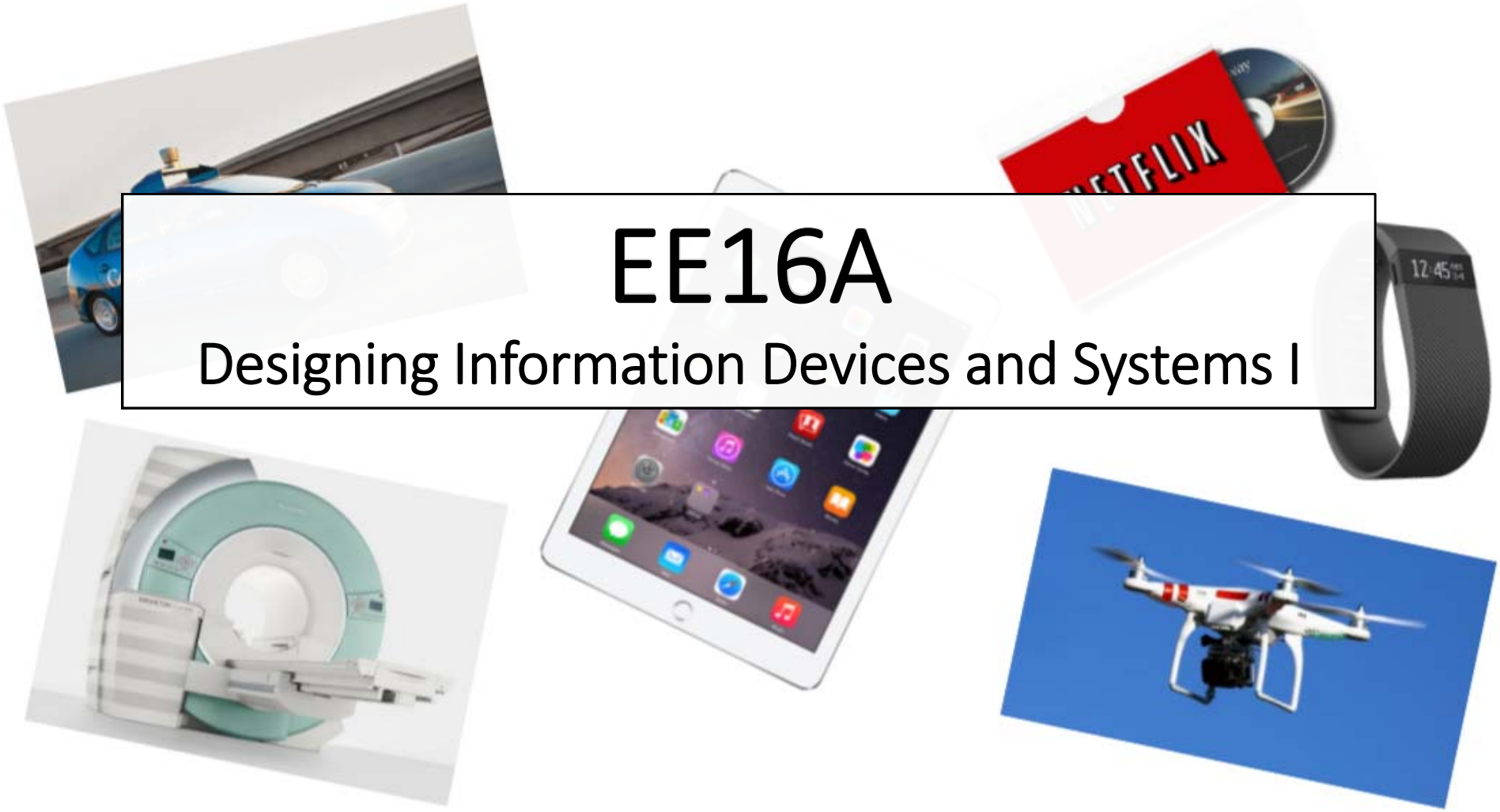
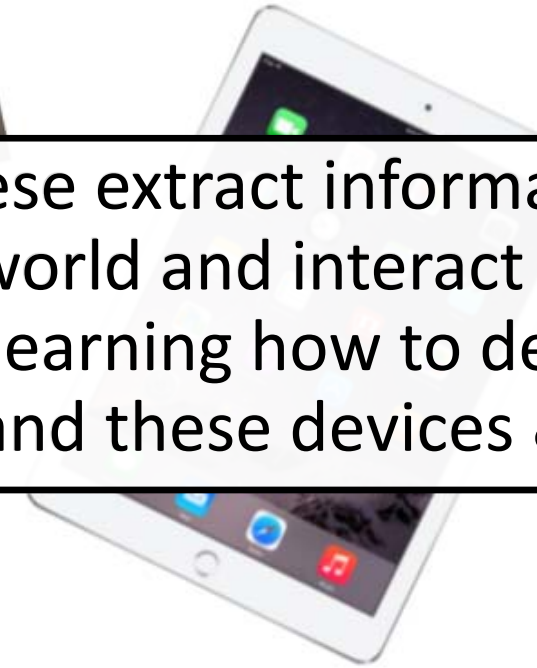
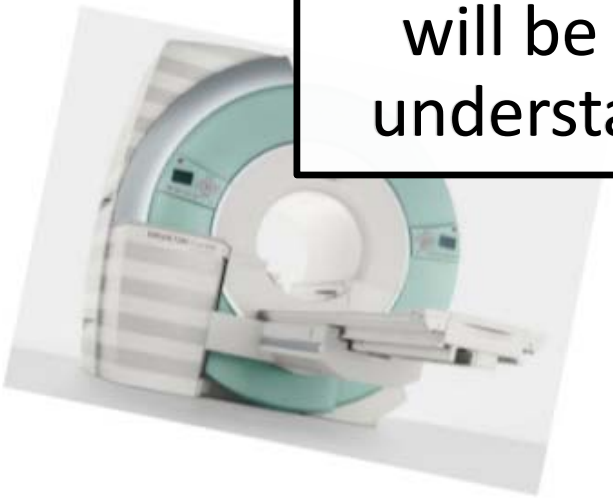


EE16A

Designing Information Devices and Systems I





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

Instructors

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- Other contributors to 16: Elad Alon, Anant Sahai, Gireeja Ranade, Ali Niknejad, Claire Tomlin, Michel Maharbiz, Miki Lustig, Vivek Subramanian, Thomas Courtade, Babak Ayazifar

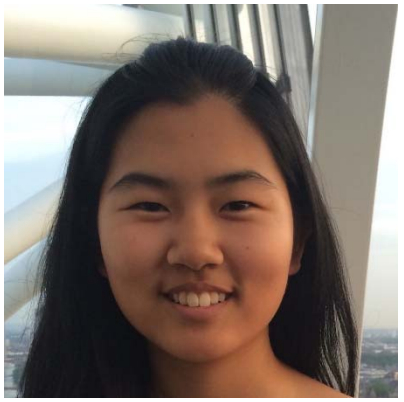
TAs and GSIs

Head GSIs:

ee16a.staff@gmail.com

Email with:
- Questions not for Piazza
- All conflicts
- Any emergencies
- Administrative questions

Grace Zhang



- GSIs

Hannah Li

And we have even more!

- An army of Academic Student Employees…
  - Former 16A students just like you …
- The path to being on 16A staff
  - Do great in 16A
  - Become an Academic Student Employee
    - Grade homeworks, assist in labs, help out in OH, etc.

Important web sites

- EECS 16A

http://inst.eecs.berkeley.edu/~ee16a/sp18/

- Piazza

http://piazza.com/

Course policies

- Syllabus is on course website
  - You are responsible for reading and following all course policies listed
- Grading is absolute
  - We'll release the grading sheet so you can keep track of your progress
- No technology (usage) during lecture!

Should you take this course?

- Freshmen and Freshwomen are the target audience
  - Assume no prior background in linear algebra and physics
- If you are L&S CS student ***graduating this semester***, there is a long list of temporary alternatives you can take to fulfill the requirement
- If you are an L&S CS (intended) student and ***have taken Math 54*** (and understood it)
  - You should probably take 16B, not 16A
  - Sign up for EECS 47D to learn the circuits content from 16A (see piazza)
  - Contact Prof. Elad Alon if interested in this option

You are here to learn!

