Arduino

Let's Interacting in Arduino

[Class 1]

April 8 2008 , MAO

what's for Today?

- Arduino **的簡介**
  ～ Introduction to Arduino

- **Arduino 環境設定** ....
  ～ Setting up your Arduino environment

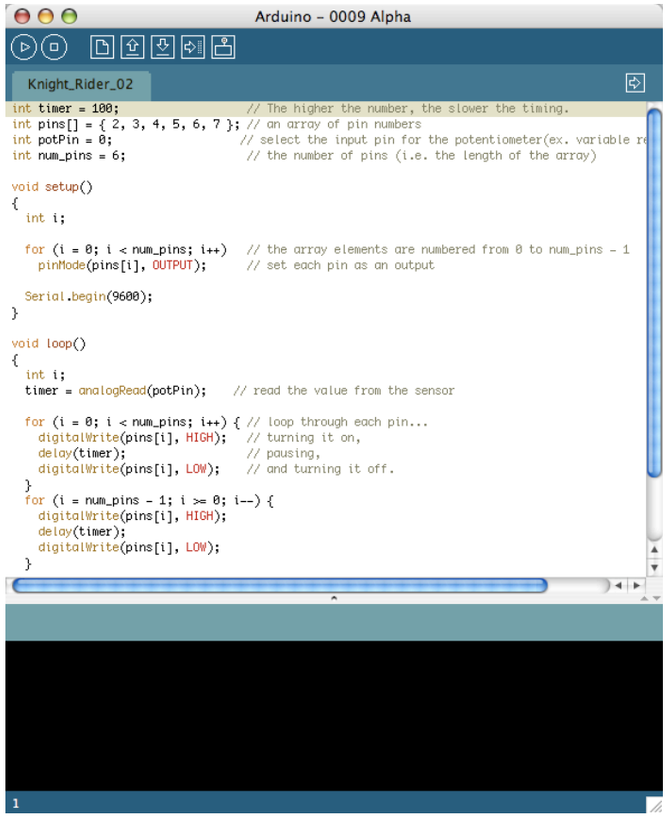
- **基本知識**....
  ～ Basic knowledge about physical computing before the practice

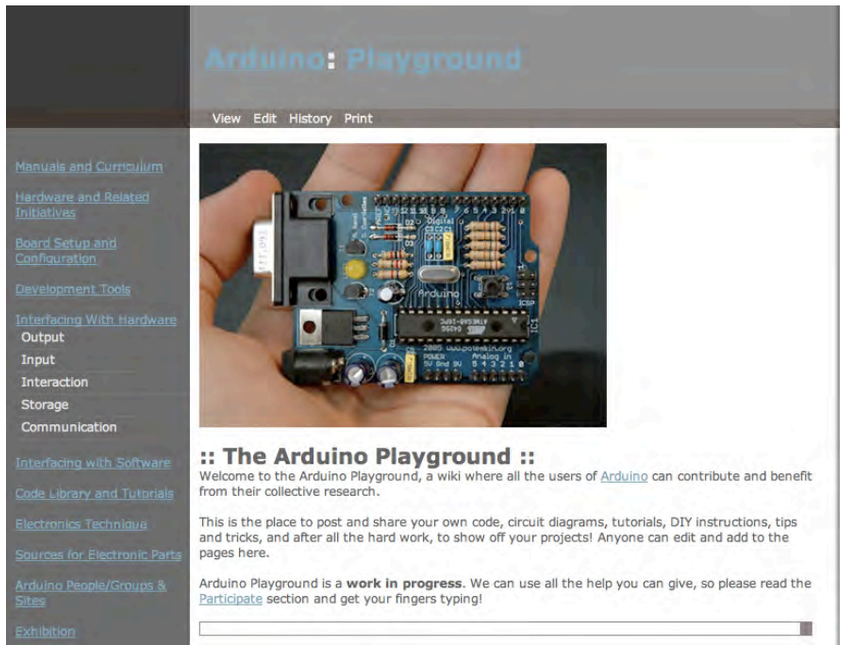
- **與Arduino第一次親柔的接觸**
  ～ Your first circuit & Arduino sketch - Basic Digital Output
  ～ Basic Digital Input

What is Arduino?

What is Arduino ?

Arduino Hardware + Arduino Software + Open Source Physical Computing Platform & Group

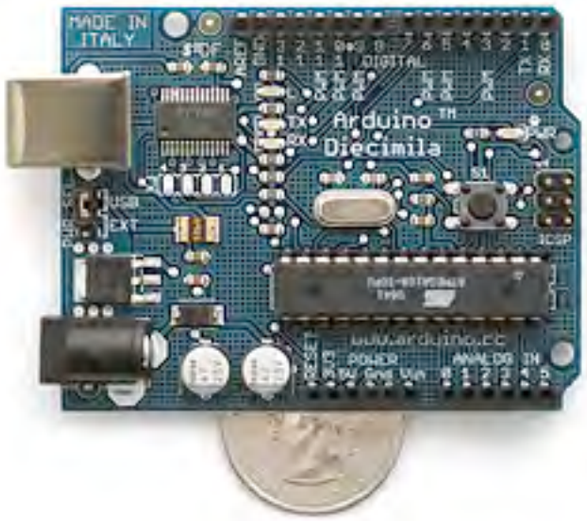




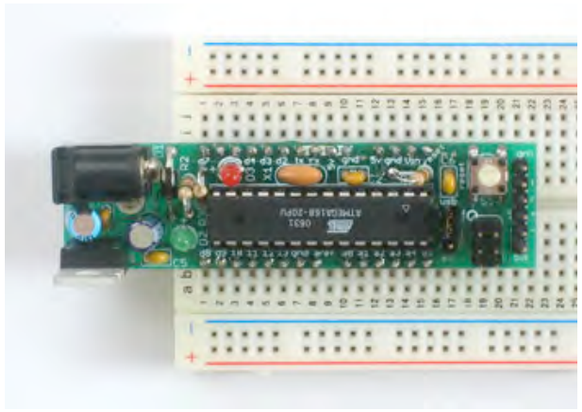
arduino : Playground
http://www.arduino.cc/playground/

各種 Arduino板

Arduino Diecimila

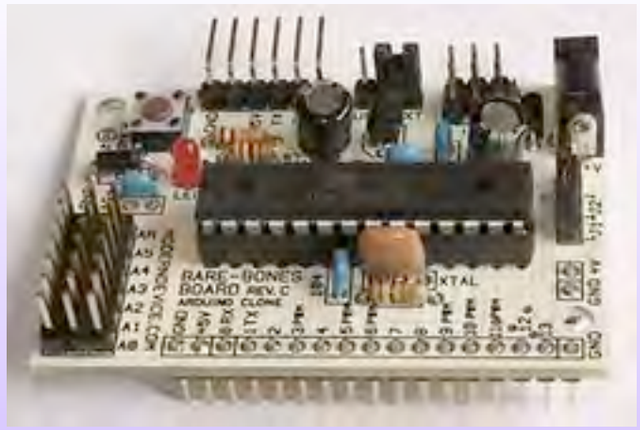


Arduino BT

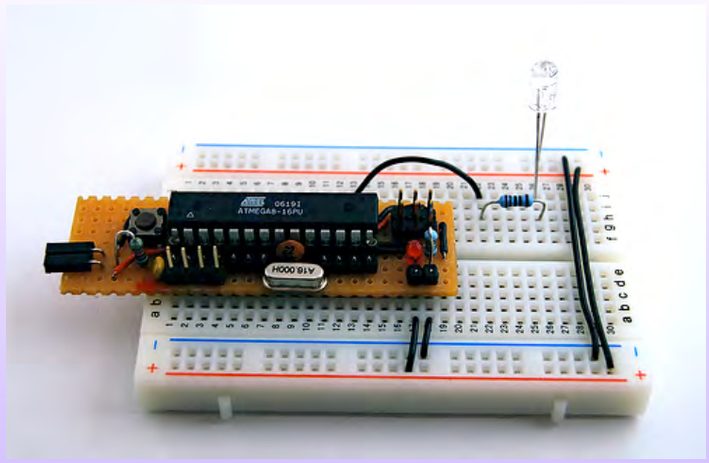


Boduino

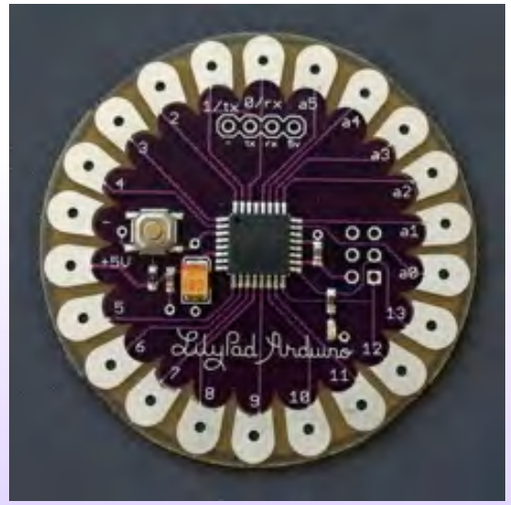
Arduino Mini



Bare Bones



DIY

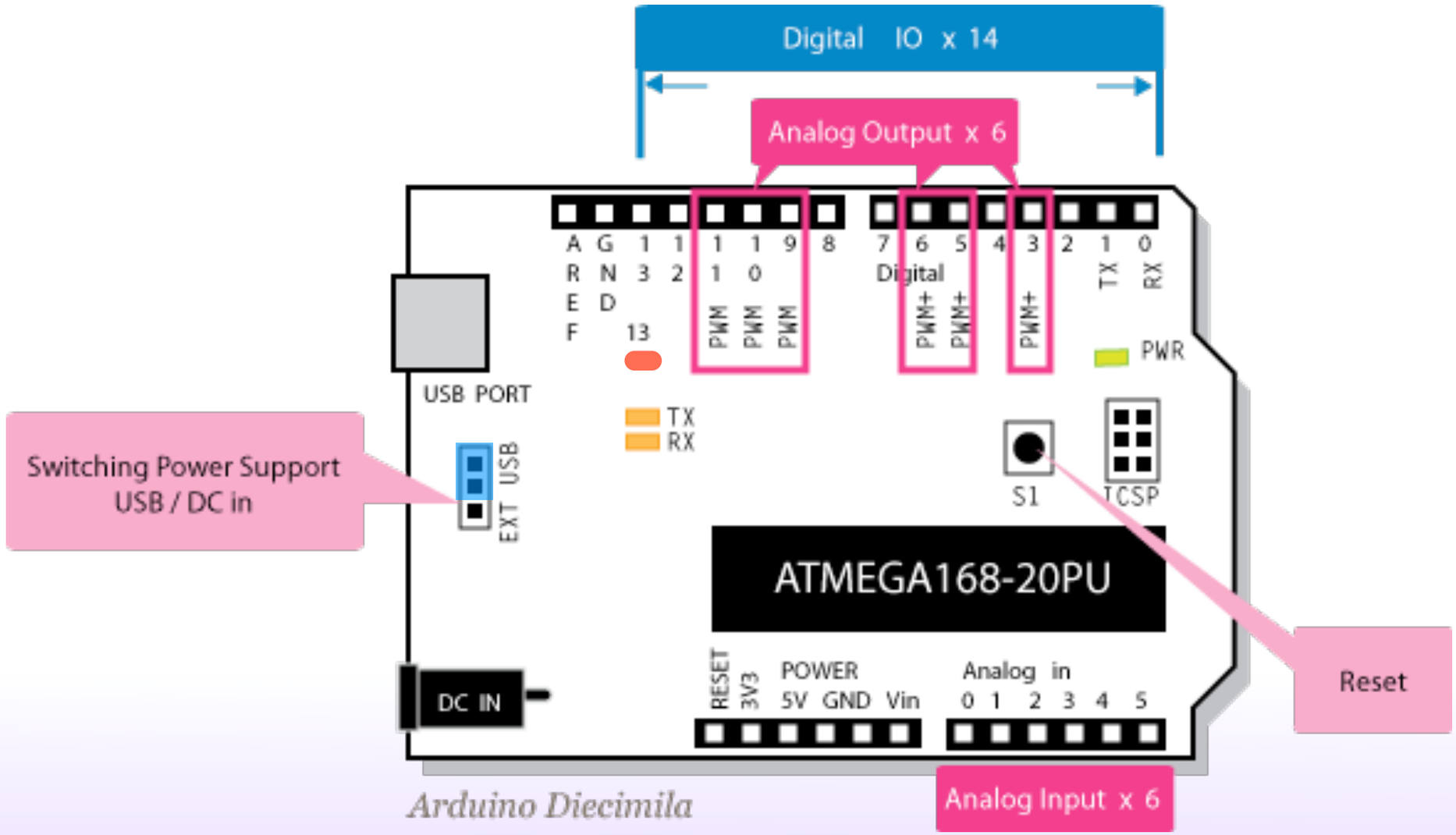


LilyPad

* Product images from Arduino.cc / Adafruit.com / SparkFun.com / Tinkerlog

Arduino
Let's Interacting in Arduino

Arduino Diecimila Board



- 數位輸出輸入共14組 ～ Digital Pins 0-13
- Digital Pins 0-1/Serial In/Out - TX/RX
  - 若你會用到Serial port與電腦等傳輸，建議別使用 *Pin 0,1*.
- 類比輸入共6組 ～ Analog Input Pins 0-5
- 類比輸出 Analog Output * (Digital Pins 3,5,6,9,10,11)

