Comparing interface and application programming tools

FABLAB BRIGHTON 2018

This week we're comparing a few tools, including:

- WeMos D1 mini (Pro) and Node-RED
- Grasshopper and Firefly
- Python

WeMos D1 Mini (Pro) and Node-RED

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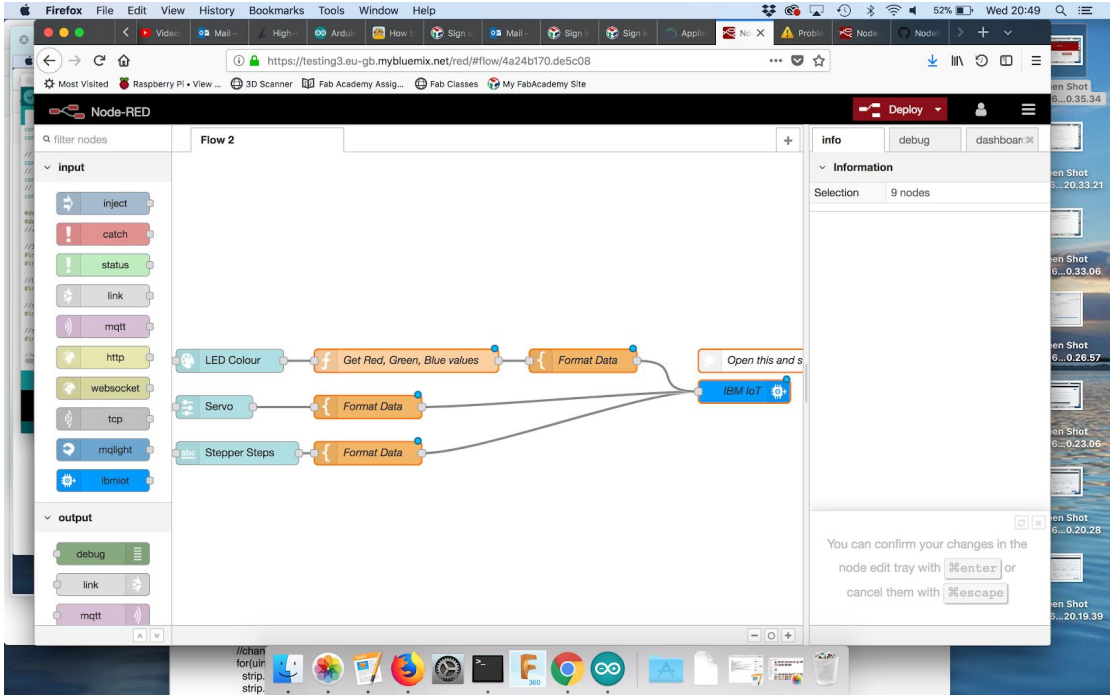
The Wemos mini is a miniature wireless microcontroller development board that can be programmed via the Arduino IDE. Like the Arduino boards i has input/output pins, but gains extra functionality with the wifi chip and antenna.

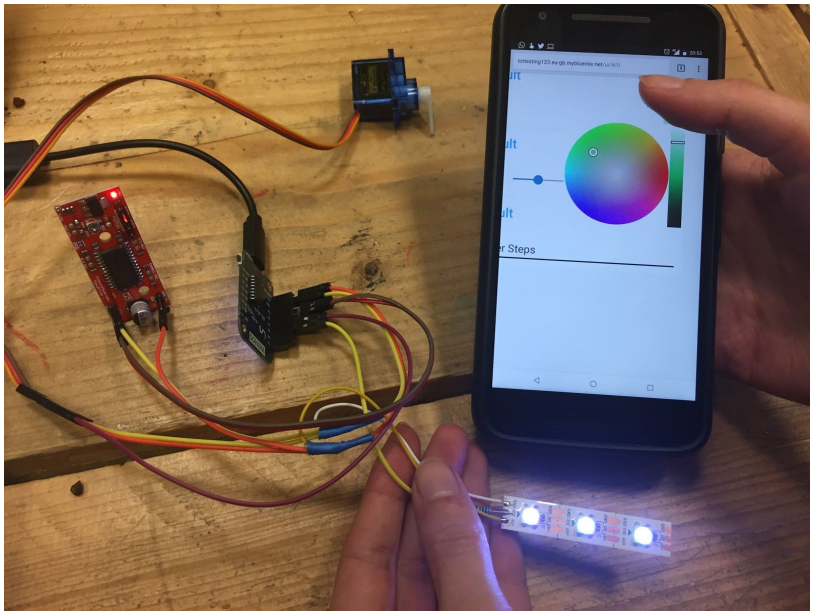
Node-RED is a visual programming tool, not dissimilar to how grasshopper works, with 'nodes' of code that can be put together and connected via 'wires'. Each node has a purpose that takes data, does something with the data and then passes it onto the next node.



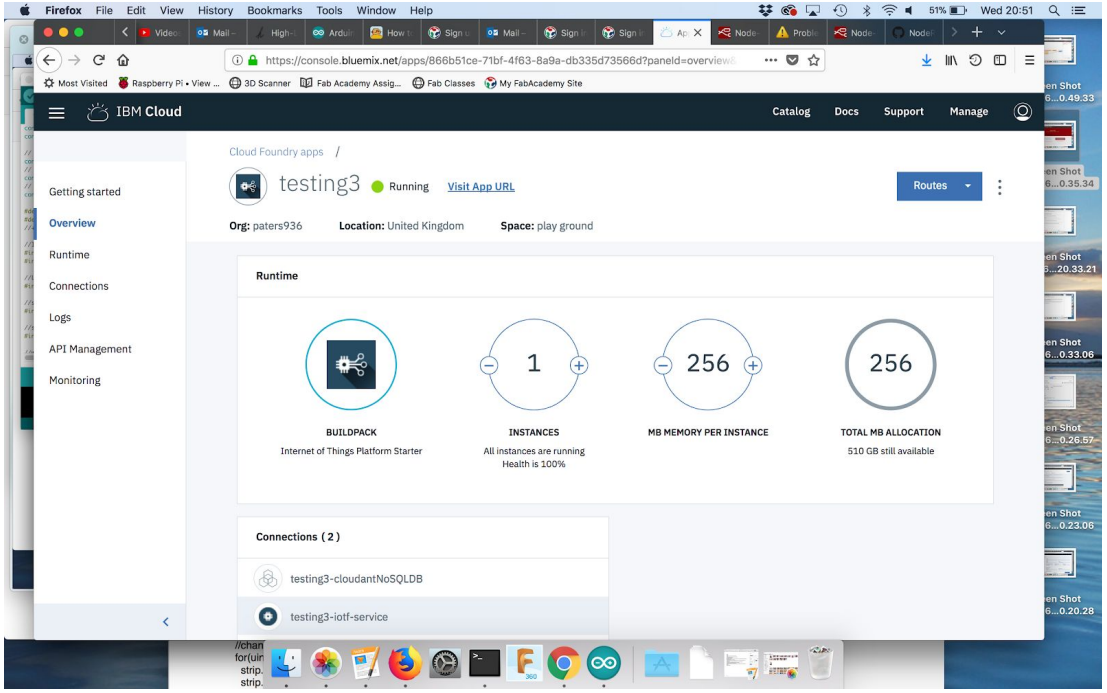
Node-RED lends itself to interface application and can be a much more accessible way to gain this skill than learning a new coding language. The platform is open source so users can create their own nodes using code if they want.

We had a lesson from Tim Minter of IBM. We started with a kit that had a Stepper motor, a servo and 3 RGB LED NeoPixel strip all hooked up to the Wemos Mini providing power and digital input/outputs.

