



cs61c.org

UCB CS61C

Great Ideas in Computer Architecture (aka Machine Structures)



Summary & Goodbye

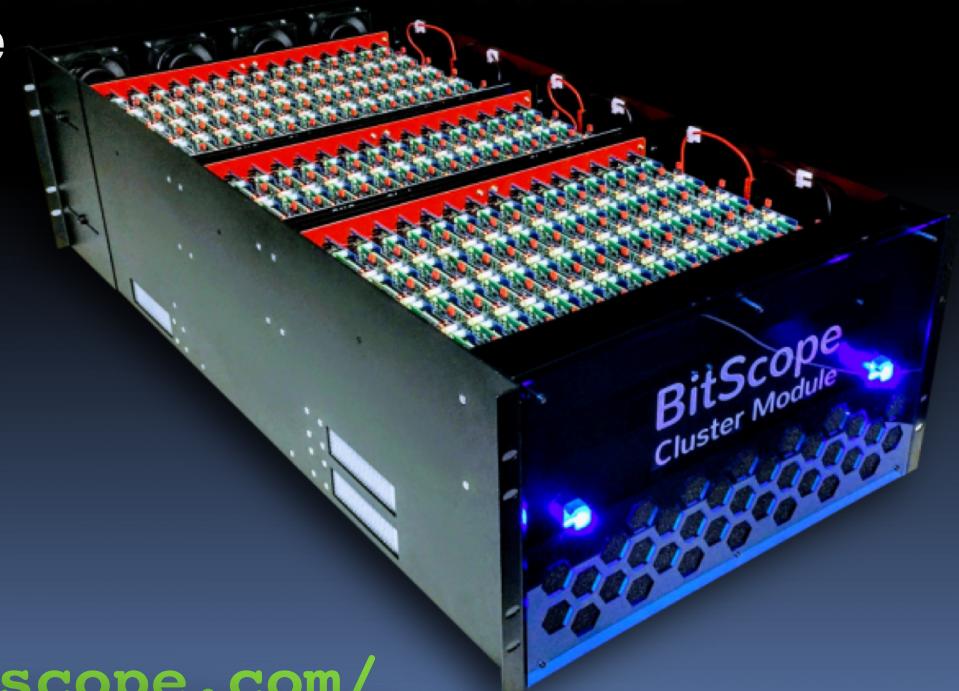
Teaching Professor
Dan Garcia

Professor
Miki Lustig

SUPERCOMPUTER IN FILE DRAWER

“The Raspberry Pi modules let developers figure out how to write software and get it to work reliably without having a dedicated testbed of the same size, which would cost a quarter billion dollars and use 25 megawatts of electricity.”

