

# MAE 6392

## Internet of Things for Engineers

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Week 1 [01/22/2025]

- Sneak preview at the edge-lab and hardware
- What is the thing in IoT?
- Overview of computing in IoT
- What is Edge Computing?
- Setting up the Edge Lab
- Understanding the Python installation on the Raspberry Pi
- Some basic Python programming constructs
- First steps in Raspberry Pi programming [Blinking LEDs]

git clone [https://github.com/gwu-mae6291-iot/spring2025\\_codes.git](https://github.com/gwu-mae6291-iot/spring2025_codes.git)



School of Engineering  
& Applied Science

Spring 2025

THE GEORGE WASHINGTON UNIVERSITY

Photo: Kartik Bulusu

## Setting up the Edge-lab each week

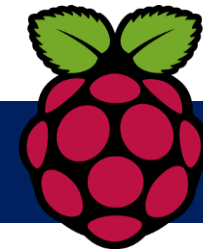
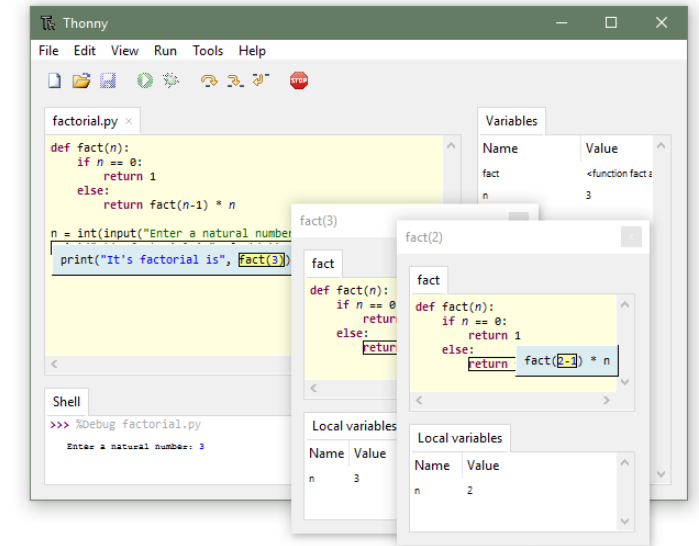
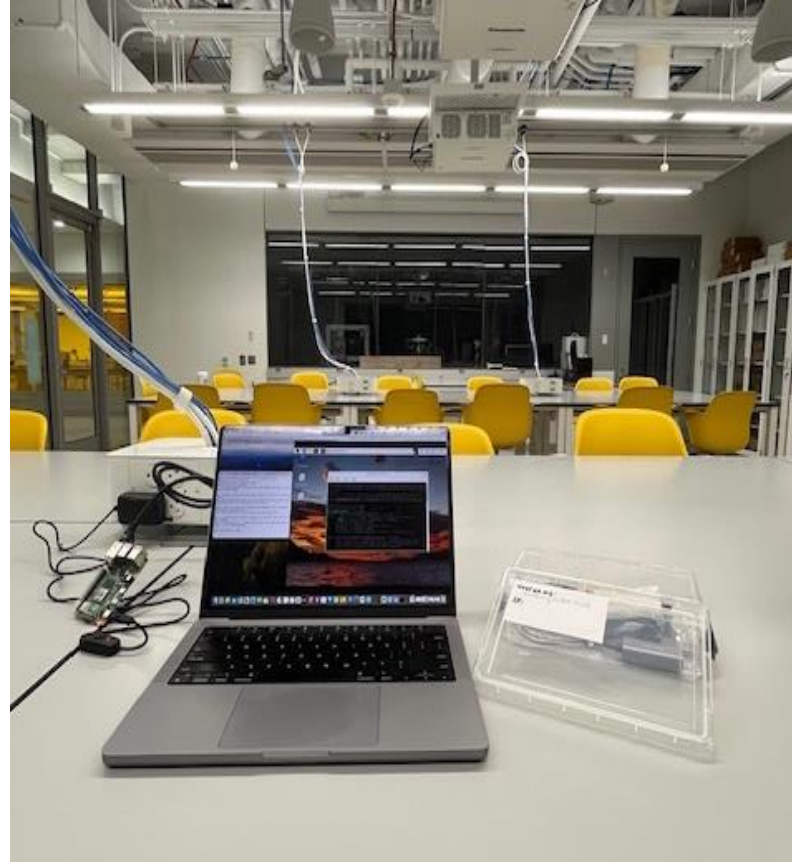
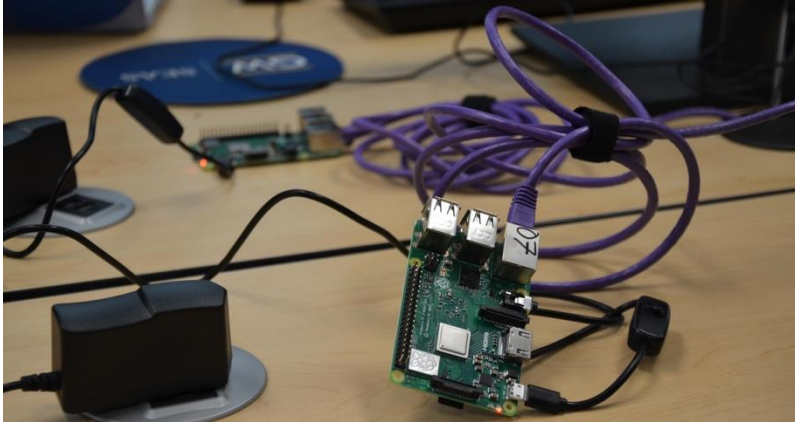
Work together to set it up .. every week!



