

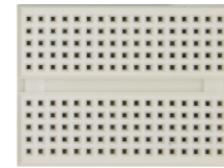
Workshop

IoT Prototyping 101

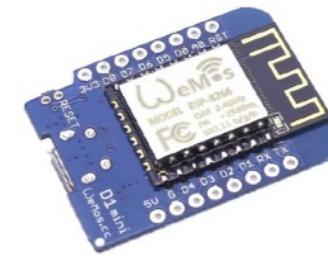
WATT*x*

Checklist

1x Small breadboard



1x Wemos



1x Temp. & humidity sensor



1x Resistor

1x LED

1x Motion sensor



1x MicroUSB cable



1x bunch of wires



A bit of theory



PSALM 105:23

23 Is'-ra-el also came into E'-gypt; and Ja'-cob sojourned in the land of Ham.
24 And he increased his people greatly; and made them stronger than their enemies.
25 He turned their heart to hate his people, to deal subtilly with his servants.
26 He sent Mo'-ses his servant; and Aa'-ron whom he had chosen.
27 They shewed his signs among them, and wonders in the land of Ham.
28 He sent darkness, and made it dark; and they rebelled not against his word.
29 He turned their waters into blood, and slew their fish.
30 Their land brought forth frogs in abundance, in the chambers of their kings.
31 He spake, and there came divers sorts of flies, and lice in all their coasts.
32 He gave them hail for rain, and flaming fire in their land.
33 He smote their vines also and their fig trees; and brake the trees of their coasts.
34 He spake, and the locusts came, and caterpillars, and that without number,
35 And did eat up all the herbs in their land, and devoured the fruit of their ground.
36 He smote also all the firstborn in their land, the chief of all their strength.
37 He brought them forth also with silver and gold: and there was not one feeble person among their tribes.
38 E'-gypt was glad when they departed: for the fear of them fell upon them.
39 He spread a cloud for a covering; and fire to give light in the night.
40 The people asked, and he brought quails, and satisfied them with the bread of heaven.
41 He opened the rock, and the waters gushed out: they ran in the dry places like a river.

God's Faithfulness to Israel

42 For he remembered his holy promise, and A'-bra-ham his servant.
43 And he brought forth his people with joy, and his chosen with gladness:
44 And gave them the lands of the heathen: and they inherited the labour of the people:
45 That they might observe his statutes, and keep his laws. Praise ye the LORD.

PSALM 106

PRAISE ye the LORD. O give thanks unto the LORD; for he is good: for his mercy endureth for ever.
2 Who can utter the mighty acts of the LORD? who can shew forth all his praise?
3 Blessed are they that keep judgment, and he that doeth righteousness at all times.
4 Remember me, O LORD, with the favour that thou bearest unto thy people: O visit me with thy salvation:
5 That I may see the good of thy chosen, that I may rejoice in the gladness of thy nation, that I may glory with thine inheritance.
6 We have sinned with our fathers, we have committed iniquity, we have done wickedly.
7 Our fathers understood not thy wonders in E'-gypt; they remembered not the multitude of thy mercies; but provoked him at the sea, even at the Red sea.
8 Nevertheless he saved them for his name's

sake, that he might make his mighty power to be known.
9 He rebuked the Red sea also, and it was dried up: so he led them through the depths as through the wilderness.
10 And he saved them from the hand of him that hated them, and redeemed them from the hand of the enemy.
11 And the waters covered their enemies: there was not one of them left.
12 Then believed they his words; they sang his praise.

Moses Was Used to Free Israel
13 They soon forgot his works: they were not for his counsel:
14 But lust exceedingly in the wilderness, and tempted God in the desert.
15 And he gave them their request: but suffered their leanness into their soul.
16 They envied Mo'-ses also in the camp, Aa'-ron the saint of the LORD.
17 The earth opened and swallowed up Dathan and covered the company of A-bi'-ram: and a flame burned up in their company.
18 And a fire was kindled in their company, which consumed the wicked.
19 They made a calf in Ho'-reb, and worshipped the molten image.
20 Thus they changed their glory into the multitude of an ox that eateth grass.
21 They forgat God their saviour, which had done great things in E'-gypt;

22 Wondrous works in the land of Ham, terrible things by the Red sea.
23 Therefore he said that he would destroy them, had not Mo'-ses his chosen stood before him in the breach, to turn away his wrath, before he should destroy them.

Israel Refused to Enter the Land
24 Yea, they despised the pleasant land, in believed not his word:
25 But murmured in their tents, and hardened not unto the voice of the LORD.
26 Therefore he lifted up his hand against them, to overthrow them in the wilderness: to overthrow their seed also among the nations, and to scatter them in the lands.

God's Redemptive Power
27 To give thanks unto the LORD, for he is good: for his mercy endureth for ever.
28 Let the redeemed of the LORD say so: for he hath redeemed from the hand of the enemy:
29 And gathered them out of the lands, from the east, and from the west, from the north, and from the south.

30 They wandered in the wilderness in a solitary way; they found no city to dwell in.
31 Hungry and thirsty, their soul fainted in them.

32 Then they cried unto the LORD in their trouble, and he delivered them out of their distresses.
33 And he led them forth by the right way, if they might go to a city of habitation.
34 Oh that men would praise the LORD for his goodness, and for his wonderful works to the children of men!

35 For satisfieth the longing soul, and filleth the hungry soul with goodness.
36 Such as sit in darkness, and in the shadow of death, being bound in affliction and iron:
37 Because they rebelled against the words of the Lord, and contemned the counsel of the most High.

38 Therefore he brought down their heads with labour; they fell down, and there was no one to help.
39 Then they cried unto the LORD in their trouble, and he saved them out of their distresses.

40 He brought them out of darkness and into light: he delivered them from affliction and iron:
41 And he gave them into the hand of the heathen, and they that hated them ruled over them.

42 Therefore was the wrath of the LORD kindled against his people, insomuch that he scorched his own inheritance.
43 And he gave them into the hand of the heathen, and they that hated them ruled over them.

44 Their enemies also oppressed them, and they were brought into subjection under their rule.
45 Many times did he deliver them; but they provoked him with their counsel, and were brought low for their iniquity.
46 Nevertheless he regarded their affliction, and heard their cry:

47 And he remembered for them his covenant, and repented according to the multitude of his mercies.
48 He made them also to be pitied of all those that carried them captives.
49 Save us, O LORD our God, and gather us in among the heathen, to give thanks unto thy holy name, and to triumph in thy praise.
50 Blessed be the LORD God of Is'-ra-el from everlasting to everlasting: and let all the people of A'-men. Praise ye the LORD.

BOOK V

psalms 107—150

ALM 107

God's Redemptive Power

GIVE thanks unto the LORD, for he is good: for his mercy endureth for ever.
Let the redeemed of the LORD say so: for he hath redeemed from the hand of the enemy:
Enemies.

And gathered them out of the lands, from the east, and from the west, from the north, and from the south.

They wandered in the wilderness in a solitary way; they found no city to dwell in.

Hungry and thirsty, their soul fainted in them.

Then they cried unto the LORD in their trouble, and he delivered them out of their distresses.

And he led them forth by the right way, if they might go to a city of habitation.

Oh that men would praise the LORD for his goodness, and for his wonderful works to the children of men!

For satisfieth the longing soul, and filleth the hungry soul with goodness.

Such as sit in darkness, and in the shadow of death, being bound in affliction and iron:

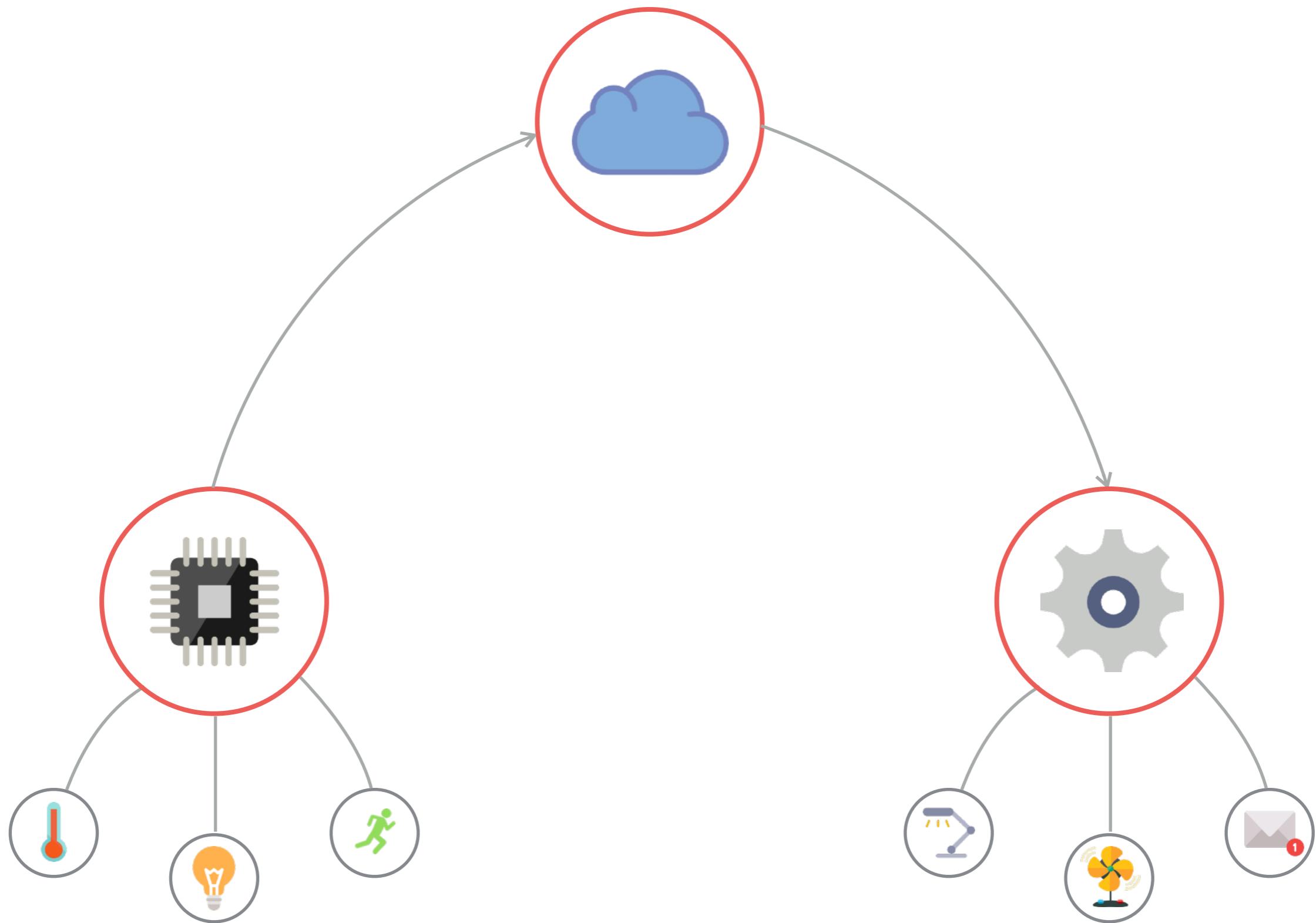
Because they rebelled against the words of the most High.

Therefore he brought down their heads with labour; they fell down, and there was no one to help.

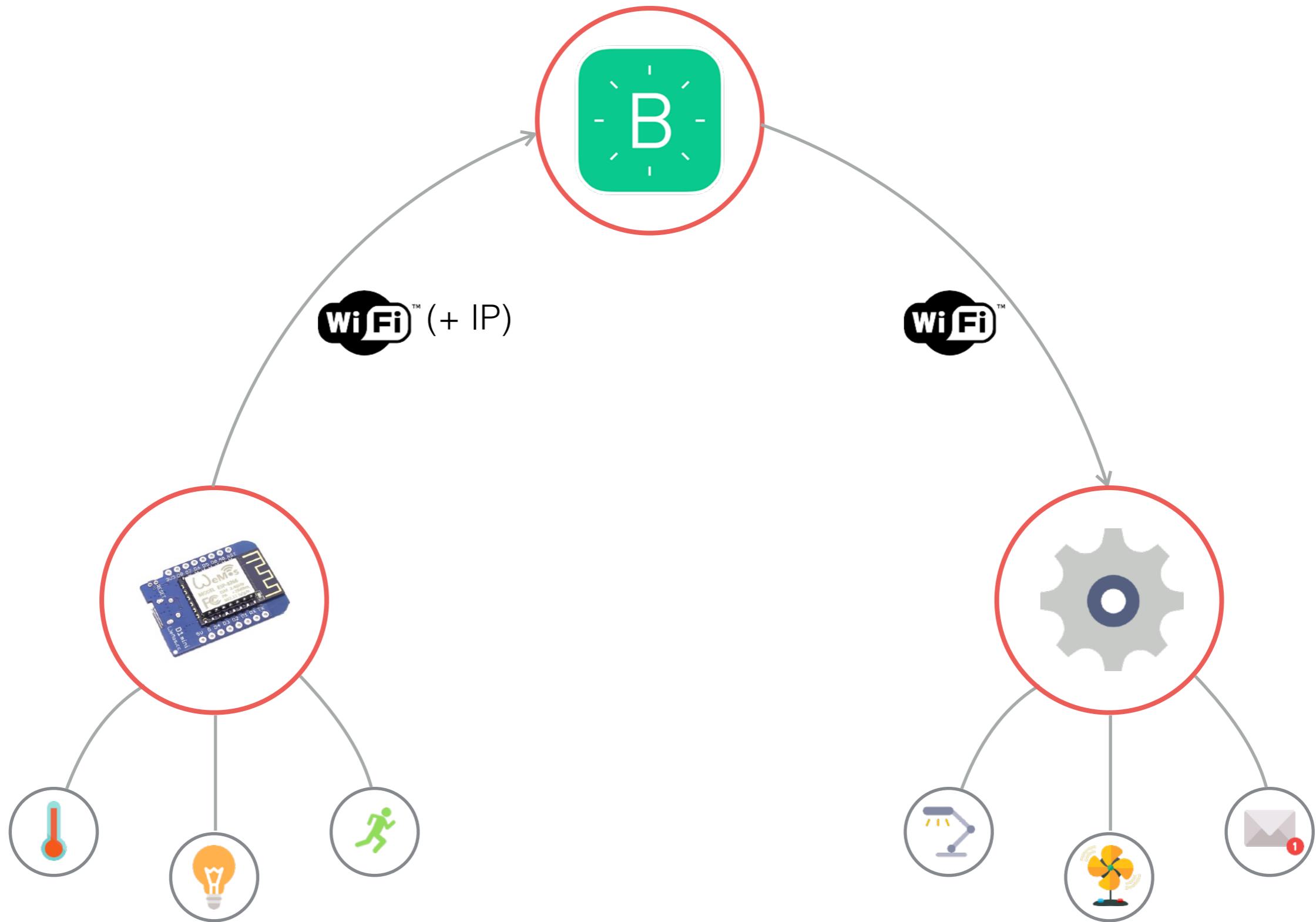
Then they cried unto the LORD in their trouble, and he saved them out of their distresses.

