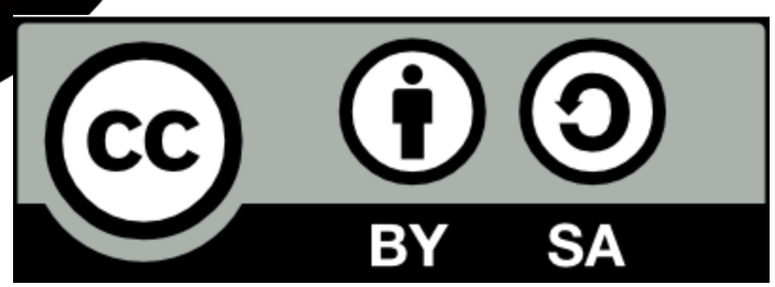
A Slice of Raspberry Pi

Original By Spencer Martin
Revised By Thomas “Tweeks” Weeks



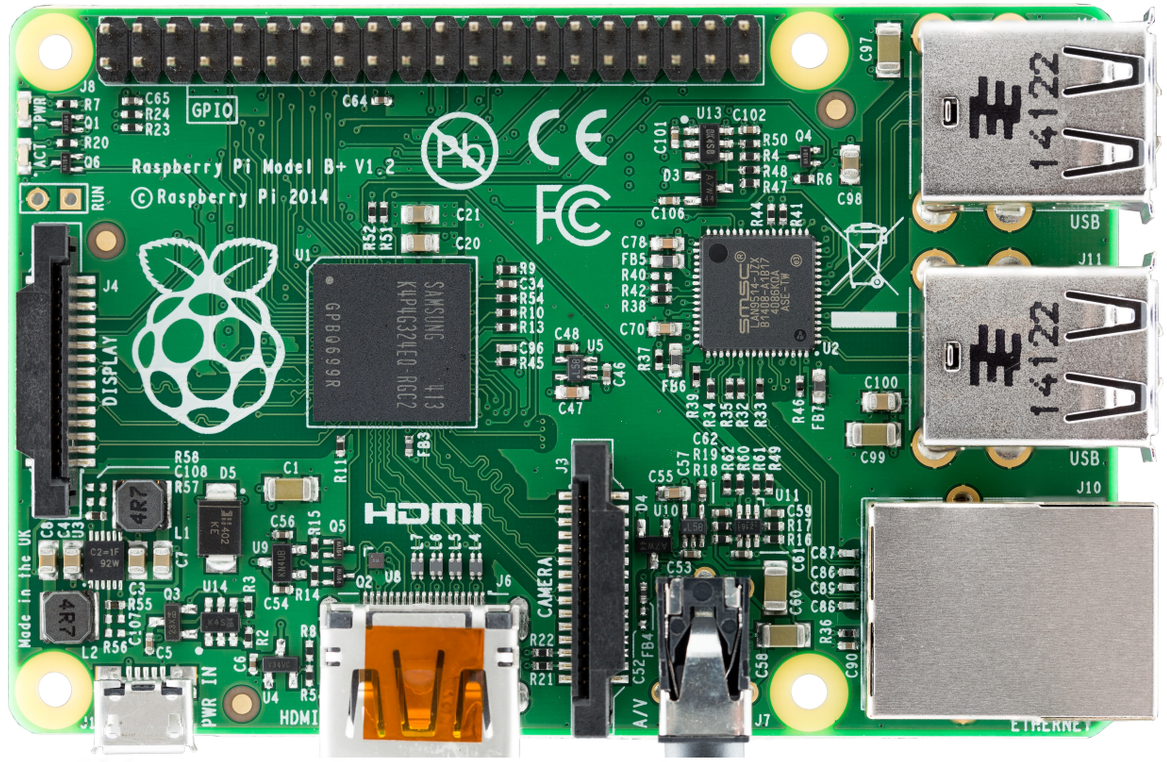
About Me

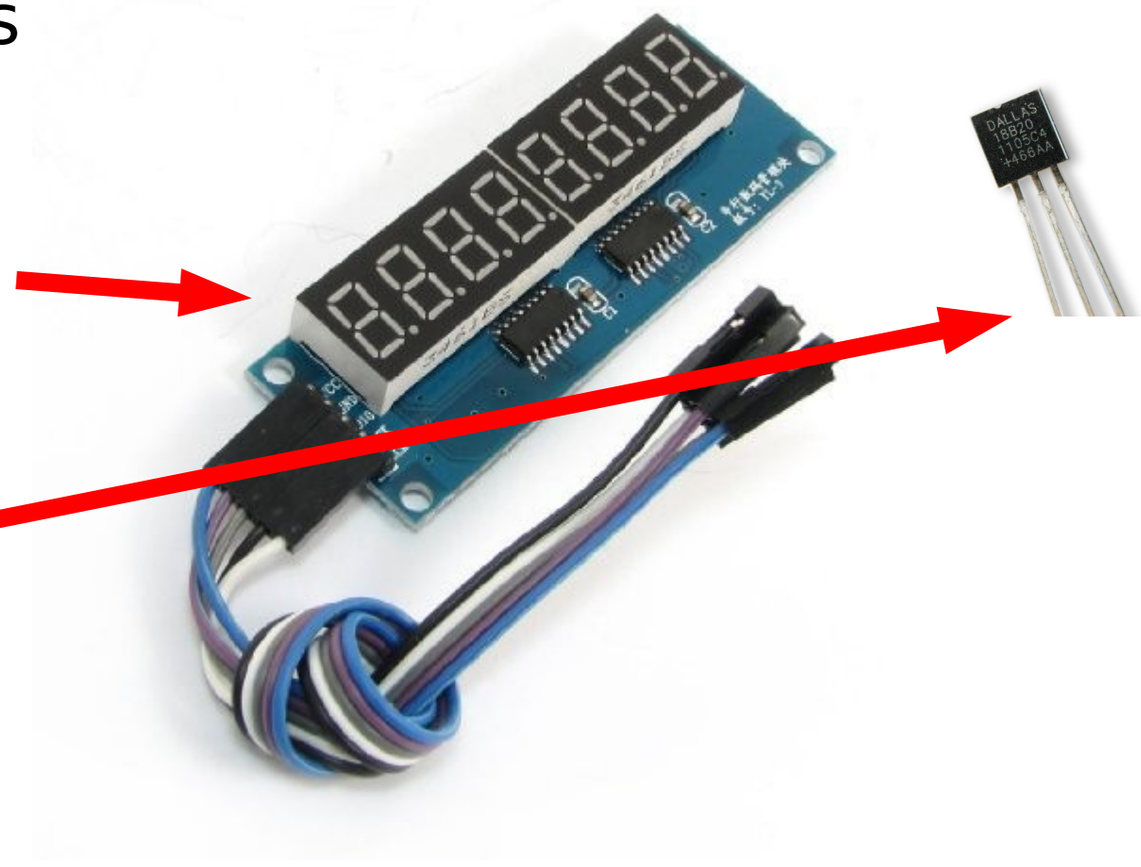
Class goals

1)Learning a bit about the python language

2)Write a final program called **piTempLogger.py** that:

- Measures things and outputs results to a blinking LED
- Output to a 7 segment LED display to show more data.
- Read temp from a sensor
- Research how to email the temperature to yourself in python





Connecting To Your Pi From a Laptop

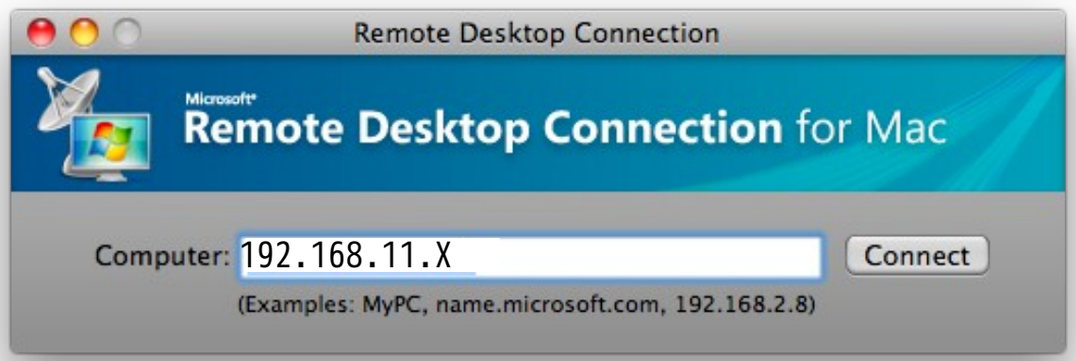
Connect to the Pi using
“Remote Desktop” clients:

- For Windows type:

  mstsc /v:*ip-address*

- For Mac OSX install/use:

  10.6 http://tinyurl.com/mac-rdp-10-6
  10.7 http://tinyurl.com/mac-rdp-10-7



- For Linux type

  rdesktop -u pi -g 1024x768 *ip-address*

*** -In the IP 192.168.11.X where X is your Pi number if on wifi**

1) Getting Familiar with the Python Language

Hello world!

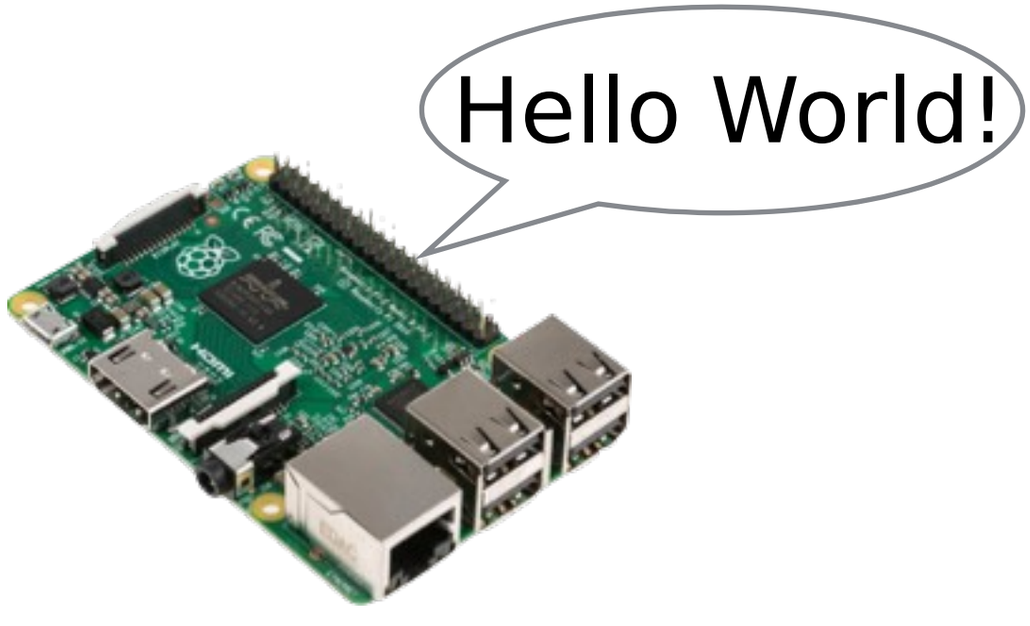
Your first program

Open terminal or command prompt and type in **`python`**

At the “**`>>>`**” python prompt, type in:

```
print "hello world"
```

```
>>> print "hello world!"
hello world!
>>>
```



Math and Variables

Try setting a variable by typing in:

```
x = 1
```

You multiply, divide, add, subtract using operators:

```
*       /     +     -
```