- Reset 按鈕- S1
- 額外電源輸入 (建議7-12VDC)
- 可透過Jumper切換由USB供電或DC電源輸入
- USB可使程式由電腦端輸入到板上的晶片，也能同時供給電
- 電源供應Vin, 5V, 3.3V(Diecimila 才有)

*只是透過 PWM 的方式達到近似於類比，爾後的課程會再進一步講解
*Diecimila 在Digital Pin 13 有內建一個測試LED

Arduino
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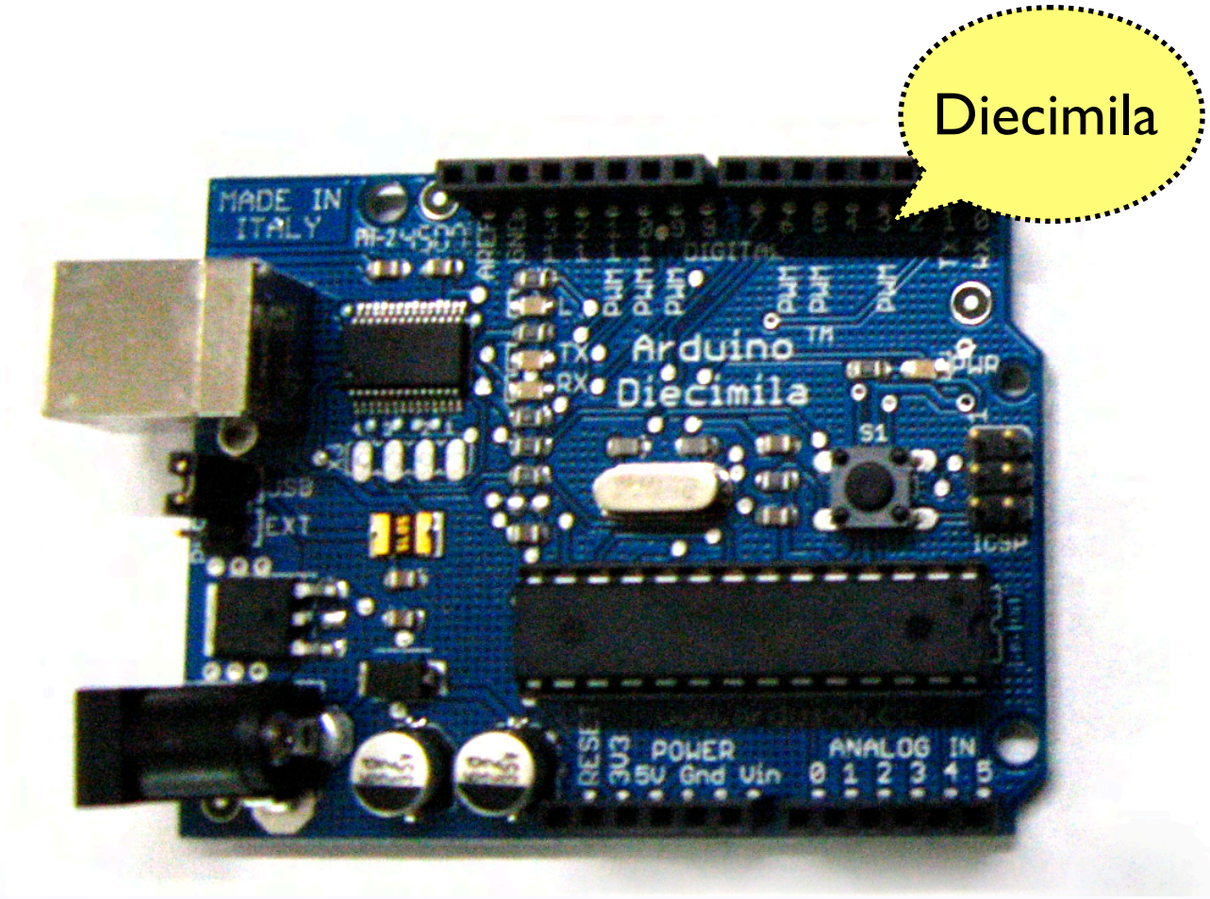
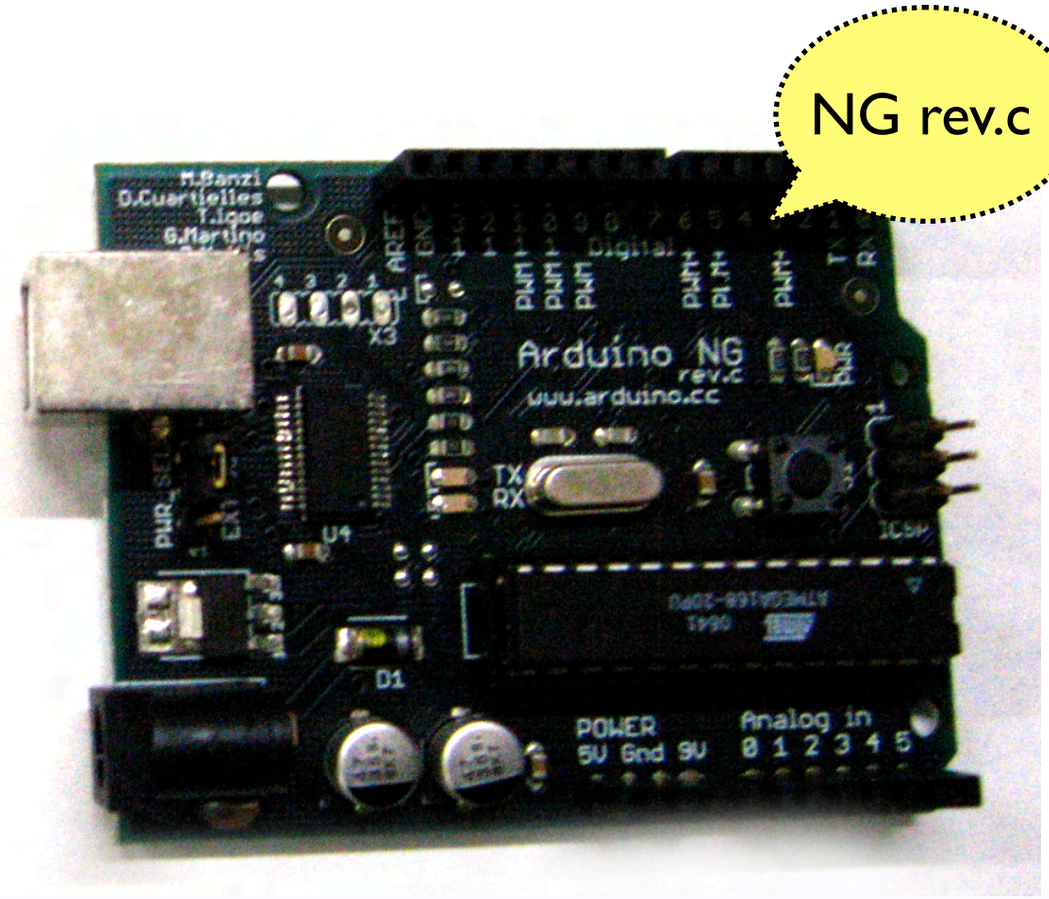
Diecimila v.s NG rev. c





- 自動reset，Diecimila則輕輕鬆鬆地讓你可以直接在軟體端按顆update就直接寫入。
- USB有防止電流逆衝，當板子那端有短路或電流稍微負載過大(>500mA)，會自動將USB斷線。
- NG rev.c板被閹掉的LED又回來了，pin13又有顆內建的LED啦。
- 改標為Vin，直接由參考電源輸入的電壓。

- 不會自動reset，在NG rev.c時最麻煩就是要在update時要按住板子上的reset再放開，才能寫入。
- USB無防止電流逆衝。
- NG rev.c pin13沒有顆內建的LED
- NG rev.c 有個有名無實的9V輸出 (須接電源供應)。

