Lab Lecture 3 – Fall 2018
Arduino

Intelligent Robotics Lab

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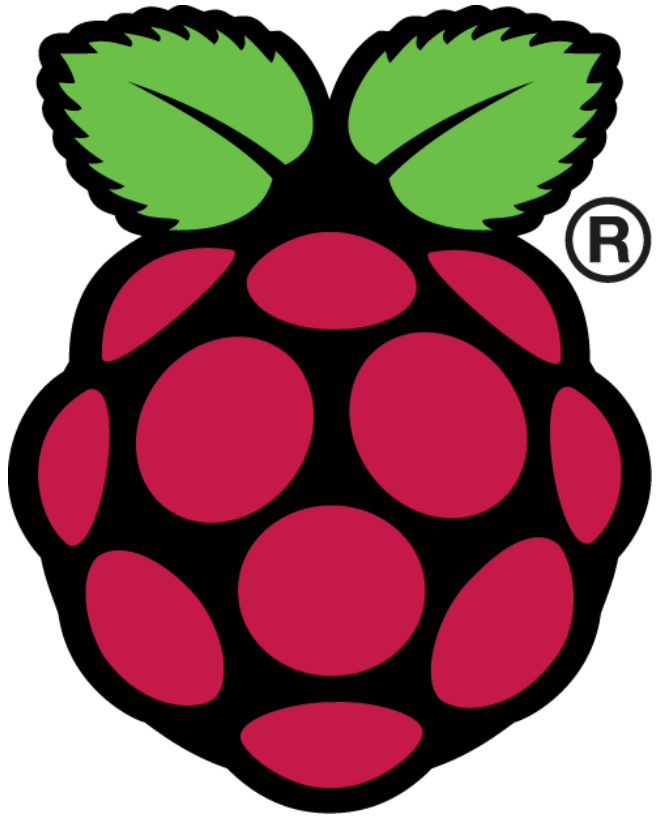
Introduction to Raspberry Pi



Who has any experience with Raspberry Pi?

Today's Agenda

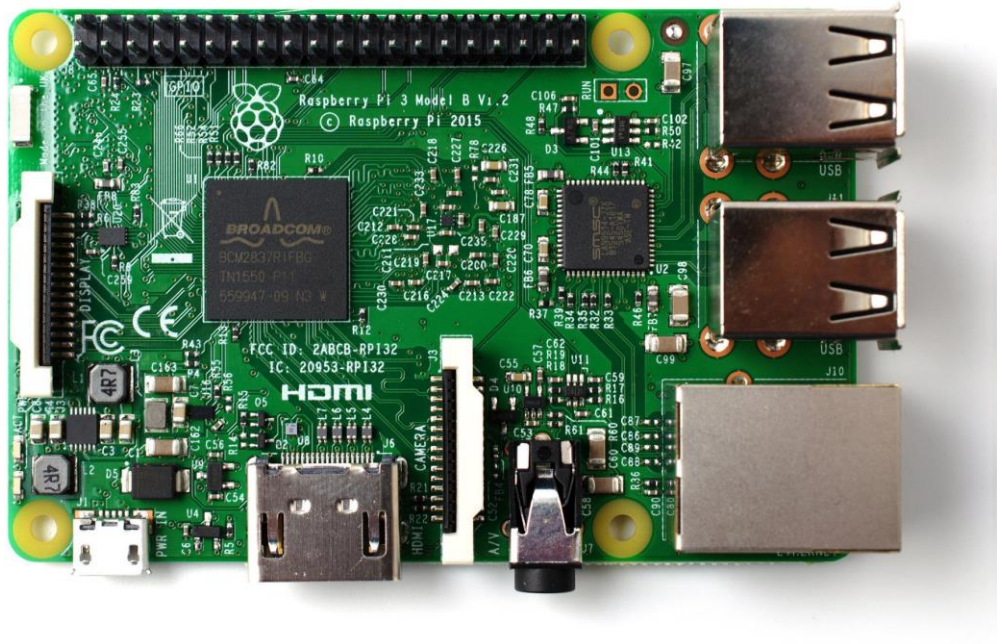
- What is Raspberry Pi?
- Raspberry Pi Specs?
- A little history of Raspberry Pi - What happened?, What is happening?
- What is on the board?
- Arduino vs Raspberry Pi
- Things that you can do with a Raspberry Pi
- What you will need
- First look – Quick demo
- How to set up your Raspberry Pi?
- SSH
- Next week

Lecture Description

- The goal of this lecture series is to equip students with the software, hardware, and basic programming skills required to program Raspberry Pi.
- We will use Raspberry Pi 3 and Linux OS that is specifically designed for Raspberry Pi.
- Students will also learn about the fundamentals of electronics and variety of different electronic components and devices that are widely used in robotics projects such as sensors, servo motors, dc motors, displays, LEDs etc.
- The lectures are designed as project-oriented, so students can have hands-on experiences based on the material thought in the lectures.

What is Raspberry Pi?

The Raspberry Pi is a credit card-sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word processing, browsing the internet, and playing games. It also plays high-definition video. (www.raspberrypi.org)



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Where can I buy one?

- You can get your Raspberry Pi board online on their website, or any other shopping websites such as Amazon, eBay, Adafruit, and Element14.
- You can also buy Raspberry Pi kits that comes with all the necessary things you need to use a raspberry Pi such as micro SD card, USB charger, and HDMI cable. Some kits include other electronics such as LEDs, buttons, switches, cables etc. to build simple electronic circuits.

What is the Raspberry Pi Foundation?

- The Raspberry Pi Foundation works to put the power of digital making into the hands of people all over the world, so they are capable of understanding and shaping our increasingly digital world, able to solve the problems that matter to them, and equipped for the jobs of the future.
- We provide low-cost, high-performance computers that people use to learn, solve problems and have fun. We provide outreach and education to help more people access computing and digital making. We develop free resources to help people learn about computing and how to make things with computers, and train educators who can guide other people to learn.
- https://www.raspberrypi.org/about/

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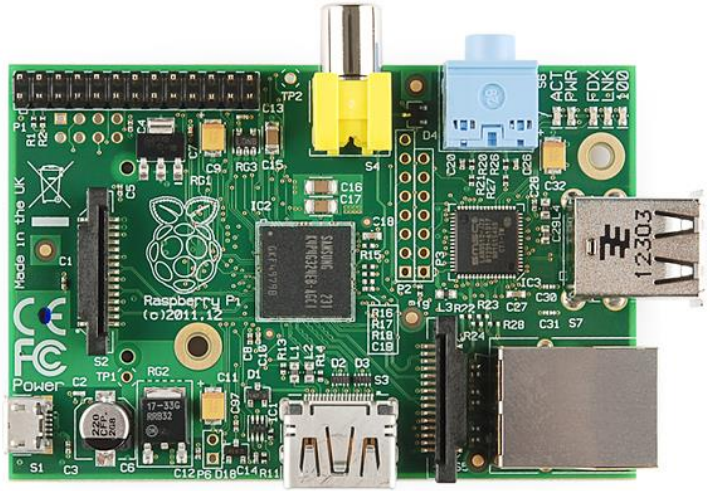
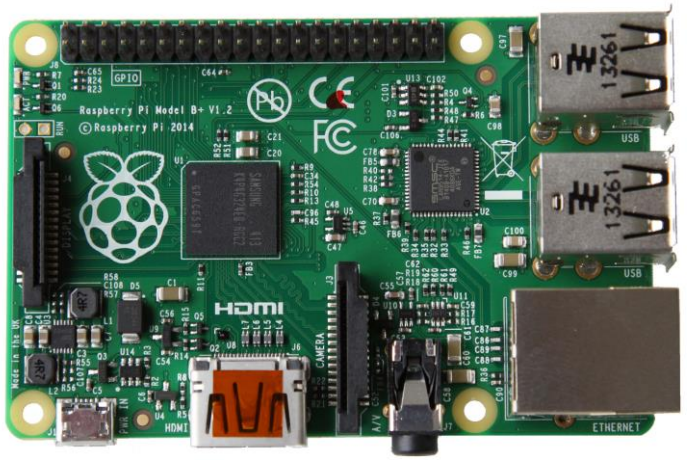
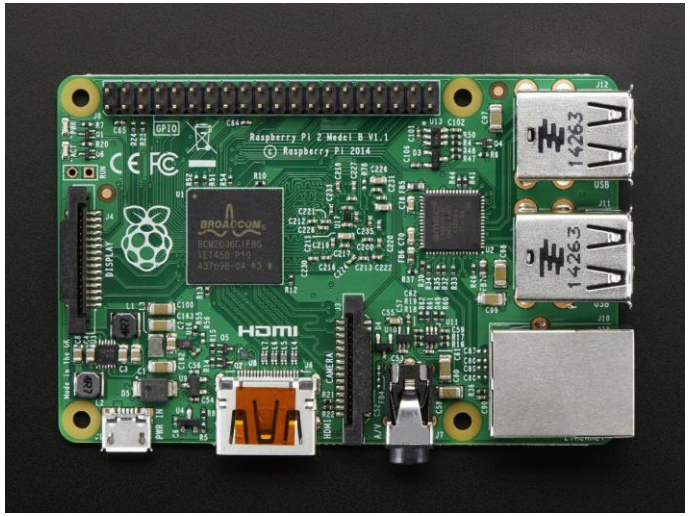
Raspberry Pi 3 Specs.

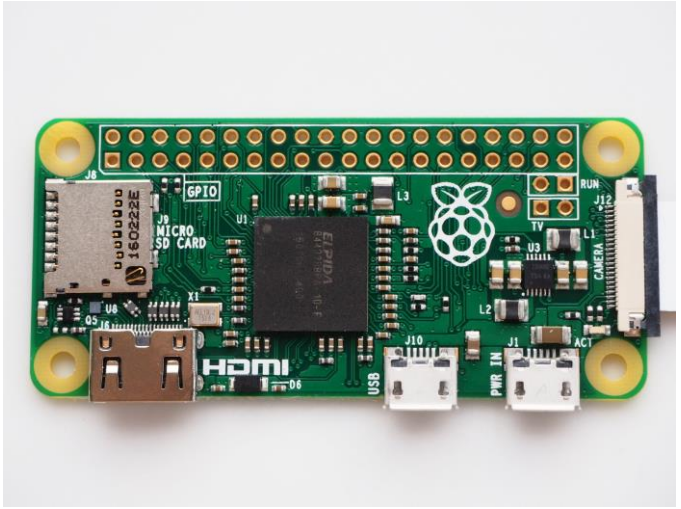
- Specifications
- **SoC:** Broadcom BCM2837 Chipset
  CPU: 4× ARM Cortex-A53, 1.2GHz
  GPU: Broadcom VideoCore IV
  RAM: 1GB LPDDR2 (900 MHz)
  Networking: 10/100 Ethernet, 2.4GHz 802.11n wireless
  Bluetooth: Bluetooth 4.1 Classic, Bluetooth Low Energy
  Storage: microSD
  GPIO: 40-pin header, populated
  Ports: HDMI, 3.5mm analogue audio-video jack, 4× USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI)

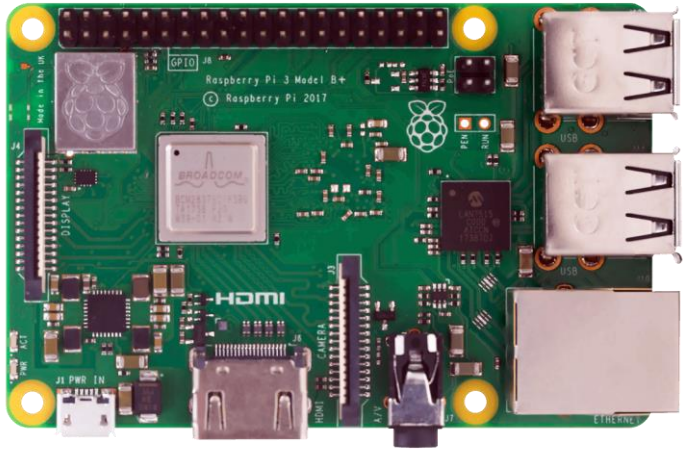
Raspberry Pi Family











[Raspberry Pi Timeline]