Print variables by omitting quotes

```
print x
```

```
>>> x = 1
>>> y =(x+2)*7
>>> print y
21
>>> print "y"
y
>>>
```

Math and Variables

Try setting a variable by typing in:

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You multiply, divide, add, subtract using operators:

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*       /     +     -
```

Print variables by omitting quotes

```
print x
```

```
>>> x = 1
>>> y =(x+2)*7
>>> print y
21
>>> print "y"
y
>>>
```

<u>WARNING:</u> Standard mathematical “order of operations” applies. Remember PEMDAS ?

Input

Taking input from users

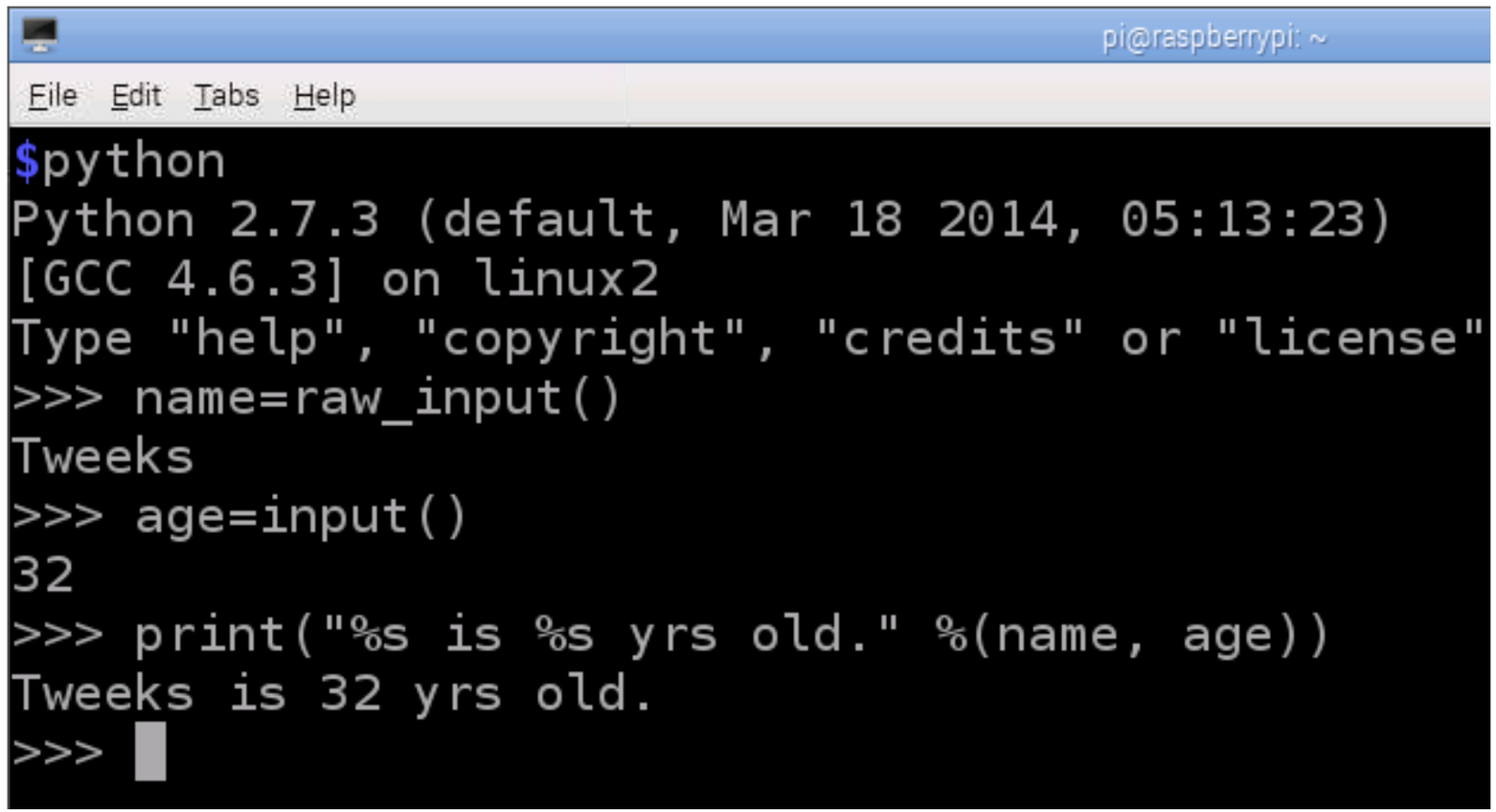
The command **`input()`** is good for taking numbers as input from users and **`raw_input()`** is good for taking text (without needing quotes).

Either quietly prompts the user to enter data.

Here's how you might use each:

```
name = raw_input()
age = input()
```

And what it would look like using them:



Writing Multi line programs

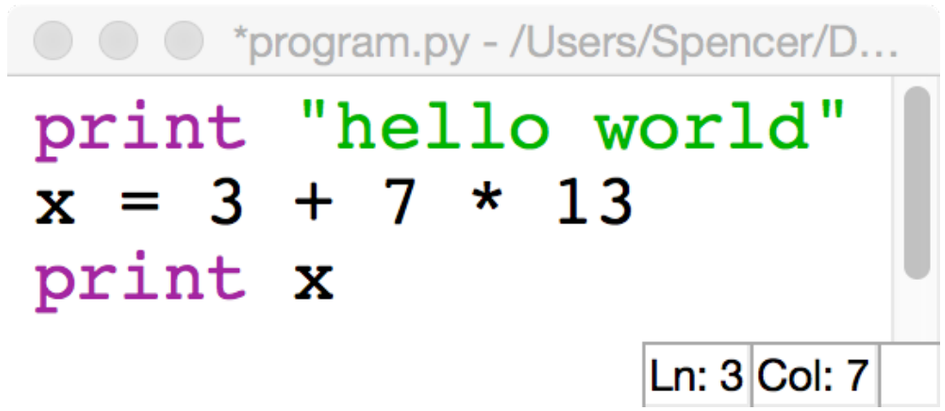
- Open the programming interface called **`idle.sh`** and select File / New Window

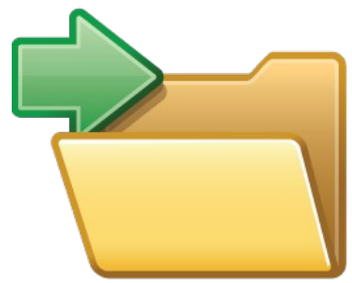
- Type your python commands into the **`idle`** programming window

- Save-As your program to “program.py”

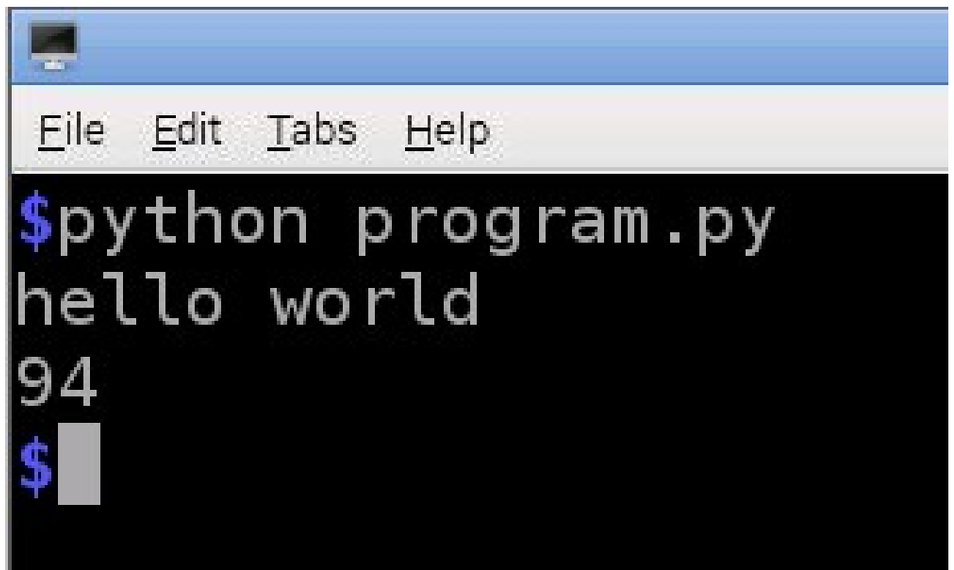
- Close all idle windows

- Run your program from the terminal, by typing in
  `python program.py`



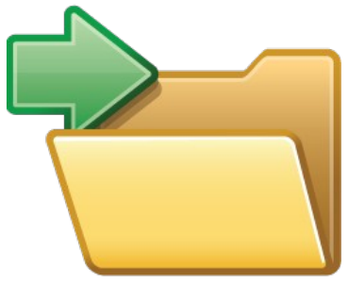


In Idle, save your program to a file called “program.py”



For loops

Doing things against a list

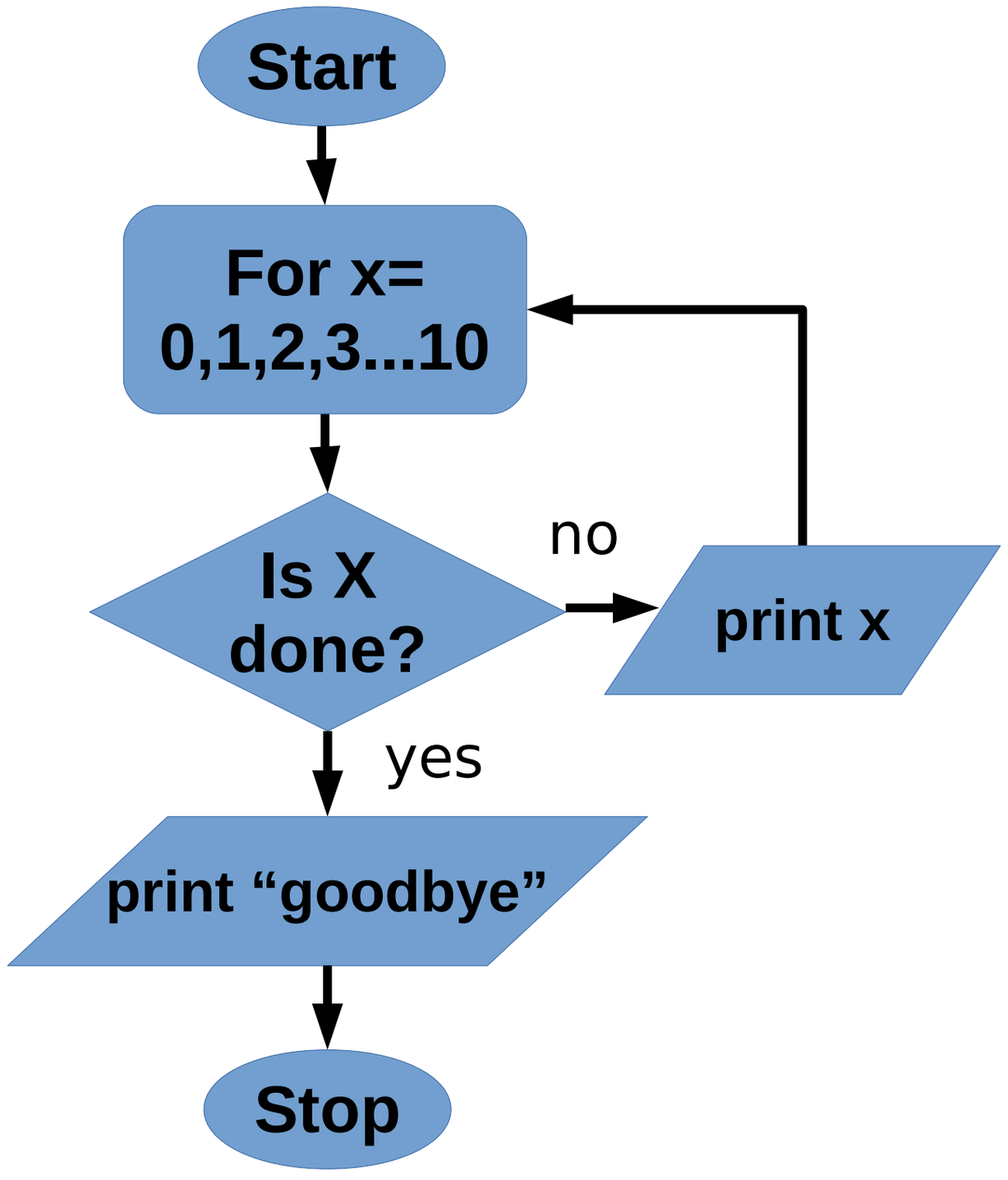


In Idle, save to a file called ‘for-loop.py’

For loops step through lists (in this case a range of numbers).

A *for loop* condition ends with a colon, and the code block within a for loop is all indented by spaces.

