Introduction

CS 351: Systems Programming
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Agenda

- Syllabus & Administrivia
- Course overview (“Systems Programming”)

Science

Computer Science

§Syllabus

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Prerequisites

- "substantial" programming experience
- data structures: concepts & implementation
- basic run-time analysis (big O)
- knowledge of (any) assembly language
- computer organization essentials

- computer organization essentials:
  - data representation (binary, two's comp, f.p. inaccuracy, etc.)
  - von Neumann model
    - CPU, memory, I/O
  - stack usage / conventions

Online resources

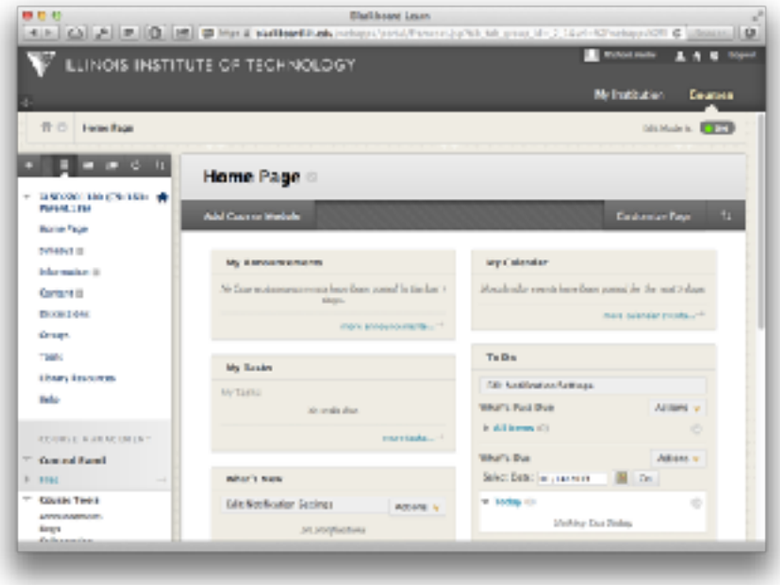
1. Course website
   moss.cs.iit.edu/cs351

- static information
  - lecture calendar, assignment writeups, slides, screencasts, links, etc.

Online resources

2.Blackboard

- *only for grade reporting*!

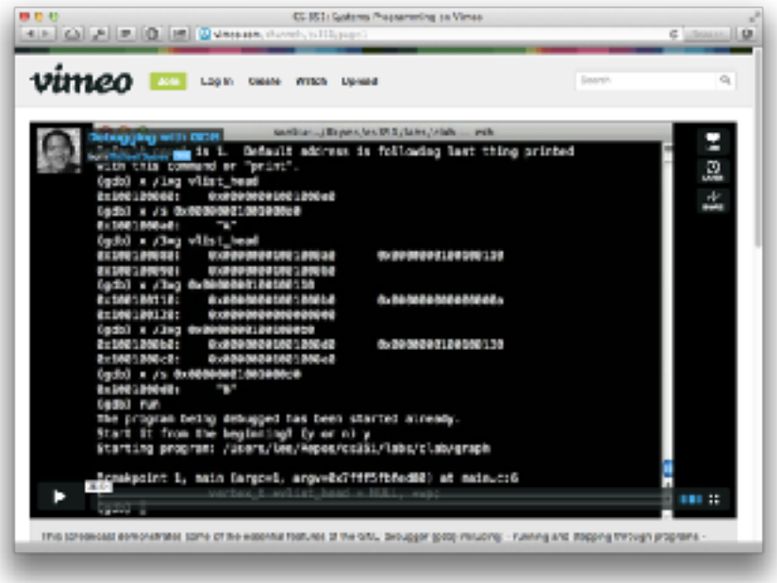


Online resources

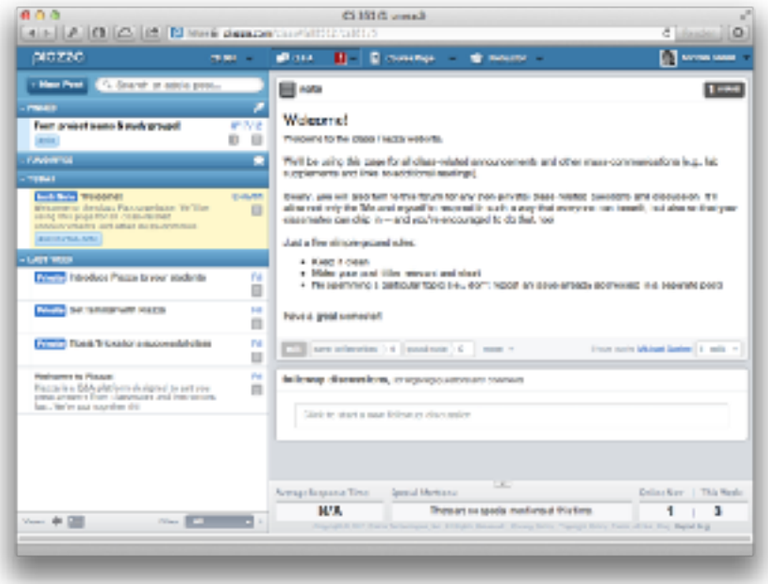
3. Vimeo channel: screencasts

- vimeo.com/channels/cs351

- walkthroughs & tutorials
  (check before starting labs!)



