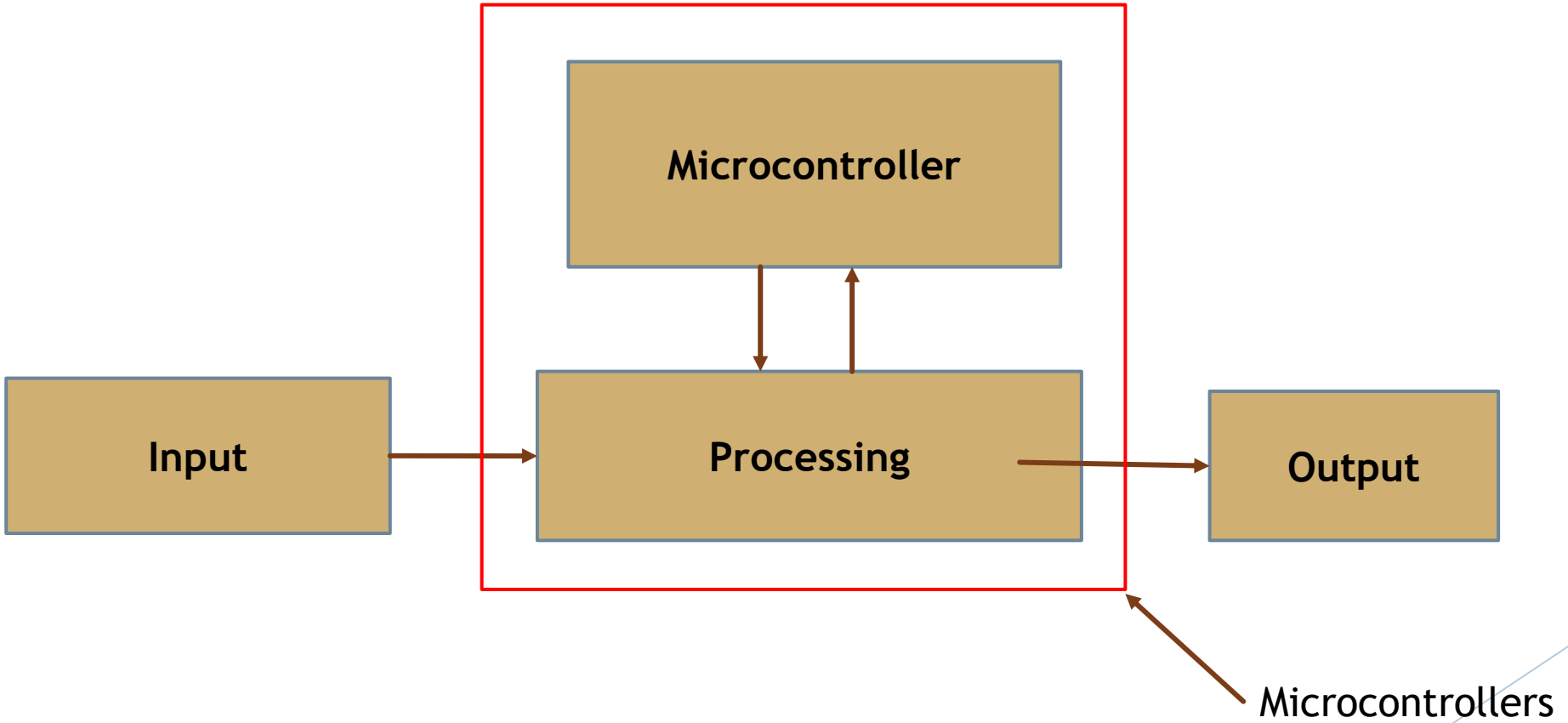
GETTING STARTED WITH ARDUNIO

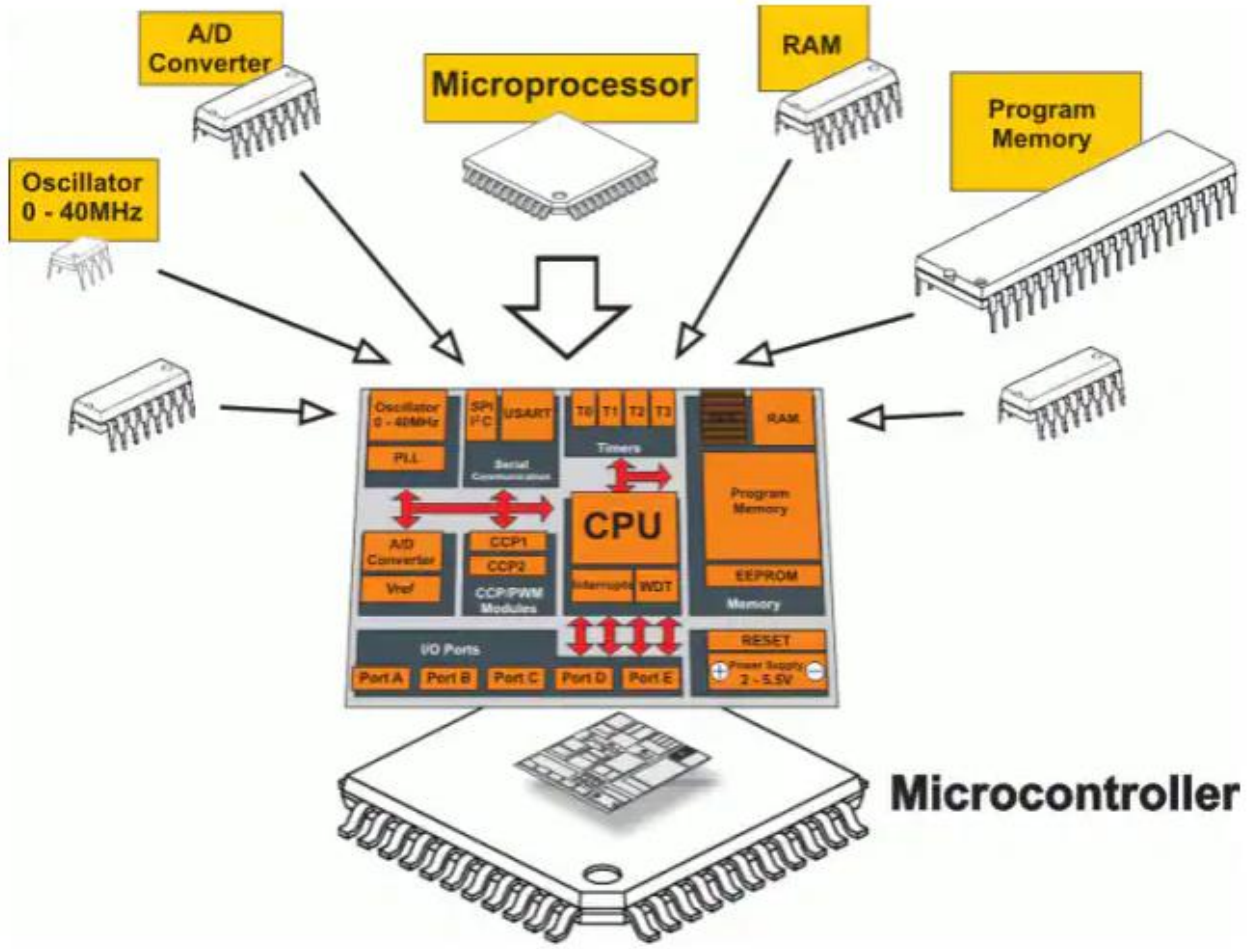
Conducted by : Devinda Srinath

B.Sc. Undergraduate university of Moratuwa

What is a System ?



What are Microcontrollers?



