CSE 374
Programming Concepts & Tools

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Lecture 1 – Course Introduction

Welcome!

- We have 10 weeks to move to a level well above novice programmer:
  - Command-line tools/scripts to automate tasks
  - C programming (lower level than Java; higher than assembly)
  - Tools for programming
  - Basic software-engineering concepts
  - Basics of concurrency
- That's a lot!
- Get used to exposure, not exhaustive investigation
  - This is not intro programming anymore

Today

- In class today
  - Course mechanics
  - Overview and plan
  - Dive into the *command shell*
- By next time
  - Get going on homework 0
    - Due Thursday night!!
    - Goal: Get a login shell on your Linux machine (usually CSE VM or cancun) so you're ready to go!
  - Start reading Linux Pocket Guide (first sections: overview, shell, basic directory & file operations for sure; skim other parts for interesting things)
    - and *try stuff* !! Don't just read about it, do it!

To get started…

- Welcome back. It's all in-person this quarter (but we'll adjust if things need to change for some reason)

- UW mask policy is optional, but strongly recommended for at least the first couple of weeks
  - No judgement: people can do what they will, and do not read anything into how others do or don't use masks
  - Please be courteous and allow people distance or otherwise help them feel comfortable if asked.

- Stay healthy! If you do come down with something, please stay home until recovered and not contagious
  - Lectures are on panopto if you do need to miss

Stay in touch – speak up!

- This is a strange world we've been in and there's still a lot of stress for many people

- Please speak up if things aren't (or are!) going well
  - We can often help if we know about things, so stay in touch with TAs, instructor, advising, friends and peers, others
  - Don't try to "tough it out" or pretend it will get better if you just ignore it – speak up!

- We're all in this together but not all in the same way, so please show understanding and compassion for each other and help when you can – both in and outside of class

Who

- Staff
  - Hal Perkins, instructor
  - TAs: Xinyue Chen, Maxim Klyuchko, Ben Soesanto, Dixon Tirtayadi, Qingyuan Dong
- Office hours posted shortly. Use them to get "unstuck" so you can make progress on your own.
- You!
  - Almost 90 people(!)
  - Who has used Linux before?
  - Who has written a C program before?
    - Beyond hello world?
  - Who has used git/gitlab/github?

What

- 3 classes/week (slides, code, demos, questions)
  - Material online (slides posted before class, demo transcripts after), but **TAKE NOTES!**
  - Advice: jot down keywords and ideas; look up details later
  - Advice: use class for concepts (you can do *this*); use documentation for details (*how*)
  - Advice: experiment, try things later that day
  - Warning: the slides are **not** *nearly enough* to learn everything you need. They are an outline, tour guide, orientation only.

Laptops in class?

- Huge distraction – cannot be immersed in a laptop and be mentally present in class at the same time
- Just say no!!
- No open laptops during class (no kidding!)
  - (unless we're doing something where everyone should participate)
- Why? You will learn better if you are mentally present during the class (not just physically)
- Got the urge to search? Ask a question!
- Exception: if you *actually*, *really*, ***really***, use a laptop or tablet to take notes, that's fine, but don't distract others
  - But you'll learn more if you use paper instead! (really!!)
- And no phone texting, web surfing, etc., either…
- You may close your non-notetaking electronic devices now.

Requirements

- 7 homeworks (+ / - 1) (70%)
  - 3 shell commands and scripting
  - 3 C programming
    - Later two of these use tools extensively
    - One is a team project (work in pairs)
  - 1 more (probably concurrency)
- 1 midterm (10%), 1 final (15%)
- Last 5% is citizenship, participation, tbd, etc.
- Collaboration: individual work unless announced otherwise; *never* look at or show your code to others
- Extra credit: when available, small effect on your grade if you do it – no effect if you don't

Academic Integrity

- Policy on the course web. **Read it!**
- Do your own work – always explain any unconventional action on your part
- I trust you completely
- I have no sympathy for trust violations – nor should you
- Honest work is the most important feature of a university. It shows respect for your colleagues *and yourself.*
- But: don't sit in a silo, alone. Talk with others, share ideas, learn from each other – but do your own work.

