

CS107e

Computer Systems from

the Ground Up

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Autumn 2020

<https://cs107e.github.io/>



Phil



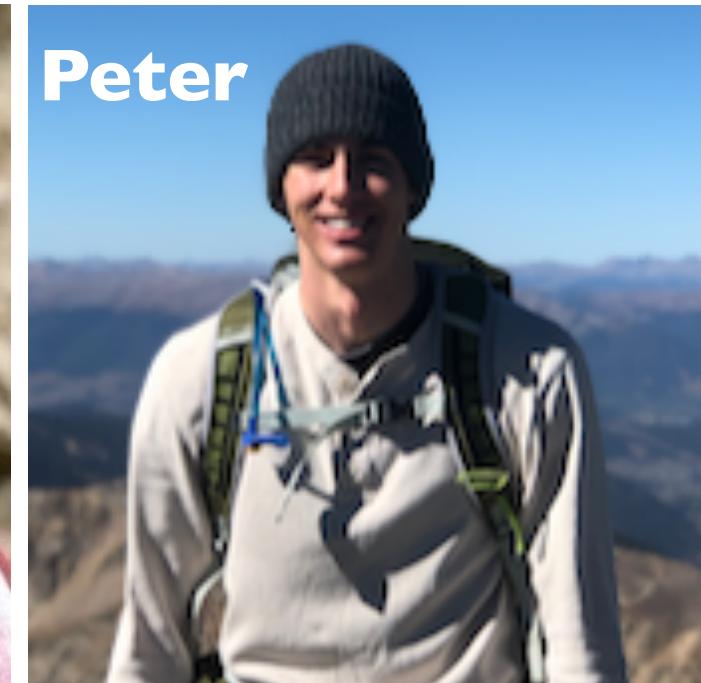
Christos



Sean



Liana



Peter

Class Meeting Protocol I

Class attendance is expected. The slides are not intended to be a replacement for being in class. There are a lot of conceptually difficult topics, and having you there to ask us to stop and clarify is important.

In our experience from last quarter, students who stopped regularly attending lectures struggled greatly and spent the last two weeks trying to earn more points back by fixing bugs and resubmitting.

Class Meeting Protocol 2

However, we acknowledge and realize some of you have difficult living situations and real life things come up. We record every lecture. If you had to miss a lecture, email -staff and we will send you a link to the video with no questions asked. If you start missing multiple lectures we will reach out to see if something we can do to help -- you won't learn as well from videos and we want you to excel in this course.

Class Meeting Protocol 3

We'll see how to manage questions. Last quarter we were small enough (20) that people could ask questions as they came up. If that becomes difficult, we can try something else.

If you are not comfortable to/can't unmute, you are welcome to write a question in chat and ask a CA to ask it for you.

Class Meeting Protocol 4

We'd like it if you can have video on, so we can see your faces and get to know you, but if you'd rather not, that's OK.

If you'd like to keep your video off, then please ask questions sometimes so we can at least get to know your voice.

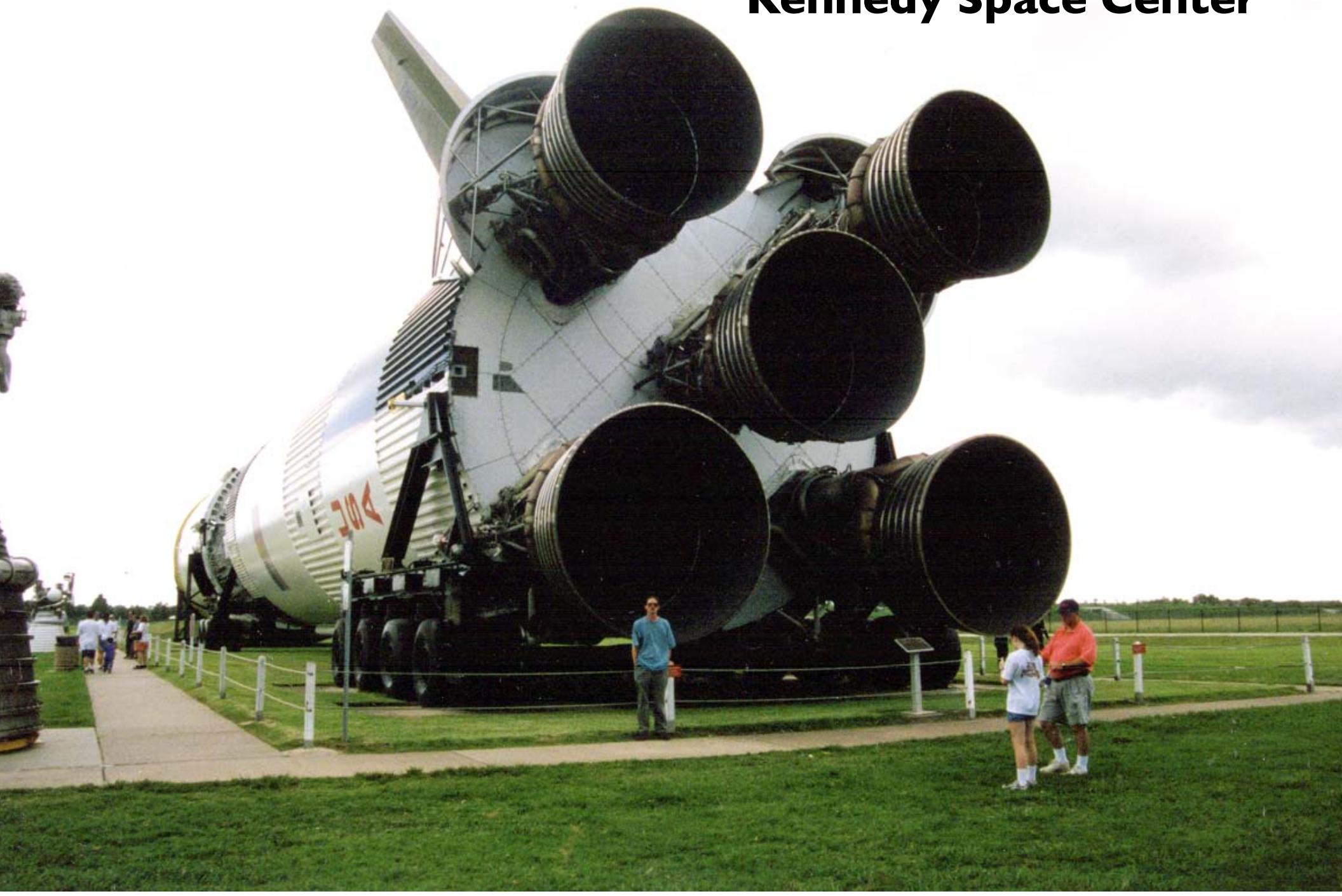
If you are having weird problems with your home network connection, I can help. I put a doc up on Piazza about how to make your network better.

