Computer Systems from the Ground Up

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Learning Goal 1

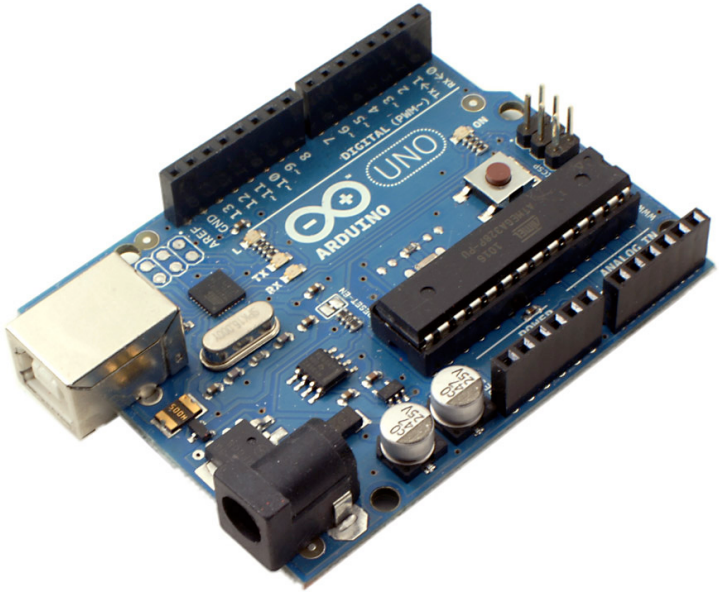
Understand how computers represent data and execute programs

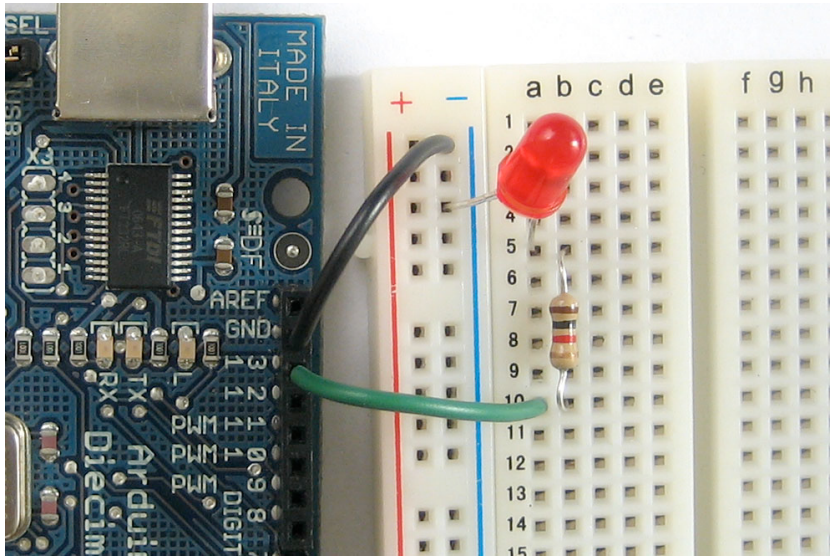
Arduino UNO

```
// Blink an led
int led = 13;

void setup() {
   pinMode(led, OUTPUT);
}

void loop() {
   digitalWrite(led, HIGH);
   delay(1000); // 1000 msec
   digitalWrite(led, LOW);
   delay(1000);
}
```