He brought them out of darkness and into light: he delivered them from affliction and iron:

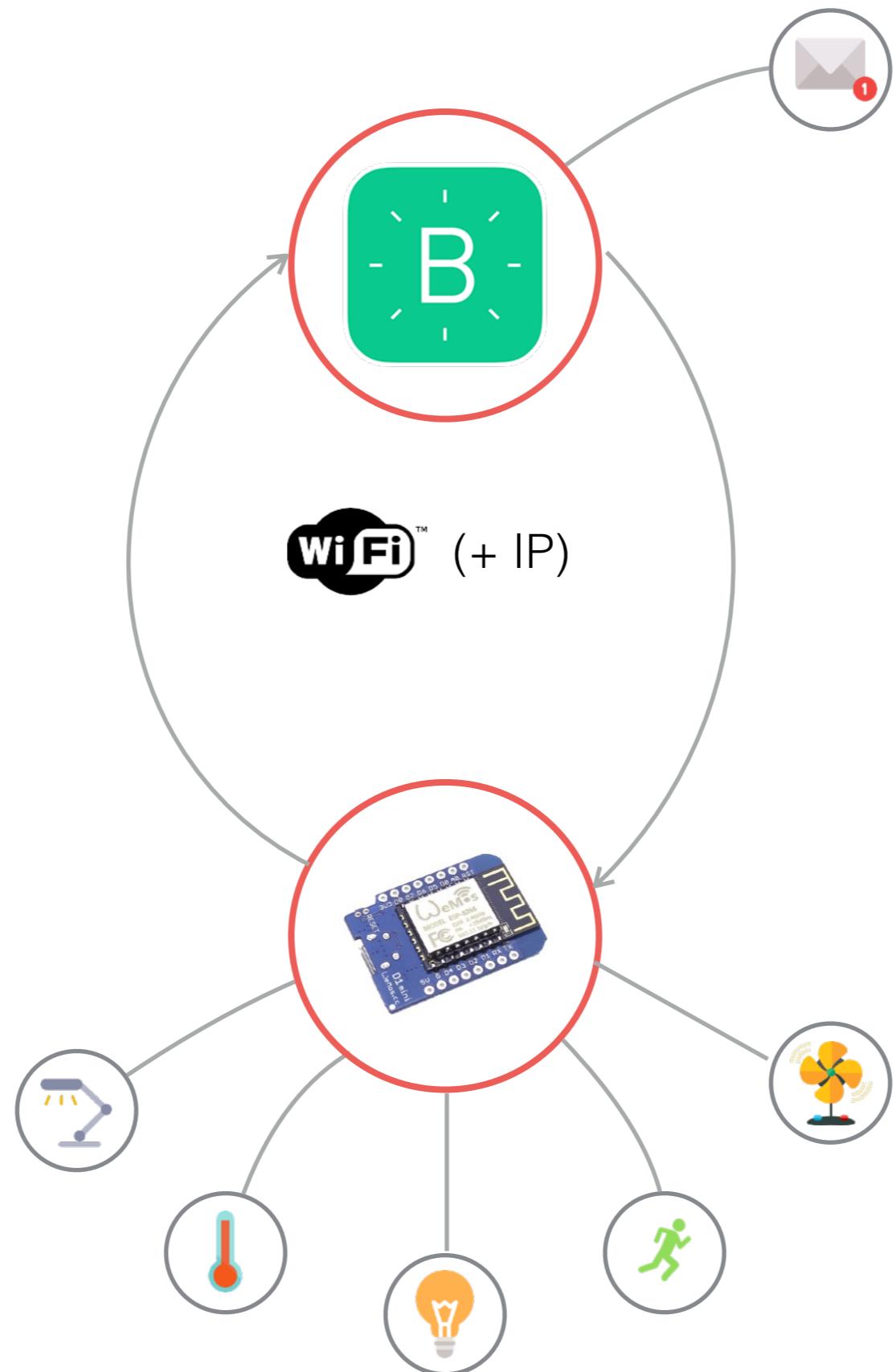
How IoT works (basically)



What we're using today



What we're using today



What we're using today

WeMos D1 mini Pro

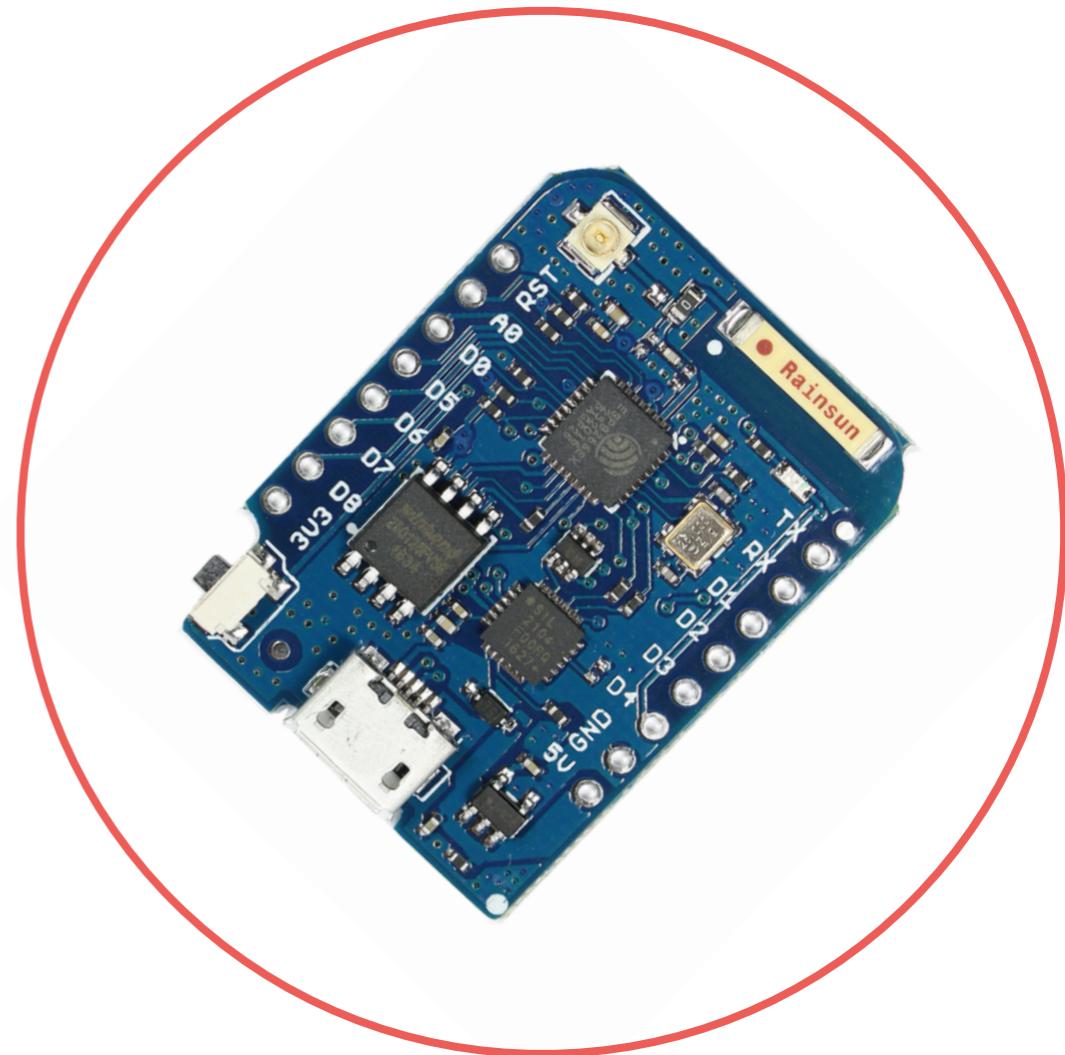
1. The *brains* of the operation.

Runs at 80 MHz, or about 20 times faster than the Apollo 11's computer 🌙

2. It's actually based on the ESP8266-EX

3. It's got a tiny computer, Wi-fi and 8 digital inputs and outputs (you can read 8 different sensors or control 8 different things)

4. Cheaper than a Latte Macchiato ☕



What we're using today

Blynk

1. Neat mobile app that lets you quickly prototype with your phone
2. Lets you do a lot of cool stuff (*you'll see*)
3. Has a bunch of widgets and each widget uses 'Energy'
4. You get 2000 Energy to start
5. You won't need more than that today



What you'll learn today

1. How to use a breadboard



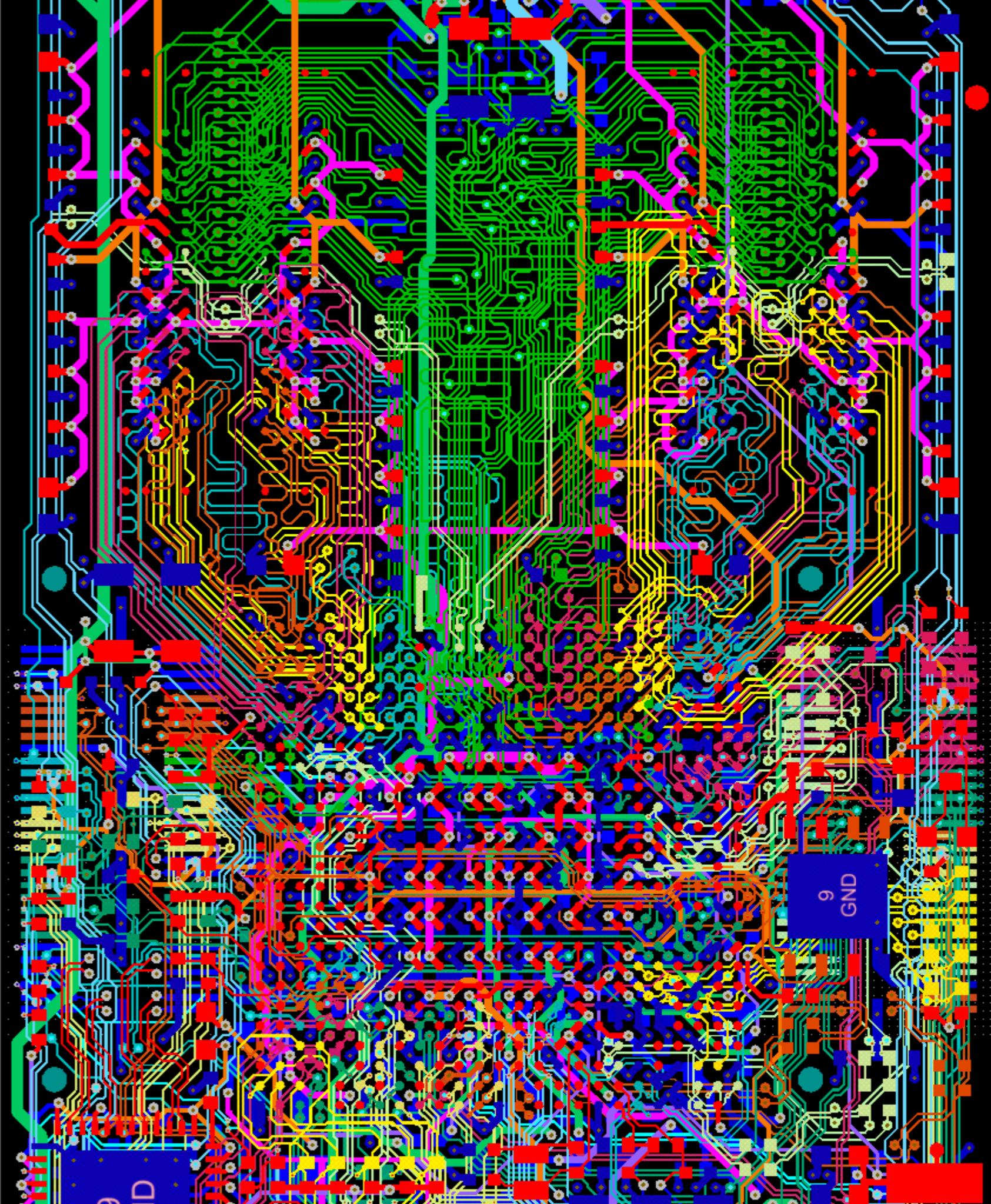
2. How to hook up and read sensors through your microcontroller



3. How to look at the data from *anywhere* (or sending it to the ☁)

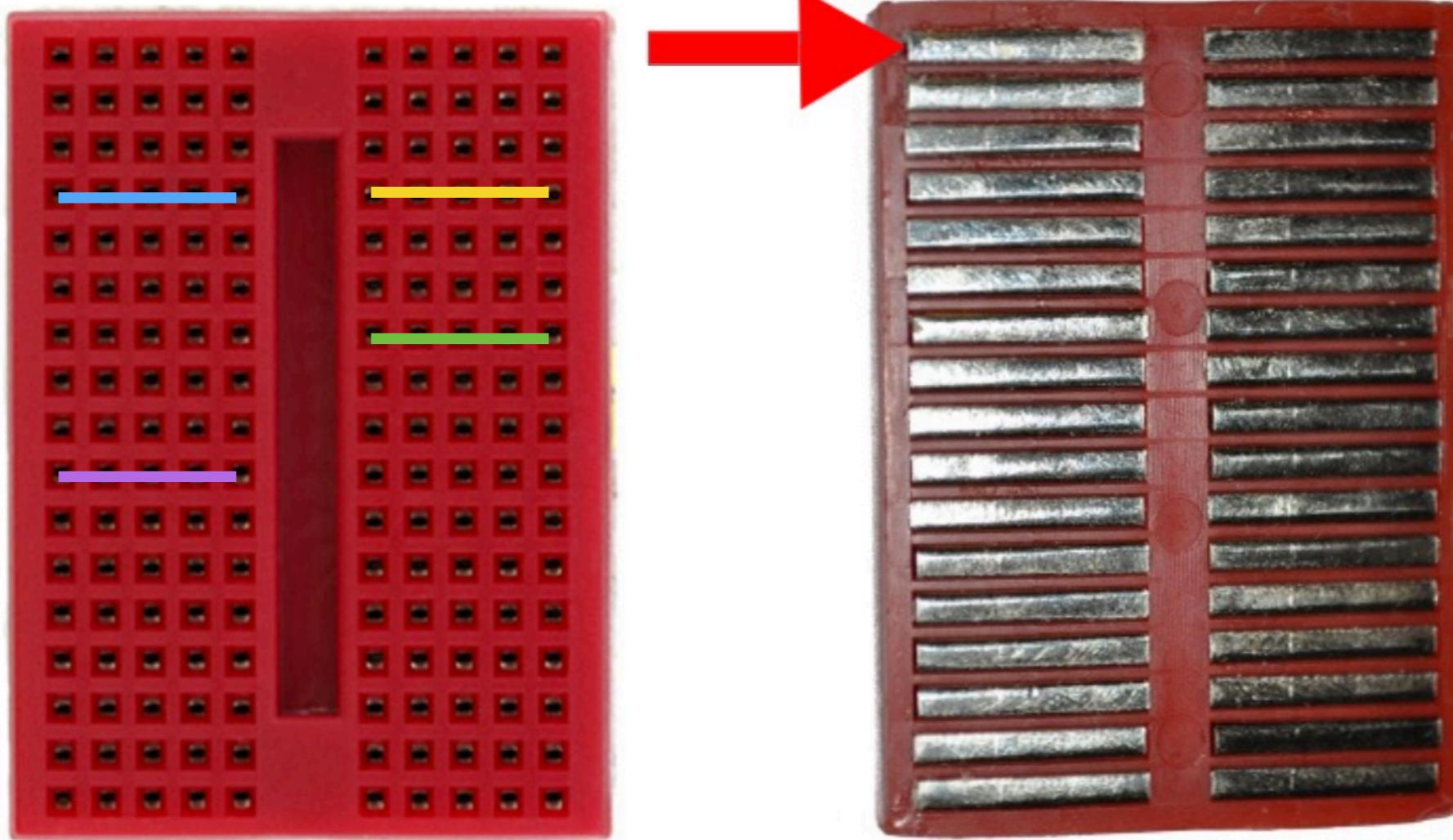
4. How to do *cool stuff* with those data and your smartphone

So it begins...