- Our staff wants to help you learn
  - In-lecture q&a, OH, Homework parties, Lab, Guerilla sessions
- Cheating directly detracts from learning
  - Any cheating will be immediately sent to the Office of Student Conduct
  - Report bad behavior
- Everyone here is smart
  - Students have different backgrounds
  - Professors make mistakes – feedback helps
  - Helping others is good for both of you
  - If you are struggling, ask for help!

Topics

- 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”

Related courses

				Specific Domains	
16AB 70 61B 61A 61C 16AB	Modeling and Algorithms	170, 126, 188, 127	189, 120, *121*, 123, 174, 144, 172	*121*, 122, *168* Comm+Net	176, 145B CompBio, Imaging
				191 Quantum	128, 106, 192 Control + Robotics
	General Software	162, 161, 169	160, *168*, 149	184 Graphics	186 Databases
				164 Compilers	152 Computers
	General Hardware	105, 140, 151	130, 143, 145L	145MO Bio	147 MEMS
				117 Antennas	142 Comm ICs
				118 Optics	113, 137AB, 134 Power+SolarEnergy

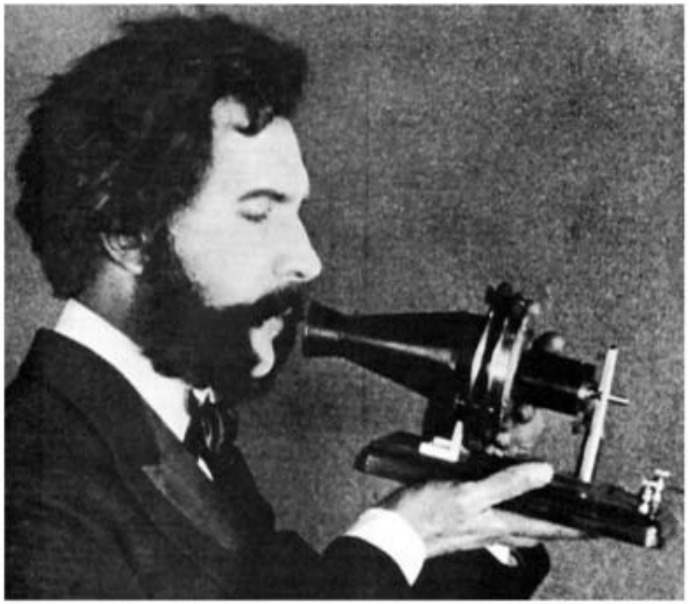

START

How Did We Get From This…

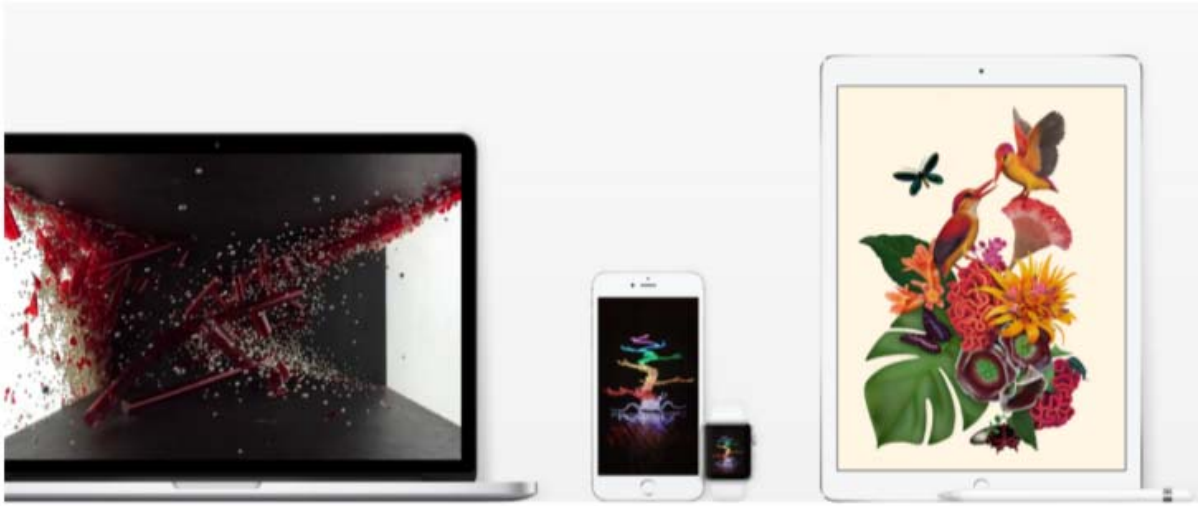
1837

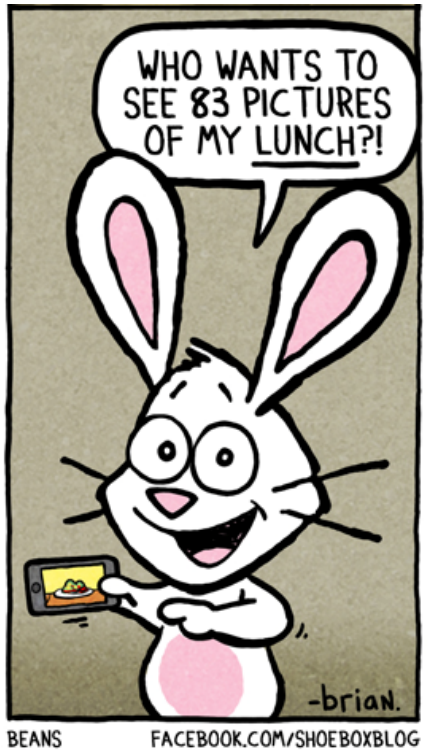
1876

1866



To This?



