

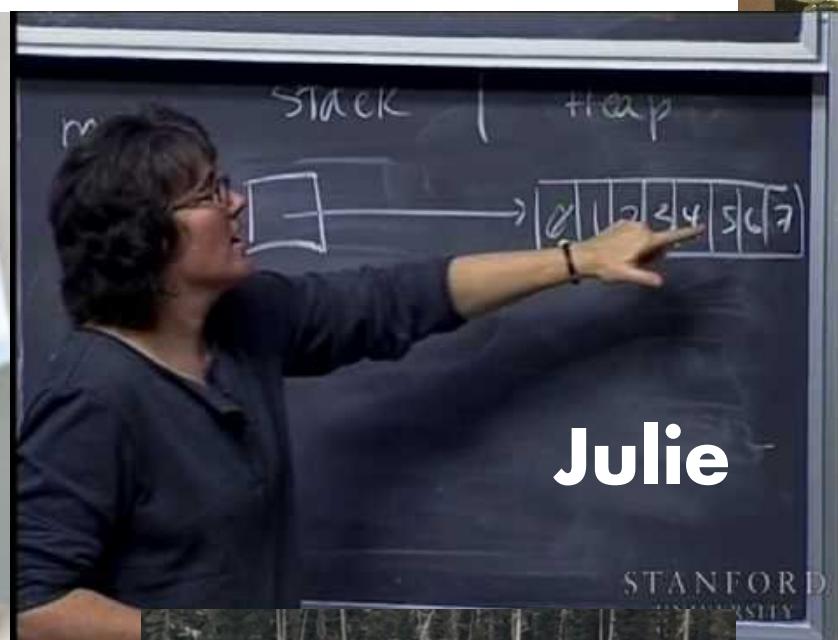
**CS107e**

**Computer Systems from  
the Ground Up**

**Julie Zelenski, Pat Hanrahan,  
Lenny Truong, Mark Miller,  
Anna Zeng, Michelle Park**

