In the next 4 yrs, time-lapse movies will show the construction of the new CITRIS building. Very cool.

www.cs.berkeley.edu/~ddgarcia/tl/
Teaching Assistants

° Andy Carle [Head TA]
° Steven Kusalo
° Danny Krause
° Casey Ho
What are “Machine Structures”?

* Coordination of many levels (layers) of abstraction
### 61C Levels of Representation

**High Level Language Program (e.g., C)**

- Compiler
- **Assembly Language Program (e.g., MIPS)**
  - Assembler
- **Machine Language Program (MIPS)**
  - Machine Interpretation
  - Hardware Architecture Description (e.g., Verilog Language)
  - **Architecture Implementation**
  - Logic Circuit Description (Verilog Language)

#### Machine Interpretation

```plaintext
temp = v[k];
v[k] = v[k+1];
v[k+1] = temp;

lw $t0, 0($2)
lw $t1, 0($2)
sw $t1, 0($2)
sw $t0, 0($2)
```

#### Logic Circuit Description (Verilog Language)

```plaintext
wire [31:0] dataBus;
regFile registers (databus);
ALU ALUBlock (inA, inB, databus);
```

#### Architecture Implementation

```plaintext
wire w0;
XOR (w0, a, b);
AND (s, w0, a);
```
Anatomy: 5 components of any Computer

- **Processor**
  - Control ("brain")
  - Datapath ("brawn")

- **Memory**
  (where programs, data live when running)

- **Devices**
  - Input
  - Output

- **Computer**

- **Keyboard, Mouse**
- **Disk**
  (where programs, data live when not running)
- **Display, Printer**
Technology Trends: Memory Capacity
(Single-Chip DRAM)

- Now 1.4X/yr, or 2X every 2 years.
- 8000X since 1980!
Technology Trends: Microprocessor Complexity

2X transistors/Chip
Every 1.5 years

Called “Moore’s Law”
Technology Trends: Processor Performance

We’ll talk about processor performance later on…
Computer Technology - Dramatic Change!

° Memory
  • DRAM capacity: $2x / 2$ years (since ‘96); $64x$ size improvement in last decade.

° Processor
  • Speed $2x / 1.5$ years (since ‘85); $100X$ performance in last decade.

° Disk
  • Capacity: $2x / 1$ year (since ‘97); $250X$ size in last decade.
Computer Technology - Dramatic Change!

We’ll see that Kilo, Mega, etc. are incorrect tomorrow!

° State-of-the-art PC when you graduate: (at least…)
  
  • Processor clock speed: 5000 MegaHertz (5.0 GigaHertz)
  • Memory capacity: 4000 MegaBytes (4.0 GigaBytes)
  • Disk capacity: 2000 GigaBytes (2.0 TeraBytes)
  
  • New units! Mega =

(Kilo, Mega, Giga, Tera, Peta, Exa, Zetta, Yotta = 10^{24})

Come up with a clever mnemonic, fame!

It must have 1st 2 letters of each word. E.g., Kim Meat…
CS61C: So what's in it for me?

Learn some of the big ideas in CS & engineering:

- 5 Classic components of a Computer
- Data can be anything (integers, floating point, characters): a program determines what it is
- Stored program concept: instructions just data
- Principle of Locality, exploited via a memory hierarchy (cache)
- Greater performance by exploiting parallelism
- Principle of abstraction, used to build systems as layers
- Compilation v. interpretation thru system layers
- Principles/Pitfalls of Performance Measurement
Others Skills learned in 61C

° Learning C
  • If you know one, you should be able to learn another programming language largely on your own
  • Given that you know C++ or Java, should be easy to pick up their ancestor, C

° Assembly Language Programming
  • This is a skill you will pick up, as a side effect of understanding the Big Ideas

° Hardware design
  • We think of hardware at the abstract level, with only a little bit of physical logic to give things perspective
  • CS 150, 152 teach this
Course Lecture Outline

- Number representations
- C-Language (basics + pointers)
- Storage management
- Assembly Programming
- Floating Point
- *make-ing an Executable*
- Caches
- Virtual Memory
- Logic Design
- Introduction to Verilog (HDL)
- CPU organization
- Pipelining
- Performance
- I/O Interrupts
- Disks, Networks
- Advanced Topics
Texts

- **Required:** *Computer Organization and Design: The Hardware/Software Interface, Third Edition*, Patterson and Hennessy (COD). *The second edition is far inferior, and is not suggested.*

- **Required:** *The C Programming Language*, Kernighan and Ritchie (K&R), 2nd edition

- Reading assignments on web page
Tried-and-True Technique: Peer Instruction

- Increase real-time learning in lecture, test understanding of concepts vs. details

- As complete a “segment” ask multiple choice question
  - 1-2 minutes to decide yourself
  - 3 minutes in pairs/triples to reach consensus. Teach others!
  - 5-7 minute discussion of answers, questions, clarifications

- Buy PRS transmitters from ASUC student store or others
Peer Instruction

° Read textbook
  • Reduces examples have to do in class
  • Get more from lecture (also good advice)

° Fill out 3-question Web Form on reading (released Mondays, due every Friday before lecture)
  • Graded for effort, not correctness…
  • This counts for “E”ffort in EPA score
**Weekly Schedule**

We are having discussion, lab and office hours this week...

