UCB CS61C : Machine Structures
Lecture 38 – Summary & Goodbye
2010-04-28

Lecturer SOE
Dan Garcia

…please exit via upper doors today…

BRAIN INTERFACES MADE OF SILK

Traditionally, surgeons have implanted devices into brains for neural interfaces, but that is irritating and causes scarring. Now, doctors are investigating "gentler, softer, biocompatible electrodes on thin, flexible substrates". Inserted through small hole in the skull, mechanically strong silk films measure high-res brain activity.

www.technologyreview.com/biomedicine/25154

Cool Stuff...the videos before lecture
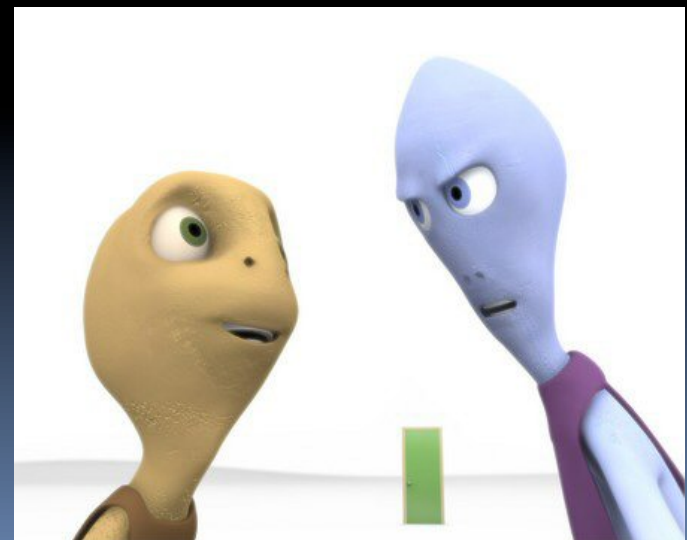
- **SIGGRAPH Electronic Theatre**

  `www.siggraph.org/publications/video-review`
  - $40/video for ACM Members

- **SIGGRAPH Conference in Los Angeles!**
  - 2010-07-25 $\Rightarrow$ 2010-07-29

    `www.siggraph.org/s2010/`

SIGGRAPH2010
The 37th International Conference and Exh
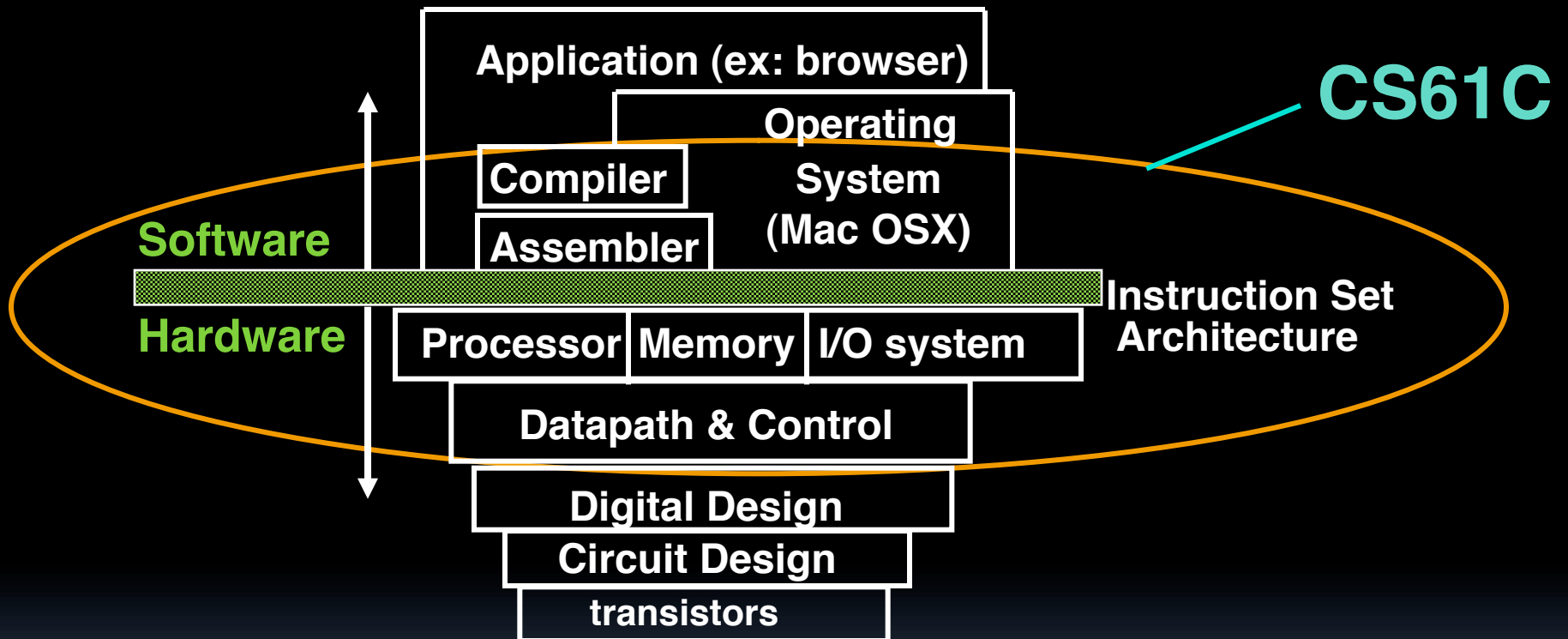Conference 25-29 July 2010