Different types of Microcontrollers

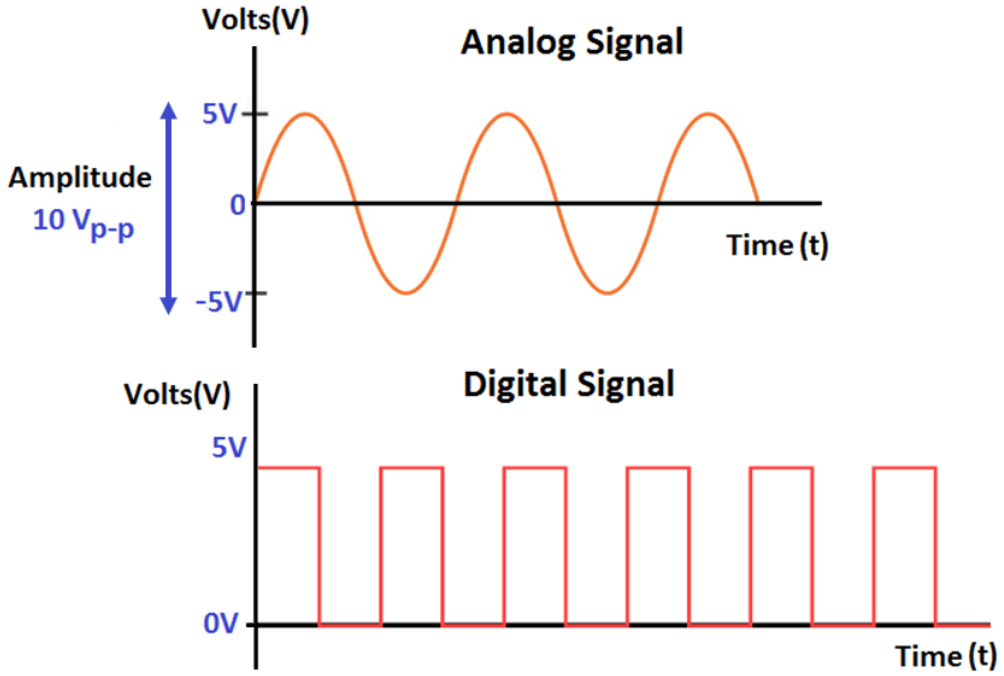


What is a Signal ?

In electronics and telecommunications, a signal **refers to any time-varying voltage, current, or electromagnetic wave that carries information**.

There are two main types of signals :

1 . Analog
2. Digital



Introduction to Arduino

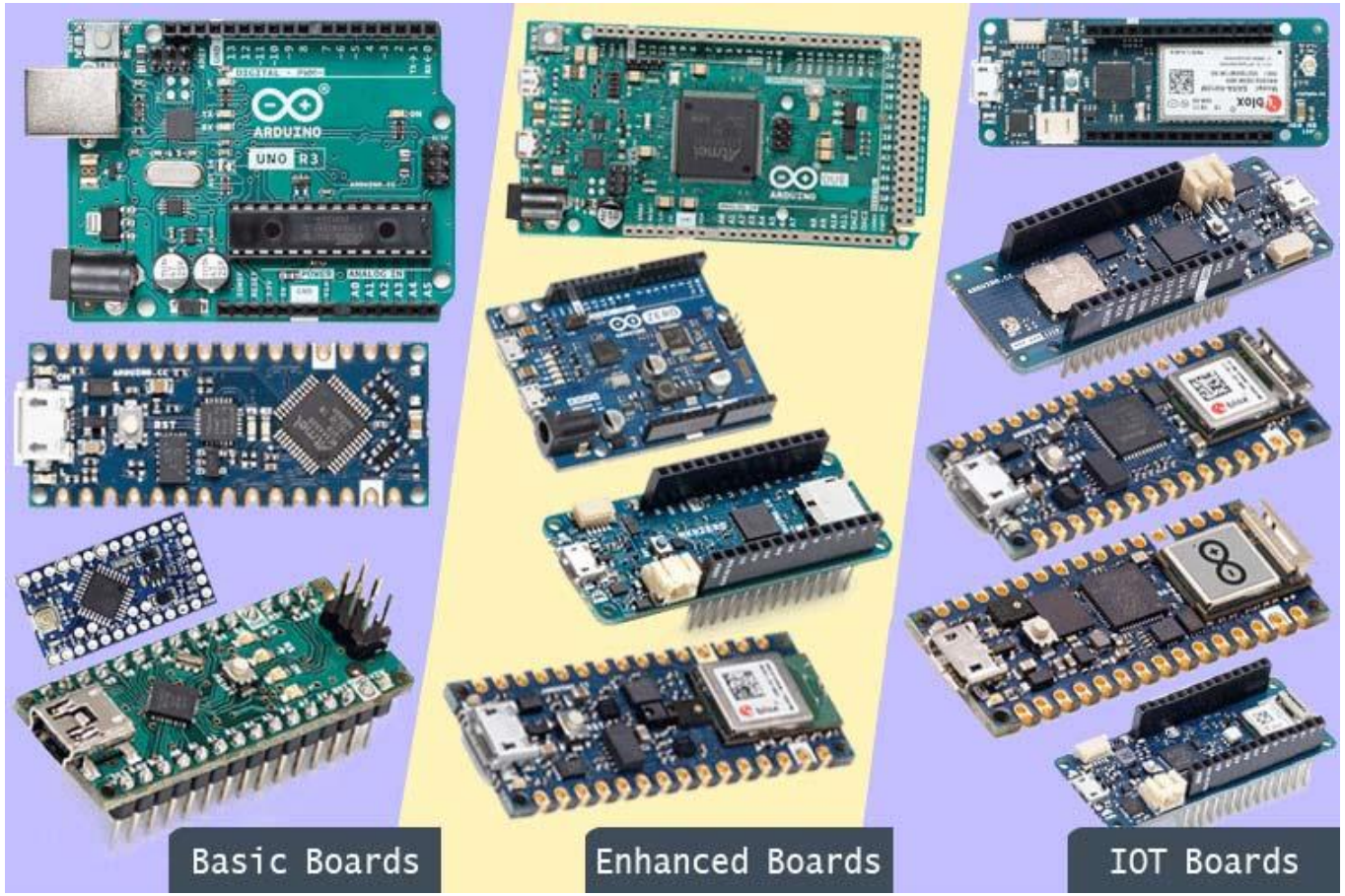
Arduino is an open-source platform used for building electronics projects.

Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board

Arduino IDE : The open-source **Arduino** Software (**IDE**) makes it easy to write code and upload it to the board. This software can be used with any **Arduino** board.

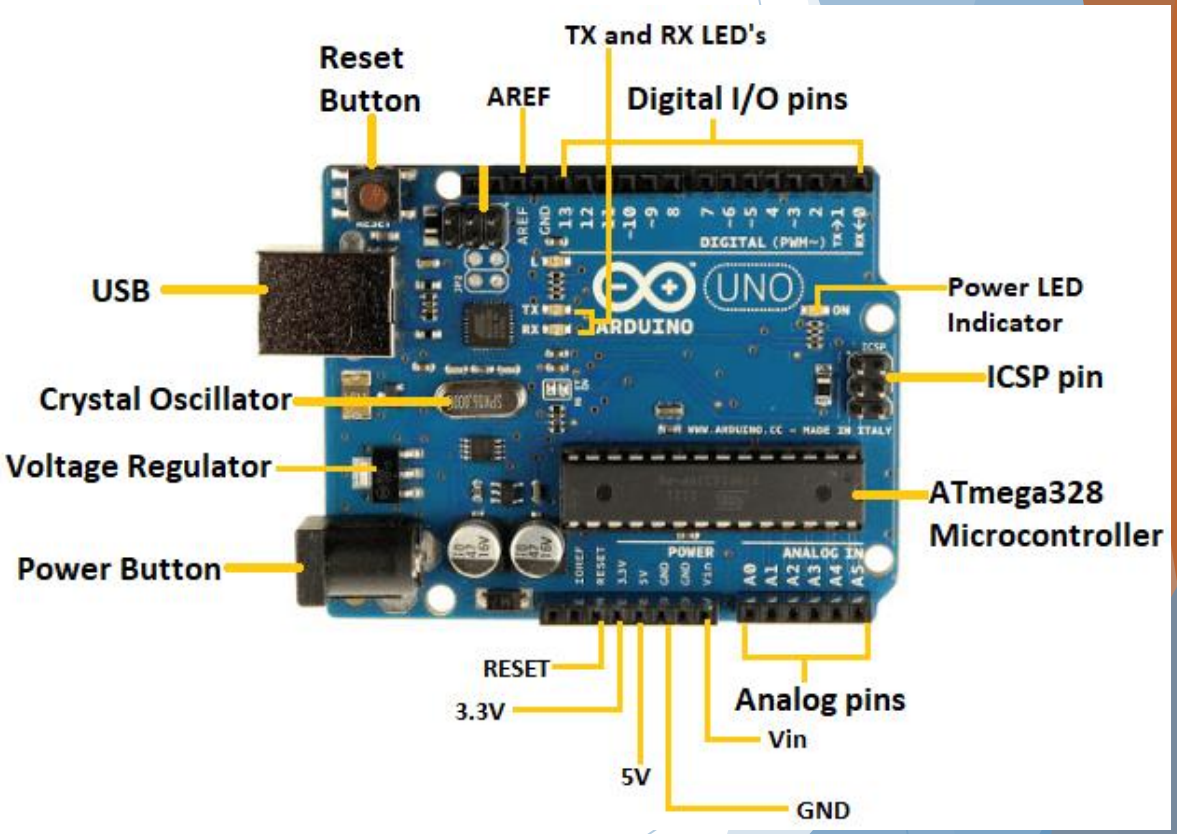
Arduino Boards : Pre-assembled Hardware with embedded microcontrollers and other components(USB to UART, Peripherals, and more…)

