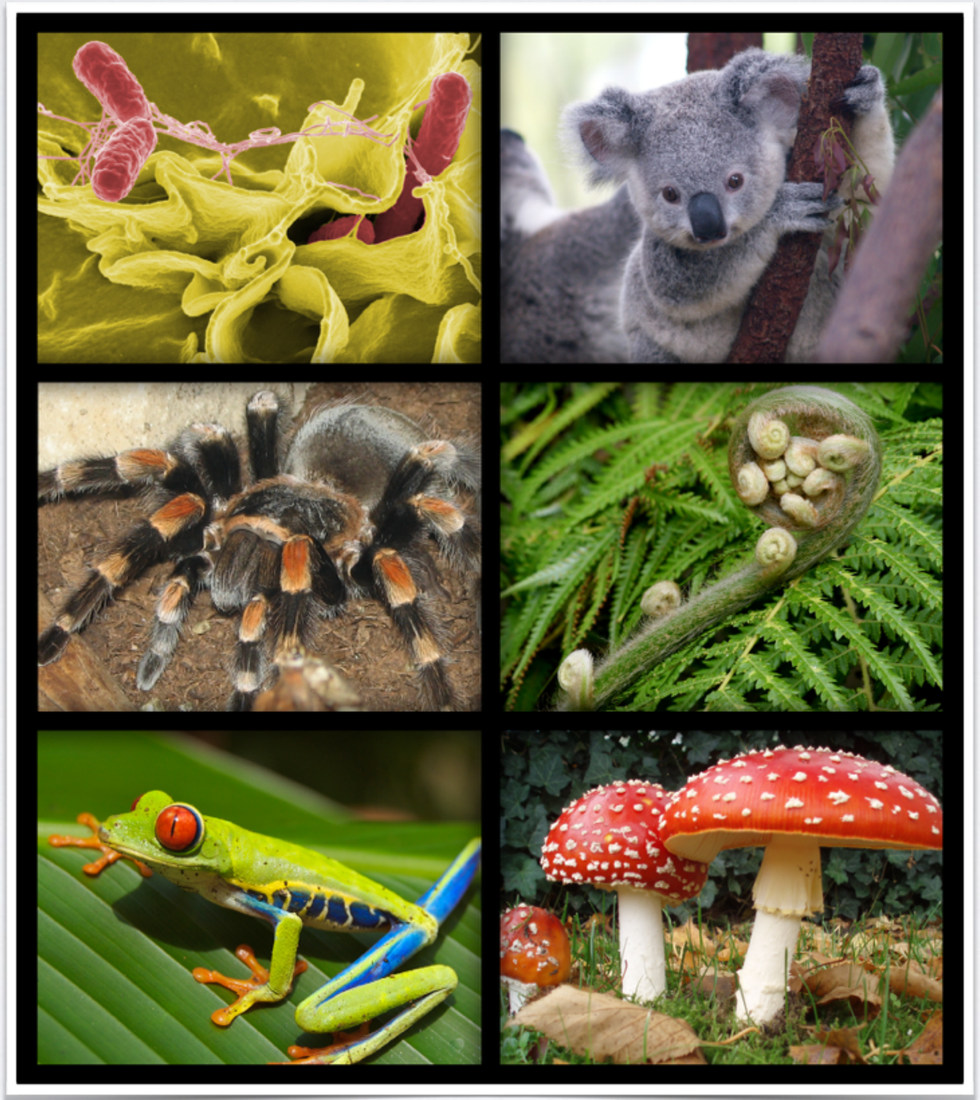
COURSE DETAILS (4)

- Evaluation and Grades
  - Novelty of Approach
  - Correctness, Generality, and Efficiency of the solution
  - Thoroughness and Clarity of report and presentation
  - Class participation (attendance is mandatory!)
  - Peer Evaluations