**Winter 2018**

**Pat**



**Julie**



**Anna**



**Lenny**



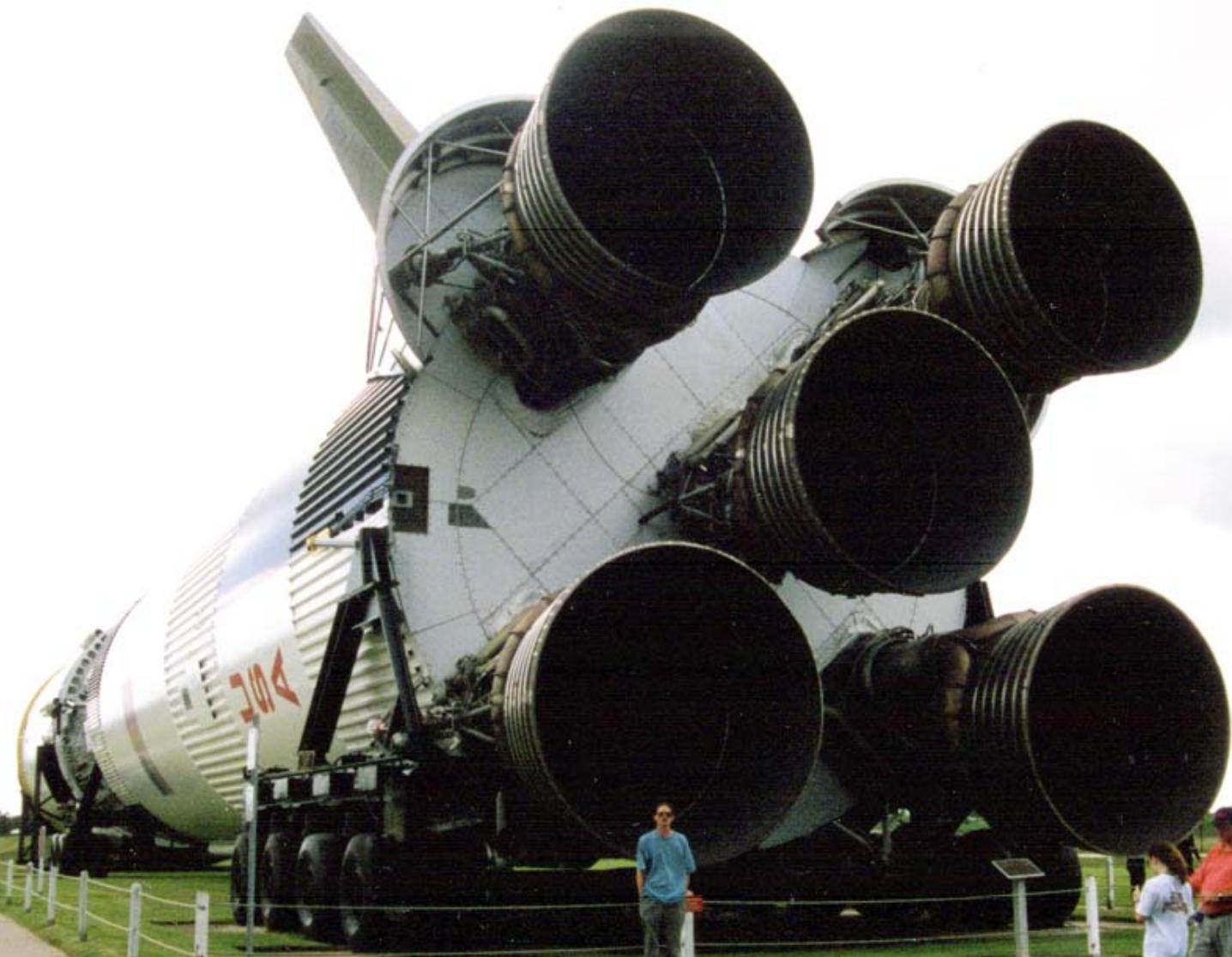
**Mark**



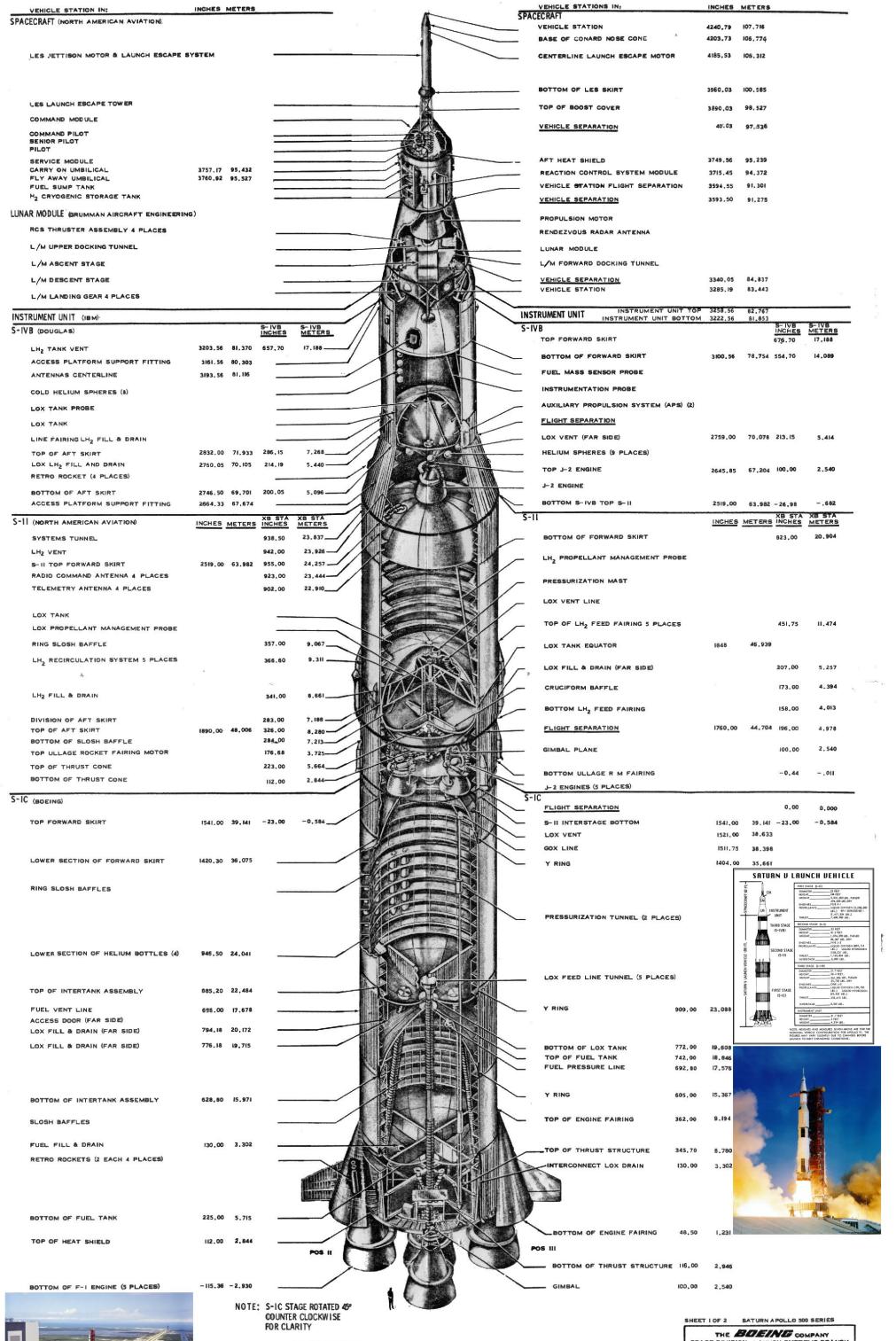
