

Last Class

Chris Piech

CS 106B
Lecture 25
Mar 11, 2016

Today's Goal

1. Know where you came from
2. Show you where you could go



Final notes

Final Exam

Dink Aud + Cub Aud

Monday, March/14,

8:30am-11:30am

Final Exam Location

Last Name Location

A–G : Cubberley Aud

H–Z : Dinklespiel Aud.

Final Exam

Short answer
question

Class
Implementation

Recursion

Linear Structures +
Hashing

Trees

Graphs

Challenge Question

Practice Exam 1

Short answer
question

Class
Implementation

Recursion

Linear Structures +
Hashing

Trees

Graphs

Challenge Question

Practice Exam 2

Short answer
question

Class
Implement-
ation

Recursion

Trees

Graphs

Challenge Question

Practice Exam Sitting

Hewlett 200,
Saturday, March/12,
11am-2pm.

Extra Office Hours

Today,
3pm-4:30pm
Conceptual

Leave a Review on Axess



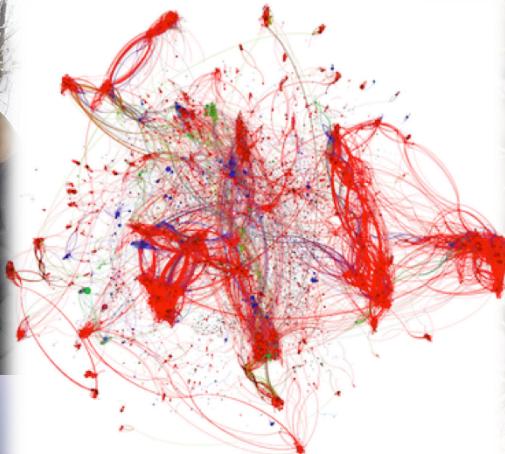
CS 106B Montage

First Day of Class



Hi, I'm Chris

Chris Piech (piech@cs.stanford.edu)



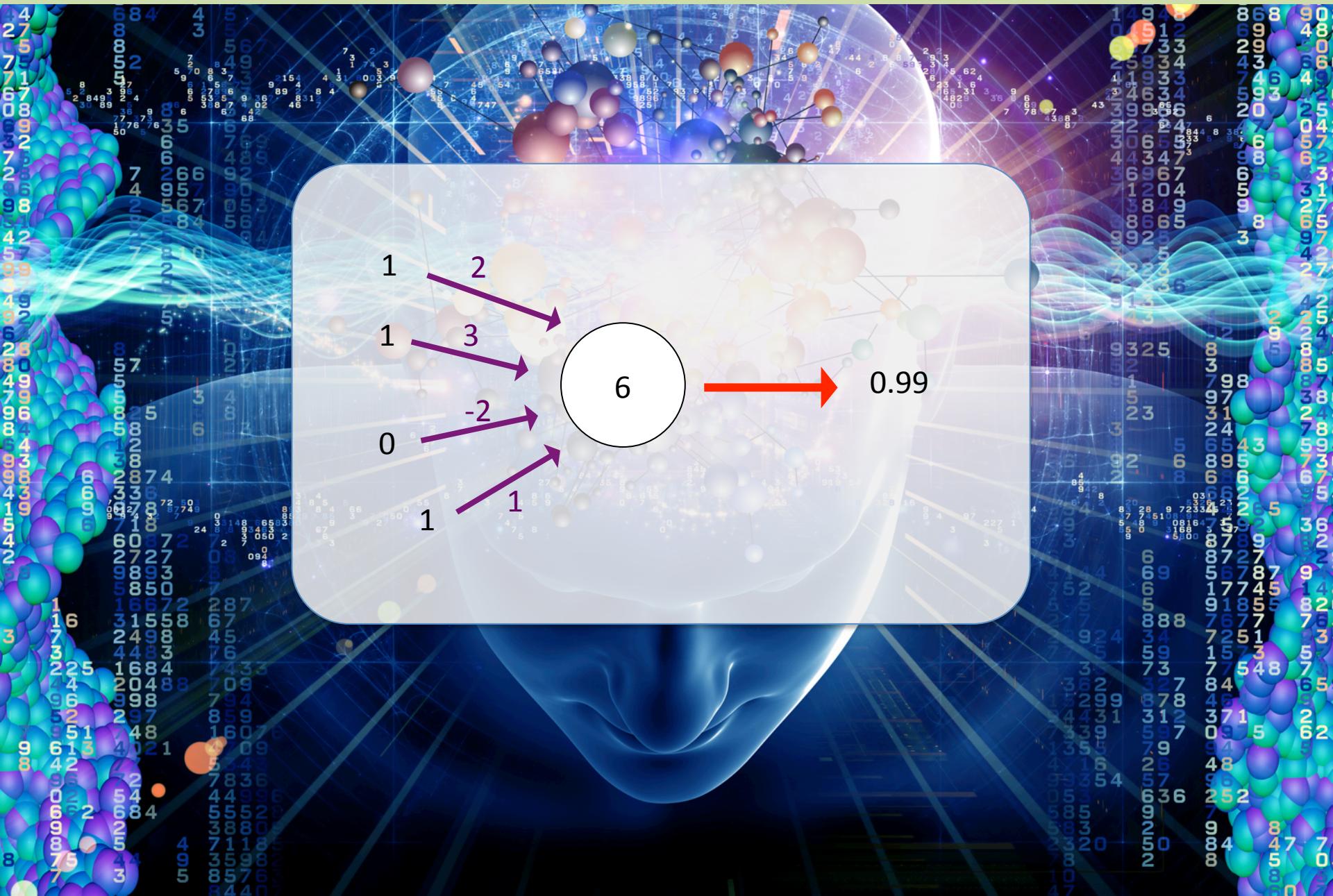
Who are You?

- African Studies
- Applied Physics
- Bioengineering
- Biology
- Business Administration
- Chemical Engineering
- Chemistry
- Classics
- Civil and Environmental Engineering
- Computational and Mathematical Engineering
- Computer Science
- Creative Writing
- East Asian Studies
- Economics
- Education
- Electrical Engineering
- Energy Resource Engineering
- English
- Financial Mathematics
- Film and Media Studies
- French
- History
- International Relations
- Japanese
- Law
- Materials Science and Engineering
- Mathematical and Computational Sciences
- Mathematics
- Mechanical Engineering
- Medicine
- Management Science and Engineering
- Modern Language
- Music
- Neuroscience
- Physics
- Political Science
- Psychology
- Science, Technology, and Society
- Statistics
- Symbolic Systems
- Undeclared!

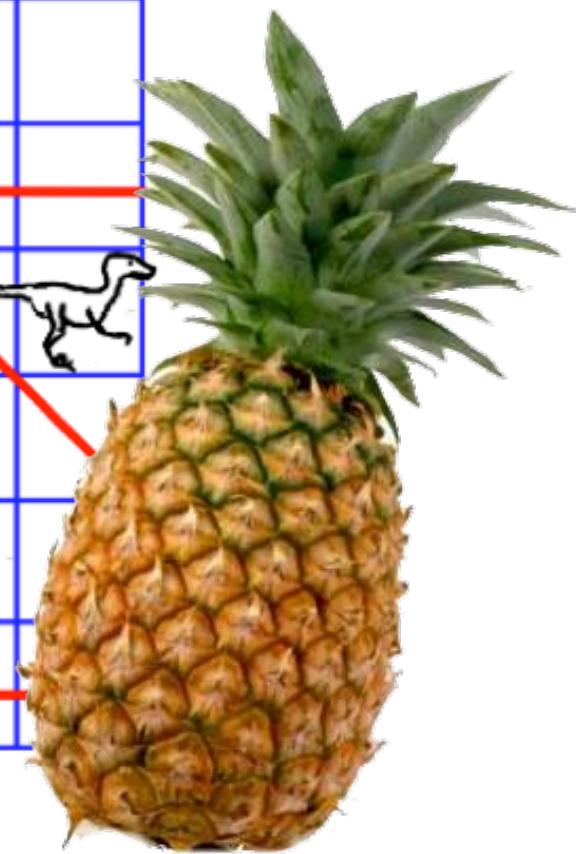
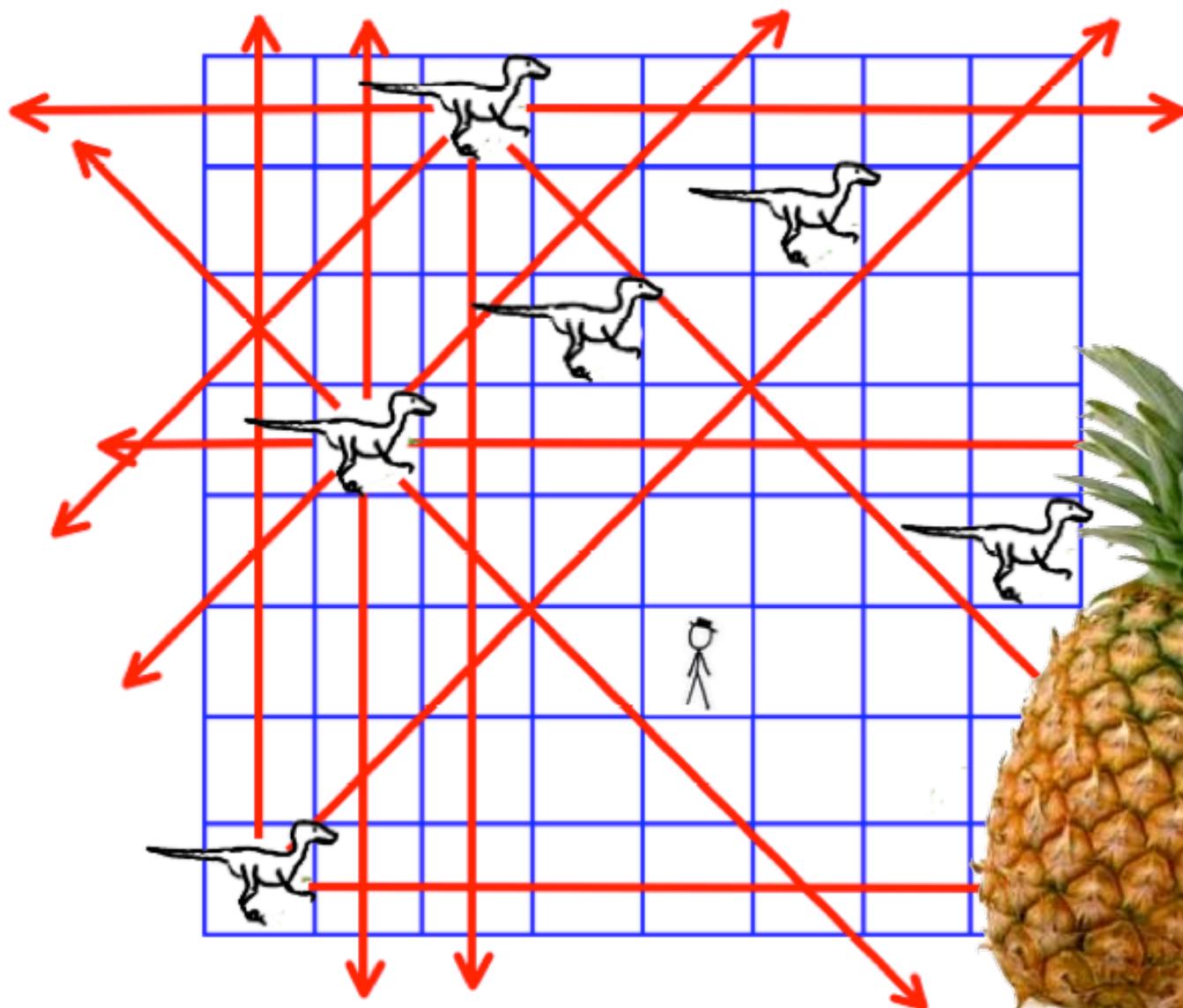
Class Two



