



Maker Space Lecture

1. What is Arduino?



YONSEI, where we make *history*

<http://bitly.kr/o2w8JA3>



연세대학교
Yonsei Where we make History



YONSEI, where we make *history*

CONTENTS

1. Introduction to Arduino
2. Arduino Grammar
3. LED Tutorials
4. References



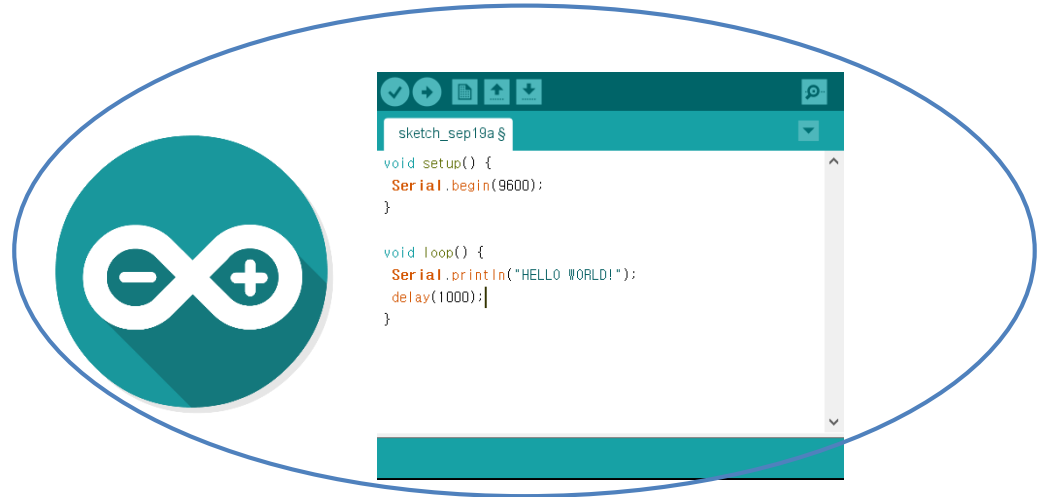
1
2
3
4

Definition of Arduino

Easy to share code, library, and even hardware!

Arduino is an **open-source** electronics platform based on easy-to-use **hardware** and **software**.

To use it, you use the Arduino programming language, and the Arduino Software(IDE).

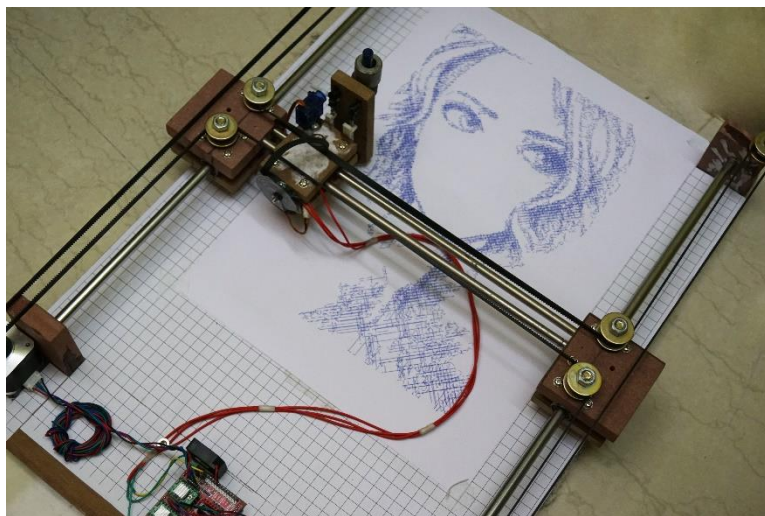


1 2 Applications of Arduino

3

4

<https://www.youtube.com/watch?v=swoiluHrq4c&t=167s>



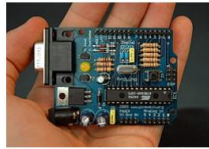
Arduino CNC Drawing Machine



8x8x8 LED CUBE

<http://www.arnabkumardas.com/product/arduino-cnc-drawing-machine/>

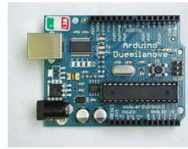
Types of Arduino



Arduino RS232^[32]
(male pins)



Arduino Diecimila



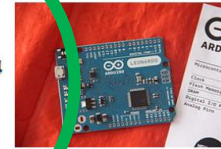
Arduino Duemilanove^[34]
(rev 2009b)



Arduino Uno R2^[35]^[36]



Arduino Uno SMD
R3^[37]



Arduino Leonardo^[38]



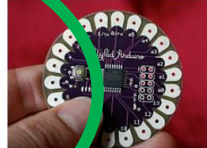
Arduino Pro^[39]
(No USB)



Arduino Mega^[40]



Arduino
Nano^[41]
(1.8 inch
footprint
)



Arduino LilyPad 00^[42]
(rev 2007) (No USB)



Arduino Robot^[43]



Arduino Esplora^[44]



Arduino Ethernet^[45]
(AVR + W5100)



Arduino Yun^[46]
(AVR + AR9331)



Arduino Due^[47]
(ARM Cortex-M3 core)



1
2
3
4

Arduino Download



The screenshot shows the Arduino website's 'Download' page. The header includes the Arduino and Genuino logos, a search bar, and navigation links: Home, Buy, Download, Products, Learning, Forum, Support, Blog, and a LOG IN button. Below the header, there's a 'DOWNLOAD' section with a language dropdown set to 'ENGLISH'. The main content area is titled 'Download the Arduino Software'. On the left, there's a large Arduino logo and text for 'ARDUINO 1.6.8', describing it as open-source software for writing code and uploading it to the board. On the right, there's a list of download options: 'Windows Installer' (highlighted with a red box and a red arrow pointing to it with the text '클릭해서 다운로드합니다'), 'Windows ZIP file for non admin install', 'Mac OS X 10.7 Lion or newer' (highlighted with a purple box and a purple arrow pointing to it with the text 'For Mac OS'), 'Linux 32 bits', 'Linux 64 bits', 'Release Notes', 'Source Code', and 'Checksums'.

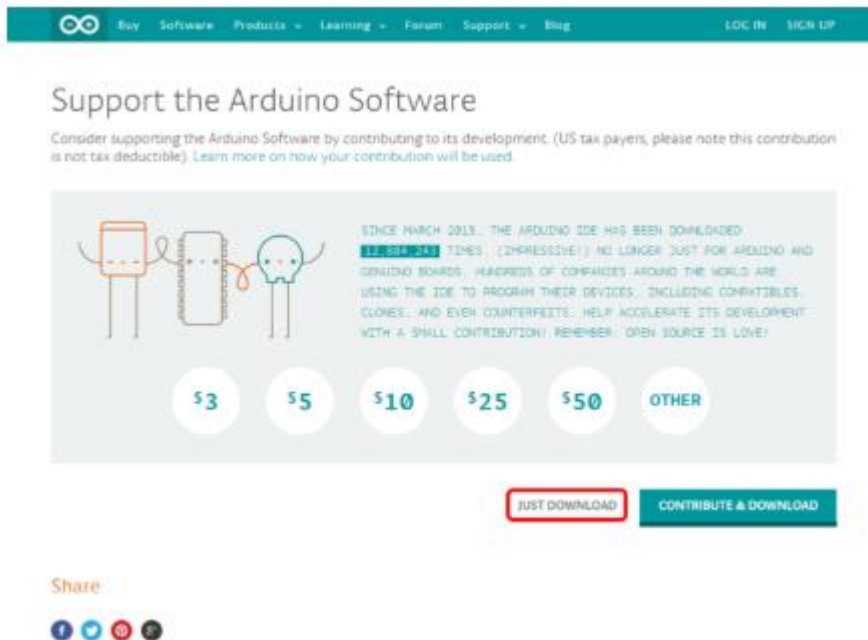
Step 1.

<https://www.arduino.cc/en/Main/Software>



1
2
3
4

Arduino Download



Support the Arduino Software

Consider supporting the Arduino Software by contributing to its development. (US tax payers, please note this contribution is not tax deductible) [Learn more on how your contribution will be used](#)

SINCE MARCH 2013, THE ARDUINO IDE HAS BEEN DOWNLOADED **1,000,000+** TIMES. (IMPRESSIVE!) NO LONGER JUST FOR ARDUINO AND GENUINO BOARDS, HUNDREDS OF COMPANIES AROUND THE WORLD ARE USING THE IDE TO PROGRAM THEIR DEVICES, INCLUDING COMPATIBLES, CLONES, AND EVEN COUNTERFEITS. HELP ACCELERATE ITS DEVELOPMENT WITH A SMALL CONTRIBUTION! REMEMBER: OPEN SOURCE IS LOVE!