本頁只是額外的補充說明

人體感知 v.s 機器感測

視覺 → **光電轉換元件** ex.WebCam, 光電晶體, 光敏電阻, 太陽能板

視覺←光

聽覺 → **壓電/磁力轉換元件** ex. 壓電元件, 麥克風

聽覺←聲音

嗅覺 → **氣體感測元件** ex. CO2/ CO氣體感測器

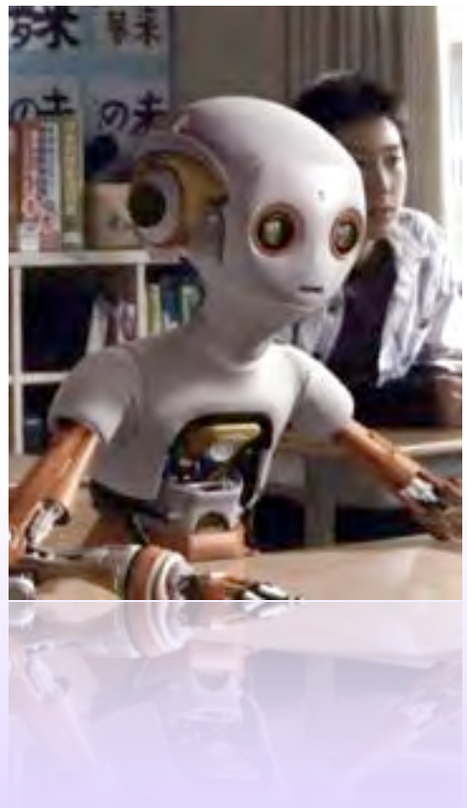
嗅覺←分子吸附

味覺 → **電氣化學轉換元件** ex. 酵素感測器, 化學感測器

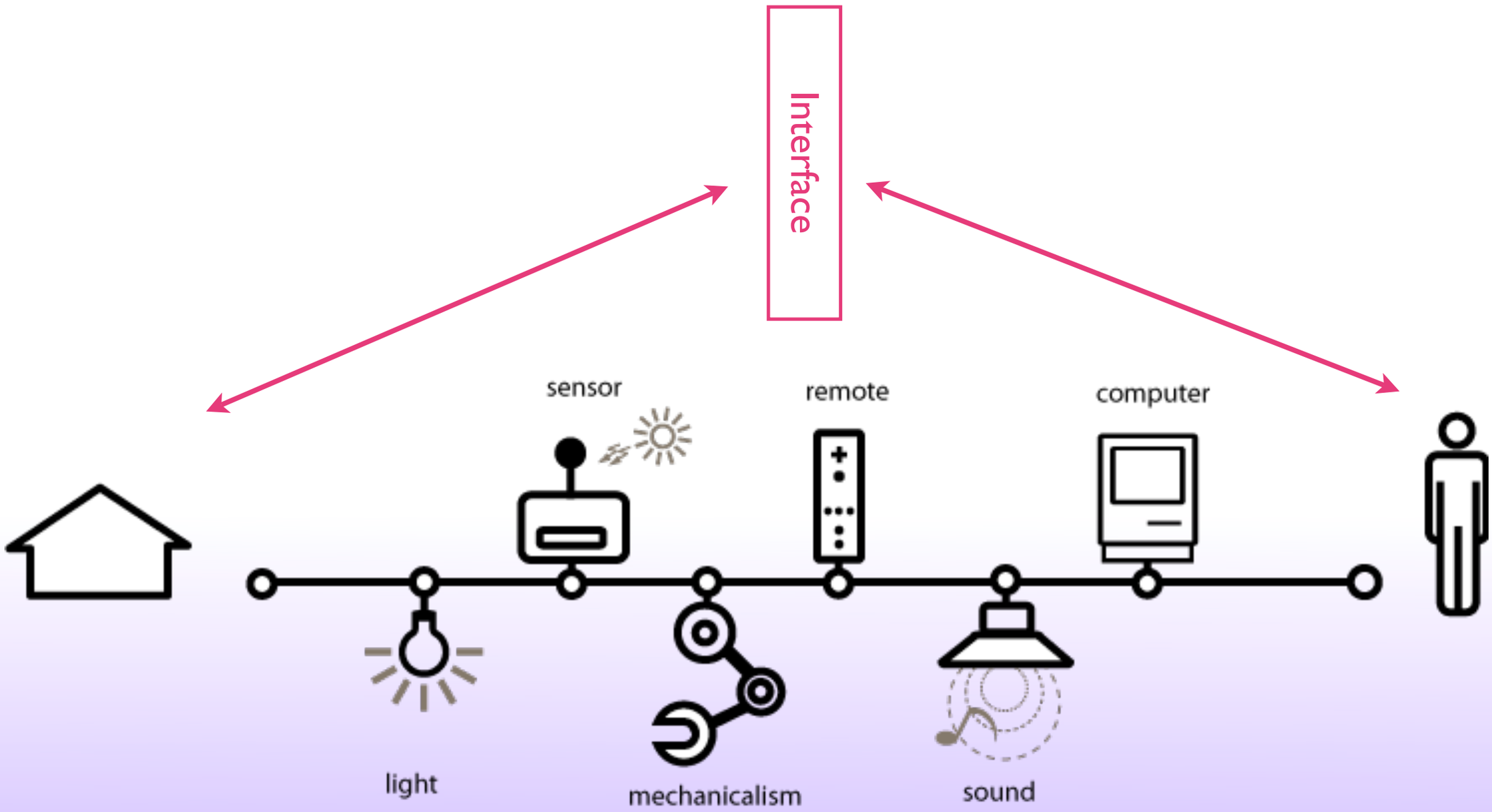
味覺←分子吸附

觸覺 → **光電/磁力轉換元件** ex. 震動感測器, 加速器, 水銀開關, 壓電元件, 觸碰感測器
位移轉換元件 ex. 光學編碼器, 電位計
熱電轉換元件 ex. 熱敏電阻

觸覺←位移壓力
溫覺←溫度



Space = Interface



design process via Arduino

(機器感測)

input

光 (photocell)
動作 (bend sersor, gyroscope,IR)
聲音 (microphone)

...

Computer control

Arduino

(人體感知)

output

光 (LED)
動作 (DC motor, Servo)
聲音 (speaker)

...

feedback to Computer

Set Up !

接下來, 我們全部要做的步驟是 ...

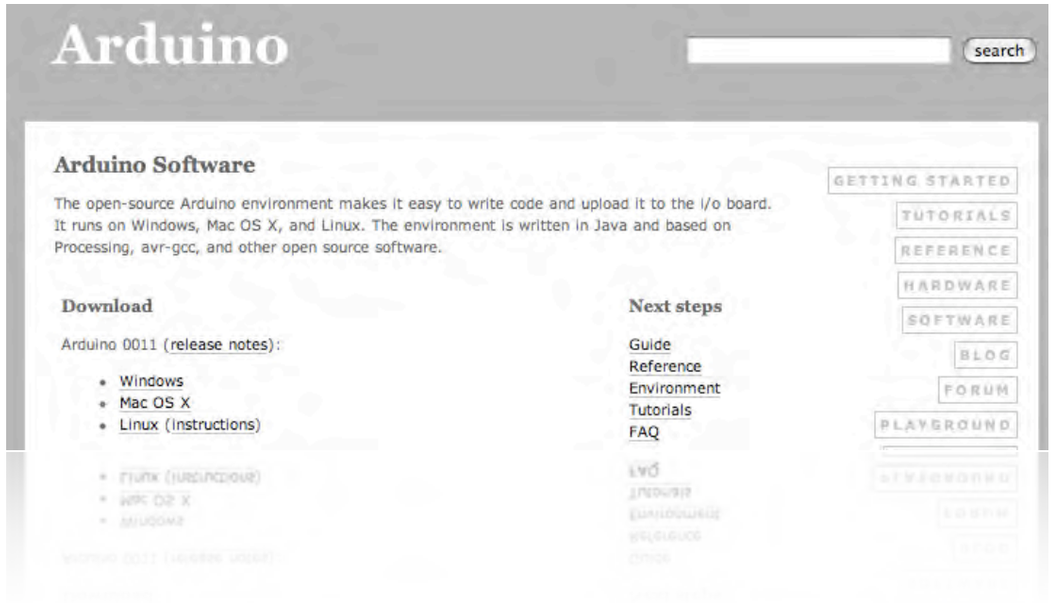
1. 取得Arduino的開發軟體
2. 將USB輕柔地插入Arduino
3. 安裝驅動程式
4. 重開機
5. 找到你的Arduino資料夾，開啟Arduino
6. 讓你的Aruduino (Software) 呼喚 Arduino (板子)

你可以參考 http://www.arduino.cc/en/Guide/HomePage 或 http://wiki.arch.nctu.edu.tw/Arduino/ArduinoSetUp

Arduino Software 取得

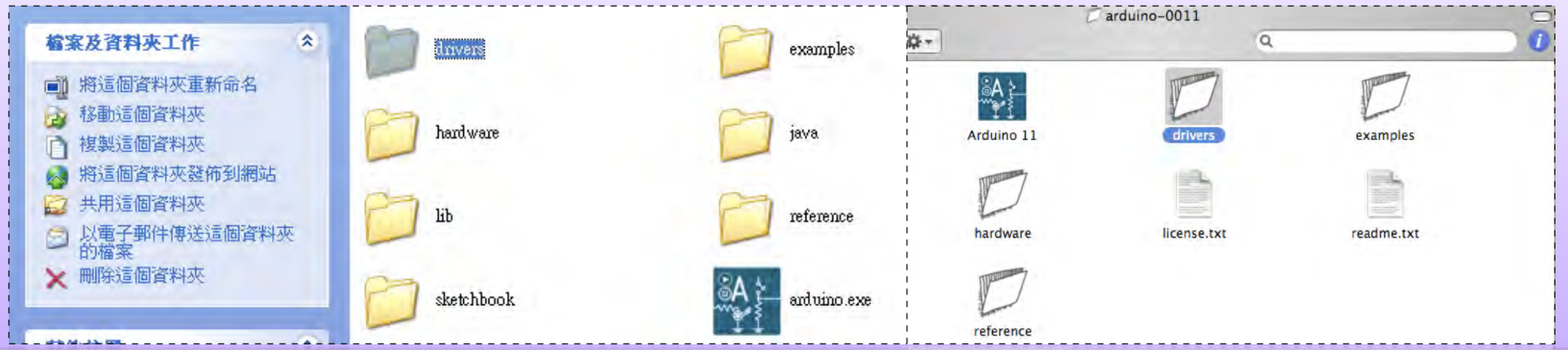
- 於 http://www.arduino.cc/en/Main/Software 取得：

  - Mac OS X ~ arduino-0011-mac.zip
  - Windows ~ arduino-0011-win.zip



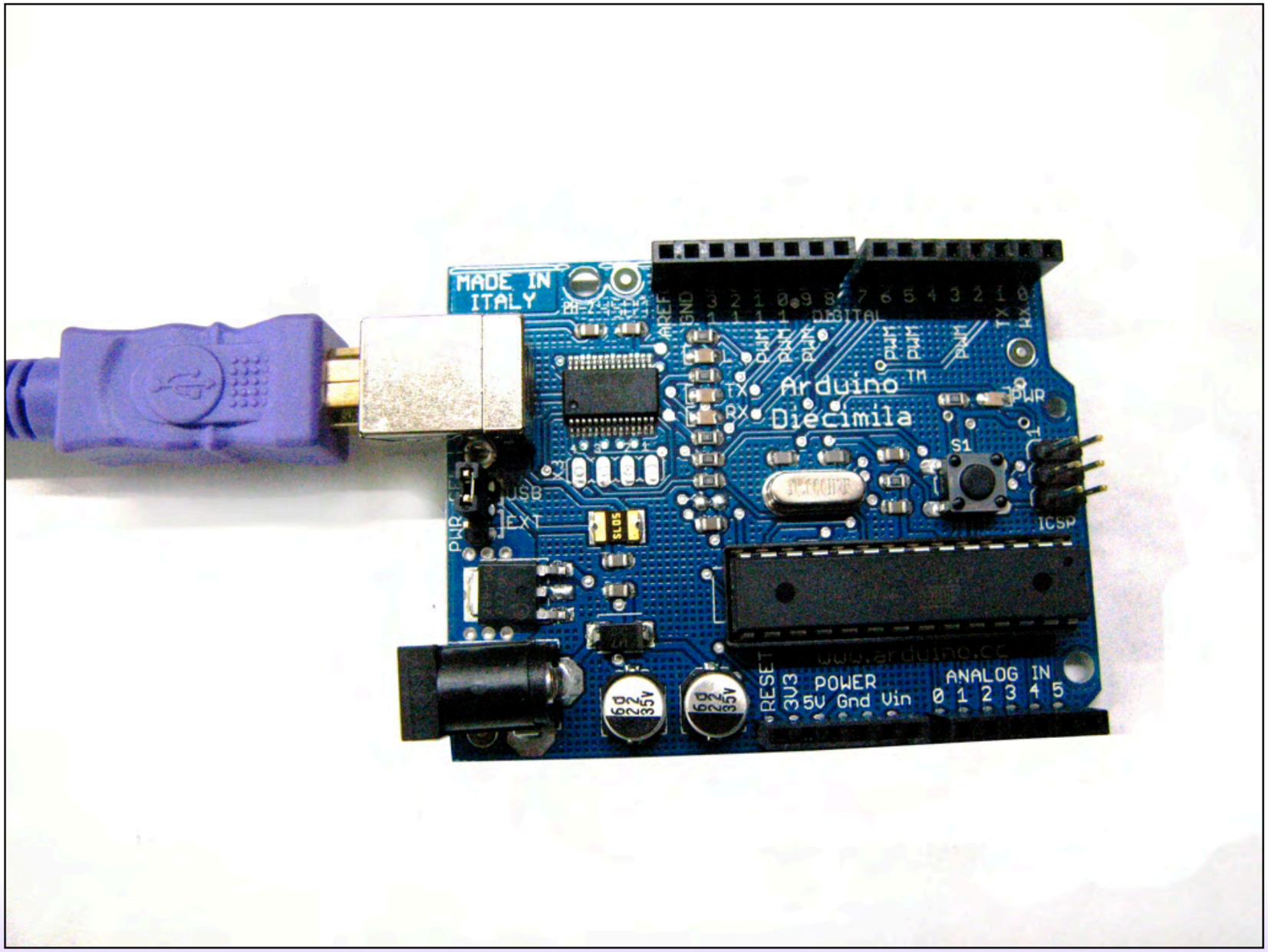
- 盡量將解壓縮後的資料夾放到純英文路徑，以防萬一。

- 到資料夾中找尋drivers資料夾 (windows使用者其實可以不用)