Different types of Arduino boards

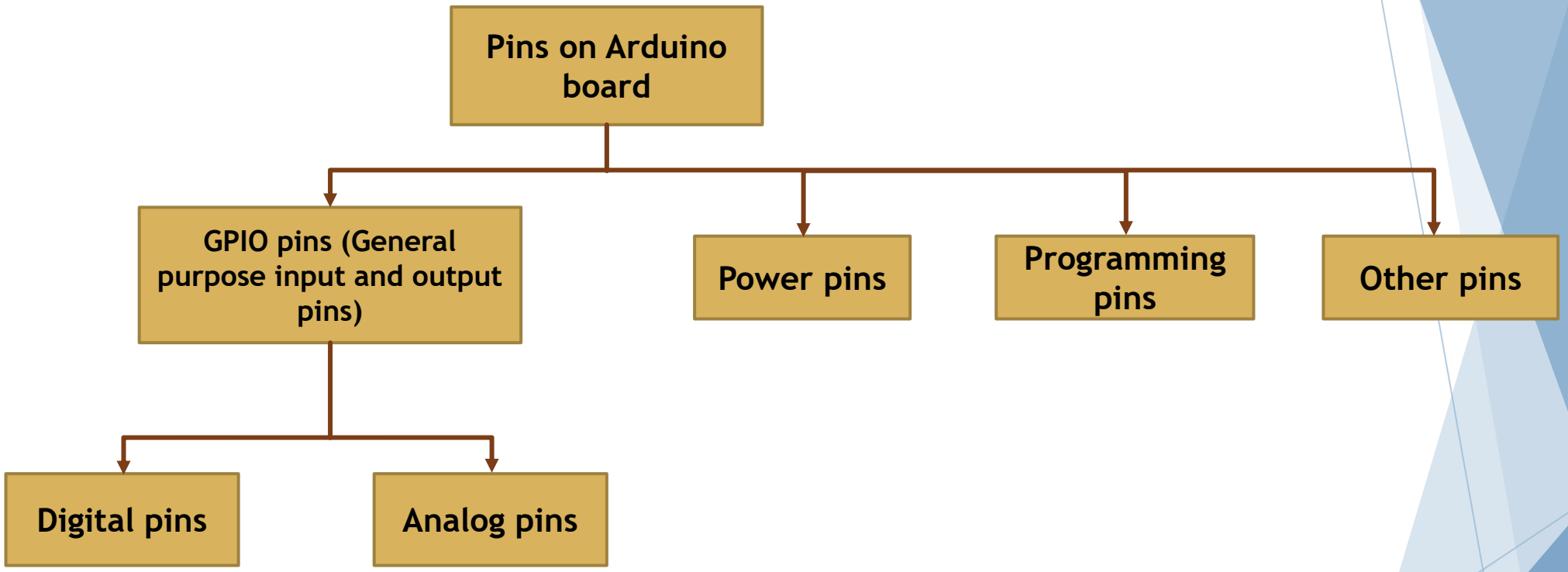


Arduino Uno

Microcontroller	ATmega328P
Operating Volt.	5V
Input Volt. (recommended)	7-12V
Input Volt. (limit)	6-20V
Digital I/O Pins	14 (6 PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm



Main types of Pins on Ardunio boards



Digital pins : pins which can generate or process digital signals

Analog pins : pins which can generate or process analog signals

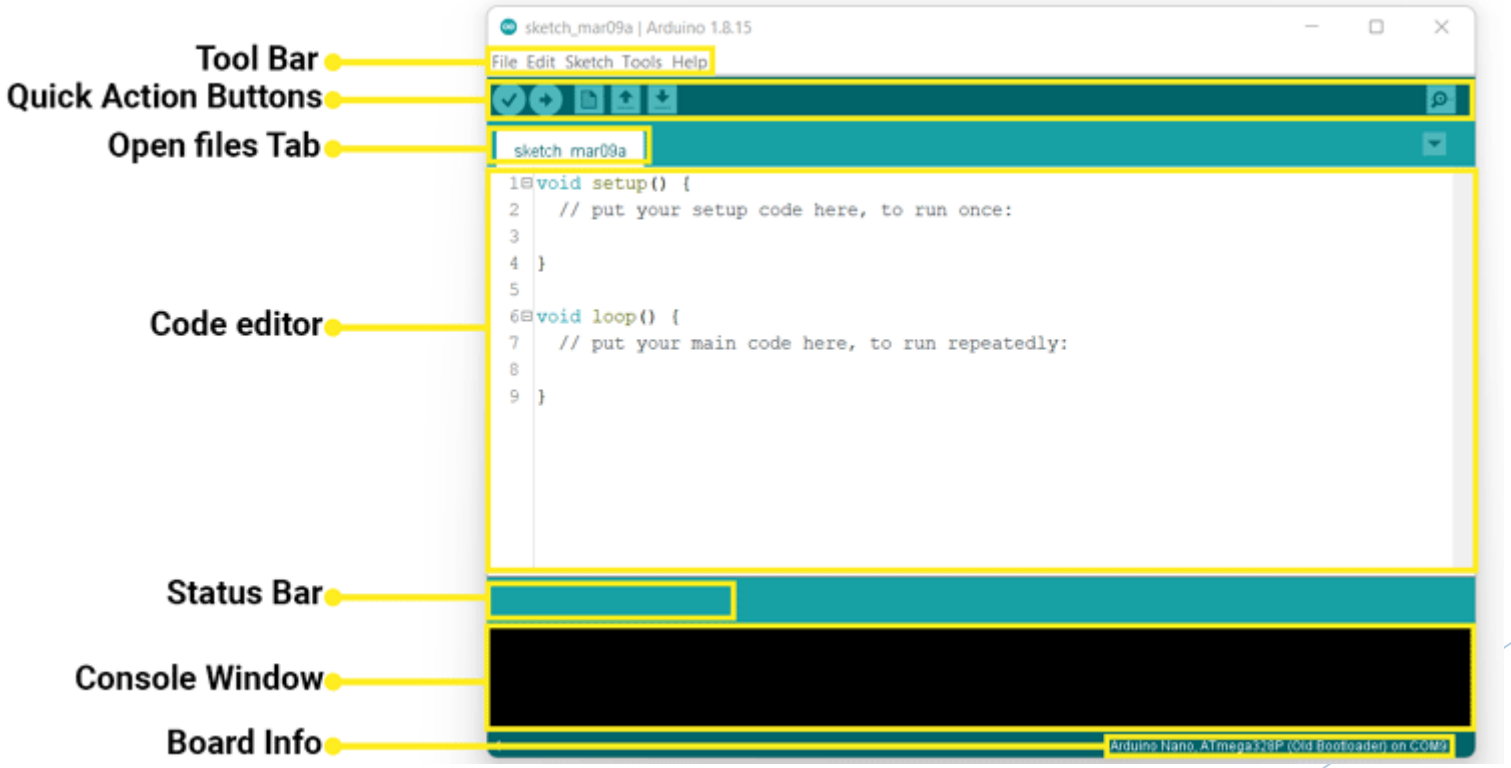
Hands-on programming with Arduino

Arduino IDE (Open-source software)

Available install setup at https://www.arduino.cc/en/software

Recommended version : 2.0> Version> 1.0

Available online version at https://create.arduino.cc/editor



Arduino code structure

```
/* define variables and fuction here*/

void setup() {

  //run code once
  //pin mode sets here
  //configurations done here

}

void loop() {

  //loop code repeatedly

}
```

Set pin mode

Key word : pinMode(GPIO Pin number , Pin mode)

GPIO Pin number : for digital pins => 0 - 13
for Analog pins => A0 - A5

Pin mode : for Output => OUTPUT
for Input => INPUT

Generate digital output

Key word : digitalWrite(GPIO Pin number , State)

GPIO Pin number : for digital pins => 0 - 13
for Analog pins => A0 - A5

State : High signal(5V) => HIGH / 1
Low signal(0V) => LOW / 0

Pause the code for a desired duration

Key word : delay(duration)