```
for x in range(0, 10):
 print x
print “goodbye”
```



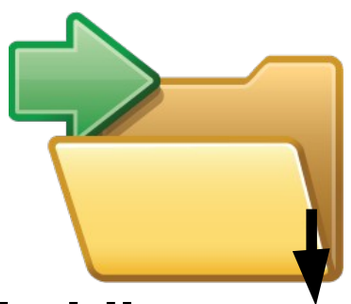
Ifs

If checks a condition and executes code if the condition is true.

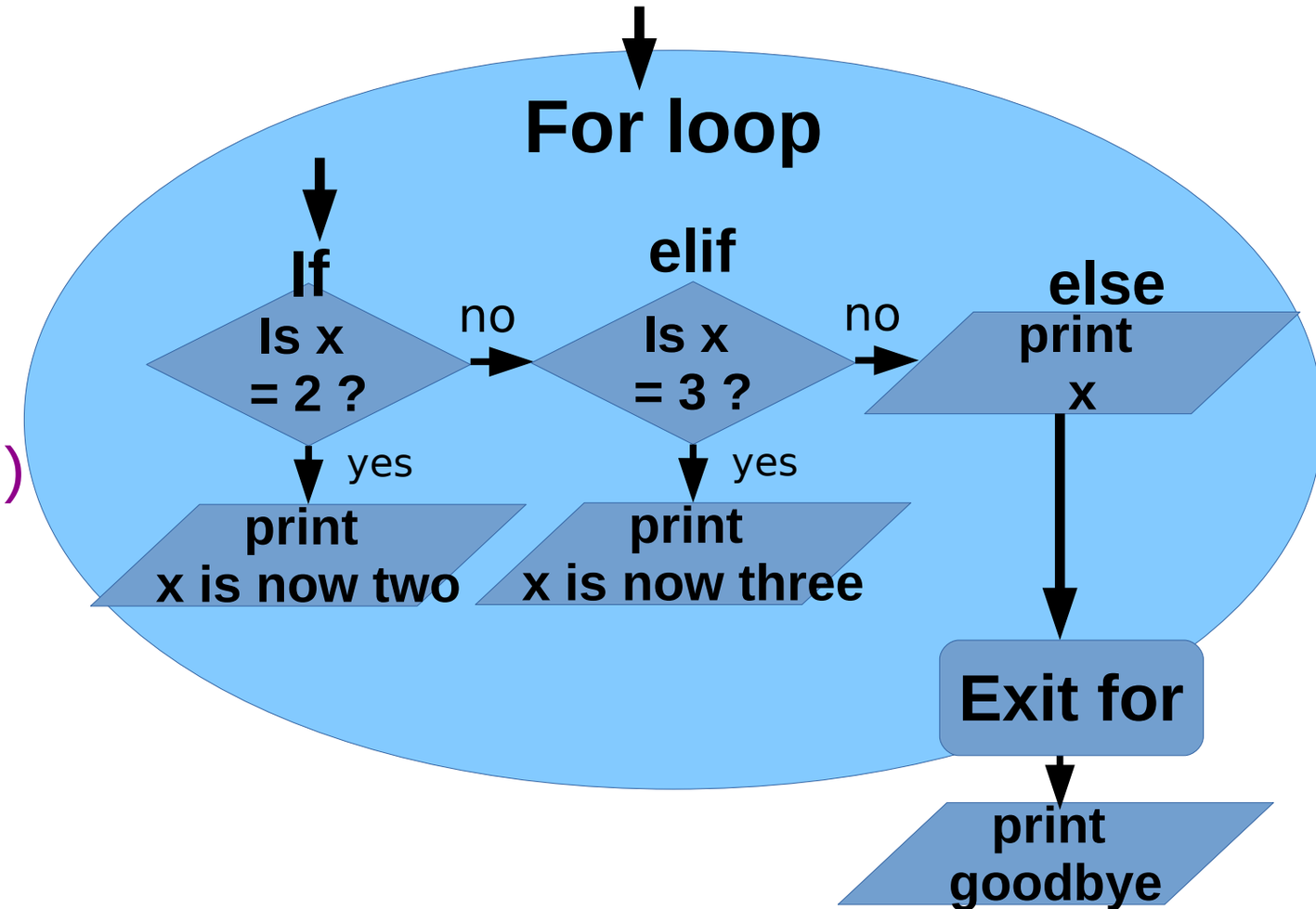
If conditions end with a colon, and the code block within an if is indented with spaces.

```
for x in range(0, 10):
 if x == 2:
  print(“x is now two”)
 elif x == 3:
  print(“x is now three”)
 else:
  print(x)
print “goodbye”
```

Conditionals.
If this, then do that.



In idle, save this program as “for-if-loop.py”



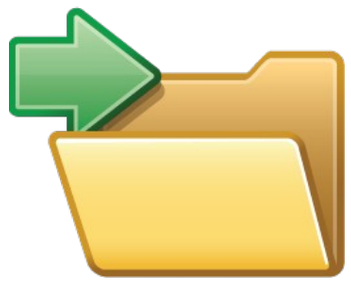
While loops

While loops repeat code while a condition is true.

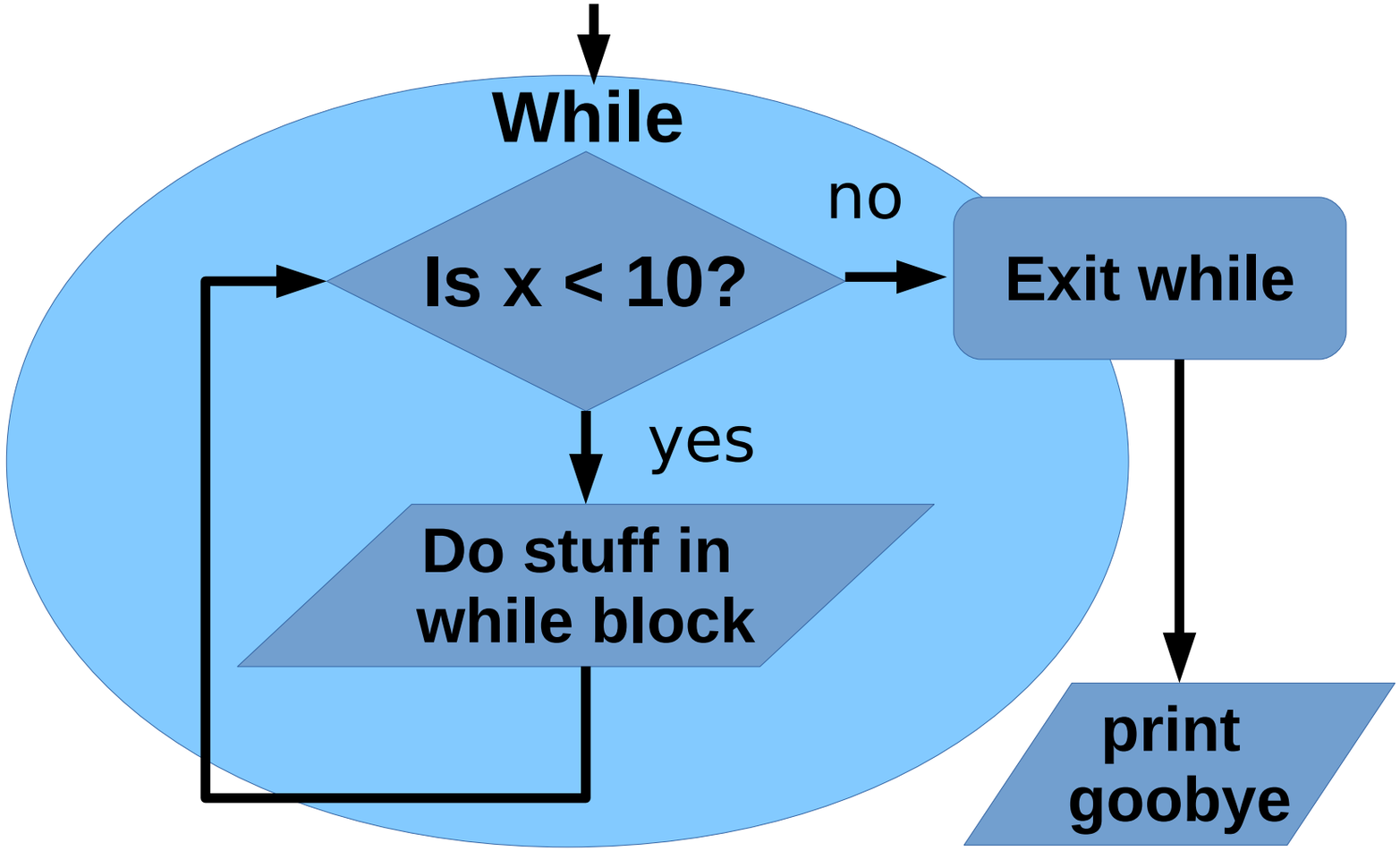
Code in while loops are indented by spaces, and conditions are ended with colons.