http://www.ladyada.net/learn/arduino/lesson3.html

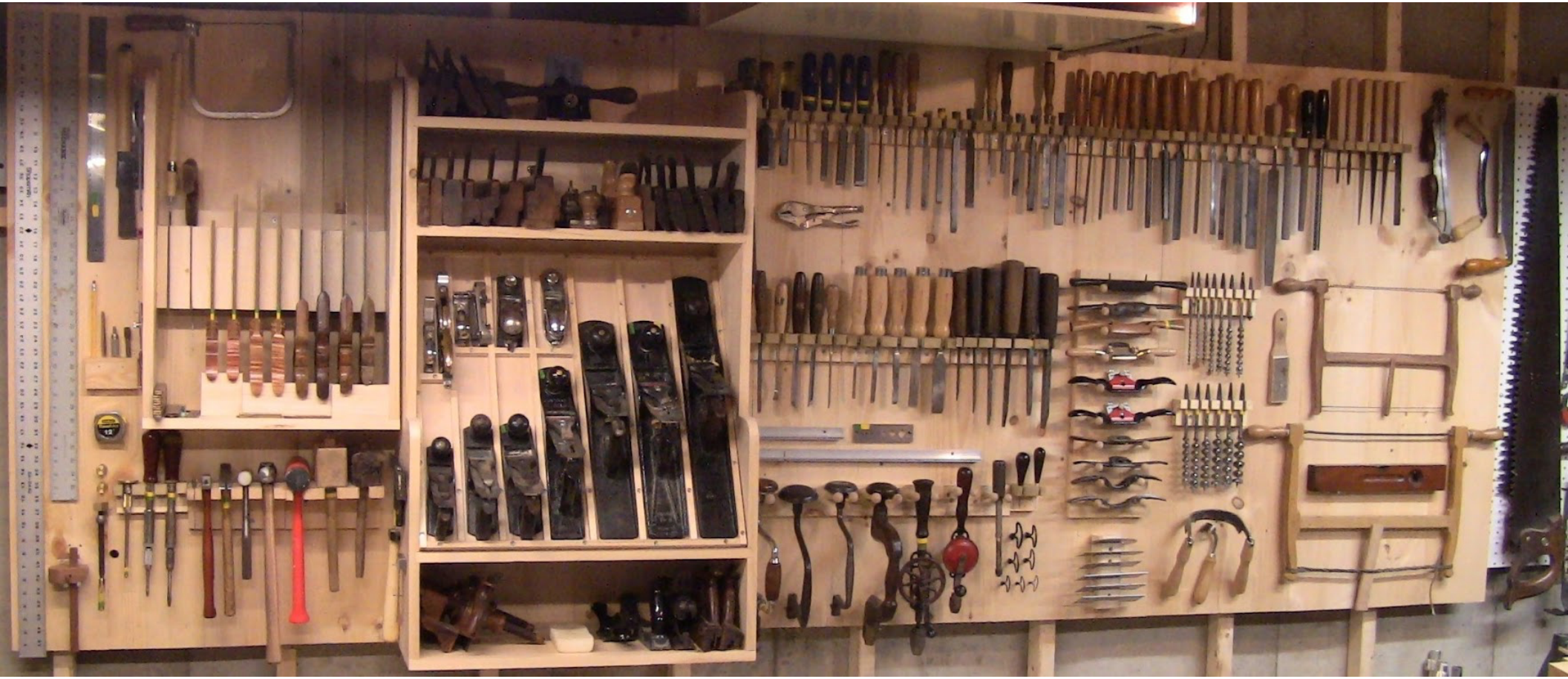
Quinn Dunki

http://quinndunki.com/blondihacks/

Learning Goal 2

Learn tools

Different Tools for Different Jobs



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


Mastery
https://paulsellers.com/tag/gouge/