**Michelle**

# **Learning Goal 1**

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



304



# Falcon 9

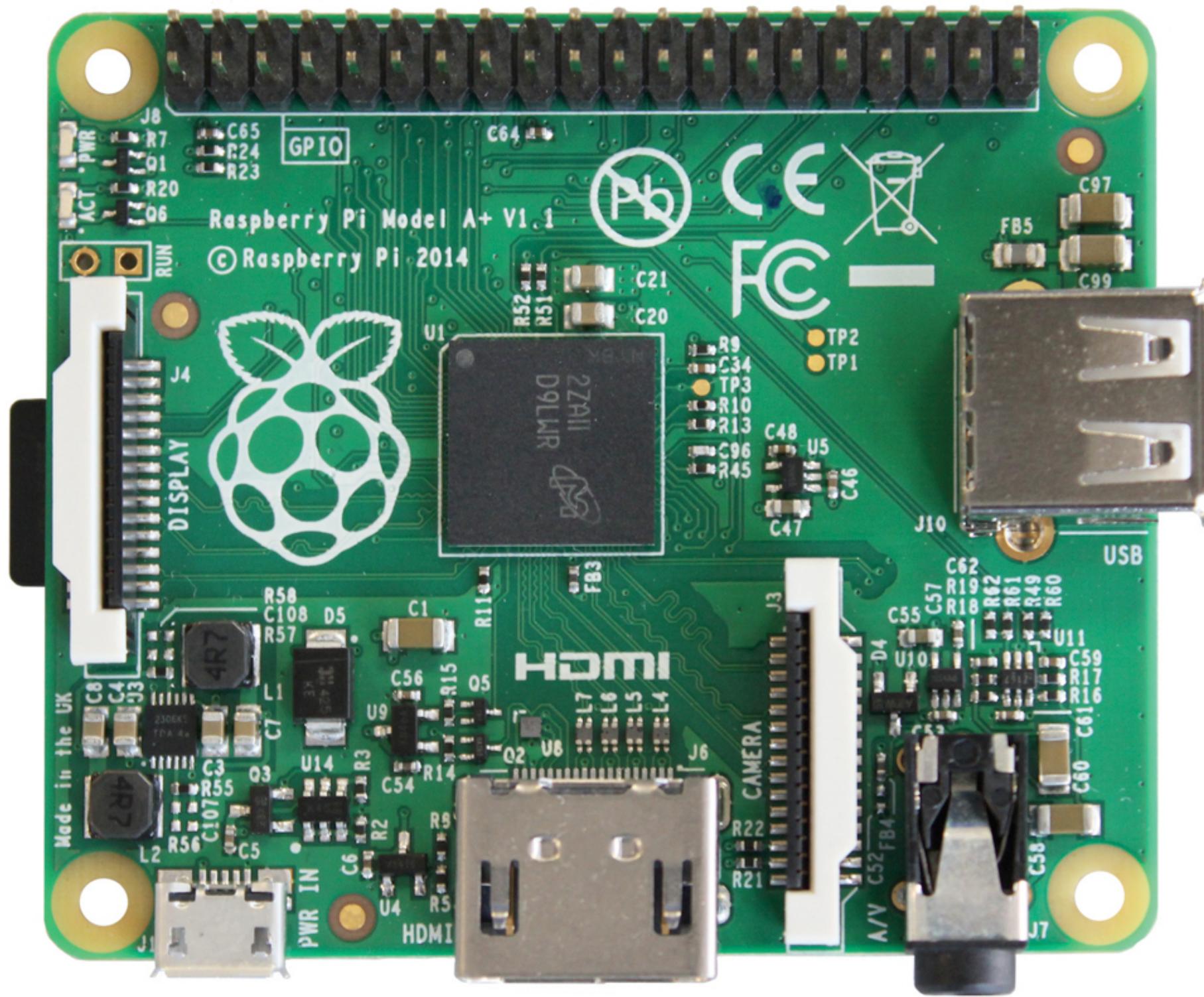


# Elon Musk

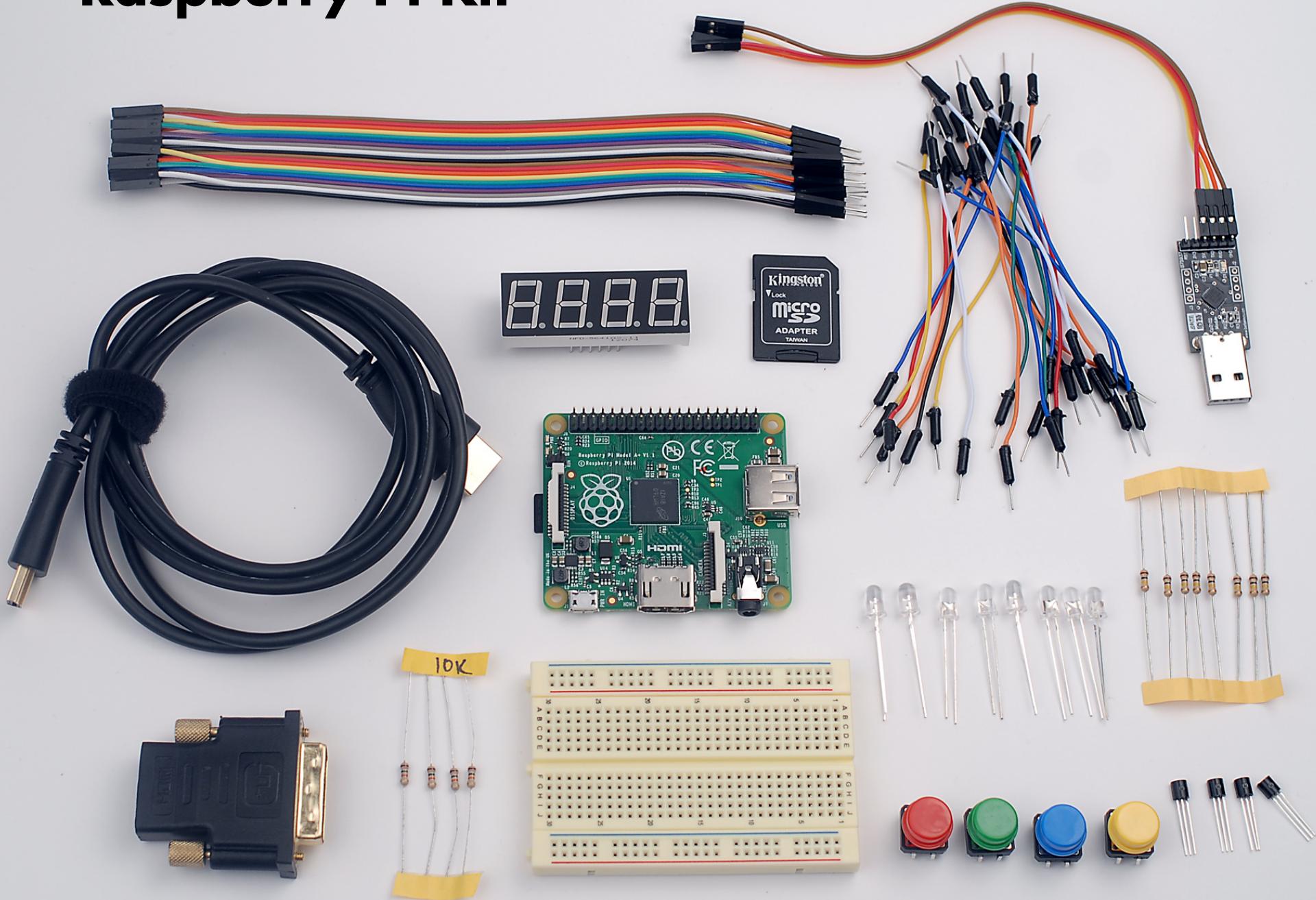
