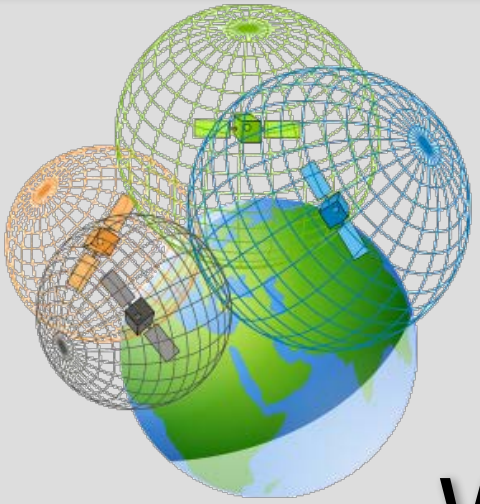


Welcome to EECS 16A!

Designing Information Devices and Systems I

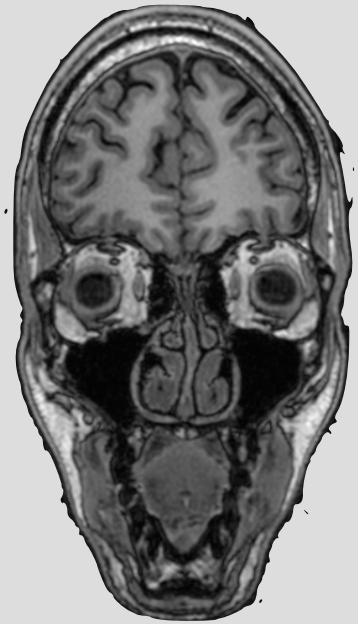
Ana Arias and Miki Lustig

Fall 2021

Instructors

Prof. Ana Claudia Arias
acarias@berkeley.edu

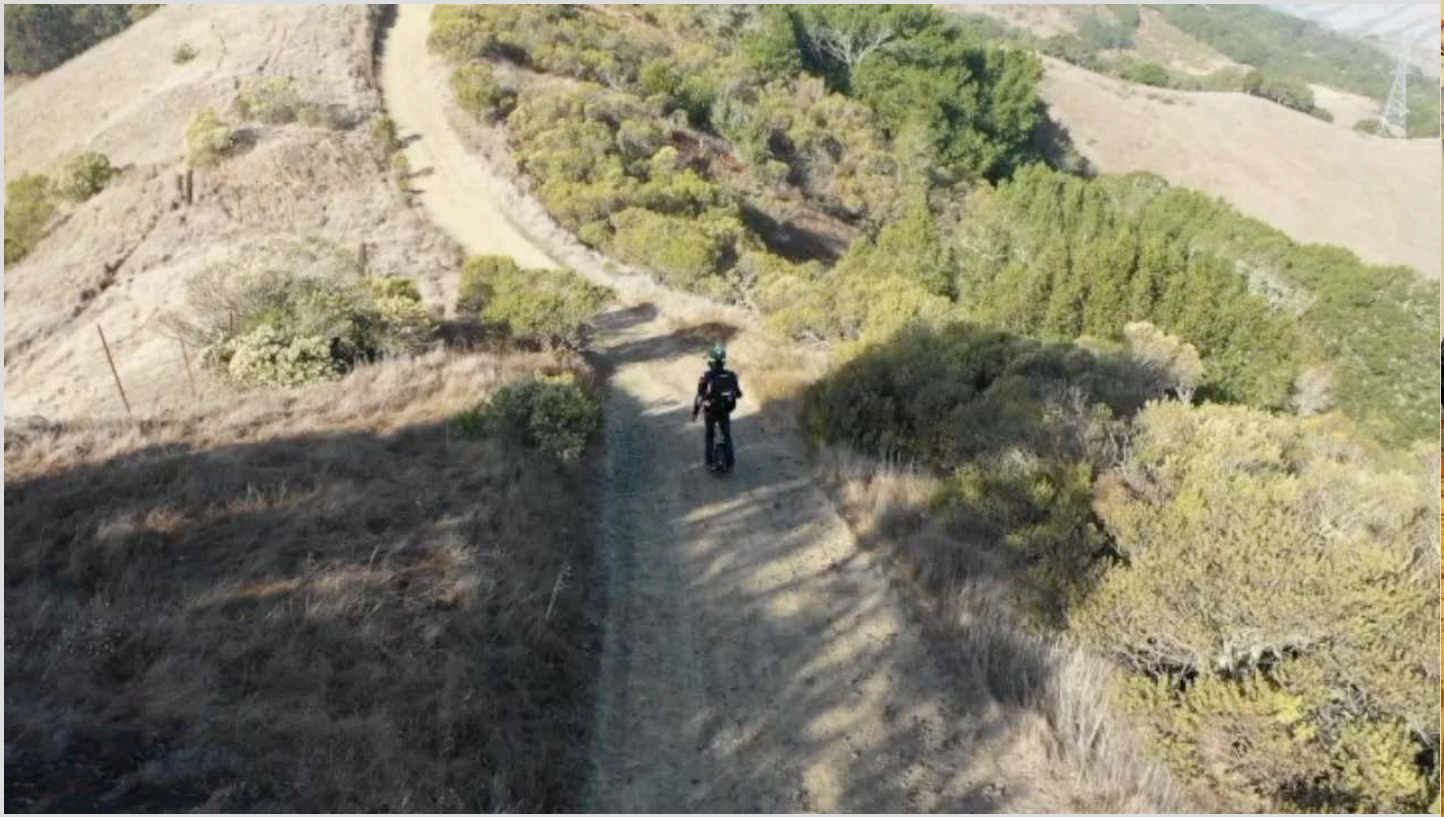
Prof. Miki Lustig
mikilustig@berkeley.edu



Office Hours: right after lecture, but at
https://berkeley.zoom.us/j/95519379606?pwd=UkYvYUxUbjlEYm9xRE5kOVE1aEtHZz09

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

Miki Pandemic Special



Ana Claudia Pandemic Special

Other Staff

Head GSIs:
eecs16a@Berkeley.edu
Email with:
Questions not for Piazza
Conflicts, accommodations for exams etc.
Emergencies
Administrative questions

Dahlia Saba

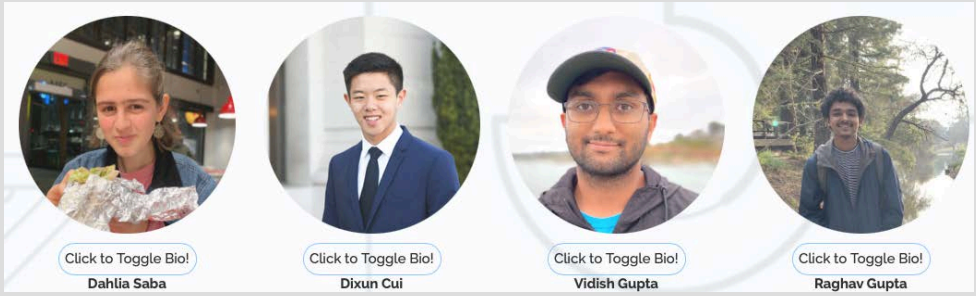
Dixun Cui

Course manager
Great resource for 1-1 concerns
Krystle@eecs.Berkeley.edu

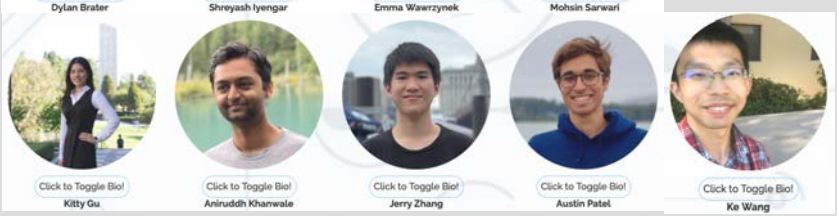
Krystle Simon

Teaching Assistants (TAs) Intro - We are here to help!

Head TA's **Lab Head TAs**



- 29 TAs, 51 ASEs!
  - Lots of different research areas and interests represented (by design)



EECS Pathway

- We are here to help!
- We want you to do well in class
  - Have 83 people committed to support you

- If you do well in class — you can get involved!
  - Become an ASE
    - Grade homeworks, assist in labs, tutor and help out in OH, work on improving the notes …
  - Become a uGSI
    - Lab / Discussion / content
  - Become head TA…

Course policies

- Our goal is learning!

- Syllabus is on the course website: https://eecs16a.org/
  - You are responsible for reading and following all course policies listed
  - Almost as long as the US tax code.
    - HW0 is your tax return

- Piazza: http://piazza.com/
  - a resource for you to help each other out

- Gradescope

- Exams via bCourses

Home work

- Due Fridays 11:59pm, on GradeScope
- We have a HW Party! W9-11am, F8-10am @Woz
- Office hours — almost every hour of the week

- You grade, we check!
  - Self-grading due Mon 11:59pm
  - Resubmissions due Mon 11:59pm
  - Resub, self-grading due Mon 11:59pm

- Graders verify your self-grading

Class Weekly Events

- Attend lecture — best way to keep along
- Attend discussions (MW)
  - “Free” participation points!
- Lab
  - Required!
  - Attend at your scheduled time!
  - Checkoff during your lab
- Office Hours
  - Faculty after class
  - GSI many
  - HW Party Friday 9-11am @Woz

Learning

- Collaborate and build community on Piazza/HW Party/Study Groups
- Encourage different perspectives – this is Berkeley!
- Everyone here is smart
  - Students have different backgrounds
  - Professors make mistakes – feedback helps
  - If you are struggling, ask for help!