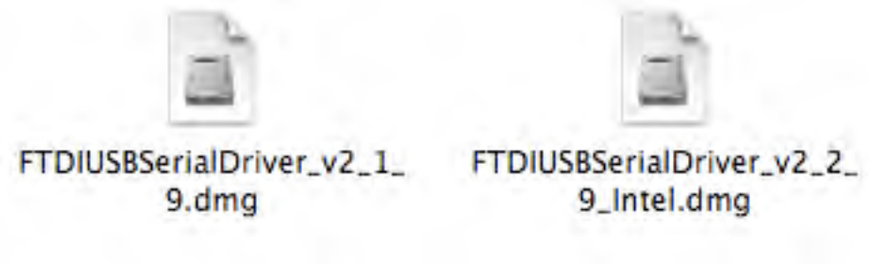
也可到 http://wiki.arch.nctu.edu.tw/Arduino/ArduinoSetUp 下載

Plug USB wire in Arduino



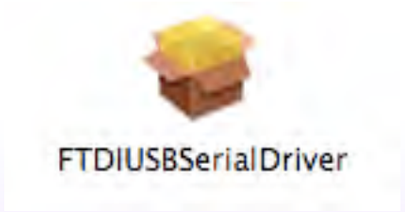
安裝FTDI USB Driver

Mac OS X ：



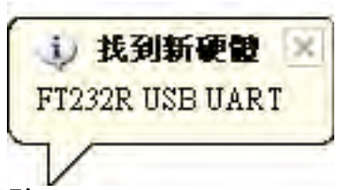
給PPC MAC用的　　Intel MAC用的

double click .dmg 掛上驅動程式安裝檔：

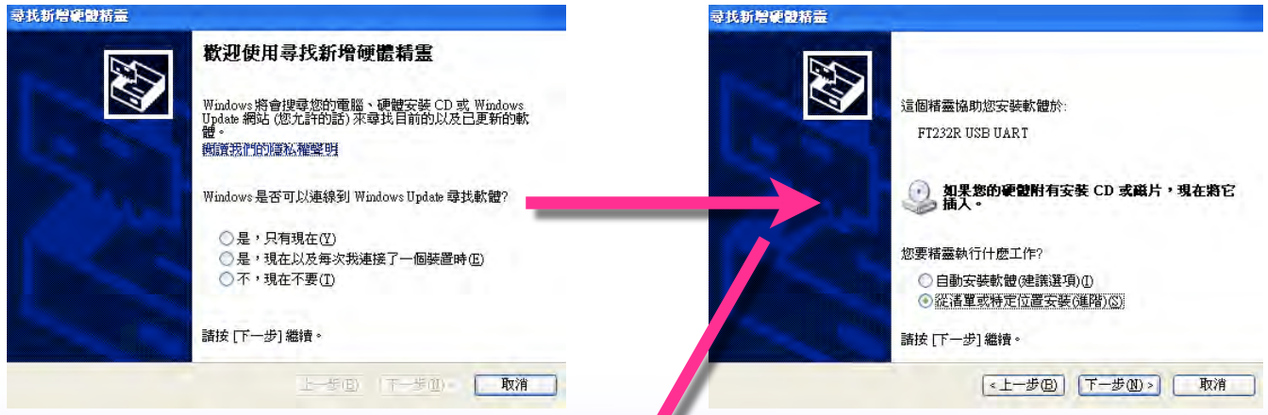


然後系統會自動重開機.....

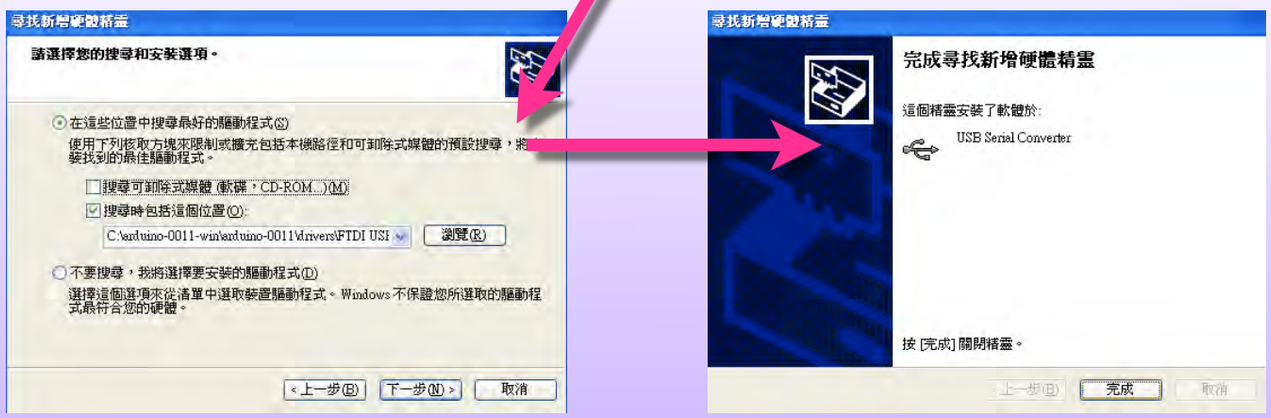
#Windows ：



找到硬體後，交給它跑

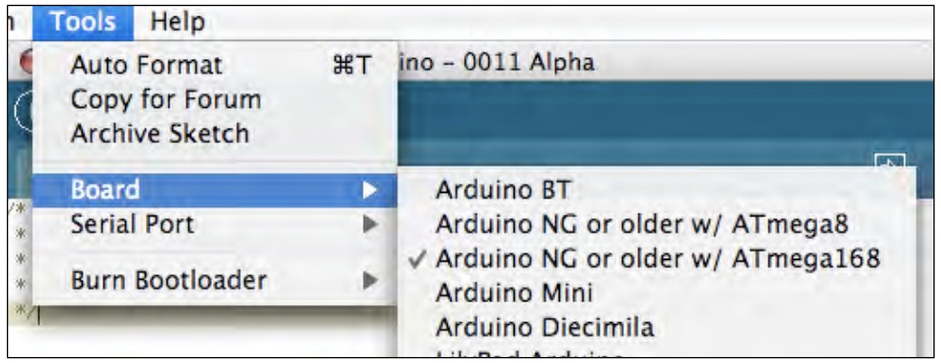


不過最好指定好driver的目錄路徑



選擇 Board & Serial Port

- 選擇你所使用的板子:　Tools > Board



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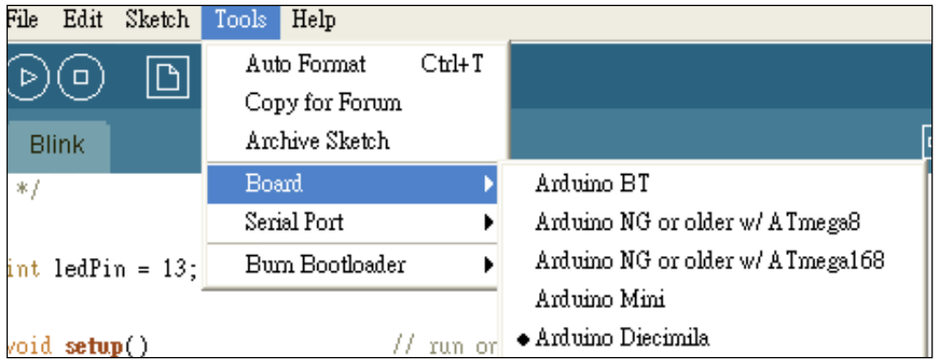

[Windows]

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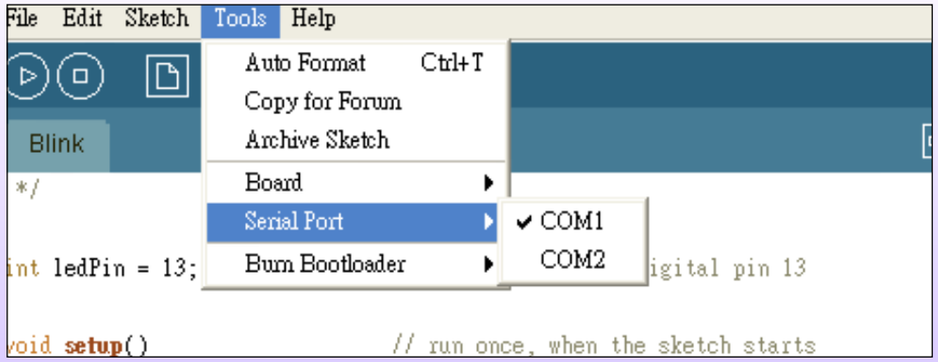
[Mac OS X]

Mac的版本皆會以/dev/tty.usbserial- 開頭*



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* cu.usbserial- 的方式在某種狀況下，我們才會採用，在此先不用理會。

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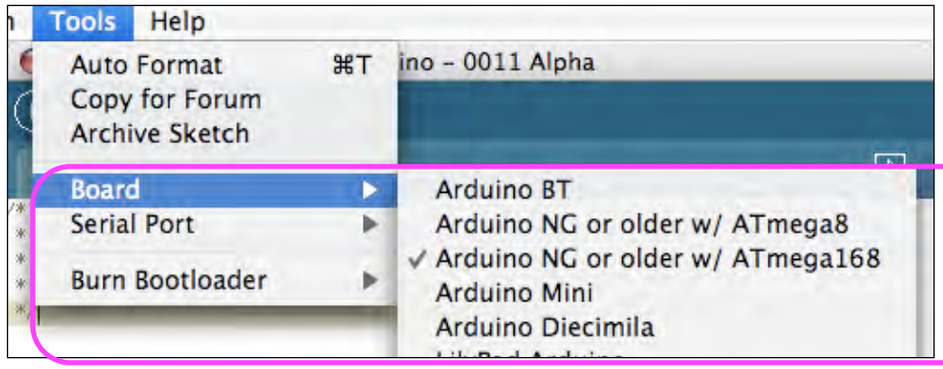

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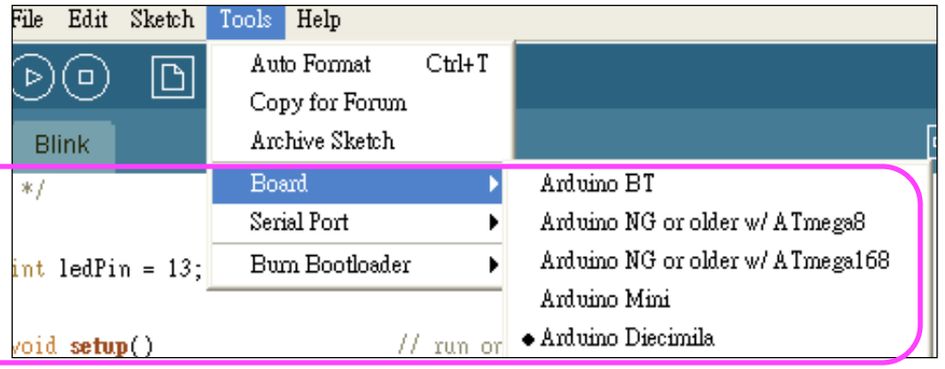

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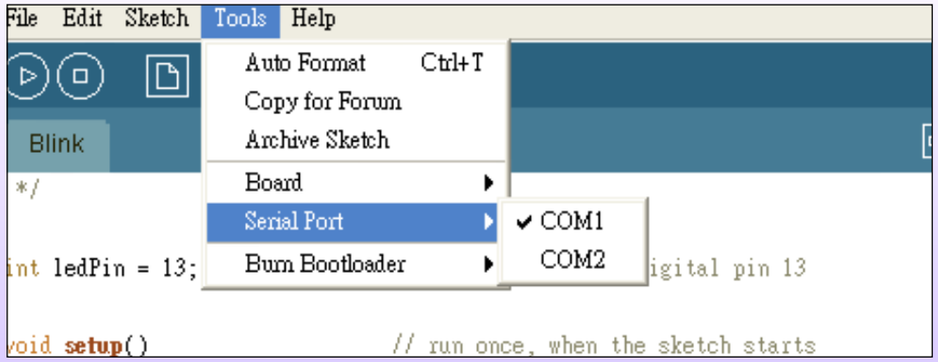