This is a description of what we did. It shows how complicated it and what's involved. IBM is in the process of changing from Bluemix to IBM Cloud and the steps are also being updated. Hopefully this will make it more intuitive to use. At the time of writing these details are more up to date than many of the tutorials out there, but maybe not for long. We are still at the beginners stage of a steep learning curve, but once beyond that it will make connecting devices to each other and the web easier.



We dived straight into the Node-RED environment. We used the cloud option for this and created a free IBM Creative Cloud account at www.ibm.com/cloud. After confirming the account via email we selected the Catalog menu in the top right hand corner and when the page opened we scrolled down to Boilerplates and installed the IoT platform starter.
Note: It would have seemed logical to install the Node Red starter but don’t because it doesn’t have the devices panel for attaching things.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Getting started
Overview
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Connections
Logs
API Management
Monitoring
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BUILDPACK
Internet of Things Platform Starter
INSTANCES
All instances are running
Health is 100%
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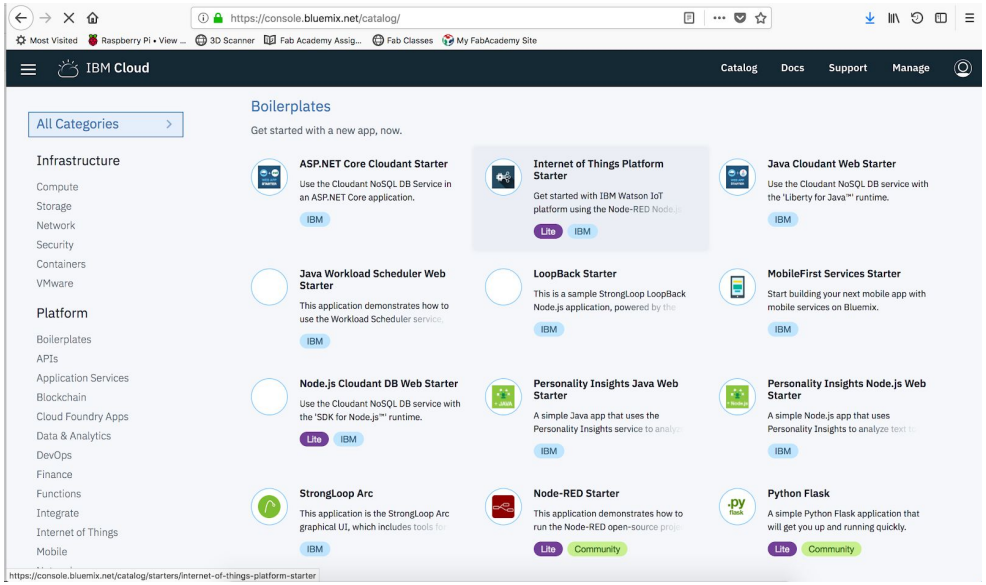
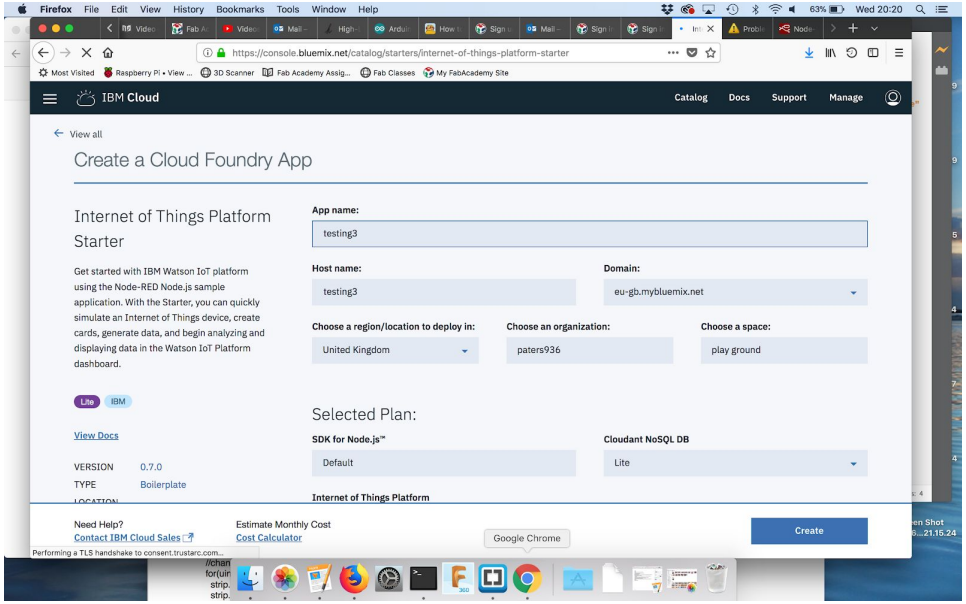
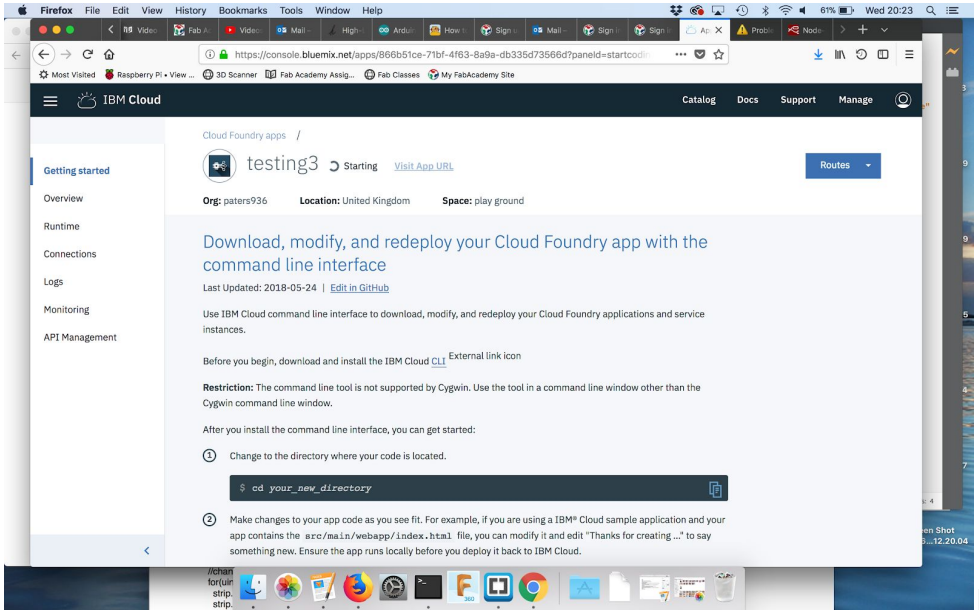
testing3-cloudantNoSQLDB
testing3-iotf-service



