1

Introduction to Raspberry Pi & Python Programming

https://tinyurl.com/designWk2

DOWNLOAD MATERIALS HERE

Session Details

- Date: 25 September 2019
- Instructor Names: Pei Yuan & Yuxuan & Jason

- Objectives:
  - Understand what is RPi
  - Exposure to the Linux command
  - Exposure to Python programming
  - Build a simple quiz program with Python

Session Logistics

- What you need:
  - Pre-configured RPi
  - Laptop
    - Installed and working VNC viewer
    - Installed and working Python SDK and IDE

Program outline for 3 weeks

- Raspberry Pi setup and connection
- Linux basic commands in Terminal
- Python programming
- Basic Google Firebase credentials setup
- Python codes to update Firebase data via cloud
- Python Flask web micro-framework [bonus]
- App development using MIT app inventor [bonus]

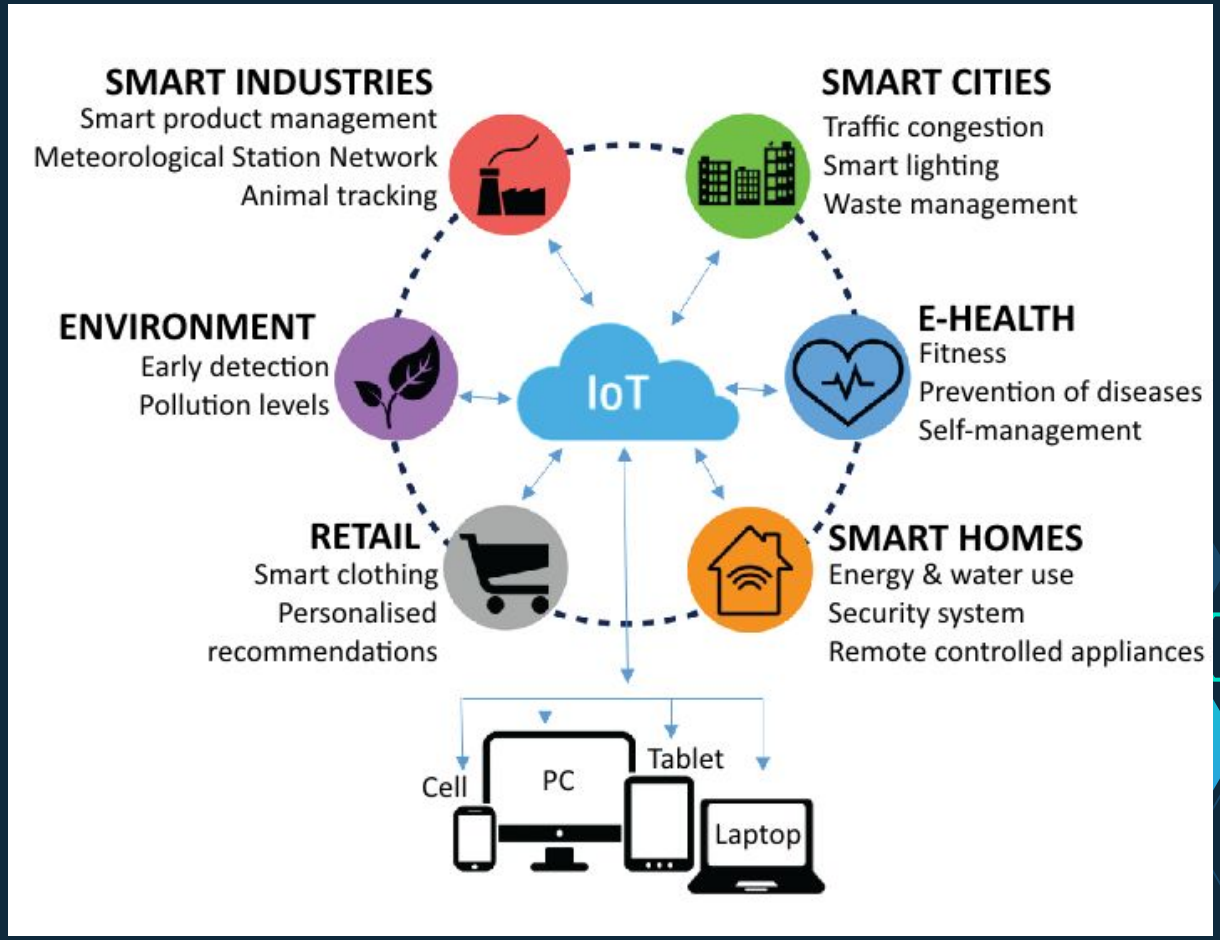
Internet of things (IOT)

What is Internet of Things?

