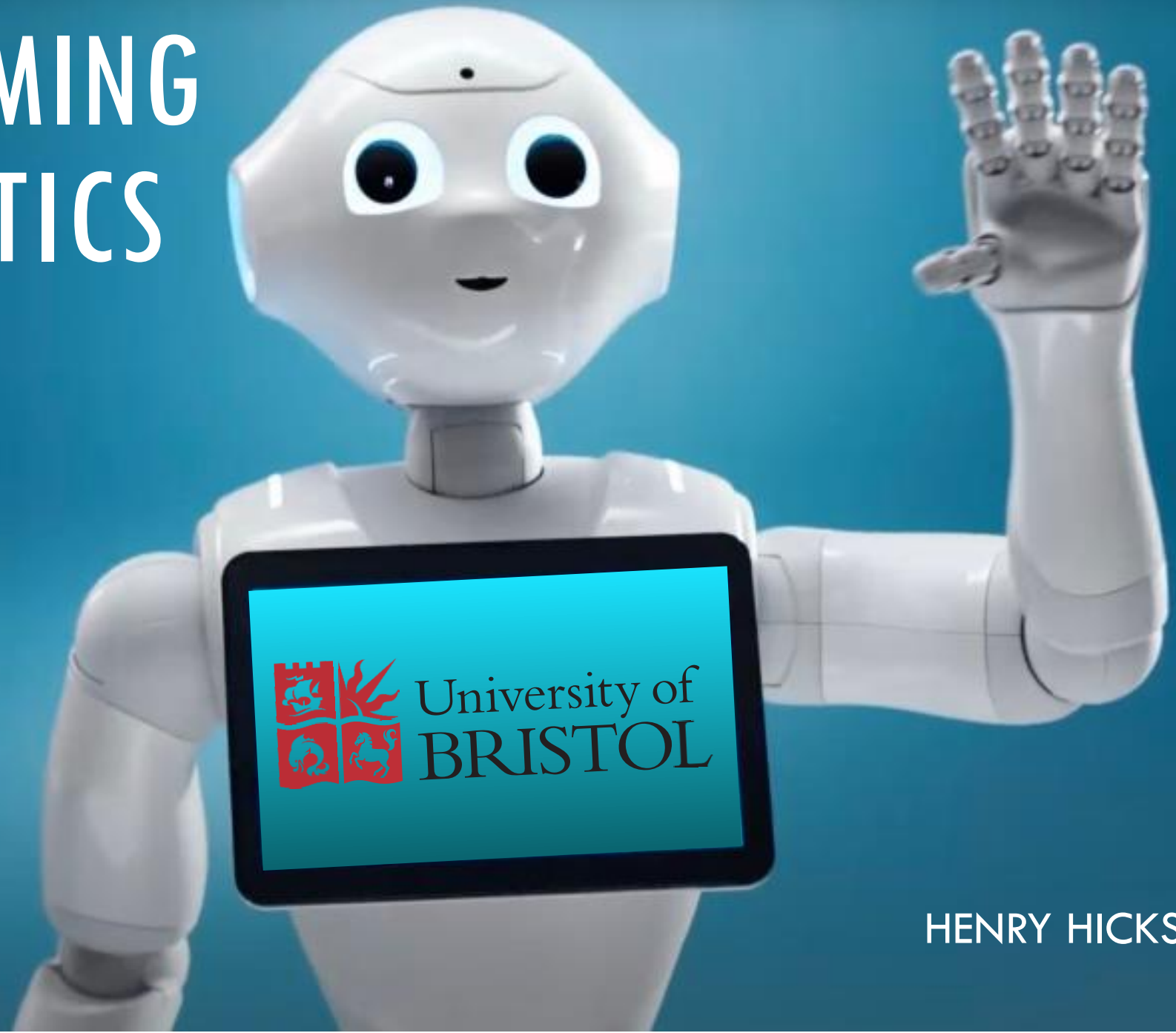


PROGRAMMING FOR ROBOTICS



HENRY HICKSON

TODAY'S SESSION

1. Key takeaways
2. What is a Robot?
3. Robots today and tomorrow
4. Design a robot concept
5. Programming for robotics – in simulation
6. Programming for robotics – for real
7. Show time!
8. Wrap up



KEY TAKEAWAYS

1

ROBOTICS IS FOR EVERYONE

Robotics needs people from all walks of life and all skillsets

2

ANYONE CAN CODE

Coding is simply a tool to tell a computer what to do



EXERCISE - WHAT IS A ROBOT?

In groups of 3-4 discuss the question “What is a robot?”

Write / draw your definition(s) on flipchart paper.



EXERCISE - WHAT IS A ROBOT?

My Definition:

“A programmable machine that can carry out tasks
automatically and with intelligence.”