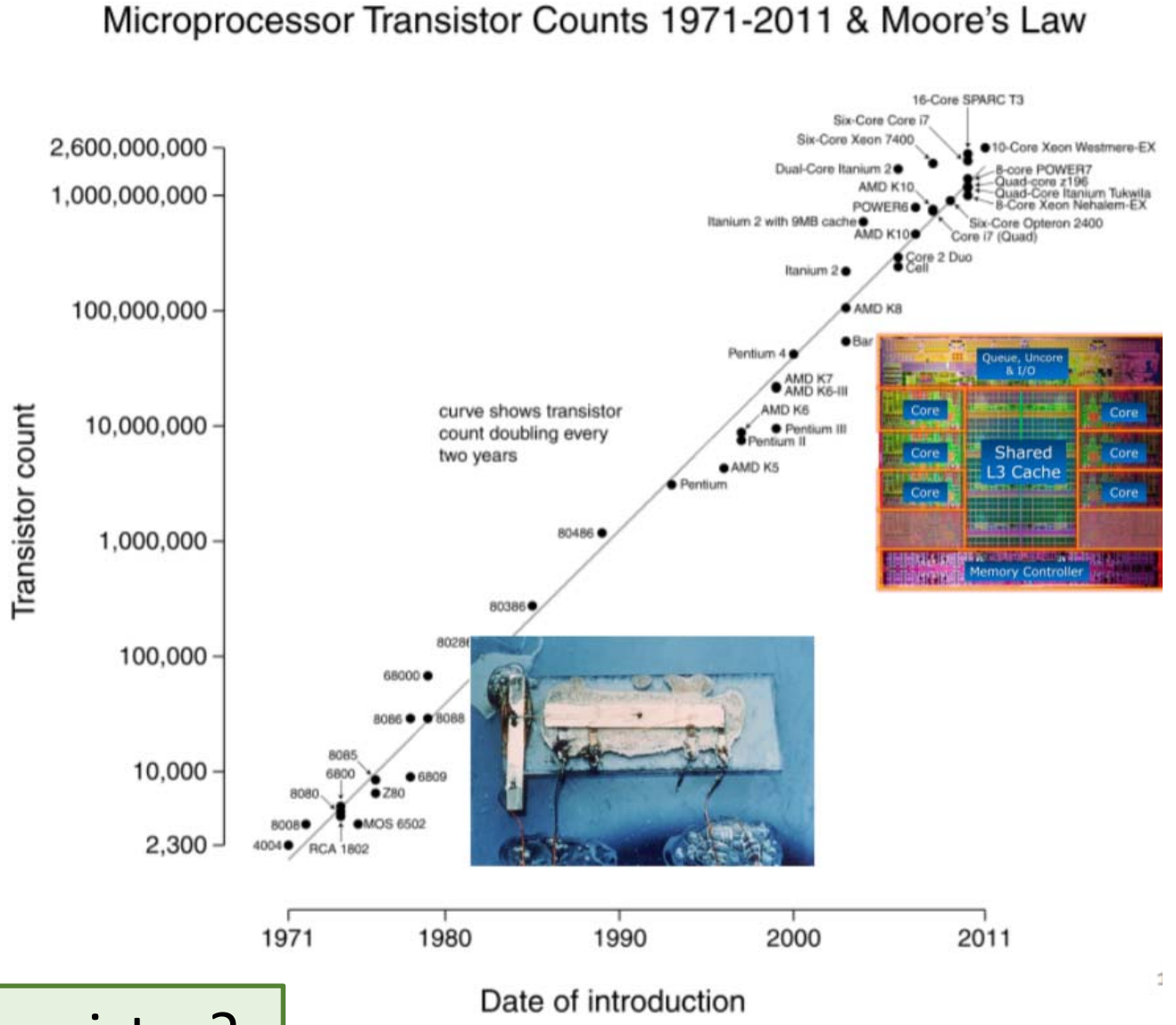

WHO WANTS TO SEE 83 PICTURES OF MY LUNCH?!
-brian.
BEANS
FACEBOOK.COM/SHOEBOXBLOG

Moore's Law

Gordon Moore

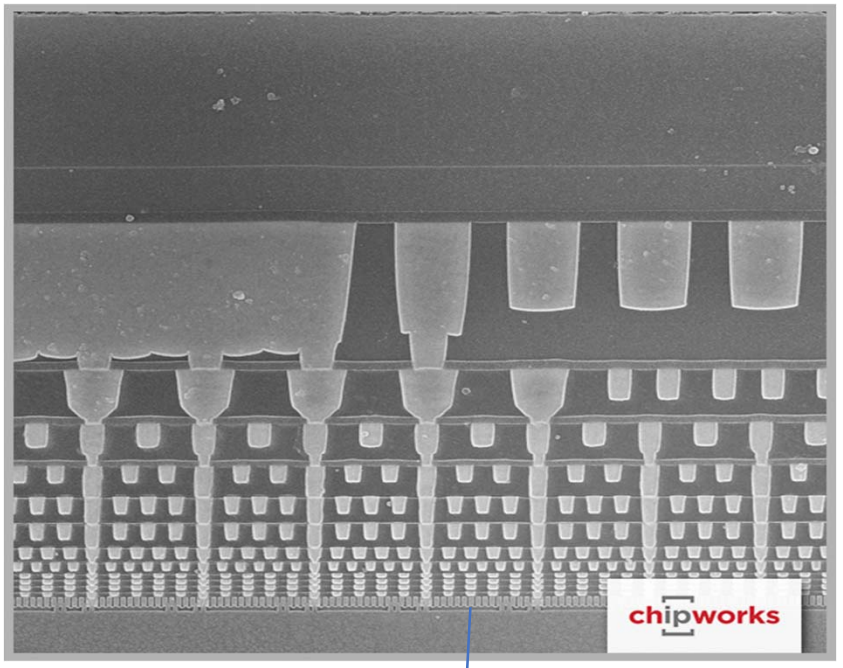
Intel Cofounder

B.S. Cal 1950!



What is a transistor?

