Electrical Engineering and Computer Sciences

EECS 16A

Head TAs

- Email: head-ta-ee16a@berkeley.edu

Email Harrison with:

- Questions not for piazza
- Conflicts
- Emergencies

Introduce TAs

- Many are returning 16A staff members

Introduce Faculty

- Babak Ayazifar

  ayazifar@eecs.berkeley.edu

  517 Cory
- **No surprise visits, please!**
  - For one-on-one matters,
    - make appointment by e-mail;
    - provide your availability; and
    - we'll pick a mutually-convenient slot to meet.

Introduce Faculty

- Vladimir Stojanović

  vlada@eecs.berkeley.edu

  513 Cory
- Story…
- Other contributors to 16 (besides Babak/Vladimir):
  - Elad Alon, Anant Sahai, Ali Niknejad, Claire Tomlin, Gireeja Ranade, Michel Maharbiz, Laura Waller, Miki Lustig, Vivek Subramanian, Thomas Courtade

And we have even more!

- An army of Academic Interns…
  - Former 16A students just like you …
- The path to being on 16A staff
  - Do great in 16A
  - Become a lab assistant, reader/tutor

Important Web Sites

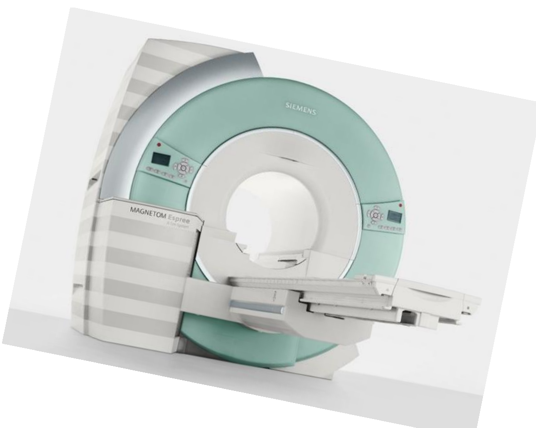
- EECS 16A

  http://inst.eecs.berkeley.edu/~ee16a/sp17/

- Piazza

  http://piazza.com/

Content Introduction



- **All of these extract information from the real world and interact with it; we will be learning how to design and understand these devices & systems!**

16A: Information Devices and Systems

- **Imaging/Tomography and Google PageRank (~5 wks)**
  - Topics: Linear algebraic thinking and graphs
  - Lab: Single-pixel imager
- **Touchscreens (5 wks)**
  - Topics: Linear circuits and design
  - Lab: Home-made R and C touchscreens
- **Locationing and Least-Squares (4 wks)**
  - Topics: Linear-algebraic optimization
  - Lab: Acoustic localization "GPS"

Some detailed topics for 16A

- Vectors and vector spaces
- Inner products, projection, orthogonality
- Matrices and linear transformations
- Rank and solving systems of linear equations
- Graphs, flows, and matrices
- How to do design and synthesis
- KCL, KVL, Ohm's Law
- Equivalence, modeling, and abstraction
- Capacitance and charge
- Gain and feedback
- Correlation and interference
- Linear regression and optimization
- Determinants, eigenvalues and eigenvectors
- Diagonalization

EECS Upper Divs: What 16AB feed

16AB

~~20~~
70

61B

61A

61C

~~40~~

16AB

Modeling and Algorithms	**170, 126, 188, 127**	**189, 120, *121*, 123, 174, 144, 172**
General Software	162, 161, 169	160, *168*, 149
General Hardware	105, 140, 151	130, 143, 145L

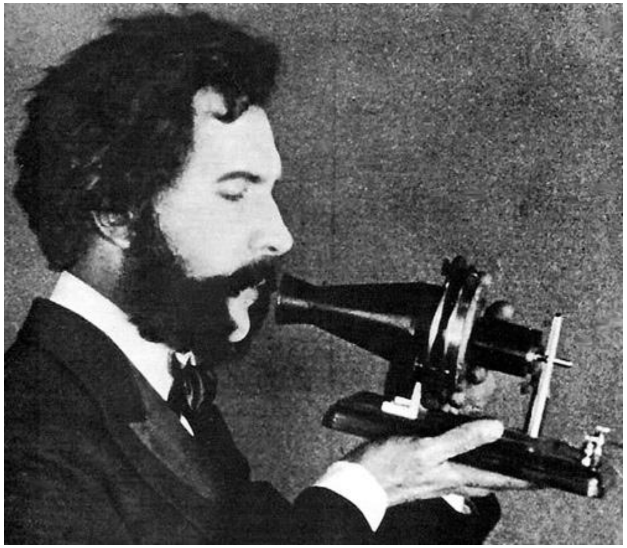
Specific Domains	
121, 122, *168* Comm+Net	176, 145B CompBio, Imaging
191 Quantum	128, 106, 192 Control + Robotics
184 Graphics	186 Databases
164 Compilers	152 Computers
145MO Bio	147 MEMS
117 Antennas	142 Comm ICs
118 Optics	113, 137AB, 134 Power+SolarEnergy