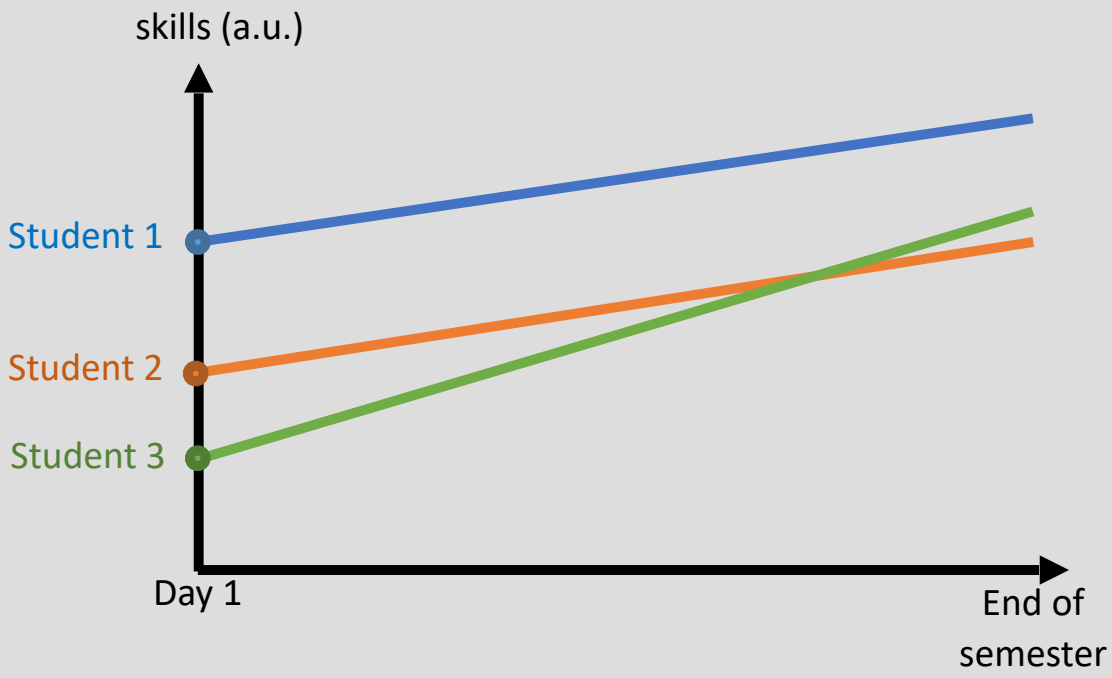
- Optional system to match you into study groups
  - Fill out info in HW0
  - Chance to meet new friends and study mates

study

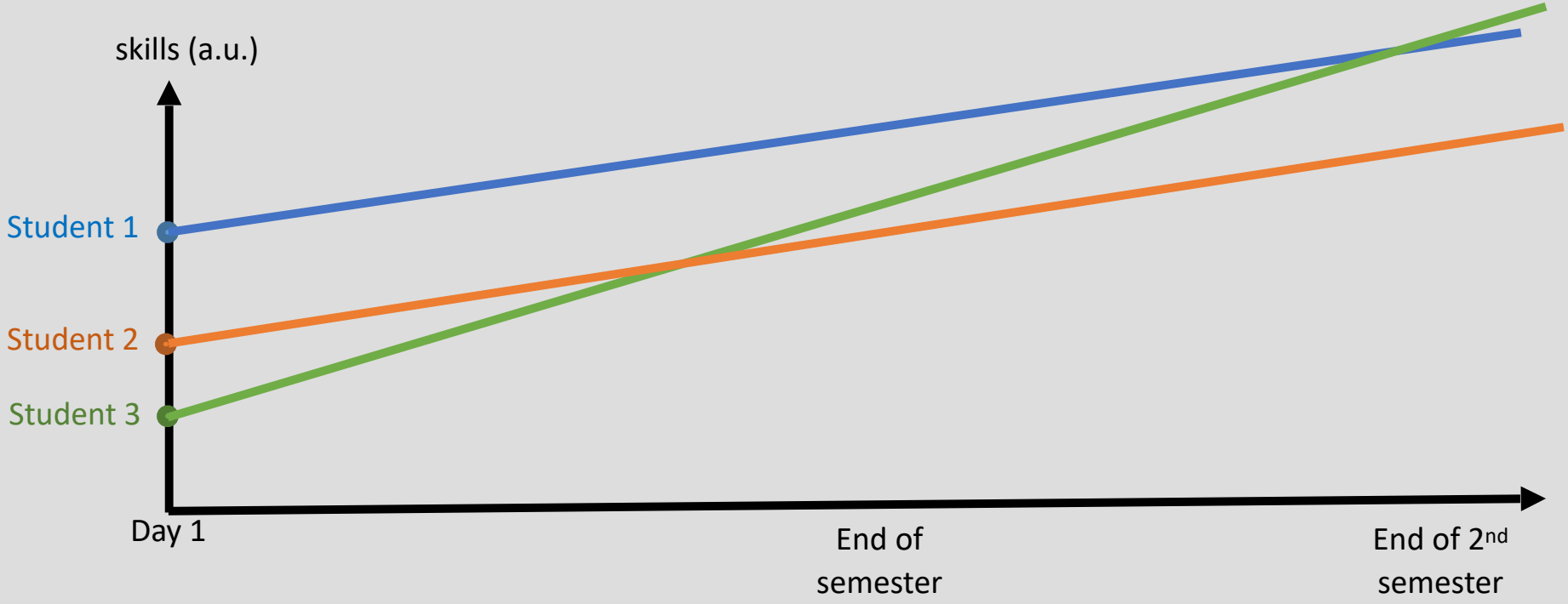
(verb)

The act of texting, eating and watching TV with an open textbook nearby.

