Physical Computer Science

with the Raspberry Pi

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Computer Science

"…as much about computers as astronomy is about telescopes."

- Growing in demand across country. (K12CS, CS for All, etc)
- Need for Computer Science and computational thinking across all grade levels
- Computer science in every classroom, applicable to every classroom
- Nothing too hard, only new

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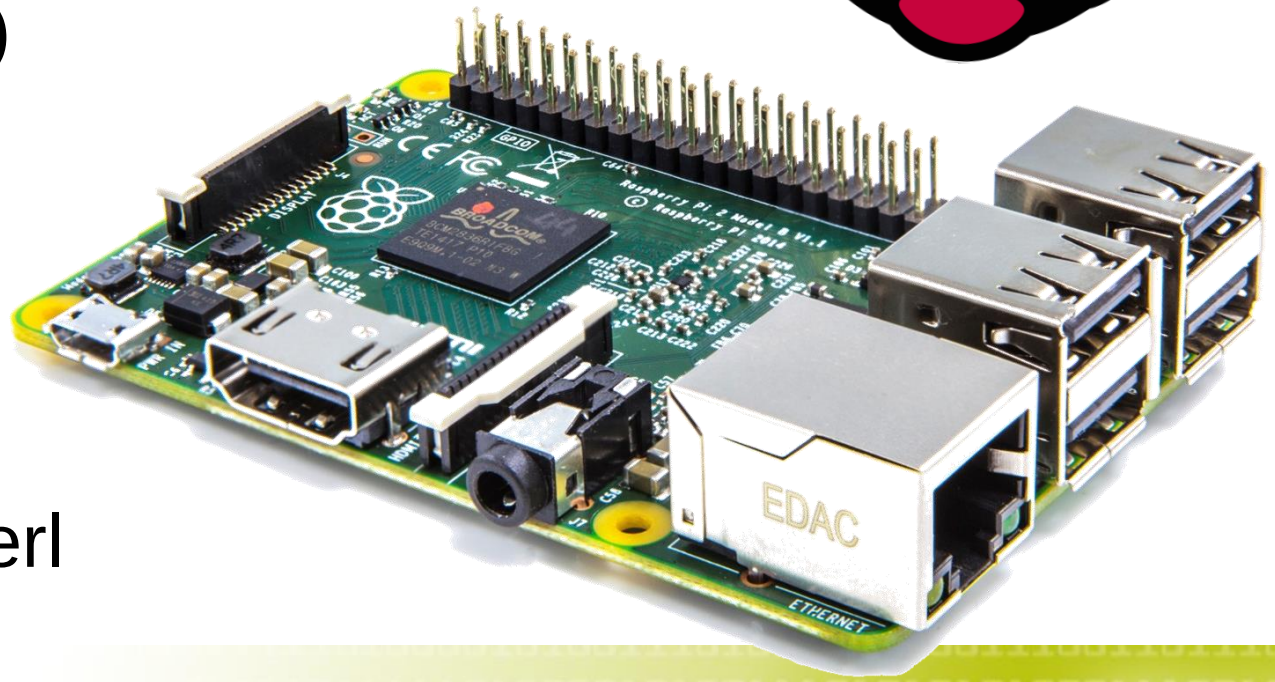
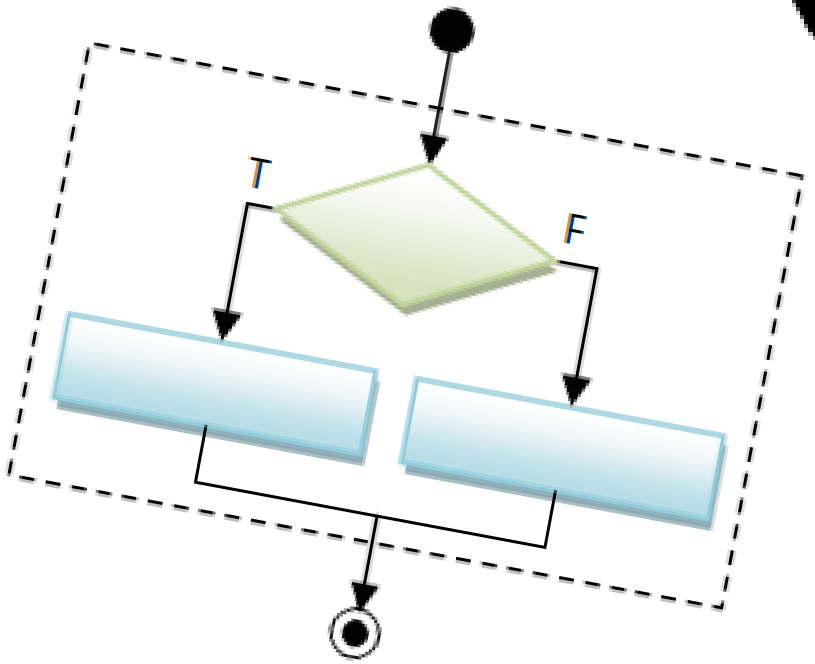
Raspberry Pi

