

CS 241: Systems Programming

Lecture 1. Introduction

Spring 2024

Prof. Stephen Checkoway

What is this course about?

Tools for succeeding in computer science

- ▶ Unix command line
- ▶ Bash scripting
- ▶ **Rust programming**
- ▶ Building software
- ▶ Debugging
- ▶ Linters/static analyzers
- ▶ Version control
- ▶ Collaborative development
- ▶ Regular expressions
- ▶ Looking things up like a real programmer
- ▶ ...

What is this course not about?

Learning to program (you already know how to do that!)

...but you'll get a lot of good programming practice

You should expect to

Do a lot of programming and debugging!

Learn about tools by reading their documentation and Googling

Read a lot

Work on projects in groups

What is “Systems Programming”?

Systems programming

- ▶ Builds software to support other programs (e.g., operating systems, network services)
- ▶ Traditionally written in low-level languages (first assembly, then C)
- ▶ Often written with specific computer hardware in mind (e.g., x86-64 or ARM64)

Contrast with application programming which

- ▶ Builds software for end users (e.g., word processors, video players)
- ▶ Often built in languages with automatic memory management like Java, C#, Swift

We'll be learning Rust, a general purpose programming language good for both!

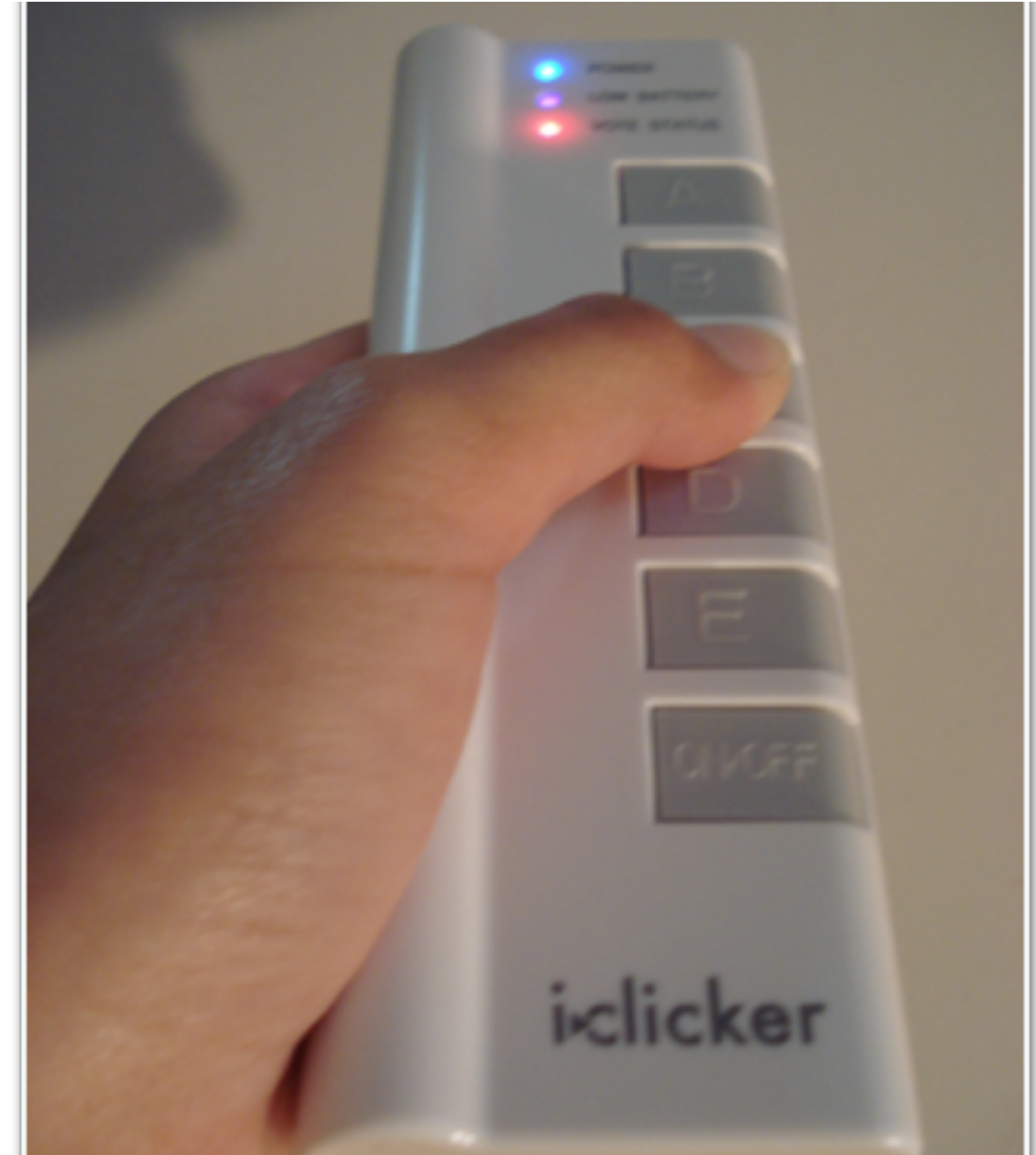
iClickers

Need to have one and register it by next Monday's class

Register by following the instructions:

<https://mhe.my.site.com/iclicker/s/article/How-to-Register-an-iClicker-Remote>

Do not borrow them from the Science Library!



<http://citadel.sjfc.edu/students/emm00561/e-port/msti260/iclicker.jpg>