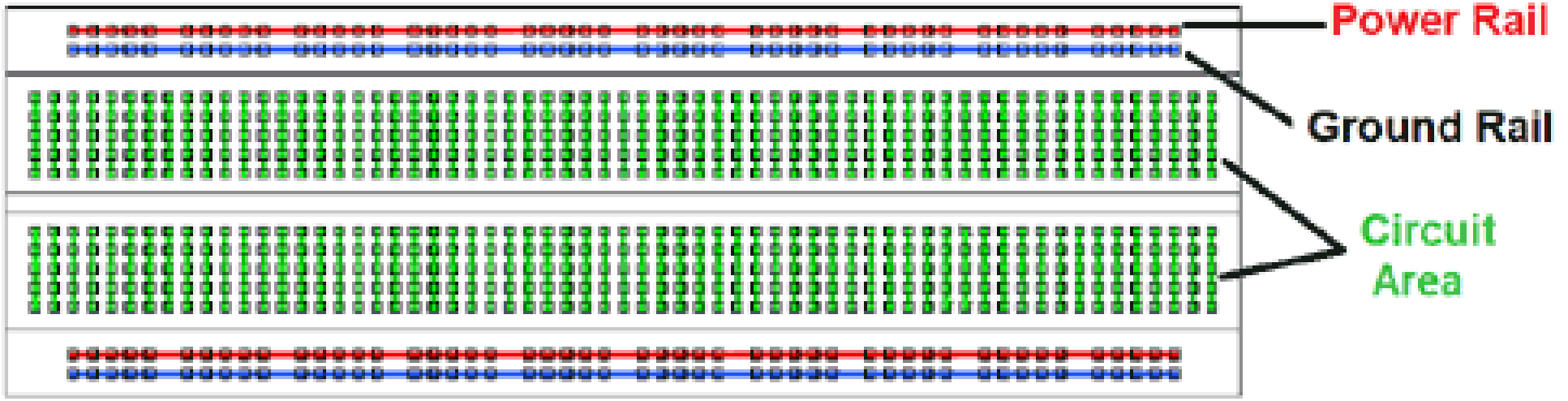
Duration: Time duration to pause the code => time in milliseconds

e.g. : To delay 1 seconds => **delay(1000);**

Note : for micro seconds delays use

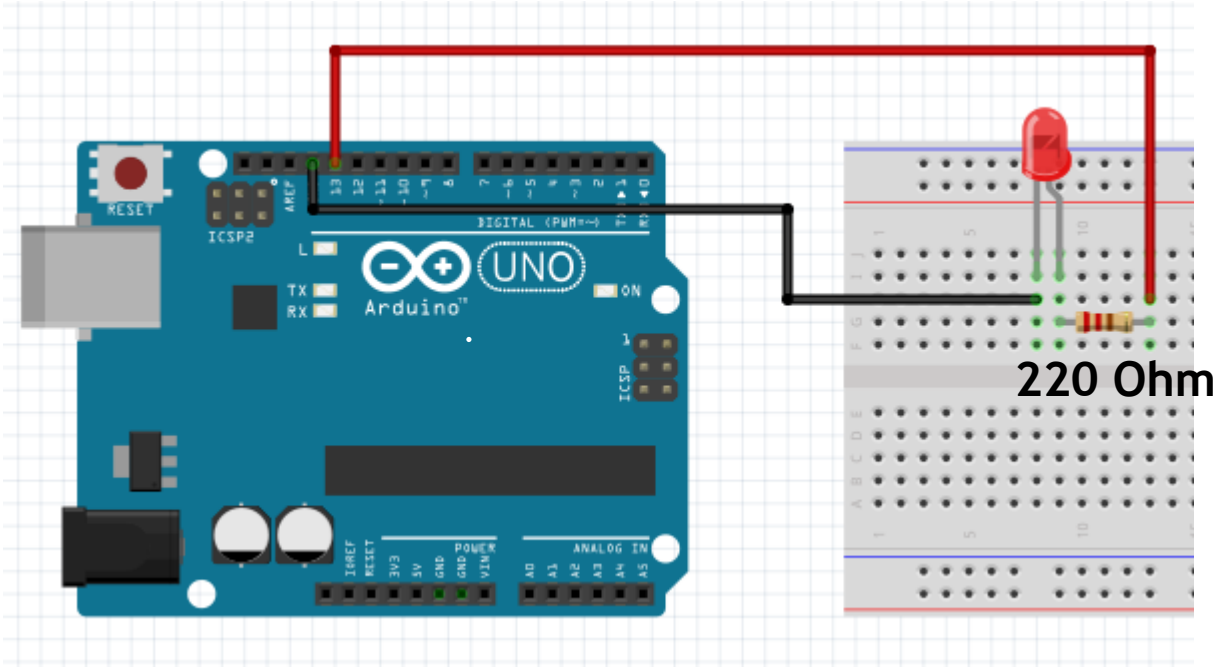
```
delayMicroseconds(us)
```

Breadboard connection diagram



Blink LED using Arduino

Connection diagram



Note : There is an inbuild LED connected with D13 pin

Code for blink LED with 1 second interval

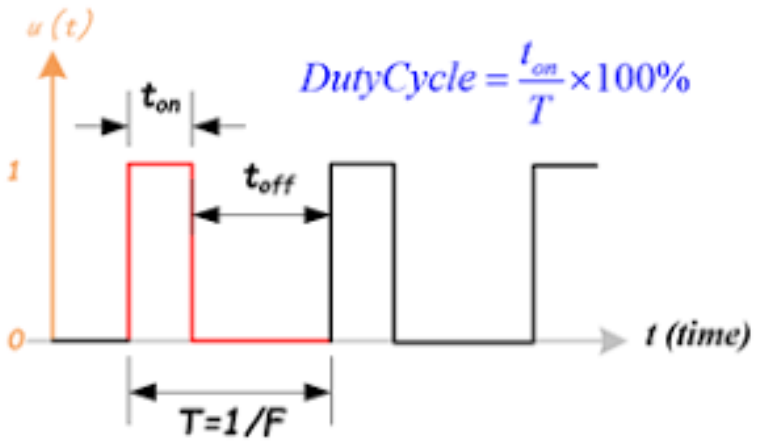
```
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(13, OUTPUT);
}

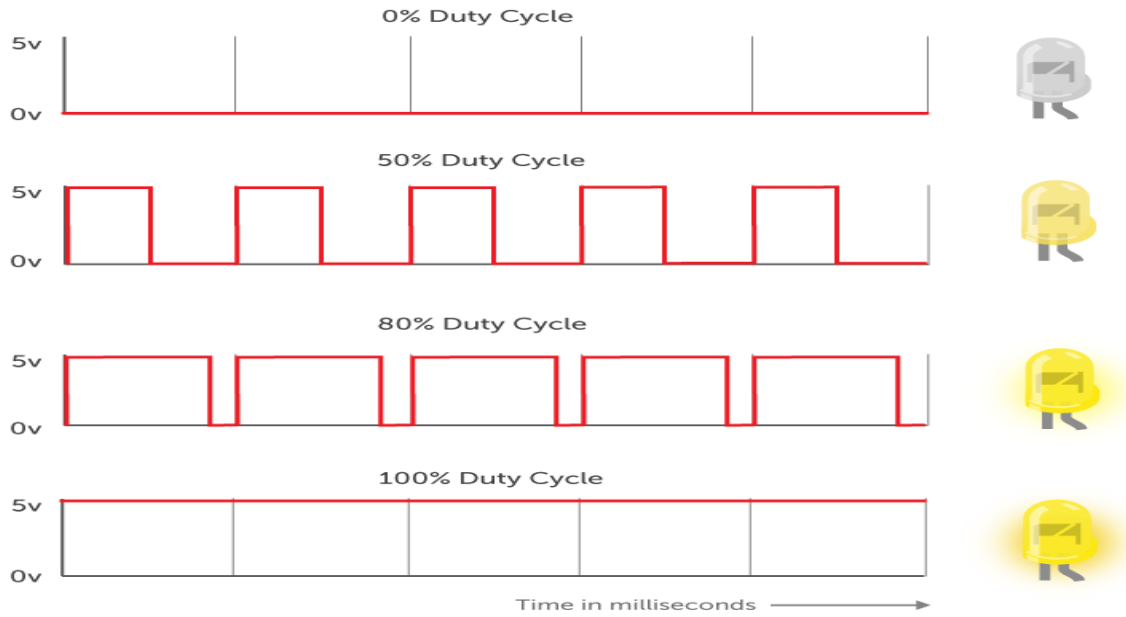
// the loop function runs over and over again forever
void loop() {
  digitalWrite(13, HIGH);  // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(13, LOW);   // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
}
```

Generate Analog output

- There is no way to generate an analog output from the microcontroller on most times.
- But the same effect can be archived by using PWM signals.