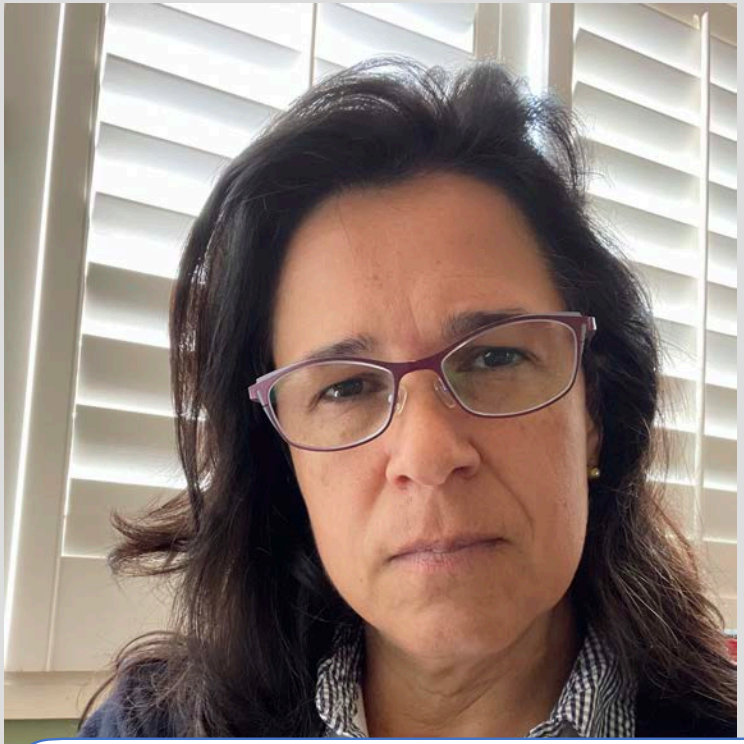
Slope is more important than intercept



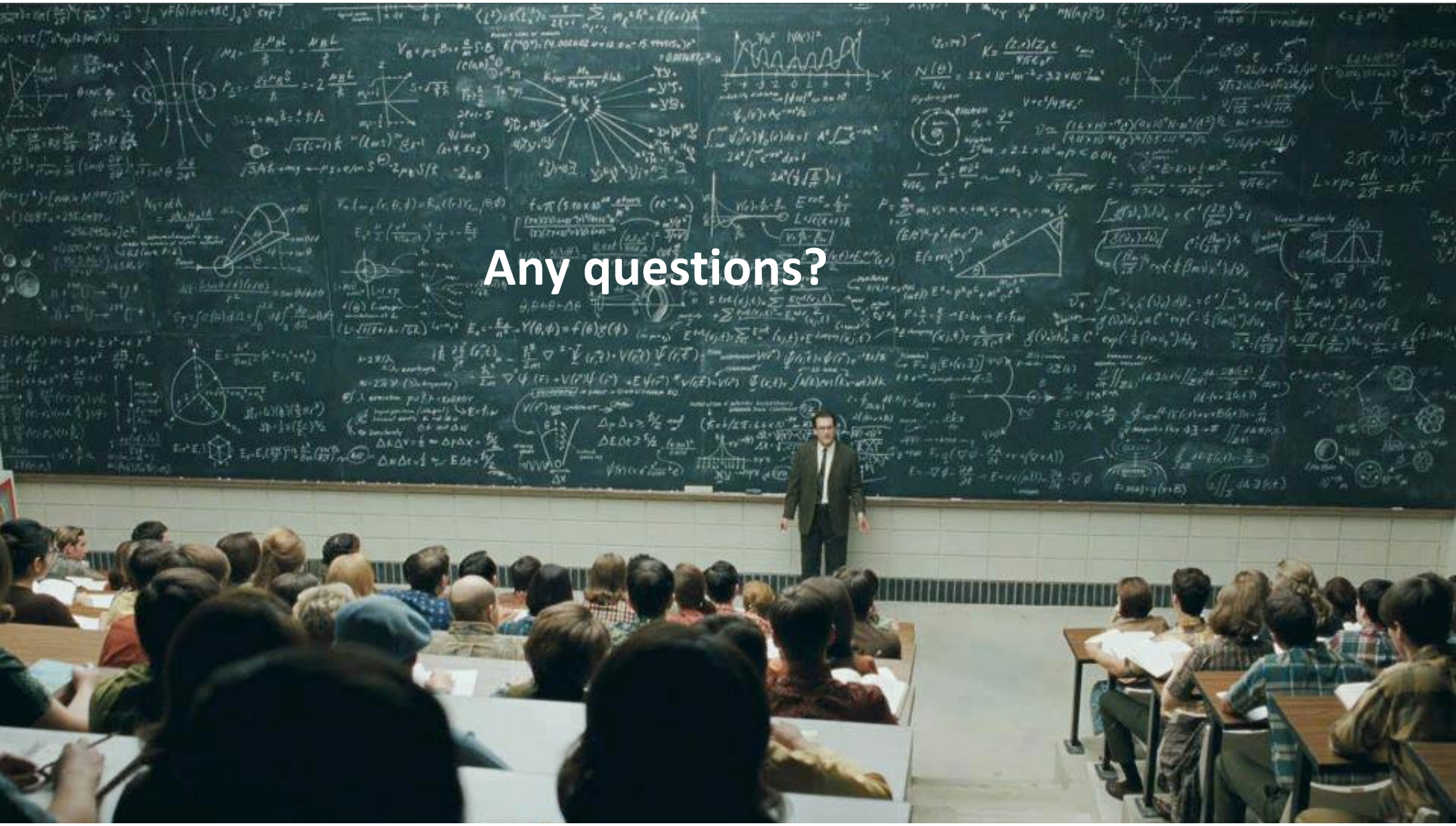
Slope is more important than intercept



Academic Honesty



We treat all our students with utmost trust and respect, and expect students to return the same trust and respect. In EECS16A we will have ***zero-tolerance*** for academic dishonesty. There will be ***dire consequences*** for students that violate that trust and the Berkeley code of conduct. Both professors Arias and Lustig are committed to enforcing academic honesty, and ***dishonesty cases will be punished in their fullest -- no excuses or special circumstances will be considered***. Always seek help, never cheat.


Any questions?


START

Some ideas taught in the class (1)

Some ideas taught in the class (1)

Eigen Values (and vectors)

Used in detection of touch in touch screens

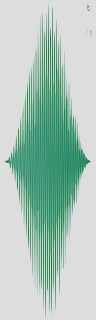
Used in control and Robotics — make autonomous cars run straight!

Used in Ranking of webpages (and other recommendation systems)

Controlling Eigen-Values make optimization problem converge faster (training Deep Neural Nets for example)

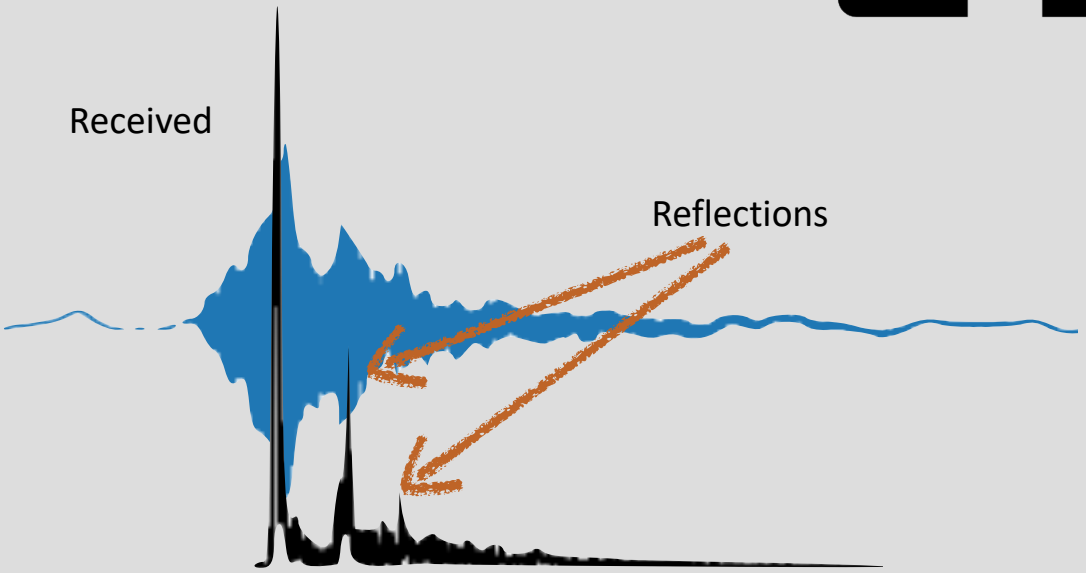
Some ideas taught in the class (2)

Sent

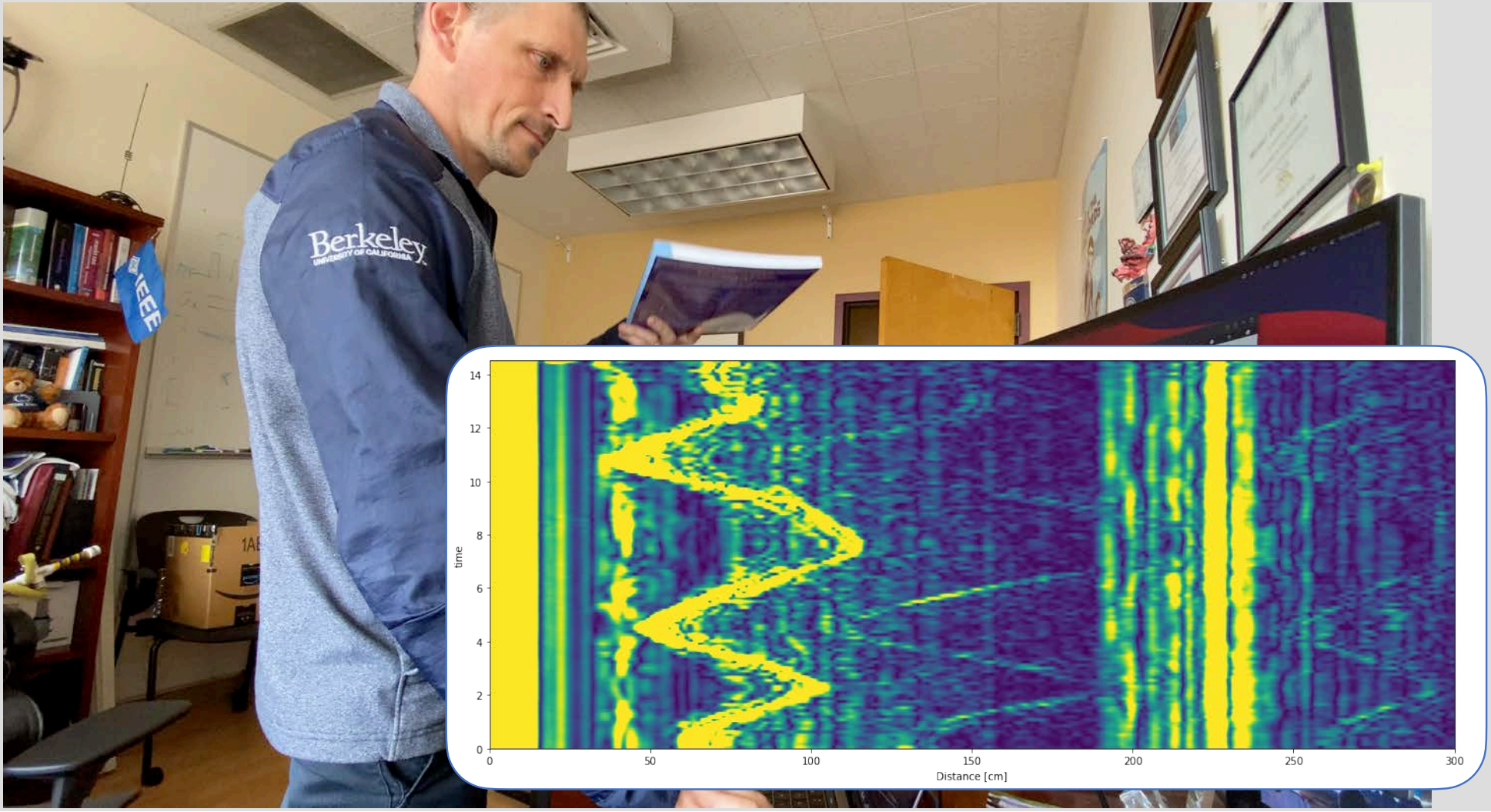


Received

Reflections



Some ideas taught in the class (2)



Cross Correlation

Fundamental operation for detection / classification

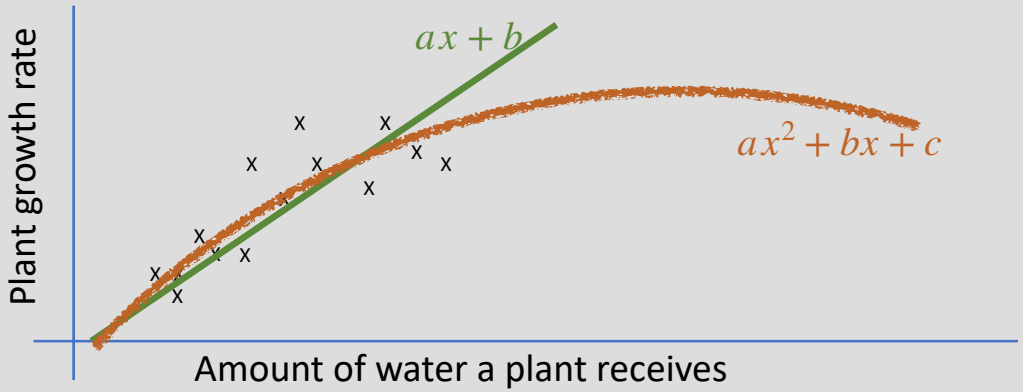
Used in Radar / Sonar

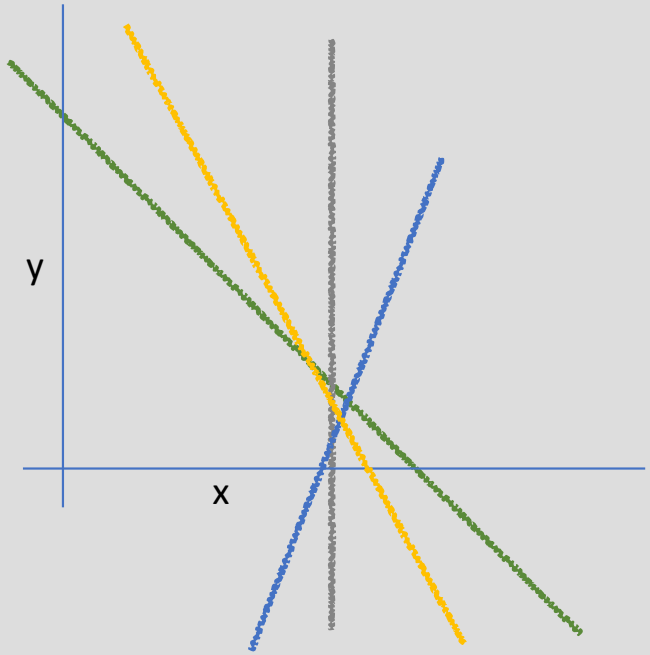
Used in GPS

Used for cellphone communication

Used in Convolutional Neural Networks

Some ideas taught in the class (3)