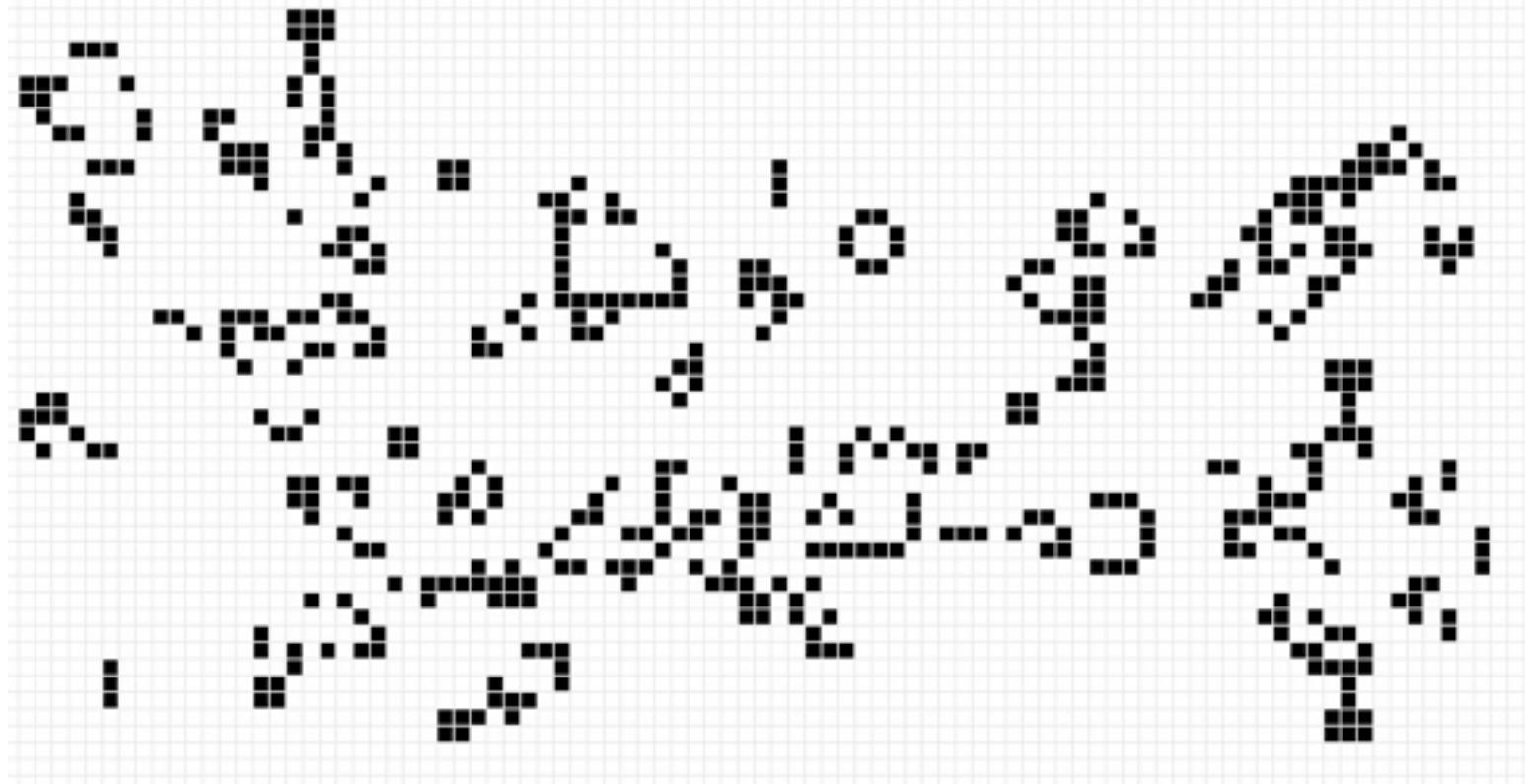
Functions and Parameters



Velociraptor Safety



Life



Karplus Algorithm: Sample

1. Average these two numbers and enqueue the result * 0.997

0.01	0.16	0.31	0.45	0.58	...
------	------	------	------	------	-----



Front of the queue

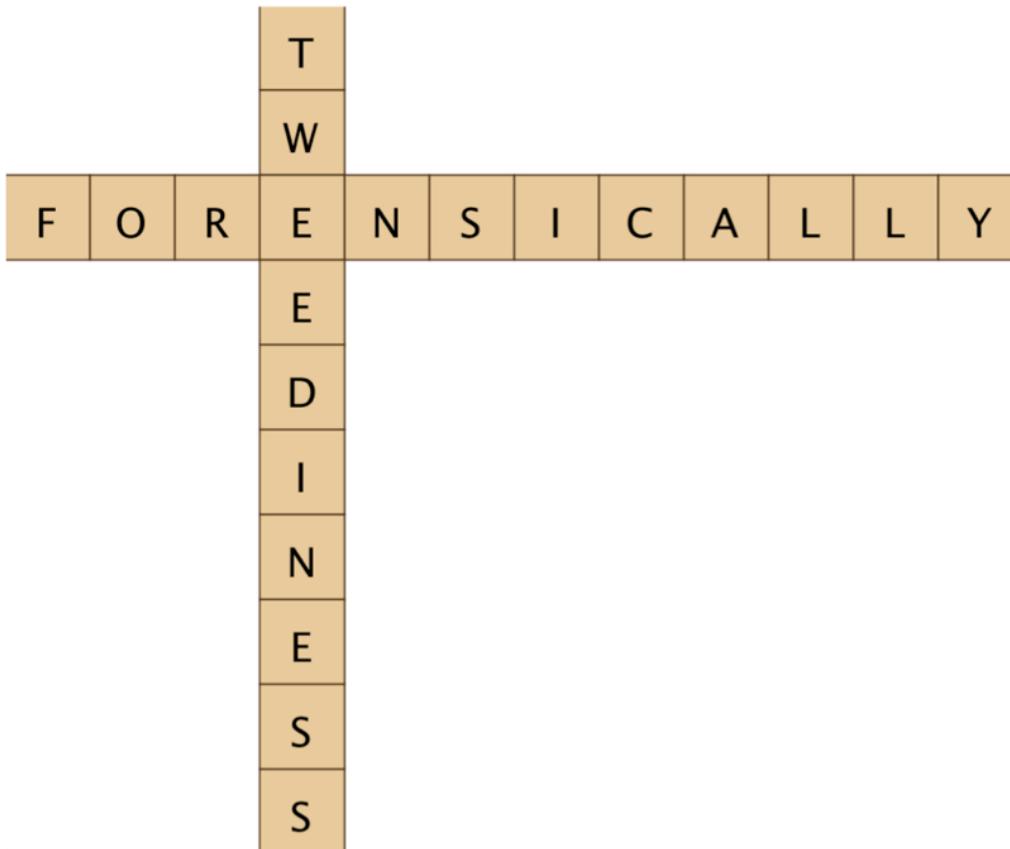
M Pedigree



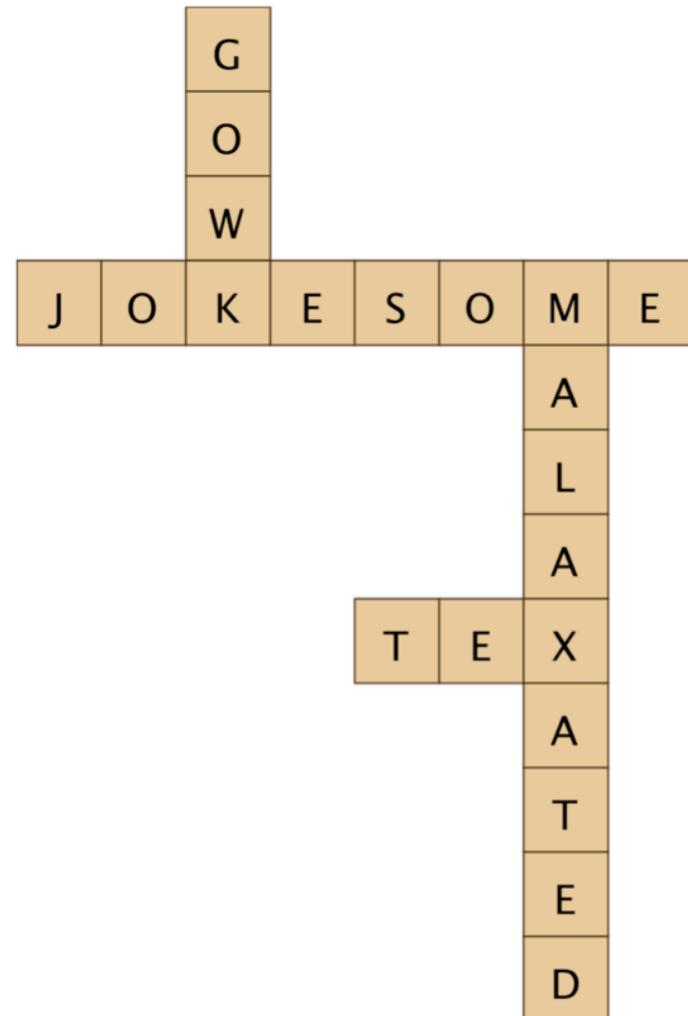
Bright Simons

First Ever Banangrams

Tiles: LEFNWDRELCAIEIYNSOSST



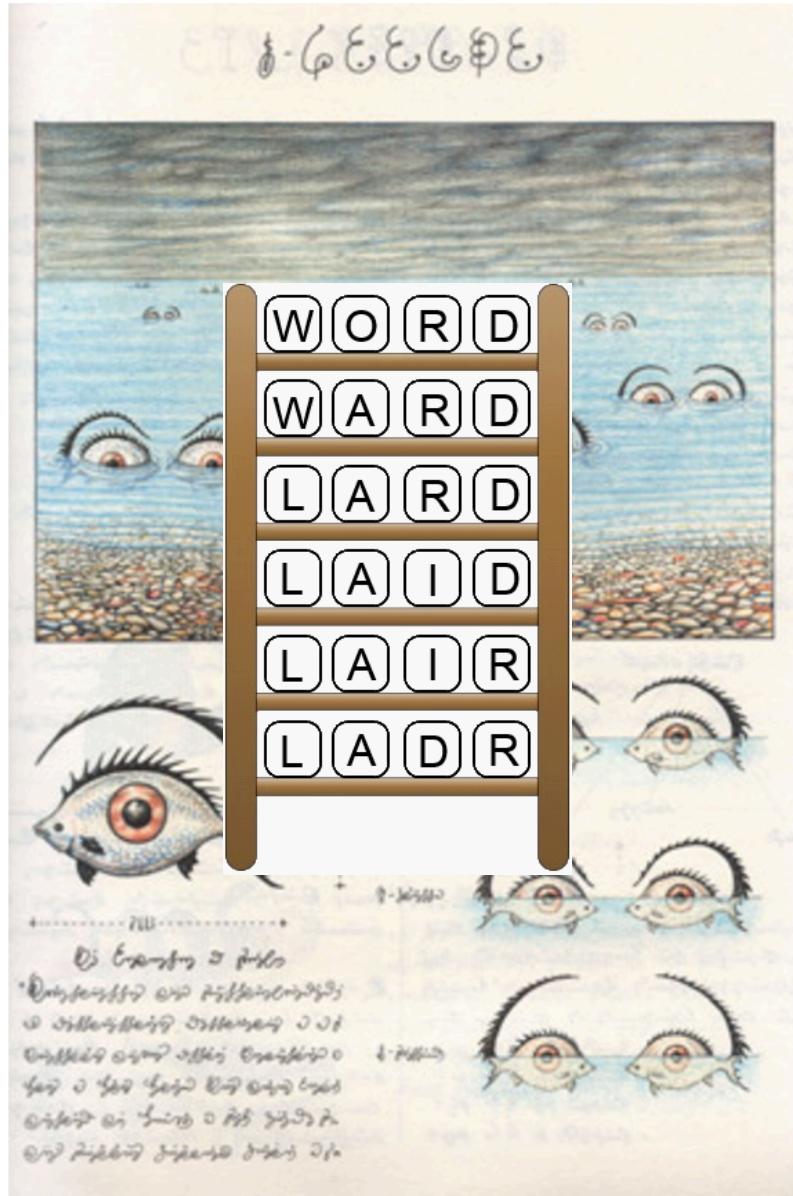
Tiles: DTGEMAOTOWKJEAAESELXO



Duolingo



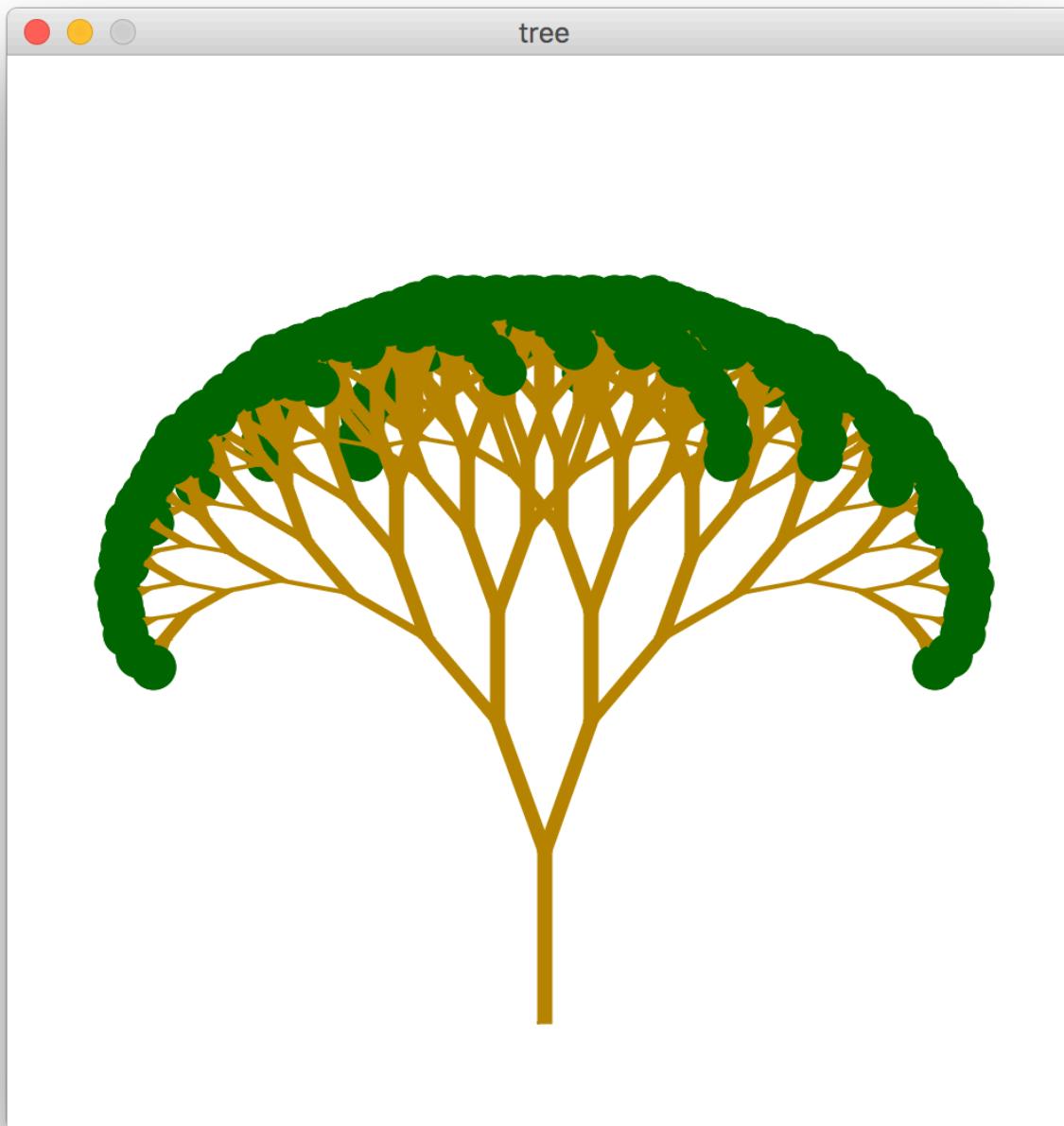
Serafini



Towers of Hanoi



Pythagoreas Tree



Meta Academy



META

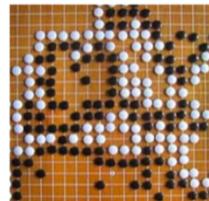
ACADEMY

Labyrinth



Alpha Go

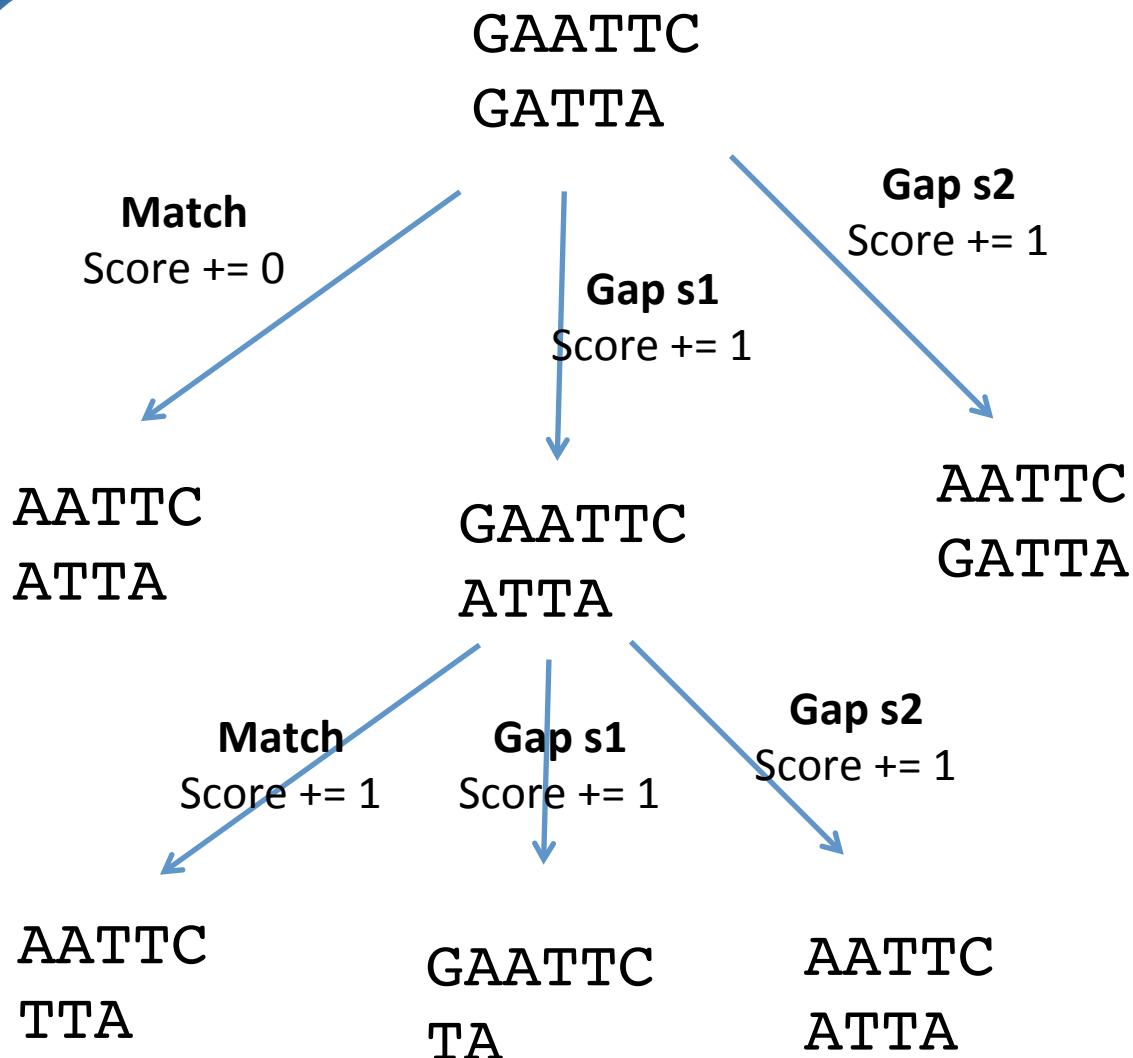
$\mathcal{O}(n^2!)$



Only search moves
that the policy network
says are good

When you get deep.
stop. Use value
network to eval.

