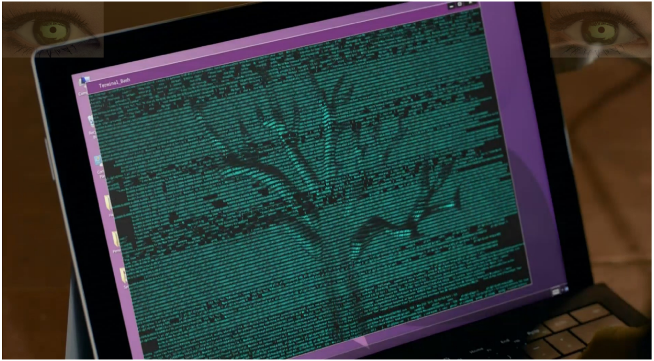
CS 253: Intro to Systems Programming



Topics

- Intro to Team-Based Learning (TBL)
- Syllabus and class logistics
- What is Systems Programming?

Team-Based Learning

- Evidence-based instructional practice proven to increase student motivation and comprehension.
- You are responsible for reviewing material *before* class.
- We make sure you have a basic understanding before we jump into more complicated material.
- You get instant feedback.
- Our class discussion is based on what you need.
- And its just more fun!

Team-Based Learning (2)

- "Random" teams of 3-4 students.
- Team work is only in-class (quizzes, exercises).
- TBL quizzes
  - Quiz over reading assignments and pre-quiz exercises.
  - Every week unless specified otherwise.
  - Each quiz will be taken first as an individual.
  - Same quiz will be taken as a team.
    - Instant feedback, partial credit for the team.
  - Keep track of individual vs team performance.
- In-class exercises
  - Team exercises to make sure you are absorbing material.
  - Give you a break from listening to me talk.
- Let's make some teams...

Build Teams

Prioritized Sorting Criteria:

- Do you have any experience programming in C? Number of years?
- Do you have any real-world software development experience (internship or career)?
- Prior experience using Linux/Unix command line and system utilities/scripting?
- Is computer science your first major?
- Have you ever lived outside of Idaho?
- Are you excited to take this class? ;-)

Meet team members and introduce yourself!

- Syllabus and practice quiz.

Collaborative Learning using Piazza

“Piazza is a free online gathering place where students can ask, answer, and explore 24/7, under the guidance of their instructors.”

- Piazza invite sent out
- Use Piazza to help each other
- Ask questions anonymously
- Answer questions and doubts that everyone seems to be having

Goals

By taking this course the student will be able to:

- design and develop programs of moderate complexity in C,
- translate their knowledge of object-oriented programming in Java to C,
- use various tools like IDEs, build tools, debuggers, version control and memory checkers to improve their productivity,
- use shell commands and system utilities, and
- use basic system calls related to files, processes and threads.

Where does 253 fit?

- Prerequisite for required class: 453 (Operating Systems)
- Prerequisite for various electives:
  - 425 (Introduction to Computer Networks)
  - 430 (Parallel Computing)
  - 450 (Programming Language Translation)
  - 455 (Distributed Systems),
  - 457 (Artificial Intelligence)

Major topics

- Linux (and Microsoft Windows) programming environments (1 week)
- C programming (7 weeks)
- Programming tools (2 weeks)
- Shell commands and scripts (1 week)
- Basic systems programming in Linux (and Microsoft Windows) (4 weeks)

So, what is systems programming?

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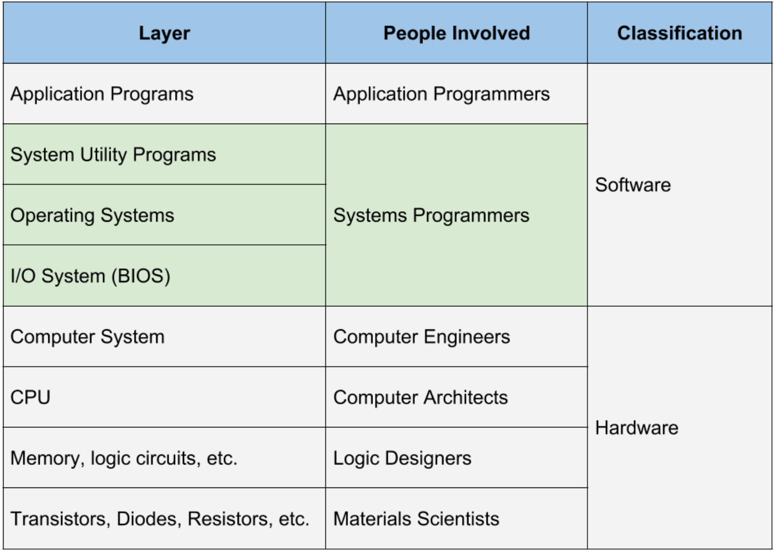
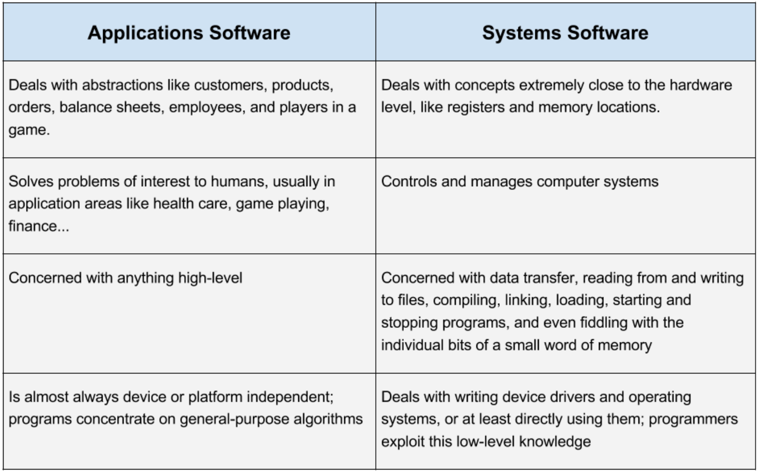


