Prototyping Predictive Analytics Techniques
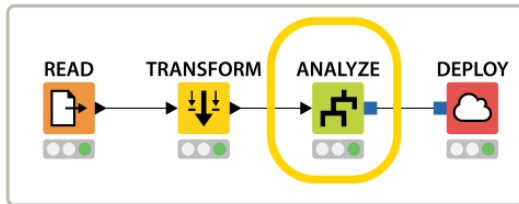## Class 5: Monitoring and Analyzing an Accelerometer Using The BBC micro:bit

March 22, 2019
Don Wilcher

Class 5: Monitoring and Analyzing an Accelerometer Using The BBC micro:bit

Agenda

- Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit

- Lab Project: Build a Talking Accelerometer Gesture Device

Presented by:

What is an Accelerometer?

- A device that measures the rate of change of velocity.

- Behaves as a damped mass on a spring (electromechanical).

- Mass is displaced by a spring.
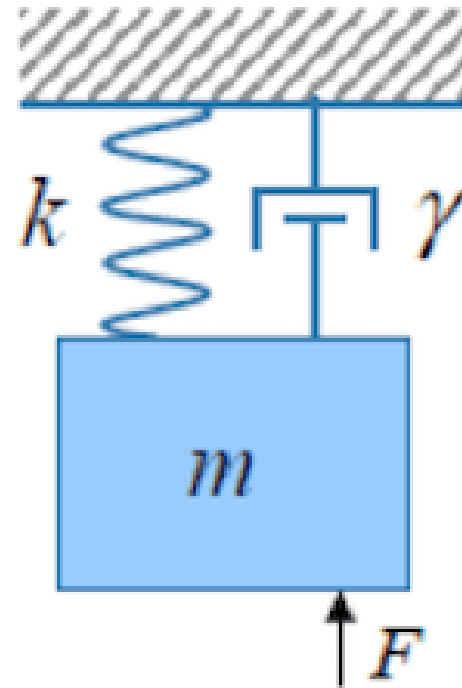
   a. spring is able to accelerate the mass

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Mass is displaced by_____

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What is an Accelerometer?...

Electromechanical Accelerometer

where:

k is the spring mass

m is the mass

f is the force

y is the damping constant (in this system y is the spring constant (ζ).

What is an Accelerometer?...

Modern accelerometers have the following physical characteristics.

- small micro-electromechanical systems (MEMS)

- has a cantilever beam

- seismic mass

- damping results from the residual gas select in the device

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What is an Accelerometer?...

The BBC micro:bit has a MMA8653FC 3-axis, 10bit digital accelerometer. The MMA8653FC accelerometer is

- low power

- capacitive micromachined

    a) microstructures built by deposition

        i. deposition process is removal of materials

        ii. associated with subtractive manufacturing

    b) etched structural layers over a substrate

    c) microstructure becomes sensing surface

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What is an Accelerometer?...

MMA8653FC features

- 1.95V to 3.6V supply voltage

- 1.62V to 3.6V digital interface voltage

- ±2g, ±4g, and ± 8g dynamically selectable full scale ranges.

- Output Data Rates (ODR) from 1.56Hz to 800Hz
  Note: ODR is the **rate** at which it samples the values being measured.