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Other Small Computers

	Raspberry Pi	Beaglebone Black	GK802 Mini PC	MK803 Mini PC	Hackberry	Goosberry	Parallella	ODROID-X2	Pandaboard es	Gumstix DuoVero Zephyr COM	MarsBoard	Cubieboard	UDOO	A13-OLinuXino	DragonBoard	Wandboard Quad	VIA APC (Rock)	SABRE Lite
CPU	ARM1176JZF-S (armv6k)	ARM Cortex-A8	AIRM Cortex-A8	ARM Cortex-A9	ARM Cortex-A8	ARM A10	ARM Cortex-A9 + 16/64 Epiphany Multicore Accelerator	Quad-core ARM Cortex-A9	OMAP4430 Dual-core ARM Cortex-A9	OMAP4430 ARM Cortex-A9	ARM Cortex-A8	ARM Cortex-A8	ARM Cortex-A9 (dual/quad core) & Atmel SAM3X8E ARM Cortex-M3	ARM Cortex-A8	Snapdragon 8074 Quadcore	ARM Cortex-A9 quad core	ARM Cortex-A9	ARM Cortex-A9 quad core
CPU Speed	700 Mhz	1GHz	1 GHz	1.5 GHz	1GHz	1 GHz	1 GHz	1.7 GHz	1.2 Ghz	1 GHz	1.2 GHz	1 GHz	1 GHz	1 GHz	2.3 GHz	1 GHz	800 Mhz	1 GHz
GPU	Broadcom VideoCore IV	PowerVR SGX530	AMD Z430/AMD Z160	AMD Z430/AMD Z160	Mali-400	Mali-400	Onchip	Mali-400	POWERVR SGX540	POWERVR SGX540	Mali-400	Mali-400	3x accelerators	Mali-400	Adreno 330	Onchip	Onchip 2D/3D	Tripple Play Graphics System & OpenVG Vertex
Ram	[SDRAM] 256MB (Model A, Model B rev 1) / 512 MB Model B rev 2	[DDR3] 512MB	[DDR3] 512 MB / 1GB	[DDR3] 512 MB / 1GB	[DDR3] 512MB/1GB	512MB	[DDR3] 1GB	[DDR2] 2GB	[DDR2] 1GB	1GB	[DDR3] 1GB	1GB	[DDR3] 1GB	512 MB	[DDR3] 2GB	[DDR3] 2GB	[DDR3] 512 MB	[DDR3] 1GB
Onboard Storage	NA	2GB Flash	4GB NAND Flash	4GB NAND Flash	4GB NAND Flash	4GB NAND Flash	NA	NA	NA	NA	4GB NAND Flash	4GB NAND Flash	NA	NA	NA	NA	4 GB NAND Flash	2MB SPI Flash
Expandable Storage	SD/SDHC/SDIO card slot	microSD	microSD	microSD	SDHC card	microSD	microSD	Mass storage microUSB	SD/MMC/SDIO/USB	mocroSD	microCD/SATA	microSD/SATA	microSD/SATA	microSD	microSD/SATA	2x microSD /SATA	microSD	Dual SD 3.0 /SDXC/SATA, TF CARD
Network Connection	10/100 Ethernet	2ports 10/100 Ethernet	802.11b/g, WAPI	802.11b/g, WAPI	10/100 Ethernet/802.11n	802.11 b/g/n	Gigabit Ethernet	10/100 Ethernet	10/100 Ethernet/Bluetooth/WLAN	802.11b/g/Bluetooth/Ethernet via expansionboard	10/100 Ethernet0/1WONNEW	10/100 Ethernet	Gigabit Ethernet	UEXT for Zigbee/Bluetooth/relays	Gigabit Ethernet, 802.11ac, Bluetooth 4.0/GNSS	Gigabit Ethernet, 802.11, Bluetooth	10/100 Ethernet	10/100 Ethernet
USB 2.0	1 port Model A/ 2 ports Model B	4+1 ports	2 ports	2 ports	2+1 ports	1 port	2 ports 1 OTG	6 ports	3 ports	via expansion board	2 ports 1 OTG	2 ports	2 ports 1 OTG + 2 microUSB	3 ports 1 OTG	2 ports 1 OTG (1 port USB 3.0)	1 ports 1 OTG	2 ports / microUSB (OTG)	2 ports USB (OTG)
HDMI	yes	yes	yes	yes	yes	yes	yes	yes	yes	via expansionboard	yes	yes	yes	no	yes	yes	yes	yes
Other display options	Composite RCA	no	no	no	Composite/component via 3.5mm	no	no	no	DVI	DVI	no	VGA via GPIO	no	np	Display port	no	VGA	RGB, LVDS
LCD Panel interface	no	yes	no	no	no	no	no	yes/RGB-24bit LCD	yes/LCD	yes/LCD via expansion board	no	no	yes/LCD+touch	yes/LCD+touch	yes/qHD LCD	yes/LCD	no	yes/LCD+touch
Audio	3.5mm /HDMI/I2S	3.5mm/HDMI	HDMI	HDMI	3.5mm/HDMI	3.5mm	HDMI	3.5mm	3.5 mm	3.5mm via expansionboard	HDMI	3.5 mm/HDMI	3.5mm in/out	3.5mm in/out	3.5mm in/out /HDMI	3.5mm Digital	3.5mm in/out/HDMI	3.5mm in/out/HDMI
GPIO/misc Ports	8x, I2C bus, SPI bus	69 pin GPIO/SPI, I2C, 4 serial ports, CAN GPMC/ MMC/ AIN/ XDMA/	NA	NA	4 pin serial	NA	48 pin in 4 expansion headers	50pin IO LCD/I2C/UART/SPI/ADC/ GPIO	RS232/JTAG	various via breakout board	140 pin GPIO	96 pin GPIO/ I2c/SPI/RGB/LVDS/CSI/TS /FM-IN/ADC/CVBS/VGA/SPDIF OUT	76 pin GPIO/various/Arduino	68/74 pin GPIO	GPIO Header/RS-232/JTAG/NFC/Onboard sensors	47 pin GPIO	GPIO, SPI, I2C bus header	PCIe port, GPIO, 10-pin JTAG, SPI, CAN, I2C bus header, RS232, RS485
real time clock	NA	optional	No info	No info	No info	No info	No info	yes	No info	No info	No info	No info	yes	No info	No info	yes	No info	yes
OS Support	Various Linux/ Debian, Android, BSD, RISC OS, webOS	Various Linux/ Ubuntu, Debian, Gentoo, ArchLinux, LinuxCNC, Minix, XNU, FreeBSD, Nintendo, Symbian, QNX, Windows CE	Android 4.0	Android 4.0	Various Linux/ Debian, Hackb3rry, Fedora, Android ICS	Android ICS, Ubuntu	Various Linux/ Ubuntu	Android 4.0/Ubuntu	Linux/Ubuntu	Linux Kernet	Various Linux/Ubuntu/Fedora/Android	Various Linux/ Ubuntu, Android	Android/Linux/ ArduinoTM	Android 4/Linux	64-bit Linux Ubuntu	Various Linux/ Ubuntu, Android	Android 4.0 (PC System)	Various Linux / Linux BSP/Ubuntu/ LTIB/Timesys/ Android
Size LxW (mm)	85.6x53.98	87x53	88.5x35	56x34	100x80	86x54	86x53	90x54	114.3x101.6	58x17	80x55	100x60	110x90	120x120	Mini-ITX	95x95	170x85	83x83
Power	300 mA (1.5W) Model A / 700 mA (3.5W) Model B	5V / 460mA (2.4W max)	5V/?	5V/?	5.5V / 700mA (4W)	5V/?	5W	5V/?	5V/2.5A	5V/?	5V/2A	5V/2A	12V	6V / 1A (6W)	ATX power	2A @ 5V	13.5W max	5V @ 4A (20W)
Cost	$25 / $35	$45	$59	$69	$65	$61	$99	$89	$162	$242-264 kit	$49.90	$49	$109-119	$59	$499	$129	$	$179

Raspberry Pi versus The World : Round One (July 25th, 2013 - version 1 - Cabe Atwell)

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Raspberry Pi Models Comparison

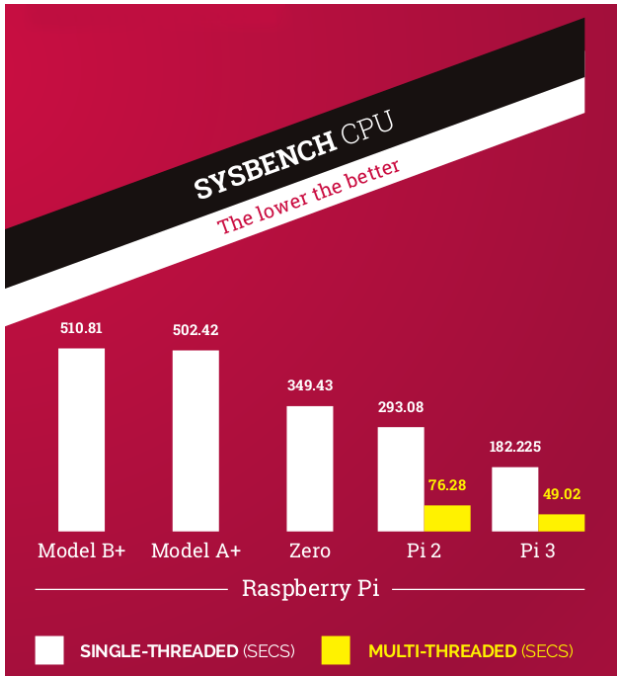
	Raspberry Pi 3 Model B	Raspberry Pi Zero	Raspberry Pi 2 Model B	Raspberry Pi Model B+
Introduction Date	2/29/2016	11/25/2015	2/2/2015	7/14/2014
SoC	BCM2837	BCM2835	BCM2836	BCM2835
CPU	Quad Cortex A53 @ 1.2GHz	ARM11 @ 1GHz	Quad Cortex A7 @ 900MHz	ARM11 @ 700MHz
Instruction set	ARMv8-A	ARMv6	ARMv7-A	ARMv6
GPU	400MHz VideoCore IV	250MHz VideoCore IV	250MHz VideoCore IV	250MHz VideoCore IV
RAM	1GB SDRAM	512 MB SDRAM	1GB SDRAM	512MB SDRAM
Storage	micro-SD	micro-SD	micro-SD	micro-SD
Ethernet	10/100	none	10/100	10/100
Wireless	802.11n / Bluetooth 4.0	none	none	none
Video Output	HDMI / Composite	HDMI / Composite	HDMI / Composite	HDMI / Composite
Audio Output	HDMI / Headphone	HDMI	HDMI / Headphone	HDMI / Headphone
GPIO	40	40	40	40
Price	$35	$5	$35	$35

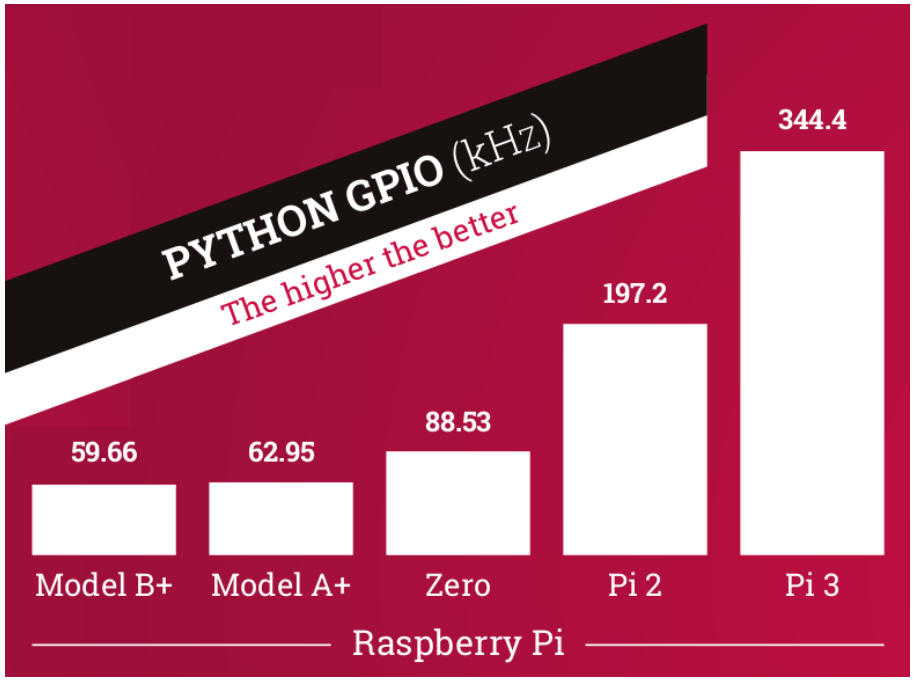
Raspberry Pi Models Comparison

Raspberry Pi 3B+ vs Raspberry Pi 3B

No	Specification	Raspberry Pi 3B+	Raspberry Pi 3B
1	Release Date	14th March 2018	29th Feb 2016
2	SOC Type (Processor)	Broadcom BCM2837B0 (with metal cover)	Broadcom BCM2837
3	Core Type	Cortex-A53 64-bit	
4	No. of Cores	4 Cores	
5	GPU	VideoCore IV	
6	CPU Clock	1.4 GHz	1.2 GHz
7	Memory	microSD	
8	RAM	1 GB LPDDR2	
9	Ethernet	Gigabit over USB 2.0 (Max 300Mbps)	Megabit (Max 100Mbps)
10	USB Port	4 x USB 2.0	
11	HDMI	1 x full size HDMI	
12	WiFi	802.11 b/g/n/ac (Shielded)	802.11 n
13	Bluetooth	4.2 (Shielded)	4.1 LE
14	Antenna	PCB Antenna (Similar to Rpi Zero W)	Chip Antenna
15	GPIO	40 pins	
16	Operating System	Latest Raspbian (> March 2018)	Backward compatible
17	Dimension	85mm x 56mm	
18	POE	Yes, with PoE HAT	No
19	Power Rating	1.13A @ 5V	1. 34A @ 5V

Newer model = Better performance





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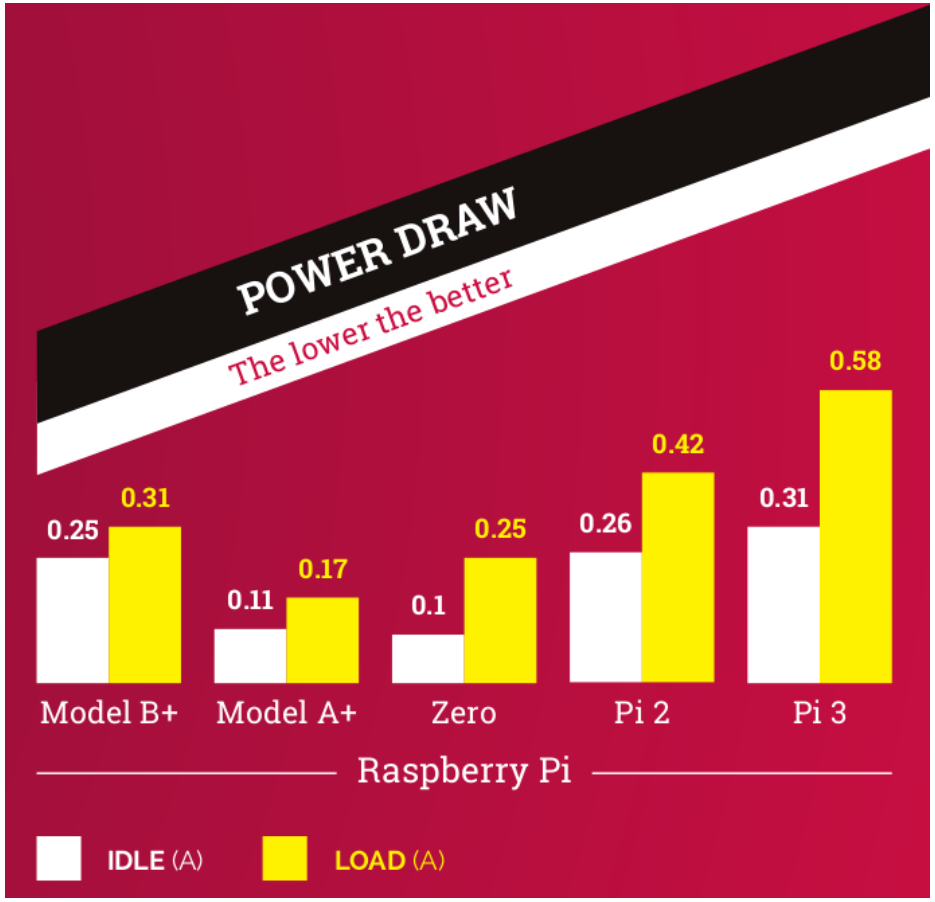
What about power consumption?