- Developed by Raspberry Pi Foundation from Cambridge University
- $35 computer (base cost)
- Shrunken full-size PC
- ~Pentium 3 (circa 2001)
- Runs Linux (Raspbian)
- Programming via Scratch, Python, Java, Perl



Computer Science Concepts

- Sorting
- Searching
- Logic (AND / OR / NOT)



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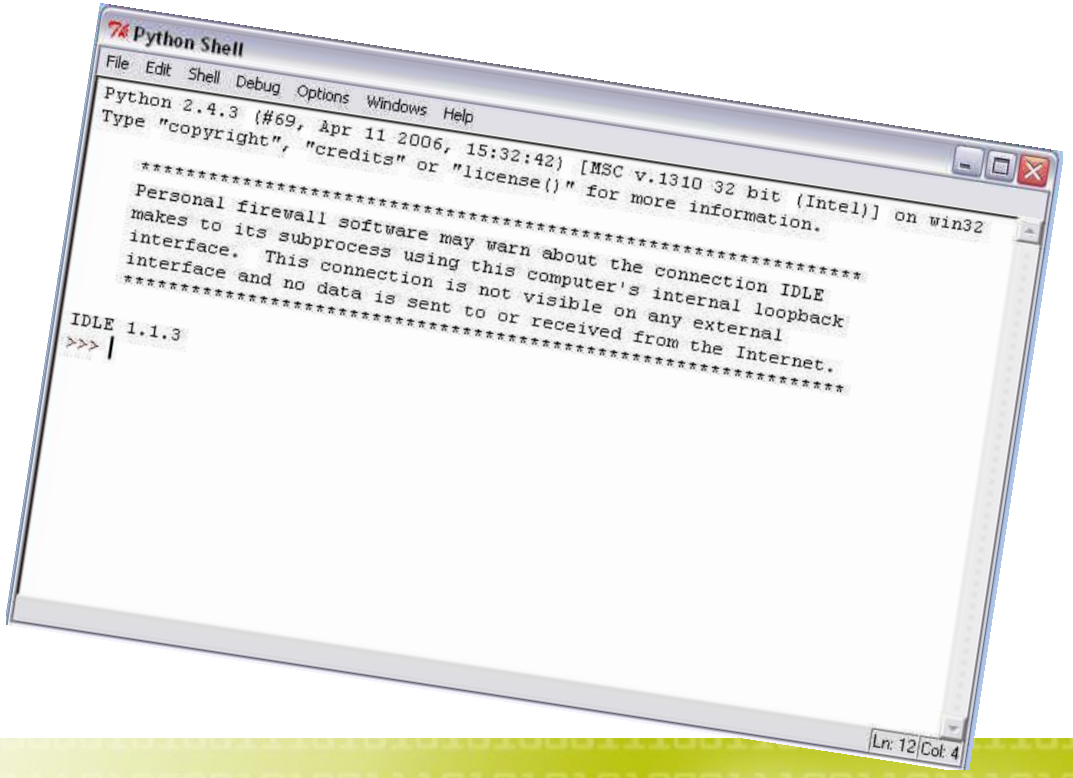
PYTHON

