

# CS107 Lecture 2

## Unix and C

***While you're waiting – get set up with PollEverywhere!  
Visit [pollev.stanford.edu](http://pollev.stanford.edu) to set up your account.***

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Based on slides created by Cynthia Lee, Chris Gregg, Jerry Cain, Lisa Yan and others.

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# PollEverywhere

- Today we're doing a "trial run" of using PollEverywhere for poll questions
  - Not counted for attendance (that starts next lecture), just a chance to try it out
  - Canvas Gradebook records lecture scores
  - Responses not anonymized, but we look only at aggregated results and totals
  - Poll responses require being present in the lecture room to receive credit
  - Alternative option instead of lecture credit is to shift the full 5% weight to the final exam
- Visit [pollev.stanford.edu](http://pollev.stanford.edu) to log in (or use the PollEverywhere app) and sign in with your **@stanford.edu email – NOT your personal email!**
- Compatible with any device with a web browser, mobile app also available.
- Poll questions in slides will automatically activate the poll and respond at [pollev.com/cs107](http://pollev.com/cs107).
- Polls will prompt for location check-in; check in **prior** to inputting response.

# Announcements

- Remember to input your lab preferences through 11:30AM Fri! Link is on the course website (under “Labs”).
- Helper Hours scheduled and starting this week!
- assign0 released, due Mon 11:59PM PDT
- Make sure to submit our OAE accommodations form or our exam information form on the course homepage if applicable!

# Learning Goals

- Learn how to navigate a computer and edit/run programs using the terminal
- Understand the differences between C and other languages and how to write C programs

# Lecture Plan

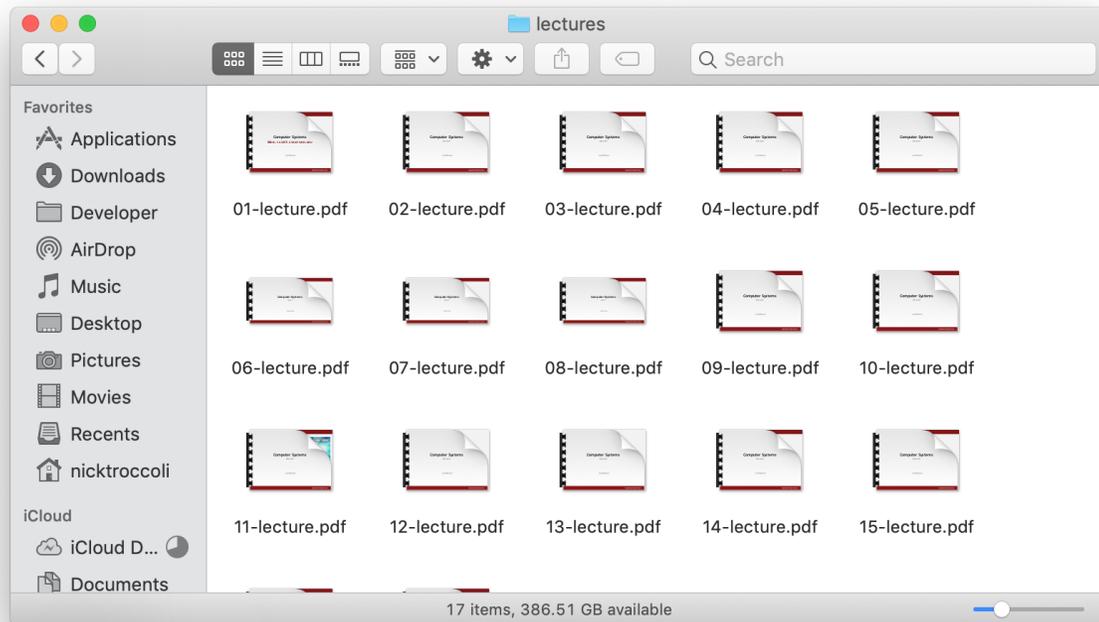
- Unix and the Command Line
- Getting Started With C

# Lecture Plan

- **Unix and the Command Line**
- Getting Started With C

# What is the Command Line?

- The **command-line** is a text-based interface (i.e., **terminal** interface) to navigate a computer, instead of a Graphical User Interface (GUI).



