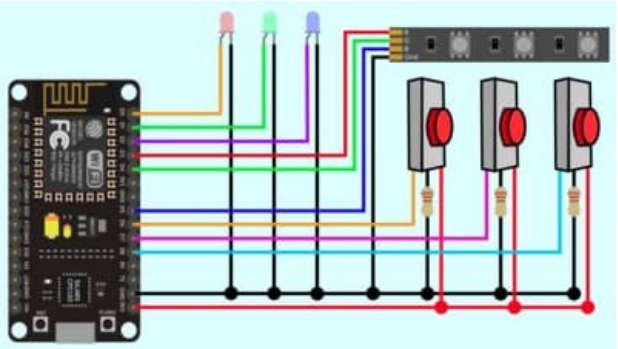

Virtual Workshop (Internet-of-Things)

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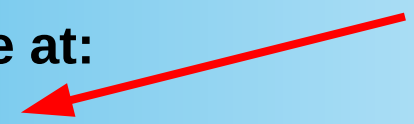
Play · Experience · Learn

Before we start...

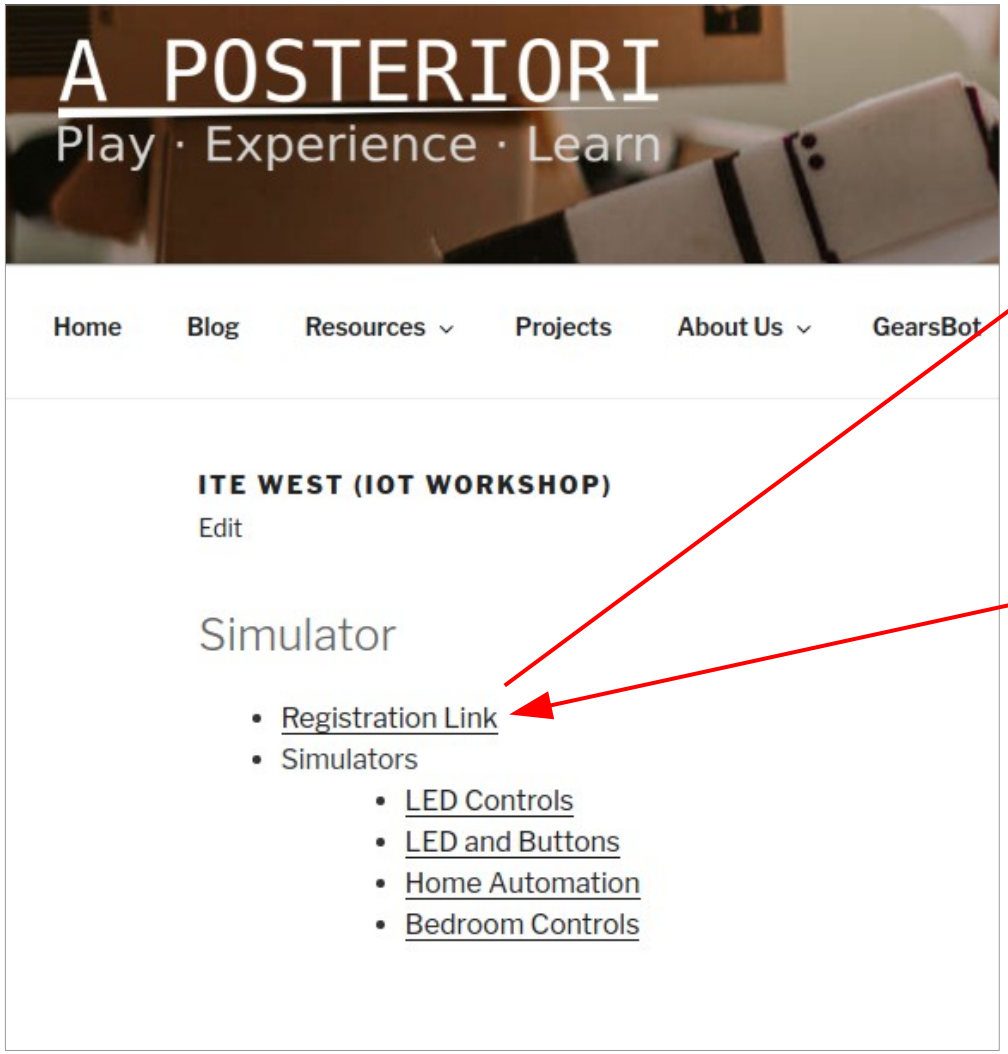
- Open this page!

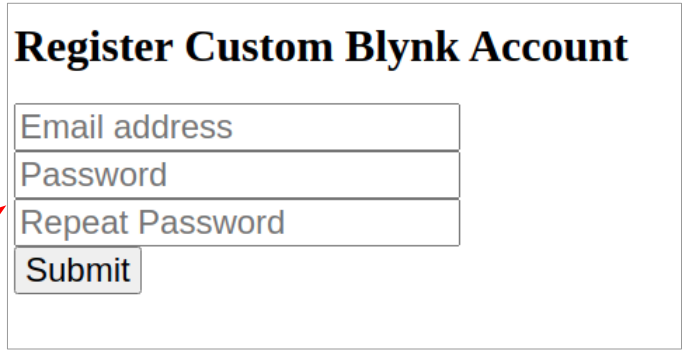
https://a9i.sg/ite

Slides available at:
https://a9i.sg/ite



Register





- Register an account
- Use any email (personal or school)

If you haven't registered, do this NOW.

About Us - A Posteriori

YONI
Spent 15 years developing software in the financial service industry, now developing the next generation of Makers and Coders.

CORT
Ex-Navy engineer managing big engines, powerful generators, and easily choked toilets. Codes and builds stuff because he's too cheap to buy

What is the Internet-of-Things (IoT)?

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What is IoT?

Control lights through phone...

Turn on aircon before reaching home...

Toast your bread remotely (...we don't know why either)

- Make existing or new devices more useful by connecting them to the internet (eg. lights, aircon, door locks, burglar alarm)

IoT in Industry

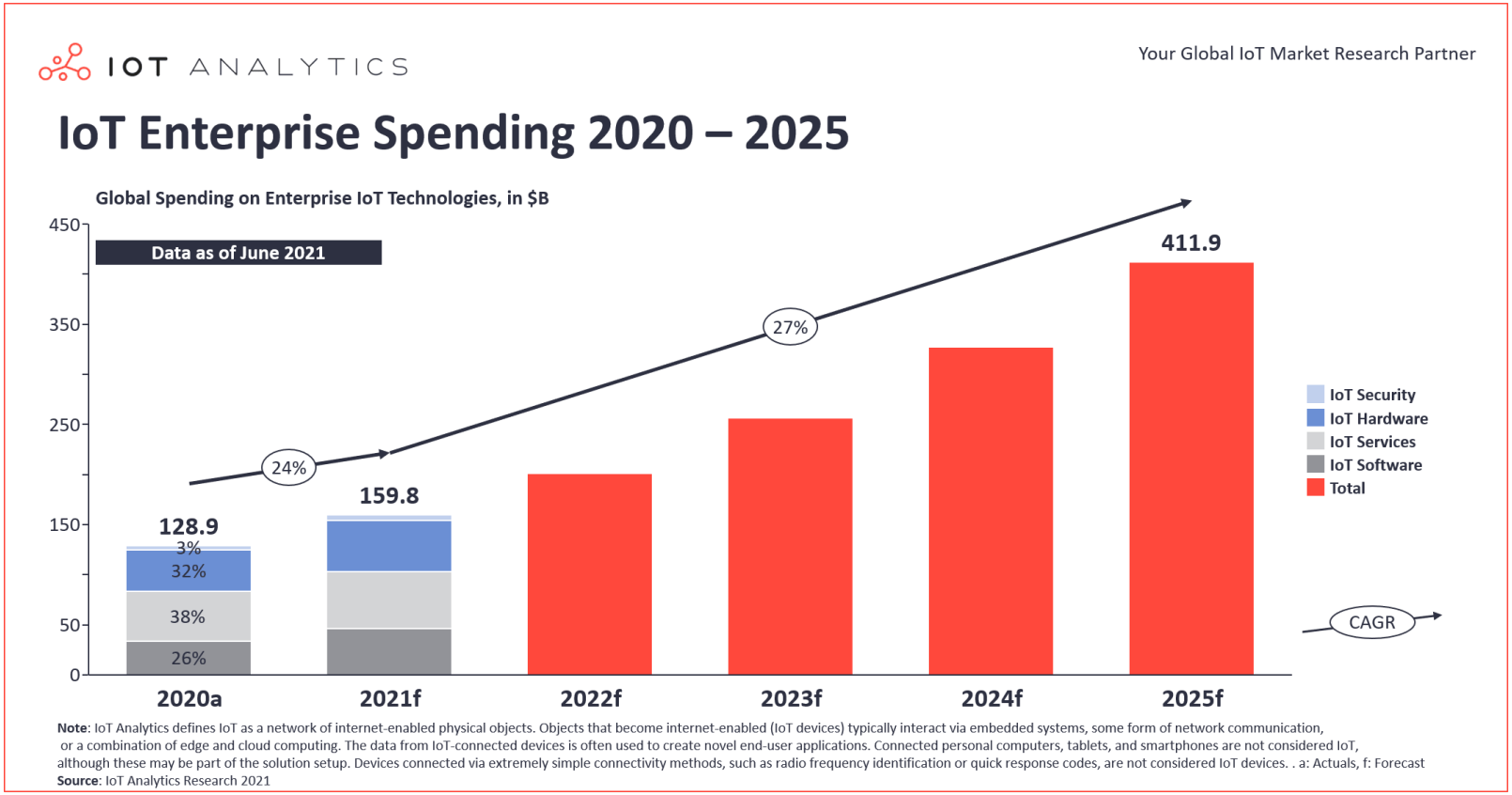
Notify vendor to top-up machine when empty

Track water and power usage

Arrange for garbage collection when bin is full

Growth in IoT

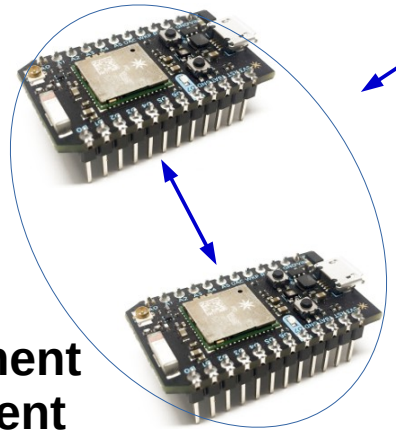
- More companies are spending on IoT
- High demand for expertise



Growth Drivers

- Smart Sensors
  - Water level, temperature, pressure
- Improved Capabilities
  - Aircon control, phone apps for home devices
- Data Analytics
  - Detect potential defects before they happen
  - Movement of people

How Does IoT Work?

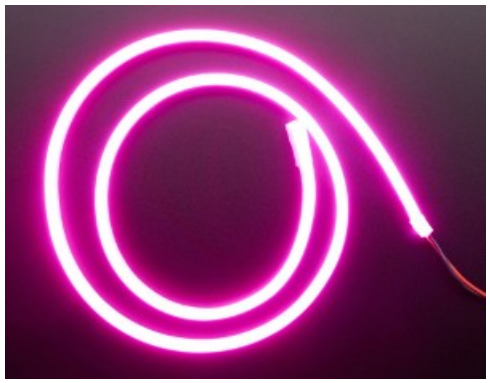


Internet Server
- Store and Process

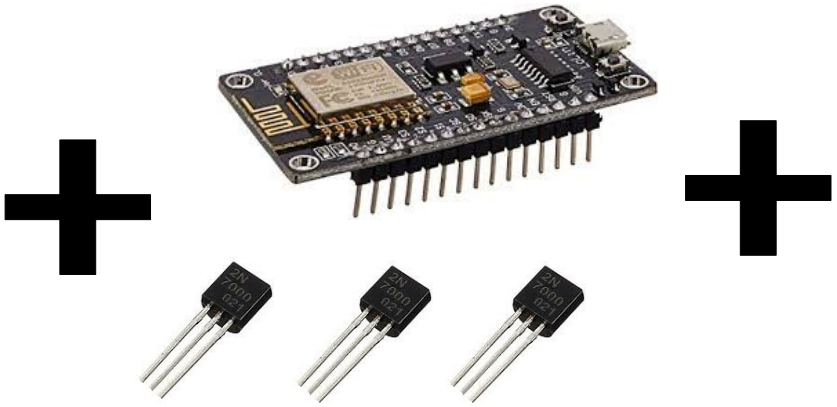
IoT Devices
- Sense environment
- Control equipment

User Devices
- View and Control
- Typically phones or computers

IoT Can Be Cheap & Easy!



LED Strips
($15 with power supply)



Controller and transistors ($10)

```
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

char auth[] = "xxx";

char ssid[] = "HomeWifi";
char pass[] = "yyy";

void setup()
{
  Blynk.begin(auth, ssid, pass);
}

void loop()
{
  Blynk.run();
}
```

13 lines of code
(5 mins of your time)

Phone controllable mood lighting

Easy IoT With Blynk

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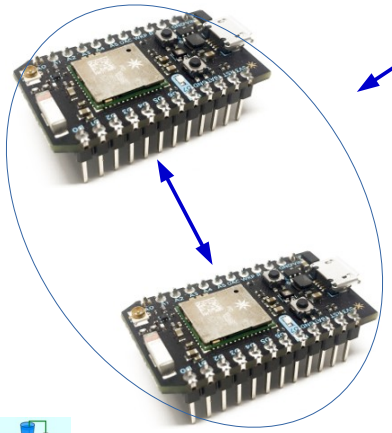
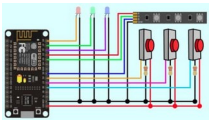
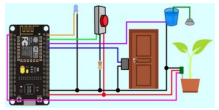
3 Elements of IoT

Internet Server
- **Blynk Server**
- **Already set up for you**



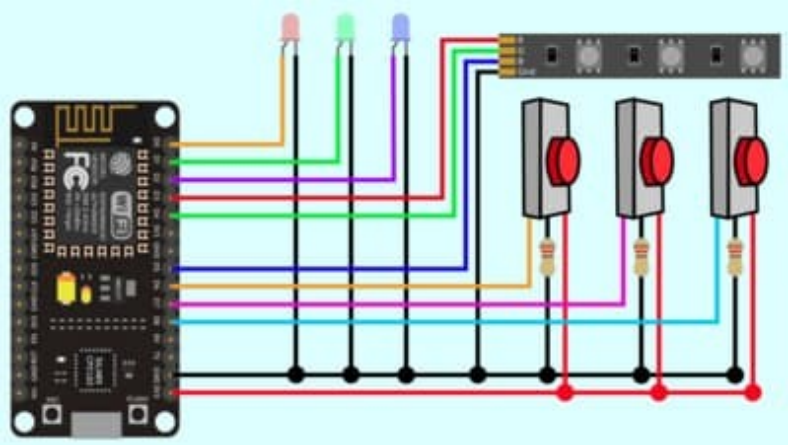
IoT Devices
- **Simulator**

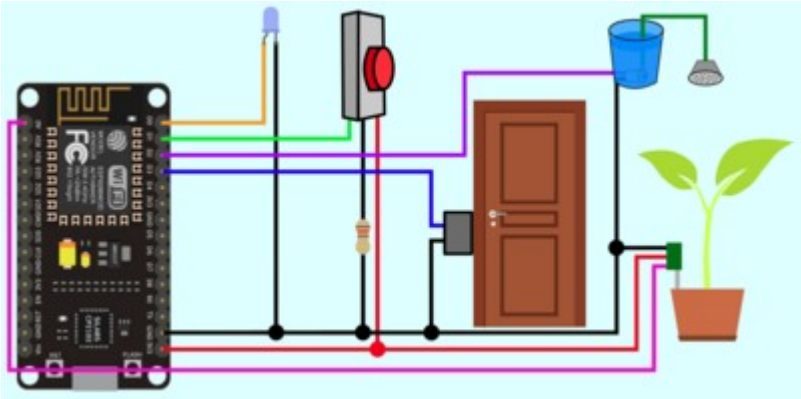




User Devices
- **Your Phone**
- **Blynk App**

Our Virtual Devices





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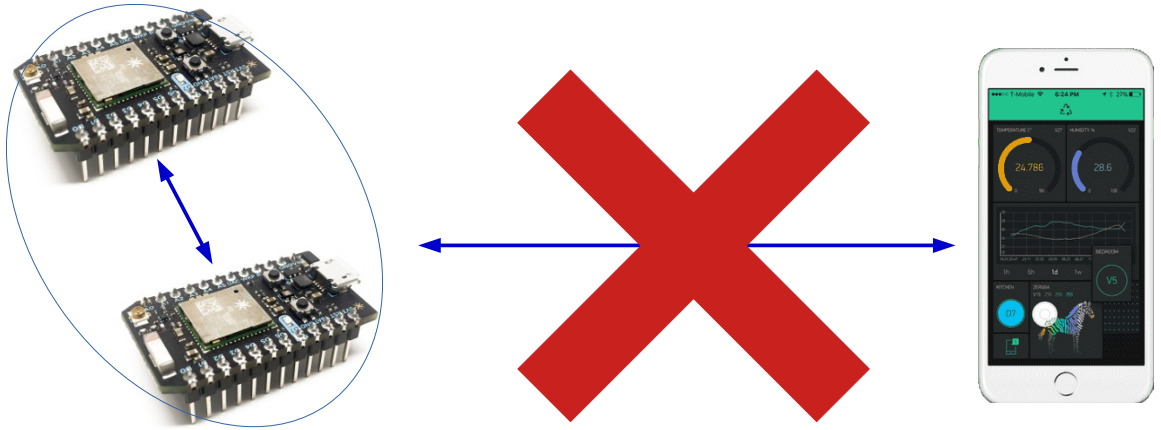
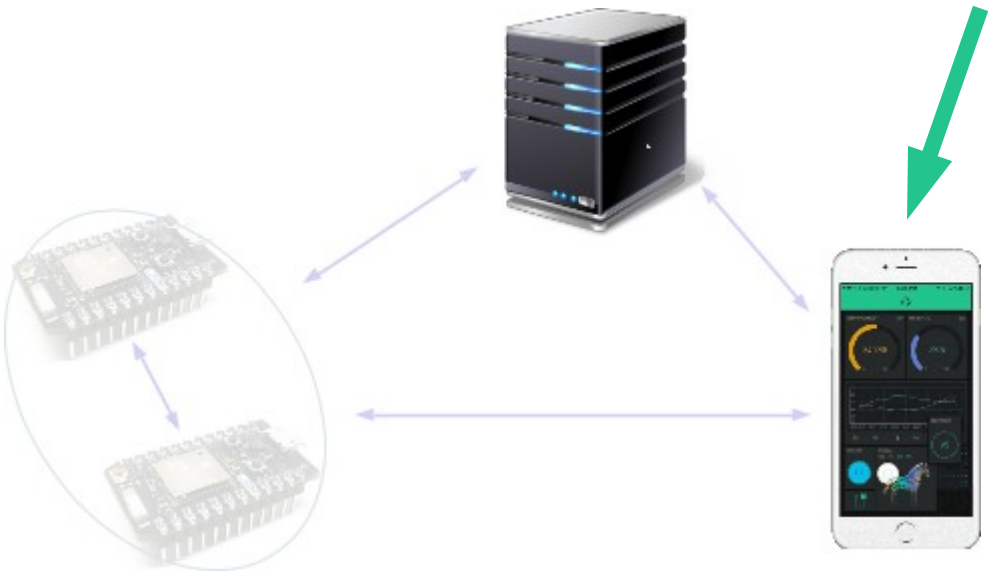
No Server?



- Cannot work without server
- Home and Phone do not have fixed internet (IP) addresses
- Unable to contact each other as they don’t know their address
- Server helps by acting as a middleman

Blynk

Blynk provides the *server* and the *mobile app* for your IoT device.



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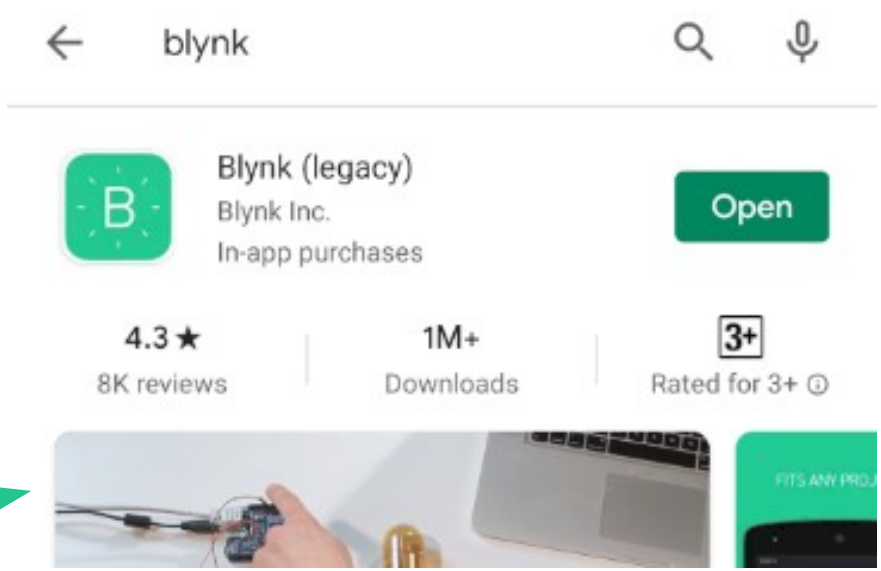
Blynk

- Install Blynk (legacy)
- Available for iOS or Android
- Register and Login



Challenge 1:
Setup your Blynk App

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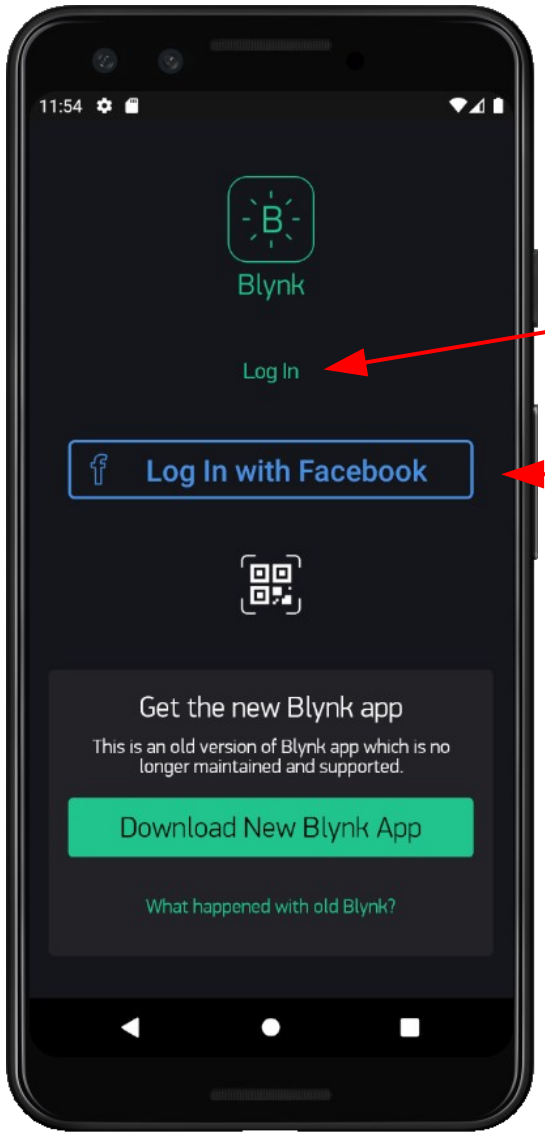
Challenge 1 : Setup Blynk App



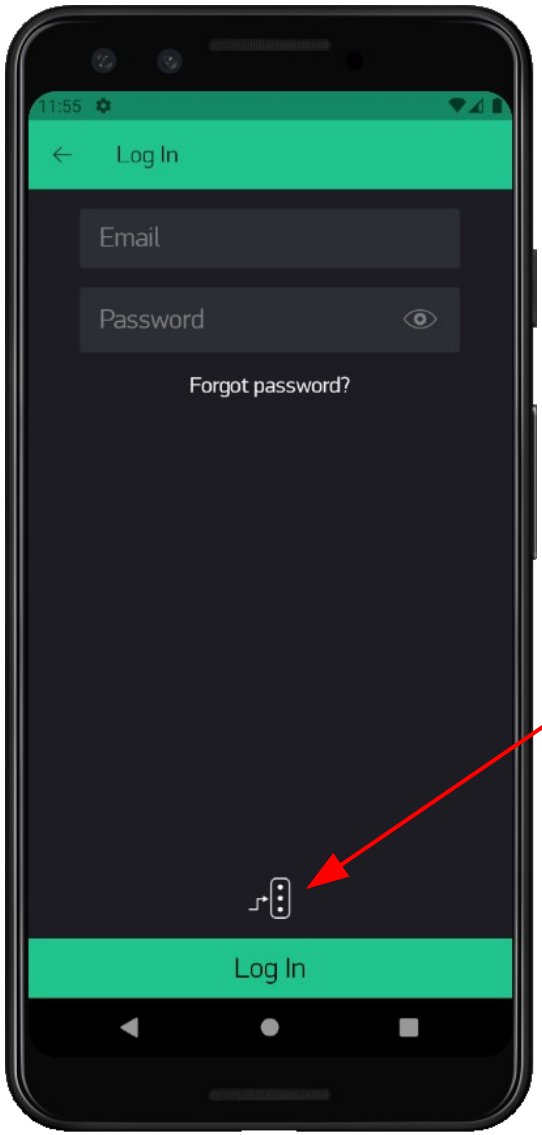
Click “Log In”

Do NOT use Facebook login

Turn OFF your phone’s WiFi.