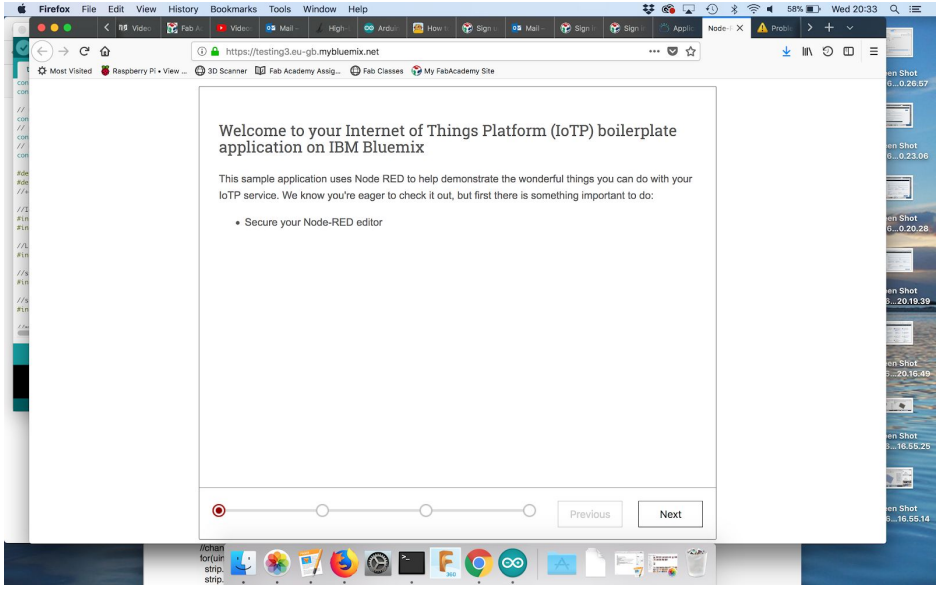
We went onto the page and gave our application a name and clicked on Create at the bottom right. It then starts creating a database and installs the instances that we need (ie it is giving us 3 servers - IoT, Cloudant database, and Node Red). This takes a while. When it’s done the word 'starting' at the top changes to 'running'.

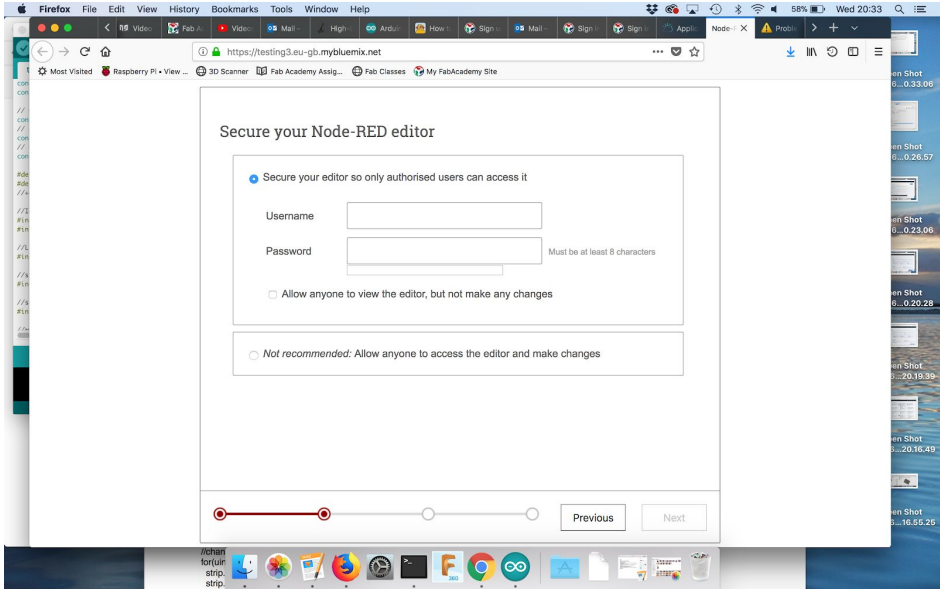




Next to the word 'running' we clicked on 'Visit App URL'

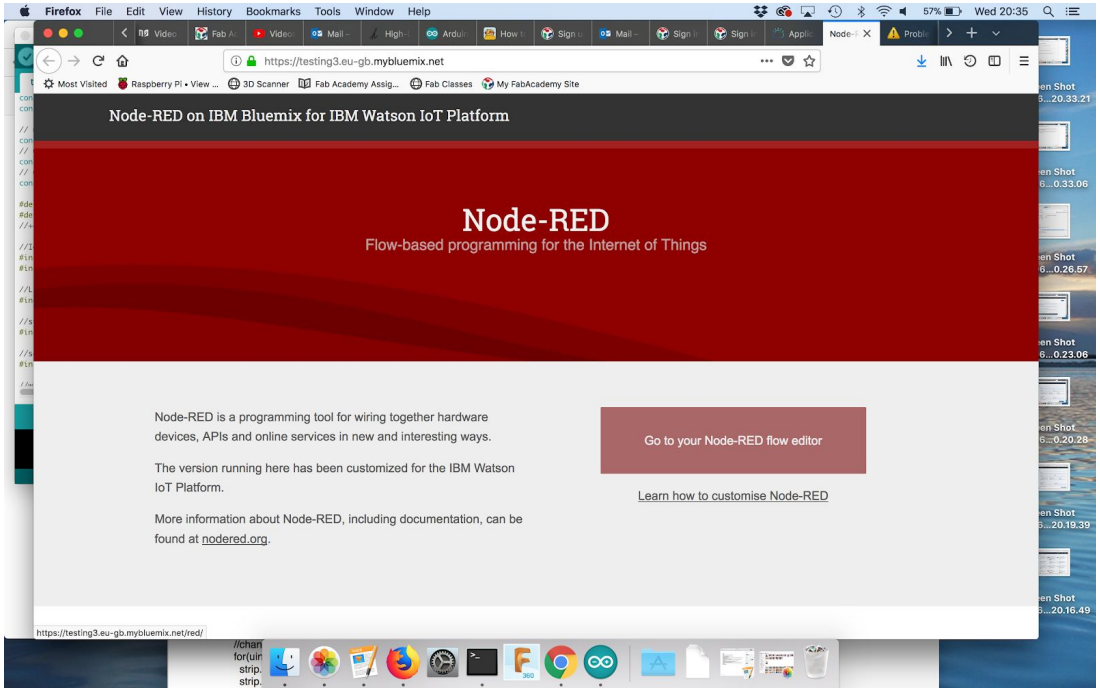
And a new tab opens with a welcome page. We clicked on 'next', created a username and password and clicked 'next' and 'next' again





This installs our user credentials and finishes the installation of Node Red
Then we clicked on the button to take us to Node Red and put in the user name and password.

It loads with a sample Flow.



The Node-RED environment consists of inputs/output and data processing nodes on the left, a workspace in the middle and a menu on the right where you can debug and view what is happening to the data at the the different stages of the sketch.
LED

We introduced a ‘colour picker’ node from the dashboard tab for our LED. This connected to a ‘function’ node from the function tab which allowed to to enter code to extract the RGB data.

```
// msg.payload is what "comes into" this node. This is the same for most NodeRED nodes
var colourInput = msg.payload;
// In this case msg.payload comes in looking like this "rgb(100,100,100)" where the
// values in the brackets ate the amount or red, green and blue light respectively
// (on a scale of 0 to 255).
```

```
// That input format is no good for us, we need to extract the individual red,
// green, blue values...

//first lets remove the beginning "rgb(" part of the text
colour = colourInput.replace('rgb(', ''); //this replaces 'rgb(' with '' ie nothing
// now lets replace the end bracket with nothing...
colour = colour.replace(')', '');
// finally we remove all the spaces
colour = colour.replace(' ', '');
// now the colour vaiable contains just the red, grren, blue values separated by
// commas eg "100,100,100"

// To do anything with these values we need to put them in their own variables
// We do this by creating an array of the values which is straight forward now that
// we have them in a comma separated string

var colourArray = colour.split(","); // we create an array and use the split function
// to put each value into the array.
// now we can get to each value using the colourArray[x] notation where x is the
// position in the array we want to look at. The vluae have ben put into the 0,1,2
// positions in the array

    msg.red = colourArray[0];
    msg.green = colourArray[1];
    msg.blue = colourArray[2];

// now when a rgb value comes into this node, the node outputs the individual
// red, green, blue values which can be accessed by looking at
// msg.payload.red, msg.payload.green and msg.payload.blue values

return msg;
```