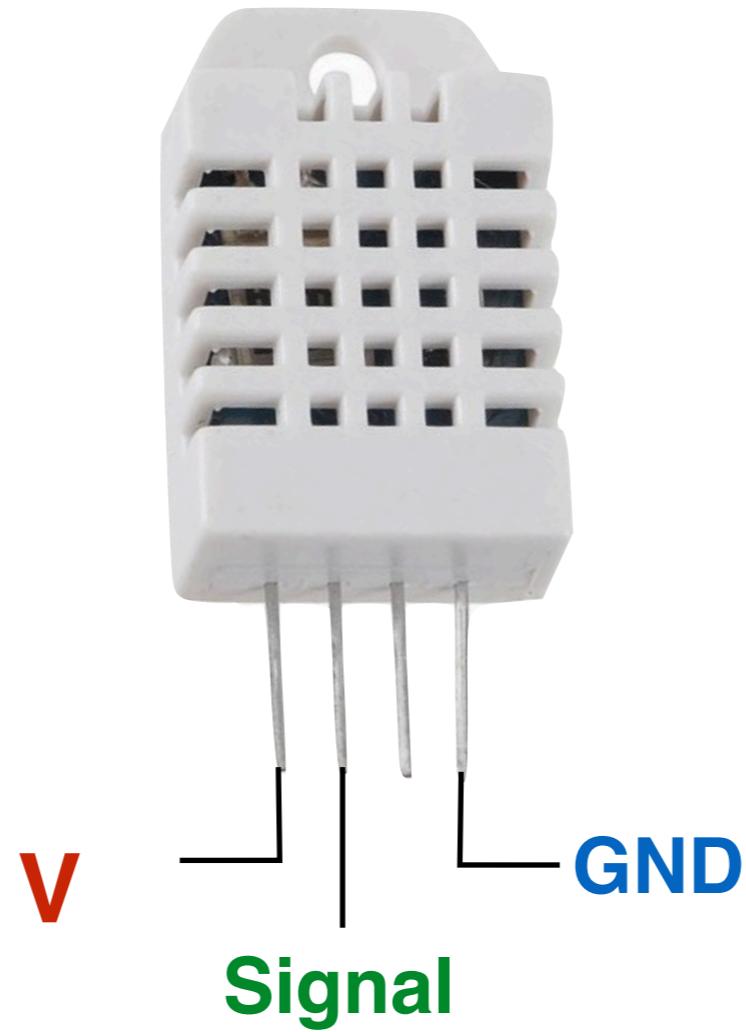


Breadboards

(pretty simple really)

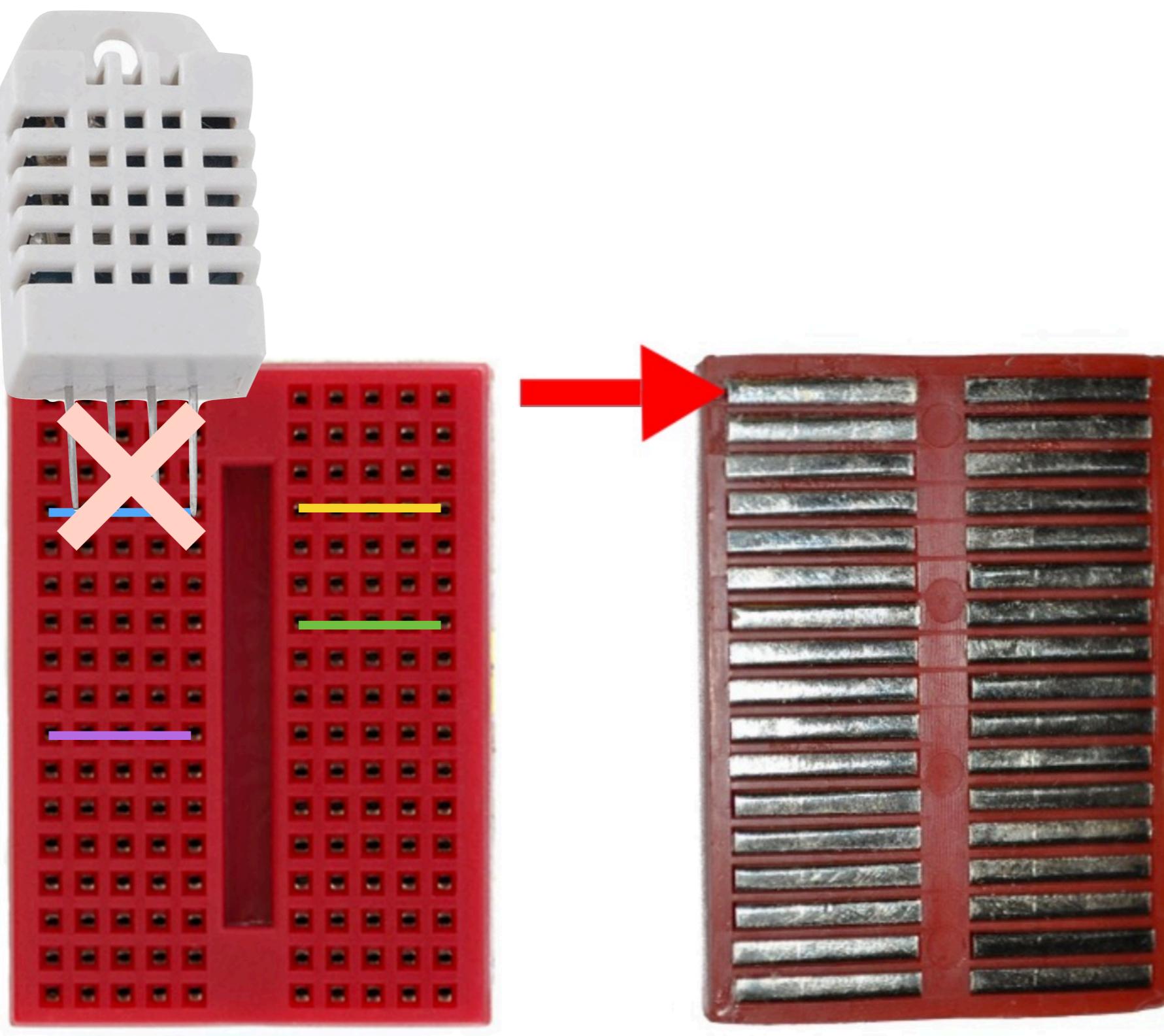


Humidity & temperature sensor



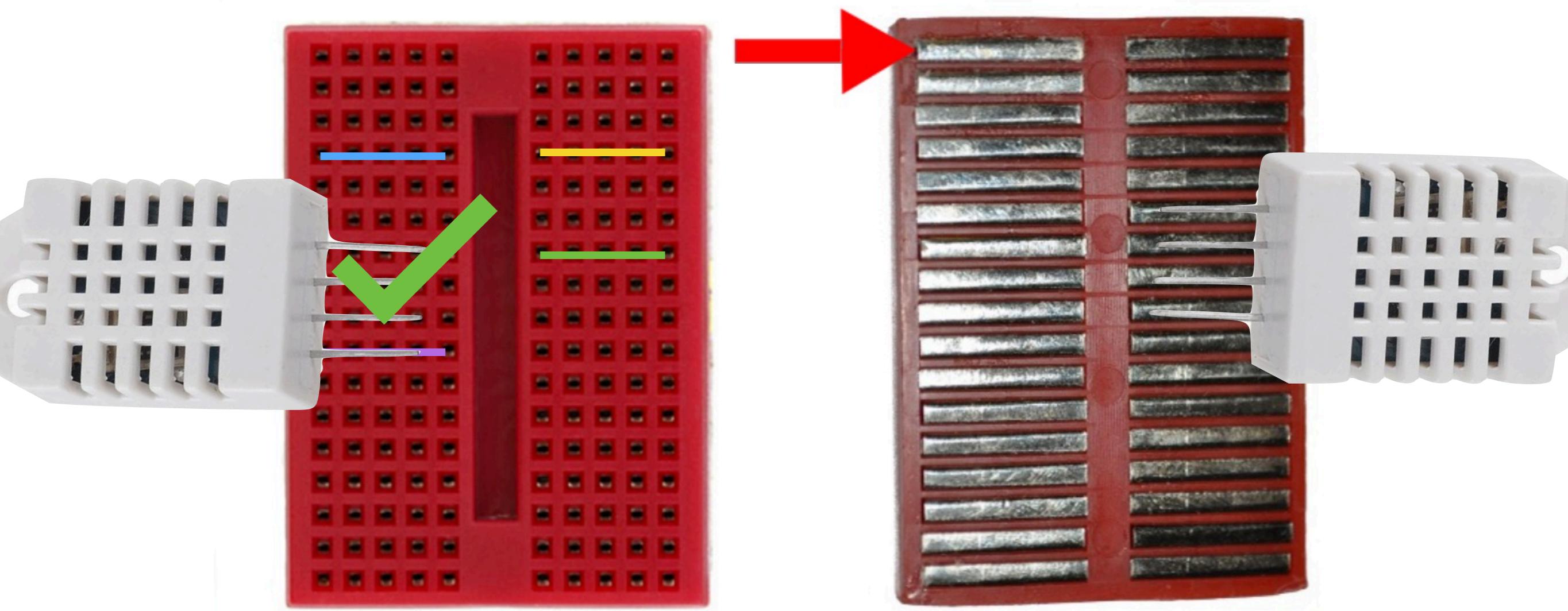
Breadboard

(pretty simple)



Breadboards

(pretty simple really)