- Your school currently blocks the server.
- You need to use your phone data.
- Data usage is very low (less than 1 webpage for the 3 hours)

Challenge 1 : Setup Blynk App

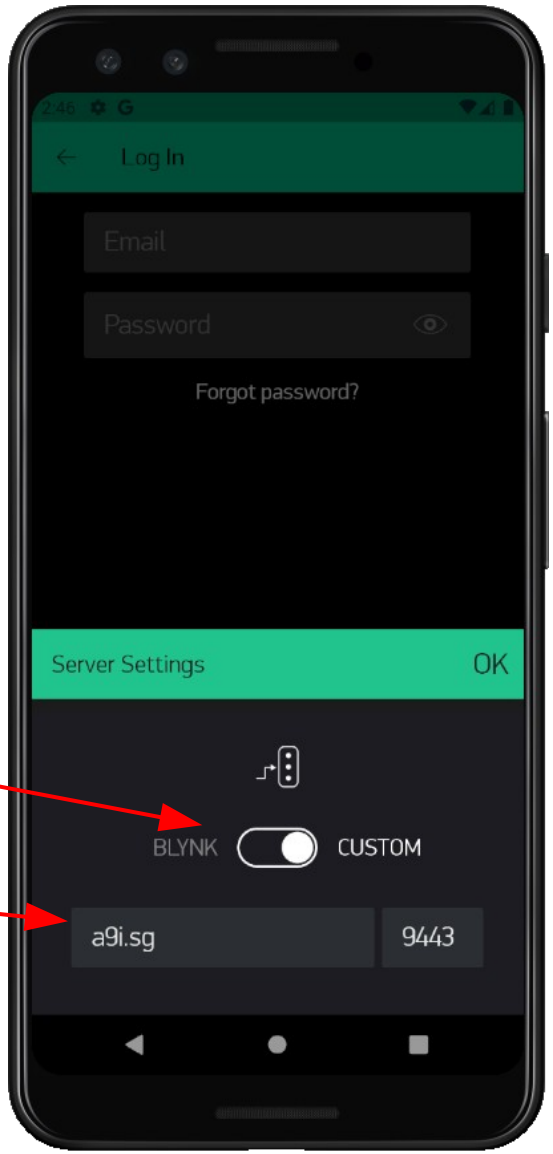


Click this icon...

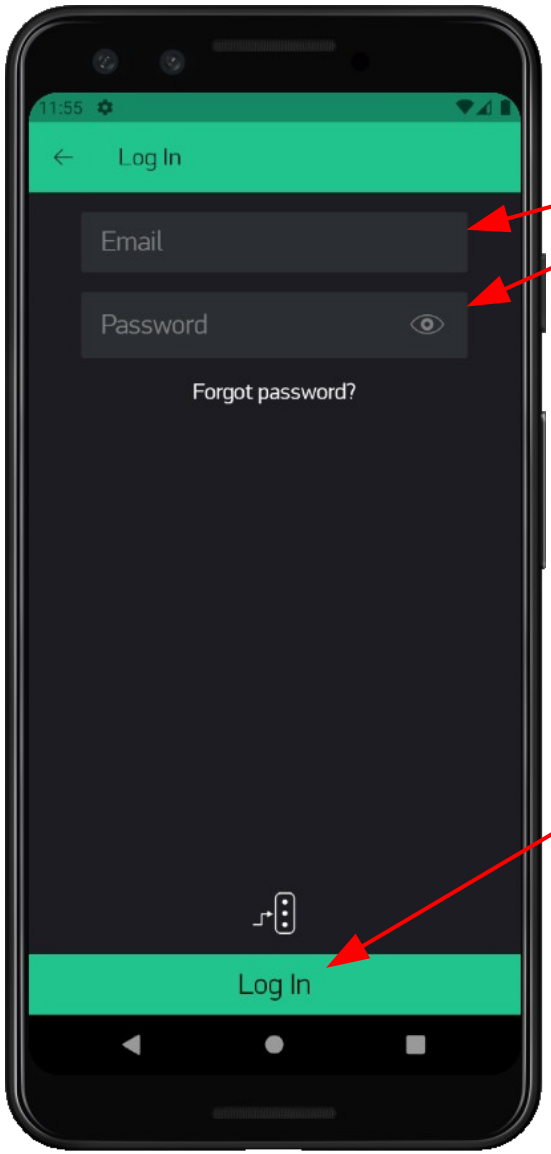
...select “CUSTOM”...

...and set the server to “a9i.sg” and “9443”

Click “OK”



Challenge 1 : Setup Blynk App

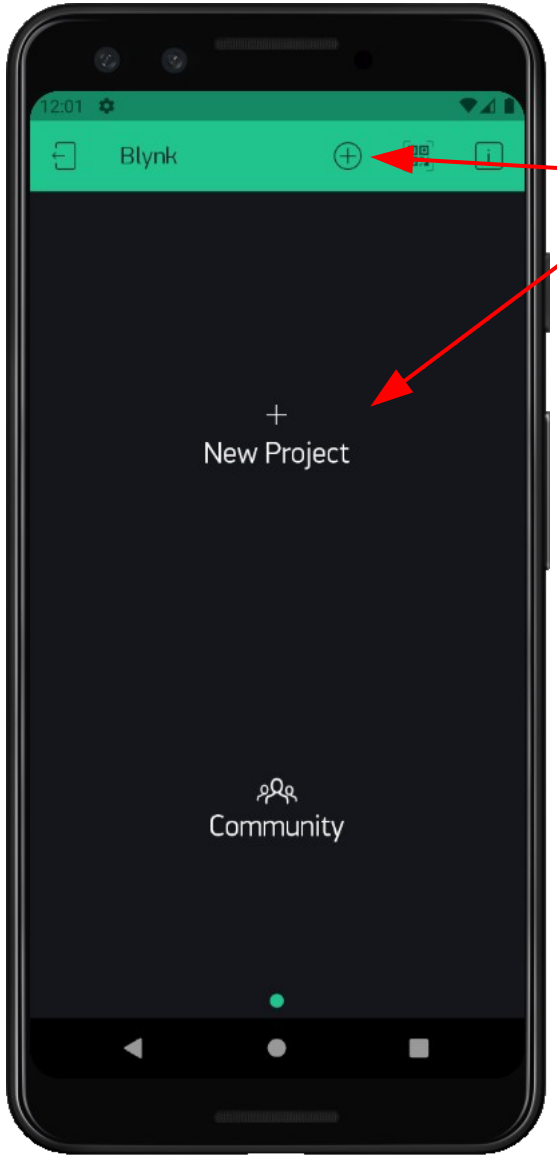


Use the email and password that you have registered...

If you have just registered your account, you may need to wait up to 5 mins before you can log in!

...and “Log In”

Challenge 1 : Setup Blynk App

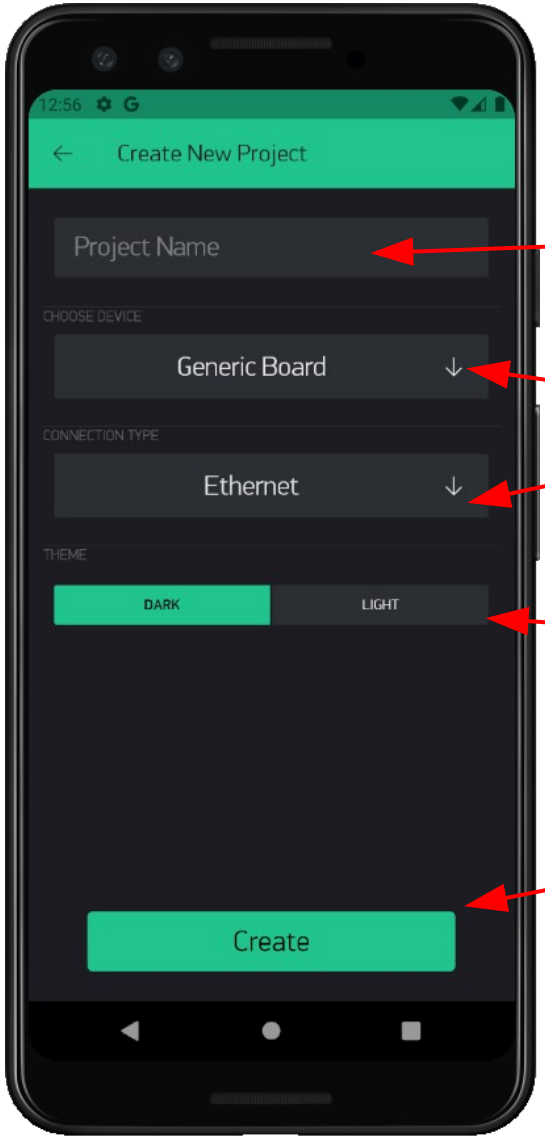


Create a new project

For your first project, either of these button will do.

For subsequent projects, the bottom button may be hidden.

Challenge 1 : Setup Blynk App



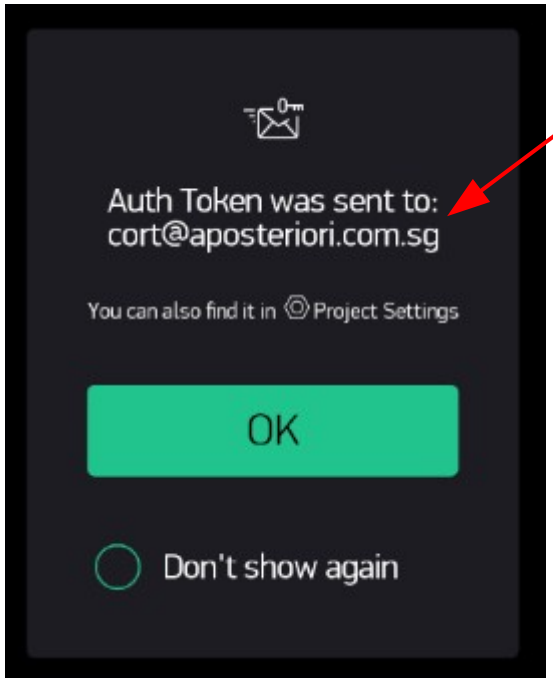
Choose Name (eg. “Project 1”)

Set “Device” to “Generic Board” and “Connection Type” to “Ethernet”

Change the theme if you want

Tap “Create” when you’re done

Challenge 1 : Setup Blynk App



You'll receive an email with the "Auth Token".
May take a few minutes to arrive in your mail.

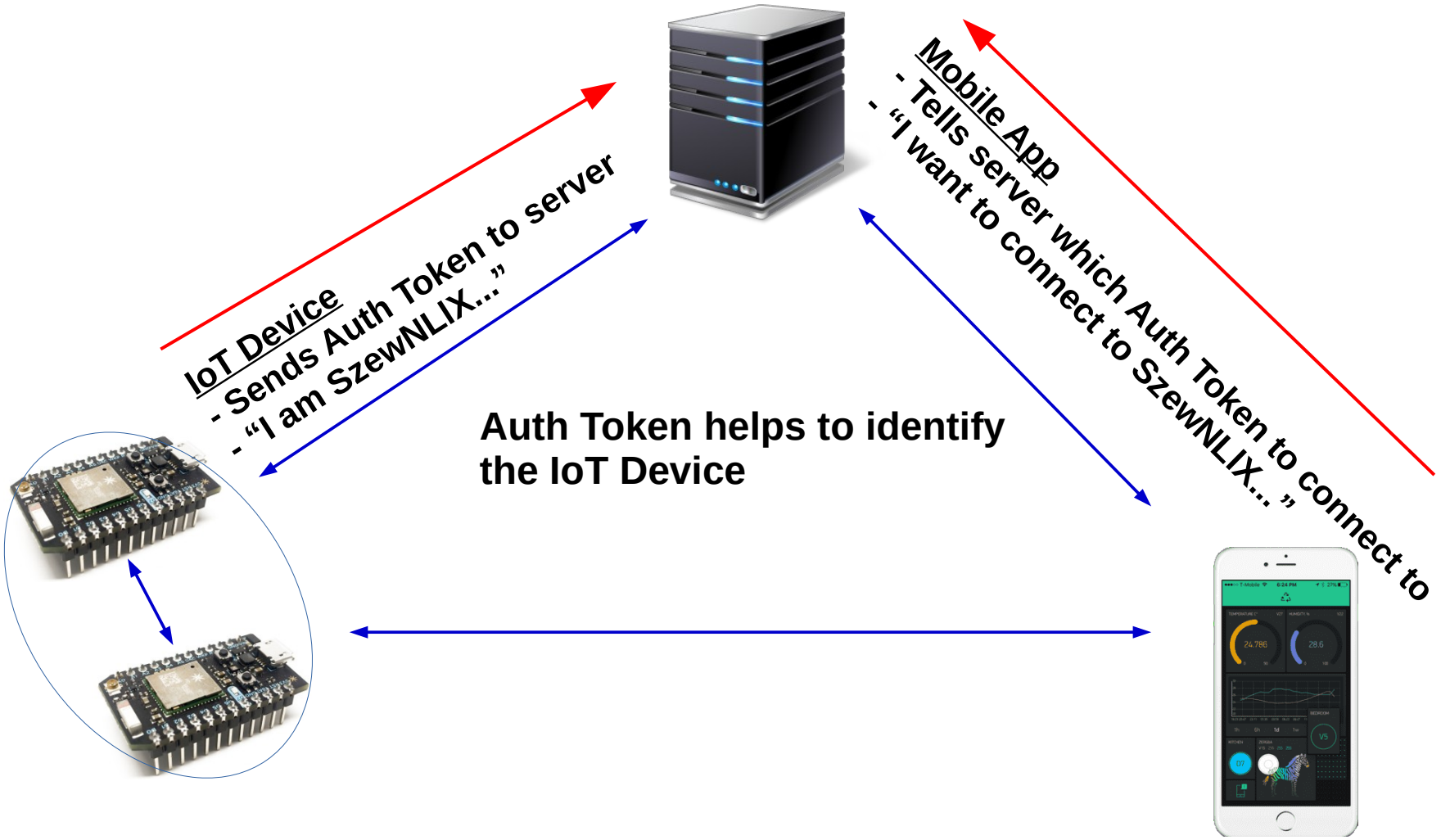
Auth Token for Project 1 project and device Project 1

From blynk.a9i@gmail.com on 2021-10-18 12:02

Details

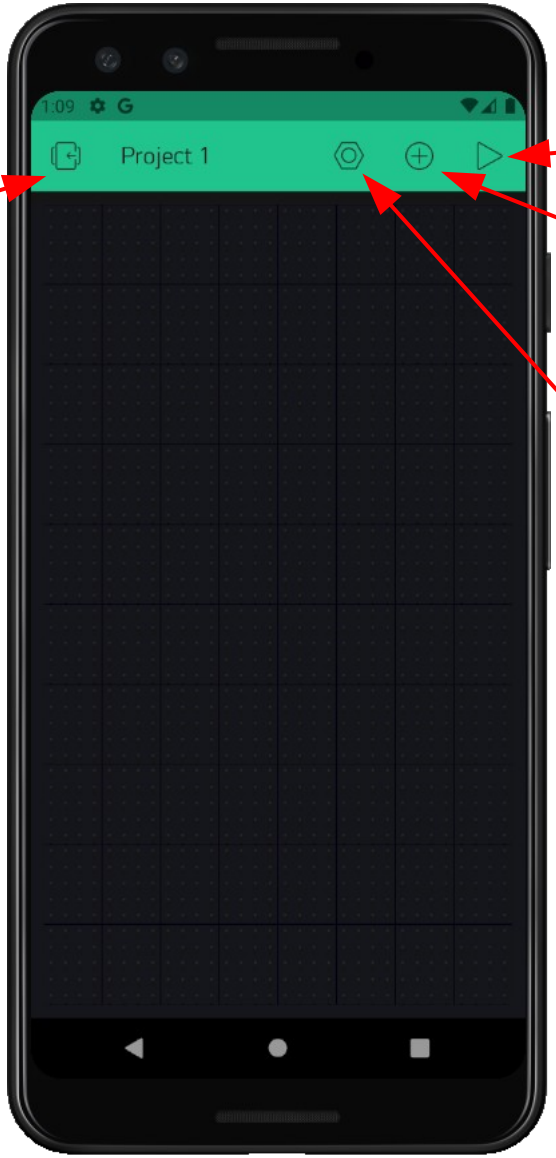
```
Auth Token : SZewNLlX__53ZqXXrS3KPGuewje0AcYm

Happy Blynking!
-
Getting Started Guide -> https://www.blynk.cc/getting-started
Documentation -> http://docs.blynk.cc/
Sketch generator -> https://examples.blynk.cc/

Latest Blynk library -> https://github.com/blynkkk/blynk-library/releases/download/v0.6.1
/Blynk_Release_v0.6.1.zip
Latest Blynk server -> https://github.com/blynkkk/blynk-server/releases/download/v0.41.13/server-
0.41.13.jar
-
https://www.blynk.cc
twitter.com/blynk_app
www.facebook.com/blynkapp
```

Auth Token


IoT Device
- Sends Auth Token to server
- "I am SzewNLIX.."
Mobile App
- Tells server which Auth Token to connect to
- "I want to connect to SzewNLIX.. "
Auth Token helps to identify the IoT Device

Challenge 1 : Setup Blynk App

Project Editor Screen



Exit
Go back to project manager

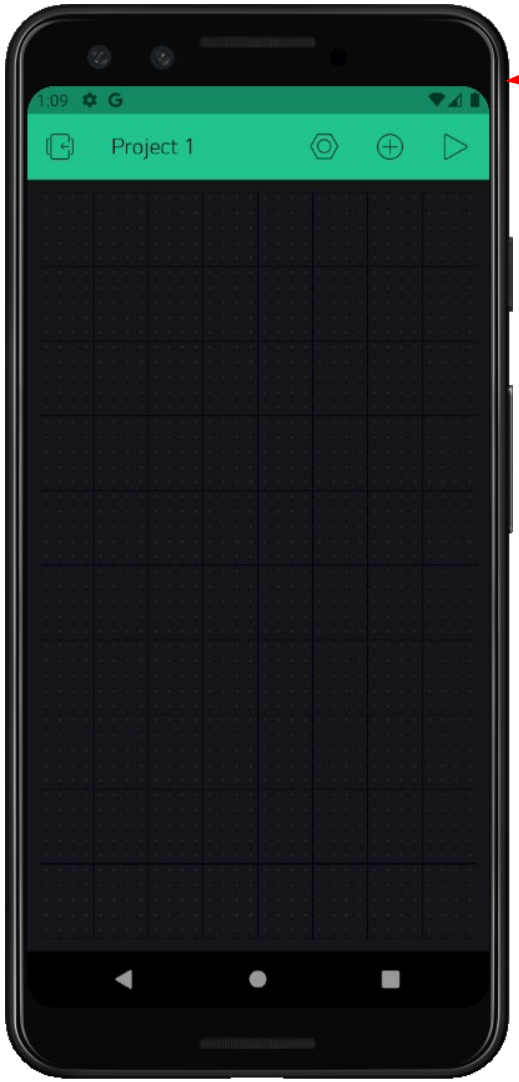
Play
Start your IoT app.

Add Widget
Add buttons and other components to your IoT app

Project Settings
Change Settings

Challenge 1 : Setup Blynk App

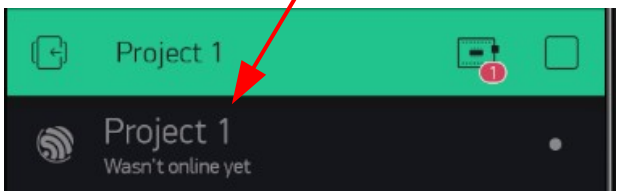
Edit Screen



Click the “Play” button

Run Screen

Devices button
Click on this to show your device status...



Device not online (...we haven’t started the IoT device simulator)

Challenge 2:
Connect IoT Device

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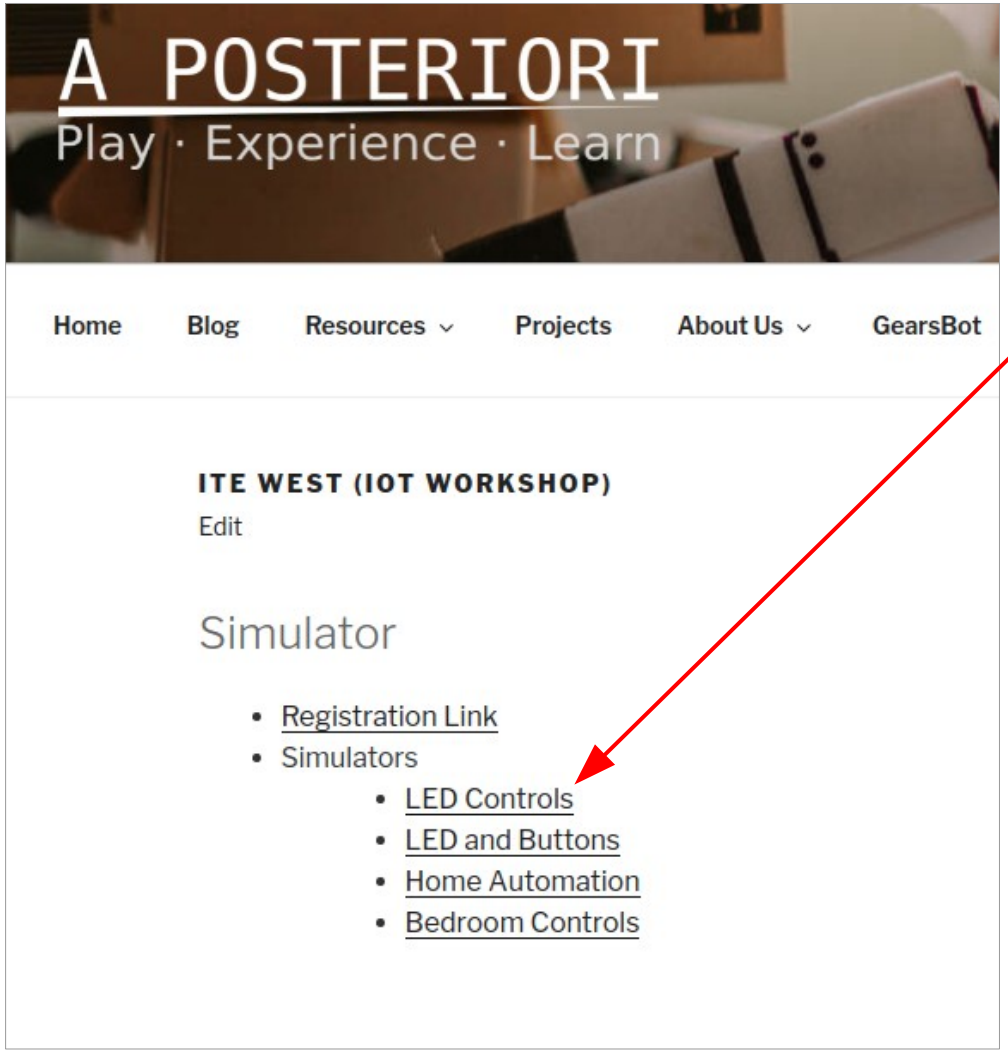
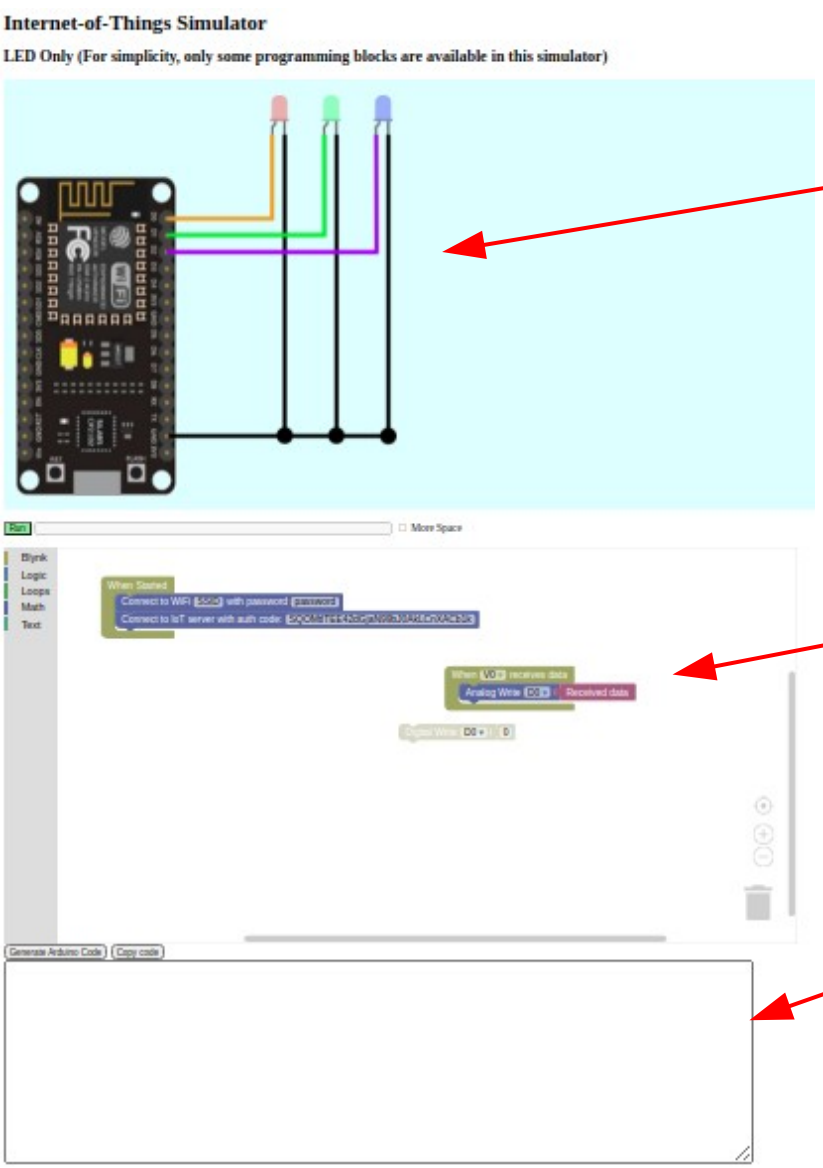
Challenge 2 : Connect IoT Device