Understanding PWM(Pulse Width Modulation signals)





Generate PWM signal using arduino

Key word : analogWrite(GPIO Pin number , PWM value)

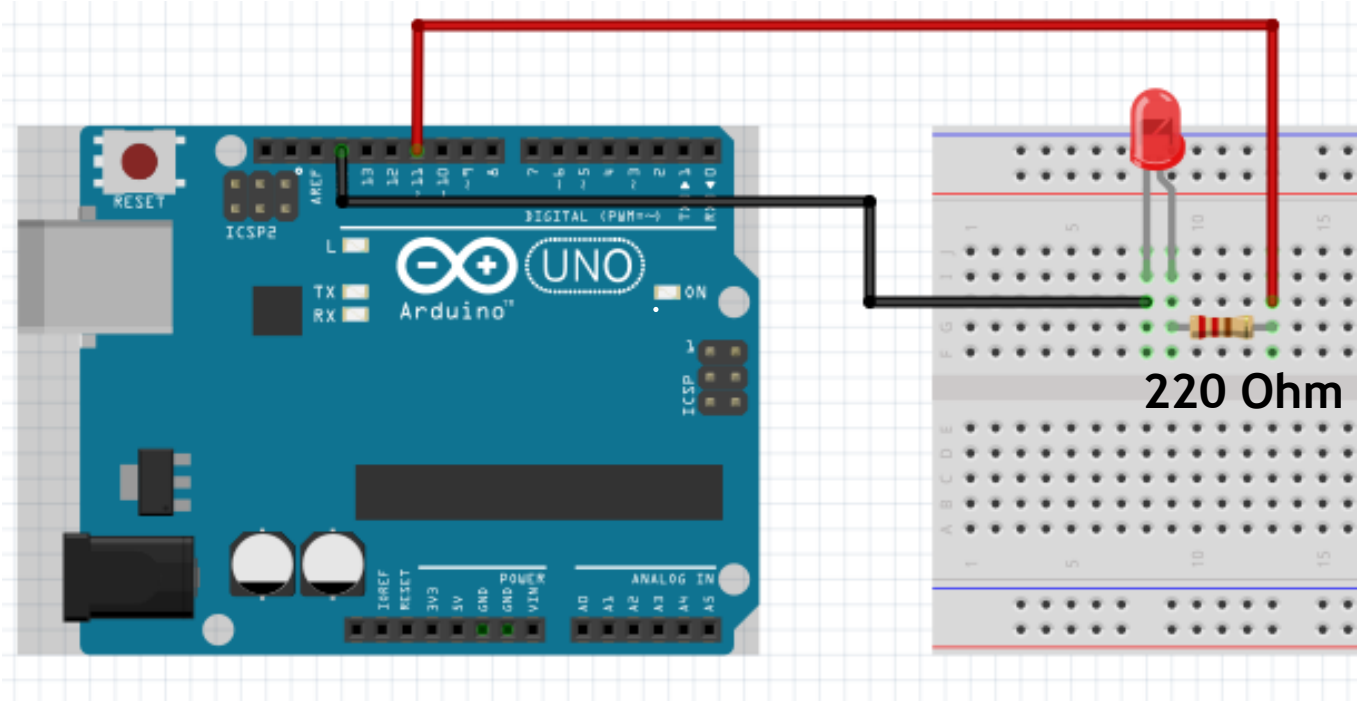
GPIO Pin number : Depends on the microcontroller type
Most Arduino boards these pins marked with "~" symbol.

e.g. : Arduino UNO => 3,5,6,9,10

PWM value : Duty cycle => 0 - 255 (0 => 0 % , 255=>100 %)

Dim LED using Arduino

Connection diagram



Code for dim LED recursively

```
void setup() {
  // initialize digital pin as an output.
  pinMode(11,OUTPUT);
}

// the loop function runs over and over again forever
void loop() {

  for(int i = 0; i<255; i++)//loop for 255 times
  {
    analogWrite(11, i);  // turn the LED on (HIGH is the voltage level)
    delay(10);              // wait for a second
  }
  for(int i = 255; i>0; i--)//loop for 255 times
  {
    analogWrite(11, i);  // turn the LED on (HIGH is the voltage level)
    delay(10);              // wait for a second
  }
}
```

- Slowly increase the brightness.
- Increasing speed depend on the delay.

- Slowly decrease the brightness.
- Decreasing speed depend on the delay.

Getting digital input

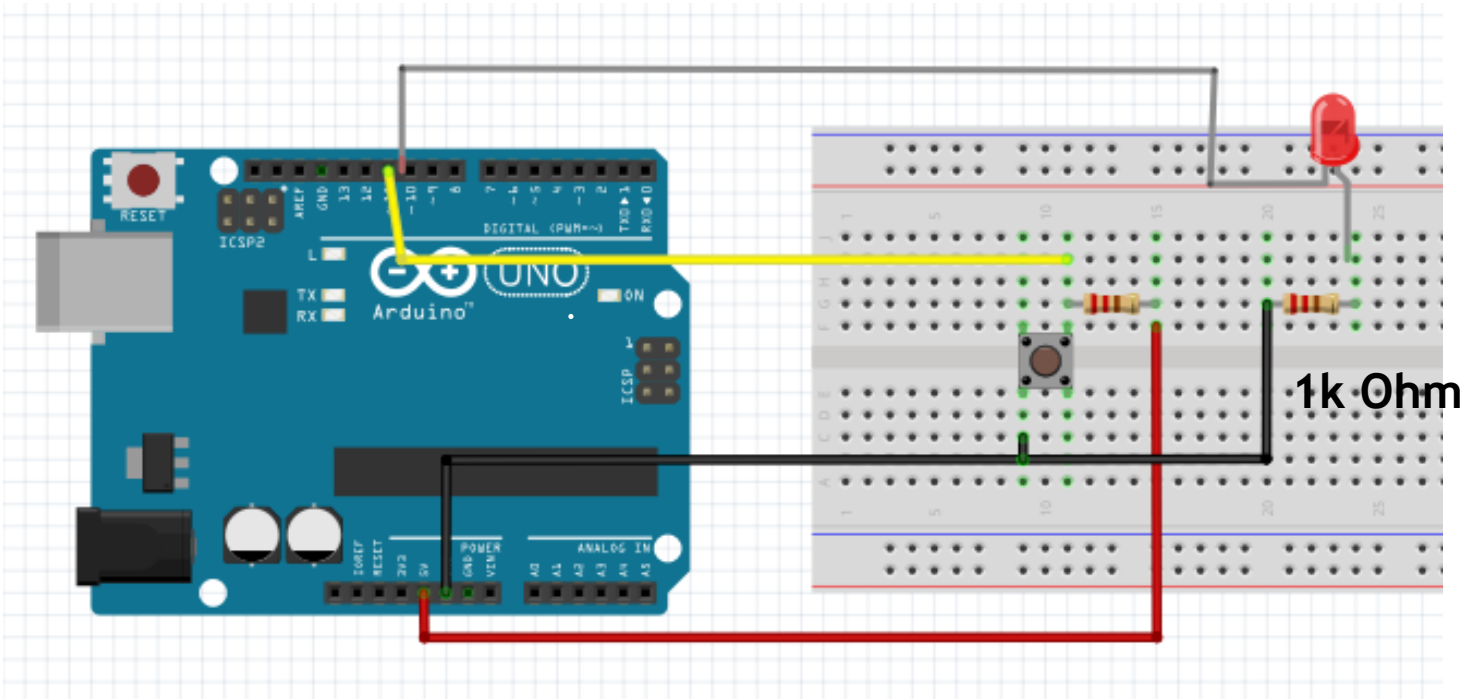
Key word : digitalRead(GPIO Pin number)

GPIO Pin number : for digital pins => 0 - 13
for Analog pins => A0 - A5

- This function return Digital state(HIGH(1) or LOW(0)) of the corresponding pin.