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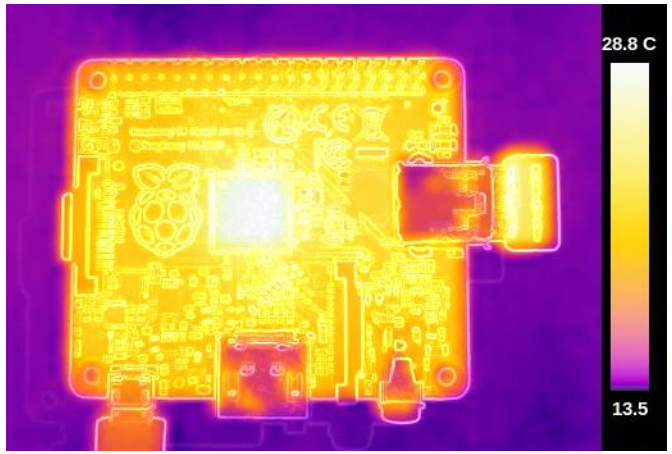
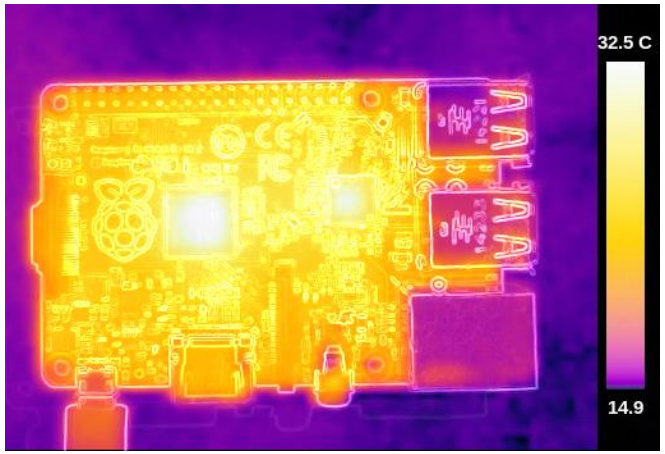
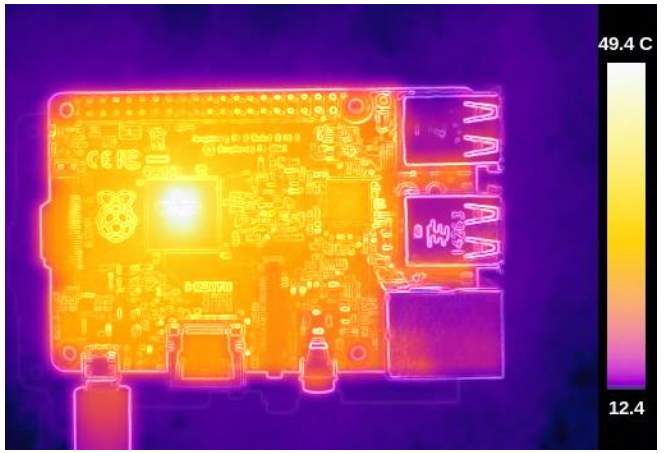
Is it getting hot?



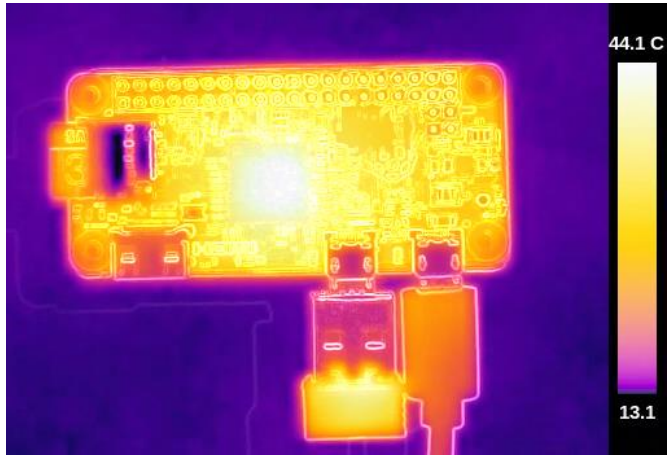
Model A



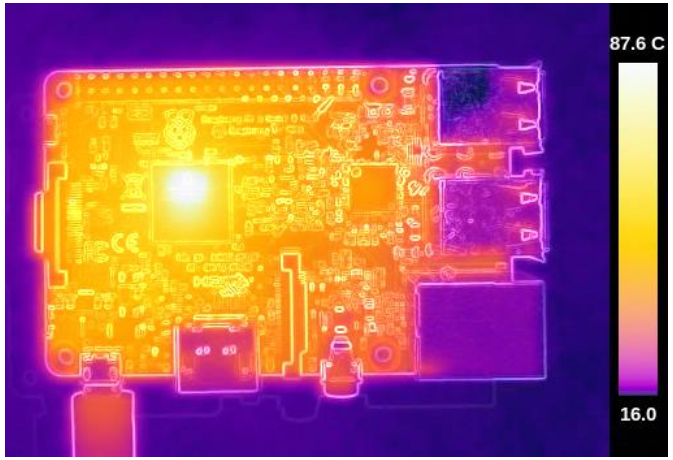
Model B



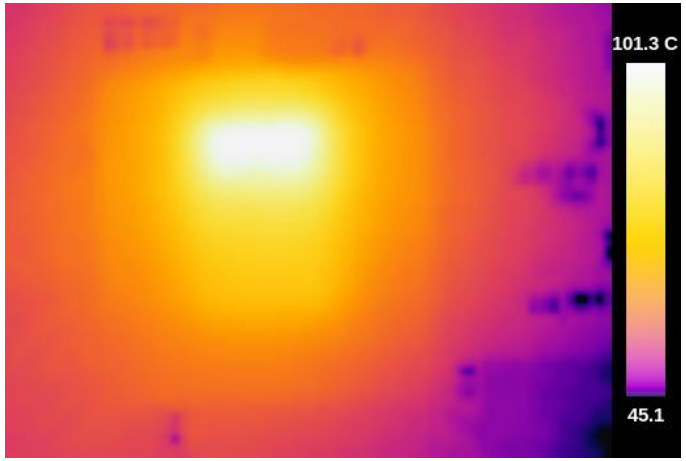
Model 2B



Pi Zero



Pi 3 Model B



Pi 3 Model B CPU

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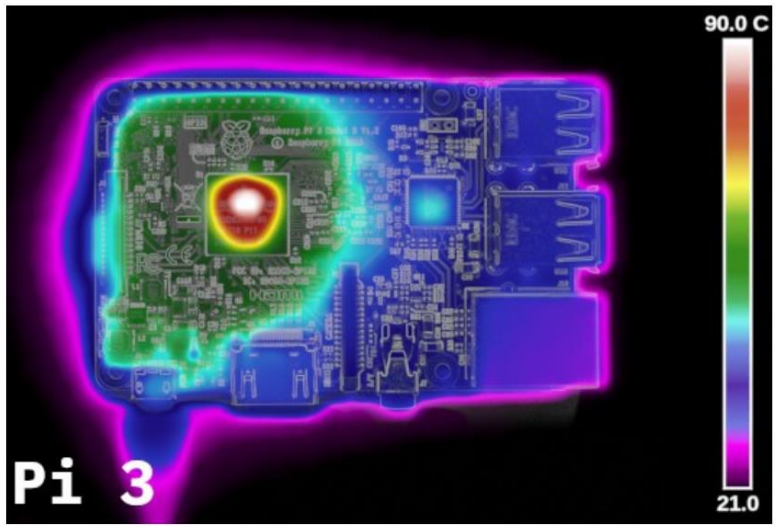
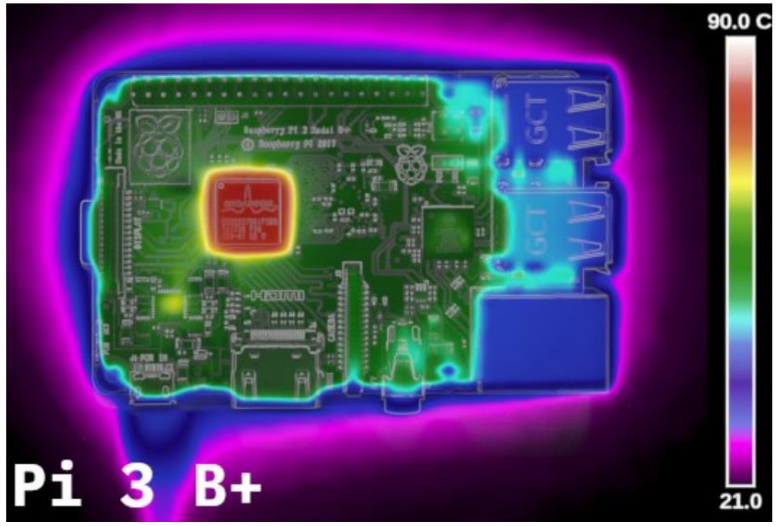
Is it getting hot?



Raspberry Pi 3 Thermal Photograph



Raspberry Pi 3 B+ Thermal Photograph

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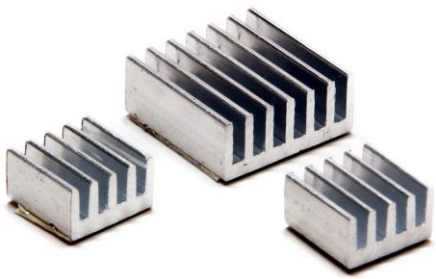
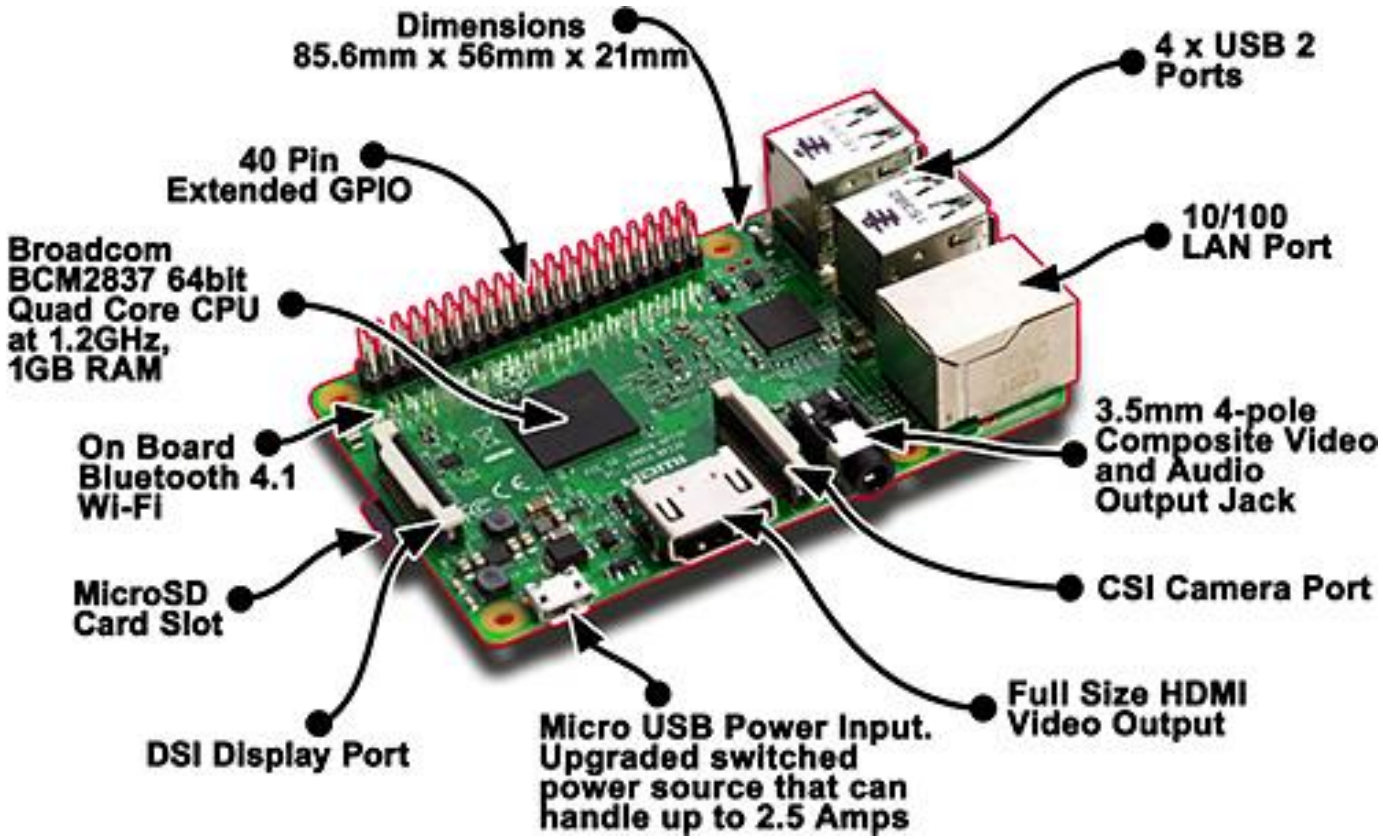
Raspberry Pi Heat Sinks and Cooling Fan



Heat Sink

Cooling Fan

What is on the board?