Open the first simulator "LED Controls"

Challenge 2 : Connect IoT Device



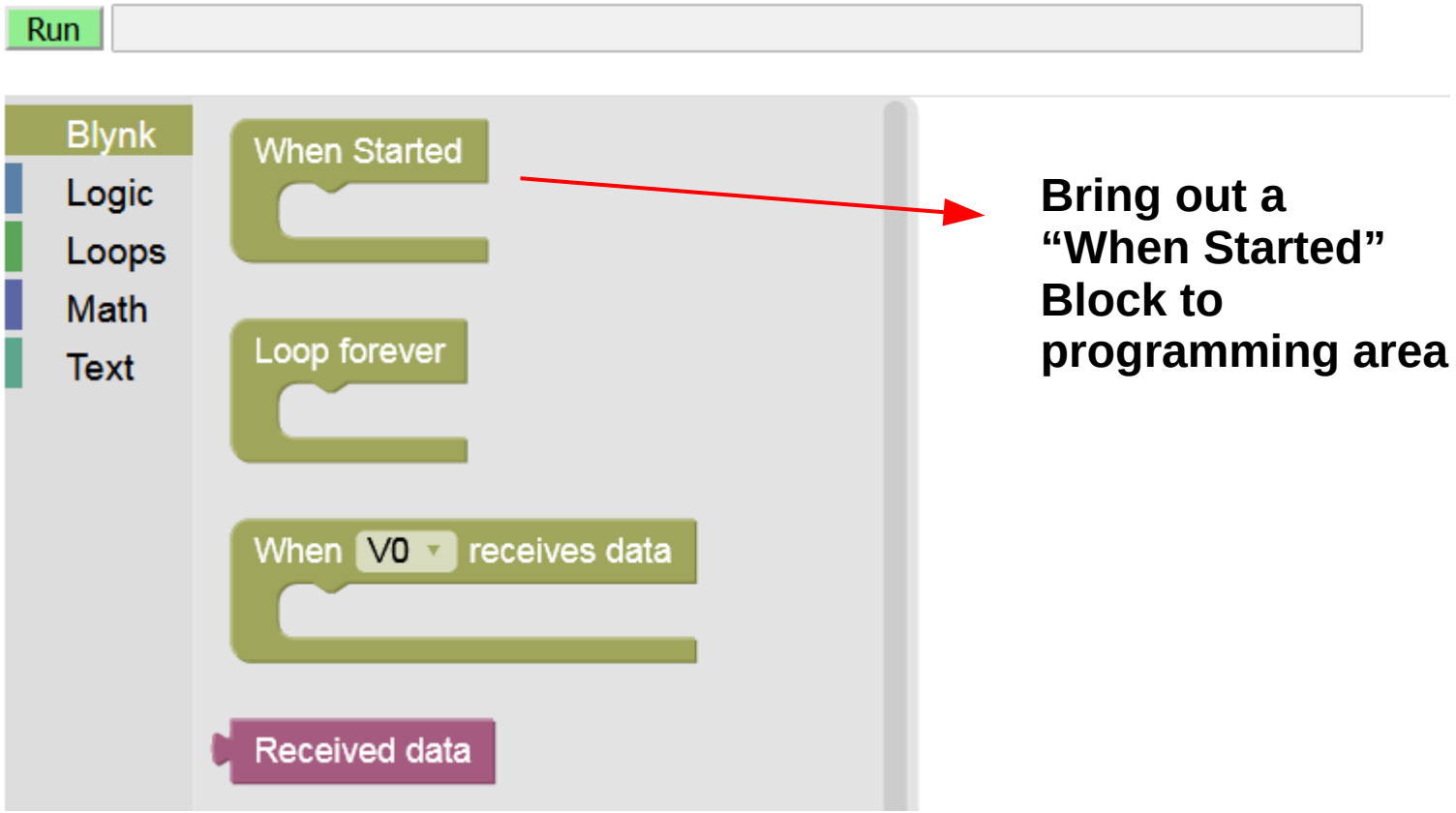
Simulator Screen
This shows the effects of your IoT controls

Blocks program
Here's where we program our IoT device

Auto-generated Arduino code
Clicking "Generate Arduino Code" will convert your block program into "C++" code that you can run on a physical IoT microcontroller (eg. ESP8266).

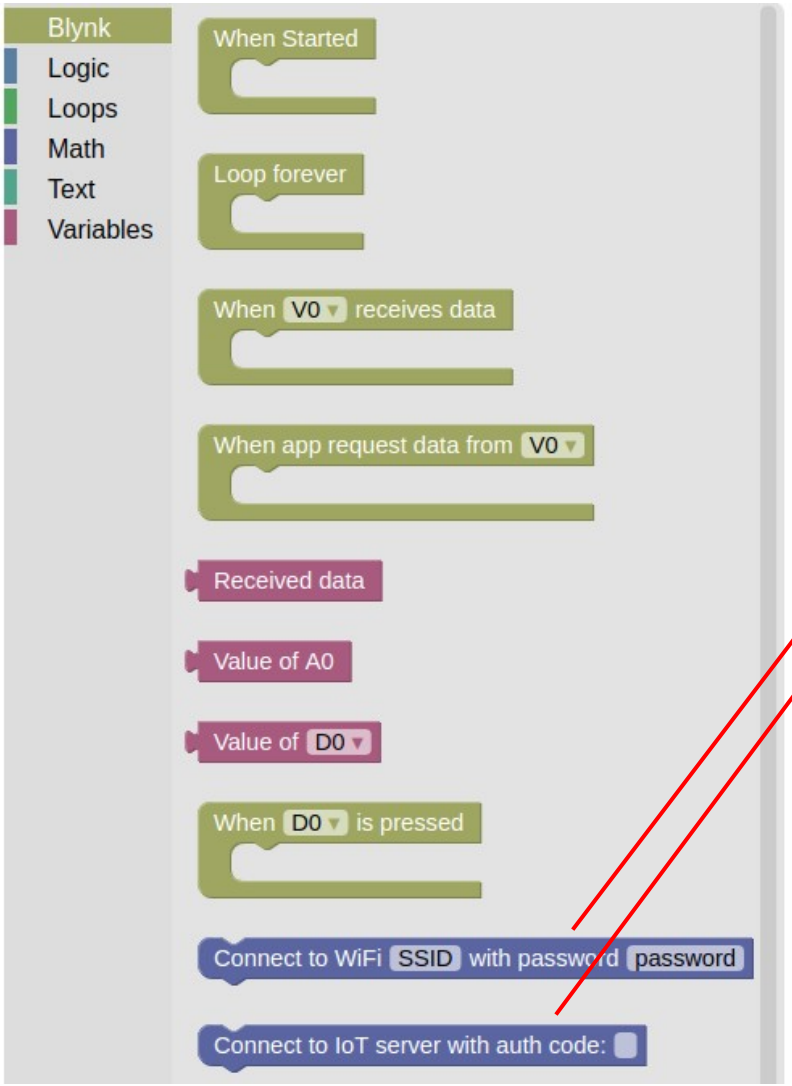
Challenge 2 : Connect IoT Device

Blocks Program

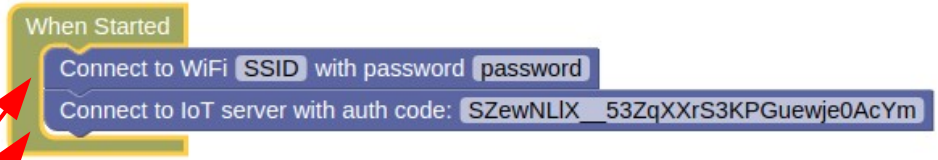


Bring out a "When Started" Block to programming area

Challenge 2 : Connect IoT Device

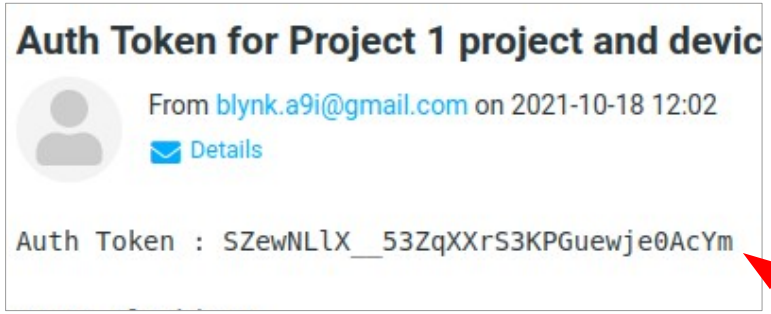


Place a “Connect to WiFi” block followed by a “Connect to IoT Server” block inside the “When Started” block.



You don’t actually need the “Connect to WiFi” block in the simulator, but you’ll need it if you want to use the code for a real IoT device.

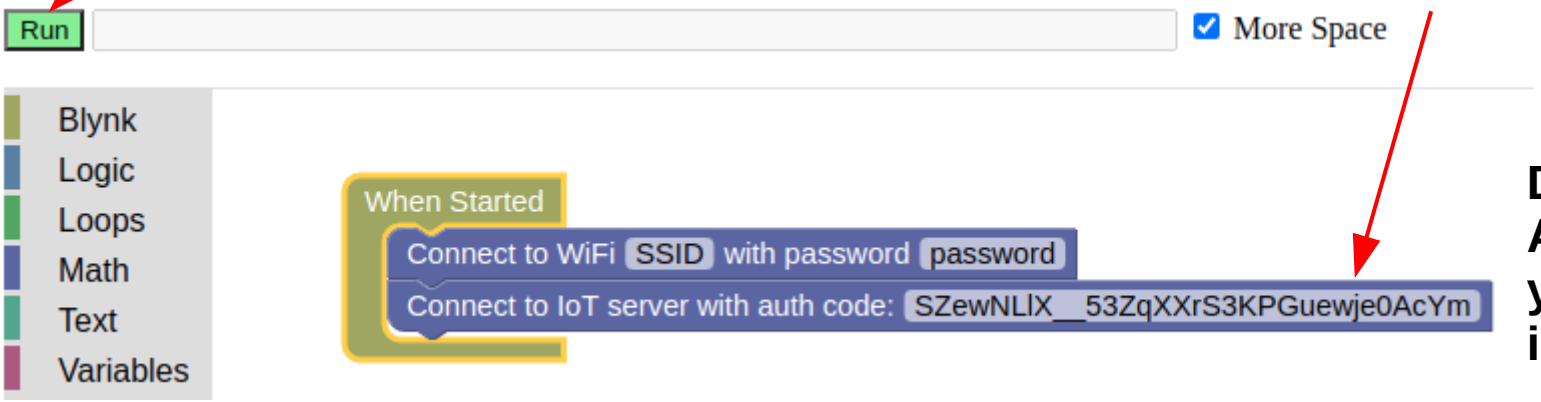
Challenge 2 : Connect IoT Device



Check your email for the Auth Token…

Press “Run” when ready

...and put it in here.



Do NOT copy my Auth Token. Use your own token in your email

No need to change the “SSID” and “password” unless you are using a real device

Challenge 2 : Connect IoT Device

Warning icon should turn off

Click on Device icon
Should say: “Online since...”

CONGRATULATIONS!
You’ve Connected your first IoT Device.

Now Click the Stop Button, so we can add some UI to our Dashboard.

Challenge 3:
Add a Remote Light Switch (Digital)

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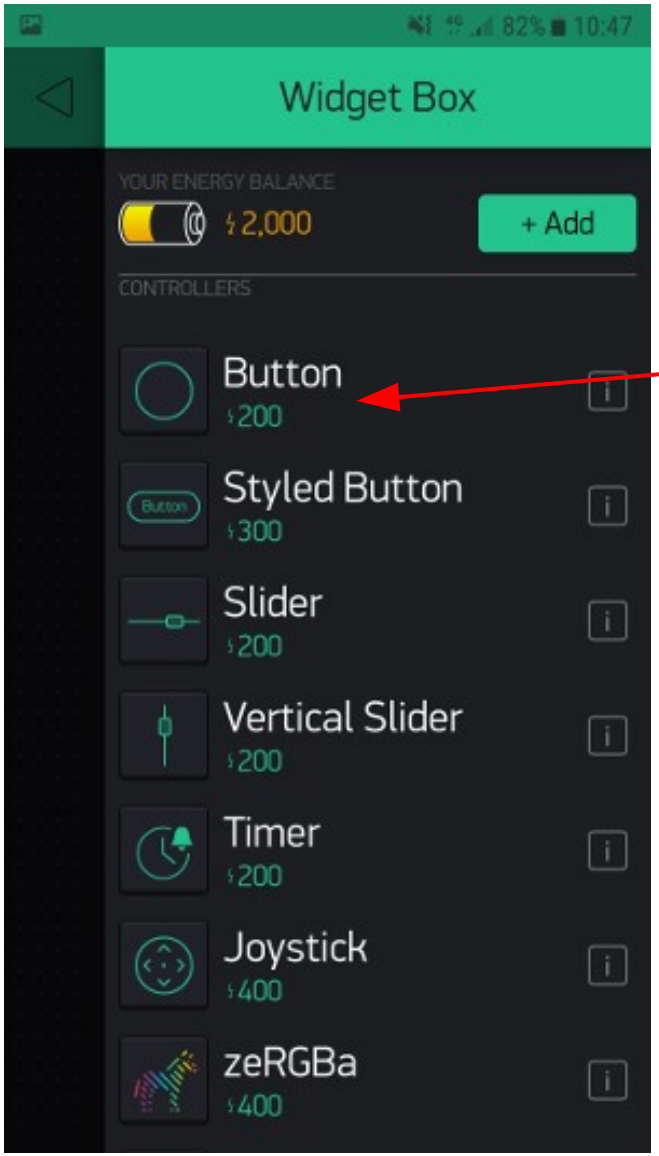
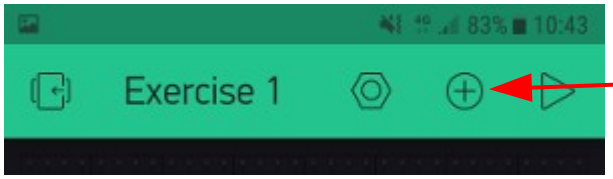
Challenge 3 : Add Light Switch

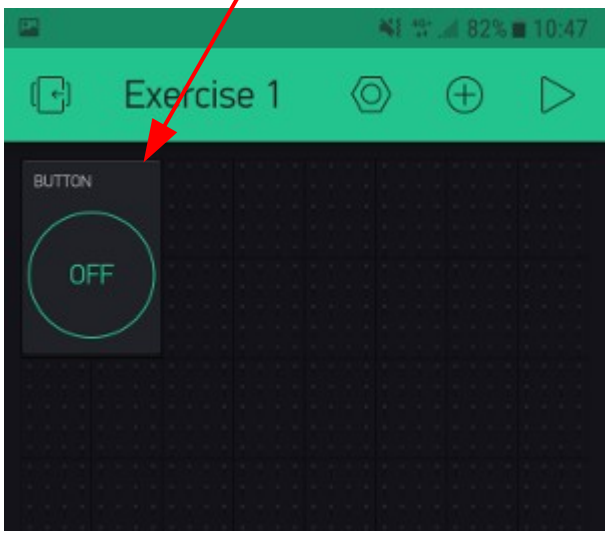




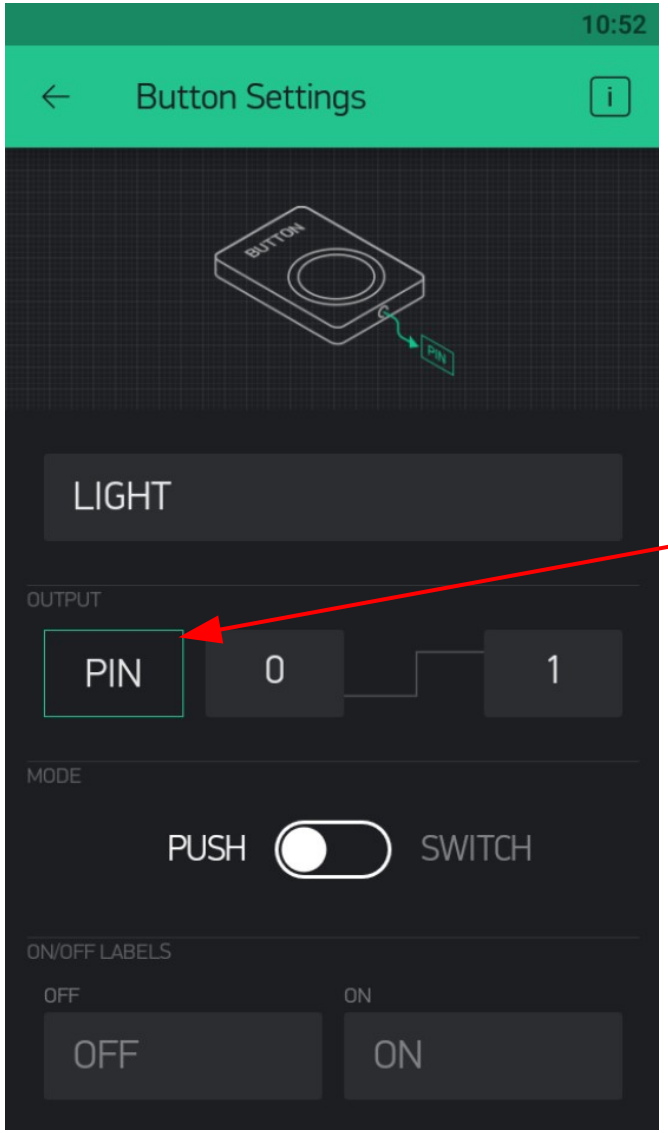
Tap the “+” to open a widget box

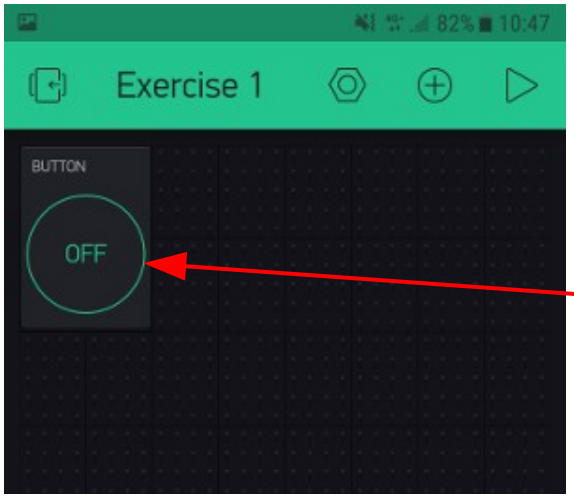
Tap this…

...to add a button to your screen



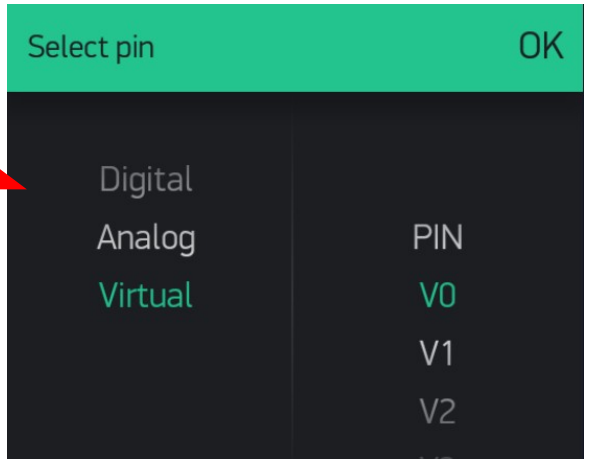
Challenge 3 : Add Light Switch





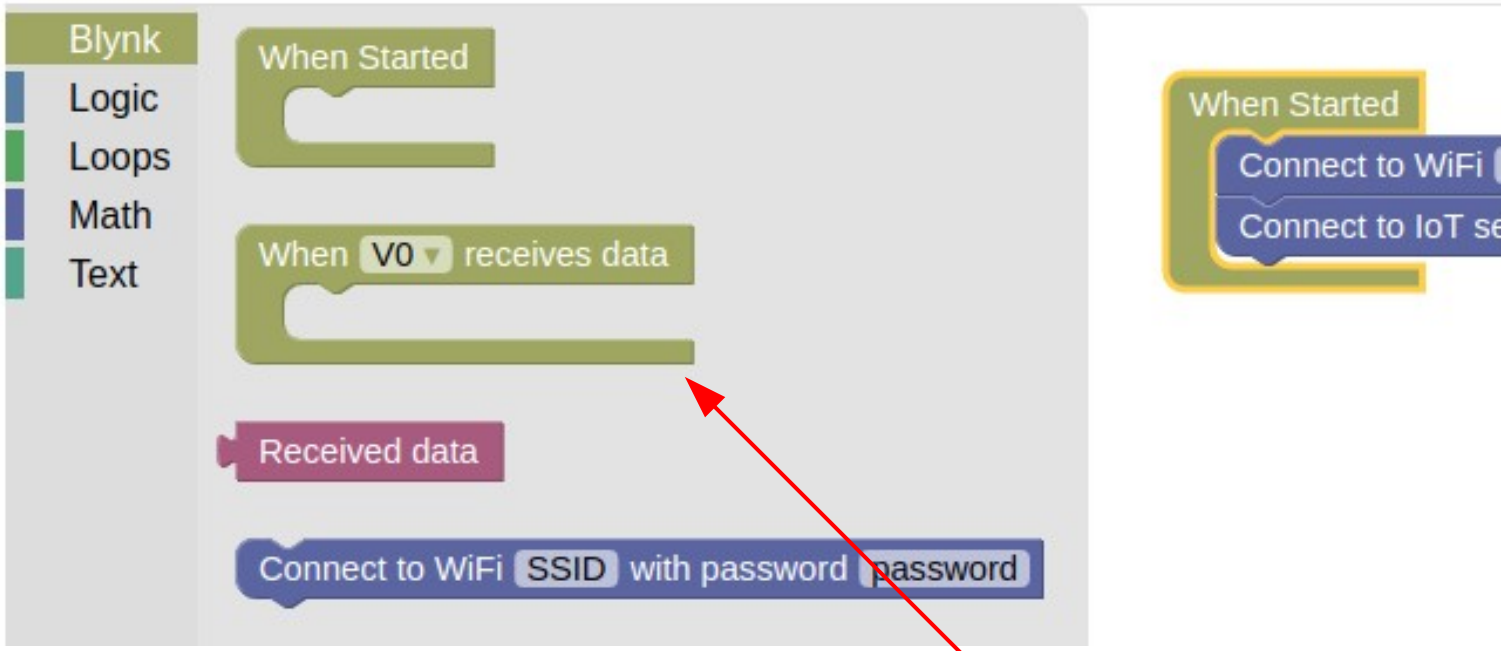
Tap your newly added button to configure it

Tap on “PIN” and select “Virtual | V0”



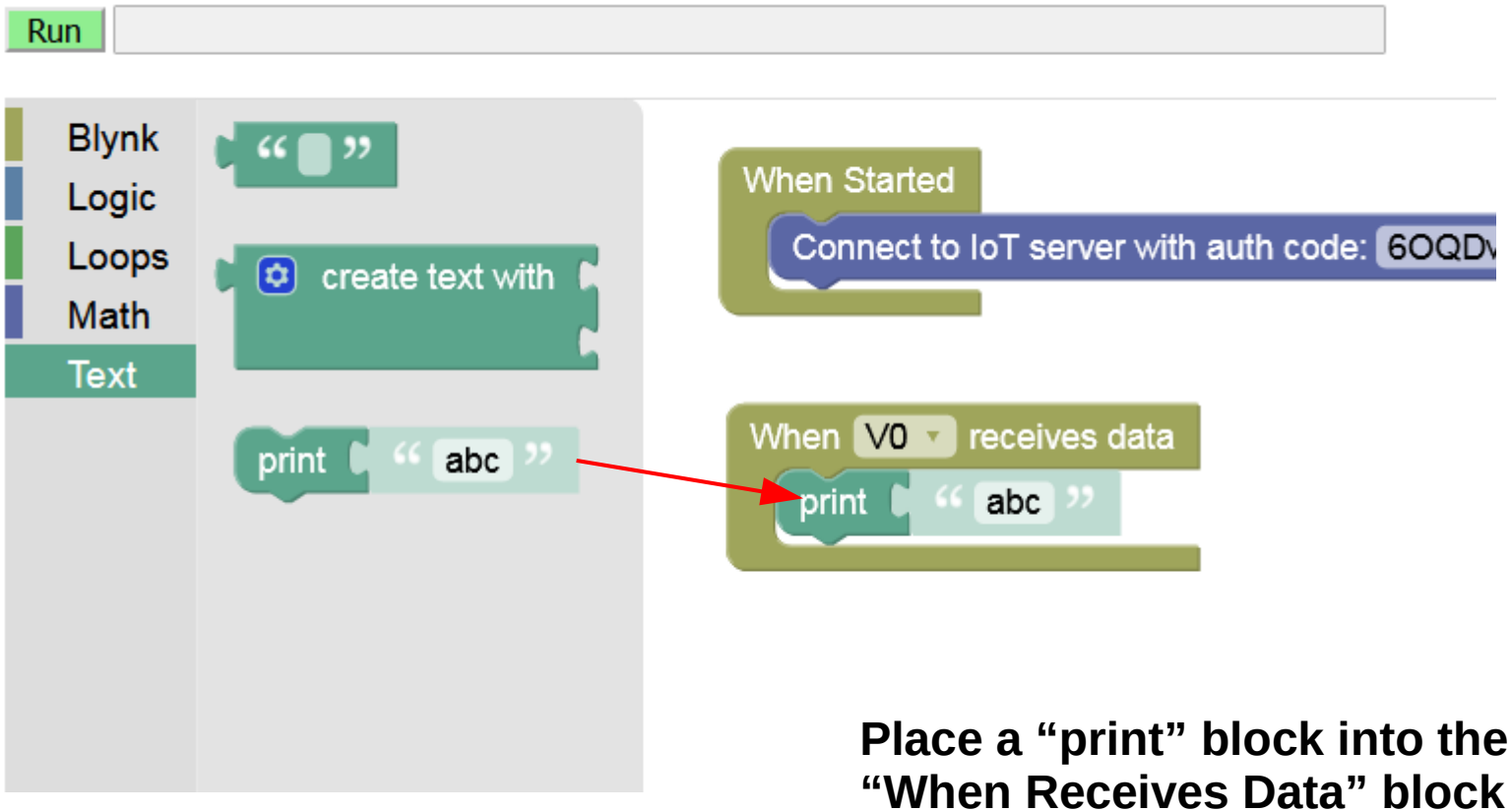
By default, Blynk will send a 0 when the button is released, and a 1 when the button is pressed. You can modify this by changing the 0 and 1 next to the PIN button.