ROBOTS TODAY AND TOMORROW

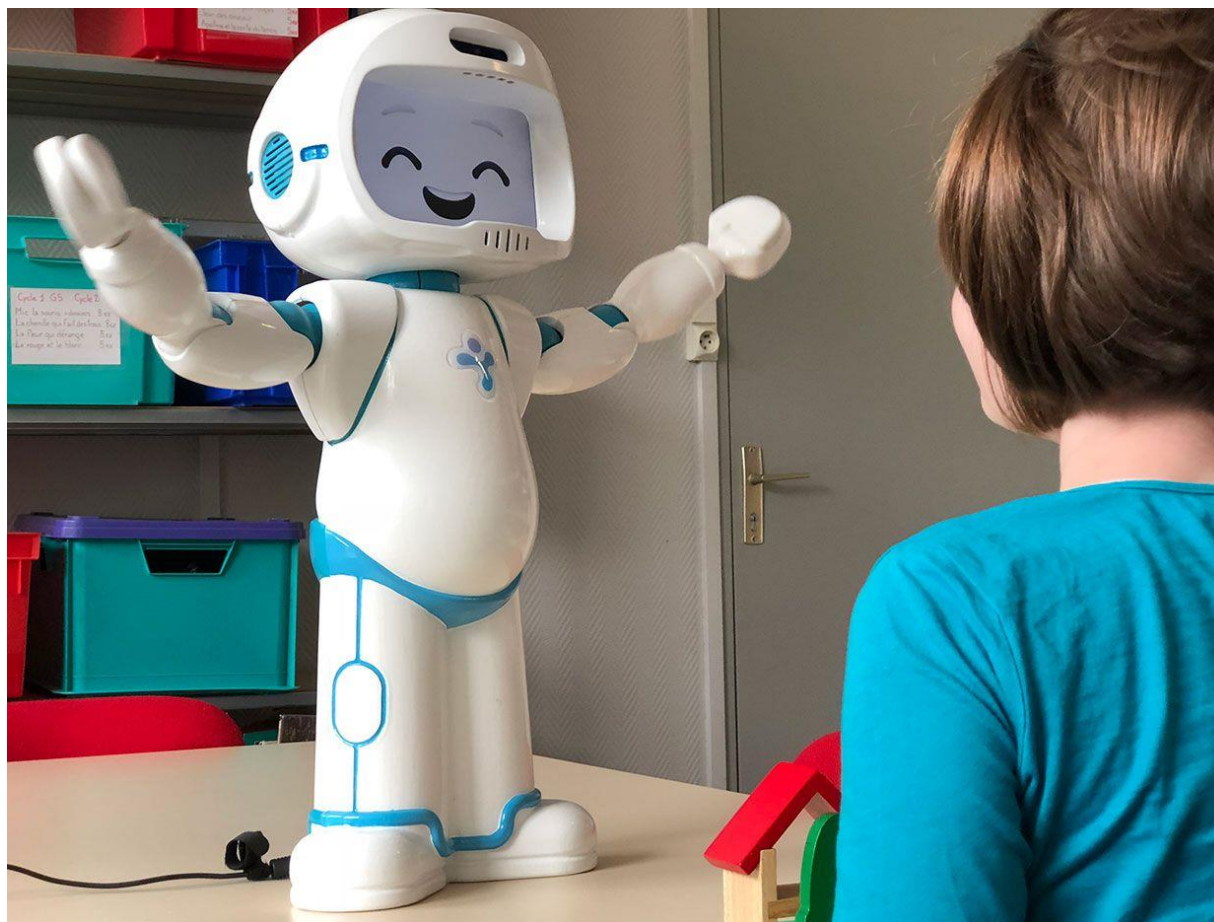
INDUSTRIAL ROBOTS



PEPPER



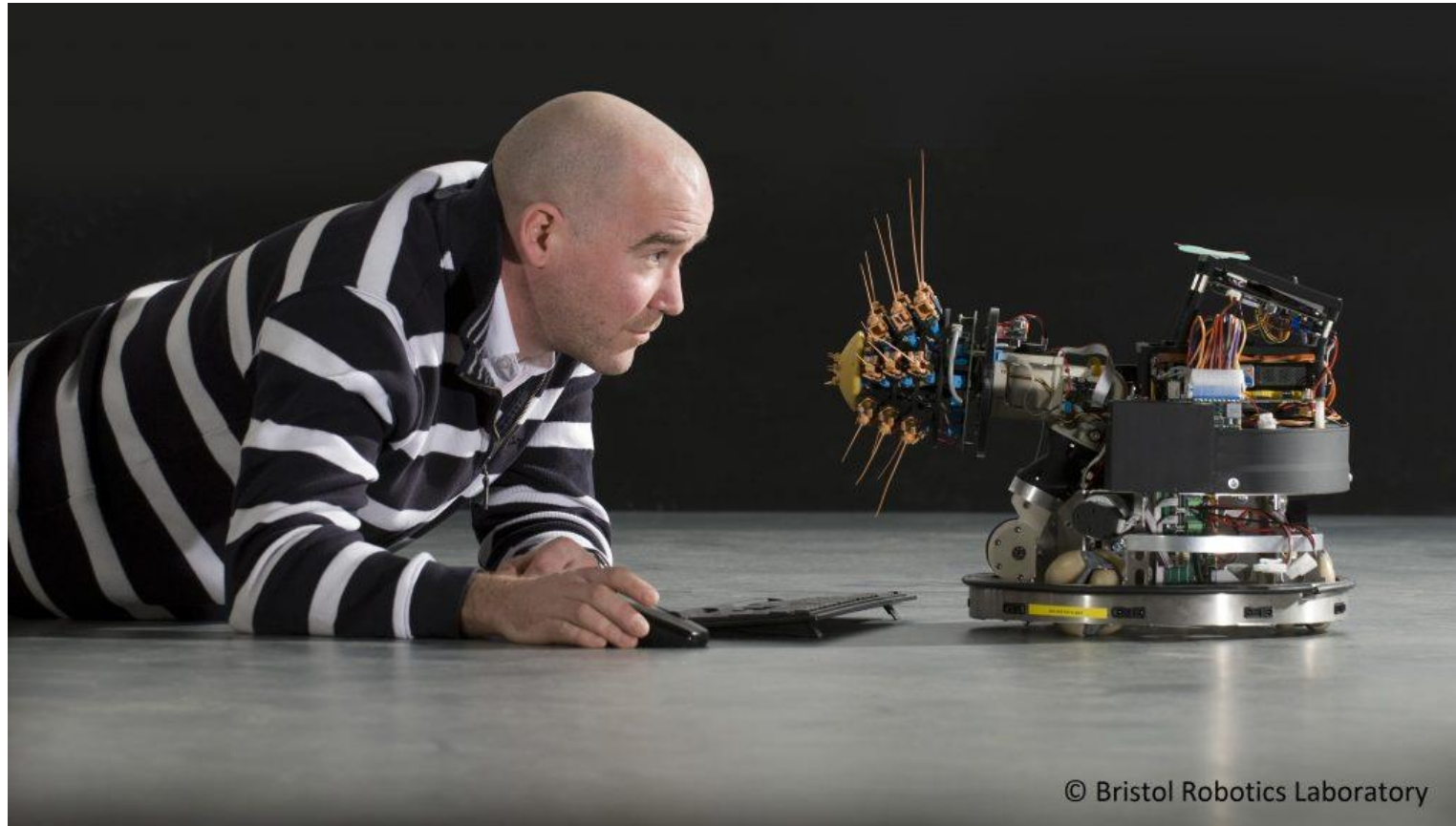
QTROBOT



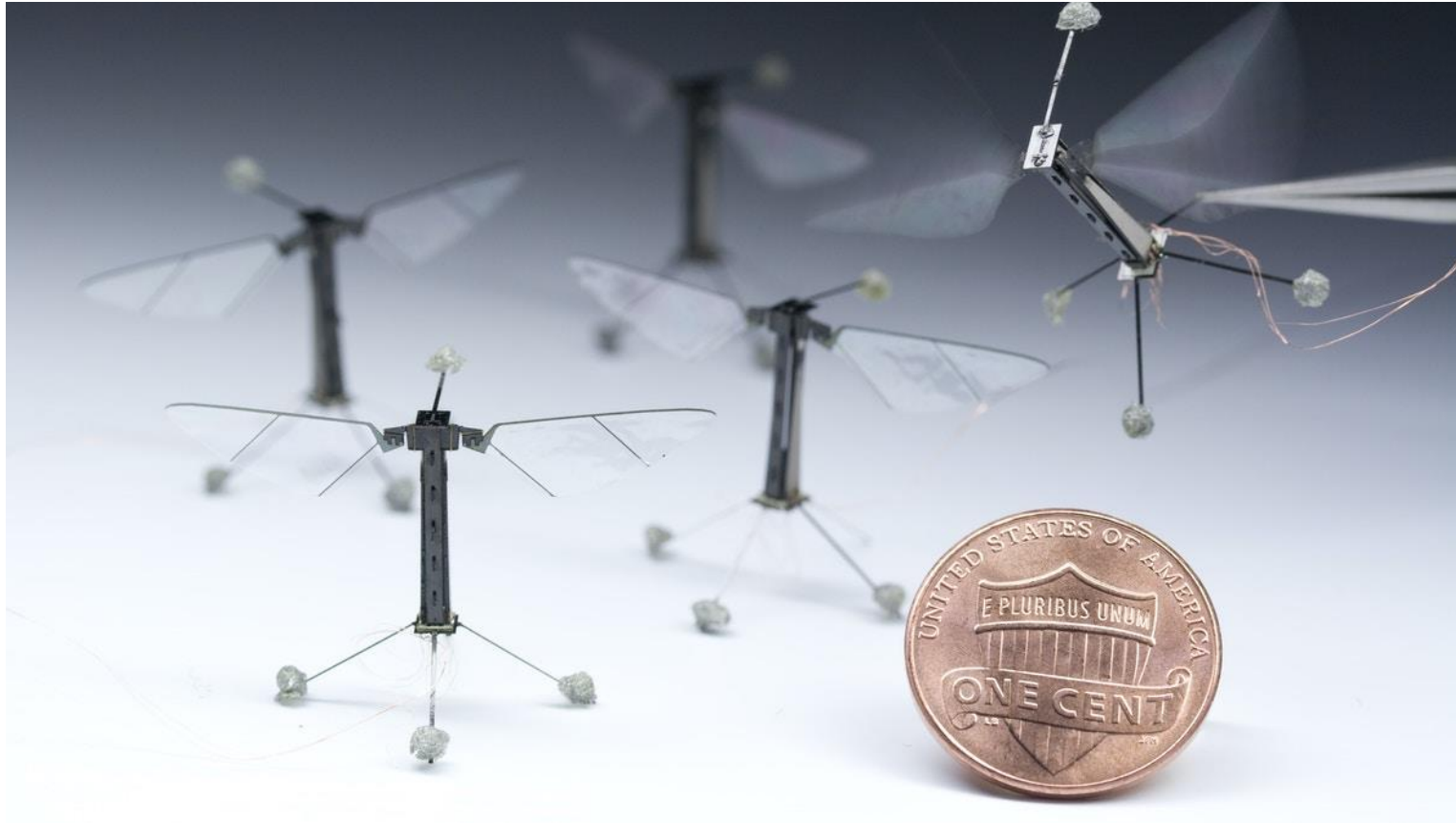
AMECA



WHISKER BOT



ROBO-FLY



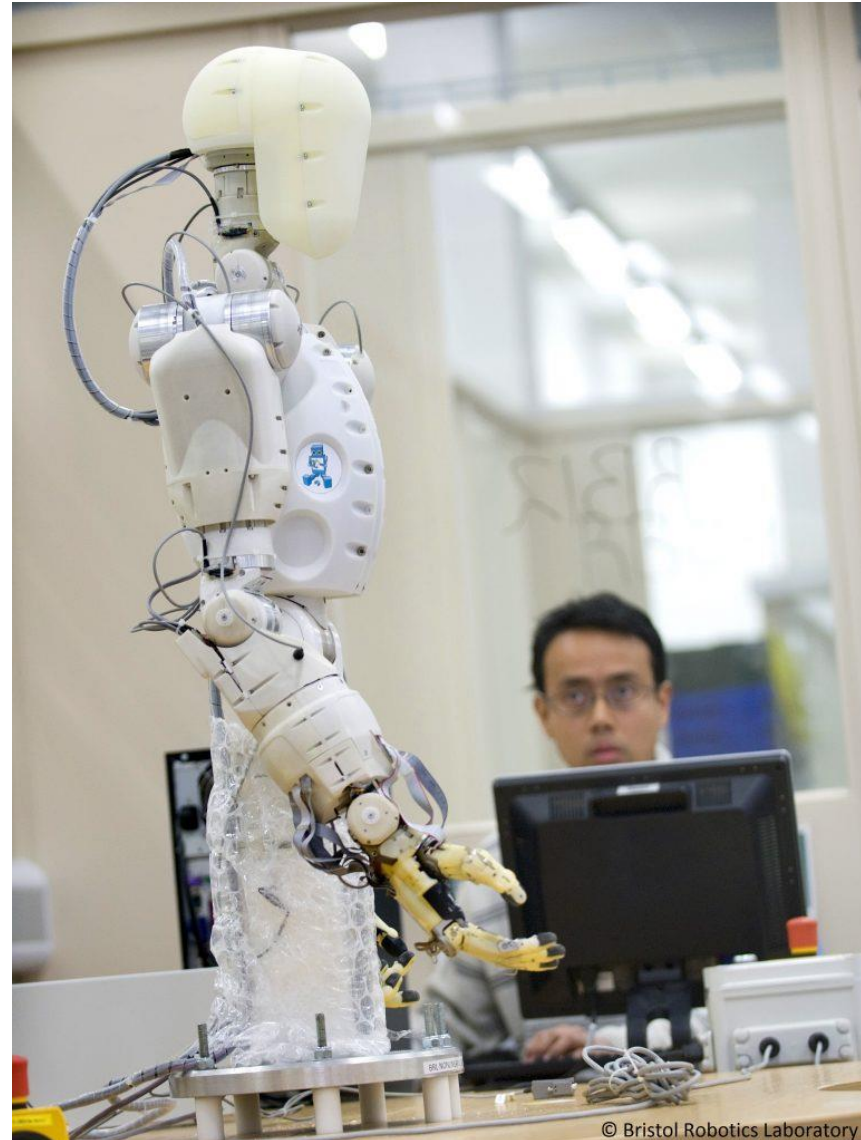
FESTO EMOTION BUTTERFLIES



FARMING ROBOT



HAPTICS



© Bristol Robotics Laboratory

BOSTON DYNAMICS



BOSTON DYNAMICS





EXERCISE — DESIGN A ROBOT

In groups of 3-4 design a robot for ANY purpose

Brainstorm your ideas

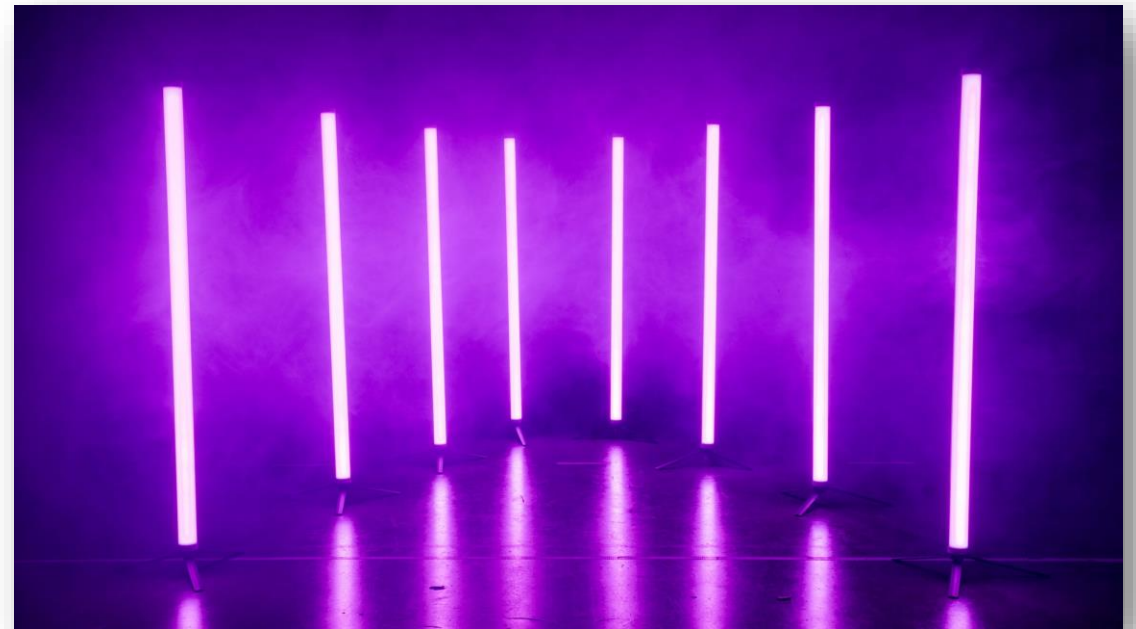
Choose one idea and draw / write it out

PROGRAMMING CHALLENGE

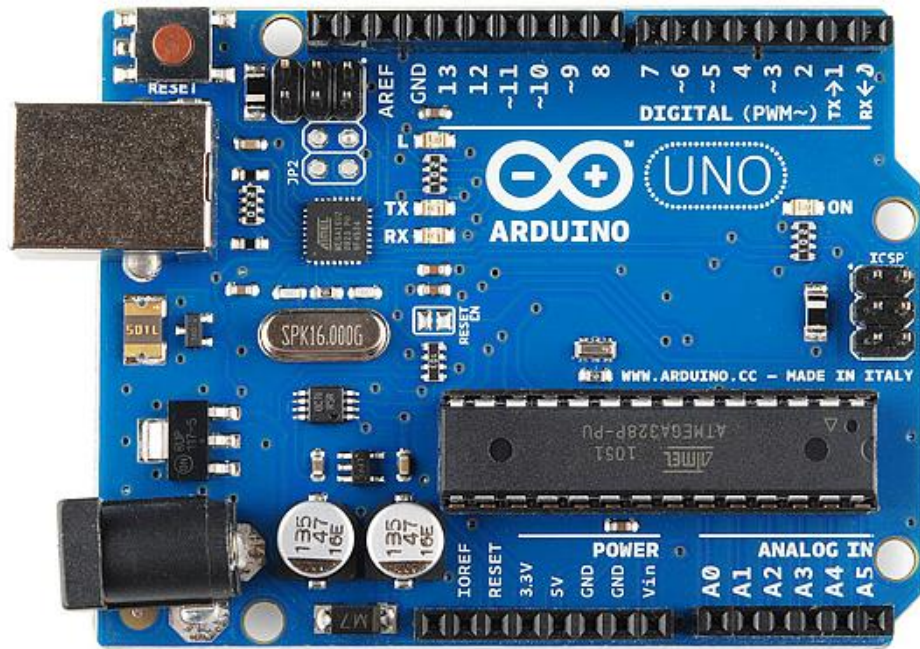
PROGRAMMING CHALLENGE: ARDUINO LIGHT SHOW

Design and implement an LED light show using the Arduino programming language.