How Did We Get From This…

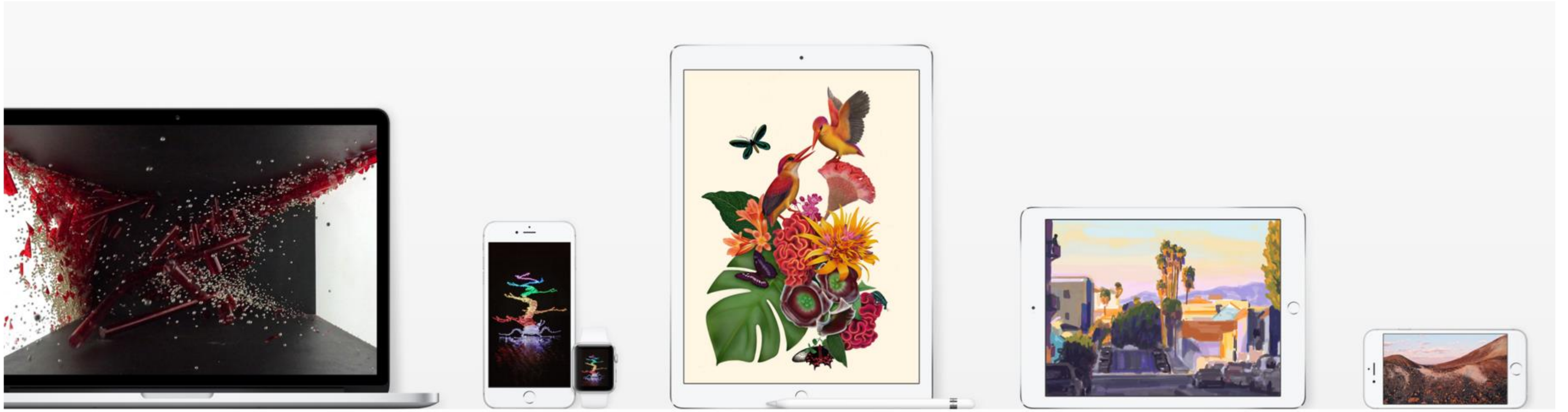
1837

1866

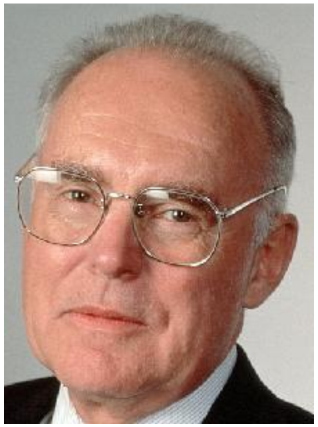
1876



To This?



