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Raspberry Pi
and
Sense HAT

Programming I (PRG1)

Diploma in Information Technology

Diploma in Financial Informatics

Diploma in Cybersecurity & Digital Forensics

Common ICT Programme

Year 1 (2019/20), Semester 1

Objectives

At the end of this lecture, you will ….

- **Be able to write Python code in Raspberry Pi**
  - **Pre-Class Preparation**
  - **What is Raspberry Pi**
  - **Raspberry Pi and Internet of Things**
  - **Connecting to Raspberry Pi**
  - **Transferring files to/from Raspberry Pi**
  - **Introduction to Sense HAT**

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Pre-Class Preparation

- **Download and install a File Transfer Protocol (FTP) client**
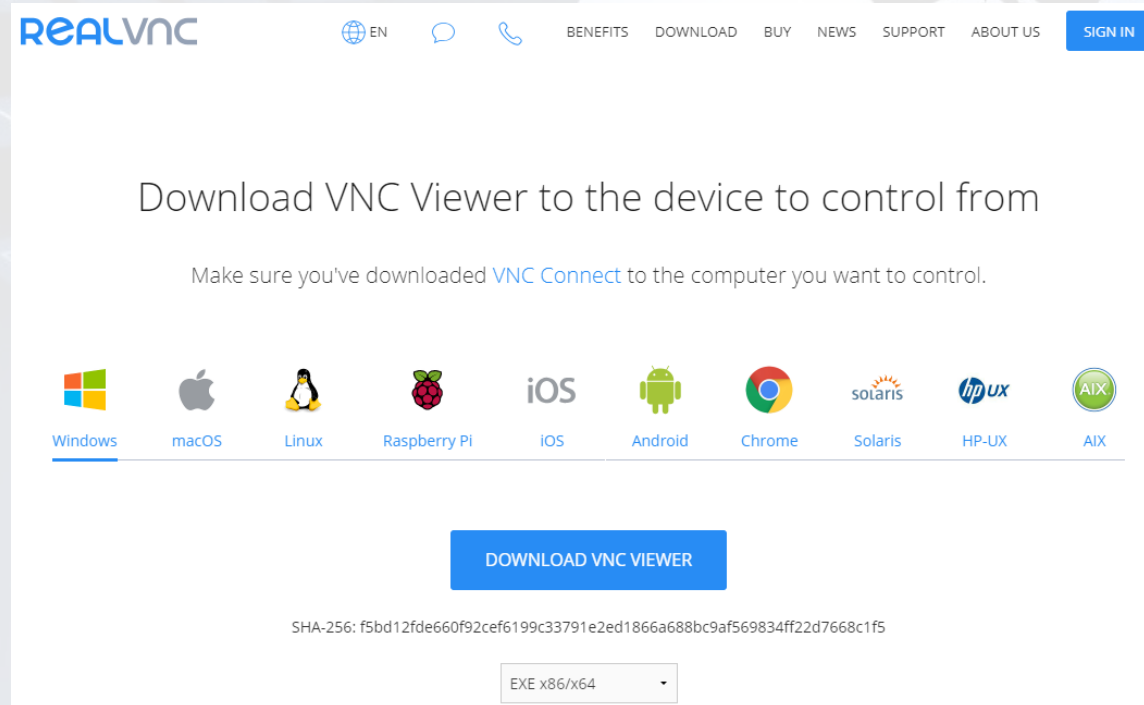 - **To transfer files between your laptop and the Raspberry Pi**
  - **FileZilla**

    https://filezilla-project.org/download.php

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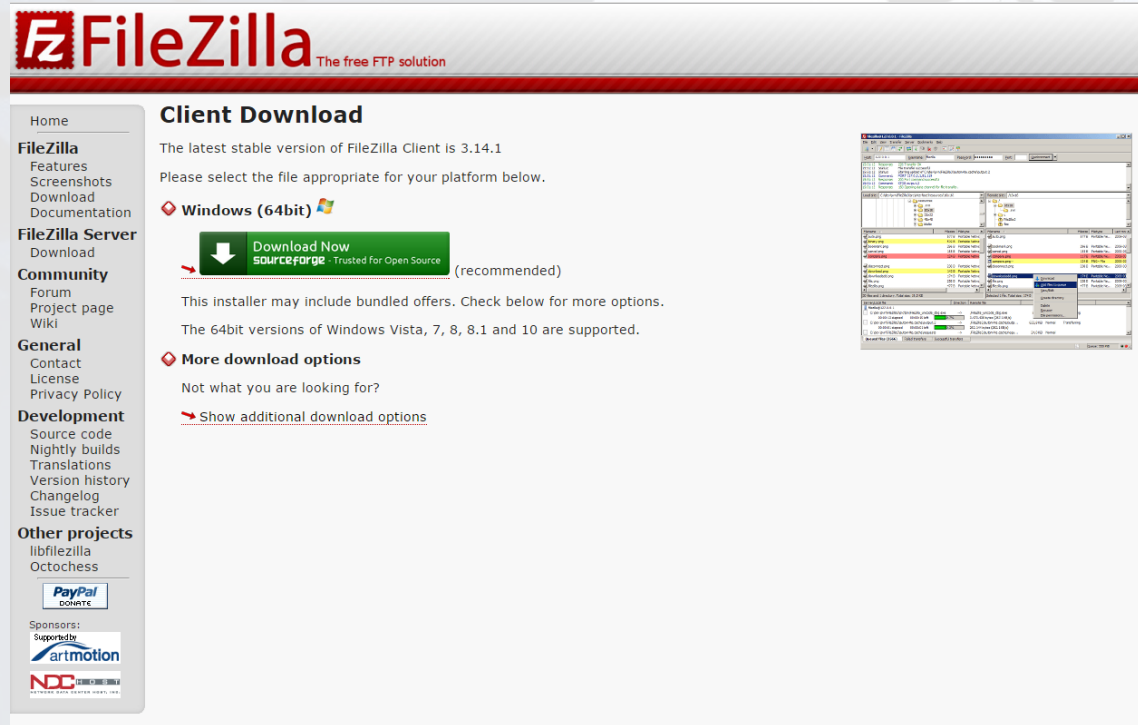
Pre-Class Preparation