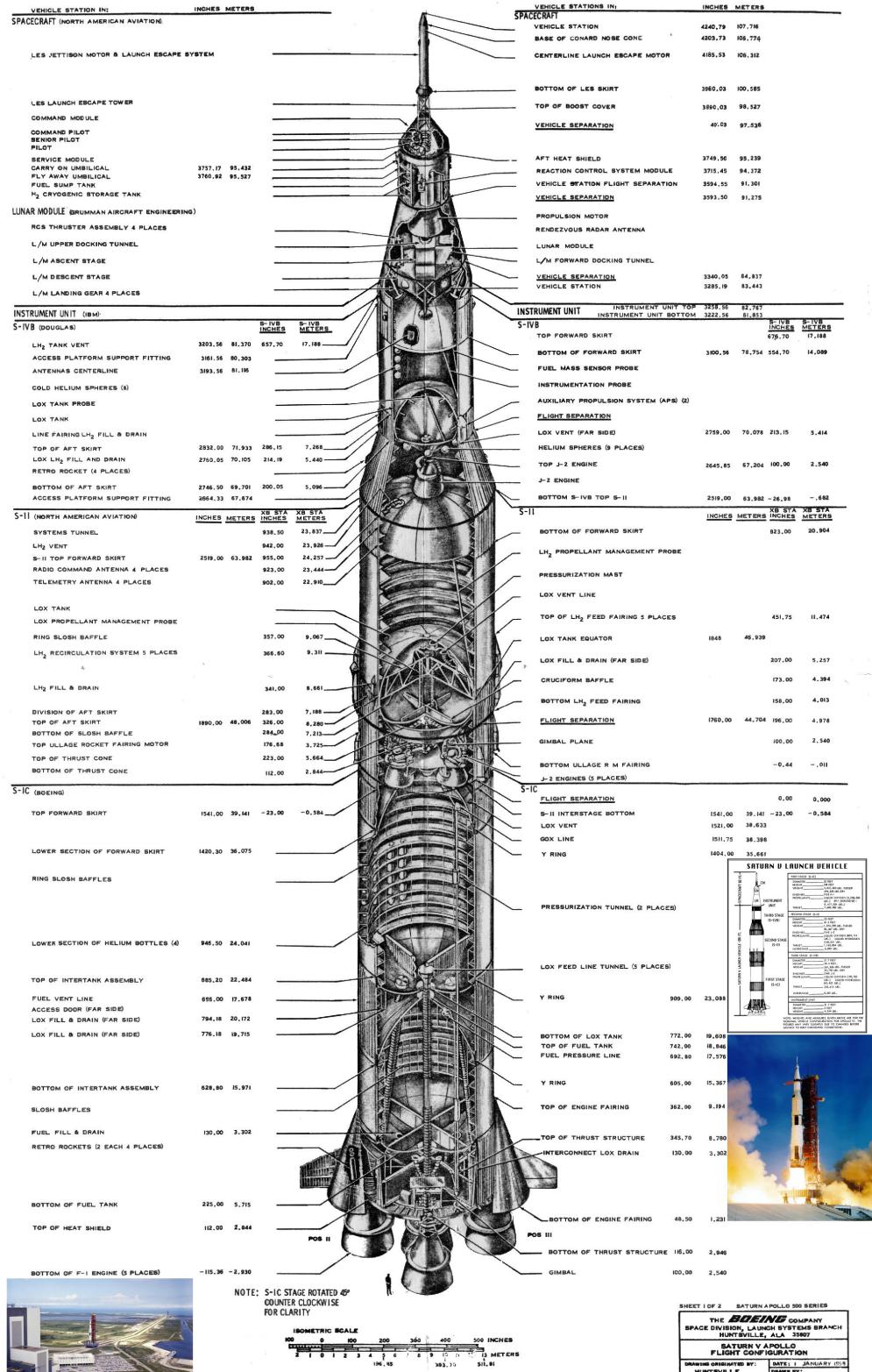
Any Questions?

Learning Goal I

Understand how computers
represent data,
execute programs,
and control peripherals