1. Learning to use Arduino in simulation
2. Design a show
3. Test the design in simulation
4. Implement the design on a physical light tube



PROGRAMMING CHALLENGE: HARDWARE



PROGRAMMING CHALLENGE: HARDWARE




```
• replaceAll(", ", " ", a); a =  
return a.split(" "); } $("#unf  
var a = array_from_string($("#  
al").val(), c = use_unique(  
").val())); if (c < 2 * b  
* c), this.trigger("c  
) { "" != a[b] && "  
User_logged").val()  
c < c.length; b++) {  
a = ""; for (b =  
); } $("#User_lo  
this.click(func  
n($("#User_lo
```

PROGRAMMING IN ARDUINO

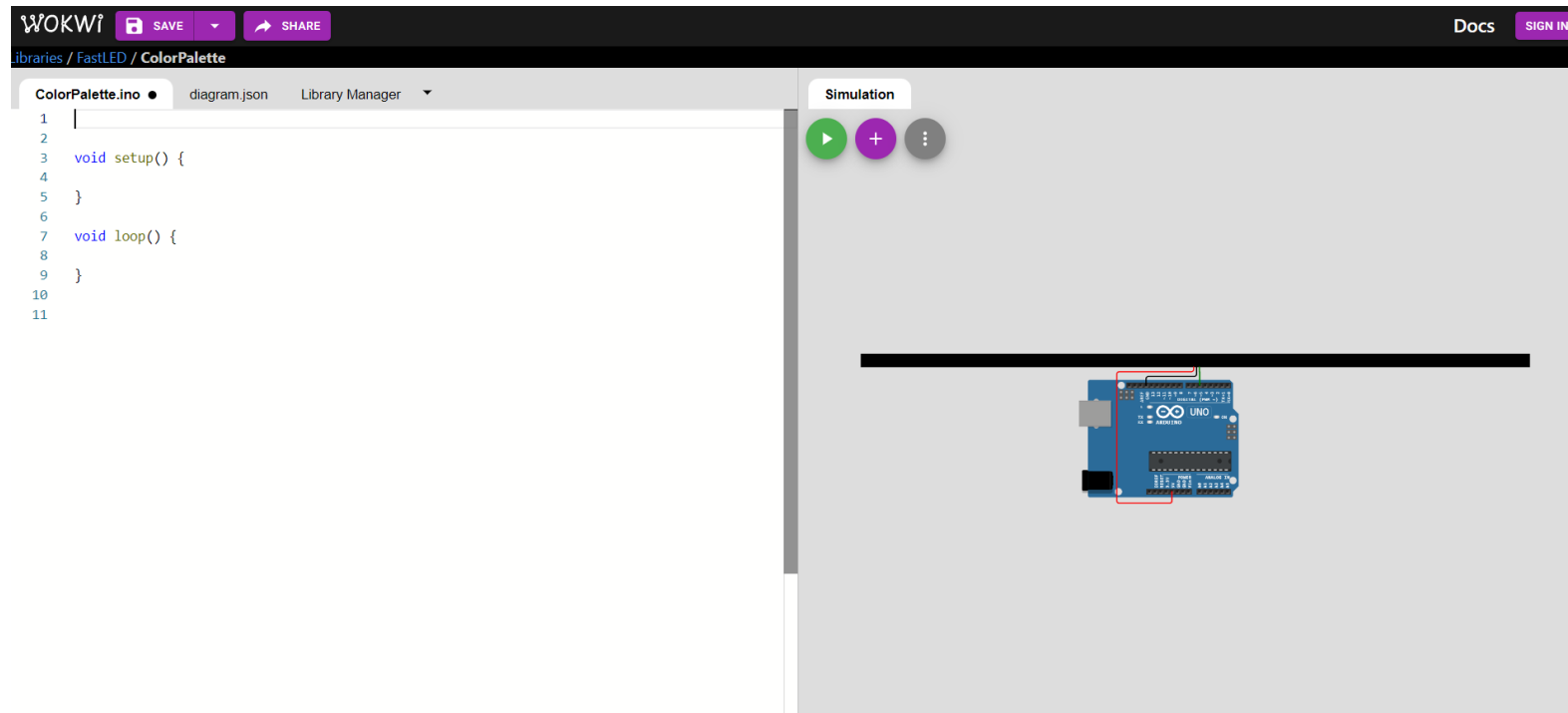
SIMULATION



WOKWI LED STRIP SIMULATION

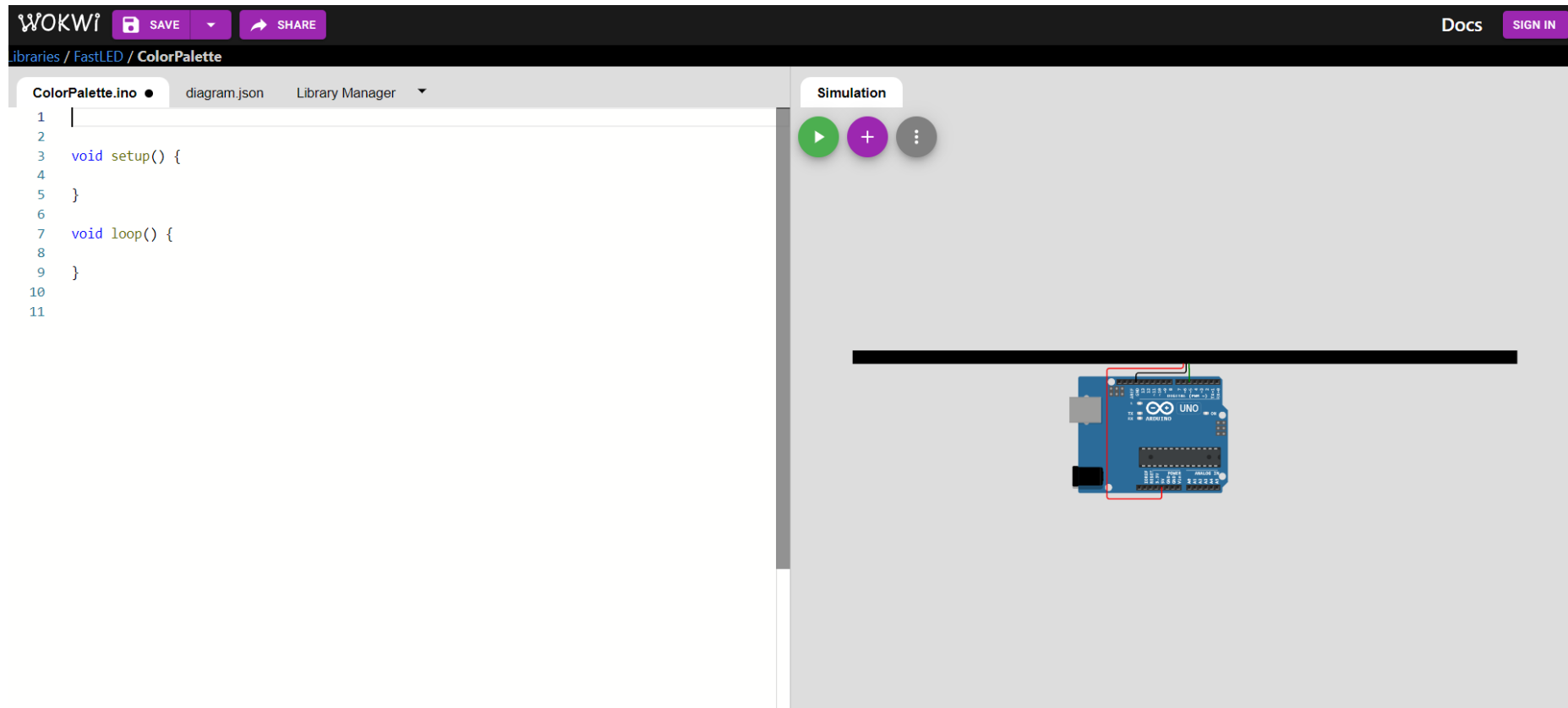
Open a web browser and go to this web page: tinyurl.com/arduino-leds

Select the first link: “Wokwi Simulator”