Moore's Law

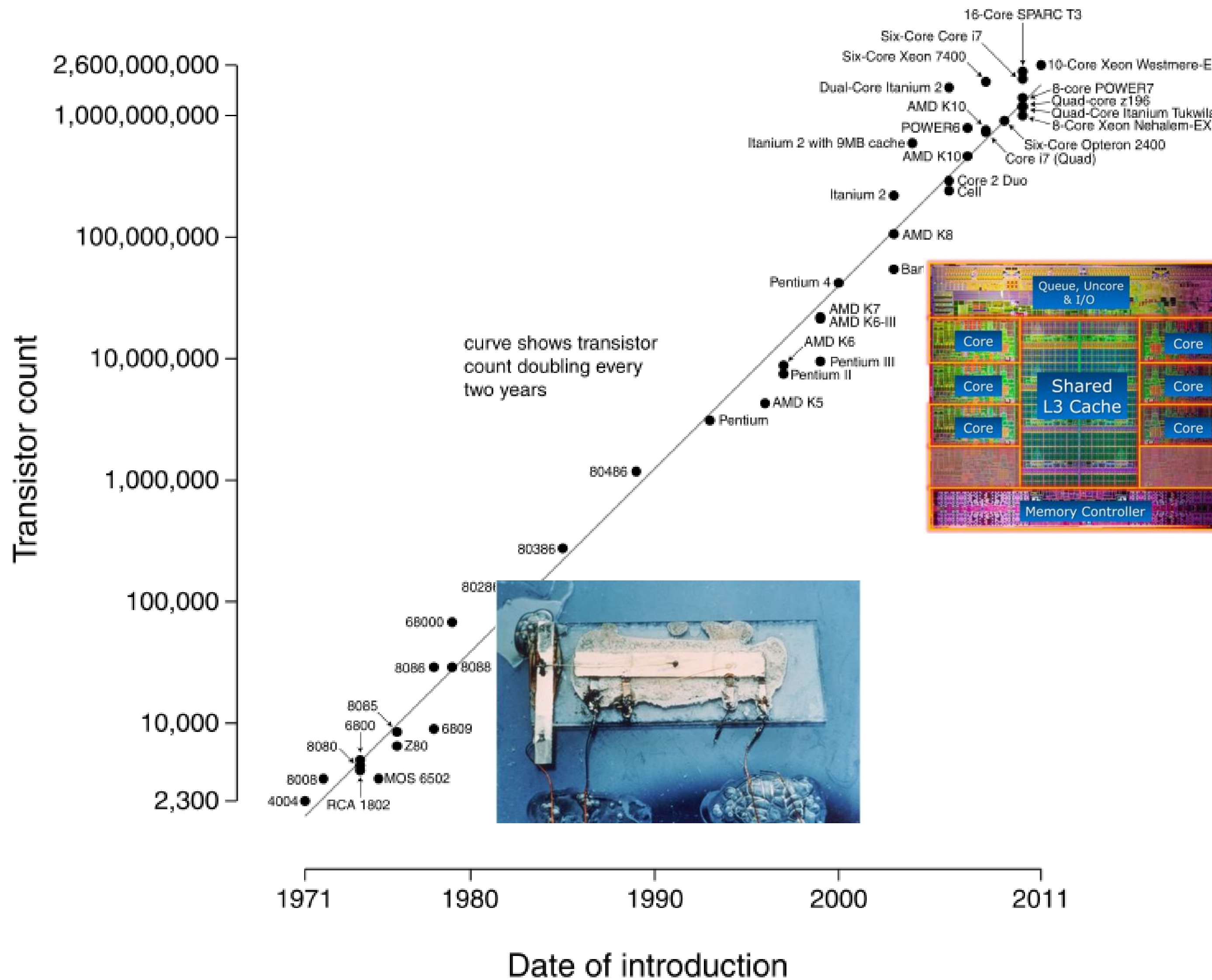


Gordon Moore

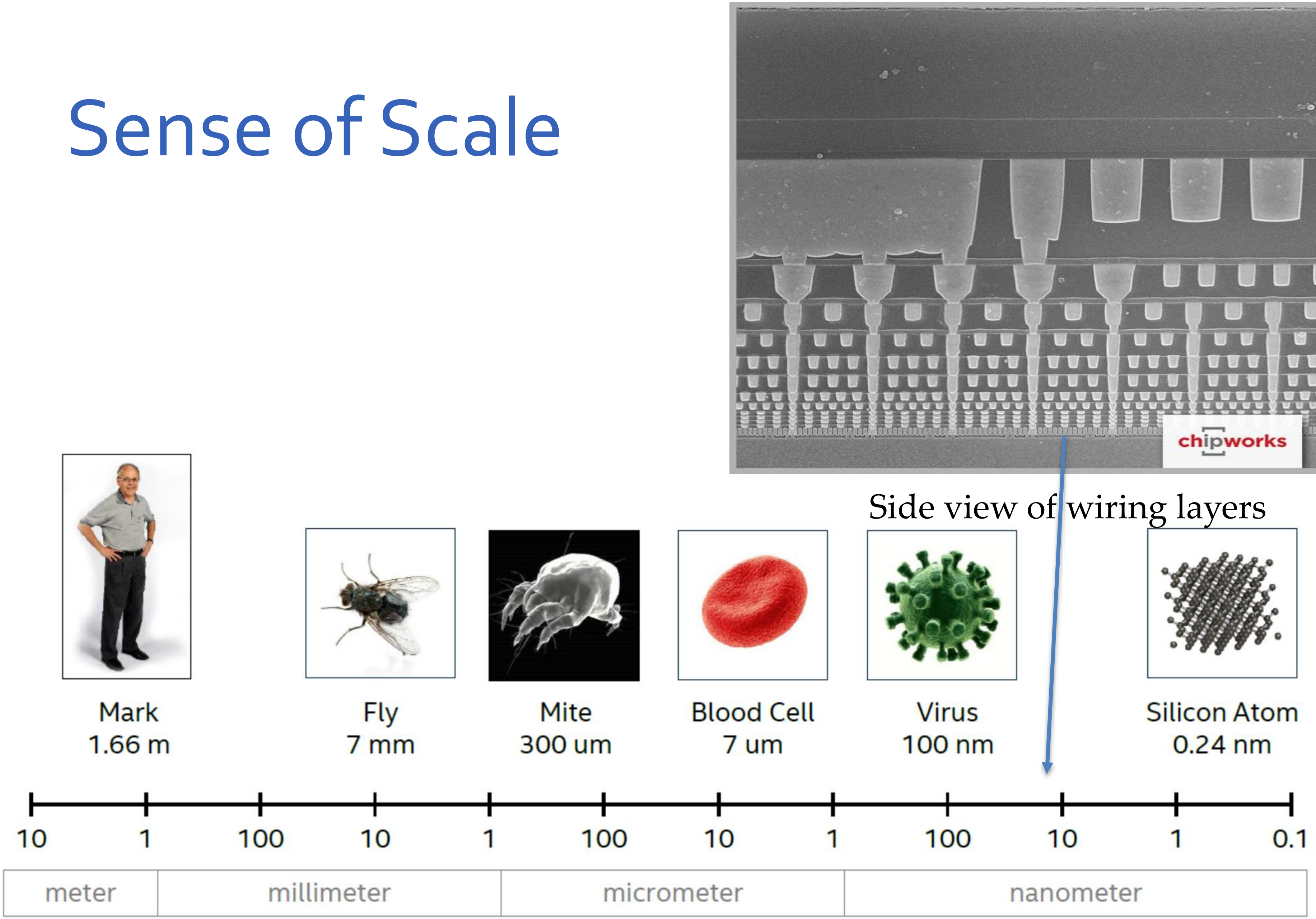
Intel Cofounder

B.S. Cal 1950!

Microprocessor Transistor Counts 1971-2011 & Moore's Law

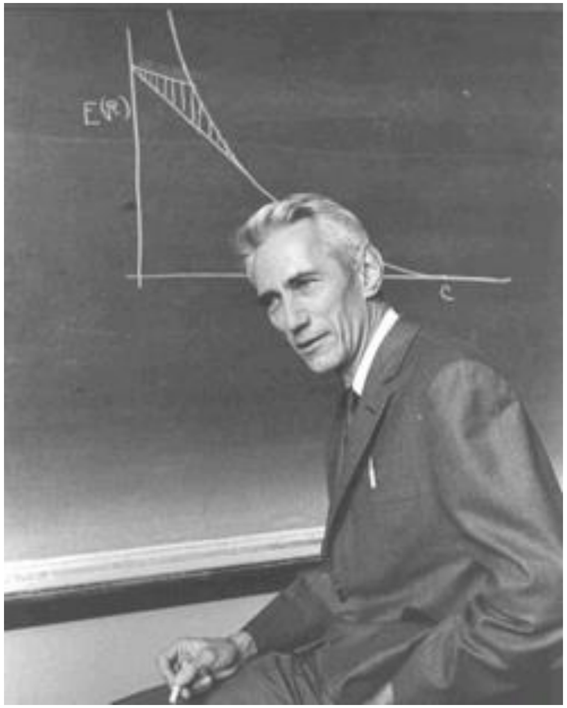


Sense of Scale



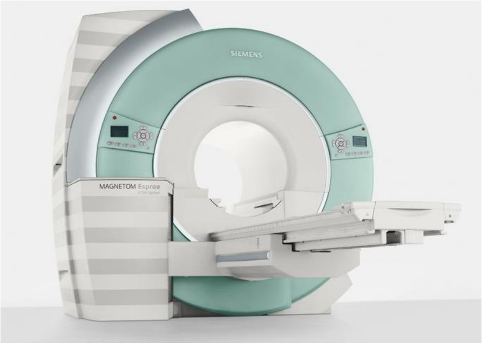
Source: Mark Bohr, IDF14

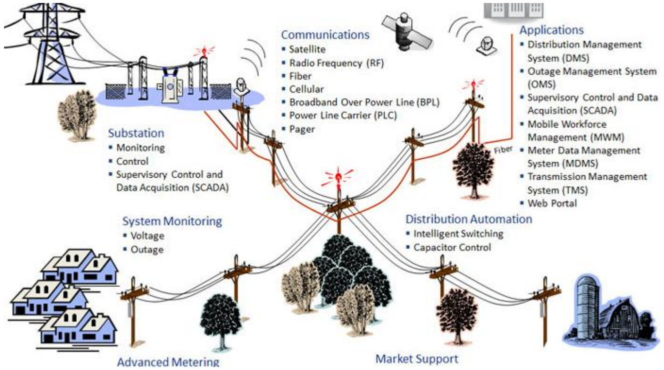
That's Just One Piece of the Puzzle…



1940's

Where This is Used:





Whom We're Training You to Be

2017

An example system: iPad Air 2

- Runs apps, but:
  - How is it charged / discharged?
  - What makes the display tick?
  - How does the Wi-Fi work?
  - How does it sense touch on the touch screen?
  - How does it sense motion?
  - How do the “brains” operate?