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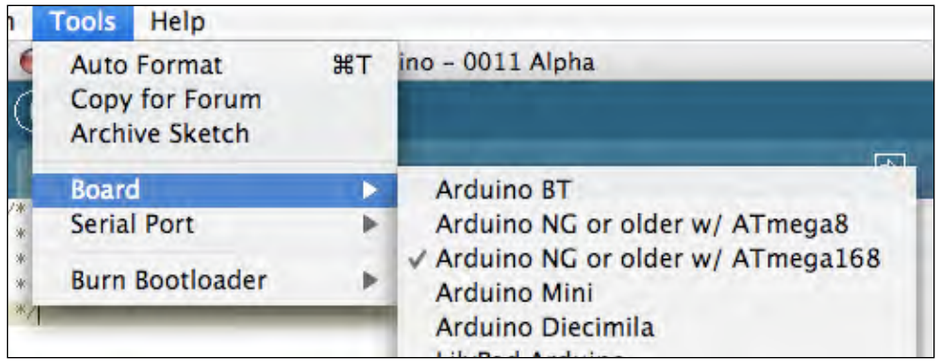

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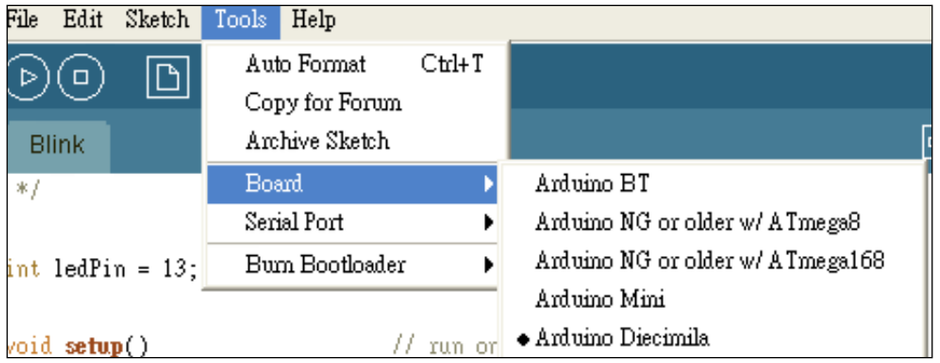

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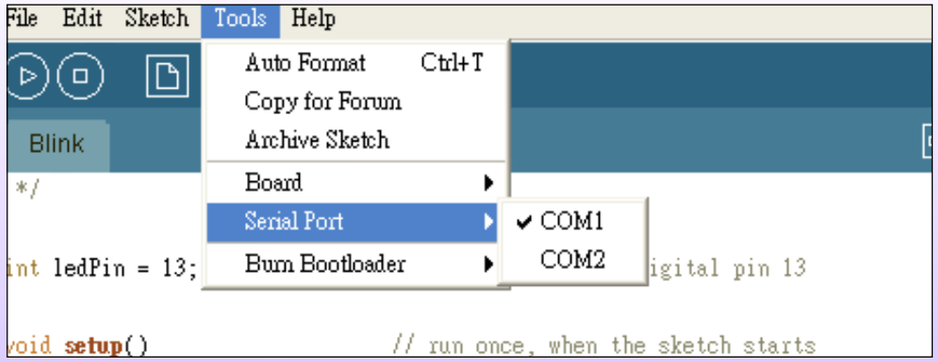

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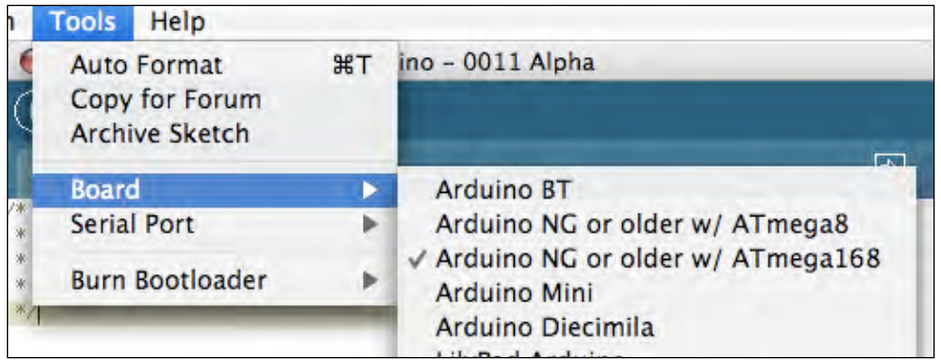

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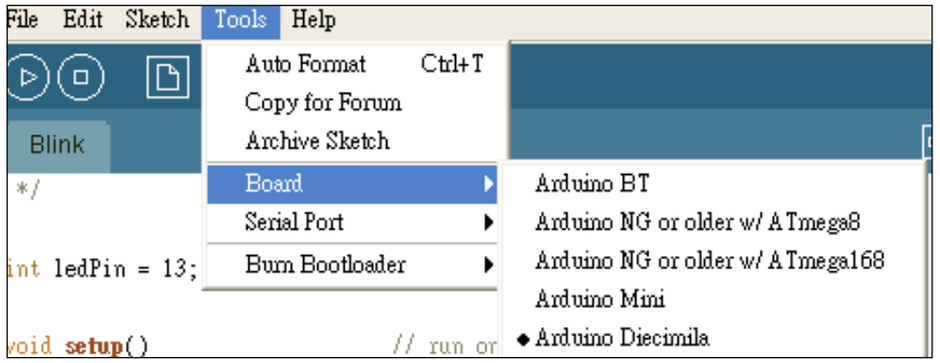

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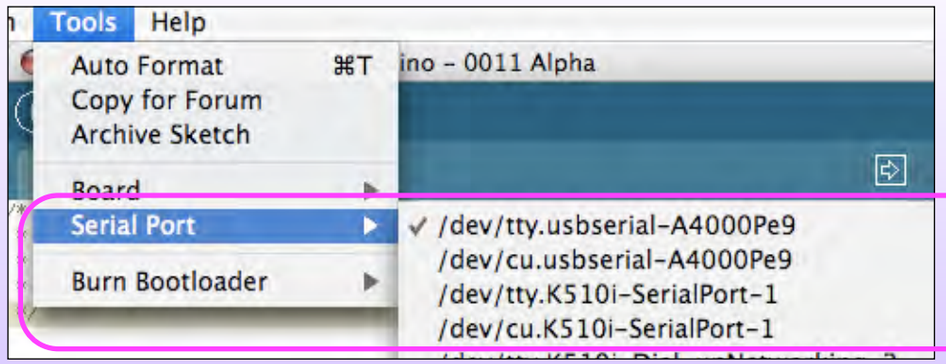

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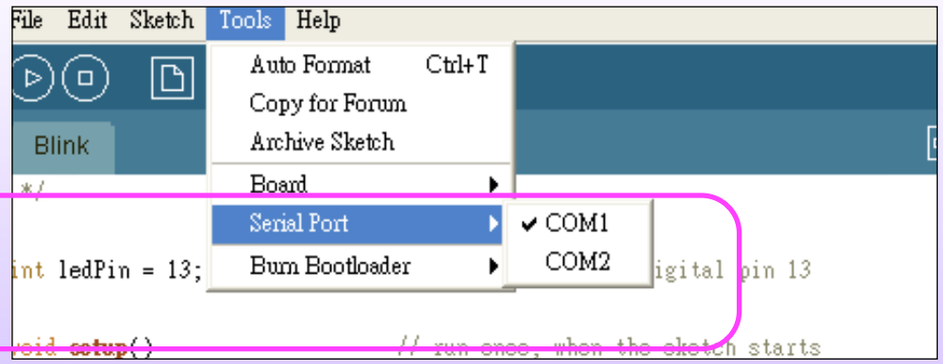

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Arduino
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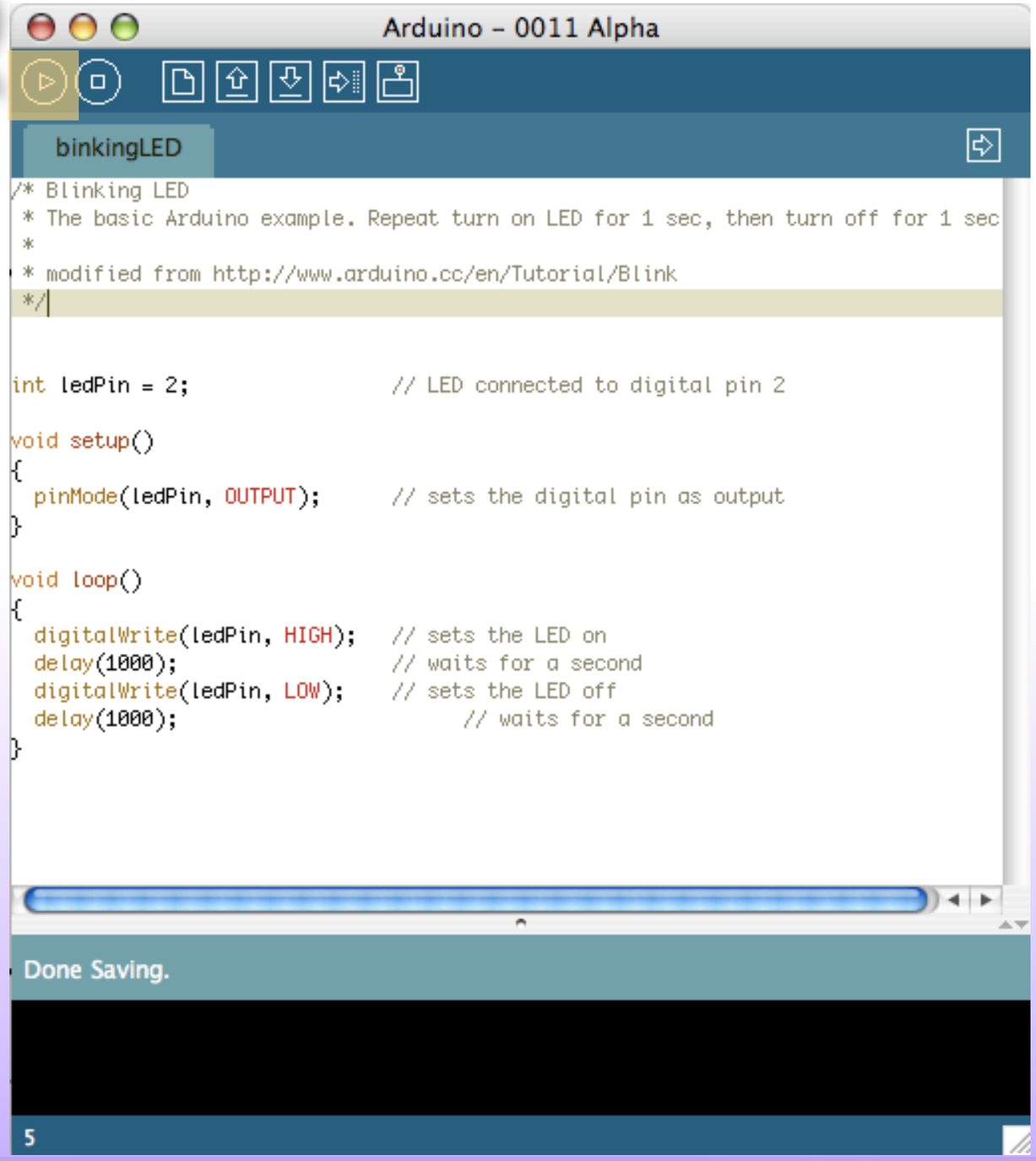
Arduino Software UI