\$3 \$5 \$10 \$25 \$50 OTHER

JUST DOWNLOAD **CONTRIBUTE & DOWNLOAD**

Share

f t y i

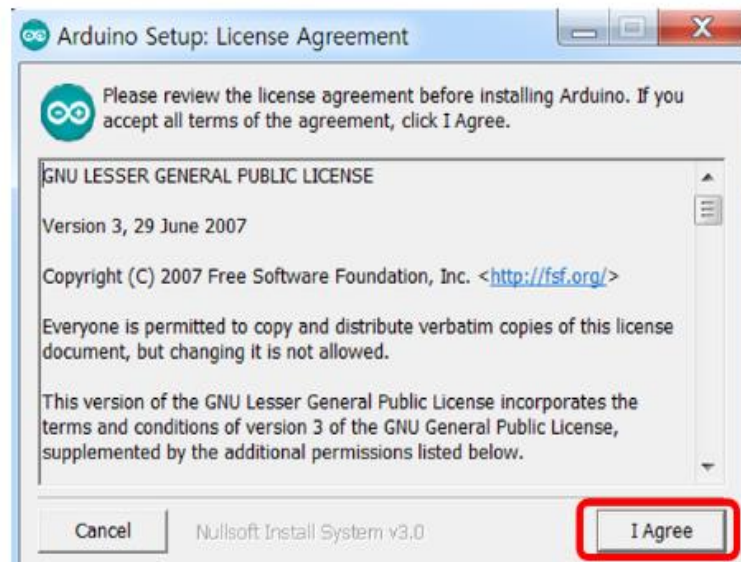
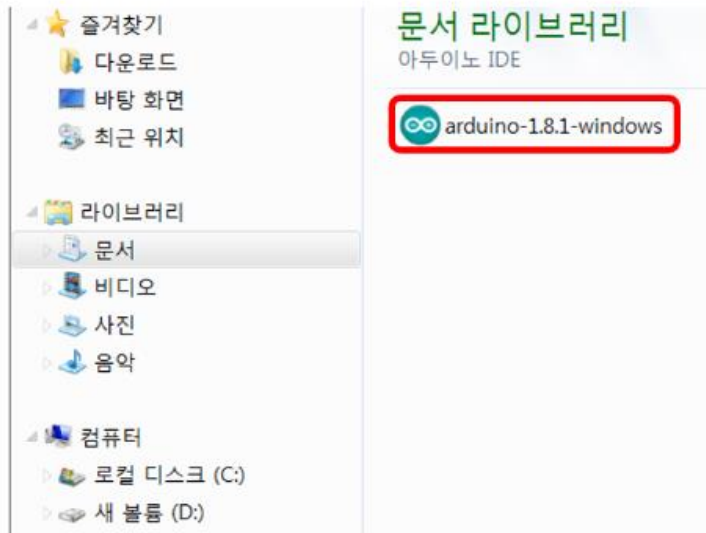
Step 2.
'JUST DOWNLOAD' 클릭



1
2
3
4

Arduino Download

Step 4.
Double click the icon and click 'I Agree'

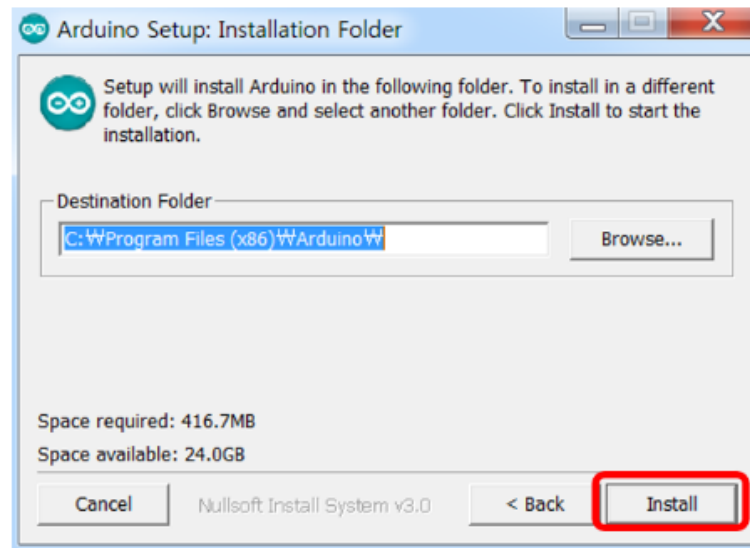
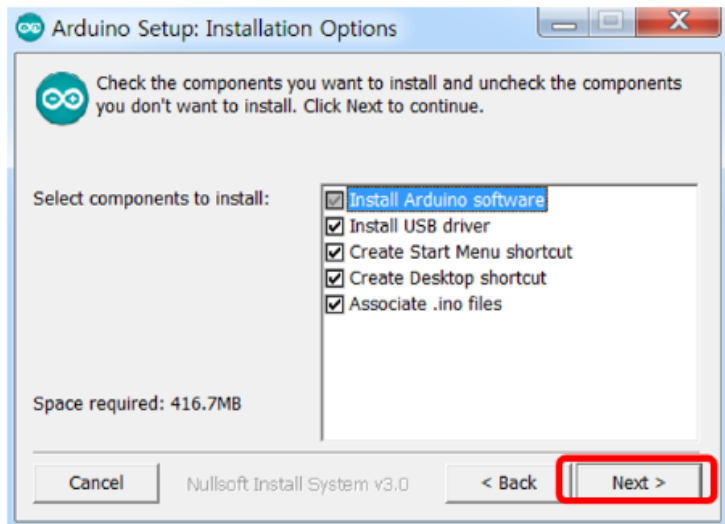




1
2
3
4

Arduino Download

Step 4. Click 'Next' and Install

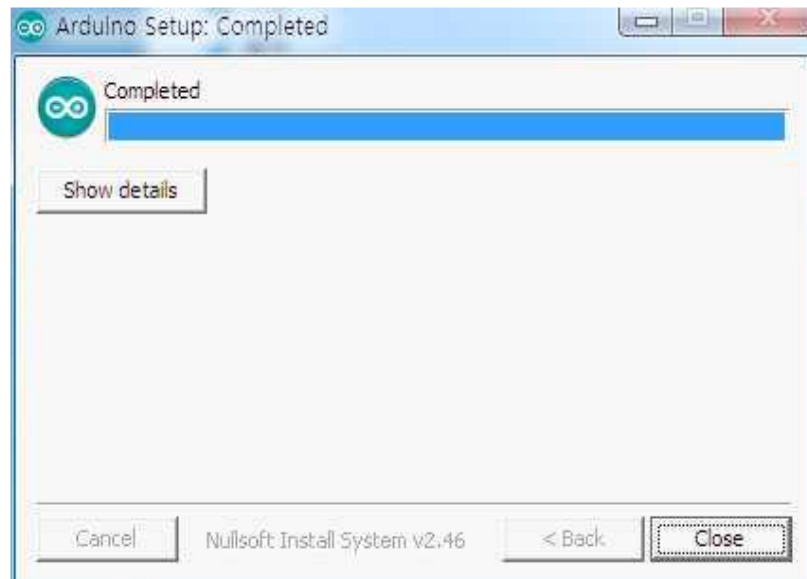
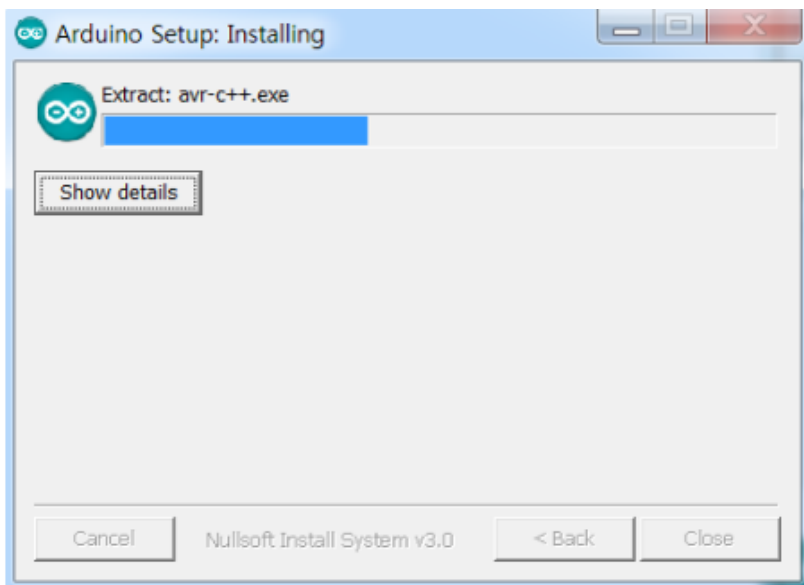