Review : Parallelism

- **Above the line (inter-computer, many machines) & below the line (intra-computer, multiple cores & CPUs) both critical for future.**

  - Hard to write code that fully takes advantage of all available resources to get optimal speedup.
    - Amdahl's Law: MaxSpeedup = 1/s (s = % of serial code)
  - Inter-computing llism : Distributed & Supercomputing
    - Grid (usu remote, heterogeneous) & Cluster computing
    - Synchronization hard, APIs help (MapReduce, MPI)
  - Intra-computing llism : pthreads, OpenMP
    - Cache coherence makes it difficult! Manycore, not multicore!

- **Berkeley EECS & PAR lab on cutting edge!!**

We learned about "Machine Structures"

Application (ex: browser)

Operating System (Mac OSX)

Compiler

Assembler

CS61C

Software

Hardware

Instruction Set Architecture

Processor | Memory | I/O system

Datapath & Control

Digital Design

Circuit Design

transistors

Coordination of many *levels (layers) of abstraction*

We made HW/SW contact!

High Level Language Program (e.g. C)
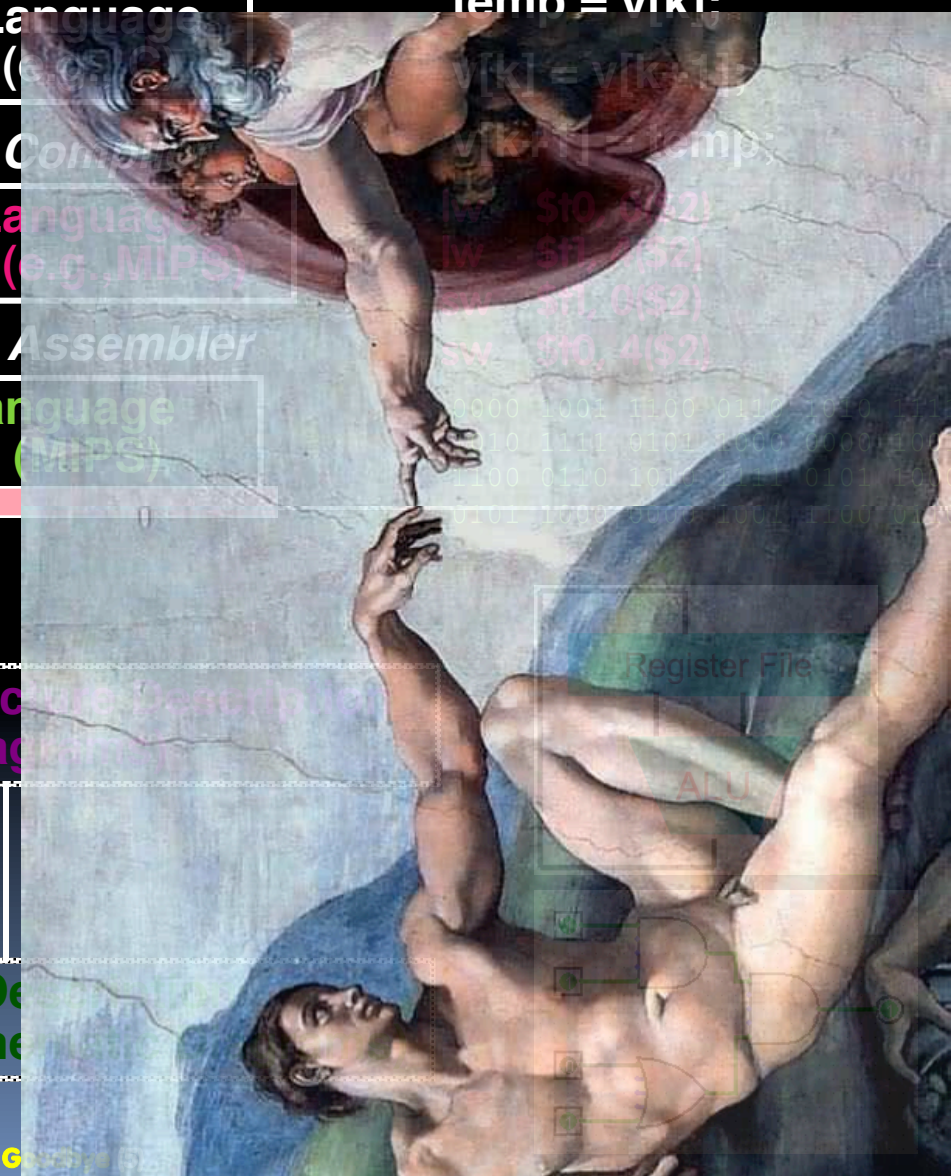
Assembly Language Program (e.g. MIPS)

Machine Language Program (MIPS)

Machine Interpretation

Hardware Architecture Description (e.g., block diagrams)

Architecture Implementation

Logic Circuit Description (Circuit Schematic)

temp = v[k];

CS61C: So what did you learn? (1st lecture)

Learn some of the big ideas in CS & Engineering:

- **5 classic components of a Computer**

- **Principle of abstraction, systems built as layers**

- **Data can be anything (integers, floating point, characters): a program determines what it is**

- **Stored program concept: instructions just data**