Use push button with Arduino

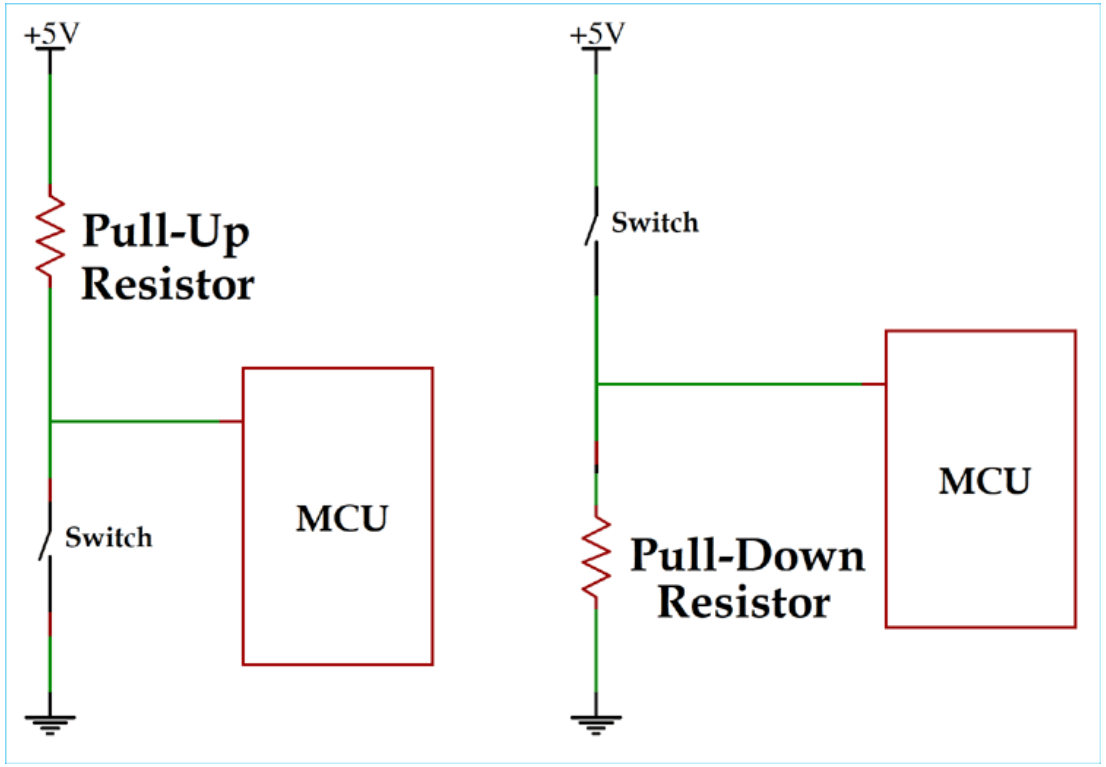
Connection diagram



Pull down and Pull up configurations

IN Pull-Up configuration
Switch ON => 0
Switch OFF => 1

IN Pull-Down configuration
Switch ON => 1
Switch OFF => 0



Code for push button example

```
void setup() {
  // initialize digital pins
  pinMode(11,OUTPUT);
  pinMode(10,INPUT);
}

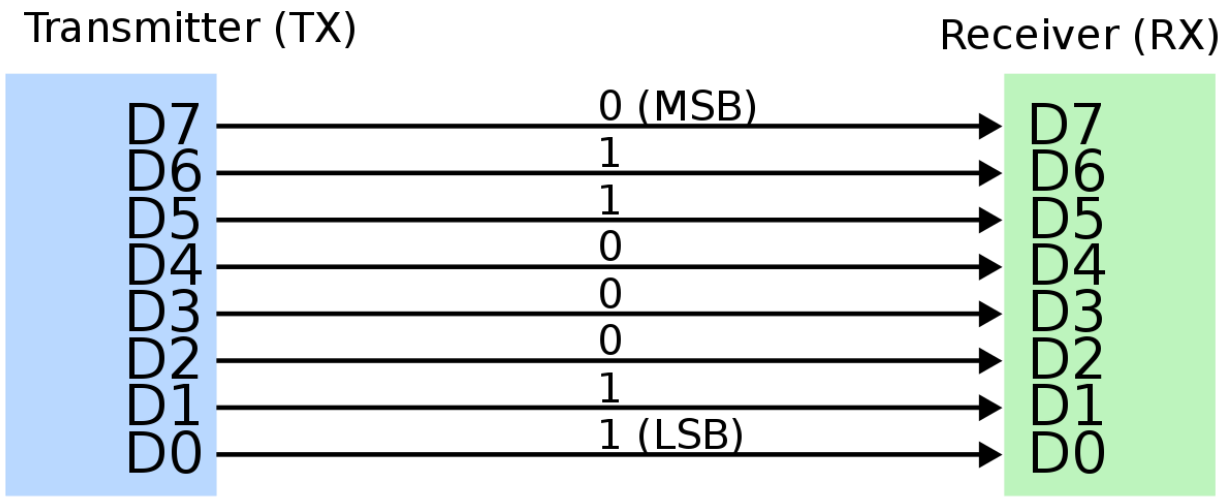
// the loop function runs over and over again forever
void loop() {

  if(digitalRead(10) == 0) //for pullup configuration(HI)
  {
    digitalWrite(11 , HIGH);
  }
  else//(LOW)
  {
      digitalWrite(11 , LOW);
  }

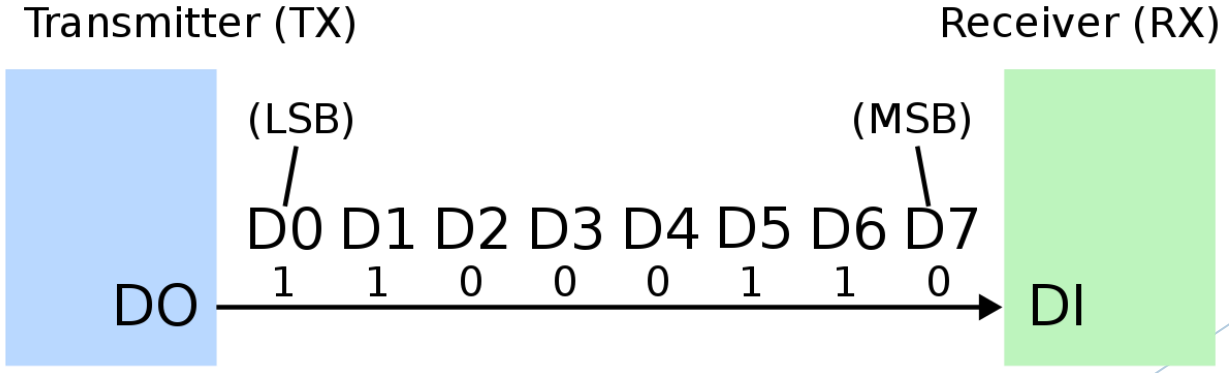
}
```