Gary Grider, leader of the High Performance Computing Division



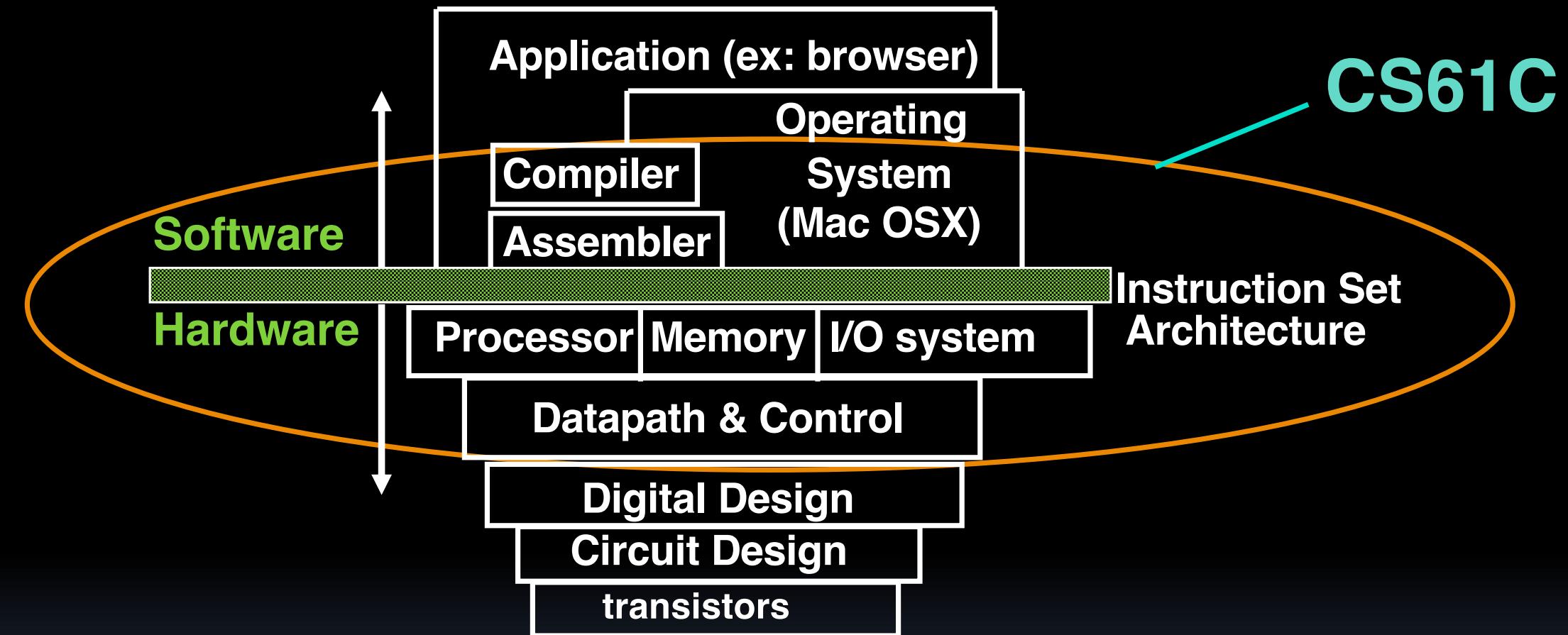
<http://cluster.bitscope.com/>

Six 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

Hardware

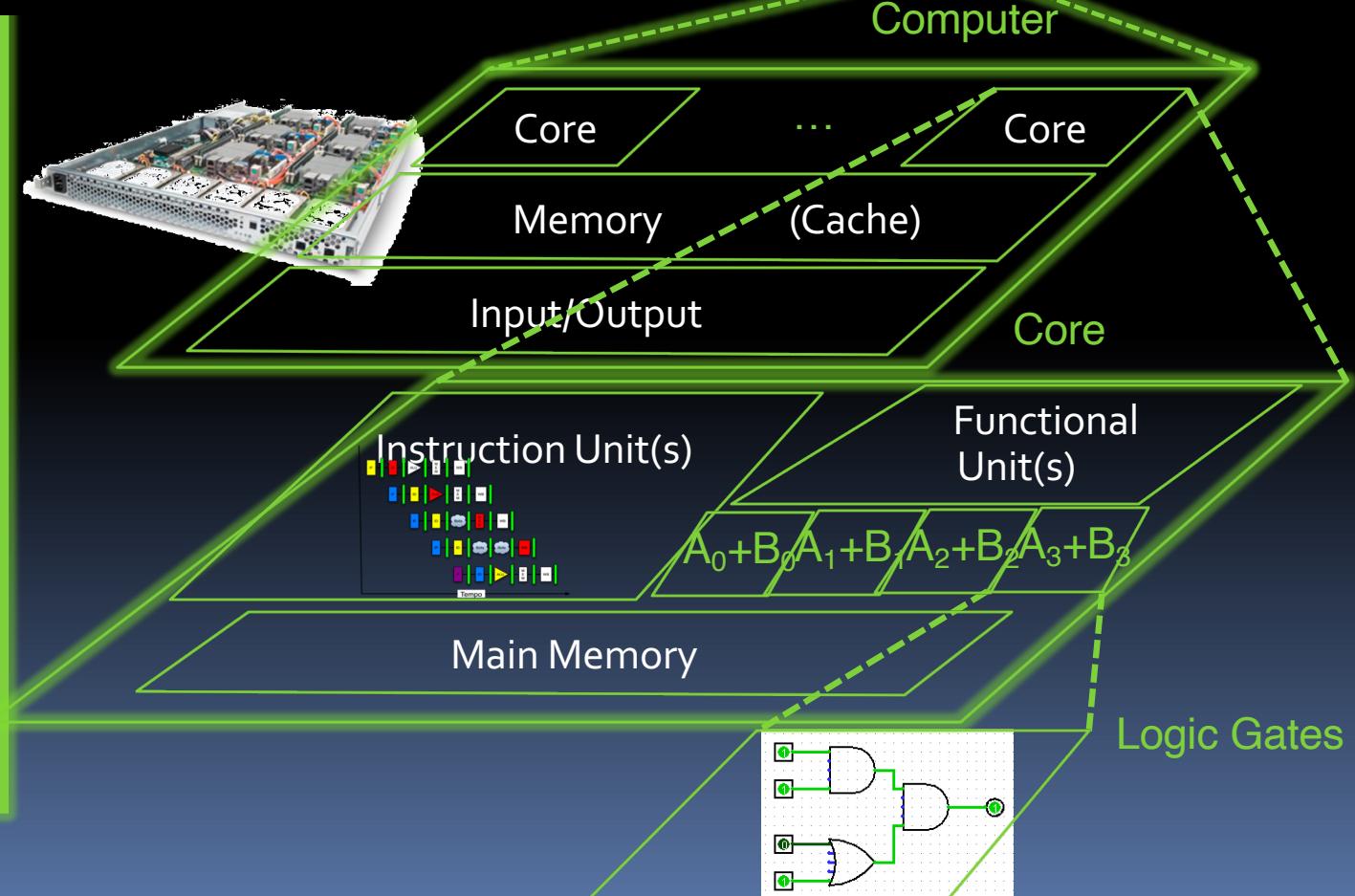
Warehouse Scale Computer



Smart Phone



Harness Parallelism & Achieve High Performance

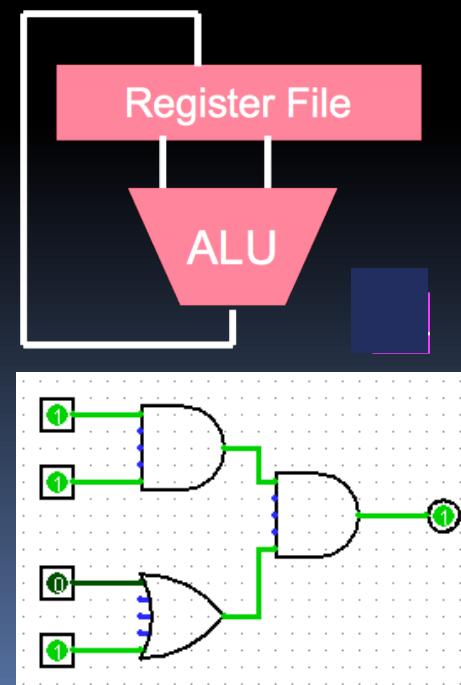


HW/SW contact!



```
temp = v[k];
v[k] = v[k+1];
v[k+1] = temp;
lw t0, 0($0)
lw t1, 4($0)
sw t1, 0($0)
sw t0, 4($0)
```

```
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 (see web)



Administrivia: Become active!

- **Final Exam details**
 - Only bring pen{cils}, **three** 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 CS10 or 61[ABC] (B or above) and want to be on staff?**
 - Usual path: LA (Academic Intern) → Tutor/Reader → TA
 - Reader/TA/LA forms:
<https://eecs.berkeley.edu/resources/gsis/prospective>
 - We 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 are we one of the top Univ in the WORLD?**