- 10bit digital output

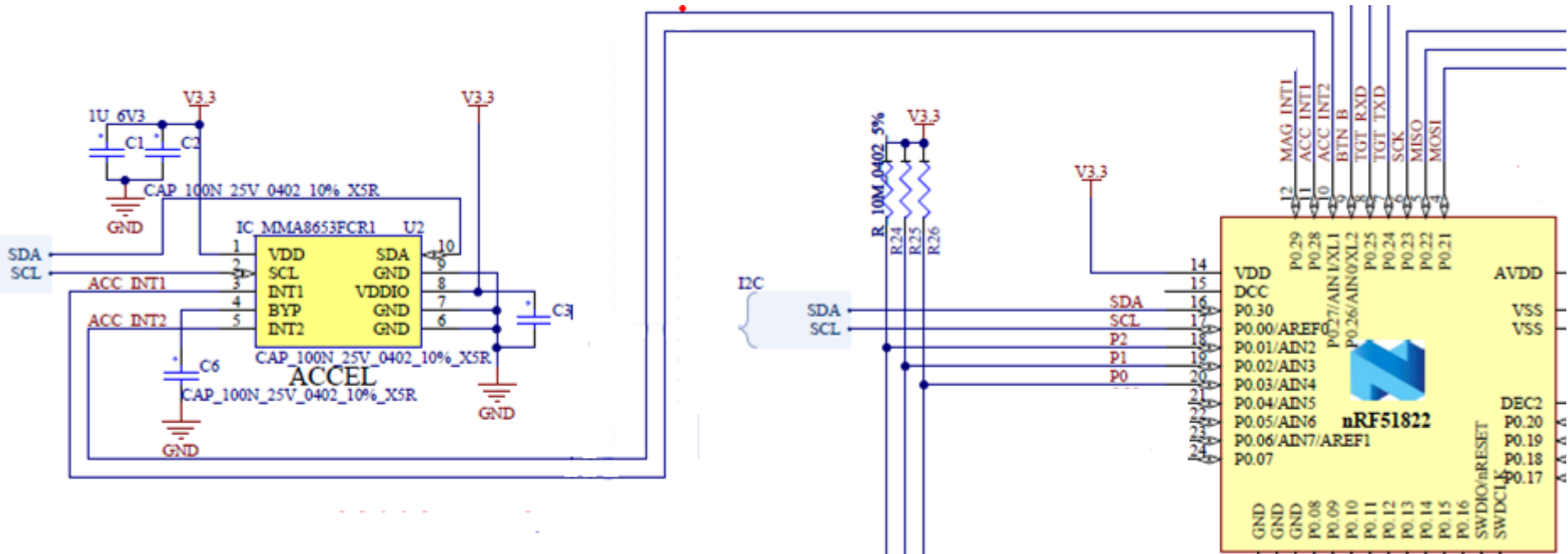- I2C digital output interface with programmable interrupts

8

Question 2:

True or False: The MMA8653FC accelerometer has a 12bit output?

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What is an Accelerometer?

MMA8653FC accelerometer to nRF51822 uC interface circuit diagram.

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What is an Accelerometer?...

MMA8653FC accelerometer

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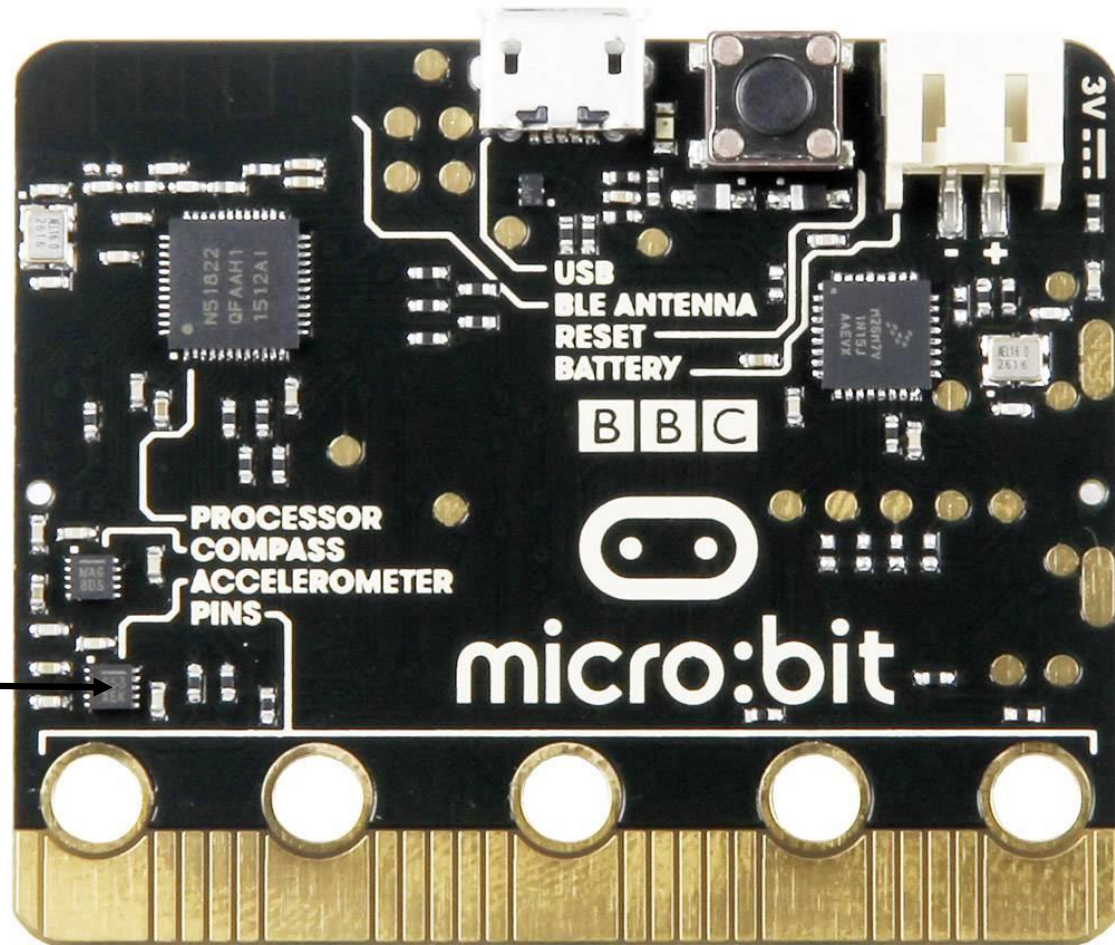
On slide 10, what are the designated I2C pins on the MMA8653FC accelerometer?