- **Download and install a Virtual Network Computing(VNC) client**
  - **To view the Raspberry Pi desktop remotely**
  - **RealVNC**

    https://www.realvnc.com/en/connect/download/viewer/

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Raspberry Pi - What is it?

- **Developed by Raspberry Foundation (UK) aims to promote teaching of programming in schools.**

- **US$35 (~S$55)**

- **Version 3B+ launched in Mar 2018**

Raspberry Pi 3 Model B+	
CPU	1400MHz QUAD Core
Memory	1GB RAM
Graphics	Broadcom Video Core IV
USB	4
Video out	HDMI
Networking	Ethernet and Wireless
Storage	microSD

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Raspberry Pi – Internet of Things

- **One of the key learning platforms for Internet of Things**
  - **Fully functional computer**
  - **Low-cost**
  - **Easily connect physical devices and sensors**
- **Internet of Things**
  - **Arguably the hottest topic in IT currently**
  - **Definition**
    - **The network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data**
  - **Example: Devices (wearables and ingestibles) to monitor and maintain human health and wellness; disease management, increased fitness, higher productivity**
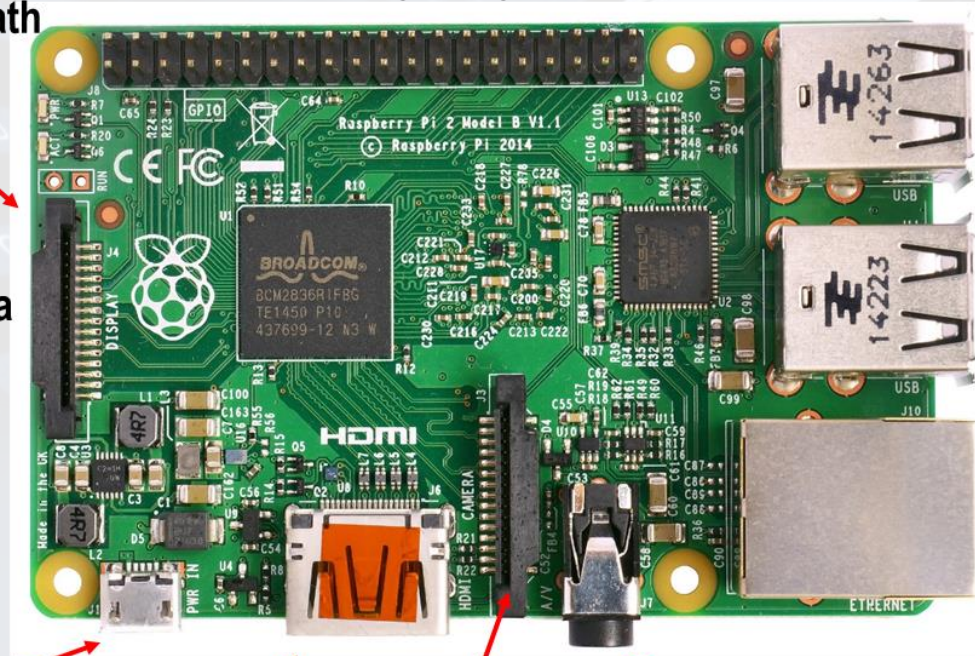
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Raspberry Pi - Layout

40-pin General Purpose Input/Output (GPIO) pins

MicroSD slot underneath

To external display via ribbon cable
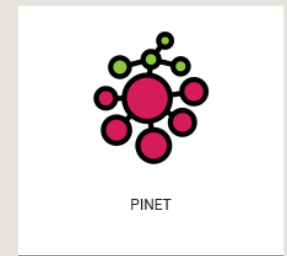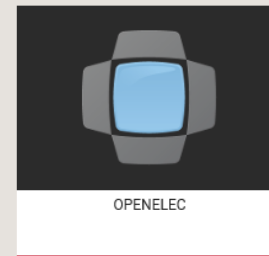
Power through Micro-USB