# **Bare Metal on the Raspberry Pi**

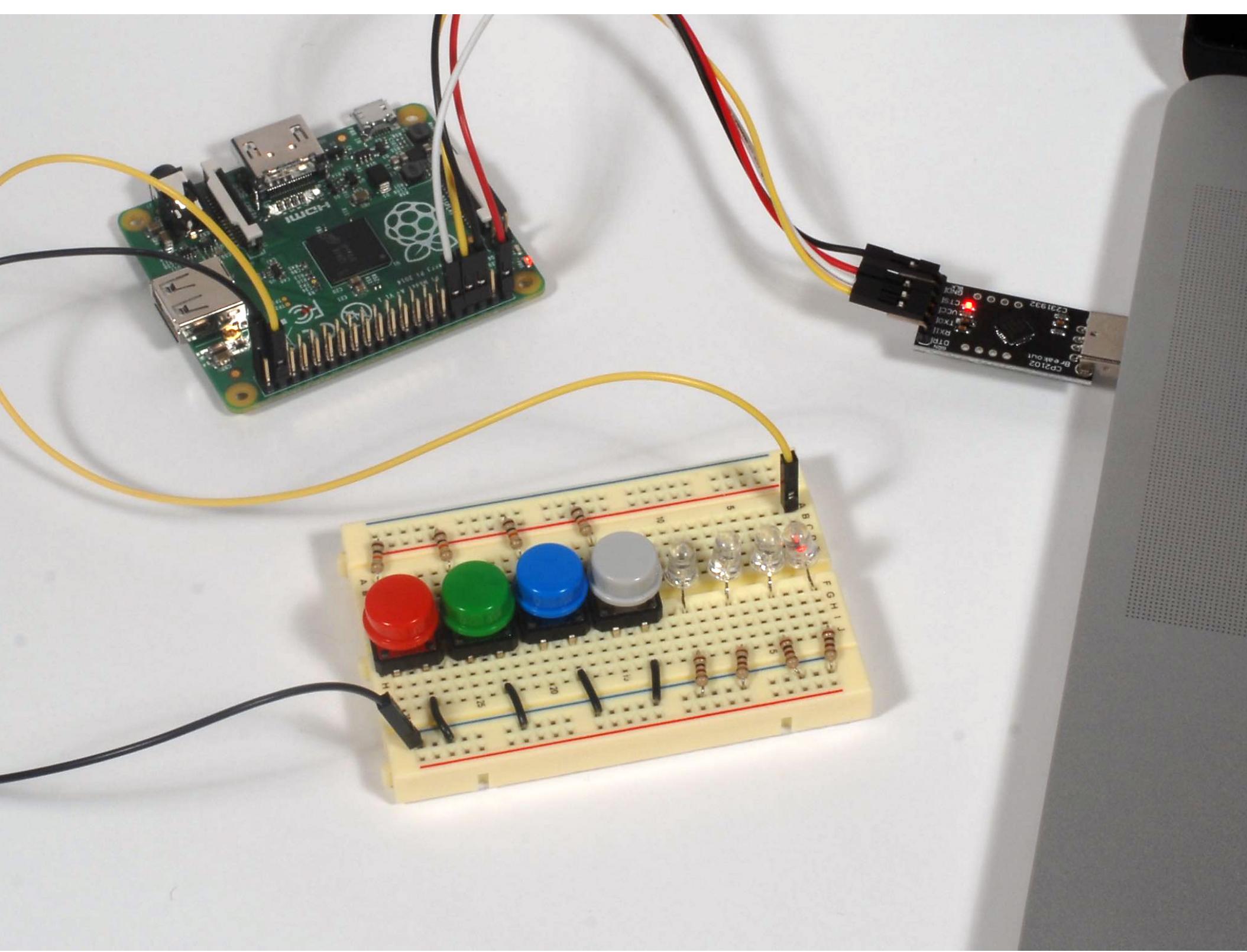
**Definition: Bare metal programming involves no operating system (programmer constructs libraries)**