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DSI Display Port

DSI stands for Display Serial Interface. According to MIPI, DSI specifies the interface between a host processor and a peripheral such as a display module. It is a high-speed serial interface based on a number of data lanes. The chipset on the board sends the graphics data directly to the display panel trough this port. That allows us to connect color LCD to a Raspberry Pi.

Some of the advantages of DSI:

- High bandwidth 1Gbits.
- Low operating voltage (200mV)
- Less noise
- Less electromagnetic interface
- Lower price
- Less power consumption

According to, Raspberry Pi foundation DSI displays are only created and sold for special purposes such as smartphones, tablets, and other mobile devices.

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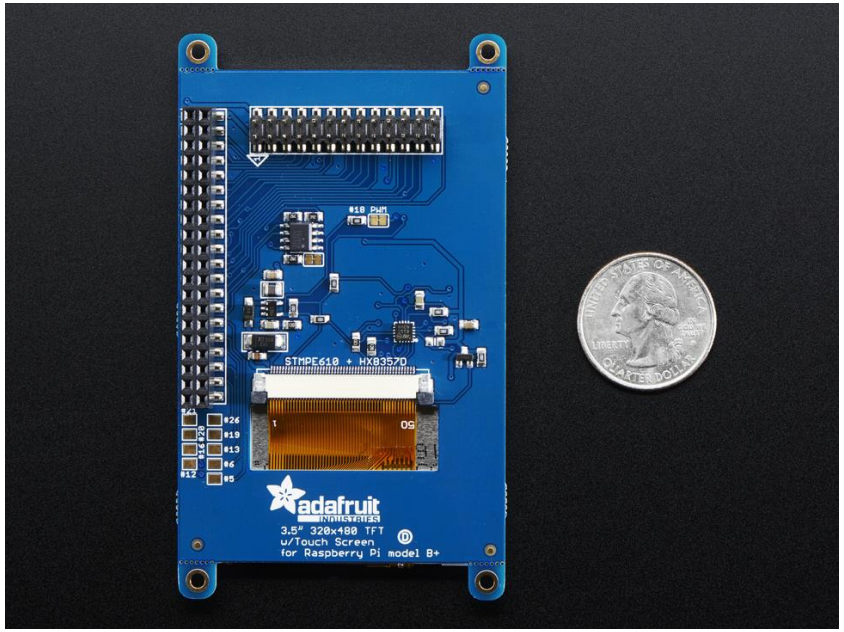
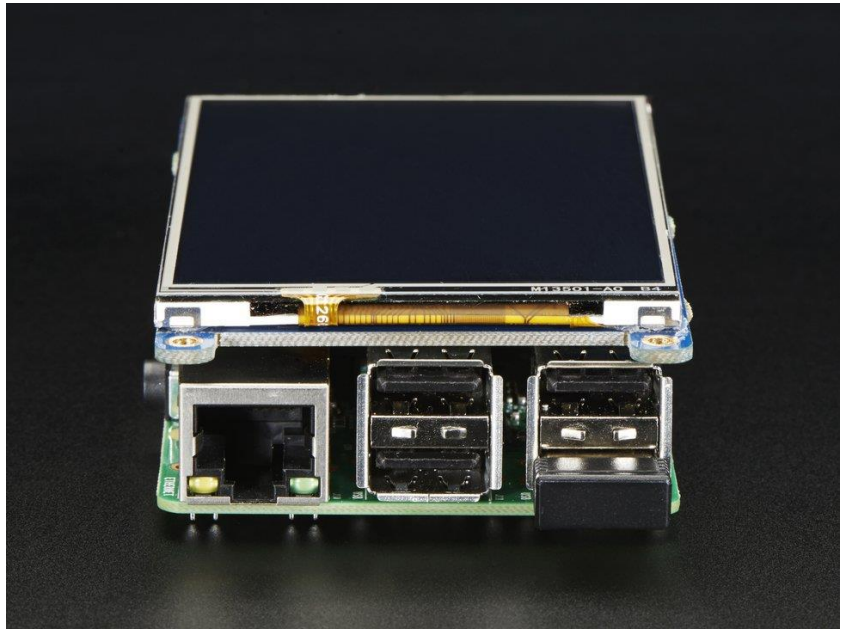
What other display options do we have?

- https://www.adafruit.com/product/2097
- It is a touch screen TFT display that uses the hardware SPI pins to send the graphics data to the display. That means it uses some of the GPIO pins.
- Resolution is reasonable.





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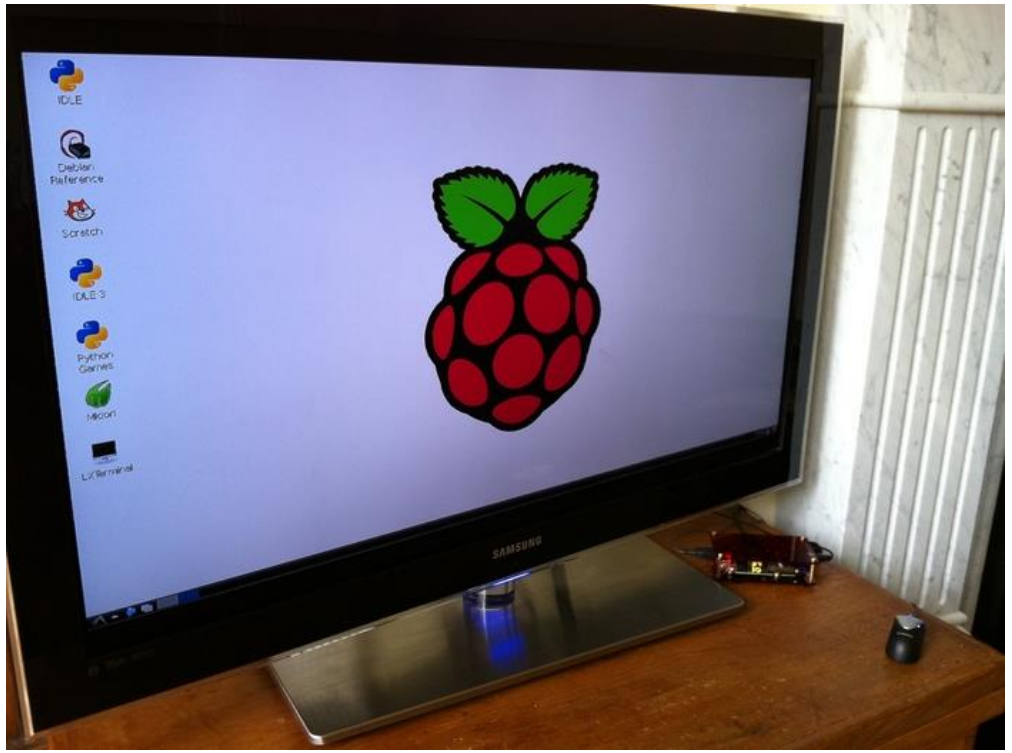
HDMI and Composite Video & Audio

You can use your Raspberry Pi with any display or TV that has a HDMI input.
If you have an ancient display that uses RCA connecter, you can connect your Raspberry Pi to your display with a composite video adaptor.



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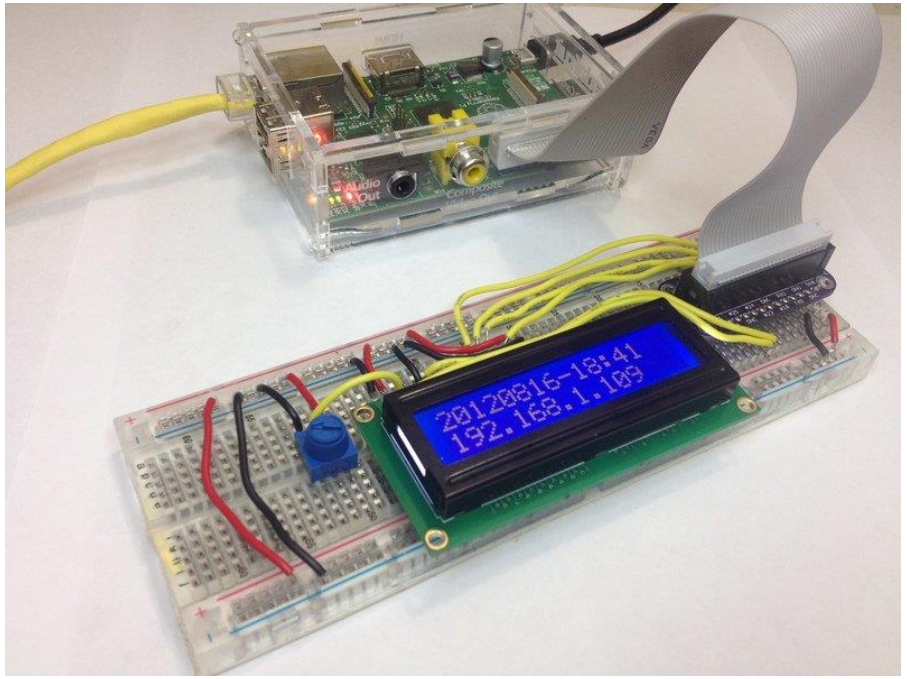
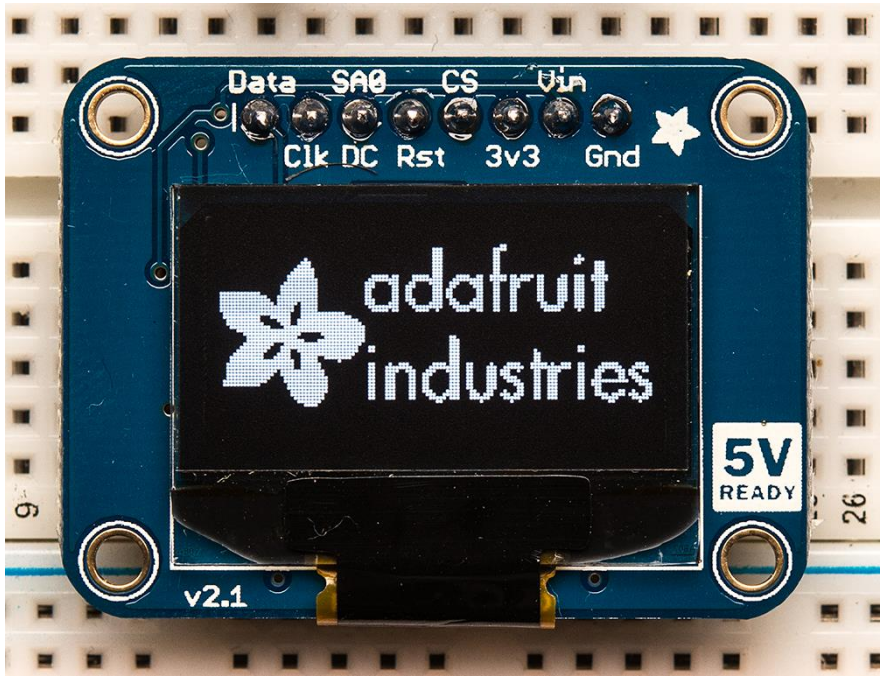
Character cell LCD and OLED Graphic Display

They are easy to use and find, cheap, usually very small. Character cell LCD usually uses the UART serial communication port and Graphic displays uses SPI or I2C communication ports. Therefore, you don’t need a specific cable, connector, or a an adaptor to connect them to your Raspberry Pi. You can use use a bread board and several cables to use them in your project.





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What is GPIO?

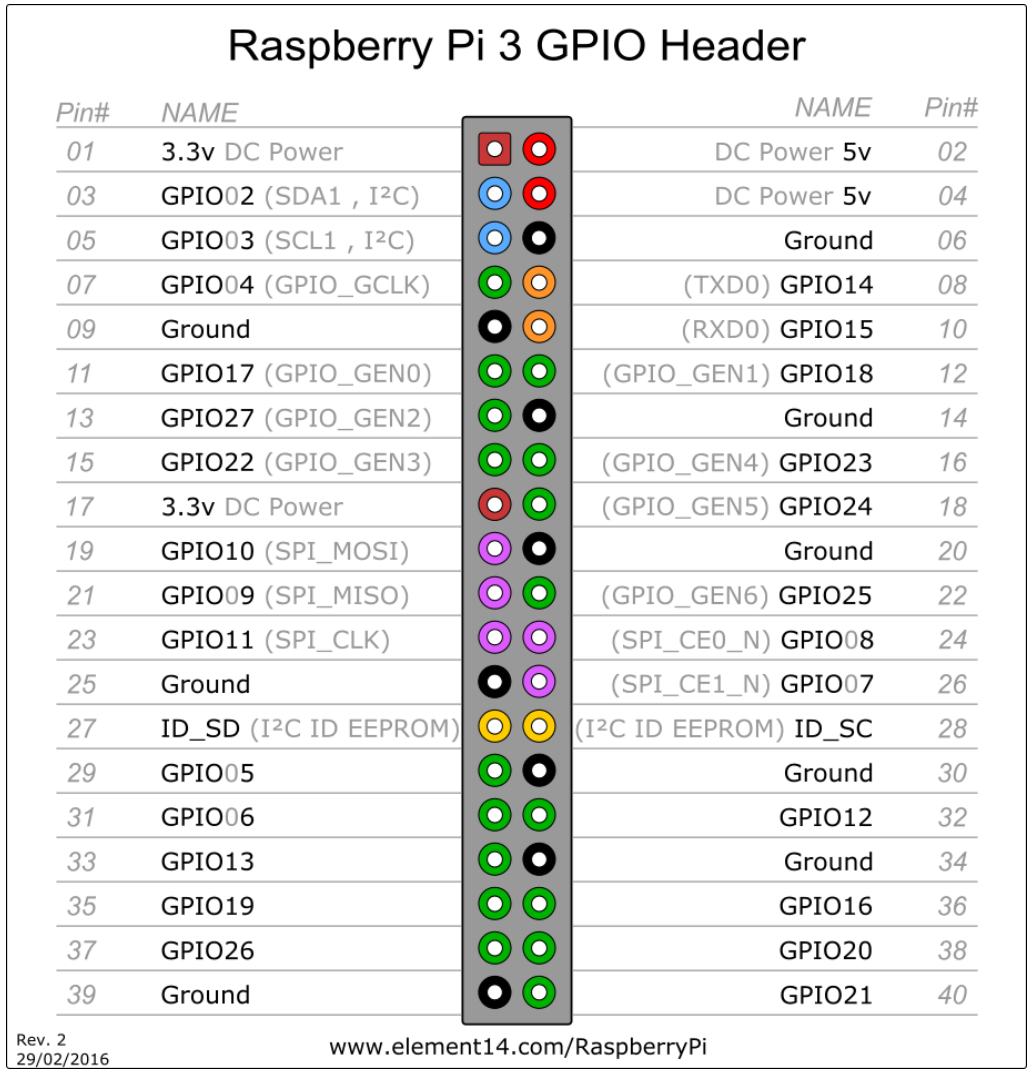
- GPIO stands for General-Purpose Input-Output.
- It is a generic set of pins on an integrated circuit or computer board.
- They are the physical interface between a computer and outside world.
- They can be used as an input or output.
- They have no standard purpose. That means every device can have a different types of GPIO pins or their pin layout could be different on each board.
- They can be used for serial communication, powering a device, or reading analog or digital data.
- You need to read device datasheet before you program GPIO pins.