Sources:

Thonny (IDE): <https://en.wikipedia.org/wiki/Thonny>

Thonny: <https://thonny.org>



## SEH B2020: Laboratory set up





## STEP [-1]:

Familiarize yourself with SEH B2020 classroom layout

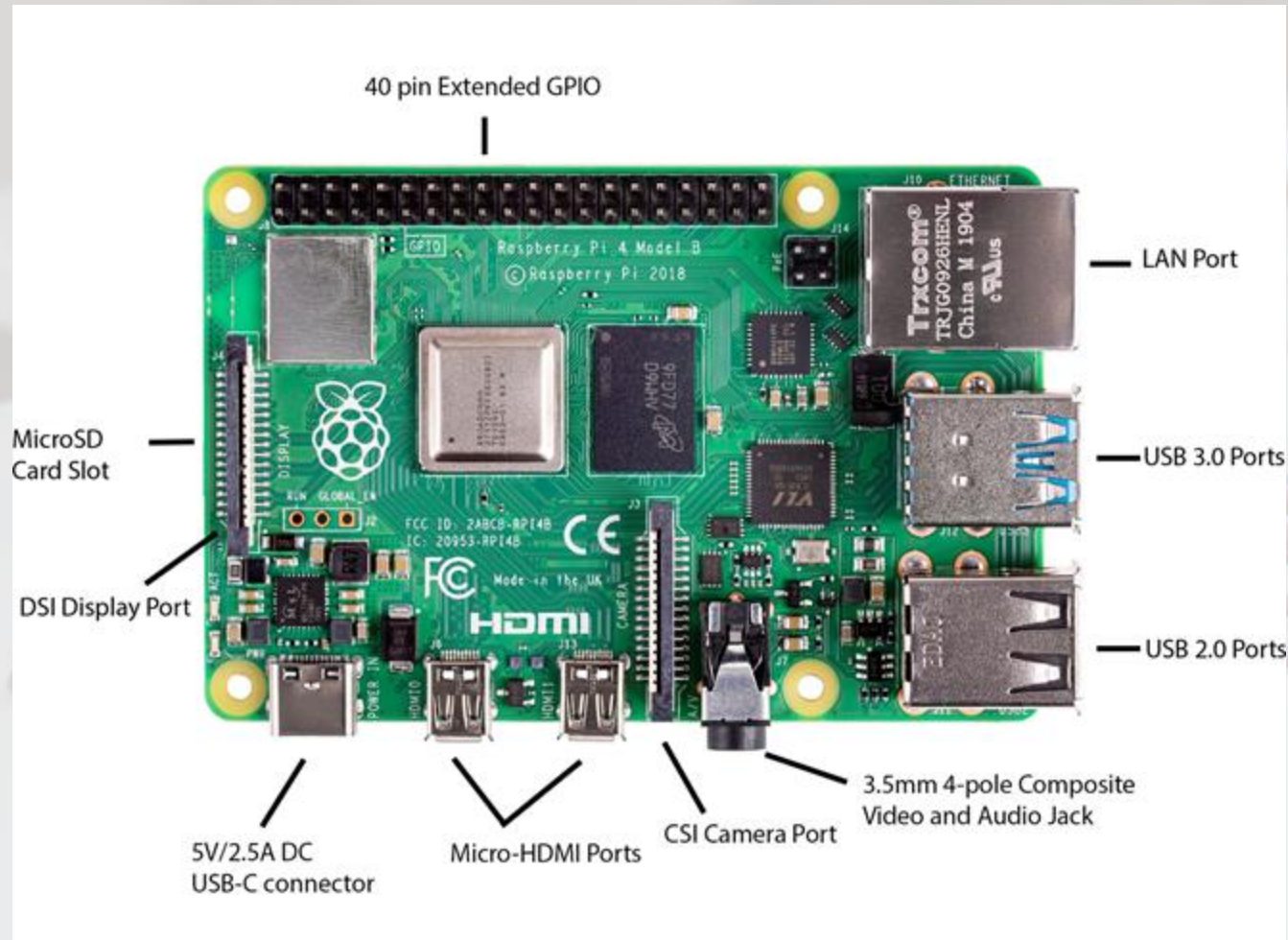


- 7 clusters of desks
- Each cluster has either wall-mounted or centrally located power outlets
- Locate a power outlet for your laptop and your Raspberry Pi closest to where you are seated
- Locate the blue-colored ethernet wall jack closest to where you are seated