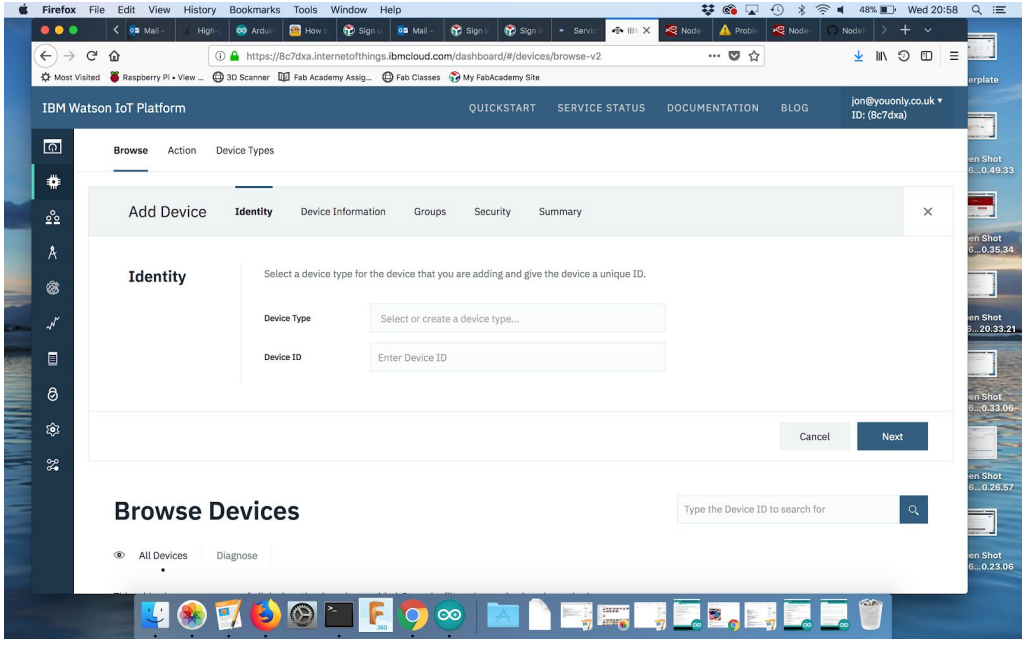
After the function node we went into a ‘template’ node, also in the function tab which contained;

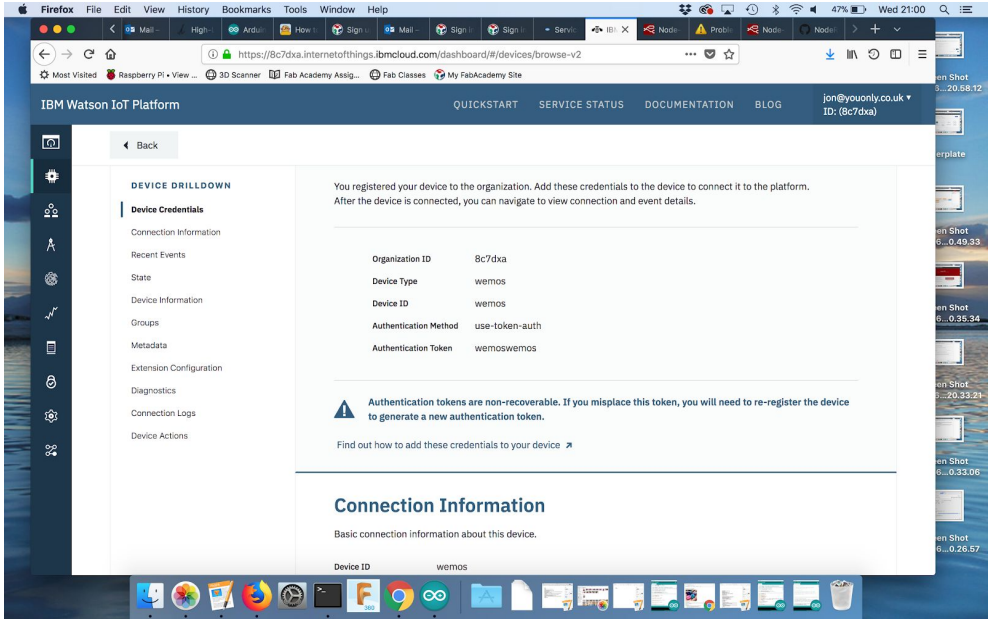
```
{
    "R":{{red}},
```

```
    "G":{{green}},
    "B":{{blue}}
}
```

All the data was output as ‘Parsed JSON’. The final connection was to the IBM IoT node found in the output tab.
To save and activate our nodes

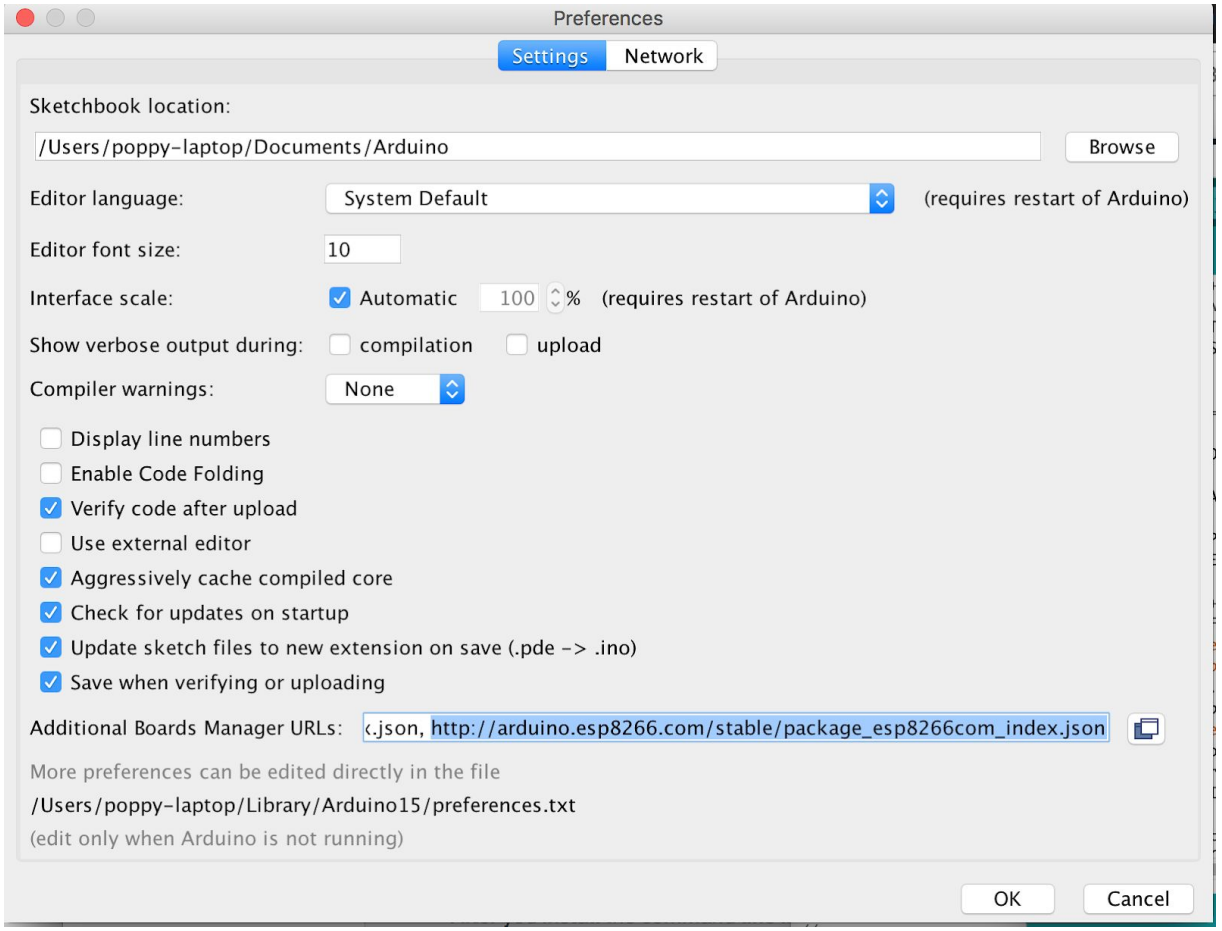
Node red sounds simple but It doesn’t just connect to the device.
We had to create a device by clicking on 'Devices' on the left, then 'Add Device' on the top right. Then we added a device type and device ID in the boxes. We called it Wemos for both.