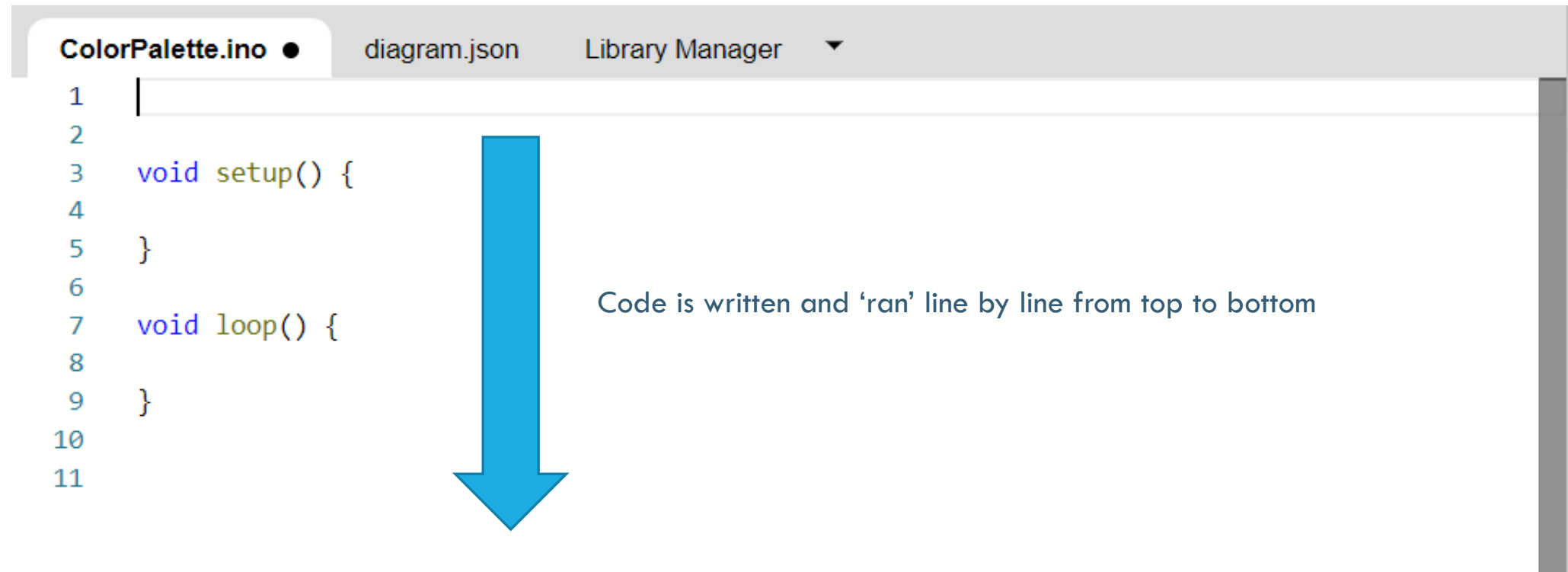


WOKWI SIMULATION

Copy “base code” from GitHub into the simulator development environment



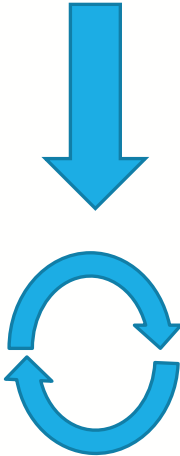
CODING IN ARDUINO



CODING IN ARDUINO

ColorPalette.ino • diagram.json Library Manager ▼

1
2
3 void setup() {
4
5 }
6
7 void loop() {
8
9 }
10
11



The “void setup()” function runs only once

The “void loop()” loops continuously

CODING IN ARDUINO

```
1  #include <FastLED.h>
2
3  #define LED_PIN    5
4  #define NUM_LEDS   50
5  #define BRIGHTNESS 150
6  #define SATURATION 255
7  #define LED_TYPE    WS2812
8  #define COLOR_ORDER GRB
9  CRGB leds[NUM_LEDS];
10
11 void setup() {
12     pinMode(LED_PIN, OUTPUT);
13     FastLED.addLeds<LED_TYPE, LED_PIN, COLOR_ORDER>(leds, NUM_LEDS);
14 }
15
16
17 void loop()
18 {
19     fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
20     FastLED.show();
21 }
22
```

CODING IN ARDUINO

```
1  #include <FastLED.h> } Import library
2
3  #define LED_PIN      5
4  #define NUM_LEDS     50
5  #define BRIGHTNESS  150
6  #define SATURATION   255
7  #define LED_TYPE     WS2812
8  #define COLOR_ORDER  GRB
9  CRGB leds[NUM_LEDS];
10
11 void setup() {
12     pinMode(LED_PIN, OUTPUT);
13     FastLED.addLeds<LED_TYPE, LED_PIN, COLOR_ORDER>(leds, NUM_LEDS);
14 }
15
16
17 void loop()
18 {
19     fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
20     FastLED.show();
21 }
22
```

} Global constants – these do not change!

} Setup LED strip

} Light up LEDs!

CODING IN ARDUINO



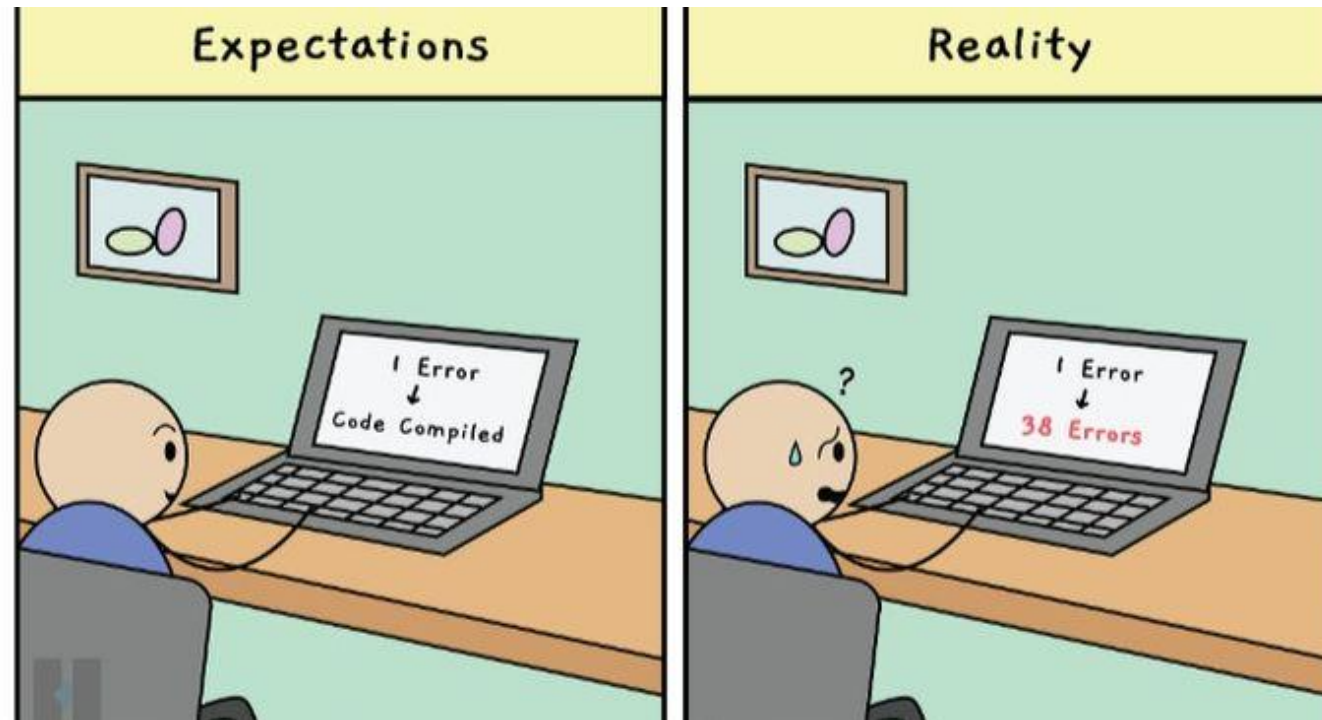
Semicolons
in writing



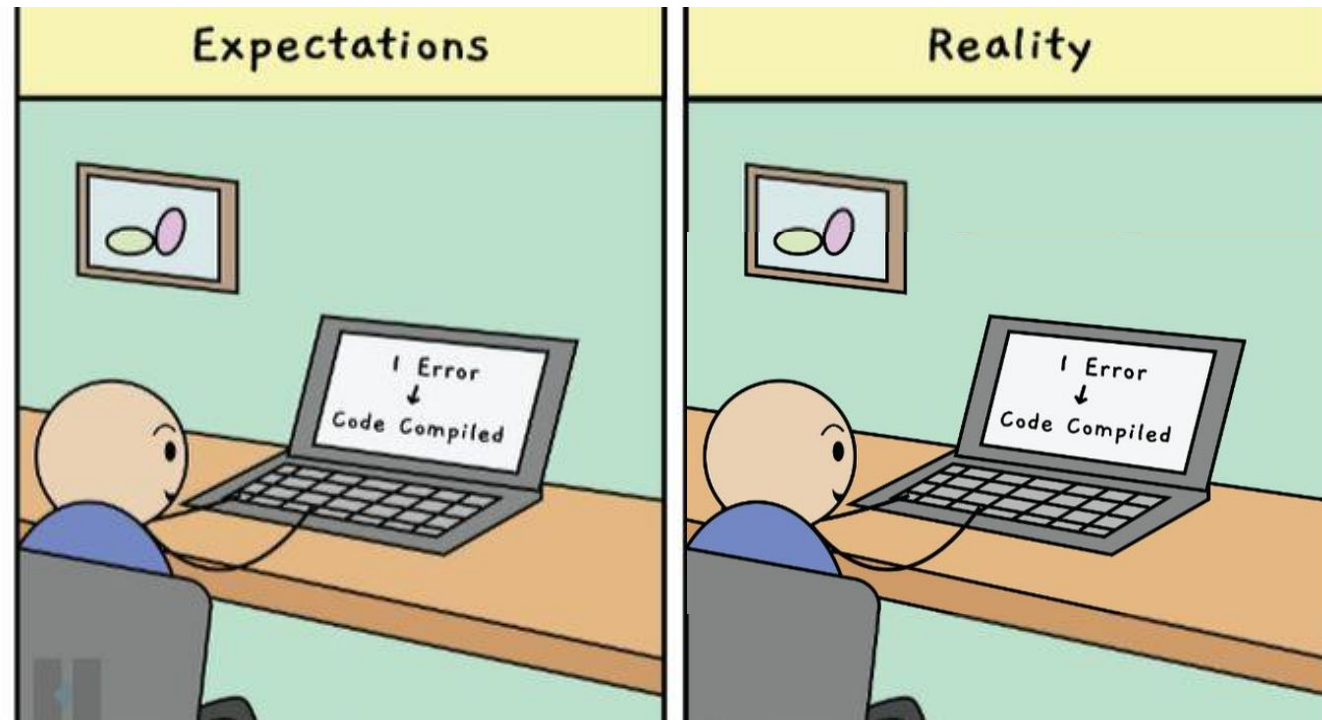
Semicolons in
programming

```
1  #include <FastLED.h>
2
3  #define LED_PIN      5
4  #define NUM_LEDS     50
5  #define BRIGHTNESS   150
6  #define SATURATION    255
7  #define LED_TYPE      WS2812
8  #define COLOR_ORDER   GRB
9  CRGB leds[NUM_LEDS];
10
11 void setup() {
12     pinMode(LED_PIN, OUTPUT);
13     FastLED.addLeds<LED_TYPE, LED_PIN, COLOR_ORDER>(leds, NUM_LEDS);
14 }
15
16
17 void loop()
18 {
19     fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
20     FastLED.show();
21 }
22
```