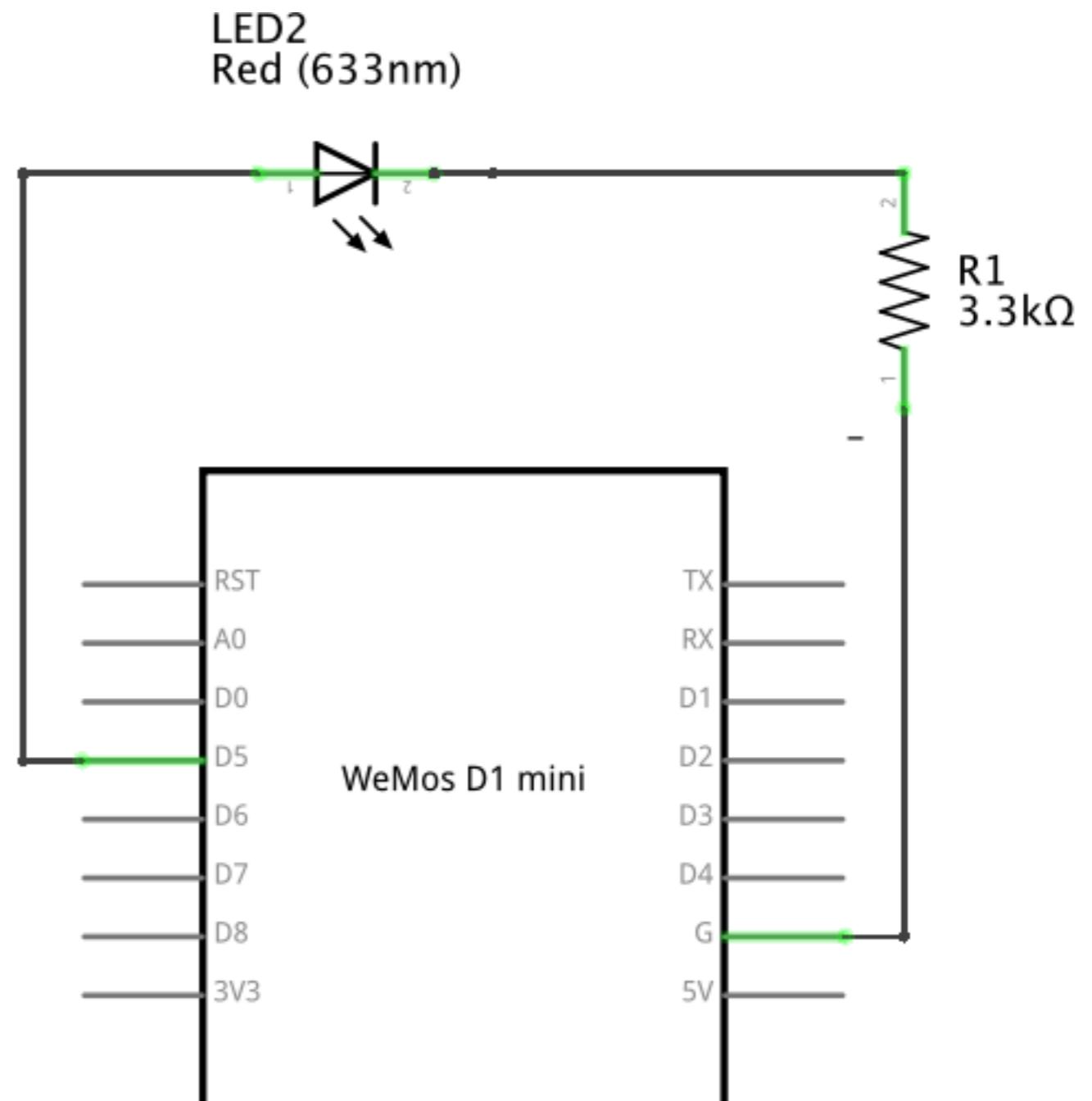


Task #1

Let there be light

Your first circuit

*Connecting the
Wemos to an LED*

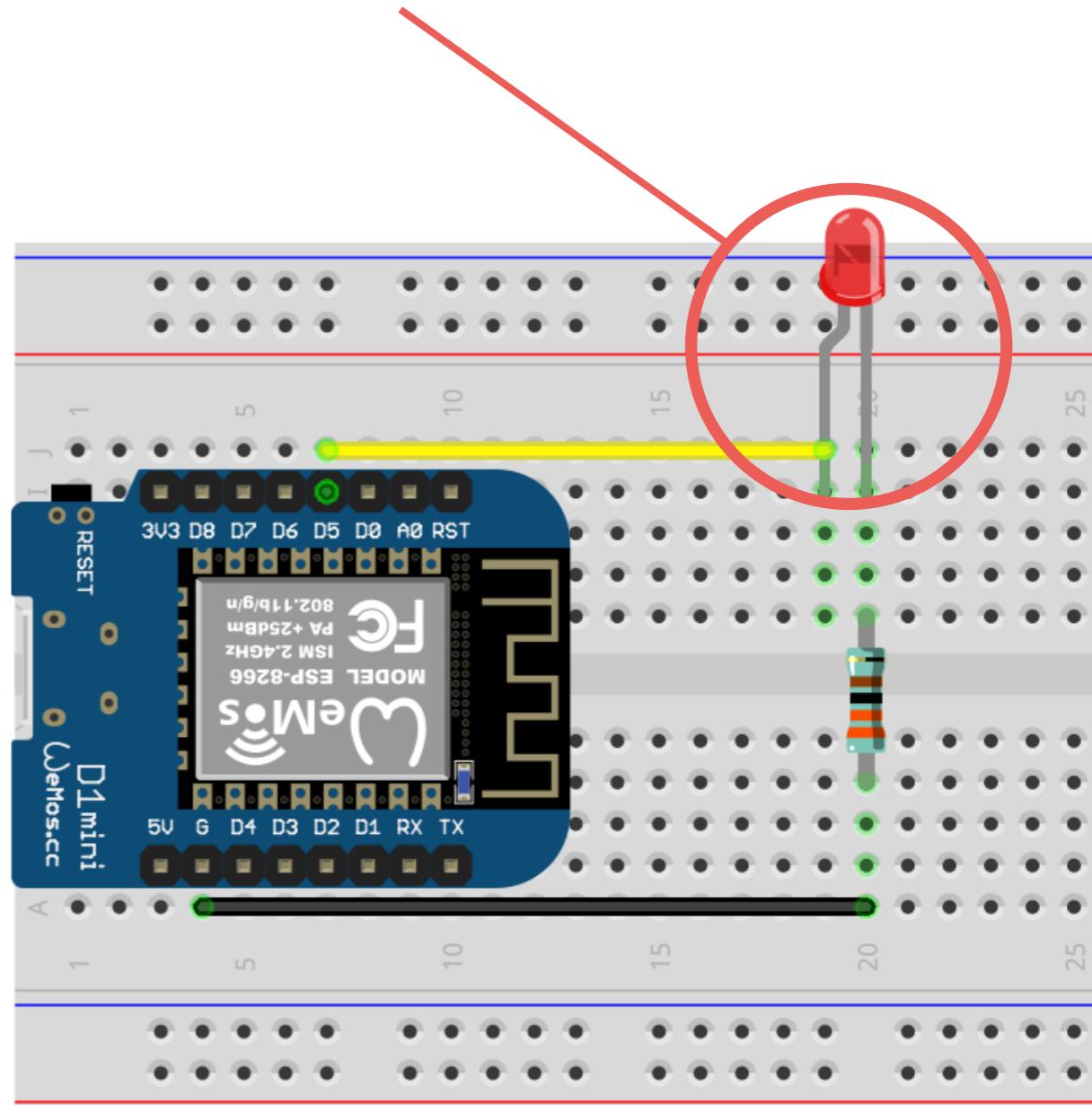


fritzing

Your first circuit

*Connecting the
Wemos to an LED*

Watch out for the LED!
It's a diode so current only flows one way.



Code examples

tinyurl.com/vdmaiot

Your first program

Controlling the LED



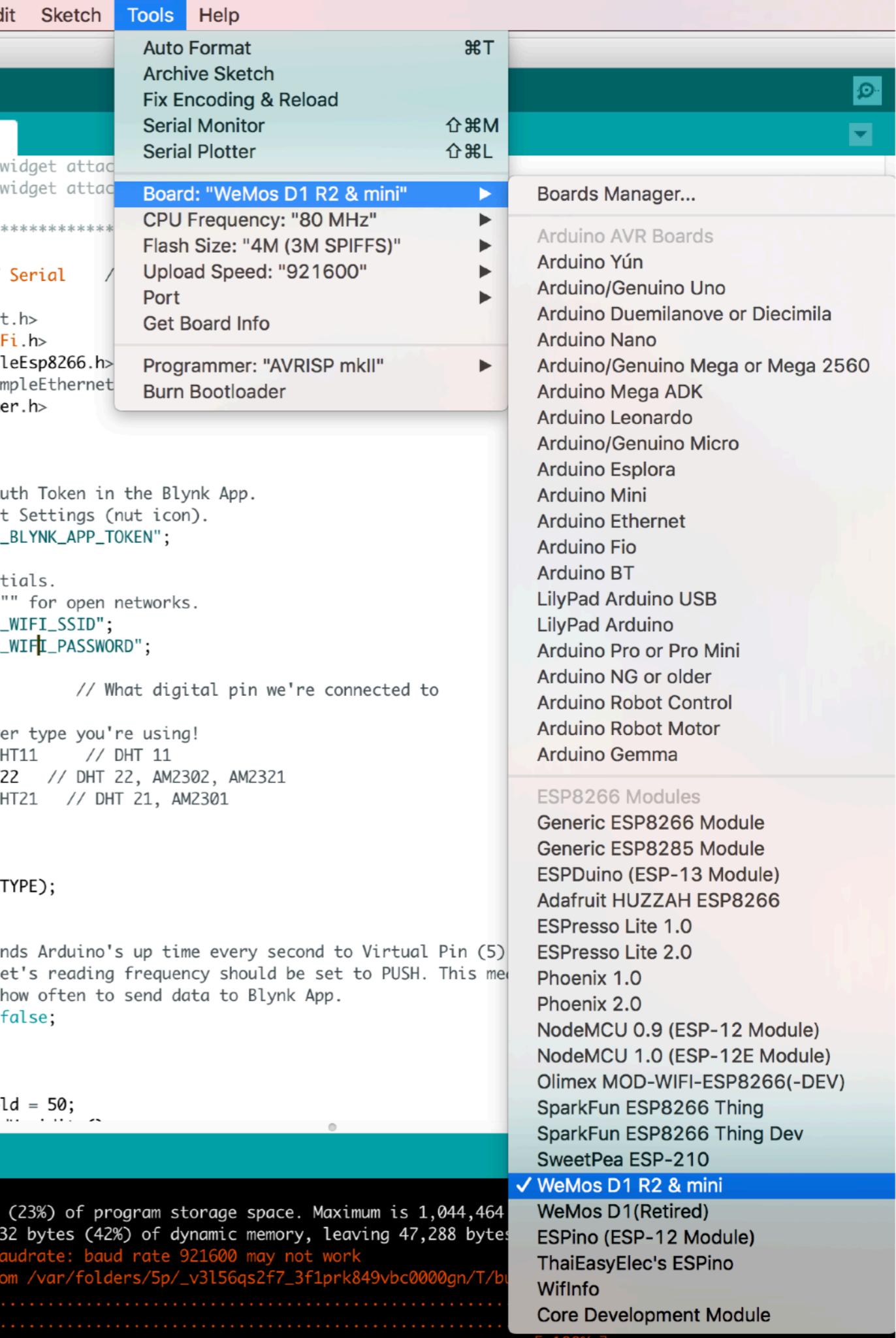
The screenshot shows the Arduino IDE interface with the title bar "ex1a | Arduino 1.6.9". The code editor contains the following sketch:

```
1 |
2 int led = D5; // This is the pin where the LED is connected to
3
4 // the setup routine runs once when you press reset:
5 void setup() {
6     // initialize the digital pin as an output.
7     pinMode(led, OUTPUT);
8 }
9
10 // the loop routine runs over and over again forever:
11 void loop() {
12     digitalWrite(led, HIGH);    // turn the LED on (HIGH is the voltage level)
13 }
```

The status bar at the bottom right indicates the hardware configuration: "WeMos D1 R2 & mini, 80 MHz, 115200, 4M (3M SPIFFS) on /dev/cu.wchusb".

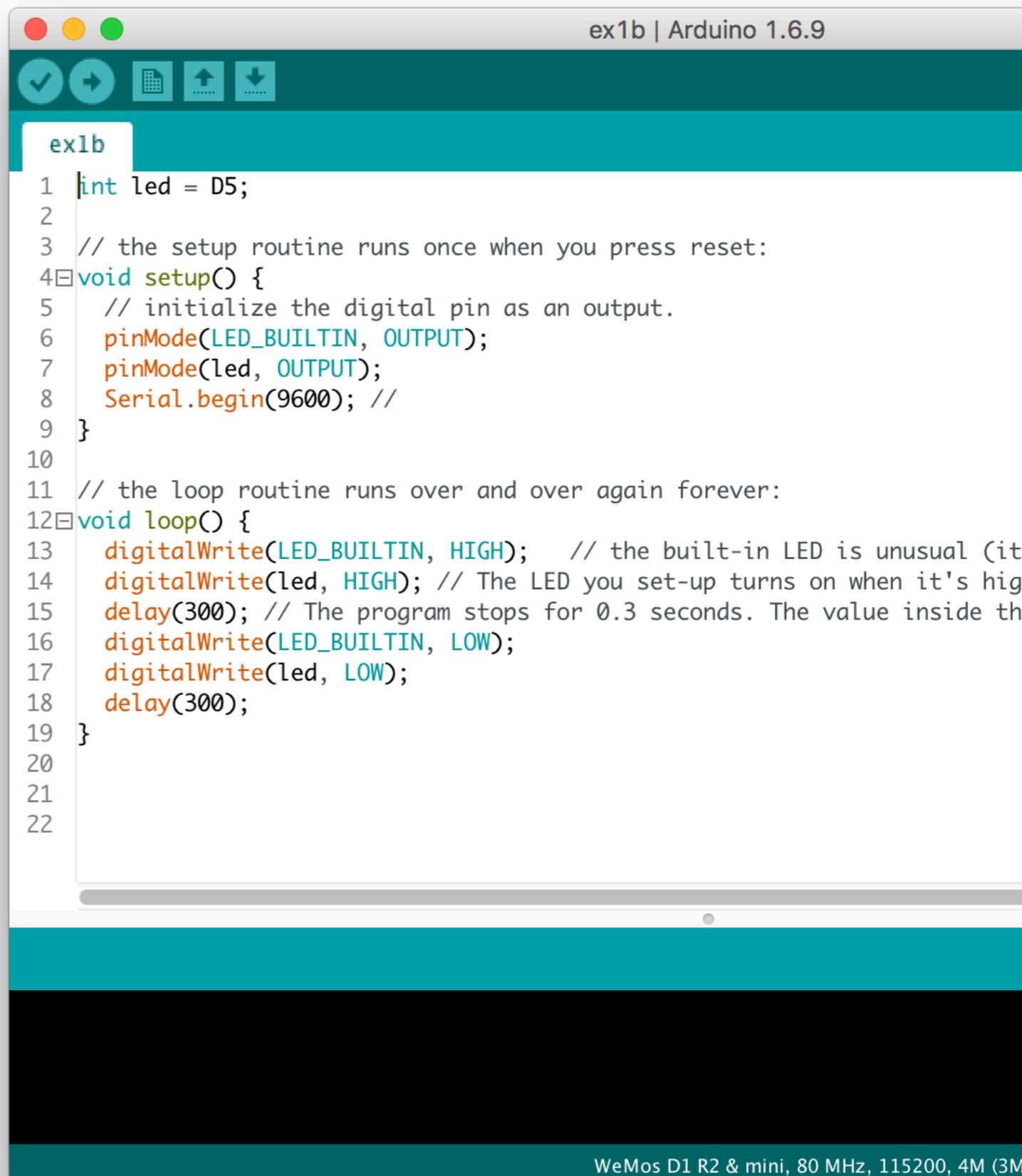
Programming it

1. Make sure the Wemos board is selected. Go to Tools > Board > and select "WeMos D1 R2 & mini"
2. Where it says **Upload Speed** select **115200**
3. On **Port** on a Mac or Linux select **dev/cu.SLAB_USART**.
Windows should have something like **COM1**
4. Make sure your laptop is connected to the Wemos with a MicroUSB button and hit the Upload button.
5. You should now have your very first program loaded onto the Wemos.
Congrats!
6. Use the **Serial Monitor** with **Both NL & CR** and **9600 baud** to see the messages the Wemos sends to your computer



Your first program

The Wemos has its own LED as well



The screenshot shows the Arduino IDE interface with the title bar "ex1b | Arduino 1.6.9". The main window displays the code for "ex1b". The code initializes pin D5 as an output and sets up serial communication at 9600 baud. It then enters a loop where it alternates between turning the built-in LED and the user-defined LED on and off every 0.3 seconds.

```
int led = D5;  
  
// the setup routine runs once when you press reset:  
void setup() {  
    // initialize the digital pin as an output.  
    pinMode(LED_BUILTIN, OUTPUT);  
    pinMode(led, OUTPUT);  
    Serial.begin(9600); //  
}  
  
// the loop routine runs over and over again forever:  
void loop() {  
    digitalWrite(LED_BUILTIN, HIGH); // the built-in LED is unusual (it  
    digitalWrite(led, HIGH); // The LED you set-up turns on when it's high  
    delay(300); // The program stops for 0.3 seconds. The value inside the  
    digitalWrite(LED_BUILTIN, LOW);  
    digitalWrite(led, LOW);  
    delay(300);  
}
```

WeMos D1 R2 & mini, 80 MHz, 115200, 4M (3M)

Functions

Let's wrap what we did in a function



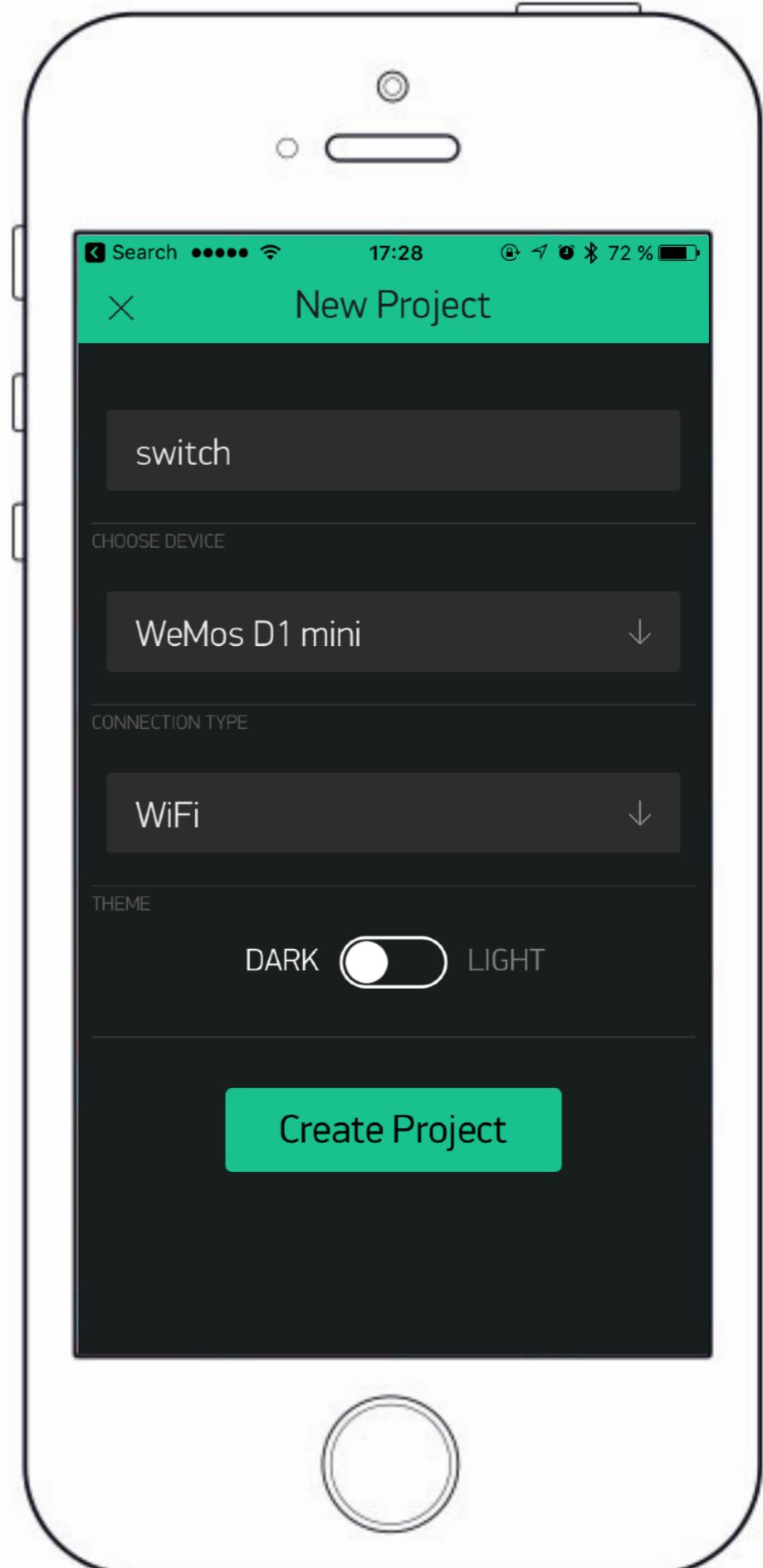
```
ex1c | Arduino 1.6.9

ex1c
1 int led = D5;
2
3 // the setup routine runs once when you press reset:
4 void setup() {
5     // initialize the digital pin as an output.
6     pinMode(LED_BUILTIN, OUTPUT);
7     pinMode(led, OUTPUT);
8 }
9
10 // the loop routine runs over and over again forever:
11 void loop() {
12     blinkLeds();
13 }
14
15 void blinkLeds() {
16     digitalWrite(LED_BUILTIN, HIGH);      // the built-in LED is unusual
17     digitalWrite(led, HIGH);             // (it turns on when it's low and off when it's high)
18     delay(300); // The program stops for 0.3 seconds. The value inside the () is milliseconds
19     digitalWrite(LED_BUILTIN, LOW);
20     digitalWrite(led, LOW);
21     delay(300);
22 }
23
```