Organize Your (Dev) Environment

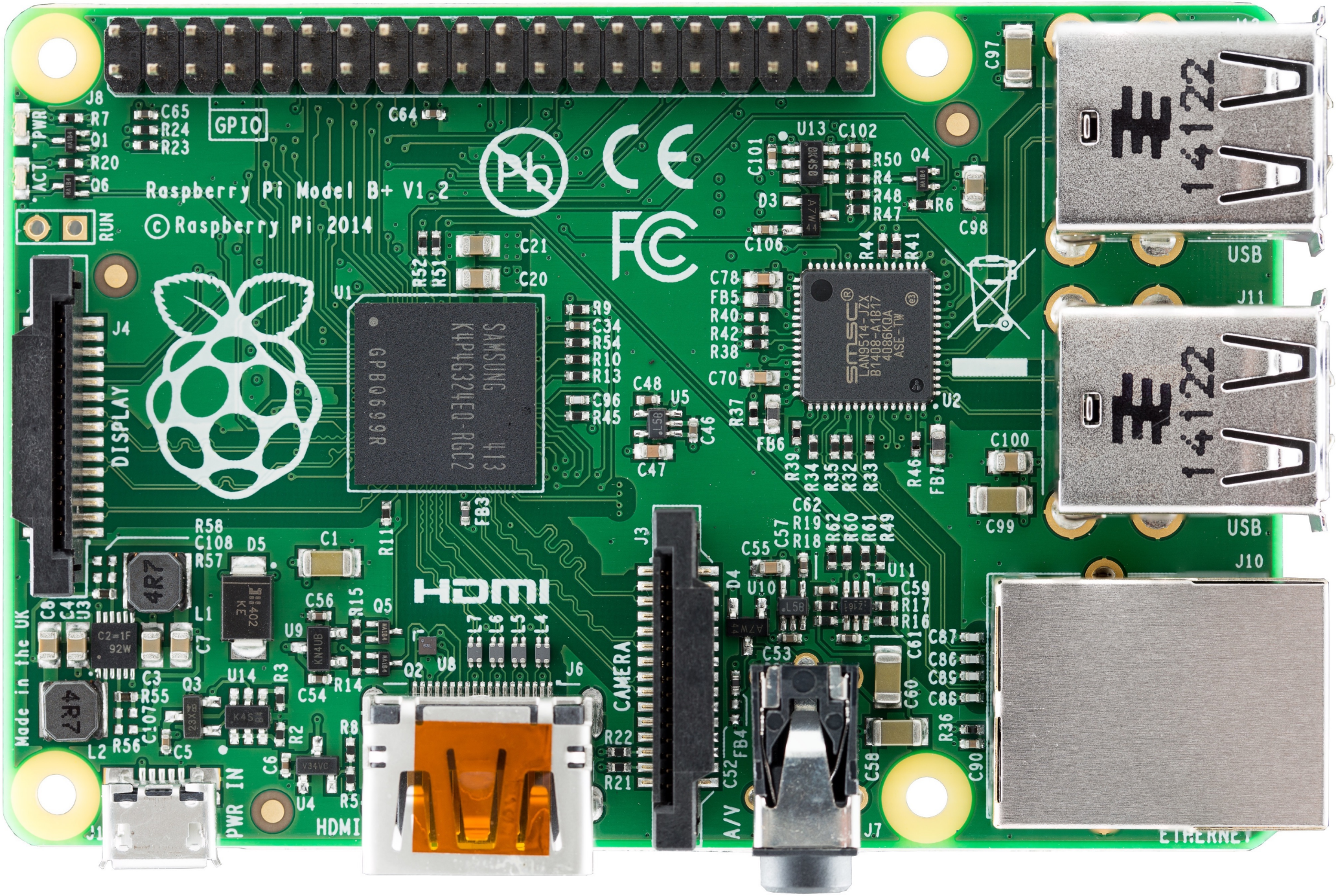
http://amhistory.si.edu/juliachild/

Approach

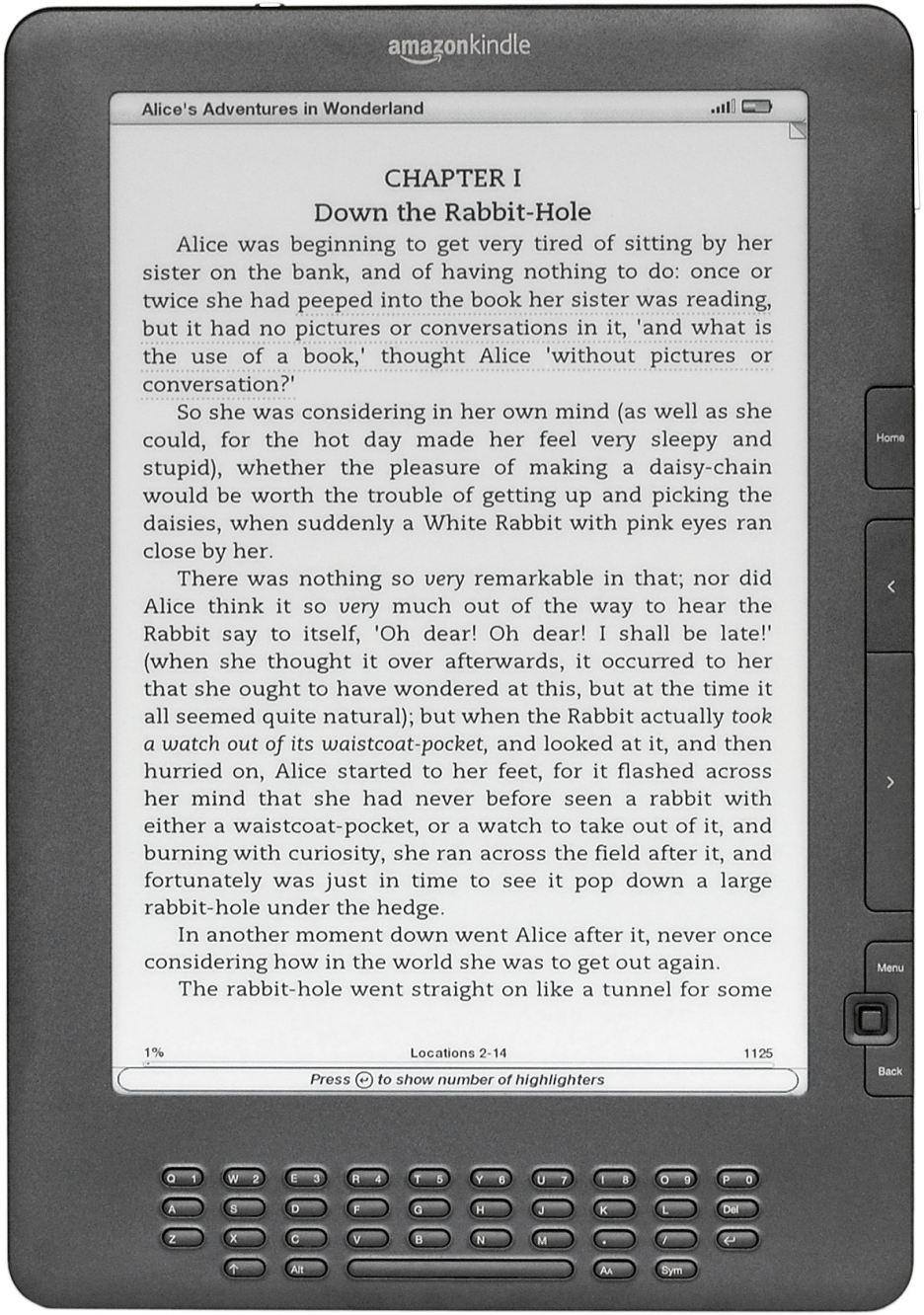
Bare Metal on the Raspberry Pi

Definition: Bare metal programming involves no operating system and minimal use of libraries.

