



Lecturer SOE
Dan Garcia

`inst.eecs.berkeley.edu/~cs61c`

UCB CS61C

Great Ideas in Computer Architecture (aka Machine Structures)

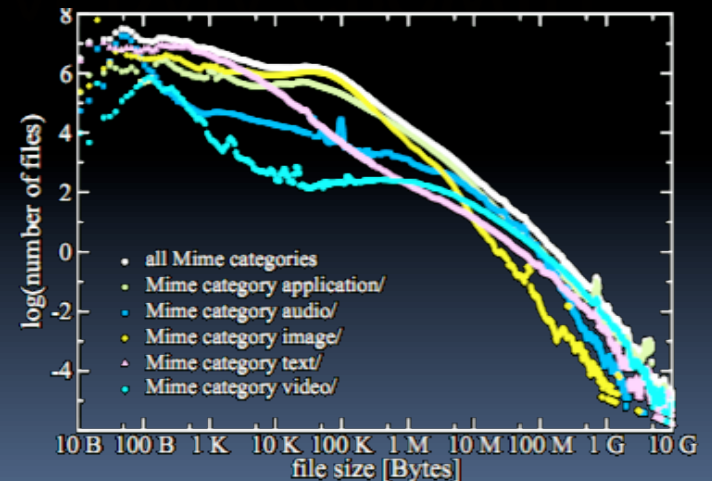
Lecture 40 – Summary & Goodbye

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!



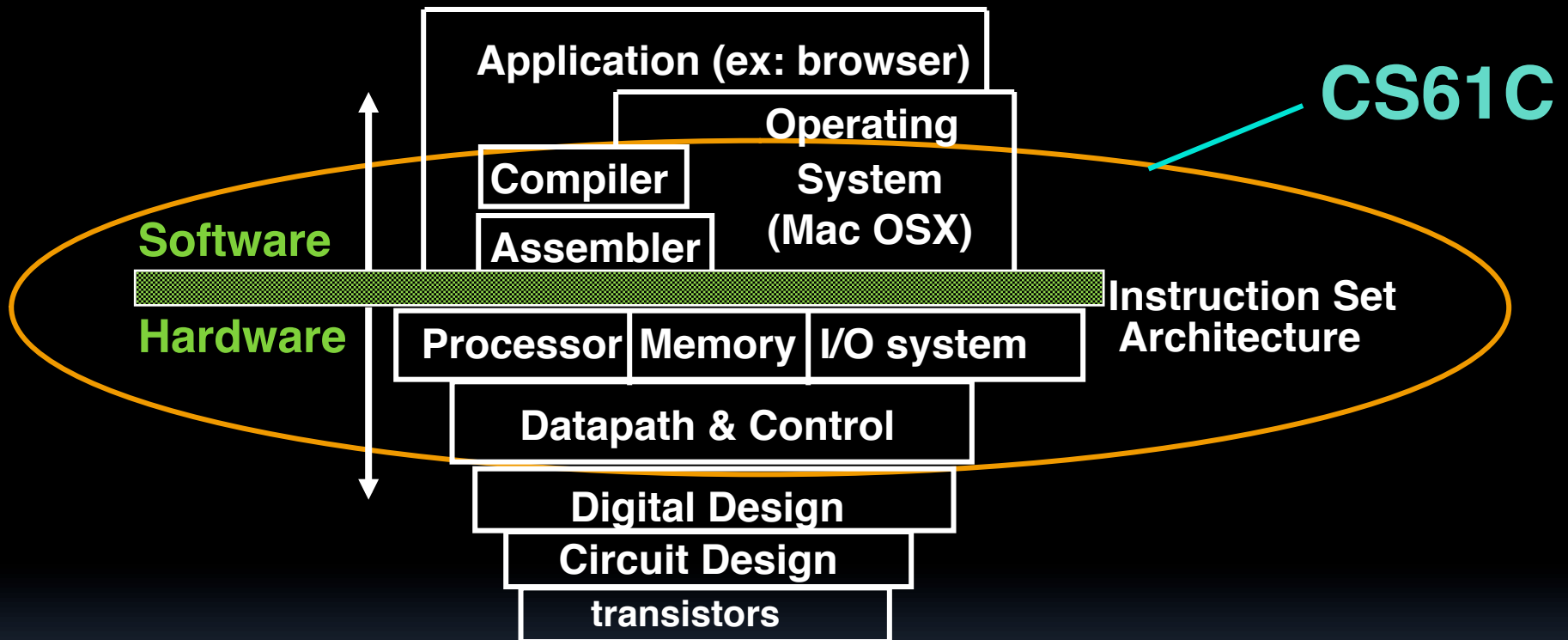
www.technologyreview.com/blog/arxiv/27379/

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**



We learned Old-School “Machine Structures”



Coordination of many *levels (layers) of abstraction*



...and New-School Machine Structures

(It's a bit more complicated!)