HDMI video-out

To Pi Camera

4 x USB2.0 ports

Ethernet port
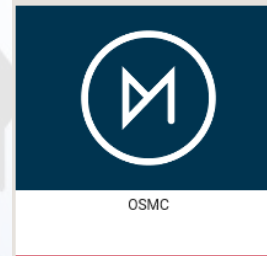
AUX audio-out

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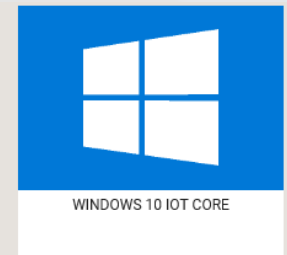PRG1 AY19/20, Sem 1

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Raspberry Pi – Operating Systems

New Out Of the Box Software

- 1st Party : Noobs & Raspbian

NOOBS

RASPBIAN

- 3rd Party :

UBUNTU MATE

SNAPPY UBUNTU CORE

WINDOWS 10 IOT CORE

OSMC

OPENELEC

PINET
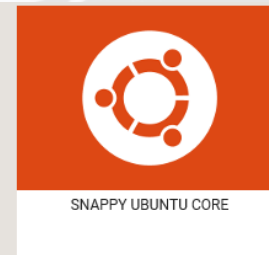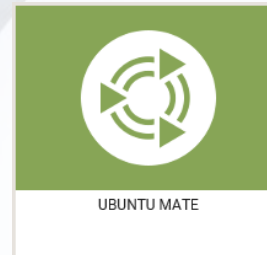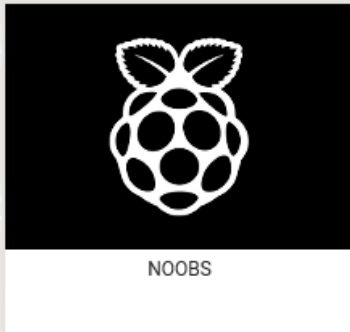
Linux
not Windows / not OSX

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Raspberry Pi – What It Can Do

- ## A LOT!
  - ### Music Server
  - ### Pi Internet TV
  - ### Pi Radio
  - ### Small Web Server
  - ### Retro Game Machine
  - ### Etc...

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Raspberry Pi – Connecting

Note: The MicroSD card is already loaded with Raspbian

- **Step 1: Plug in the micro-USB plug to the RPi3 and turn on the power from the power socket**

- **Step 2: Wait for approximately 1 min for the RPi3 to load Raspbian**

- **Step 3: Check the Batch and Set No. on the under side of the RPi3 casing**

- **Step 4: Connect to the wireless SSID broadcasted by your given RPi3**
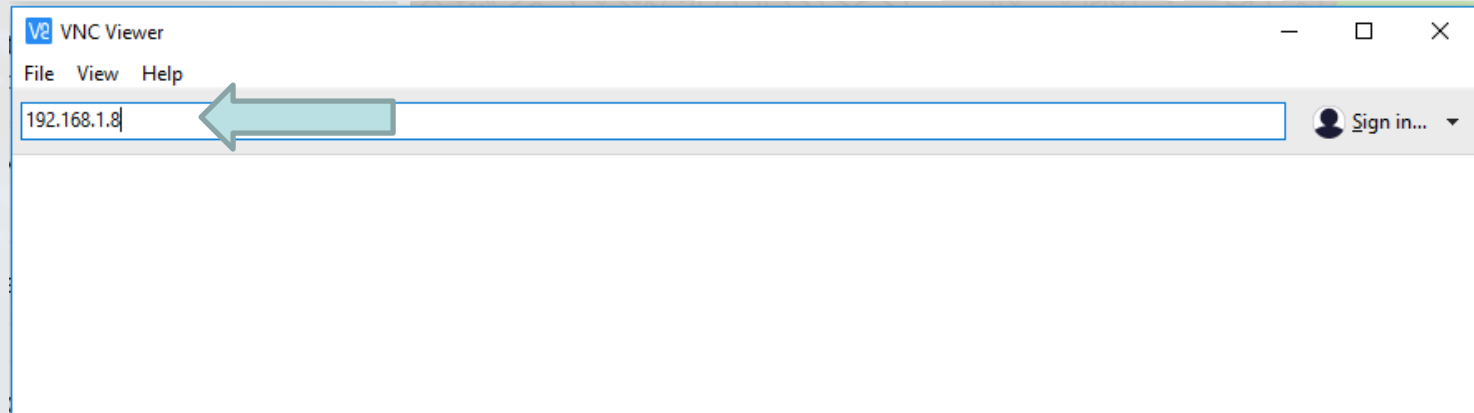
Password: 0123456789

Examples:

Batch No.	Set No.	SSID
750	34	750-1-1 Set34
	59	750-1-1 Set59
723	12	723-1 Set12
	57	723-1 Set57

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Raspberry Pi – Connecting

- **Note: At this point, your browser might load to prompt you to log in to NPWireless. Enter your credentials to attain Internet access.**

- **Step 5: Load the "VNC Viewer" program on your laptop and enter "192.168.50.1" into the "Enter a VNC Server address or search" field**

- **Step 6: Press the "Enter" key on your keyboard**

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Raspberry Pi – Connecting

- **Step 7: Enter the following credentials and press "OK":**
  - **Login: pi**
  - **Password: raspberry**

  Note: You might wish to check the "Remember password" box.