*Connecting the
light to the world.*

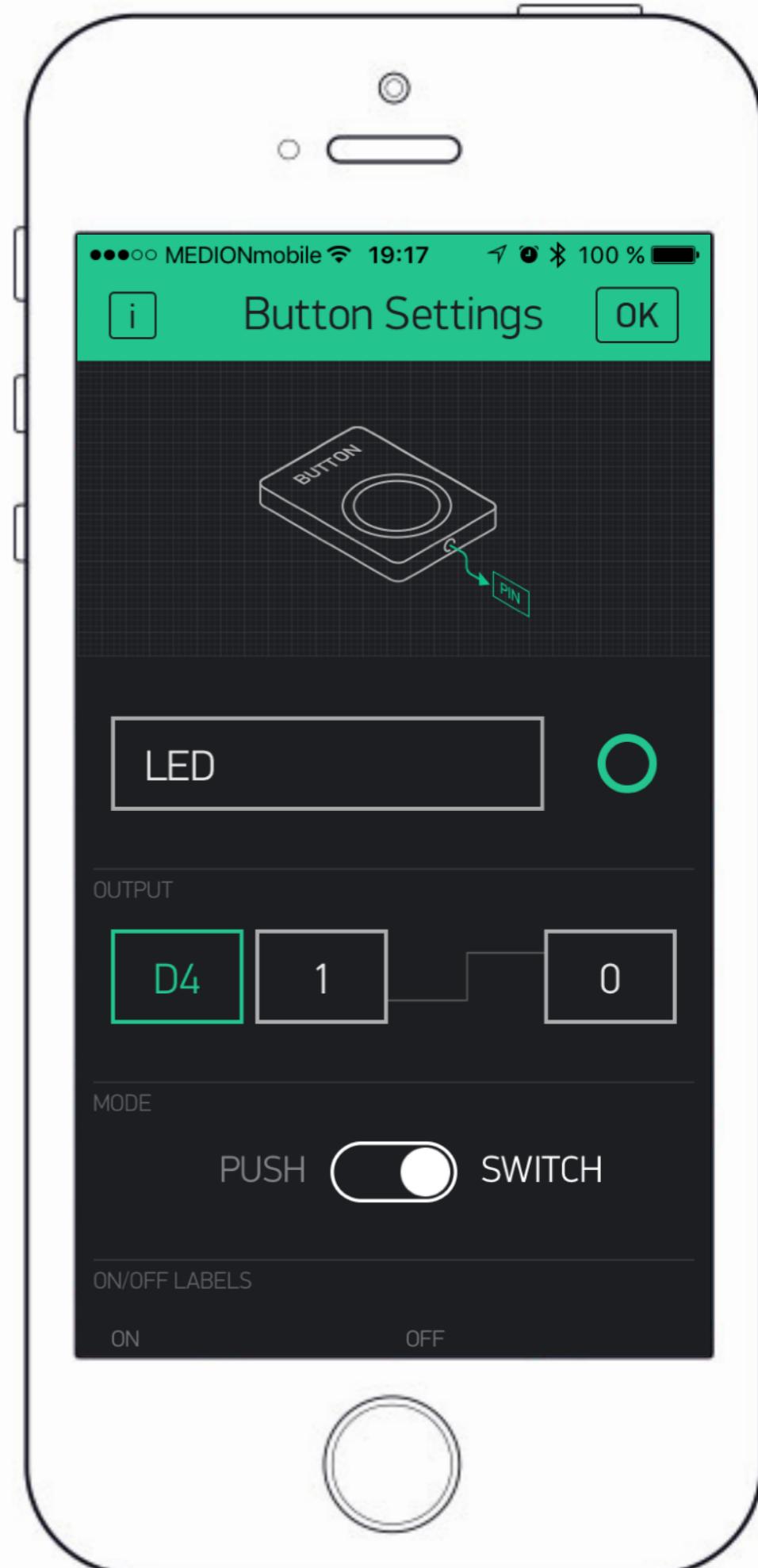
Your first Blynk project

1. Open the Blynk app and hit 'Create New Project'
2. Give it some name (here it's 'switch')
3. Tap 'Choose Device' and scroll all the way down until you find the 'WeMos D1 Mini'
4. Hit 'Create Project' and *boom*, you got your first project!
5. Your auth token has been sent to your mail. You can always check Settings to see your token



Your first Blynk project

1. You're now gonna control a Digital I/O . Add a Button and tap it
2. Because you connected the LED to D5, select D5 on the Digital Output. Tap OK.
3. The Wemos has a blue LED that's controlled by the D4 pin. Add another button and choose that pin. Name it Wemos LED (or whatever you want) Change the 0 to 1 and the 1 to 0 (like in the screenshot) cause otherwise it's just gonna be on when off and off when on, and then it just gets weird.
4. You can choose Push or Switch, it's cool either way.



Programming it

1. Fire up the Arduino app.
2. Download (or copy-paste) the **ex1d.ino** file and open it with the app.
3. Around line 27*, copy your token from the Blynk app and replace in between the “ “, in the **auth[]** variable.
4. Do the same for the Wifi.
5. We tell the Wemos how to connect to the Wifi using **Blynk.begin(auth, ssid, pass)** then we use **Blynk.run()** to actually connect.
6. Flash it! Congrats, you can now use your Wemos as a flashlight 
7. Don't forget to tap  in the Wemos app to start it



```
8 *   Blynk community: http://community.blynk.cc
9 *   Social networks: http://www.fb.com/blynkapp
10 *
11 *
12 * Blynk library is licensed under MIT license
13 * This example code is in public domain.
14 *
15 *
16 *****/
17
18 #define BLYNK_PRINT Serial // Comment this out to disable prints and save space
19 #include <ESP8266WiFi.h>
20 #include <BlynkSimpleEsp8266.h>
21 #include <Wire.h>
22
23 int led = D5;
24
25 // You should get Auth Token in the Blynk App.
26 // Go to the Project Settings (nut icon).
27 char auth[] = "get_it_from_your_app_or_check_your_email";
28
29
30
31 // Your WiFi credentials.
32 // Set password to "" for open networks.
33 char ssid[] = "WATTx_WiFi";
34 char pass[] = "check_the_screen";
35
36
37 void setup()
38{
39  Serial.begin(9600);
40  Blynk.begin(auth, ssid, pass);
41 }
42
43
44 void loop()
45{
46  Blynk.run(); // Initiates Blynk
47 }
```

Done Saving.

Uploading 240016 bytes from /var/folders/5p/_v3l56qs2f7_3f1prk849vbc0000gn/T/build65a535..... [34%]
..... [68%]
..... [100%]

So you can turn on a light anywhere in
the world with your smartphone... *Cool!*

Now let's do something actually useful.

Task #2

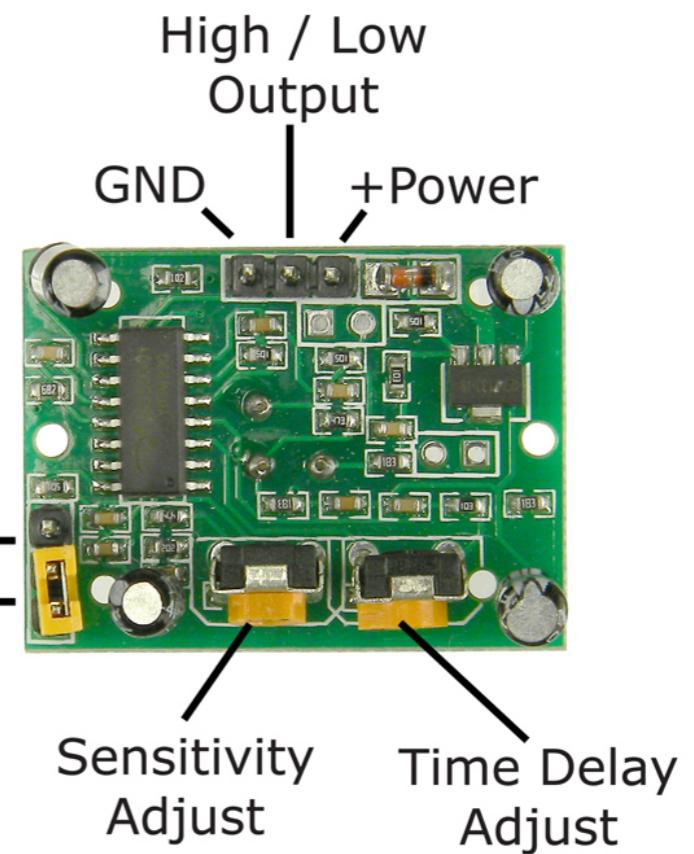
Motion detection



The motion sensor

*Uses infrared
waves to
detect people*

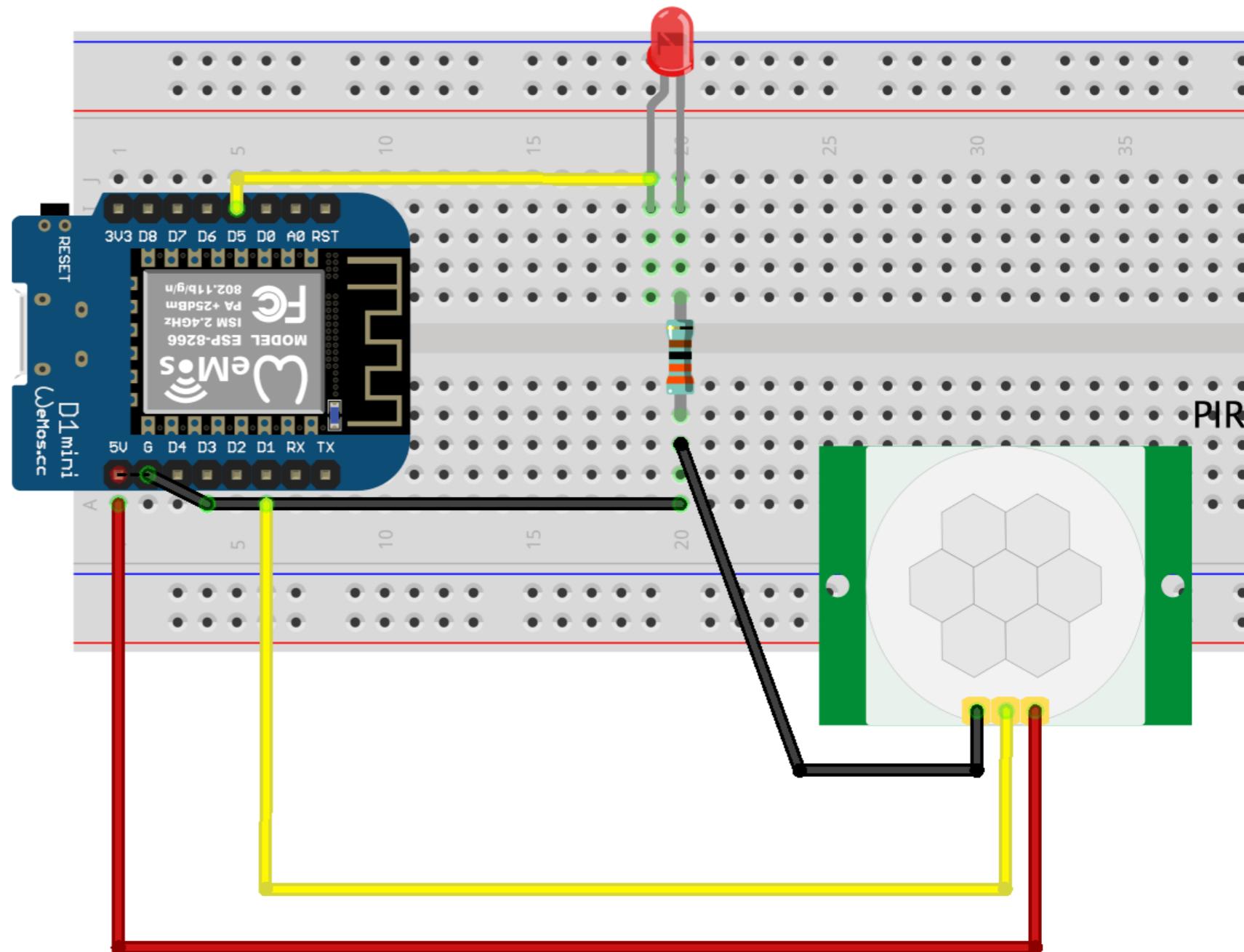
Jumper Set:
H: Repeat Trigger
L: Single Trigger



More info

Your second circuit

Adding the motion sensor



Your second program

1. So we're gonna detect people with this sensor. Cool! How?

2. Let's use an `if-else` statement to trigger a warning if movement is detected

3. We're also using `Serial` to send messages back to the computer

The screenshot shows the Arduino IDE interface with the following details:

- Title Bar:** ex2a | Arduino 1.6.9
- Toolbar:** Includes icons for file operations (New, Open, Save, Print, Upload, Download).
- Code Editor:** The code for "ex2a" is displayed:

```
1 int led = D5;
2 int motionSensorPin = D1;
3 int motionState;
4
5 // the setup routine runs once when you press reset:
6 void setup() {
7     // initialize the digital pin as an output.
8     pinMode(LED_BUILTIN, OUTPUT);
9     pinMode(led, OUTPUT);
10    Serial.begin(9600); // We'll use Serial to talk with the computer
11 }
12
13
14 // the loop routine runs over and over again forever:
15 void loop() {
16
17     motionState = digitalRead(motionSensorPin); // Reading the state of the sensor
18
19     if (motionState == LOW) // if value is LOW, then no motion has been detected
20     {
21         Serial.println("No motion detected");
22     }
23     else // if value is something other than LOW then it must be HIGH meaning motion
24     {
25         Serial.println("Motion detected!! Someone is here!");
26         blinkLeds();
27         digitalWrite(LED_BUILTIN, HIGH); // Turn off the built-in LED
28     }
29     delay(500);
30 }
31
32
33 void blinkLeds() {
```
- Status Bar:** Shows "Done uploading." followed by a progress bar with three segments: [35%, [71%, and [100%].
- Bottom Status:** WeMos D1 R2 & mini, 80 MHz, 115200, 4

*What about an
Internet connected
motion sensor that
warns you when
you're away?*

Great idea!