Graphical User Interface

```
lectures — -bash — 80x24
Nick-Troccoli-MacBook-Pro-2:~ nicktroccoli$ cd Developer/CS107\ Winter\ 18-19/
Nick-Troccoli-MacBook-Pro-2:CS107 Winter 18-19 nicktroccoli$ cd WWW/lectures/
Nick-Troccoli-MacBook-Pro-2:lectures nicktroccoli$ ls
01-lecture.pdf 05-lecture.pdf 09-lecture.pdf 13-lecture.pdf 17-lecture.pdf
02-lecture.pdf 06-lecture.pdf 10-lecture.pdf 14-lecture.pdf
03-lecture.pdf 07-lecture.pdf 11-lecture.pdf 15-lecture.pdf
04-lecture.pdf 08-lecture.pdf 12-lecture.pdf 16-lecture.pdf
Nick-Troccoli-MacBook-Pro-2:lectures nicktroccoli$
```

Text-based interface

# Unix Commands To Try

- **cd** – change directories (..)
- **ls** – list directory contents
- **mkdir** – make directory
- **emacs** – open text editor
- **rm** – remove file or folder
- **man** – view manual pages

See the course website for more commands and a complete reference.

# Demo: Using Unix and the Command Line



Get up and running with our guide:

<http://cs107.stanford.edu/resources/getting-started.html>

# Lecture Plan

- Unix and the Command Line
- **Getting Started With C**

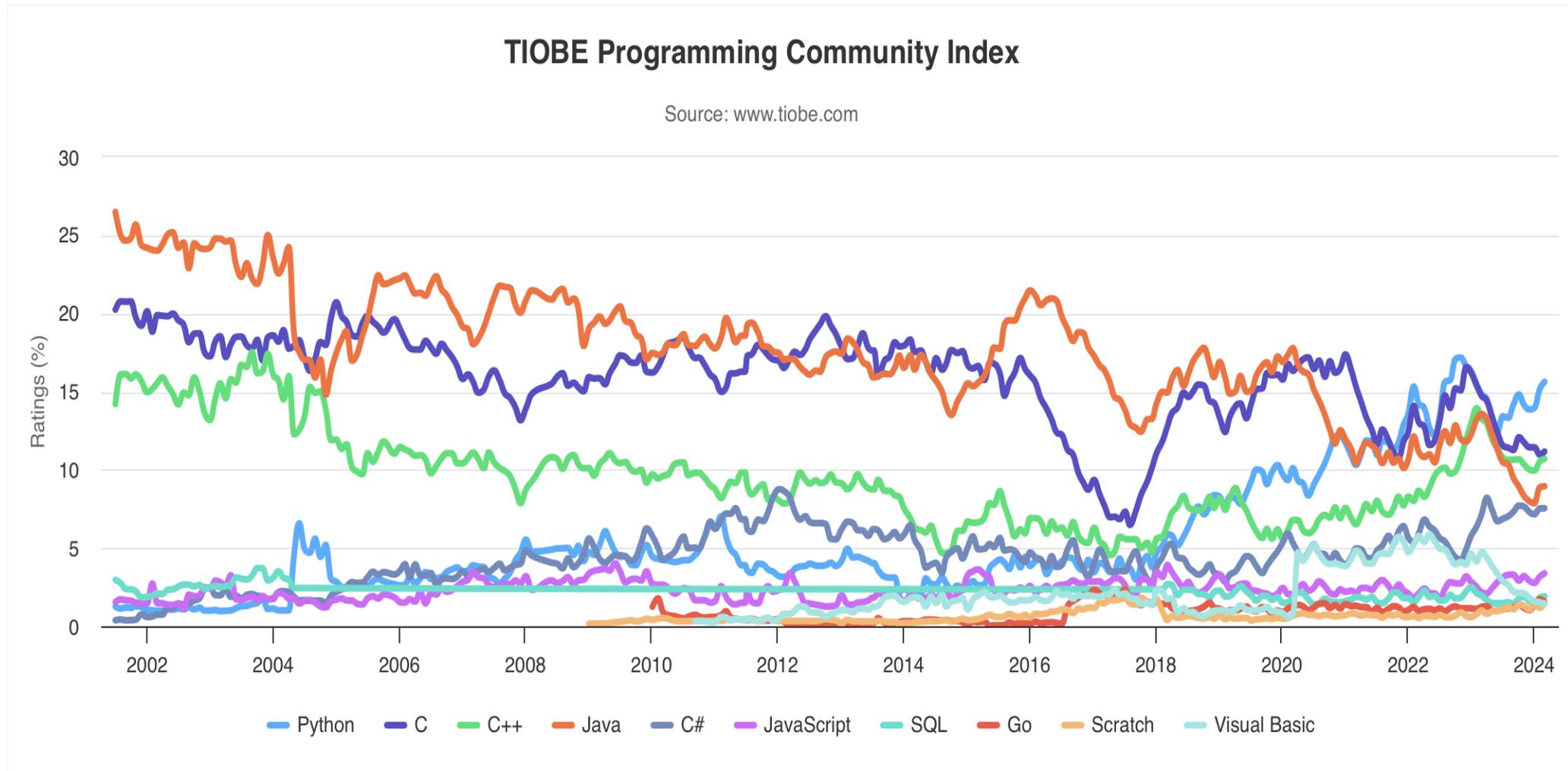
# The C Language

- C was created around 1970 to make writing Unix and Unix tools easier.
- Part of the C/C++/Java family of languages (C++ and Java were created later)
- Design principles:
  - Small, simple abstractions of hardware
  - Minimalist aesthetic
  - Prioritizes efficiency and minimalism over safety and high-level abstractions
- Procedural (you write functions, no classes or methods) – vs. C++ or Python where you can write functions but also classes with methods
- Doesn't have all features you may know from other languages (e.g., no pass by reference, no classes and objects, no ADTs, no extensive libraries, weak compiler and almost no runtime checks – which can cause security vulnerabilities!)

# Why C?

- Many tools (and even other languages, like Python!) are built with C.
- C is the language of choice for fast, highly efficient programs.
- C is popular for systems programming (operating systems, networking, etc.)
- C lets you work at a lower level to manipulate and understand the underlying system.

# Programming Language Popularity



<https://www.tiobe.com/tiobe-index/>

# Our First C Program

```
/*  
 * hello.c  