GPIO on Raspberry Pi

- The header provides 5V on Pin 2 and 3.3V on Pin 1.
- The 3.3V supply is limited to 50mA.
- The 5V supply draws current directly from your microUSB supply so can use whatever is left over after the board has taken its share.
- A 1A power supply could supply up to 300mA once the board has drawn 700mA.
- Using the GPIO outputs is an easy task. They are on or off. In other words, the signal on a GPIO output pin can be HIGH or LOW. HIGH means 3.3v and LOW means 0v.
- **Be careful!** The most pins are directly connected to the chipset. That means there is no voltage protection on the board. If you do something wrong, you can easily damage your Raspberry Pi.

Raspberry Pi GPIO Pinout

- **24x** - GPIO pins
- **2x** - SPI bus
- **1x** - I2C bus
- **2x** - 5V power pins
- **2x** - 3.3V power pins
- **8x** - Ground pins



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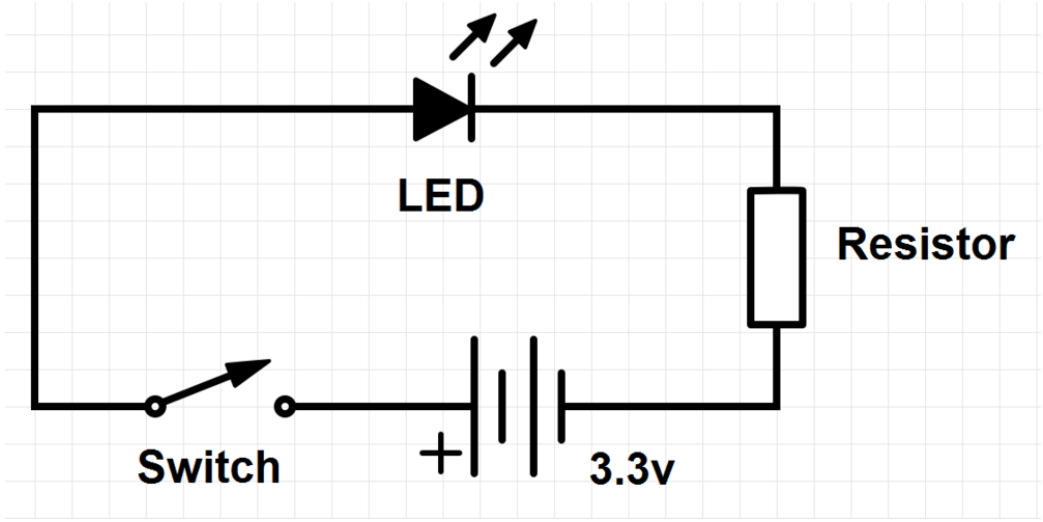
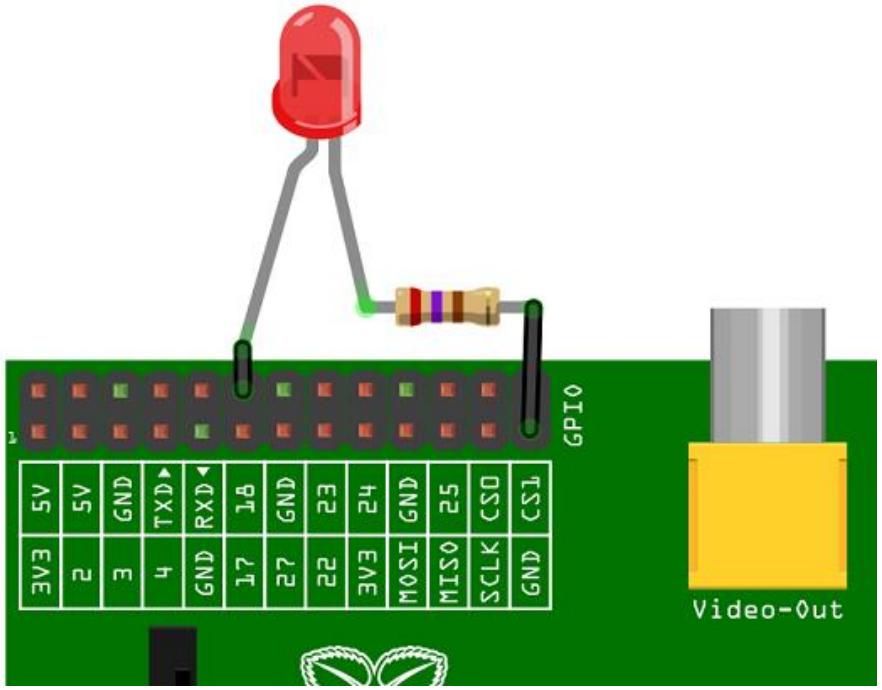
A Simple circuit design that uses the RasPi GPIO Pins.





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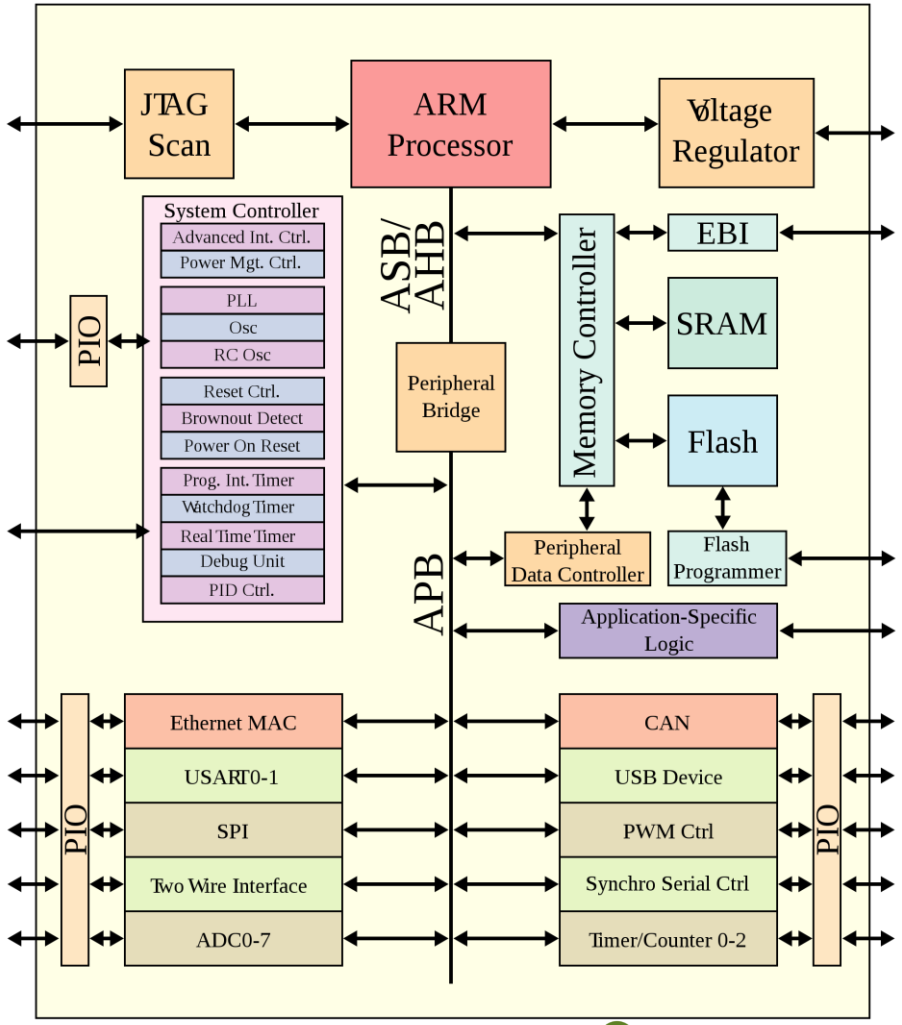
What is SoC?

- SoC means System on a Chip.
- SoC is an integrated circuit that includes all components of a computer or other electronic system into one single chip.
- It may contain PID controller, audio receiver, ADC (Analog Digital Converter), sensors, memory etc.
- System-on-a chip technology is used in small, and usually complex electronic devices such as smartphones, tablet computers, single board computers, FPGA boards etc.



What is Arm?

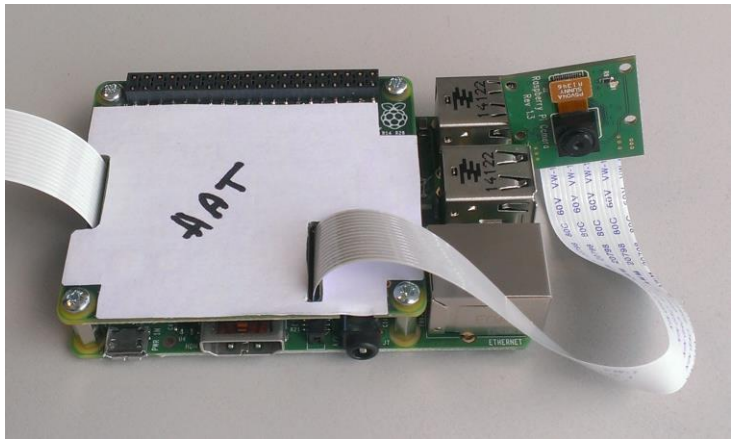
- ARM is one of the industry leading suppliers of microprocessor technology. They dominate the market.
- ARM stands for Advanced RISC (Reduced Instruction Set Computing) Machine.
- ARM develops the architecture of microprocessors and licenses it to other companies.
- This means that they don’t really produce microprocessor, but they sell other companies their designs, and these companies build a system around ARM’s architecture. They add maybe some data busses and modules to it.
- Broadcom that is used on Raspberry Pi 3 is an ARM based SoC.

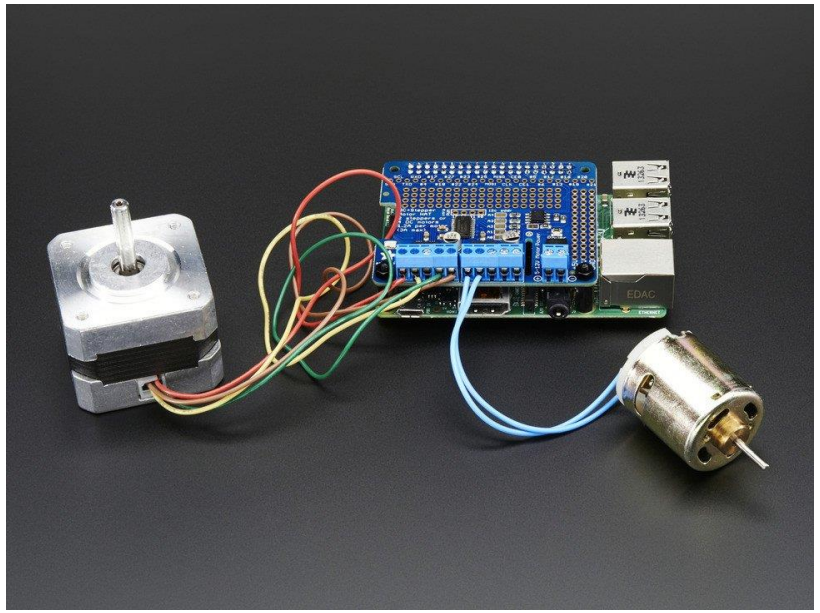
What is Flash RAM, SRAM, and Micro SD Card?