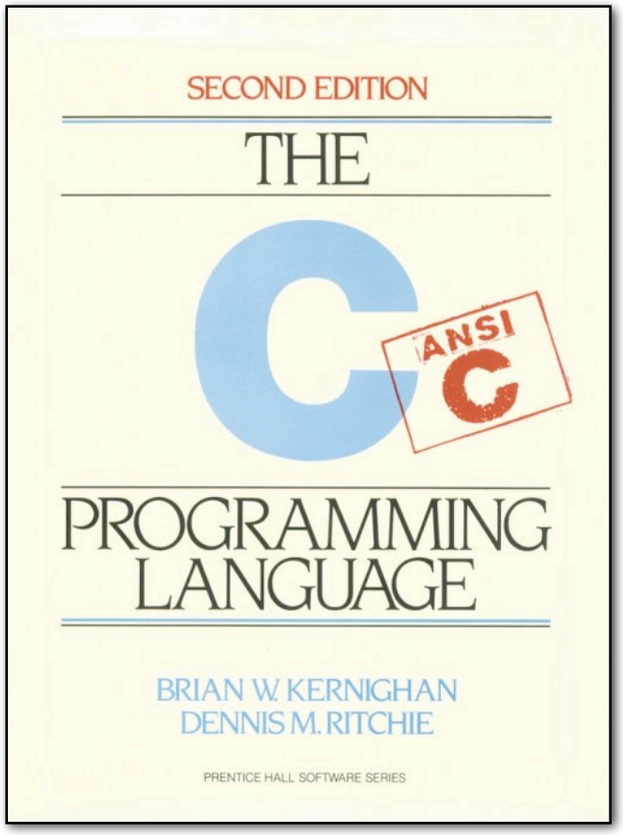
Online resources

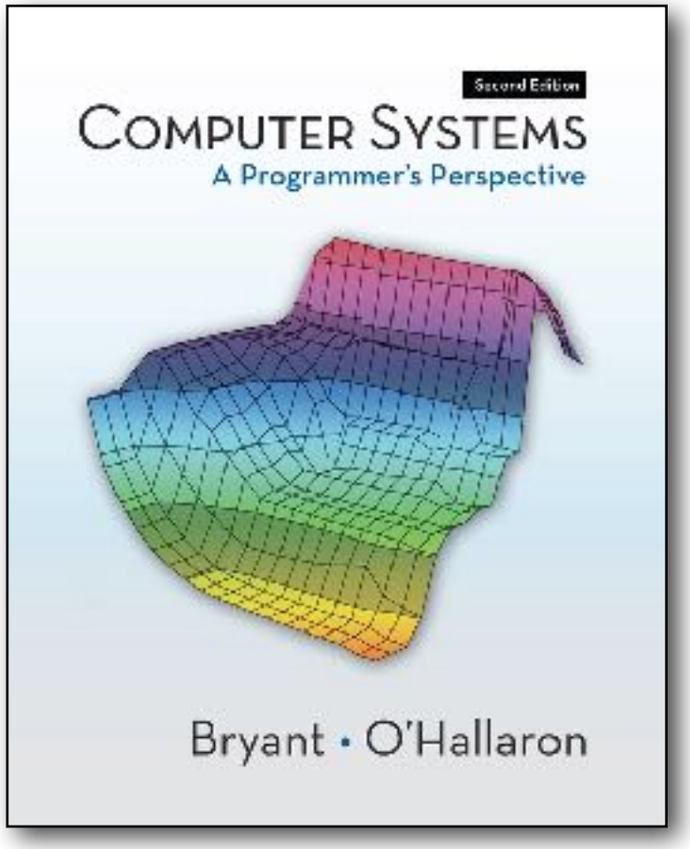


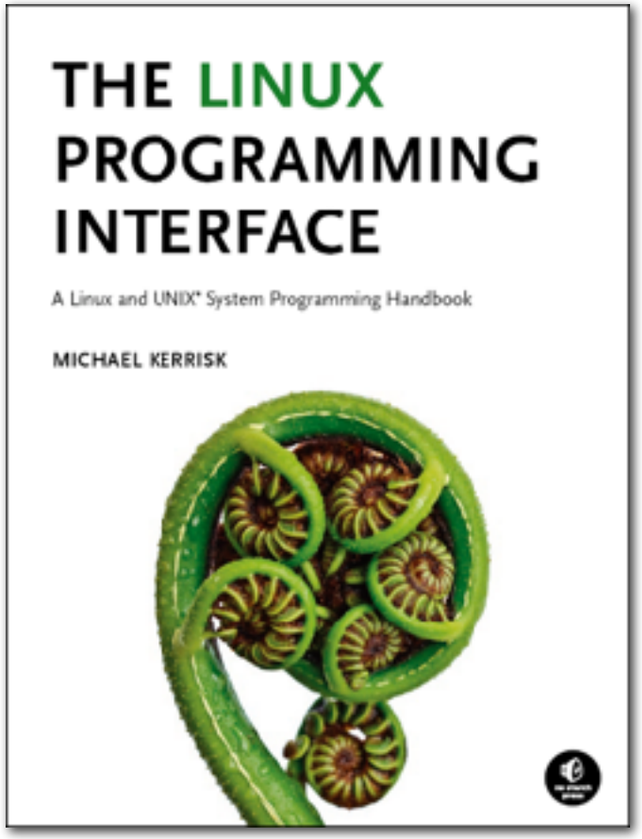
4.Piazza: discussion forum

- all class-related questions
- monitored by TAs
- scales *way* better than e-mail
- announcements, links to additional readings & resources

Textbooks


SECOND EDITION
THE
C
ANSI
C
PROGRAMMING
LANGUAGE
BRIAN W. KERNIGHAN
DENNIS M. RITCHIE
PRENTICE HALL SOFTWARE SERIES


Second Edition
COMPUTER SYSTEMS
A Programmer's Perspective
Bryant • O'Hallaron


THE LINUX
PROGRAMMING
INTERFACE
A Linux and UNIX® System Programming Handbook
MICHAEL KERRISK

Grading

- 50% Labs
- 25% Midterm exam
- 25% Final exam
  - exam scores *normalized* to 70%
  - need ≥ 50% on both exams to pass

Grade Scale

```
char letter_grade(float score) {
    if (score >= 90.0)      return 'A';
    else if (score >= 80.0) return 'B';
    else if (score >= 70.0) return 'C';
    else if (score >= 60.0) return 'D';
    else return 'E';
}
```

Labs

- fairly substantial machine problems
  - 100-1000 LOC
- real-world application of concepts covered in lecture & textbook
- 1-3 weeks allotted for each

§Course Overview

“Systems Programming”

system |ˈsistəm|

noun

1 a set of connected things or parts forming a complex whole

(*New Oxford American Dictionary*)

"Systems Programming"

- Programming the *operating system*
- What does *that* mean?

OS vs. OS *kernel*

- OS kernel ≈ smallest subset of OS code needed to bootstrap system and provide basic services to user programs
- "smallest" is debatable

How to “program” it?

- Require some API
  - Application Programming Interface
    - A collection of (documented) functions
      - e.g., get/put/del for a hashtable

OS API

- a.k.a. “system call” interface