Vertify

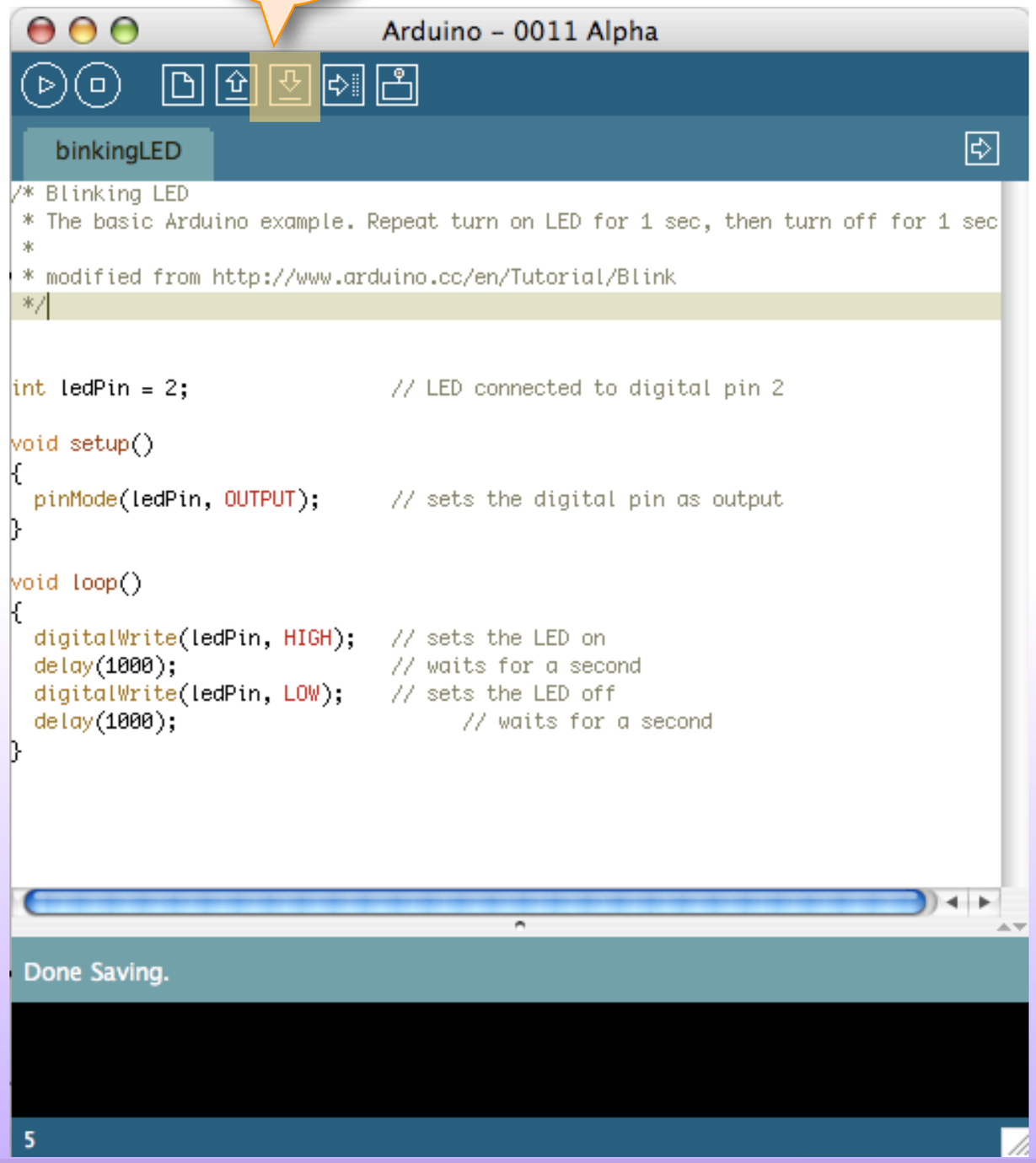
檢驗編輯的程式語法是否正確



Arduino Software UI

Save

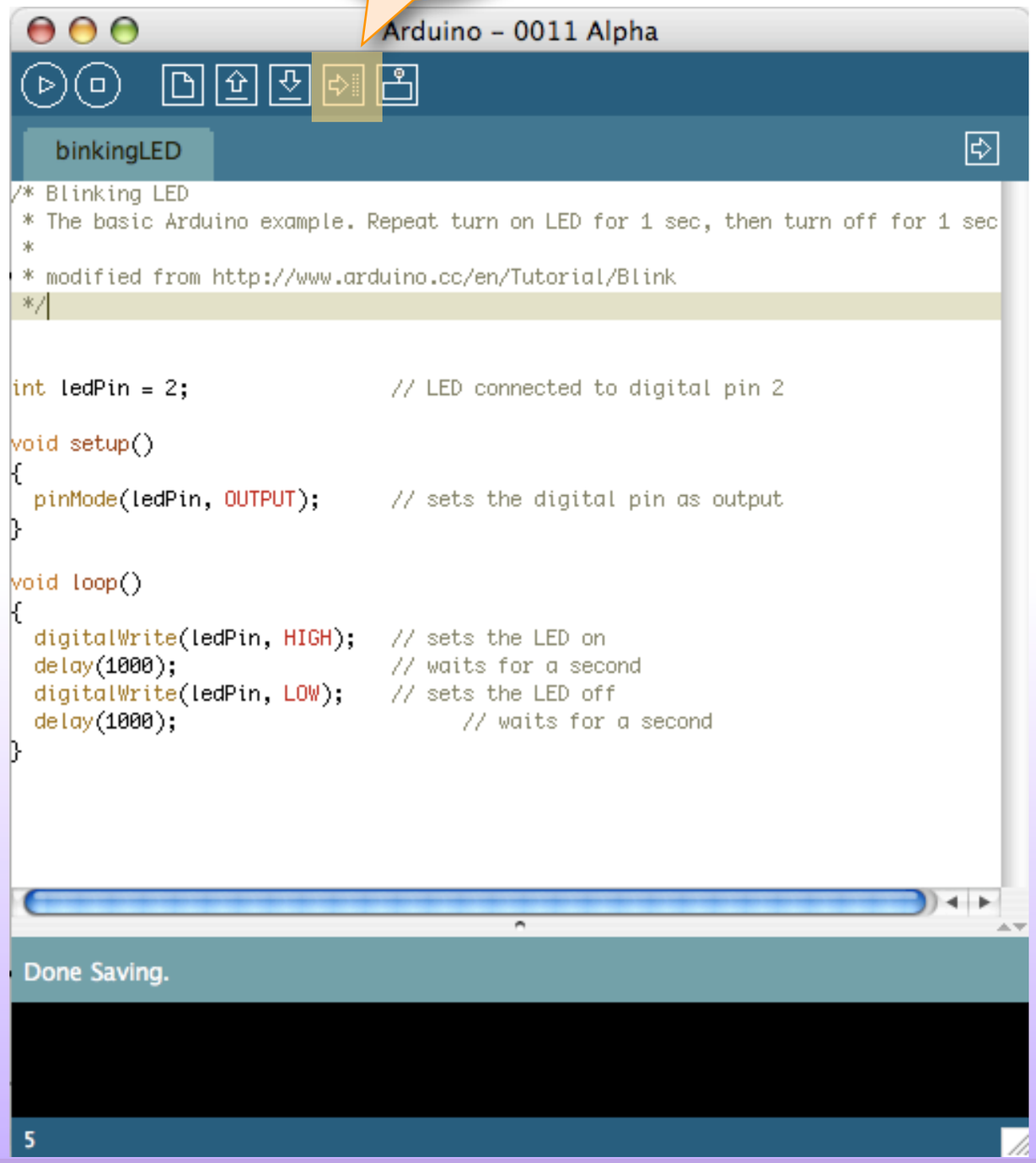
存檔



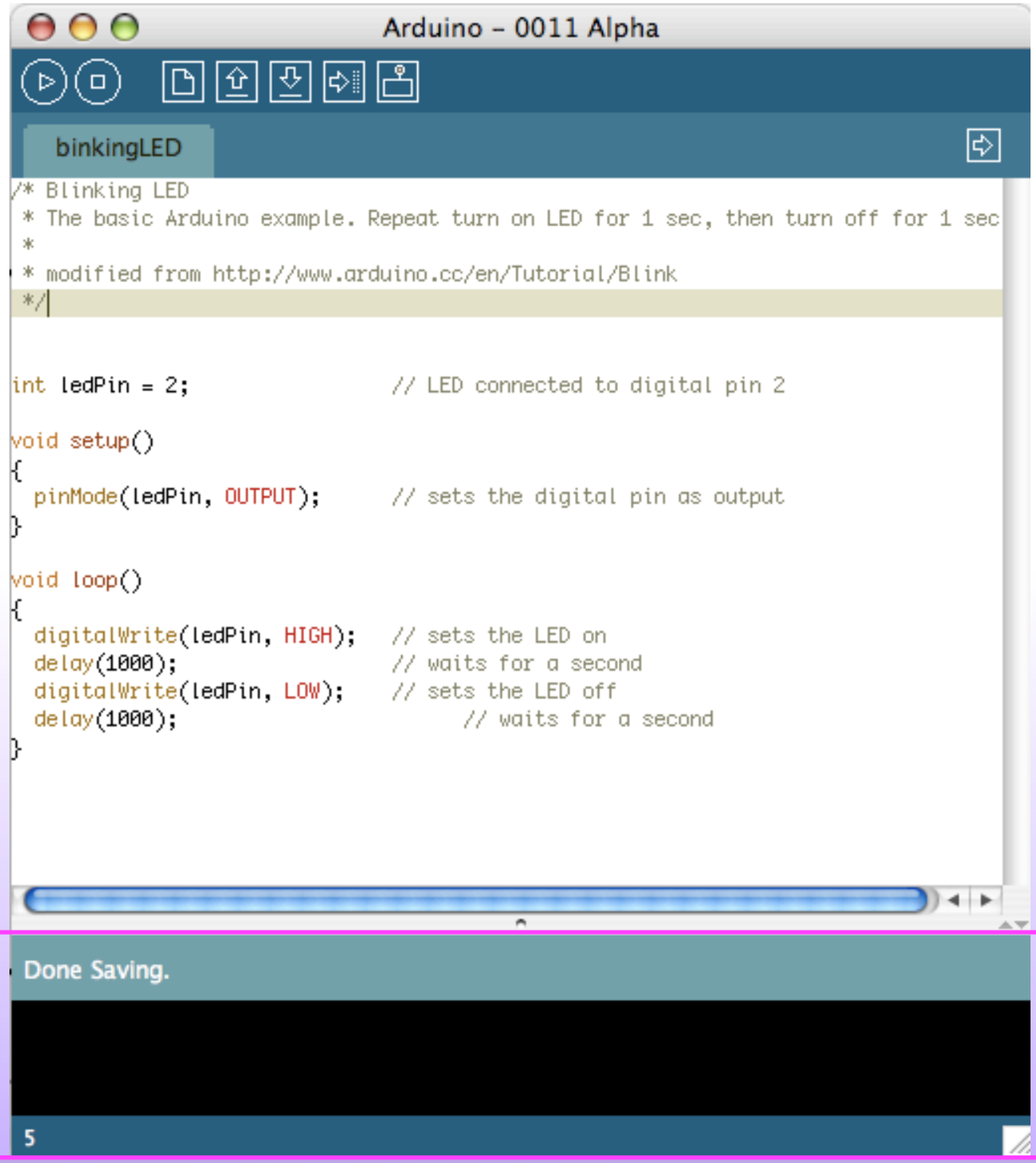
Arduino Software UI

Update

會檢驗語法是否正確，且上傳
編譯過後的檔案到板子上



Arduino Software UI



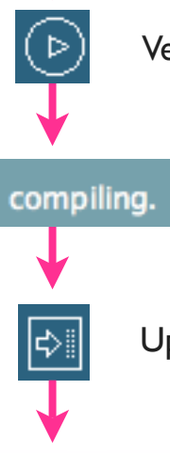
狀態列：編譯的狀況，以及錯誤訊息都會顯示在此

Arduino Process

- 開啟 File > Sketchbooks > Examples > Digital > Blink
- 試著按照右邊的流程，將程式上傳到板子上去
- 若成功....板子上的燈會每隔一秒亮一次。

```
void setup()
{
  pinMode(ledPin, OUTPUT);
}

void loop()
{
  digitalWrite(ledPin, HIGH);
  delay(1000);
  digitalWrite(ledPin, LOW);
  delay(1000);
}
```

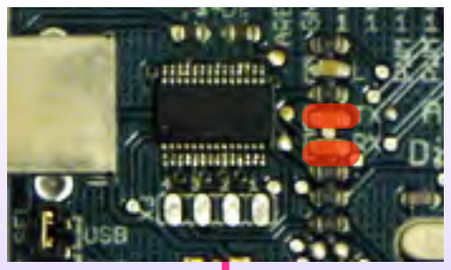
編寫程式



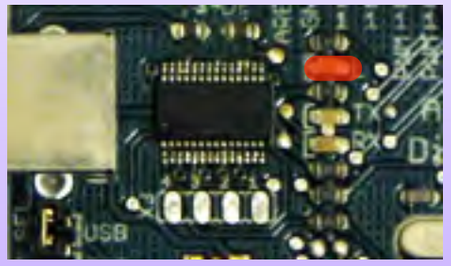
Vertify

Done compiling.