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2
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4

Arduino Download

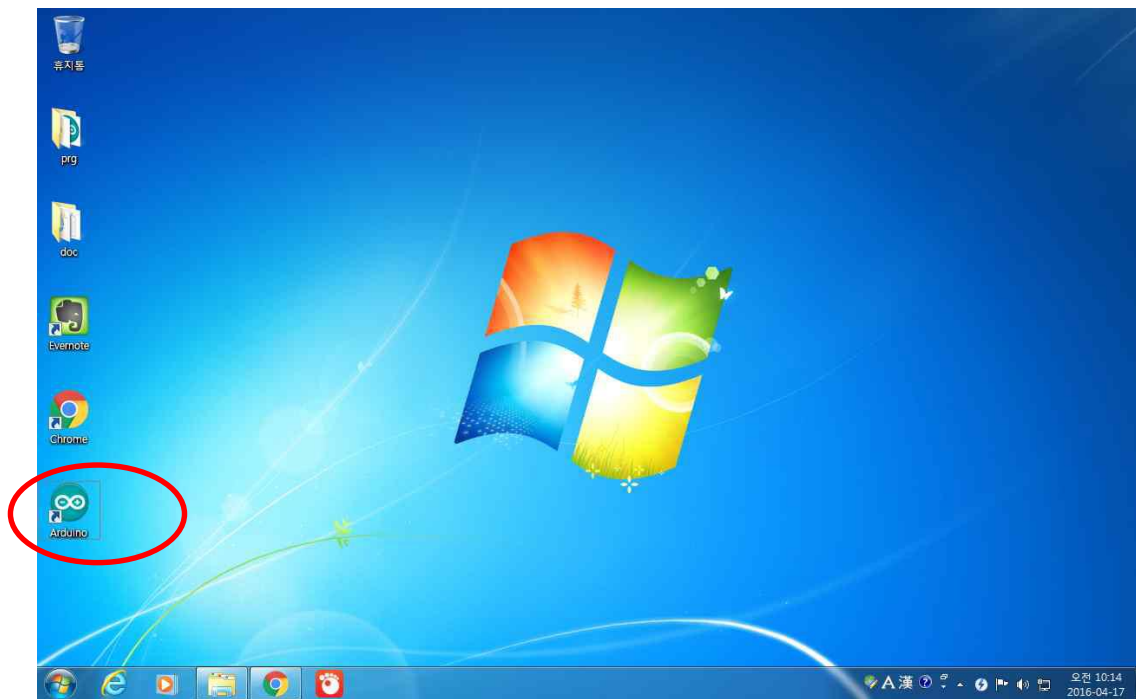
Step 5.
Click 'Close'



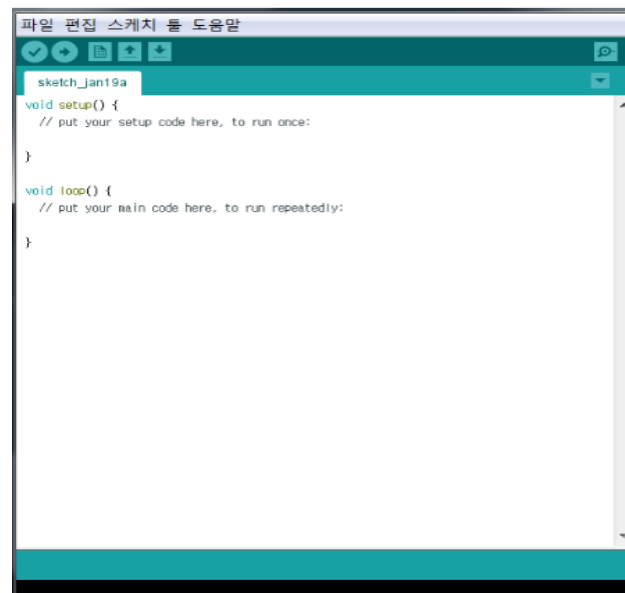


1
2
3
4

Arduino Download



Step 6.
Double Click Arduino icon

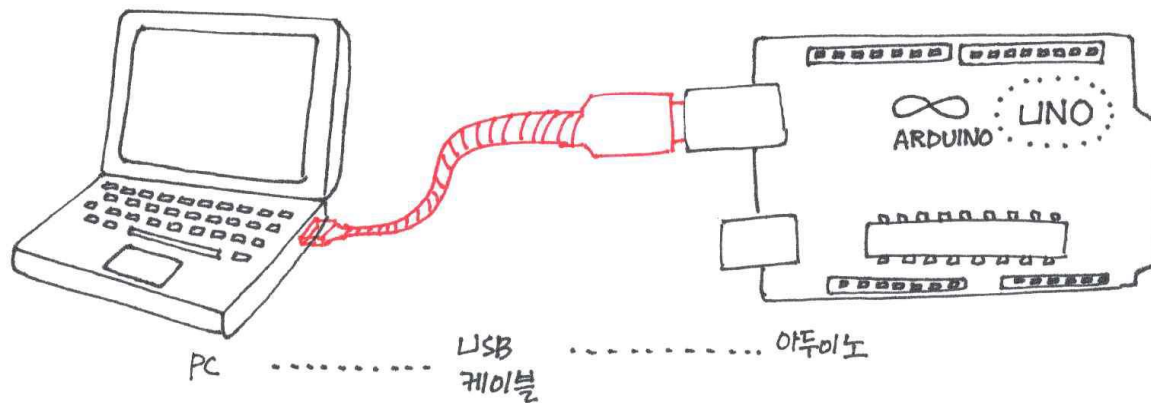


1
2
3
4

Arduino Connection

Step 1.

그림과 같이 연결한다.

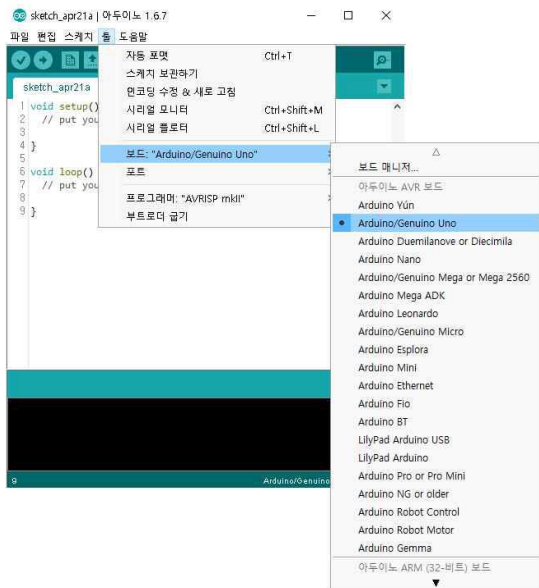


- 1
- 2
- 3
- 4

Arduino Connection

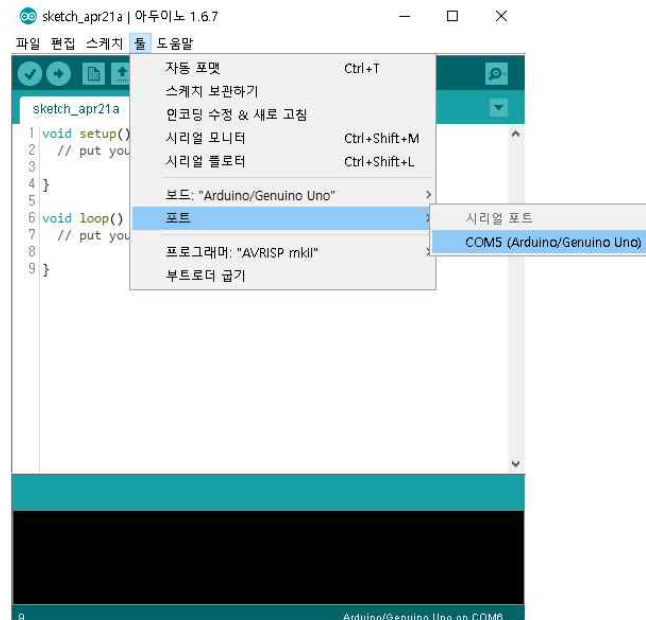
Step 2.

상단 메뉴 '툴'에서 '보드' 설정



Step 3.