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


Raspberry Pi Model B+ V1.2
© Raspberry Pi 2014
GPIO
DISPLAY
HDMI
CAMERA
A/V
USB
USB
ETHERNET
PWR IN
Made in the UK
SAMSUNG
K4P4G324EQ-RGC2
smsc
LAN9514-JZX
B1408-A1B17
4086KOA
ASE-TW

iPhone 3



Kindle 2


V3.co.uk
The Pi Store

Exercise

Inspect Raspberry Pi

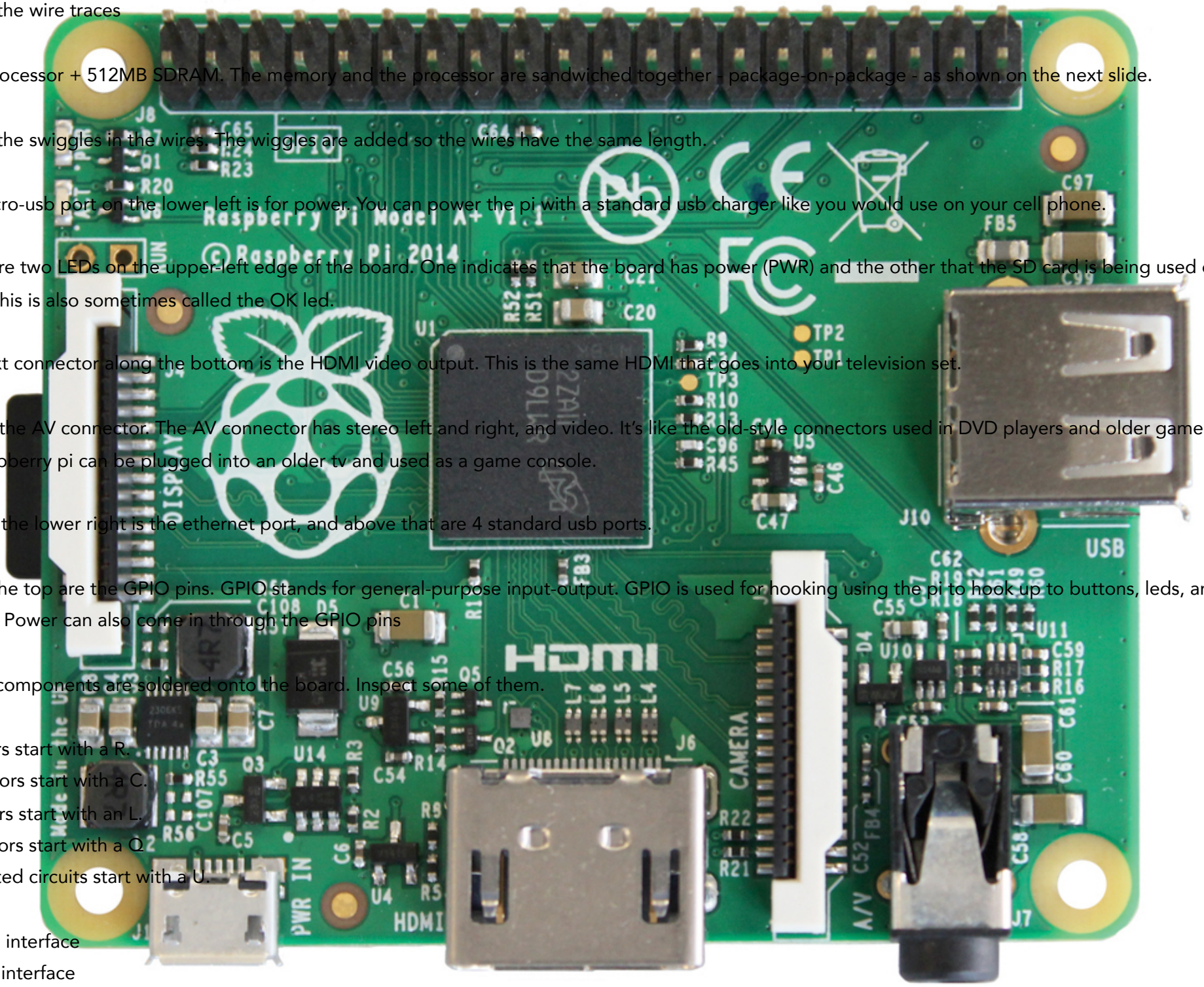
Notice the wire traces

ARM Processor + 512MB SDRAM. The memory and the processor are sandwiched together - package-on-package - as shown on the next slide.