Deadlines

- Turn things in on time!
- But things happen, so …
  - You have 4 late days to use this quarter
  - No more than 2 late days per assignment
  - Counted in 24 hour chunks (10 min = 24 hours)
  - On group projects, can only use if both partners have late days and both partners are charged
- That's it. No other extensions
  - But we will work with you if unusual circumstances / problems
- Advice: Save late days for the middle or end of the quarter when you (might) really need them

Background / prerequisites

- You should have strong programming skills at the level of CSE 143 using Java (or a similar language), including experience with linked data structures like lists, queues, and trees
  - You should easily be able to write code to search, insert, and delete items in a double-linked list, or create, insert and find strings in a binary search tree
    - If this is difficult or it has been a long time and your skills are rusty, you will need to get up to speed quickly

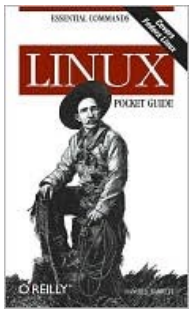
What to Expect (1)

- Assignments may be less structured than you're used to
  - "Write a program that does this"
    - You need to figure out if you're getting the right output
    - Usually no "sample solution" or "magic oracle" to compare with
  - Learning how to deal with this is part of the plan

What to Expect (2)

- Learning how to learn things is also part of the plan
  - Learn your way around man pages, books, online documents (Google *is* your friend – but only one of them, and not a substitute for the rest)
  - But *don't* just cut-n-paste code to "get it to work"
    - You ***must*** *understand* why your code does what it does, and be able to explain it!
- Tinker – try things. Write toy programs
  - The course is *much* harder if you only do the assigned work
  - *Don't* avoid learning new tools

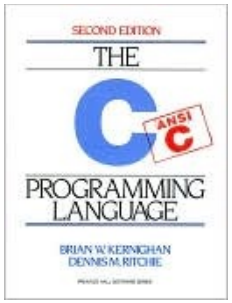
Resources – Books



Linux Pocket Guide: Enough Linux for CSE 374 and well beyond (you should have this). Any edition is ok

- Read manual pages and docs for more details

- *C Programming Language* (K&R) – The classic. Good for C & programming philosophy, examples + concise language & library reference (optional)
  - Use web references for library details, etc.
    - Link to cplusplus.com (C and C++ info) on CSE 374 web front page



Books? In the 21st Century??

- Why not just use Google, Stack Overflow, Reddit, Quora, …?
- Web-search good for:
  - Quick reference (What is the name of the function that does …? What are its parameters?)
  - Links to a good reference
- (can be) Bad for:
  - Why does it work this way?
  - What is the intended use?
  - How does my issue fit into the bigger picture?
- Beware:
  - Random code blobs cut-and-paste into your code (why does it work? what does it do?)
  - This inscrutable incantation solved my problem on an unstated version for no known reason

So What is CSE 374?

- Something of a "laundry list of everything else", but…

  There is an amorphous set of things computer scientists know about and novice programmers don't. Knowing them empowers you in computing, lessens the "friction" of learning in other classes, and makes you a mature programmer.

- The goal is to give you a sense of what's out there and what you can expect – and how you can learn more later when you need to

5 General Areas

1. The command line
   - Text-based manipulation of the computing environment
   - Automating (scripting) this manipulation
   - Using powerful *utility* programs

- Let the computer do what it's good at so you don't have to!
- We'll use Linux (an operating system) and bash (a *shell*) – but the concepts are not tied to these
- Idea: Knowing the name of what "ought to exist"
- Idea: Programming in a language designed for interaction

5 General Areas

2. C (and maybe a little C++)
   - "The" programming language for operating systems, networking, embedded devices, …
   - Manual resource management
   - Trust the programmer: a "correct" C implementation will run a program with an array-bounds error and whatever happens, happens
   - A "lower level" view of programming: all code and data sits together in a "big array of bits"

- Idea: Parts look like Java – don't let that deceive you!
- Idea: Learn to think before you write, and test often

5 General Areas

3. Programming tools – so far you have written programs and run them. There are programs for programming you should know about:
   - Compilers (vs interpreters)
   - Debuggers
   - Linkers
   - Recompilation managers
   - Version-control systems
   - Profilers
   - …

5 General Areas

4. Software development concepts – what do you need to know to write a million lines of code*?
   - Testing strategies
   - Team-programming concepts
   - Software specifications and their limits
   - …

*No, you will not write a million lines of code for CSE 374 this quarter, although it may seem like it at times…

5 General Areas

5. Basics of concurrency – what happens when more than one thing can happen at once in a program?
   - Brand-new kinds of bugs (e.g., races)
   - Approaches to synchronization
   - And it matters – most computers you can buy have (at least) 2-4 processors / cores
     - How do we run enough stuff concurrently to keep all of these busy?