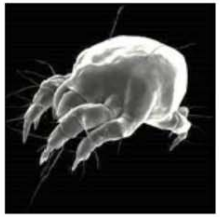
Sense of Scale



Side view of wiring layers

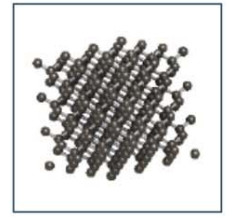

Mark
1.66 m


Fly
7 mm


Mite
300 um


Blood Cell
7 um


Virus
100 nm

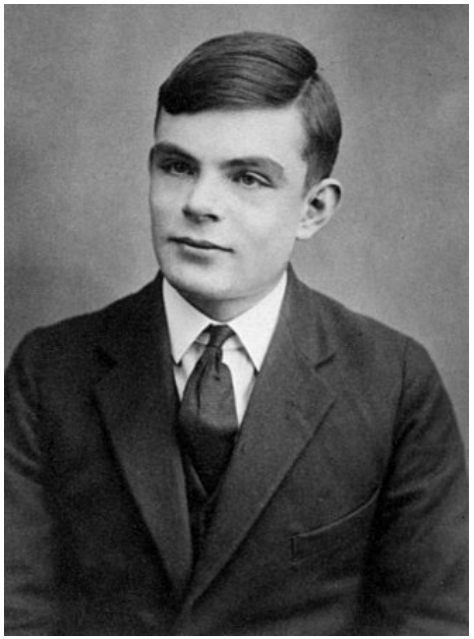

Silicon Atom
0.24 nm

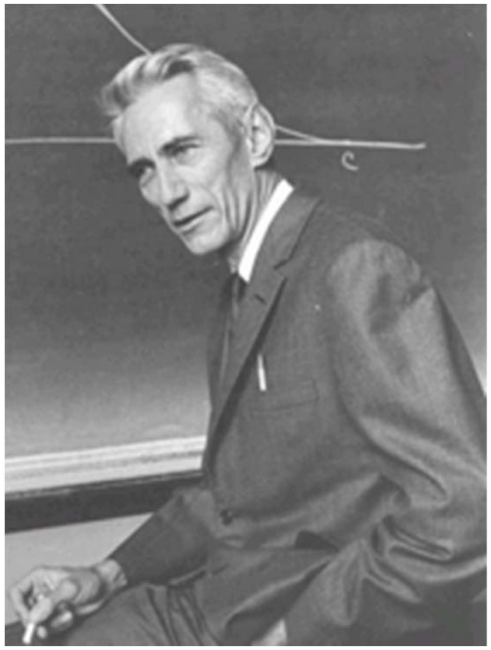
10 1 100 10 1 100 10 1 100 10 1 0.1

meter | millimeter | micrometer | nanometer

Source: Mark Bohr, IDF14

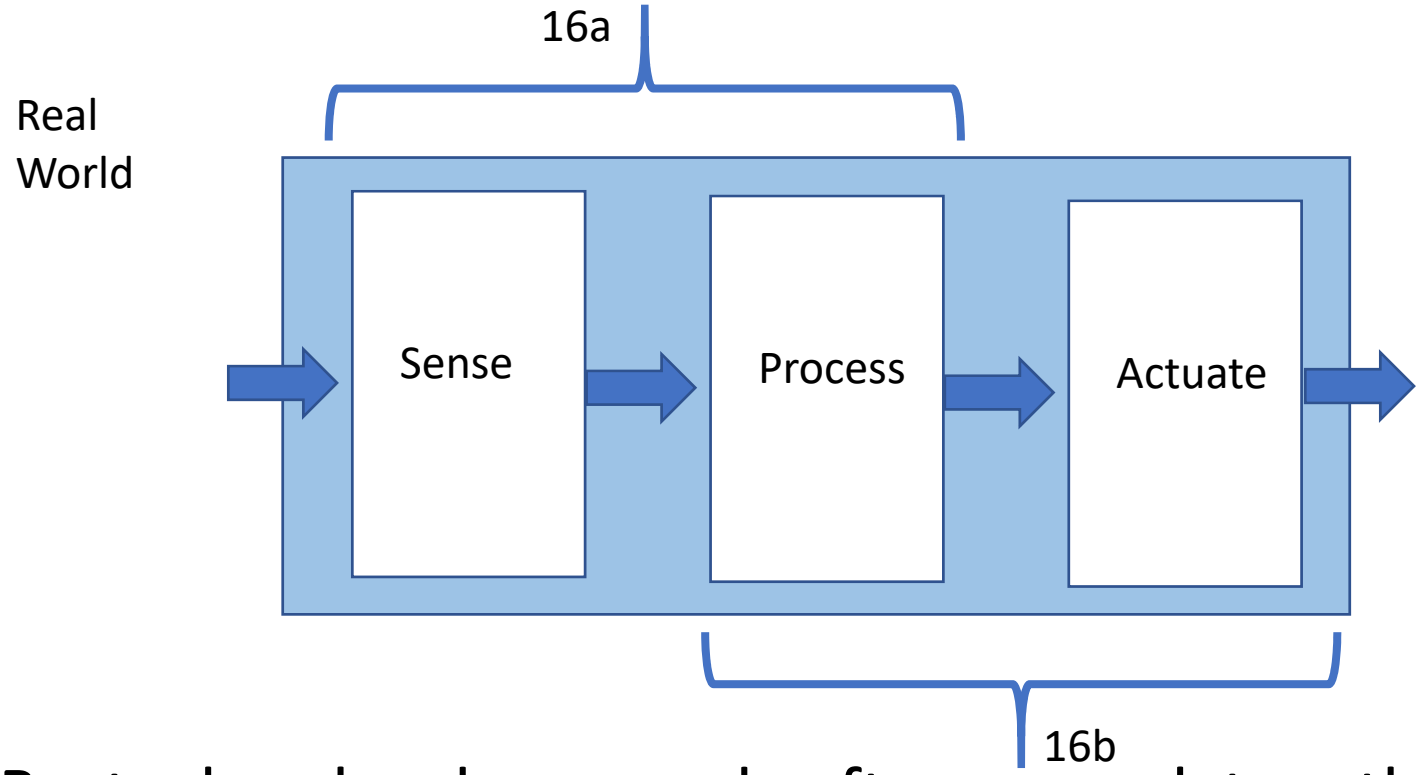
Completing the puzzle …





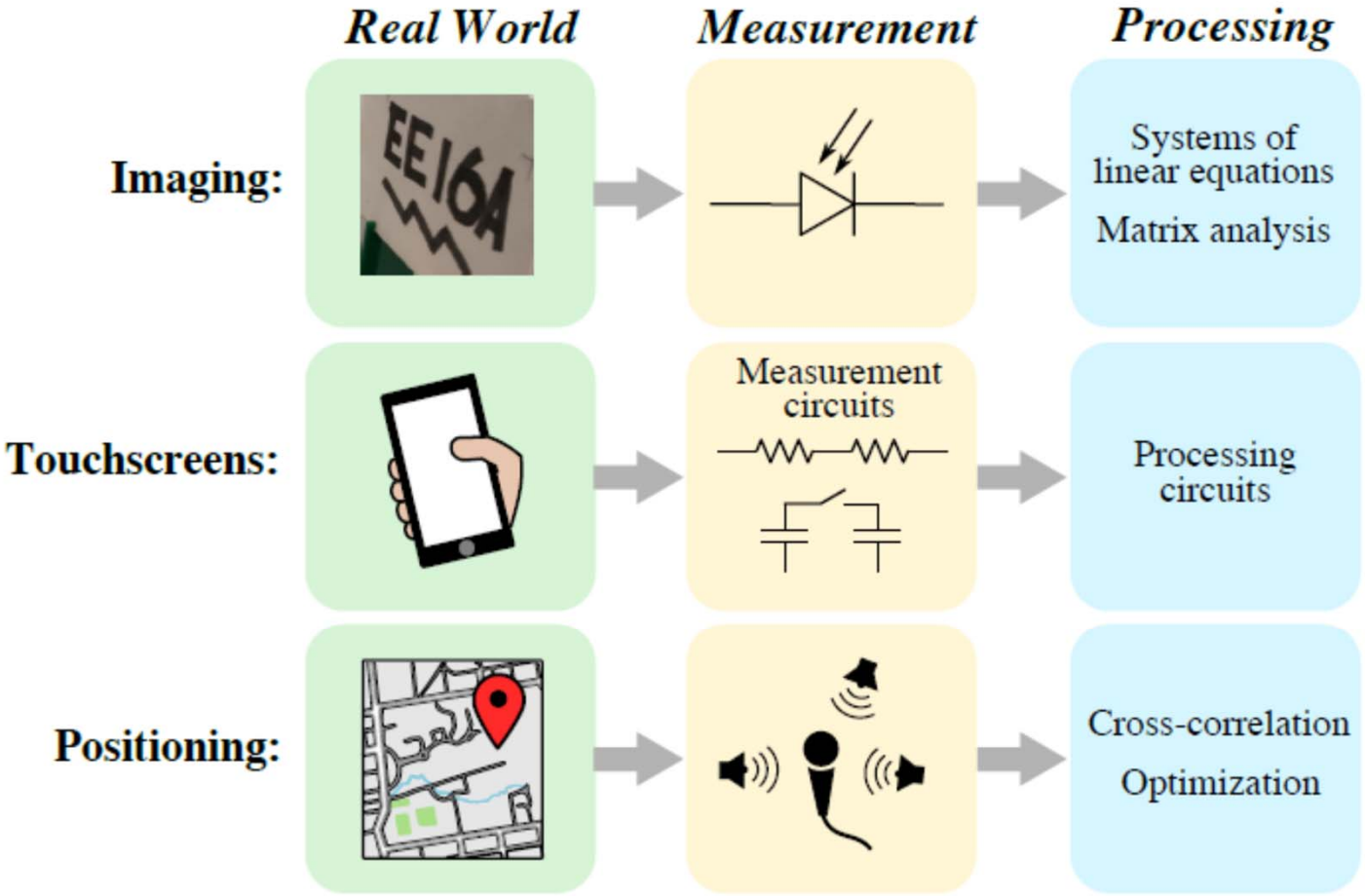
- Ada Lovelace - wrote the first computer program
- Turing – invented the Turing machine – how to build a computer to execute programs – what is actually computable?
- Claude Shannon – info theory, + how to implement logic out of EM switches

Design of Information Devices and Systems



- Best when hardware and software work together
  - Best algorithms and best code written by understanding the sensing and compute mechanisms
  - Best devices designed understanding the physical limitations

16a Examples



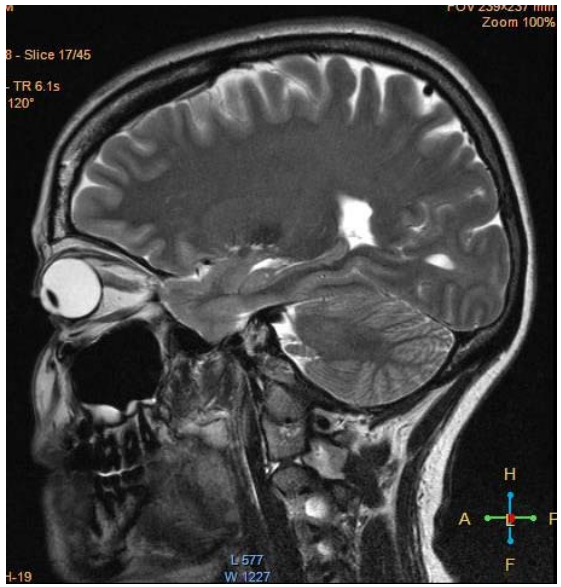
Module 1: Imaging

Seeing inside bodies: the early days…

Rembrandt + modifications

Seeing inside bodies: sans surgery…

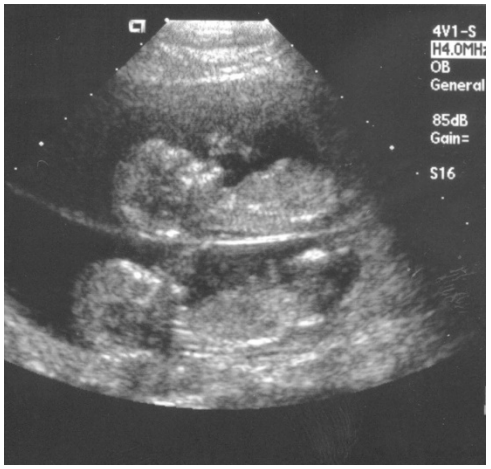
MRI



X-Ray

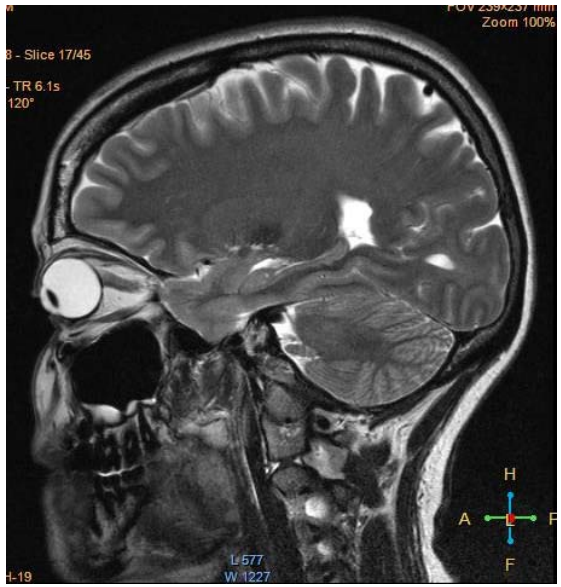
CT

All of these benefitted from the math/hardware design techniques you will learn in this class!