DNA Alignment

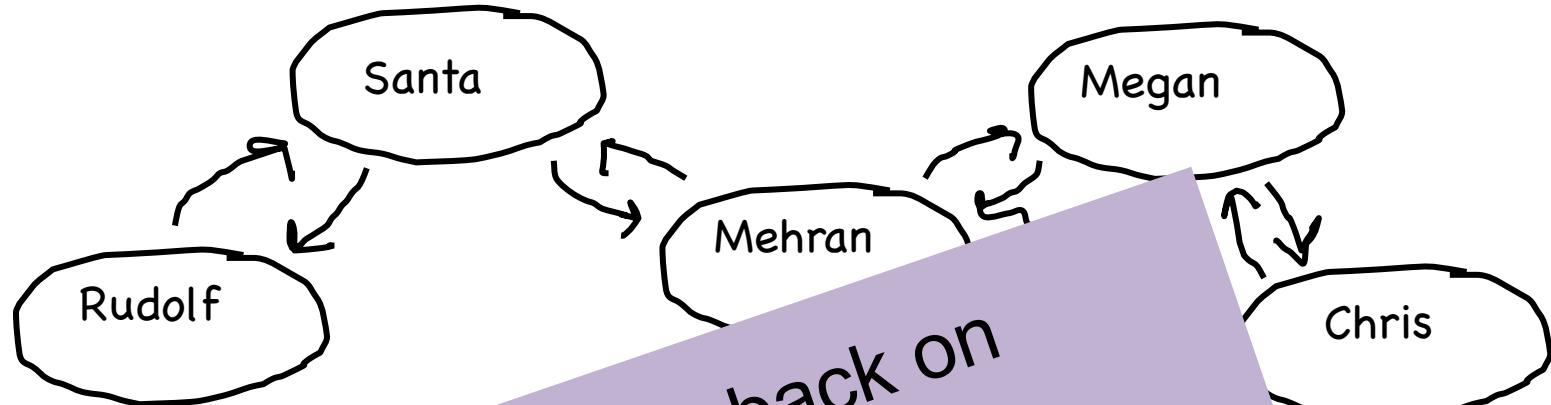


Boggle



Midterm

Midterm



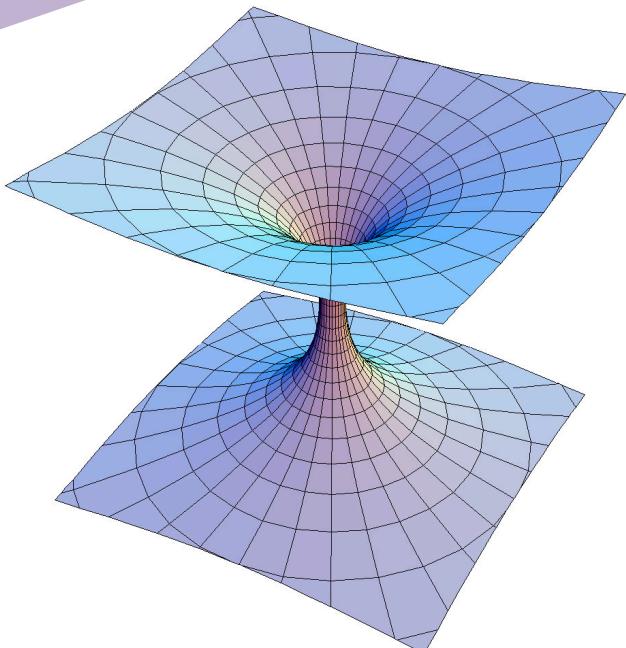
Get them back on
Wednesday

PANDORA
internet radio

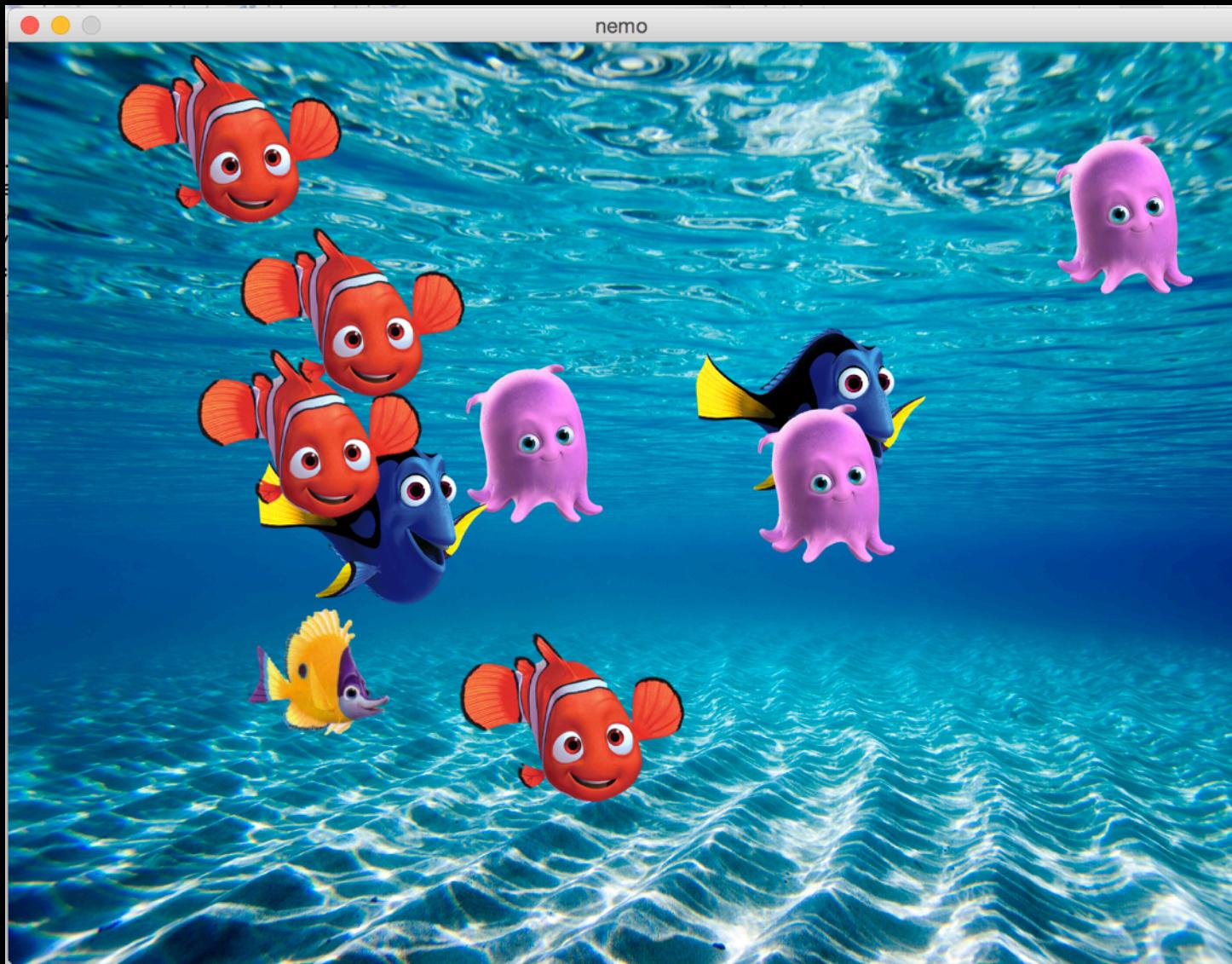
Tell us your favorite song and we'll create a station that explores that part of the music universe.

Enter Song

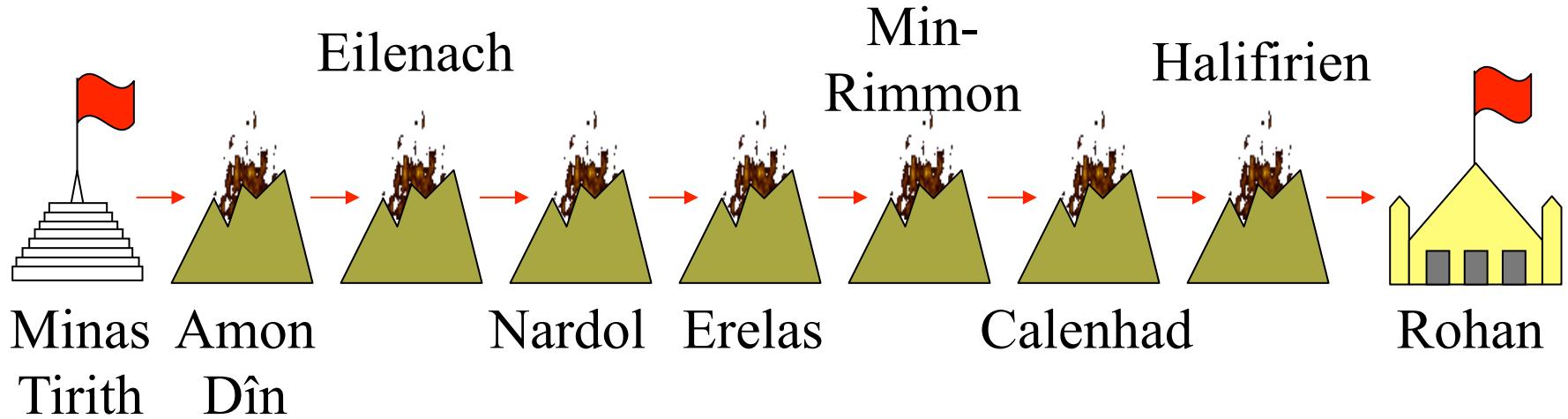
Create



Pointers + Class Example

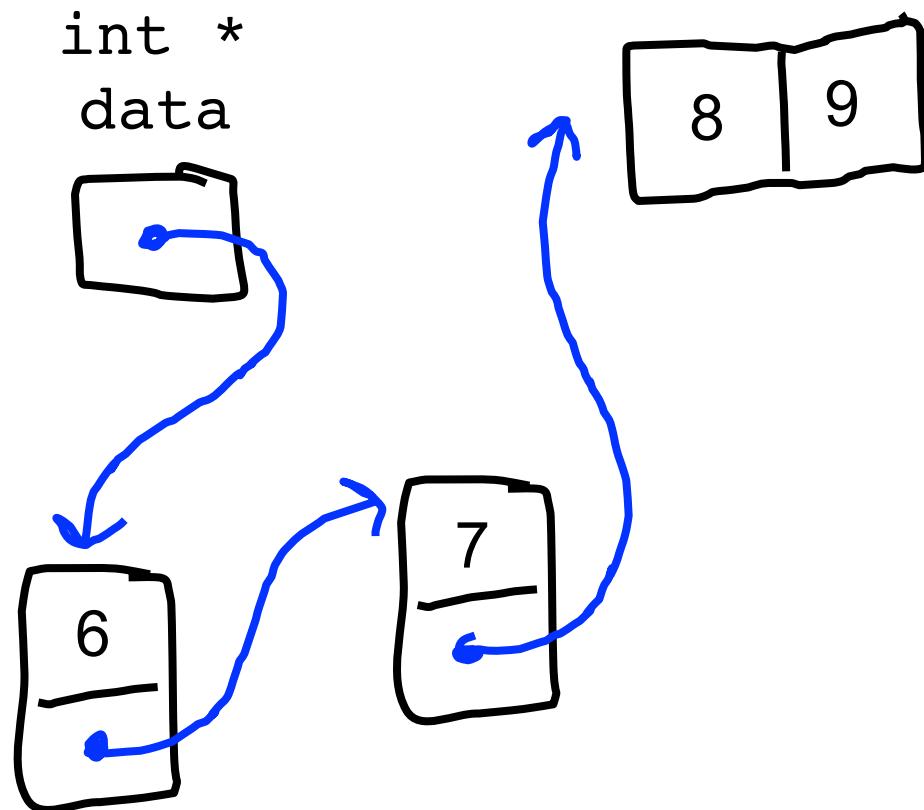


Beacons of Gondor



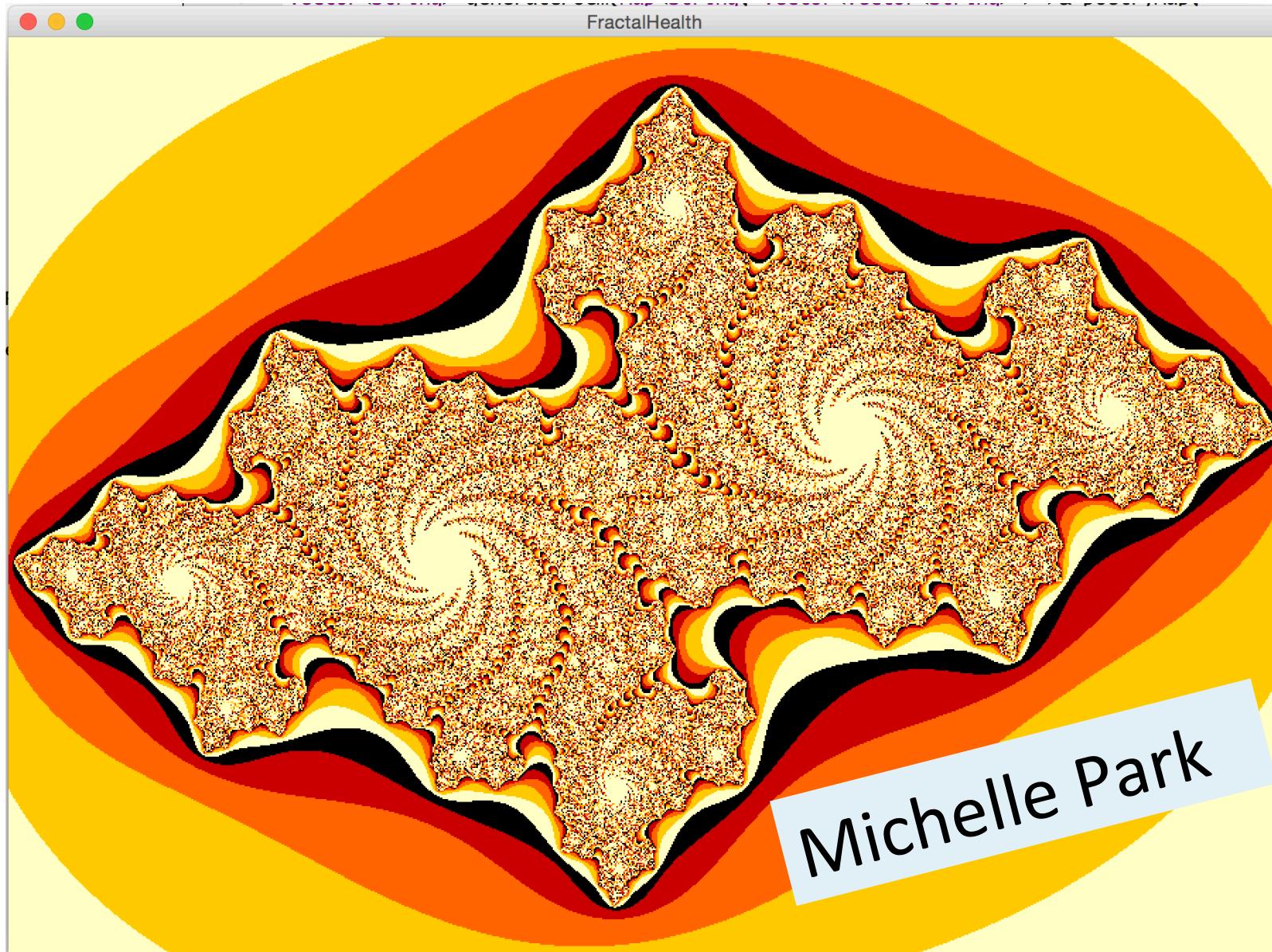
```
// add a new tower
Tower * temp = new Tower;
temp->name = towerName;
temp->link = head;
head = temp;
```

Implemented Collections

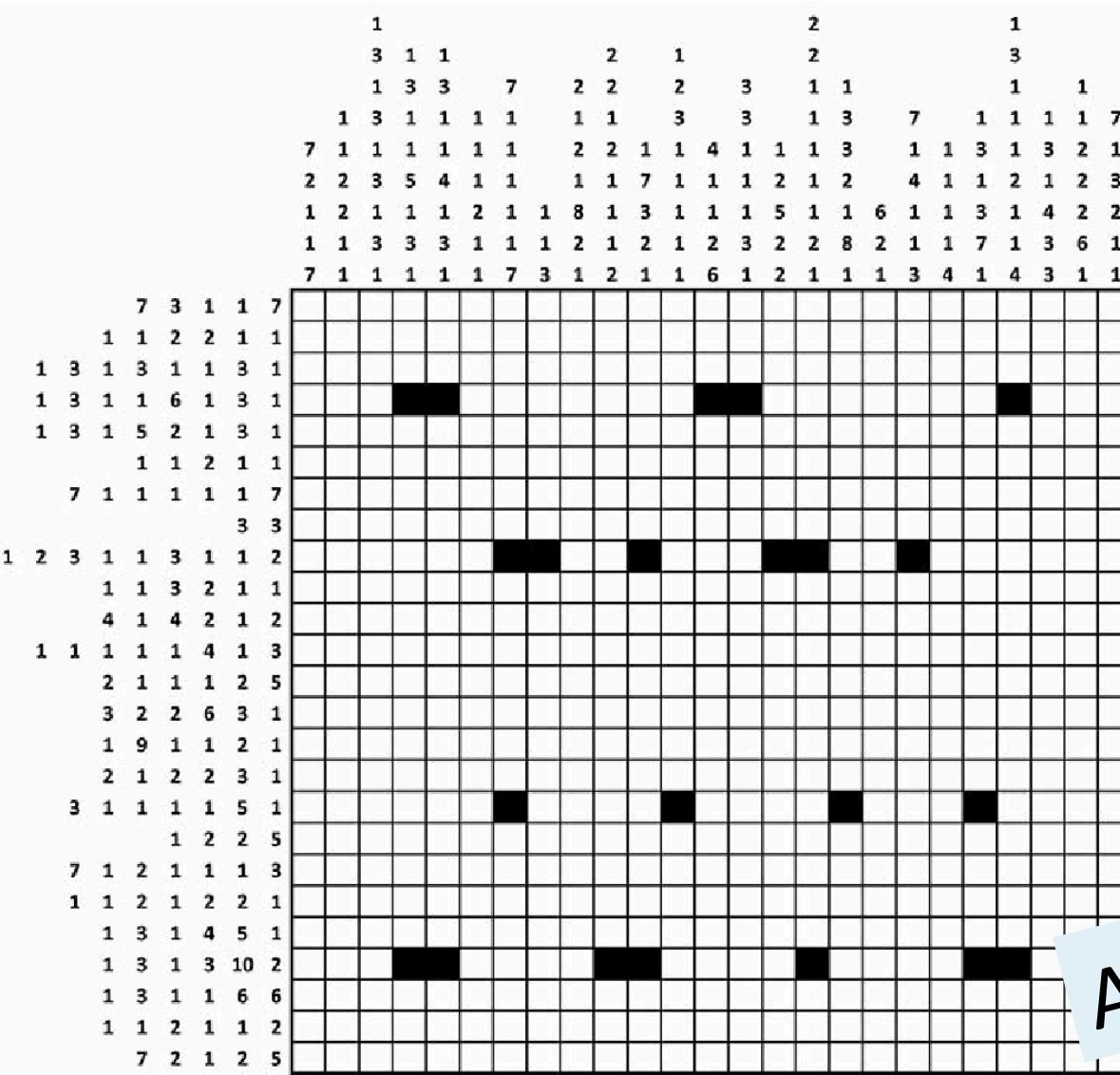


push(6);

Contest Winner: Creativity



Contest Winner: Algorithmic



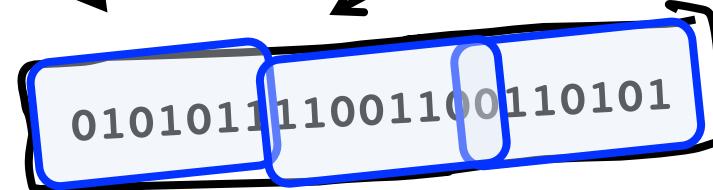
Ali Malik

Evolving Art

Species * parent1



Species * parent2





IT'S A CHRISTMAS TREE WITH A
HEAP OF PRESENTS UNDERNEATH!