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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<td>018 Lab 271 Soda - Steven</td>
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<td>11:00-12:00</td>
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<td>1:00-2:00</td>
<td><strong>Lecture 2050 VLSB</strong></td>
<td>113 Dis 320 Soda - Casey</td>
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<td>Lecture 2050 VLSB</td>
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<td>2:00-3:00</td>
<td>114 Dis 320 Soda - Casey</td>
<td>OH 795 Soda - Prof Garcia</td>
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<td>3:00-4:00</td>
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<td>014 Lab 271 Soda - Casey</td>
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<td>4:00-5:00</td>
<td>115 Dis 320 Soda - Danny</td>
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<td>015 Lab 271 Soda - Danny</td>
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<td>7:00-8:00</td>
<td>116 Dis 320 Soda - Andy</td>
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<td>016 Lab 271 Soda - Andy</td>
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</table>

We are MOVING discussion 118 to Wednesdays noon-1pm in 320 Soda.
Homeworks, Labs and Projects

° **Lab exercises** (every wk; due in that lab session unless extension given by TA) – extra point if you finish in 1st hour!

° **Homework exercises** (~ every week; (HW 0) out now, due in section next week)

° **Projects** (every 2 to 3 weeks)

° All exercises, reading, homeworks, projects on course web page

° We will DROP your lowest HW, Lab!

° Only one {HW, Project, Midterm} / week
2 Course Exams + 2 Faux Exams

• **Midterm:** Early 8th week, room TBA
  - Give 3 hours for 2 hour exam
  - One “review sheet” allowed
  - Review session Sun beforehand, time/place TBA

• **Final:** Sat 2005-05-14 @ 12:30-3:30pm (grp 5)
  - You can *clobber* your midterm grade!
  - (students last semester LOVED this…)

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UCB CS61C 2004Fa Midterm Clobber
(Final midterm coverage - actual midterm)
Your final grade

Grading (could change before 1st midterm)

- 15pts = 5% Labs
- 30pts = 10% Homework
- 45pts = 15% Projects
- 75pts = 25% Midterm* [can be clobbered by Final]
- 135pts = 45% Final
- Extra credit for EPA. What’s EPA?

Grade distributions

- Similar to CS61B, in the absolute scale.
- Perfect score is 300 points. 10-20-10 for A+, A, A-
- Similar for Bs and Cs (40 pts per letter-grade)
- … C+, C, C-, D, F (No D+ or D- distinction)
- Differs: No F will be given if all-but-one {hw, lab}, all projects submitted and all exams taken
- We’ll “ooch” grades up but never down
Extra Credit: EPA!

- **Effort**
  - Attending Dan’s and TA’s office hours, completing all assignments, turning in HW0, doing reading quizzes

- **Participation**
  - Attending lecture and voting using the PRS system
  - Asking great questions in discussion and lecture and making it more interactive

- **Altruism**
  - Helping others in lab or on the newsgroup

- **EPA!** extra credit points have the potential to bump students up to the next grade level! (but actual EPA! scores are internal)
Course Problems...Cheating

° What is cheating?
  • Studying together in groups is encouraged.
  • Turned-in work must be completely your own.
  • Common examples of cheating: running out of time on a assignment and then pick up output, take homework from box and copy, person asks to borrow solution “just to take a look”, copying an exam question, ...
  • You’re not allowed to work on homework/projects/exams with anyone (other than ask Qs walking out of lecture)
  • Both “giver” and “receiver” are equally culpable

° Cheating points: negative points for that assignment / project / exam (e.g., if it’s worth 10 pts, you get -10) In most cases, F in the course.

° Every offense will be referred to the Office of Student Judicial Affairs.

www.eecs.berkeley.edu/Policies/acad.dis.shtml
Student Learning Center (SLC)

° Cesar Chavez Center (on Lower Sproul)

° The SLC will offer directed study groups for students CS 61C.

° They will also offer Drop-in tutoring support for about 20 hours each week.

° Most of these hours will be conducted by paid tutorial staff, but these will also be supplemented by students who are receiving academic credit for tutoring.
Summary

° Continued rapid improvement in computing
  • 2X every 2.0 years in memory size; every 1.5 years in processor speed; every 1.0 year in disk capacity;

  • Moore’s Law enables processor (2X transistors/chip ~1.5 yrs)

° 5 classic components of all computers
  Control  Datapath  Memory  Input  Output

Processor