Saturn V Kennedy Space Center





Command Module 64,000 lbs

Saturn V 6,200,000 lbs

Payload 1.5% of total weight



Falcon 9



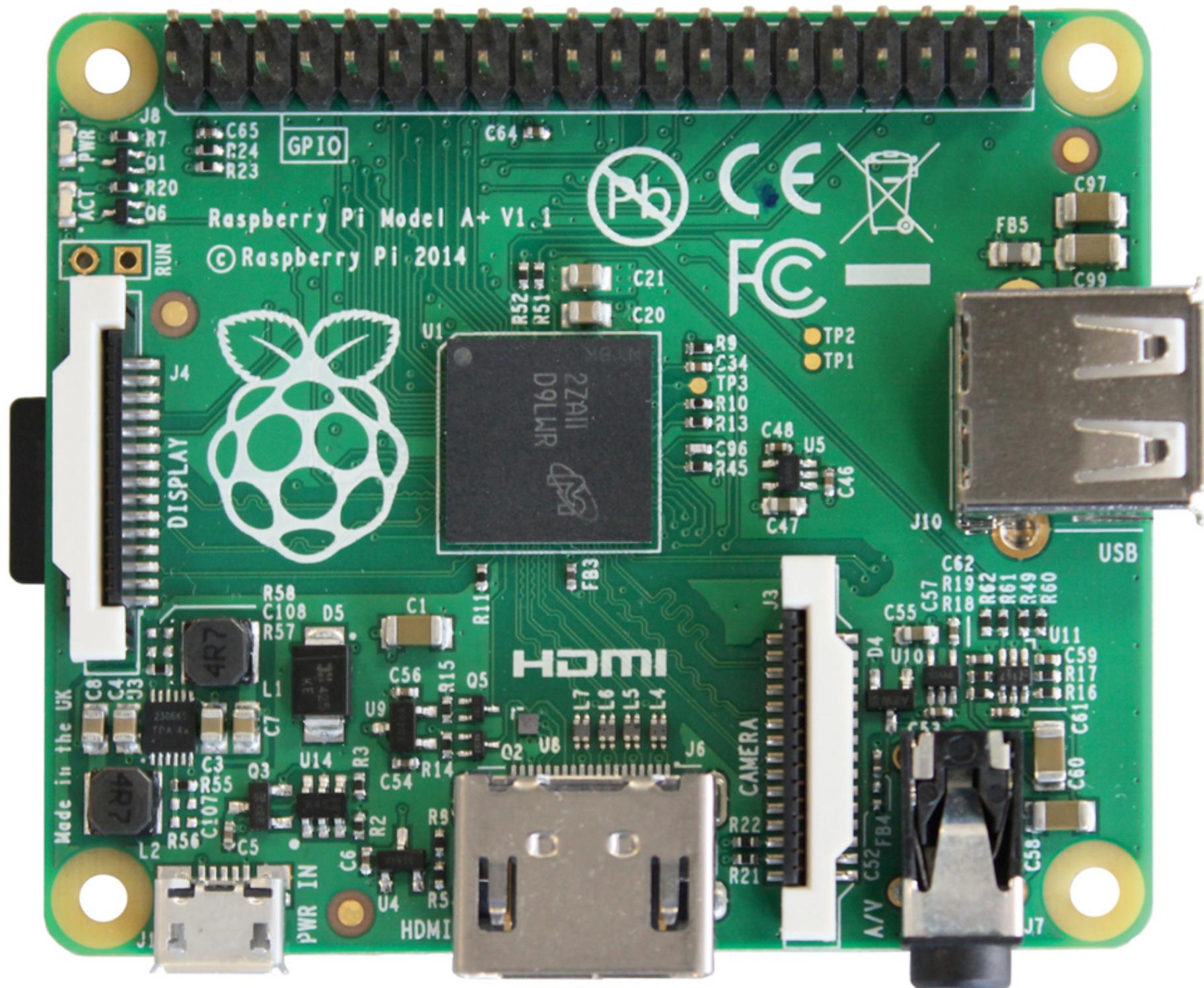


Understanding is Empowering

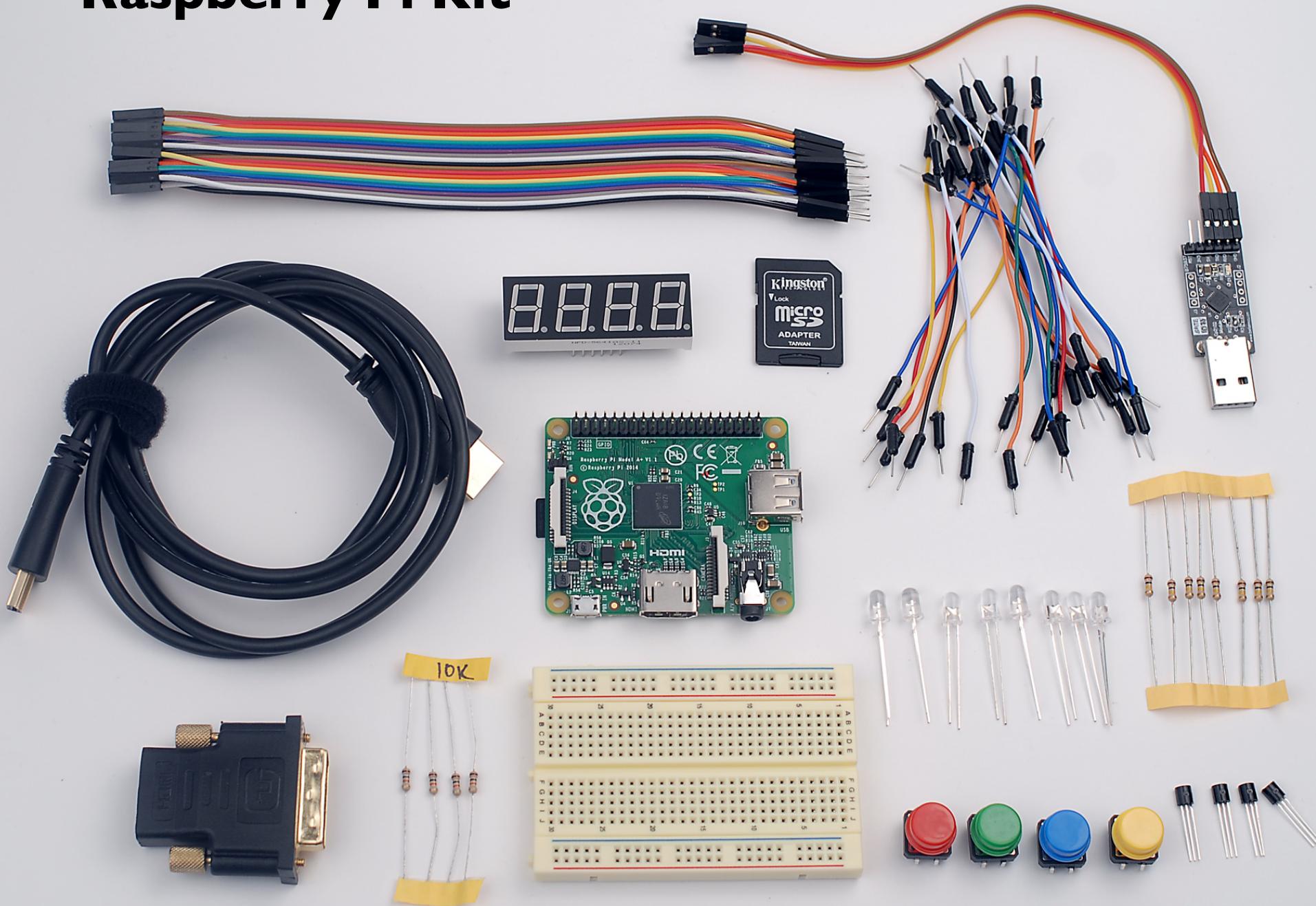
Bare Metal on the Raspberry Pi

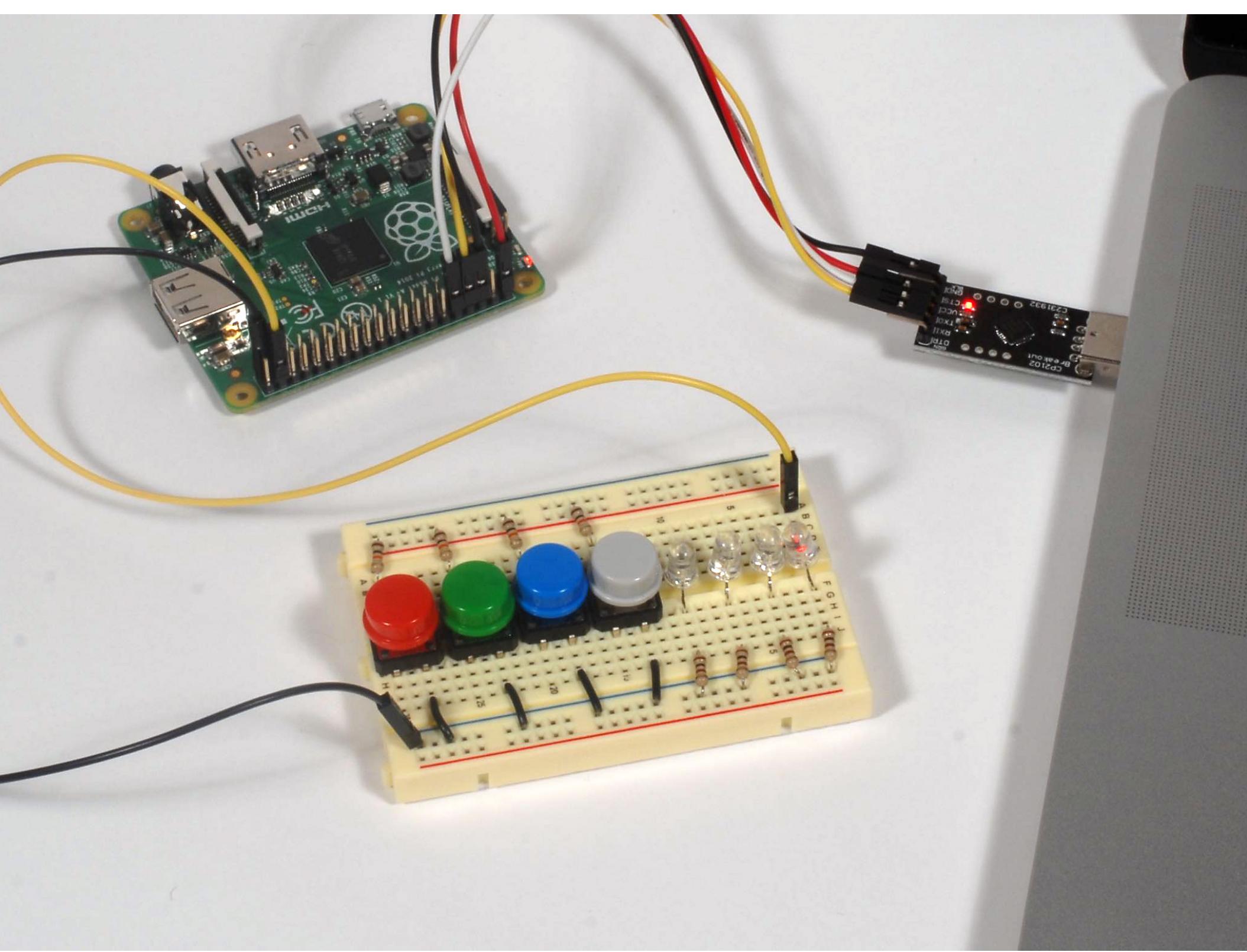
Definition: Bare metal programming involves no operating system (programmer constructs libraries)