Software

- 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 pipelined 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

*Harness
Parallelism &
Achieve High
Performance*

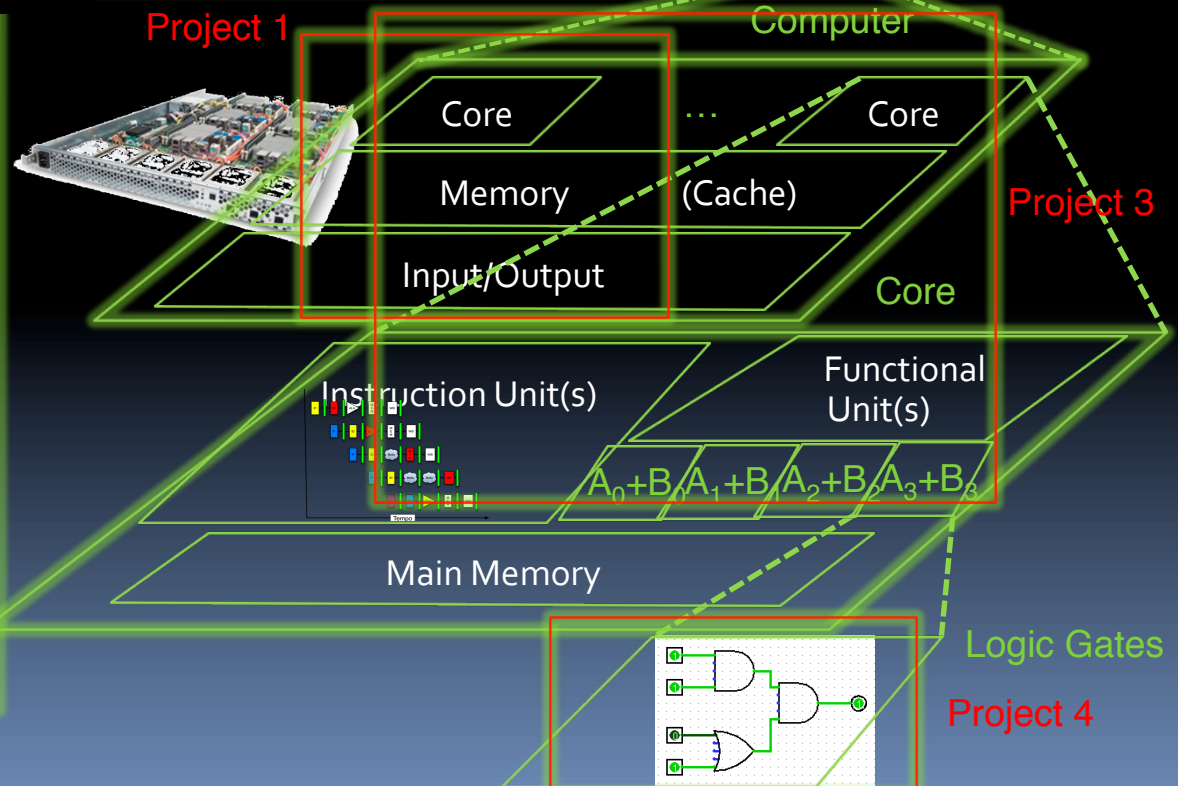
Hardware

Warehouse
Scale
Computer

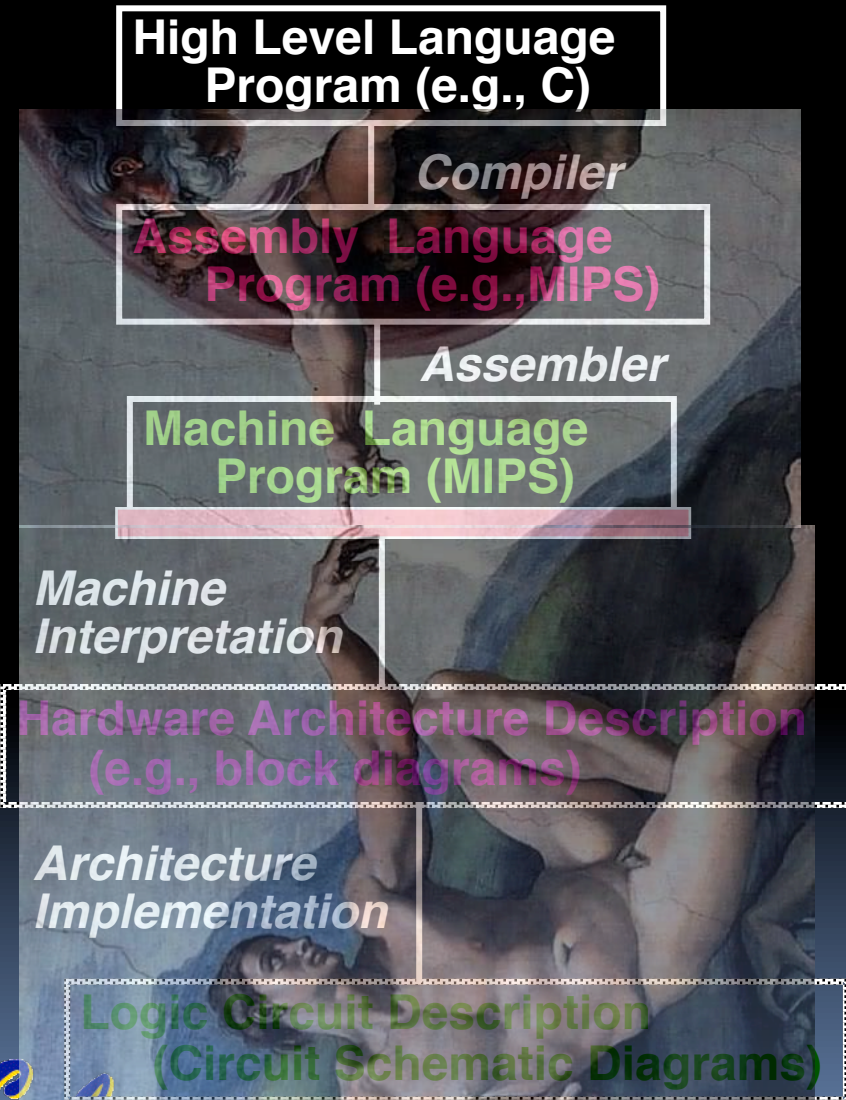


Project 2

Smart
Phone



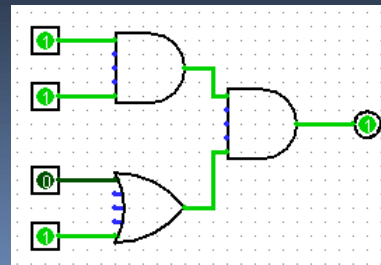
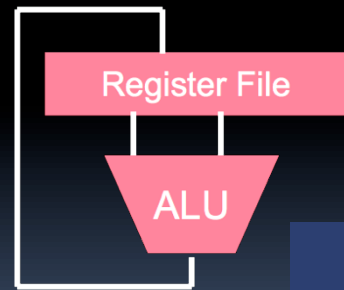
We made HW/SW contact!



```
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
```



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 Review TBA		Final Exam 3-6pm in 2050 VLSB			