## STEP [0]:

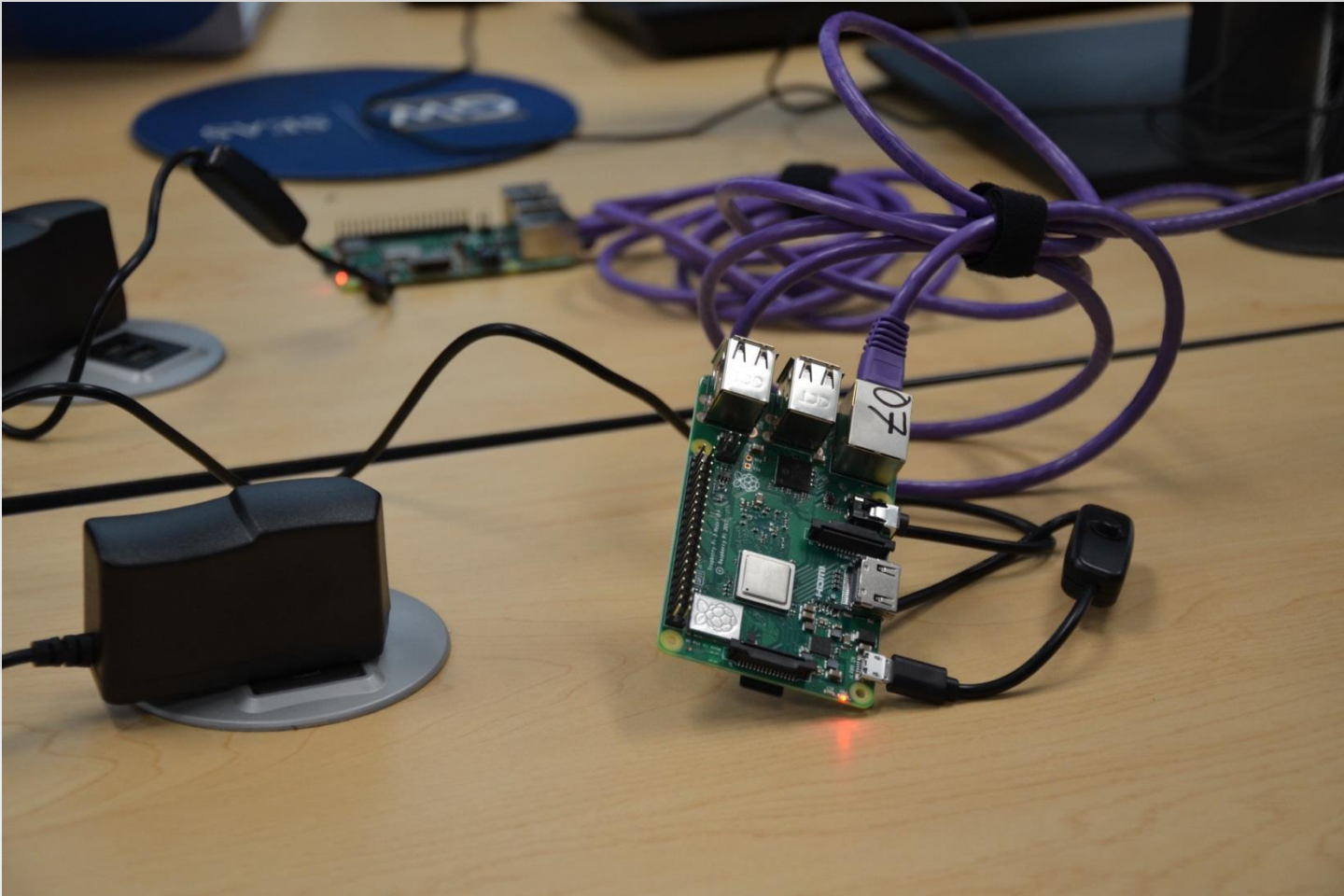
Familiarize yourself with the Raspberry Pi 4B (RPI) layout



- Each RPi will come with a preconfigured OS in a microSD card
- Each RPi will have a microSD card already installed
- Each RPi is assigned a unique alphanumeric name (e.g., 007, 015 etc)
- To power, boot up and test the RPi you will need
  - USB-C power cord
  - Ethernet cord for 10/100 LAN port
  - IP address
  - Login and password for the RPi
  - Remote desktop feature enabled in your computer

## STEP [1]:

Connect the RPi to each desk power outlet as shown



- Make sure there is a microSD card installed in the RPi
- Connect the RPi using the microUSB power cable provided
- Connect the ethernet cables specifically for RPi connections
- LEDs on the RPi will start blinking indicating that it is booting up