Bare metal programs boot and startup on their own, and directly control peripherals



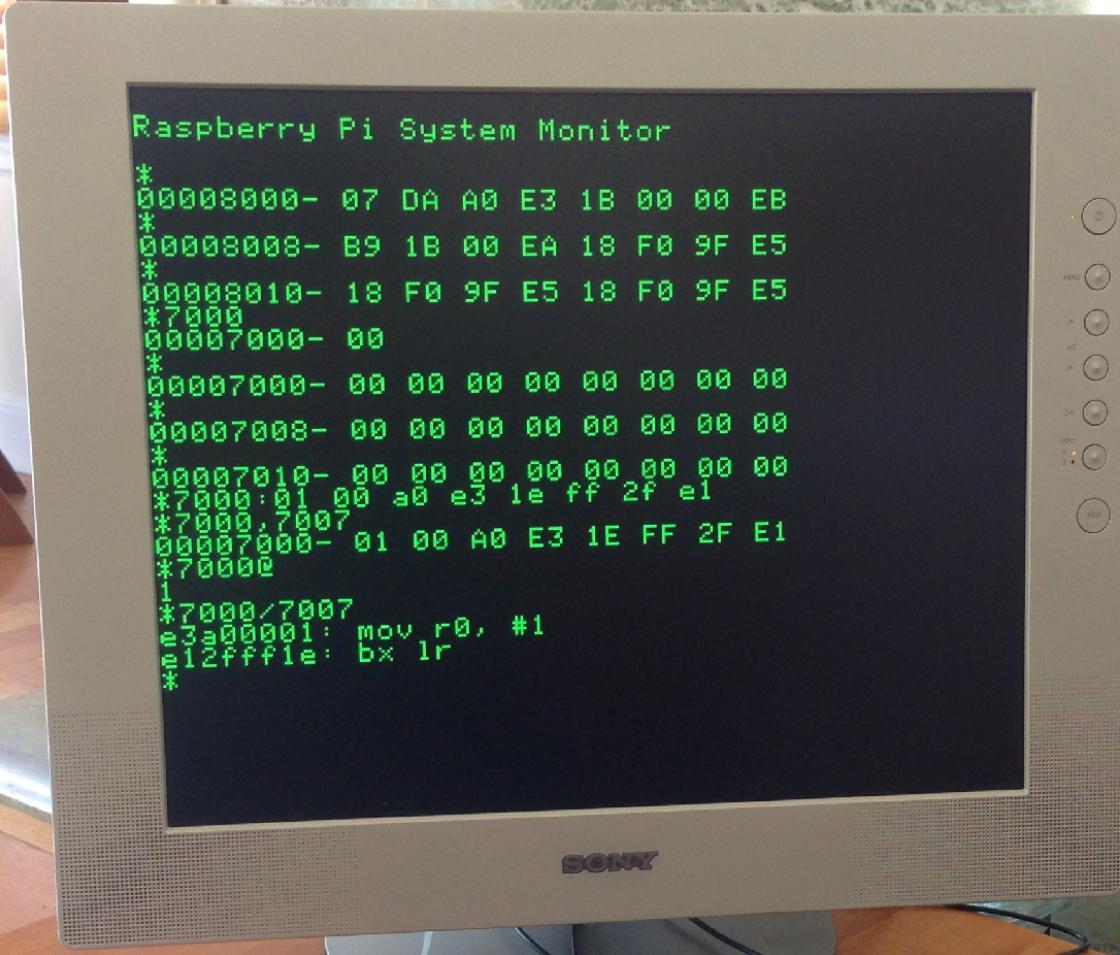
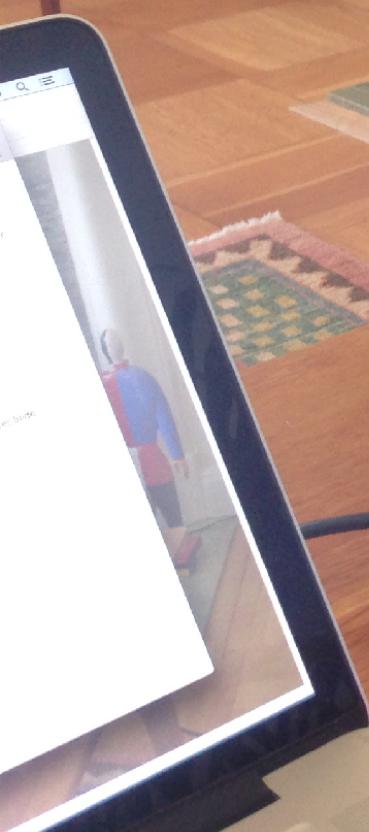
Raspberry Pi Kit





Raspberry Pi Shell

```
Raspberry Pi System Monitor  
*  
00008000- 07 DA A0 E3 1B 00 00 EB  
*  
00008008- B9 1B 00 EA 18 F0 9F E5  
*  
00008010- 18 F0 9F E5 18 F0 9F E5  
*7000  
00007000- 00  
*  
00007000- 00 00 00 00 00 00 00 00  
*  
00007008- 00 00 00 00 00 00 00 00  
*  
00007010- 00 00 00 00 00 00 00 00  
*7000:01 00 a0 e3 1e ff 2f e1  
*7000,7007  
00007000- 01 00 A0 E3 1E FF 2F E1  
*70000  
1  
*7000/7007  
e3a00001: mov r0, #1  
e12fffffe: bx lr  
**
```



**Almost every instruction
will be code you've written!**

Learning Goal 2

Master your tools

Software Tools

UNIX command line: bash, cd, ls, ...

Programming languages: C, ...

gcc

as

ld

binutils: nm, objcopy, objdump, ...