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



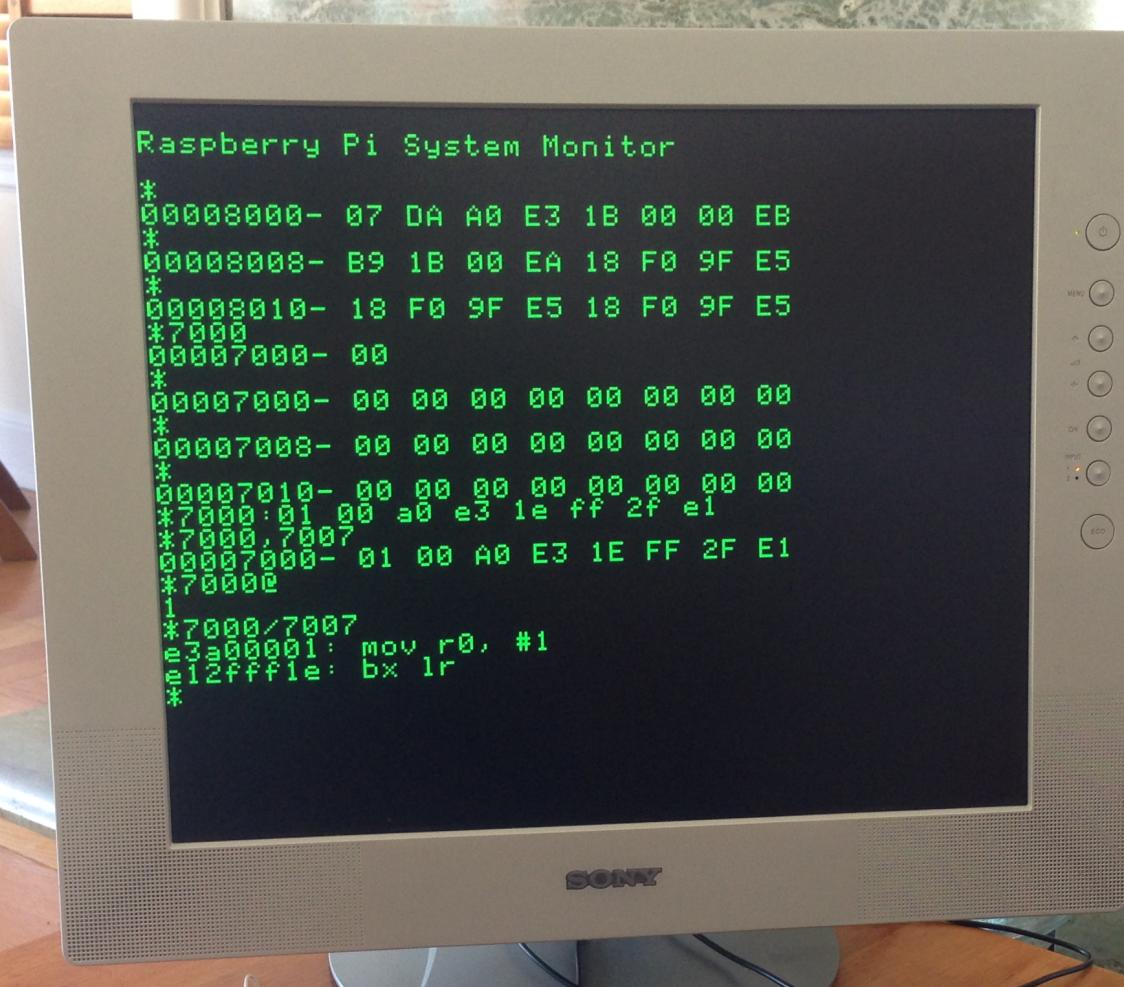
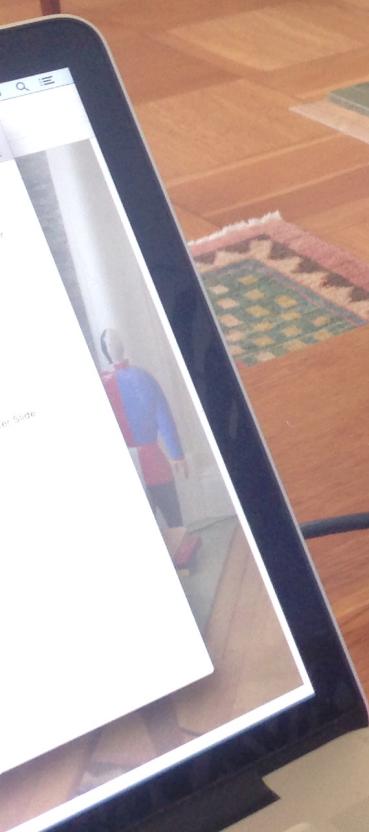
# Raspberry Pi Kit