PROBLEM 1 - PARALLEL SOCCER

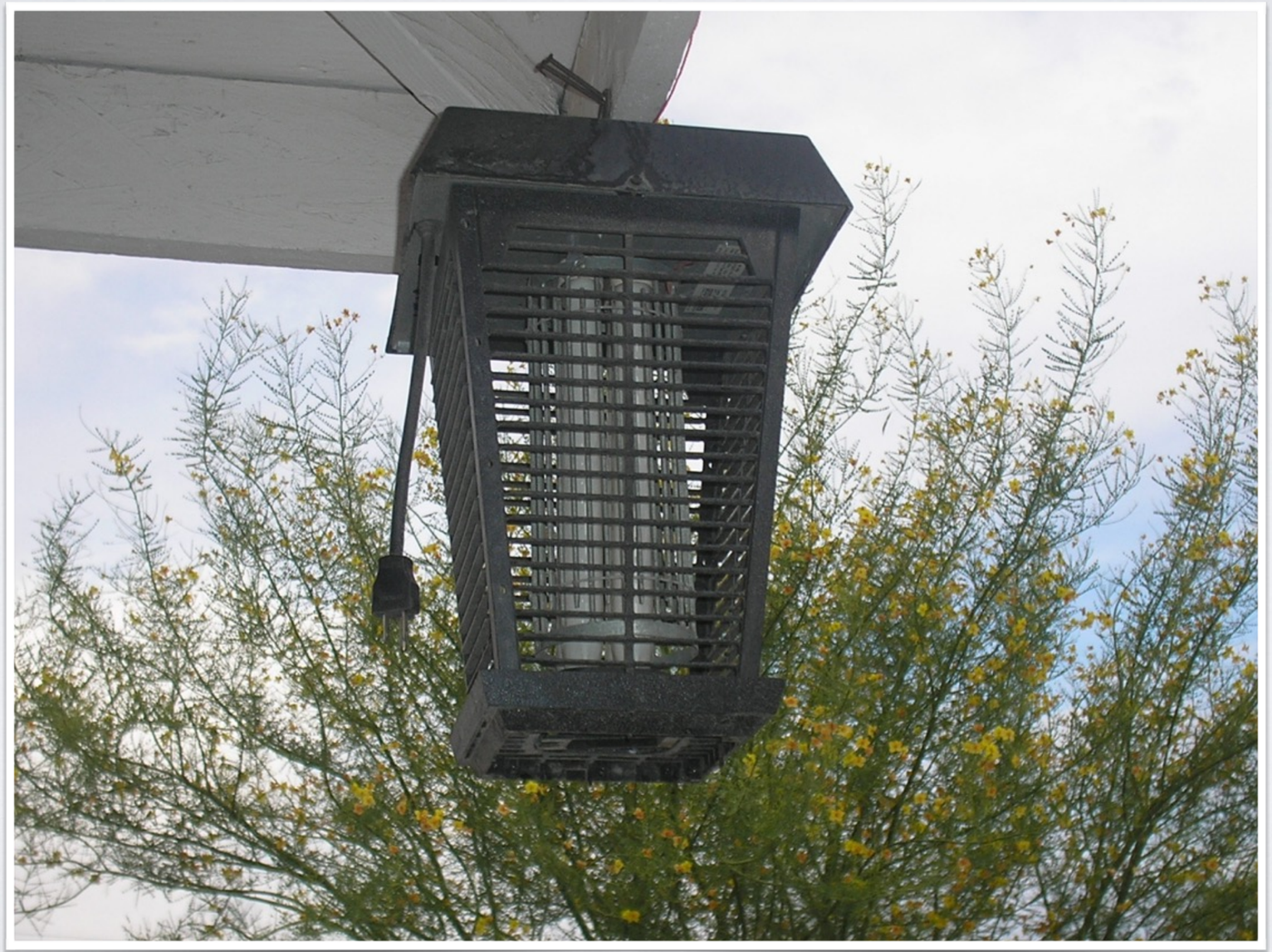


PROBLEM 2 - ORGANISMS



PROBLEM 3 - GUNSLINGER

PROBLEM 4 - MOSQUITO



DEMO

OUTCOMES

- The class has been taught 35+ times across 3 institutions by the authors
- More details in the paper

WANT TO ADOPT THIS COURSE?

- Recommendations and Advice
  - Teaching the class; What makes a good problem?
- Repository of Existing Problems available
  - Three different sets of problems maintained at the three institutions
  - 85+ problems available
  - For all problems - code, GUI, simulators available

programming-and-problem-solving.github.io