## STEP [2]:

Access the RPi in the Edge-lab

2.1 Log in to GWU Virtual private network (GWU VPN)  
Downloads: <https://it.gwu.edu/vpn-global-protect>

2.2 Open up remote desktop connection  
(using the VNC server)

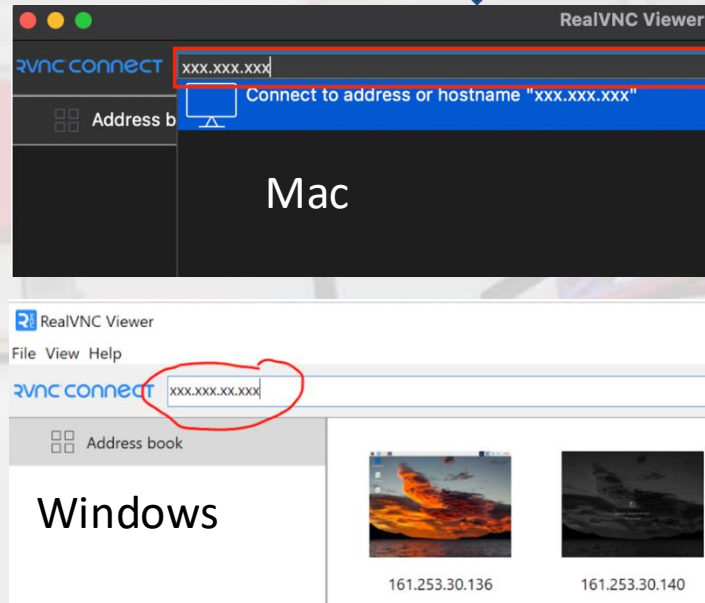
Each RPi has unique alpha-numeric name (e.g., 007, 015 etc.)

- Locate the Pi-name and the IP address on the <128.164.139.xx>

OR

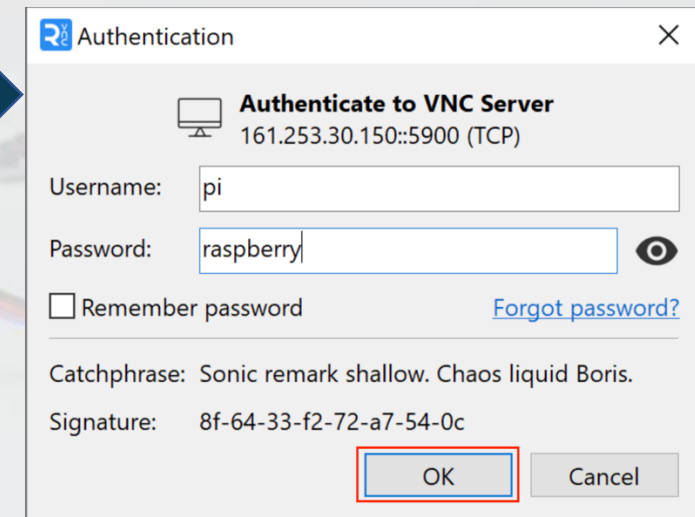
Each RPi connected using an ethernet cable directly to your laptops

- raspberrypi###.local



2.3 Once you are connected you will

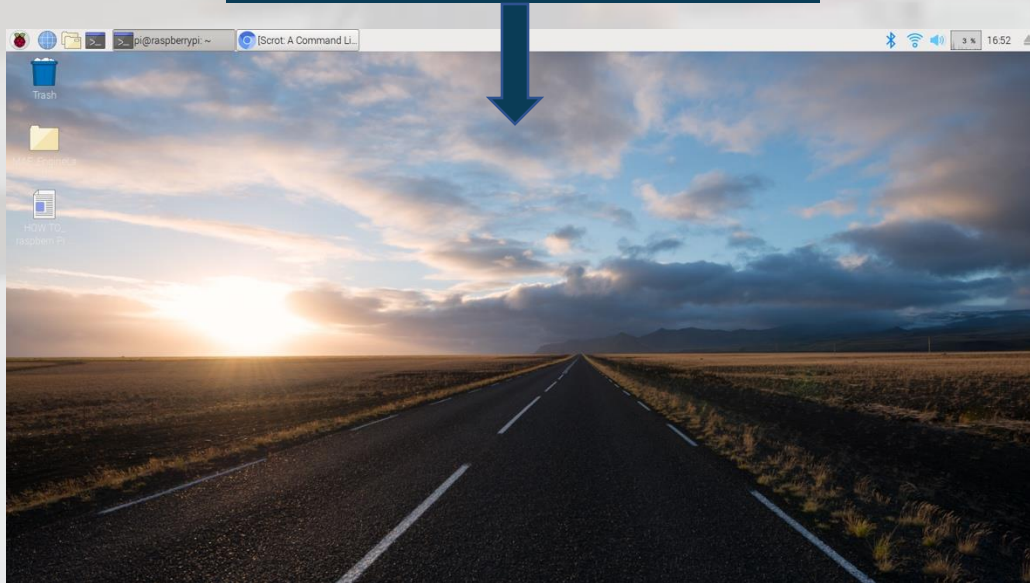
- See Authentication box below
- Type in the Username and Password



## STEP [3]:

Now that you accessed the RPi...