Notice the swiggles in the wires. The wiggles are added so the wires have the same length.

The micro-usb port on the lower left is for power. You can power the pi with a standard usb charger like you would use on your cell phone.

There are two LEDs on the upper-left edge of the board. One indicates that the board has power (PWR) and the other that the SD card is being used or active (ACT); this is also sometimes called the OK led.



The next connector along the bottom is the HDMI video output. This is the same HDMI that goes into your television set.

Next is the AV connector. The AV connector has stereo left and right, and video. It's like the old-style connectors used in DVD players and older game machines. The raspberry pi can be plugged into an older tv and used as a game console.

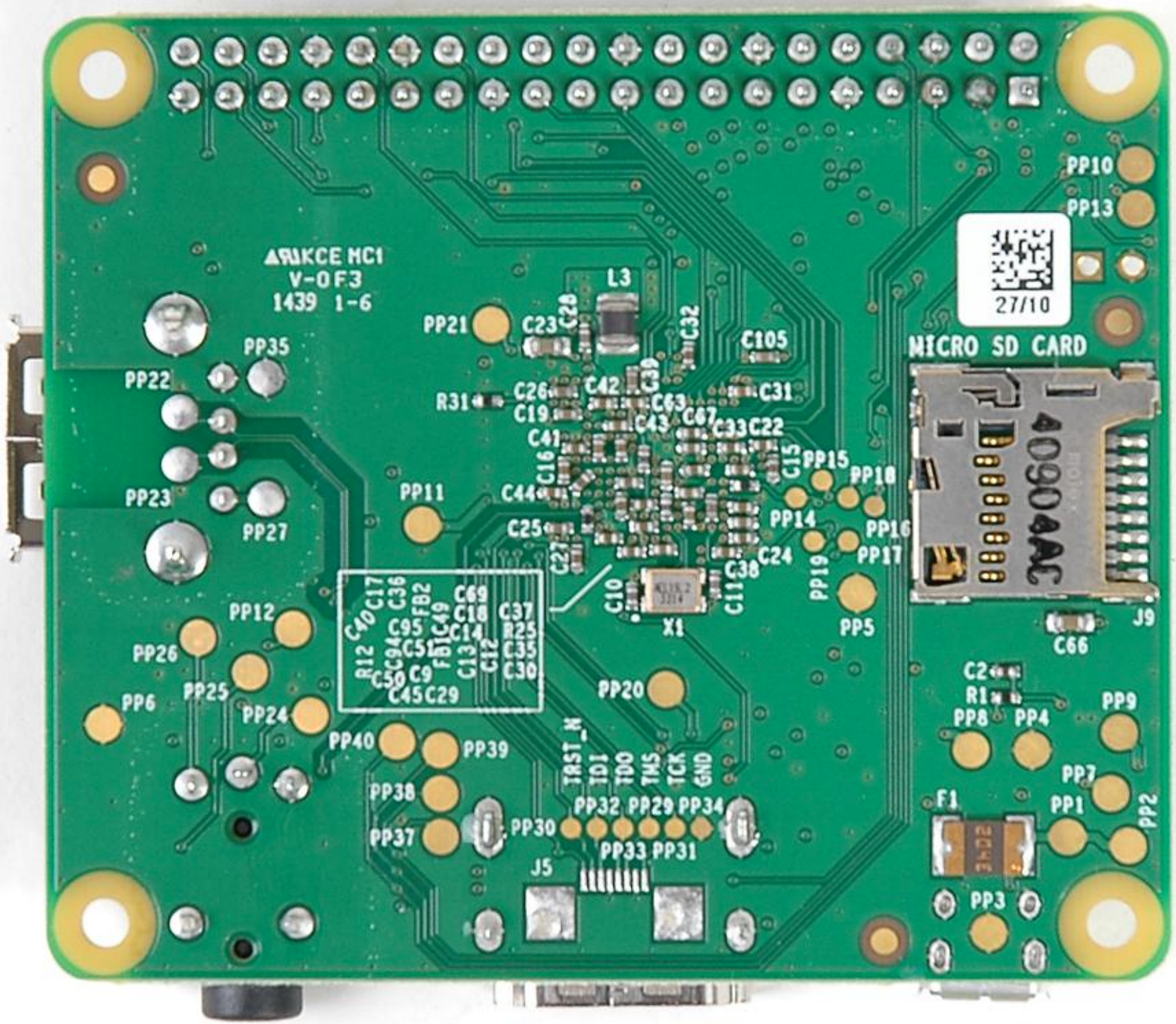
Next in the lower right is the ethernet port, and above that are 4 standard usb ports.