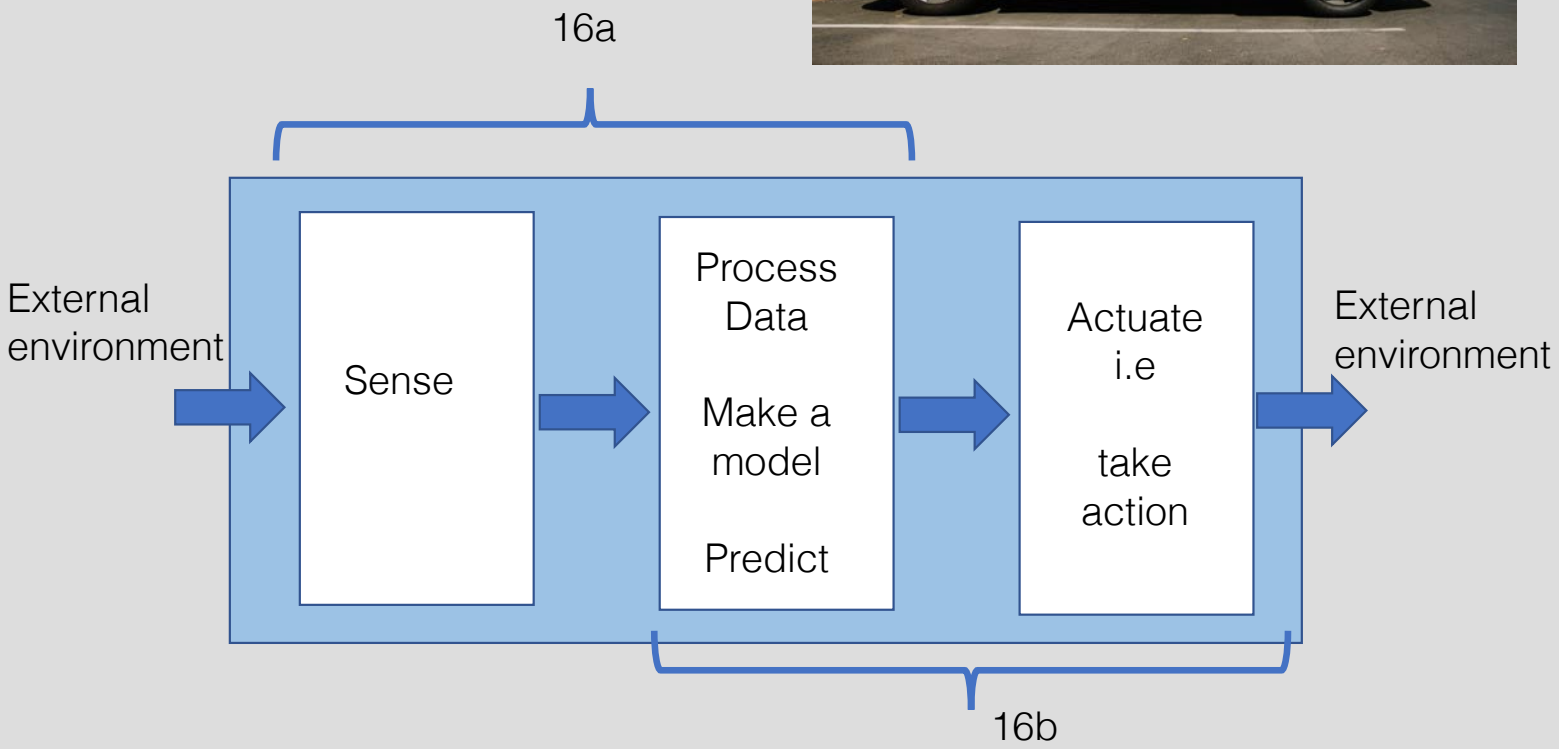
Least Squares

Fundamental approach for solving inconsistent sets of linear equations (due to noise and disturbances…)

Used for regression and prediction

Applications in Biology, Social sciences, brain-machine interface, AI

Example application: self-driving cars

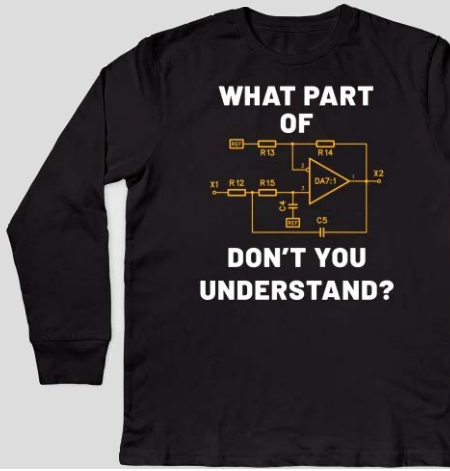


Learning Goals

Not a survey class — rigorous and deep

EECS 16A

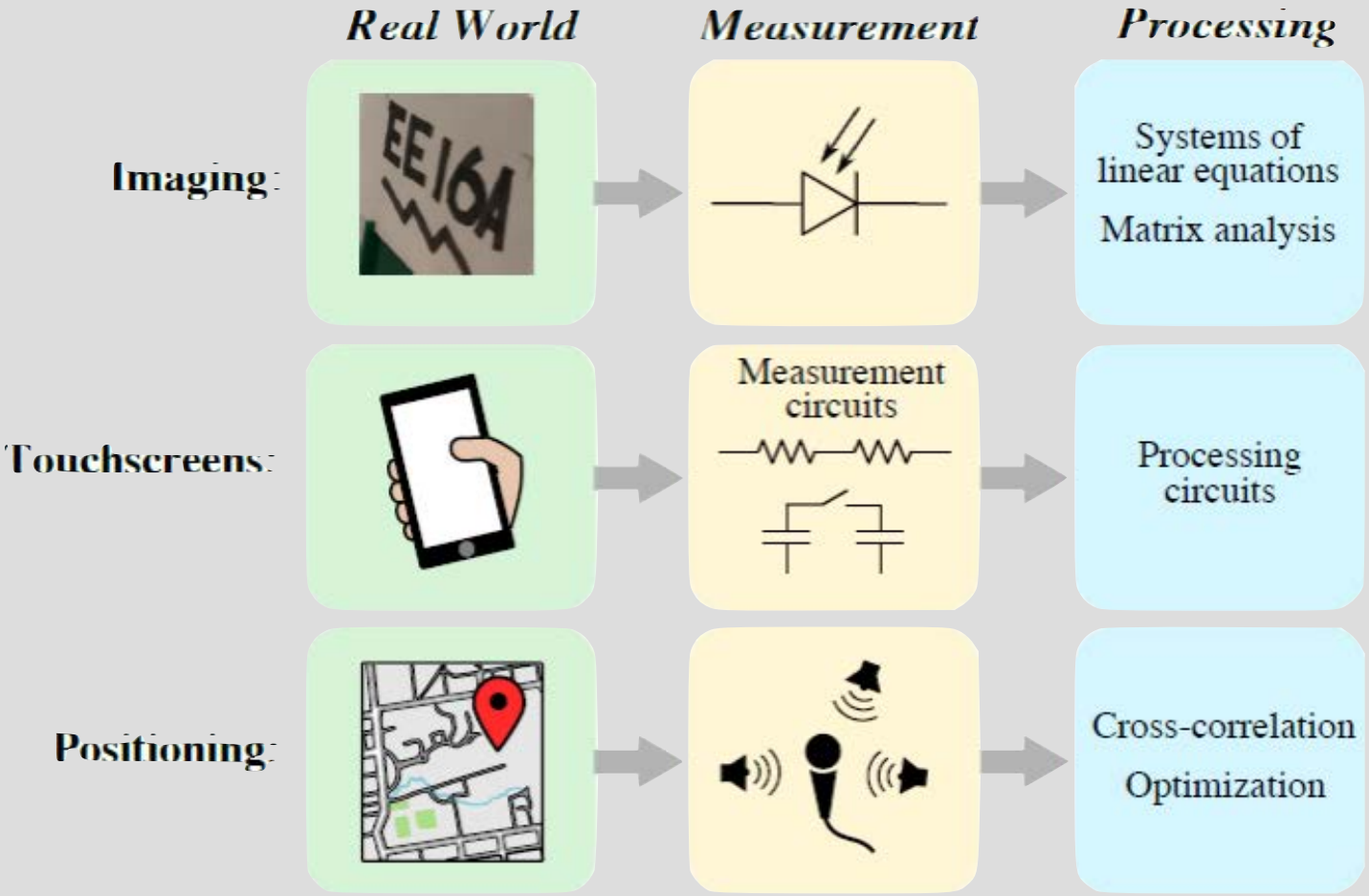
- Module 1: Introduction to systems
  - How do we collect data? build a model?
- Module 2: Introduction to circuits and design
  - How do we use a model to solve a problem
- Module 3: Introduction Signal Processing and Machine Learning
  - How do we “learn” models from data, and make predictions?