On the next 2 pages we just clicked 'next'.
For the authentication token we called it wemoswemos because it had to be at least 8 characters and clicked 'next'
By clicking 'done', our device was set up.
Note: Take note of the organisation ID on the next page because it is needed later.
We needed to adjust the security settings for the device by clicking on the security tab on the left.
The policies page appears. We changed the connection Security, security level TLS optional and clicked 'save'.
That's created the device.

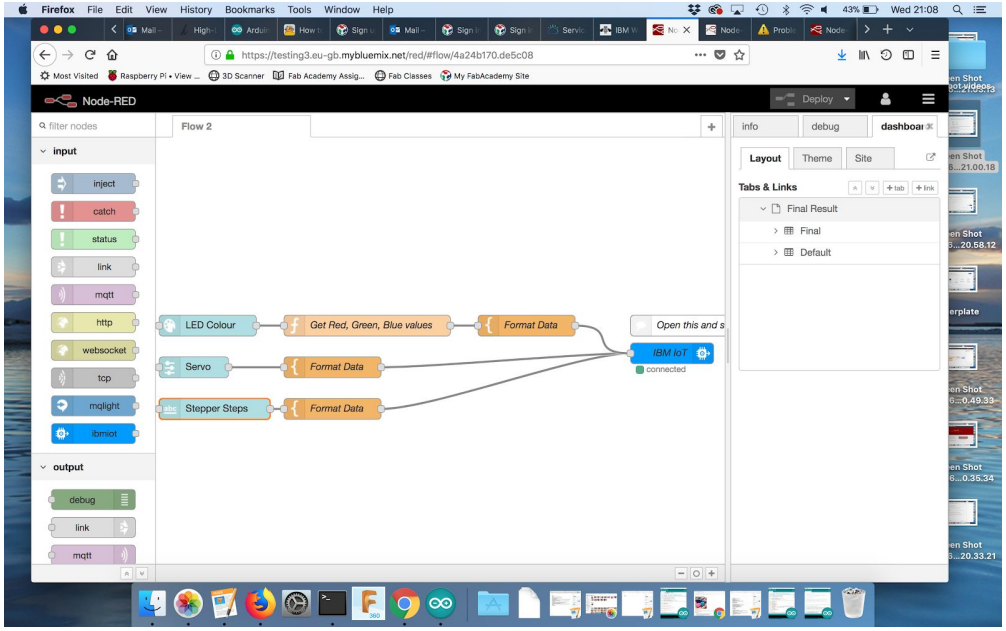
To use the Arduino IDE with this board, we first had to install the board, much like we did to be able to talk to the attiny chips, by pasting "http://arduino.esp8266.com/stable/package_esp8266com_index.json" in *File > Preferences > Additional Board Manager URLs.*

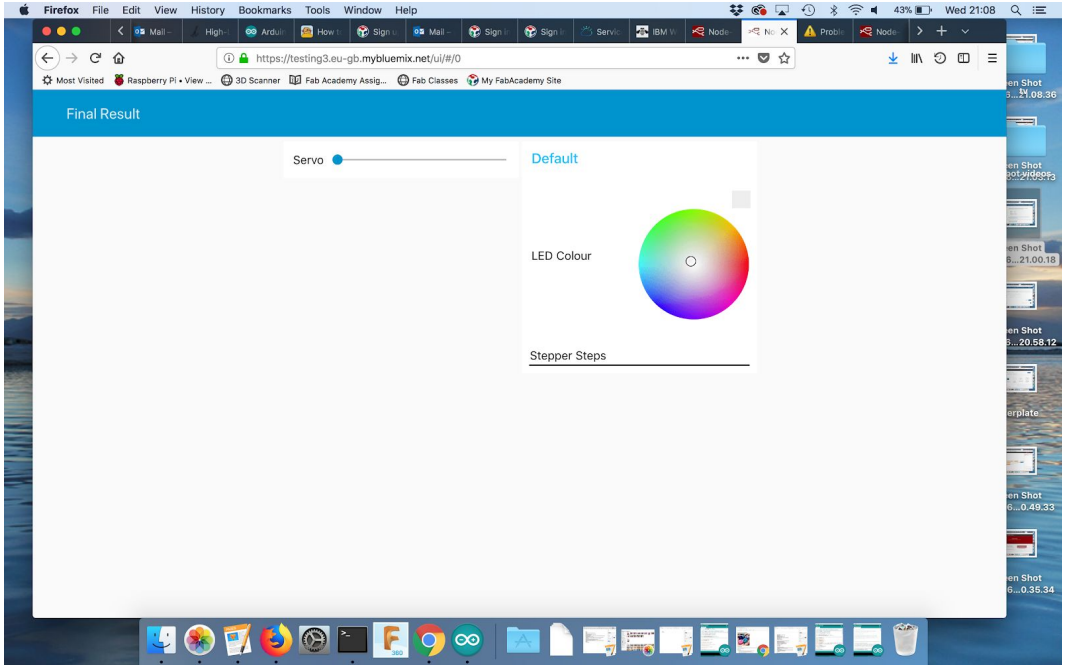


We copied the Sketch below into Arduino, scrolled down and filled in the Broker ID which is the Organisation ID that appears on the Device Drill Down Page.
Note: What to fill in for the Client ID is shown in the comments on the Sketch. That solves the connection to IBM.
Then we changed the WiFi connection in the same way.

Putting it All Together
Back to Node Red we double clicked on the the 'IoT out' node in our flow and used the credentials from our device.

When we hit deploy a little green square appeared below the node to show it's connected and we could see them on the dashboard by clicking the dashboard tab on the right hand side and the link icon - a little box with an arrow coming out of it.





