Controlling Servo Motors with the Arduino Uno R4

UB IEEE x DREAM

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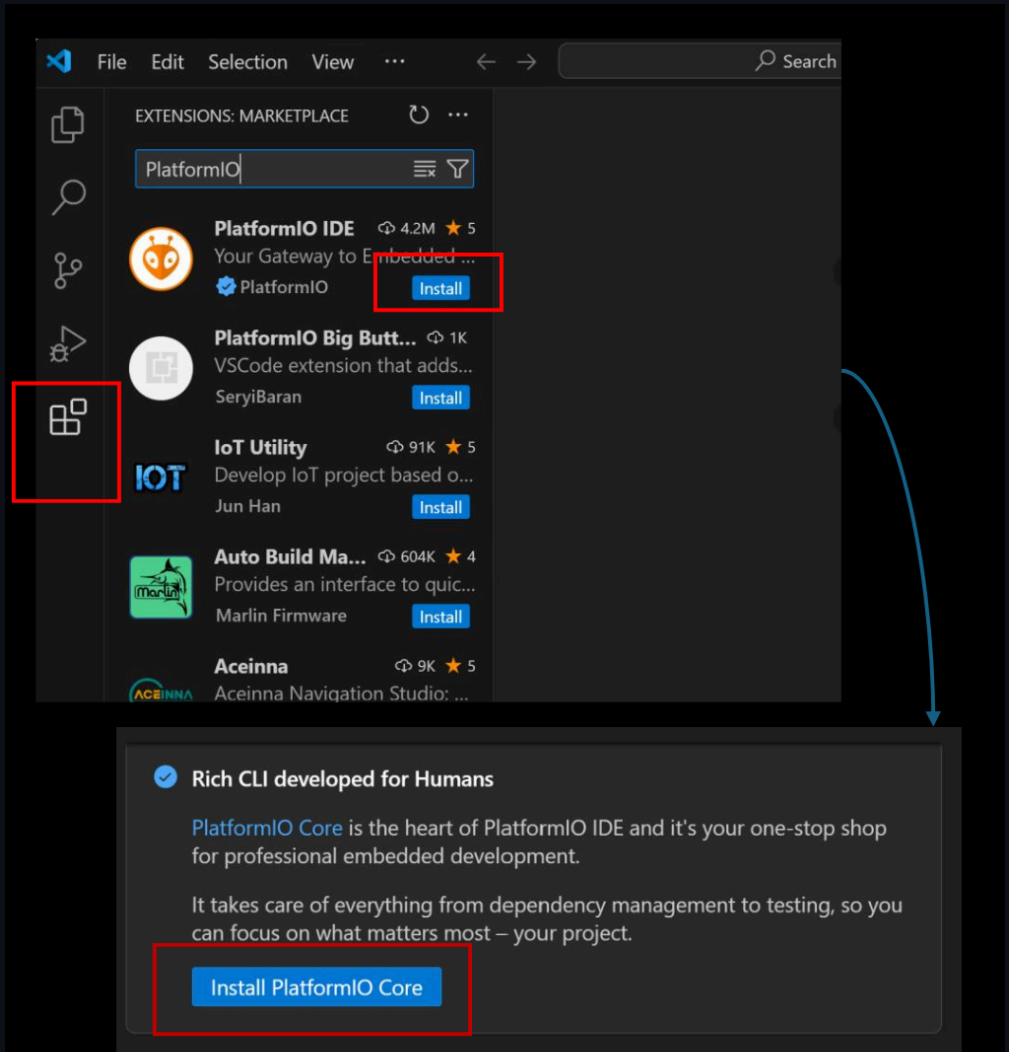
Installing VSCode