Update to board*



TX/RX的LED狀態燈會交錯閃爍



當傳輸結束後，等約2~3秒，Pin13的pin腳會閃爍(因為我們上傳的程式)

* Arduino NG 的使用者，因為舊板子沒有自動Reset功能，在按Update鈕前，必須先按住Arudino 板子上的Reset鈕，使其在不做任何動作的狀態下，接著在放開Reset鈕後，馬上按下Update鈕，才能正確上傳程式。

Arduino
Let's Interacting in Arduino

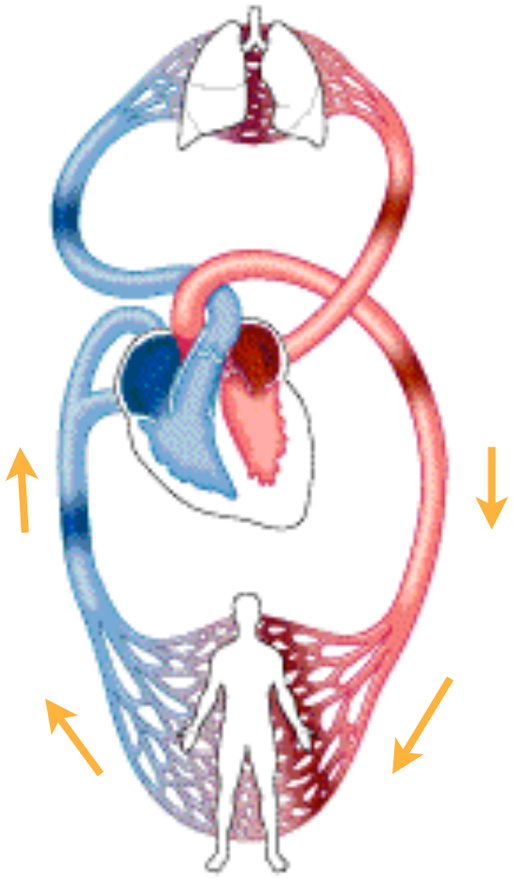
若沒上傳成功，到底會是什麼問題勒？

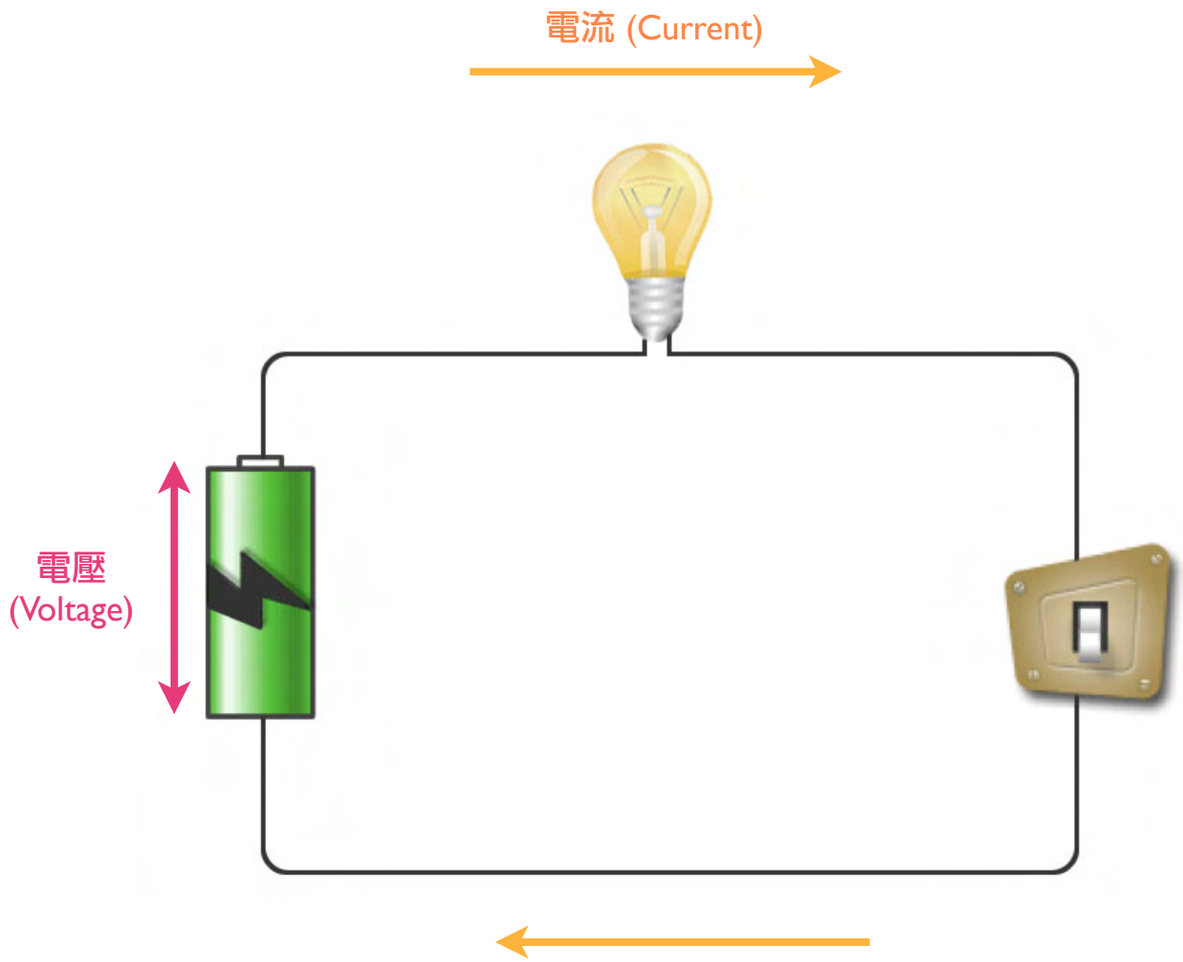
- 檢查你是否選擇正確的板子與Serial port，重新設定一次。
- 語法有問題，修正語法後就可以了。
- Serial Port 正被佔用中，關掉其他正在用此Serila port的程式
- 板子正在瘋狂忙碌中，按住板子上的Reset，使其初始化，然後在放開Reset時，馬上按下軟體端的Update。
- 所接的電路使得Arudino負載過高，自動保護斷掉USB。
- 很不太可能的是，你的板子或傳輸線壞了。

You should know.....

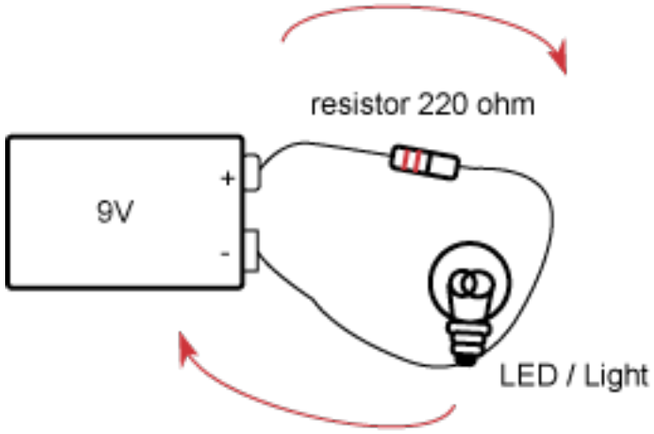
What is the circuit ?