1. Let's combine our last program with the Blynk code

2. Again, add the Wifi credentials and your token to your code

3. Let's send a notification! This function is part of the Blynk library and sets off a notification on your phone:

```
Blynk.notify("Your message here");
```

4. Flash it! ⚡

5. Don't forget to add a Notification widget on your Blynk app



```
ex2b | Arduino 1.6.9

ex2b

27
28 // You should get Auth Token in the Blynk App.
29 // Go to the Project Settings (nut icon).
30 char auth[] = "get_it_from_your_app_or_check_your_email";
31
32 // Your WiFi credentials.
33 // Set password to "" for open networks.
34 char ssid[] = "WATTx_WiFi";
35 char pass[] = "check_the_screen";
36
37 void setup()
38{
39  pinMode(LED_BUILTIN, OUTPUT);
40  pinMode(led, OUTPUT);
41  Serial.begin(9600); // We'll use Serial to talk with the computer
42  Blynk.begin(auth, ssid, pass);
43}
44
45
46 void loop()
47{
48  Blynk.run(); // Initiates Blynk
49  motionState = digitalRead(motionSensorPin); // Reading the state of the sensor
50
51  if (motionState == LOW) // if value is LOW, then no motion has been detected
52  {
53    Serial.println("No motion detected");
54  }
55  else // if value is something other than LOW then it must be HIGH meaning motion has been detected
56  {
57    Serial.println("Motion detected!! Someone is here!");
58    Blynk.notify("ALARM! Your motion detector has sensed someone!");
59    // This will trigger a notification on your phone
60
61    blinkLeds();
62    digitalWrite(LED_BUILTIN, HIGH); // Turn off the built-in LED
63  }
64  delay(2000);
65}
```

Done Saving.

[34%] [68%] [100%]

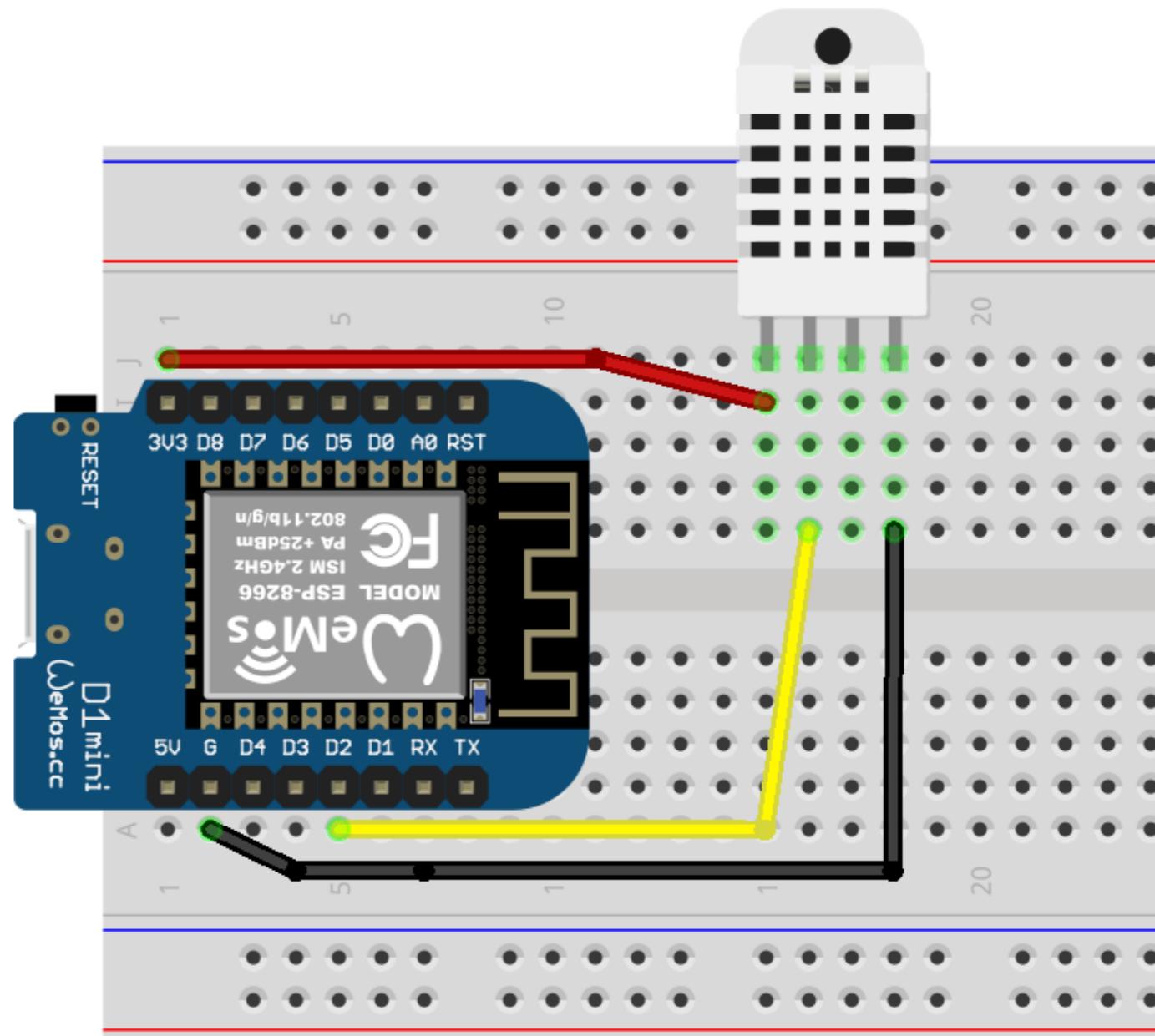
WeMos D1 R2 & mini, 80 MHz, 115200, 4M (3M SPIFFS) on /dev/cu.wchusbse

Task #3

*Smart temperature &
humidity sensor*

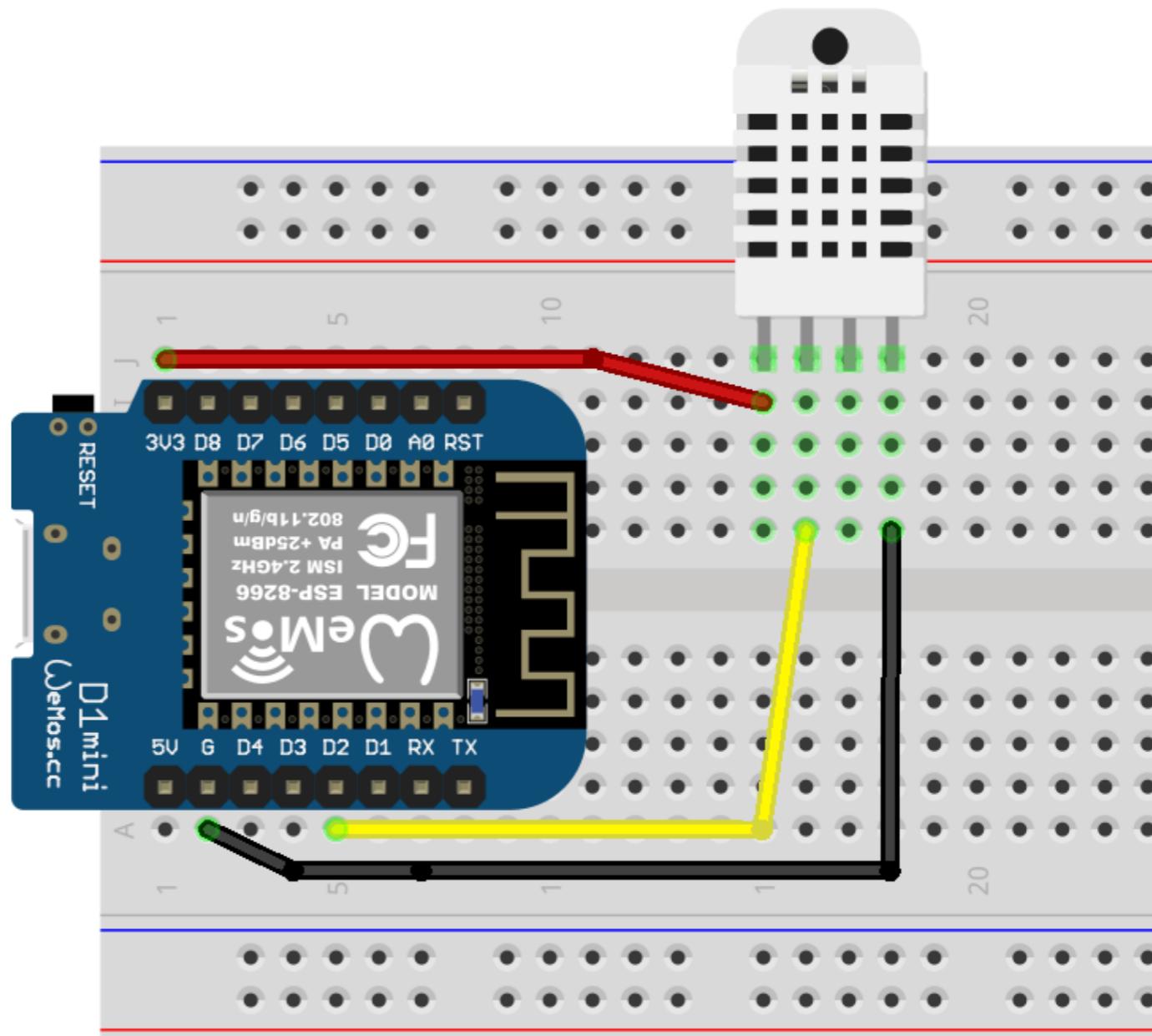
Your third circuit

*Wifi Temperature &
humidity sensor*



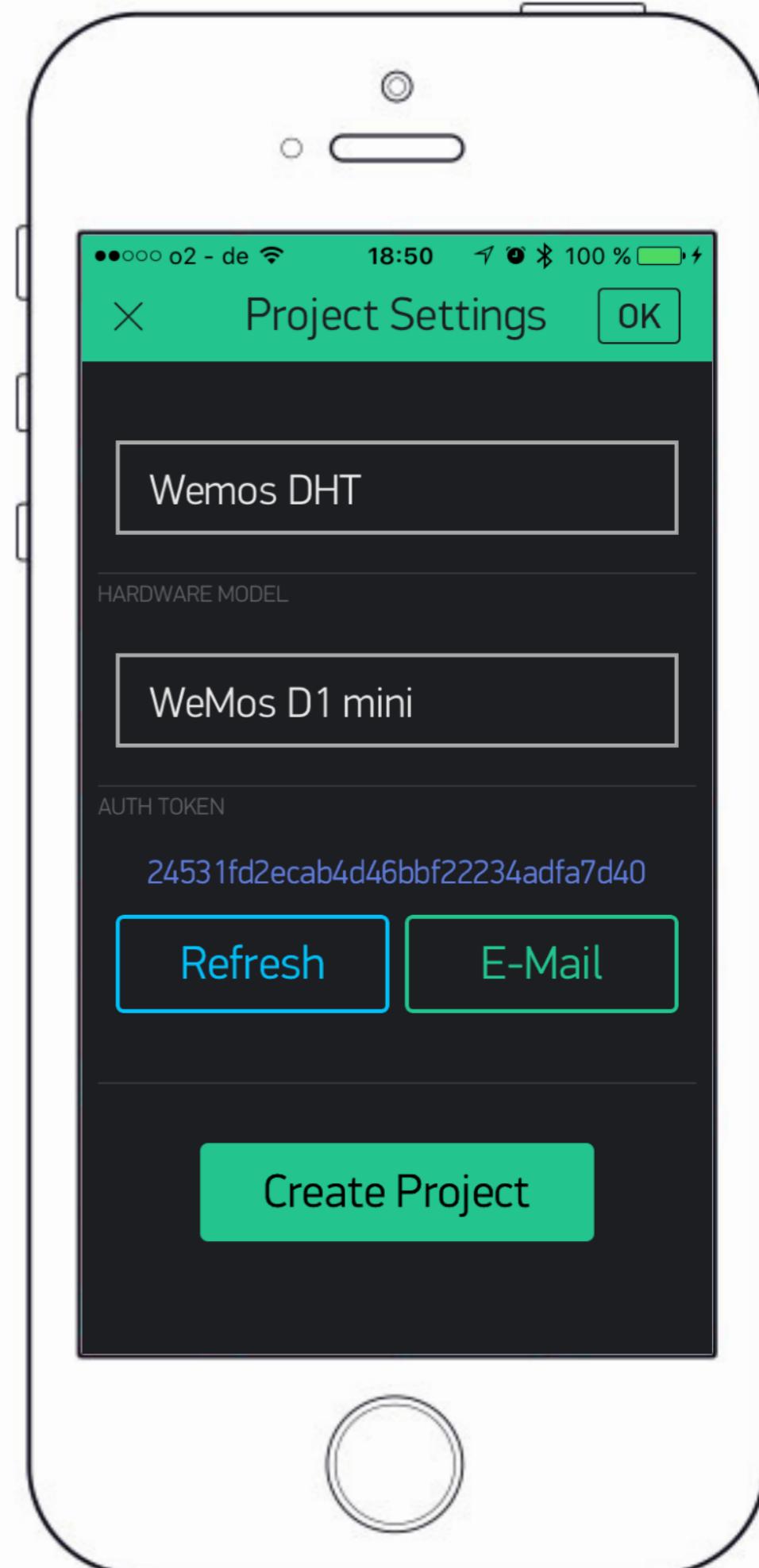
Your third circuit

1. Plug in the Wemos at the edge of the breadboard (leave a row free on each side)
 2. Connect the DHT sensor somewhere on the breadboard
 3. Wire'em up like shown in the diagram
 4. Use a MicroUSB cable and connect the Wemos to your laptop