You will see a screen like the one shown below

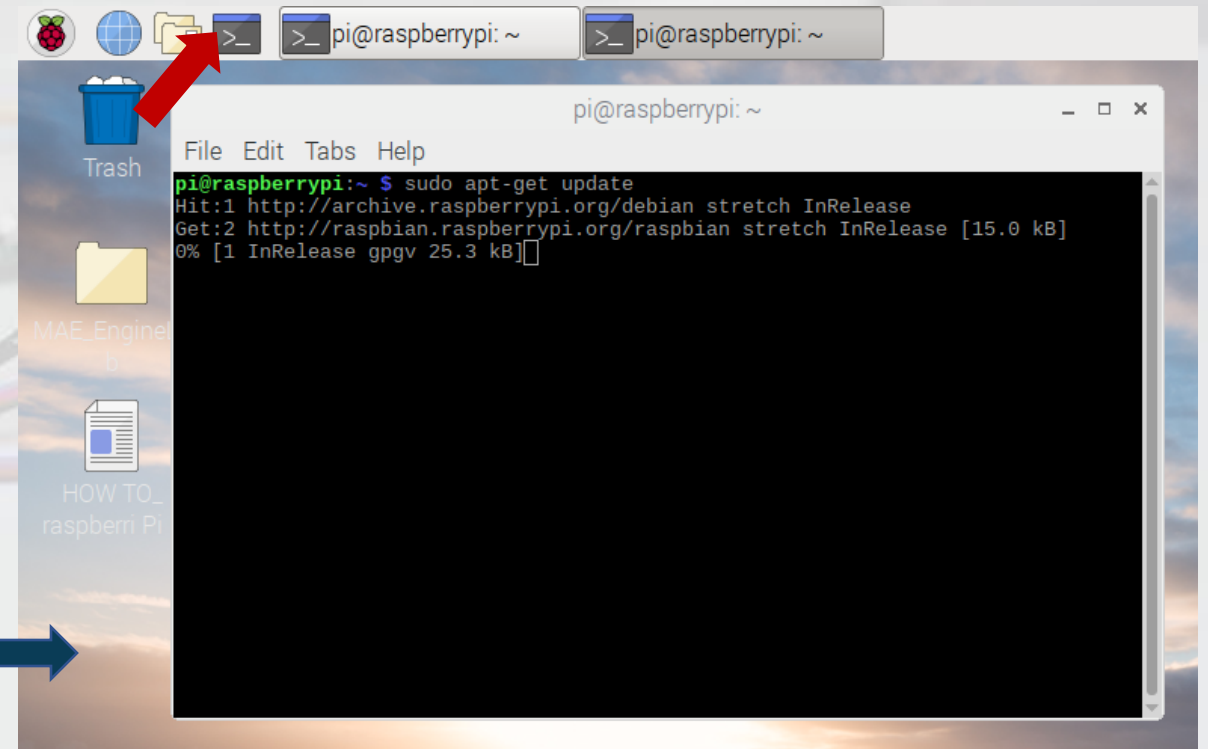


3.2 Testing is complete when you get to this step.

- Students should get the RPi to this step before the laboratory modules begin.

### 3.1 Click on terminal (shown with a red arrow below)

- At the prompt type: **sudo apt-get update**
- Wait for the updates to complete
- Then type: **sudo apt-get upgrade**
- If you get the following prompt
  - **Do you want to continue [Y/n]**
  - Type: **y**
  - And hit "Enter" on your keyboard and let the upgrades complete





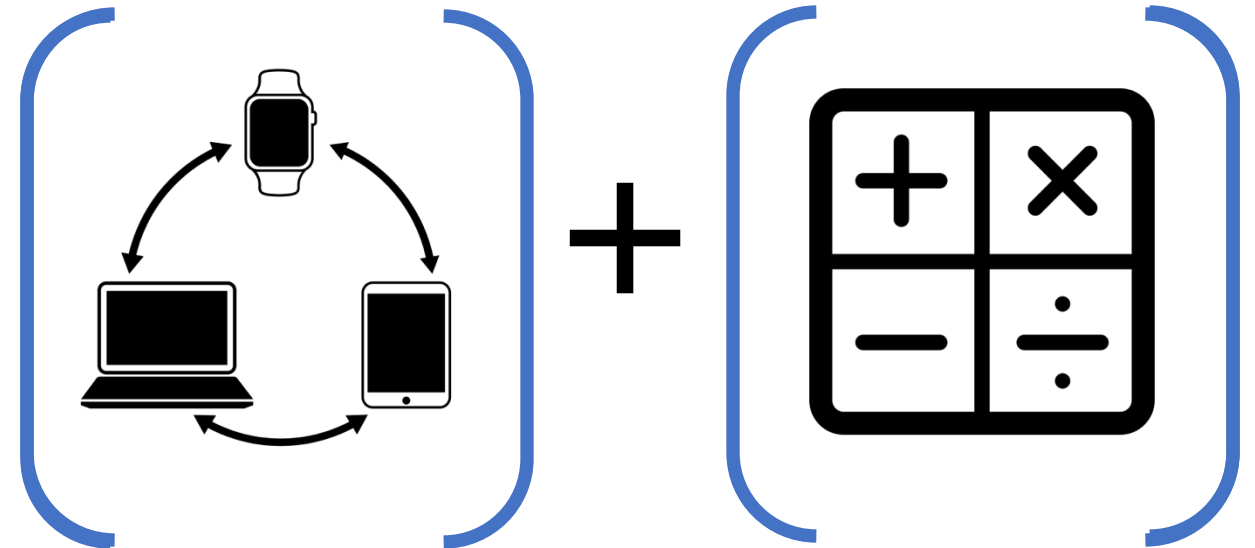
# What's the “thing”?