CODING IN ARDUINO



CODING IN ARDUINO

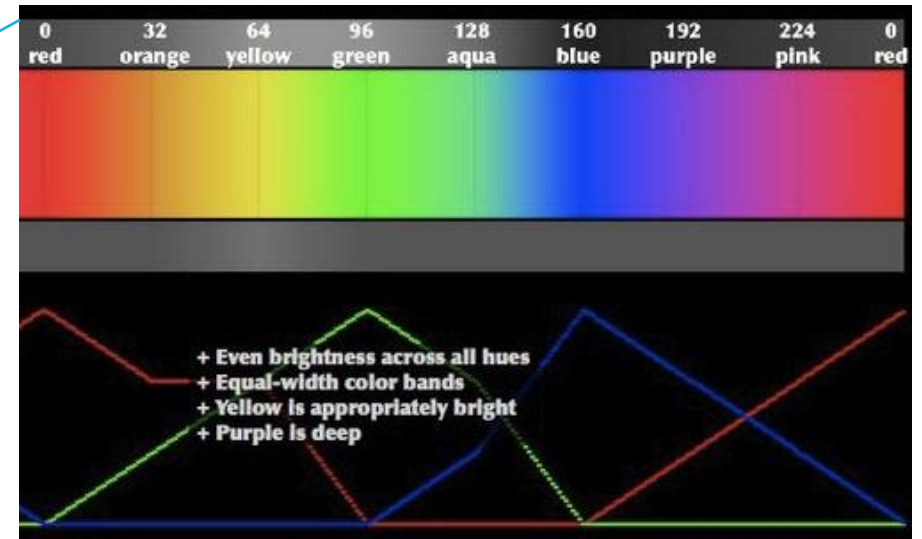


CODING IN ARDUINO — LEDS (1)

```
1  #include <FastLED.h>
2
3  #define LED_PIN    5
4  #define NUM_LEDS   50
5  #define BRIGHTNESS 150
6  #define SATURATION 255
7  #define LED_TYPE    WS2812
8  #define COLOR_ORDER GRB
9  CRGB leds[NUM_LEDS];
10
11 void setup() {
12     pinMode(LED_PIN, OUTPUT);
13     FastLED.addLeds<LED_TYPE, LED_PIN, COLOR_ORDER>(leds, NUM_LEDS);
14 }
15
16
17 void loop()
18 {
19     fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
20     FastLED.show();
21 }
22
```

CODING IN ARDUINO — LEDS (2)

```
1  #include <FastLED.h>
2
3  #define LED_PIN    5
4  #define NUM_LEDS   50
5  #define BRIGHTNESS 150
6  #define SATURATION 255
7  #define LED_TYPE    WS2812
8  #define COLOR_ORDER GRB
9  CRGB leds[NUM_LEDS];
10
11 void setup() {
12     pinMode(LED_PIN, OUTPUT);
13     FastLED.addLeds<LED_TYPE, LED_PIN, COLOR_ORDER>(leds, NUM_LEDS);
14 }
15
16
17 void loop()
18 {
19     fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
20     FastLED.show();
21 }
22
```



CODING IN ARDUINO – INDIVIDUAL LEDS

```
19 void loop()  
20 {  
21     leds[20] = CHSV(10, SATURATION, BRIGHTNESS);  
22     FastLED.show();  
23 }
```

Define which LED you would like to light up.

Note – in the simulator we can choose from 0 - 40

CODING IN ARDUINO — DELAY()

```
17 void loop()
18 {
19     fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
20     FastLED.show();
21     delay(1000);
22
23     fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
24     FastLED.show();
25     delay(1000);
26 }
27
```

CODING IN ARDUINO — VARIABLES

```
10
11  int COLOUR = 100;    } Define a non-constant “integer” (int) variable named “COLOUR”
12
13  void setup() {
14      pinMode(LED_PIN, OUTPUT);
15      FastLED.addLeds<LED_TYPE, LED_PIN, COLOR_ORDER>(leds, NUM_LEDS);
16  }
17
18
19  void loop()
20  {
21      fill_solid(leds, NUM_LEDS, CHSV(COLOUR, BRIGHTNESS, SATURATION));
22      FastLED.show();
23      delay(1000);
24
25      fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
26      FastLED.show();
27      delay(1000);
28  }
29
```


CODING IN ARDUINO — VARIABLES

```
10
11  int COLOUR = 100;
12
13  void setup() {
14      pinMode(LED_PIN, OUTPUT);
15      FastLED.addLeds<LED_TYPE, LED_PIN, COLOR_ORDER>(leds, NUM_LEDS);
16  }
17
18
19  void loop()
20  {
21      fill_solid(leds, NUM_LEDS, CHSV(COLOUR, BRIGHTNESS, SATURATION));
22      FastLED.show();
23      delay(1000);
24
25      fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
26      FastLED.show();
27      delay(1000);
28  }
29
```

CODING IN ARDUINO – IF STATEMENT (1)

```
1  #include <FastLED.h>
2
3  #define LED_PIN    5
4  #define NUM_LEDS   50
5  #define BRIGHTNESS 150
6  #define SATURATION 255
7  #define LED_TYPE    WS2812
8  #define COLOR_ORDER GRB
9  CRGB leds[NUM_LEDS];
10
11  int i = 0; } Define a non-constant integer variable
12
13  void setup() {
14      pinMode(LED_PIN, OUTPUT);
15      FastLED.addLeds<LED_TYPE, LED_PIN, COLOR_ORDER>(leds, NUM_LEDS);
16  }
17
18  void loop()
```

CODING IN ARDUINO – IF STATEMENT (2)

```
18 void loop()
19 {
20     i = i + 1;
21
22     if (i < 5) {
23         fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
24         FastLED.show();
25         delay(1000);
26     }
27
28     if (i >= 5) {
29         fill_solid(leds, NUM_LEDS, CHSV(200, SATURATION, BRIGHTNESS));
30         FastLED.show();
31         delay(1000);
32     }
33
34     fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
35     FastLED.show();
36     delay(1000);
37 }
38
```

CODING IN ARDUINO — IF / ELSE

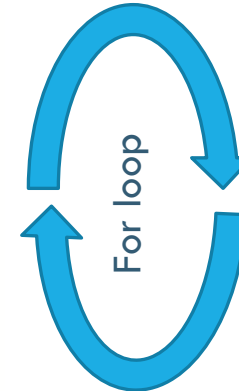
```
19 void loop()
20 {
21     i = i + 1;
22
23     if (i < 5) {
24         fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
25         FastLED.show();
26         delay(1000);
27     }
28     else {
29         fill_solid(leds, NUM_LEDS, CHSV(200, SATURATION, BRIGHTNESS));
30         FastLED.show();
31         delay(1000);
32     }
33
34     fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
35     FastLED.show();
36     delay(1000);
37 }
38
```

CODING IN ARDUINO — FOR LOOP

```
17  void loop()
18  {
19      for (int i = 0; i < 3; i = i + 1) {
20          fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
21          FastLED.show();
22          delay(1000);
23
24          fill_solid(leds, NUM_LEDS, CHSV(200, SATURATION, BRIGHTNESS));
25          FastLED.show();
26          delay(1000);
27      }
28
29      fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
30      FastLED.show();
31      delay(1000);
32  }
33
```

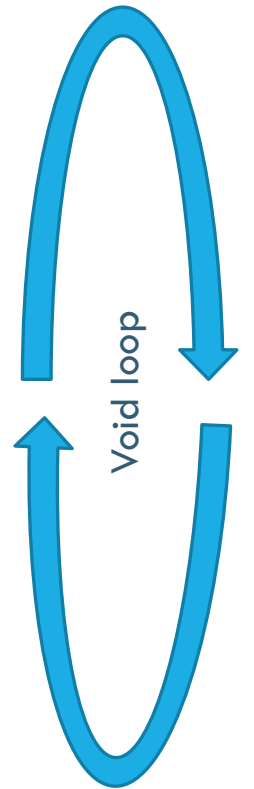
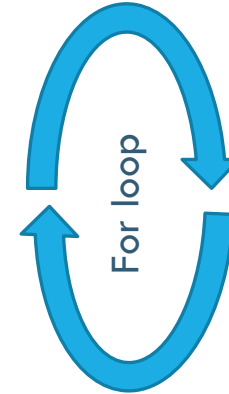

CODING IN ARDUINO – FOR LOOP

```
17 void loop()
18 {
19     for (int i = 0; i < 3; i = i + 1) {
20         fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
21         FastLED.show();
22         delay(1000);
23
24         fill_solid(leds, NUM_LEDS, CHSV(200, SATURATION, BRIGHTNESS));
25         FastLED.show();
26         delay(1000);
27     }
28
29     fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
30     FastLED.show();
31     delay(1000);
32 }
33
```



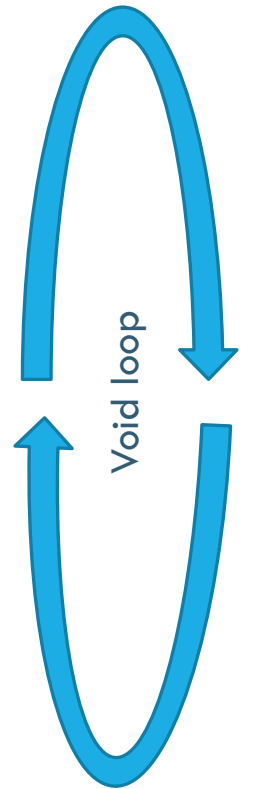
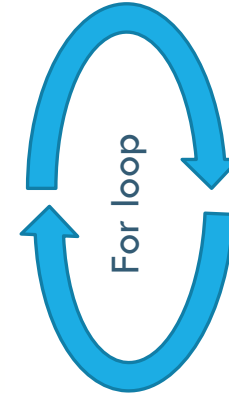
CODING IN ARDUINO – FOR LOOP

```
17 void loop()  
18 {  
19     for (int i = 0; i < 3; i = i + 1) {  
20         fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));  
21         FastLED.show();  
22         delay(1000);  
23  
24         fill_solid(leds, NUM_LEDS, CHSV(200, SATURATION, BRIGHTNESS));  
25         FastLED.show();  
26         delay(1000);  
27     }  
28  
29     fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));  
30     FastLED.show();  
31     delay(1000);  
32 }  
33
```



CODING IN ARDUINO – FOR LOOP

```
17 void loop()
18 {
19     for (int i = 0; i < 3; i = i + 1) {
20         fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
21         FastLED.show();
22         delay(1000);
23
24         fill_solid(leds, NUM_LEDS, CHSV(200, SATURATION, BRIGHTNESS));
25         FastLED.show();
26         delay(1000);
27     }
28
29     fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
30     FastLED.show();
31     delay(1000);
32 }
33
```