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

https://en.wikipedia.org/wiki/Internet_of_things

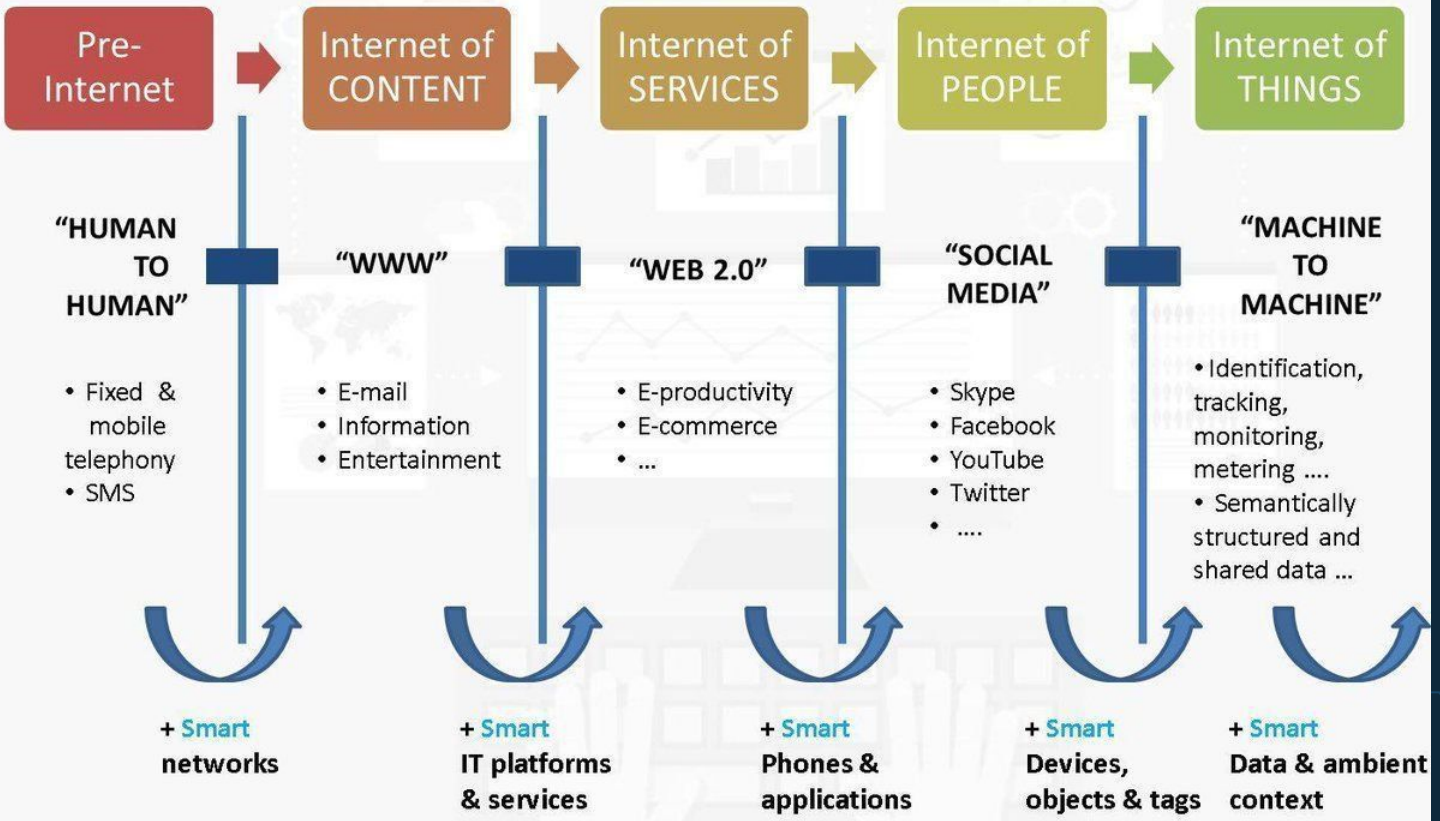
Internet of things (IOT) is everywhere!!!