- Free interpreted scripting language
- Runs across operating systems (Windows, Mac, Linux)
- Access to *huge* number of libraries
- Teaches good programming practices (whitespace, concise, reuse)
- Easy to create (personally) meaningful programs
- Runs on Raspberry Pi
- Special library allows access to GPIO
  - General Purpose Input/Output pins

IDLE

- Integrated Development and *Learning* Environment
- Simple text-editor
- Allows quick code execution
  - “Try it and see…”



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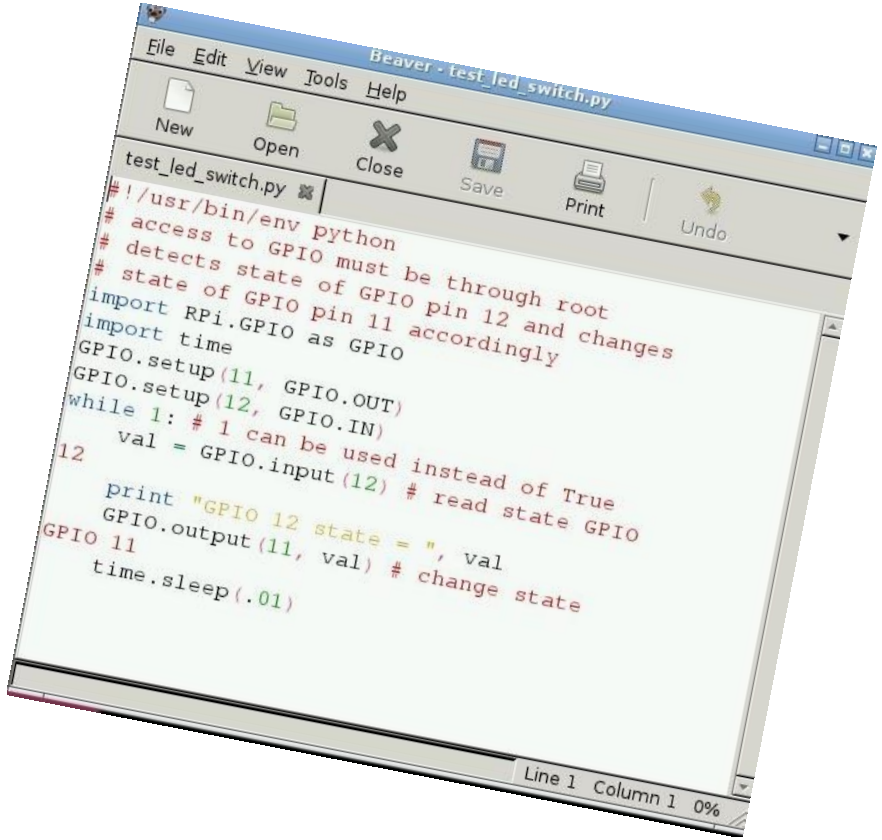
Text Editor

- A python script is plain text

```
#!/usr/bin/python

print "Hello World!"
```

- Save as “hello.py”
- Open Terminal, **`chmod +x hello.py`**
- Run script: **`hello.py`**