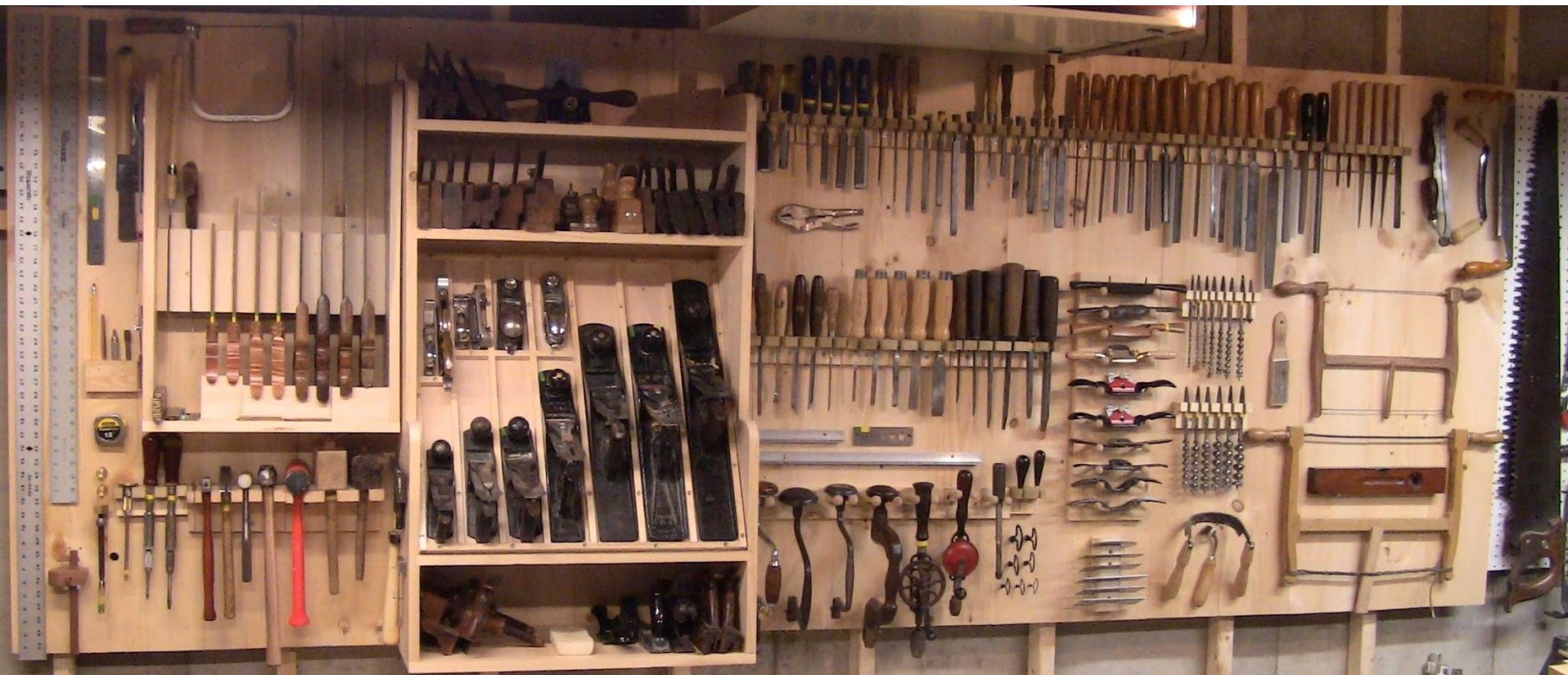
make

git and github.com

documentation: markdown



Different Tools for Different Jobs



<http://dans-woodshop.blogspot.com/>

Organized Development Environment



<http://amhistory.si.edu/juliachild/>

Don't Avoid Activation Energy

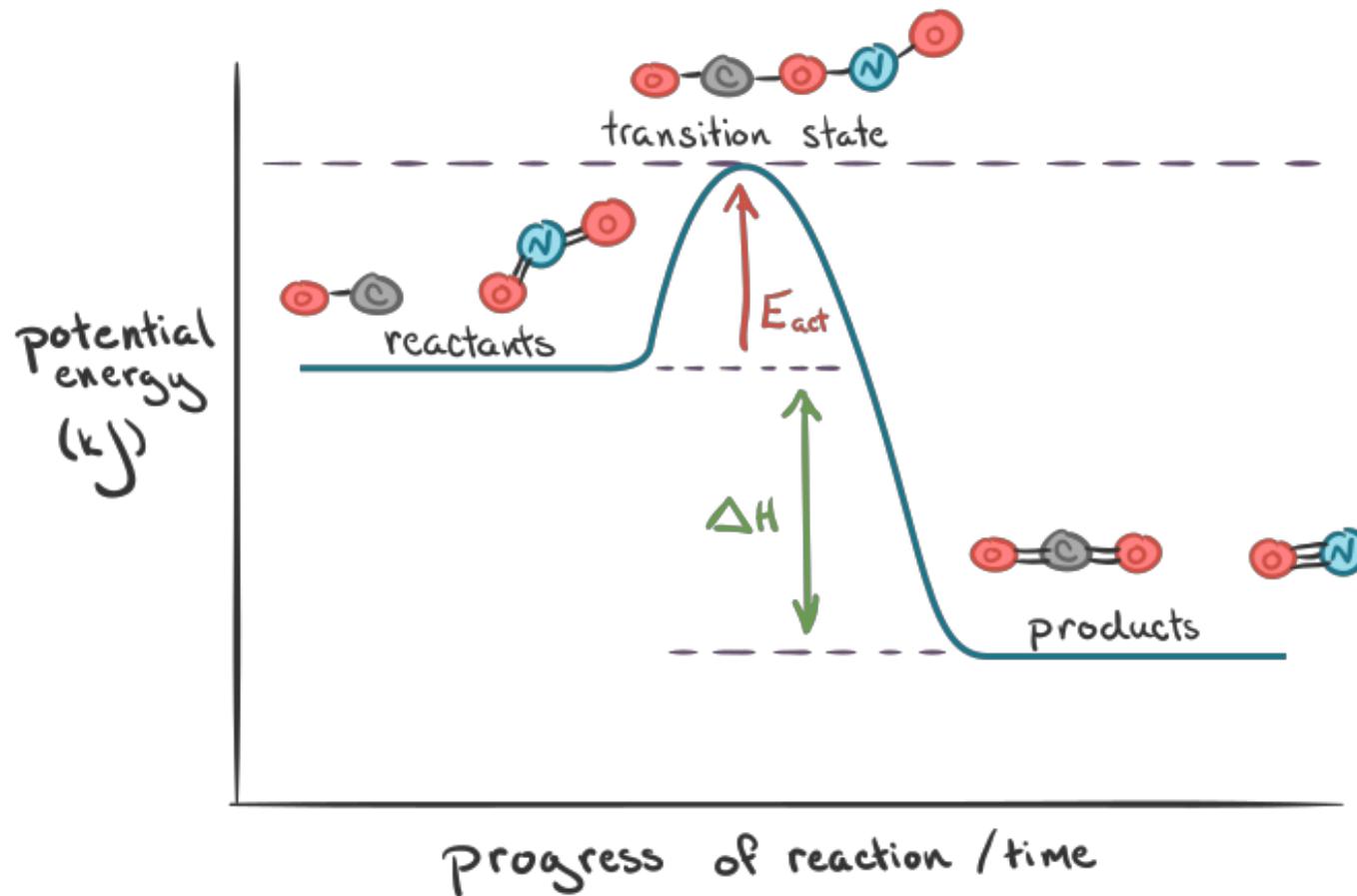


Figure from Khan Academy

<https://www.khanacademy.org/test-prep/mcat/chemical-processes/thermochemistry/a/endothermic-vs-exothermic-reactions>