Picture Source:

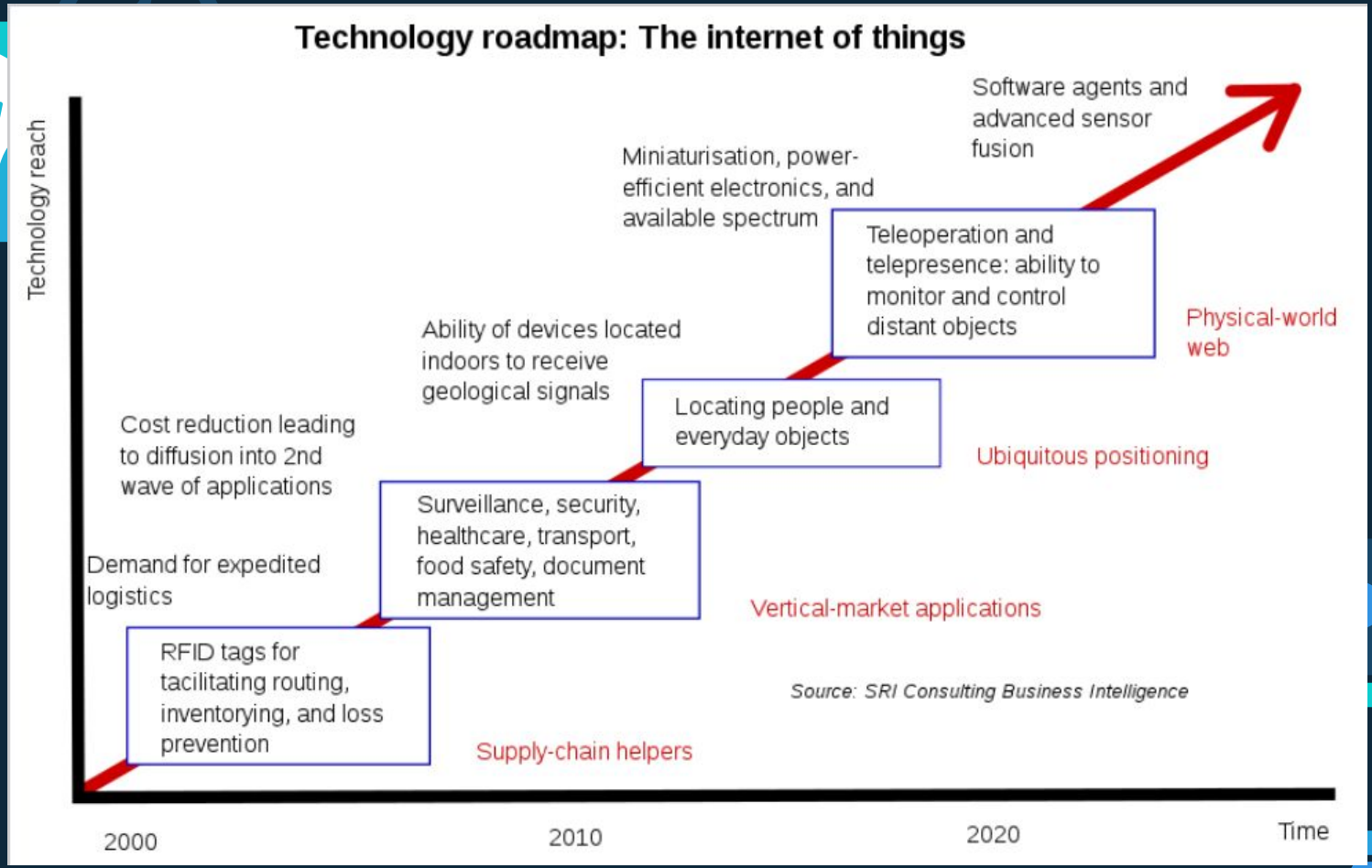
http://www.tildatech.co.za/InternetOfThings.aspx