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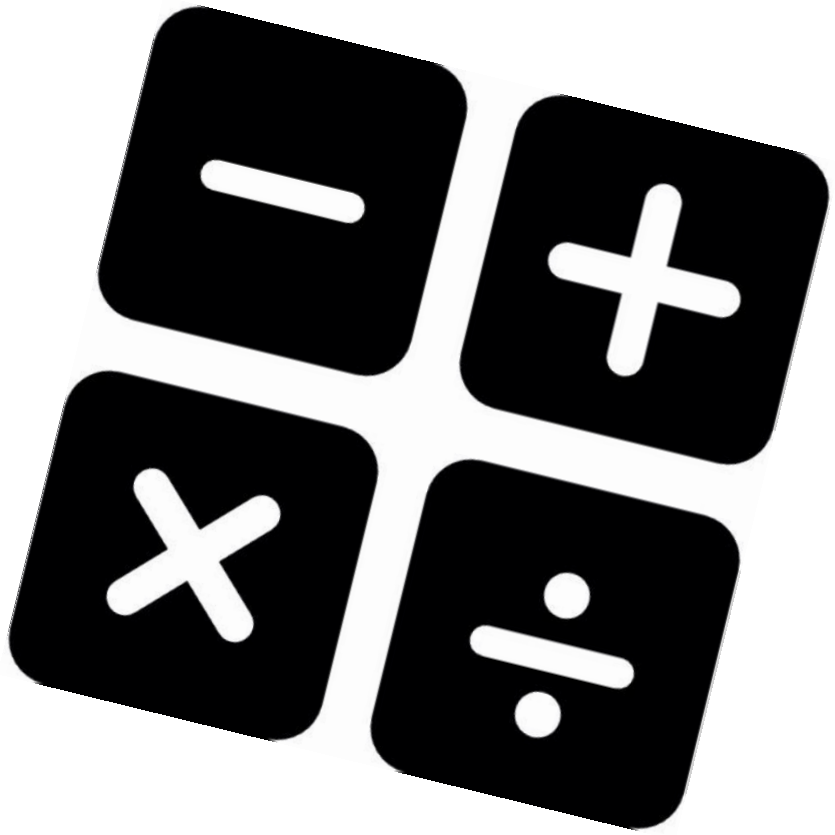
Math Operations



- Add: `5 + 2`
- Subtract: `5 - 2`
- Multiply: `5 * 2`
- Divide: `5 / 2`
- Modulus: `5 % 2`
- Exponents: `5 ** 2`
- Math *library* (`math.pi`, `math.e`, `.floor(x)`, `.ceil(x)`)

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raw_input

- Prompts user for input, stores in a variable
- Ex:

```
number = raw_input("Pick a number")
```

- Try it:

```
name = raw_input("What is your name?)
print "Hello", name
```

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IF…THEN

- IF statement

  Ex:

```
if name == “Craig”:
```

- **ELSE**

  Example:

```
if name == “Stephen”:
  print “Hello”, name
else:
  print “I don’t know you…”
```

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WHILE LOOP

- WHILE statement
- Ex:

```
while x < 10:
    #do something here
```

- As long as the condition is true, the loop will continue to run

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Circuits

- Many ways to learn about circuits
- Vocabulary:
  - Polarity (+ and -)
  - 5V
  - 3V3
  - GND

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Resistors

- Used to consume electricity in a controlled, predictable way

- Two types in kit:
  - Red, Red, Brown
  - Brown, Black, Orange

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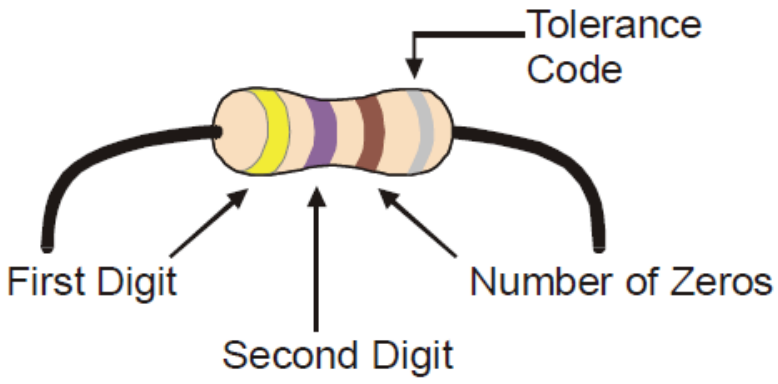
RESISTORs

Digit	Color
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray
9	White



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RESISTORS

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9	White

Identifying Resistors – Use Scientific Notation!