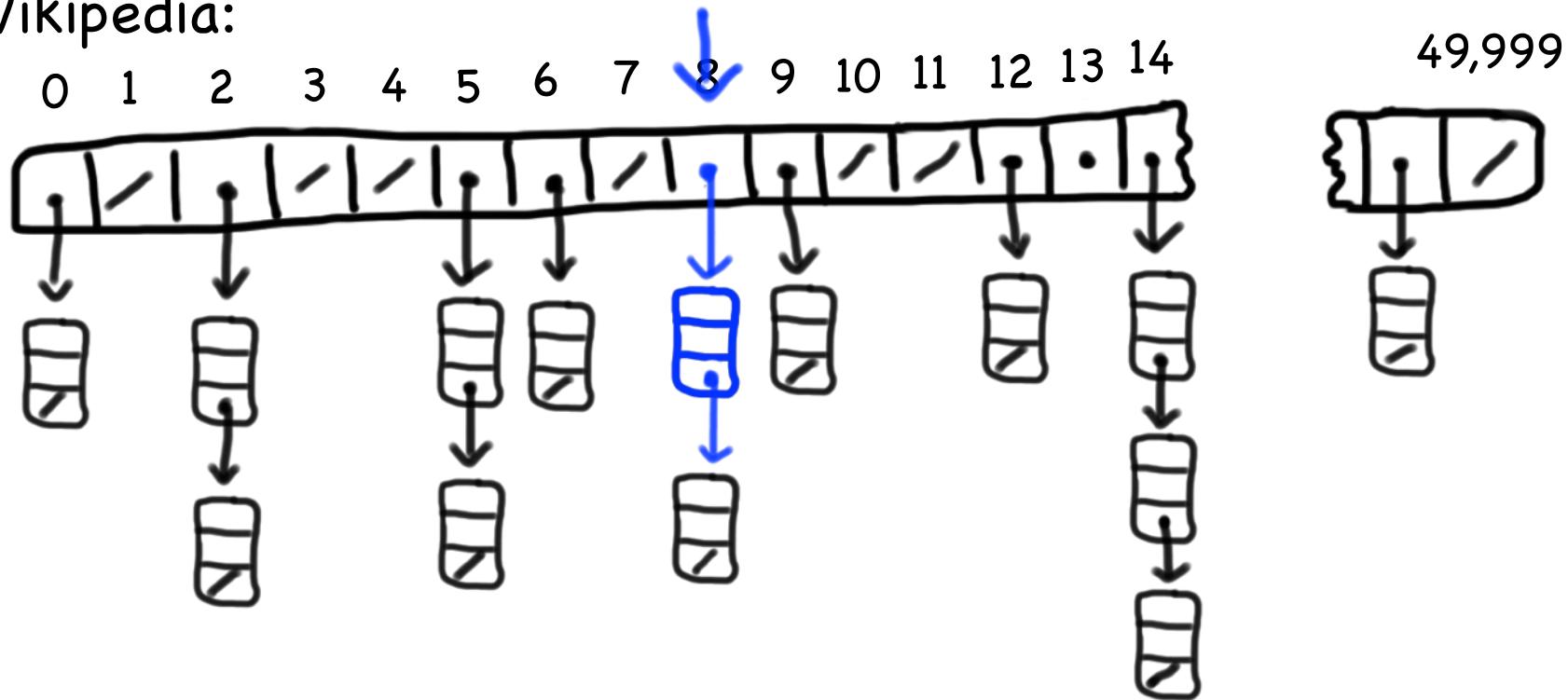
Priority Queue

... WE'RE NOT INVITING
YOU HOME NEXT YEAR.



`put("John Coltrane", html)`

Wikipedia:



"John Coltrane" → Hash Fn → 8

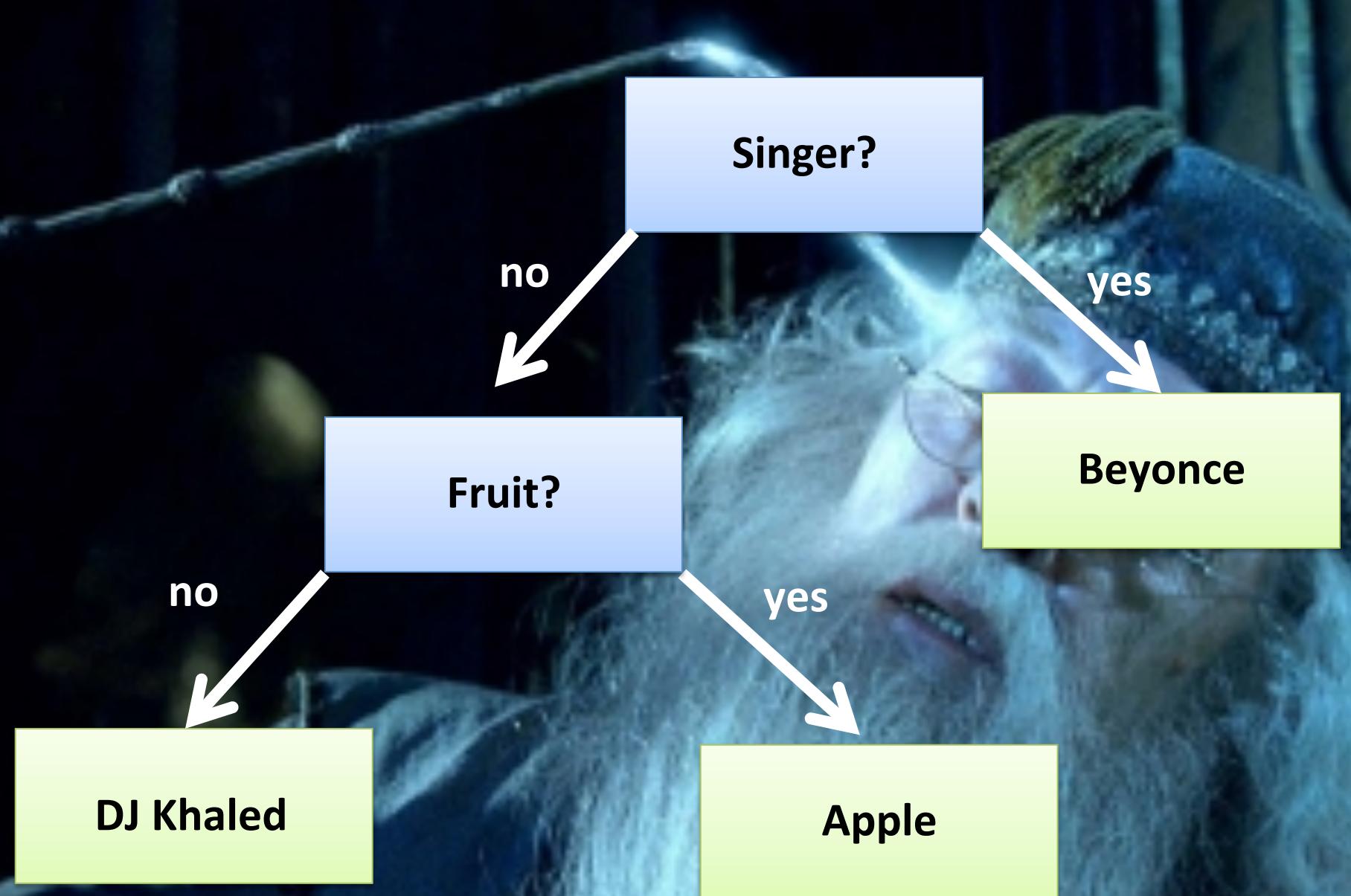


Hash-Zam



Source: Shazam

Pensive

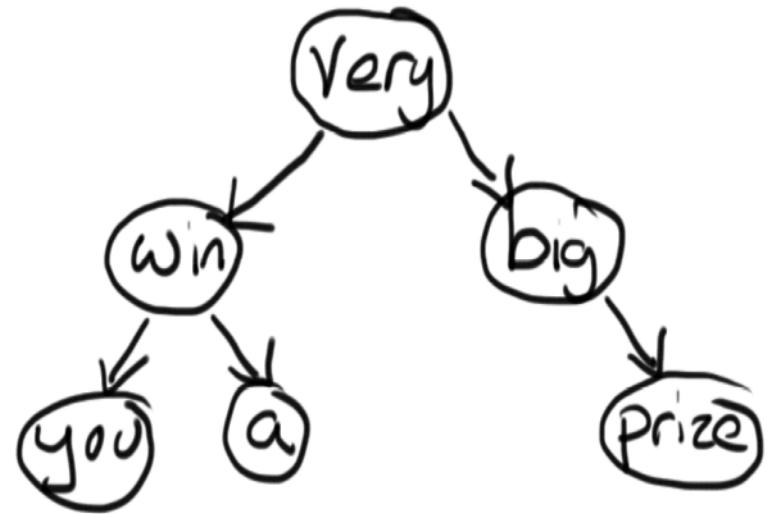


Game Show Tree

```
void doorOne(Tree * tree) {  
    if(tree == NULL) return;  
    cout<<tree->value<<" "  
    doorOne(tree->left);  
    doorOne(tree->right);  
}
```

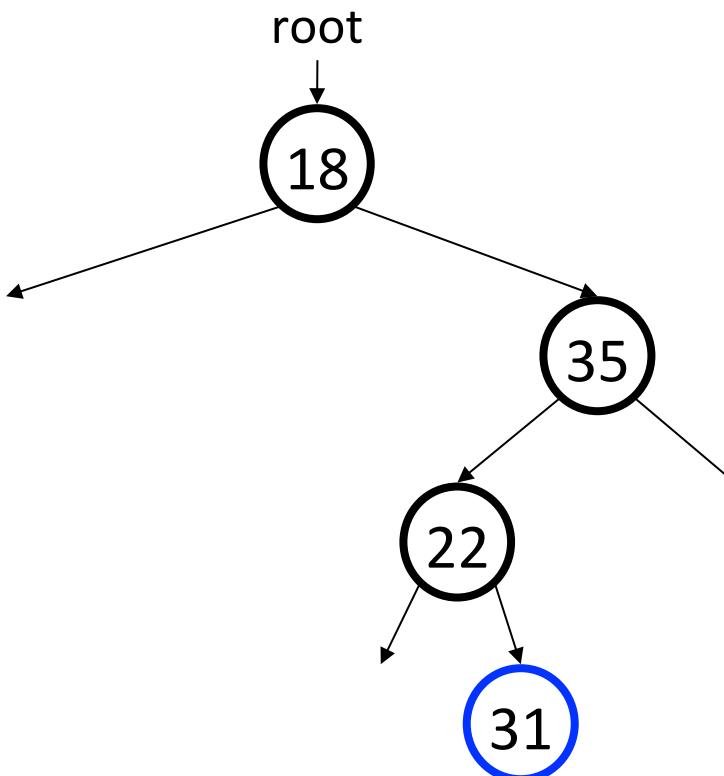
```
void doorTwo(Tree * tree) {  
    if(tree == NULL) return;  
    doorTwo(tree->left);  
    cout<<tree->value<<" "  
    doorTwo(tree->right);  
}
```

```
Void doorThree(Tree * tree) {  
    if(tree == NULL) return;  
    doorThree(tree->left);  
    doorThree(tree->right);  
    cout<<tree->value<<" "  
}
```

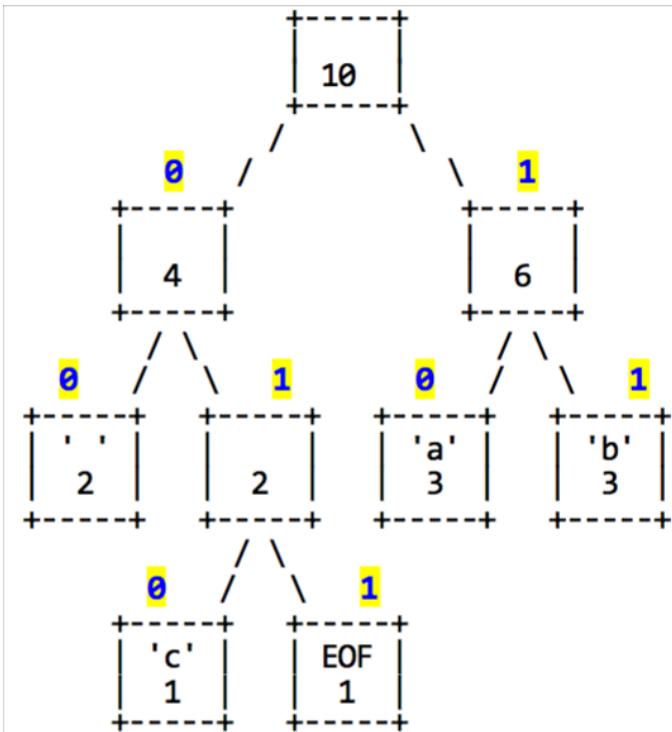


Binary Search Tree for Wikipedia

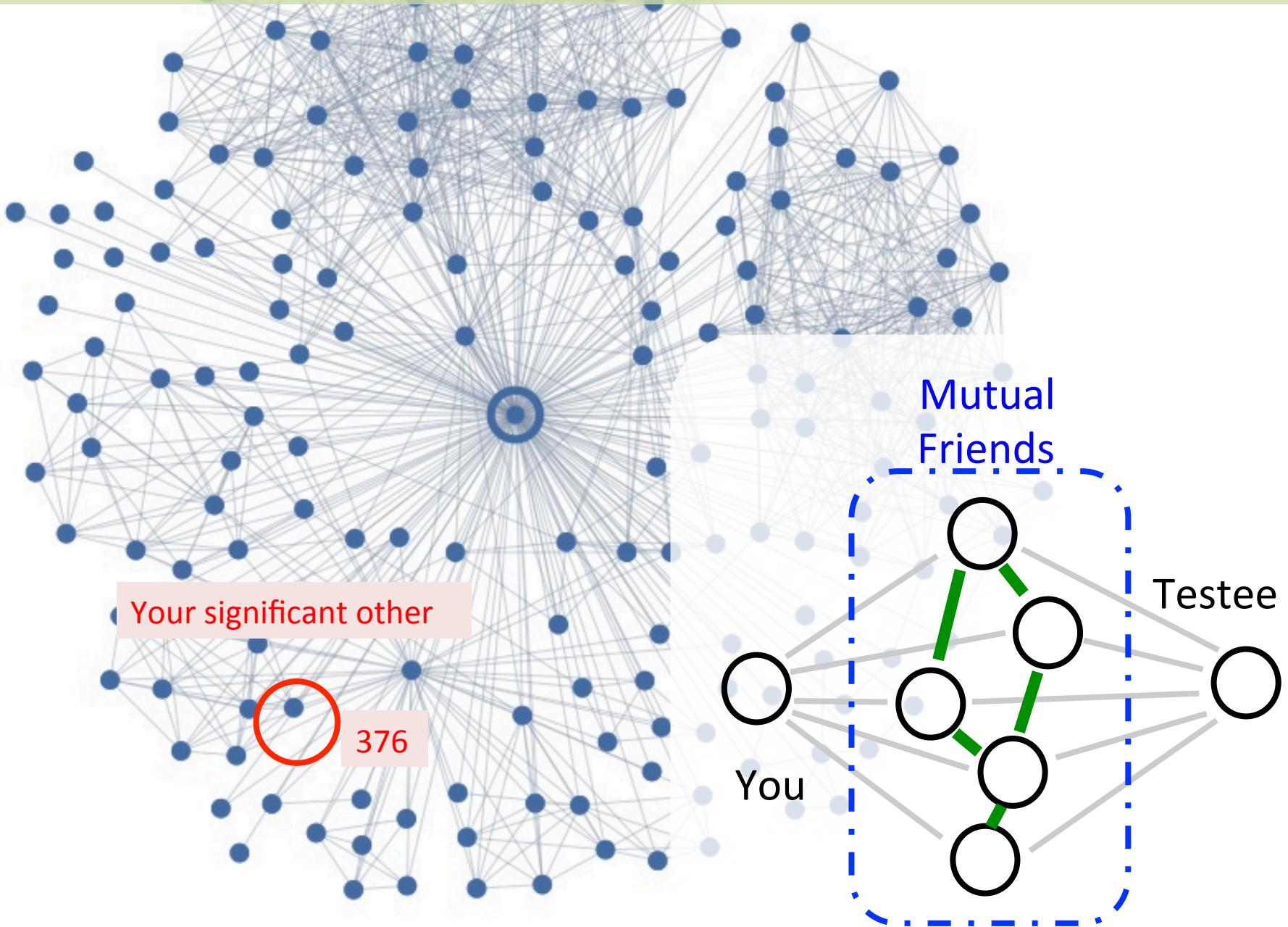
Searching for the value **31** from the root



Huffman



Who Do You Love?