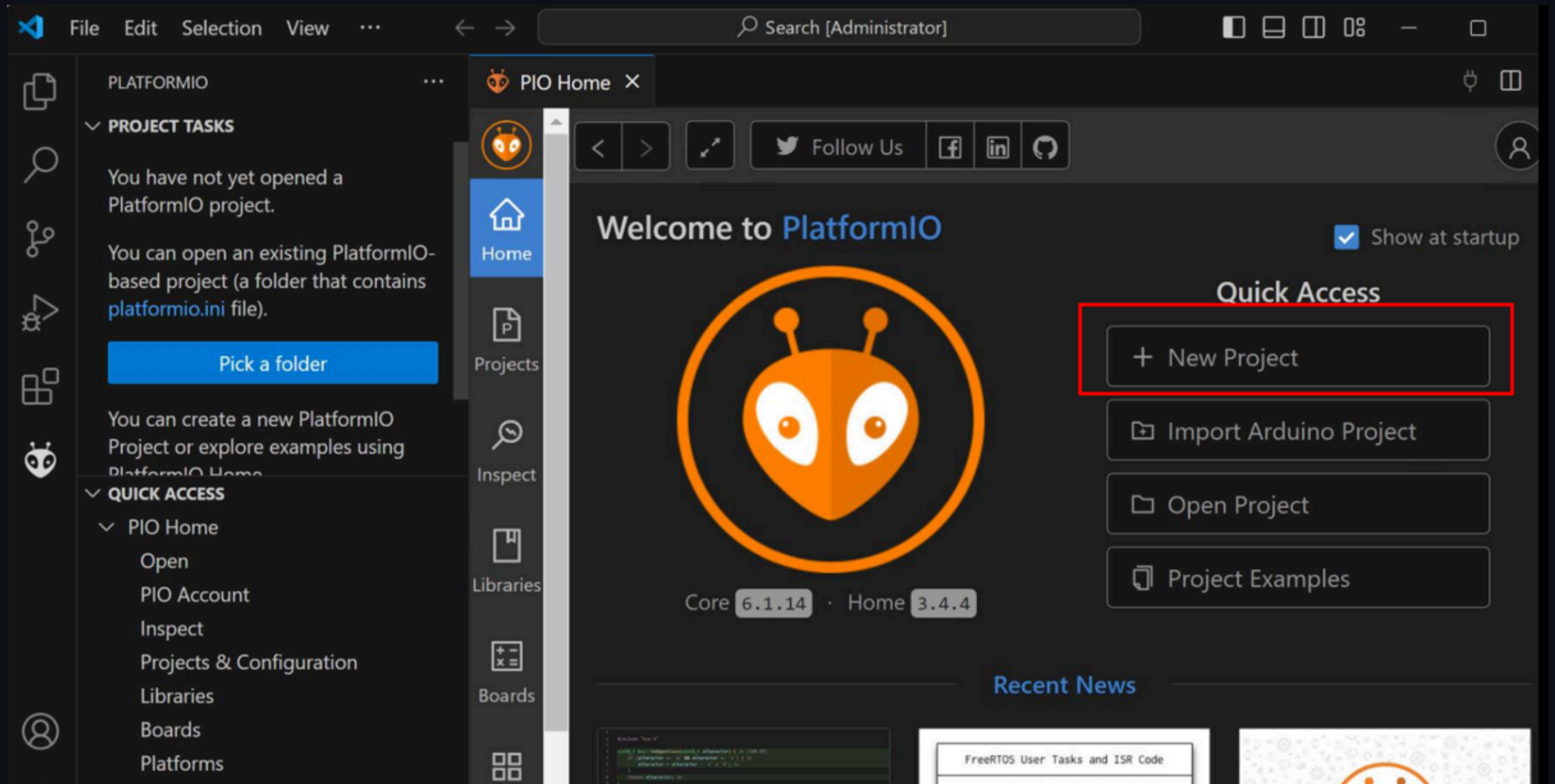
Visual Studio Code is a powerful text editor. VS Code's powerful and popular extension ecosystem can give it many of the powers of a fully-fledged IDE. You can download Visual Studio Code from here: https://code.visualstudio.com/download.