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Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer

Question: How can the BBC micro:bit collect vibration data?
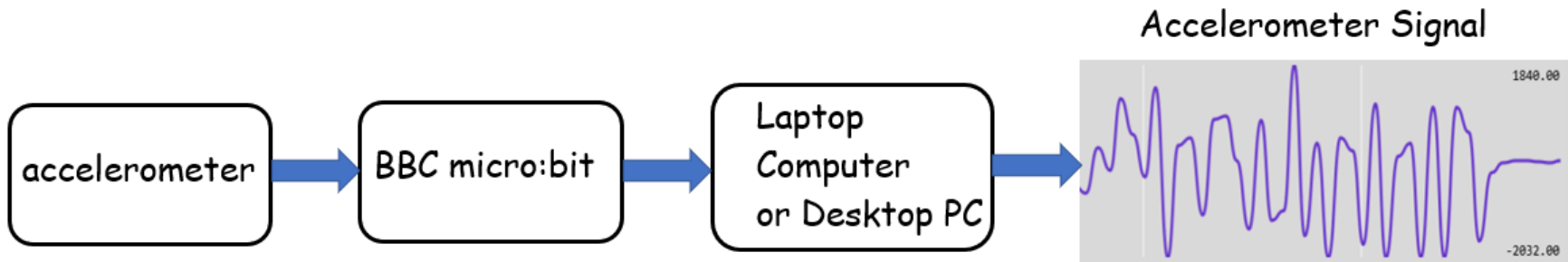
Accelerometer Signal

accelerometer → BBC micro:bit → Laptop Computer or Desktop PC → Accelerometer Signal

1840.00

-2032.00

Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer…

Blockly Code

```
forever
    serial write line "Accelerometer Data"
    serial write value "x" = acceleration (mg) x ▼
```

Javascript

```javascript
1  basic.forever(function () {
2      serial.writeLine("Accelerometer Data")
3      serial.writeValue("x", input.acceleration(Dimension.X))
4  })
```

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Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer...

MMA8653FC accelerometer signal

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Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer...

MMA8653FC accelerometer data

```
Accelerometer Data
x:-96
Accelerometer Data
x:-112
Accelerometer Data
x:-128
Accelerometer Data
x:-96
```

Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer…

Downloading accelerometer data

Click here

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Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer...