- **Compilation v. interpretation thru system layers**

- **Principle of Locality, exploited via memory hierarchy (caches)**

- **Benefits of a layer of indirection (VM)**

- **Greater performance by exploiting parallelism**
  - Pipelining, superscaler, MPI, MapReduce, OpenMP, pthreads

Principles/Pitfalls of Performance Measurement

Life: So what did you learn? (all yr)

- **Use ISO 8601**
  - YYYY-MM-DD
- **Don't be afraid**
  - …to ask questions, sit in front, dance in the aisles
- **Find your partner**
  - Find the Yin to your Yang (<u>project</u> & <u>life</u> partners)
- **Enjoy your youth**
  - E.g., Travel while you aren't tied down in your life
- **Love your job**
  - Love what you do; do what you love

20th vs. 21st Century IT Targets

- **20th Century Measure of Success**
  - Performance (peak vs. delivered)
  - Cost (purchase cost vs. ownership cost, power)

- **21st Century Measure of Success? "SPUR"**
  - Security
  - Privacy
  - Usability
  - Reliability

- **Massive parallelism greater chance (this time) if**
  - Measure of success is SPUR vs. only cost-perf
  - Uniprocessor performance improvement decelerates

Other Implications

- **Need to revisit chronic unsolved problem**
    - Parallel programming!!
- **Implications for applications:**
    - Computing power >>> CDC6600, Cray XMP (choose your favorite supercomputer) on an economical die inside your watch, cell phone or PDA
        - On your body health monitoring
        - Google + library of congress on your PDA
- **As devices continue to shrink…**
    - The need for great HCI (human-computer interfaces) is as critical as ever!