Ultrasound

Tomography

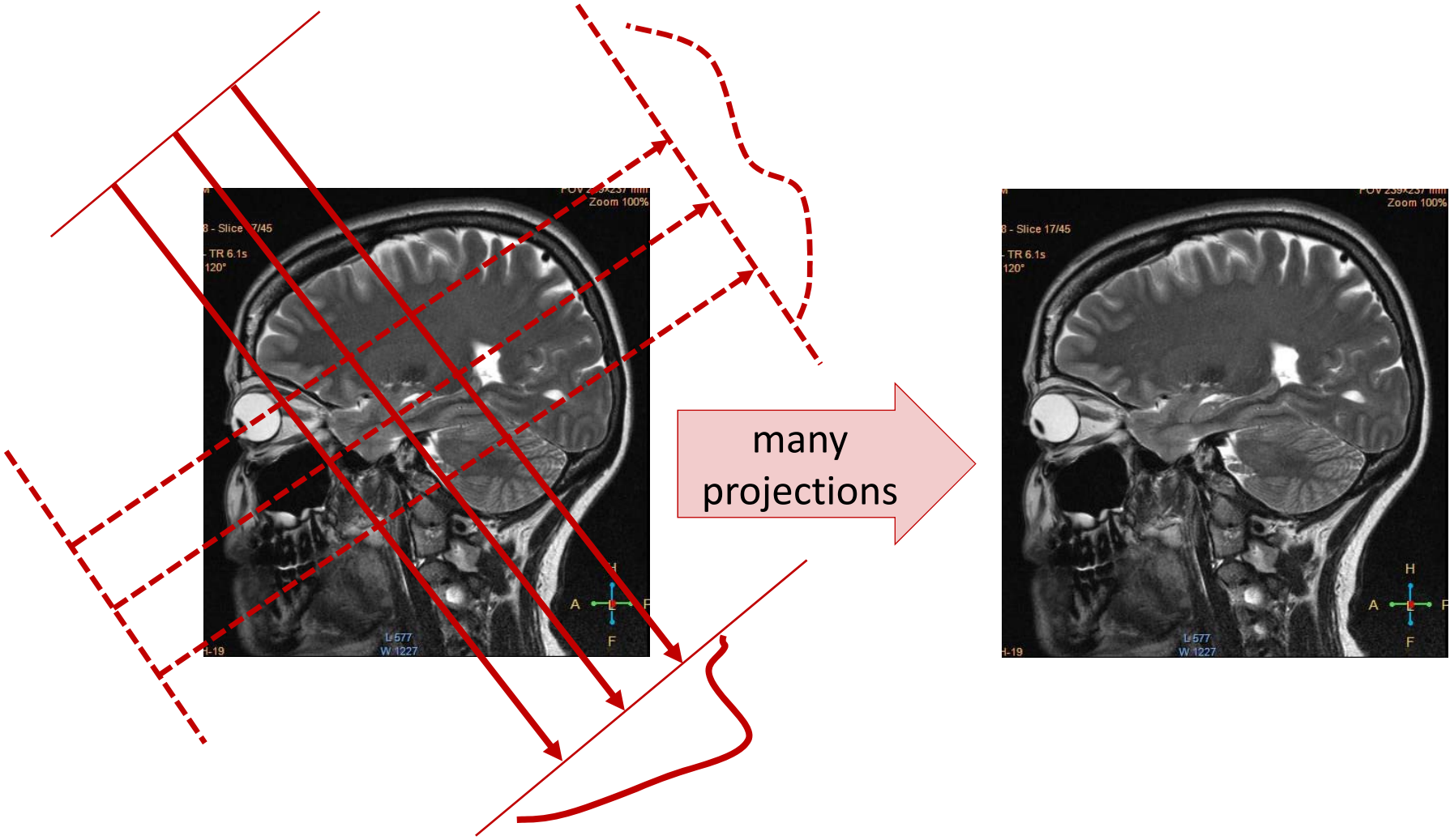


‘tomo’ – slice

‘graphy’ – to write

Assume it is not desirable to slice open my brain.
How does tomography ‘see’ inside?

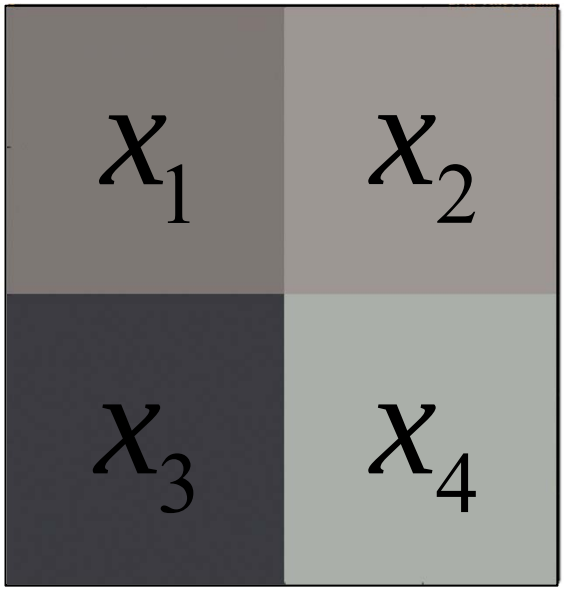
Tomography



What is a projection?

Sum of values along a line.

Example: Tomography



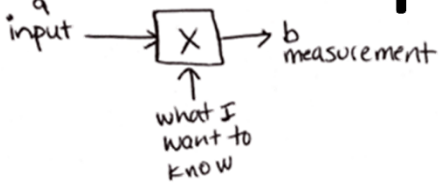
What do pixel values represent?

e.g. density, absorption, etc.

Can we solve for the pixel values from projections?

Yes, with tomography.

Example: Tomography



Trust Me that:

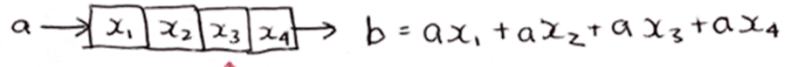
$b = ax$

Solve this:

$x = a^{-1}b$

Now I have 4 pixels:

Take a projection:



$b = ax_1 + ax_2 + ax_3 + ax_4$

Can I solve for x_i? No! Not with single measurement

1 equation, 4 unknowns = ☹

In this case: ①+② = ③+④

↳ ② = ③+④−① so ② is not new info! = REDUNDANT

So these 4 measurements are not sufficient... REDUNDANT

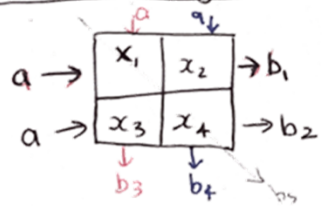
What different measurement can I take to help?

Diagonal.

$b_5 = ax_1 + ax_4$

Is it redundant? No.

Now square grid 4 pixels! (My Brain)



4 unknowns → need 4 measurements!

$ax_1 + ax_2 = b_1$ ①

$ax_3 + ax_4 = b_2$ ②

$ax_1 + ax_3 = b_3$ ③

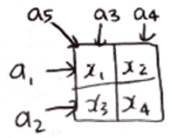
$ax_2 + ax_4 = b_4$ ④

Can I now solve for all x_i?
If yes, why/how? If no, why not?