Accelerometer data downloaded into Excel spreadsheet

Presented by:

Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer...

```
2    0,32
3    0.2,32
4    0.386,32
5    0.58,32
6    0.785,32
7    0.943,32
8    1.136,32
9    1.333,32
10   1.528,32
11   1.734,32
12   1.931,32
13   2.096,32
14   2.285,32
15   2.481,32
16   2.674,16
17   2.883,32
18   3.085,32
19   3.284,16
20   3.447,32
21   3.651,32
22   3.851,32
23   4.031,32
24   4.234,32
25   4.429,32
```

Partial accelerometer data csv file

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Question 4 :

What file format is used when the accelerometer data is downloaded into an Excel spreadsheet?

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Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer…

Orange Linear Regression Model
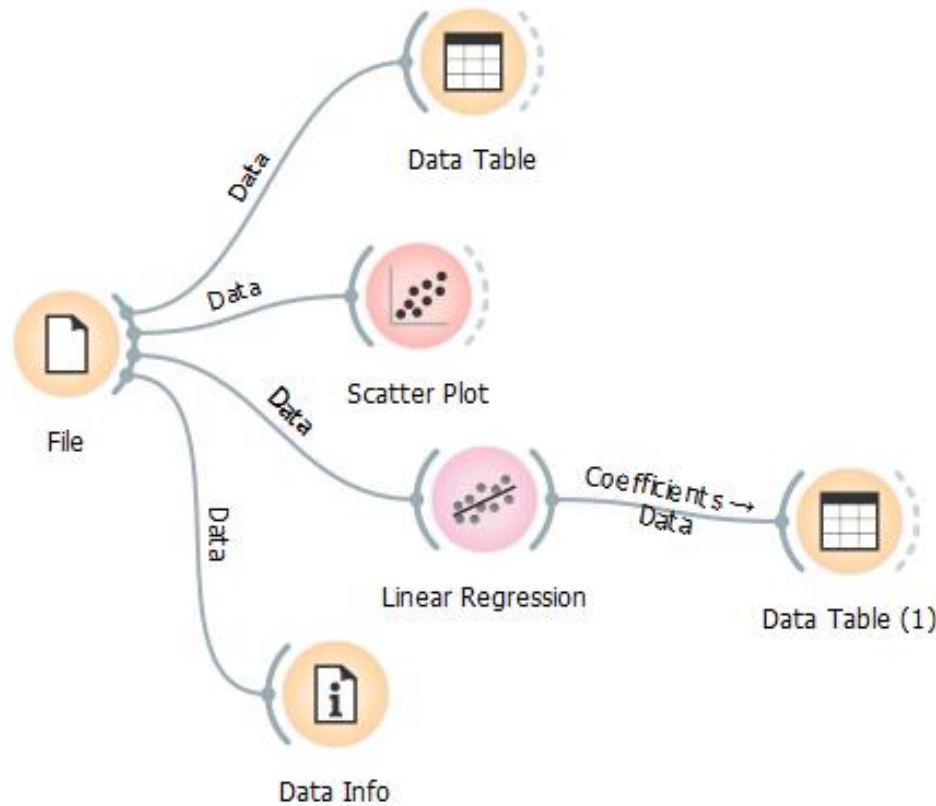
Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer...

Setting target name in Orange

Select "g" name as target

Click here to "Apply" to confirm target setting change.