Consider a Brown, Black, Orange:

1, 0, three 0's: 10,000 Ω (10k Ω)

Consider a Brown, Black, Red:

1, 0, two 0's: 1,000 Ω

Consider a Yellow, Violet, Red:

4, 7, two 0's: 4,700 Ω (4.7k Ω)

Consider a Yellow, Violet, Brown:

4, 7, one 0: 470 Ω

The third stripe is the place value!

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LED

- Light Emitting Diode
- LEDs must be connected to 3V or 5V through a resistor

- Polarity does matter!

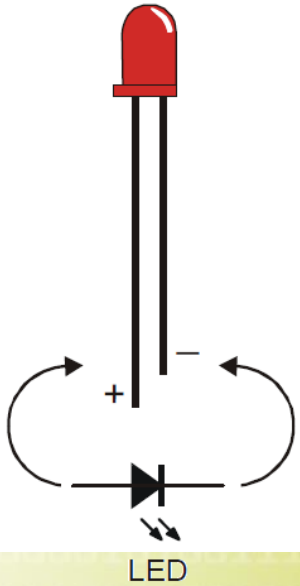

Figure 2-3
LED Part Drawing and Schematic Symbol

Part drawing (above) and schematic symbol (below)

The LED part drawings in later pictures will have a + next to the anode leg.

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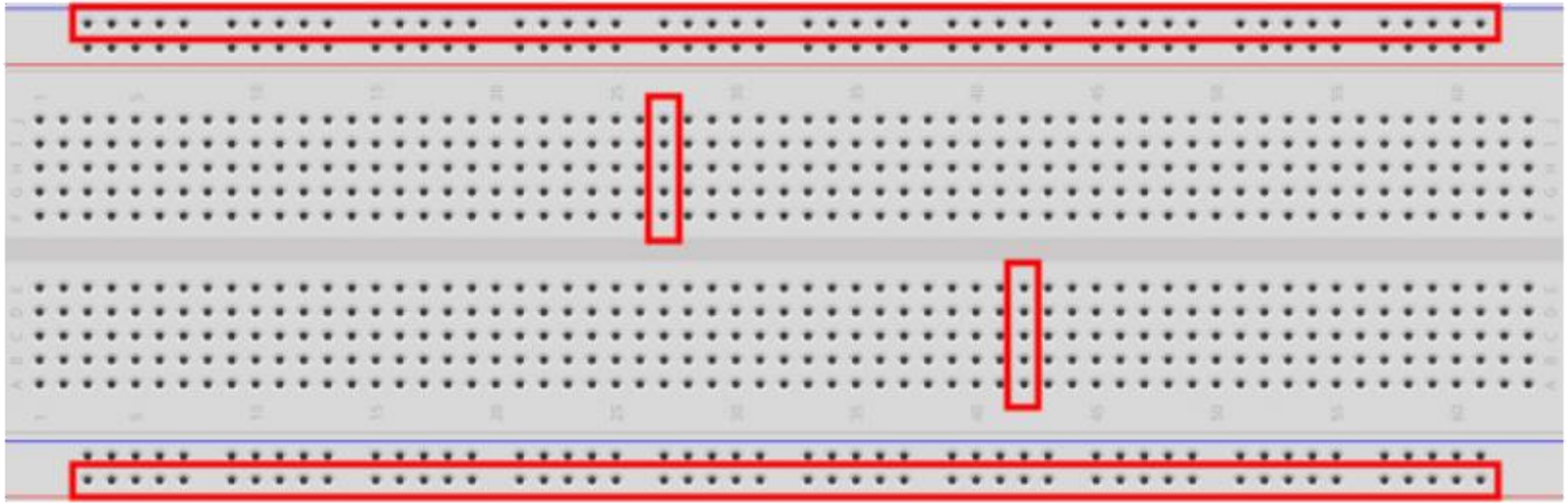
Breadboard