```
x = 0
while x < 10:
 if x == 2:
  print(“Hello World”)
 elif x == 3:
  print(“Hallo Weld”)
 else:
  print(“Hola Mundo”)
 x = x + 1
print “goodbye”
```

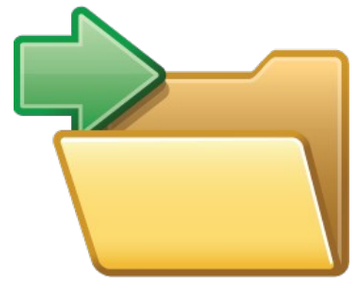
Do things *while* something is true.



Saving this as “while-if.py”



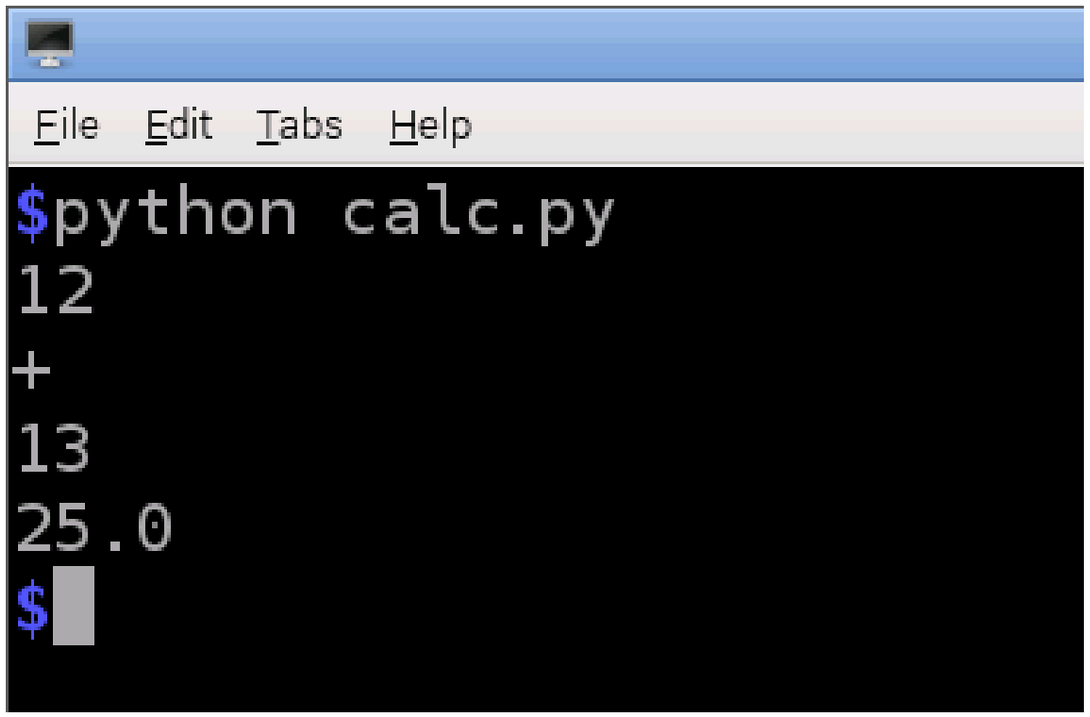
Challenge



Save into a new file called “calc.py”

Write a 4 function calculator in python that takes as input, a number, then an operation (+ - * /), the another number and prints the answer.

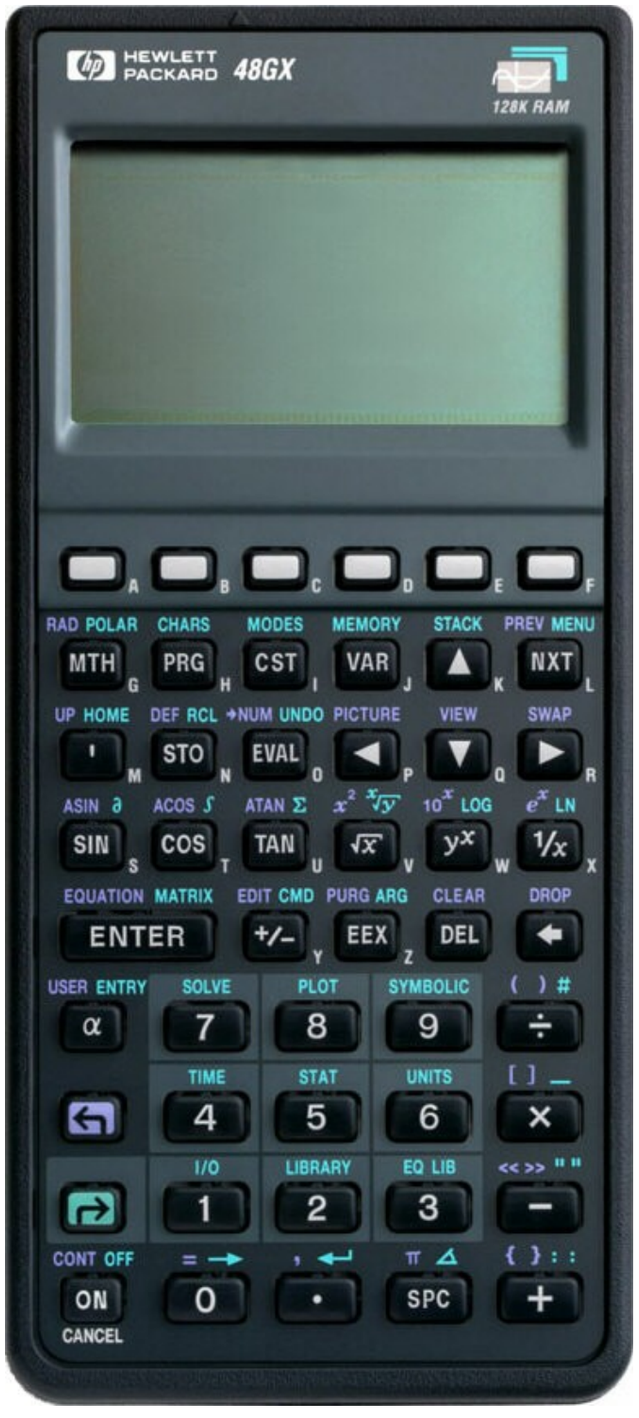
For example: If you input ‘12’ <enter>, then ‘+’ <enter>, and finally ‘13’ <enter>, then it should print 25 as the answer.



Calculator solution

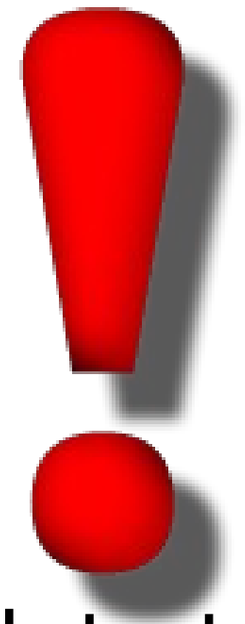
```
x = input()
op = raw_input()
y = input()

if op == '+':
 n = x + y
elif op == '-':
 n = x - y
elif op == '*':
 n = x * y
elif op == ‘/‘:
 n = x / y
print(n)
```



2) Writing piTemoLogger.py

The goal of this class is to learn how to write a python **`logger.py`** program on the RaspberryPi we will eventually build up to a program called **`piTempLogger.py`** that will:



- measure the room temperature,
- displays it on a seven segment LED,
- If we finish everything else, email the data to ourselves.

2) Writing piTemoLogger.py

But to do all this, we must first learn how to:

- Talk to the outside world using the Pis GPIO port
- Output data to a 7 segment “595 driver” LED display
- Write nested loops and conditionals
- Read the temperature from a DS18B20 temp probe
- Send email to Gmail over SMTP using python

2) Writing piTemoLogger.py

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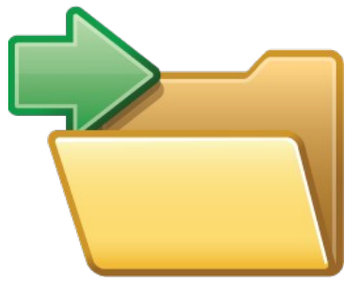
Let's get Started!!

GPIO Port Support



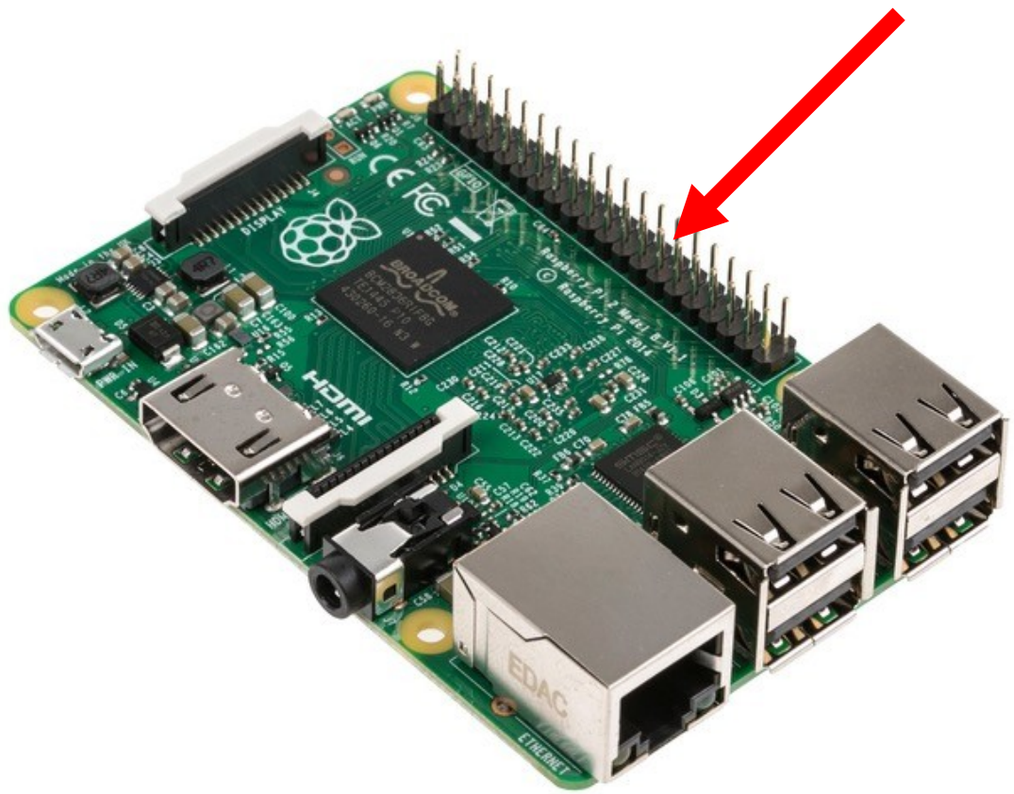
Start saving into “logger.py”

The RaspberryPi's GPIO, or *General Purpose Input/Output port*, is your Pi's gate to the outside world. It can be used to read values for sensors, or activate LEDs or motors.

It is used in python by importing (or loading) the GPIO module like this.