Challenge 3 : Add Light Switch



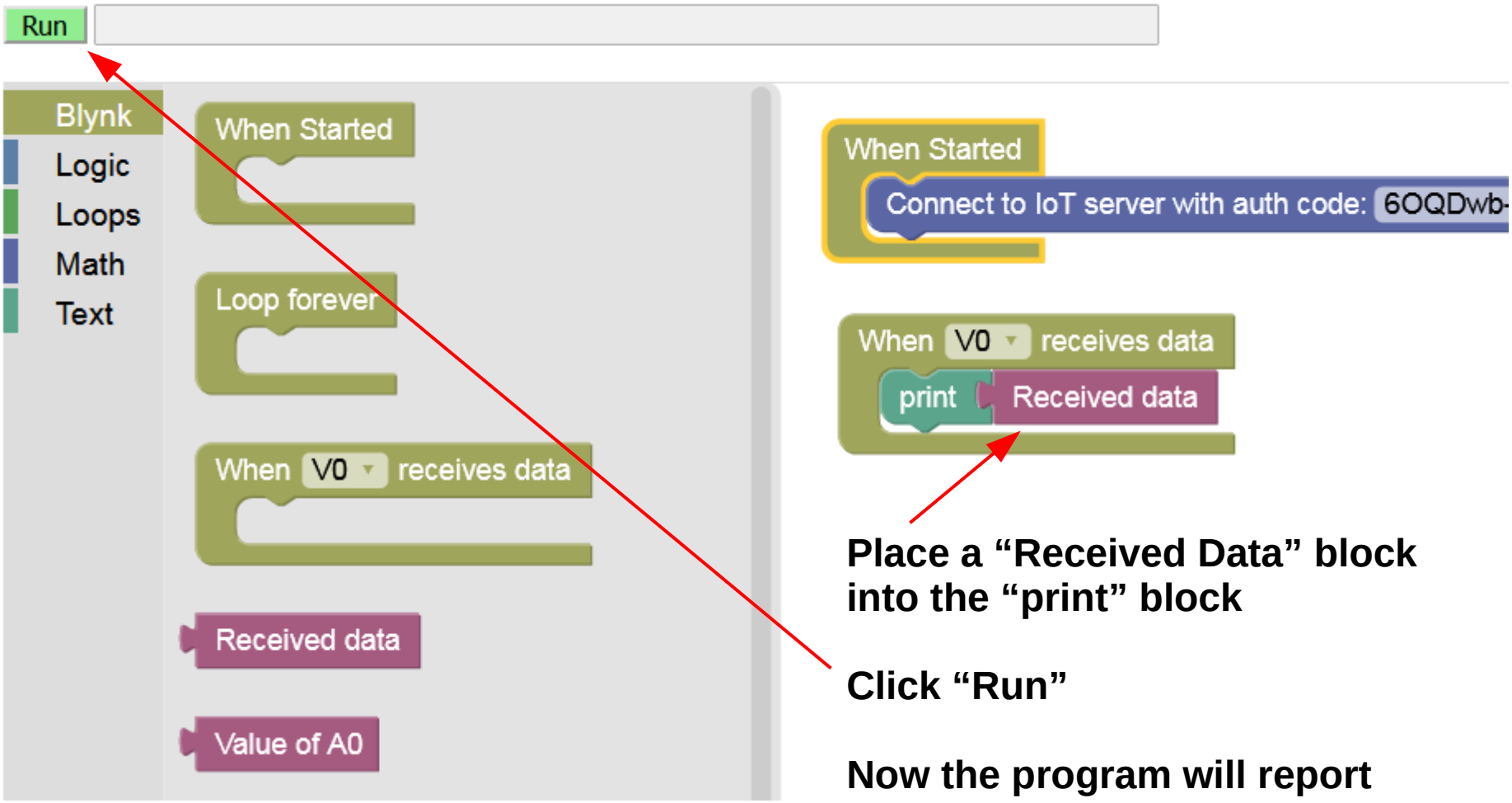
Place a "When V0 Receives Data" block into the your programming area

Challenge 3 : Add Light Switch



Place a “print” block into the “When Receives Data” block

Challenge 3 : Add Light Switch

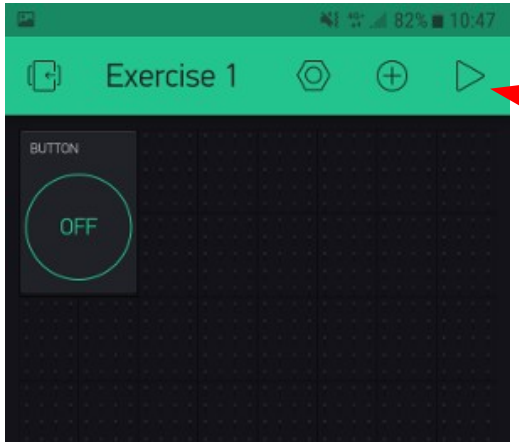


Place a “Received Data” block into the “print” block

Click “Run”

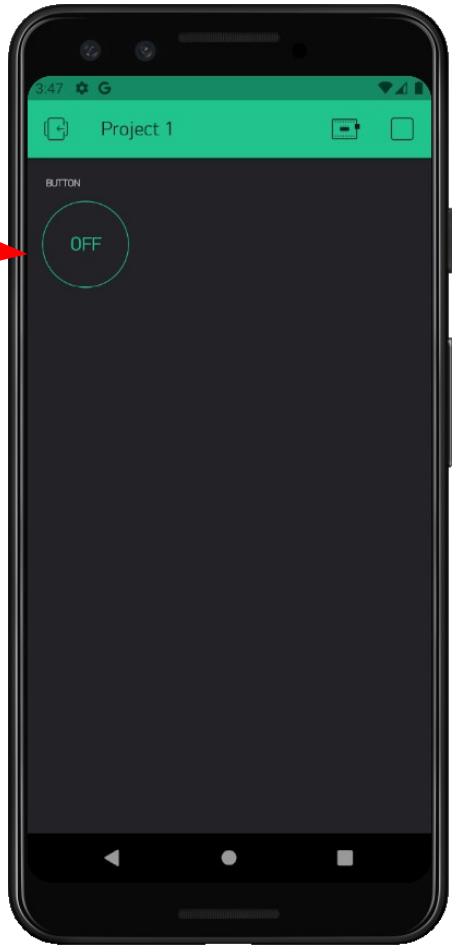
Now the program will report whatever value is being sent down from the Blynk App

Challenge 3 : Add Light Switch

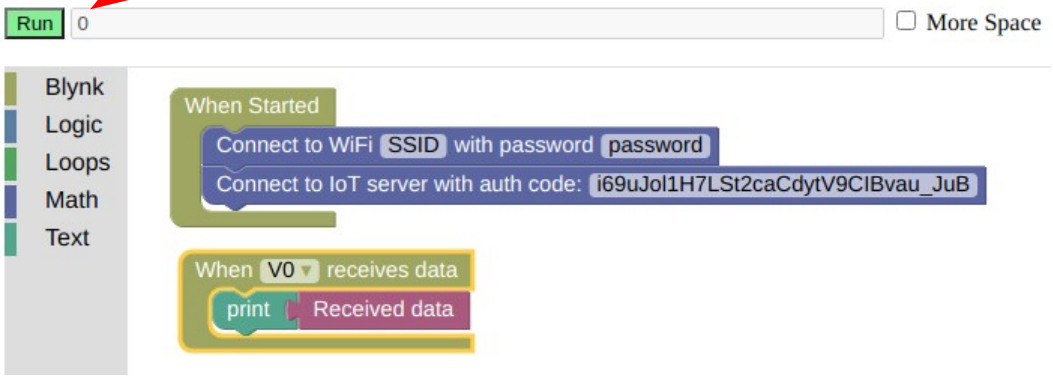


Click the “Play” button

Press the button...



When button is pressed, the console should show “1”
When button is released, the console should show “0”



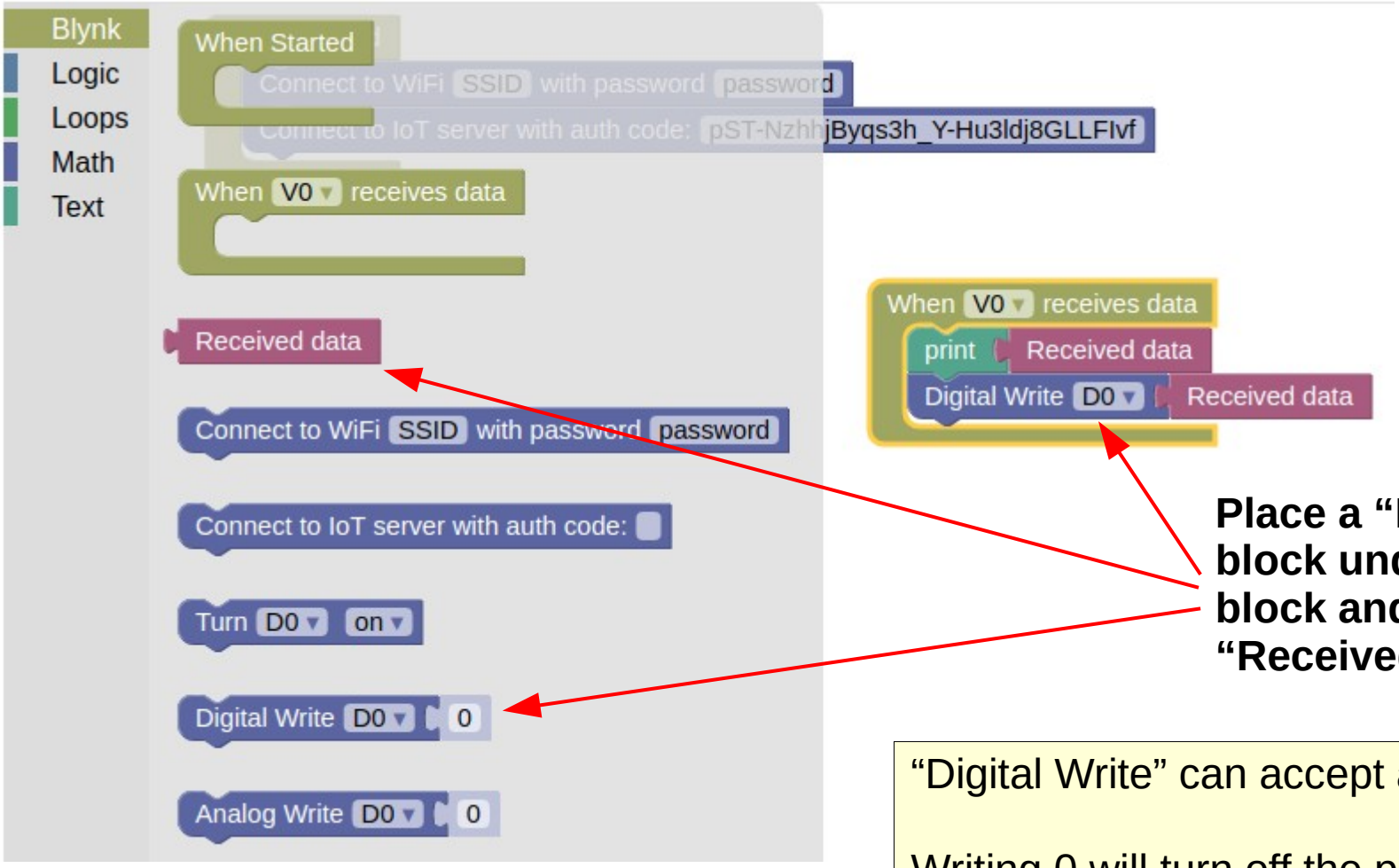
Console

- The console is useful for testing…
- ...but not available on most real device

No place to display text…

You could attach a display screen, but it'll be a waste to add a screen just for testing, as many IoT devices don't need a screen.

Challenge 3 : Add Light Switch



Place a “Digital Write” block under the “print” block and connect a “Received data” block to it

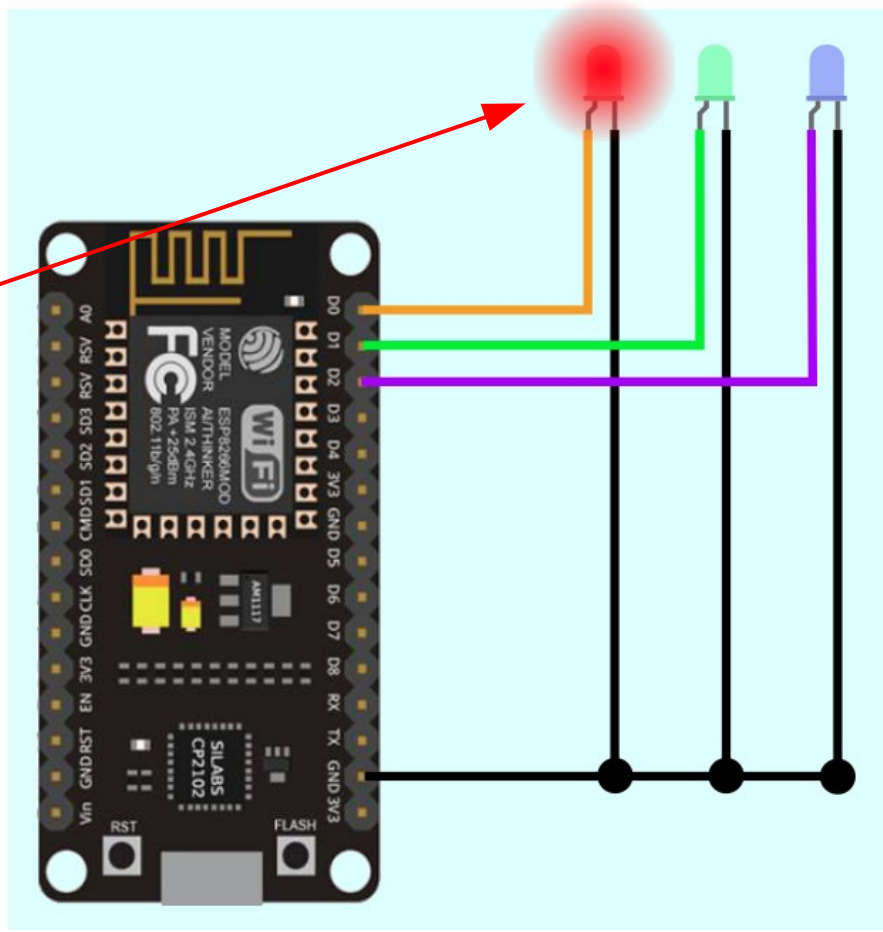
“Digital Write” can accept a “0” or a “1”.

Writing 0 will turn off the pin, while writing 1 will turn it on.

Challenge 3 : Add Light Switch

Press the button...

LED should light up



If you wire up an ESP8266 micro-controller the same way as in the simulator, this will work with a real LED as well.

Challenge 3 : Add Light Switch

Experiment with…

- Control the green and blue LED
- Adding more buttons
- The “mode” setting in the button

Challenge 4:
Dimmer Switch

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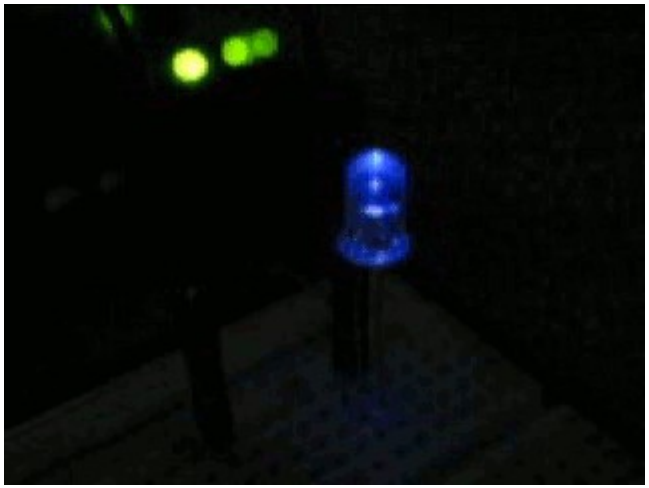
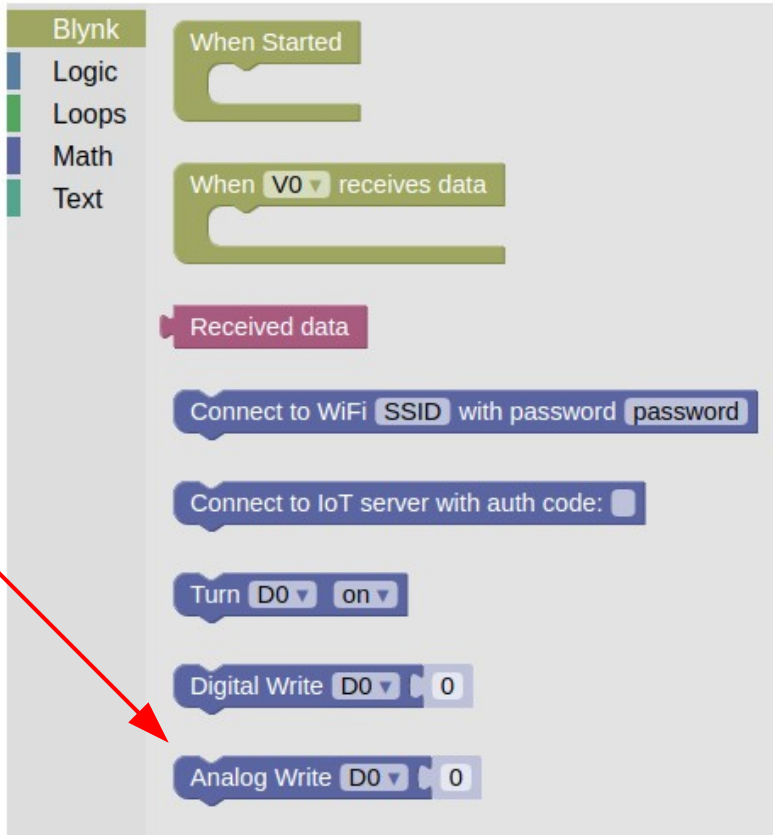
Challenge 4 : Dimmer Switch

- Sometimes, we don't want to turn the lights completely "On" or "Off"
- We want to control the brightness of the light

Challenge 4 : Dimmer Switch

- Values that have a range (...and not just On and Off) are called “Analog” values
- We can output an analog value using “Analog Write”

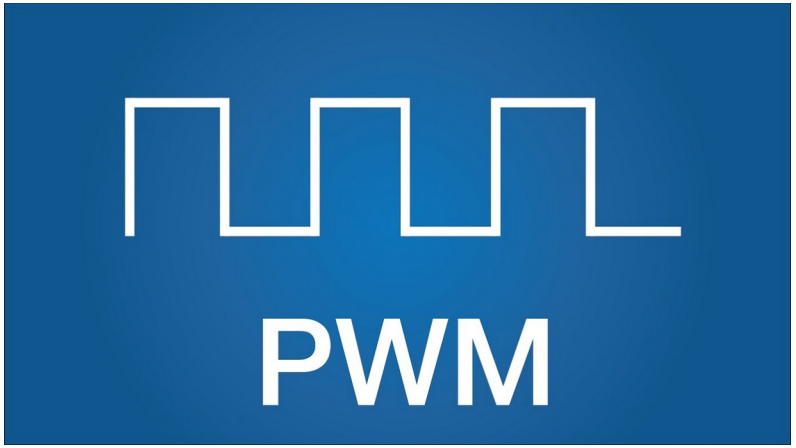




Challenge 4 : Dimmer Switch

Pulse Width Modulation (PWM)

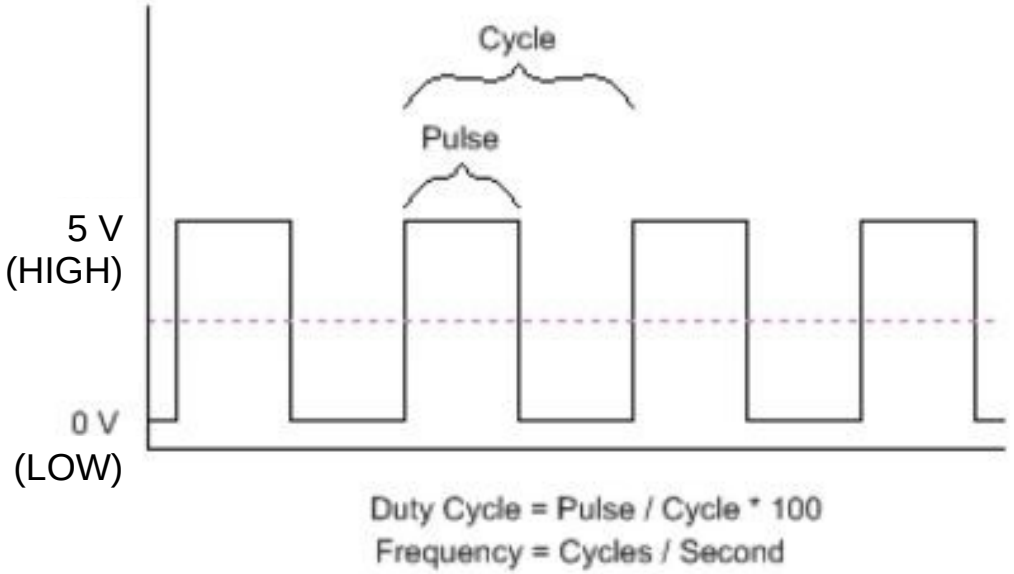
- An efficient method to vary and control power
- Used in various electrical systems
  - Lights
  - Motors
  - Comms & others