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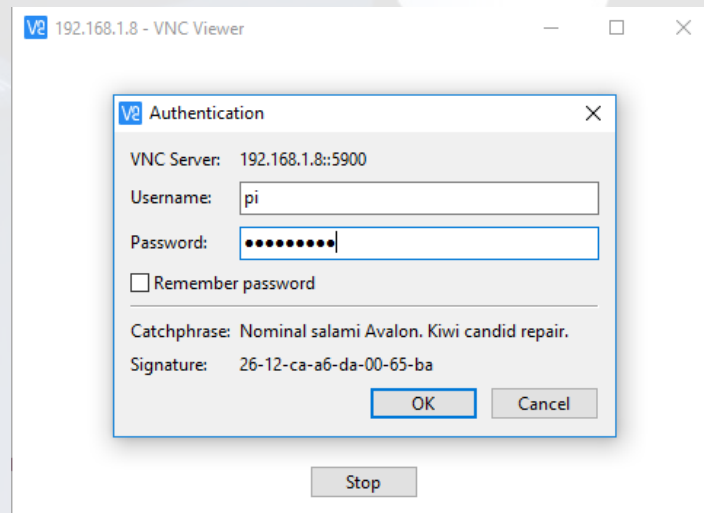
Raspberry Pi – Connecting

- **If you see the following screen or something similar, congratulations!**
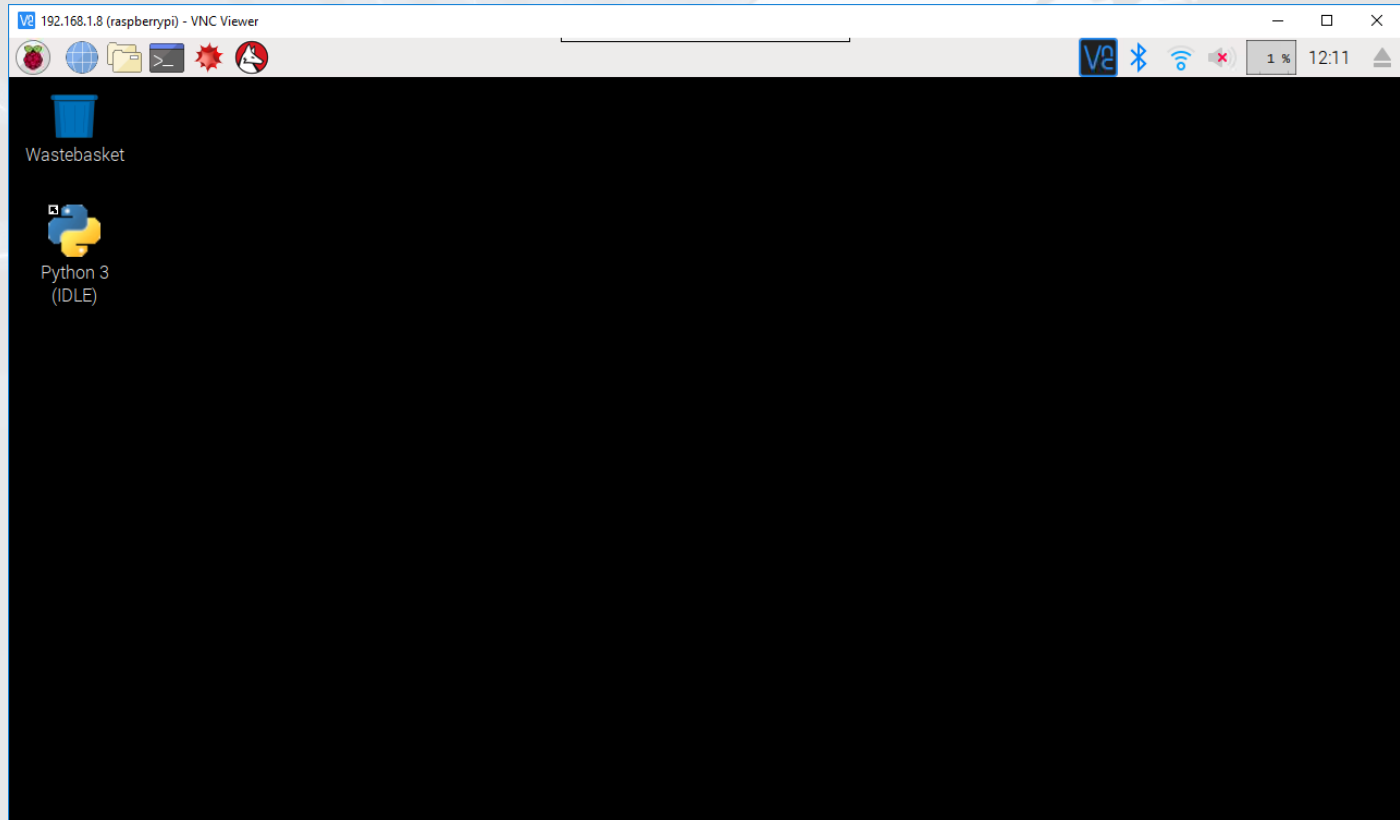
Raspberry Pi – My "First" Python Code

