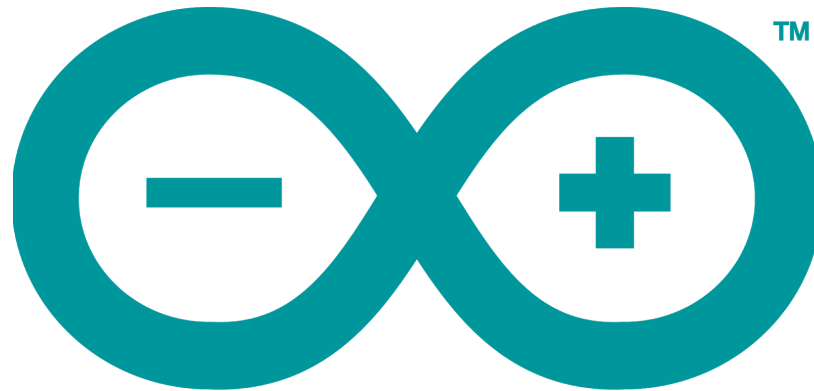
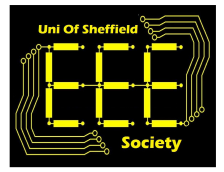




The  
University  
Of  
Sheffield.



# **Arduino Labs**

## **Session 3**

### *Practical*

### *Programming 1*

## Introduction

This session aims to reinforce the programming language learning from Session Two using practical examples. You will get to handle and use the Adafruit Neopixel Shield for the first time.

An example random colour generator program will be used to introduce the Adafruit Neopixel library and practical programming techniques.

You will then be tasked with writing your own program to show your countries flag on the neopixel shield. An example flag program will be provided to show you how to do this.

## Session Content

1. Practical Introduction of the Adafruit Neopixel Library
2. Demonstration of Random Colour Generator Code
3. Demonstration of Flag Code
4. **Practical Work** - How to program an Arduino
5. **Practical Work** - Random Colour Generator Code
6. **Practical Work** - Write your own Flag Code

## The Adafruit Neopixel Library

***We will go through this on the projector before we begin practical work, this section just contains key information that you may want to know when writing your own code for the Adafruit Neopixel Shield.***

Neopixels are slightly smarter than standard LEDs, they contain circuitry that converts a digital value received from the microcontroller (sent serially) into analog red, green and blue values.

It is very easy to communicate with neopixels because of the circuitry they already contain within them. On top of this Adafruit has done a lot of the work for us and made a library that performs some of the lower hardware level magic to communicate with the neopixels.

The Adafruit Neopixel Library provides an **Object** that can be used to communicate with a string of neopixels. Each object created using the library corresponds to a single string of neopixels and by extension a single digital pin on the Arduino. This means we could theoretically drive **13 neopixel shields** from a single Arduino (one for each digital pin).

The following code is used to create a neopixel string object:

```
Adafruit_NeoPixel [neopixel_string_name] =  
Adafruit_NeoPixel(NMBR_OF_NEOPXLS, PIN_NEOPXLS, NEO_GRB + NEO_KHZ800);
```

There are four values that you must enter into this object declaration, these are as follows:

**[neopixel\_string\_name]** ⇒ The object name that corresponds to this string of neopixels, you will use this to call functions to control this string of neopixels later in the code.

**NMBR\_OF\_NEOPXLS** ⇒ This is the number of neopixels within the string you are controlling.

**PIN\_NEOPXLS** ⇒ This is the Arduino Pin the digital input of the neopixel string is connected too. When using the Adafruit Neopixel Shield this is always pin 6 unless deliberately wired by the user otherwise.

**NEO\_GRB + NEO\_KHZ800** ⇒ This is a special value that indicates to the library what type of neopixels we are using. **For our purposes we will always type the string exactly as it is shown here.**

Once we have a neopixel object we only need 4 functions to set the colour and brightness of a string of neopixels! Yes, it really is that easy (thanks to Adafruit)! These functions are as follows:

#### **Function 1: begin()**

This function sets up communications with the neopixel string. It is called as follows:

```
[neopixel_string_name].begin();
```

This function must be called after the neopixel object is made but before any other neopixel functions are called.