```
import RPi.GPIO as GPIO
```

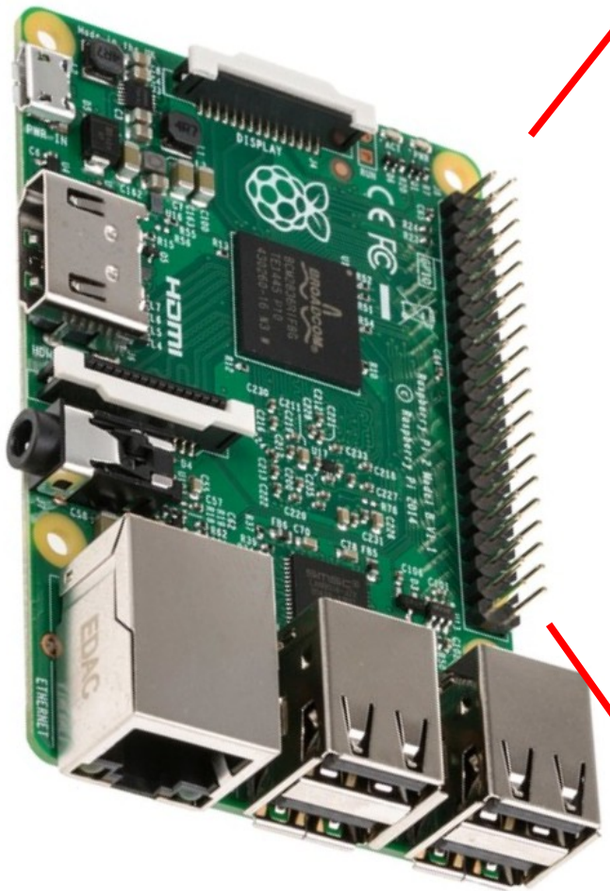
GPIO Port Hardware



GPIO Port Software

GPIO Pin Secret Decoder Ring

(keep this handy)



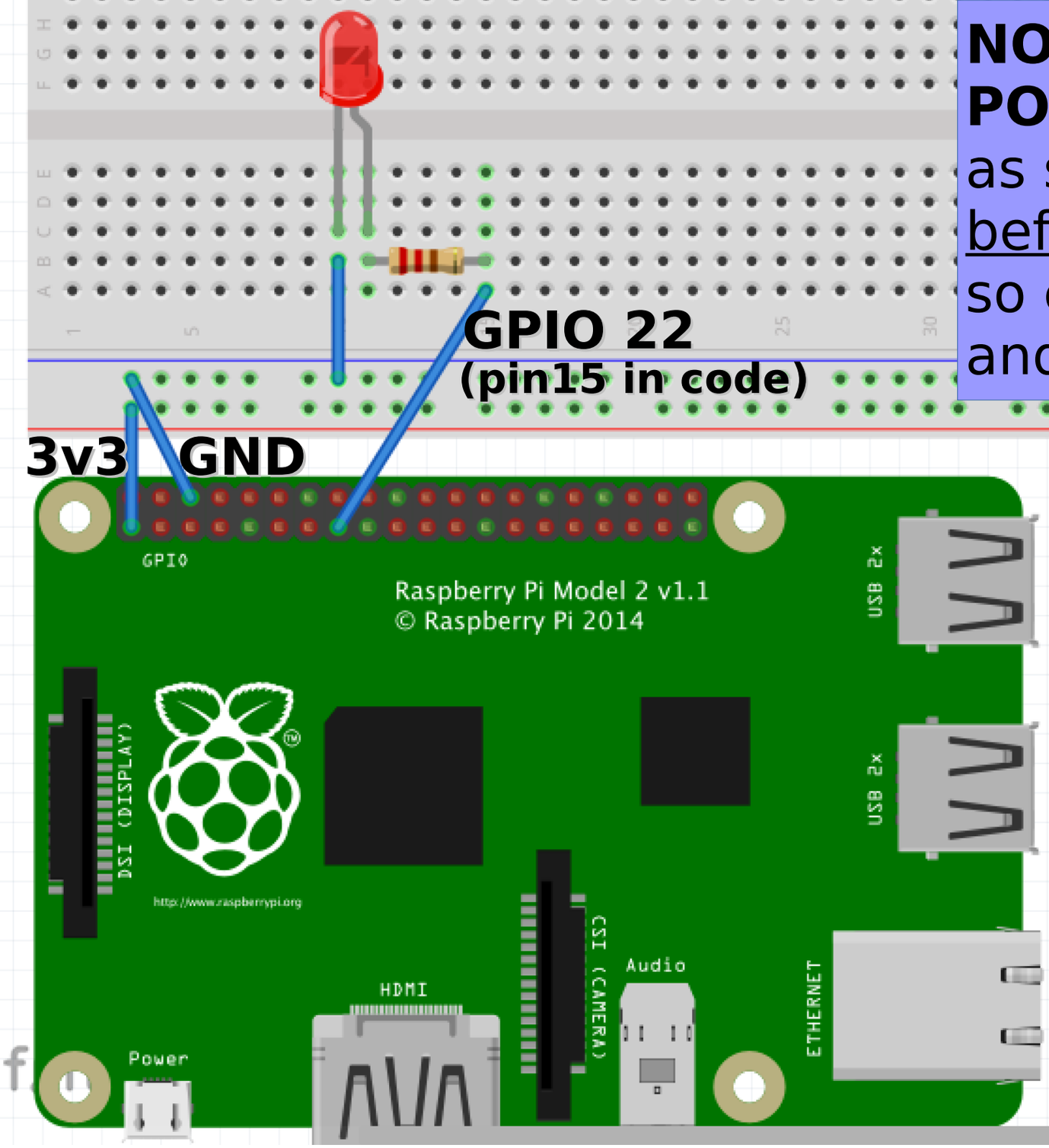
Raspberry Pi2 GPIO Header

Pin#	NAME		NAME	Pin#
01	3.3v DC Power		DC Power 5v	02
03	GPIO02 (SDA1 , I²C)		DC Power 5v	04
05	GPIO03 (SCL1 , I²C)		Ground	06
07	GPIO04 (GPIO_GCLK)		(TXD0) GPIO14	08
09	Ground		(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)		(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)		Ground	14
15	GPIO22 (GPIO_GEN3)		(GPIO_GEN4) GPIO23	16
17	3.3v DC Power		(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)		Ground	20
21	GPIO09 (SPI_MISO)		(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)		(SPI_CE0_N) GPIO08	24
25	Ground		(SPI_CE1_N) GPIO07	26
27	ID_SD (I²C ID EEPROM)		(I²C ID EEPROM) ID_SC	28
29	GPIO05		Ground	30
31	GPIO06		GPIO12	32
33	GPIO13		Ground	34
35	GPIO19		GPIO16	36
37	GPIO26		GPIO20	38
39	Ground		GPIO21	40

Rev. 1
26/01/2014

http://www.element14.com

Blinking an LED

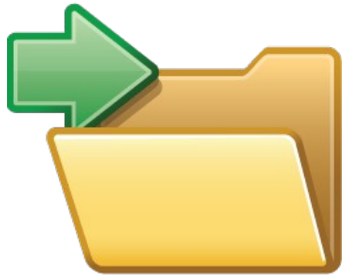


NOTE: before hooking this up POWER OFF! After it's hooked up as seen below, get TA write off before powering up. Not doing so can let the magic smoke out and (cost you $40).

Here's how to hook up the Pi (GPIO22=pin15) to your breadboard and LED. Note that your kit may have a big rainbow ribbon cable and “T” shaped board connecting your Pi to the breadboard. Do not go beyond this section until you have it working.

TA Initials _____

Blinking an LED



Continue saving into “logger.py”

After importing the GPIO module (software) and connecting up the previous circuit (hardware), here's how we program the GPIO pinouts (pin 15 below = GPIO22 on the Pi's GPIO pins). After running this program, if your hardware is all correct, your program should slowly turn the LED on, wait, and turn it off. Get TA sign-off below.

```
#This imports the GPIO module
import RPi.GPIO as GPIO
#This imports time for sleep function
import time

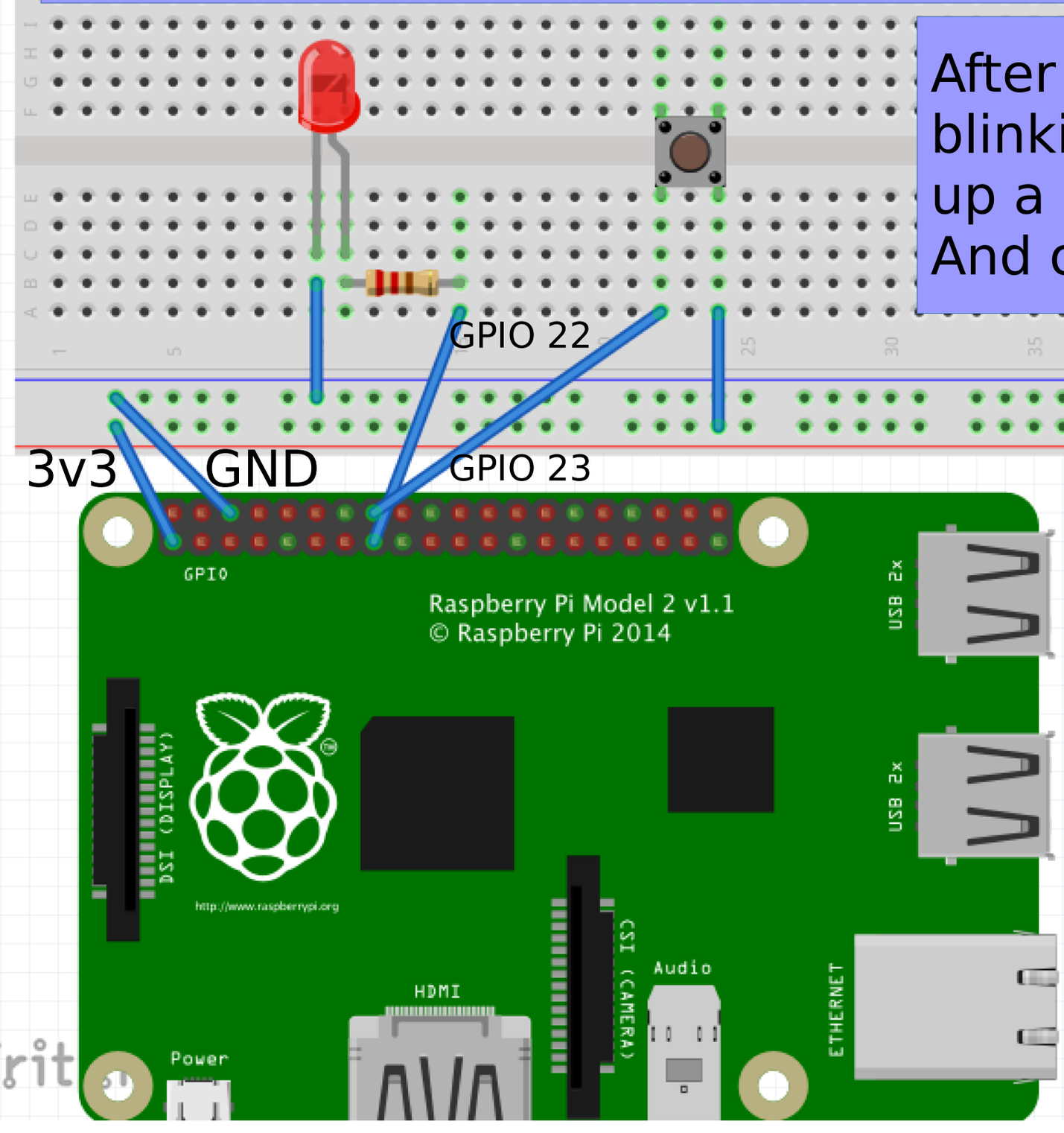
#initialize GPIO to use Raspberry Pi pinouts
GPIO.setmode(GPIO.BOARD)
#set pin 15 to output mode
GPIO.setup(15, GPIO.OUT)

while True:
 #Turn on LED and wait 1 second
 GPIO.output(15,True)
 time.sleep(1)
 #turn off LED and wait 1 second
 GPIO.output(15,False)
 time.sleep(1)
```

TA Initials

Input from buttons

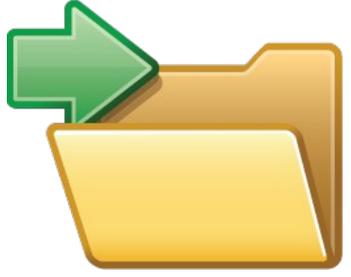
After you have the LED blinking, we're going to hook up a push button switch, read it, And output the state to the LED.



Note that the push button switch connects GPIO23(pin 14) to the + (3v) row when the button is pushed. This puts a logical “1” (True or High) on pin 14, which we will read in and output to pin 15(GPIO22). Get this working and signed off before continuing.

TA Initials _____

Input from buttons



Continue saving into “logger.py”

After connecting the push button switch to the Pi's GPIO23 (pin 14, in the code below), add the new lines of code from the program below. The button program will watch the button state, and if pressed (True), it will output that logic “True” state (on) to the LED output pin, turning on the LED. Be sure to get TA sign-off (below).

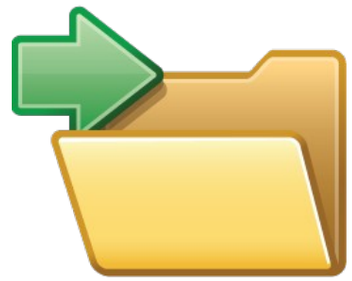
```
#get access to GPIO module
import RPi.GPIO as GPIO