Arduino Sketch

```
/*
 * Copyright 2018 IBM Tim Minter
 *
 * Licensed under the Apache License, Version 2.0 (the "License");
 * you may not use this file except in compliance with the License.
 * You may obtain a copy of the License at
 *
 * apache.org/licenses/LICEN…
 *
 * Unless required by applicable law or agreed to in writing, software
 * distributed under the License is distributed on an "AS IS" BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
```

```
 * See the License for the specific language governing permissions and
 * limitations under the License.

*/

// You will need to install all the libraries listed in the includes section via the Arduino Library Manager.

// If using the setup_wifiHotSpot option....
// If the board is started, and a known wifi connection is available, it will connect automatically.
// If no known connection is found the board will switch to access point mode and a wifi network will be created with the ACCESS_POINT_NAME set below.
// Using anotherdevice you cna the connect to that wifi connection using the ACCESS_POINT_PASSWORD set below.
// Your browser will be opened to a configuration page where you can set up the wifi credentials for this board.

//++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
// This section is where you can configure all the things that need configuring

// wifi setup
const char* WIFI_NETWORK_NAME = "eaglelabsToYou";
const char* WIFI_PASSWORD = "eagle2You";

// update this with the Broker address from IBM Watson IoT Platform
const char* BROKER = "nzs2ny.messaging.internetofthings.ibmcloud.com";
// update this with the Client ID in the format d:{org_id}:{device_type}:{device_id}
const char* CLIENTID = "d:nzs2ny:wemos:thing13";
// update this with the authentcation token
const char* DEVICE_AUTH_TOKEN = "thingthing";

//LED (Neopixel) setup
#define LED_CONTROL_PIN D1
#define NUMBER_OF_LEDS_CONNECTED 3
```

```
//servo setup
#define SERVO_CONTROL_PIN D2

//++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

//IoT and wifi libraries to include
#include <ESP8266WiFi.h>
#include <PubSubClient.h>

//LED (Neopixel) libray to include
#include <Adafruit_NeoPixel.h>

//servo control library to include
#include <Servo.h>

//wifi includes
#include <DNSServer.h> //Local DNS Server used for redirecting all requests to the configuration portal
#include <ESP8266WebServer.h> //Local WebServer used to serve the configuration portal
#include <WiFiManager.h> //https://github.com/tzapu/WiFiManager WiFi Configuration Magic

//json crunchig library
#include <ArduinoJson.h>

//define servo (the pins will be defined later)
Servo servo1;  // create servo object to control a servo

// subscribe to this for commands:
#define COMMAND_TOPIC "iot-2/cmd/command/fmt/text"

Adafruit_NeoPixel strip = Adafruit_NeoPixel(NUMBER_OF_LEDS_CONNECTED, LED_CONTROL_PIN, NEO_GRB + NEO_KHZ800);

WiFiClient espClient;
```

```
PubSubClient client(espClient);

int servoPosition = 90;

void setup() {
  Serial.begin(9600);
  Serial.println("Hello world!");  // prints hello with ending line break
  strip.setBrightness(180); //max is255
  strip.setPixelColor(0, strip.Color(255,0,0));
  strip.show();
  delay(500);
  Serial.println();
  Serial.print("MAC: ");
  Serial.println(WiFi.macAddress());
  servo1.attach(SERVO_CONTROL_PIN);  // attaches the servo on pin D4 to the servo object
  strip.begin();
  strip.show(); // Initialize all pixels to 'off'
  setup_wifi();
  client.setServer(BROKER, 1883);
  client.setCallback(callback);
  strip.setPixelColor(0, strip.Color(0,0,0));
  strip.show();
}

void setup_wifi() {
  // Start by connecting to the WiFi network
  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(WIFI_NETWORK_NAME);
  WiFi.mode(WIFI_STA);
  WiFi.begin(WIFI_NETWORK_NAME, WIFI_PASSWORD);
  wait_for_wifi();
```

```
  Serial.print("IP address: ");
  Serial.println(WiFi.localIP());
}

void callback(char* topic, byte* payload, unsigned int length) {
  Serial.println("Message Received");
  const size_t bufferSize = JSON_OBJECT_SIZE(5) + 30;
  DynamicJsonBuffer jsonBuffer(bufferSize);
  const char* json = (char*)payload;
  JsonObject& root = jsonBuffer.parseObject(json);

  int LEDAddress = root["A"];
  int R = root["R"];
  int G = root["G"];
  int B = root["B"];

  if(LEDAddress && R && G && B){
        //change the colour of the specified LED (if the colut and position has been sent
        strip.setPixelColor(LEDAddress, strip.Color(R,G,B));
        strip.show();
  } else if (R && G && B){
        //change the colour of all LEDs in any attached strip if position has not been sent
        for(uint16_t i=0; i<strip.numPixels(); i++) {
        strip.setPixelColor(i, strip.Color(R,G,B));
        strip.show();
        }
  }
  if(root["servoPosition"]){ //only if a value for this has been sent take action otherwise don't set the position
        servoPosition = root["servoPosition"];
  }

  }
```

```
  Serial.println(servoPosition);

}

 void wait_for_wifi(){
  Serial.println("waiting for Wifi");
  while (WiFi.status() != WL_CONNECTED) {
          delay(1000);
          strip.setPixelColor(1, strip.Color(255,0,0));
          strip.show();
          delay(500);
          strip.setPixelColor(1, strip.Color(0,0,0));
          strip.show();
  }
  Serial.println("");
  Serial.println("WiFi connected");
}

 void reconnect() {
  boolean first = true;
  // Loop until we're reconnected to the broker
  while (!client.connected()) {
          if (WiFi.status() != WL_CONNECTED) {
          wait_for_wifi();
          first = true;
          }
          Serial.print("Attempting MQTT connection...");
          if (first) {
          first = false;
          }
          // Attempt to connect
          if (client.connect(CLIENTID, "use-token-auth", DEVICE_AUTH_TOKEN)) {
```

```
        Serial.println("connected");
        strip.setPixelColor(1, strip.Color(0,0,255));
        strip.show();
        }
        else {
        Serial.print("failed, rc=");
        Serial.println(client.state());
        strip.setPixelColor(1, strip.Color(0,255,0));
        strip.show();
        delay(500);
        strip.setPixelColor(1, strip.Color(0,0,0));
        strip.show();
        delay(500);
        strip.setPixelColor(1, strip.Color(0,255,0));
        strip.show();
        }
  }
  // subscribe to the command topic
  client.subscribe(COMMAND_TOPIC);
}

void loop() {

  if (!client.connected()) {
        reconnect();
  }

  // service the MQTT (IoT) client
  client.loop();


  }
```

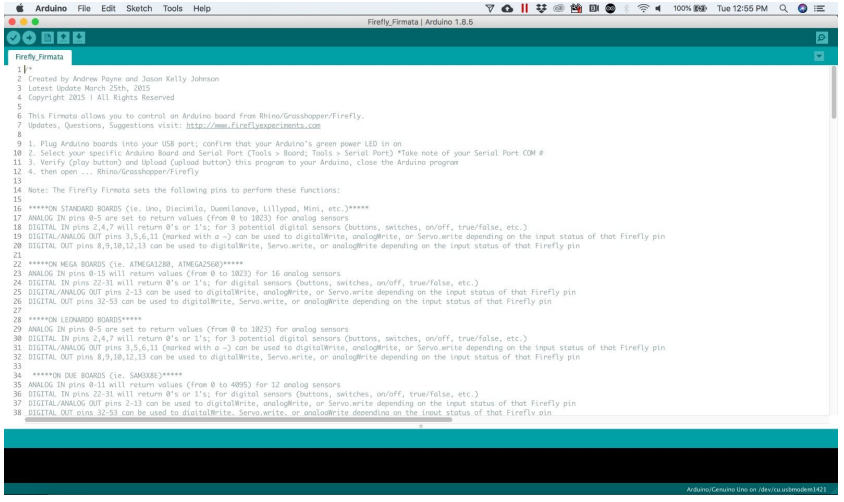
```
  stepper.run();

  //move the servo
  servo1.write(servoPosition); //servo 1
}
```

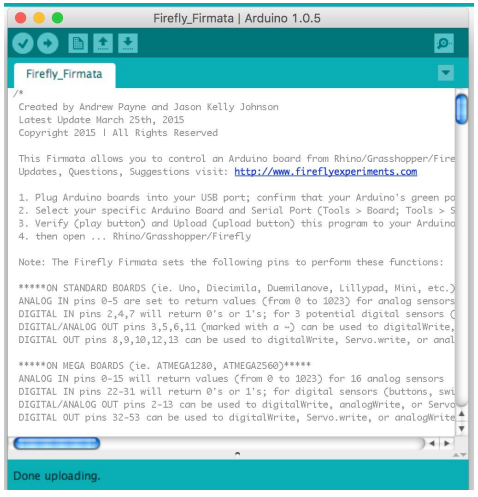
Thanks to Tim Minter from IBM and Jon Paterson at Eagle Lab Brighton for helping us get to grips with Node Red

