inst.eecs.berkeley.edu/~cs61c

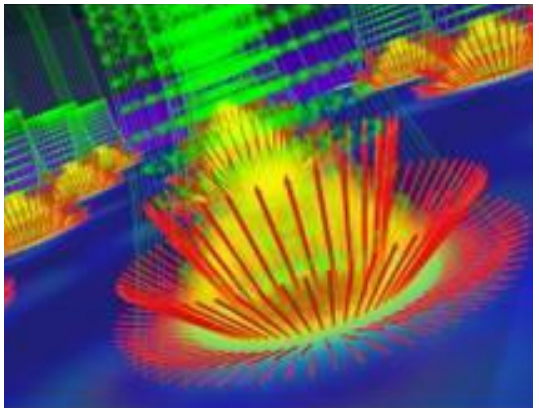
CS61C : Machine Structures

Lecture 43
Summary & Goodbye

Lecturer PSOE Dan Garcia

www.cs.berkeley.edu/~ddgarcia

Future? Spintronics! ⇒



Current silicon chips carry info with electron *charge*. This idea has them carry info with their spin. Lower power, higher processing speeds, and quantum computing!

www.physorg.com/news3998.html

Cool Stuff…the videos before lecture

SIGGRAPH2005

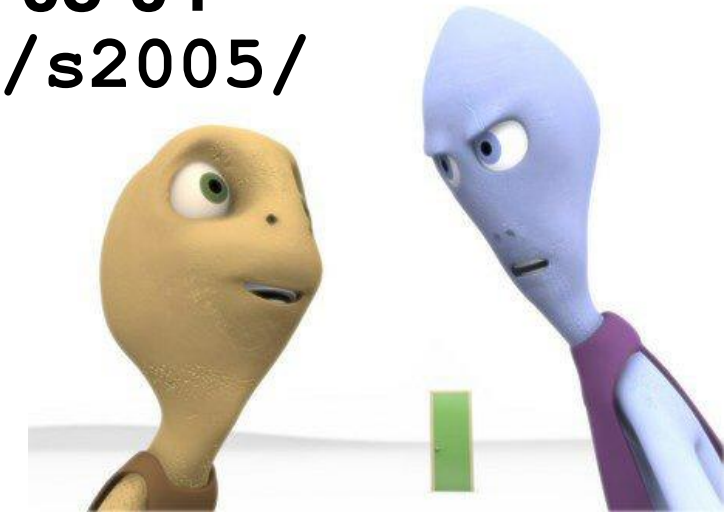
- SIGGRAPH Electronic Theatre

  `www.siggraph.org/publications/video-review/SVR.html`

  - $40/video for ACM Members

- SIGGRAPH Conference in LA!

  - 2005-07-31 ⇒ 2005-08-04
    `www.siggraph.org/s2005/`



Review

- Benchmarks
  - Attempt to predict performance
  - Updated every few years
  - Measure everything from simulation of desktop graphics programs to battery life
- Megahertz Myth
  - MHz ≠ performance, it's just one factor

CS61C: So what's in it for me? (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 a memory hierarchy (cache)
- Greater performance by exploiting parallelism (pipelining)
- Principles/Pitfalls of Performance Measurement