#set up pins
GPIO.setmode(GPIO.BOARD)
GPIO.setup(14, GPIO.IN)
GPIO.setup(15, GPIO.OUT)

#check whether button is pressed and
#change LED accordingly
while True:
 button = GPIO.input(14)
 GPIO.output(15,button)
```

TA Initials _____

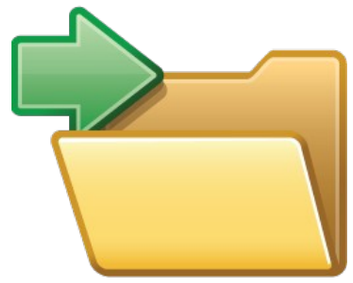
Blinker Challenge



Save-As to a new program called “blinker.py”

Using your logger.py code as a starting place (saving it to blinker.py) modifying the code so that the Pi blinks the LED **`while`** the button is released, and stops blinking when the button is pressed.

Blinker Solution



Save to “blinker.py”

```
#import GPIO module
import RPi.GPIO as GPIO

#import time for sleep function
import time

#initialize GPIO to use
#Raspberry Pi pinouts
GPIO.setmode(GPIO.BOARD)

#set pin 15 to output,14 as input`
GPIO.setup(15, GPIO.OUT)
GPIO.setup(14, GPIO.IN)
```

```
while True:
    button = GPIO.input(14)
    while button == True:
        print 'waiting'

#turn on LED and wait 1 second
GPIO.output(15,True)
time.sleep(1)

#turn off LED and wait 1 second
GPIO.output(15,False)
time.sleep(1)
```

Using 7-segment LED display modules

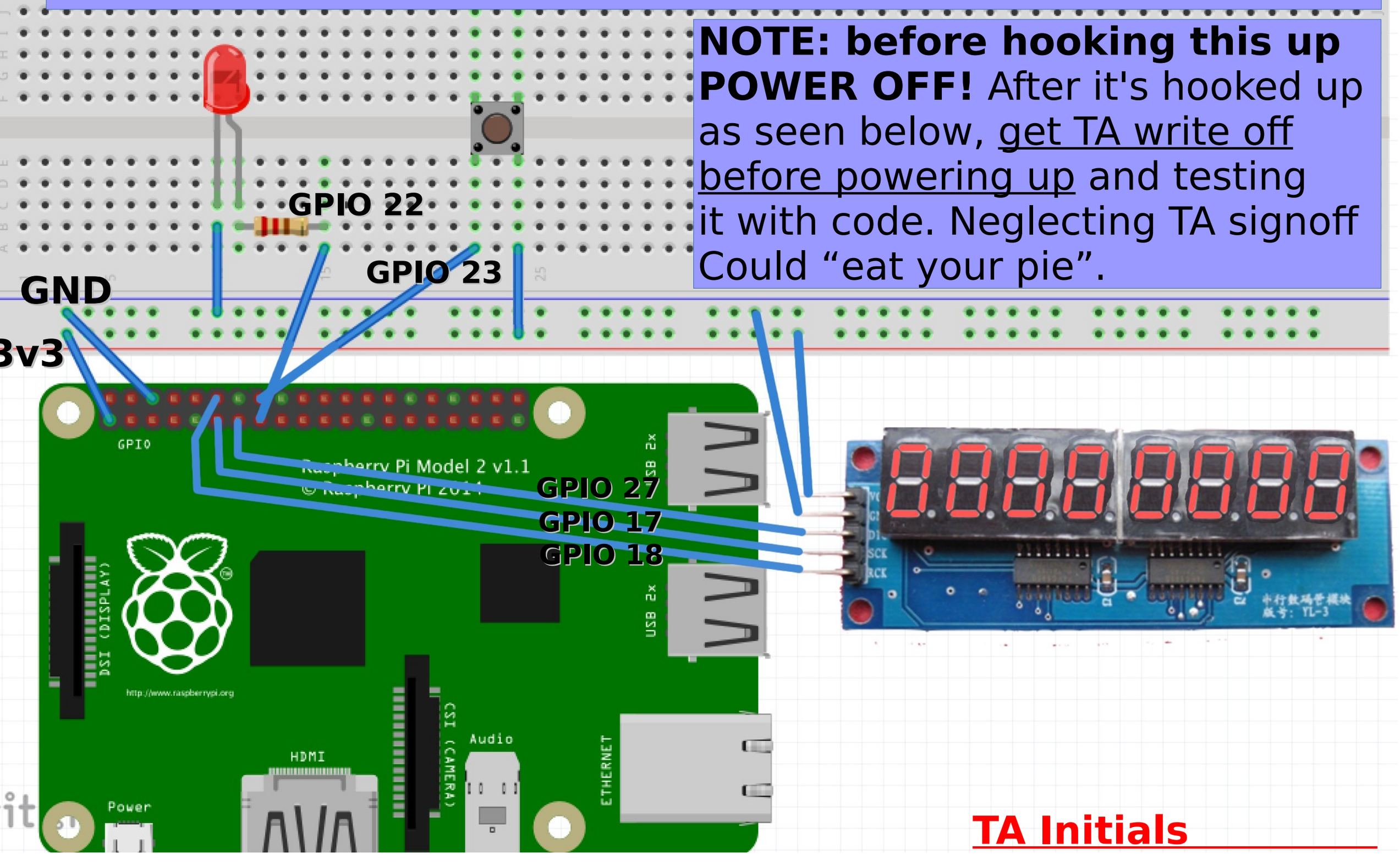
The seven-segment LED module “shifts” in the display number data into those two small “74LS595” TTL driver chips. As a result, this module only needs to be hooked up to ground, power (3.3v), a DATAinput, and two clock lines. If you hooked up eight 7-segment LEDs directly, it would take over 64 wire connections plus a bunch of electrical resistors!

If interested in how these chips work (or digital logic), then see the spec sheet for this common “TTL chips”*.

* - **http://www.ti.com/product/SN74LS595/technicaldocuments**

Connecting 7-segment module

NOTE: before hooking this up POWER OFF! After it's hooked up as seen below, get TA write off before powering up and testing it with code. Neglecting TA signoff Could “eat your pie”.

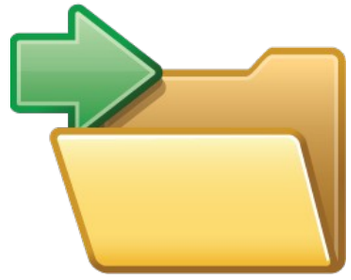


TA Initials

Programming a 7-segment LED module

Create a new program called “test-led.py” that will use this new 7 segment LED display.

- 7 segment “595 driver” displays require a custom module called **`PiSlice.py`** (in LCBB-Pi dir)
- Initialize display by using **`PiSplice.init()`**
- Output to the display by using **`PiSlice.number=n`**

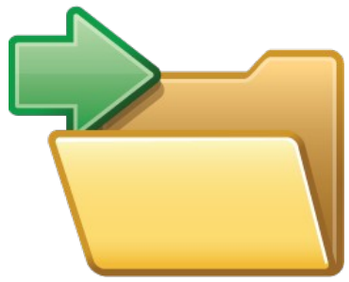


Make a new program and save it to a file “test-led.py”

```
import PiSlice   #load module
#DATAIN=13, CLOCK=11, LOCK=12
PiSlice.init()   #initialize

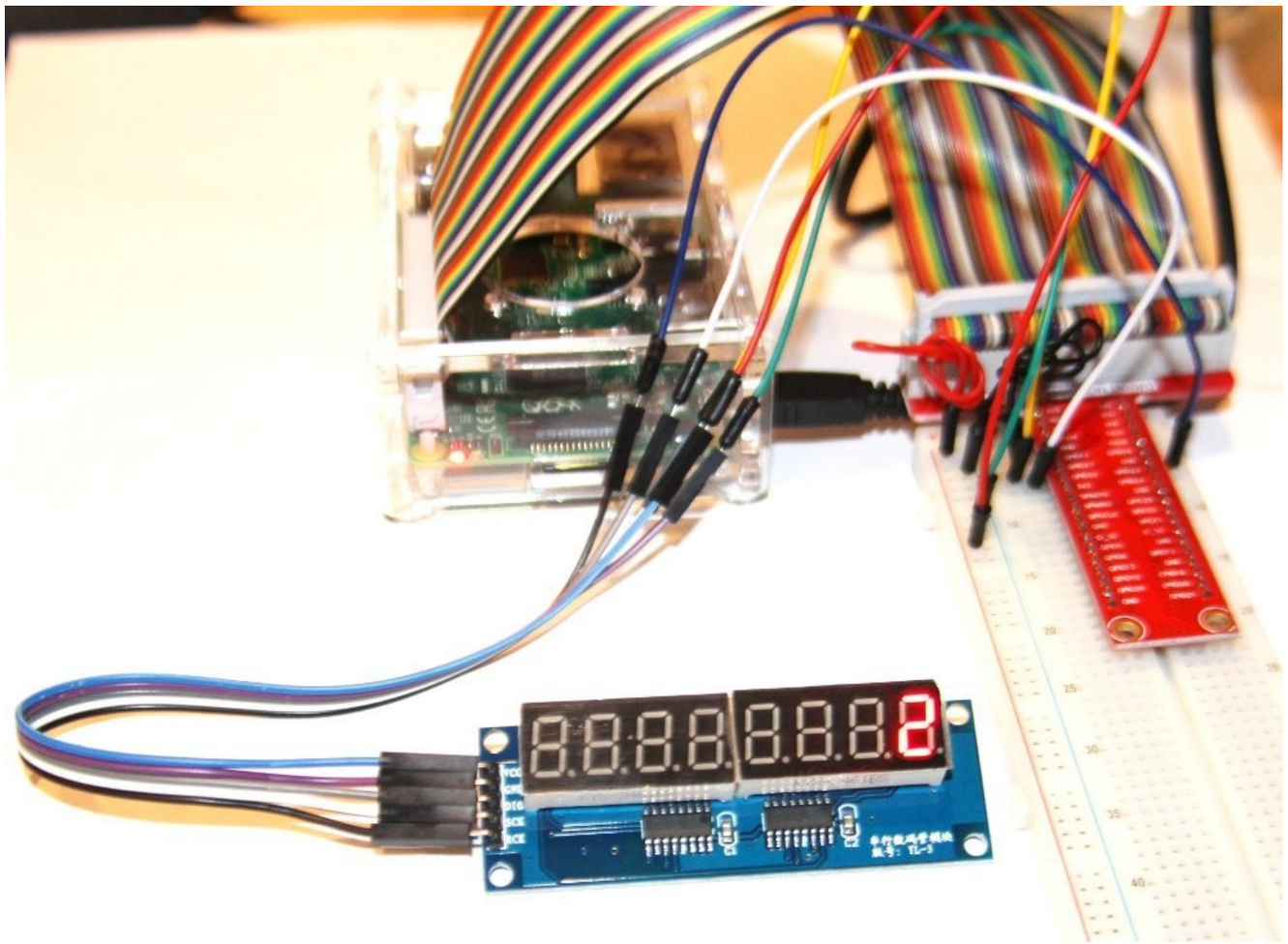
#This displays numbers
PiSlice.number = 12345678
```

Counter Challenge



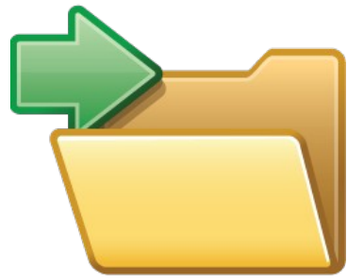
Open existing “logger.py” and continue coding in it.

Modify your logger.py program to use the 7-segment LED module, count your button presses, and add each press to the LED display (starting at zero).



TA Initials _____

Counter Solution



Open existing “logger.py” and continue coding in it.