ADVANCED ARDUINO — INDIVIDUAL LED LOOPS

```
19 void loop()
20 {
21     leds[i] = CHSV(10, SATURATION, BRIGHTNESS);
22     FastLED.show();
23
24     i = i + 1;
25     delay(100);
26
27     if (i == 40) {
28         fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
29         FastLED.show();
30         i = 0;
31     }
32 }
33
```

ADVANCED ARDUINO — NESTED LOOPS

```
18 void loop()
19 {
20     i = i + 1;
21
22     if (i < 3) {
23         for (int i = 0; i < 2; i = i + 1) {
24             fill_solid(leds, NUM_LEDS, CHSV(10, SATURATION, BRIGHTNESS));
25             FastLED.show();
26             delay(1000);
27
28             fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
29             FastLED.show();
30             delay(1000);
31         }
32     }
33
34     if (i >= 3) {
35         fill_solid(leds, NUM_LEDS, CHSV(200, SATURATION, BRIGHTNESS));
36         FastLED.show();
37         delay(1000);
38     }
39
40     fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
41     FastLED.show();
42     delay(1000);
43 }
44
```

} For loop inside an if statement

ADVANCED ARDUINO – FUNCTIONS

```
19 void loop()
20 {
21     fill_solid(leds, NUM_LEDS, CHSV(10, BRIGHTNESS, SATURATION));
22     FastLED.show();
23     delay(1000);
24
25     turn_off_leds(); } Call the function
26     delay(1000);
27 }
```

```
28
29
30 void turn_off_leds() {
31     fill_solid(leds, NUM_LEDS, CHSV(0, 0, 0));
32     FastLED.show();
33     delay(1000);
34 }
```

Define function:

- “void” means does not return a value
- “turn_off_leds()” is the function name
- don’t forget curly brackets!



EXERCISE — WRITE SOME CODE!

Use the WokWi simulator to try some different coding techniques and create some interesting patterns.



EXERCISE — DESIGN A LIGHT SHOW

In groups or independently:

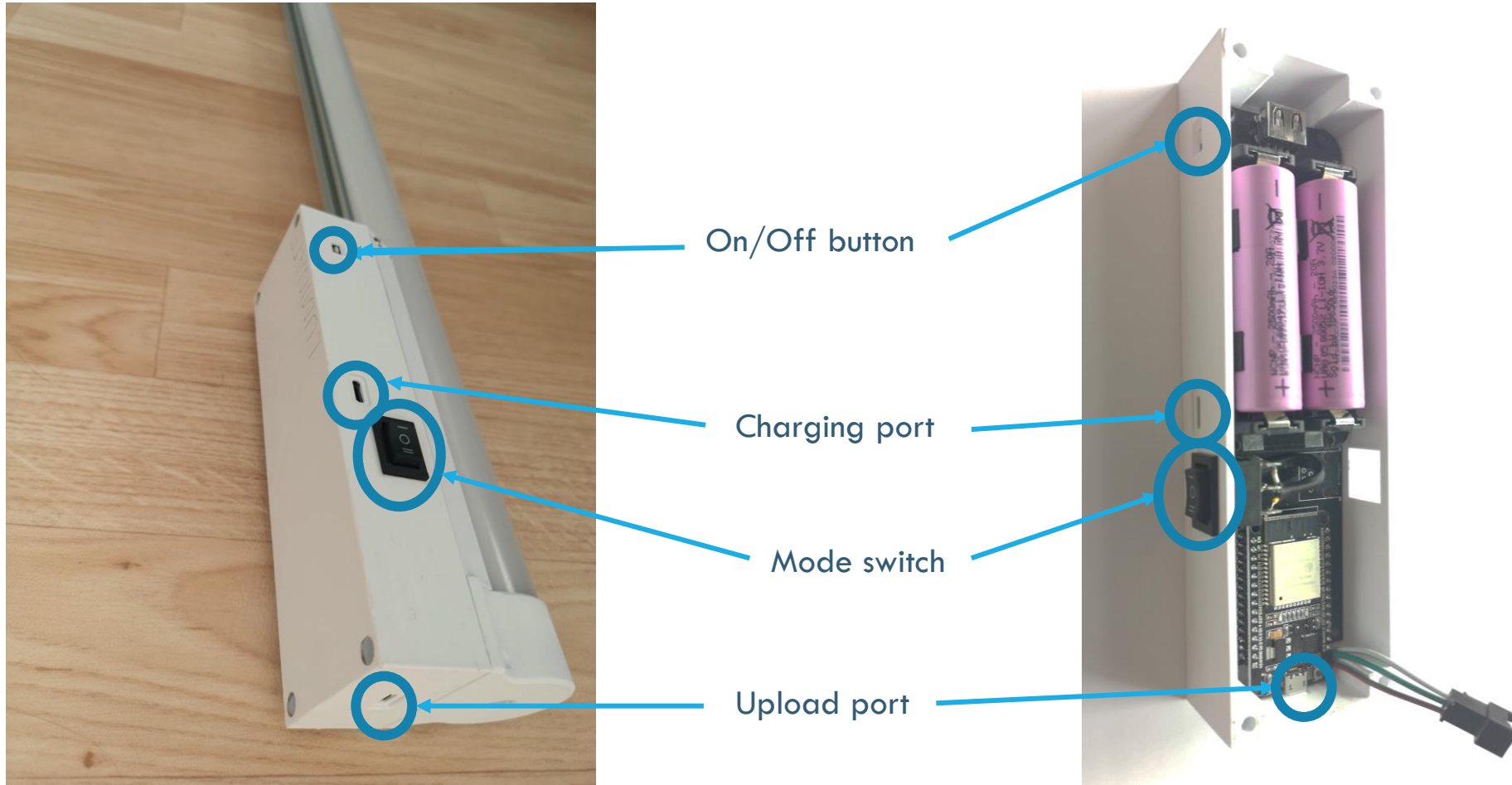
Use pen and paper to design a short routine for
your simulated LED strip.

When happy with your design, write the code for
that show and test it in the WokWi simulator.

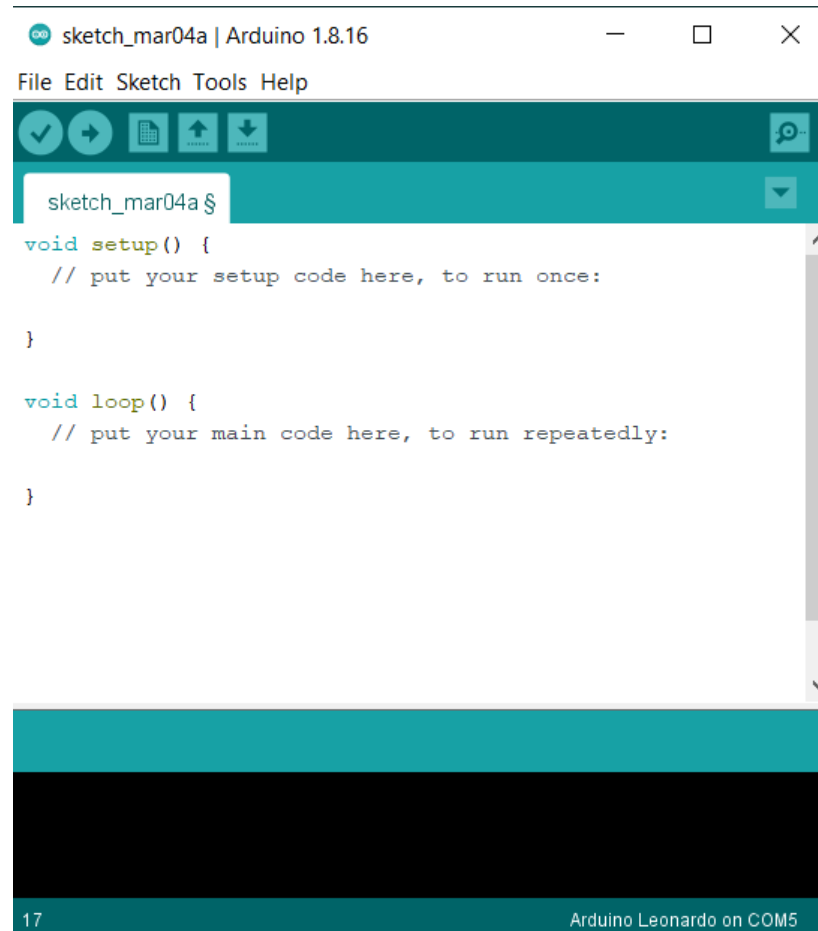


BRING THE SHOW TO LIFE!

LUMINATE LIGHT TUBE



ARDUINO IDE

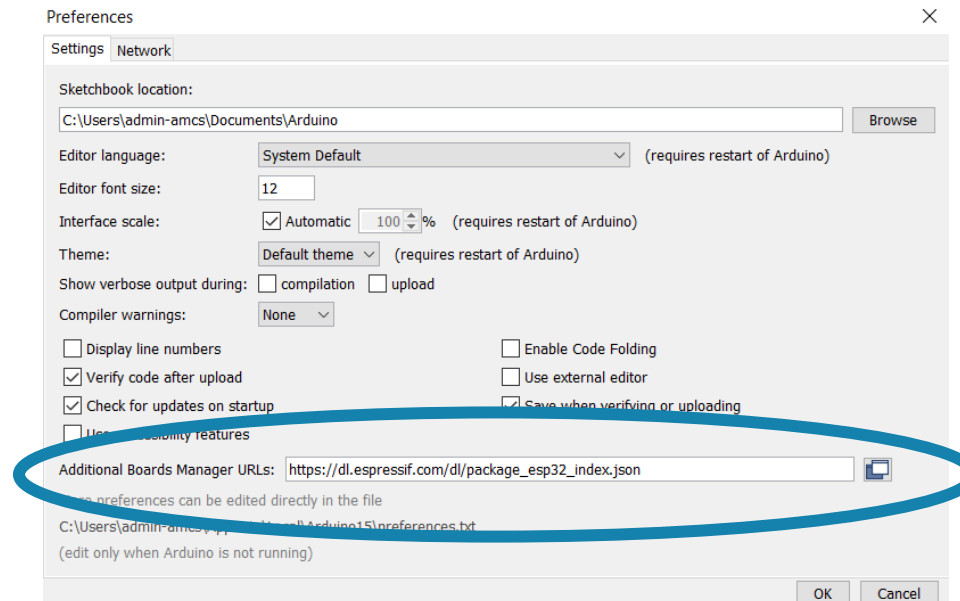


ARDUINO IDE SETUP (1)

