This is CS50x

OpenCourseWare

Donate (https://cs50.harvard.edu/donate)

David J. Malan (https://cs.harvard.edu/malan/)
malan@harvard.edu
(https://www.facebook.com/dmalan) (https://github.com/dmalan)
(https://www.instagram.com/davidjmalan/) (https://www.linkedin.com/in/malan/)
(https://orcid.org/0000-0001-5338-2522)
(https://www.quora.com/profile/David-J-Malan)
(https://www.reddit.com/user/davidjmalan) (https://twitter.com/davidjmalan)

Lecture 10

The End

- Big thanks to the American Repertory Theater (https://americanrepertorytheater.org/) for hosting lectures this term, providing amazing props, lighting, and sounds to our stage.
- CS50's team, too, has been making everything possible off-stage, including our teaching fellows and course assistants, at both Harvard and Yale.
- And even David makes mistakes and can be unsure about answers for some questions, so rest assured that learning will continue well beyond this course.
- Don't forget that, ultimately:

  > what ultimately matters in this course is not so much where you end up relative to your classmates but where you end up relative to yourself when you began

- We've learned some first principles:
  - computational thinking
  - using algorithms to solve problems, given some inputs from which to produce outputs

    - axes of correctness, design, and style to evaluate our code
    - abstraction, using layering to simplify problems, as with functions in code
    - precision, as by considering all the possible edge cases in our instructions
- With these basic building blocks, we can learn to use tools in the future, beyond C and Python, to solve even more problems.
- We ask a volunteer to give a series of instructions for how to draw a cube and a snowman, and since everyone else interpreted each instruction slightly differently, the final drawings all ended up very different.

Ethics

- We might think of ethics as whether we *should* do something, or *how* we go about doing it, even when we have the ability to.
- For example, we can now use code to send lots of emails, creating more spam. We can collect passwords for our website with a form, and if a user uses that same password for another site, we end up with access to their account unless we store the passwords securely.
- JavaScript, too, can be used to log users' actions on our sites, like items they've added to their cart. But logging all actions, over time, can cause worry for users' privacy.
- Before Facebook, the website, there was another website, Facemash (https://www.thecrimson.com/article/2003/11/19/facemash-creator-survives-ad-board-the/), where code was used to scrape, or download, images of Harvard students and use them without prior permission.
- With some colleagues from the Department of Philosophy, Meica Magnani and Susan Kennedy, we discuss some frameworks for making decisions more rigorously.
- The Embedded EthiCS (https://embeddedethics.seas.harvard.edu/) program at Harvard integrates tools for ethical reasoning into computer science courses, to help ensure that future computer scientists will be creating and using technology ethically.
- The transcript for this section of lecture, as well as readings for the related lab, have been posted separately.

Looking Forward

- Even without additional courses in computer science, we hope that you're now equipped to use technology to solve problems in your own domain.
- When we face new problems, we can rely on one or more of these skills:
    - asking questions
    - finding answers
    - reading documentation