... and how can I learn stuff, so I can work on such cool technology?

Inside an iPad Air 2

Physical world interaction: camera

Communication: Antenna

Display / touch screen

“Brains”: the main board

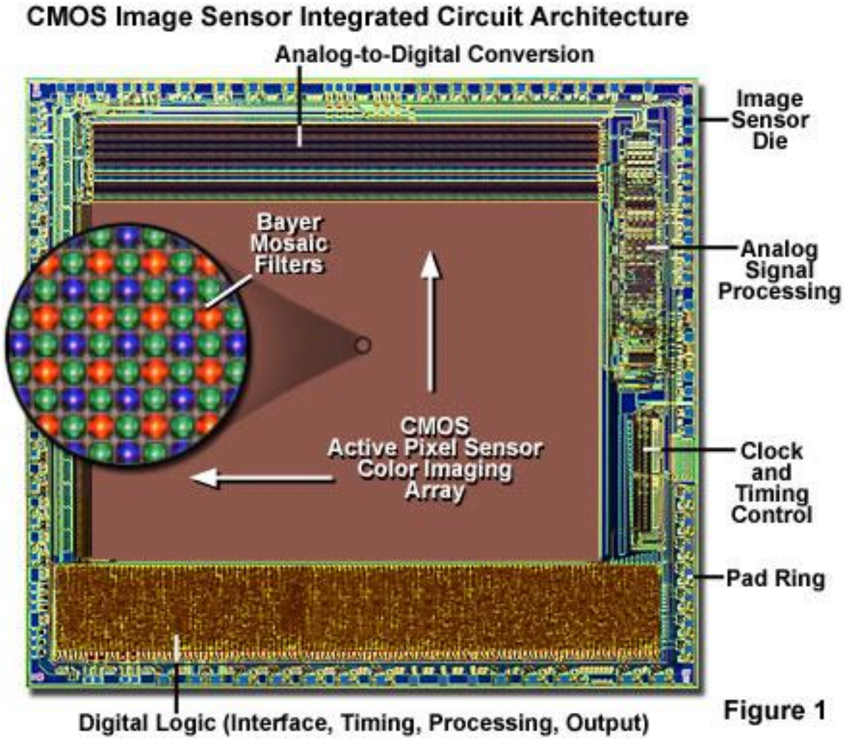
Energy: Battery

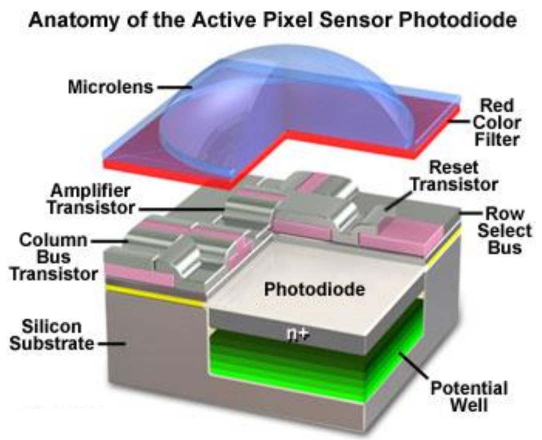
User interface device: home button

Physical world interaction: speakers

The Camera

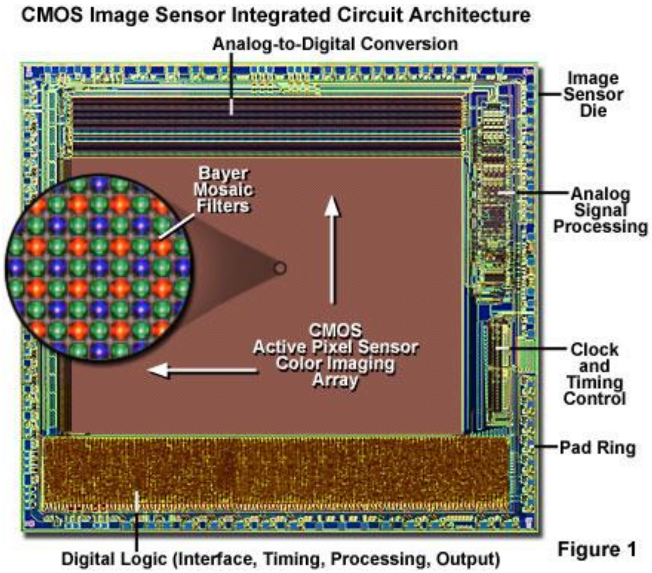
Goal: Convert light into electrical signals