#### **Function 2: setBrightness()**

This function sets the brightness of all neopixels in the string. It is called as follows:

```
[neopixel_string_name].setBrightness([brightness_value]);
```

The **[brightness\_value]** argument is an arbitrary number that sets the relative brightness of the neopixels. It can take a value between 0 and 255. I have found that a value of around 20 is good to work with. Maximum brightness can light up a whole room!

### Function 3: `setPixelColor()`

This function sets the RGB Colour of a single neopixel. It is called as follows:

```
[neopixel_string_name].setPixelColor(NEOPXL_INDx, red, green, blue);
```

There are four arguments that must be entered for this function, these are as follows:

**NEOPXL\_INDx** ⇒ The index of the neopixel in the string that you want to change the colour of. This is a range that can take an inclusive value between 0 and the number of neopixels in the string - 1. In the case of the Adafruit Neopixel Shield it can take a value between 0 and 39.

**Red** ⇒ A value between 0 and 255 that represents the red component of the colour you are setting the LED too.

**Green** ⇒ A value between 0 and 255 that represents the green component of the colour you are setting the LED too.

**Blue** ⇒ A value between 0 and 255 that represents the blue component of the colour you are setting the LED too.

A useful tool for picking RGB colour values can be found here: <https://goo.gl/57zysr>.

### Function 4: `show()`

This function updates the neopixels with the colours you have set them too. It is called as follows:

```
[neopixel_string_name].show();
```

It is important to call this function at the right time. If you call it after you change each neopixel colour you will see the colour of the neopixels change individually as you move along the string. If you call this after you change the colour of all of the neopixels then the colours will all update at once. It depends upon the effect you are going for!

For more information about the Adafruit Neopixel library please visit this awesome tutorial written by Adafruit themselves: <https://goo.gl/CqfqTd>.

### How to Program an Arduino

Before we can do anything with our Arduino, we have to know how to actually load our program onto the device. Luckily, the developers at Arduino have done a lot of the hard work for us! Here are some easy steps to guide you through programming an Arduino:

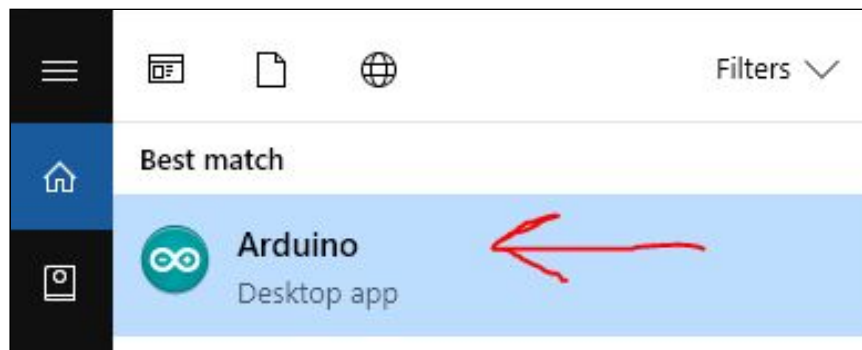
## Step One:

Navigate to the Arduino Labs repository in the EEE Society Github pages. These Github pages will be used for storing all of the Arduino Labs code so make sure to check back here regularly for updates and improvements to the sample code! This link will take you to the repository: <https://github.com/uoseeesoc/Arduino-Labs-2018>.

Once you are at the repository, navigate to the following file and open it: **Session Three ⇒ random\_colours\_neopixel ⇒ random\_colours\_neopixel.ino**

## Step Two:

Launch the Arduino software on your PC, this can be done by searching for “Arduino” in the windows search bar at the bottom left hand corner of the desktop as follows:



Copy the contents of the **random\_colours\_neopixel.ino** into the Arduino IDE editor. The editor should now look like this:

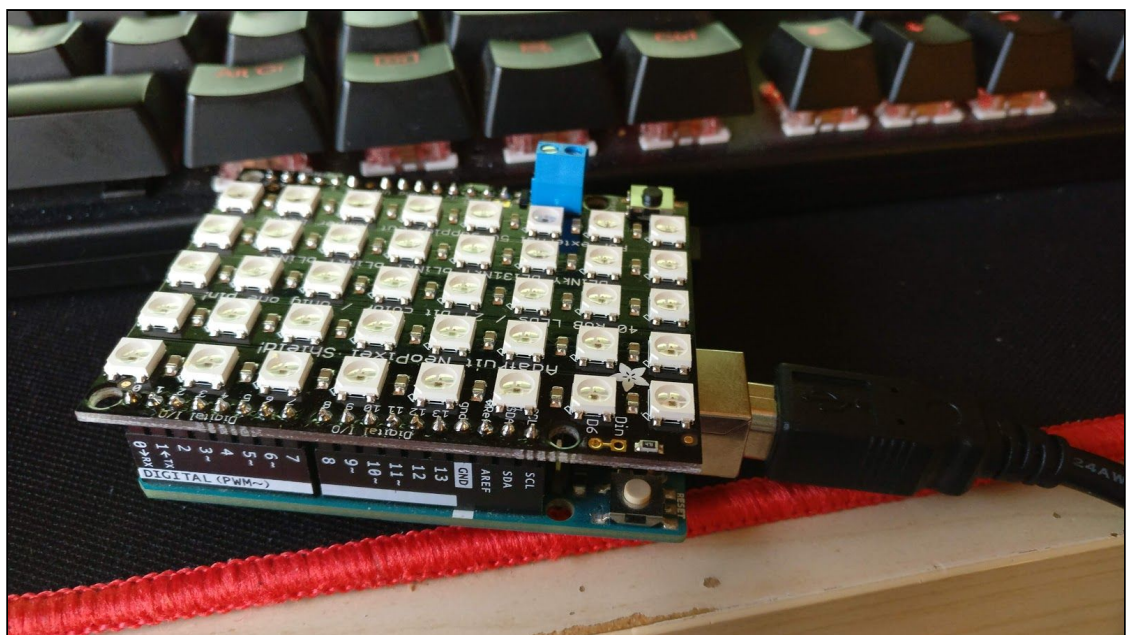
```
sketch_sep09a | Arduino 1.8.6
File Edit Sketch Tools Help
sketch_sep09a $
1 /*
2  * This code is part of the University of Sheffield EEE Society Arduino Labs, Session Three. It makes the Adafruit Neopixel Strip
3  * display random colours across all 40 LEDs. For more information about the society please visit our website: www.eeesoc.com
4  *
5  * DATE: 24/07/2018
6  * AUTHOR: Sam Maxwell
7  */
8
9 //LIBRARIES - Imports libraries of functions that we can use in the code
10 #include <Adafruit_NeoPixel.h>
11
12 //DEFINITIONS - Contains values that will not be changed whilst the code is running
13 //Neopixel setup definitions
14 #define NUM_OF_NEOPIXLS 40 //The number of neopixels we are interfacing with
15 #define PIN_NEOPIXLS 6 //The pin the neopixel data line is connected too
16 #define UPDATE_RATE 1000 //The update rate of the neopixel shield in MILLISECONDS
17
18 //Neopixel Colour definitions, all values can be between 0 and 255
19 #define RED_MAX_VAL 255 //The maximum value the red channel can take
20 #define RED_MIN_VAL 0 //The minimum value the red channel can take
21 #define GRN_MAX_VAL 255 //The maximum value the green channel can take
22 #define GRN_MIN_VAL 0 //The minimum value the green channel can take
23 #define BLU_MAX_VAL 255 //The maximum value the blue channel can take
24 #define BLU_MIN_VAL 0 //The minimum value the blue channel can take
25 #define MAX_BRIGHTNESS 255 //The maximum brightness of the LEDs
26
27 //VARIABLES - Contains values that will be changed whilst the code is running
28 //Generates a connection to the Neopixel Strip on the specified pin for the specified number of neopixels
29 Adafruit_NeoPixel neopixels = Adafruit_NeoPixel(NUM_OF_NEOPIXLS, PIN_NEOPIXLS, NEO_GRB + NEO_KHZ800);
30
31 //Variables that store the brightness values of each of the colours: RED, GREEN, BLUE
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### Step Three:

Save the file in a location of your choice. Call it “random\_colours\_neopixel”, ensure that you do not make any edits to the file whilst doing this.

### Step Four:

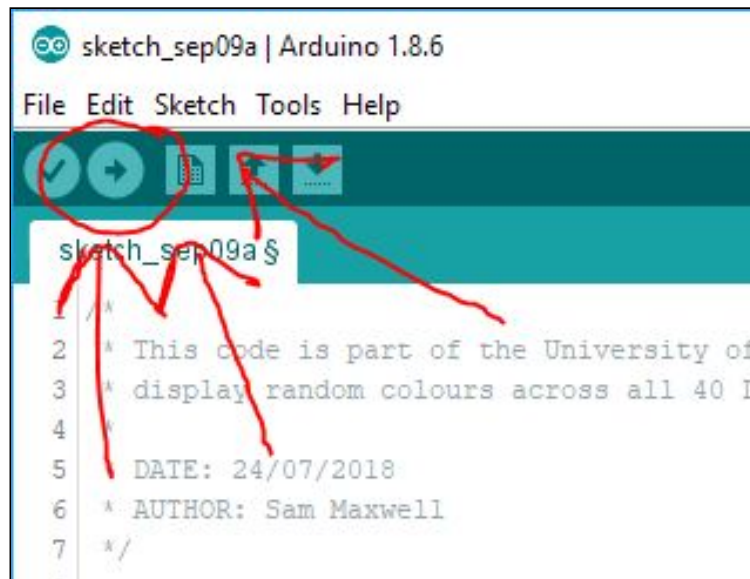
Connect the Arduino to the computer using a USB-A to a USB-B cable, these are provided in the Arduino Starter Kit boxes that we are using in the lab. Your set up should now look like this:





### Step Five:

Press the upload button in the top left hand corner of the Arduino IDE, it looks like this:



This will start to **compile** and **upload** the software to the Arduino. Compiling means that the code is being converted into **Machine Code** (raw binary instructions that the processor understands). Uploading means that the code is being sent from the computer that it is being written on to the Arduino itself.

Once the upload is complete you should see the random colours being generated by the Neopixel LEDs as in the demonstration.