Don't Avoid Activation Energy

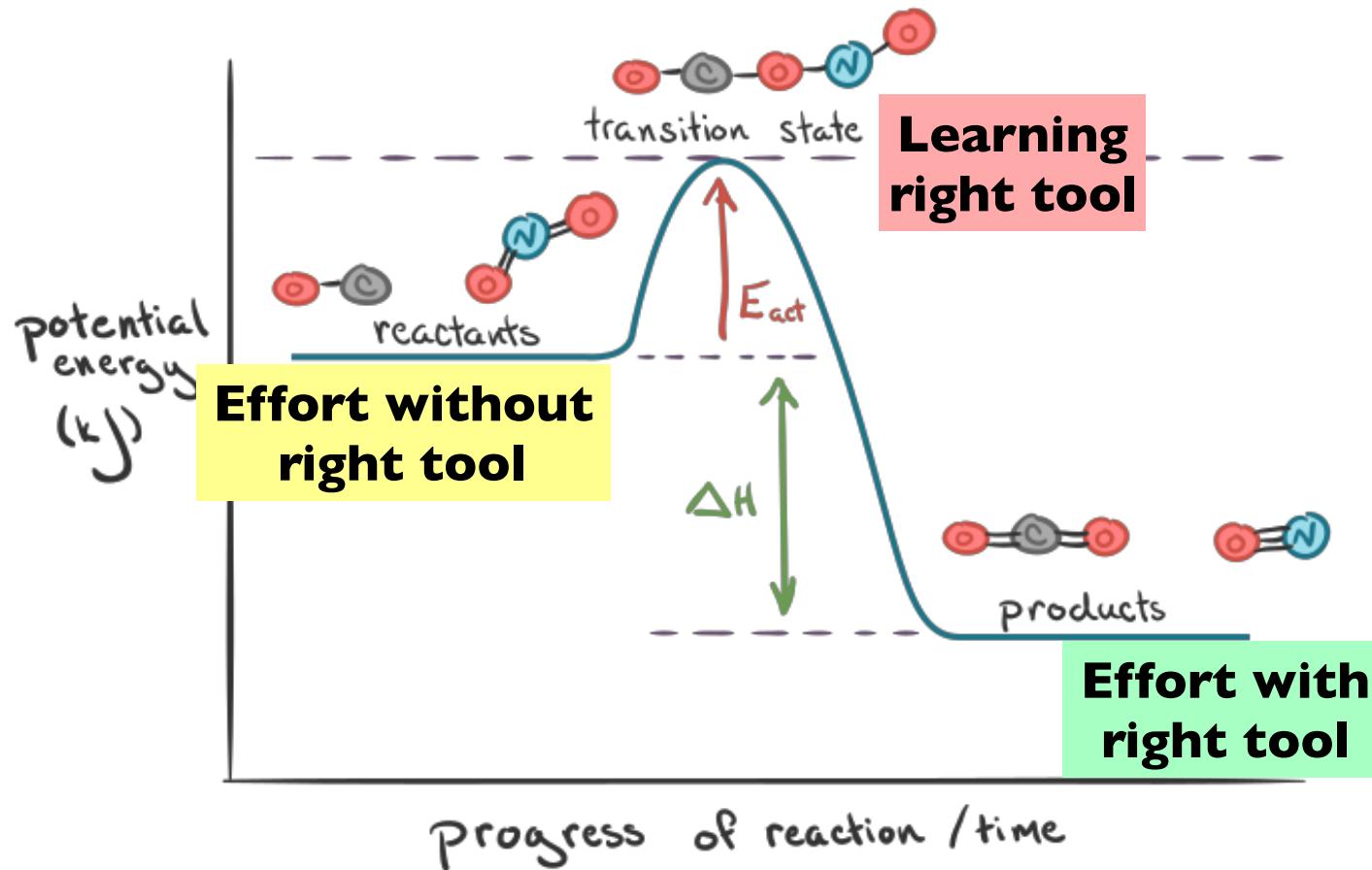


Figure from Khan Academy

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Hyperbolic Discounting



<https://medium.com/behavior-design/hyperbolic-discounting-aefb7acec46e>

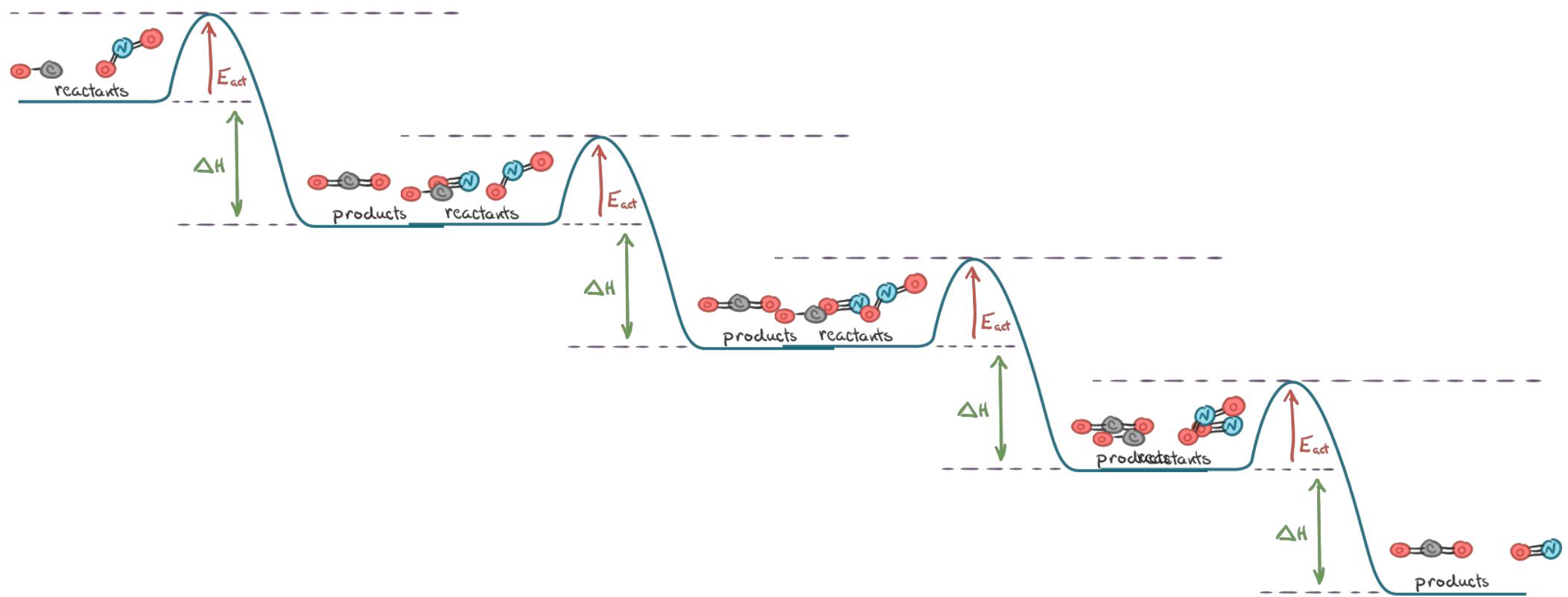
Hyperbolic Discounting



<https://medium.com/behavior-design/hyperbolic-discounting-aefb7acec46e>

A close-up photograph showing a person's hands working on a piece of wood. The person is using a chisel to shape a dark, rectangular block of wood that is resting on a larger, lighter-colored wooden board. The background shows a workshop environment with various tools and equipment. A bottle of water is visible on the right side.