Grasshopper and Firefly

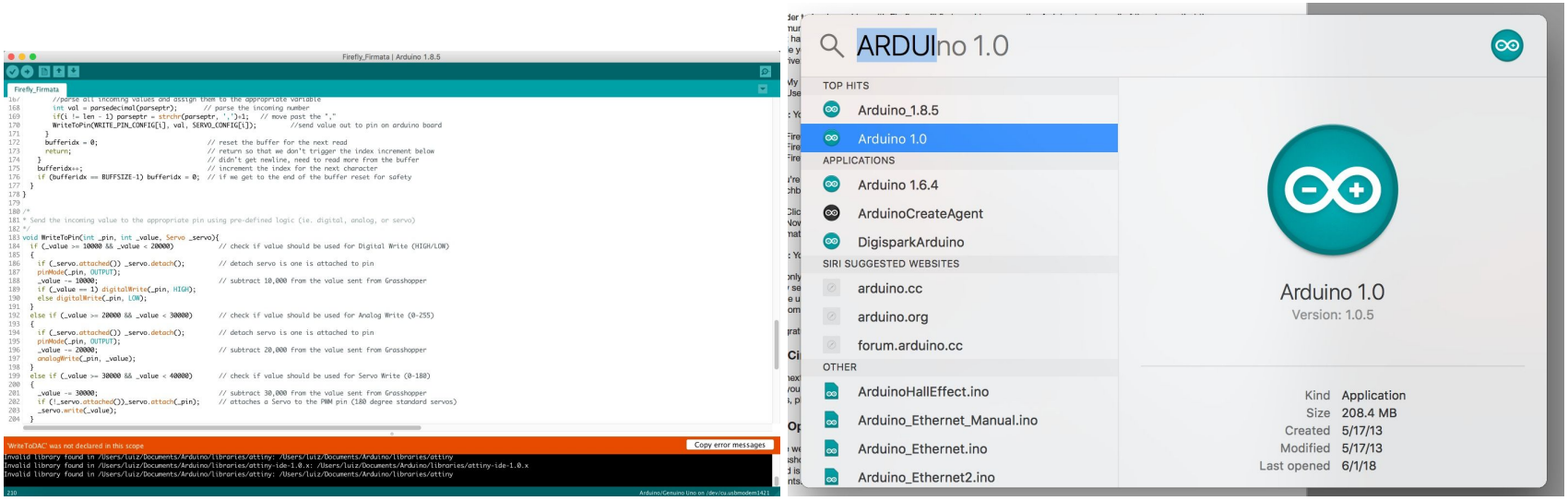
Grasshopper is a plugin for Rhino which enables parametric modelling. It is similar to Node-RED in that it has ‘nodes’ of code which alter data which is then passed onto subsequent nodes. It is open source which has allowed developers to create additional plugins. One very interesting one is called Firefly which allows Grasshopper to communicate with an Arduino getting information from its inputs and sending data back to control the outputs.

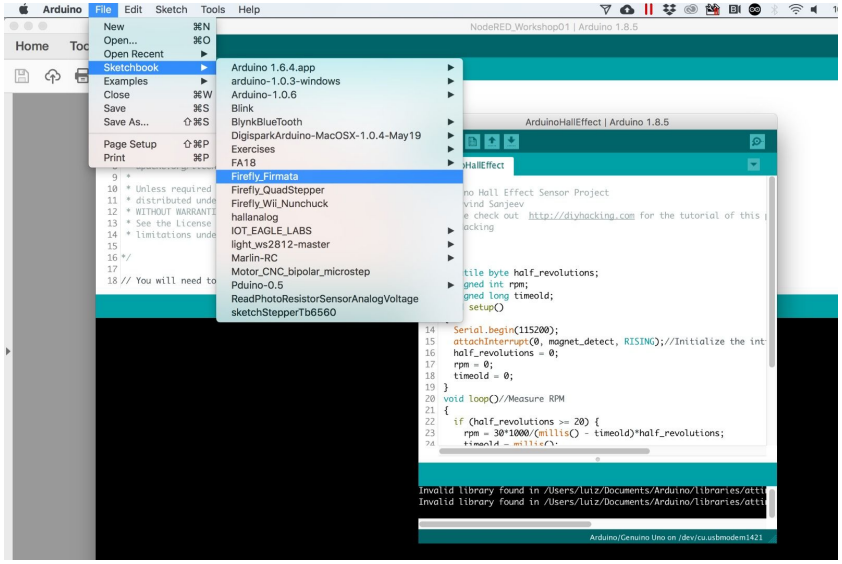
To get this to work you first need Rhino and Grasshopper installed on your computer and then download and install the Firefly plugin for Grasshopper. Next you need to upload the Firefly Firmata to your Arduino board. In the .zip folder downloaded from the FoodforRhino website open up the Firefly_Firmata Arduino sketch.



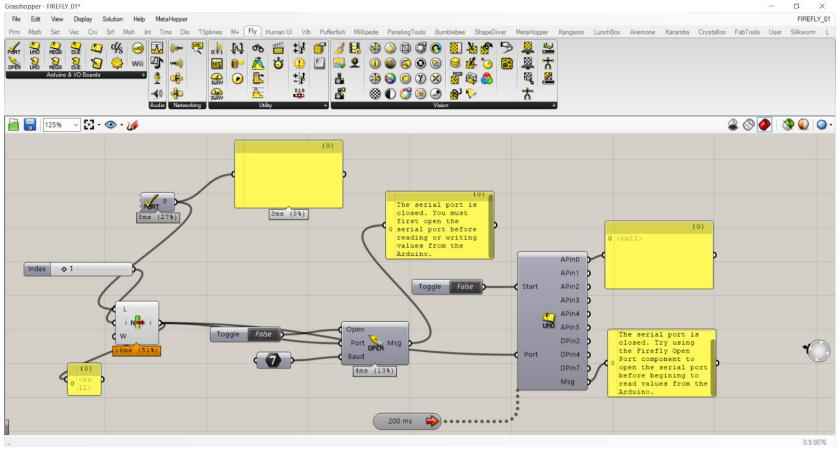


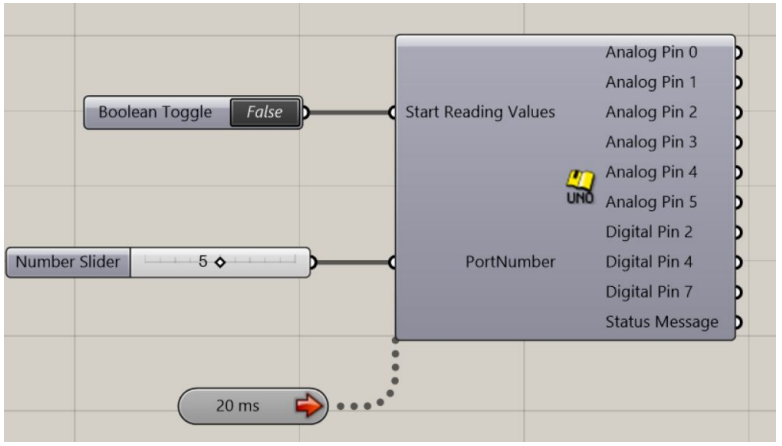
At the start is some information about the boards that are compatible and how the pins are used. It is important to open up this code in an older version of Arduino (Arduino 1.0.5) as otherwise there will be an error compiling due to the ‘WritetoDAX’ error. It is possible to fix this, but requires some editing of the Firmata





Once we had successfully uploaded the Firmata to the Arduino we can move into Grasshopper.