Along the top are the GPIO pins. GPIO stands for general-purpose input-output. GPIO is used for hooking using the pi to hook up to buttons, leds, and all sorts of stuff. Power can also come in through the GPIO pins

All the components are soldered onto the board. Inspect some of them.

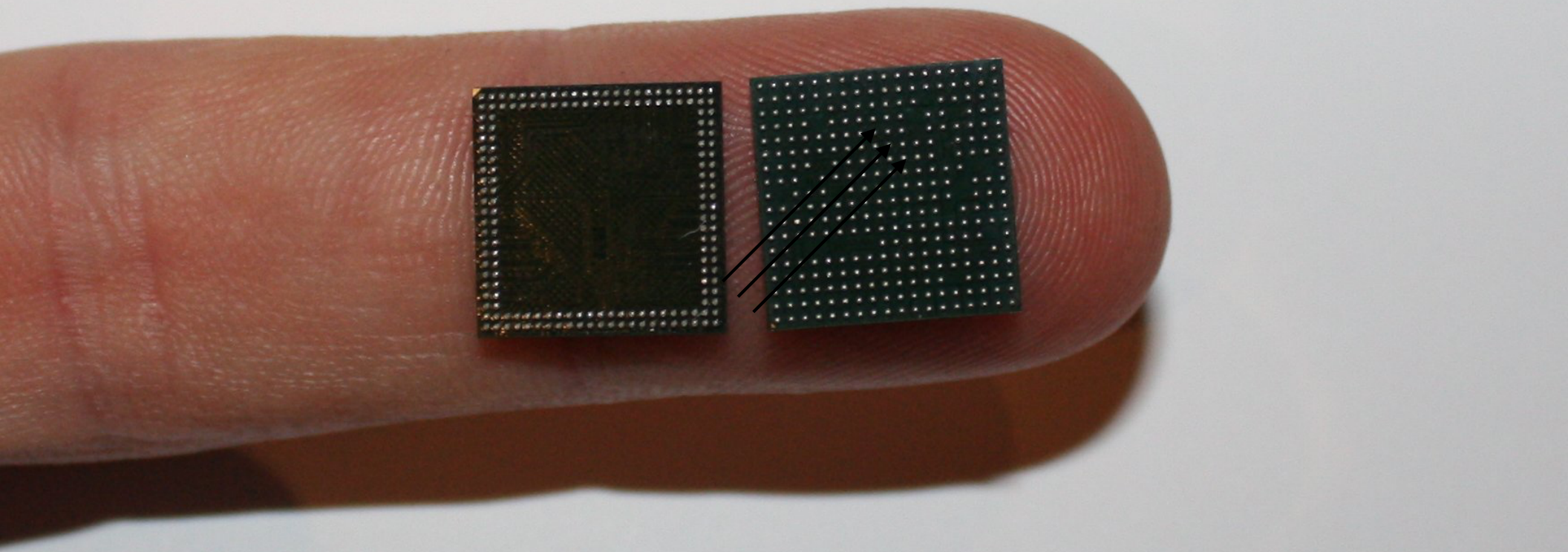
Resistors start with a R.
Capacitors start with a C.
Inductors start with an L.
Transistors start with a Q.
Integrated circuits start with a U.

Camera interface
Display interface


MICRO SD CARD
J9
J5
X1
L3
F1
C66
27/10
PP10
PP13
PP35
PP22
PP23
PP27
PP11
PP21
PP12
PP26
PP25
PP6
PP24
PP40
PP39
PP38
PP37
PP30
PP32
PP29
PP34
PP33
PP31
PP20
PP15
PP18
PP14
PP16
PP17
PP19
PP5
PP8
PP4
PP9
PP7
PP1
PP2
PP3
TRST_N
TDI
TDO
TMS
TCK
GND