Evolution of Internet of Things



Picture Source:

https://twitter.com/fisher85m/status/926360908900773889

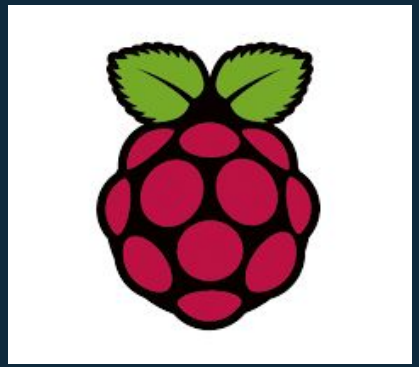


Picture Source: https://en.wikipedia.org/wiki/Internet_of_things

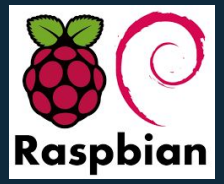
Raspberry Pi

What is a Raspberry Pi?

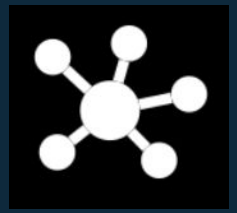
The Raspberry Pi as a Single board computer with mutiple I/O to interface with external electronics components

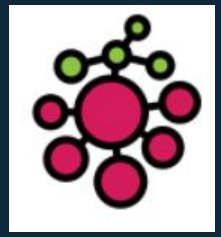
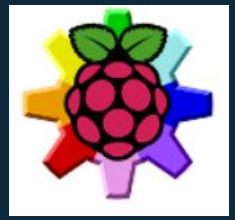


Supported OS on Raspberry Pi



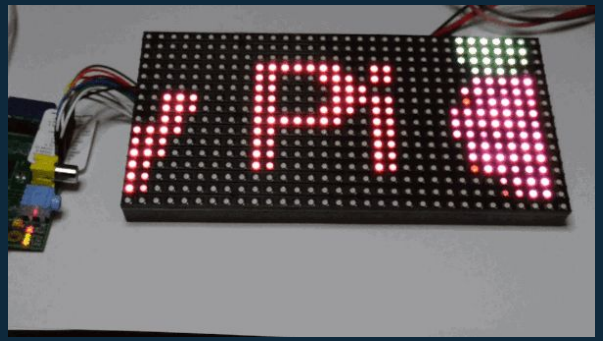


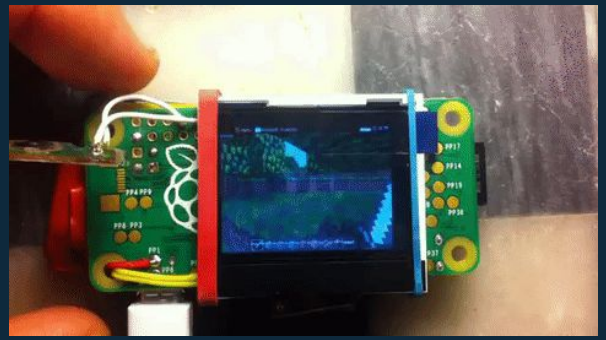




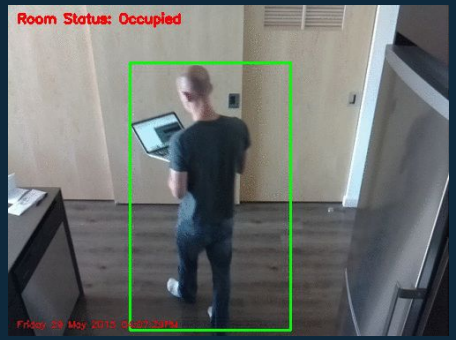


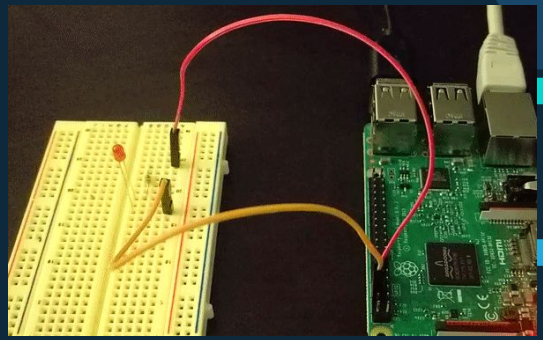



Raspberry Projects









RPi 3 Model B+

The Raspberry Pi 3 Model B+ is the final revision in the Raspberry Pi 3 range.

- Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz
- 1GB LPDDR2 SDRAM
- 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE
- Gigabit Ethernet over USB 2.0 (maximum throughput 300 Mbps)
- Extended 40-pin GPIO header
- Full-size HDMI
- 4 USB 2.0 ports
- CSI camera port for connecting a Raspberry Pi camera
- DSI display port for connecting a Raspberry Pi touchscreen display
- 4-pole stereo output and composite video port
- Micro SD port for loading your operating system and storing data
- 5V/2.5A DC power input
- Power-over-Ethernet (PoE) support (requires separate PoE HAT)

We will use the Raspberry Pi (RPi) 3 Model B+ for these 3 weeks

https://www.raspberrypi.org/products/raspberry-pi-3-model-b-plus/

RPi vs Arduino

Raspberry Pi	Arduino
Microcomputer	Microcontroller
Needs an operating system	Does not need an operating system
Complicated	Simple
Video out, Camera, Ethernet ports, Wifi, Bluetooth, USB, I2C, SPI, UART etc. on board	USB only for power and serial in/out, I2C, SPI, UART
Best for general computer	Best for small tasks that constantly repeat
Capable of performing a huge range of tasks	Optimised for sensing and controlling the world around it
Best for more advanced makers	Best for beginners
Programmed in many languages, including C/C++, Python, Ruby	Programmed in C/C++
Relatively high power consumption	Relatively low power consumption

RPi vs Arduino

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Arduino Uno Rev3

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

RPi vs Samsung Galaxy S10

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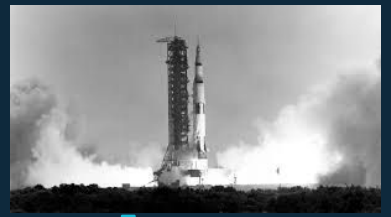
Samsung Galaxy S10

NETWORK	Technology	GSM / CDMA / HSPA / EVDO / LTE EXPAND ▾
LAUNCH	Announced	2019, February
	Status	Available. Released 2019, March
BODY	Dimensions	149.9 x 70.4 x 7.8 mm (5.90 x 2.77 x 0.31 in)
	Weight	157 g (5.54 oz)
	Build	Back glass (Gorilla Glass 5), aluminum frame
	SIM	Single SIM (Nano-SIM) or Hybrid Dual SIM (Nano-SIM, dual stand-by)
		Samsung Pay (Visa, MasterCard certified)
		IP68 dust/water proof (up to 1.5m for 30 mins)
DISPLAY	Type	Dynamic AMOLED capacitive touchscreen, 16M colors
	Size	6.1 inches, 93.2 cm^2 (~88.3% screen-to-body ratio)
	Resolution	1440 x 3040 pixels, 19:9 ratio (~550 ppi density)
	Protection	Corning Gorilla Glass 6
		HDR10+
		Always-on display
PLATFORM	OS	Android 9.0 (Pie); One UI
	Chipset	Exynos 9820 (8 nm) - EMEA/LATAM
		Qualcomm SDM855 Snapdragon 855 (7 nm) - USA/China
	CPU	Octa-core (2x2.73 GHz Mongoose M4 & 2x2.31 GHz Cortex-A75 & 4x1.95 GHz Cortex-A55) - EMEA/LATAM
		Octa-core (1x2.84 GHz Kryo 485 & 3x2.42 GHz Kryo 485 & 4x1.78 GHz Kryo 485) - USA/China
	GPU	Mali-G76 MP12 - EMEA/LATAM
		Adreno 640 - USA/China
MEMORY	Card slot	microSD, up to 1 TB (uses shared SIM slot) - dual SIM model only
	Internal	128GB 8GB RAM, 512GB 8GB RAM

https://www.gsmarena.com/samsung_galaxy_s10-9536.php



Trival of the day

Raspberry Pi has better computing power than the Apollo 11's Apollo Guidance Computer (AGC)!