Peer instruction

I will pose a multiple-choice question about a concept

Think and choose your answer individually with your clicker

After the time ends, discuss your answers with the people around you, come to consensus, and vote again

After the group vote, you explain why your group voted that way

Why peer instruction?

You get to make sure you're following the material

I get immediate feedback about what parts are confusing

It's less boring than lecture

Research shows it promotes more learning than standard lecture

Which cat is cutest?

A. Kirk



B. Spock



C. Bones



D. Equally cute

E. I don't like cats (I'm a monster)

Course website

<https://checkoway.net/teaching/cs241/2024-spring/>

- ▶ Syllabus (there's (a fair bit of) reading for Wednesday!)
- ▶ Links to books
- ▶ Labs
- ▶ Resources
- ▶ Ed forum
- ▶ Policies
- ▶ Office hours

Grading

10% Class participation

75% Weekly labs

15% Final group project

The final project must be completed to pass the course

Late days/missing class

You have 3 late days you can use on any homework

- ▶ If you work with a partner (and you should), late work counts against both of your remaining late days

You can choose not to participate in class (including missing class) three times without penalty

You get participation points each day by answering clicker questions, so make sure you answer them all

- ▶ You get three excused absences (including if you forget to bring your clicker to class)

Final group project

Work in groups of 4

More about this in a few weeks

You will write a project proposal

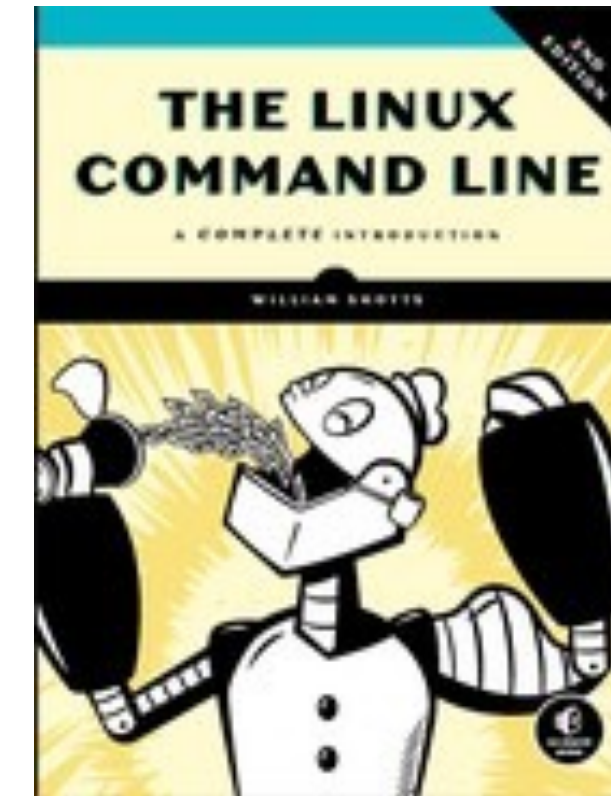
You will have a bunch of time to work on it

