CS 5 finale

**Looking back!** Evals, Ideas

CS 5: Final lecture *now!*

I'll be back...

but that's my line!

CS 5, on the verge of termination

**Looking ahead?** Options...

CS 5 Final Projects
due this Fri. eve @ 8 (Sat. w/ Euro)
LAC hrs Fri. & tutoring hours through then...

CS 5 Review Session
7-8 pm Sun., 12/11 in Shanahan B460
warning: only 100 seats!
- to go over the practice exam problems + q'ns

CS 5 Final Exam
comprehensive – *but not this week's material*
7pm Mon. 12/12 in Shan 1430 – this room
Accommodations nearby rooms (next door)
ALL DAY 9am-5pm Tue. 12/13 in the Green Room (in the HMC Platt Building)
CS 5's map of final events...

**Monday exam** – 7pm-10pm
usual place: Shan 1430

**Tuesday exam** – any time 9am-5pm
HMC Green Room in Platt

**Review Session!** – Sunday @ 7pm
Shan B460
I started at noon, I'm done at 11:11
minus a brief break to watch
shawshank redemption and eat dinner,
I've been working solid

I AM TOTALLY THE WINNER!

final project

one of many favorite grading - encountered comments
may you find equal success (and equal movie-watching time!)
The CS view of the world...

Input → Algorithm → Output

CS's challenge
Uncomputable functions

Sometimes an algorithm simply does not exist...

more precisely: every possible algorithm contains bugs!
Haltchecking is uncomputable.

\[ \text{hc}(\ f\ ) \]

\[ \sim \text{ returns whether } f() \text{ halts or not} \]

hc always has a bug!
Haltchecking is uncomputable.

It is impossible to write a (bug-free) function \( \text{hc}(f) \) that determines if a function \( f \) halts when run:

1. \( \text{hc}(f) \) returns \( \text{True} \) if \( f() \) halts and
2. \( \text{hc}(f) \) returns \( \text{False} \) if \( f() \) loops infinitely
Suppose $\text{hc}(f)$ worked for all $f$  

Create this $\text{BFF}$:

```python
def BFF():
    if hc(BFF) == True:
        while 1+1==2:  print 'Ha!'
    else:
        return  # halt!
```

Is $\text{hc}(\text{BFF}) == \text{True}$?  

Is $\text{hc}(\text{BFF}) == \text{False}$?  

$\text{hc}$ *always* has a bug  

Proven!
And this is important because ...

∞ loops are undetectable

some are detectable, but some are not
– and there’s no way to know!

bugs are inevitable

infinite loops are just one type of bug...
In general, they’re all undetectable

programming is not automatable...

not perfect programming, at least
it's why CSers *celebrate* infinite loops!
In **computability theory**, the **halting problem** can be stated as follows: Given a description of a **computer program**, decide whether the program finishes running or continues to run forever. This is equivalent to the problem of deciding, given a program and an input, whether the program will eventually halt when run with that input, or will run forever.

**Alan Turing** proved in 1936 that a general **algorithm** to solve the halting problem for *all* possible program-input pairs cannot exist. A key part of the proof was a mathematical definition of a computer and program, what became known as a **Turing machine**; the
Corporate Address

Apple
1 Infinite Loop
Cupertino, CA 95014
408.996.1010

original iPhone icon for Maps

Apple Campus
One Infinite Loop
the iPhone's icon for Google Maps ...

CS tourism !
More CS tourism...
(Google)
Meaningful functions?

but nearly all *meaningful*
functions *are* computable...
CS 5's examples...

Input \[\rightarrow\] Algorithm \[?\] Output

Connect 4 Board \[\rightarrow\] intelligent move
Input text \[\rightarrow\] Markov model + new text
current gener. of “life” cells \[\rightarrow\] next gener. of “life” cells
CS 5's examples...

Input → Algorithm → Output

Connect 4 Board

Input text

Markov model + new text

next gener. of “life” cells

Intelligent move

current gener. of “life”

balance of utility & creativity & aesthetics?
Mandelbrot Vistas!
"Science without religion is lame, religion without science is blind."
"Two things are infinite: the universe and human stupidity; and I'm not sure about the universe."
"Duct tape is like the force, it has a light side, a dark side, and it holds the world together"
"If you die in an elevator, be sure to push the Up button."
"All generalizations are false, including this one."
"Clearly you've never been to Singapore!"
"Luke, I am your father."
"To be, or not to be."
"You shall not pass!"
(... all with authors ...)
"Science without religion is lame, religion without science is blind."
"Two things are infinite: the universe and human stupidity; and I'm not sure about the universe."
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"Luke, I am your father."
"To be, or not to be."
"You shall not pass!"
(... all with authors ...)