No. 4 unknowns + 4 equations does not mean you can solve it! They need to be 'linearly independent' i.e. each provides new information!

eg. if I can derive one eqn. from other 3, it's not new info!

Now consider changing illumination:



Not all a's are equal now.

Can I solve it? Yes if I know what the a's are.

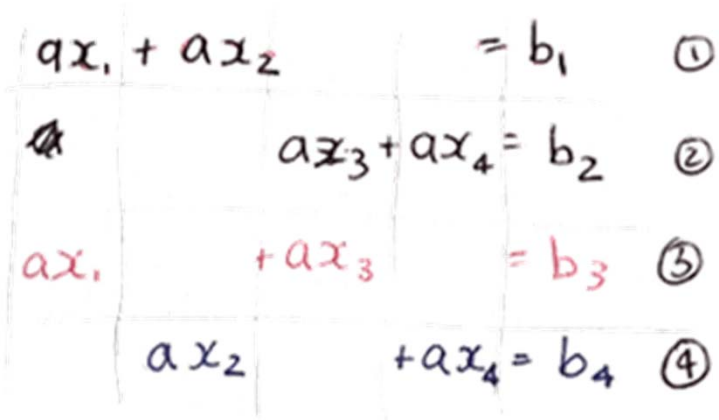
e.g. $b_1 = a_1x_1 + a_2x_2$

becomes $\left(\frac{b_1}{a_1}\right) = x_1 + x_2\left(\frac{a_2}{a_1}\right)$

All our measurements are *linear*

What does that mean?

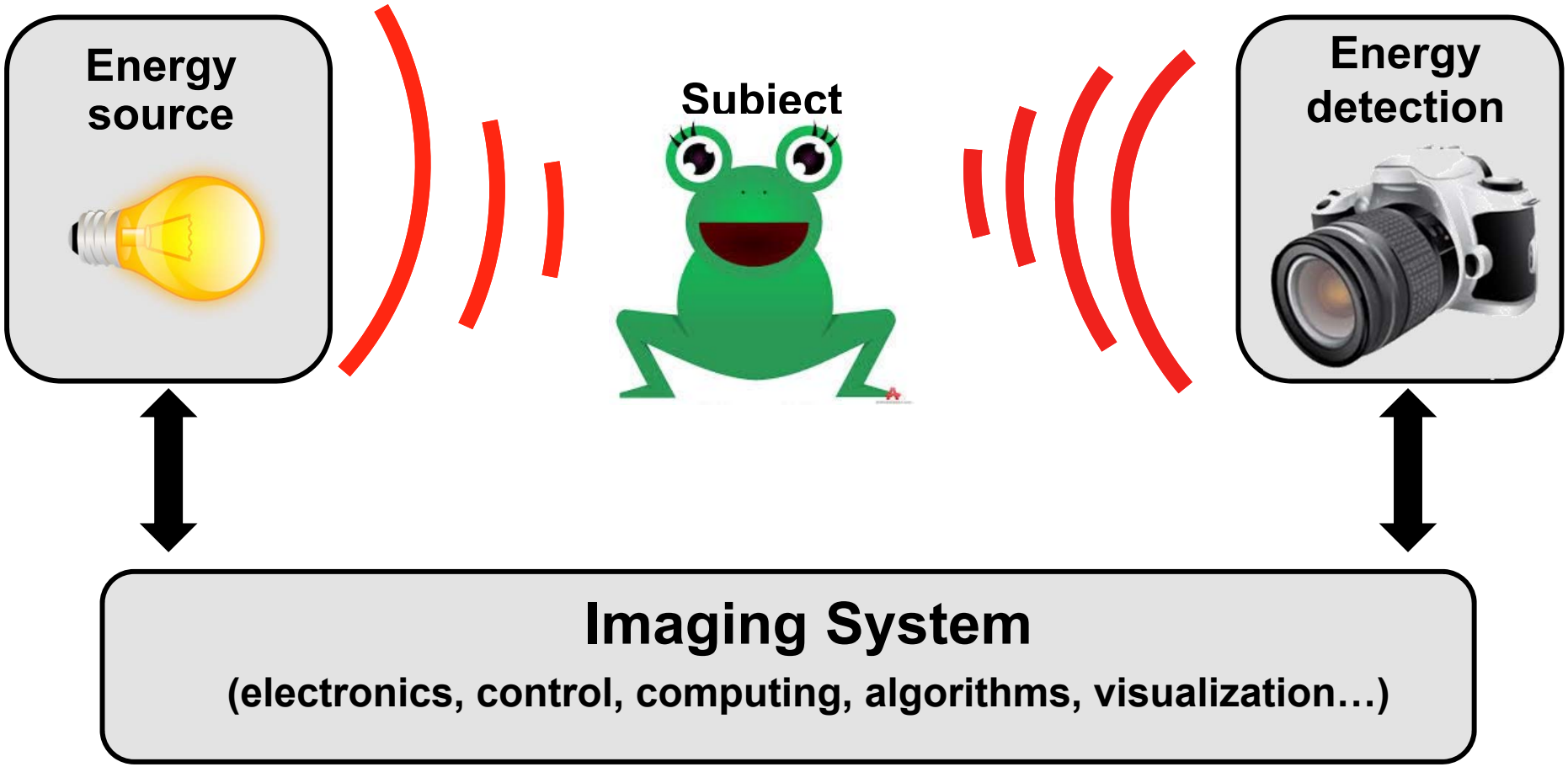
Each variable (x) is multiplied by a scalar (a) to contribute to the measurement



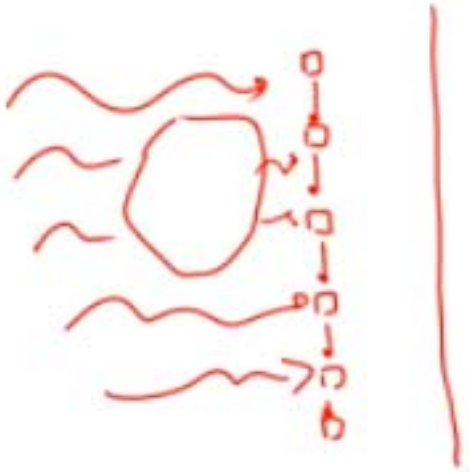
This is called a *system of linear equations*