  - OS as a very low-level library
- common purpose: provide services to user level programs
  - *def:* program in execution = ***process***

The Process

- A program in execution
- Code + Data { global, local, dynamic }

  + OS kernel data
- OS hides complexity of machine from processes by creating *abstractions*

“Abstraction”

http://xkcd.com/

Primary Abstractions

- Logical control flow
- Exceptional (extra-process) control flow
- Logical address space
- Uniform I/O
- Interprocess Communication

In the old days …

- … every program had to include its own implementation of all the above!
- Now, OS simplifies life for all of us.
  - Only need to know how to *use* them, not how they're *implemented*.

But!

- In this class we dig a bit deeper
- What facilities are encapsulated by syscalls?
- What limitations/restrictions do they have?
- Why are they designed the way they are?
- How do they work behind the scenes?

Science

Computer Science

But why should I care?

- *efficiency*: know how to use tools optimally; reuse existing features and design/layer new ones appropriately
- *robustness*: avoid bugs/failures & know how to diagnose and fix them

the real reason: it's fun to take things apart!

goal: turn you into a **hacker**

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(or: make you a **better** hacker)

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hacker |ˈhakər|

noun

1 A person who enjoys exploring the details of programmable systems and how to stretch their capabilities, as opposed to most users, who prefer to learn only the minimum necessary.

The Jargon File, version 4.4.7

Our tools (& approach)

- C & Linux
  - C: low-level language
  - GNU Linux: open source kernel & tools
    - GNU gdb & gcc; debugger & compiler