1) Clock speed 2Mhz
2) RAM 4KB

https://en.wikipedia.org/wiki/Apollo_Guidance_Computer

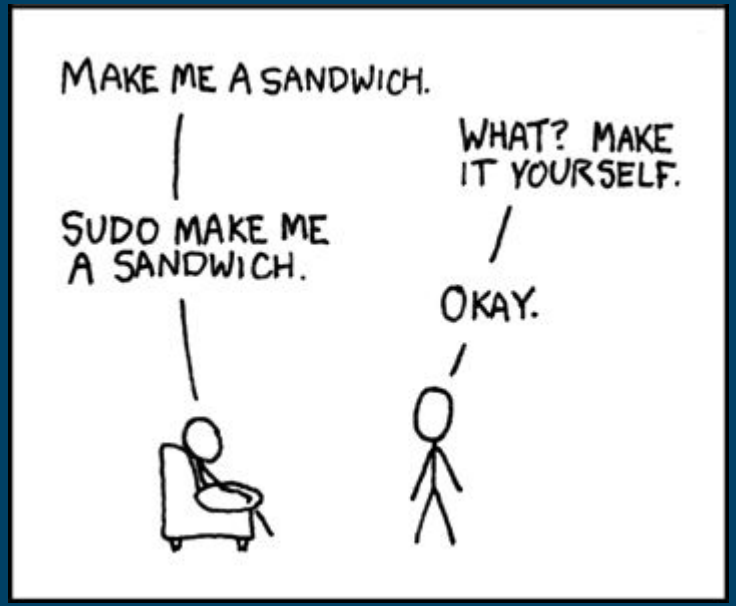
Linux commands

The following slides are contributed by IEEE HKN previous workshop

sudo

$ sudo <command>

- super user do
- Elevated privilege



nano

$ nano <file>

Text editor

ls

$ ls [directory]

Lists down directories/files

grep

$ grep <word> <file1> <file2>
See also “ | ”

Used to search for text in files.
Similar to CTRL + F function

cd

$ cd <directory>

Changes directory

mkdir/rmdir

$ mkdir <name>

- Makes a directory
- Removes a directory

touch

$ touch <name>

- Creates a blank file

man/help

$ man <command>

$ help <command>

- Difference:
- **help** is for **bash** commands only
- **man** is for a lot more others

whereis

$ whereis <namespace>

- Used to find stuff

pwd

$ pwd

- Prints current working directory

apt

$ apt <command>

- Advanced Packaging Tool (APT)
- SUPER useful
- Also: pip, npm.

watch

$ watch [options] [command]

- Execute a program periodically, showing output fullscreen

Python Basics

Useful resources:

- https://www.w3schools.com/python/
- https://docs.python.org/3/tutorial/
- https://open.kattis.com
- https://www.codingame.com/start
- https://repl.it

Basic of Basics

py1.py

Anything stuck?

- Google is always there to help you :)
- Ask your peers
- Ask your prof
- Ask your seniors
- Ask us :) IEEE Family Telegram Group

Mini Activities

Design a quiz system that evaluate user's answers and give a final grade.

Your system should contain:

1. Input field for user's name
2. 5 math questions and input fields for the questions
3. Start with 0 mark. Correct is +1 mark. Wrong is -1 mark. Invalid answer will show alert message and start over.

Mini Activities

Step One:

Create a folder called “questions”. We will put all the questions in there.

The objective is to create multiple functions that handle different parts of this system and in the end combine everything together.

Mini Activities

Task 1:

Create a python file in the folder, name it as "question1.py"

Define a function called question1(grade). It takes in an argument which is the current grade, and prompt user a summation question. It takes in user's input and evaluate the sum result. It returns the new grade.

Mini Activities

Task 2:

Create a python file in the folder, name it as "question2.py"

Define a function called question2(grade). It takes in an argument which is the current grade, and prompt user a division question. It takes in user's input and evaluate the division result. It returns the new grade.

Mini Activities

Task 2:

[BONUS]

Use try and except block to do error handling. If user input invalid character, program should print out the error and alert message and return the current grade.

Mini Activities

Task 3:

Create a python file in the folder, name it as “question3.py”

Define a function called question3(grade). It takes in an argument which is the current grade, and prompt user this question: “What is the full name of SUTD?”. The program should be able to run even if user does not enter a string. Use **Try and Except** to ensure the program does not crash when invalid input is entered and function will return the current grade as normal.

[Search on string methods: **String.strip()** and **String.split()**]

Mini Activities

Task 4:

Create a python file in the folder, name it as “question4.py”

Define a function called question4(grade). It takes in an argument which is the current grade, and prompt user this question: “Give a list of 5 numbers separated by commas that add up to 21”. The function will convert the input to a list and evaluate whether the summation of the 5 numbers equal to 21. Use **Try and Except** to ensure the program does not crash when invalid input is entered and function will return the current grade as normal.

for loop & String.split() is required for this question!