You will give a short presentation on it at the end of the semester

Everybody is expected to work on all parts of the final; in particular, if you do not show up for the presentation, you will fail the course

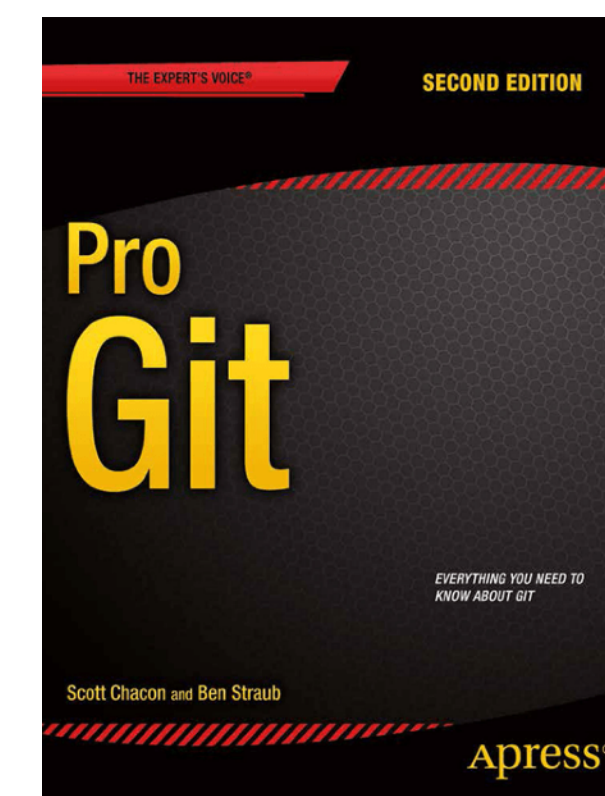
Textbooks

William E. Shotts. *The Linux Command Line*, 2nd edition



Steve Klabnik and Carol Nichols. *The Rust Programming Language*, available online with quizzes

Scott Chacon and Ben Straub. *Pro Git*, 2nd edition



Honor code

Do

- ▶ Work in groups of size 2 (or 4 for the project)
- ▶ Discuss assignments with others in the class, including on the discussion forum
- ▶ Cite sources if using code/ideas from outside class

Do not

- ▶ Share your solutions outside your group
- ▶ Use someone else's solutions

Labs

Brand new lab assignments for CS 241!

First one (Lab 0) is on Tuesday (it will be short)

Subsequent labs will be longer (like 150/151 labs) and have code to turn in each week

Final few labs of the semester will be designed to be completed in the lab period