Serial vs Parallel Communication

Parallel interface example



Serial interface example



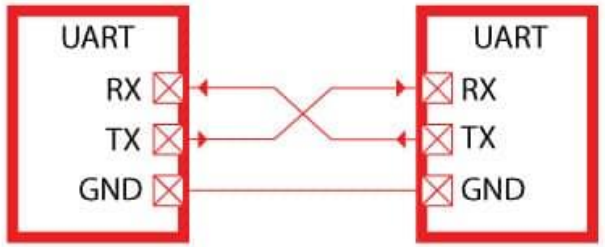
Serial Communication

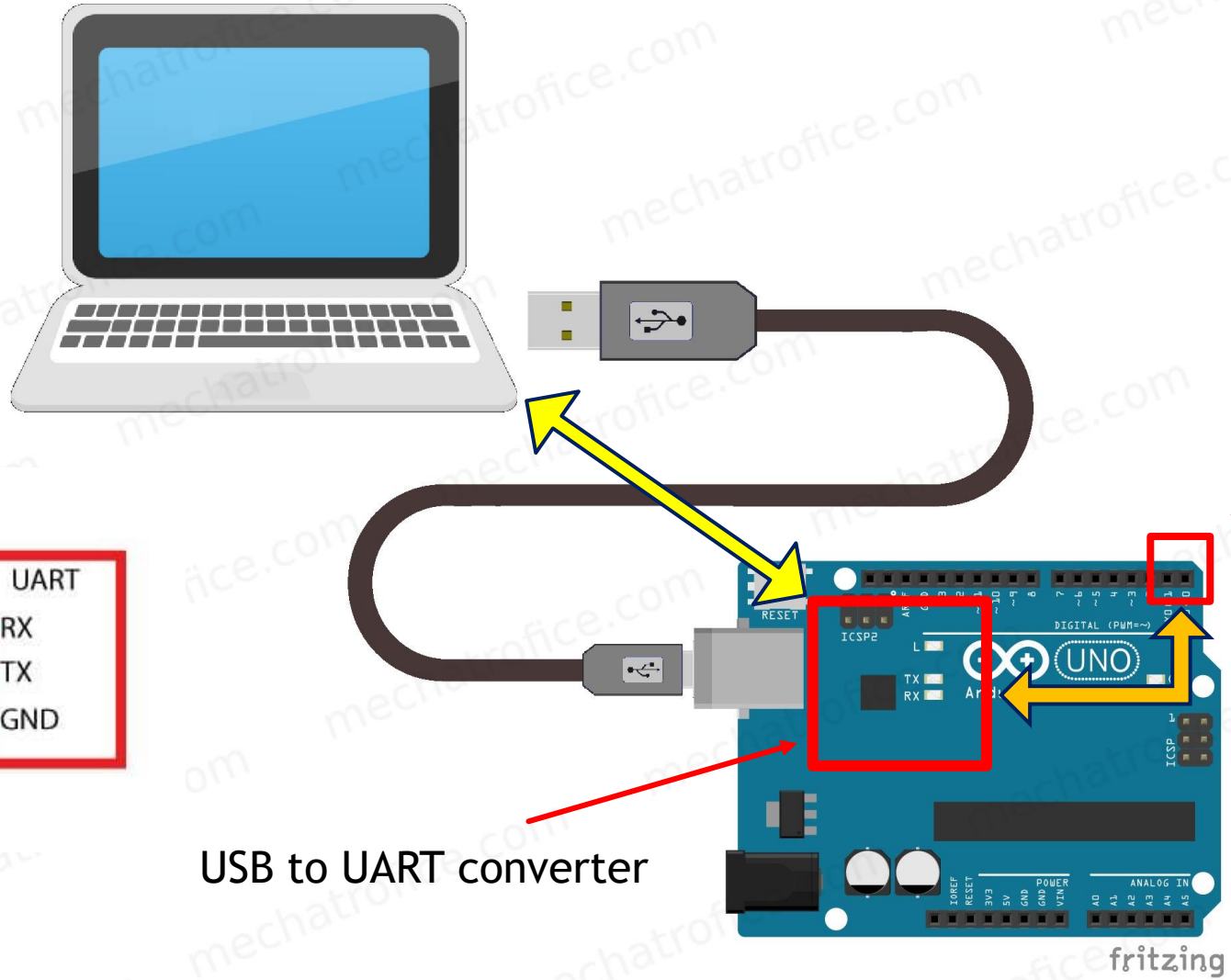
- Microcontrollers have several communication protocols to communicate with other electronic devices. Serial communication is one domain communication technique .
  E.g. :CAN,UART ,USART, I2C, SPI,USB ….

- UART is a one of major communication protocol which use in almost all electronic devices not only Arduino but also other types of microcontrollers.

- UART have 2 pins to communicate which are Tx and Rx for transmission and receiving functions respectively.

- The ATMega328P also have there two pins and these are connect two to the computer USB port through some converter circuit which is already implemented in Arduino UNO.





TX and RX pins

USB to UART converter

Commonly used methods for serial communication

Key word : Serial.begin(baud rate) => Initialize UART

Baud rate : Frequency of communication (9600 , 115200 ,...)
9600 is mostly used with Arduino boards.

Key word : Serial.print(statement) => Print line of a data without ending

Statement : Which should be print(value of variable, string, char array, function output

Key word : Serial.println(statement) => Print line of a data with ending

Communicate with PC via UART

NOTE : No hardware required . Connect Arduino to computer using USB cable.

- **Upload the code**
- **Now open serial monitor from Arduino IDE.**
- **Select board rate which should be same value that you entered in Arduino code.**

```
int x = 3;

void setup() {

  Serial.begin(9600);

}

void loop() {

  //Send the value of x to the the Serial port.
  //So we can see it in the serial monitor window
  Serial.print(x);
  Serial.print(" ");
  Serial.println(x + 1);

}
```

Code for UART communication example

Expected output

```
3 4
3 4
3 4
3 4
3 4
3 4
3 4
```

Getting Analog input

Key word : analogRead(GPIO Pin number)

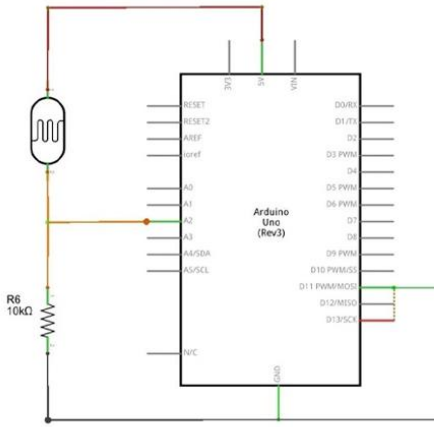
GPIO Pin number : For Analog pins => A0 - A5

- This function return the value corresponding to the input voltage to the GPIO pin.
- The range will be 0-1023 . In default case 0 - 5V is mapped to 0 - 1024 .
- Therefore,

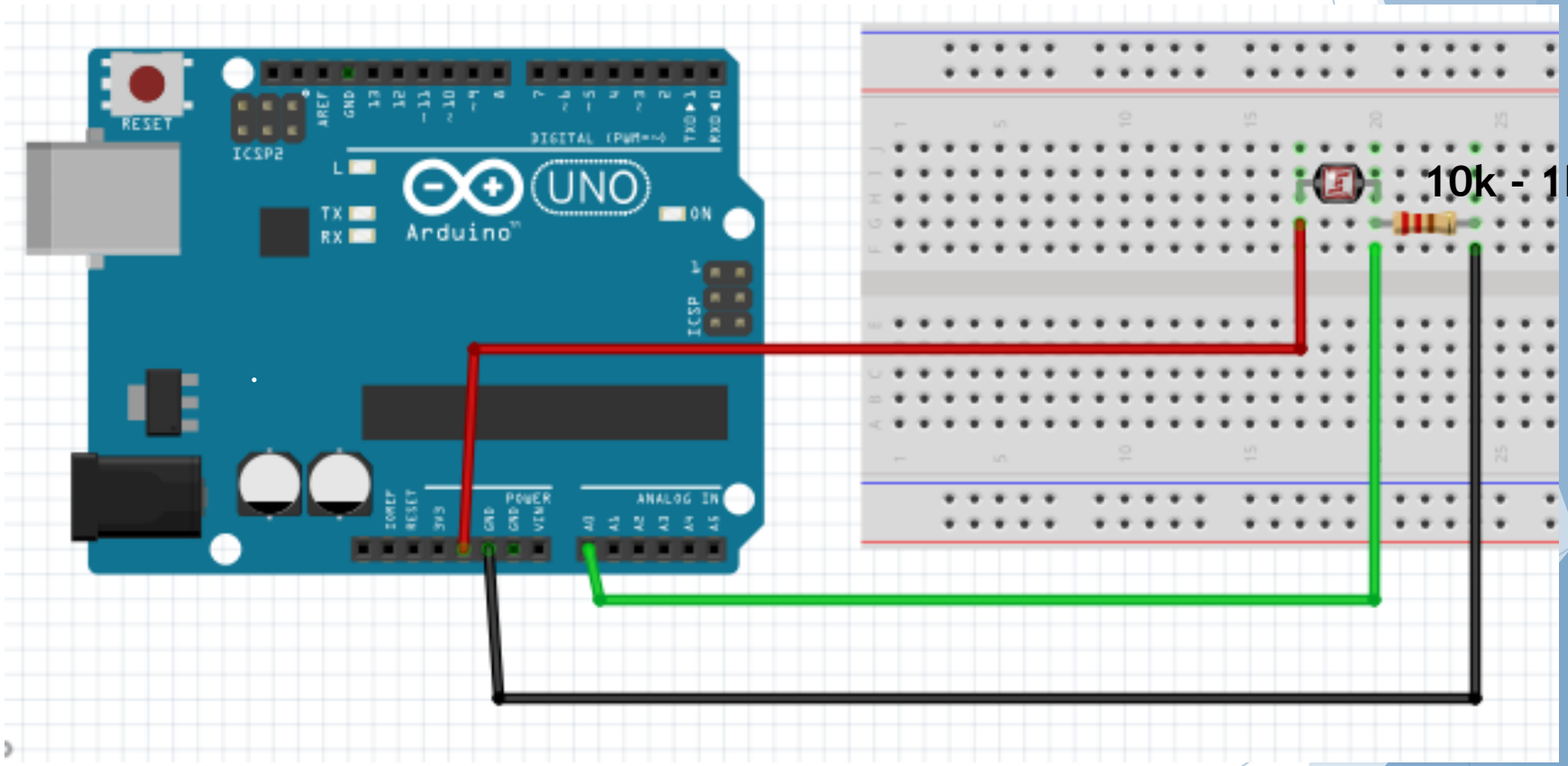
  Analog voltage = Analog Read* 5 /1024

Use LDR with Arduino

LDR
(light dependent resistor)