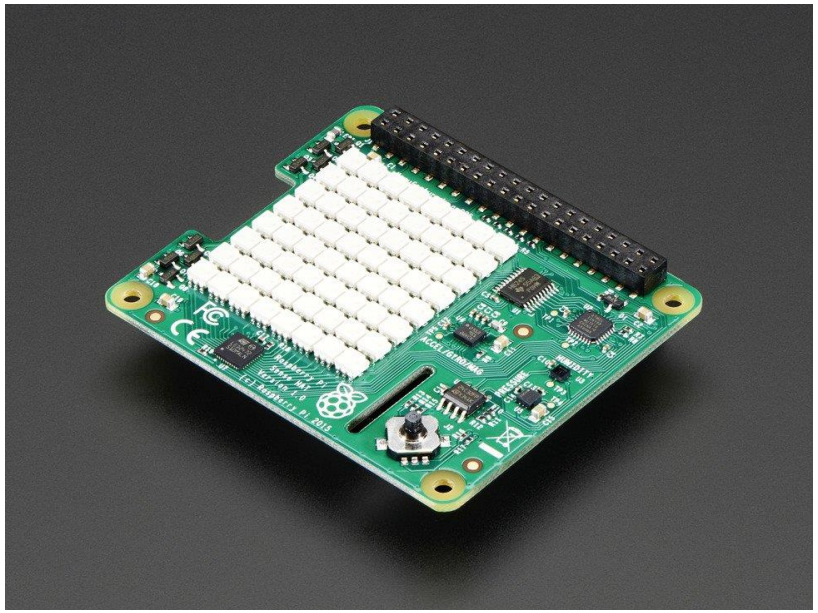
- RAM stands for random access memory. It is type of a memory that the microprocessor can read from and write to. The data is on the memory as long as the power is on.
- Flash RAM = It is a special type of memory. It is just like RAM you can write an read data, but it is not erased when the power is off.
- DRAM = A type of RAM that needs refresh cycles to keep the data on it.
- SRAM = A type of RAM that doesn’t have refresh cycles.
- Micro SD Card = It is type of a removable flash memory that is used for storing data. It is the main storage unit of Raspberry Pi.

Raspberry Pi hats and devices

- Attachable hardware to the Raspberry Pi GPIO connector.
- They are used to extend Raspberry Pi's functionality.
- HAT stands for Hardware Attached on Top.
- Rapsberry PI HAT specifications are available on their website, so you can build your own Hat for your project.





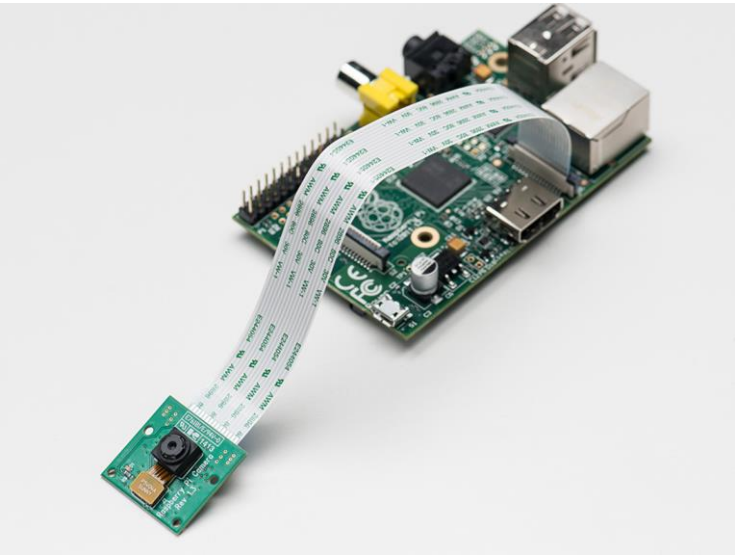


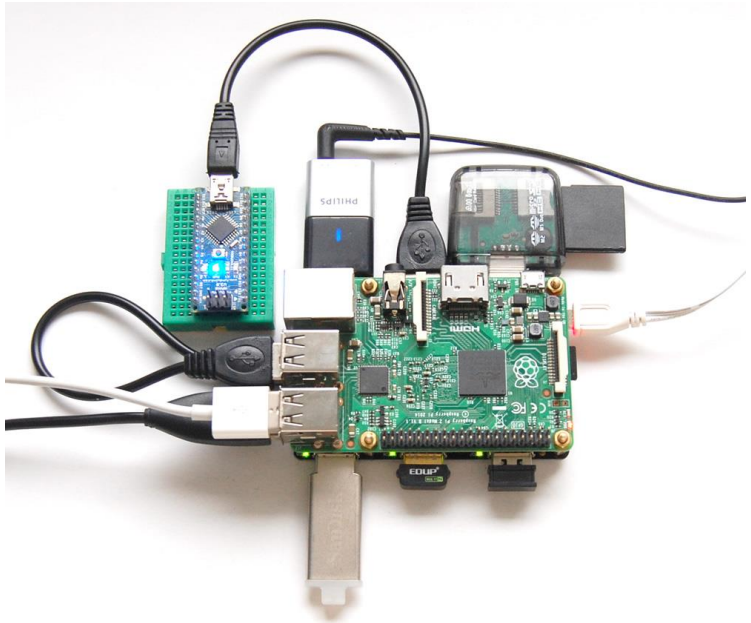
Raspberry Pi Cam

- The module has an 8 megapixel sensor.
- The camera can be used in projects that requires high-definition picture an video quality.
- It is cheap, small and easy to use.
- It supports high definition video formats such as 1080p30, 720p60 and VGA90
- It works with all the model.
- It uses the CSI Camera Port. This port is directly connected to the chipset. This makes it run very fast.

USB Devices

- You can connect any USB device to you Raspberry Pi such as USB flash memory, mouse, keyboard, webcam, USB sound card.
- The device needs to supported by the operation system that you have on your Raspberry Pi.
- Raspberry Pi can power devices from 100 mA to 500 mA.
- If you need more power for your USB device you should you a USB hub that has an external power supply.





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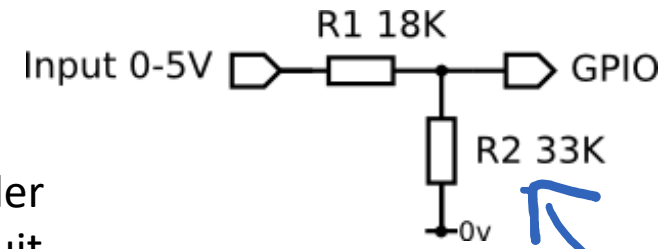
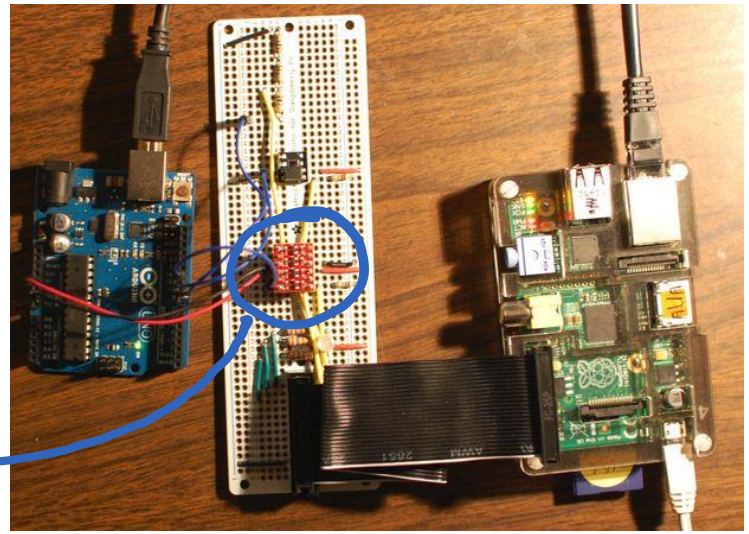
Voltage Divider - 5V <-> 3.3V

- There is a problem when connecting a 5V device to the GPIO on a Raspberry Pi. The logic level on Raspberry Pi is 3.3V, so sensing 5V to the GPIO pin may damage the Raspberry Pi.
- Therefore, we need to change the logic level from 5V to 3.3V.
- In our case voltage divider is used to connect a digital signal from a **5V** device to a GPIO pin on the Pi, which requires a **3.3V** input level.
- Raspberry Pi uses 3.3V logic level to decrease the power consumption.





You can build your own voltage divider or you can buy a voltage divider circuit board.

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What is Arduino?

- Arduino is an open-source electronics platform. It has a microcontroller on it. It also has input and output pins on it.
- Arduino consist of both a physical programmable circuit board and a IDE that runs on an computer. IDE is used to write code and upload it to the physical board.
- It is very popular and it is supported by a very large community.
- Microcontroller is a SoC just like the chipset that is on Raspberry Pi.

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Arduino vs Raspberry Pi

Arduino	Raspberry Pi
Slower	Faster
32-bit processor (Can have more resolution)	32 - bit processor
32K Flash	4GB Flash
2K SRAM + ADC	512K SRAM + SD Card
5V Voltage Level – consumes more power	3.3 Voltage level - consumes less power
Application (IDE) to Microcontroller (Very Fast)	Runs an operating system (Layer of software that run on hw)
	App -> Library -> System Calls -> Microcontroller
	Require Memory
	+ Text-based interface, Graphic Interface
	Multiple Processes
Need to write code to add devices	No need to write any code to use devices
$5 - $25	$35

Is it really an IoT device?

- IoT means Internet of Things, and Internet of Things means internetworking devices with some electronics, sensors, actuators, and software.
- If you use your Raspberry Pi as a laptop, it is a substitute for your laptop.
- However, if you add some electronics to your Raspbeery Pi sensors, motors, displays, microphone, and try to read from and send data to your Raspberry Pi via a network connection, it is a IoT device.

The things you can do with it

- https://www.raspberrypi.org/magpi-issues/MagPi50.pdf

What you will need

- USB Charger
- HDMI Cable
- HDMI to VGA Adaptor
- Mouse
- Keyboard
- Micro SD Card (only buy this one) Class 10 - 16 GB Micro SD Card
- Monitor

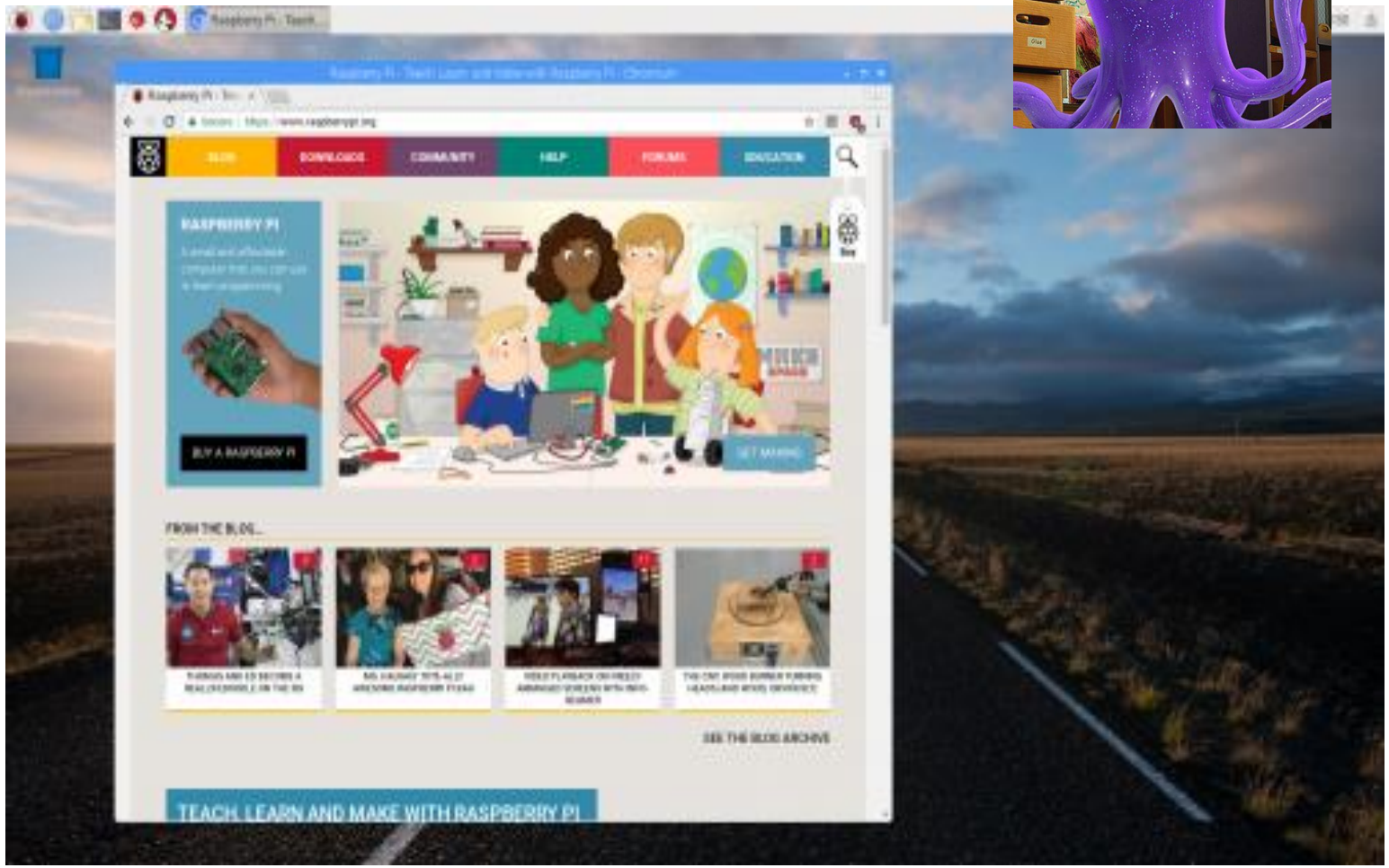
Software

Since it takes a long time to download all these files, you need to download them on your laptop before you come to the lecture next week.

- Raspbian Stretch with PIXEL
  - https://www.raspberrypi.org/downloads/raspbian/
- Micro SD Card Formatter
  - https://www.sdcard.org/downloads/formatter_4/
- RUFUS (If you use Linux or Windows)
  - https://rufus.akeo.ie/
- Ubootin (If you use OSX)
  - https://unetbootin.github.io/
- Putty (If you use Windows)
  - http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html

Raspbian Stretch

- Raspbian is the supported operating system for Raspberry pi.
- It is a free operation system based on Debian that is optimized for the Raspberry Pi hardware.
- Verisons are named after the character of the “Toy Story” movie. The previous Raspbian version is named Wheezy.
- It is still under active development.
- Raspberry Pi foundation doesn’t make this OS. It is not their product.
- It comes with pre-install software for education, programming, and general use such as text editor, Python, and Java more.
- Its GUI is also very easy to use.