Practice, Practice, Practice



It never ends... 1000x improvements possible!

Jeff Dean
Mark Horowitz over dinner
Radio SPI bug

Figure from Khan Academy

<https://www.khanacademy.org/test-prep/mcat/chemical-processes/thermochemistry/a/endothermic-vs-exothermic-reactions>

Debugging and Troubleshooting



Course Topics

cs107e.github.io

§ I Bare Metal Programming

1. ARM processor and memory architecture
2. ARM assembly language and machine code
3. C
4. Functions
5. Serial communication
6. Linking and loading
7. Memory allocation

§2 Personal Computer

- I. Keyboard**
- 2. Graphics**
- 3. Interrupts**

Goal: Build Raspberry Pi shell

§3 Additional Topics

- 1. Sensors**
- 2. Performance**
- 3. Towards Linux and beyond**

And a special guest lecture!

Administration

Weekly Cadence

Each week has a focus topic

Pair of coordinated lectures on Fri and Mon

Mandatory lab on Wednesdays

Assignment handed out Wed evening (after lab),
YEAH hours on Thu, assignment due following Tue at
6 pm (before Tue lab)

Laboratories

Attendance is **mandatory**

Do exercises and complete check-list

Leave lab ready for assignment: walks you through tricky bit (hardware/software interface) to get you started

Philosophy: lots-of-help, hands-on, collaborative

We will organize your lab into small (2-3 person) breakout groups so you can do the lab with mute off and chat/collaborate. Initially groups are randomly assigned, later in the quarter we will let you choose partners if you want to.

Assignments

7 assignments

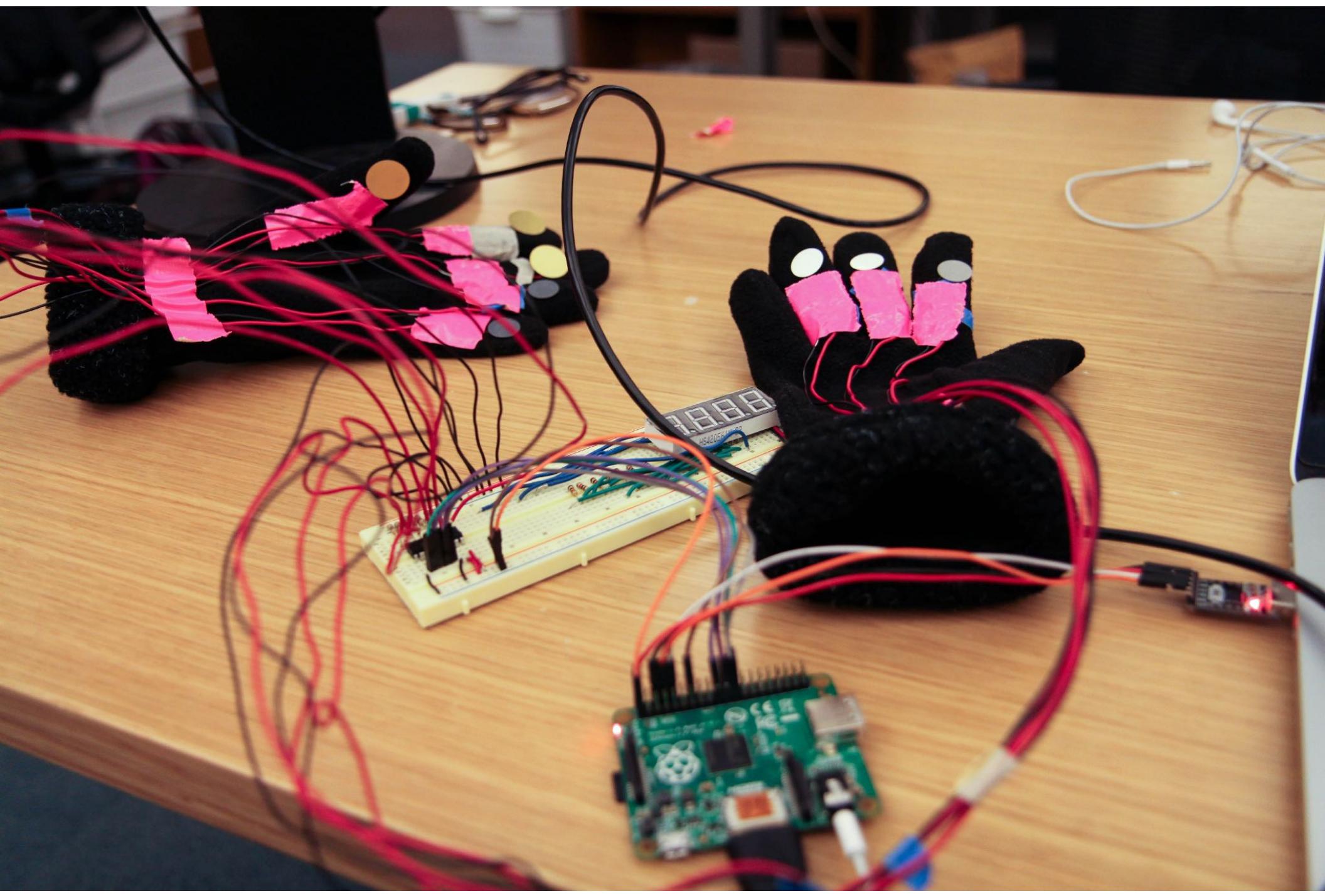
- **Build** on each other

Two parts for each assignment

- Basic (required, tight spec, guided steps)
- Extension (optional, opportunity for your exploration/creativity)

Final project demonstrations on Wednesday, June 10

- Scaled back due to lack of exam period, physical lab resources
- Encourage you to play with some hardware (e.g. sensors)