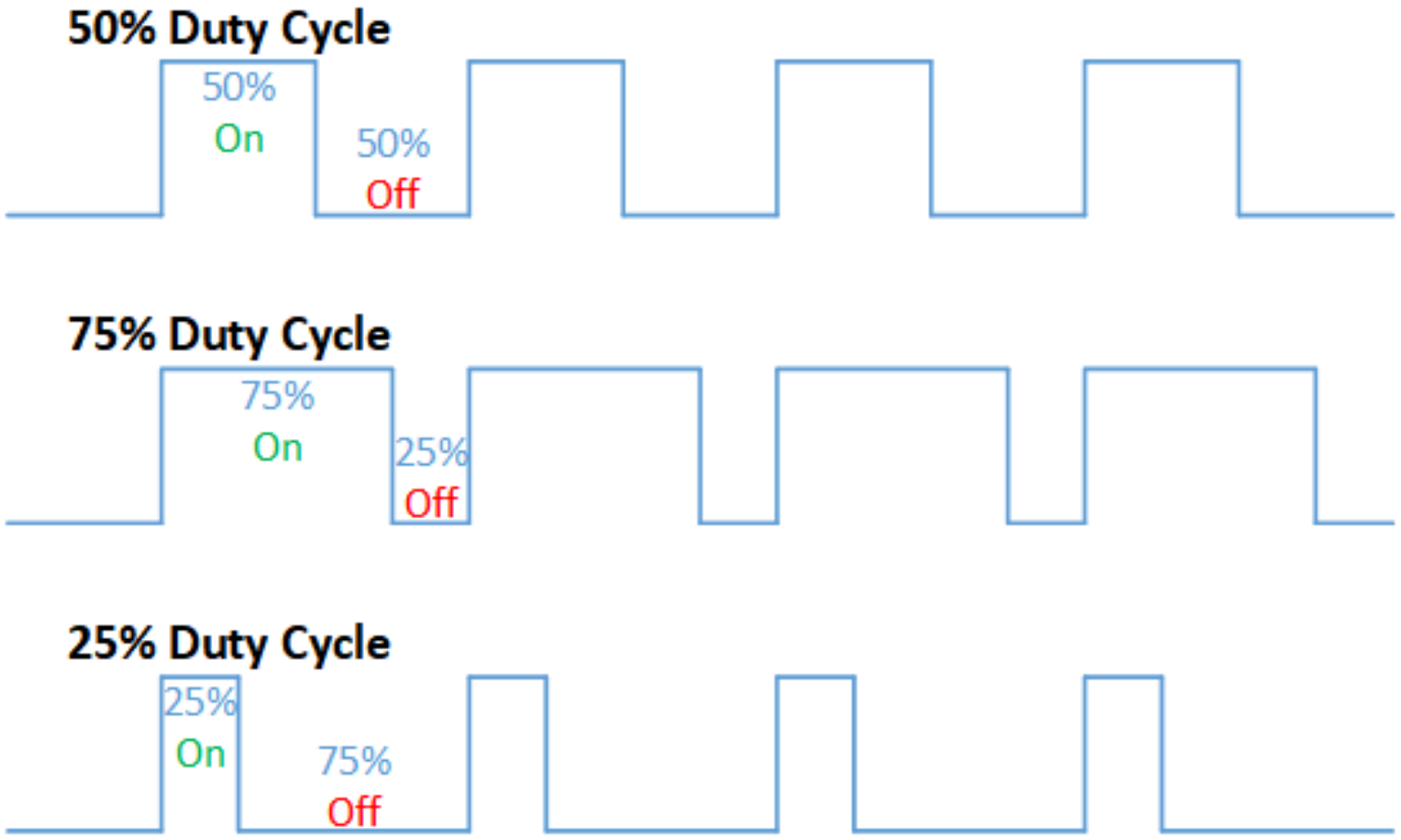
Challenge 4 : Dimmer Switch

50% Duty Cycle

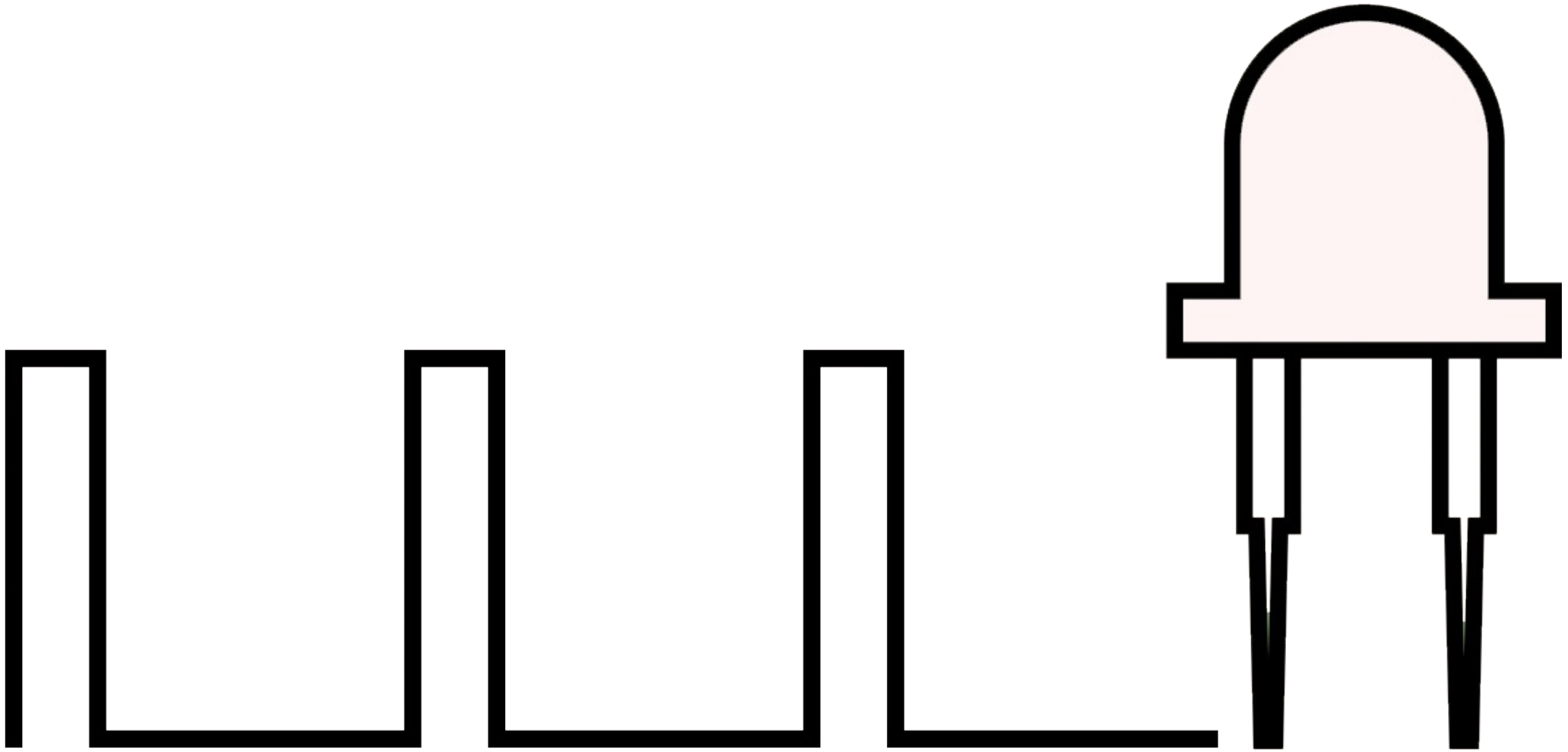
- Set signal to HIGH ½ of the period (eg. 0.5 ms)
- Set signal to LOW rest of the period (eg. 0.5 ms)
- Run signal over and over...



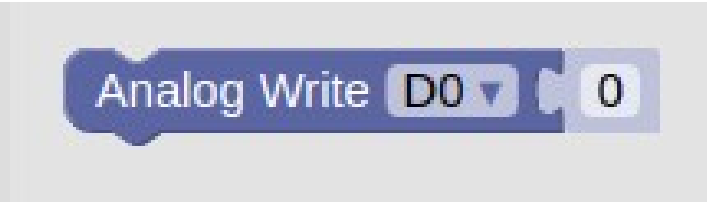
Challenge 4 : Dimmer Switch



Challenge 4 : Dimmer Switch



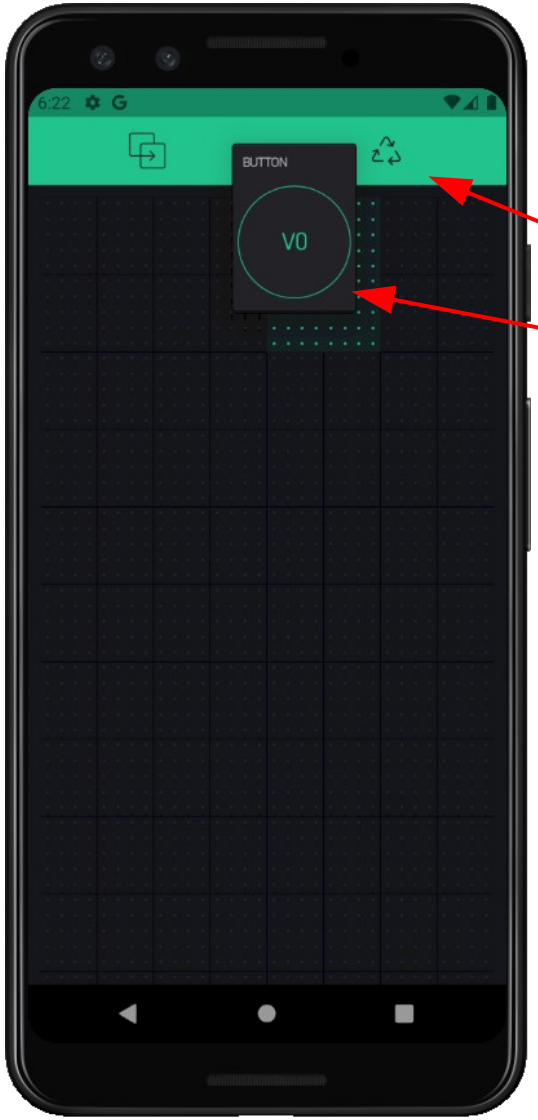
Challenge 4 : Dimmer Switch



Analog Write

- Accepts a value from 0 to 1023
- Meaning…
  - 0 : 0%
  - 256 : 25%
  - 512 : 50%
  - 768 : 75%
  - 1023 : 100%

Challenge 4 : Dimmer Switch

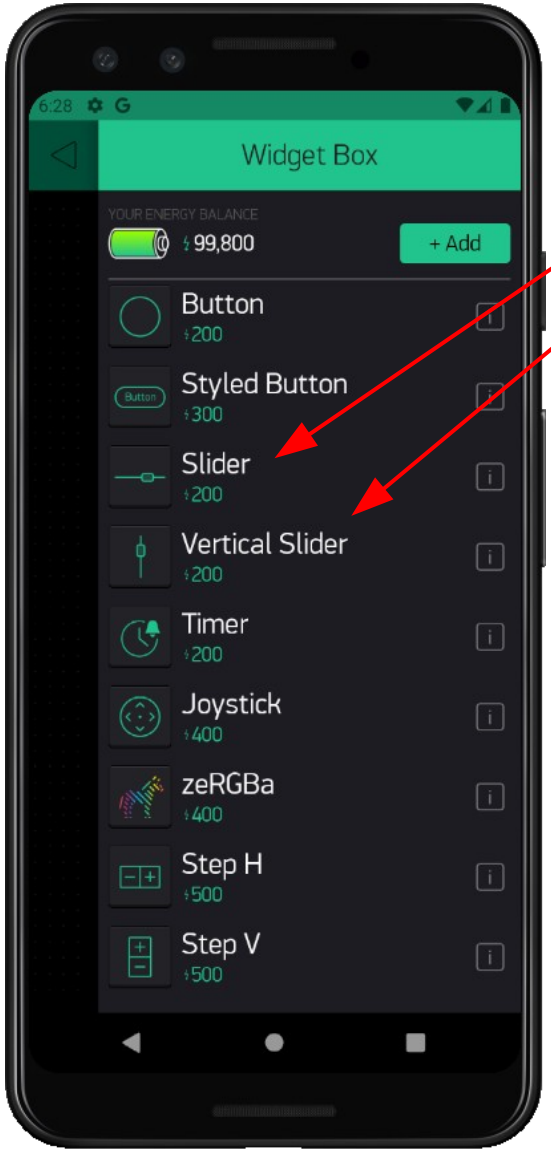


The button can only do “0” and “1”, so let’s start by getting rid of it...

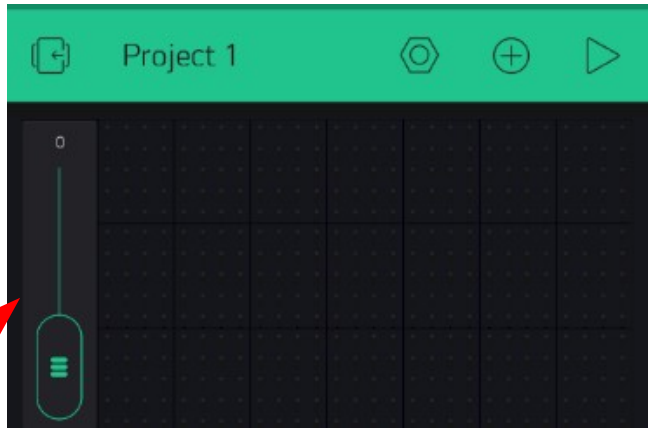
Drag the button to the Recycle area

Strictly speaking, you can keep the button if you want to. Just be aware that it may override your analog value if you use it.

Challenge 4 : Dimmer Switch

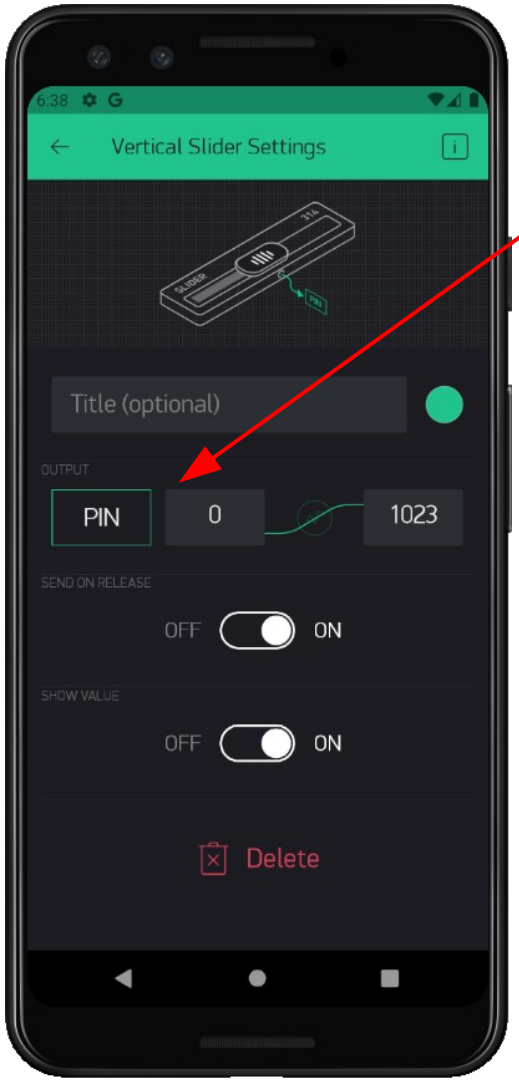


Add a “Slider” or “Vertical Slider”



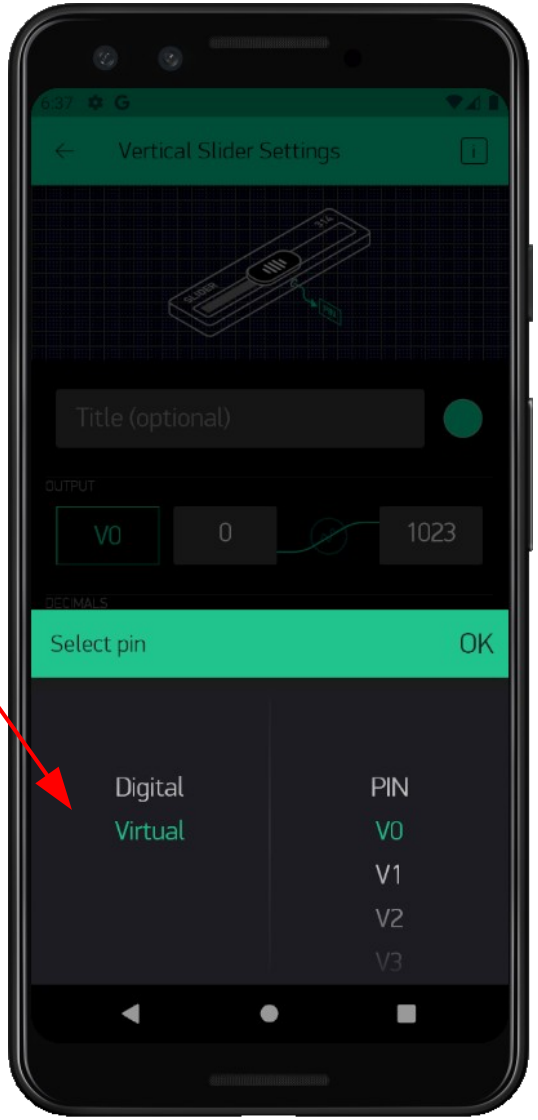
Tap on the slider to change its settings

Challenge 4 : Dimmer Switch



Click on “PIN”

Set the pin to “V0”



You can use a different virtual pin if you want, just adjust your blocks program accordingly.

Challenge 4 : Dimmer Switch

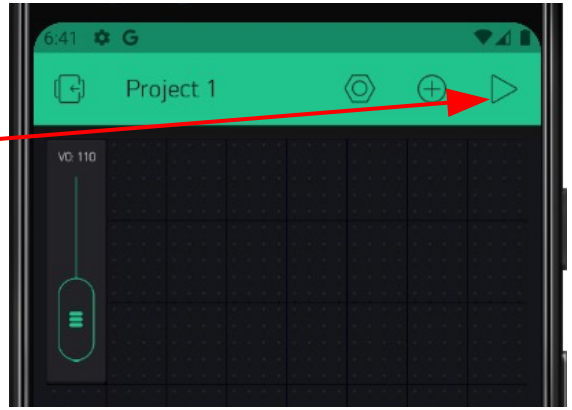
Replace “Digital Write” with “Analog Write”

Remove this...

...replace with this...

...click “Run”

...and “Play”



Challenge 4 : Dimmer Switch

Experiment with…

- Analog controls for the green and blue LED
- The “Send on Release” setting in the slider

Challenge 4 : Dimmer Switch

What have we Built?

- IoT lights control
- Able to change color and brightness
- Similar to the Philips “Hue” light bulbs

Challenge 5:
IoT Inputs

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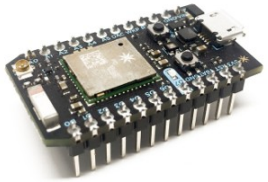
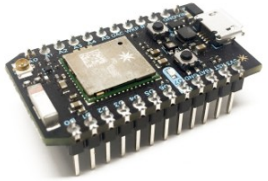
Challenge 5 : IoT Inputs

- So far, we have only sent commands from the mobile app to the IoT device



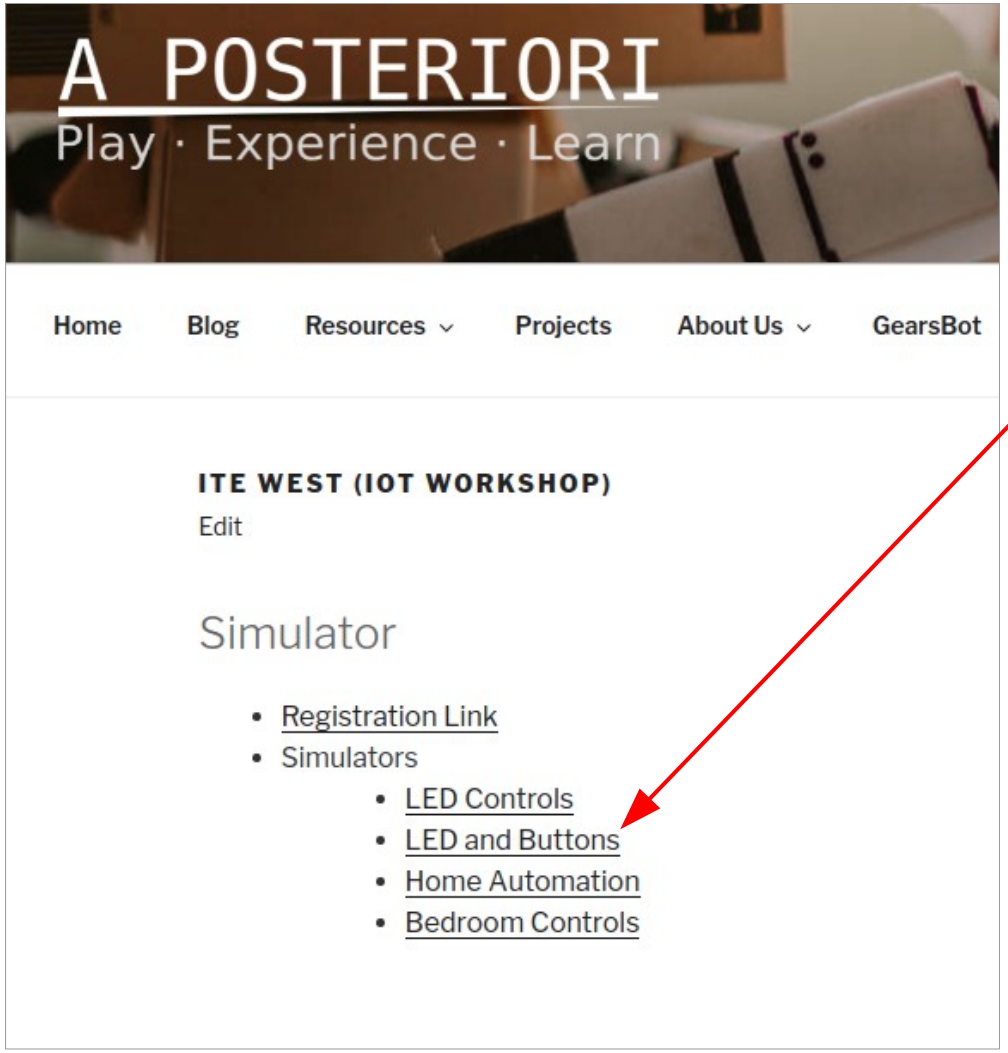
Phone to IoT Device

- Now we will look at sending data from the IoT device to the mobile app



IoT Device to Phone

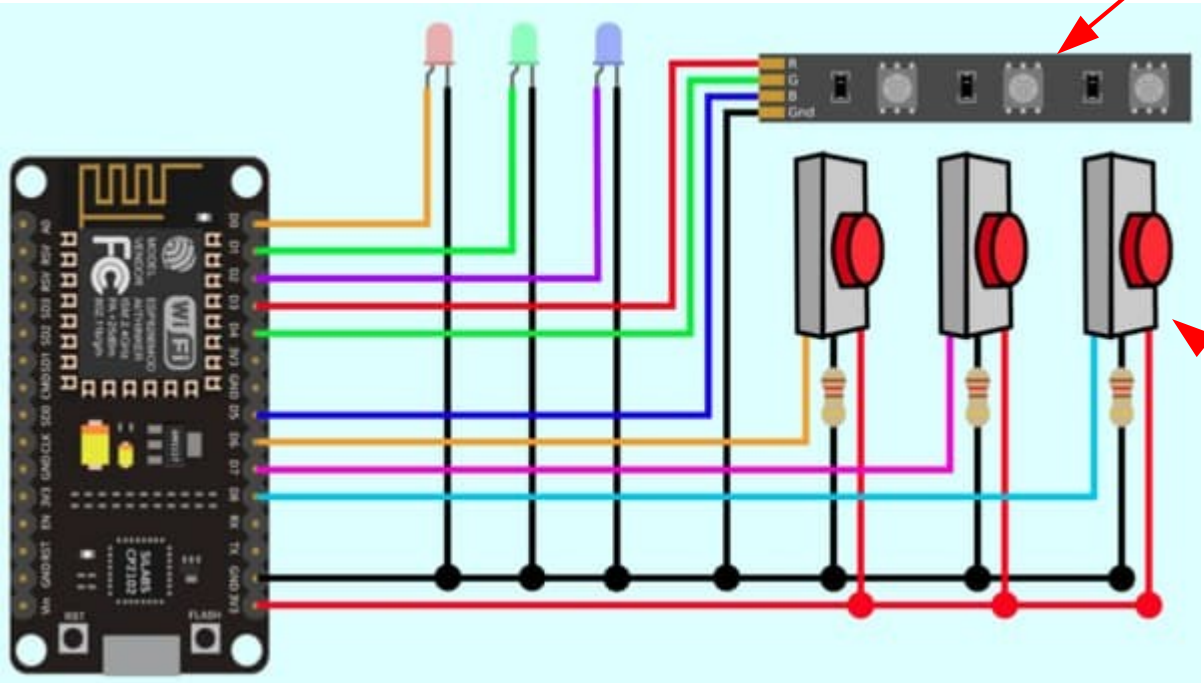
Challenge 5 : IoT Inputs



Open the second simulator “LED and Buttons”

Challenge 5 : IoT Inputs

What's New?