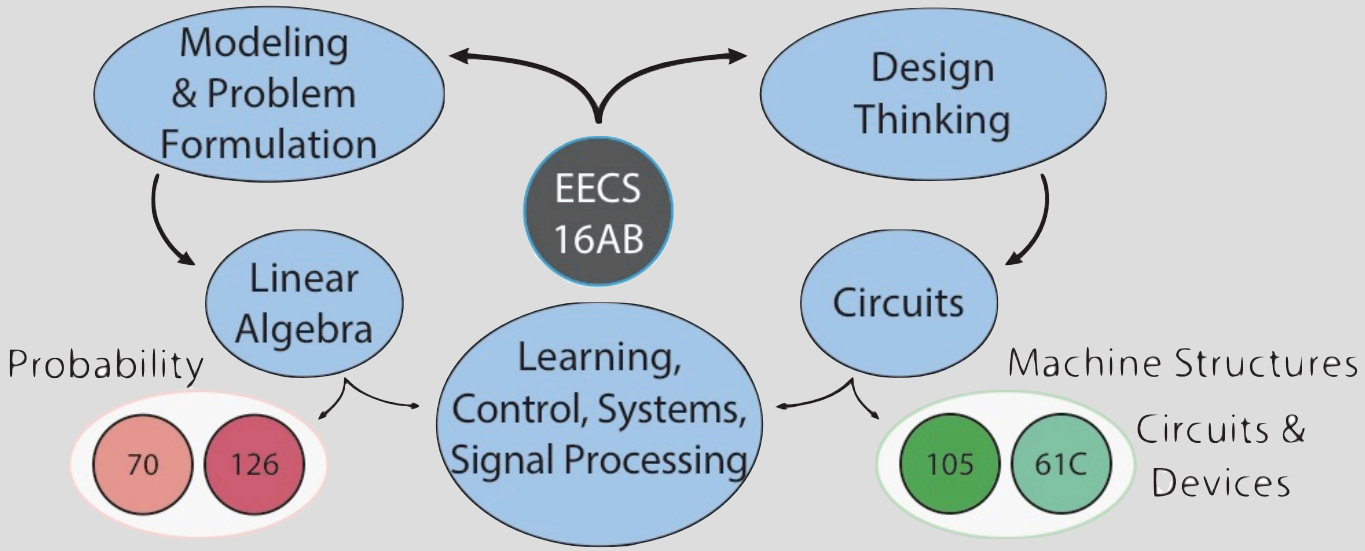


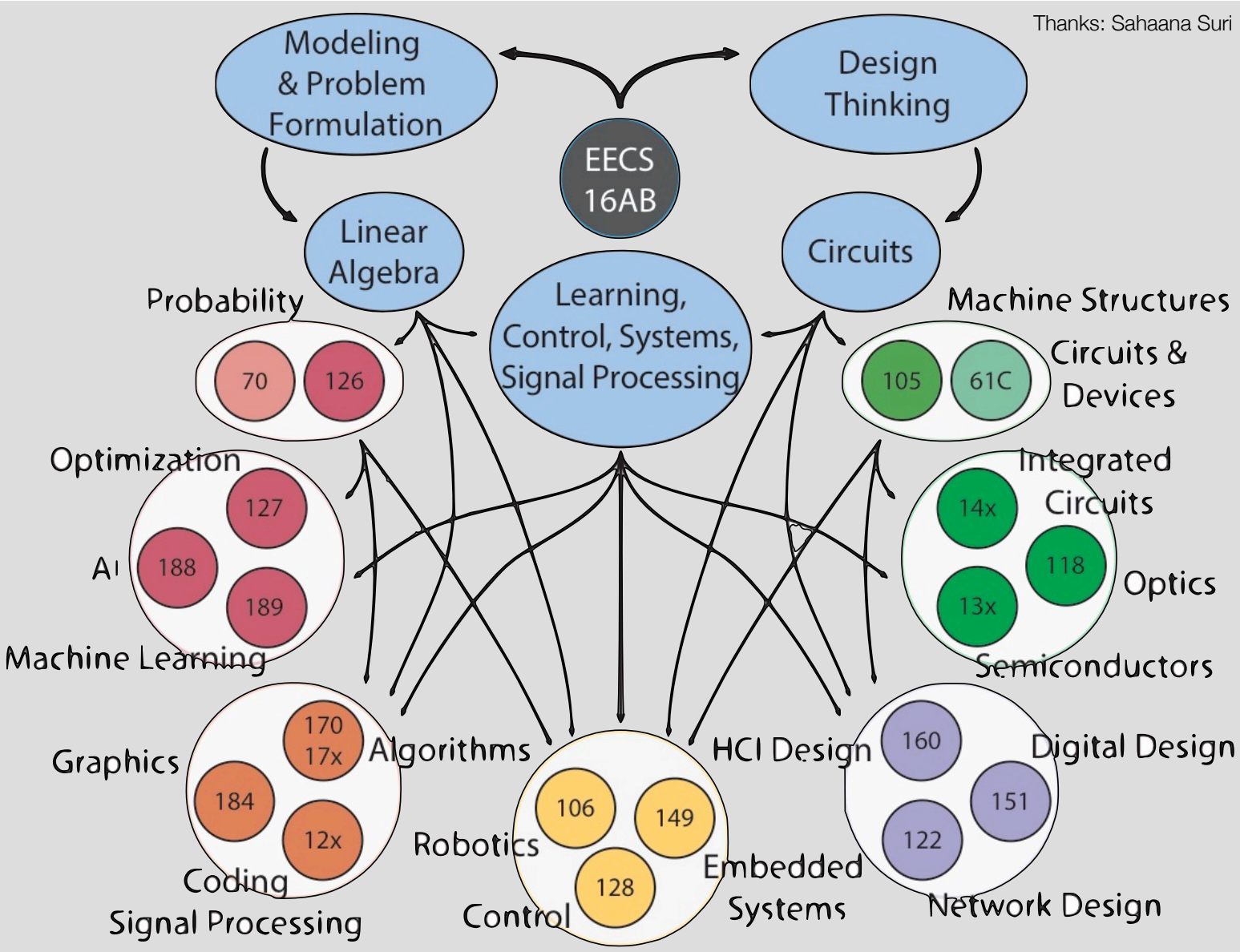
EECS 16B

- Module 4: Advanced circuit design / analysis
- Module 5: Introduction to control and robotics
- Module 6: Introduction to data analysis and signal processing

16A Lab Examples




Modeling & Problem Formulation
Design Thinking
EECS 16AB
Linear Algebra
Circuits
Probability
Learning, Control, Systems, Signal Processing
Machine Structures
70
126
105
61C
Circuits & Devices


Thanks: Sahaana Suri
Modeling & Problem Formulation
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EECS 16AB
Linear Algebra
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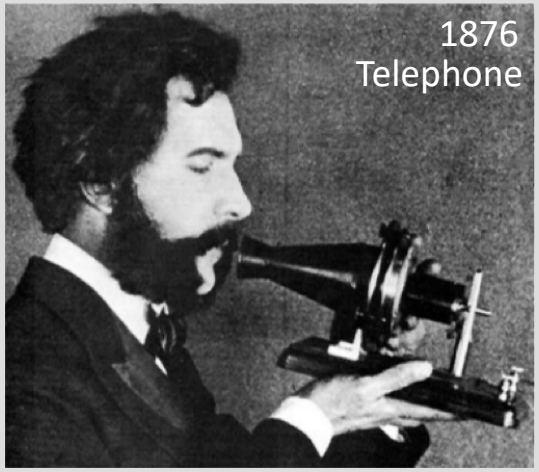
70
126
Machine Structures
105
61C
Circuits & Devices
Optimization
127
AI
188
189
Machine Learning
Integrated Circuits
14x
118
13x
Optics
Semiconductors
Graphics
170
17x
184
12x
Coding
Signal Processing
Algorithms
106
149
128
Robotics
Control
HCI Design
160
151
122
Embedded Systems
Digital Design
Network Design

How did we get from this…



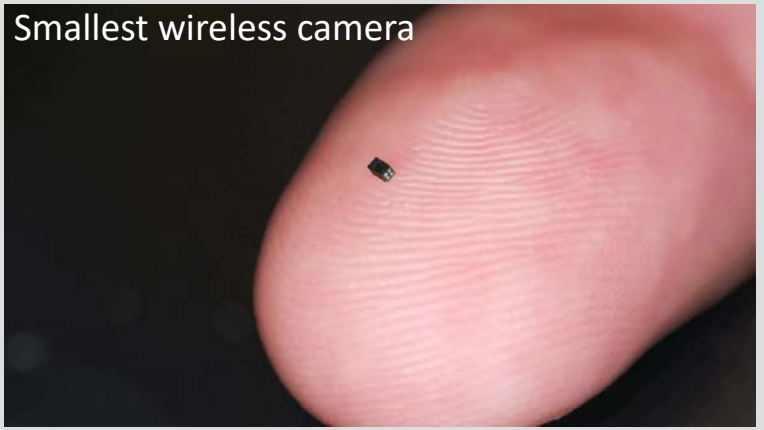
Flight of the Conchords S01E03 (HBO)