***Linear Algebra* is what we need to solve it!**

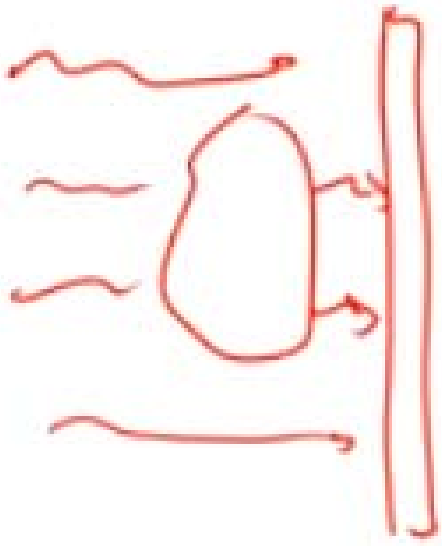
Imaging in general



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

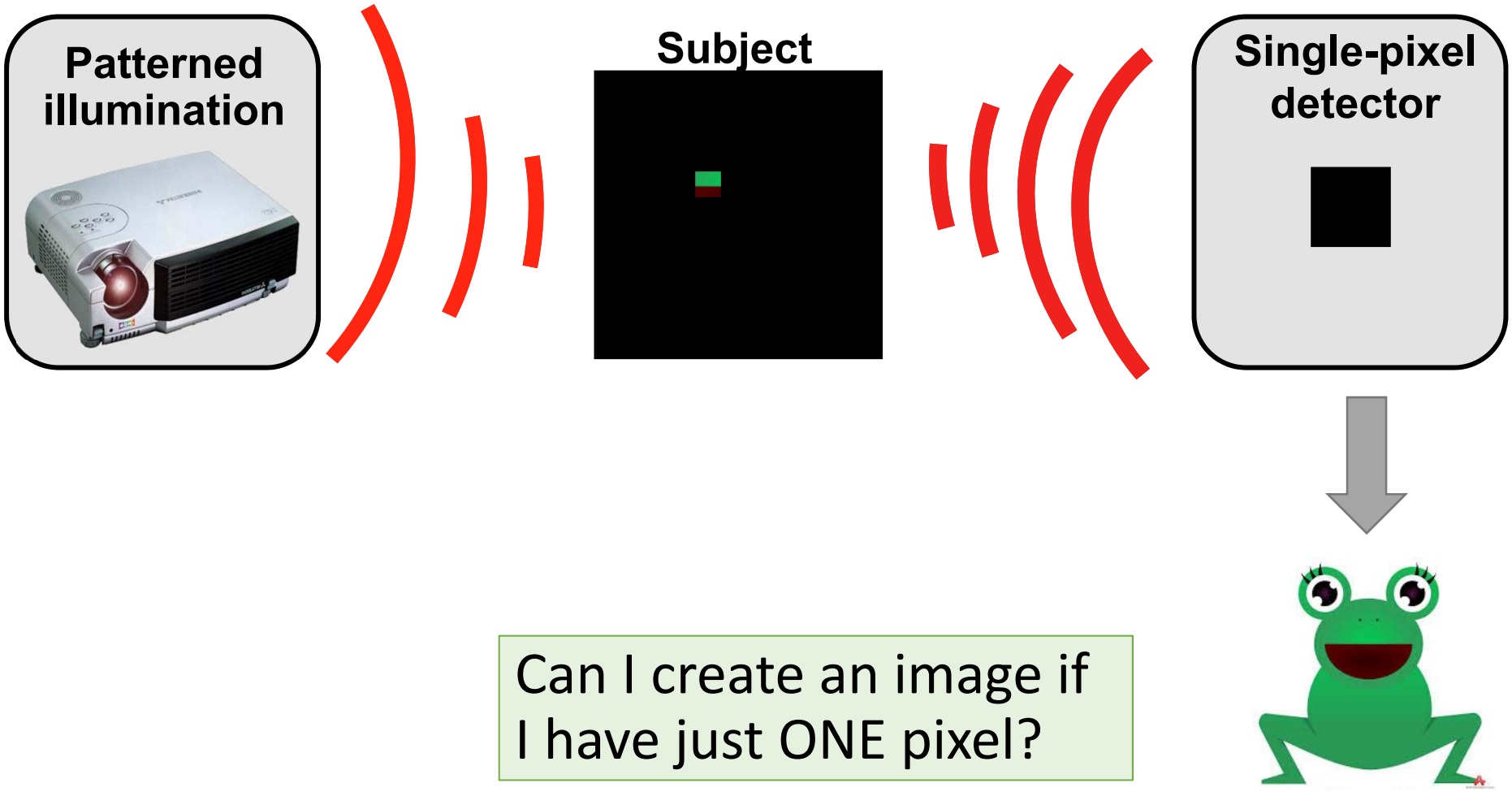


Example: flat illumination, one photosensor scans through pixels



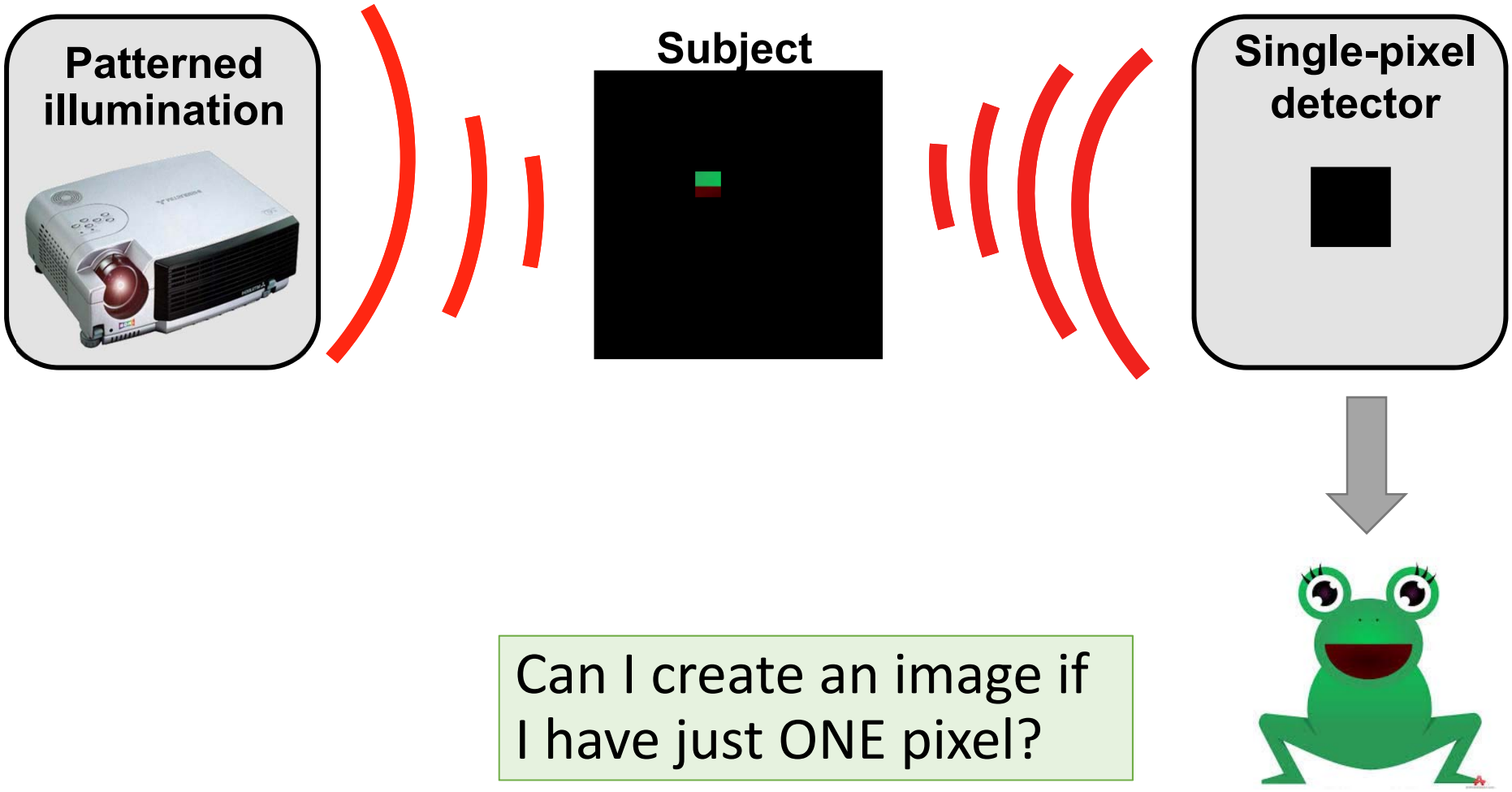
OR scan the illumination, use only one big pixel