Get color spatial distribution by using an array of “light” detectors, each under a color filter

Cameras: “Mathematical” Guts



Focus/exposure Control → preprocessing → white-balancing → demosaic → Color transform → Post-processing → Compression

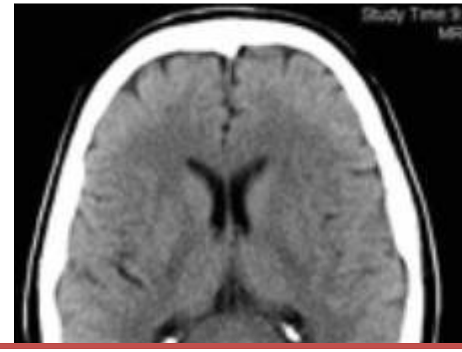
Medical Imaging ca. 1895

- **Need to find a way to see inside without "light"**

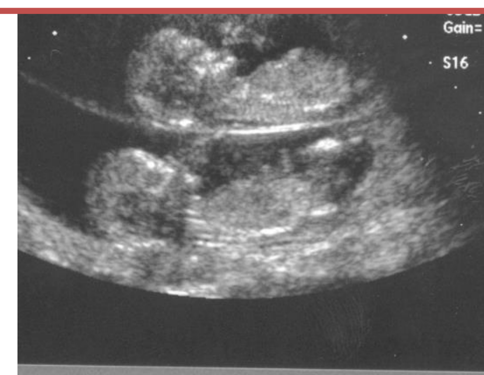
