Final exam: Wednesday, March 20, 2:30pm

- **Here in Mary Gates 389, 2:30pm – 4:20pm**
- **Focus will be on material covered in lecture and in labs during the second half of the course**
  - Use textbook to supplement / fill in details; if you see something in the textbook that we didn't cover in class, then it's not on the exam
- **Questions will be similar to homeworks and past exams**
- **How to prepare:**
  - Study lecture slides (review coursecasts if you missed something)
  - Understand the homework problems and solutions
  - Review the practice problems in the book
  - Look at previous exams
- **Q&A session: Tuesday, at ??**
  - But please post questions to the discussion board before then

CSE 351 grading

- **Your overall grade in the class is calculated from:**
  - Homeworks (20%)
  - Labs (40%)
  - Midterm exam (15%)
  - Final exam (25%)

http://www.cs.washington.edu/education/courses/cse351/13wi/policies.html

The Big Theme: Interfaces and Abstractions

- **Computing is about abstractions**
  - (but we can't forget reality)
- **What are the abstractions that we use?**
- **What do YOU need to know about them?**
  - When do they break down and you have to peek under the hood?
  - What bugs can they cause and how do you find them?
- **How does the hardware (0s and 1s, processor executing instructions) relate to the software (C/Java programs)?**
  - Become a better programmer and begin to understand the important concepts that have evolved in building ever more complex computer systems

Little Theme 1: Representation

- **All digital systems represent everything as 0s and 1s**
  - The 0 and 1 are really two different voltage ranges in the wires
- **"Everything" includes:**
  - Numbers – integers and floating point
  - Characters – the building blocks of strings
  - Instructions – the directives to the CPU that make up a program
  - Pointers – addresses of data objects stored away in memory
- **These encodings are stored throughout a computer system**
  - In registers, caches, memories, disks, etc.
- **They all need addresses**
  - A way to find them
  - Find a new place to put a new item
  - Reclaim the place in memory when data no longer needed

Little Theme 2: Translation

- **There is a big gap between how we think about programs and data and the 0s and 1s of computers**
- **Need languages to describe what we mean**
- **Languages need to be translated one step at a time**
  - Words, phrases and grammars
- **We know Java as a programming language**
  - Have to work our way down to the 0s and 1s of computers
  - Try not to lose anything in translation!
  - We'll encounter Java byte-codes, C language, assembly language, and machine code (for the X86 family of CPU architectures)

Little Theme 3: Control Flow

- **How do computers orchestrate the many things they are doing – seemingly in parallel**
- **What do we have to keep track of when we call a method, and then another, and then another, and so on**
- **How do we know what to do upon "return"**
- **User programs and operating systems**
  - Multiple user programs
  - Operating system has to orchestrate them all
    - Each gets a share of computing cycles
    - They may need to share system resources (memory, I/O, disks)
  - Yielding and taking control of the processor
    - Voluntary or "by force"?

Roadmap

C:

```
car *c = malloc(sizeof(car));
c->miles = 100;
c->gals = 17;
float mpg = get_mpg(c);
free(c);
```

Java:

```
Car c = new Car();
c.setMiles(100);
c.setGals(17);
float mpg =
    c.getMPG();
```

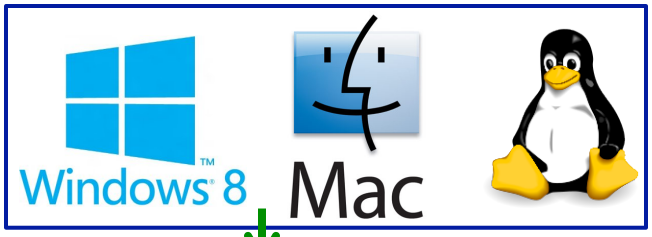
Assembly language:

```
get_mpg:
    pushq   %rbp
    movq    %rsp, %rbp
    ...
    popq    %rbp
    ret
```

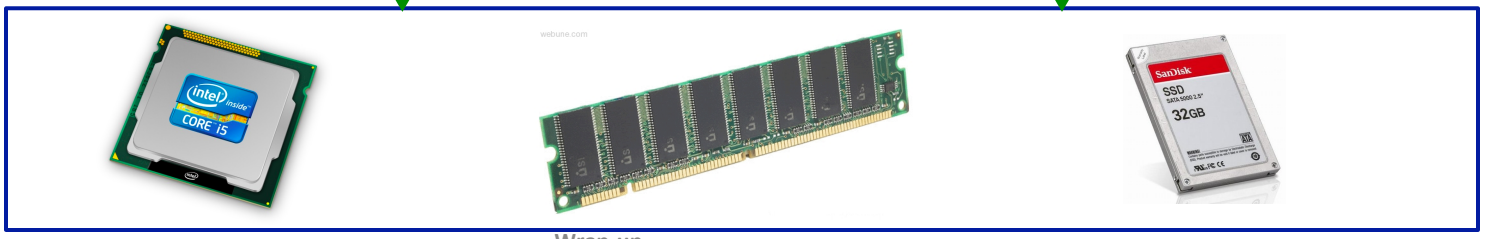
Machine code:

```
0111010000011000
100011010000010000000010
1000100111000010
11000001111110100011111
```

OS:



Computer system:



- Data & addressing
- Integers & floats
- Machine code & C
- x86 assembly programming
- Procedures & stacks
- Arrays & structs
- Memory & caches
- Processes
- Virtual memory
- Memory allocation
- Java vs. C

Course Perspective

- **This course will make you a better programmer**
  - Purpose is to show how software really works
  - By understanding the underlying system, one can be more effective as a programmer
    - Better debugging
    - Better basis for evaluating performance
    - How multiple activities work in concert (e.g., OS and user programs)
  - Not just a course for dedicated hackers
    - What every CSE major needs to know
    - Job interviewers love to ask questions from 351!
  - Provide a context in which to place the other CSE courses you'll take

If you liked this class, then consider…