**If you have any issues with the programming process please ask one of the Arduino Labs demonstrators to help you.**

### Random Colour Generator Code

You should now have programmed your Arduino with the Random Colour Generator Code sample that has been provided for you. Now that you have done this, complete the following steps to learn more about the code:

1. Read through the code:
  - a. What functions and statements do you recognise from our previous sessions?
  - b. What are the key sections of the code?
  - c. Can you sketch a top level block diagram of the codes operation?
2. Modify the code:
  - a. Change some of the key values in the code definitions and functions?
  - b. What do the changes you've made do?
  - c. Can you change the time between colour changes?
  - d. Can you change the range of colours that appear?
  - e. Can you change the number of neopixels that light up?

**Remember to ask a demonstrator if you need help with any of these steps or you have any questions!**

### **Your Countries Flag!**

Now it's your turn to write some code for the Arduino to control the Adafruit Neopixel Shield. I would like you to write a program that can display your countries flag on the Neopixel Shield using the skills you have learned over this and the previous sessions.

The previous section on the Adafruit Neopixel library will be particularly useful to you as it contains information on all the functions you will need to control the neopixel shield for this task.

I have also written some example code to help you, you can find this on the Arduino Labs Github repository here:

[https://github.com/uoseeesoc/Arduino-Labs-2018/blob/master/Session%20Three/england\\_flag/england\\_flag.ino](https://github.com/uoseeesoc/Arduino-Labs-2018/blob/master/Session%20Three/england_flag/england_flag.ino)

You might want to think about the following things before starting:

- How are you going to display your flag using 40 LEDs?
- How are you going to easily set the colour of individual LEDs?
- How are you going to update the Neopixel Shield?

When you have got your flag displayed on the Shield let a demonstrator know! We'd love to see your work and share it on the society social media!

**Remember to ask a demonstrator if you need help with any of these steps or you have any questions!**

### **Society Social Media and Feedback**

Don't forget to follow the society to here about the latest news and events! We'd love for you to post on social media about the Arduino Labs! Don't forget to tag us in any posts you make when at society events!

Our social media information:

- [www.facebook.com/uoseeesoc](http://www.facebook.com/uoseeesoc)
- [www.twitter.com/uoseeesoc](http://www.twitter.com/uoseeesoc) ⇒ @uoseeesoc
- Snapchat - uoseeesoc
- Gmail - [eesoc@sheffield.ac.uk](mailto:eesoc@sheffield.ac.uk)

We'd love your feedback! Please fill out this form at the end of the session if you have time:

<https://goo.gl/forms/Ep4upOA4pgq8CW6u2>