# **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  
e12ffff1e: bx lr  
**
```



# **Learning Goal 2**

## **Master your tools**

# **Software Tools**

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

**Programming languages:** C, C++

gcc

as

ld

**binutils:** nm, size, ...

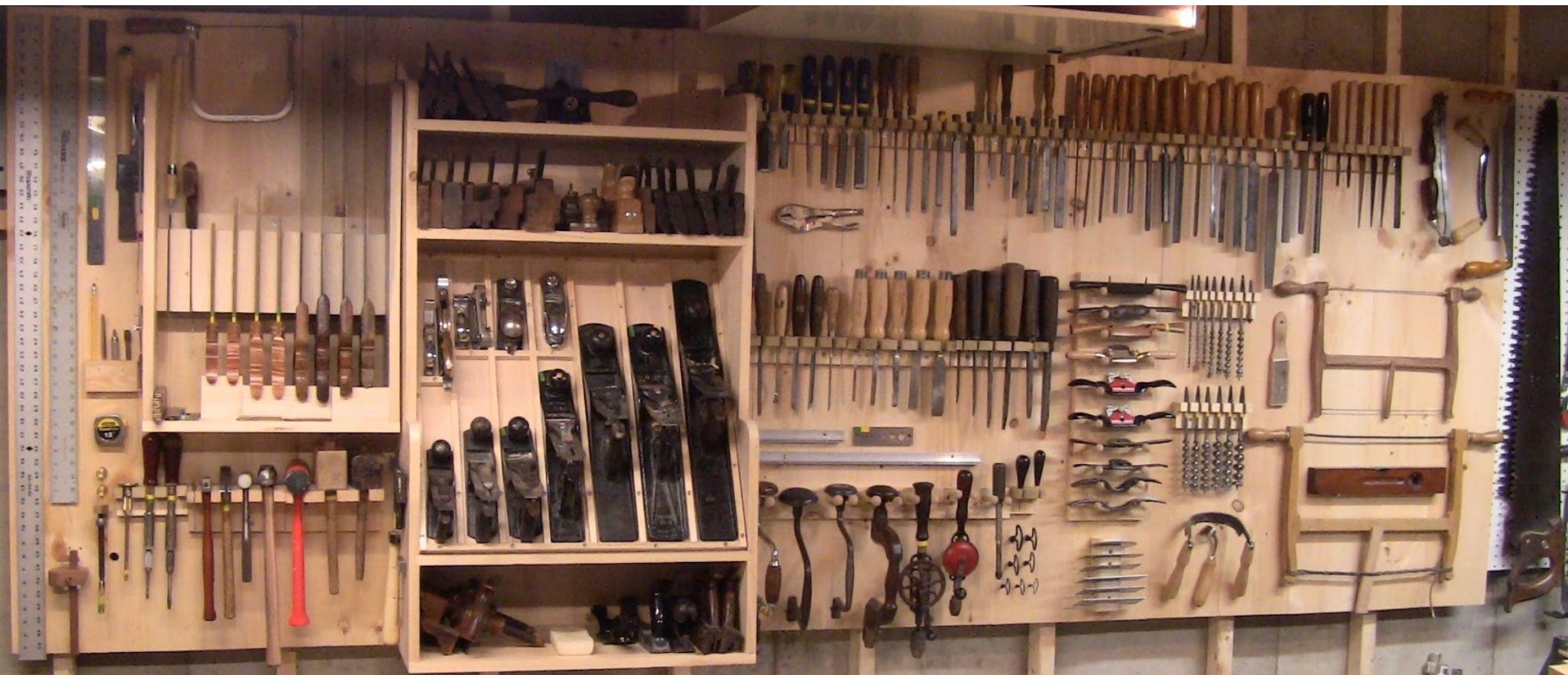
make

git **and** github.com

**documentation:** markdown



# Different Tools for Different Jobs



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

# Organized Development Environment



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

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, light-colored wooden board. The background shows a workshop environment with various tools and equipment.

**Master the Craft**

<https://paulsellars.com/tag/gouge/>