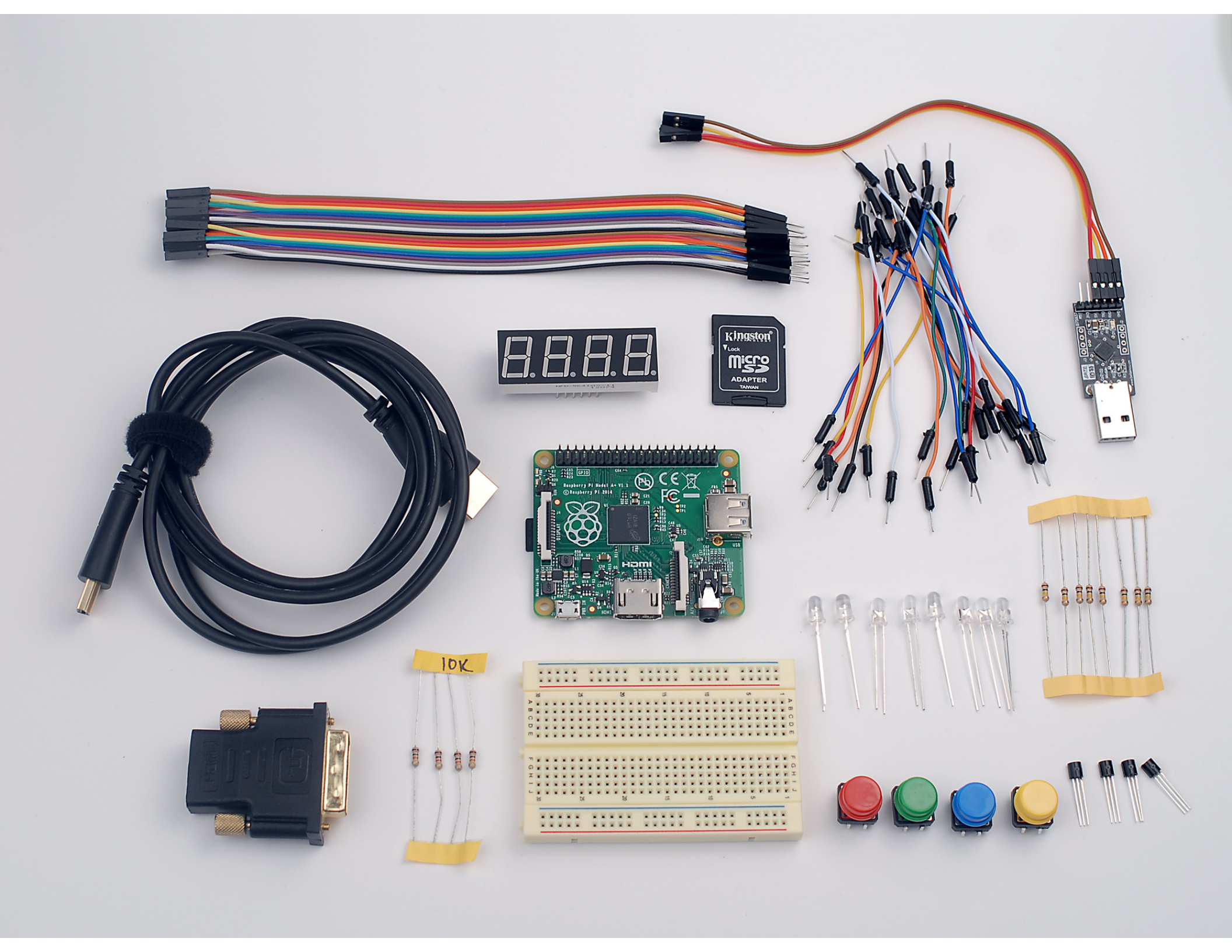
Package on Package

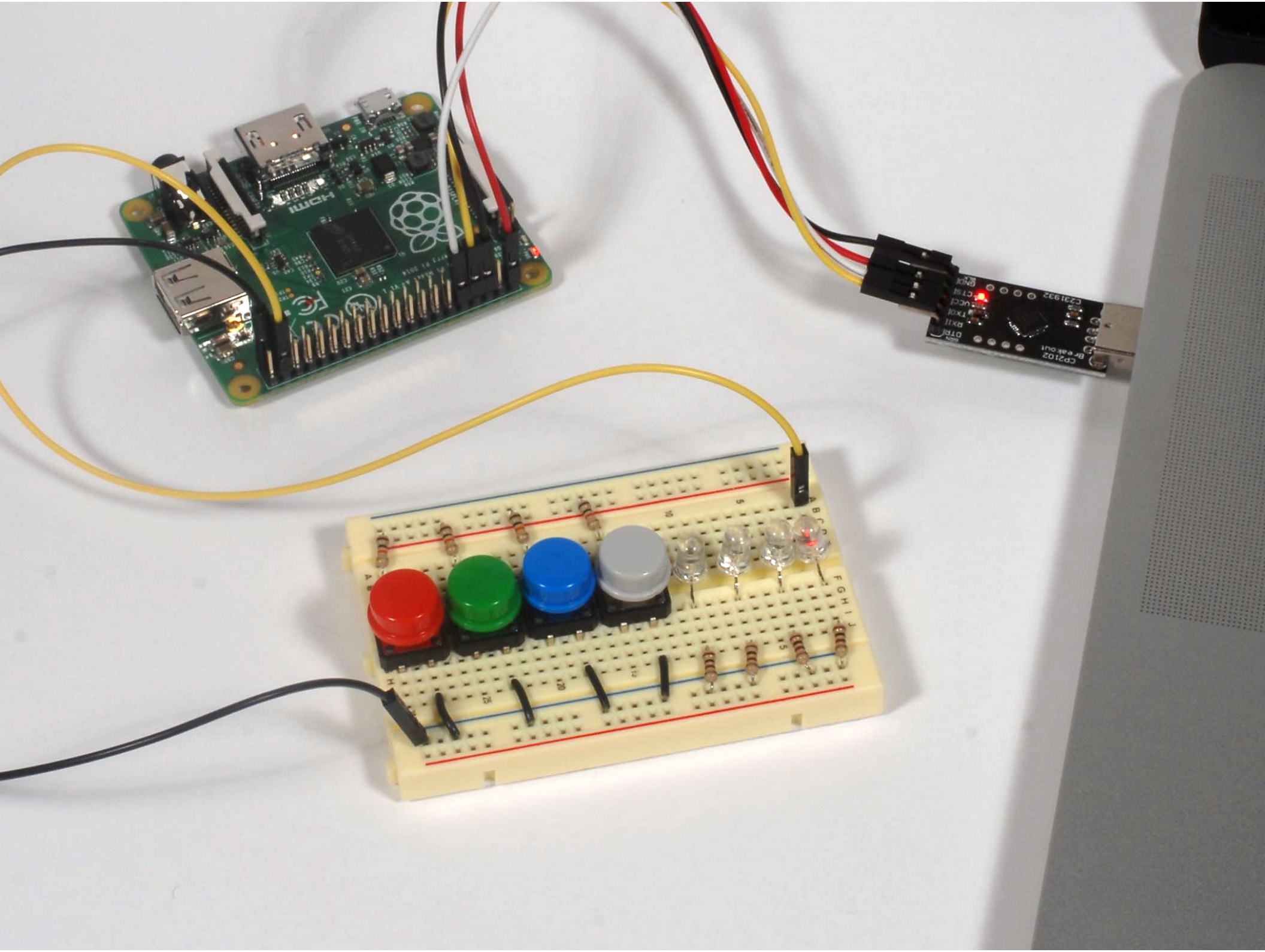
Broadcom 2865 ARM Processor
ARM1176JZF-S 700 MHz
ARMv6 Architecture



Samsung512MB SDRAM

Pi Kit


Kingston
Lock
micro SD
ADAPTER
TAIWAN
10K
HDMI



Manifest

Raspberry Pi A+

4GB SD card

USB-Serial breakout board

Breadboard and jumpers

LEDs, pushbuttons, resistors, and transistors

HDMI cable and HDMI-DVI adapter

Keyboard

Policy

Lab fee of $50 (collected during 1st lab)

You break/lose it, you replace it

The lab has a collection of useful parts that you are free to take

Course Topics

cs107e.github.io

§1 Baremetal Programming

1. ARM architecture
2. ARM Assembly language
3. C
4. Functions
5. Strings and serial communication
6. Memory allocation
7. Linking and loading

§2 Personal Computer

1. Graphics and the framebuffer
2. Keyboard input
3. Sound and MIDI
4. Interrupts

Computer History Museum Tour

Guest Lecture

§3 Additional Topics

1. Signed and unsigned arithmetic
2. Tasks
3. Networking protocols
4. Python
5. Towards Linux and beyond

Administration

Weekly Modules

Cadence

- 2 lectures on Fri and Mon
- Mandatory lab on Tue or Wed evening from 7-9 pm in Gates 325
- Assignment due following Mon at 12 midnight

Laboratories