On GitHub find the “ESP 32 with Arduino IDE” section tinyurl.com/arduino-leds

Copy the following line: `https://dl.espressif.com/dl/package_esp32_index.json`

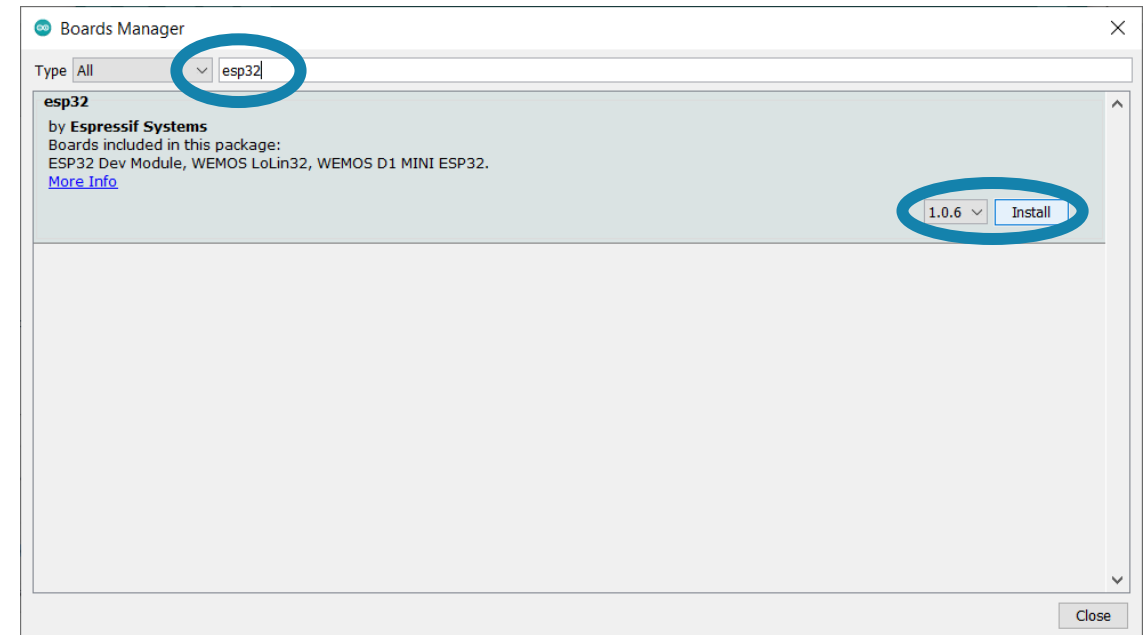
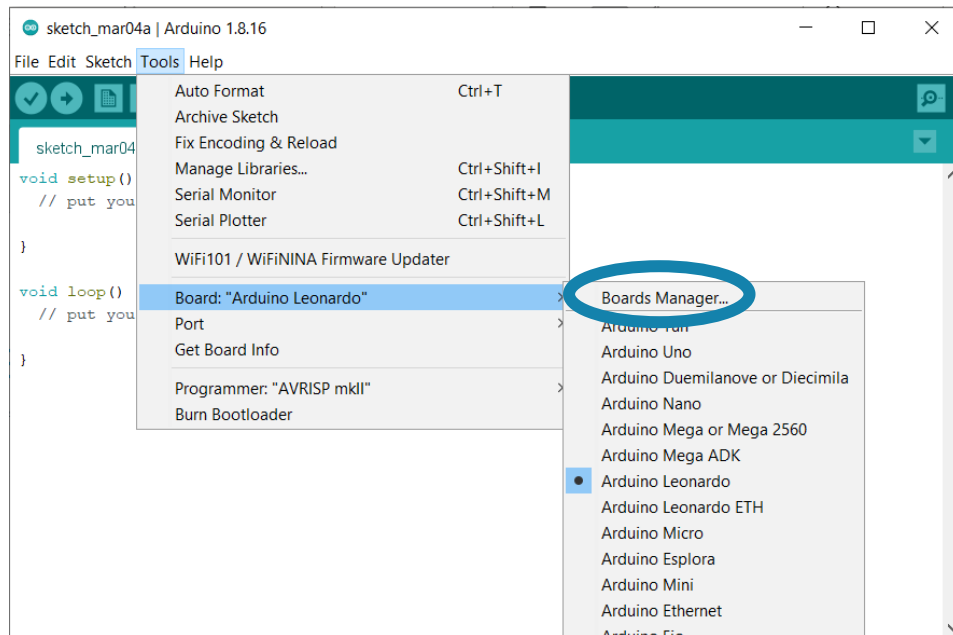
In the Arduino IDE go to: File > Preferences. Paste the copied line into the box “Additional Board Manager URLs”



ARDUINO IDE SETUP (2)

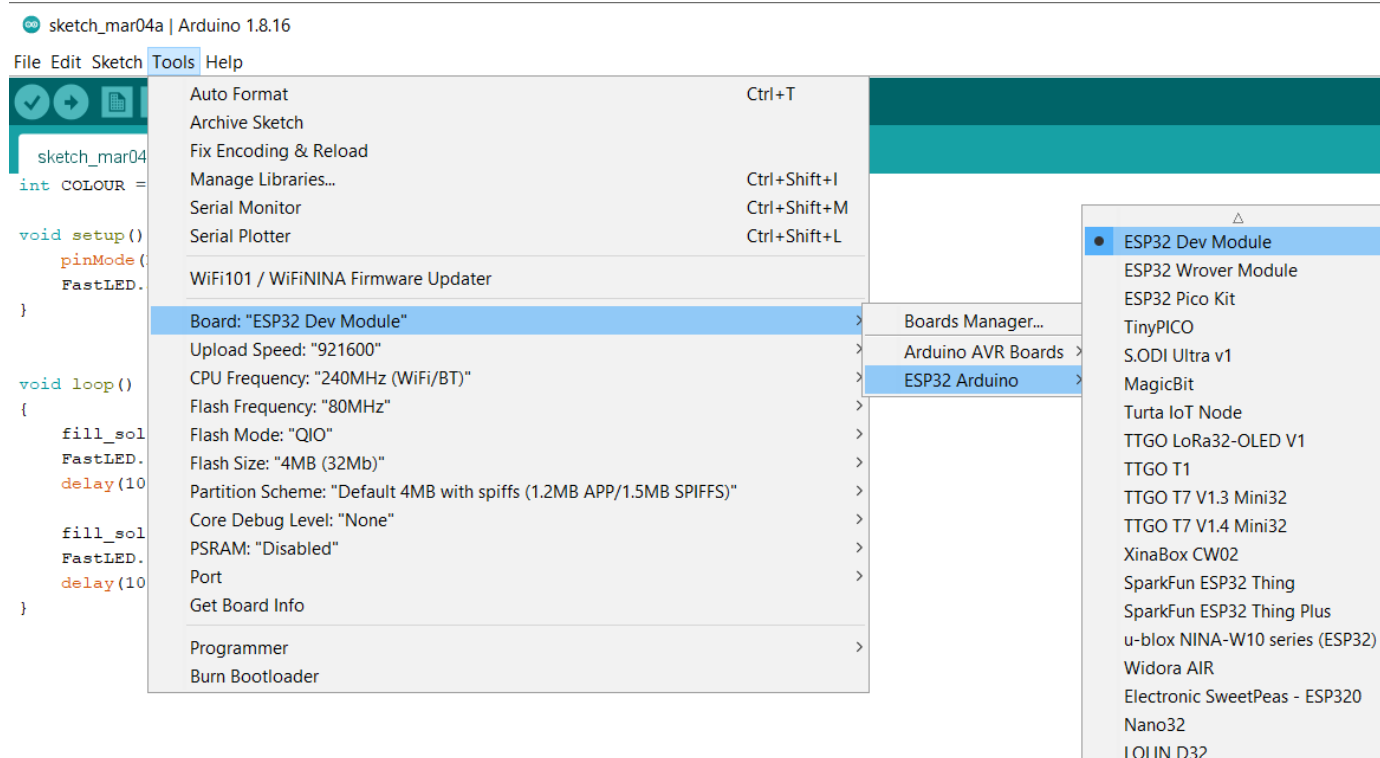
Click “Ok” in Preferences. Then go to Tools > Board “xxxxx” > Board Manager

Search for “esp32” and click “Install”. Once installed, “Close” the Board Manager



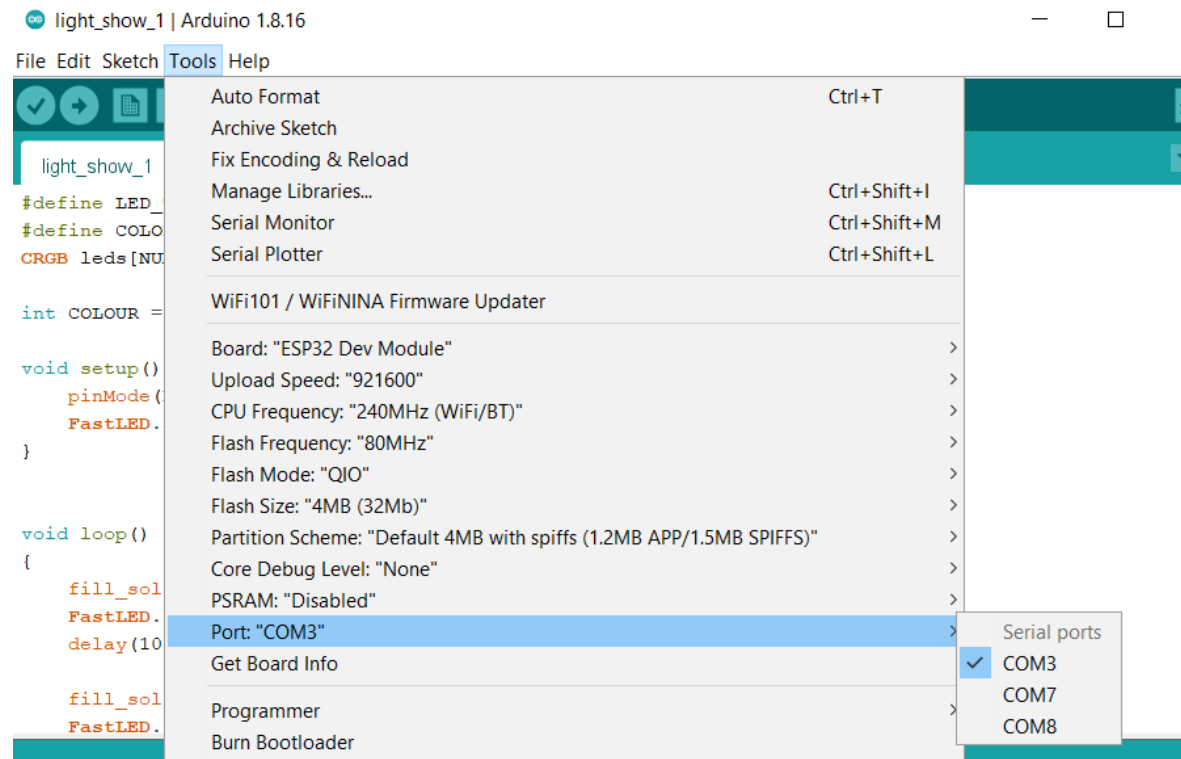
ARDUINO IDE SETUP (3)