Installing PlatformIO

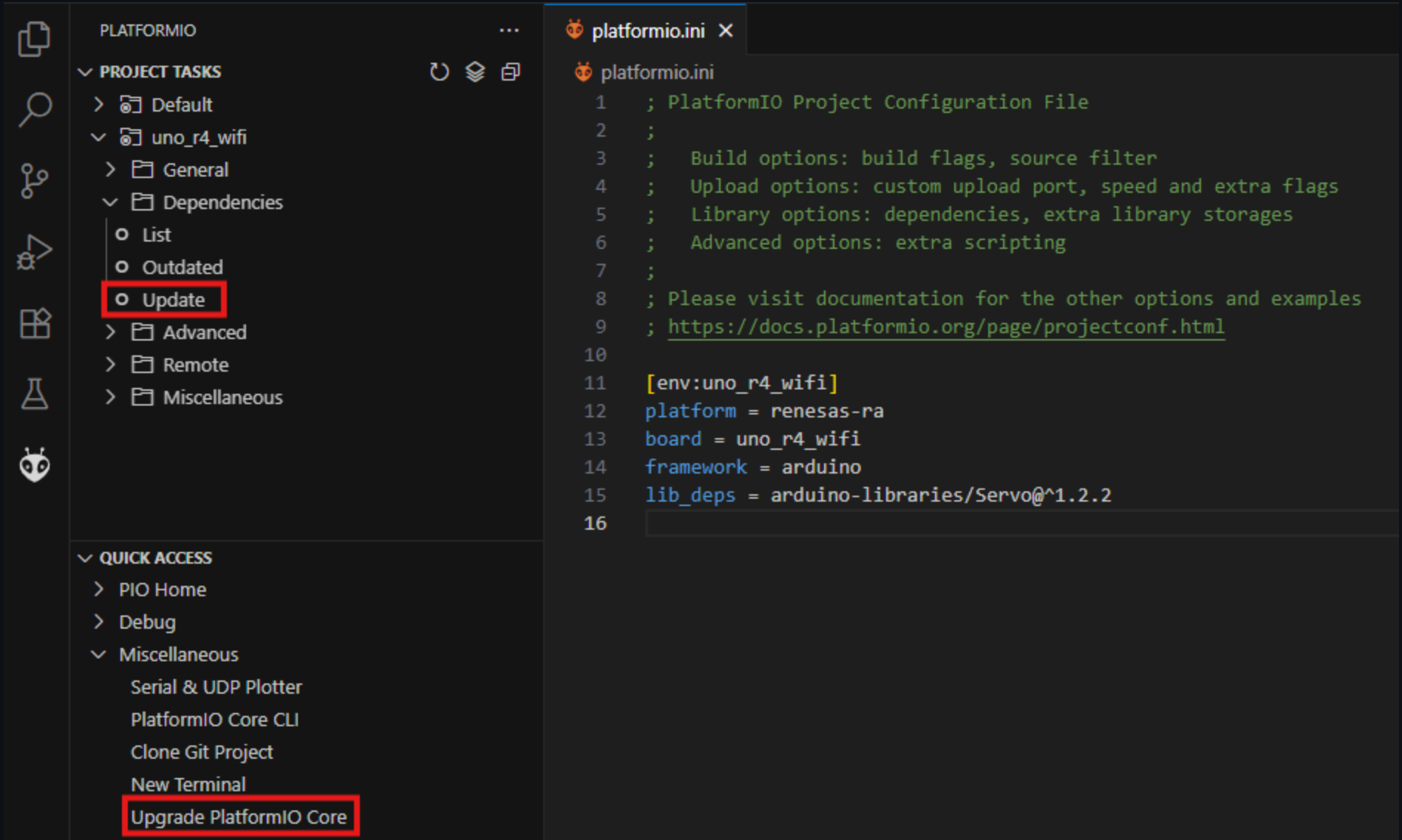
Install PlatformIO as a VSCode extension:



Creating a New Project



Upgrade Core + Update Dependencies



Arduino Software Convention

Arduino main:

```
int main(void){
    init();
    setup();
    while (true){
        loop();
    }
    return 0;
}
```