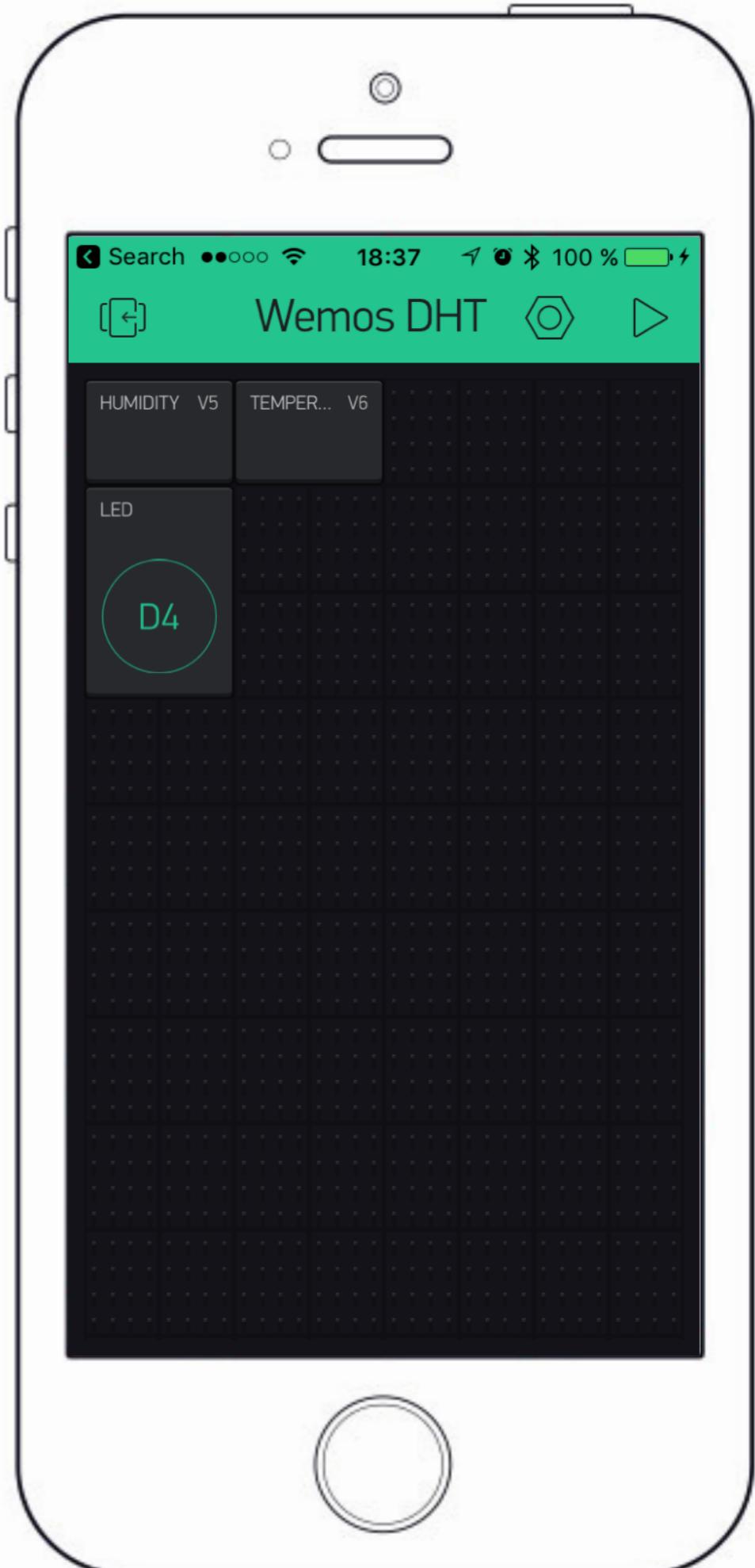
Your second Blynk project

1. Open the Blynk app and hit 'Create New Project'
2. Let's give it a new name
3. Same thing, tap the 'Hardware Model' and scroll all the way down until you find the 'WeMos D1 Mini'
4. You know the drill



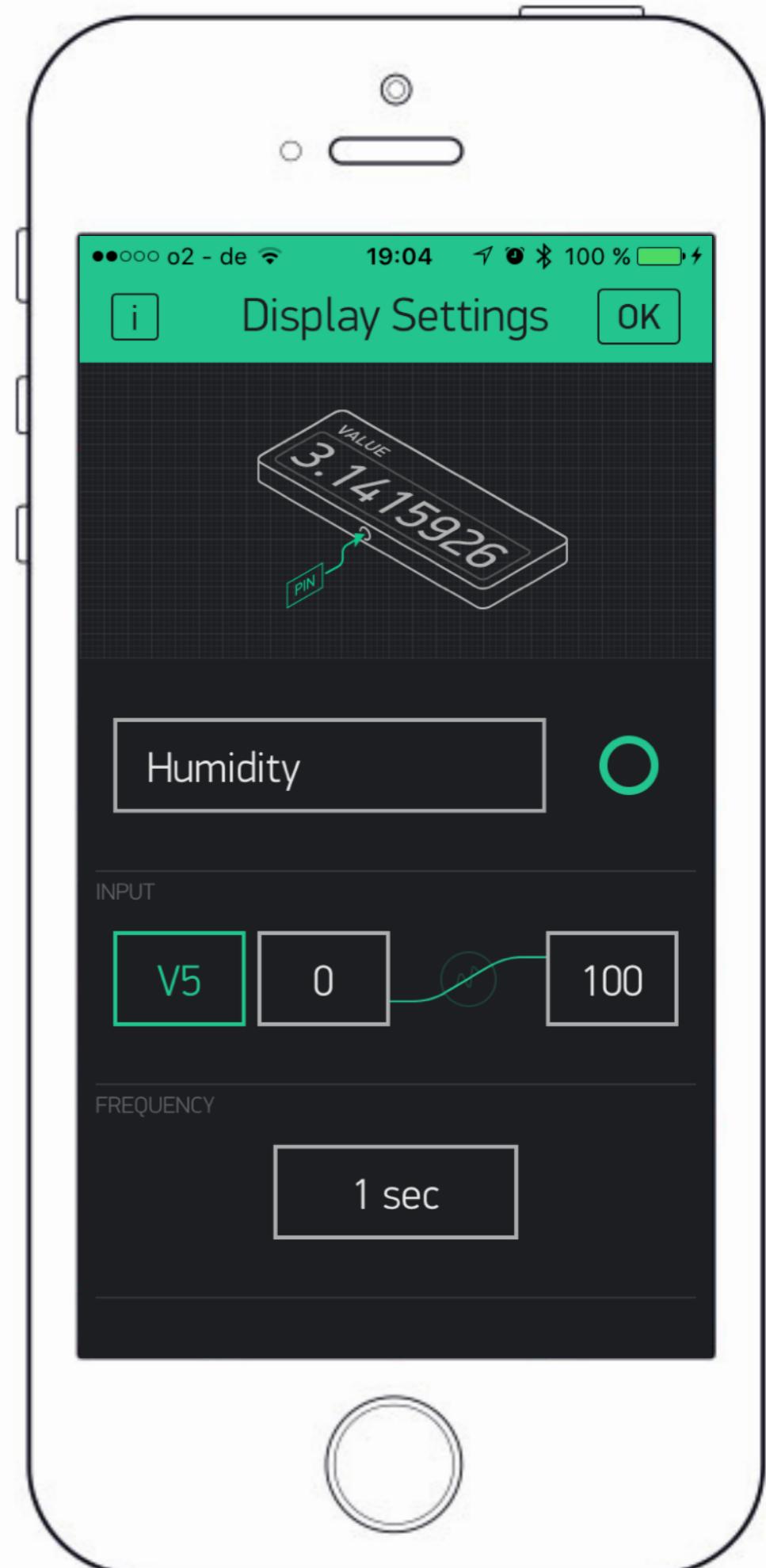
Your second Blynk project

1. Tap anywhere on the black mat
2. You'll see a bunch of components. Scroll down and tap Value Display (costs 200 ⚡)
3. Get another one of those



Your second Blynk project

- 1.Tap the first Value Display.
- 2.You're gonna read Humidity with this one. So change the name to Humidity.
- 3.On the Input, go to Virtual Pins and select V5. This is where your Wemos will write its humidity values.
- 4.Because humidity varies between 0 and 100%, change 1024 to 100
- 5.Do the same thing for Temperature, and use V6, with whatever values you like



Your new program

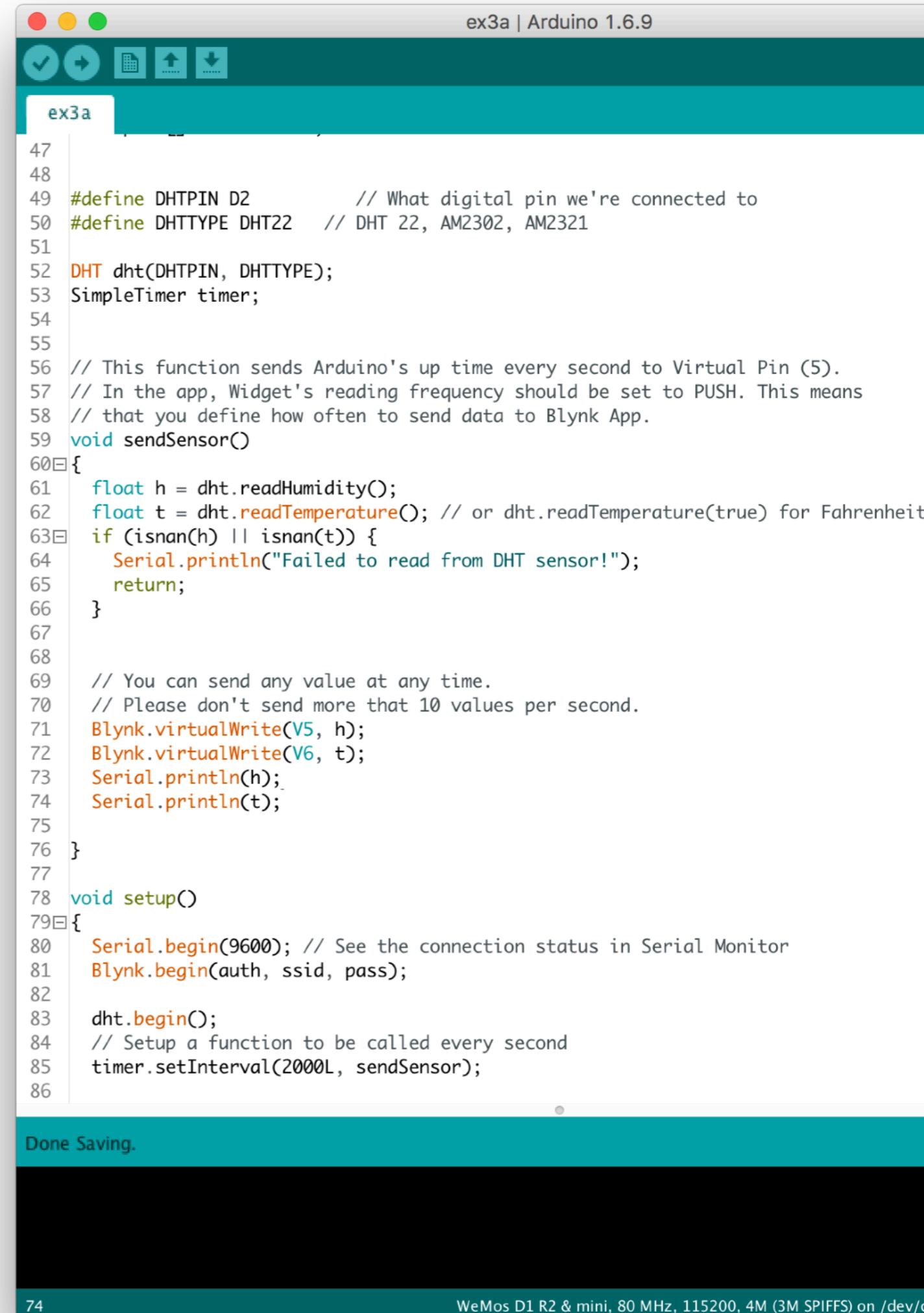
1. This time we're sending values to the Blynk app.

2. We're using

`Blynk.virtualWrite()` to write temperature and humidity measurements to Blynk's virtual variables that we set up on the app.

3. **If your sensor is blue,** change where it says `DHT22` (line 50) to `DHT11`

4. Flash the Wemos with the new code.



```

47
48
49 #define DHTPIN D2           // What digital pin we're connected to
50 #define DHTTYPE DHT22       // DHT 22, AM2302, AM2321
51
52 DHT dht(DHTPIN, DHTTYPE);
53 SimpleTimer timer;
54
55
56 // This function sends Arduino's up time every second to Virtual Pin (5).
57 // In the app, Widget's reading frequency should be set to PUSH. This means
58 // that you define how often to send data to Blynk App.
59 void sendSensor()
60{
61    float h = dht.readHumidity();
62    float t = dht.readTemperature(); // or dht.readTemperature(true) for Fahrenheit
63    if (isnan(h) || isnan(t)) {
64        Serial.println("Failed to read from DHT sensor!");
65        return;
66    }
67
68
69    // You can send any value at any time.
70    // Please don't send more than 10 values per second.
71    Blynk.virtualWrite(V5, h);
72    Blynk.virtualWrite(V6, t);
73    Serial.println(h);
74    Serial.println(t);
75}
76
77
78 void setup()
79{
80    Serial.begin(9600); // See the connection status in Serial Monitor
81    Blynk.begin(auth, ssid, pass);
82
83    dht.begin();
84    // Setup a function to be called every second
85    timer.setInterval(2000L, sendSensor);
86}

```

Done Saving.

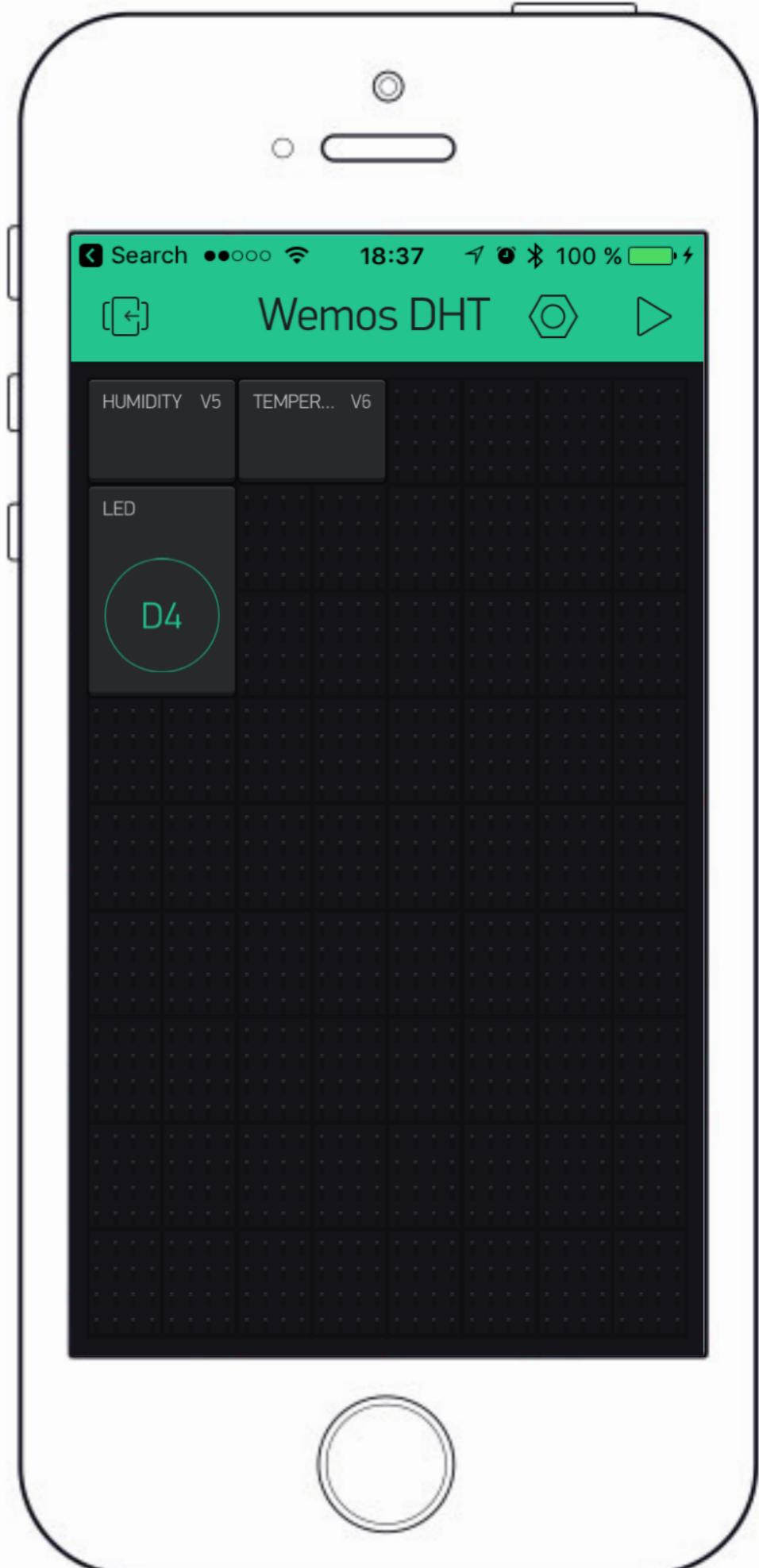
Back in the app

1. Hit the  button

2. You now have your very own connected & super smart humidity & temperature sensor.

Awesome job!