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Good sources to learn more about Raspberry Pi.

- MagPi Magazine
- Raspberry Pi website and blog
- Element 14 Forum
- Hack a Day website
- Adafruit website

Setting up your Raspberry Pi

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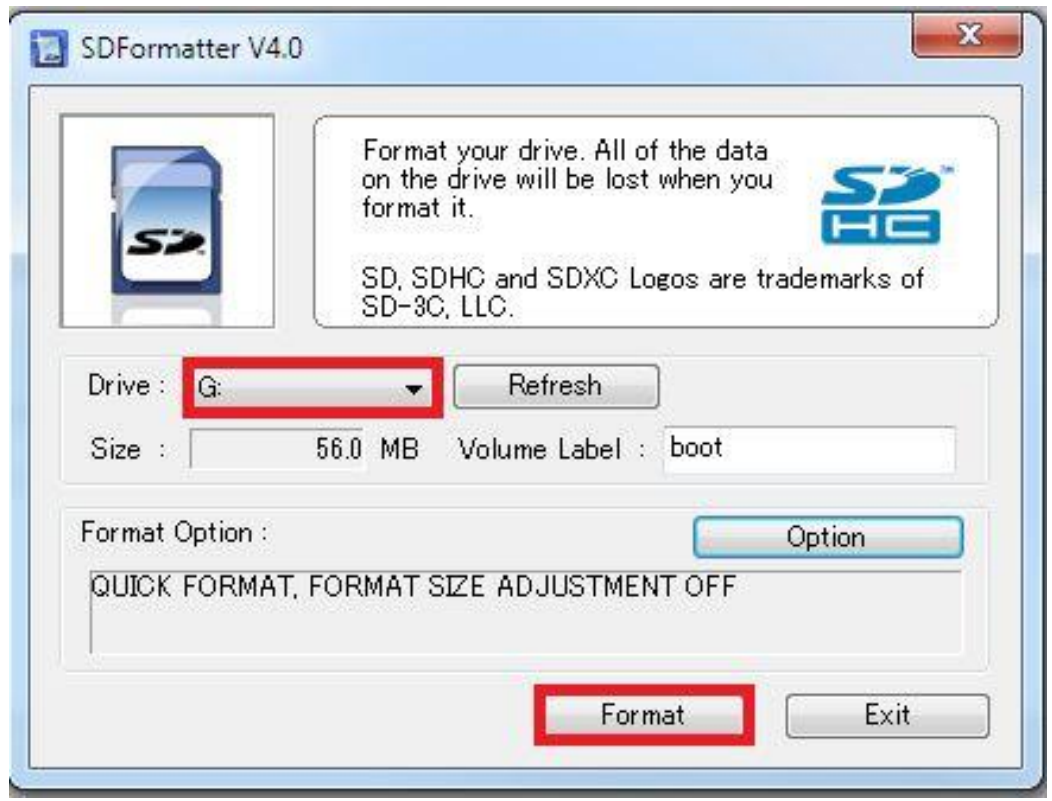
SD Formatter



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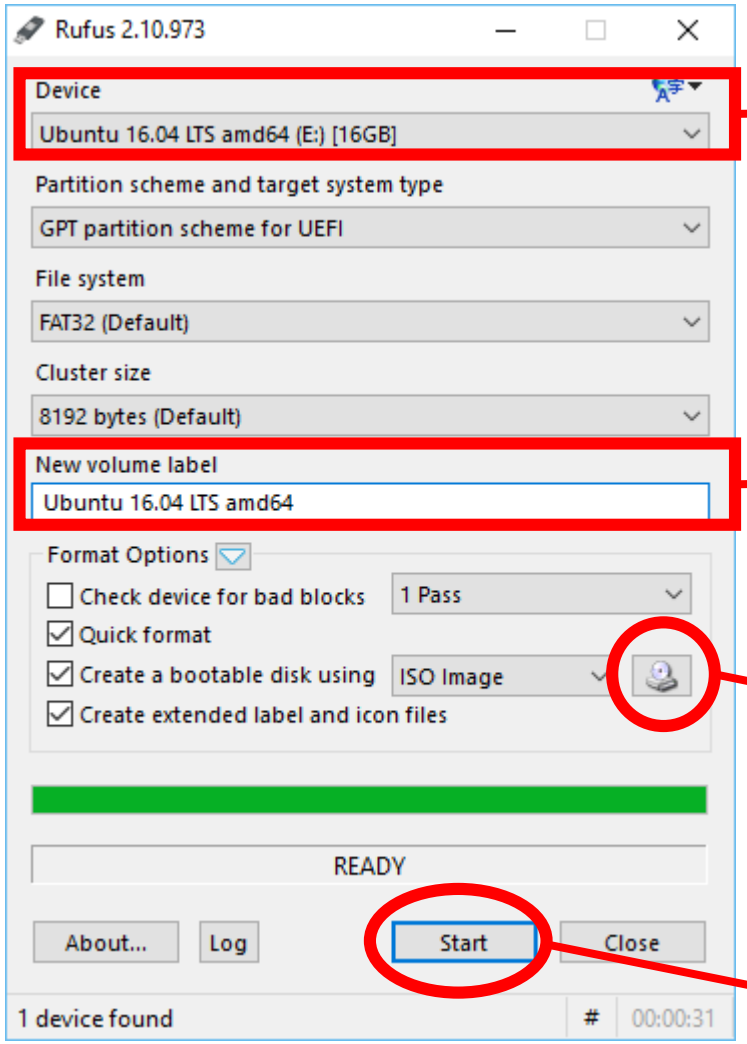
Rufus



Choose the device

Label the volume (use any name)

Choose the image file that you downloaded

Click on start

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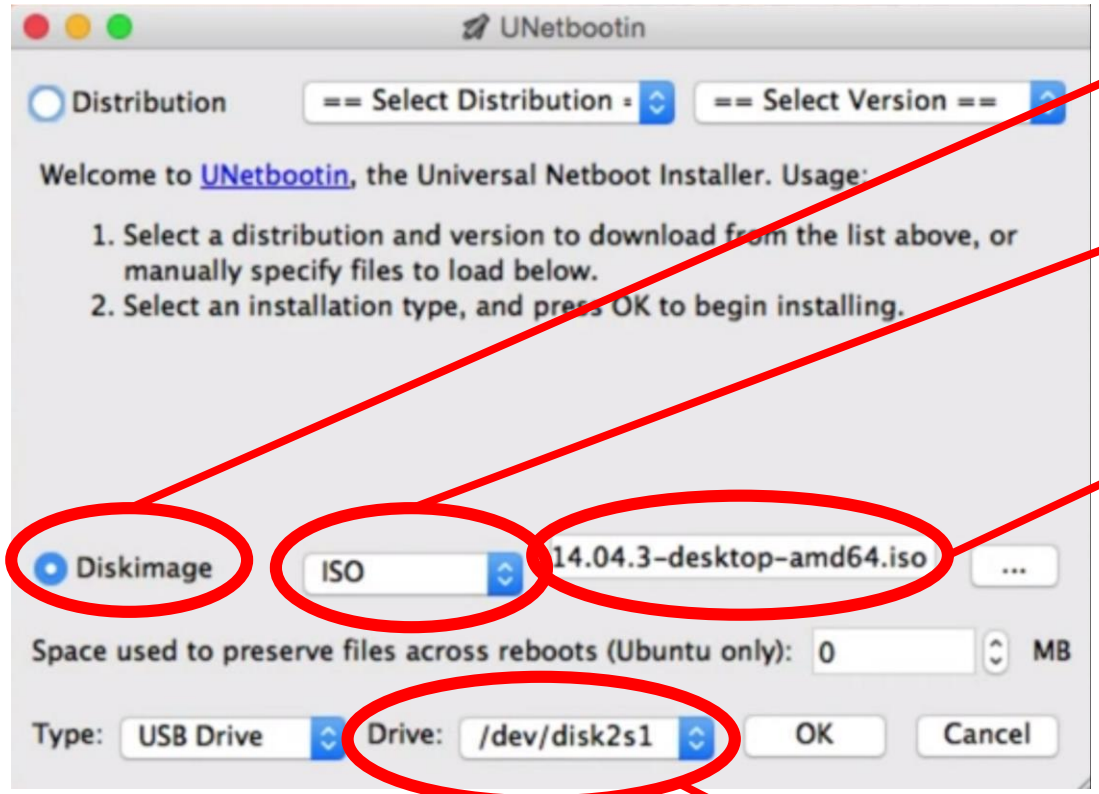
MAC OSX - Ubootin



Select disk image

Choose image file format

Choose the image file

Make sure you pick the right drive

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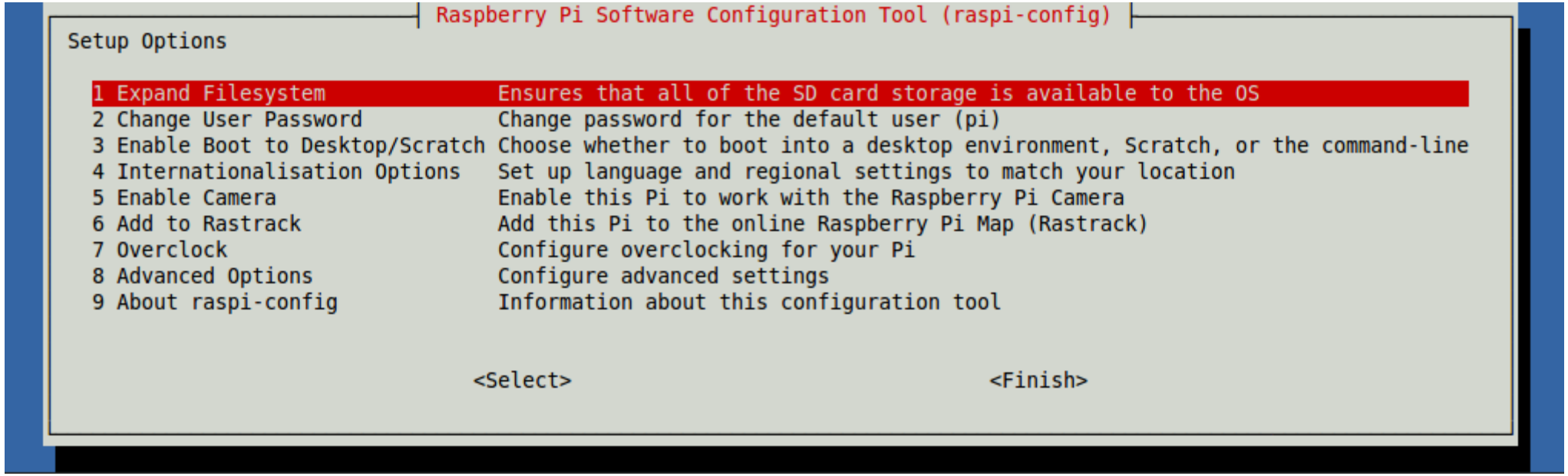
Raspbian - Login

- Default user name: **pi**
- Default password : **raspberry**
- Type “**startx**” to start the GUI of Desktop doesn’t appear.

Raspberry Pi Software Configuration Tool raspi-config



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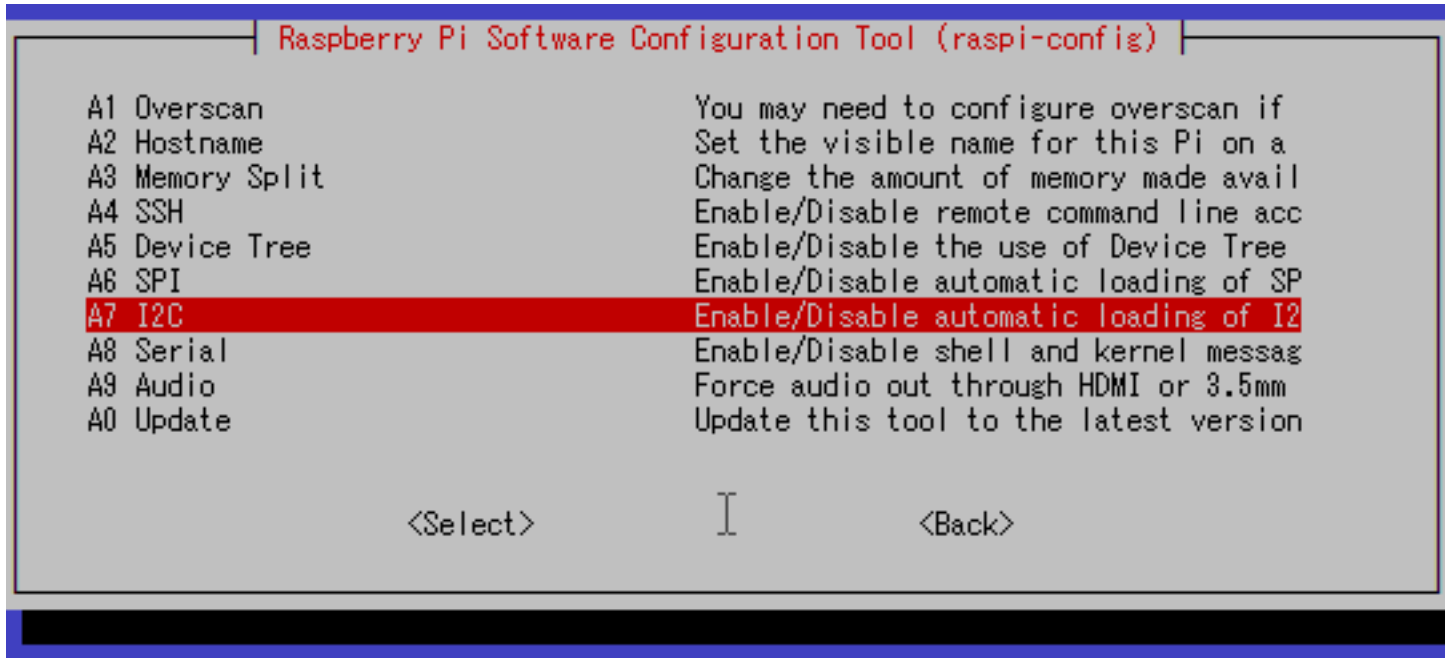
Advanced Options