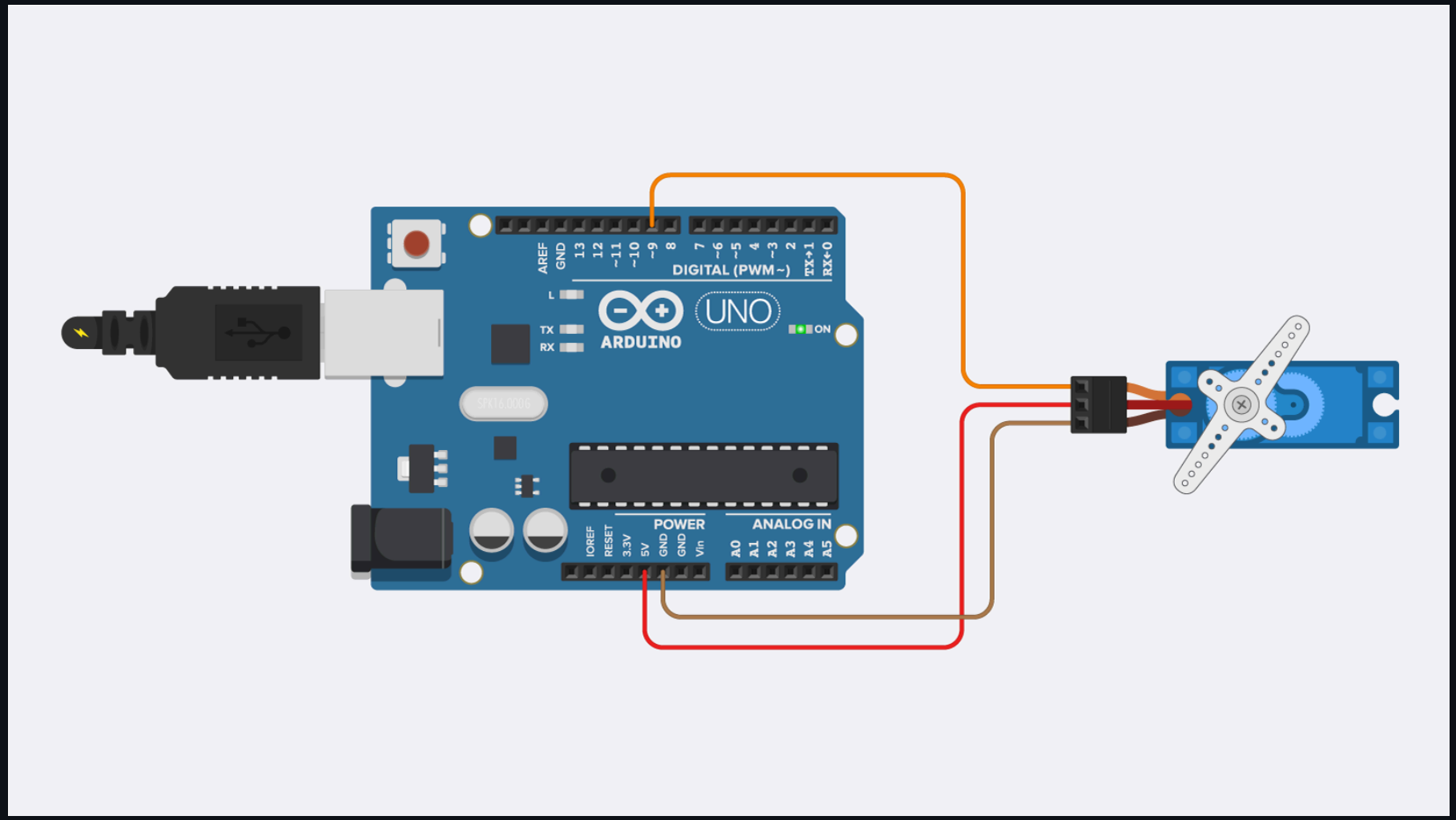
The `platformio.ini` Configuration File

```
[env:uno_r4_wifi]
platform = renesas-ra
board = uno_r4_wifi
framework = arduino
```