Medical Imaging Today

X-Ray

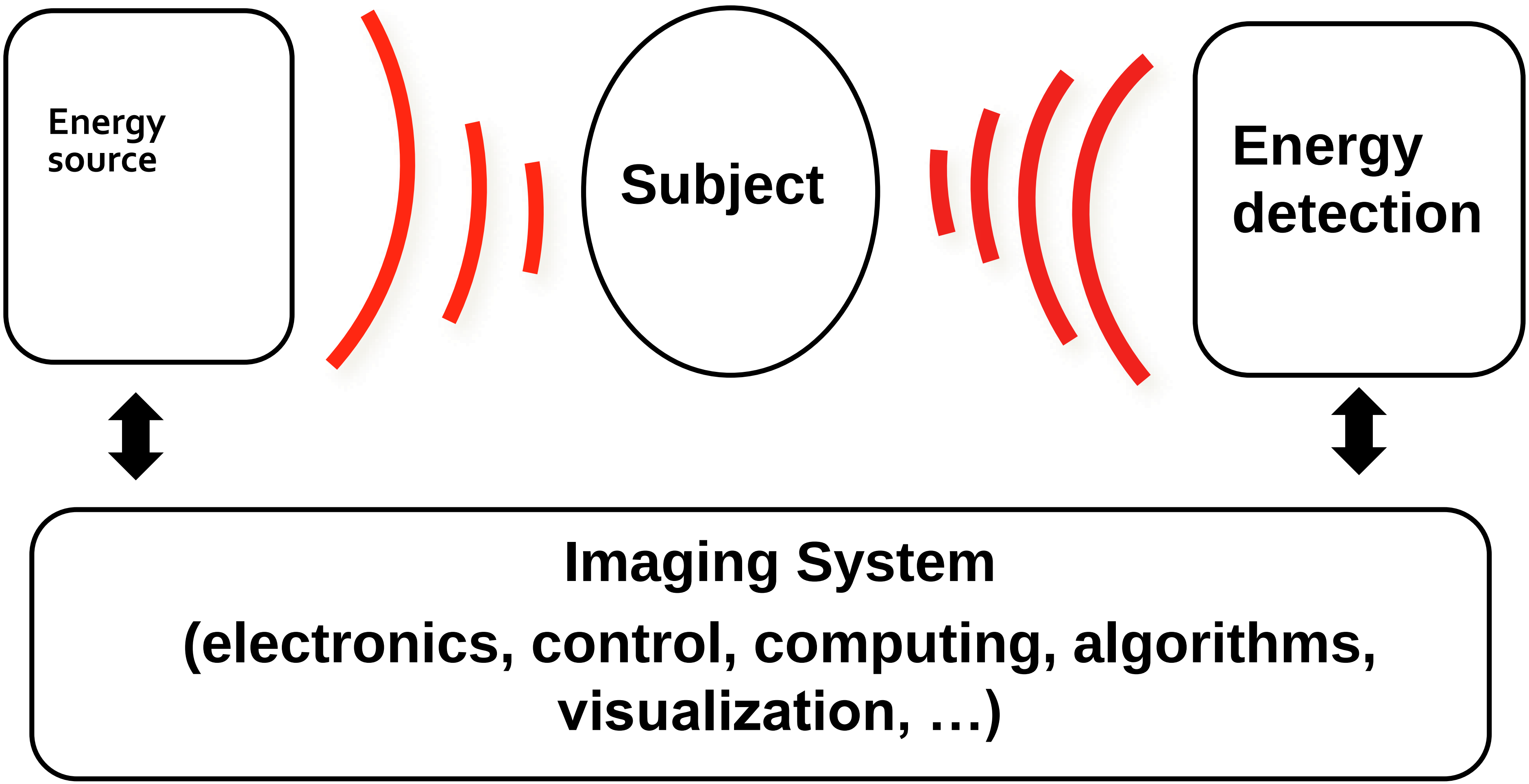
CT



All of these were enabled/dramatically advanced by the mathematical and hardware design techniques you will learn in this class!



Imaging In General



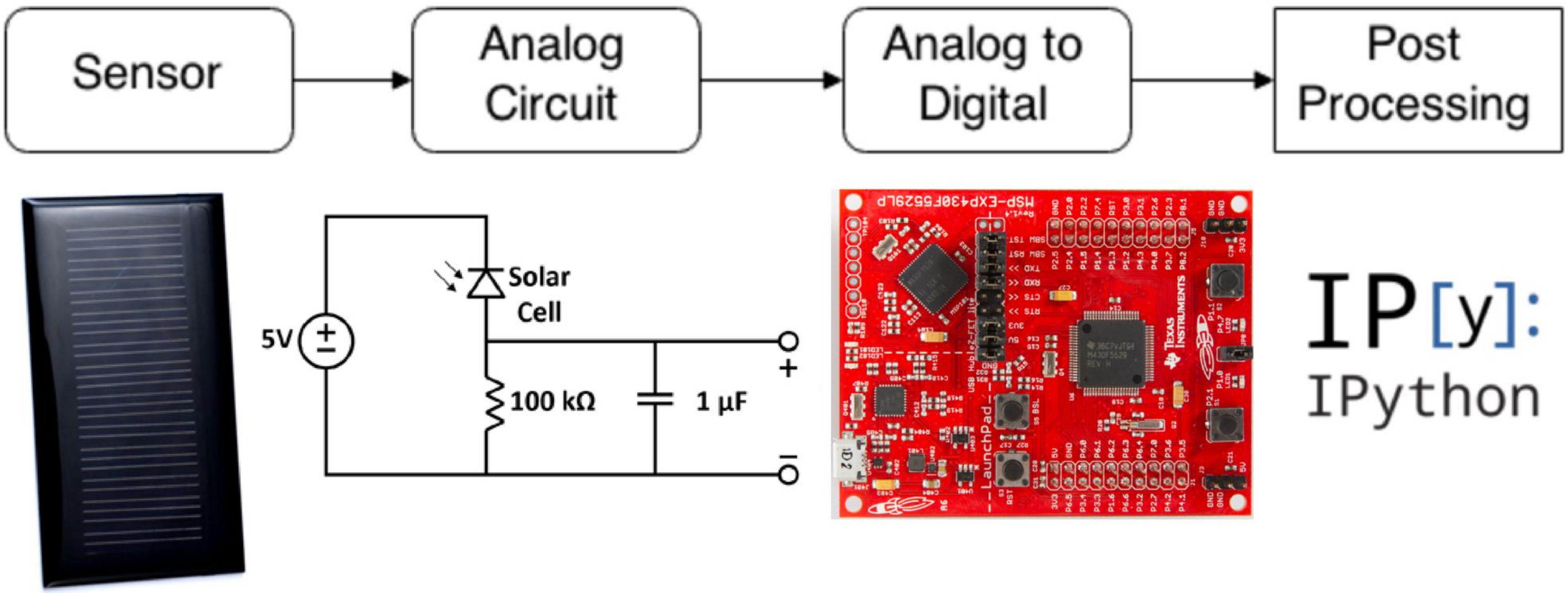
Simplest Imaging System

- **What is the absolute smallest number of components you need to make an imaging system?**