상단 메뉴 '툴'에서 '포트'설정





1
2
3
4

Basic Structure



```
void setup() {  
  // put your setup code here, to run once:  
  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
  
}
```

setup()

: 최초 1회 실행, 초기 설정 함수

loop()

: 반복 실행, 동작 함수



1
2
3
4

Practice 1 - HELLO WORLD!



```
sketch_sep19a $  
void setup() {  
  Serial.begin(9600);  
}  
  
void loop() {  
  Serial.println("HELLO WORLD!");  
  delay(1000);  
}
```

Serial.begin()

: Serial 포트 초기화, 통신의 시작을 선언

Serial.println("string")

: Serial 모니터에 **string**을 출력하고
"Wn"을 출력한다.

"Wn"은 새 줄로 입력함을 의미

delay()

: () milli seconds 동안 대기

-> 1초마다 "HELLO WORLD!" 출력

Serial Communication?

<https://m.blog.naver.com/yuyyulee/220301424499>



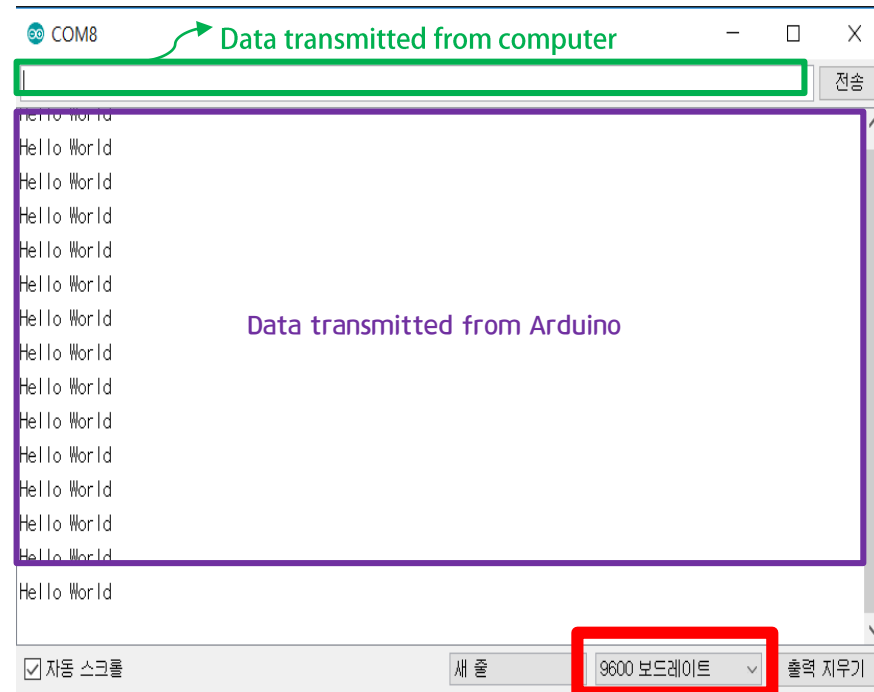
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2
3
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1 : Upload

2 : Click Serial monitor



3 : Set the baud rate

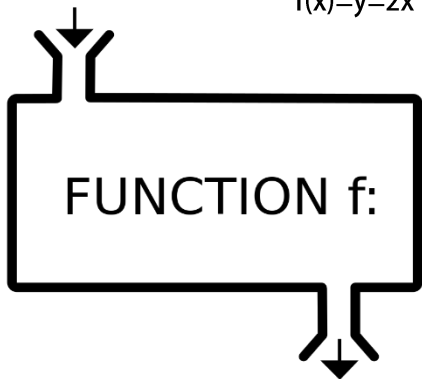


1
2
3
4

Function

INPUT x

E.g. 두배함수
 $f(x)=y=2x$



OUTPUT $f(x)$

```
sketch_apr22a $
나가는값의자료형 함수이름(들어오는값){
  처리를 위한 명령문들...
}
```

```
sketch_apr16a $
void happy() {
  //주석이여서 아무 효과 없어요~
  /*
   이렇게 쓰면
   여러 줄을 주석으로 쓸 수 있습니다.
   */
  Serial.println("HELLO WORLD!");
}
```

`{ }` Paragraph

`;` End a statement

주석

`//` for one line

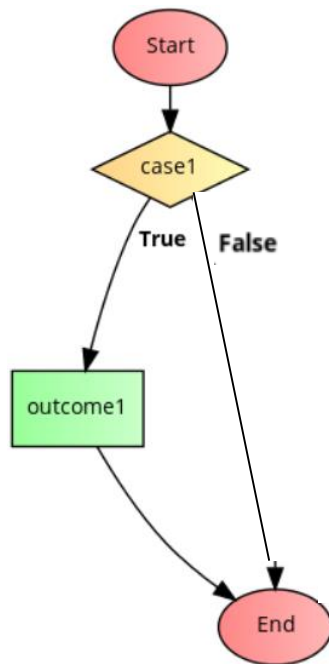
`/* */` for multiple lines



1
2
3
4

if statement

```
if(case1){
    outcome1
}
```



-if문은 () 안의 참 거짓을 판별한다. 참이라면 {} 안의 내용을 실행한다.

-if문 뒤의 **else**, **else if** 는 생략해도 된다.

-**else if**는 무수히 많이 사용할 수 있다.

cf.

1 means 'ON', 'True', and 'HIGH'

0 means 'OFF', 'False', and 'LOW'

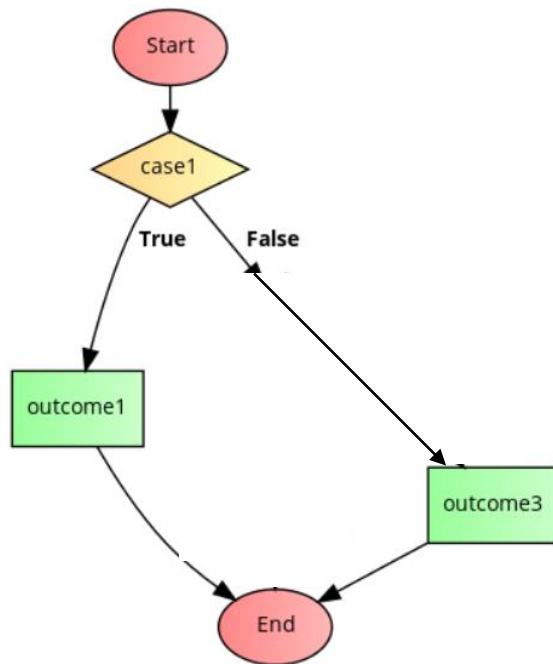


1
2
3
4

if statement

```
if(case1){
    outcome1
}
```

```
else(){
    outcome3
}
```



-if문은 () 안의 참 거짓을 판별한다. 참이라면 {} 안의 내용을 실행한다.

-if문 뒤의 **else**, **else if** 는 생략해도 된다.

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cf.

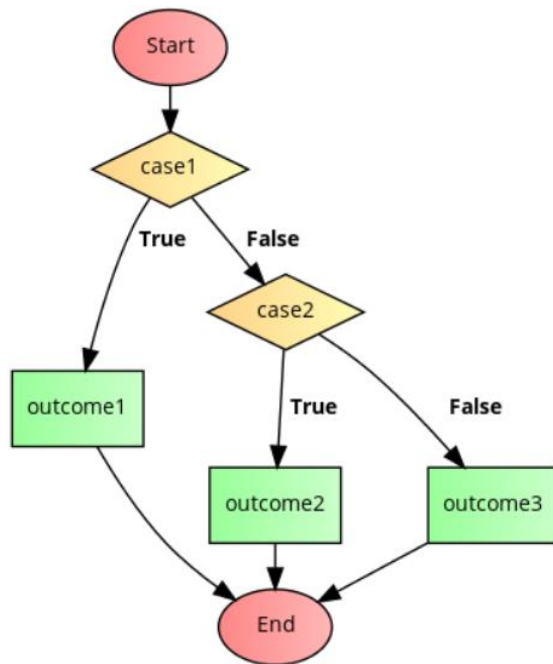
1 means 'ON', 'True', and 'HIGH'

0 means 'OFF', 'False', and 'LOW'

1
2
3
4

if statement

```
if(case1){
    outcome1
}
else if(case2){
    outcome2
}
else(){
    outcome3
}
```



-if문은 () 안의 참 거짓을 판별한다. 참이라면 {} 안의 내용을 실행한다.

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1
2
3
4

Variable (변수)

-변수는 데이터를 저장하는 공간이며, **name**, **value**, **type**을 가지고 있다.

예를 들어, `int pin = 13;` 는 일반적인 변수 선언 방식이다.

이름은 **pin**, 값은 **13**이고 자료형은 **int**인 변수를 선언한 것이다.