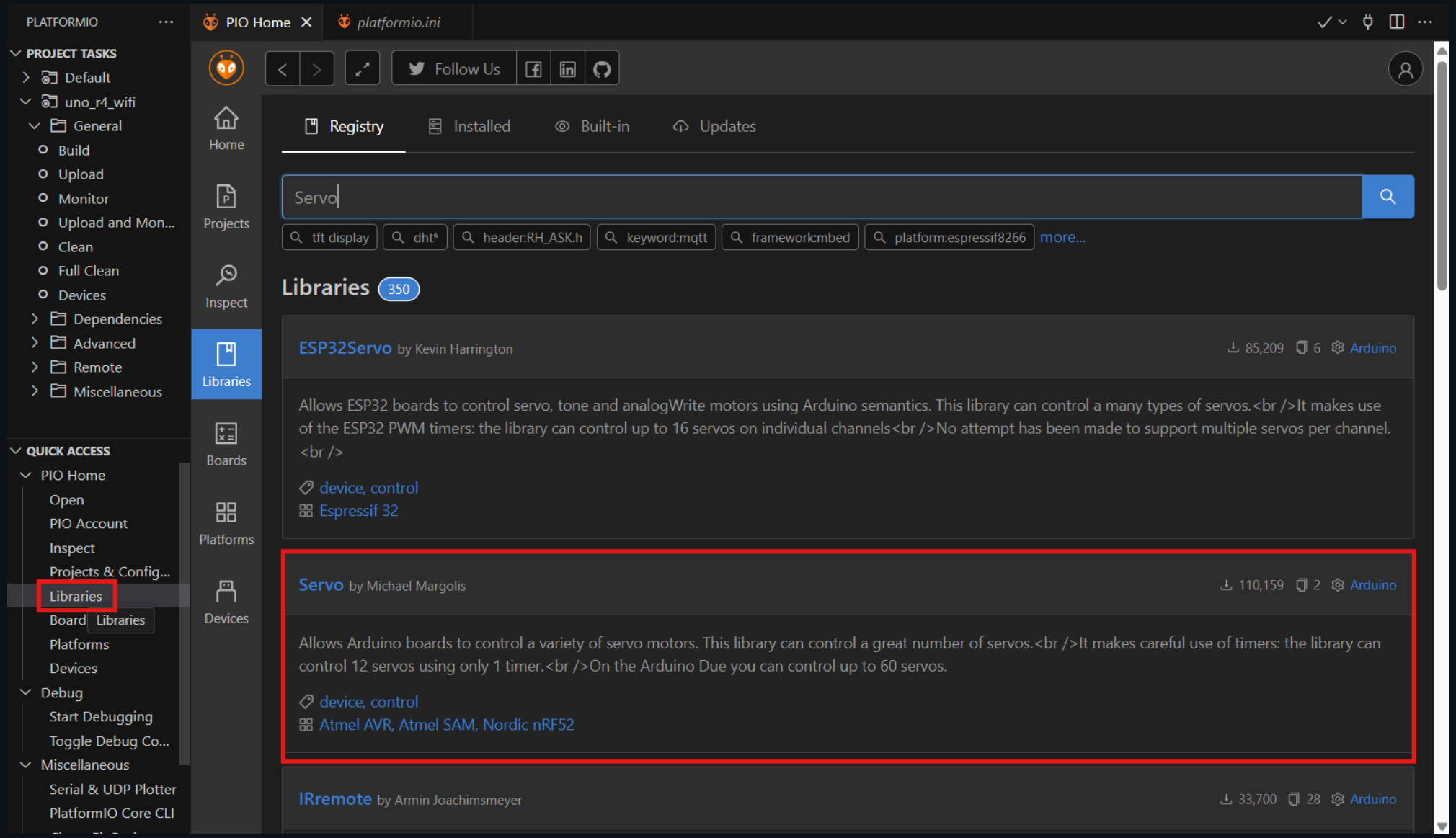
Blink - the `Hello, World!` of Hardware

```
#include <Arduino.h>

// put function declarations here:
int myFunction(int, int);

void setup() {
  // put your setup code here, to run once:
  int result = myFunction(2, 3);
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(LED_BUILTIN, HIGH);
  delay(1000);
  digitalWrite(LED_BUILTIN, LOW);
  delay(1000);
}

// put function definitions here:
int myFunction(int x, int y) {
  return x + y;
}
```