Above left we can see the full sketch we used to connect the Arduino to Grasshopper. It starts by getting the port ‘available ports’ from our machine. We then select which port the Arduino is connected to and run this through the ‘open port’ node. Here we can open and close the port and also set the baud rate (115200 for this example).

The right image shows the Arduino ‘Uno Read’ which gets the data from the pins of our arduino, here we can start and stop reading. It is also important to set the timer as this is the interval at which data is received.

With this sketch we are able to read the value coming from our LED (used as an LDR) which can be seen in the video below.

https://youtu.be/RScf1e6t14E

Python

Python is a general-purpose interpreted programming language.The written code is not actually translated to a computer-readable format at runtime, where most programming languages do this conversion before the program is even run. This type of language is also referred to as a "scripting language" because it was initially meant to be used for trivial projects.

We wanted to use Python to create a graph based on data sent through the serial communication protocol.

To install and run Python programmes, you run a series of commands in the terminal window. The first one here installs XCode which has a set of command line tools.
`xcode-select --install`

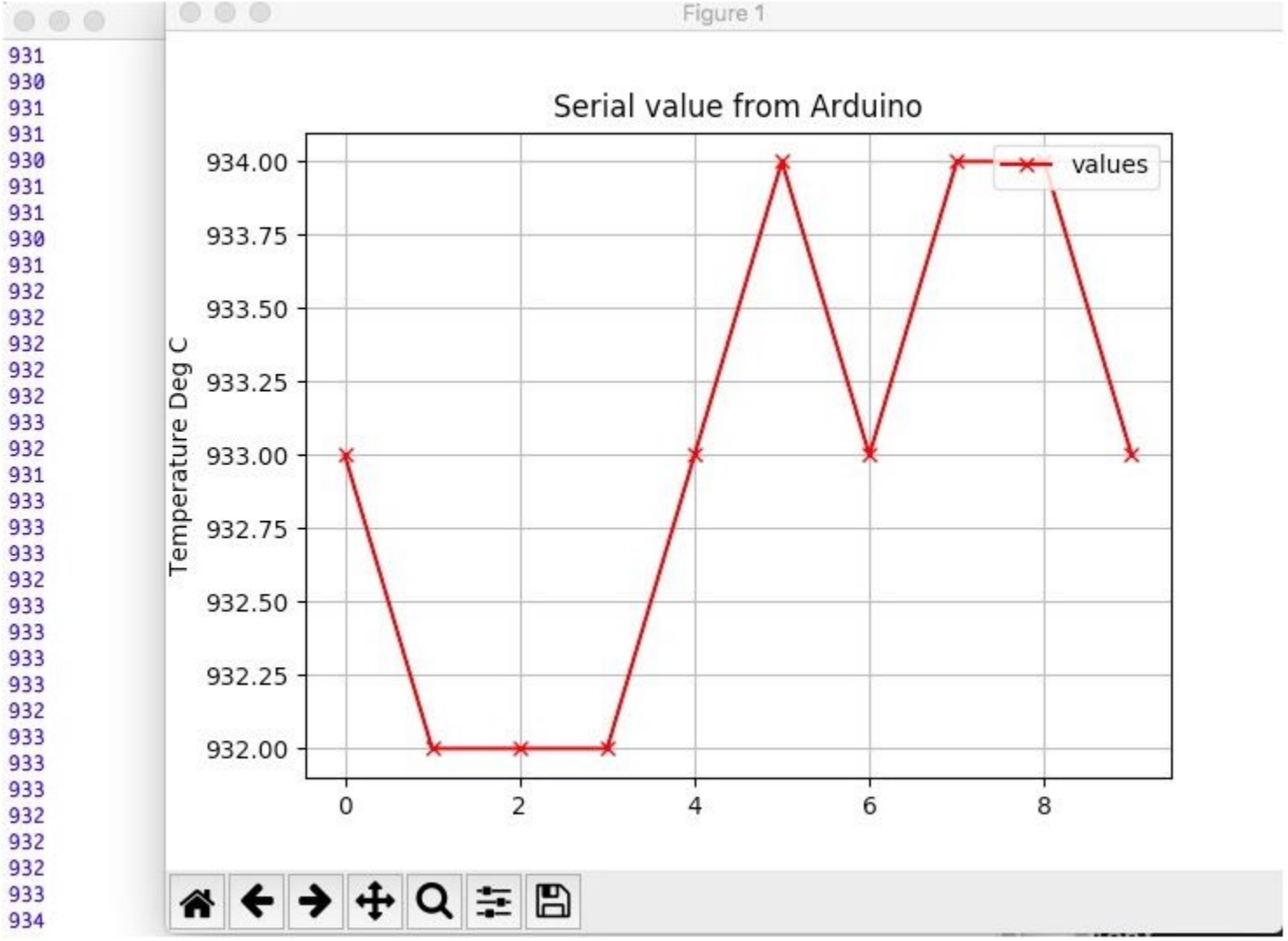
Then we install Homebrew, which is a package manager, here's the code to install it:
`/usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"`
Then to install Python 2.7:
`brew install python@2`

Homebrew installs Setuptools and pip for you. Setuptools enables you to download and install any compliant Python software over a network (usually the Internet) with a single command (easy_install). It also enables you to add this network installation capability to your own Python software with very little work. Pip is a tool for easily installing and managing Python packages.
`pip2 -V  # pip pointing to the Homebrew installed Python 2 interpreter`

You also need to install all the necessary libraries, including these (separately):

```
sudo pip install matplotlib
    sudo pip install numpy
    sudo pip install pyserial
    sudo pip install drawnow
```

We found another youtube video which seemed like a nice simple programme to do what we wanted in Python2.7, so we thought I'd give this a try, since the last few attempts have not gone well...and it works!!! Here's a screengrab of the raw analog data (noting that the data is actually mV, not temperature as suggested in the y-axis title...that will come later once the thermistor has been calibrated):



After installing Python2.7, we needed to open the corresponding Idle2.7. To do this: in the command terminal type: Idle2.7

This opens the python shell. Then file > open the .py file. Then to run it, goto RUN menu > RUN MODULE. Alternatively, in the command terminal, goto the python directory and type:

```
cd python
python2.7 filename.py
e.g. python2.7 plot-serial-v4-WORKING.py
```

Here's the code for the arduino:

```
int value;
void setup() {
  // initialize the serial communication:
  Serial.begin(9600);
}

void loop() {
  // send the value of analog input 5:
  value=analogRead(A5);
  Serial.println(value);
  delay(500);
}
```

And here's the code to run in Python 2.7.

```
import serial
import numpy
import matplotlib.pyplot as plt
from drawnow import *
values = []

plt.ion()
cnt=0

serialArduino = serial.Serial('/dev/cu.usbmodem1421', 9600)
```

```
def plotValues():
    plt.title('Serial value from Arduino')
    plt.grid(True)
    plt.ylabel('Temperature Deg C')
    plt.plot(values, 'rx-',label='values')
    plt.legend(loc='upper right')

for i in range (0,600):
    values.append(0)

while True:
    while (serialArduino.inWaiting()==0):
        pass
    valueRead = serialArduino.readline()

    try:
        valueInInt=int(valueRead)
        print (valueInInt)
        if valueInInt <= 1024:
            if valueInInt>=0:
                values.append(valueInInt)
                values.pop(0)
                drawnow(plotValues)
            else:
                print "Invalid! negative number"
        else:
            print "invalid too large"
    except ValueError:
        print "Invalid! cannot cast"
```

and here are the files to download:

- plot-serial-in-python.ino

- plot-serial-in-python.py

here's a video of me loading idle2.7 and python2.7, opening the file, and running the graph:
https://youtu.be/Y1Ufu_ieVwc