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Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer...
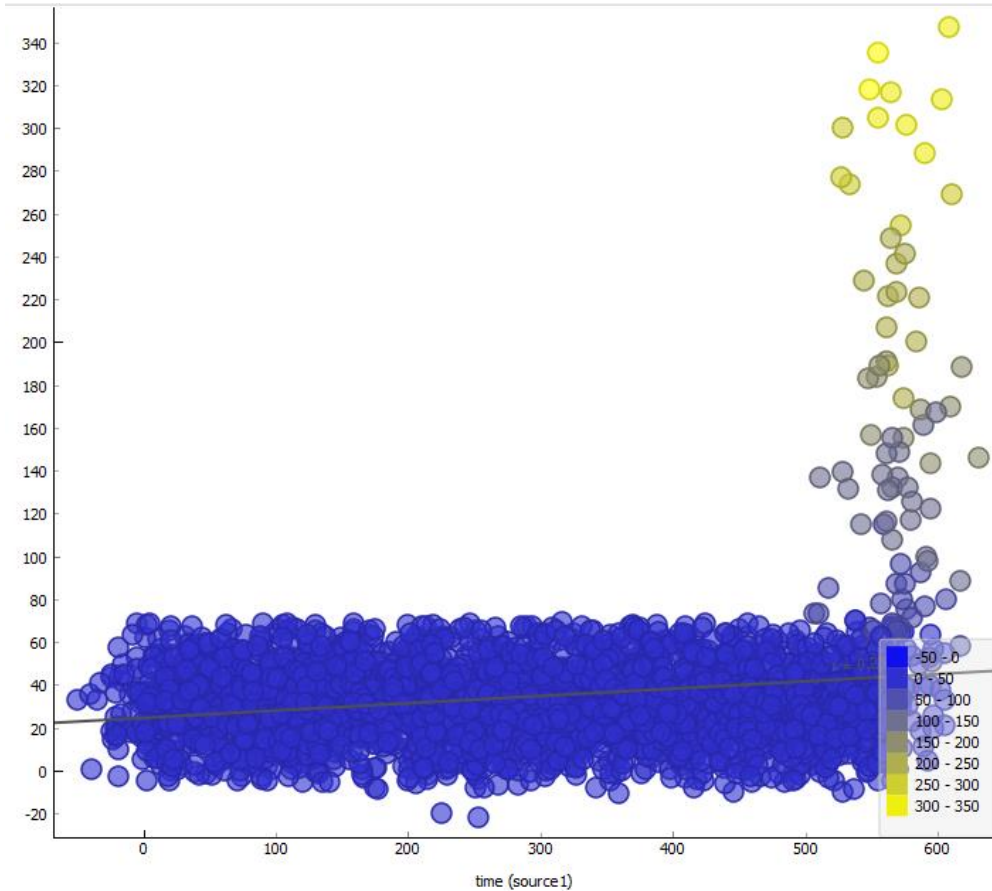
Accelerometer Data: Scatter Plot

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Mini Lab Activity: Collecting accelerometer vibration data from the BBC micro:bit accelerometer...

name	coef
intercept	24.8984775
time (source1)	0.0341277

Coefficients from Coefficient Data Table

$$y = 0.0341277x + 24.8984775$$

Accelerometer Linear Regression Equation

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Lab Project: Building a Talking Accelerometer Gesture Device

Question: How can an accelerometer talk?

accelerometer → BBC micro:bit → Speaker
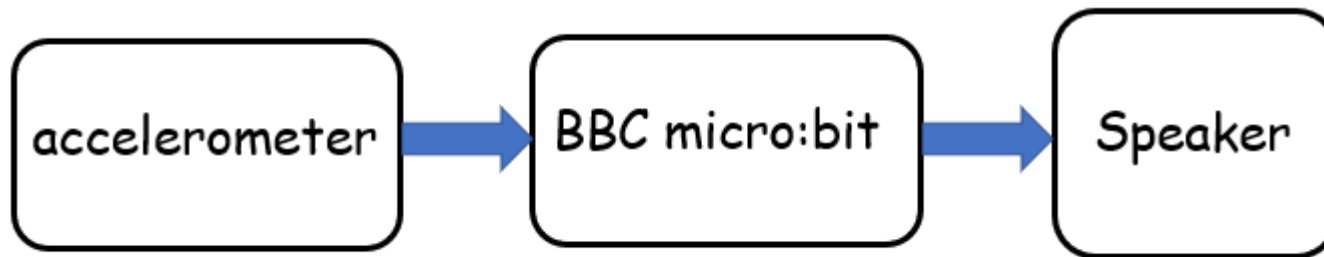
Talking Accelerometer Gesture Device Block Diagram

Presented by:

Lab Project: Building a Talking Accelerometer Gesture Device…

Hardware: Talking Accelerometer Gesture Device Electrical Wiring Diagram
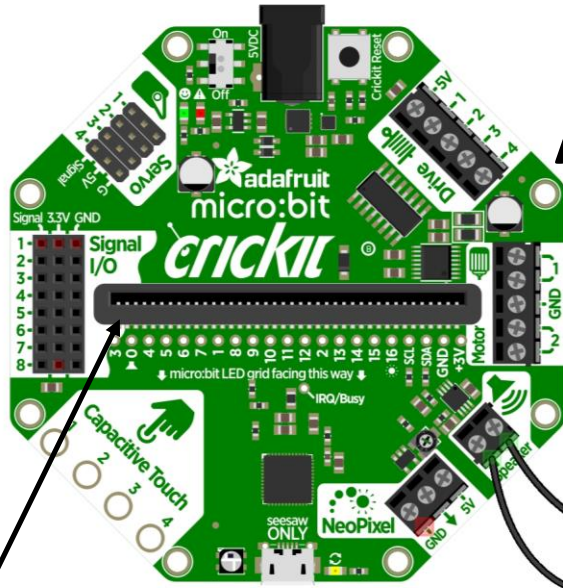
BBC micro:bit inserts here
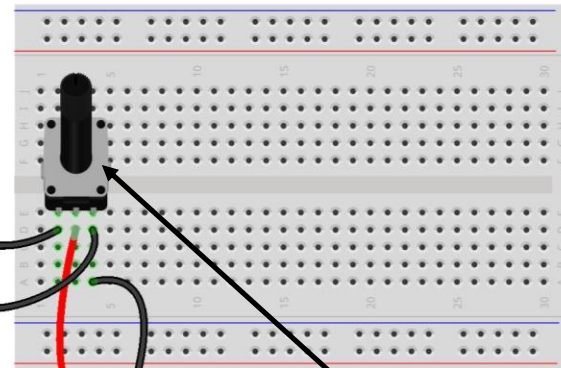
SPK1
8Ω
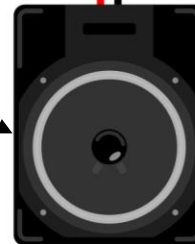
R1
10KΩ

Volume Control

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Lab Project: Building a Talking Accelerometer Gesture Device…

Hardware: Talking Accelerometer Gesture Device Electronic Circuit Schematic Diagram

+3.3V

Adafruit
Crickit

Speaker

GND

Volume
Control

R1
10KΩ

SPK1
8Ω

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Lab Project: Building a Talking Accelerometer Gesture Device...

Mu IDE

https://codewith.mu/

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Lab Project: Building a Talking Accelerometer Gesture Device...
Software: Talking Accelerometer Python Code


```python
from microbit import *
import speech
while True:
    if accelerometer.is_gesture("up"):
        display.show(Image.ARROW_N)
        speech.say("up")
        sleep(100)
    elif accelerometer.is_gesture("right"):
        display.show(Image.ARROW_E)
        speech.say("right")
        sleep(100)
    elif accelerometer.is_gesture("down"):
        display.show(Image.ARROW_S)
        speech.say("down")
        sleep(100)
    elif accelerometer.is_gesture("left"):
        display.show(Image.ARROW_W)
        speech.say("left")
        sleep(100)
    else:
        display.clear()
    sleep(20)
```

Presented by:

Lab Project: Building a Talking Accelerometer Gesture Device...
Software: Talking Accelerometer

```python
from microbit import *
import speech
while True:
    if accelerometer.is_gesture("up"):
        display.show(Image.ARROW_N)
        speech.say("up")
        sleep(100)
    elif accelerometer.is_gesture("right"):
        display.show(Image.ARROW_E)
        speech.say("right")
        sleep(100)
    elif accelerometer.is_gesture("down"):
        display.show(Image.ARROW_S)
        speech.say("down")
        sleep(100)
    elif accelerometer.is_gesture("left"):
        display.show(Image.ARROW_W)
        speech.say("left")
        sleep(100)
    else:
        display.clear()
    sleep(20)
```

Python Code (Zoom In)

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Lab Project: Building a Talking Accelerometer...
Accelerometer Objects

http://www.multiwingspan.co.uk/micro.php?page=pyacc

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Lab Project: Building a Talking Accelerometer Gesture Device...

Completed Project!