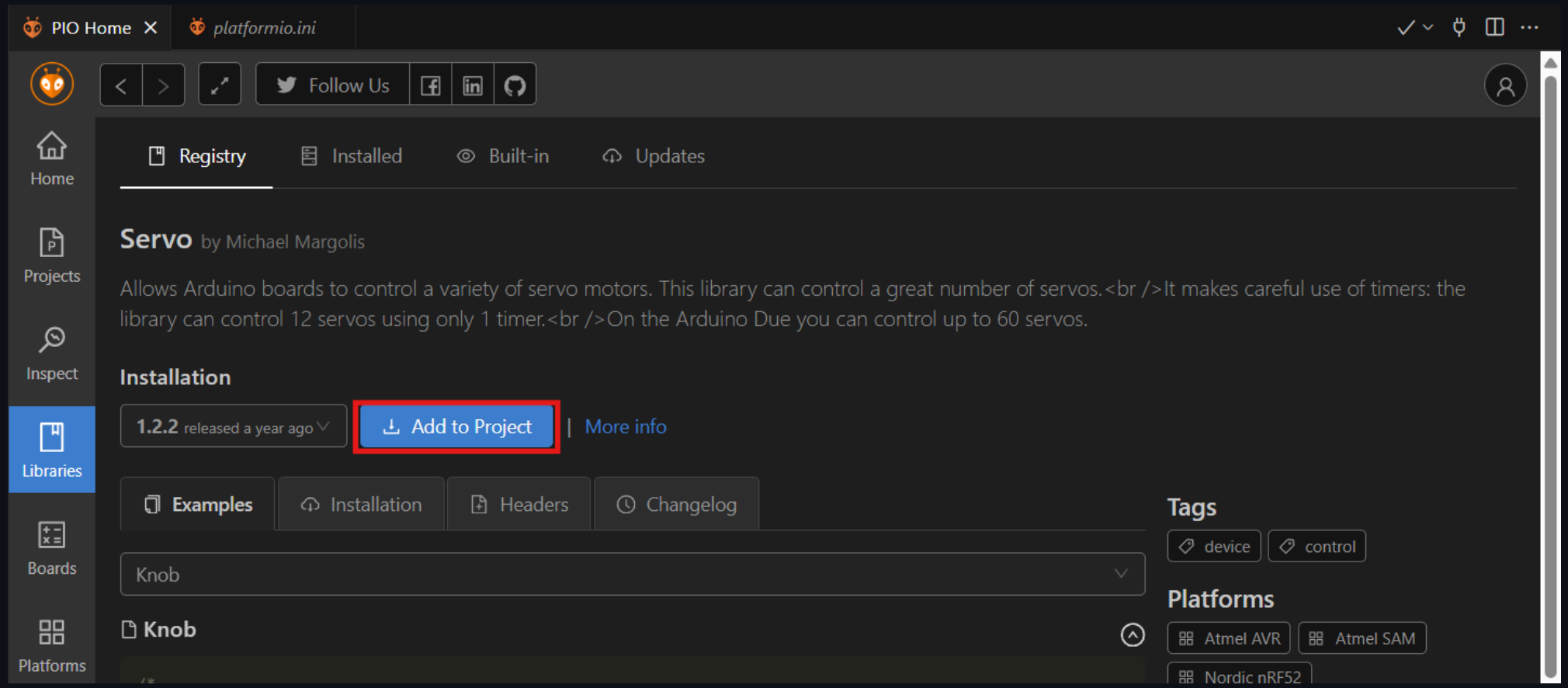
Connecting your Servo Motor



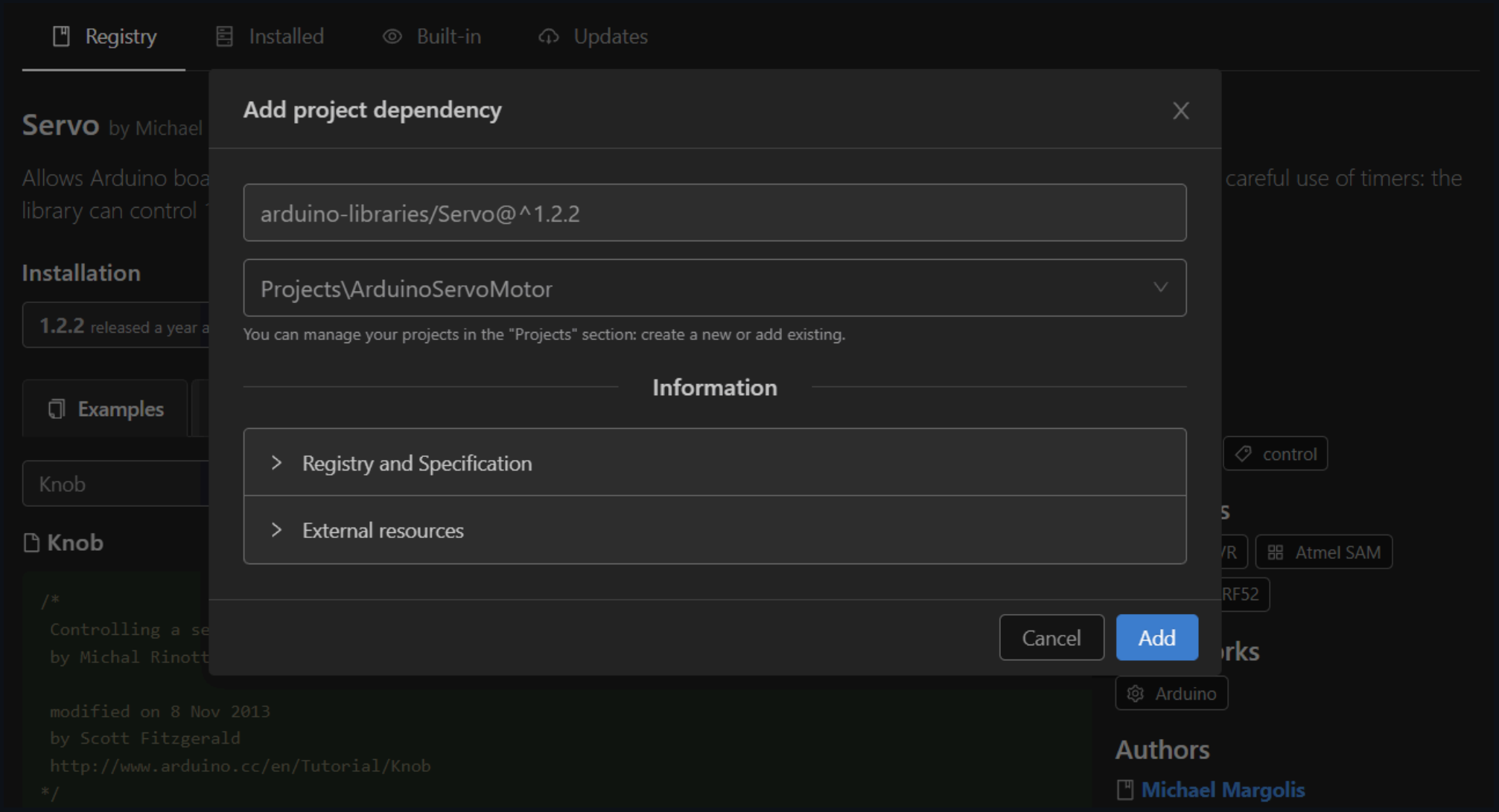
Installing Libraries Using PlatformIO



Installing Libraries Using PlatformIO



Installing Libraries Using PlatformIO



Controlling the Servo

```
#include <Arduino.h>
// Include Servo Library
#include <Servo.h>

Servo myServo;

void setup() {
  // Setup pin 9
  myServo.attach(9);
}

void loop() {
  // control the servo
  myServo.write(0);
  delay(1000);
  myServo.write(90);
  delay(1000);
}
```

Summary of Syntax

Include the Servo Library:

```
#include <Servo.h>
```

Setup your Arduino pin, PWM pins are signaled by "~":

```
myServo.attach(PWM Pin);
```

Control the Servo Motor:

```
myServo.write(Angle Measurement);
```

C++ Looping

```
for (int i = 0; i < 10; i++)
{
  // Loop here
}
```

Coding Challenge

Can you use a loop to gradually change the servo motor?

Remember how to loop from the previous slide, and alter this code to move the servo from 0° to 180°:

```
for (int i = 0; i < 10; i++)
{
  // Loop here
}
```

Once you have the servo rotate from 0° → 180° can you make it go from 180° → 0°?

Hint: You will need to change your starting value, condition, and the increment!

Coding Challenge Answer:

```
for (int pos = 0; pos < 180; pos++)
{
  myServo.write(pos);
  delay(50);
}
for (int pos = 180; pos > 0; pos--)
{
  myServo.write(pos);
  delay(50);
}
```