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 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 \Rightarrow Reader \Rightarrow TA
- LA: sign up w/Jenny Jones (jennyj@eecs) before 1st week
- Reader/TA forms: www.cs/~juliaa/
- I strongly encourage anyone who gets an B 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

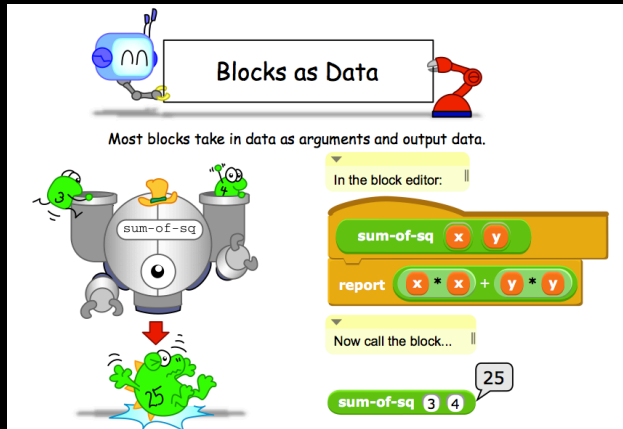
- <http://research.berkeley.edu/>

- <http://researchmatch.herokuapp.com/>



Dan's Research Projects

■ CS Illustrated



Blocks as Data

Most blocks take in data as arguments and output data.