 - 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, be a go-getter!
- **<http://research.berkeley.edu/>**
- **<http://researchmatch.herokuapp.com/>**



Research Opportunities in Systems

(From Dave Patterson's lecture)

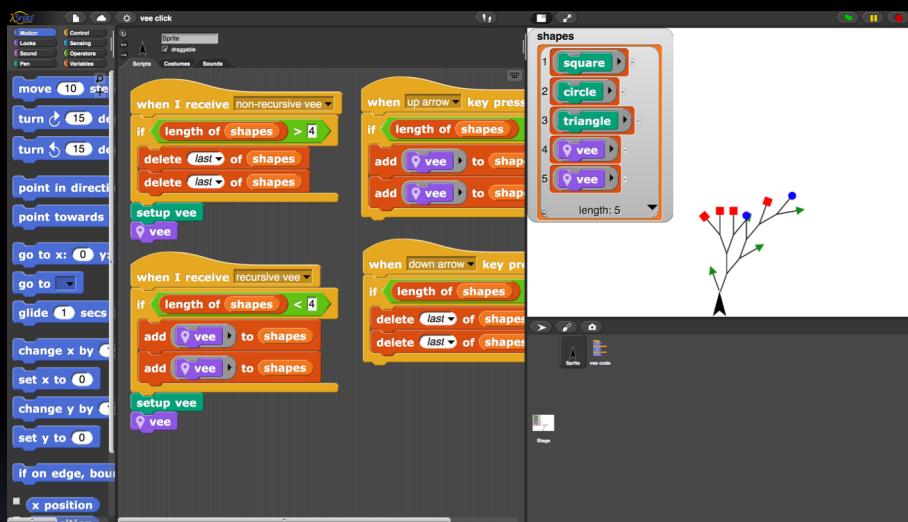
- **General-purpose applications:**
 - Make Python run like C with compiler + HW
 - Deja vu: make HLLs fast on RISC-V
- **Domain-specific applications (bigger opportunity?)**
 - What are the right DSLs for important applications?
 - Codesign of new DSLs and DSAs
 - Advanced compilation techniques for optimizing the matching:
 - New territory: not extraction of high level structure from C/Fortran but matching/optimization



Dan's Research Projects

■ Improve CS10/Snap!

- If interested, contact Lauren Mock
`<lmock@berkeley.edu>`,
cc `ddgarcia@berkeley.edu`



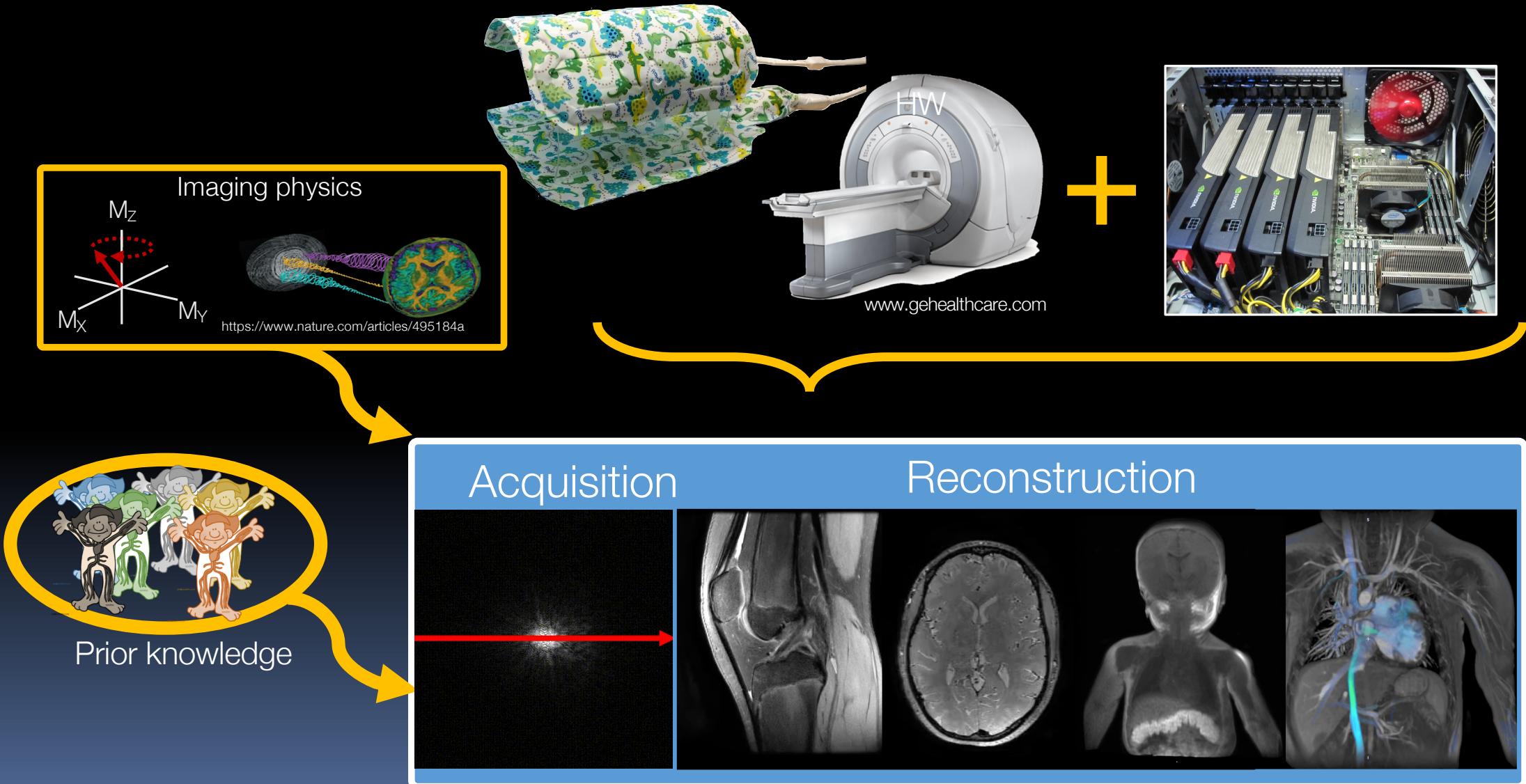
■ Game Theory!

- Want to solve board games using parallel algorithms on a cluster?