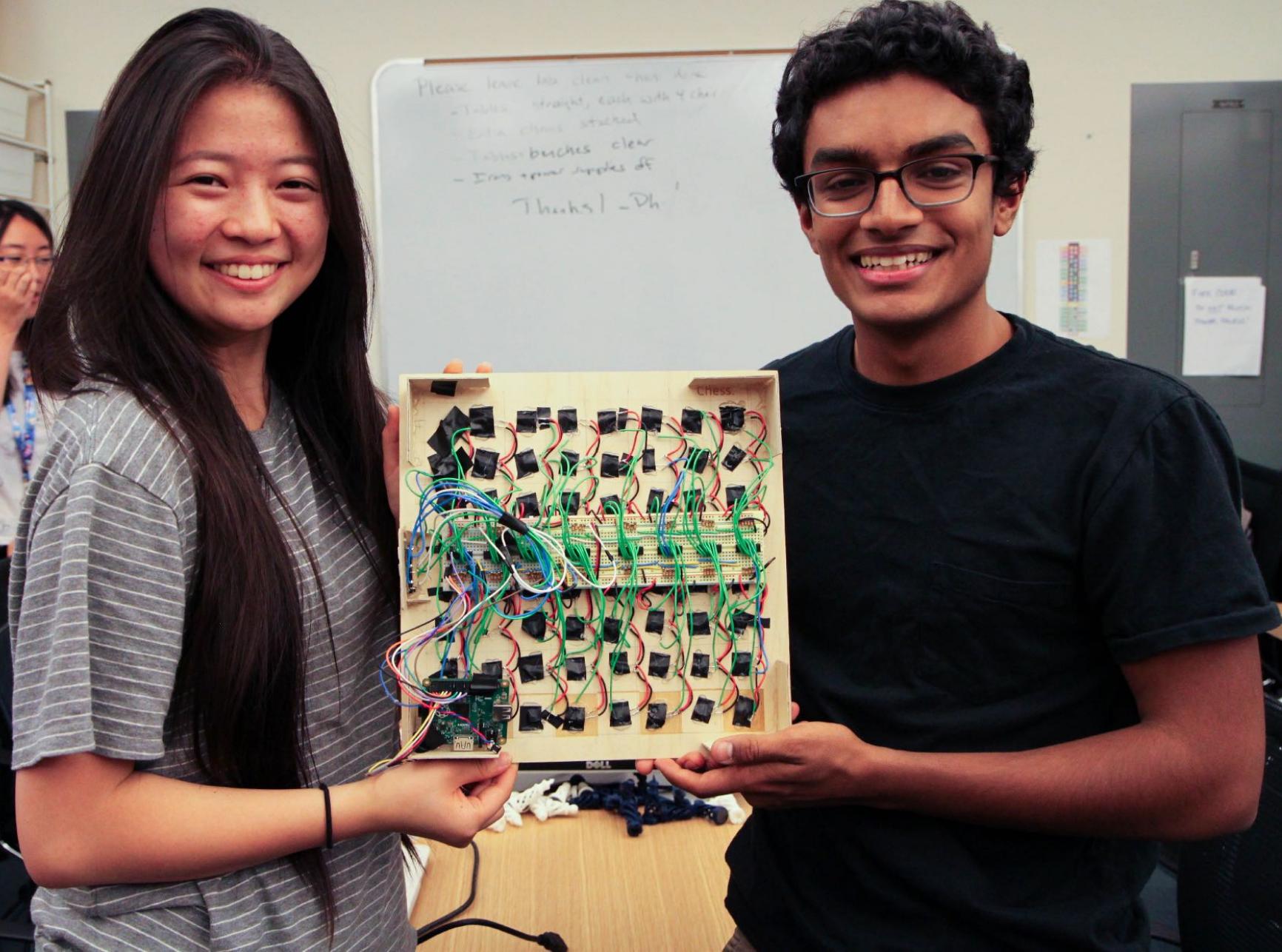




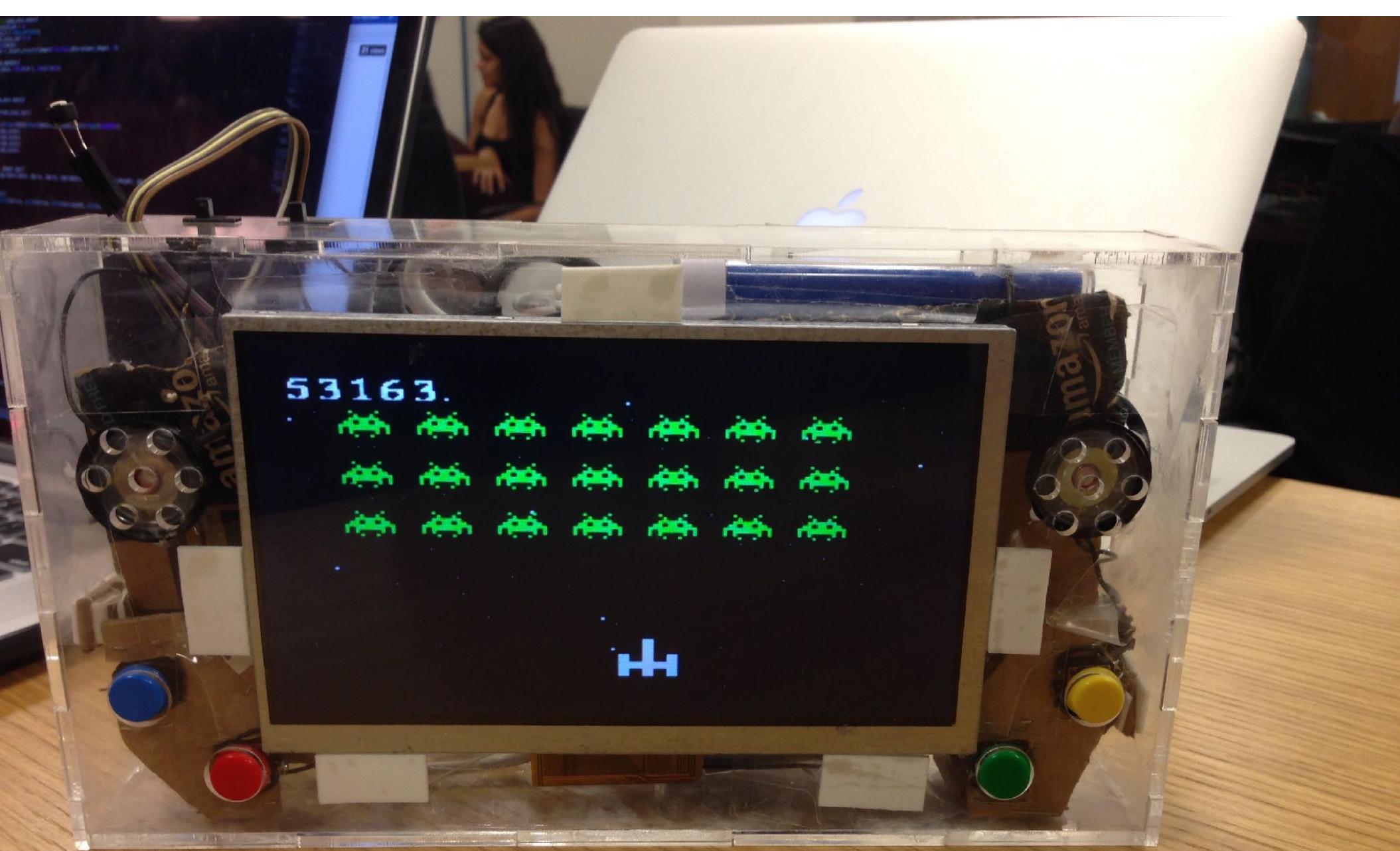


Please leave box clean - no dust
- Tables straight, each with 4 chairs
- Extra chairs stacked
- Tissue boxes clear
- Irons & paper supplies off

Thanks! - Dh







First Week

Today

Fill out the lab poll if you haven't already

We will assign labs tonight

Lab 0 is not on course material: it's a short meeting in which you can all get to know one another and us a bit

Assignment 0

TODOs

- Join forum piazza.com/stanford/fall2020/cs107e
- Read and understand our guides on basic topics (electricity, numbers, unix)
- Create github account and send us your GitHub id
- Install/setup your development environment

Number Representations

Binary representation

Hexadecimal

Bit operators

Guide: <https://cs107e.github.io/guides/numbers/>

Basic Electricity

Voltage and current

Ohms Law : $V = I R$

Power : $P = IV$

Driving an LED

Transistor switches

Breadboarding

Guide: <https://cs107e.github.io/guides/electricity/>

Unix Command Line

Moving around the file system

Creating, moving, and deleting files

Compiling and running programs

Profiles and paths

Guide: <https://cs107e.github.io/guides/unix/>

Watch cs107 UNIX videos!