Search

Recursive Exploration

Depth First

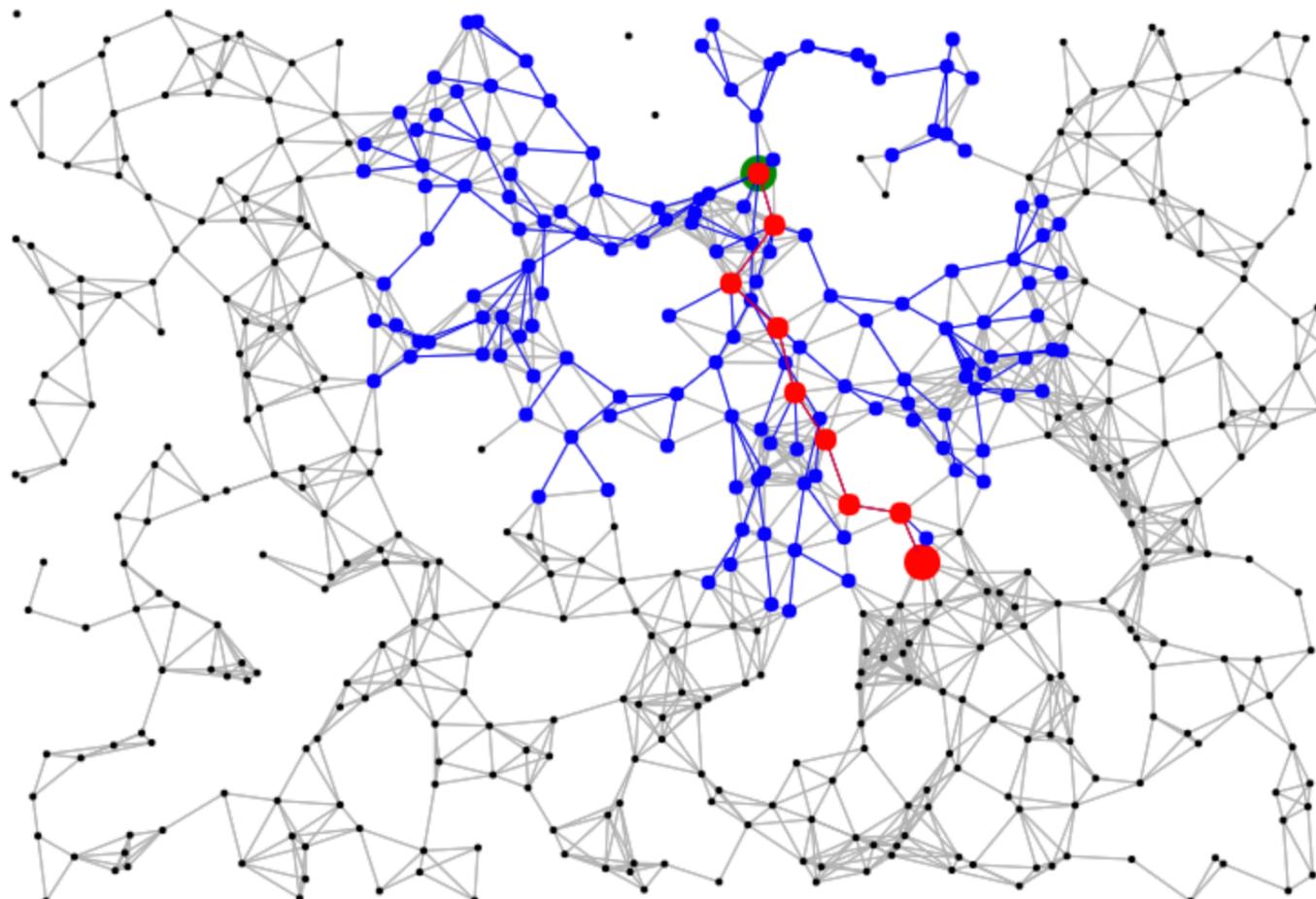
Breadth First

Dijkstra

A Star

Unweighted Graph

Weighted Graph

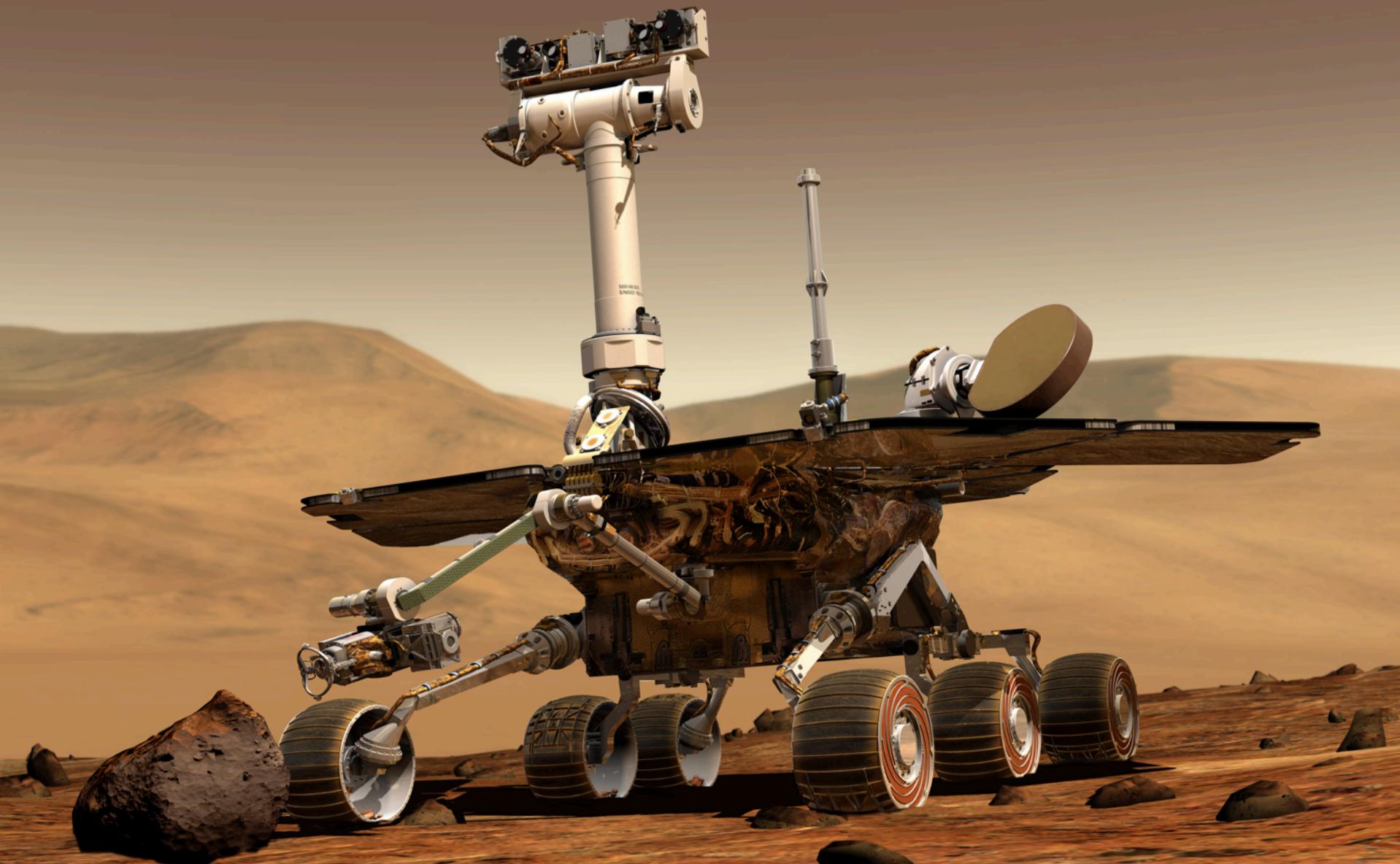


Path hops: 9

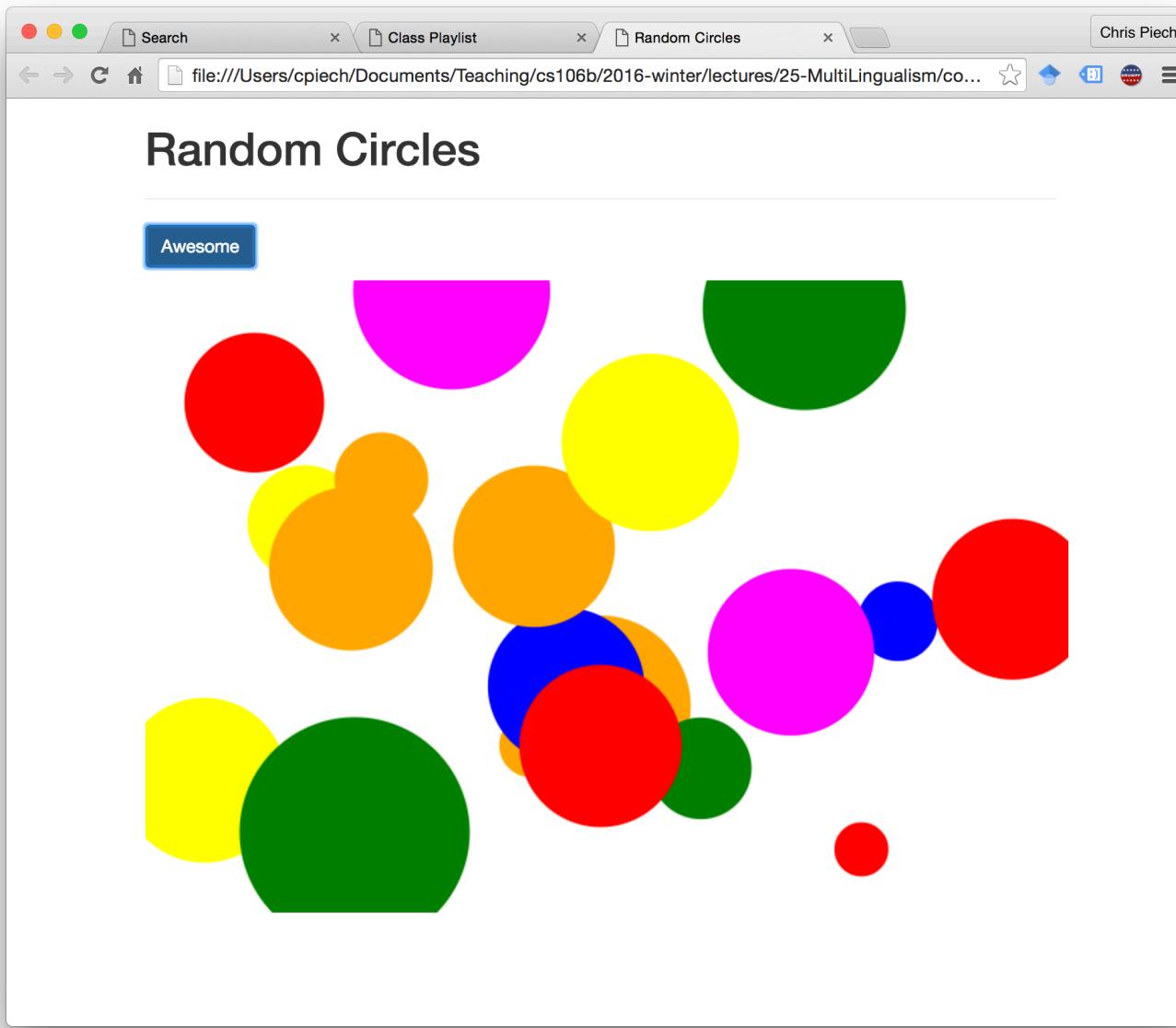
Google Maps



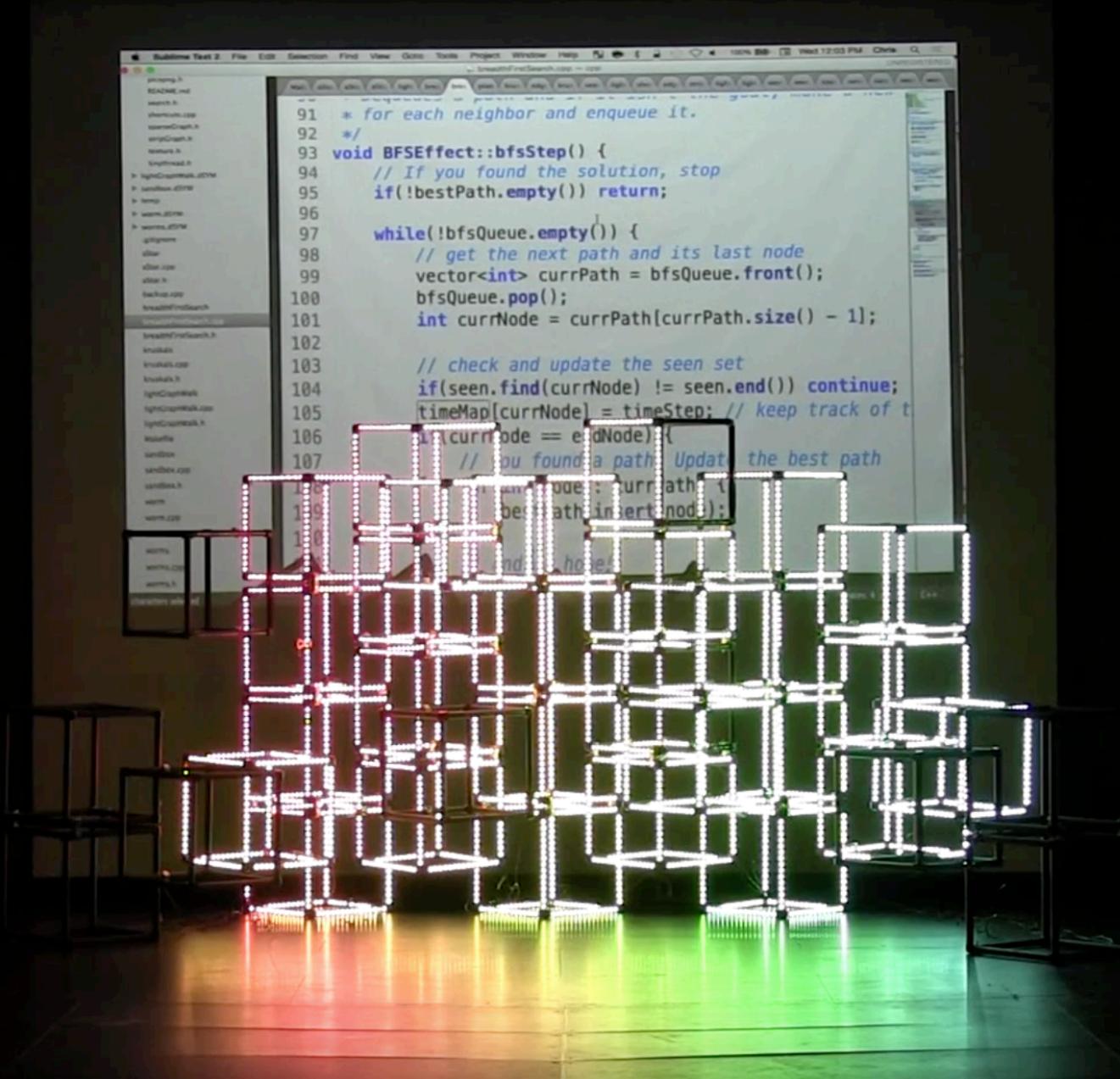
Trailblazer



JavaScript



C++ For Art



John Cena



End Montage

Overview

Functions
Use of Collections
Recursion
Recursive Exploration
Big O
Pointers
Classes and Structs
Linked Lists
Hashing
Trees
Under the Hood
Binary Search Trees
Graphs
Graph Search

Overview

Intro to Abstractions

ADTs



Recursion



Under the Hood

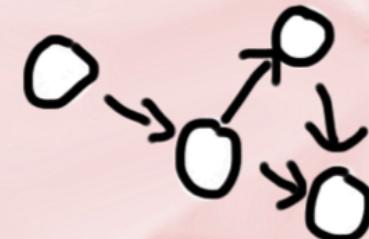
Vectors

Linked Lists

Hash Maps

Trees

Graphs



Goals for the Course

- **Learn how to model and solve complex problems with computers.**
- To that end:
 - Explore common abstractions for representing problems.
 - Harness recursion and understand how to think about problems recursively.
 - Learn and analyze different approaches for solving problems.

Why CS?



photo: D Sallery

Why CS?



Why CS?