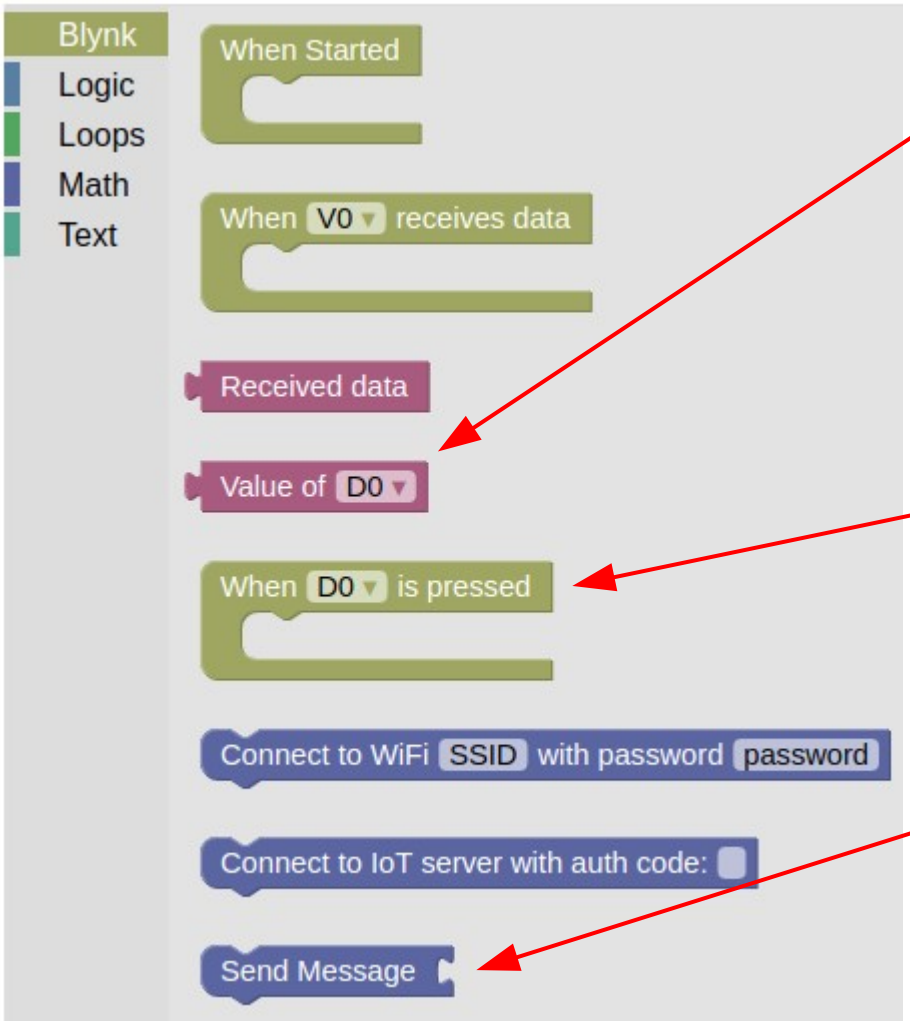
RGB LED strip
Nothing special. They are just red, green, and blue LEDs combined into one.

Push Buttons
These sends a "High" signal to the IoT microcontroller when pressed, and a "Low" signal when released.

There are some resistors connected to the push buttons. In a real circuit, these are necessary to prevent a short circuit when the button is pressed.

Challenge 5 : IoT Inputs

What's New?



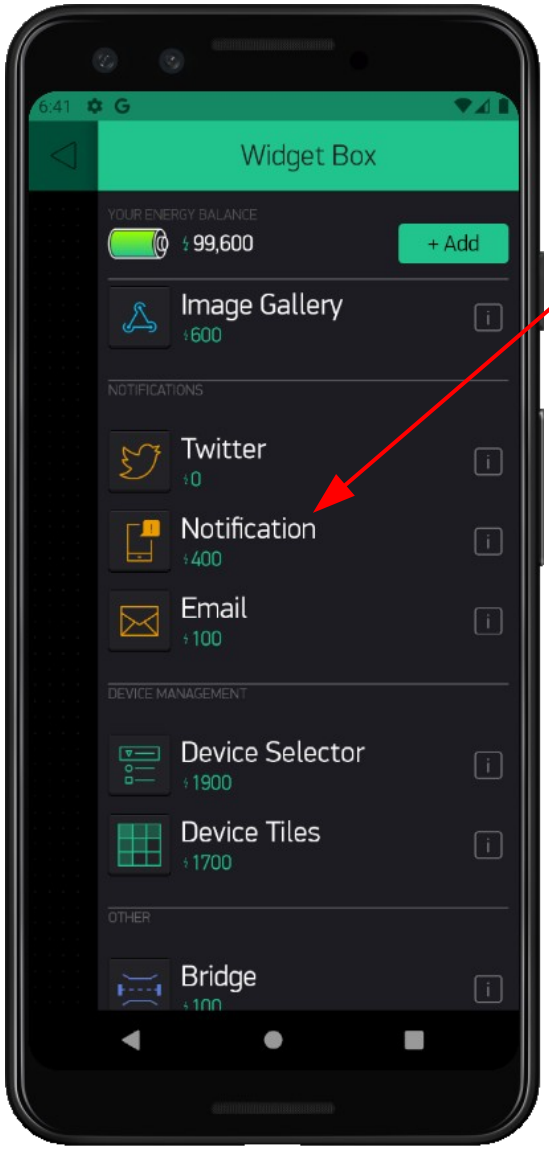
Value of D
This block provides the value of the connected pin.

If it's "High", the value will be "1".
If it's "Low", the value will be "0".

When D is pressed
Runs the blocks inside when the button is pressed.

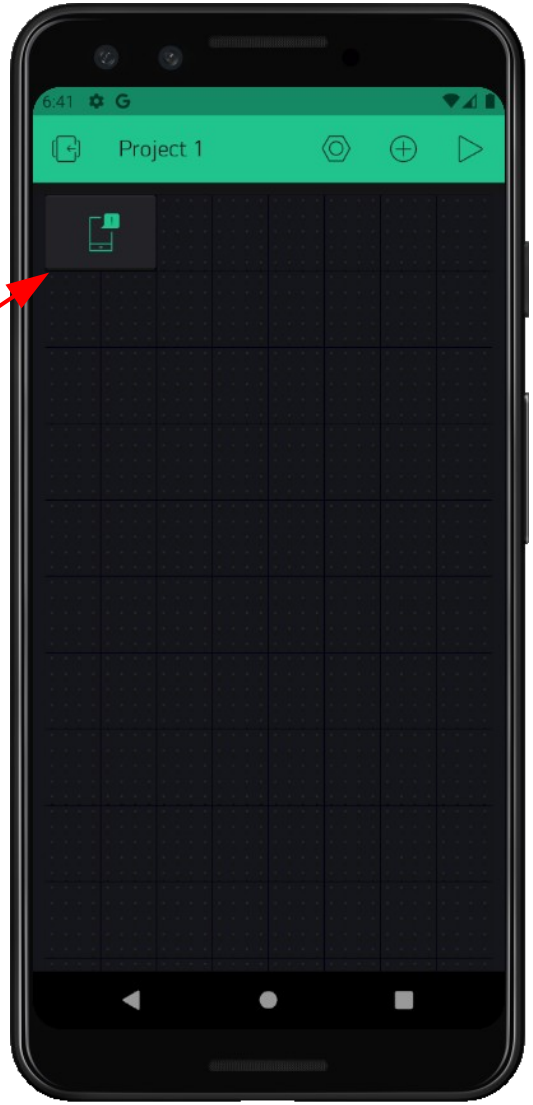
Send Message
Send a message to the mobile app. This will trigger a notification on your phone.

Challenge 5 : IoT Inputs

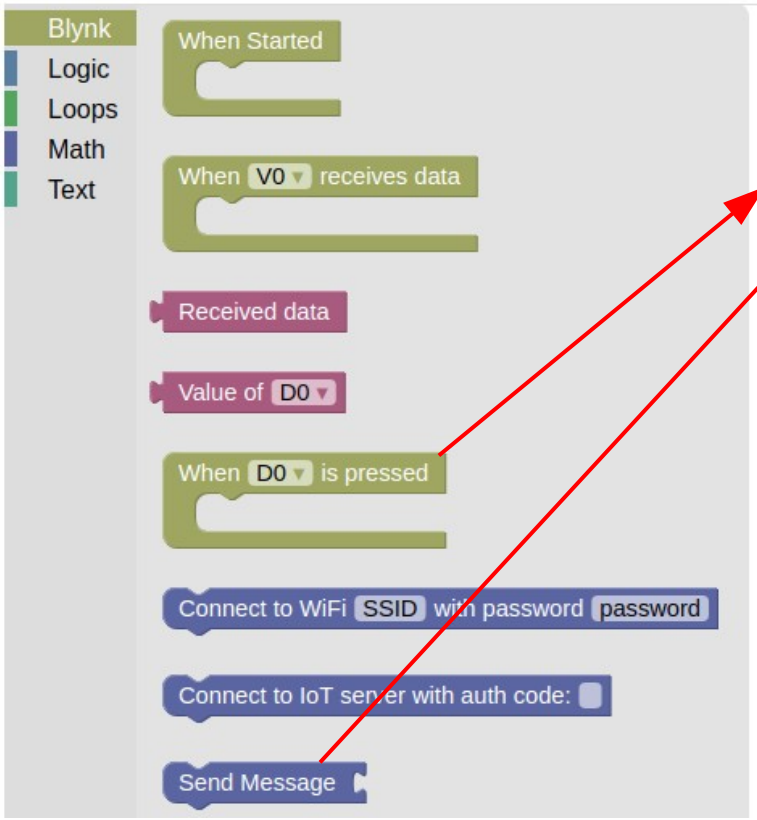


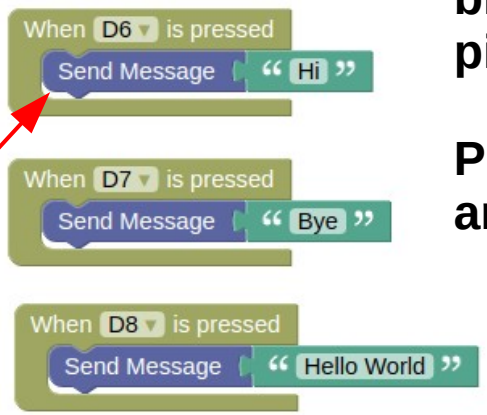
Add the “Notification” widget This will allow your phone app to receive notifications from the IoT device

You’ll get a notification icon in your app, but you won’t need to interact with it, so either leave it alone or move it out of the way.



Challenge 5 : IoT Inputs

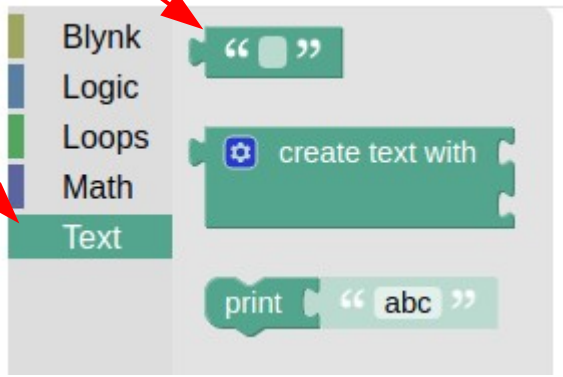




Drag in a "When D is pressed" block, and set it to "D6" (...that's the pin the first button is connected to)

Put a "Send Message" block inside, and add a text message.

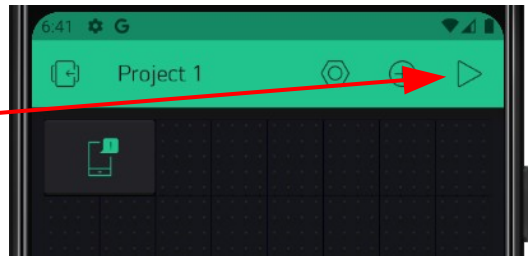
You can find the text message block under "Text"

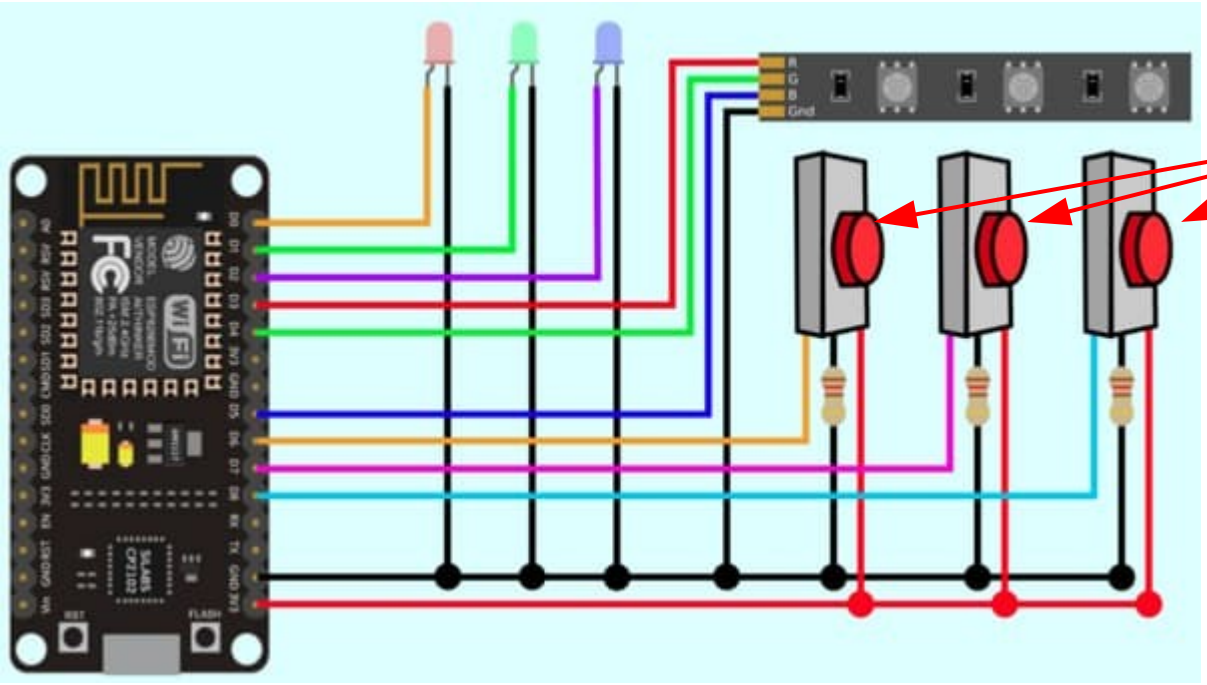


Challenge 5 : IoT Inputs

...click “Run”

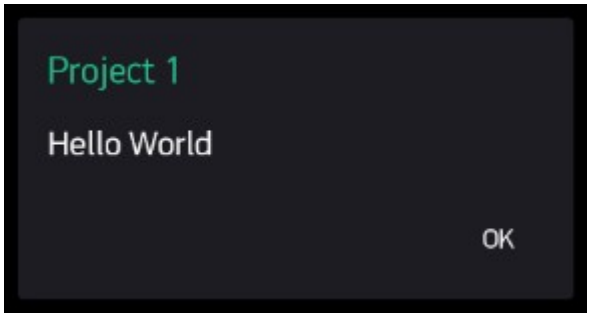
...and “Play”





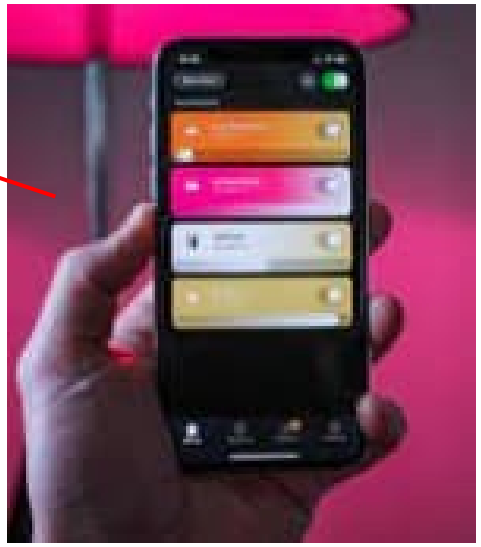
Click on the buttons to simulate a press…

…you should get a notification on your phone



Challenge 5 : IoT Inputs

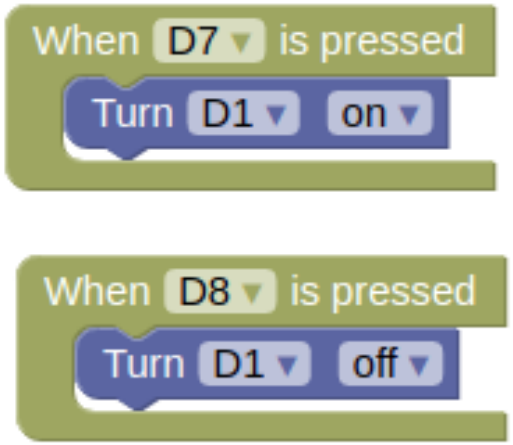
- Besides sending data to the phone, inputs can also be used to directly control the IoT device
- Eg. A button to turn on / off the lights



Buttons… **OR** **...Phone App**

Challenge 5 : IoT Inputs

Modify the blocks program to this…

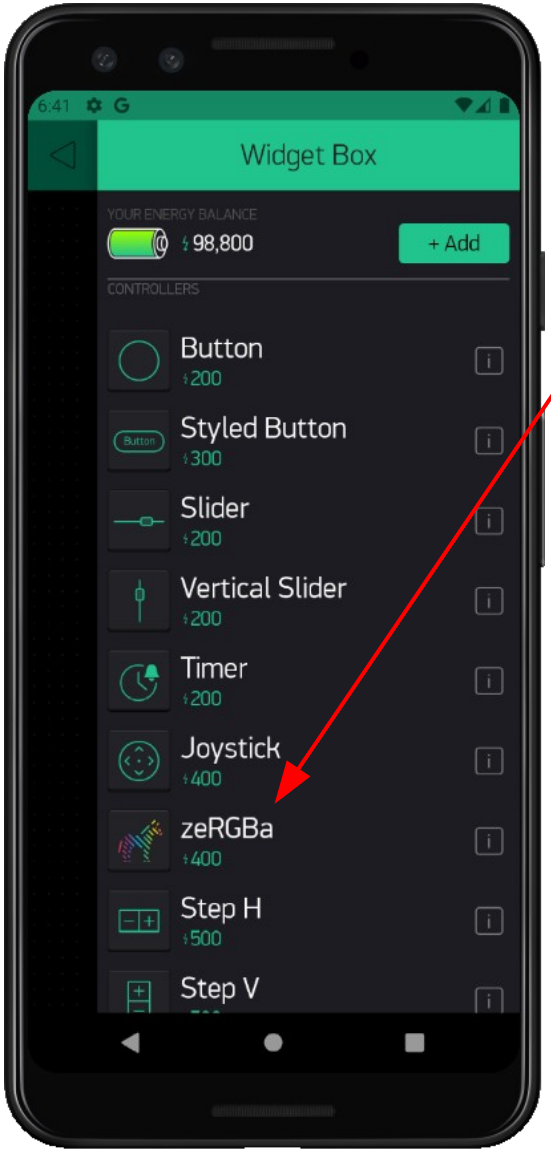


Now you'll be able to turn the green LED "On" using the middle button, and "Off" using the third button.

You can also program it to use only a single button to turn the lights on and off, but this simulator doesn't provide you with the necessary blocks.

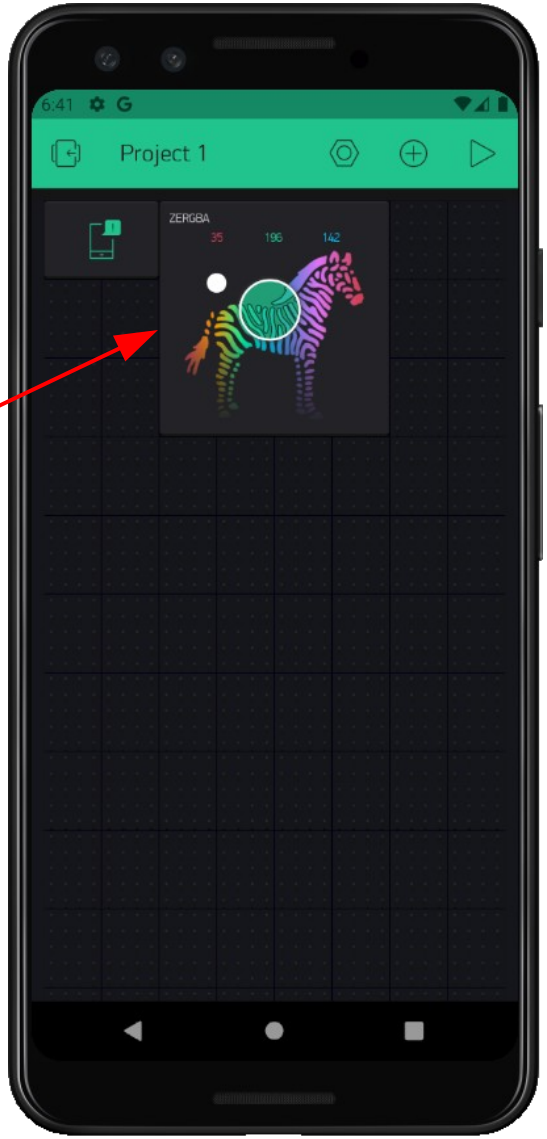
We'll provide more blocks in the next simulator, so you'll be able to do it then.

Challenge 5 : IoT Inputs



Add the “zeRGBa” widget
This will allow you to select colors

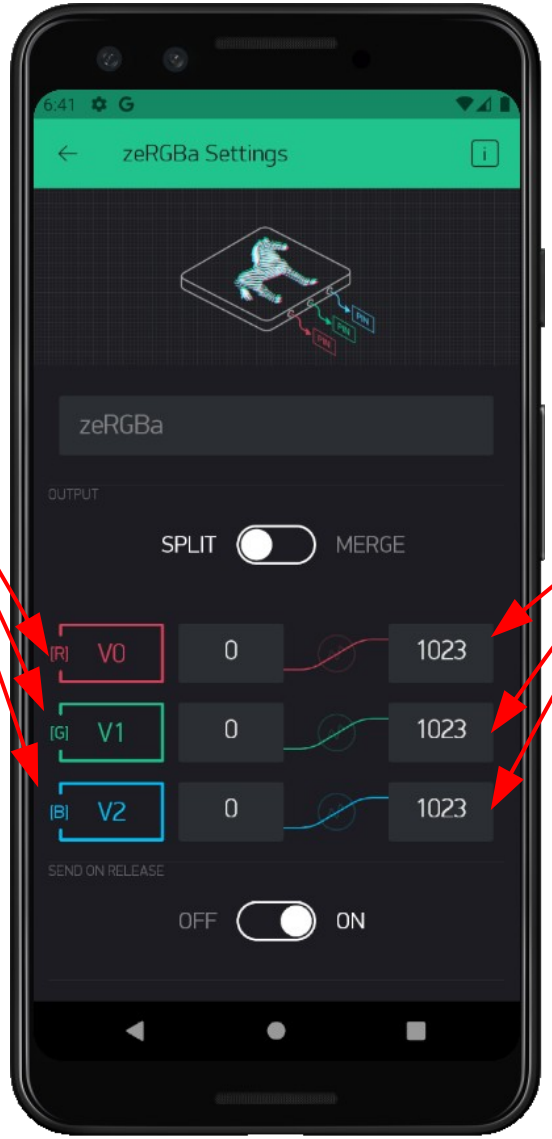
Tap on the “zeRGBa” widget to configure it



Challenge 5 : IoT Inputs

The “zeRGBa” widget provides 3 analog outputs, representing Red, Green, and Blue.