- If interested, take the CS198 DeCal



Miki's Computational MRI Research

- Use computation to jointly design the system, acquisition, and reconstruction



Opportunities Next Semester

- **CS152 (Computer Architecture and Engineering)**
 - If you liked CPU design, this is a great follow-on course!
- **CS162 (OS and System Programming)**
 - If you liked the OS parts, this is a great follow-on course!
- **GamesCrafters CS198 DeCal (Game Theory R & D)**
 - Develop SW, analysis on 2-person games of no chance.
(e.g., go, chess, connect-4, nim, etc.) Taught by Dan!!
 - Req: Game Theory / SW Interest / MWF 11am-noon free
- **iOS Dev CS198 DeCal (Mac Student Developers)**
 - Learn to program iOS devices.
 - Req: Interest. Owning a mac helps, not required.
- **UCBUGG CS198 DeCal (Recreational Graphics)**
 - Develop computer-generated images, animations.
 - Req: 3D interest



Opportunities Next Semester

- **EE16A, EE16B (lower-div EE courses)**
 - Fundamentals of signal processing, learning, control, and circuit design while introducing key linear-algebraic concepts motivated by application contexts.
- **EE12X (signals, systems, comm, networks and optimization)**
 - If you like making the computer solve interesting problems and make things work!
- **EE105, 14X series (Circuits)**
 - If you like to know what's below the gates
- **EE13X (Devices)**
 - ...To know how to make IC and devices for computing
- **EECS151 – Intro to Digital Systems and Circuits**
 - EECS151LA – ASIC lab, EECS151LB – FPGA lab
 - Build RISC-V processors, peripherals, run on an FPGA or create chip layout



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...



Jose Carmena, UCB EECS Prof
Research: Brain-Machine Interface
www.eecs.berkeley.edu/~carmena/



Penultimate slide: Thanks to the staff!

- (see the website)

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, The Internet of Things, AI, 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

The Future is up to you!