Upcoming Calendar

Week #	Mon	Wed	Thu Lab	Fri
#14 Last week o' classes	Inter-machine Parallelism	Summary, Review, Evaluation	Parallel	Intra-machine Parallelism (Scott) P3 due
#15 RRR Week				Perf comp due 11:59pm
#16 Finals Week Review Sun May 9 3-6pm 10 Evans				Final Exam 8-11am in 230 Hearst Gym

Administrivia: Become active!

- **Final Exam details**
  - Only bring pen{,cil}s, two 8.5"x11" handwritten sheets (writing on both sides) + green sheet.
  - Leave backpacks, books, calculators, cells & pagers home!
  - Everyone must take ALL of the final!

- **If you did well in CS3 or 61[ABC] (A- or above) and want to be on staff?**
  - Usual path: Lab Assistant $\Rightarrow$ Reader $\Rightarrow$ TA
  - LA: sign up w/Jenny Jones in 395 Soda before 1st week of semester
  - Reader/TA forms: `www.cs/~juliea/`
  - I strongly encourage anyone who gets an A- or above in the class to follow this path…

Taking advantage of Cal Opportunities

"The Godfather answers all of life's questions"

– Heard in "You've got Mail"

- **Why were we the #2 Univ in the WORLD?**
  So says the 2004 ranking from the "Times Higher Education Supplement"
  - Research, reseach, research!
  - Whether you want to go to grad school or industry, you need someone to vouch for you!
    - …as is the case with the Mob

- **Techniques**

  - Find out what you like, do lots of web research (read published papers), hit OH of Prof, show enthusiasm & initiative

- `http://research.berkeley.edu/`

Dan's Opportunities Fall 2010

- **GamesCrafters (Game Theory R & D)**
  - Develop SW, analysis on 2-person games of no chance. (e.g., go, chess, connect-4, nim, etc.)
  - Req: ≥ A- in CS61C, Game Theory / SW Interest
- **MS-DOS X (Mac Student Developers)**
  - Learn to program Macintoshes.
  - Req: Interest. Owning a mac helps, not required.
  - Taught as a DeCal by MS-DOS X veterans
- **UCBUGG (Recreational Graphics)**
  - Develop computer-generated images, animations.
  - Req: 3D interest
  - Taught as a DeCal by UCBUGG veterans
- **CNM190/CS194-8 (Advanced Digital Animation)**
  - Learn how the experts make 3D computer animations
  - Req: 3D Experience; we'll choose students by experience
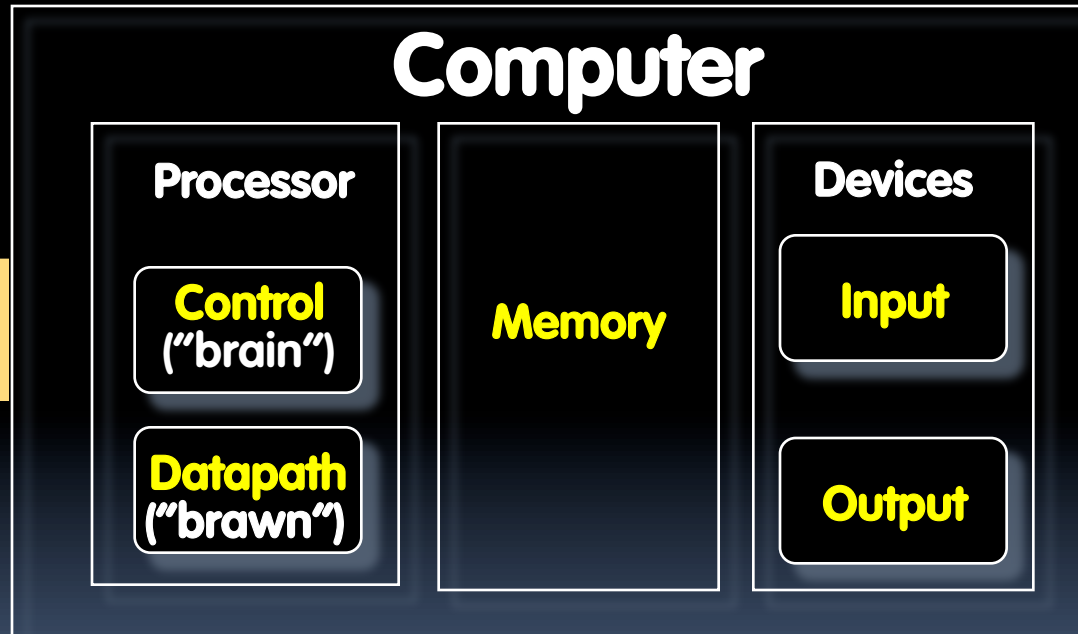 - This is a ONE-YEAR course… (Fall 2010 + Spring 2011)