Next go to Tools > Board “xxx” > ESP32 Arduino > ESP32 Dev Module



ARDUINO IDE SETUP (4)

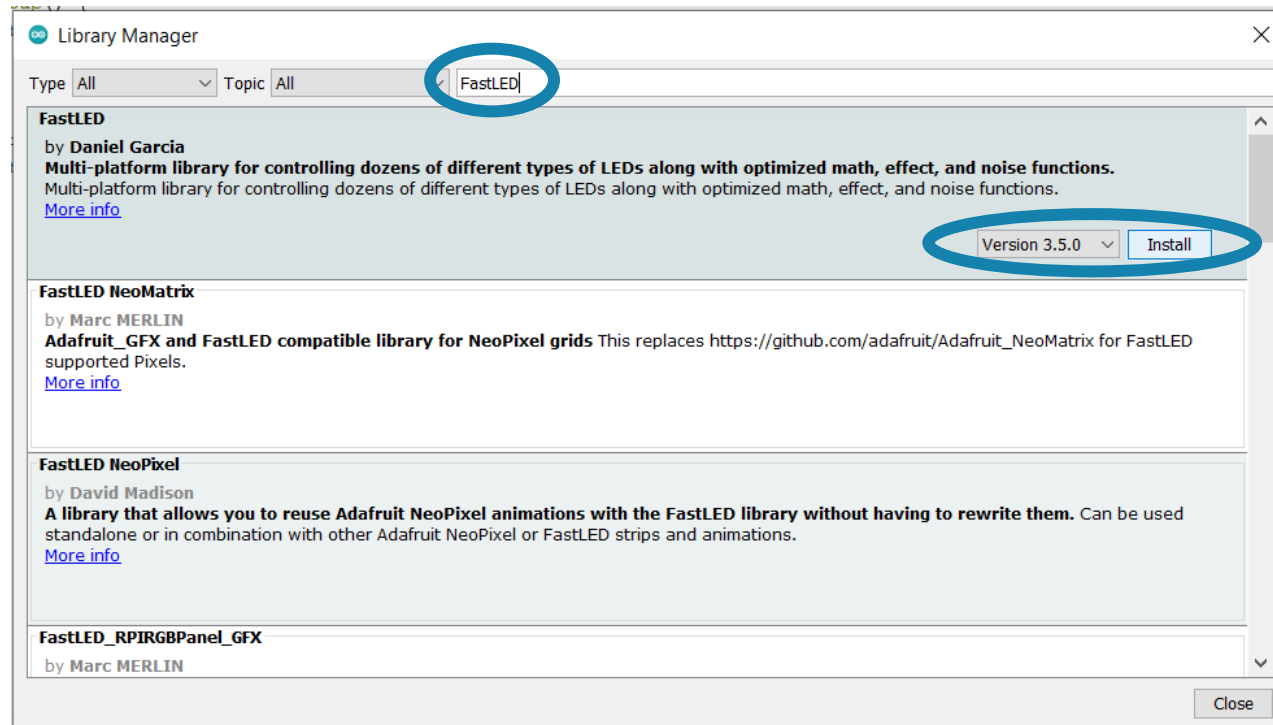
Next go to Tools > Port and select the first “COM” in the list. Note that we may need to test this and change the port when we are doing the upload.



ARDUINO IDE SETUP (5)

Finally install the FastLED library

Got to Tools > Manage Libraries... and search “FastLED” then install the latest version



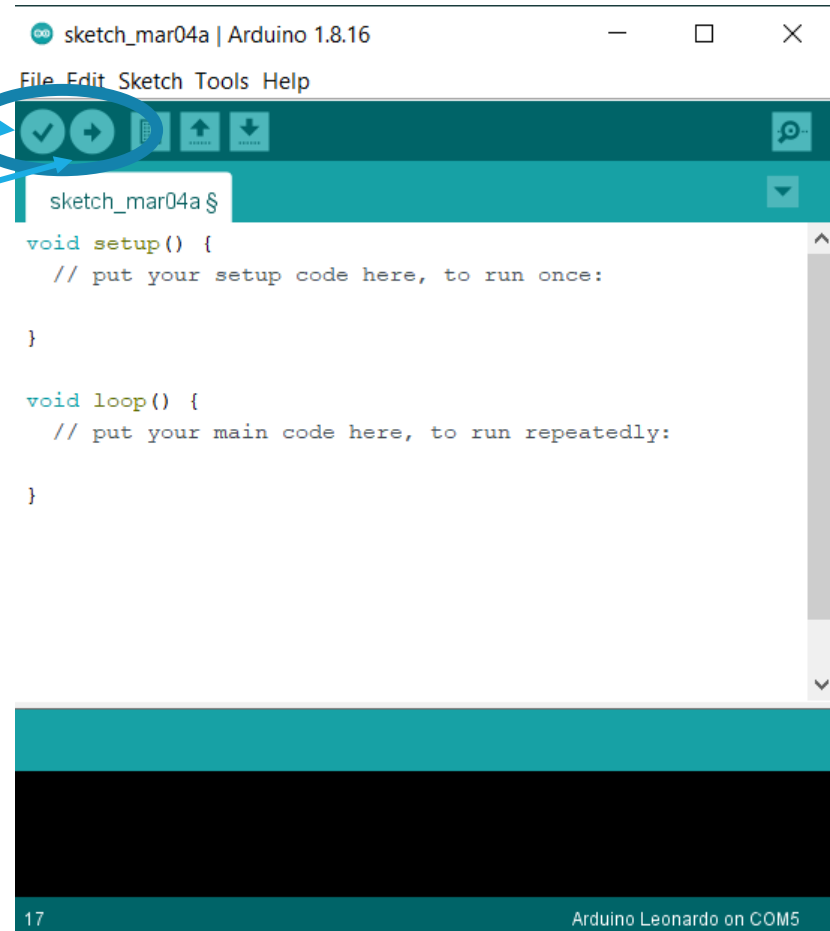
ARDUINO IDE — COMPILE AND UPLOAD



Compile



Upload



To compile a sketch, simply press the compile button. If there are any errors they will appear at the bottom of the window.

To upload a sketch, plug in the micro-USB cable and click "Upload"



EXERCISE — UPLOAD AND TEST

In group:

Choose a set of working code from WokWi from one or more group members
(remember you can combine your code together)

Upload to the light tube and test it out.

Make some changes and see what happens.



EXERCISE — MAKE YOUR LIGHT SHOW

In group:

Choose one light show design or use your coding skills to combine all three designs.

Upload to the Light Tube and test / debug the program.

Update with new features ready for the final show!



SHOW TIME!



WRAP UP

BACK TO ROBOTICS

- Robotics = controlling physical hardware using code to create an automatic and useful output
- Exactly the same principles apply to programming lights as they do to programming robots
- For example: Robo Vacuum



KEY TAKEAWAYS

1

ROBOTICS IS FOR EVERYONE

Robotics needs people from all walks of life and all skillsets

2

ANYONE CAN CODE

Coding is simply a tool to tell a computer what to do

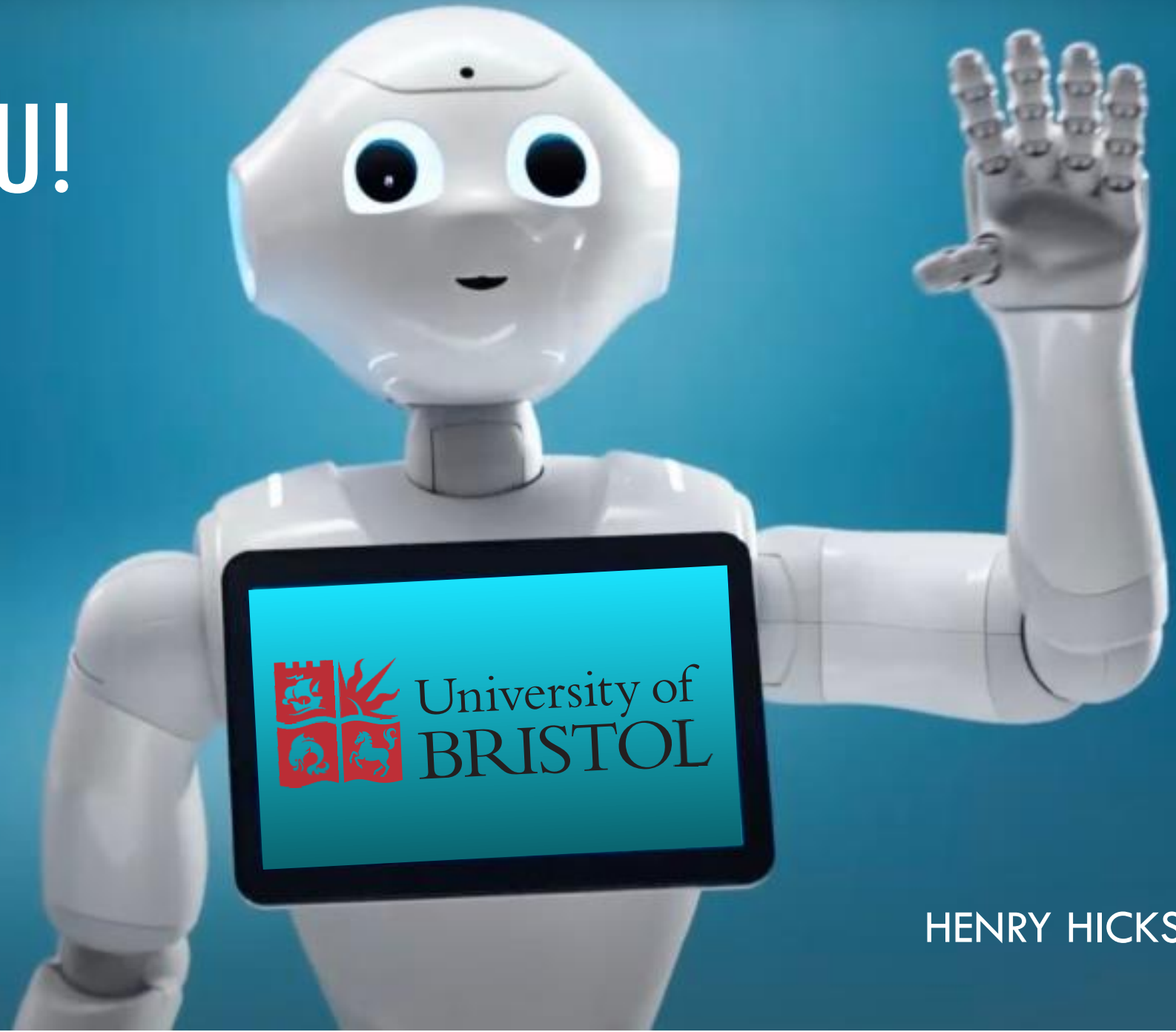




1/7/20XX



THANK YOU!



HENRY HICKSON