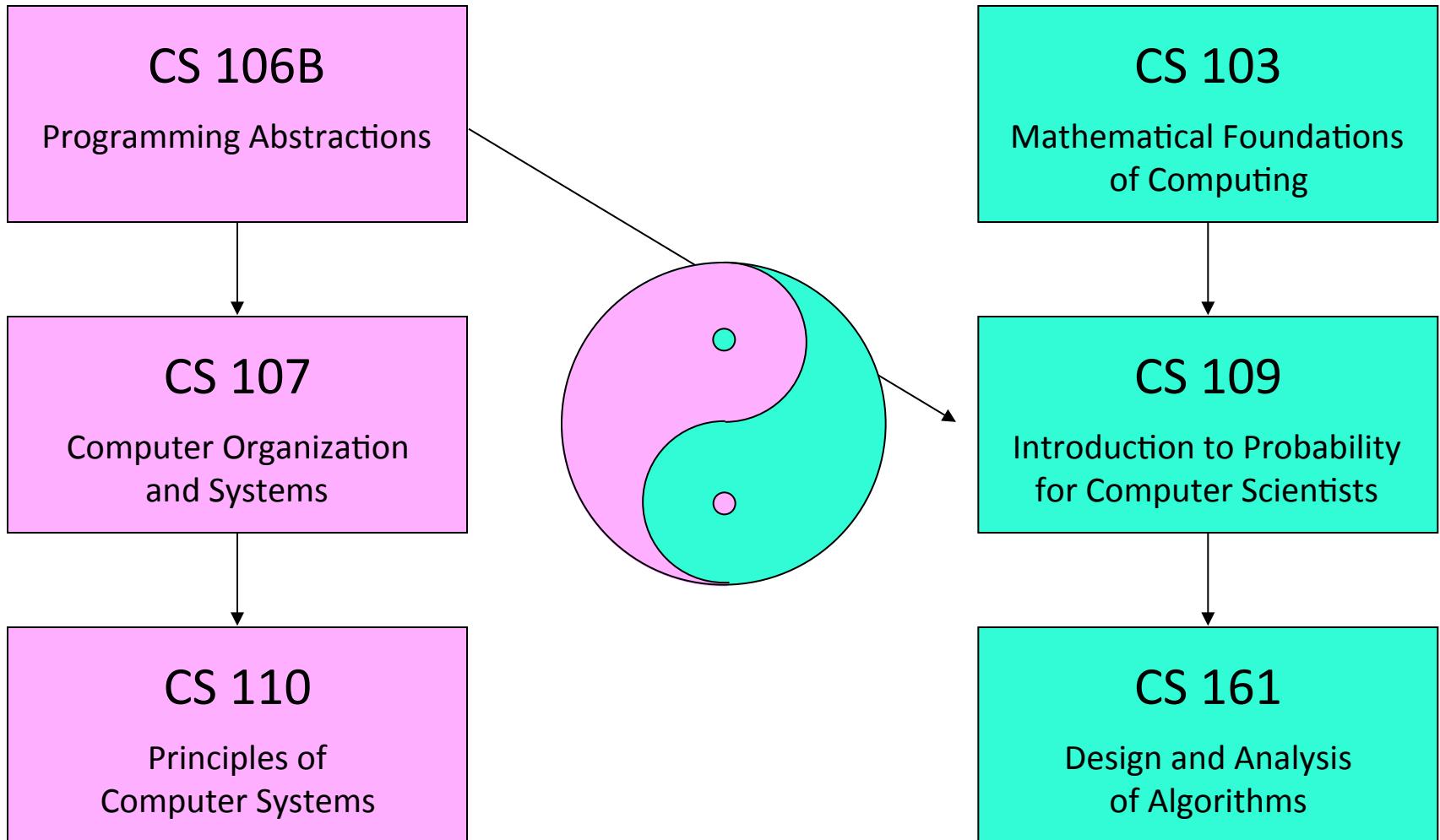


Why CS?

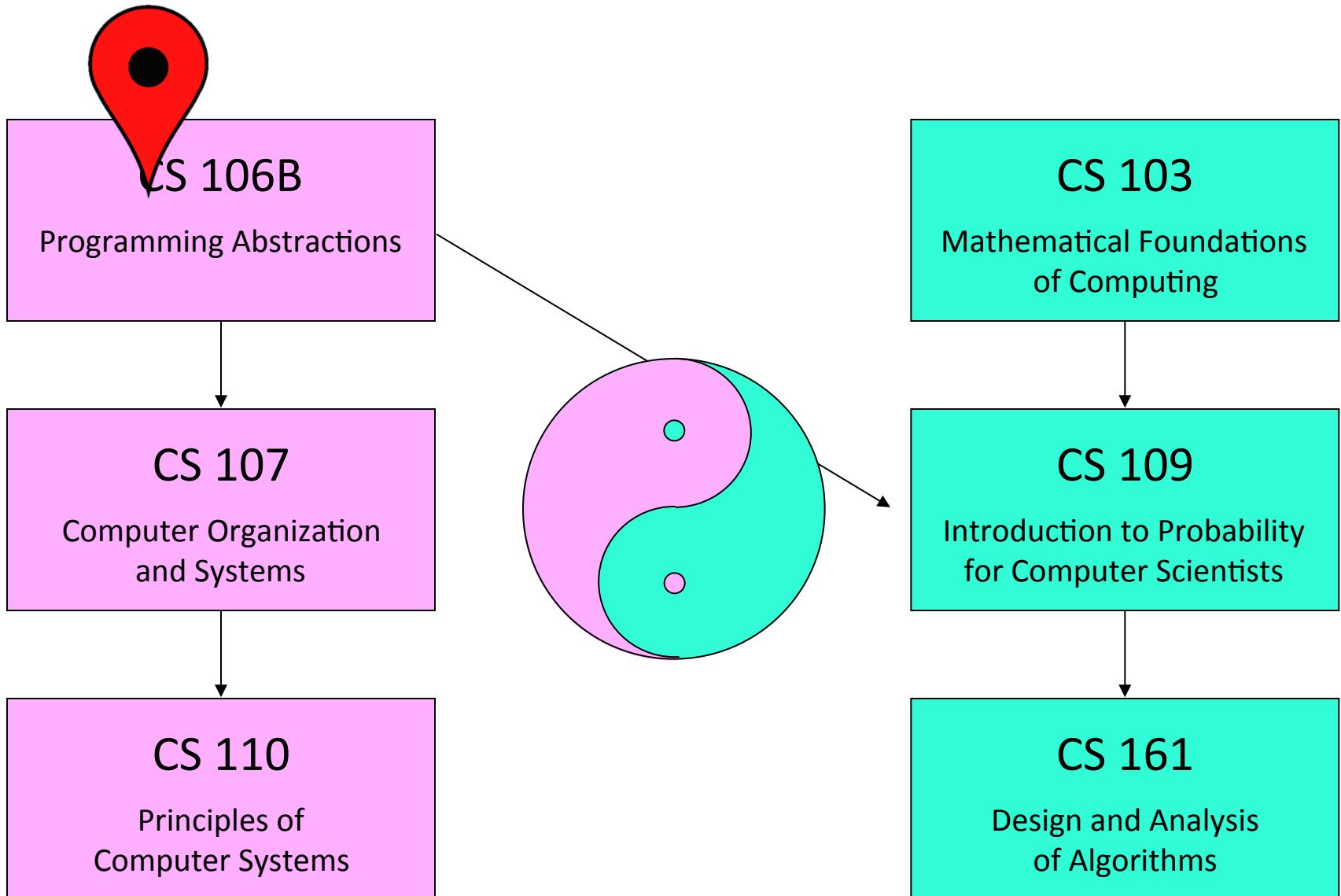


Where to Next?

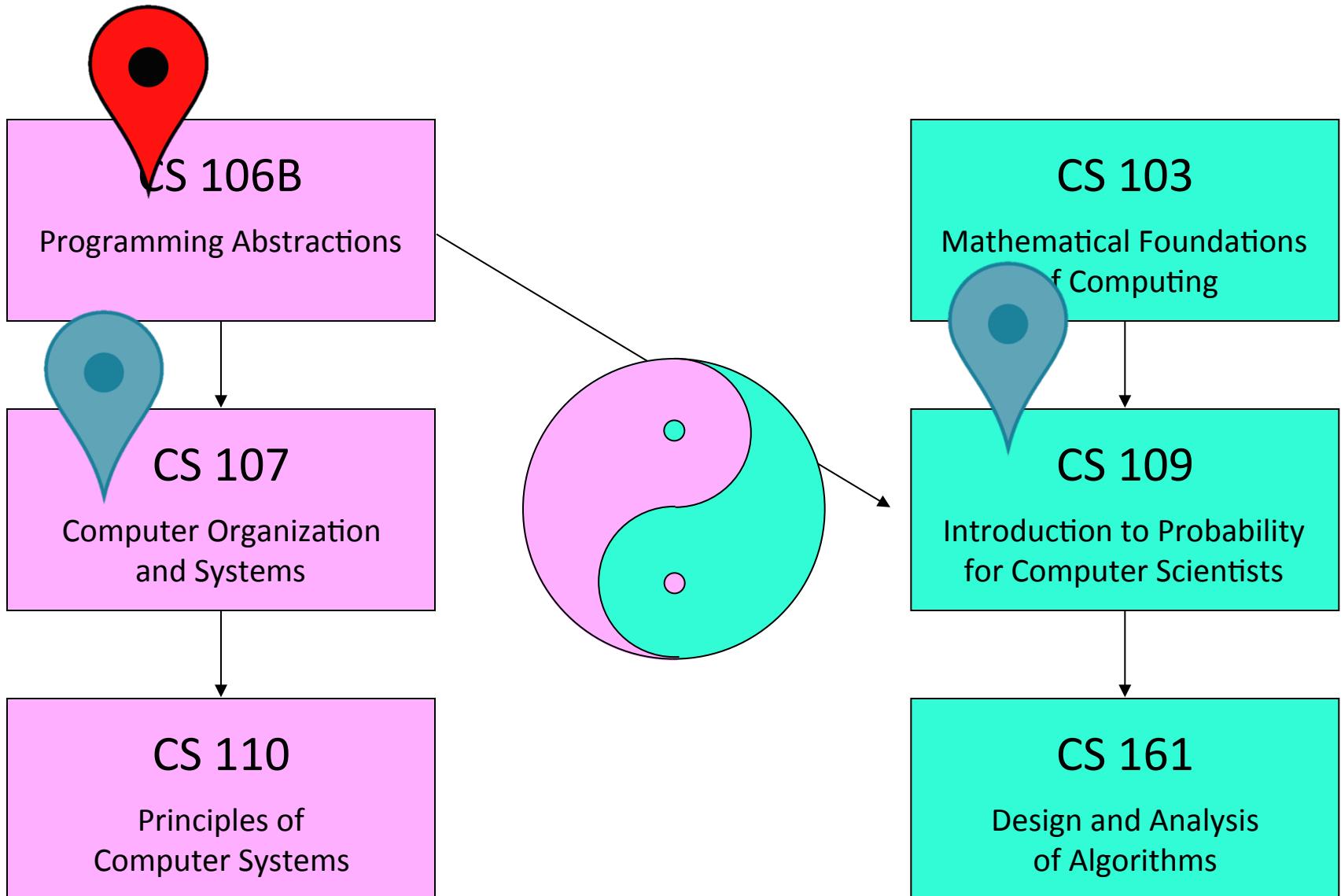
CS Core



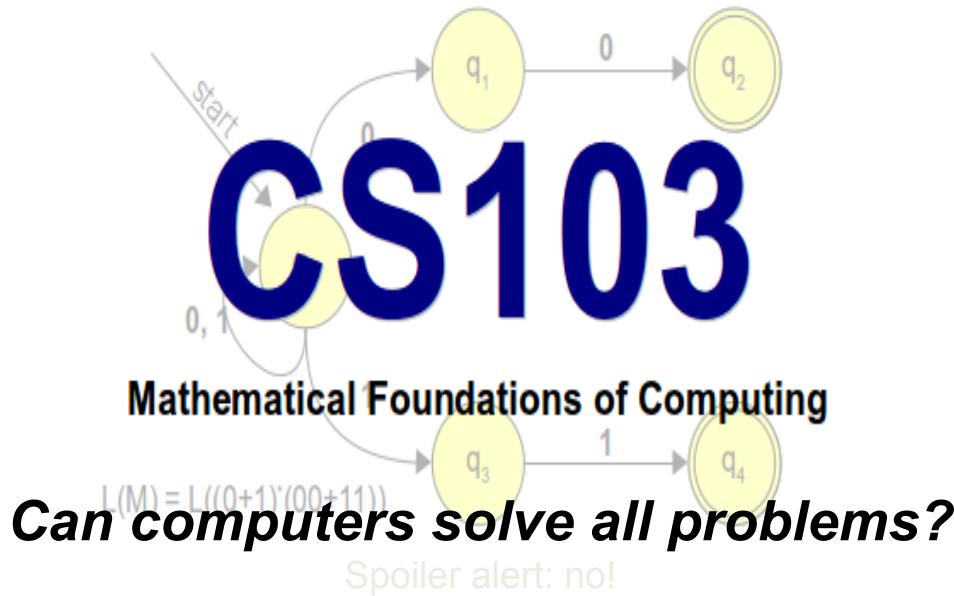
CS Core



CS Core



CS103



Why are some problems harder than others?

We can do find in an unsorted array in $O(N)$, and we can sort an unsorted array in $O(N \log N)$. Is sorting just inherently a harder problem, or are there better $O(N)$ sorting algorithm yet to be discovered?

How can we be certain about this?

CS107 (kinda like CS106C)

**How do we encode text, numbers,
programs, etc. using just 0s and 1s?**

**Where does memory come from?
How is it managed?**

How do compilers, debuggers, etc. work?

CS107 in the News

- In April 2014, security experts warned that users of thousands of major websites needed to change their passwords due to potential exposure caused by the “Heartbleed” vulnerability

- Heartbleed exploited a **buffer overrun** bug in OpenSSL

SSL is the layer that secures web interactions, i.e., it's what make the “s” in “<https://>” mean something



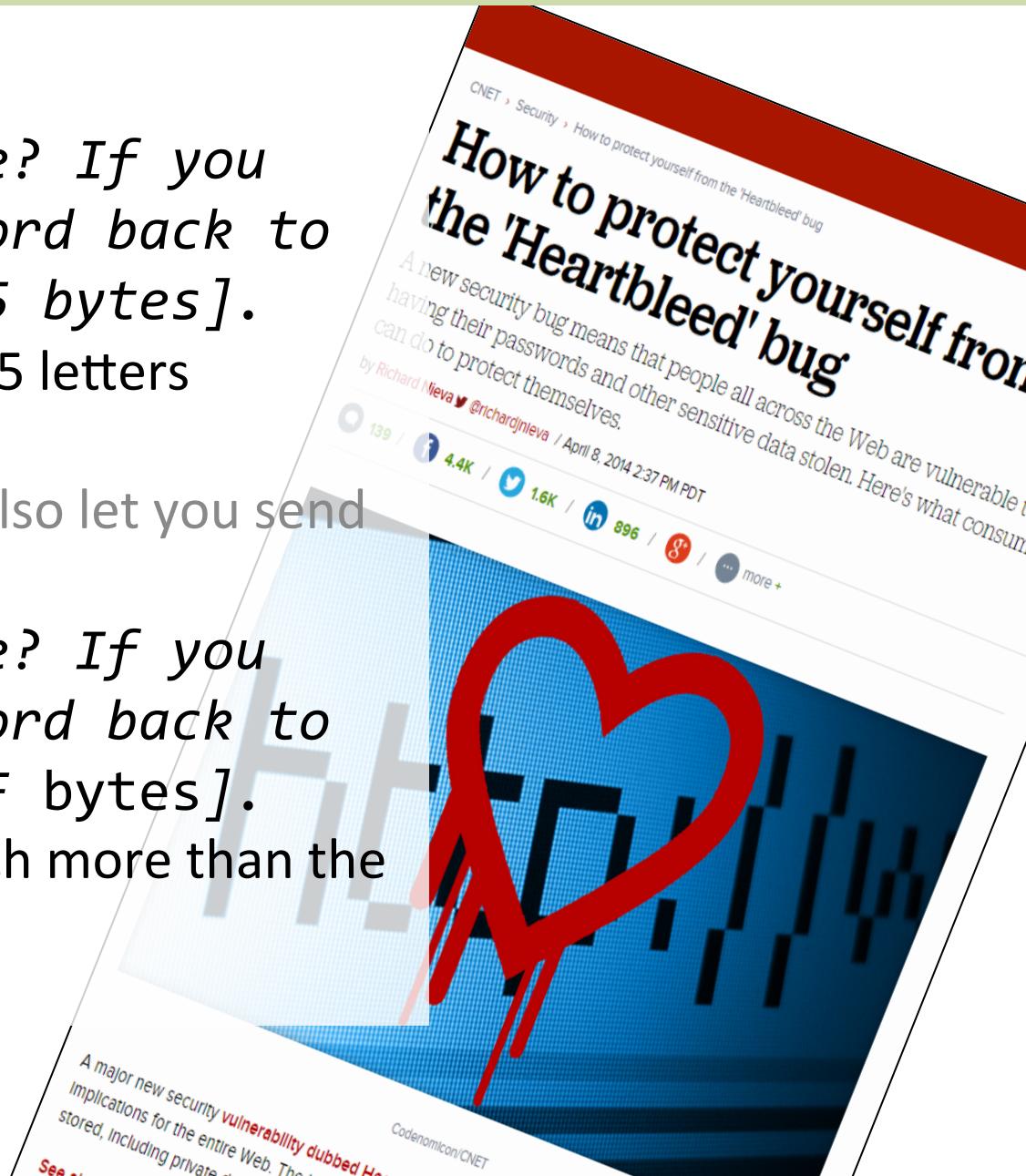
CS107 in the News

“heartbeat”

Are you still there? If you are, repeat this word back to me: "hello" [0x0005 bytes]. Each char is one byte, so 5 letters

Unfortunately, the software also let you send messages like this:

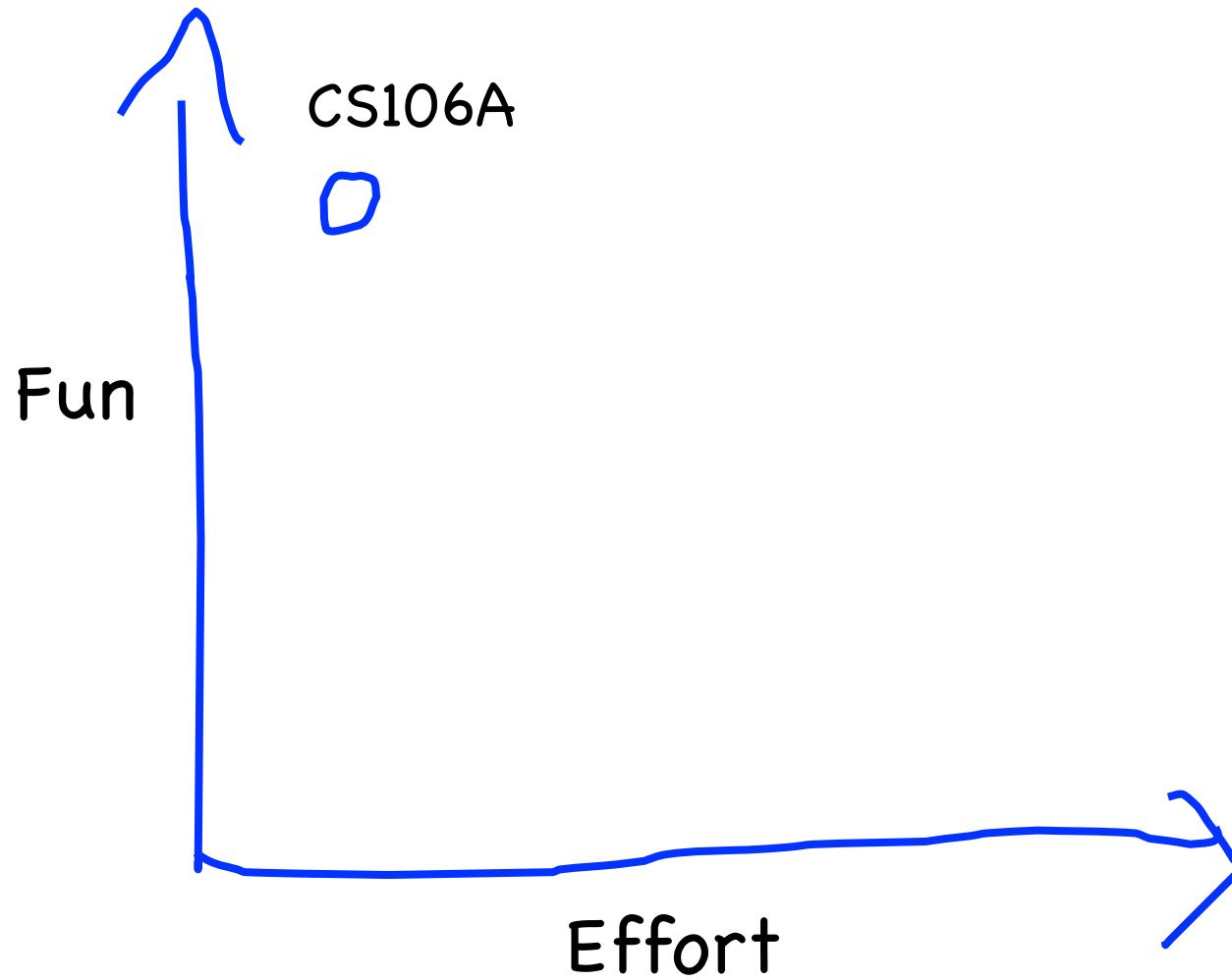
Are you still there? If you are, repeat this word back to me: "hello" [0xFFFF bytes]. That's 65535 bytes—much more than the length of "hello"!



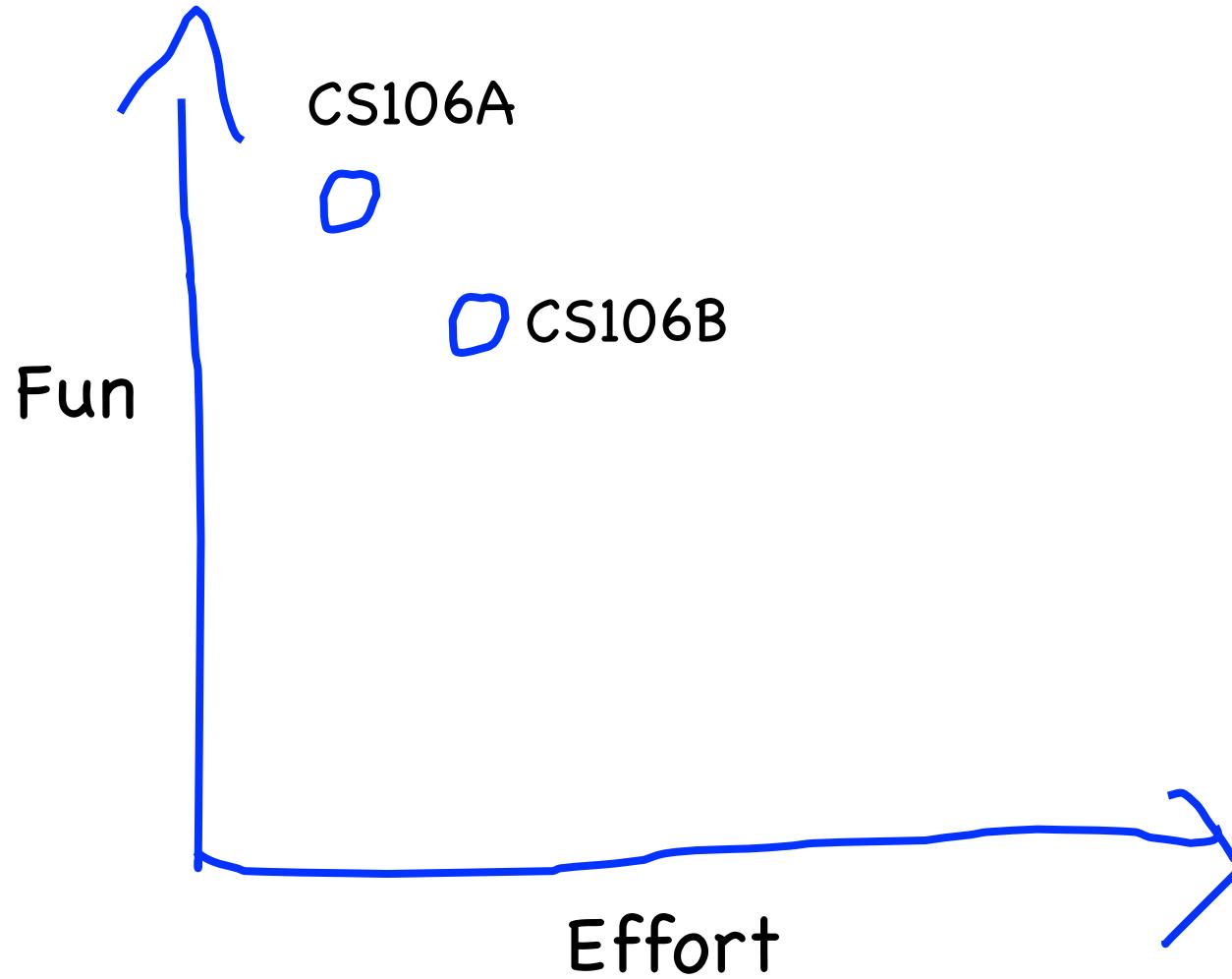
CS107 is **not**

- CS107 is **not** a litmus test for whether you can be a computer scientist.
 - You can be a *great* computer scientist without enjoying low-level systems programming.
- CS107 is **not** indicative of what programming is “really like.”
 - CS107 does a lot of low-level programming. You don't have to do low-level programming to be a good computer scientist.