Lab room

King 137

Door code: 8372

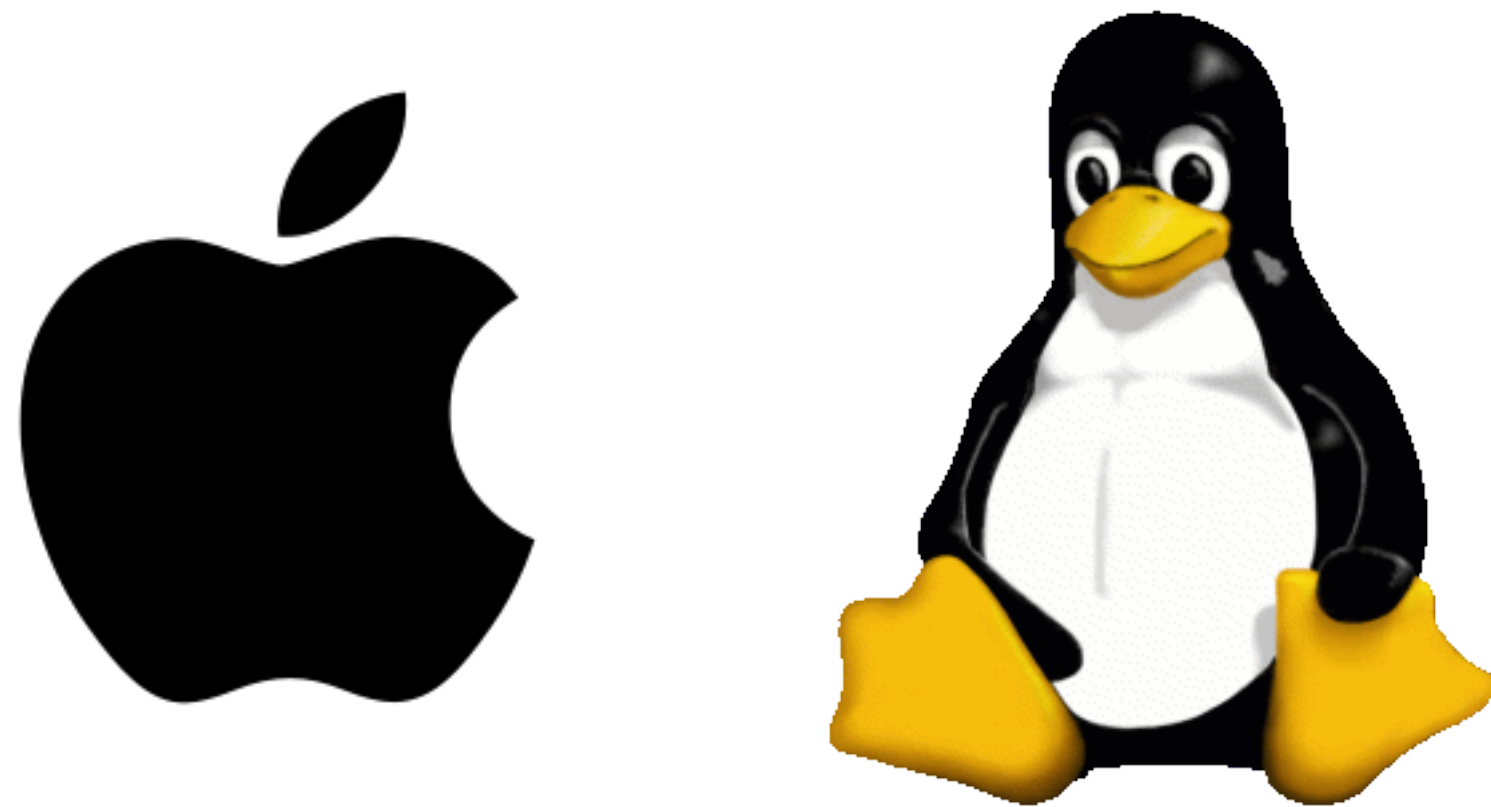
See Lucas Draper if you don't have an account

See Wendy Black-Parsons in the CS office if you add late for 24 hour access to King

Connecting to mcnulty

Remote server for CS 241: mcnulty.cs.oberlin.edu (named for Kay McNulty)

- ▶ Access via ssh
- ▶ Accessible from on campus but not outside Oberlin



From a terminal:

```
$ ssh username@mcnulty.cs.oberlin.edu
```



Use PuTTY <https://putty.org/>

Can't connect to mcnulty?

mcnulty.cs.oberlin.edu isn't **reachable** outside of Oberlin

occs.cs.oberlin.edu is!

```
$ ssh username@occs.cs.oberlin.edu
```

```
$ ssh mcnulty.cs.oberlin.edu
```

Alternatively

```
$ ssh -J user@occs.cs.oberlin.edu user@mcnulty.cs.oberlin.edu
```