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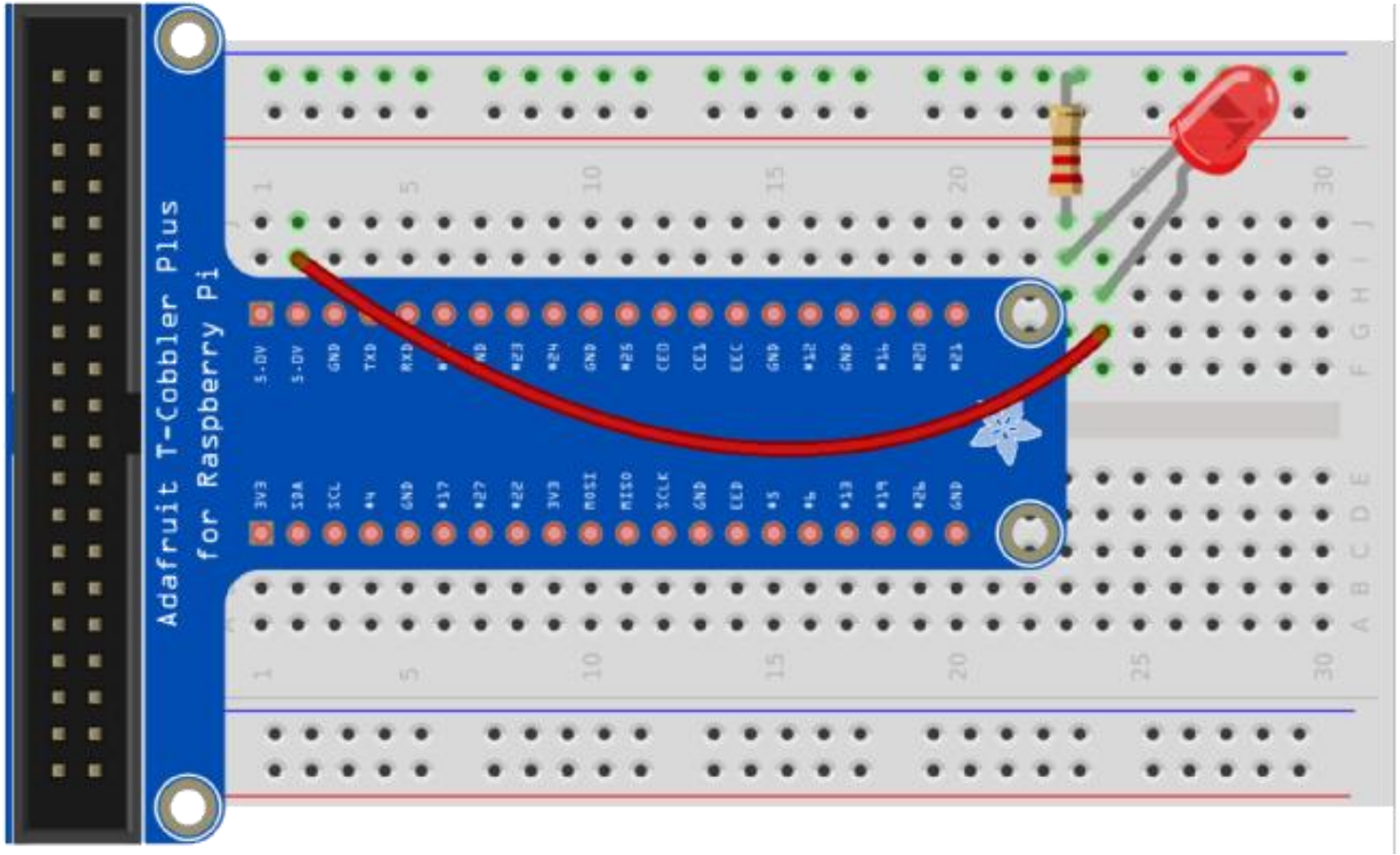
LED



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LED

- Connect **positive wire** to GPIO21
- ***ALWAYS*** *use a resistor with LEDs!*
- Anytime you turn a gpio pin **on**, remember to turn it **off**