To this…

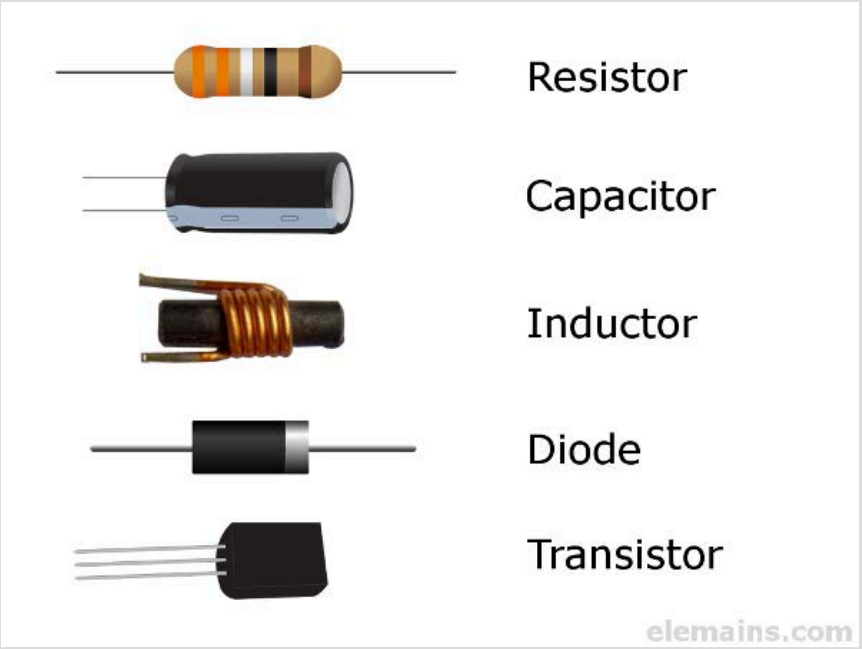

Drone delivery

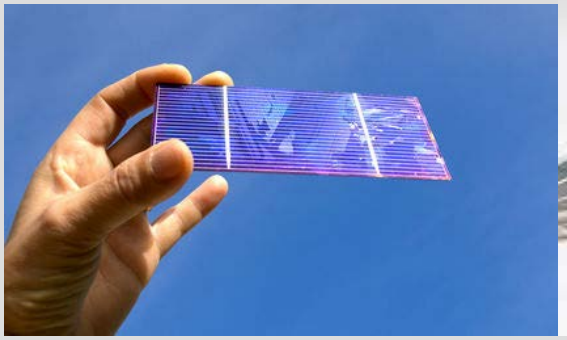
Autonomous cars

A 1000 student class on a computer screen

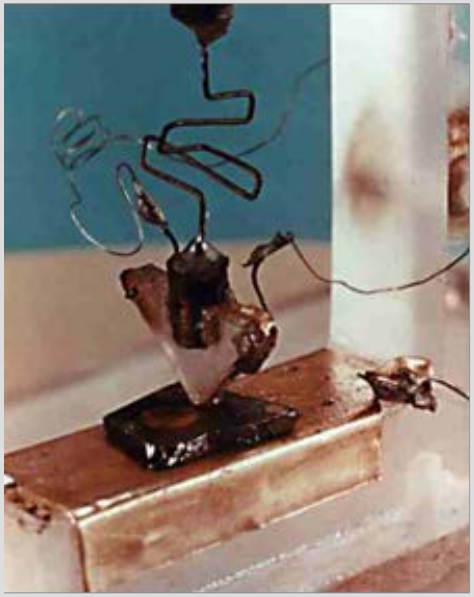

Smallest wireless camera

Devices as part of a system

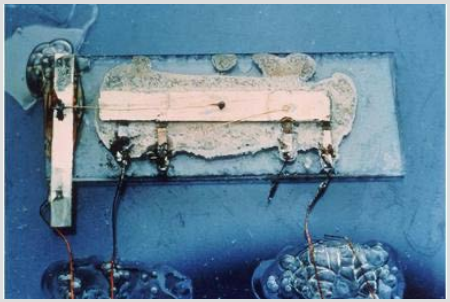




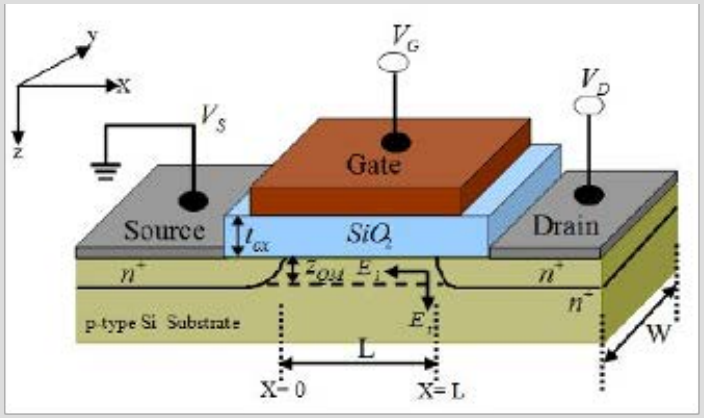
Transistor

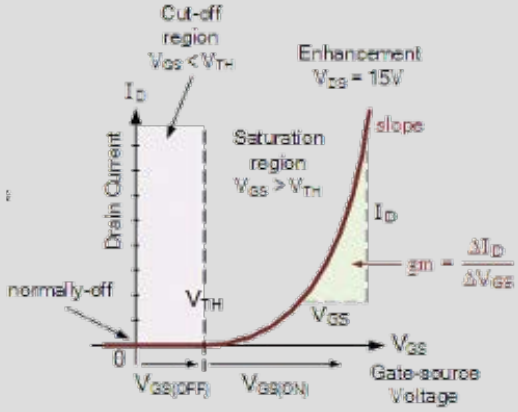


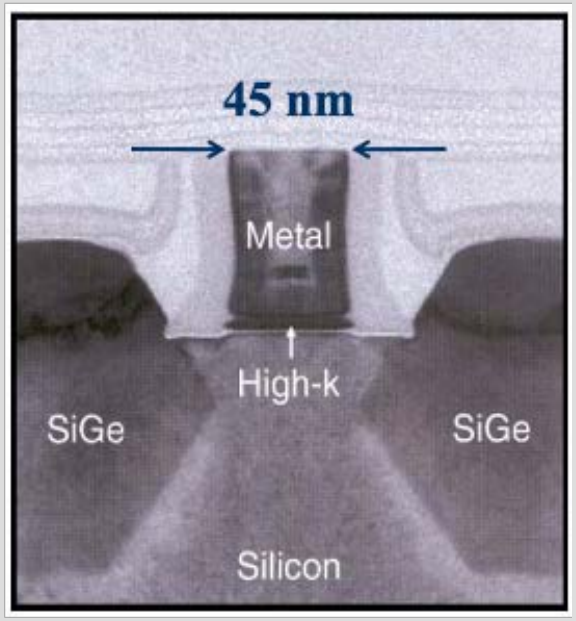
First transistor – Dec 1947



First integrated circuit 1958







Computational advances due to fabrication advances

Moore's law is the observation that the number of [transistors in a dense integrated circuit doubles approximately every two years.]

Gordon Moore

Intel Cofounder

B.S. Cal 1950!

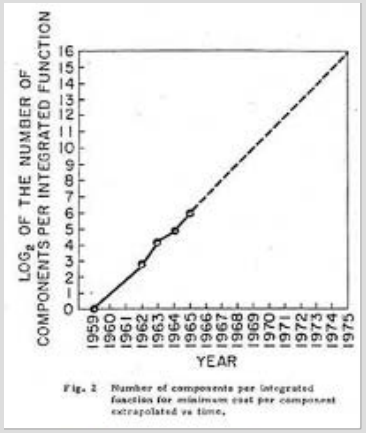
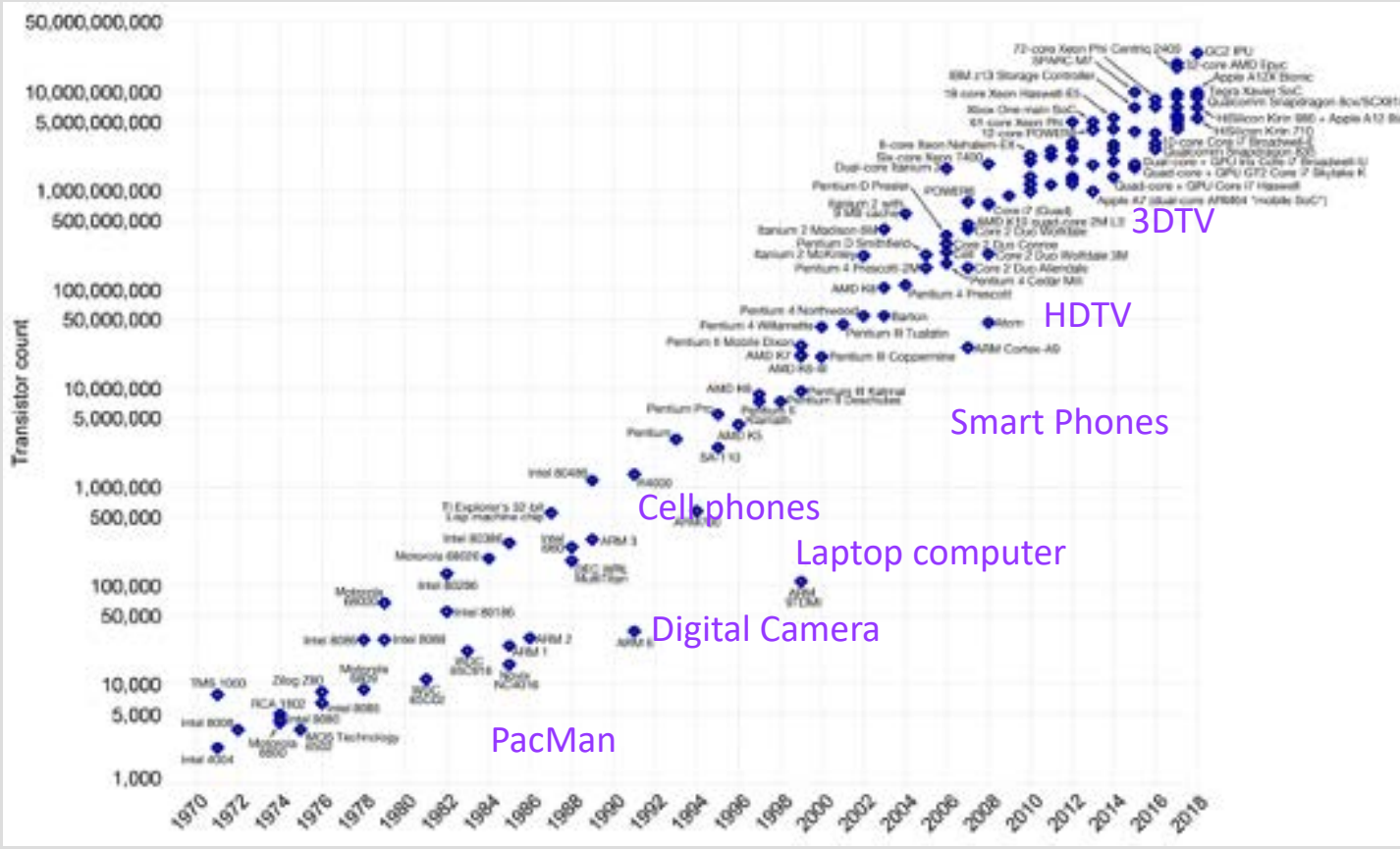
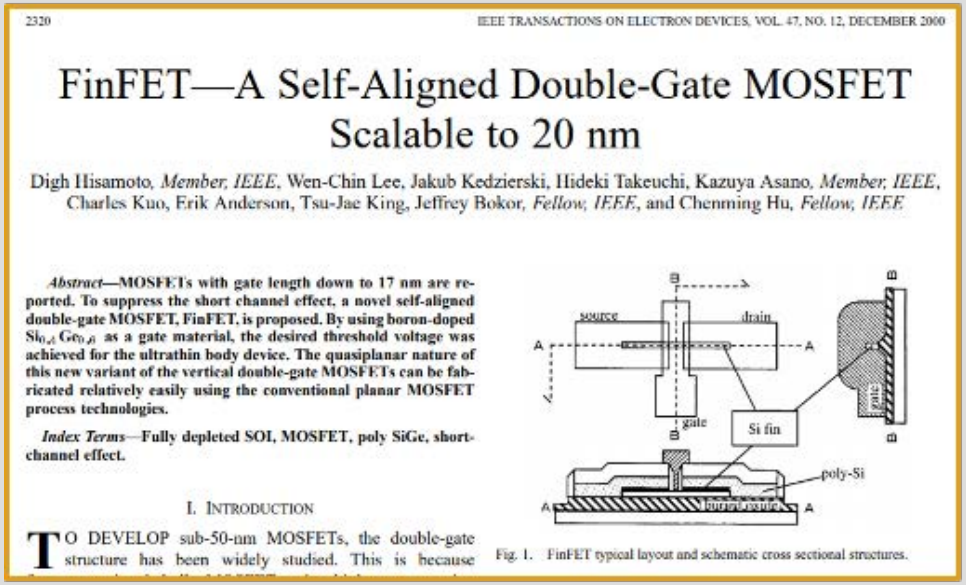