- **Launch Python 3 (IDLE) program (double-click icon)**

File → New Window
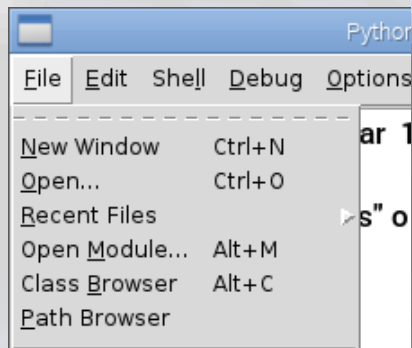
Type in the code
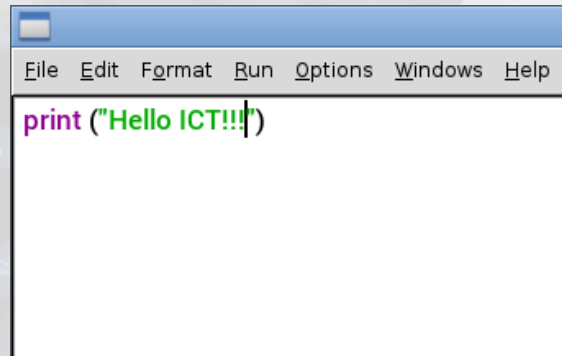
Save as "hello" (default is py)
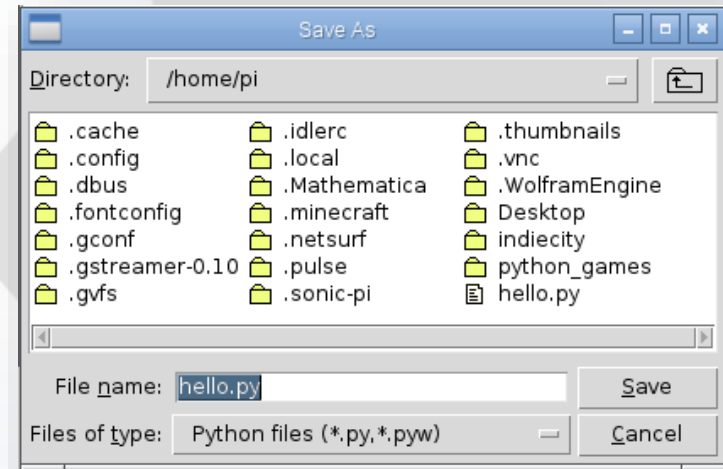
Run the program – do you see any output?

Note: Please **transfer out** all your files and **delete** them from the Pi before returning the set to your tutor.

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Activity 1

- **Raspberry Pi – Transferring Files Through FTP**

- **Use FTP (e.g., with Filezilla) to easily transfer files from/to** *the Pi*
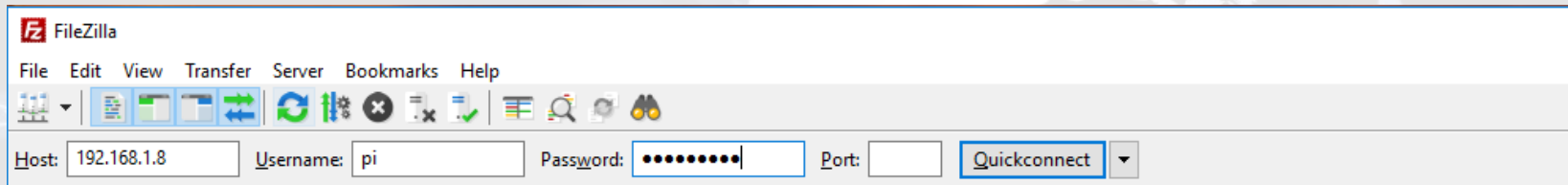
Host: 192.168.1.8

Username: pi

Password: raspberry

Filezilla: https://filezilla-project.org/download.php

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Raspberry Pi – Sense HAT (hardware attached on top)

- ## An add-on board for Raspberry Pi

- ## Features:
  - ### 8×8 RGB LED matrix
  - ### Five-button joystick
  - ### Sensors
    - #### Gyroscope
    - #### Accelerometer
    - #### Magnetometer
    - #### Temperature
    - #### Barometric pressure
    - #### Humidity