-변수의 이름은 A~Z, a~z, 0~9, _ (숫자가 제일 앞에 올 수는 없음) 으로 쓸 수 있다.

-변수의 자료형	integer(정수형)	: int, long (변수에 맞춰 적절한 자료형을 입력하여야 한다.)
	real number(실수형)	: float
	character(문자형)	: char

Type?

<http://www.3demp.com/community/boardDetails.php?cbID=212>



1
2
3
4

Practice 2

```
practice2 $  
void setup() {  
  Serial.begin(9600);  
}  
  
void loop() {  
  if(Serial.available()>0){  
    char c = Serial.read();  
    if(c=='a'){  
      Serial.println("You typed a");  
    }  
    else{  
      Serial.println("You didn't type a");  
    }  
  }  
}
```

업로드 완료.

Serial.available()

: Serial 포트에 유의미한 값이 있는지 확인.

: If data does exist, then its value is more than zero

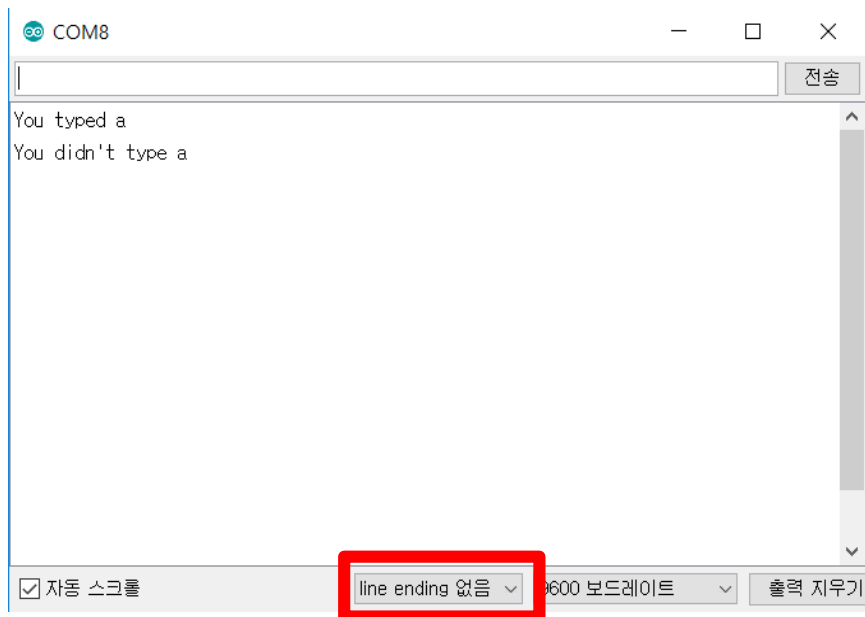
Serial.read()

: Serial 통신으로 들어온 데이터의 맨 앞의 1바이트를 읽어와 그 값을 반환한다.
(or -1 if no data is available)



1
2
3
4

Practice 2



Error case :

-한글자만 입력을 때, 2회 출력이 될 경우
line ending 없음 으로 설정할 것.

New line으로 설정되어 있는 경우, 아스키코드 10에 해당하는
line feed가 `Serial.available()`을 통과하며 빈 명령이 출력된다.



1
2
3
4

Practice 3 – About Numbers



```
sketch_apr21a
void setup() {
  Serial.begin(9600);
}
void loop() {
  if(Serial.available()){
    long c = Serial.parseInt();
    long d = Serial.parseInt();
    Serial.println(c*d);
  }
}
```

업로드 완료.

Serial.parseInt()

: 정수를 읽을 때 사용

Serial 모니터로 받은 값은 무조건 문자형으로 인식하기 때문에, 정수형으로 읽기 위해 **read** 대신 사용한다.

: 다수의 입력을 할 때에는 **Space**로 구분하여 입력한다.

: 숫자가 아닐 경우, 0을 반환한다.



1
2
3
4

Practice 3 — About Numbers

COM8

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전송

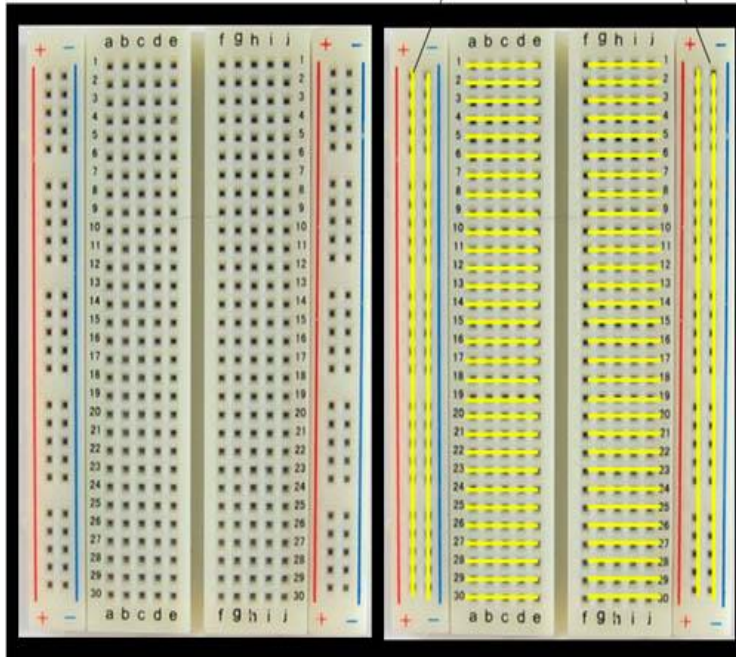
120

☒ 자동 스크롤 line ending 없음 9600 보드레이트 출력 지우기

1
2
3
4

Breadboard(빵판)

Power bus Ground bus



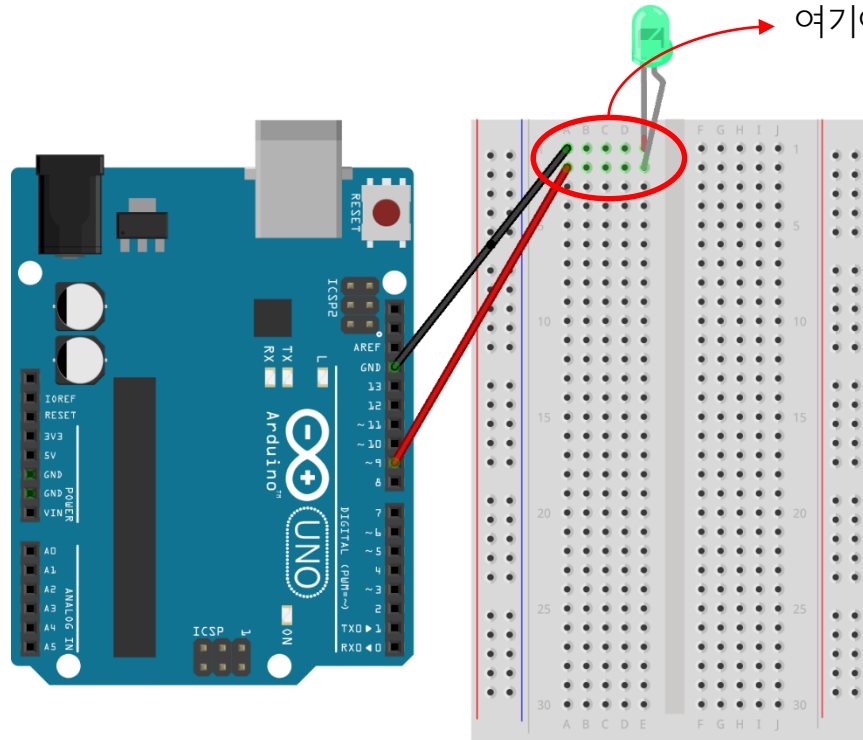
Directions for the use

Connection

: Always disconnect an Arduino from external power sources (laptop, battery, etc.) before making an electrical circuit.

: 가장자리의 2줄은 세로, 나머지는 가로로 연결되어 있다.