"I have a dream! Duct tape is written on. Luke, I am your thoughts and what lies within us."
    ---- Audrey Rooney

"Your work is lame, religion is lame, religion is nearly the Up button."
    ---- Abraham Marx

"Two things are false, including this one."
    ---- Captain_Jack Truman
Connect-4  *tiebreaking*...

*scoreBoard* would give each of these 50.0
but which board is *really* better for black?

Ex. Cr.: write a *scoreBoard4Tourney* f’n.

taken *beyond* the extreme...
C4 Tourney ~
23 entries in fall 2016!

Wow!

thanks, everyone!

CMC
aibrahim.py
aliu.py
bblackstone.py
clu.py
crlee.py
elarsen.py
hpinson.py
jseacat.py
kkapur.py
lgjurata.py
mmuller.py
mmulligan.py
nbehrman.py
nkanade.py
rmoore.py
rsalazar.py
rzimmerman.py
smarkowitz.py

Pitzer
ltran.py
syasunaga.py

Scripps
ahembrough.py
ewalter.py
jliao.py
yyang.py

H.S.
nlibeskind.py
pdonnelly.py

HMC
aschulze.py
cmcelroy.py
bbrown.py
kyamada.py
lstevenson.py
mguillory.py
nsmith.py
vivojha.py

Pomona
abi.py
gbarlow.py
mhahn.py
obell.py
yzhao.py
39 entries in fall 2015!

C4 Tourney ~

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will run this evening...

gbarlow vs. obell ...

syasunaga: ( undefeated! )

ahembrough: ( undefeated! )

nl_pd vs pd _nl: ( one entry! )

bbrown, lstevenson, kyamada

Finals: cmcelroy, lstevenson

cmcelroy, vivojha, mg_ns
Inspired by Chris Cecka...

Hi Prof Dodds!

Looks like it's been twelve years now (choke)... Glad to hear you're still doing this in class!

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Introduction

I am currently a Lecturer/Research Scientist in the new Institute for Applied Computational Science (IACS) at Harvard University. Previously, I was a graduate student in the Institute for Computational and Mathematical Engineering (ICME) at Stanford University with Eric Darve.

My research focuses on computational mathematics, particularly for interdisciplinary applications in science and engineering. I emphasize physical modeling and high performance computing, but am recently interested in mathematical and computational abstractions to produce efficient, library-quality scientific software. Specifically, I am interested in integral equation methods, structured dense matrices, and parallel algorithmic development.
This year's Cris Cecka award... 

Hi Prof Dodds!

Looks like it's been twelve years now (choke)... Glad to hear you're still doing this in class!

Think I got it fixed -- the html didn't survive the move to the new computer/format apparently. I tested on Safari (after nuking all the security settings of course. Adobe kicked up their efforts to kill applets last February), but it should work on everything. Let me know if that did it for you too.

I heard through the grapevine that CS5 is done in Python now. Still do the C4 competition too? The one I got second place in? The one that started me working on ConnectFour for over a year? Still salty. Loved that and used the same concept for developing Harvard's Computational Challenge the past 2 years -- develop an AI for a game (any language the student wants), connect to...
Fortunately, nearly all meaningful functions are computable...

but this doesn't mean we know how to compute them (yet)!

for example ...
the computer vision problem
computer vision: what's the input and output?
Input → Algorithm → Output

That's the Mona Lisa (low difficulty)

2d array of ints

That's a 16thc. woman, smiling (maybe...) (high difficulty)

an image... of what?
btw, why is it clear these data/image examples definitely don't match?
The summer vision project is an attempt to use our summer workers effectively in the construction of a significant part of a visual system. The particular task was chosen partly because it can be segmented into sub-problems which will allow individuals to work independently and yet participate in the construction of a system complex enough to be a real landmark in the development of "pattern recognition".
The basic structure is fixed for the first phase of work extending to some point in July. Everyone is invited to contribute to the discussion of the second phase. Sussman is coordinator of "Vision Project" meetings and should be consulted by anyone who wishes to participate.

Goals - General

The primary goal of the project is to construct a system of programs which will divide a vidisector picture into regions such as likely objects
likely background areas
chaos.
We shall call this part of its operation FIGURE-GROUND analysis.

It will be impossible to do this without considerable analysis of shape and surface properties, so FIGURE-GROUND analysis is really inseparable in practice from the second goal which is REGION DESCRIPTION.
Subgoal for July

Analysis of scenes consisting of non-overlapping objects from the following set:

balls
bricks with faces of the same or different colors or textures
cylinders.