# Debugging and Troubleshooting



# **Course Topics**

**cs107e.github.io**

# **§1 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**

**1. 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 Tue/Wed evening from 6:30-8:30 pm in Gates B21**

**Assignment due following Tue at 6 pm (before Tue lab)**

# **Laboratories**

**Gates B21: Attendance is **mandatory****

**Do exercises and complete check-list**

**Leave ready to do assignment**

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

**Lab: access to tools and supplies**

**Lab fee: \$50 (the kit is yours)**

# **Assignments**

**7 assignments**

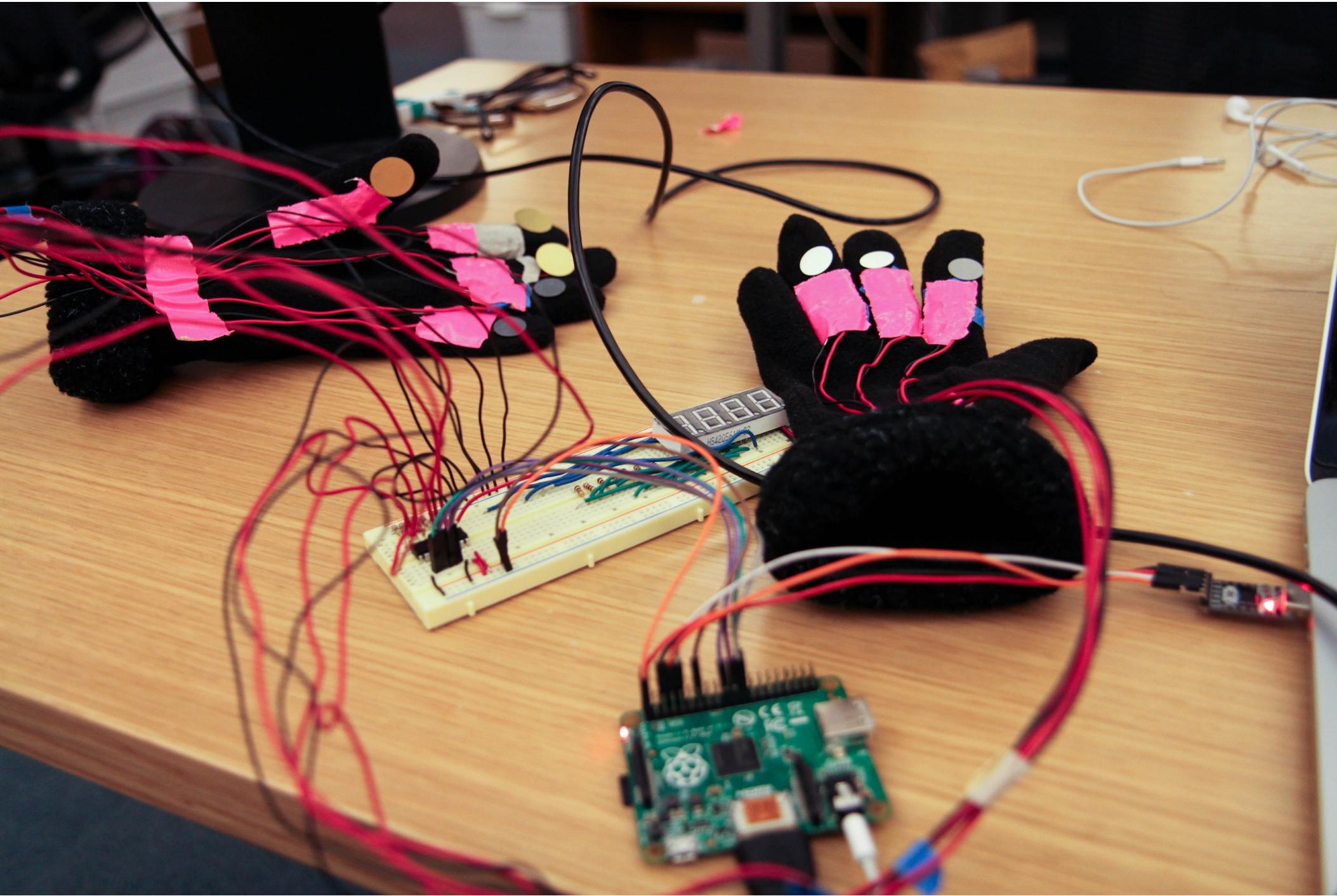
- **Build on each other**

**Two parts for each assignment**

- **Basic**
- **Extension**

**Final project**

**NO EXAMS**

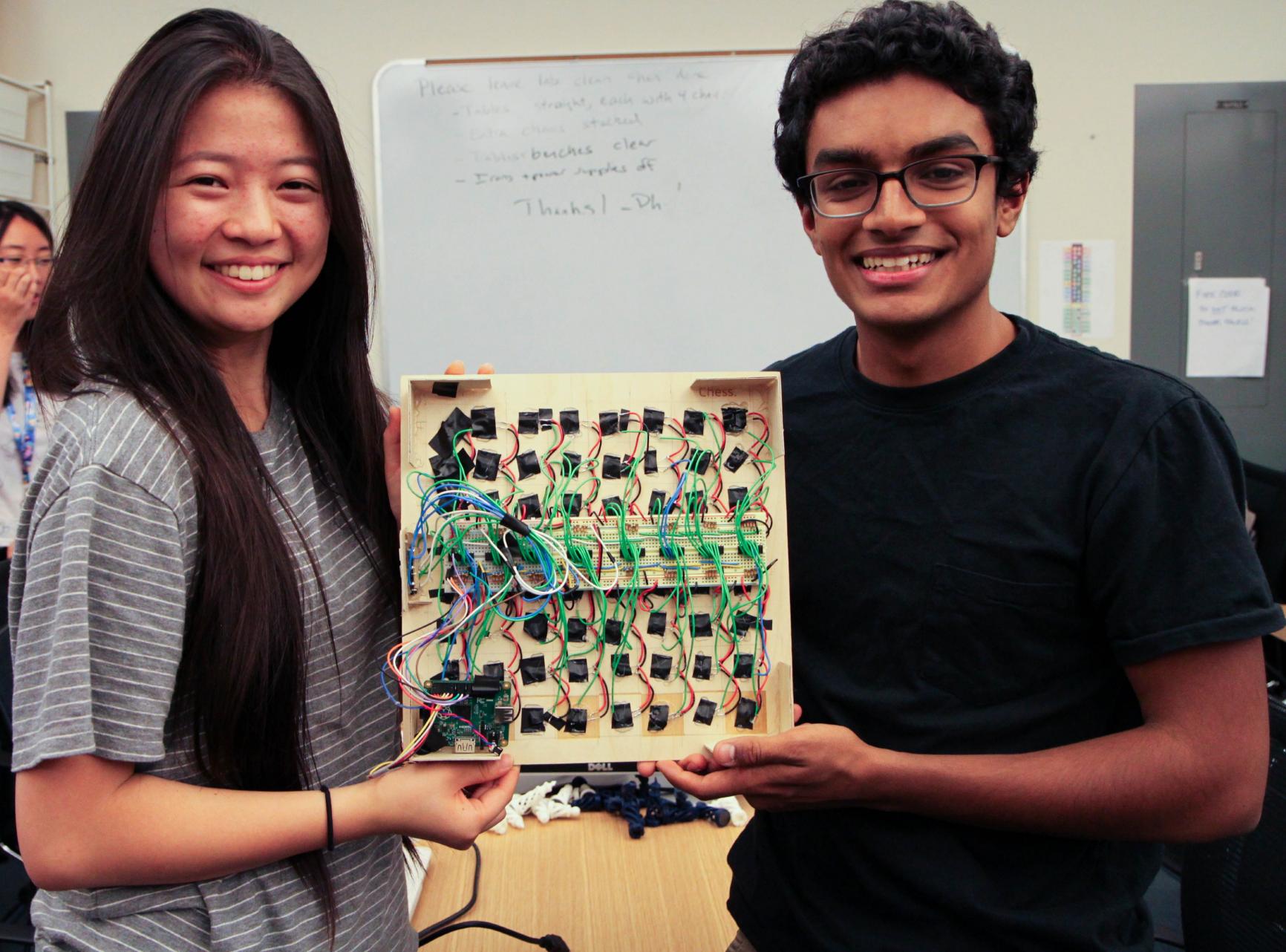




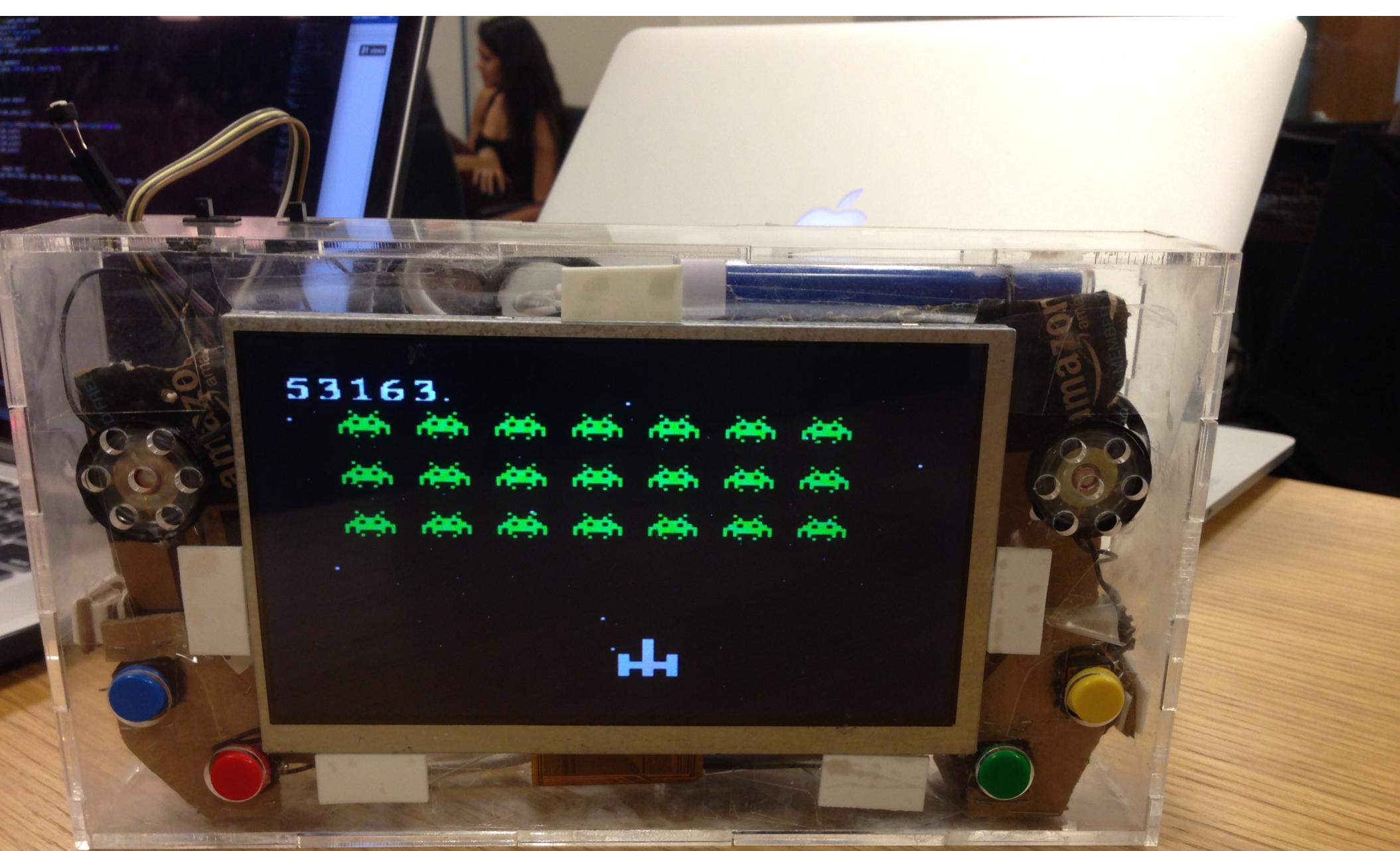


Please leave the clean "bar" area  
-Tables straight, each with 4 chairs  
-Extra chairs stacked  
-Tissue boxes clear  
-Irons + ironing supplies off

Thanks! -Dh!







# **First Week**

# **Assignment 0**

**Subscribe to cs107e in piazza**

**Attend cs107 UNIX labs**

**Assignment 0**

- Using git and github**
- Submit your lab preference**

**Read and understand basic guides**

# **Number Representations**

**Binary representation**

**Hexadecimal**

**Bit operators**

**Guide: number.md**

# **Basic Electricity**

**Voltage and current**

**Ohms Law :  $V = I R$**

**Power :  $P = I V$**

**Driving an LED**

**Transistor switches**

**Breadboarding**

**Guide: [electricity.md](#)**

# **Unix Command Line**

**Moving around the file system**

**Creating, moving, and deleting files**

**Compiling and running programs**

**Profiles and paths**

**Guide: unix.md**

**Note: Attend cs107 labs this week**

# **Questionnaire**

**Will email "Accepts" by Tue**