1
2
3
4



여기에 저항을 연결해야 함

LED 사용하기

Long lead : + (plus)

Short lead : - (minus)

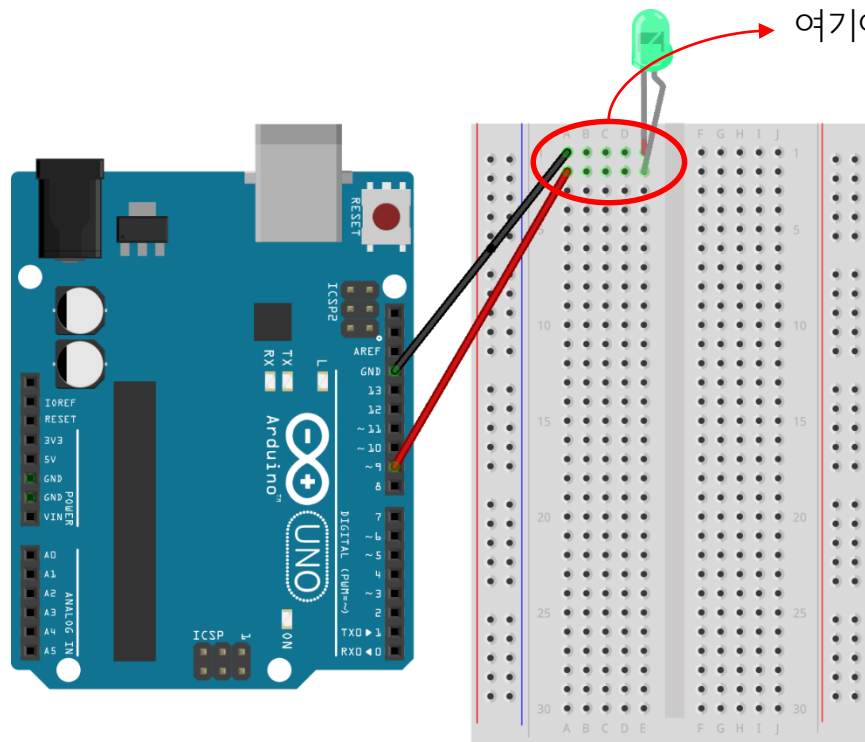
LED 색상에 맞는 정격 전압이 있음

붉은색 : 1.8~2.2 V, 20 mA

초록색 : 3~3.4 V, 20 mA

파란색 : 3~3.4 V, 20 mA

1
2
3
4



여기에 저항을 연결해야 함

필요 저항(R) 계산하기

아두이노 출력 : 5V

정격 전압 : x V

정격 전류 : y mA

$$R = (5-x) / y$$

붉은색 : 1.8~2.2 V, 20 mA

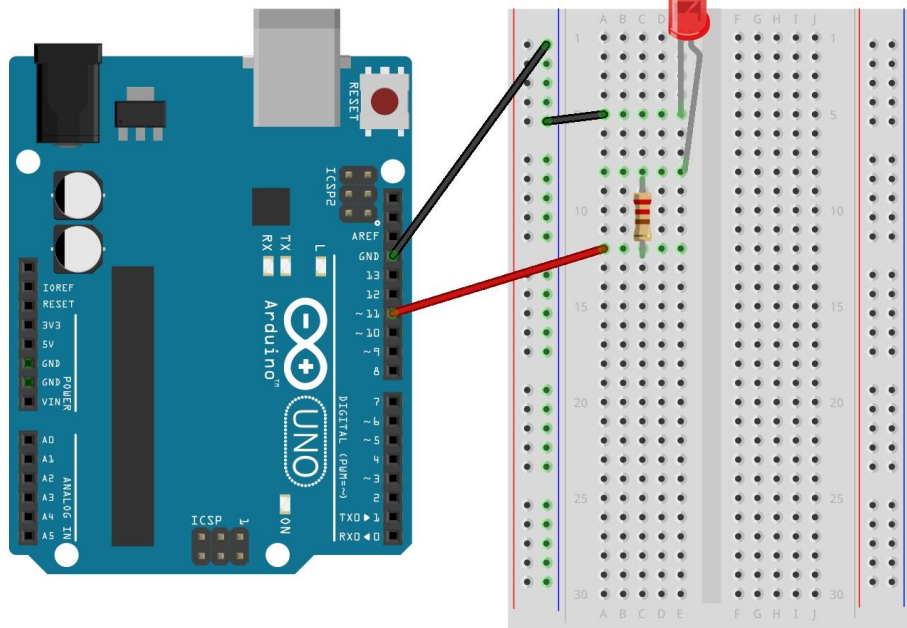
-> R = 140 ~ 160 Ω

초록색 : 3~3.4 V, 20 mA

파란색 : 3~3.4 V, 20 mA

-> R = 80 ~ 100 Ω

1
2
3
4



왼쪽 그림과 같이 연결!

붉은색 LED는 150 Ω 저항을 쓴다.



1
2
3
4

Practice 4 – Blink

4_LED_Blink

```
#define LED 11

void setup() {
  pinMode(LED, OUTPUT);
  Serial.begin(9600);
  Serial.println("Start");
}

void loop() {
  digitalWrite(LED, HIGH);
  Serial.println("LED ON");
  delay(2000);
  digitalWrite(LED, LOW);
  Serial.println("LED OFF");
  delay(2000);
}
```

업로드 완료.

#define

: Give a name to a constant
: **#define** constantName value

pinMode()

: Configures the specified pin to behave either as an input or an output

: pinMode(pin, mode)

pin – the number of the pin whose mode you wish to set

mode – **INPUT** or **OUTPUT**

digitalWrite()

: Write a HIGH or a LOW value to a digital pin

: digitalWrite(pin, mode)

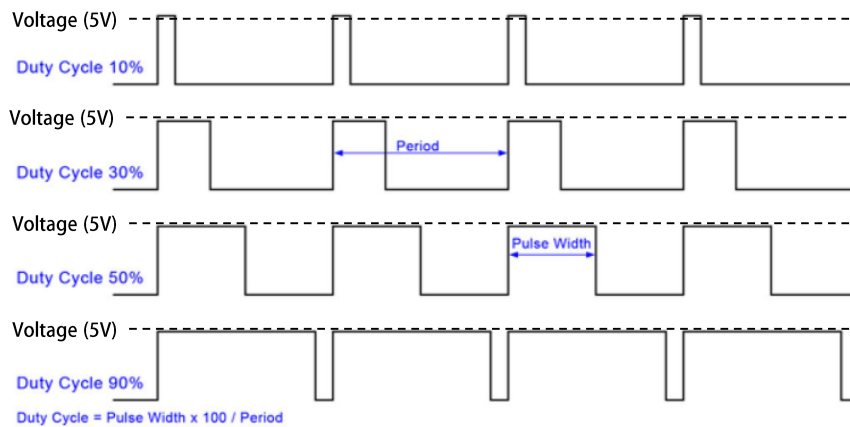
pin – the pin number

value – **HIGH** or **LOW**

PWM (Pulse Width Modulation)

1. 한 주기(Period)안에서 신호가 'ON' 상태인 시간을 지속시간 (Pulse Width)
2. 'ON'시간과 'OFF'시간의 비율을 Duty Cycle.

** 주기의 경우(t) 1/f 로 표현된다. $t=1/f$ (주파수)



Digital signals

: ON or OFF (interpreted in shorthand as 1 or 0)

Analog signals

: infinite number of positions between 0 and 1

PWM

: A way to control analog devices with a digital output. You can output a modulating signal from a digital device such as an Arduino to drive an analog device.





1

2

3

4

for statement

- for 문은 {}로 묶인 블록을 반복하는 데에 사용한다.
- for(초기식; 조건식; 증감식){명령}의 구조

초기 시작값을 지정하고 그 값이 조건식을 불만족할 때 종료된다.
시작값은 증감식에 의해 조정된다.

```
: for(initialization; condition; increment){  
    statement (s);  
}
```

Examples

```
: for(int i=0; i<=255; i++){  
    statement (s);  
}
```

```
: for(int i=255; i>=0; i--){  
    statement (s);  
}
```

cf.
i++ is equal to i=i+1;
i-- is equal to i=i-1;



1
2
3
4

Practice 5 – Brightness

5_LED_Brightness \$

```
#define LED 11

void setup() {
  pinMode(LED, OUTPUT);
  Serial.begin(9600);
  Serial.println("Start");
}

void loop() {
  // 점점 밝아진다.
  for(int i=0; i<=255; i++){
    analogWrite(LED, i);
    Serial.print("LED : \t");
    Serial.println(i);
    delay(10);
  }
}
```

analogWrite()

: Writes an analog value (PWM wave) to a pin. Can be used to light a LED at varying brightnesses or drive a motor at various speeds

: analogWrite(pin, value)

pin – the pin to write to

value – the duty cycle between 0 (always off) and 255 (always on)

Serial.print("")

: Print sentence on the serial monitor (no new line)



1
2
3
4

Practice 5 – Brightness

```
5_LED_Brightness $
```

```
#define LED 11

void setup() {
  pinMode(LED, OUTPUT);
  Serial.begin(9600);
  Serial.println("Start");
}

void loop() {
  // 점점 밝아진다.
  for(int i=0; i<=255; i++){
    analogWrite(LED, i);
    Serial.print("LED : \t");
    Serial.println(i);
    delay(10);
  }
}
```

점점 어두워지게 하려면?