Editors

For the Rust portion of the course, we'll be using Visual Studio Code

For the Bash portion of the course, you can use whatever editor you like

- Learning a command-line editor like vim or emacs can be really helpful
- Using VS Code is also an excellent choice

Video Studio Code lets you connect to computers via ssh for remote editing

Why Rust

Traditionally 241 taught C

C is (essentially) impossible to write correctly

Incorrect C leads to vulnerabilities which can be exploited

C does almost nothing to prevent you from writing unsafe programs

A Python program

```
small_primes = [2, 3, 5, 7, 11, 13, 17, 19, 23]
index = int(input("Enter the index of a small prime: "))
print(f"The small prime at index {index} is {small_primes[index]}")
```

```
$ python small_primes.py
Enter the index of a small prime: 4
The small prime at index 4 is 11
```

What happens if I enter a number that's too large?

```
$ python small_primes.py
Enter the index of a small prime: 10
```

A Python program

```
small_primes = [2, 3, 5, 7, 11, 13, 17, 19, 23]
index = int(input("Enter the index of a small prime: "))
print(f"The small prime at index {index} is {small_primes[index]}")
```

What happens if I enter a number that's too large?

```
$ python small_primes.py
Enter the index of a small prime: 10
Traceback (most recent call last):
  File "/Users/steve/small_primes.py", line 3, in <module>
    print(f"The small prime at index {index} is
{small_primes[index]}")
IndexError: list index out of range
```

A Java program

```
public class SmallPrimes {  
    public static void main(String[] args) {  
        int[] small_primes = {2, 3, 5, 7, 11, 13, 17, 19, 23};  
        System.out.print("Enter the index of a small prime: ");  
        System.out.flush();  
        int index = Integer.parseInt(System.console().readLine());  
        System.out.println("The small prime at index " + index +  
                           " is " + small_primes[index]);  
    }  
}
```

```
$ java SmallPrimes  
Enter the index of a small prime: 4  
The small prime at index 4 is 11
```

What happens if I enter a number that's too large?

A Java program

```
public class SmallPrimes {  
    public static void main(String[] args) {  
        int[] small_primes = {2, 3, 5, 7, 11, 13, 17, 19, 23};  
        System.out.print("Enter the index of a small prime: ");  
        System.out.flush();  
        int index = Integer.parseInt(System.console().readLine());  
        System.out.println("The small prime at index " + index +  
                           " is " + small_primes[index]);  
    }  
}
```

What happens if I enter a number that's too large?

```
$ java SmallPrimes
```

```
Enter the index of a small prime: 10
```

```
Exception in thread "main" java.lang.ArrayIndexOutOfBoundsException: 10  
    at SmallPrimes.main(SmallPrimes.java:7)
```

A C program

```
#include <stdio.h>
#include <stdlib.h>

int main(void) {
    int small_primes[] = {2, 3, 5, 7, 11, 13, 17, 19, 23};
    printf("Enter the index of a small prime: ");
    fflush(stdout);
    char line[1024];
    fgets(line, sizeof line, stdin);
    int index = atoi(line);
    printf("The small prime at index %d is %d\n", index,
          small_primes[index]);
    return 0;
}
```

A C program

```
$ ./small_primes  
Enter the index of a small prime: 4  
The small prime at index 4 is 11
```

What happens if I enter a number that's too large?

```
$ ./small_primes  
Enter the index of a small prime: 10
```

A C program

```
$ ./small_primes  
Enter the index of a small prime: 4  
The small prime at index 4 is 11
```

What happens if I enter a number that's too large?

```
$ ./small_primes  
Enter the index of a small prime: 10  
The small prime at index 10 is 129070014
```

???

```
$ ./small_primes  
Enter the index of a small prime: -7  
The small prime at index -7 is 83427584
```

???

For next class

Register your iClicker

Read chapters 1–5 of *The Linux Command Line*

Bring your iClicker and a laptop to class