```
#import GPIO module and PiSlice module

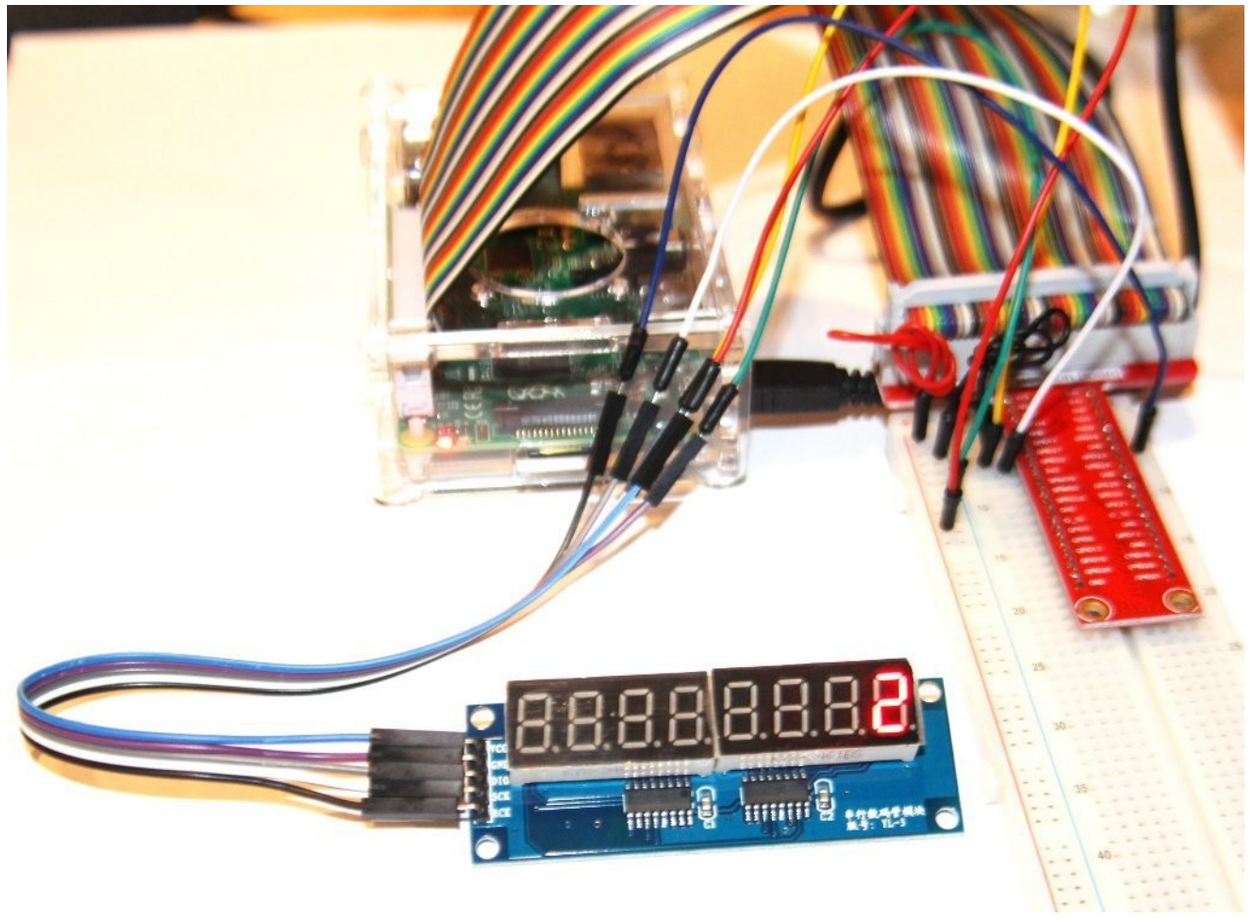
import RPi.GPIO as GPIO
import PiSlice

#start up 7 segment display

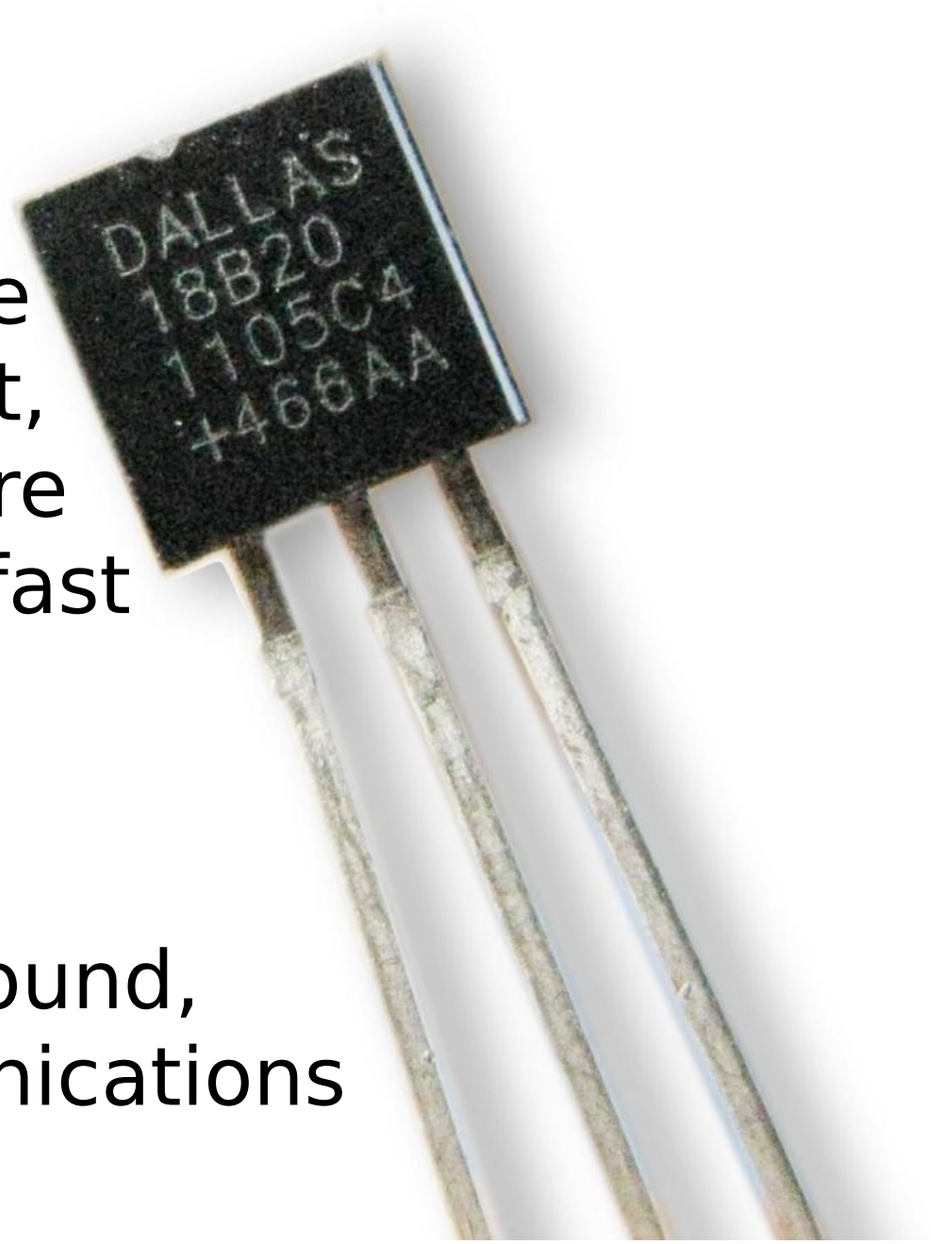
PiSlice.init()