Mini Activities

Task 5:

Create a python file in the folder, name it as “question5.py”

Define a function called question5(grade). It takes in an argument which is the current grade. For this exercise, you design whatever question you want.

Mini Activities

Task 6:

Go outside of the “questions” folder, create a file called “quiz.py”

We will learn how to import modules that you have created from other folders. Please follow the demonstration!

Mini Activities

Task 7:
Handling repeat when invalid input is given

Use a combination of while loop and if-else:

```
set a status variable to be true
while status:
        new grade generated by new question function
        if new grade is different old grade:
                old grade = new grade
                change status to false to break out of the loop
        else:   (same as old grade)
                do nothing, loop continue
```

Mini Activities

Bonus Task:

Realize your code is very long-winded and the code blocks kind of follow a similar pattern?

Do you know function can actually have other function as argument?

You can create another function that handles this similar pattern, the function argument will be a **list** of question functions you created. Use **for loop** to loop through each question. Use **conditional statement** to decide whether to repeat the question or go on to the next one! You may want to use **List.index(element)** method to check whether you have reached the last question!

Mini Activities

Example codes given in the “example” folder

Next workshop:

1. Write a python programme on RPi to control LED using GPIO pins.
2. Buttons as GPIO input and LEDs as GPIO output.
3. Mini-activity:
    a. Manual Traffic light control mini project
    b. Ultrasonic sensor with RPi: distance alert system

End of workshop

Thank you all for coming!

Maker Extravaganza

Date: 18 October 2019, Friday
Location: Singapore Science Centre
Time: 1pm (Meet at campus centre)

We will be providing transport from school to the science centre

Registration link: http://bit.ly/makerfaire2019

Find out more:
https://sciencecentresg.shinyapps.io/sgme2019/
https://makerfaire.com/makerfairehistory/

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Approach any of the exco members to find out more about what we do

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@ieeesutd_bot on Telegram is here to help you :)

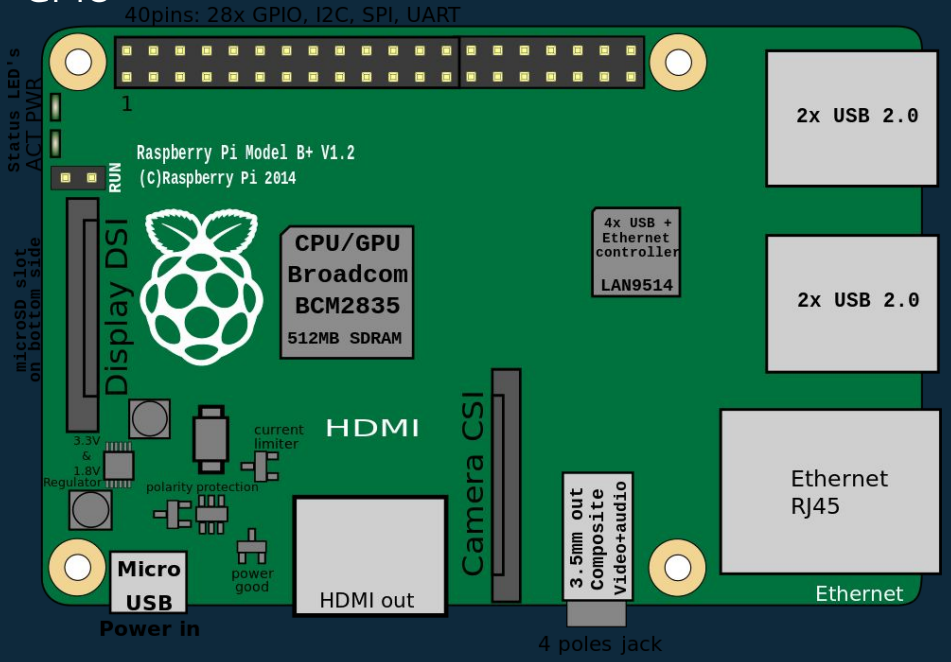
Join the AC-DC converter Project!

Talk to our Project Director Dhruv to find out more about this exciting project!

The End

Raspberry Pi

GPIO



RaspberryPi