Local Wi-Fi Connection in the Robotics Lab

- WiFi Network Name: **Robot Theater**

- Password: **robotics**

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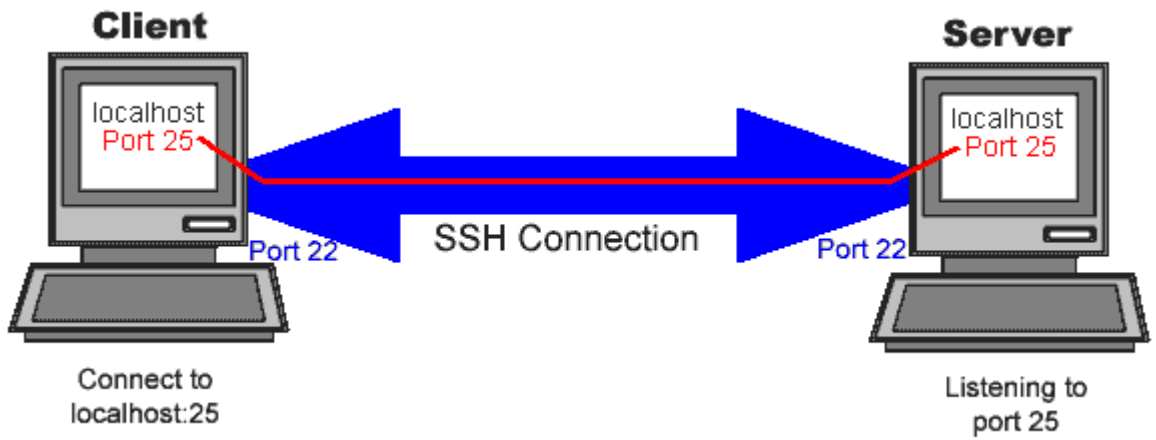
SSH

- SSH, also known as Secure Socket Shell, is a network protocol that provides administrators with a secure way to access a remote computer.
- In our case, we will use SSH connection to remote control our Raspberry Pi computers.



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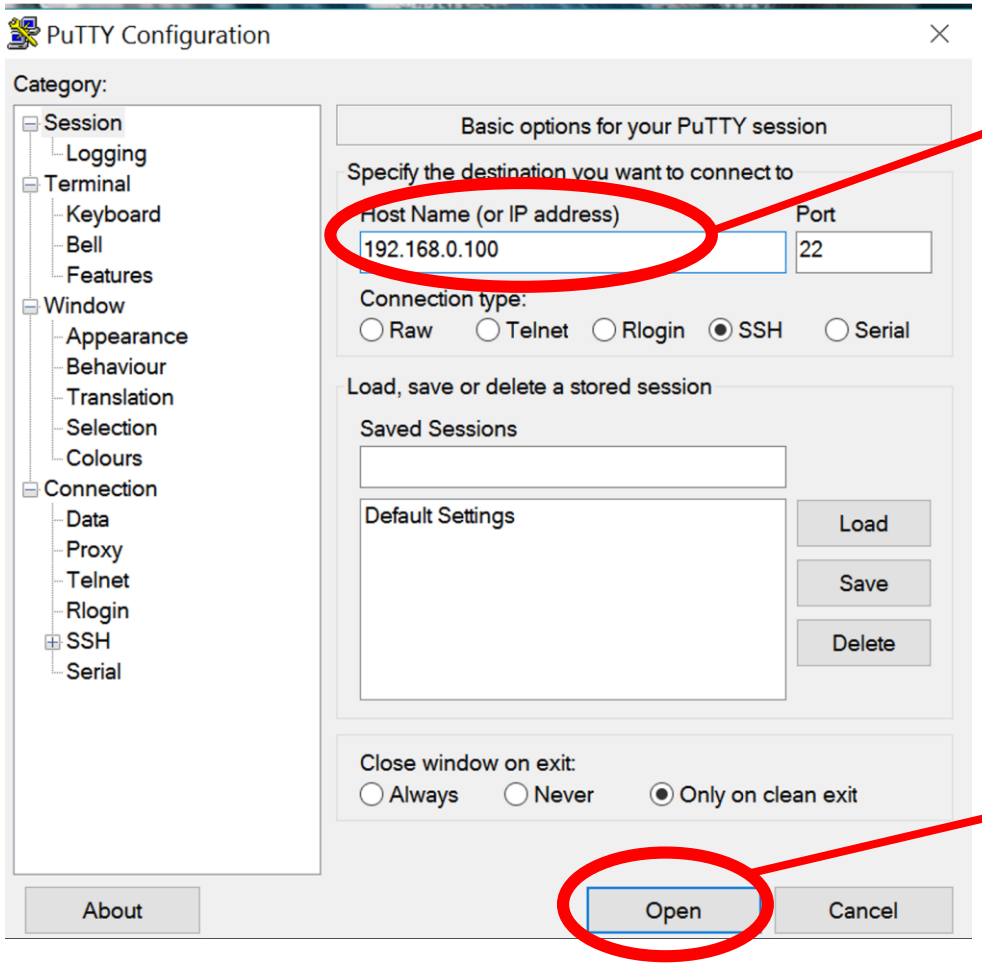
SSH - Windows



Type Raspberry Pi's IP Address

Click on Open

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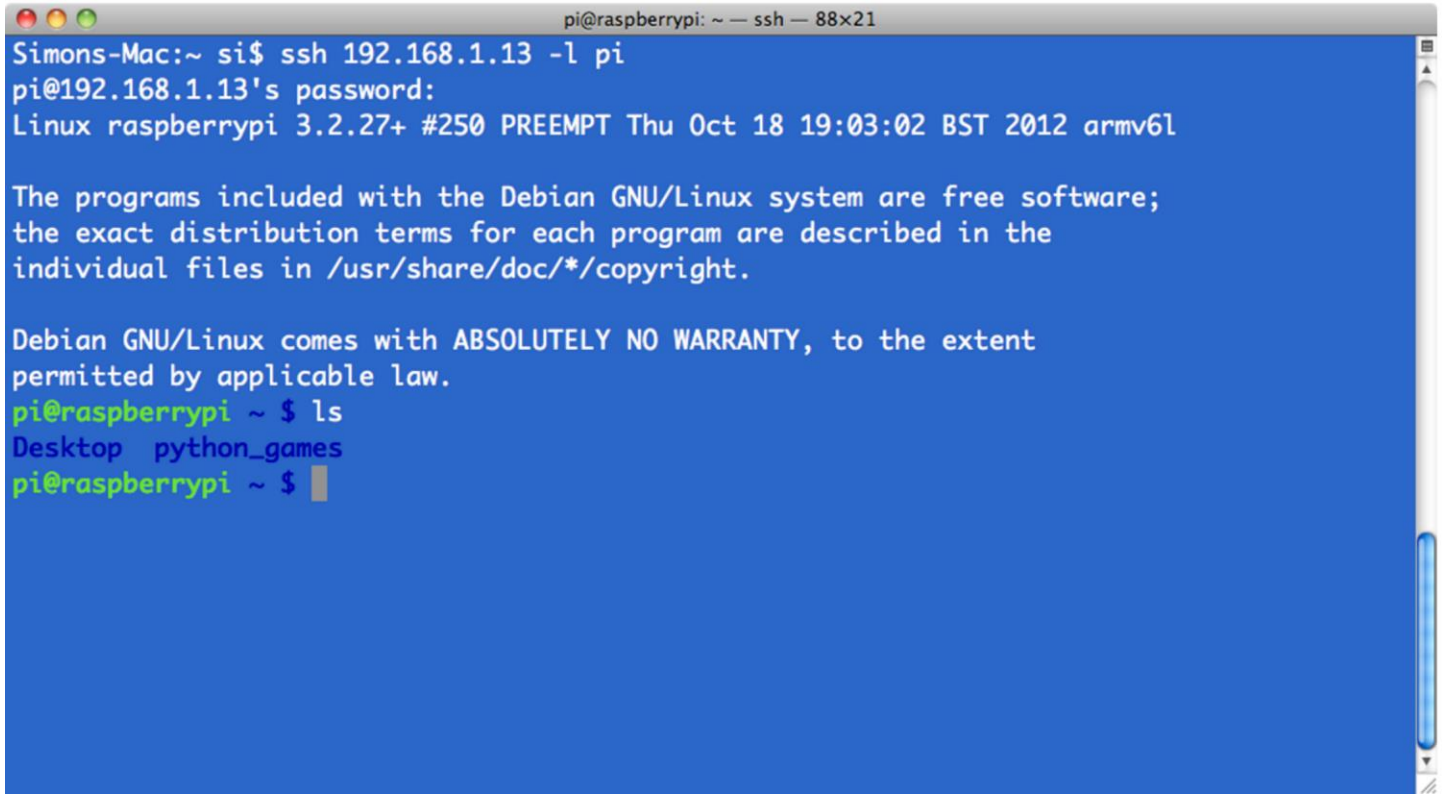
SSH – MAC OSX and Linux

- ssh <ip address> -l pi
- ssh 192.168.1.13 -l pi



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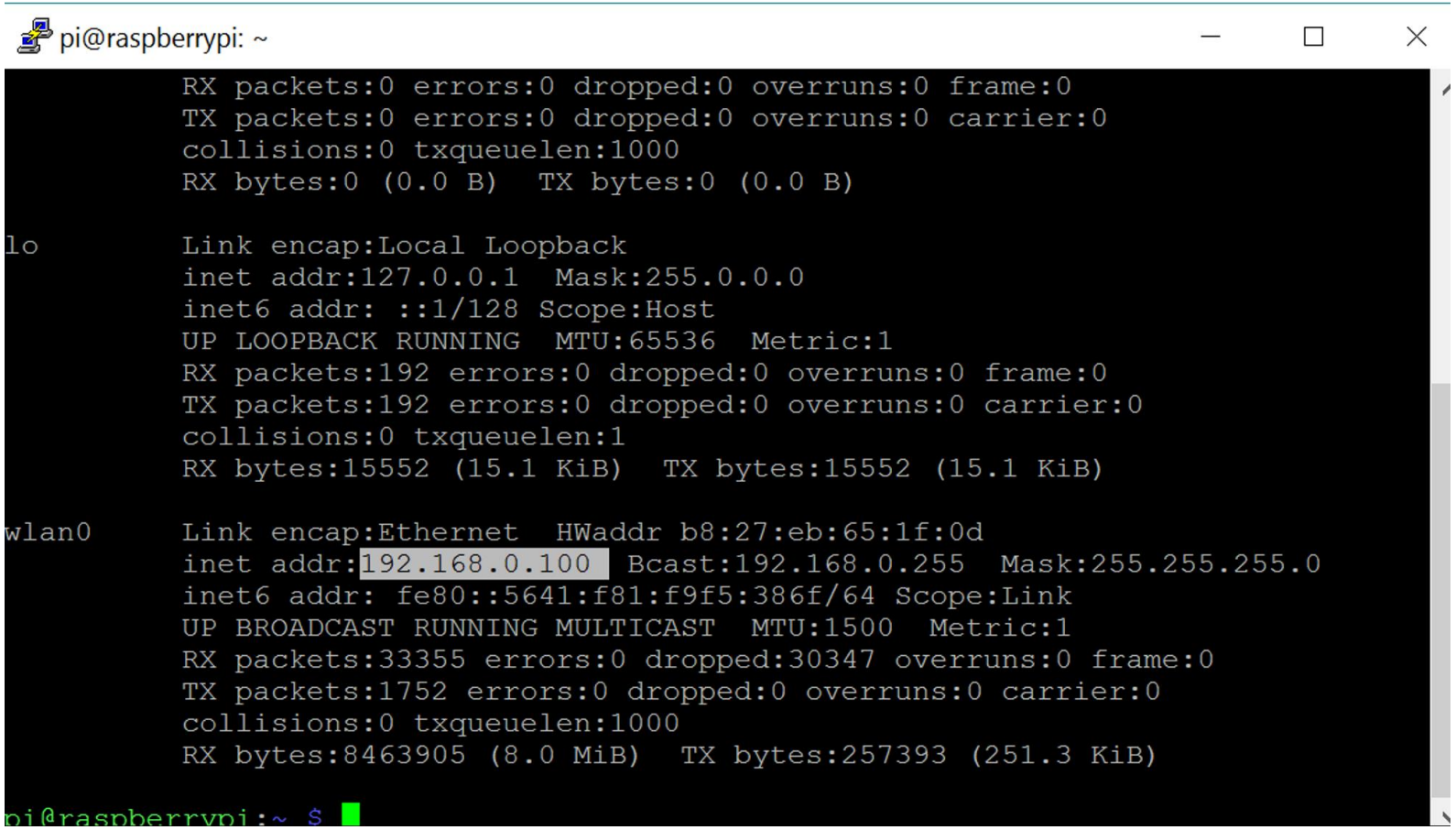
How to learn your IP address?



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Linux – Useful Linux Commands

- ls : Lists the content of the current directory
- cd : Changes the current directory to the one specified
- pwd: Displays the name of the current working directory
- mkdir: Makes a new directory
- rmdir: Remove empty directories
- nano:
- rm: Removes the specified file
- cp: Makes a copy of a file and places it at the specified location
- mv: Moves a file and places it at the specified location

Linux – Useful Linux Commands

- cmod : Normally used to change the permissions for a file
- ssh: Secure shell. Connect to another computer using an encrypted network connection
- sudo: Run a command as a superuser, or another user.
- unzip : Extracts the files from a compressed zip file.
- Ifconfig : Displays the network configuration details for the interfaces on the current system when run without any arguments
- sudo shutdown –h