Each face will be of uniform and distinct color and/or texture.
Background will be homogeneous.

Extensions for August

The first priority will be to handle objects of the same sort but with complex surfaces and backgrounds, e.g. cigarette pack with writing and bands of different color, or a cylindrical battery.

Then extend class of objects to objects like tools, cups, etc.
What's red?

Goal: a coke-can collecting robot...
What's red?

not good enough...
Idea: Use *hue*

- Increasing hue
  - hue = 25°
  - hue = -25°
What's red?

hue's too much!
Idea: Use **hue** and **saturation**

- **Saturation (sat)**: The intensity of the color. When sat < 0.75, the color is less saturated.
- **Hue**: The color itself. For example, hue = 25° for yellow, hue = -25° for blue, and hue = 0° for red.

The diagram illustrates the color wheel with increasing hue and saturation. The red region indicates sat > 0.75.
What's red?

The door is still matched, too... **why?**
What's red?

Aargh!

Remarkably, this problem is, in a sense, our own vision systems' fault...!

door is still matched, too... why?
Try it! Illusions? What computations is your brain doing to cause them? Why?

two tones
two towers
two tables
two segments
2 layers
2 layers
Edward H. Adelson

2 layers
Edward H. Adelson

2 layers
Are *these* four lines parallel?
Try it! Illusions? What **computations** is your brain doing to cause them? 

Vision is more challenging than it might seem on first "**glance**"!
we don't always give our own vision system credit for *all the work* it's doing...
we don't always give our own vision system credit for *all the work* it's doing...
we don't always give our own vision system credit for *all the work* it's doing...

Not real life? What's the *most famous* of patterns like these?
the now-familiar striped dress...!

blue + black
vs.
white + gold
IS THE DRESS IN SHADOW?
If you think the dress is in shadow, your brain may remove the blue cast and perceive the dress as being white and gold.

THE DRESS IN THE PHOTO
If the photograph showed more of the room, or if skin tones were visible, there might have been more clues about the ambient light.

IS THE DRESS IN BRIGHT LIGHT?
If you think the dress is being washed out by bright light, your brain may perceive the dress as a darker blue and black.
Let it go!

Door == coke can?  *We'll work around it!*
The coke-can collector: *seeking...*
The coke-can collector: seeking...
The coke-can collector: *success!*
Computer Vision fail...

vs. Diversity fail!
Computer Vision is unusual...
How good is CV on *inanimate* things? 

*with human help*, pretty good!
How good is CV on *inanimate* things?
CS 5: the past...

Functions & variables
Recursion
Representations (binary, ascii)
Circuit design & Hmmm
Loops, 2d arrays
Dictionaries
Objects and Classes
Computability

---

Caesar cipher
4-bit multiplier
Mandelbrot, Life
Markov Text Gen.
Date, C4, Project
Finite state machines
Uncomputable functions
CS 5: the past...

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Looks like broccoli to me!
Interfaces

User Interfaces, Graphics, Animation
CS 124, 155, 157

AI

AI, Neural Networks, Computer Vision, Robotics
CS 151, 152, 153, 154

Systems

Compilers, Programming Languages, Networking, Operating Systems, Computer Architecture
Eng 85, 155, 158 & CS 125, 131, 132, 133

Theory

Theory of Computation, Advanced Algorithms
Math 167, 168 & CS 141, 142

SW Engineering & Data structures
CS 70, 121

Logic & Computability
CS 81

Principles of CS
CS 60
Beyond classes?

Other CS courses?

Sw Engineering &
Data structures

CS 70, 121

Logic & Computability

CS 81

Principles of CS

CS 60
Regardless, it reminded me of the three-eyed alien.

I hope all is well.

I never thought I'd say this, but thank you so much for finding us to learn all of it. I planned to have a great semester so far and have a fun spring break.

Professor Dods

To Zachary

Nathan Fahl (nathan.fahl@gmail.com)
However you're CSing, enjoy!

but what if I'm nostalgic for CS 5 itself?
However you're CSing, enjoy!

consider grutoring for CS5 next term or beyond...

but what if I'm nostalgic for CS 5 itself?
No matter *what* path you choose, *it's likely to be in binary*...
Thank you for joining CS5!  

Good luck on all finals (projects, exams, papers...)

Final Projects:  due *Friday* evening...

Exam:  **Mon, 12/12 @ 7pm**  or  **Tue, 12/13 all day**

Here in Shan 1430  
HMC Green Room

REVIEW:  Optional review session covering the practice final and any other questions...

Sunday evening, **12/11 7-8 pm**  Shan B460