Single-pixel camera



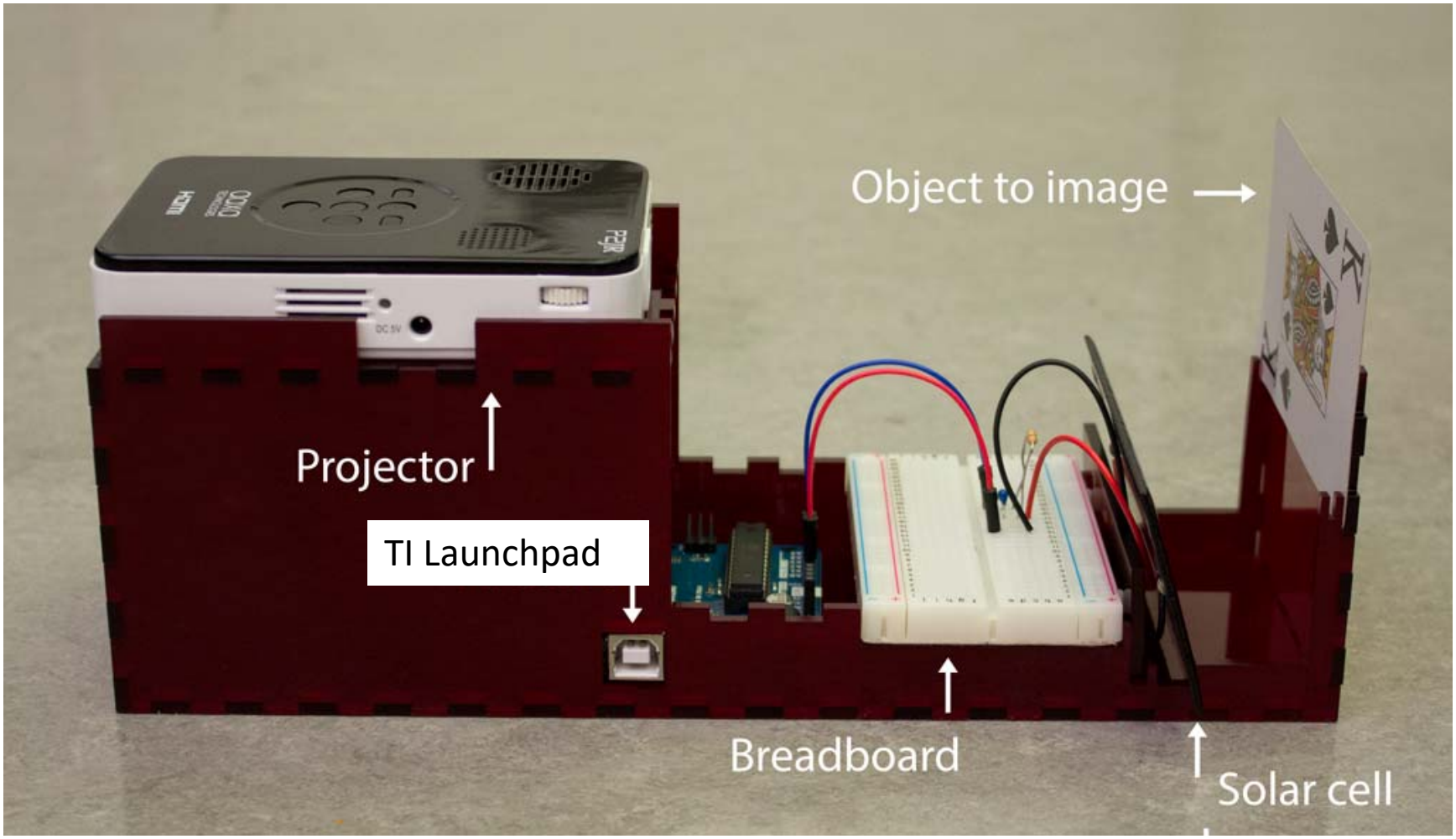
Can I create an image if I have just ONE pixel?

Single-pixel camera

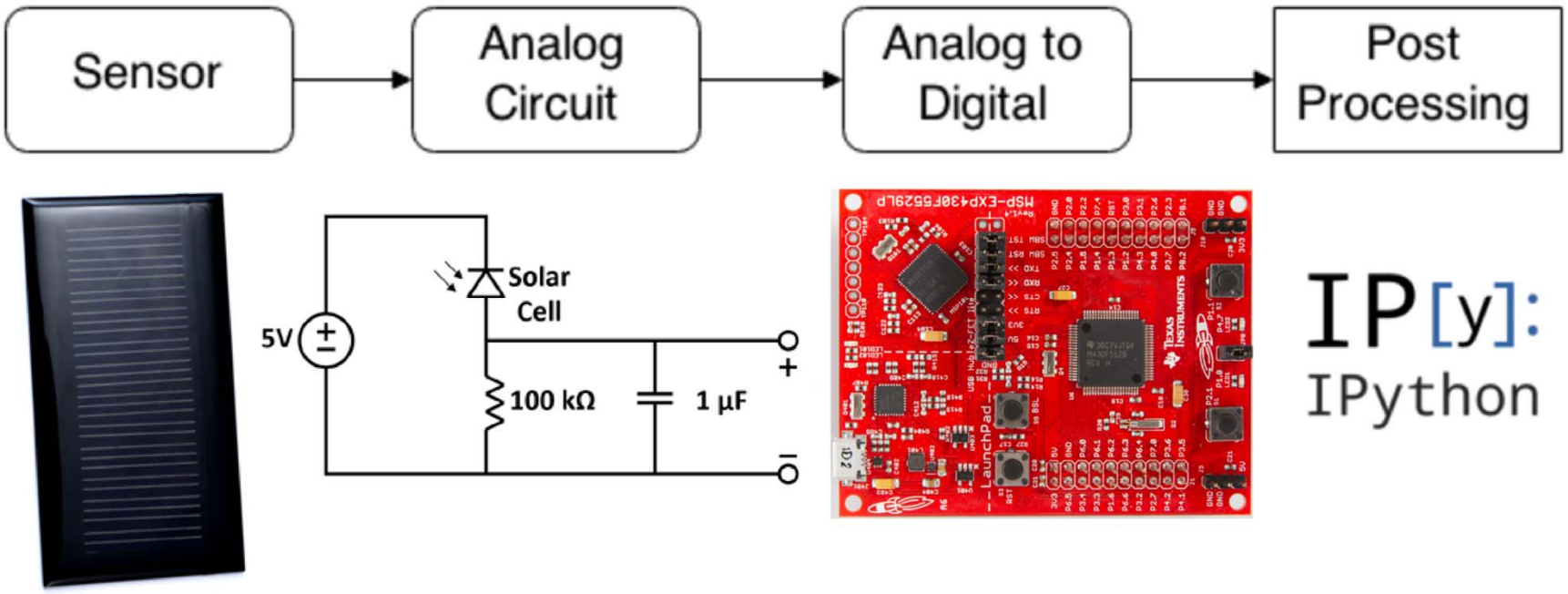


Can I create an image if I have just ONE pixel?

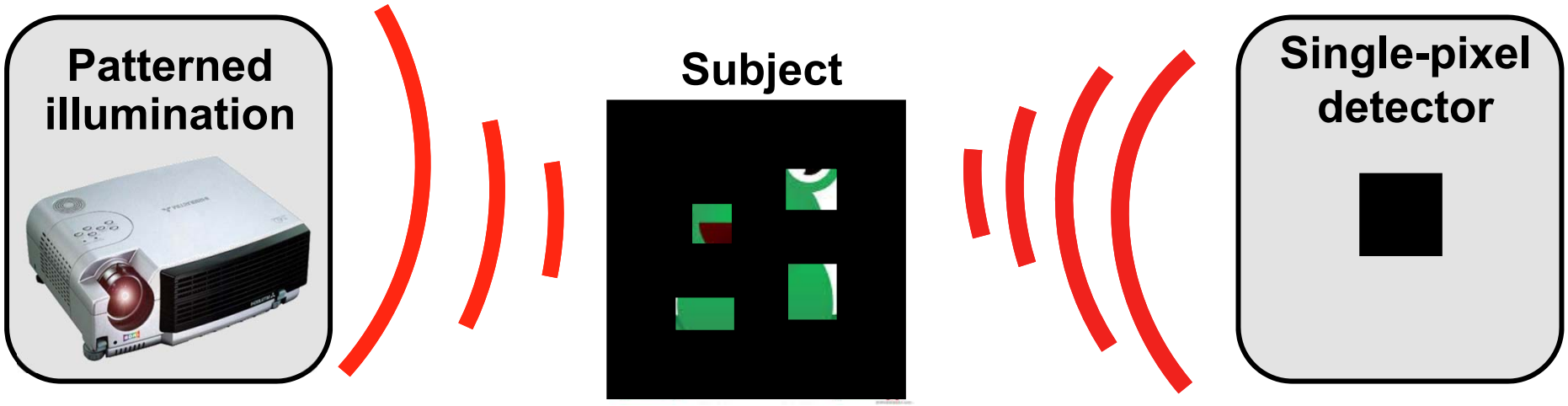
Imaging Lab #1 Setup



Imaging Lab #1



Single-pixel camera



What if I can't light up just one pixel at a time?

Can we recover the frog?

How many measurements do I need?

How should I choose illumination patterns?