Fig. 2 Number of components per integrated function for minimum cost per component extrapolated vs time.

Electronics Magazine, 1965



FinFET



2320 IEEE TRANSACTIONS ON ELECTRON DEVICES, VOL. 47, NO. 12, DECEMBER 2000

FinFET—A Self-Aligned Double-Gate MOSFET Scalable to 20 nm

Digh Hisamoto, *Member, IEEE*, Wen-Chin Lee, Jakub Kedzierski, Hideki Takeuchi, Kazuya Asano, *Member, IEEE*, Charles Kuo, Erik Anderson, Tsu-Jae King, Jeffrey Bokor, *Fellow, IEEE*, and Chenming Hu, *Fellow, IEEE*

***Abstract*—MOSFETs with gate length down to 17 nm are reported. To suppress the short channel effect, a novel self-aligned double-gate MOSFET, FinFET, is proposed. By using boron-doped $Si_{0.4}Ge_{0.6}$ as a gate material, the desired threshold voltage was achieved for the ultrathin body device. The quasiplanar nature of this new variant of the vertical double-gate MOSFETs can be fabricated relatively easily using the conventional planar MOSFET process technologies.**

***Index Terms*—Fully depleted SOI, MOSFET, poly SiGe, short-channel effect.**

I. Introduction

TO DEVELOP sub-50-nm MOSFETs, the double-gate structure has been widely studied. This is because

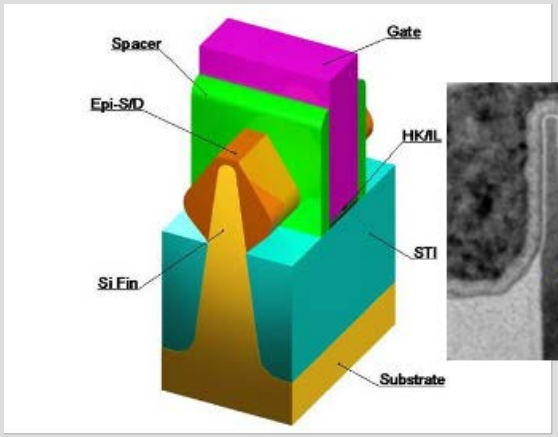
Fig. 1. FinFET typical layout and schematic cross sectional structures.

Prof. Tsu-Jae King Liu

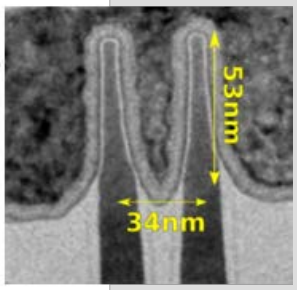
Prof. Jeff Bokor

Prof. Chenming Hu (left)

Go Bears!