Sources:  
Calculator by Markus from <https://thenounproject.com/browse/icons/term/calculator/>  
internet of things by Davo Sime from <https://thenounproject.com/browse/icons/term/internet-of-things/>  
L. Bernardi, S. Sarma and K. R. Traub, The Inversion Factor: How to Thrive in the IoT Economy

## Paradigm #1

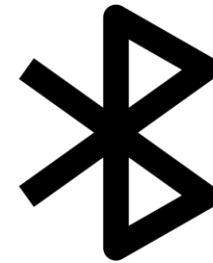
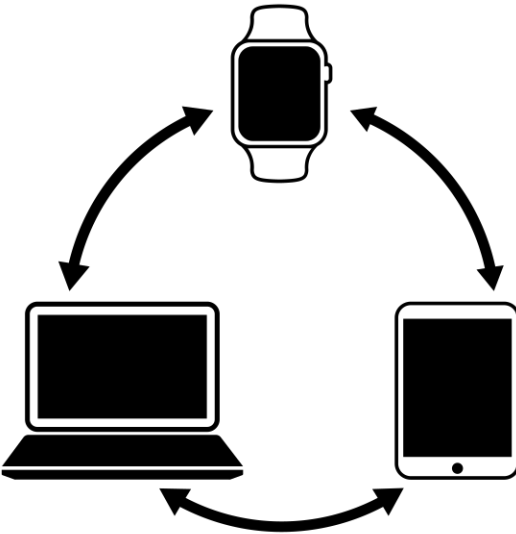
- A **thing** is self-contained and only operates within the confines of its physical shell.
  - **Thing** carries out only those functions that its designer envisioned when it was fabricated.
- The **thing** contains a powerful computer inside but is completely hidden from the user.
- The **thing** has firmware (not called software).

## Paradigm #2



## Paradigm #3

# Connected “things”



## 5G

Icon Sources:

Bluetooth by J703 from <https://thenounproject.com/browse/icons/term/Bluetooth>

wifi by Cetha Studio from <https://thenounproject.com/browse/icons/term/wifi/>

By Connectivity Standards Alliance - <https://zigbeealliance.org/solutions/>, Public Domain: <https://commons.wikimedia.org/w/index.php?curid=106668572>

By Connectivity Standards Alliance - buildwithmatter.com, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=114216376>

internet of things by Davo Sime from <https://thenounproject.com/browse/icons/term/internet-of-things/>



Use terminal commands to

- check Raspberry Pi OS version
- check Python installation version
- update and upgrade Raspberry Pi OS



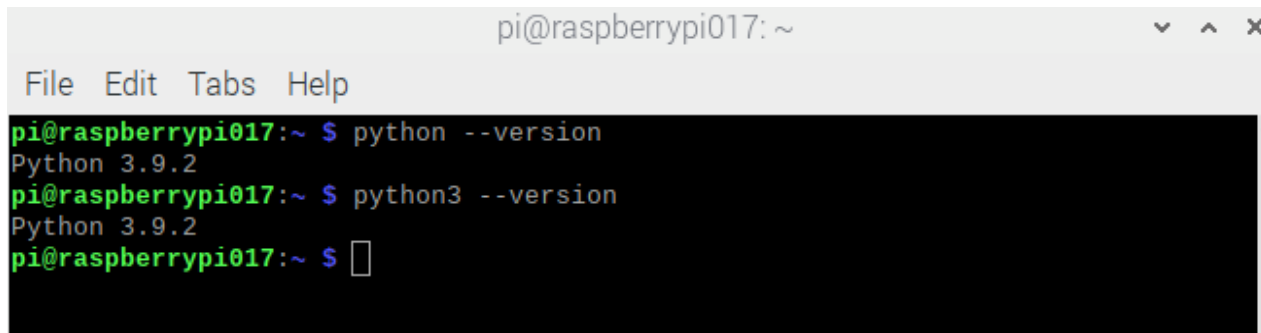


# Installed Python version Raspberry Pi: 3.9.2

The shell window on your Thonny IDE screen should show the same version as the Terminal

Type the following one after the other:

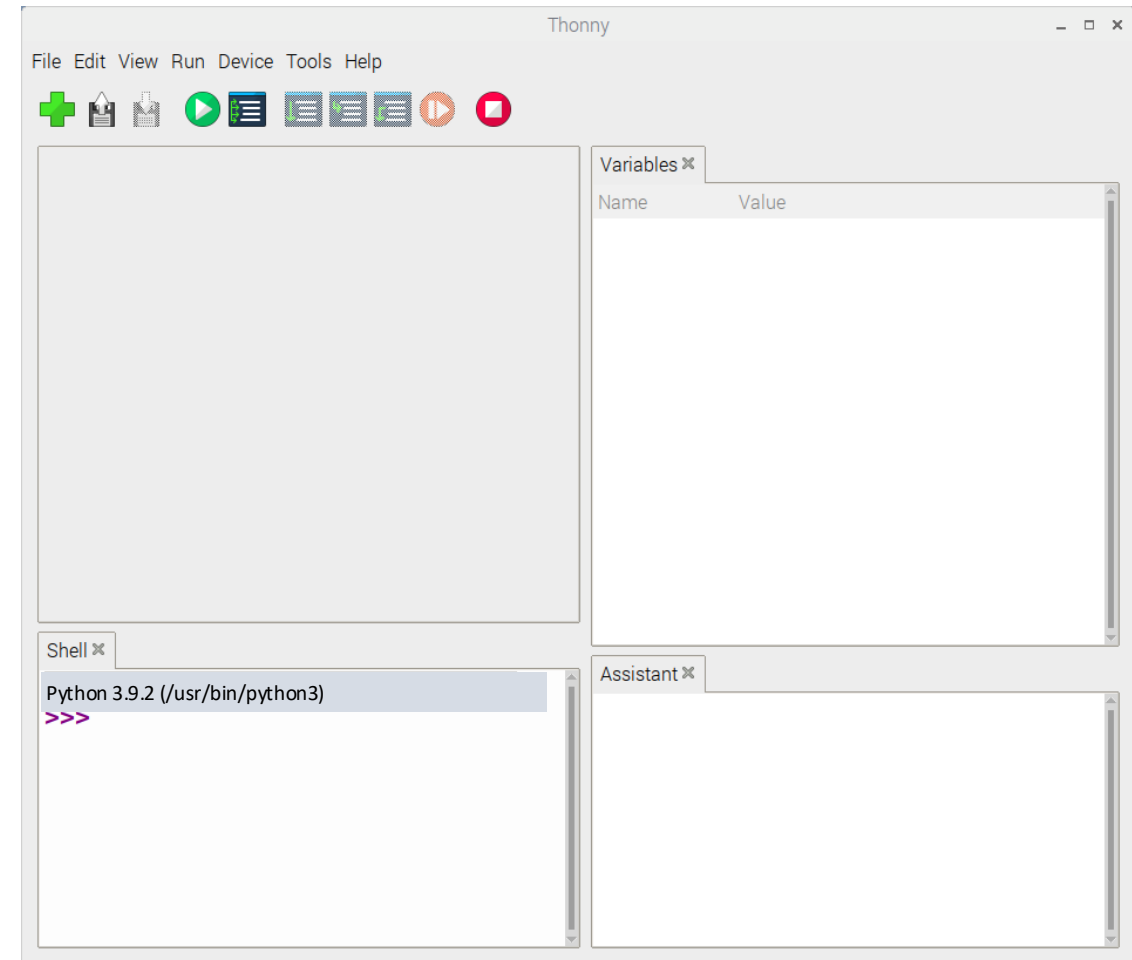
```
$ python --version  
$ python3 --version
```



```
pi@raspberrypi017: ~  
File Edit Tabs Help  
pi@raspberrypi017:~ $ python --version  
Python 3.9.2  
pi@raspberrypi017:~ $ python3 --version  
Python 3.9.2  
pi@raspberrypi017:~ $
```

“python --version” and “python3 --version” will return the same output i.e., Python 3.9.2.

That is because earlier versions of Raspberry Pi OS had two versions of Python (python 2.x.x and python 3.x.x) installed. On January 1, 2020, Python 2 was sunset or deprecated and all legacy Python 2 users had to move to Python 3. Earlier versions of Raspberry Pi OS carried the last version of Python 2 but it has now been completely phased out.



# Installed version of Raspberry Pi OS

Type the following line in your Terminal:

```
$ cat /etc/os-release
```

Output on your Terminal should look like the following:

```
PRETTY_NAME="Raspbian GNU/Linux 11 (bullseye)" NAME="Raspbian  
GNU/Linux"  
VERSION_ID="11"  
VERSION="11 (bullseye)"  
VERSION_CODENAME=bullseye  
ID=raspbian  
ID_LIKE=debian  
HOME_URL="http://www.raspbian.org/"  
SUPPORT_URL="http://www.raspbian.org/RaspbianForums"
```

More information on the bullseye OS version and its kernel version can be found in the following wikipedia page:  
[https://en.wikipedia.org/wiki/Raspbian\\_Pi\\_OS](https://en.wikipedia.org/wiki/Raspbian_Pi_OS)