Layer	People Involved	Classification
Application Programs	Application Programmers	Software
System Utility Programs	Systems Programmers	
Operating Systems		
I/O System (BIOS)		
Computer System	Computer Engineers	Hardware
CPU	Computer Architects	
Memory, logic circuits, etc.	Logic Designers	
Transistors, Diodes, Resistors, etc.	Materials Scientists	

Borrowed from: http://cs.lmu.edu/~ray/notes/sysorg/

Application vs. Systems Programming (1)?



Applications Software	Systems Software
Deals with abstractions like customers, products, orders, balance sheets, employees, and players in a game.	Deals with concepts extremely close to the hardware level, like registers and memory locations.
Solves problems of interest to humans, usually in application areas like health care, game playing, finance...	Controls and manages computer systems
Concerned with anything high-level	Concerned with data transfer, reading from and writing to files, compiling, linking, loading, starting and stopping programs, and even fiddling with the individual bits of a small word of memory
Is almost always device or platform independent; programs concentrate on general-purpose algorithms	Deals with writing device drivers and operating systems, or at least directly using them; programmers exploit this low-level knowledge

Application vs. Systems Programming (2)?

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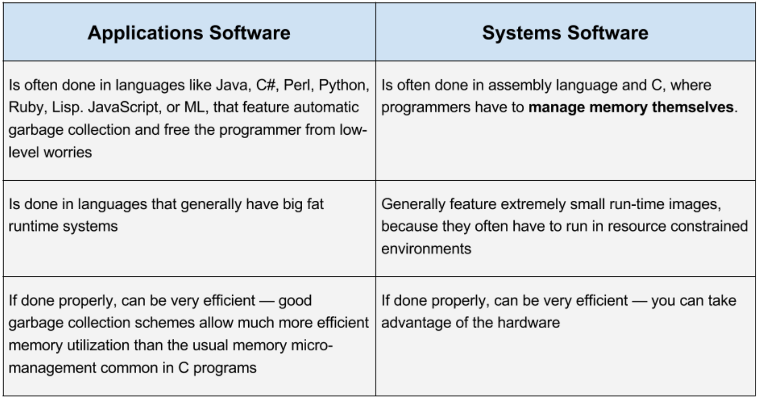

Applications Software	Systems Software
Is often done in languages like Java, C#, Perl, Python, Ruby, Lisp. JavaScript, or ML, that feature automatic garbage collection and free the programmer from low-level worries	Is often done in assembly language and C, where programmers have to **manage memory themselves**.
Is done in languages that generally have big fat runtime systems	Generally feature extremely small run-time images, because they often have to run in resource constrained environments
If done properly, can be very efficient — good garbage collection schemes allow much more efficient memory utilization than the usual memory micro-management common in C programs	If done properly, can be very efficient — you can take advantage of the hardware

Borrowed from: http://cs.lmu.edu/~ray/notes/sysprog/

Application vs. Systems Programming (3)?

Classify the following:

- Word Processor
- Google Chrome
- Linux Operating System
- Device Drivers
- System Utilities
- Database Software

Why C?

- C is the most widely used systems programming language (followed by Java and C++)
- C is low-level and procedural while Java is high-level and object-oriented. Knowing these two languages gives you a strong basis for learning other languages down the road
- Overall, Java and C are the two most commonly used languages in the industry. `http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html`
- Internship and job interview questions are mostly based on CS 121, 221, 253 and 321.

Working on Programming Projects

- Similar to working on projects in CS 121 and CS 221.
- The GCC C compiler is available on the Linux machines in the labs that can be used directly from the command line.
- We recommend using VIM text editor for C development (see notes on website).
- You may, however, use Eclipse (with the CDT plugin) if you want a full featured IDE.
- Try downloading and configuring VIM before next class - Post questions on Piazza, drop in the tutoring center, come to office hours for help.

In-Class Exercise: Hello World

- In your teams, write a valid HelloWorld program in Java.
- How would you compile and run your program from the command-line?

First C Program

Now, compare and contrast it to this Hello World program written in C.

```
// This code is in hello.c
#include <stdio.h>

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

First C Program

Note: main prototype is more relaxed than Java. All of the following are valid.

```
// produces warning, but compiles (don't use).
main() { }

// compiles, but unspecified arguments (don't use).
int main() { }

// compiles, specifies no arguments (use this).
int main(void) { }
```

Compiling and Running

- `gcc -Wall helloworld.c`
  - The compiler is called `gcc`, which stands for the GNU C Compiler. It is a free, open source compiler that is widely used
  - Creates an executable named `a.out`
  - Type `./a.out` to run the program
  - The option `-Wall` asks the compiler to provide all warnings about the code, which can save us a lot of effort later!
- `gcc -Wall helloworld.c -o helloworld`
  - To create an executable called `helloworld`
- Now create a C project in Eclipse and compile and run the hello world program from Eclipse

Exercises

- Write, compile and run Hello World in C
- Activate your Piazza account
- Read pages 5-21 of the K&R C book
- Configure VIM and/or Eclipse on your computer