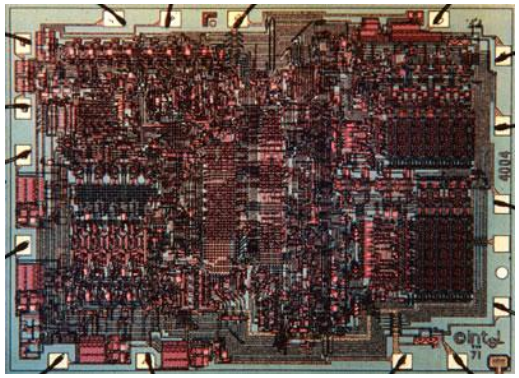
Conventional Wisdom (CW) in Comp Arch

Thanks to Dave Patterson for these

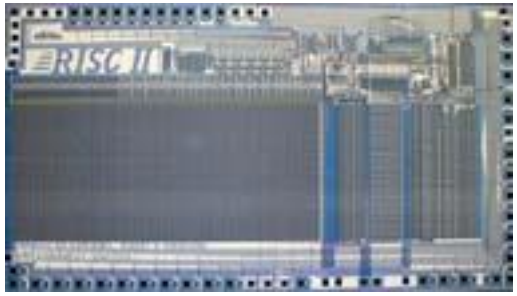
- Old CW: Power free, Transistors expensive
- New CW: Power expensive, Transistors free
  - Can put more on chip than can afford to turn on
- Old CW: Chips reliable internally, errors at pins
- New CW: ≤ 65 nm ⇒ high error rates
- Old CW: CPU manufacturers minds closed
- New CW: Power wall + Memory gap = Brick wall
  - New idea receptive environment
- Old CW: Uniprocessor performance 2X / 1.5 yrs
- New CW: 2X CPUs per socket / ~ 2 to 3 years
  - More simpler processors more power efficient

Massively Parallel Socket

- Processor = new transistor?
  - Does it only help power/cost/performance?
- Intel 4004 (1971): 4-bit processor, 2312 transistors, 0.4 MHz, 10 μm PMOS, 11 mm^2 chip



- RISC II (1983): 32-bit, 5 stage pipeline, 40,760 transistors, 3 MHz, 3 μm NMOS, 60 mm^2 chip
  - 4004 shrinks to ~ 1 mm^2 at 3 micron



- 125 mm^2 chip, 65 nm CMOS = 2312 RISC IIs + Icache + Dcache
  - RISC II shrinks to ~ 0.02 mm^2 at 65 nm
  - Caches via DRAM or 1 transistor SRAM (www.t-ram.com)?
  - Proximity Communication at > 1 TB/s ?
  - Ivan Sutherland @ Sun spending time in Berkeley!

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

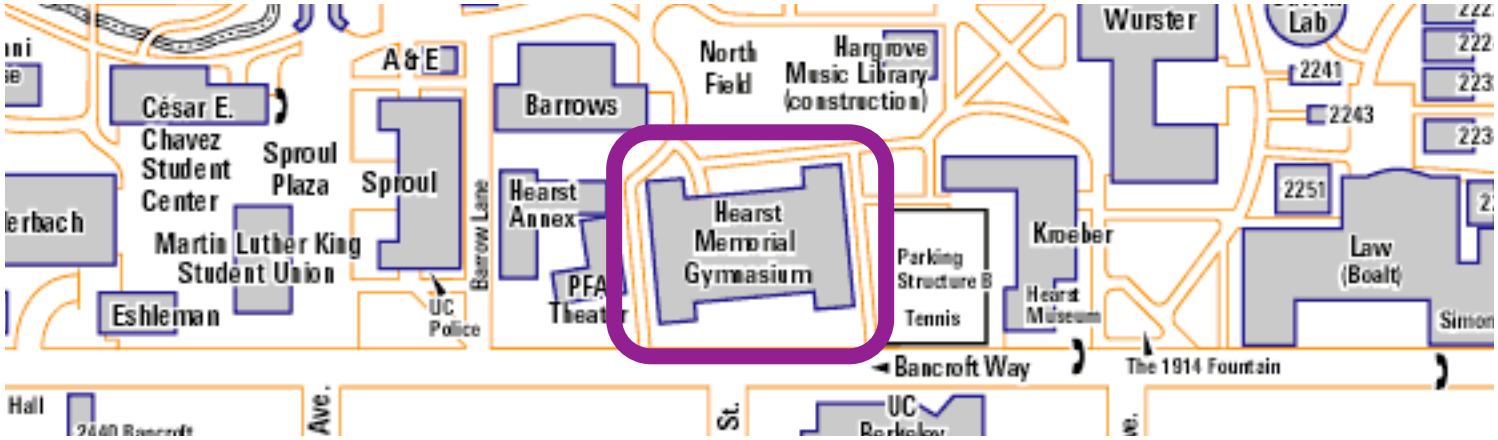
Other Implications

- Need to revisit chronic unsolved problem
  - Parallel programming!! (Thanks again Andy)
- Implications for applications:
  - Computing power >>> CDC6600, Cray XMP (choose your favorite) 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 critical as ever!