 * This program prints a welcome message  
 * to the user.  
 */  
#include <stdio.h> // for printf  
  
int main(int argc, char *argv[]) {  
    printf("Hello, world!\n");  
    return 0;  
}
```

# Our First C Program

```
/*  
 * hello.c  
 * This program prints a welcome message  
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 */
```

```
#include <stdio.h> // for printf
```

```
int main(int argc, char *argv[]) {  
    printf("Hello, world!\n");  
    return 0;  
}
```

## Program comments

You can write block or inline comments.

# Our First C Program

```
/*  
 * hello.c  
 * This program prints a welcome message  
 * to the user.  
 */  
#include <stdio.h> // for printf  
  
int main(int argc, char *argv[]) {  
    printf("Hello, world!\n");  
    return 0;  
}
```

## Import statements

C libraries are written with angle brackets.

Local libraries have quotes:

```
#include "lib.h"
```

# Our First C Program

```
/*  
 * hello.c  
 * This program prints a welcome message  
 * to the user.  
 */  
#include <stdio.h> // for printf
```

```
int main(int argc, char *argv[]) {  
    printf("Hello, world!\n");  
    return 0;  
}
```

**Main function** – entry point for the program  
Should always return an integer (0 = success)

# Our First C Program

```
/*  
 * hello.c  
 * This program prints a welcome message  
 * to the user.  
 */  
#include <stdio.h> // for printf  
  
int main(int argc, char *argv[]) {  
    printf("Hello, world!\n");  
    return 0;  
}
```

If user runs `ls -a`:

```
argv = ["ls", "-a"]  
argc = 2
```

**Main parameters** – `main` takes two parameters, both relating to the *command line arguments* used to execute the program. (split by spaces)

`argc` is the *number* of arguments in `argv`  
`argv` is an *array of arguments* (**`char *` is C string**)

# Our First C Program

```
/*  
 * hello.c  
 * This program prints a welcome message  
 * to the user.  
 */  
#include <stdio.h> // for printf  
  
int main(int argc, char *argv[]) {  
    printf("Hello, world!\n");  
    return 0;  
}
```

**printf** – prints output to the screen

# Console Output: printf

```
printf(text, arg1, arg2, arg3,...);
```

printf supports printing out the values of variables or expressions, but C does not support string concatenation with “+”.