초기식, 조건식, 증감식을 수정한다.



1
2
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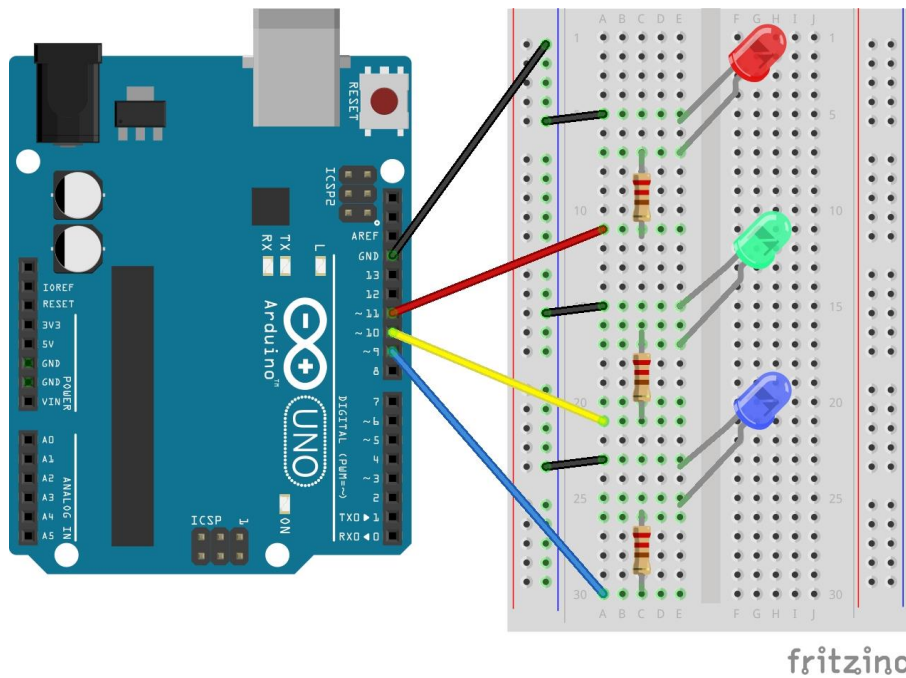
Practice 5 – Brightness

```
5_LED_Brightness $  
  
#define LED 11  
  
void setup() {  
  pinMode(LED, OUTPUT);  
  Serial.begin(9600);  
  Serial.println("Start");  
}  
  
void loop() {  
  // 점점 어두워진다.  
  for(int i=255; i>=0; i--){  
    analogWrite(LED, i);  
    Serial.print("LED : \t");  
    Serial.println(i);  
    delay(10);  
  }  
}
```

점점 어두워지게 하려면?

for(int i=255; i>=0; i--)

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왼쪽 그림과 같이 연결!

붉은색 LED는 150 Ω 저항을 쓴다.

녹색, 파란색은 100 Ω 저항을 쓴다.

fritzing



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Practice 6 – LED 3개 제어하기

6_3LED

```
#define Blue 9
#define Green 10
#define Red 11

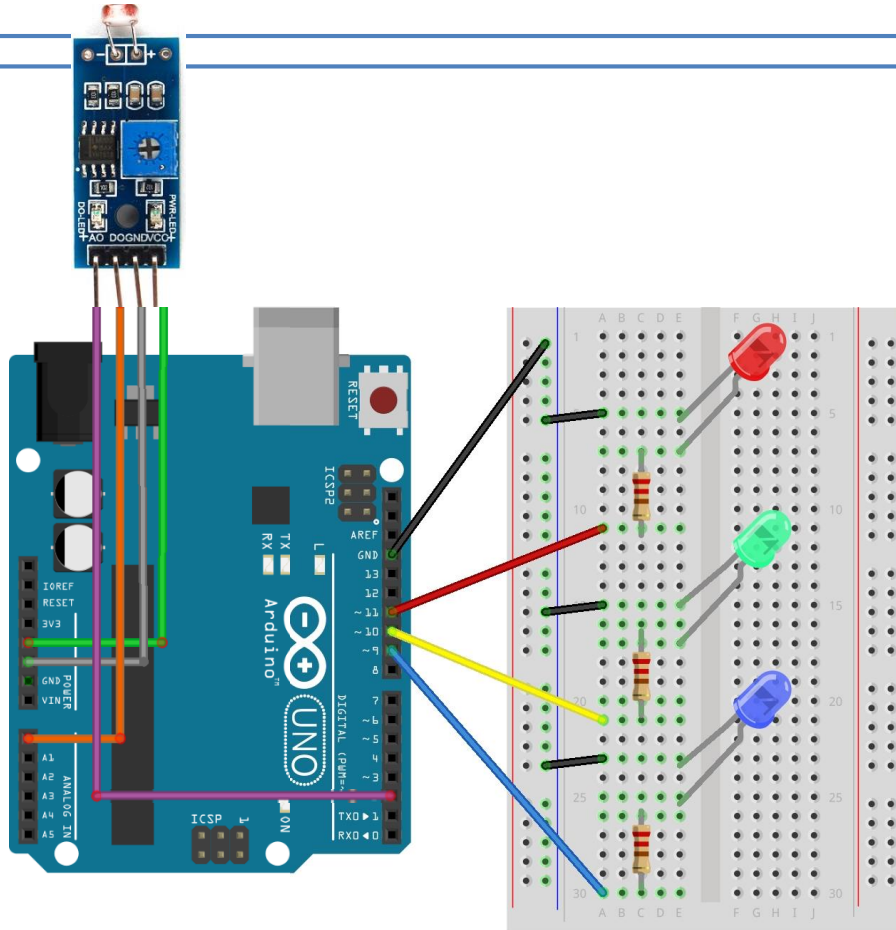
void setup() {
  pinMode(Blue, OUTPUT);
  pinMode(Green, OUTPUT);
  pinMode(Red, OUTPUT);
  digitalWrite(Blue, LOW);
  digitalWrite(Green, LOW);
  digitalWrite(Red, LOW);
  Serial.begin(9600);
  Serial.println("Start");
}

void loop() {
  digitalWrite(Blue, HIGH);
  delay(3000);
  digitalWrite(Blue, LOW);
  digitalWrite(Green, HIGH);
  delay(1000);
  digitalWrite(Green, LOW);
  digitalWrite(Red, HIGH);
  delay(3000);
  digitalWrite(Red, LOW);
}
```

1개를 연결할 때와 동일하게,

Pin 번호만 바꿔서 작성하면 된다.

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Light sensor?

<https://cafe.naver.com/mechawiki/37>



Practice 7 – Light sensor

```
7_LightSensor_only

#define D_sensor 2
#define A_sensor A0

void setup() {
  pinMode(D_sensor, INPUT);
  pinMode(A_sensor, INPUT);

  Serial.begin(9600);
  Serial.println("Start");
}

int light_digital=0;
int light_analog=0;

void loop(){
  light_digital = digitalRead(D_sensor);
  light_analog = analogRead(A_sensor);
  Serial.print("Digital : \t");
  Serial.print(light_digital);
  Serial.print("\tAnalog : \t");
  Serial.println(light_analog);
}
```

cf. in print function,
\\t is equal to tab
\\n is equal to new line

digitalRead()

: Reads the value from a specified digital pin, either HIGH or LOW. It returns HIGH or LOW

: digitalRead(pin)
pin – the number of the digital pin you want to read

analogRead()

: Reads the value from the specified analog pin. It will map input voltages between 0 and the operating voltage(5V or 3.3V) into integer values between 0 and 1023. It returns the analog reading on the pin (int) (0~1023)

: analogRead(pin)
pin – the name of the analog input pin to read from (A0 to A5)



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Practice 8 – Light sensor blink