Set the pins to V0, V1, and V2



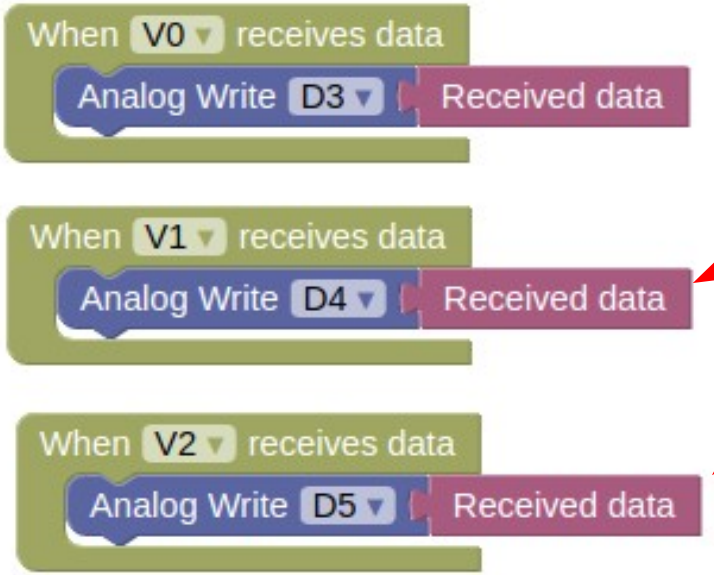
By default, the “zeRGBa” widget has an output range of “0 to 255”, but our IoT controller expects a range of “0 to 1023”.

Change the range to 1023.

As before, you can use different virtual pins, but you’ll need to modify the program on the IoT device to suit.

Alternatively, you can convert the “0 to 255” value into “0 to 1023” on the IoT device with a little math.

Challenge 5 : IoT Inputs



Create or modify your blocks program to look like this

Warning!
Make sure you only have one of each "When V receives data". (ie. you cannot have two "When V0 receives data).

If you have more than one, only one will work.

Challenge 5 : IoT Inputs

Test out...

- You should be able to control the color and brightness of the LED strip using the “zeRGBa” widget

Experiment

- Modify the program so that the buttons will set the color for the LED strip. (ie. pressing button 1 will turn the strip red, button 2 green, button 3 blue)

Challenge 5 : IoT Inputs

What have we Built?

- Input and Message
  - Emergency call button for elderly
  - Restaurant waiter call button

Challenge 5 : IoT Inputs

What have we Built?

- Replace button with other sensors?
  - Smart garbage bin (detects when bin is full)
  - Vending machines (detects when drinks are sold out)
  - Intrusion detection system

Challenge 5 : IoT Inputs

What have we Built?

- Color selection, On / Off switch
  - Improved lights color selection
  - Local controls for lights

Challenge 6:
Home Automation

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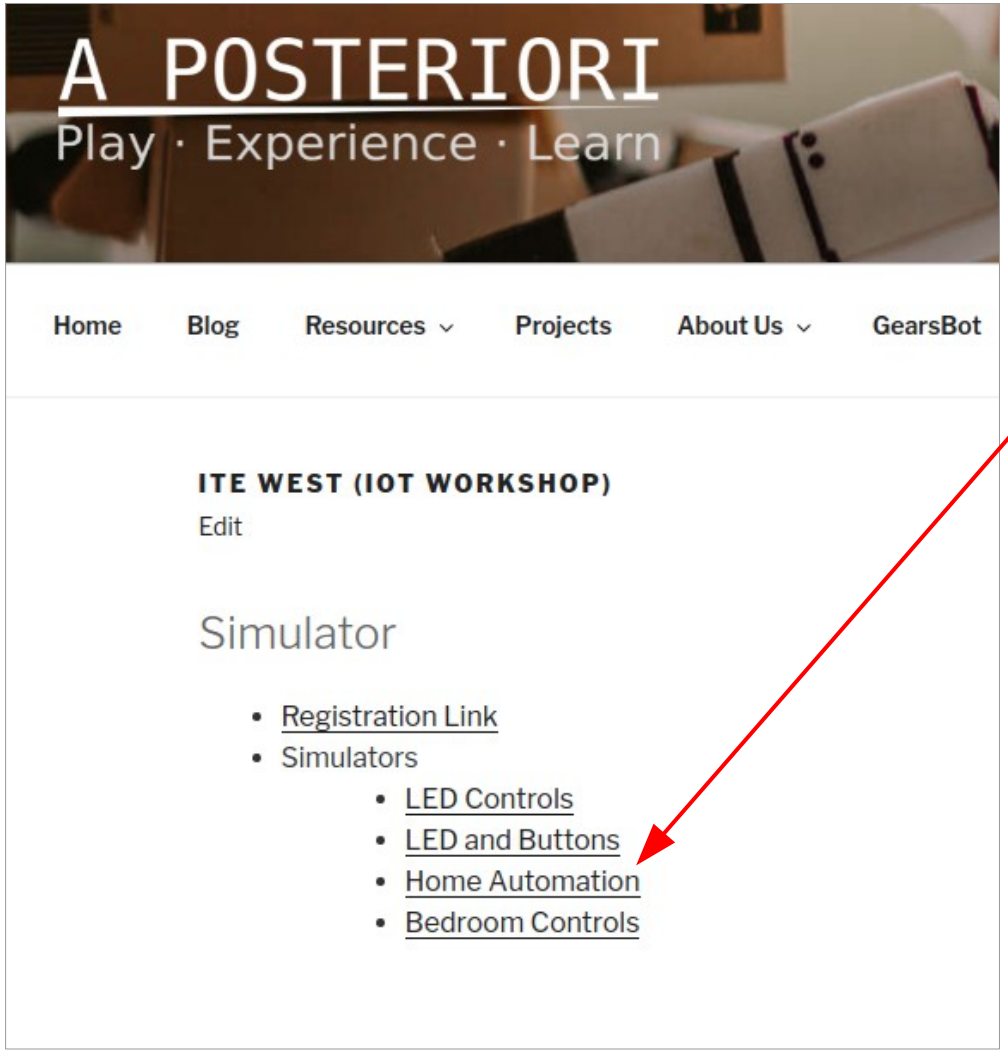
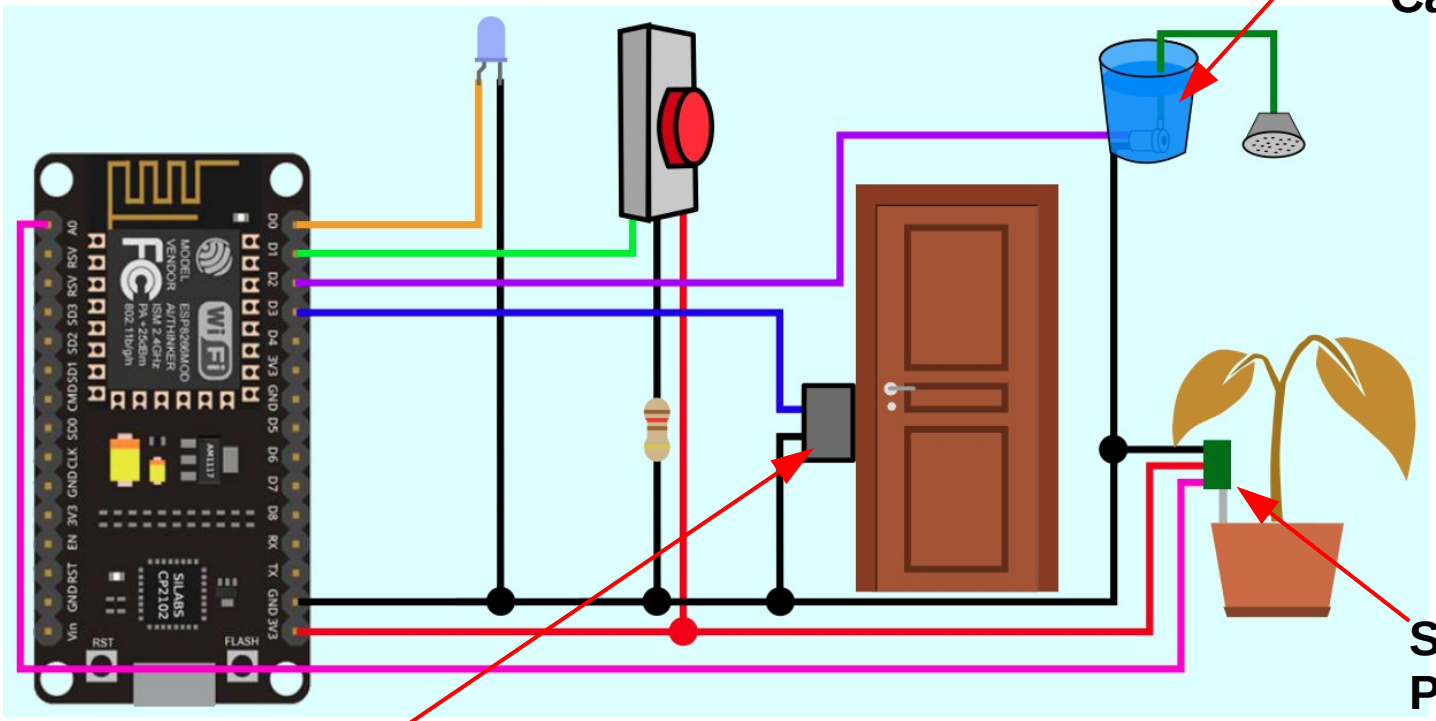
Challenge 6 : Home Automation



Open the third simulator "Home Automation"

Challenge 6 : Home Automation

What's New



Pump for watering plant
Can be fully "On" or fully "Off"
Cannot be half "On".

Soil moisture sensor
Provides an analog reading of the soil moisture level.

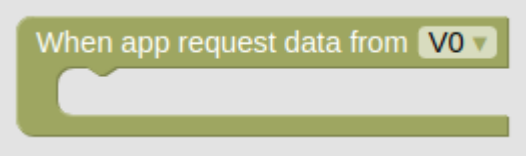
If the pump is "On" the soil moisture will rise, else it will drop slowly.

Electronic door lock
Can send it a "0" (Lock) or "1" (Unlock)

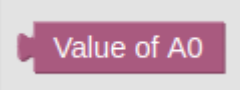
Challenge 6 : Home Automation

What's New

Anything inside this block will be repeated forever.



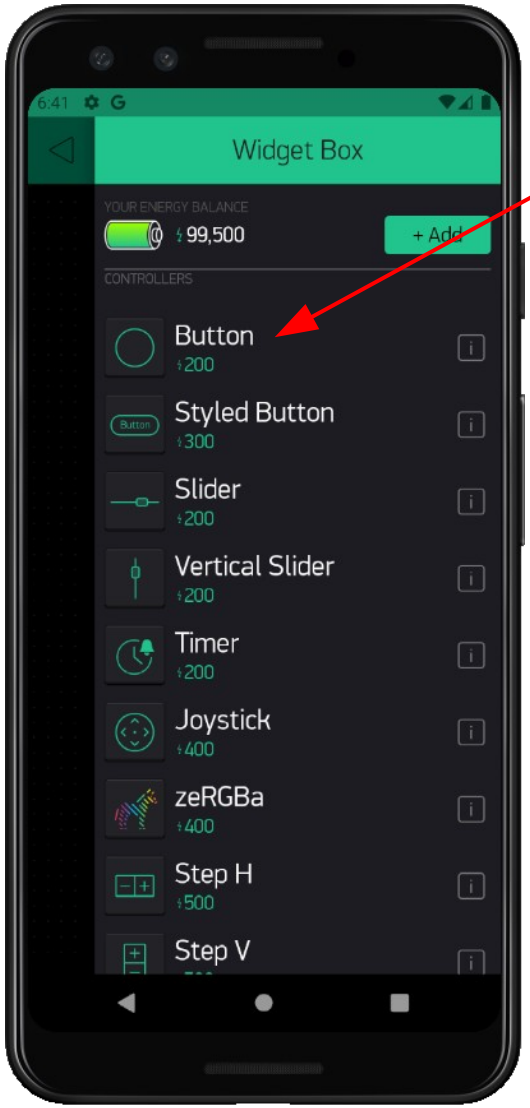
Anything inside this block will run when the mobile app request for data from the IoT device.



This is like the "Value of D" block, but instead of a "0" or "1", this gives a reading that ranges from "0" to "1023".

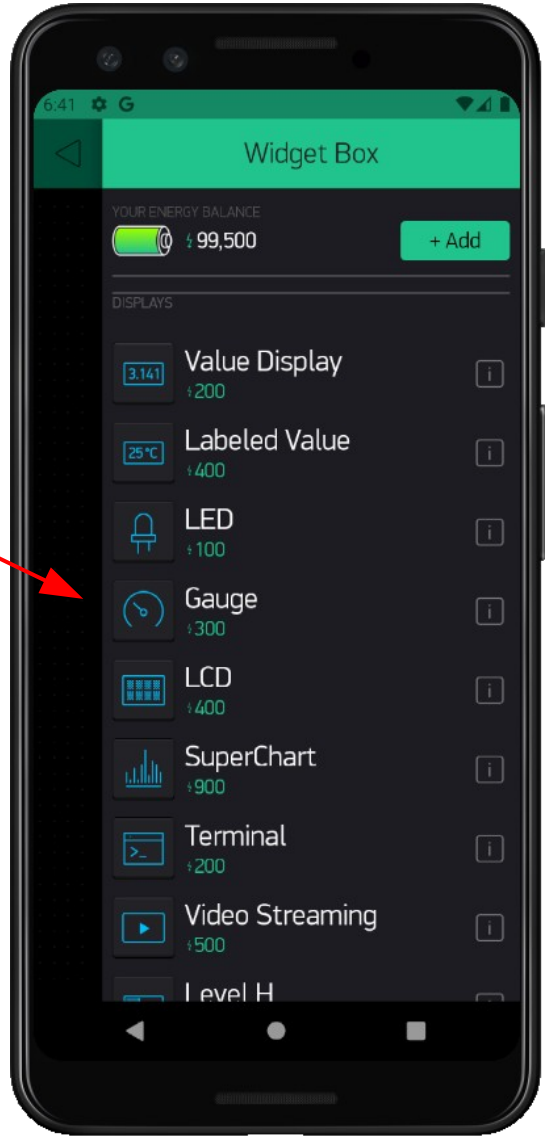
This is used to send data to the mobile app.

Challenge 6 : Home Automation

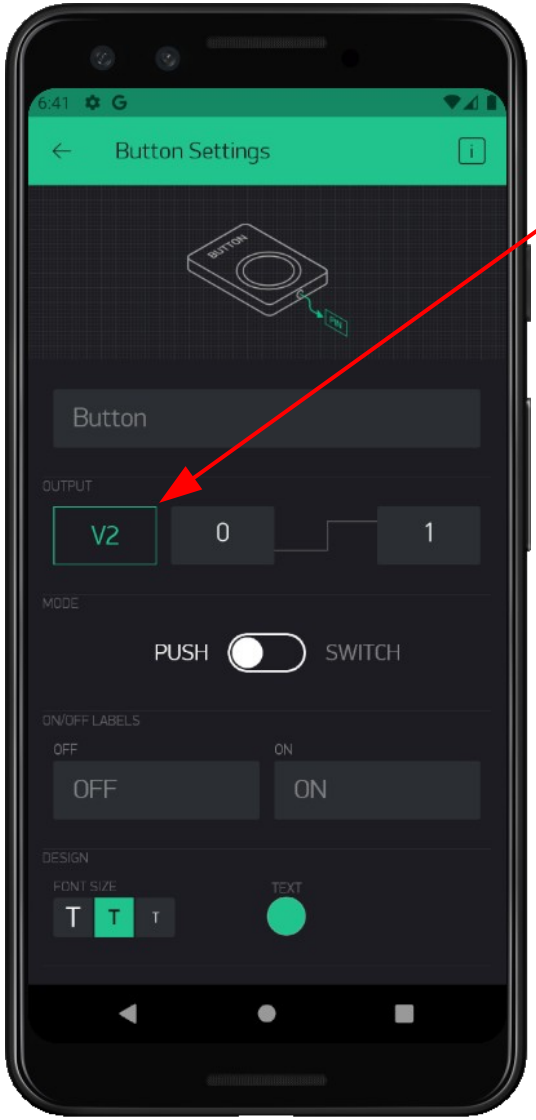


Add a button...

...and a gauge



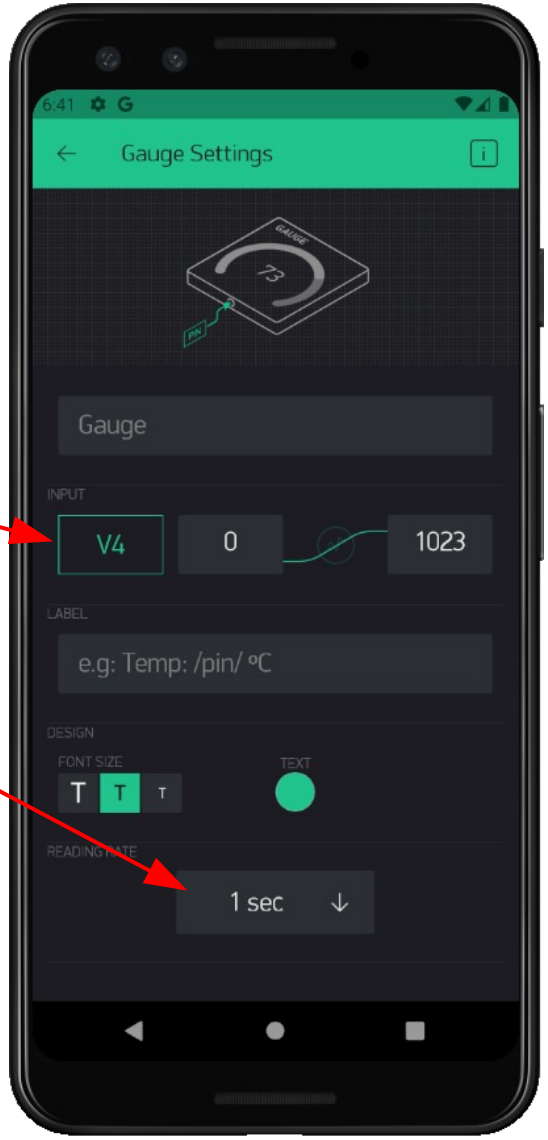
Challenge 6 : Home Automation



Set the button to pin V2

Set the gauge to V4

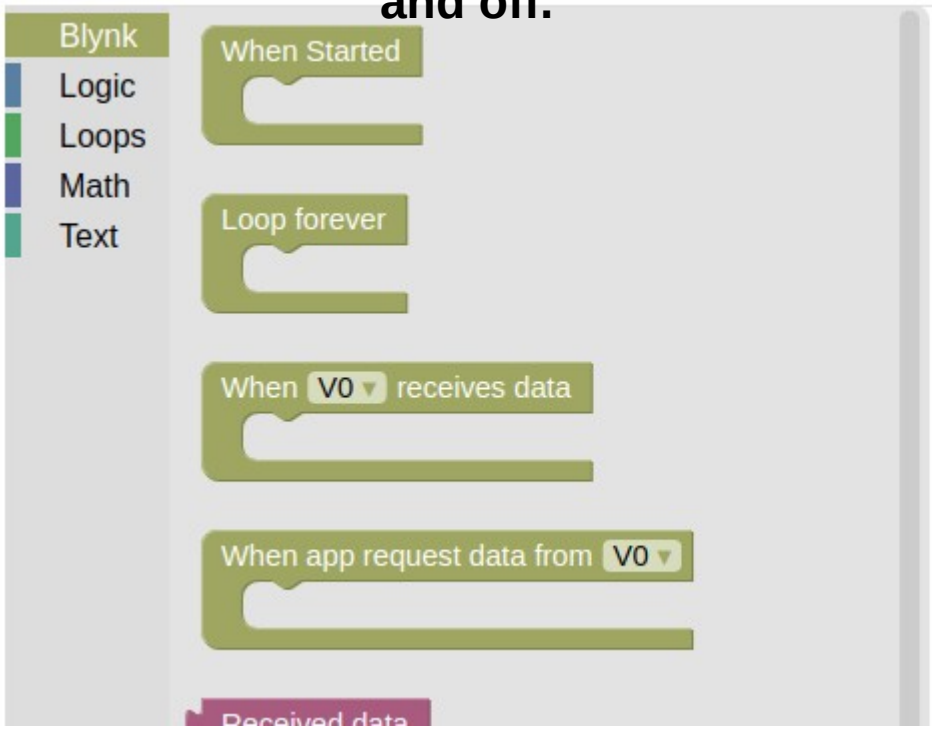
...and reading rate to 1 sec. This will make the mobile app request for data from V4 once every second

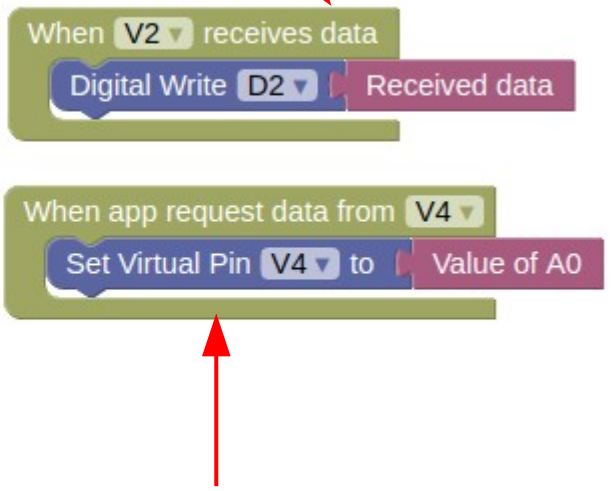


Challenge 6 : Home Automation

Drag in a “When V2 receives data” block, and add a “Digital Write D2”

We’ll use this to turn the pump on and off.





The app will request for data from V4 once every second. When the request comes in, we’ll send back the value of “A0”.

A0 is connected to the soil moisture sensor.

Challenge 6 : Home Automation

Test out...

- You should be able to read the soil moisture level on the gauge (…it'll keep decreasing)
- If you turn the pump on, the soil moisture will increase

Experiment

- Besides the gauge widget, there are other widgets that you can use to read analog data. Try these...
  - Value display, LED, Level H/V, SuperChart
  - *SuperChart requires you to "Add Datastream" first, then configure the datastream to select the pin.

Challenge 6 : Home Automation

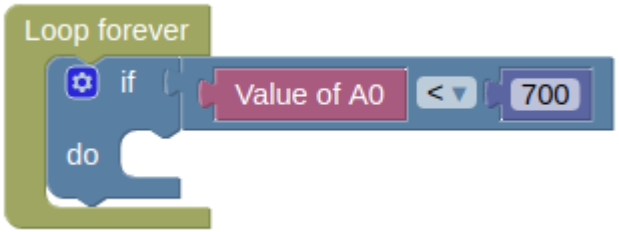
Problem

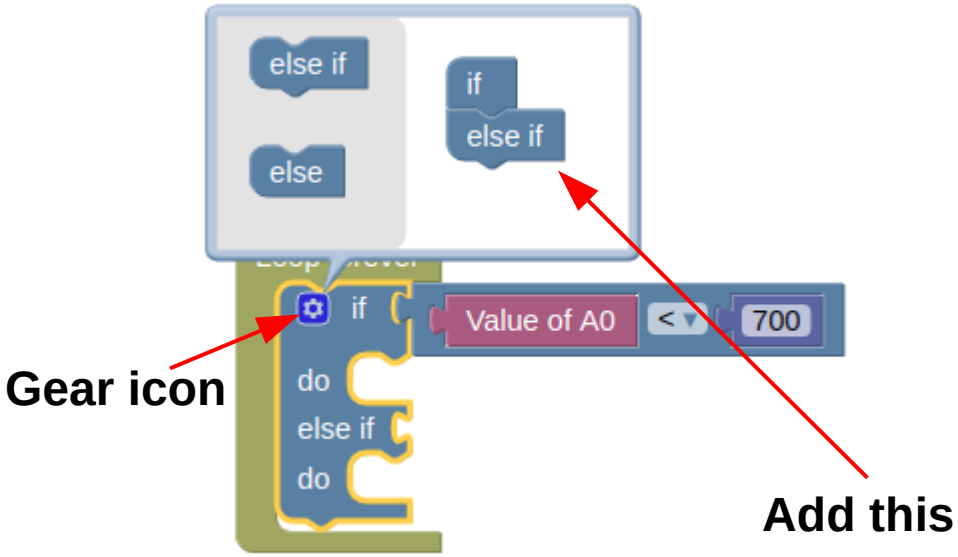
- It’s nice being able to monitor your plant and water it using your phone…
- ...but it’s also a pain-in-the-ass if you have to keep doing it every day

Solution

- Water automatically when soil is dry

Challenge 6 : Home Automation



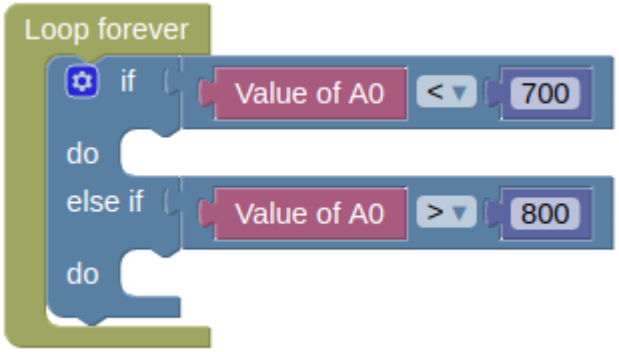


1) Drag in a “Loop forever” block, and add an “if” block (...under “Logic”).