Instead, we can include *placeholders* in our printed text, and printf will replace each placeholder *in order* with the values of the parameters passed after the text.

%s (string)

%d (integer)

%f (double)

```
// Example
```

```
char *classPrefix = "CS";
```

```
int classNumber = 107;
```

```
printf("You are in %s%d!", classPrefix, classNumber); // You are in CS107!
```

A diagram with two blue arrows and one green arrow. One blue arrow points from the variable 'classPrefix' to the '%s' placeholder in the printf format string. Another blue arrow points from the variable 'classNumber' to the '%d' placeholder. A green arrow points from the entire printf statement to the comment '// You are in CS107!'.

# Familiar Syntax

```
int x = 42 + 7 * -5;           // variables, types
double pi = 3.14159;
char c = 'Q';                 /* two comment styles */

for (int i = 0; i < 10; i++) { // for loops
    if (i % 2 == 0) {         // if statements
        x += i;
    }
}

while (x > 0 && c == 'Q' || b) { // while loops, logic
    x = x / 2;
    if (x == 42) {
        return 0;
    }
}

binky(x, 17, c);             // function call
```

# Boolean Variables

To declare Booleans, (e.g. `bool b = _____`), you must include `stdbool.h`:

```
#include <stdio.h>      // for printf
#include <stdbool.h>    // for bool

int main(int argc, char *argv[]) {
    bool x = 5 > 2 && binky(argc) > 0;
    if (x) {
        printf("Hello, world!\n");
    } else {
        printf("Howdy, world!\n");
    }
    return 0;
}
```

# Boolean Expressions

C treats a nonzero value as true, and a zero value as false:

```
#include <stdio.h>

int main(int argc, char *argv[]) {
    int x = 5;
    if (x) { // true
        printf("Hello, world!\n");
    } else {
        printf("Howdy, world!\n");
    }
    return 0;
}
```

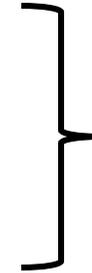
# Writing, Debugging and Compiling

We will use:

- the **emacs** text editor to write our C programs
- the **make** tool to compile our C programs
- the **gdb** debugger to debug our programs
- the **valgrind** tools to debug memory errors and measure program efficiency



Now



Next week

# Working On C Programs

- **ssh** – remotely log in to Myth computers
- **Emacs** – text editor to write and edit C programs
  - Use the mouse to position cursor, scroll, and highlight text
  - Ctl-x Ctl-s to save, Ctl-x Ctl-c to quit
- **make** – compile program using provided Makefile
- **./myprogram** – run executable program (optionally with arguments)
- **make clean** – remove executables and other compiler files
- Lecture code is accessible at **`/usr/class/cs107/lecture-code/lect[N]`**
  - Make your own copy: **`cp -r /usr/class/cs107/lecture-code/lect[N] lect[N]`**
  - See the website for even more commands, and a complete reference.

# Demo: Compiling And Running A C Program



Get up and running with our guide:

<http://cs107.stanford.edu/resources/getting-started.html>

# Assign0

**Assignment 0** (Intro to Unix and C) is due on **Mon. 4/7 at 11:59PM PDT**.

There are **5** parts to the assignment, which is meant to get you comfortable using the command line, and editing/compiling/running C programs:

- Visit the website resources to become familiar with different Unix commands
- **Clone** the assign0 starter project
- **Answer** several questions in `readme.txt`
- **Compile** a provided C program and **modify** it
- **Submit** the assignment

# Preview: Next Time

- Make sure to reboot Boeing Dreamliners [every 248 days](#)
- Comair/Delta airline had to [cancel thousands of flights](#) days before Christmas
- Many operating systems [may have issues](#) storing timestamp values beginning on Jan 19, 2038
- [Reported vulnerability CVE-2019-3857](#) in libssh2 may allow a hacker to remotely execute code

**Next time:** *How can a computer represent integer numbers? What are the limitations?*