# update and upgrade your Raspberry Pi OS

Type the following one after the other:

```
$ sudo apt-get update  
$ sudo apt-get upgrade
```

`sudo apt-get update:`

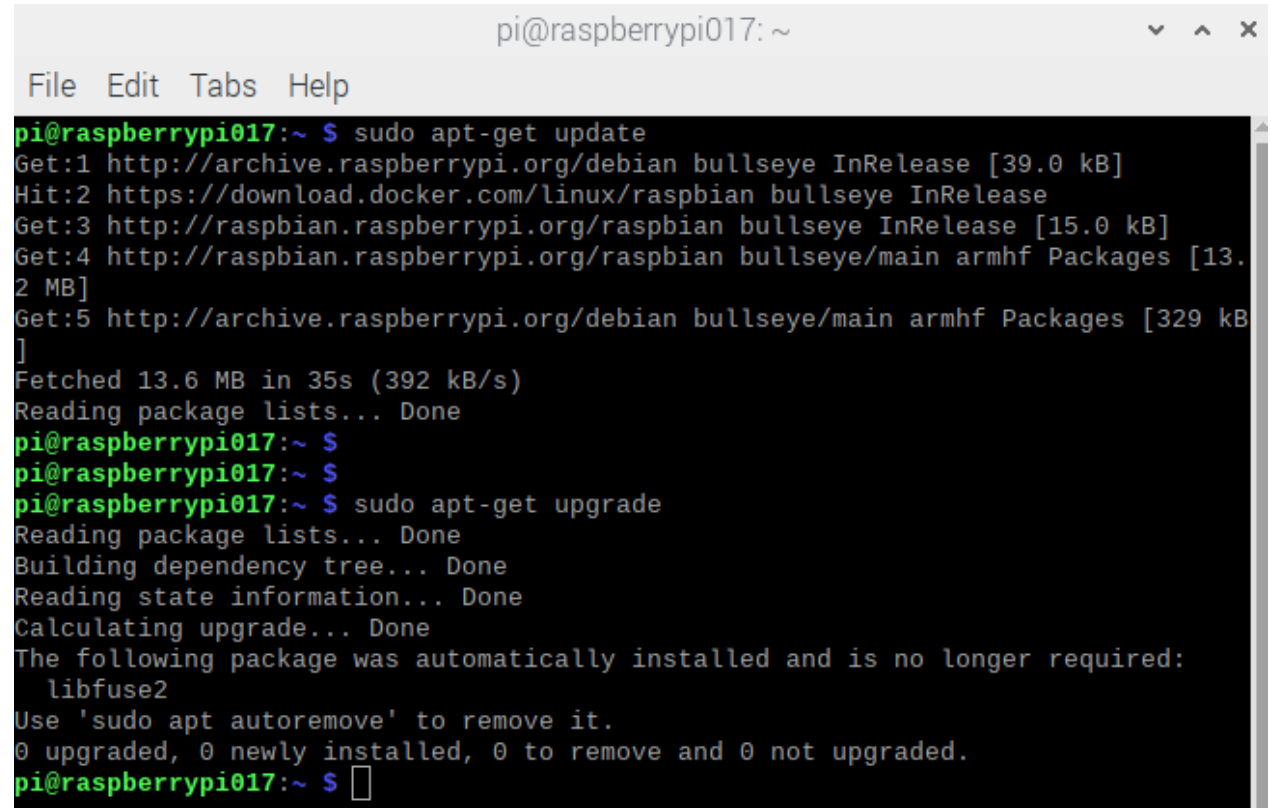
Updates the list of available packages for a Linux system

`sudo apt-get upgrade:`

Installs the latest available updates for all currently installed packages on your system

Type the following in one line:

```
$ sudo apt-get update && sudo apt-get upgrade
```



```
pi@raspberrypi017: ~  
File Edit Tabs Help  
pi@raspberrypi017:~ $ sudo apt-get update  
Get:1 http://archive.raspberrypi.org/debian bullseye InRelease [39.0 kB]  
Hit:2 https://download.docker.com/linux/raspbian bullseye InRelease  
Get:3 http://raspbian.raspberrypi.org/raspbian bullseye InRelease [15.0 kB]  
Get:4 http://raspbian.raspberrypi.org/raspbian bullseye/main armhf Packages [13.2 MB]  
Get:5 http://archive.raspberrypi.org/debian bullseye/main armhf Packages [329 kB]  
Fetched 13.6 MB in 35s (392 kB/s)  
Reading package lists... Done  
pi@raspberrypi017:~ $  
pi@raspberrypi017:~ $  
pi@raspberrypi017:~ $ sudo apt-get upgrade  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
Calculating upgrade... Done  
The following package was automatically installed and is no longer required:  
  libfuse2  
Use 'sudo apt autoremove' to remove it.  
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.  
pi@raspberrypi017:~ $
```





Setting up the headless RPi connection  
Practical side of blinking LEDs – the first RPi demo  
**[Graded Lab Activity: 10 points]**

Someone should summarize what we learned today