Administrivia (1/2) : Final Exam & Review

Final Exam: SAT 2005-05-14, 12:30-3:30pm in 220 Hearst

Only bring pen{,cil}s, two 8.5"x11" handwritten sheets + green. Leave backpacks, books, calculators, cells & pagers home!



Dan's Extended OH

- Tuesday 2005-05-10 @ noon-3pm in 795 Soda (overflowing into 751 Soda if too full)

Administrivia (2/2) : Become active!

- There IS discussion this week (no lab)
  - Make sure to talk to your TAs and get your labs taken care of.
- If you did well in CS3 or 61{A,B,C} (A- or above) and want to be on staff?
  - Usual path: Lab assistant ⇒ Reader ⇒ TA
  - Fill in form outside 367 Soda before first week of semester…
  - I (Dan) strongly encourage anyone who gets an A- or above in the class to follow this path… I'll be teaching 61C in the fall!

Taking advantage of Cal Opportunities

"The Godfather answers all of life's questions"
– Heard in "You've got Mail"

- **Why are 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/`

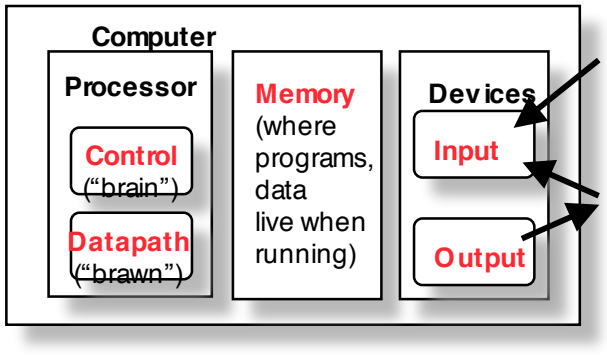
CS98/198 Opportunities Fall 2005

- GamesCrafters (Game Theory R & D)
  - We are developing SW, analysis on small 2-person games of no chance. (e.g., achi, connect-4, dots-and-boxes, etc.)
  - Req: A- in CS61C, Game Theory Interest
- MS-DOS X (Mac Student Developers)
  - Learn to program Macintoshes. No requirements (other than Mac, interest)
- UCBUGG (Recreational Graphics)
  - Develop computer-generated images and animations. Req: 3D experience, portfolio

Peer Instruction

Strong or Weak AI? Strong AI: Machines that act intelligently have real, conscious minds...sentience Weak AI: Machines can be made to act as if they were intelligent.

In the future, what'll be the most important computer component?




```
  Strong AI
1: Control
2: Datapath
3: Memory
4: Input
5: Output

  Weak AI
6: Control
7: Datapath
8: Memory
9: Input
0: Output
```

Peer Instruction Answer

"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. – Dan Garcia

- A macaque monkey at Duke University can already control a robotic arm with thought.
- DARPA is extremely interested in the technology for mind-control robots & flying
- Virtual Reality could be achieved with proper I/O interfacing…

www.popsci.com/popsci/medicine/article/0,12543,576464,00.html

Penultimate slide: Thanks to the staff!

- TAs
  - Head TA
    Andy Carle
  - Steven Kusalo
  - Danny Krause
  - Casey Ho
- Readers
  - Michael Le
  - Benjamin Mellblom
  - Mark Whitney

Thanks to Dave Patterson for these CS61C notes…

The Future for Future Cal Alumni

- What's The Future?
- New Millennium
  - Internet, Wireless, Nanotechnology, ...
  - Rapid Changes in Technology
  - World's (2nd) Best Education
  - Never Give Up!

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

The Future is up to you!