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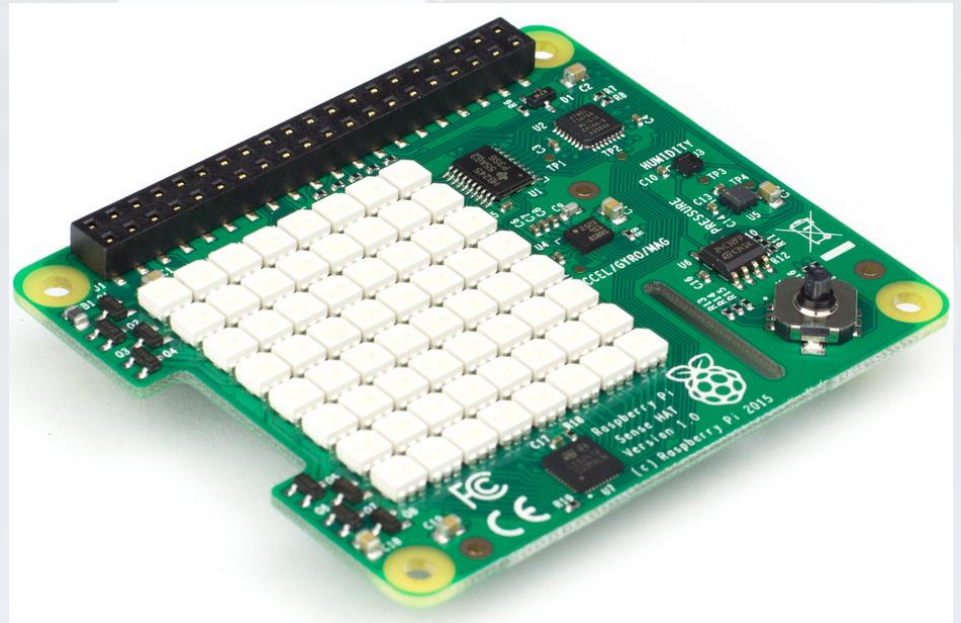
Sense HAT - Usage

- Just like how we have to import the *math* module to use the *math* functions, the same goes for SenseHAT

- After importing the SenseHAT library, you can use the functions provided by it for easy access to everything on the board

- Import SenseHAT library and initialize it
  1. from sense_hat import SenseHat
  2. sense = SenseHat()

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Sense HAT Emulator - Alternative

- **In the event that raspberry pi and Sense HAT are not available, an emulator version of the setup can be found at https://trinket.io/sense-hat**

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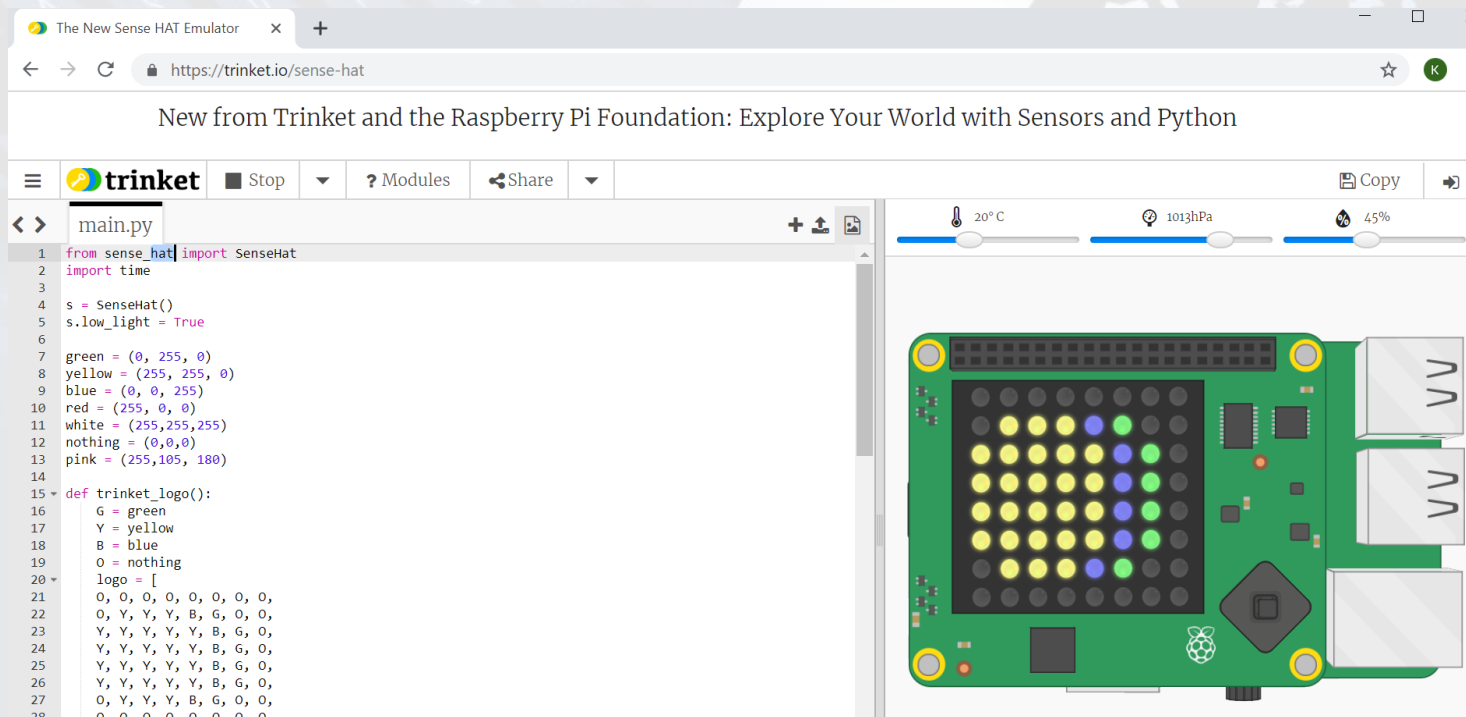
Sense HAT Emulator – Usage and Limits