    - teaching yourself new languages
- CS50 IDE, too, can be used for future projects, but it comes with tools for the course.
- More industry-standard tools, for our own Mac or PC, include a terminal and other command-line tools:
    - https://developer.apple.com/xcode/ (https://developer.apple.com/xcode/)
    - https://docs.microsoft.com/en-us/windows/wsl/about (https://docs.microsoft.com/en-us/windows/wsl/about)
    - …
- Brian has a workshop (https://www.youtube.com/watch?v=MJUJ4wbFm_A) on Git, a version-control software used to manage different versions of code and enable collaboration with others.
- One of the most popular IDEs, VS Code (https://code.visualstudio.com/) is open-source and freely available, with a text editor at its core and lots of other features that can be added. There are many alternatives as well.
- Web hosts include:
    - https://pages.github.com/ (https://pages.github.com/)
    - https://www.netlify.com/ (https://www.netlify.com/)
    - …
- Web app hosts include:
    - https://www.heroku.com/platform (https://www.heroku.com/platform)
    - https://aws.amazon.com/education/awseducate/ (https://aws.amazon.com/education/awseducate/)
    - https://azure.microsoft.com/en-us/free/students/ (https://azure.microsoft.com/en-us/free/students/)
    - https://edu.google.com/programs/students/ (https://edu.google.com/programs/students/)
    - …
- And news sources for technology and programming include:
    - https://www.reddit.com/r/learnprogramming/ (https://www.reddit.com/r/learnprogramming/)
    - https://www.reddit.com/r/programming/ (https://www.reddit.com/r/programming/)
    - https://stackoverflow.com/ (https://stackoverflow.com/)
    - https://serverfault.com/ (https://serverfault.com/)
    - https://techcrunch.com/ (https://techcrunch.com/)
    - https://news.ycombinator.com/ (https://news.ycombinator.com/)
    - …
- CS50 has many communities as well:
    - https://discord.gg/cs50 (https://discord.gg/cs50)

- https://www.facebook.com/groups/cs50 (https://www.facebook.com/groups/cs50)
- https://www.facebook.com/cs50 (https://www.facebook.com/cs50)
- https://gitter.im/cs50/x (https://gitter.im/cs50/x)
- https://github.com/cs50 (https://github.com/cs50)
- https://www.instagram.com/cs50/ (https://www.instagram.com/cs50/)
- https://www.linkedin.com/groups/7437240/ (https://www.linkedin.com/groups/7437240/)
- https://www.linkedin.com/school/CS50/ (https://www.linkedin.com/school/CS50/)
- https://www.quora.com/topic/CS50 (https://www.quora.com/topic/CS50)
- https://www.reddit.com/r/cs50 (https://www.reddit.com/r/cs50)
- https://cs50x.slack.com/ (https://cs50x.slack.com/)
- https://www.snapchat.com/add/cs50 (https://www.snapchat.com/add/cs50)
- https://soundcloud.com/cs50 (https://soundcloud.com/cs50)
- http://cs50.stackexchange.com/ (http://cs50.stackexchange.com/)
- https://twitter.com/cs50 (https://twitter.com/cs50)
- http://www.youtube.com/cs50 (http://www.youtube.com/cs50)

Quiz Show

- We host a quiz show with the audience, with the following questions:
  - What are the steps for compiling source code into machine code?
    - Preprocessing, compiling, assembling, linking
  - What is the runtime of binary search?
    - $O(\log n)$
  - Which of these animals was the first to be mentioned in a CS50 lecture?
    - Cat
  - Every time you `malloc` memory, you should also be sure to…
    - `free`
  - What is a race condition?
    - When two things happen at the same time and produce an unexpected result
  - Does zooming in on a photo let you "enhance" it to generate more detail?
    - No, a photo only has a certain amount of detail
  - Which of the following is not a characteristic of a good hash function?
    - Randomness
  - What does FIFO stand for?
    - First in, first out
  - Which of the following would represent pink using RGB values?
    - `#ffd0e0`

- In C, which of the following lines of code allocates enough memory for a copy of the string `s`?
  - `malloc(strlen(s) + 1)`
- How should you organize your clothes to be cool?
  - queue
- What is a segmentation fault?
  - When a program tries to access memory that it shouldn't
- Which of the following types of overflow can result from recursion without a base case?
  - stack overflow
- In the town of Fiftyville, what were the names of the three people who witnessed the rubber duck robbery?
  - Ruth, Eugene, and Raymond
- Which of these command-line programs check your code for memory leaks?
  - `valgrind`
- Which of the following exists in C, but not Python?
  - do-while loops
- What HTTP request method should you use when sending private information, like a password?
  - POST
- What data structure allows for constant-time lookup for words in a dictionary?
  - trie
- What is a cookie?
  - both of the above
- What's your comfort level now?
  - I'm among those more comfortable

- Thanks for joining us at CS50!