In the block editor:

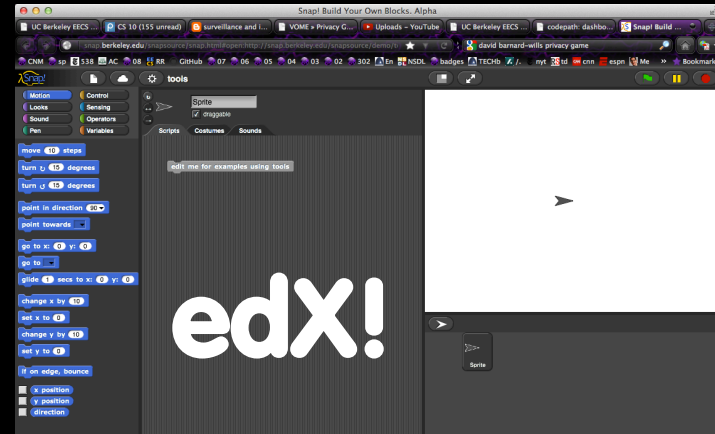
- sum-of-sq x y
- report x * x + y * y

Now call the block...

- sum-of-sq 3 4

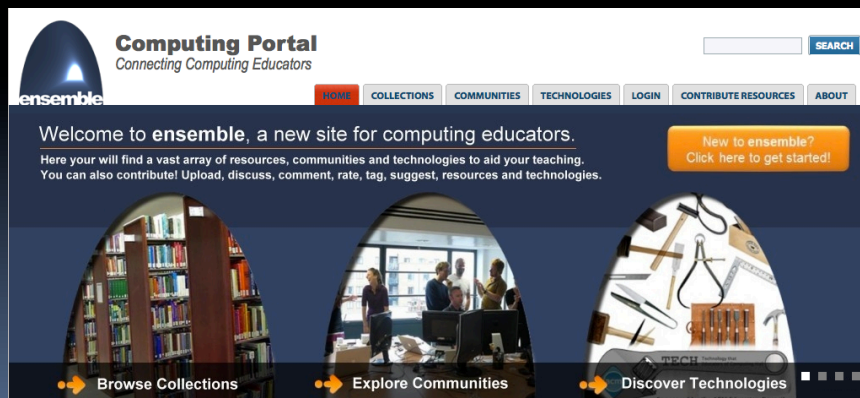
25

■ Improve CS10/Snap!



edX!

■ Ensemble



Computing Portal
Connecting Computing Educators

ensemble

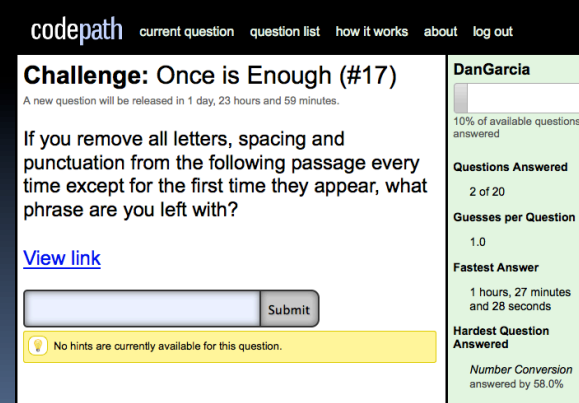
HOME COLLECTIONS COMMUNITIES TECHNOLOGIES LOGIN CONTRIBUTE RESOURCES ABOUT

Welcome to ensemble, a new site for computing educators.
Here you will find a vast array of resources, communities and technologies to aid your teaching.
You can also contribute! Upload, discuss, comment, rate, tag, suggest, resources and technologies.

New to ensemble?
Click here to get started!

Browse Collections Explore Communities Discover Technologies

■ Improve codepath



codepath current question question list how it works about log out

Challenge: Once is Enough (#17)
A new question will be released in 1 day, 23 hours and 59 minutes.

If you remove all letters, spacing and punctuation from the following passage every time except for the first time they appear, what phrase are you left with?