- **The directional arrows on keyboard emulates the directional joystick of the Sense HAT.**

- **The Enter key on keyboard emulates the depressing of the joystick of the Sense HAT.**

- **All values of roll, pitch and yaw are simulated by slider bars**

- **All values of temperature, pressure and humidity are simulated by slider bars.**

- **No reading in or writing out of external files**

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Sense HAT – Sensors

Function	get_humidity()
Description	Gets the percentage of relative humidity from the humidity sensor.
Example	humidity = sense.get_humidity()

Function	get_temperature()
Description	Gets the current temperature in degrees Celsius from the humidity sensor.

Function	get_pressure()
Description	Gets the current pressure in Millibars from the pressure sensor.

Function	get_orientation ()
Description	Gets the current orientation in degrees using the aircraft principal axes of pitch, roll and yaw.
Example	orientation = sense.get_orientation() print("p: {pitch}, r: {roll}, y: {yaw}".format(**orientation))

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Sense HAT – 8X8 Matrix LED

Function	show_message(message)	
Description	Scrolls a text message from right to left across the LED matrix	
Parameters	scroll_speed	The speed at which the text should scroll. (default=0.1)
	text_colour	A list containing the R-G-B (red, green, blue) colour of the text. (default is white = [255,255,255])
	back_colour	A list containing the R-G-B (red, green, blue) colour of the background. (default is black = [0,0,0])
Example	sense.show_message("Hello World", text_colour=[255,0,0])	

Function	clear()
Description	Resets the LED matrix

Practice: Scroll the message "I love PRG1!" on the LED. The text is to be in blue colour [0,0,255] and a background colour of yellow [255,255,0]

RGB Calculator tool: http://www.w3schools.com/colors/colors_rgb.asp

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Example: Display Message

```
# Scroll the message "I love PRG1!" on the LED
# The text is in blue colour on yellow background

from sense_hat import SenseHat
sense = SenseHat()

# to show a message in blue on yellow
sense.show_message("I love PRG1!", text_colour=[0,0,255],
back_colour=[255,255,0])

# reset the background to black
sense.clear()
```

Practice: Retrieve the temperature from the Sense HAT, and scroll the temperature
on the Sense HAT LED with a scroll speed of 0.2. The text is to be in red
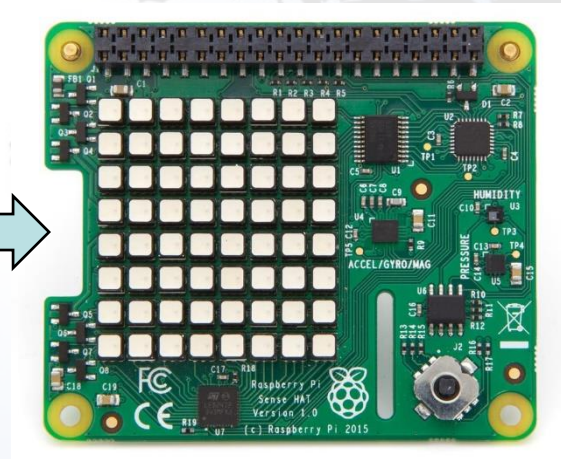colour [255,0,0].

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Example: Display Temperature

```python
# Scroll the temperature retrieved from the Sense HAT
# on the Sense HAT LED with a scroll_speed of 0.2
# The text is displayed in red colour

from sense_hat import SenseHat
sense = SenseHat()


temp = sense.get_temperature()
temp = '{:.2f}'.format(temp)
sense.show_message(temp,scroll_speed=0.2,\
                   text_colour=[255,0,0])
```

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Sense HAT – More Fun with the LED