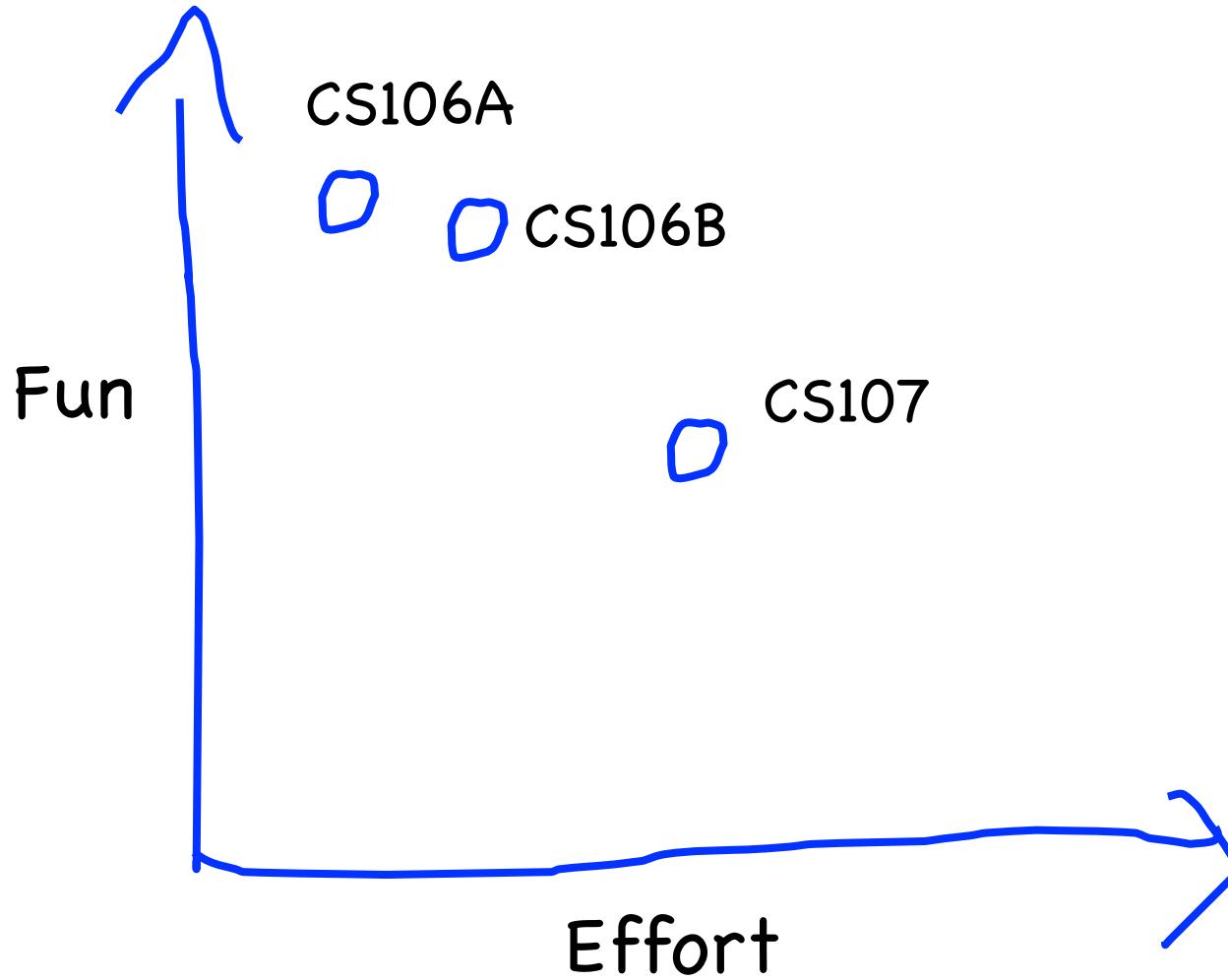
False Narrative



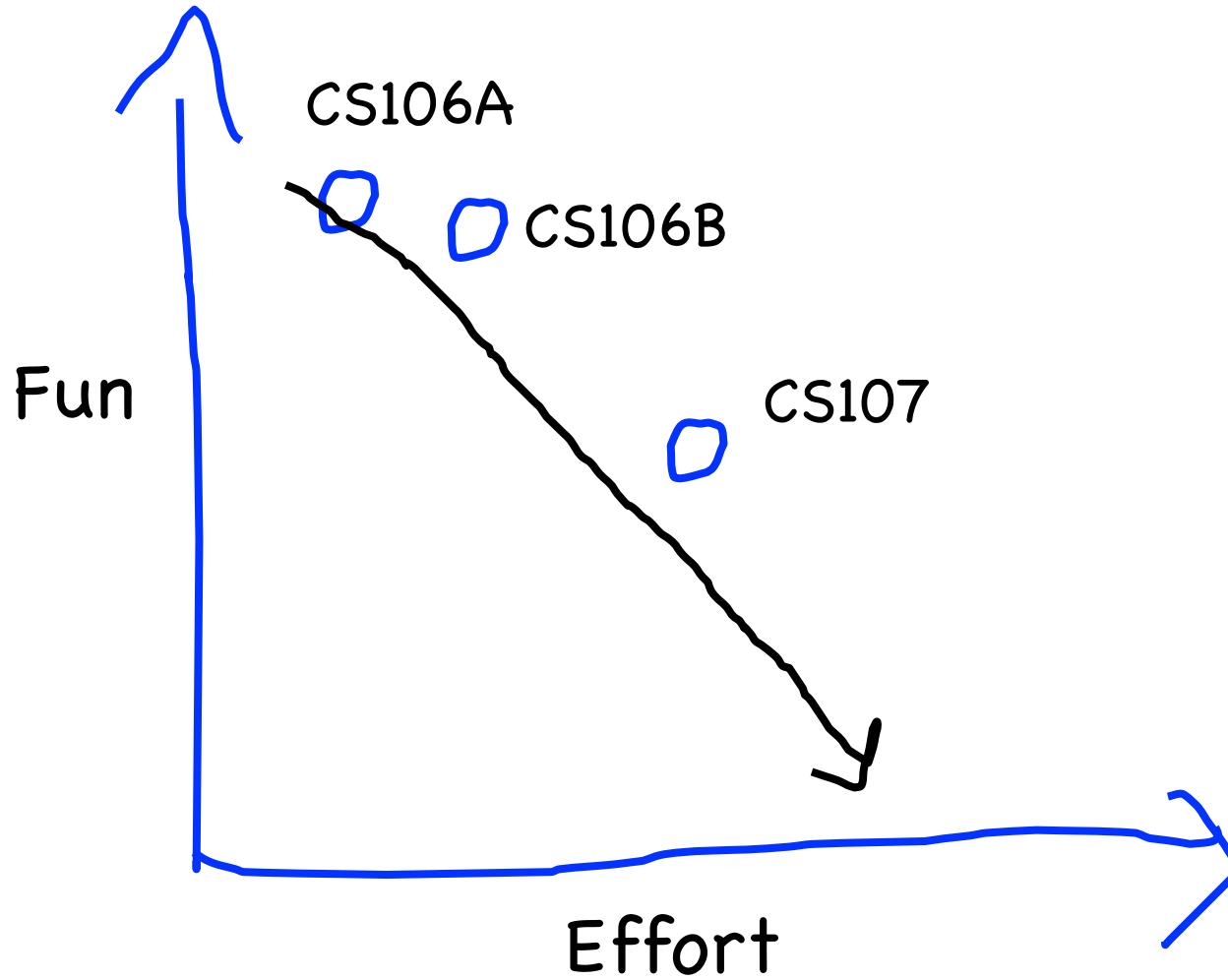
False Narrative



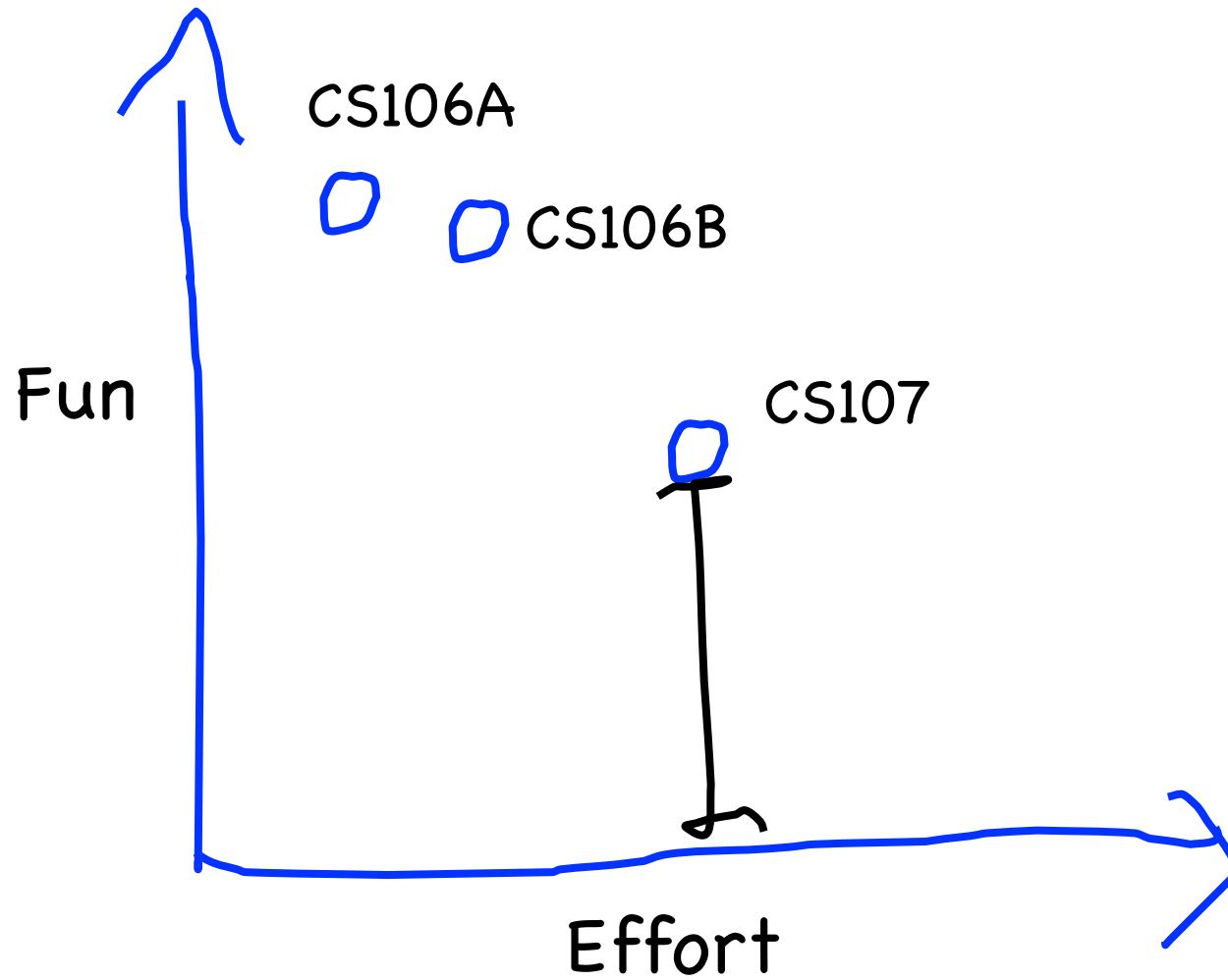
False Narrative



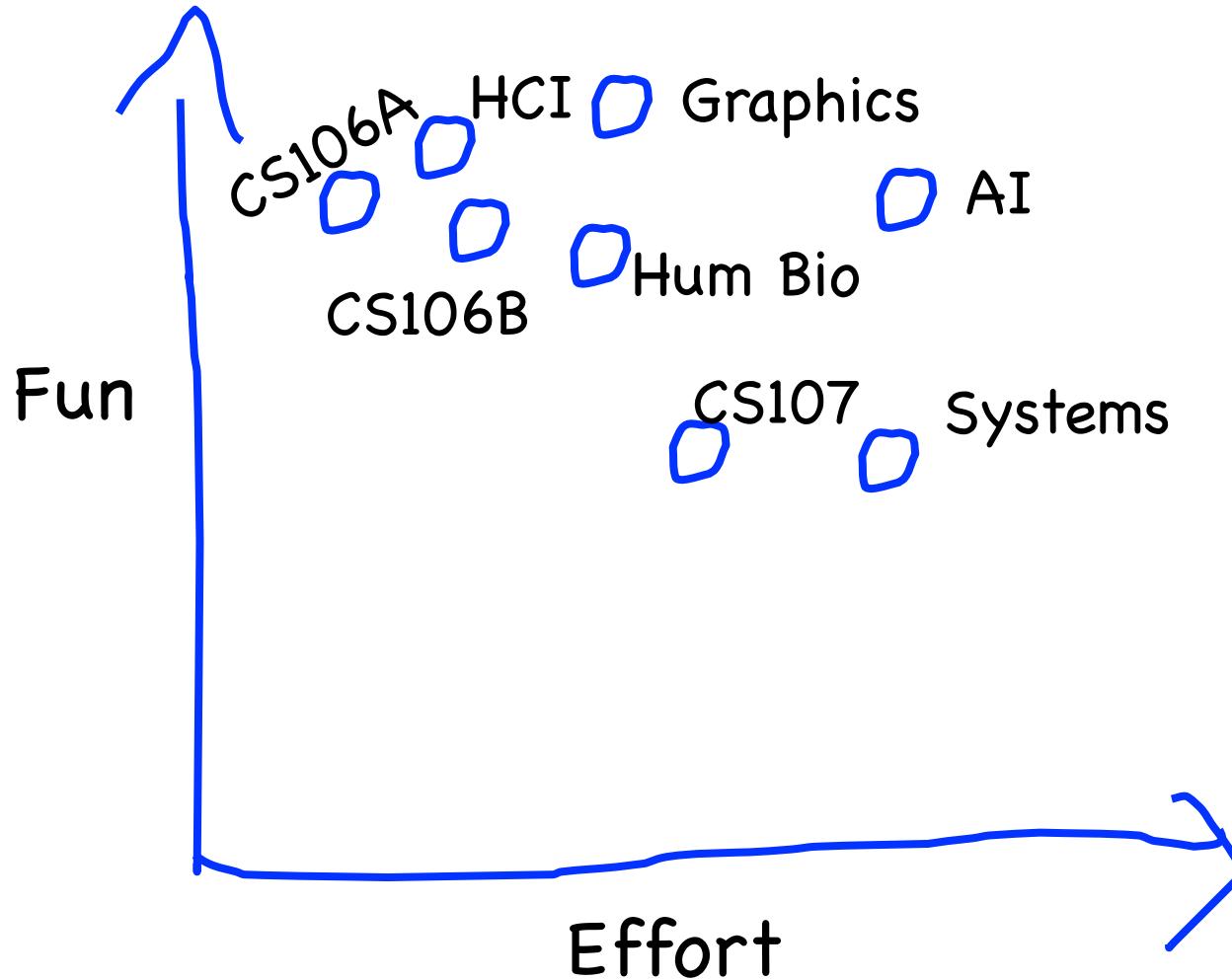
False Narrative



False Narrative



False Narrative



CS107E

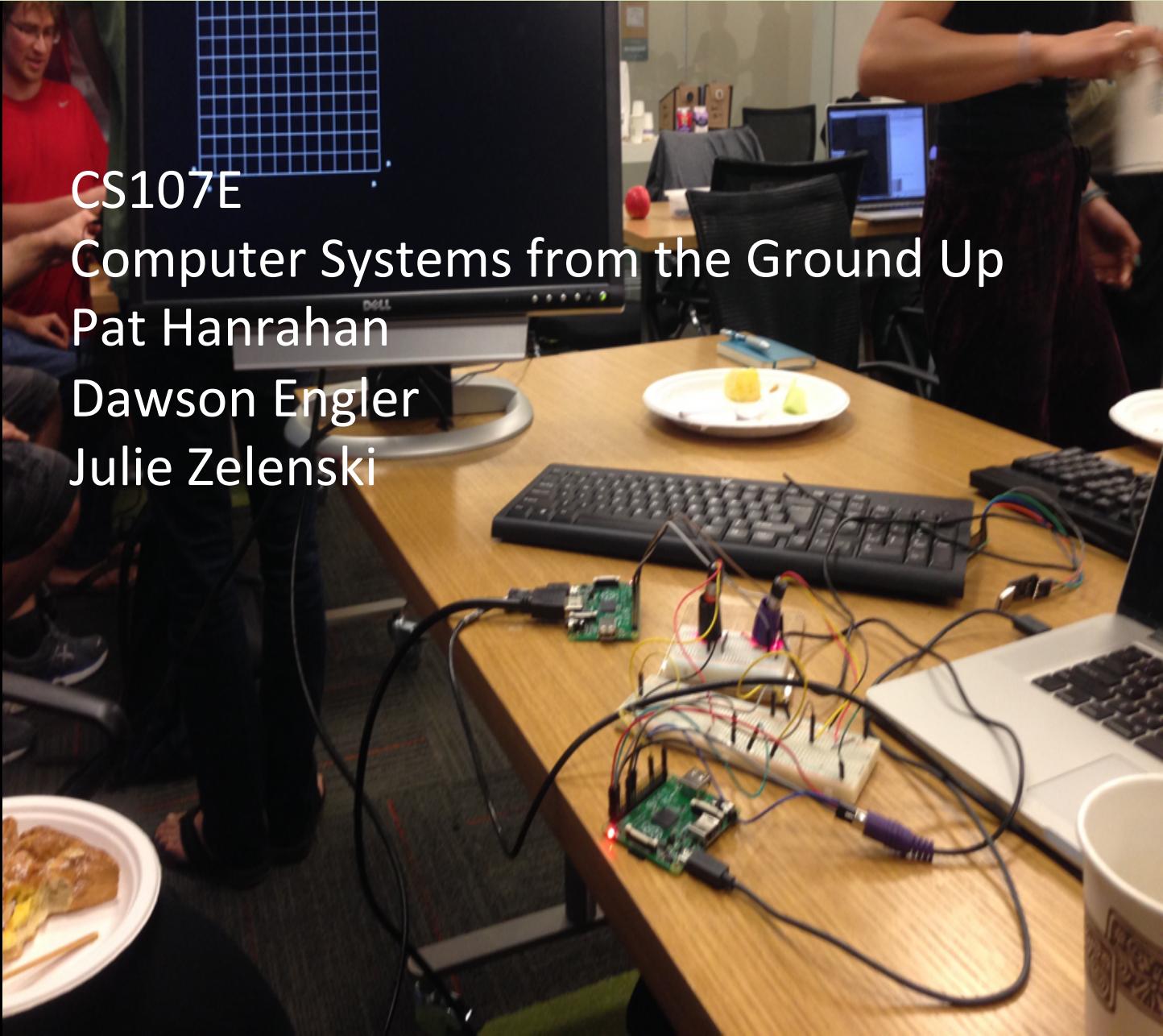
CS107E

Computer Systems from the Ground Up

Pat Hanrahan

Dawson Engler

Julie Zelenski



CS109



Foundations of
probability

Narrative driven

Intro to
Machine Learning



Other CS Courses

CS9

- 1 unit, 1 meeting per week, little to no outside work
 - Prereq: 106B/X
 - Practice **real** job interview questions
 - Additional topics such as resume polish, negotiating once you have multiple offers, differences between roles (Project Management vs Developer vs Test Engineer)
 - *Special guests from industry!*
- .Taught by Cynthia Lee, Keith Schwarz
.Offered each autumn quarter

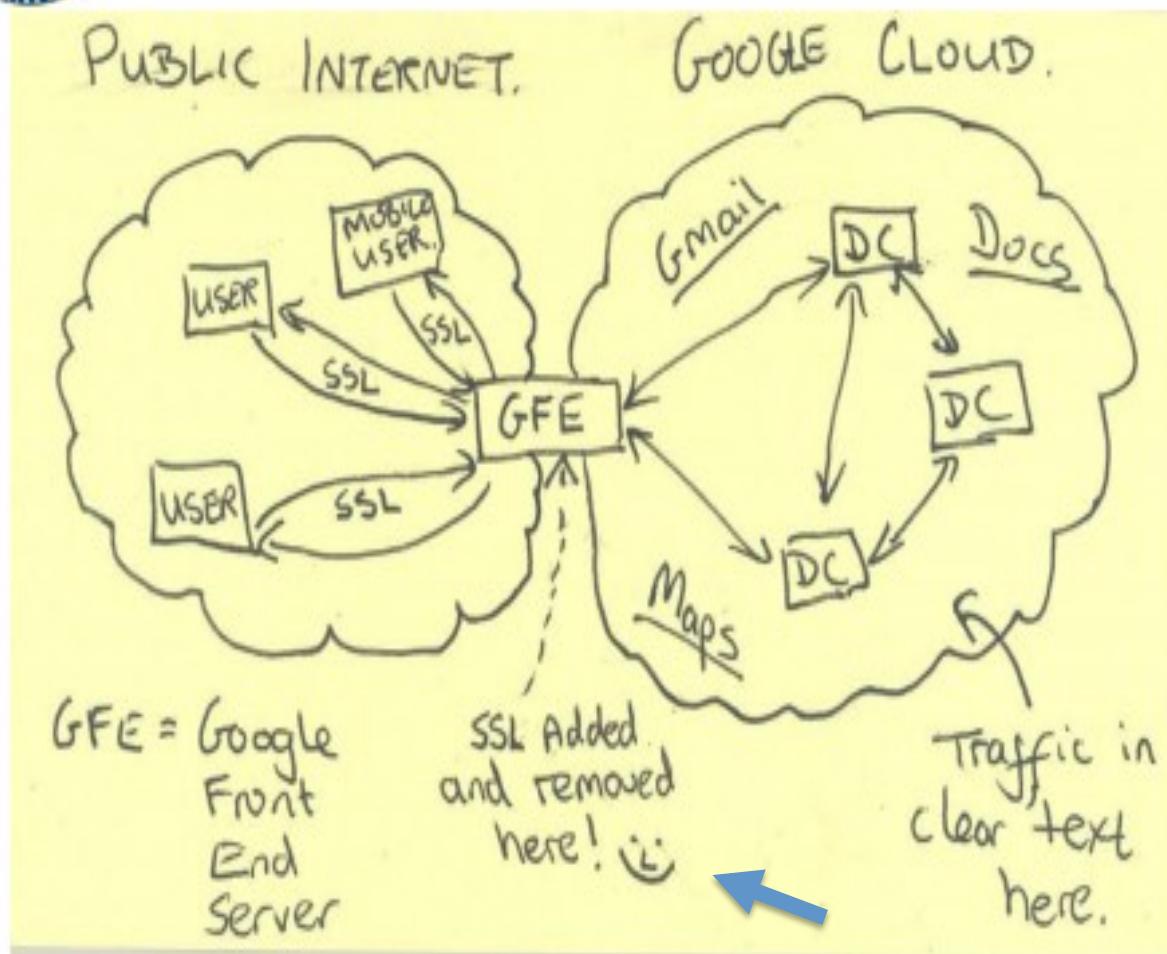
CS181 Ethics

- Modern ethics:
 - Edward Snowden reveals that NSA knows more about you than your parents do
 - GamerGate: about harassing women, or about ethics in game journalism?
 - How should AirBnB be taxed?
 - The password to launch the US nuclear arsenal was 00000000
 - Autonomous cars. How to value human life?

.We have the power to control and create technology, but how should we use it?



Current Efforts - Google



CS108

- *How do you build large software systems in a team?*
- Introduction to things you need to know for work in the “real world”:
 - Unit-testing frameworks
 - Object-oriented design
 - Multithreaded applications
 - Databases and web applications
 - Source control

CS193: Language Specific Courses

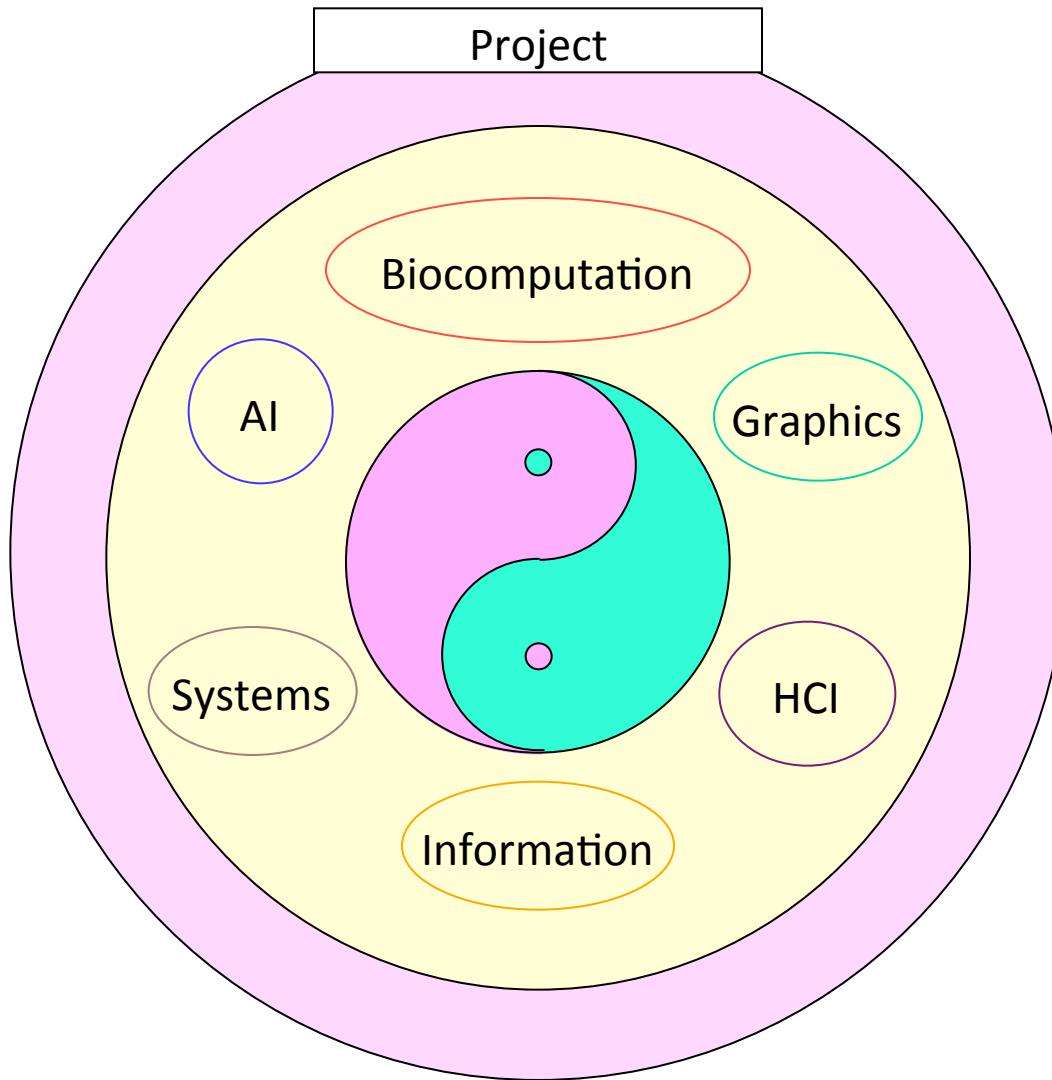
- Misc. offerings throughout the year, focused on specific technologies:
 - CS41: Python Programming
 - CS193A: Android Programming
 - CS193C: Client-Side Web Technologies
 - CS193I: iOS Programming
 - CS193L: Lua Programming
 - CS193P: iPhone and iPad programming
- Great for learning particular technologies.

Apply at stanfordpython.com

Options Beside CS Major

- **CS Minor: only 5 more classes!**
 - 103, 107, 109, two your choice—fun!
- **CS Coterminal MS degree**
 - Earn an MS in CS while you are here earning your BS
 - Possible for CS majors **and** other majors
 - ex: Math major, CS co-term

CS Major



Future Chris: Say words.

We will die one day

We will die one day.
Now you are alive.