



inst.eecs.berkeley.edu/~cs61c
UCB CS61C
 Great Ideas in Computer Architecture
 (aka Machine Structures)

Lecturer SOE
 Dan Garcia

**Lecture 40 –
 Summary & Goodbye**

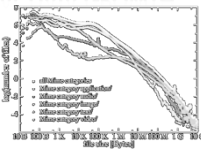
HUMAN BRAIN IS LIMITING GLOBAL DATA GROWTH

“Evidence has emerged that the brain’s capacity to absorb information is limiting the amount of data humanity can produce”

EPA for CS61C Surveys (see Piazza)

Register your iClickers!

www.technologyreview.com/blog/arxiv/27379/



6 Great Ideas in Computer Architecture

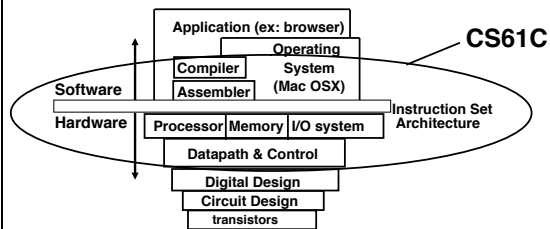
1. Abstraction
(Layers of Representation/Interpretation)
2. Moore’s Law
3. Principle of Locality/Memory Hierarchy
4. Parallelism
5. Performance Measurement & Improvement
6. Dependability via Redundancy



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We learned Old-School “Machine Structures”



Coordination of many levels (layers) of abstraction



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...and New-School Machine Structures
 (It's a bit more complicated!)

- Parallel Requests
Assigned to computer
e.g., Search “CS61C”
- Parallel Threads
Assigned to core
e.g., Lookup, Ads
- Parallel Instructions
>1 instruction @ one time
e.g., 5 nelineed instructions
- Parallel Data
>1 data item @ one time
e.g., Add of 4 pairs of words
- Hardware descriptions
All gates functioning in parallel at same time

The diagram illustrates a multi-core system with various components and projects. Project 1 is a Warehouse Scale Computer. Project 2 is a Smart Phone. Project 3 is a Core. Project 4 is Logic Gates. The system includes a Core, Memory (Cache), Input/Output, Instruction Unit(s), Functional Unit(s), Main Memory, and Logic Gates. A note says 'Harness Parallelism & Achieve High Performance'.

We made HW/SW contact!

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., block diagrams)

Architecture Implementation

Logic Circuit Description (Circuit Schematic Diagrams)

```
temp = v[k];
v[k] = v[k+1];
v[k+1] = temp;
lw $t0, 0($2)
lw $t1, 4($2)
sw $t1, 0($2)
sw $t0, 4($2)
0000 1001 1100 0110 1010 1111 0101 1000
1010 1111 0101 1000 0000 1001 1100 0110
1100 0110 1010 1111 0101 1000 0000 1001
0101 1000 0000 1001 1100 0110 1010 1111
```



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Upcoming Calendar

Week #	Mon	Tue	Wed	Thu	Fri
#14					
Last week o' classes	I/O Disks	VM + I/O	GPU Coding	Open Lab	Today Summary
#15					
RRR Week					
#16					
Finals Week		Final Exam 3-6pm in 2050 VLSB			
Review TBA					



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Administrivia: Become active!

- **Final Exam details**
 - Only bring pen(cils), two 8.5"x11" handwritten sheets (writing on both sides) + green sheet.
 - Leave backpacks, books, calculators home!
 - Everyone must take ALL of the final!
- **If you did well in CS3 or 61[ABC] (B or above) and want to be on staff?**
 - Usual path: Lab Assistant ⇒ Reader ⇒ TA
 - LA: sign up w/Jenny Jones (jennyj@eecs) before 1st week
 - Reader/TA forms: www.cs/~juliea/
 - I strongly encourage anyone who gets an B or above in the class to follow this path...



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Taking advantage of Cal Opportunities

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

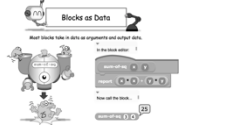
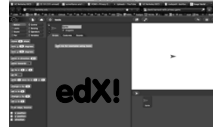


- **Why were we the #2 Univ in the WORLD?**
So says the 2004 ranking from the "Times Higher Education Supplement"
 - Research, research, research!
 - Whether you want to go to grad school or industry, you need someone to vouch for you!
 - ...as is the case with the Mob
- **Techniques**
 - Find out what you like, do lots of web research (read published papers), hit OH of Prof, show enthusiasm & initiative
- <http://research.berkeley.edu/>
- <http://researchmatch.herokuapp.com/>



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Dan's Research Projects

- **CS Illustrated**
 - 
- **Improve CS10/Snap!**
 - 
- **Ensemble**
 - 
- **Improve codepath**
 - 

Opportunities Fall 2013

- **CS150 (Digital Systems Design Techniques)**
 - If you liked SDS, this is a great follow-on course!
- **CS9 Series (Learn another computer language)**
 - I recommend Python (CS9H), Unix (CS9E), C++ (CS9F)
- **GamesCrafters (Game Theory R & D)**
 - Develop SW, analysis on 2-person games of no chance. (e.g., go, chess, connect-4, nim, etc.)
 - Req: 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



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Penultimate slide: Thanks to the staff!

- **TAs**
 - Head TA Justin Hsia
 - Paul Ruan
 - Alan Christopher
 - Sagar Karandikar
 - Sung Roa Yoon
 - Zachary Bush
- **Readers**
 - Anirudh Garg
 - Joyjit Daw
 - Kevin Lee
 - Stephen Chen

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, Post-PC Era!
 - World's .. Best Education
 - Never Give Up!
- "The best way to predict the future is to invent it"**
– Alan Kay



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The Future is up to you!