Function	set_pixels(list)	
Description	Updates the entire LED matrix based on a 64 length list of pixel values.	
Parameters	pixel_list	A list containing 64 smaller lists of [R, G, B] pixels (red, green, blue). Each R-G-B element must be an integer between 0 and 255.
Example	X = [255, 0, 0] # *Red* O = [255, 255, 255] # *White* question_mark = [O, O, O, X, X, O, O, O, O, O, X, O, O, X, O, O, O, O, O, O, O, X, O, O, O, O, O, O, X, O, O, O, O, O, O, X, O, O, O, O, O, O, O, X, O, O, O, O, O, O, O, O, O, O, O, O, O, O, O, X, O, O, O, O] sense.set_pixels(question_mark)	

Practice: Create the @ sign on the LED with the background and text colours of your choice

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Example: Display Symbol

```python
# Create a red @ sign on the LED on black background
from sense_hat import SenseHat
sense = SenseHat()
X=[255,0,0]        #red
O=[0,0,0]          #black
symbol = [
    X,X,X,X,X,X,X,X,
    X,O,O,O,O,O,O,X,
    X,O,X,X,X,X,O,X,
    X,O,X,O,O,X,O,X,
    X,O,X,O,O,X,O,X,
    X,O,X,X,X,X,X,X,
    X,O,O,O,O,O,O,X,
    X,X,X,X,X,X,X,X
    ]
sense.set_pixels(symbol)
```

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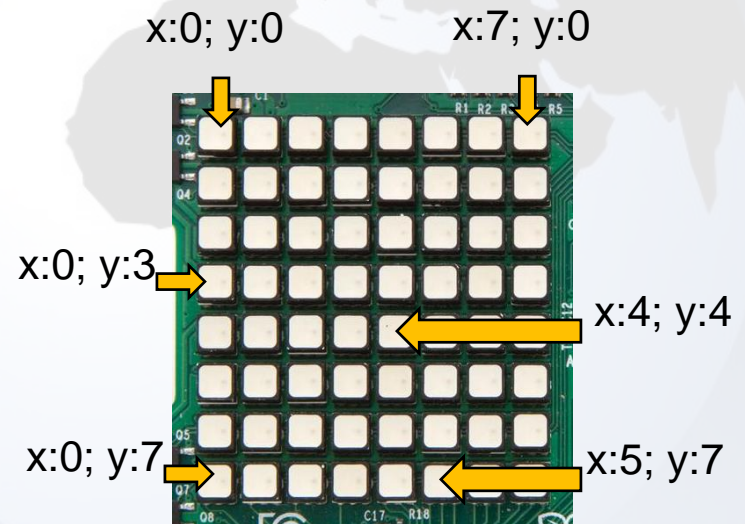Lecture 9
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Example: Light 4 Corners

```python
# Light up the four corners of the LED matrix with different
# text colours

from sense_hat import SenseHat
sense = SenseHat()


sense.clear()


sense.set_pixel(0,0,255,0,0)
sense.set_pixel(0,7,255,255,0)
sense.set_pixel(7,0,0,0,255)
sense.set_pixel(7,7,54,23,64)
```


x:0; y:0   x:7; y:0

x:0; y:3

x:4; y:4

x:0; y:7   x:5; y:7

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Sense HAT – Joystick

```python
from sense_hat import SenseHat
from time import sleep
sense = SenseHat()

sense.clear()
flag=True
while flag:
  for event in sense.stick.get_events():
    # Check if the joystick was pressed
    if event.action == "pressed":

      # Check which direction
      if event.direction == "up":
        print("up")        # Up arrow
      elif event.direction == "down":
        print("down")      # Down arrow
      elif event.direction == "left":
        print("left")      # Left arrow
      elif event.direction == "right":
        print("right")       # Right arrow
      elif event.direction == "middle":
        print("middle")        # Enter key
        flag=False

      # Wait a while and then clear the screen
      sleep(0.5)
      sense.clear()

print('End')
```

- **Template for managing joystick events**
- **Modify codes accordingly to program your algorithm!**

Sense HAT – Joystick

```python
from sense_hat import SenseHat
from time import sleep
sense = SenseHat()

sense.clear()
flag=True
while flag:
    for event in sense.stick.get_events():
        # Check if the joystick was pressed
        if event.action == "pressed":

            # Check which direction
            if event.direction == "up":
                print("up")          # Up arrow
            elif event.direction == "down":
                print("down")        # Down arrow
            elif event.direction == "left":
                print("left")        # Left arrow
            elif event.direction == "right":
                print("right")       # Right arrow
            elif event.direction == "middle":
                print("middle")      # Enter key
                flag=False

            # Wait a while and then clear the screen
            sleep(0.5)
            sense.clear()

print('End')
```

← `sense.show_message("PUSHED")`

Practice

1. **Add new code to the file such that depending on the type of joystick action, a different message will scroll on the SenseHAT LED (e.g., Scroll "Left" when the joystick is moved left)**

2. **Run and test your program**

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Reading Reference

- **SenseHAT API:**

  https://pythonhosted.org/sense-hat/api/

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Summary

- **What is Raspberry Pi**

- **Raspberry Pi and Internet of Things**

- **Getting started with the Raspberry Pi**

- **Sense HAT features**

- **Using Sense HAT**

- **Sensors**

- **LED**

- **Joystick**