num = 0

while True:
    button = GPIO.input(14)
    while button == 0:
        button = GPIO.input(14)
    while button == 1:
        button = GPIO.input(14)
    num = num + 1
    PiSlice.number = num
```



Sensing temperature



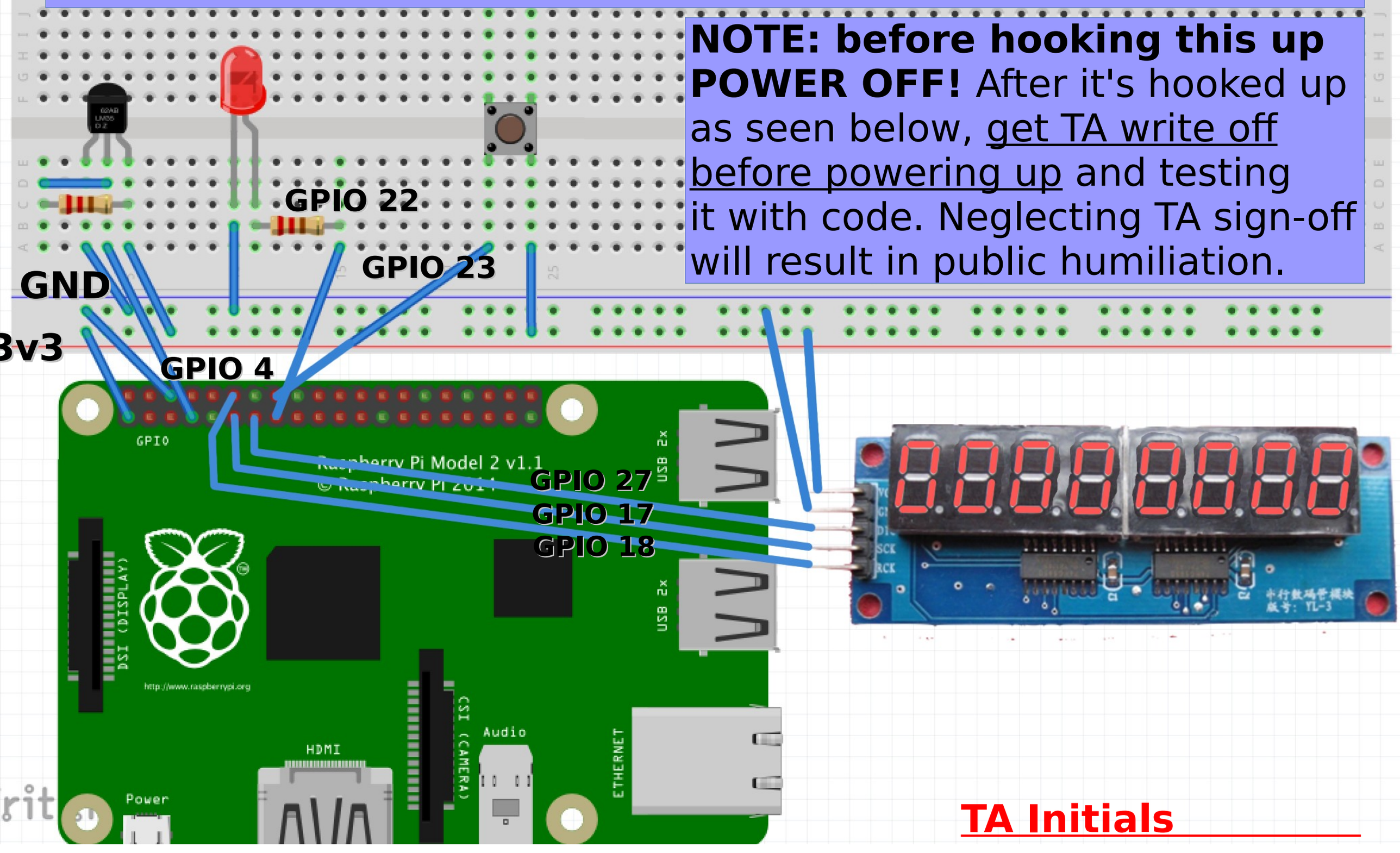
The 1-wire DS18B20 temperature sensor is a fully embedded, 12bit, serial (i2c) interfaced temperature probe that is perfect for simple, fast temperature data logging in many modern projects.

All you do it provide it power, ground, and “one wire” for serial communications

We're talking to it using our PiSlice.py python module. (next)

Connecting 1-wire Temp Sensor

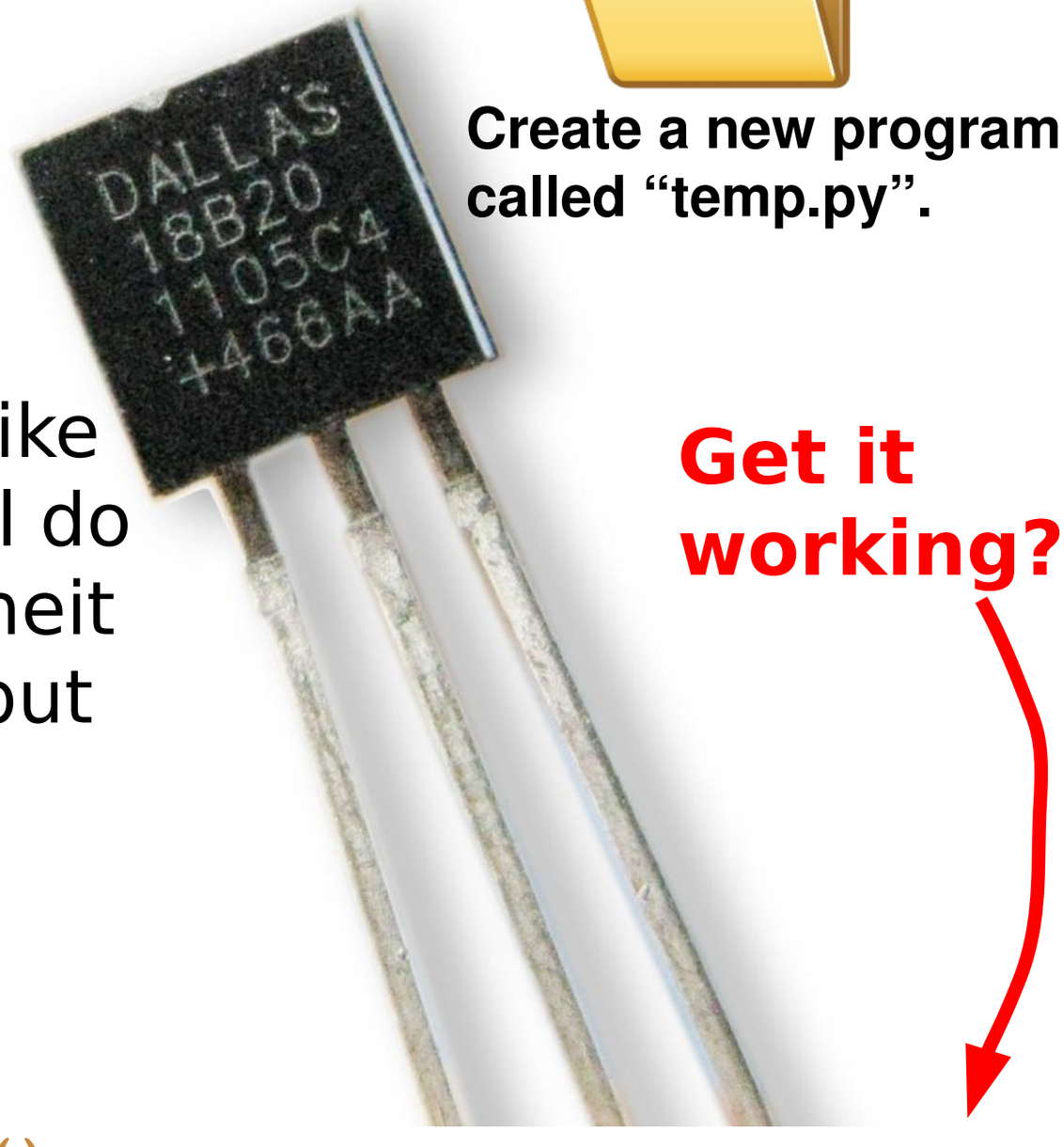
NOTE: before hooking this up POWER OFF! After it's hooked up as seen below, get TA write off before powering up and testing it with code. Neglecting TA sign-off will result in public humiliation.



TA Initials

Coding for the 1-wire Temp Sensor

Create a new program called “temp.py”.



Now to use the 1-wire temp sensor, we're just importing the PiSlice.py module, initializing it, and calling PiSlice.read_temp() like this (below). The code below will do this and then output the fahrenheit value to the PiSlice.number output (LEDs).

```
import PiSlice

PiSlice.init()
PiSlice.init_temp()
while True:
 c, f = PiSlice.read_temp()
 PiSlice.number = f
```

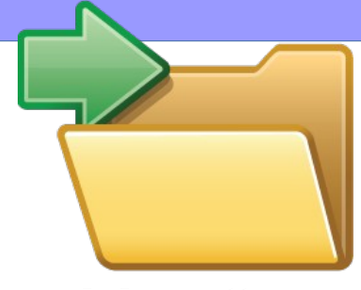
Get it working?

TA Initials

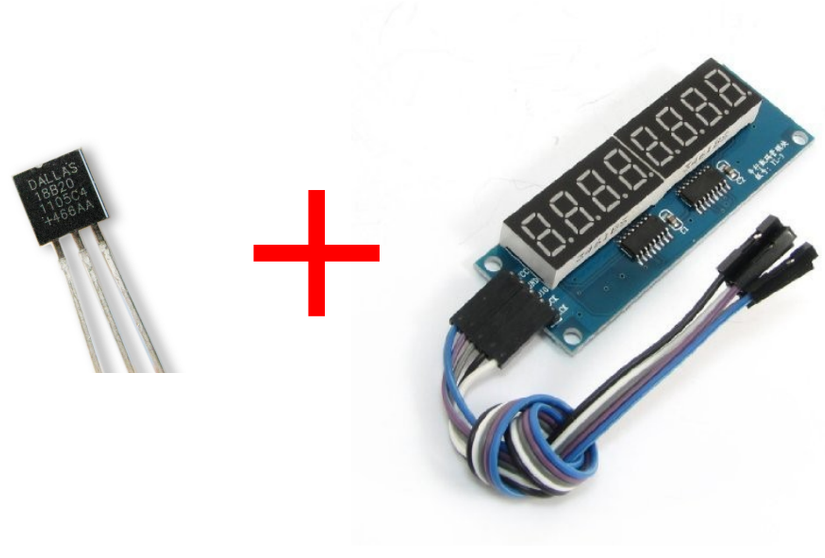
Combine Temp Sensor and 7-segment LED

Now you have the temp sensor working and the previous LED code from logger.py. Now combine them to:

- Measure the temperature once per second
- Display the temperature on 7-segment LED display



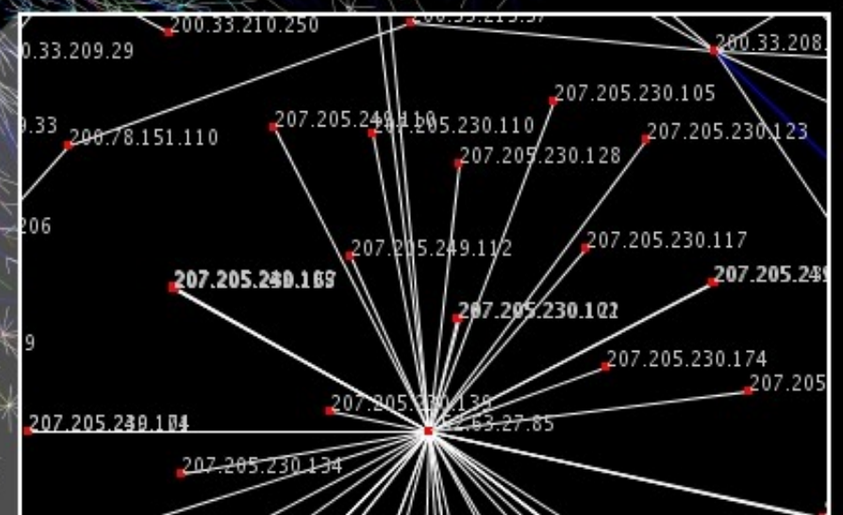
Combine “temp.py” and the needed code from “logger.py” into a new program “piTempLogger.py”.



TA Initials _____

Pi in the sky

Getting your Raspberry Pi project online



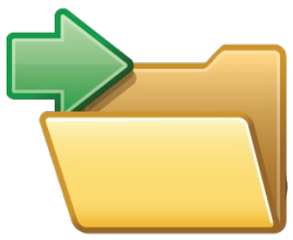
Email Your Temp Data

- Python can send and receive emails using the SMTP protocol.

- You can send yourself data logged from the pi over email

- Your email address is LetsCodePi@gmail.com

- Ask instructor for password



ending emails

In a new file
called ‘mail.py’

```
import smtplib
fromaddr = 'LetsCodePi@gmail.com'
toaddrs  = 'to@addr.com'
msg = 'testing'


# Credentials (if needed)
username = 'LetsCodePi@gmail.com'
password = 'LetsCode'

# The actual mail send
server = smtplib.SMTP('smtp.gmail.com:587')
server.ehlo()
server.starttls()
server.ehlo()
server.login(username,password)
server.sendmail(fromaddr, toaddrs, msg)
server.quit()
```

....al challenge

In ‘logger.py’

Make a program based off of the button counter that can show the number of emails you have and the current room's temperature. Cycle through these modes by pressing the button and display your output on the 7 segment displays.