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LED ON

```
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BCM)

ledPin = 21
GPIO.setup(ledPin, GPIO.OUT)
GPIO.output(ledPin, True)
```

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LED OFF

```
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BCM)

ledPin = 21
GPIO.setup(ledPin, GPIO.OUT)
GPIO.output(ledPin, False)

GPIO.cleanup
```

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LED blink

```
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BCM)
ledPin = 21
GPIO.setup(ledPin, GPIO.OUT)

GPIO.output(ledPin, True)
time.sleep(0.5)
GPIO.output(ledPin, False)
time.sleep(0.5)

GPIO.cleanup
```

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led

Challenge

- Make light come on for 1 second then turn off
- Add second LED

- Simultaneous lights
- Alternating lights

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LED flasher

```
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BCM)
ledPin = 21
GPIO.setup(ledPin, GPIO.OUT)

def blink(times, speed)
   for i in range(0, int(times)):
         print “#” + str(i)-1
         GPIO.output(ledPin, True)
         time.sleep(speed)
         GPIO.output(ledPin, False)
         time.sleep(speed)
   print(“Done!”)
   GPIO.cleanup
times = raw_input(“How many blinks? ”)
speed = raw_input(“How fast? ”)
blink(times,speed)
```

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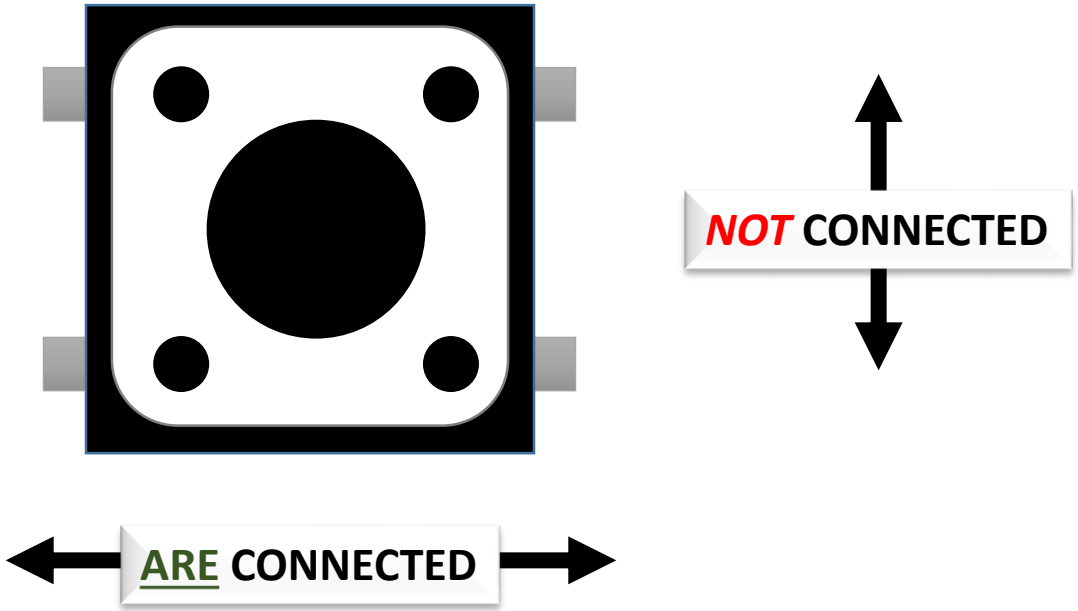
Push ButtoN

- So far no physical input.
- User engagement
- Build circuit for pushbutton
- Value
  - Value will be either 1 or 0
  - *That's* something we can work with!

PUSH BUTTON



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BUTTON PRESS

```
import RPi.GPIO as GPIO
import time

GPIO.setmode(GPIO.BCM)
GPIO.setup(18,GPIO.IN,pull_up_down =
GPIO.PUD_UP)
while True:
   input_state = GPIO.input(18)
   if input_state == False:
      print("Button pressed!")
      time.sleep(0.2)
```

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