Gates 325

Attendance is mandatory

Hands-on exercises

Submit completed check-list

Leave ready to do assignment

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

Lab: access to tools and supplies


Non-Contact Voltage Detector
EXTECH
INSTRUMENTS
NCV
REL
MODE
HOLD
RANGE
OFF
VAC
VDC
μA
mA
10A
°F
°C
EX330
AutoRanging
MultiMeter
CAT III - 600V
CAT II -1000V
COM
V/mA/μA/CAP
Ω/Hz/Temp
10A
600V MAX
600V
400mA
MAX
FUSED


Consolidated
ELECTRONIC WIRE & CABLE
100
FT
RoHs
36920
36822
36792
36856


SOLID
IDEAL INDUSTRIES
SYCAMORE IL U.S.A.

Assignments

7 assignments

- Build on each other

Two parts

- Basic
- Extensions

Final project

NO EXAMS

First Week

Assignment 0

Subscribe to cs107e in piazza

Enroll in the course officially

Attend cs107 UNIX labs

Assignment 0

- Using git and github

- Submit your lab preference

Read basic guides

Basic Electricity

Voltage and current

Ohms Law : V = I R

Power : P = I V

Driving an LED

Transistor switches

Breadboarding

Guide: electricity.md

Number Representations

Binary representation

Hexadecimal

Bit operators

Guide: number.md

Unix Command Line

Moving around the file system

Creating, moving, and deleting files

Compiling and running programs

Guide: unix.md

Note: Attend cs107 labs this week