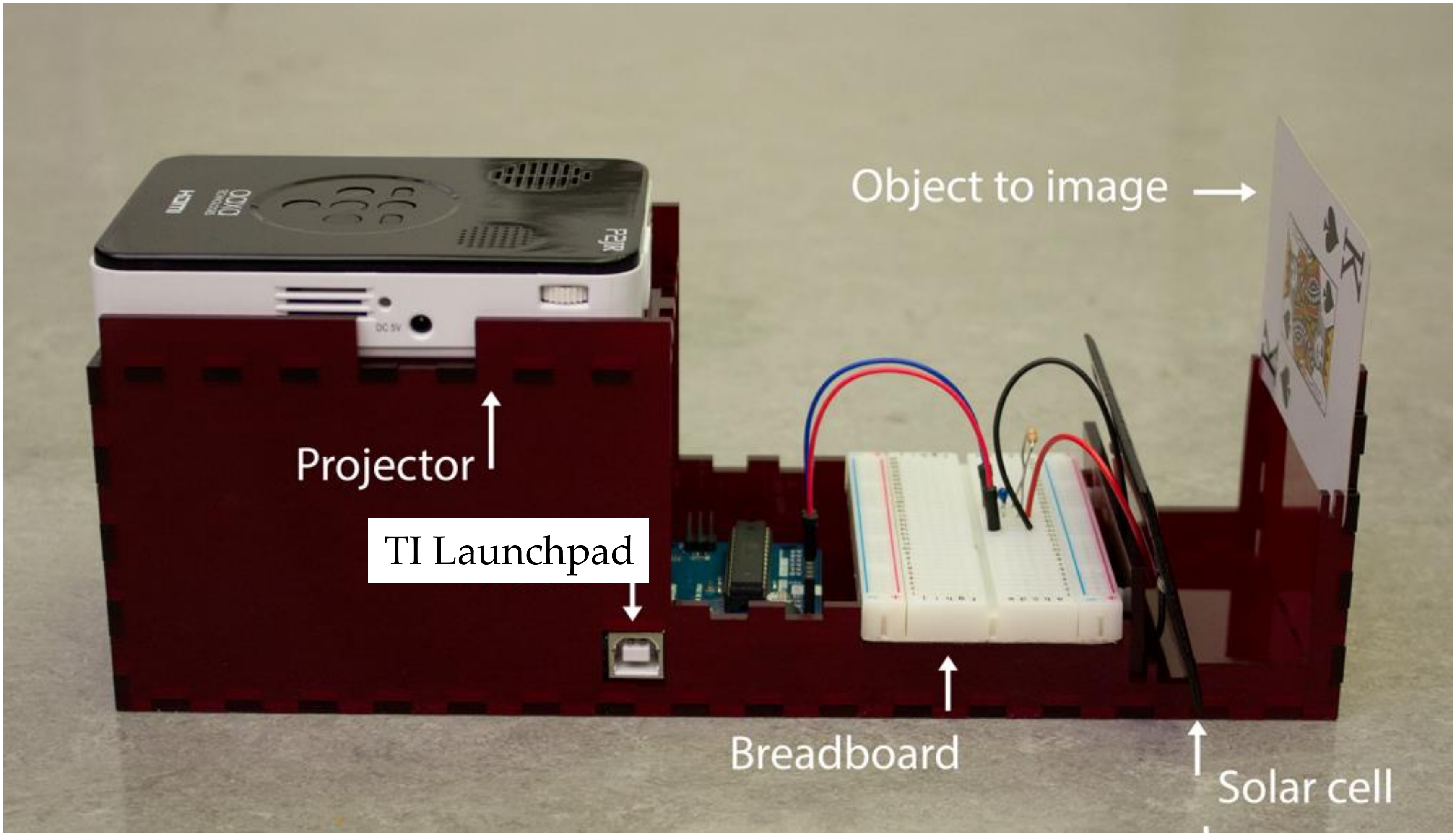
Simple Imager Example

Simple Imager Example

Imaging Lab #1



Your Setup



Object to image
Projector
TI Launchpad
Breadboard
Solar cell

An Imager with Just One Sensor?

- **After all, today's cameras have millions of pixels…**
- **Great teaching vehicle: you can actually get a lot out of surprisingly simple designs**
  - Once you know the right techniques!
- **In some systems the sources and/or detectors might actually be expensive**
  - Take this opportunity to learn a little more about how detectors usually work
  - And how we get them to "talk" to our electronic systems

More Complex Imaging Scenario

- What if we can't shine light (i.e., focus energy) either uniformly on all spots or in just one spot?

- The signal we receive on our detector will be a **linear combination** of several features of the image from different points.

- Can we recover the original image?
  - In many cases, yes!
  - Will start to see how next…