Perspective

"There is more to programming than Java methods"

"There is more to software development than programming"

"There is more to computer science than software development"

So let's get started. . .

The O/S, the Filesystem, the Shell

- Some things you might have a sense of but never were told precisely (may as well start at the beginning). . .
- The file-system is a tree
  - (Actually it's a dag – *d*irected *a*cyclic *g*raph)
  - The top is /
  - Interior nodes are directories (displayed as folders in GUIs)
- Users log-in, which for Linux means getting a shell
  - They have permissions to access certain files/directories
  - They have a "home directory" somewhere in the file-system
  - They can run programs. A running program is a process. (Actually could be more than one process.)

Linux Cycles

- We're a little agnostic about what you use
  - We provide a standard CSE Rocky Linux – two flavors: remote login and virtual machine (next)
  - We only support (i.e., office hours) this system
- Other environments are sortof possible (but not for hw0)
  - Needs to be a fairly recent Linux distribution with standard tools, bash shell, gcc, utilities
  - Mac OS X developer tools are similar
    - But not quite: Apple has their own C/C++
- BUT: We use CSE Rocky Linux to test your code, so you ~~should~~ ***must*** verify that your code works there
  - And there are enough subtle differences that you should normally use this CSE system

Free CSE Linux (virtual) Machines!

- CSE Linux virtual machine
  - 64-bit Rocky Linux with CSE configuration
  - Runs on Mac, Windows, even other Linux(!)
  - Need VMware Player (free, Windows or Linux host) or VMware Fusion (mac, but only Intel – Apple silicon machines can't run the VM)
  - Download ~10 GB
  - Run 'sudo yum update' after initial setup to grab any recent updates/security patches
  - CSE 374 web has links to VM web page with details

UW CSE Linux Virtual Machine

- Startup
- Configure user account name and user/superuser passwords
- Shell window

Demo

Or a shared Linux machine - cancun

- Everyone in the class has an account on cancun.cs.washington.edu
  - Userid and password are your regular UW netid and password credentials
- Same Rocky Linux as the virtual machine
- More details and suggestions on the CSE 374 web

demo

File Manipulation

- You may be used to manipulating files via a GUI using a WIMP interface
- You can do all the same things by running programs in the shell
- Just like an “explorer” or “finder window”, the shell has a current working directory
- It really helps to remember the names of key commands: ls, cp, mv, rm, cat, cd, pwd.
  - (most are really just programs that do things to files)
- Current directory: . Parent directory: ..
- Relative vs. absolute pathnames

Start reading *and trying* things in the *Linux Pocket Guide*

What?

- Why would anyone want to interact like this?
  - Old people who remember life before GUIs :-)
  - Power users who can go faster
  - Users who want easy logging
  - Users who want easy instructions
  - Users who want programmability (scripting!)
- The last one will be the core of the first assignments
- Most computer scientists use GUIs and shells, depending what they're doing.
- Linux has GUIs and Windows has shells

Options, man (and info)

- Bad news for new Linux users:
  - Program names and options are short, arcane, and numerous
- Good news
  - Most programs print a *usage* argument if given bad options (or often implement -help or --help)
  - The command **`man` *`what`*** prints a file describing program ***`what`*** (man pages also available online)
    - Also: **`info` *`what`*** for complex programs (bash, gcc, some others)
  - Tons of other resources (e.g., Linux Pocket Guide; the web – google is your friend for locating things)
  - Things are somewhat standardized (dashes for options followed by argument as needed)

A Few More Programs and Options

- less (is more)
  - used by man
  - spacebar, b, /search-exp, q
- chmod
- mail

And some that aren't technically programs (more on this later)

- exit
- echo
- (cd)

Work to do!

- Get started on homework 0 ***now!*** – due Thur. **11 pm**
  - This means get your Linux setup working ***today*** (well, ok, maybe tomorrow – but **not later!**)

- Start reading/trying the Pocket Guide
  - At least first sections, then skim through later ones
  - Don't memorize stuff – try it!
  - Get an idea of what's possible and where to look