Presented by:
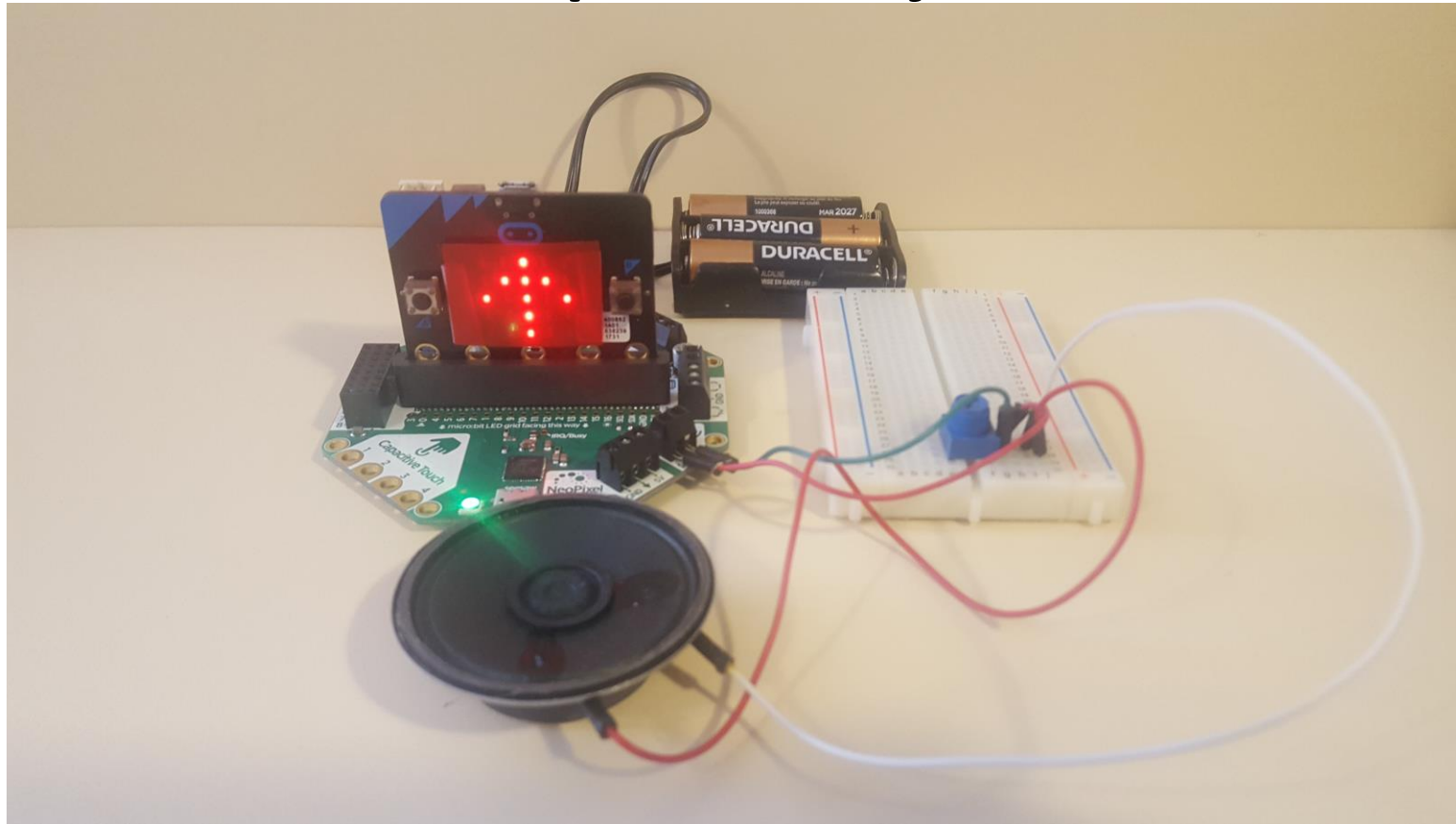
Question 5 :

What Python library is used to allow the micro:bit to speak?

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Lab Project: Building a Talking Accelerometer Gesture Device...
Congratulations!

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