[View link](#)

Submit

No hints are currently available for this question.

DanGarcia

10% of available questions answered

Questions Answered
2 of 20

Guesses per Question
1.0

Fastest Answer
1 hours, 27 minutes and 28 seconds

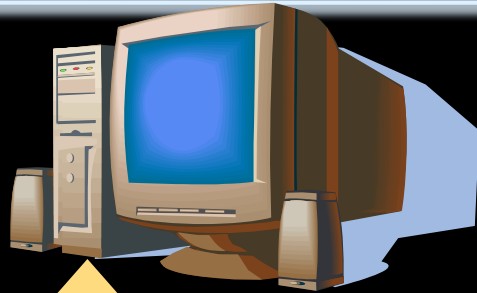
Hardest Question Answered
Number Conversion answered by 58.0%

Opportunities Fall 2013

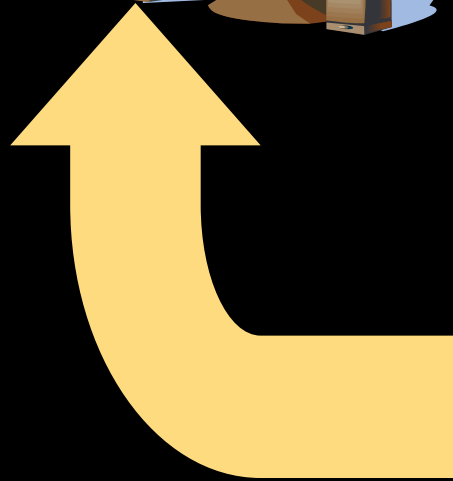
- **CS150 (Digital Systems Design Techniques)**
 - If you liked SDS, this is a great follow-on course!
- **CS9 Series (Learn another computer language)**
 - I recommend Python (CS9H), Unix (CS9E), C++ (CS9F)
- **GamesCrafters (Game Theory R & D)**
 - Develop SW, analysis on 2-person games of no chance.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



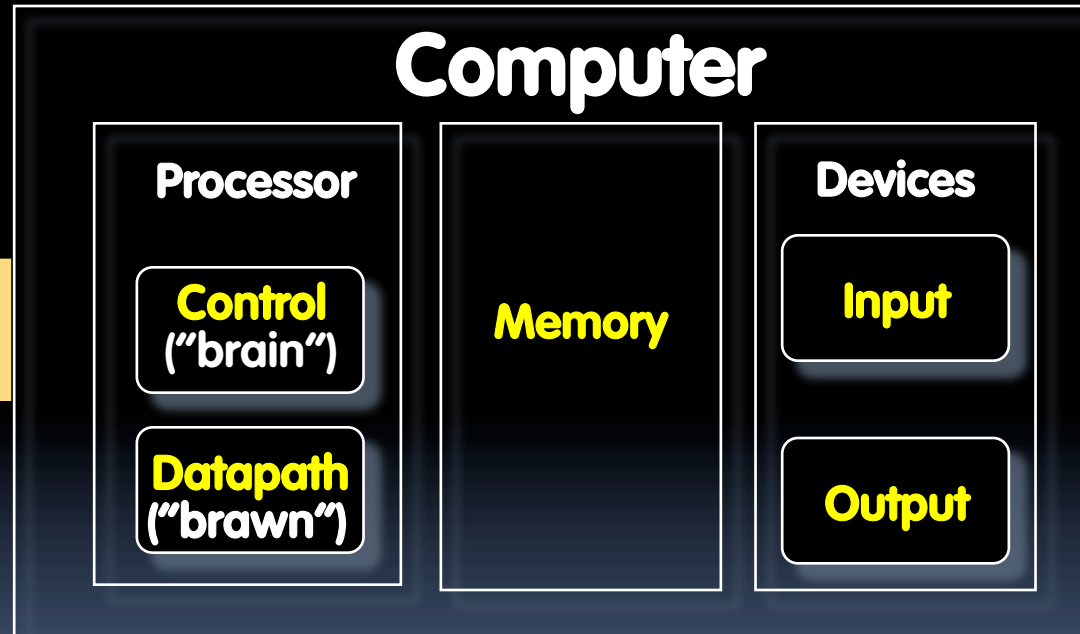
Review: 5 components of any Computer



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



- 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 wet computing.” – 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/O interfacing...



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 ^{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!