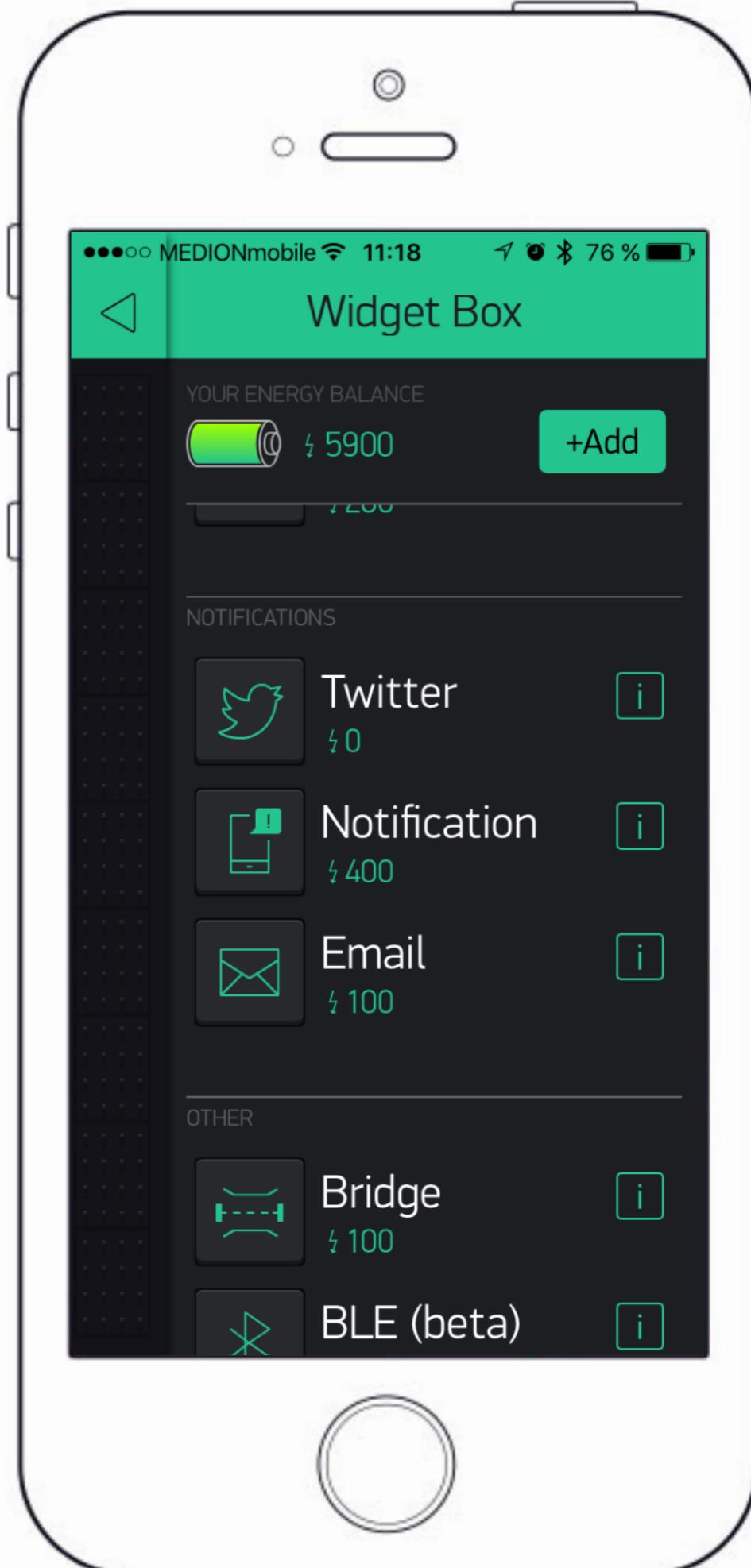
3. Check your app! You should be getting some readings by now



More notifications!

1. Let's set up a new notification widget

2. What to do next? Maybe make something useful with the humidity measurements somehow?



Back to the Arduino app

1. So you wanna get notified when humidity gets too high? *Smart!*

2. Go to line 69

3. *Time to code:* let's use an `if` to send a notification if humidity is higher than 60% then...

4. Let's use Blynk's `notify` function again to trigger a notification on your phone: `Blynk.notify("Your message here");`

5. Remind yourself to open a window or something 💨

6. Flash it! ⚡

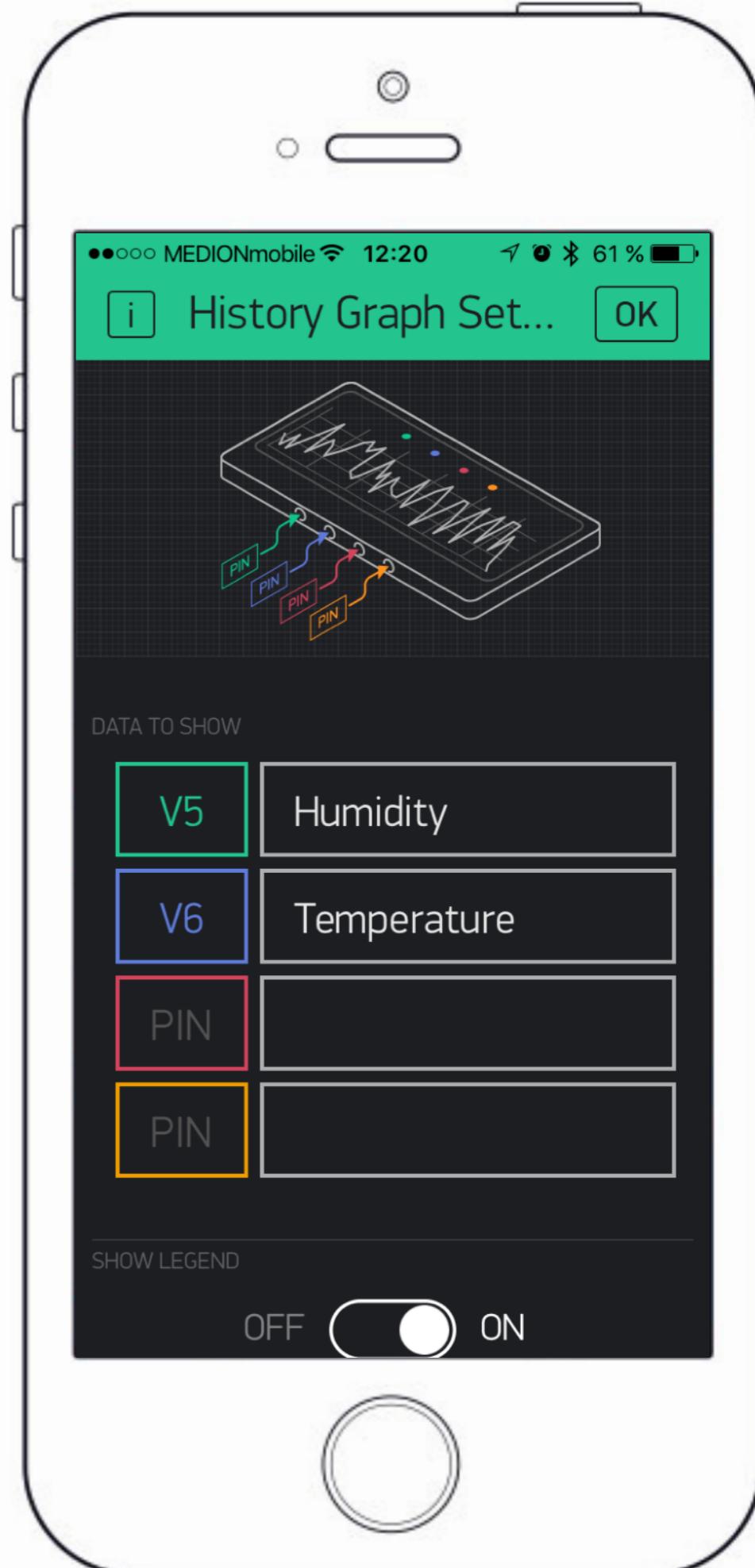
```

blynk_DHT §
50 #include <DHT.h> // DHT TYPE DHT22 // DHT 22, AM2302, AM2321
51
52 DHT dht(DHTPIN, DHTTYPE);
53 SimpleTimer timer;
54
55
56 // This function sends Arduino's up time every second to Virtual Pin (5).
57 // In the app, Widget's reading frequency should be set to PUSH. This means
58 // that you define how often to send data to Blynk App.
59 void sendSensor()
60 {
61     float h = dht.readHumidity();
62     float t = dht.readTemperature(); // or dht.readTemperature(true) for Fahrenheit
63     if (isnan(h) || isnan(t)) {
64         Serial.println("Failed to read from DHT sensor!");
65         return;
66     }
67
68 // Uncomment to play around with notifications
69 // if (h > 60) {
70 //     Blynk.notify("Your humidity is pretty high. Consider opening a window.");
71 // }
72
73 // You can send any value at any time.
74 // Please don't send more than 10 values per second.
75 Blynk.virtualWrite(V5, h);
76 Blynk.virtualWrite(V6, t);
77 Serial.println(h);
78 Serial.println(t);
79
80
81 }
82
83 void setup()
84 {
85     Serial.begin(9600); // See the connection status in Serial Monitor
86     Blynk.begin(auth, ssid, pass);
87
88     dht.begin();
89     // Setup a function to be called every second
90     timer.setInterval(2000L, sendSensor);
91
92 }
93
94
95
96 void loop()
97 {
98     Blynk.run(); // Initiates Blynk
99     timer.run(); // Initiates SimpleTimer

```

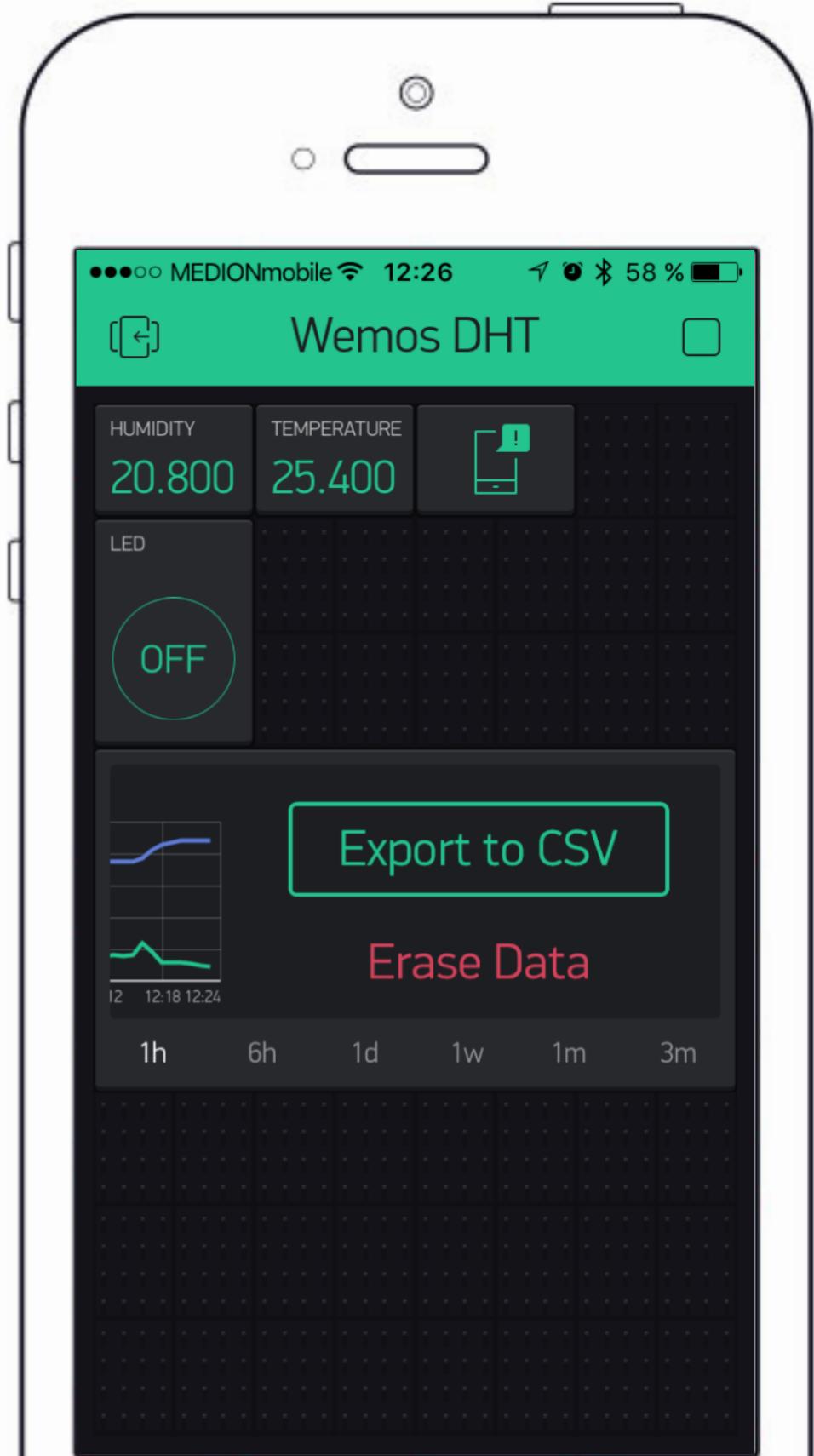
Any Data Scientists in the 🏠?

1. Yeah, cool, but how can I go back check all my measurements? Go back to the Blynk app.
2. Tap the mat, scroll down and drag a History Graph (pricey, I know)
3. Tap on it and select V5 and V6 on the first two boxes, like in the screenshot.
4. OK and then  and get ready to be amazed!



Data, Graphs & Beyond

1. Whoa! Nice graph. Thanks! You can do more though
2. Swipe left on the graph.
3. You can now get all your data sent in CSV format to your email!
4. The .csv file can be opened in a lot of different ways, including Excel. Try it out.



Thank you!

WATT *x*