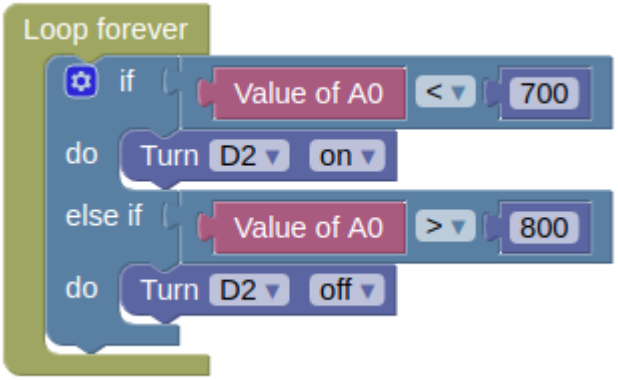
2) Add the “Value of A0 < 700” blocks as well (...the number block for “700” is under “Math”).

3) Click on the gear icon, and add in an “else if” block.

Challenge 6 : Home Automation



4) Add a “Value of A0 > 800” block.



5) Add the “Turn D2 on” and “Turn D2 off” blocks.

How it works

- **If A0 is less than 700 (...soil is dry), it’ll turn D2 (pump) on.**
- **If A0 is greater than 800 (...soil is wet), it’ll turn D2 (pump) off.**
- **The “Loop forever” makes this repeat forever**

Challenge 6 : Home Automation

Experiment

- Can you make the door automatically unlock when the button in the simulator is pressed?
- Can you make the IoT device send your phone a warning if the soil moisture is too low (eg. below 200)
  - You'll need to temporarily disable the automatic watering to test this
- Program it so that you can press a button on the mobile app to start the pump, and the pump should automatically stop when the soil moisture level reaches 800.

Challenge 6 : Home Automation

What have we Built?

- Smart plant pot
  - Automatic watering
  - Monitor soil moisture
  - Warn when water is low

Can be further improved with automatic LED grow lights, temperature monitoring, and fertilizer dosing.

Challenge 7:
Bedroom Controls

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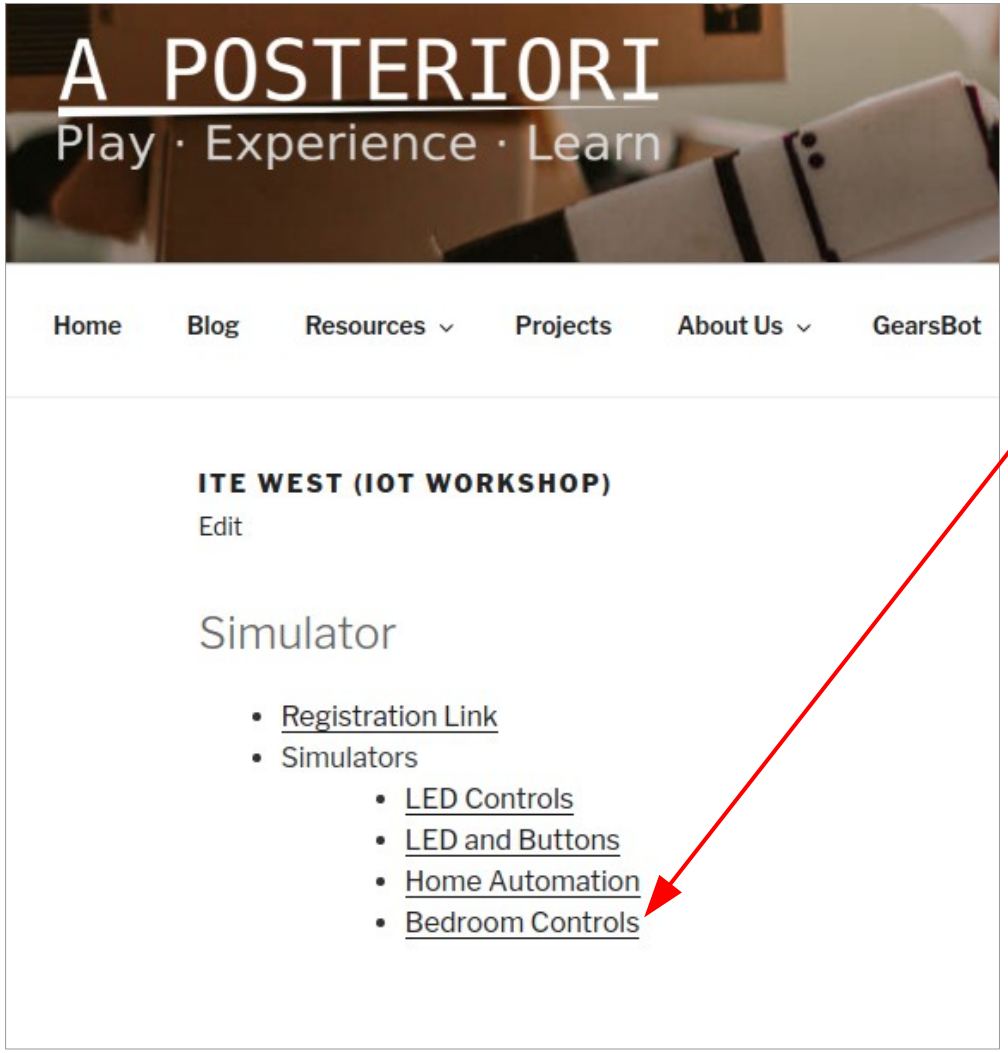
Play · Experience · Learn

Challenge 7 : Bedroom Controls



Open the last simulator “Bedroom Controls”

Challenge 7 : Bedroom Controls

What's New

No more wiring diagrams

D0 (Output): Lights (On/Off)

D1 (Output): Aircon (On/Off)

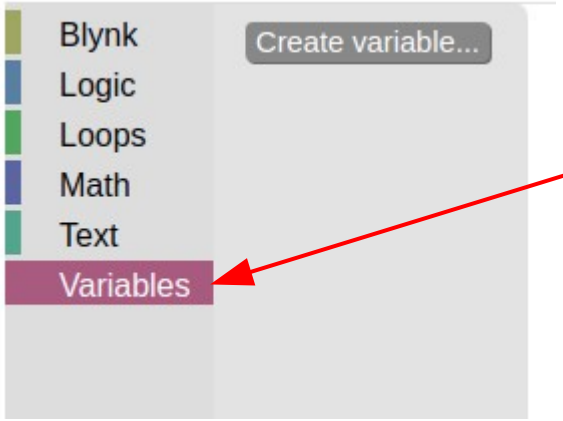
D2 (Output): CCTV (Pan, Analog)
D3 (Output): CCTV (Tilt, Analog)

D4 (Input): Motion Sensor (High/Low)

A0 (Input): Thermometer (Analog)

Challenge 7 : Bedroom Controls

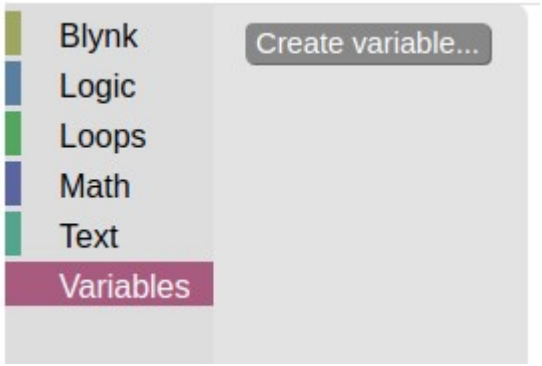
What's New



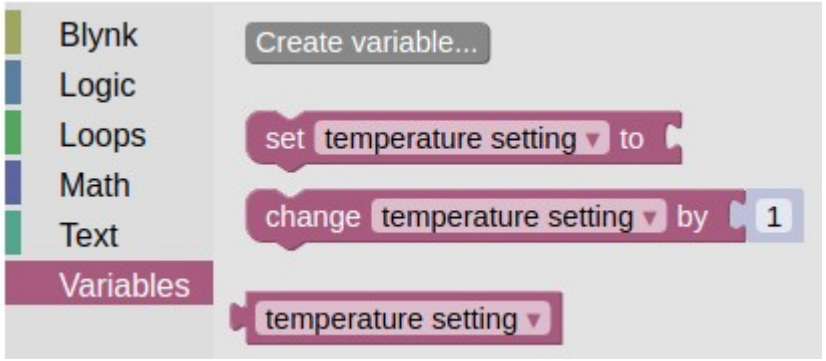
Variables
Can be used to store data. Allows the IoT controller to "remember" things.

We'll use this to "set" a target temperature for the bedroom, and create a simple program to automatically control the aircon to reach that temperature.

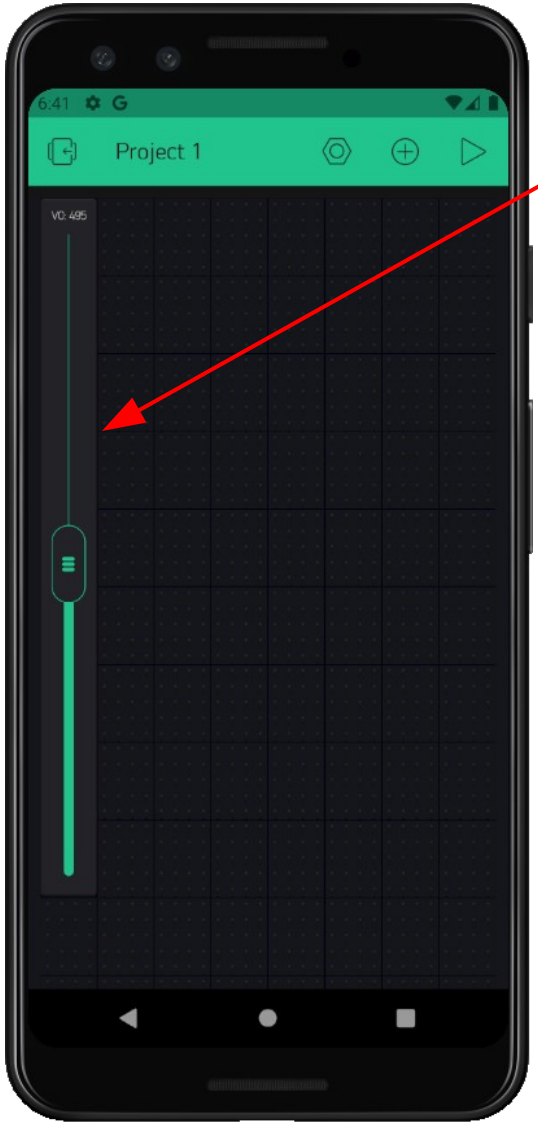
Challenge 7 : Bedroom Controls



Click on “Variables” then “Create variable…”. Name the variable “temperature setting”.



Challenge 7 : Bedroom Controls

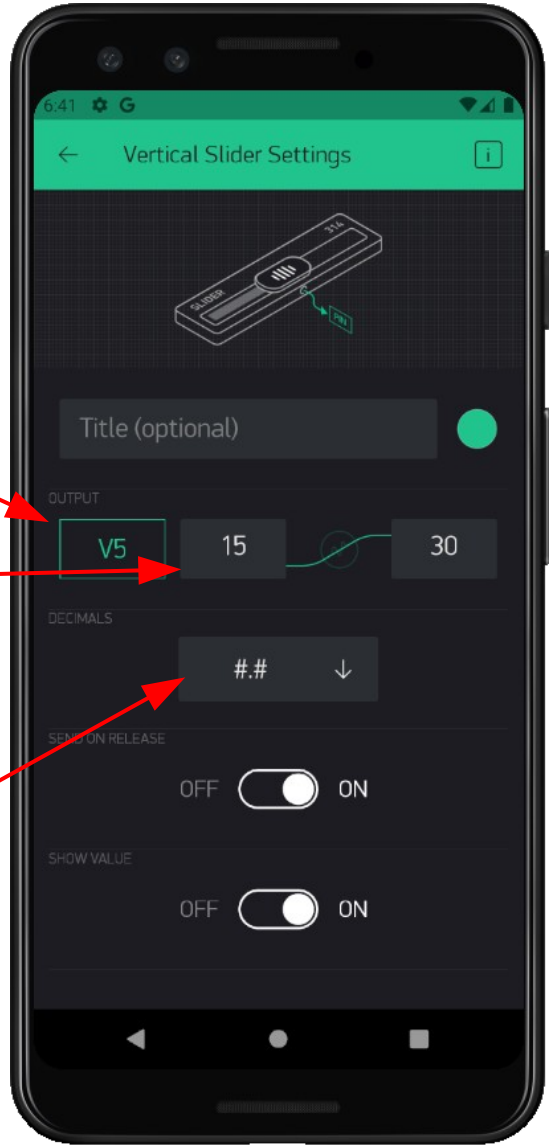


Add a new slider, and resize it to make it longer.

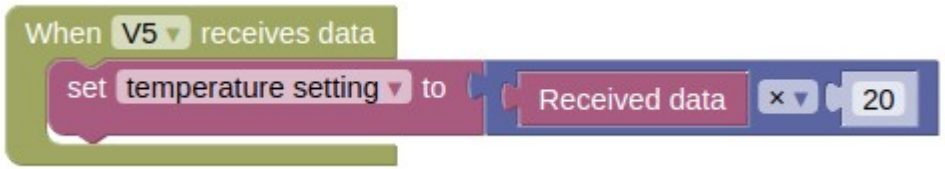
Set the pin to “V5”

Set the range to “15” to “30 This allows us to set the temperature in Celsius.

Also, set it to one decimal point. This will let us set the temperature more accurately.



Challenge 7 : Bedroom Controls

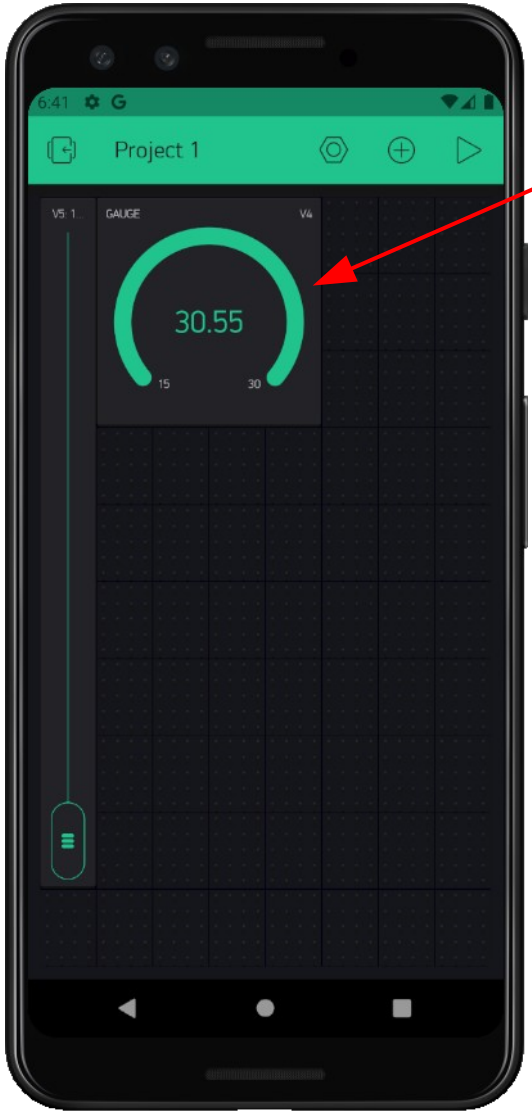


When data is received on V5, we'll multiply the value by 20 then save it in the "temperature setting" variable.

The reason we need to multiply by 20, is because the value we send from our phone app is in Celsius, while the value that the IoT device read from the thermometer is from "0 to 1023". The multiplication helps converts the value.

Not all sensors will require a multiplication by 20! It depends on the sensor, and you'll need to check the documentation of your sensor to determine the formula.

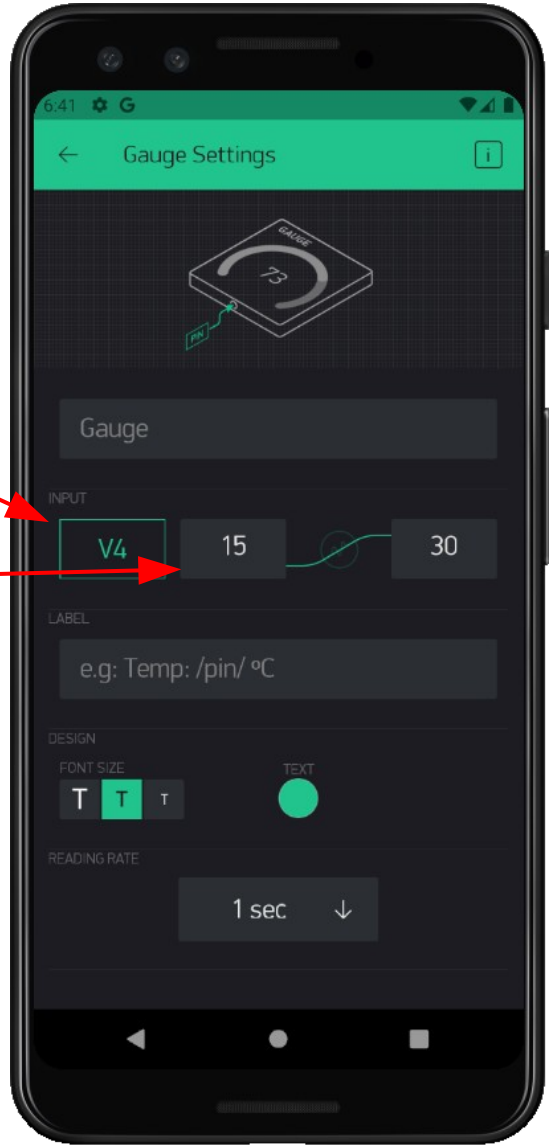
Challenge 7 : Bedroom Controls



Add a new gauge

Set the pin to “V4”

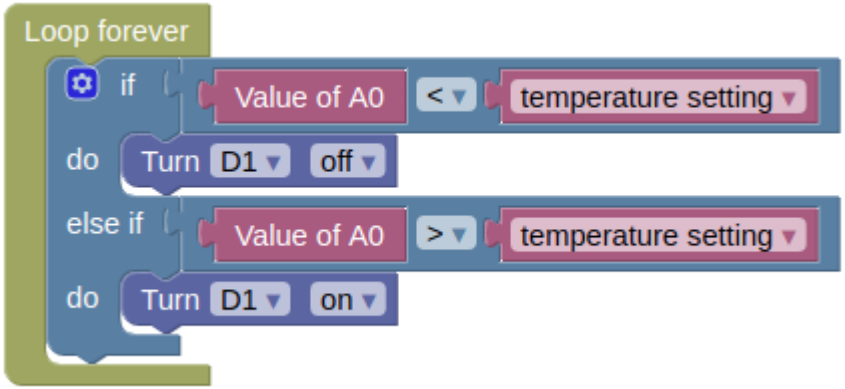
Set the range to “15” to “30
This allows us to view the temperature in Celsius.



Challenge 7 : Bedroom Controls

When data is received on V4, we'll divide the value by 20 before sending it.

This converts the value from "0 to 1023" into Celsius.



Add in this block program.

<u>How it works</u>

- **It'll compare the current temperature (A0) with the "temperature setting"**
- **If the current temperature is lower than the setting, it'll turn off the aircon.**
- **If it is higher, it'll turn the aircon on.**

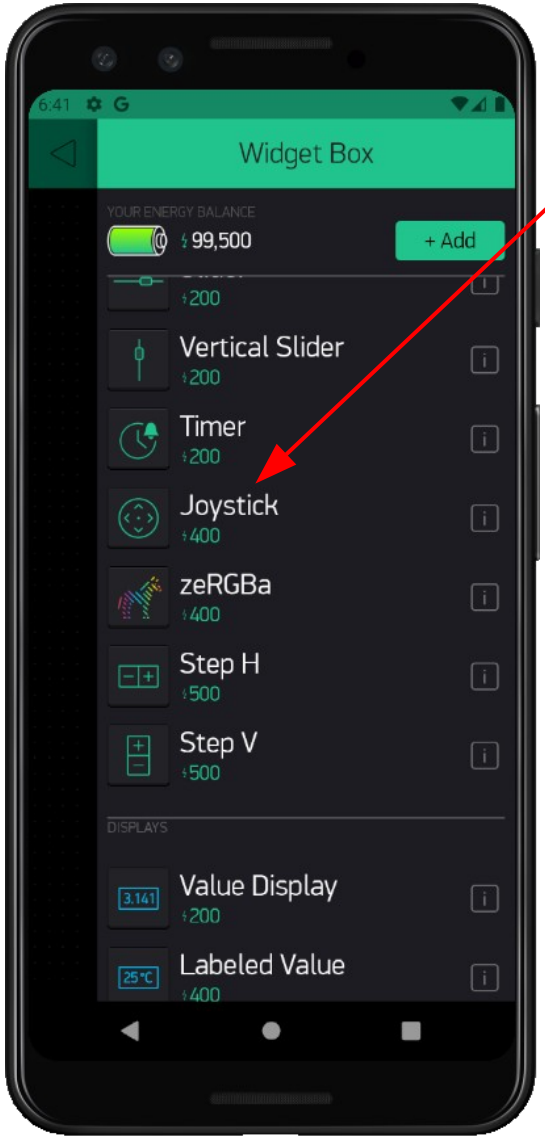
Engineers usually design in a bit of a gap between the "On" and "Off" temperature (eg. on at 26 degrees, off at 25 degrees). This is to prevent the aircon from turning on and off frequently.

Challenge 7 : Bedroom Controls

Test out...

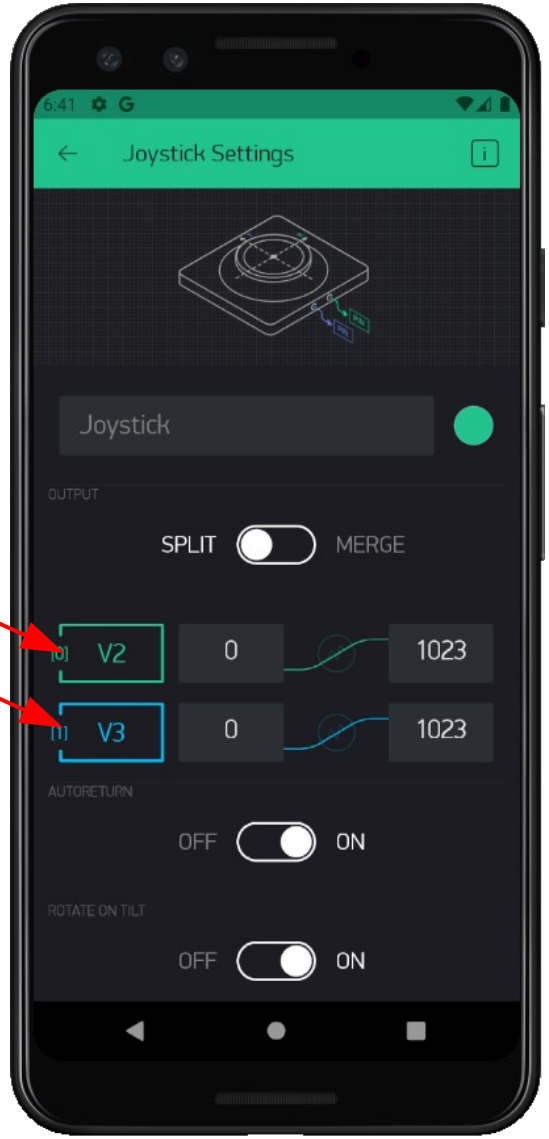
- Run the program on both the simulator and your phone
- Set a temperature (eg. 25 degrees). Wait and see if the temperature stabilize at that temperature.
- Adjust it to a different temperature (eg. 27 degrees). Does it change to the new temperature and stabilize there?

Challenge 7 : Bedroom Controls



The Joystick widget is great for controlling the camera. Add it to your mobile app.

Set the pin to “V2” and V3



Challenge 7 : Bedroom Controls

Add in the program you see on the left.

These programs will set the Pan (D2) and Tilt (D3) of the camera, based on the data sent by the joystick (V2 and V3).

Experiment

- Try the “Autoreturn” setting in the joystick widget.

Challenge 7 : Bedroom Controls

Challenges

1) Can you add in a 1 degree gap between the starting and stopping of the aircon?

2) Add an alarm when the motion sensor is triggered.

3) Add a dimmable control for the lights.

4) Difficult: Can you program the IoT device to automatically turn the lights and aircon off if there is no motion detected for 5 seconds? When motion is detected, it should turn the lights and aircon back on to its previous setting.

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