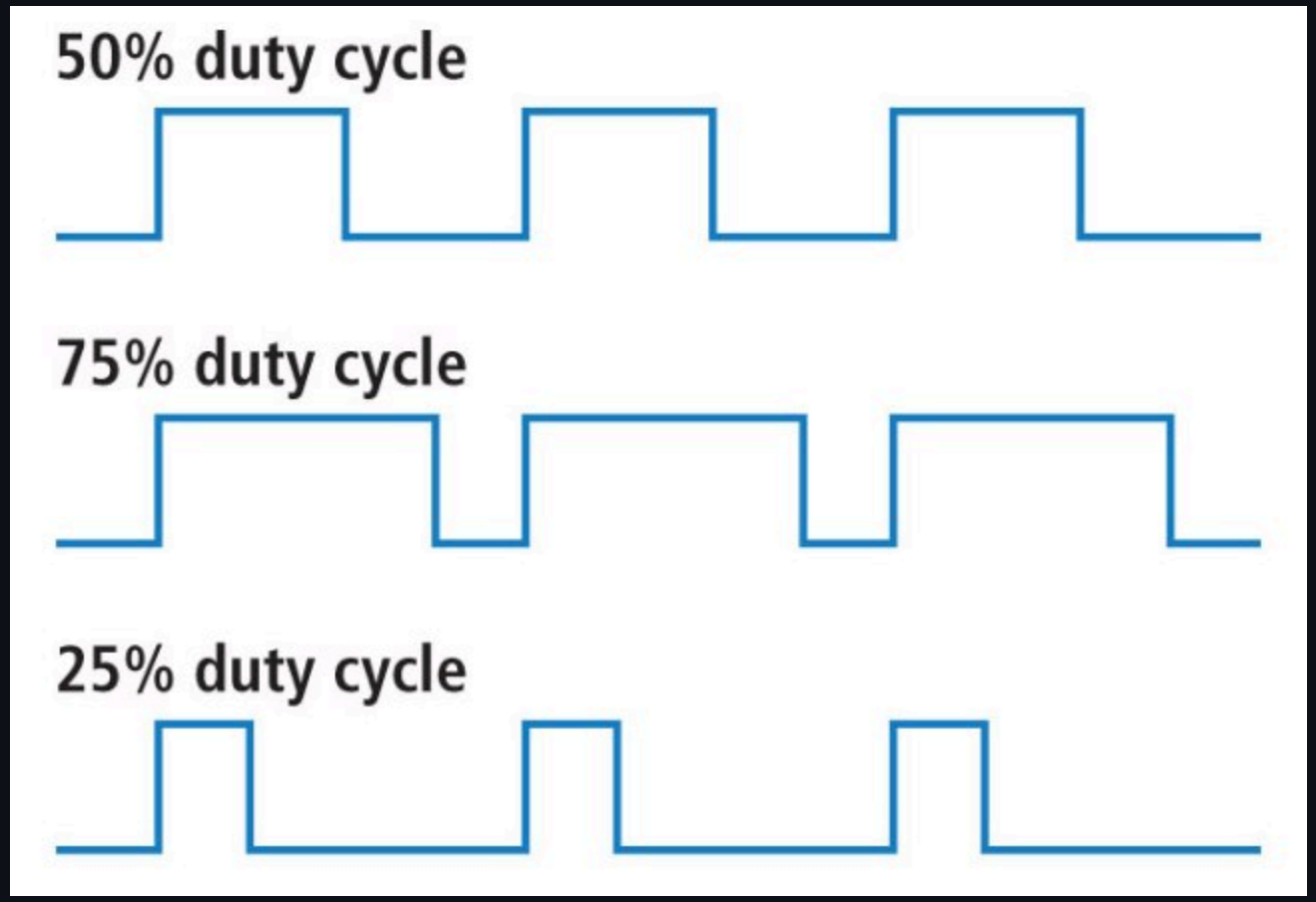
How do Servo Motors Work?

To answer that question, first we must learn what Pulse Width Modulation (PWM) is!

Pulse Width Modulation (PWM)

PWM is used to control power using digital signals. Instead of varying voltage, electronics use PWM signals. The signal is rapidly switched on and off at a fixed frequency, with a set **duty cycle**. Duty cycle is simply the percentage of time the signal is on.

Duty Cycles



Servo Motor Data Wire

Servo motors operate at 50Hz (20ms period). To control a servo motor, we will send pulses via the signal wire. Every 20ms a pulse is sent with the width of:

- ~0.5ms: 0°
- ~1.5ms: 90°
- ~2.5ms: 180°

writeServo() Function

```
#include <Arduino.h>

const int servoPin = 9;

void writeServo(int angle) {
  // Map angle to pulse width
  int pulseWidth = map(angle, 0, 180, 500, 2400);
  // Signal HIGH for width
  digitalWrite(servoPin, HIGH);
  delayMicroseconds(pulseWidth);
  // Signal LOW for remaining
  digitalWrite(servoPin, LOW);
  delayMicroseconds(20000 - pulseWidth);
}

void setup() {
  pinMode(servoPin, OUTPUT);
}

void loop() {
  for (int i = 0; i < 50; i++) {
    writeServo(0);
  }
  for (int i = 0; i < 50; i++) {
    writeServo(90);
  }
  for (int i = 0; i < 50; i++) {
    writeServo(180);
  }
}
```

Which is better?

It's nice to see how these servo motors work, but this application is unrealistic. There are some errors in our approach:

- Blocking Delays: Can't do anything else because we need to send a constant pulse.
- Pulse Range: Different servo motors have different ranges. We are assuming they are all the same.
- Software Timing: Delays are software-timed, meaning they are not as percise as hardware. This can lead to various jittering issues.

So, we use libraries!

Additional Resources

- VSCode Documentation: https://code.visualstudio.com/Docs
- PlatformIO's Documentation: https://docs.platformio.org/en/latest/
- Arduino Documentation: https://docs.arduino.cc/
- C++ Programming Language: https://www.learncpp.com/
- The C Programming Language by Brian Kernighan and Dennis Ritchie: https://en.wikipedia.org/wiki/The_C_Programming_Language
- Purchase the Arduino Uno R4 Wifi (US Store): https://store-usa.arduino.cc/products/uno-r4-wifi