Connection diagram



Code for printing analog read of a GPIO pin

```
int ldr_read = 0;

void setup() {

  pinMode(A0 , INPUT); //set pinmode as input LDR

  Serial.begin(9600); //iniitialize UARt

}

void loop() {

  ldr_read = analogRead(A0);

  Serial.print("Analog value of LDR : "); //print analog read
  Serial.println(ldr_read);

}
```

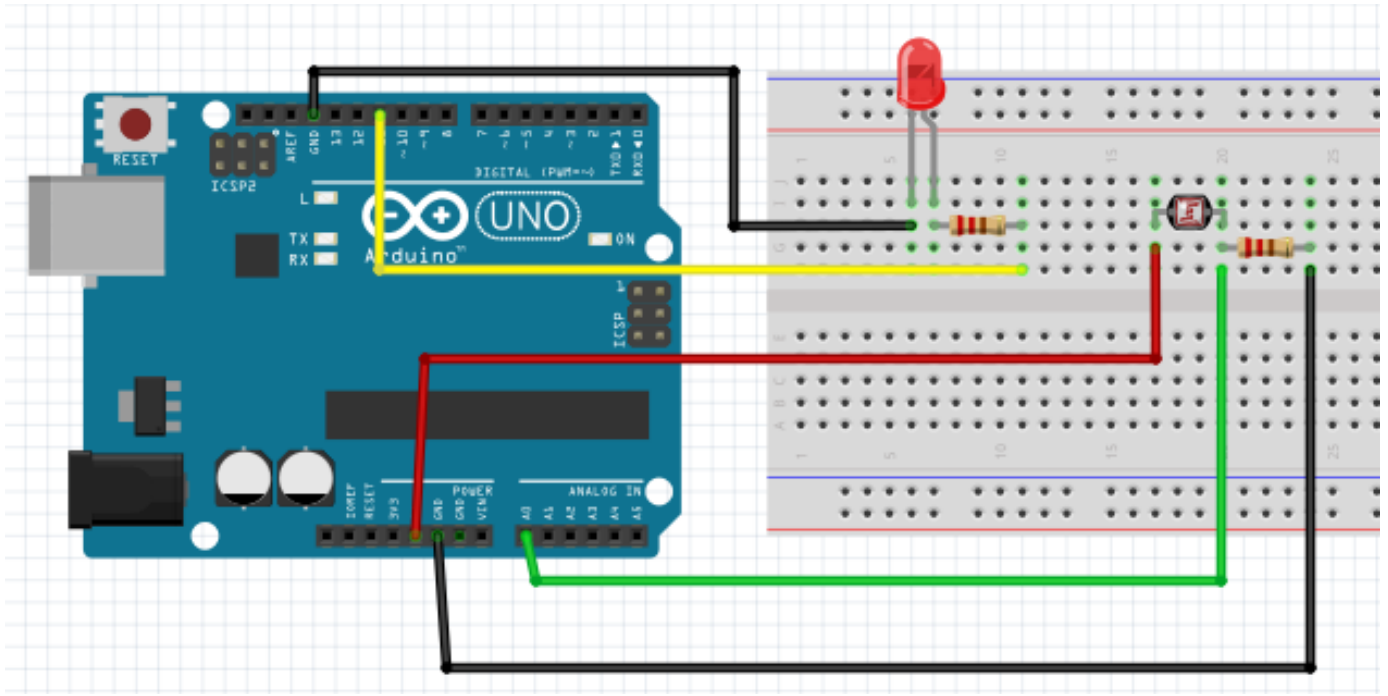
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Activity 1

Write an Arduino code and implement the circuit of light sensitive LED bulb . LED connected to the D11 and LDR connected to the A0 .
The threshold of sensitivity is 512.

Answer


RESET
ICSP2
UNO
Arduino
ON
TX
RX
ICSP
DIGITAL (PWM~)
POWER
ANALOG IN

Code for activity 1

```
int ldr_read = 0;

//constatnts
#define LED_PIN 11
#define LDR_PIN A0

#define THRESHOLD 512

void setup() {

  pinMode(LDR_PIN , INPUT); //set pinmode as input LDR
  pinMode(LED_PIN , OUTPUT); //set LED pin as output
}

void loop() {

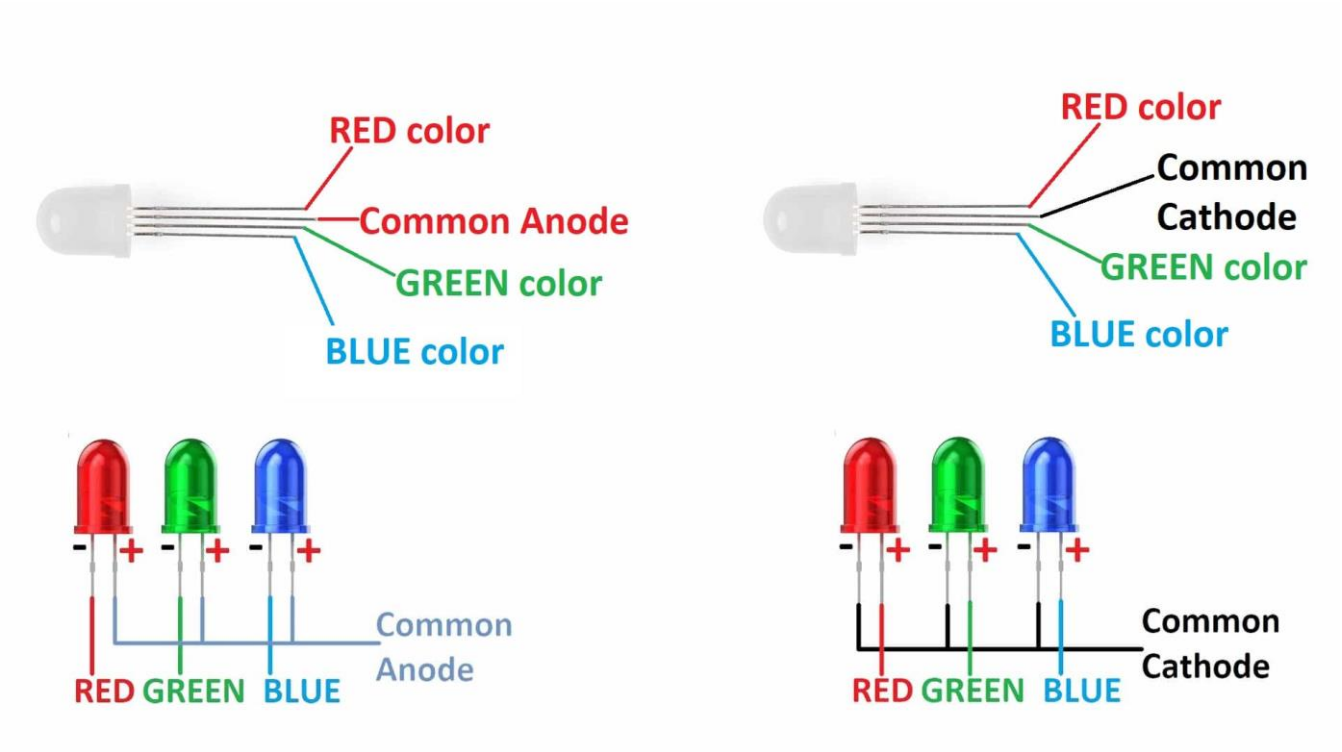
  ldr_read = analogRead(LDR_PIN);


  if(ldr_read > THRESHOLD) //if ambient light is more brighter then LED will tun off
  {
    digitalWrite(LED_PIN , LOW);
  }
  else //turn off LED
  {
    digitalWrite(LED_PIN , HIGH);
  }

}
```

Interface with RGB LED

- There are two types of RGB LEDs.



Activity 2

Which type of RGB LED do you have?
Write a code to change 3 colors recursively with 1s interval.