Anatomy: 5 components of any Computer
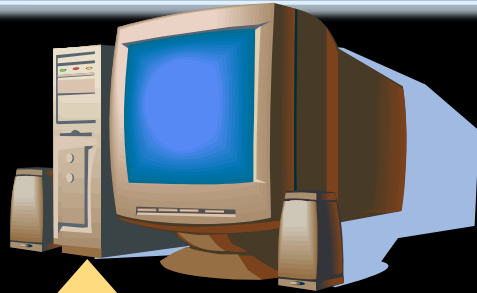
In the future, what'll be the most important computer component?

Computer

Processor

Control ("brain")

Datapath ("brawn")

Memory

Devices

Input

Output

a) Control
b) Datapath
c) Memory
d) Input
e) Output

Peer Instruction Opinion

- **"Forget cloning. Forget TVs on your wrist watch. The biggest invention of the next 100 years will be the ability to directly connect your brain to a machine, aka <u>wet computing</u>." – Dan Garcia**

  - A macaque monkey at Duke University can already control a robotic arm with thought.

  - DARPA interested for mind-control robots & flying

  - Virtual Reality achieved with proper I/<u>O</u> interfacing…
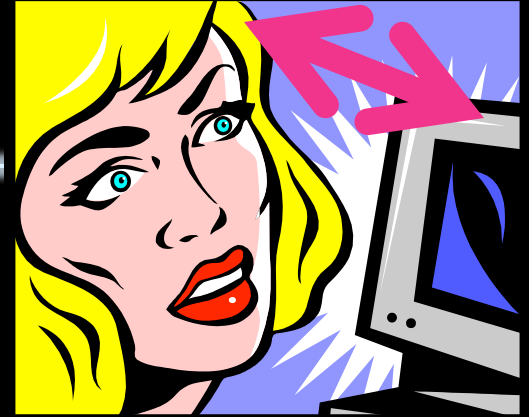
Jose Carmena, UCB EECS Prof
Research: Brain-Machine Interface
`www.eecs.berkeley.edu/~carmena/`

Penultimate slide: Thanks to the staff!

- **TAs**
  - Head TA Scott Beamer
  - Eric Chang
  - Michael Greenbaum
  - Long Wei
  - Bing Xia

- **Readers**
  - Anurag Jain
  - Rohit Poddar
  - Ibrahim Awwal
  - Myo Nyi Nyi
  - Andy Horng

Thanks to all the former CS61C instructors who have added to these notes…

The Future for Future Cal Alumni

- **What's The Future?**
- **New Millennium**
  - Ubiquitous & Quantum Computing, Nanotechnology, 10 M "volunteer" CPUs, the Parallel revolution...
  - Rapid Changes in Technology
  - World's ₂ₙd Best Education
  - Never Give Up!

Please exit via upper doors...

"The best way to predict the future is to invent it"
– Alan Kay

The Future is up to you!