8_LightSensor_LED

```
#define Blue 9
#define Green 10
#define Red 11
#define D_sensor 2
#define A_sensor A0

void setup() {
  pinMode(Blue, OUTPUT);
  pinMode(Green, OUTPUT);
  pinMode(Red, OUTPUT);
  pinMode(D_sensor, INPUT);
  pinMode(A_sensor, INPUT);

  digitalWrite(Blue, LOW);
  digitalWrite(Green, LOW);
  digitalWrite(Red, LOW);

  Serial.begin(9600);
  Serial.println("Start");
}

int light_digital=0;
int light_analog=0;
```

```
void loop() {
  light_digital = digitalRead(D_sensor);
  light_analog = analogRead(A_sensor);
  Serial.print("Digital : \t");
  Serial.print(light_digital);
  Serial.print("\tAnalog : \t");
  Serial.println(light_analog);

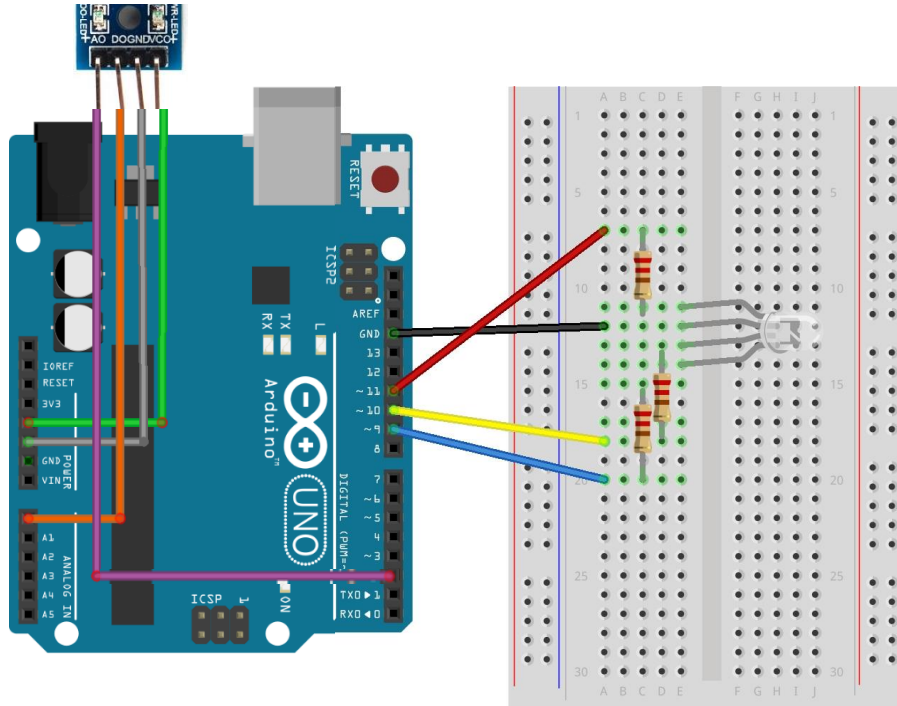
  LED_Digital(Blue);
  LED_Digital(Green);
  LED_Digital(Red);
  /*LED_Analog(Blue);
  LED_Analog(Green);
  LED_Analog(Red);*/
}

void LED_Digital(int LED) {
  digitalWrite(LED, light_digital);
}

void LED_Analog(int LED) {
  analogWrite(LED, map(light_analog, 0, 1023, 0, 255));
}
```

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Practice 9 – RGB LED



Cathode 타입 RGB LED
가장 긴 2번째 핀이 – 다.

1번째 핀 = RED
3번째 핀 = GREEN
4번째 핀 = BLUE



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Practice 9 – RGB LED

```
9_RGB_Color

#define Blue 9
#define Green 10
#define Red 11

void setup() {
  pinMode(Blue,OUTPUT);
  pinMode(Green,OUTPUT);
  pinMode(Red,OUTPUT);

  digitalWrite(Blue,LOW);
  digitalWrite(Green,LOW);
  digitalWrite(Red,LOW);

  Serial.begin(9600);
  Serial.println("Start");
}

void loop() {
  for(int i=0; i<=255;i++){
    analogWrite(Blue, i);
    analogWrite(Green, i);
    analogWrite(Red, i);
    delay(10);
  }
}
```

R, G, B 모두 점점 밝아진다.

이 때 백색으로 보인다.



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Practice 9 – RGB LED

```
10_RGB_Serial$  
  
#define Blue 9  
#define Green 10  
#define Red 11  
int R = 0, G = 0, B = 0;  
  
void setup() {  
  pinMode(Blue, OUTPUT);  
  pinMode(Green, OUTPUT);  
  pinMode(Red, OUTPUT);  
  
  digitalWrite(Blue, LOW);  
  digitalWrite(Green, LOW);  
  digitalWrite(Red, LOW);  
  
  Serial.begin(9600);  
  Serial.println("Start");  
}  
  
void loop() {  
  if(Serial.available() > 0) {  
    R = Serial.parseInt();  
    G = Serial.parseInt();  
    B = Serial.parseInt();  
    Serial.println((String) "R:" + R + "\tG:" + G + "\tB:" + B);  
  
    analogWrite(Blue, B);  
    analogWrite(Green, G);  
    analogWrite(Red, R);  
    delay(10);  
  }  
}
```

Serial 통신으로 R, G, B 값을 읽어 들여
각각의 밝기로 빛나며 색을 띄게 된다.



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Practice 9 – RGB LED

RGB 색상표 참고

red	#ff0000	(255, 0, 0)	red	#40e0d0	(064, 224, 208)
crimson	#dc143c	(220, 020, 060)	darkturquoise	#00ced1	(000, 206, 209)
firebrick	#b22222	(178, 034, 034)	aqua	#00ffff	(000, 255, 255)
maroon	#800000	(128, 000, 000)	cyan	#00ffff	(000, 255, 255)
darkred	#8b0000	(139, 000, 000)	deepskyblue	#00bfff	(000, 191, 255)
brown	#a52a2a	(165, 042, 042)	dodgerblue	#1e90ff	(030, 144, 255)
sienna	#a0522d	(160, 082, 045)	cornflowerblue	#6495ed	(100, 149, 237)
saddlebrown	#8b4513	(139, 069, 019)	royalblue	#4169e1	(065, 105, 000)
indianred	#cd5c5c	(205, 092, 092)	blue	#0000ff	(000, 000, 255)
rosybrown	#bc8f8f	(188, 143, 143)	mediumblue	#0000cd	(000, 000, 205)
lightcoral	#f08080	(240, 128, 128)	navy	#000080	(128, 000, 000)
salmon	#fa8072	(250, 128, 114)	darkblue	#00008b	(000, 000, 139)
darksalmon	#e9967a	(233, 150, 122)	midnightblue	#191970	(025, 025, 112)
coral	#ff7f50	(255, 127, 080)	darkslateblue	#483d8b	(072, 061, 139)
tomato	#ff6347	(255, 099, 071)	slateblue	#6a5acd	(106, 090, 205)
sandybrown	#f4a460	(244, 164, 096)	mediumslateblue	#7b68ee	(123, 104, 238)
lightsalmon	#ffa07a	(255, 160, 122)	mediumpurple	#9370db	(147, 112, 219)
peru	#cd853f	(205, 133, 063)	darkorchid	#9932cc	(153, 050, 204)
chocolate	#d2691e	(210, 105, 030)	darkviolet	#9400d3	(148, 000, 211)
orangered	#ff4500	(255, 069, 000)	blueviolet	#8a2be2	(138, 043, 226)
orange	#ffa500	(255, 165, 000)	mediumorchid	#ba55d3	(186, 085, 211)
darkorange	#ff8c00	(255, 140, 000)	plum	#dda0dd	(221, 160, 221)
tan	#d2b48c	(210, 180, 140)	lavender	#e6e6fa	(230, 230, 250)
peachpuff	#ffdab9	(255, 218, 185)	thistle	#d8bfd8	(216, 191, 216)
bisque	#ffe4c4	(255, 228, 196)	orchid	#da70d6	(218, 112, 214)
moccasin	#ffe4b5	(255, 228, 181)	violet	#ee82ee	(238, 130, 238)
navajowhite	#ffdead	(255, 222, 173)	indigo	#4b0082	(075, 000, 130)
wheat	#f5deb3	(245, 222, 179)	darkmagenta	#8b008b	(139, 000, 139)
burlywood	#deb887	(222, 184, 135)	purple	#800080	(128, 000, 128)
darkgoldenrod	#b8860b	(184, 134, 011)	mediumvioletred	#c71585	(199, 021, 133)
goldenrod	#daa520	(218, 165, 032)	deeppink	#ff1493	(255, 020, 147)
gold	#ffd700	(255, 215, 000)	fuchsia	#ff00ff	(255, 000, 255)
yellow	#ffff00	(255, 255, 000)	magenta	#ff00ff	(255, 000, 255)
lightgoldenrodyellow	#fafad2	(250, 250, 210)	hotpink	#ff69b4	(255, 105, 180)
palegoldenrod	#eee8aa	(238, 232, 170)	palevioletred	#db7093	(219, 112, 147)
khaki	#f0e68c	(240, 230, 140)	lightpink	#ffb6c1	(255, 182, 193)
darkkhaki	#bdb76b	(189, 183, 107)	pink	#ffc0cb	(255, 192, 203)



Q & A

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들어주셔서 감사합니다.