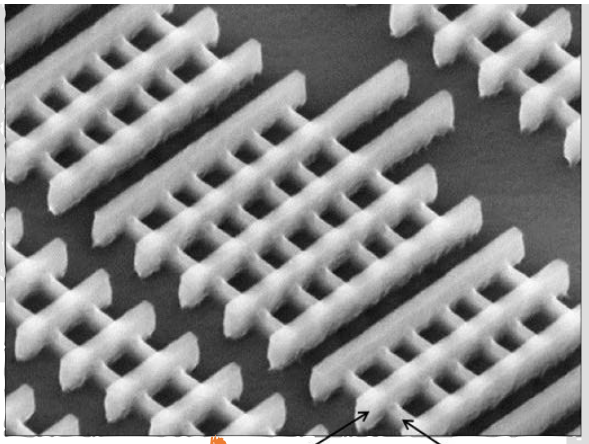


source: Chinese Academy of Microelectronics



source: Intel

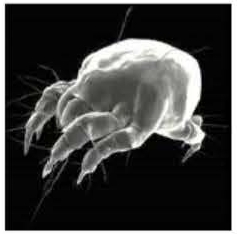
Sense of Scale



Miki 172cm

Ana 158cm

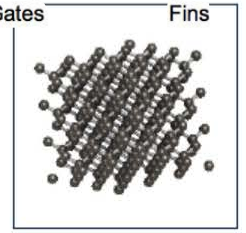
Fly 7 mm



Mite 300 um

Blood Cell 7 um

Virus 100 nm



Silicon Atom 0.24 nm

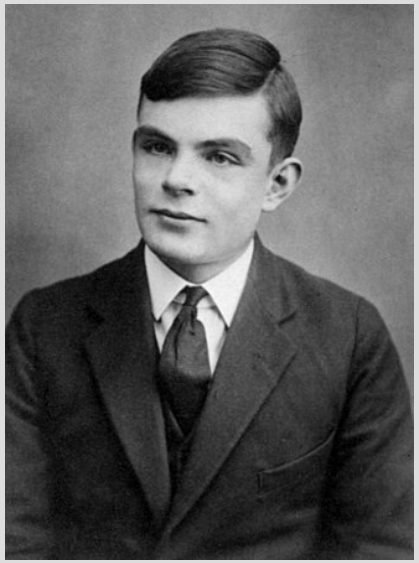
10 1 100 10 1 100 10 1 100 10 1 0.1

meter | millimeter | micrometer | nanometer

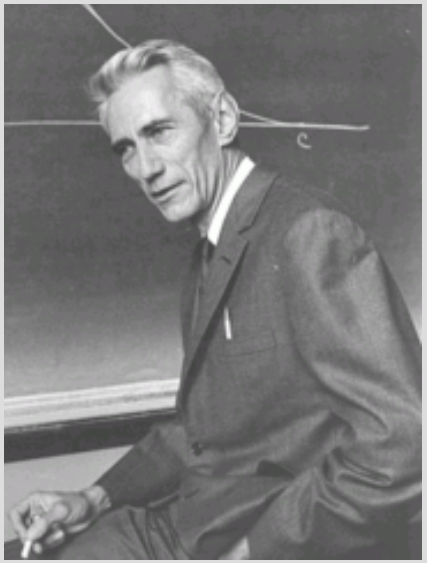
Source: Mark Bohr, IDF14

Completing the puzzle …

Ada Lovelace
wrote the first computer program

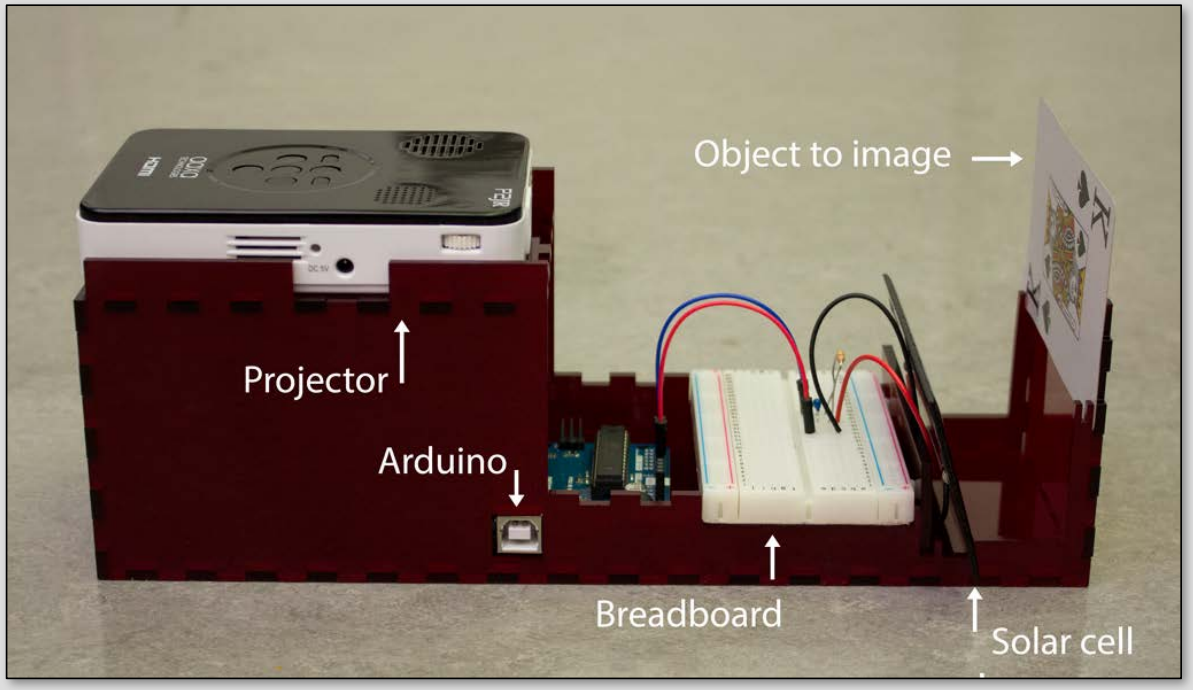


Alan Turing
figured out how to build a computer to execute programs



Claude Shannon
Information theorist

Module 1: Imaging



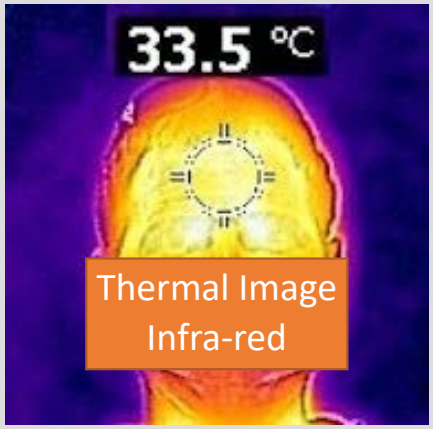
Image

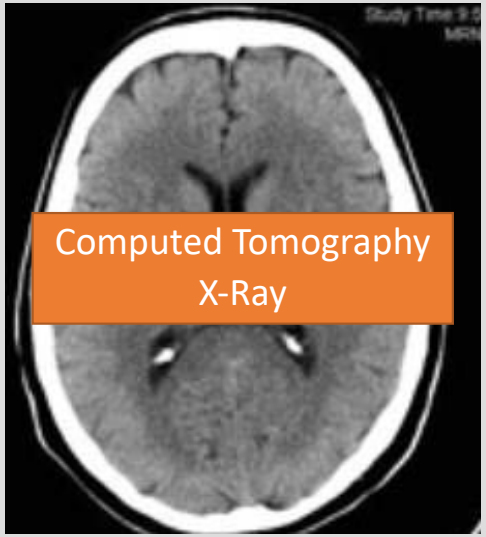
Merriam-Webster: A visual representation of something

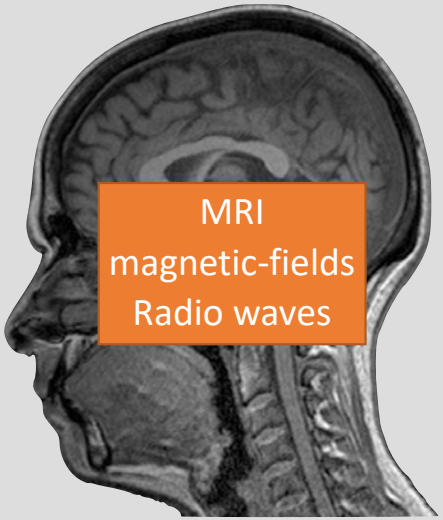
Imaging

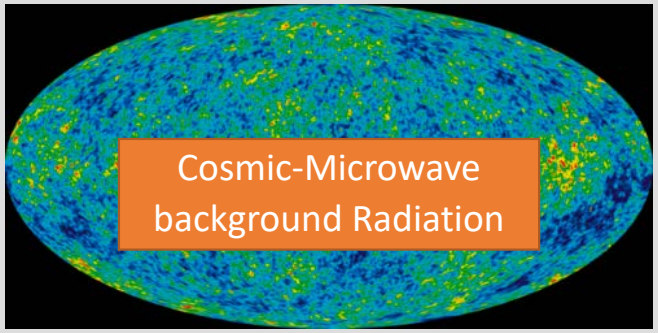
Merriam-Webster: the action or the process of producing an image

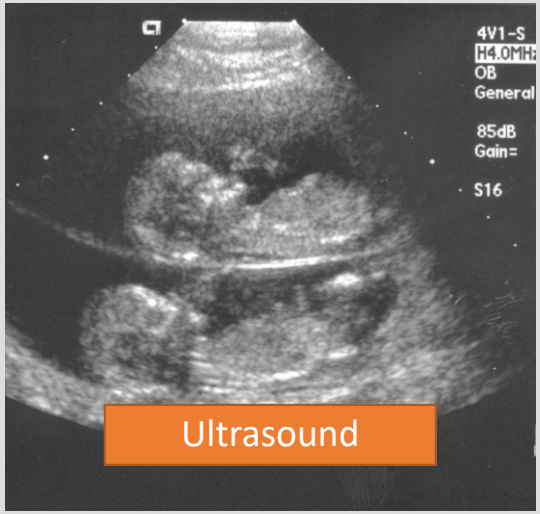
Different Images

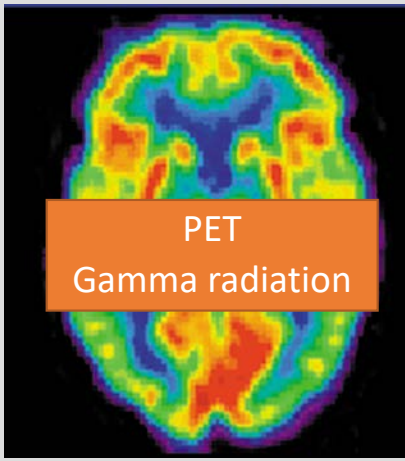




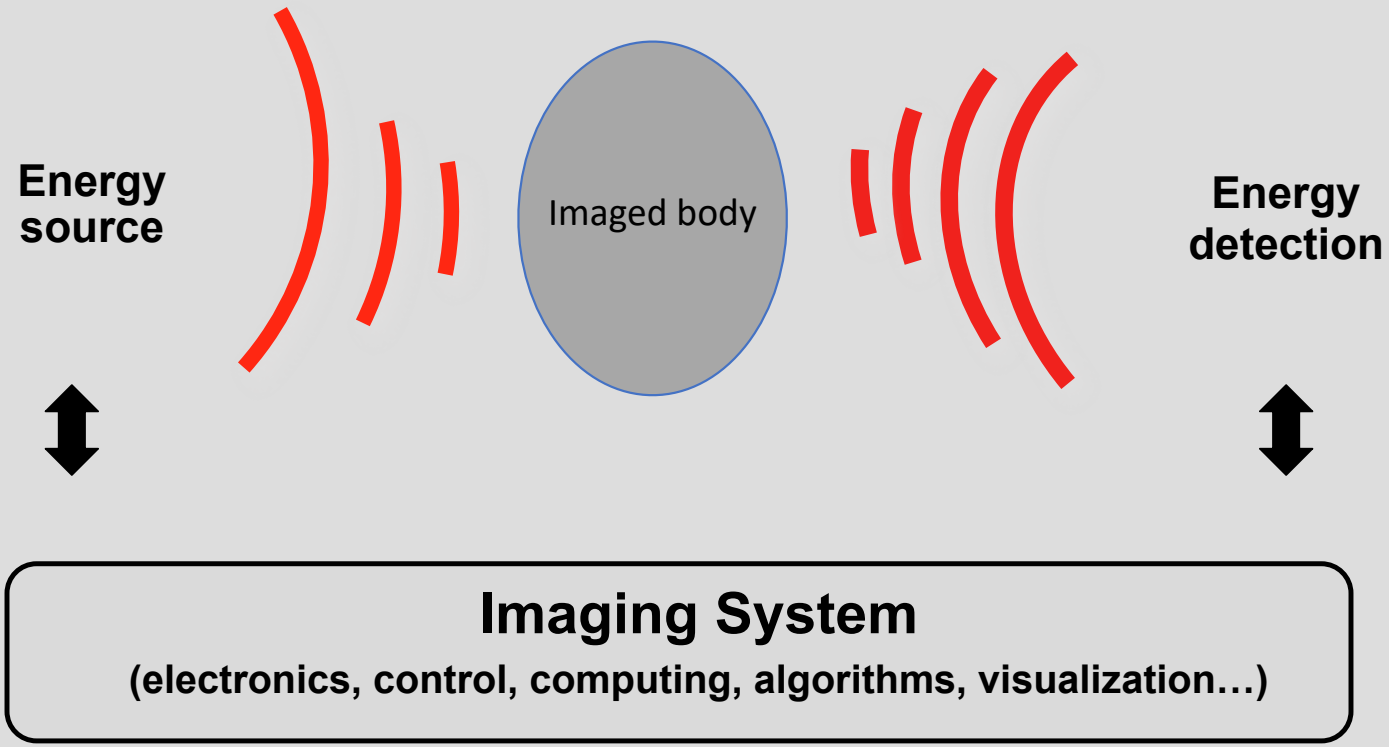








Imaging Systems in General




“Medical imaging” circa 1632
“The Anatomy Lesson of Dr. Nicolaes Tulp”, Rembrandt
Mauritshuis, The Hague