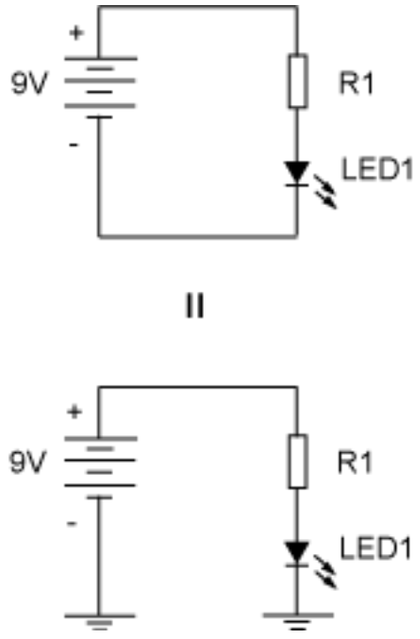
到底什麼是電路？

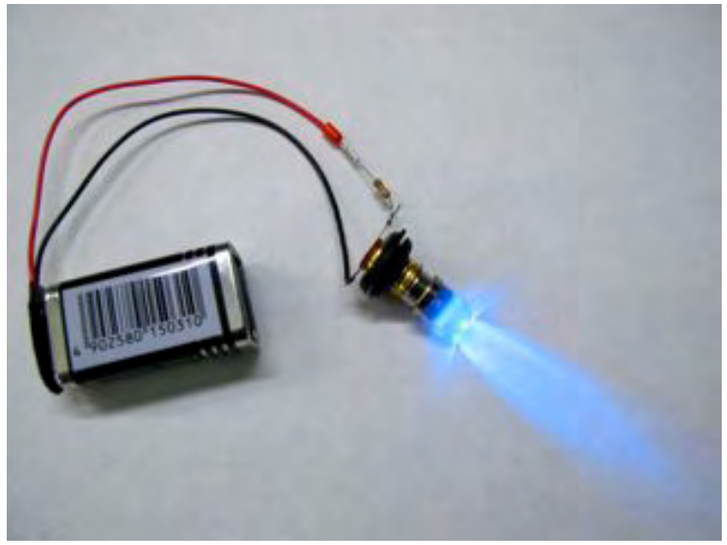




亮燈的基本電路





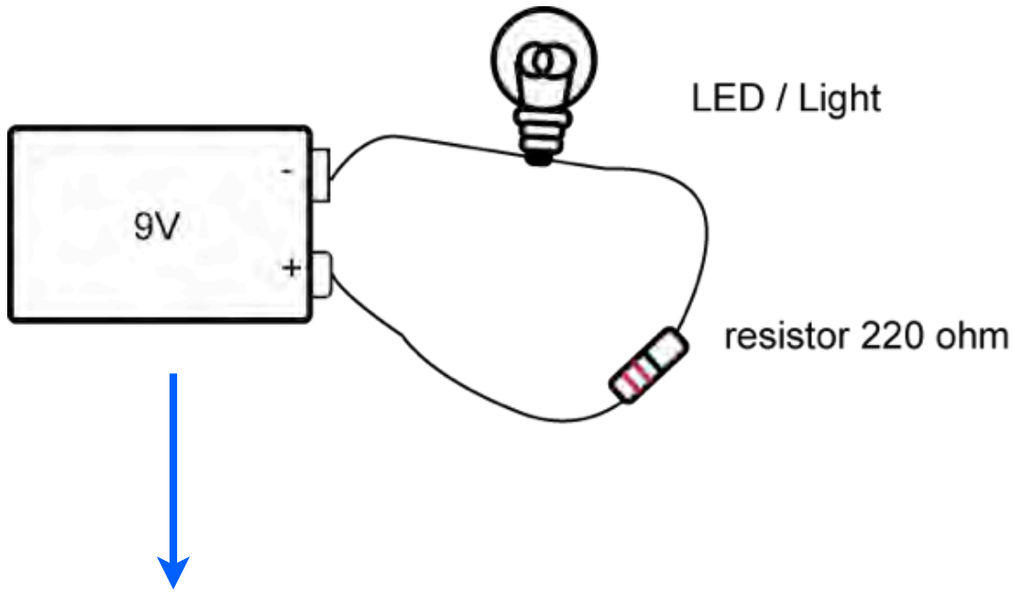


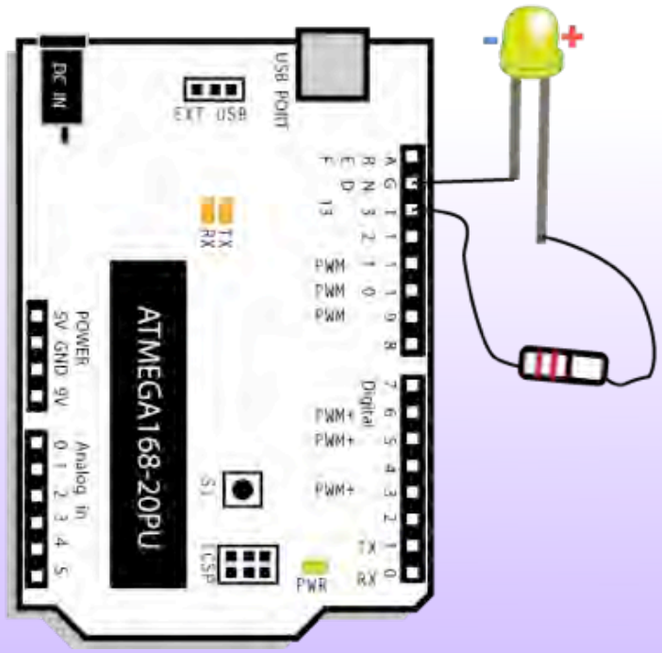
線路示意圖　　電路圖　　實作此電路

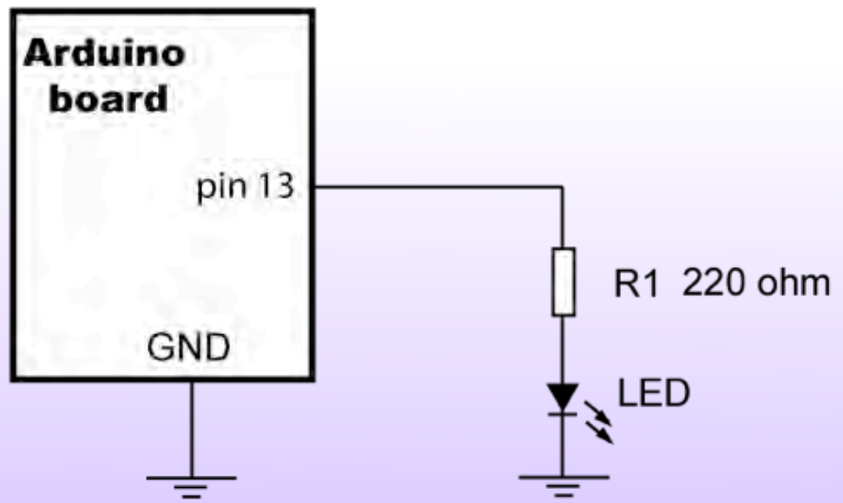
- 一個電路可視為一個迴圈，若要停止，則只要將電路形成斷路即可。

- 任何的LED線路都是由此延伸的：電源、LED、電流限制元件(此為電阻)。
- 給更大的電阻，讓經過LED的電流變小，則亮度也會減小；反之，電阻較小，則亮度變大。
- 同樣的道理，給的電越大，LED也會越亮(前提是不燒掉)。

Digital Outupt Circuit

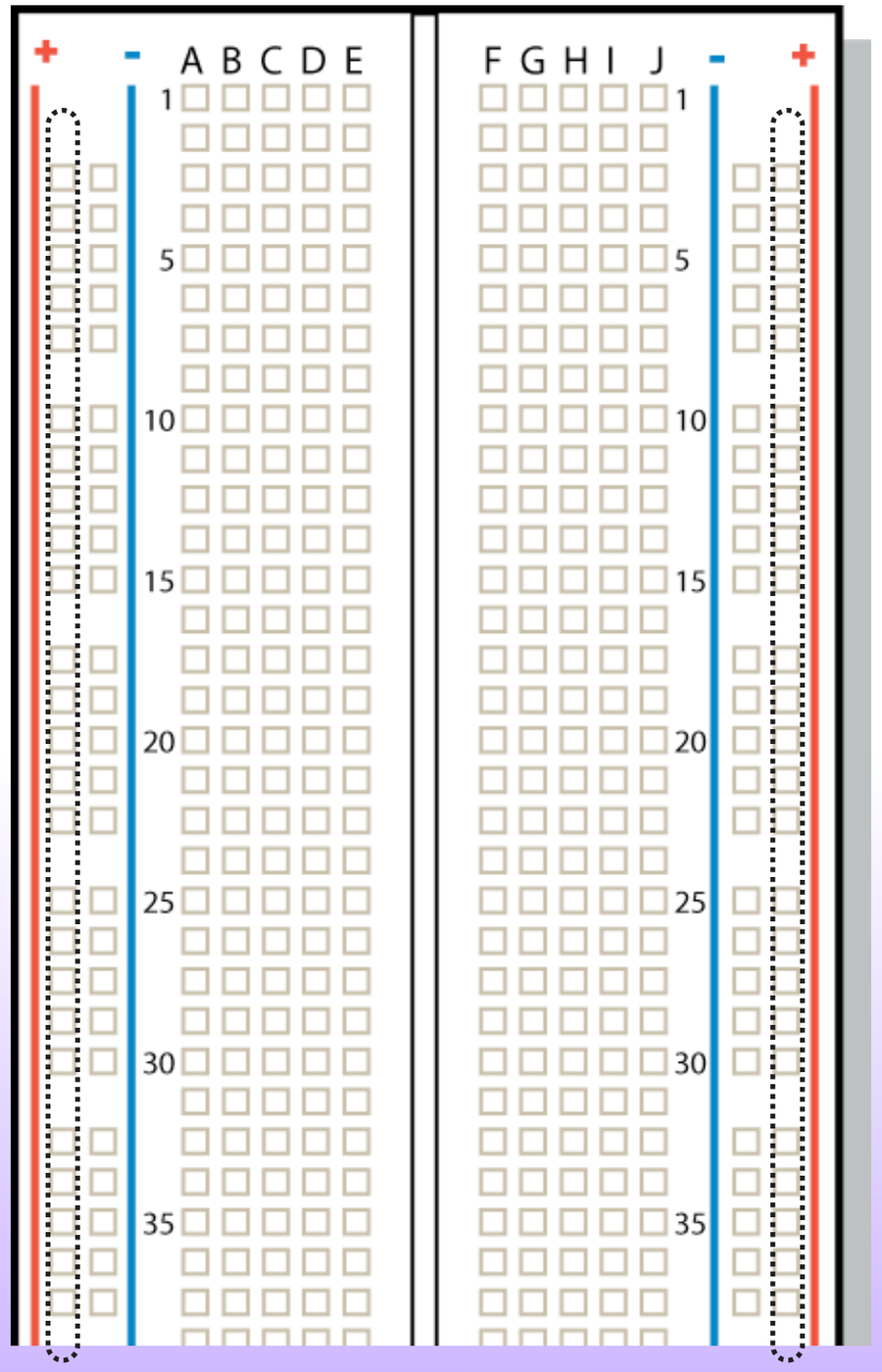




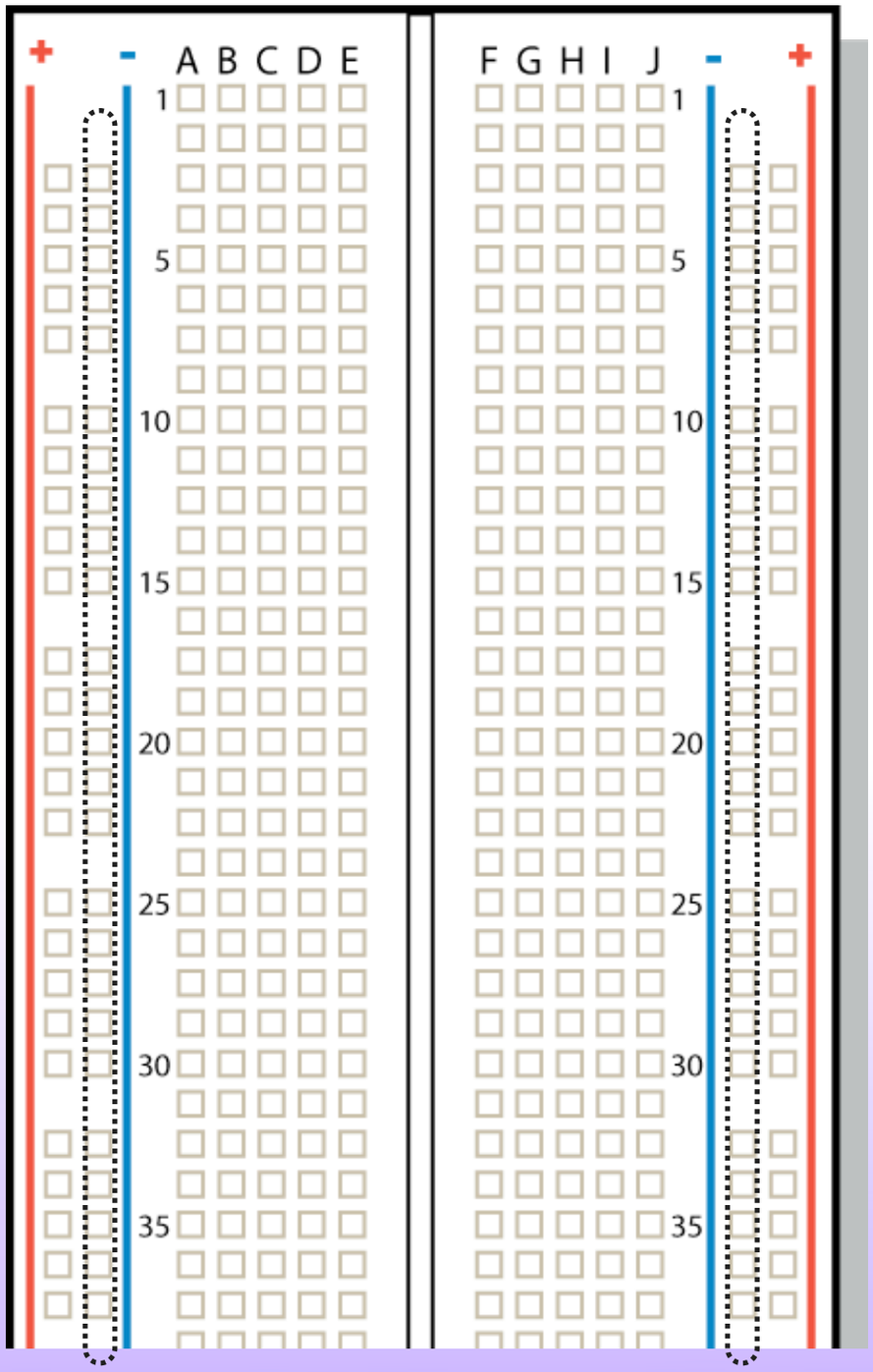


Arduino的Digital Out，一般High為 5V、LOW為 0V

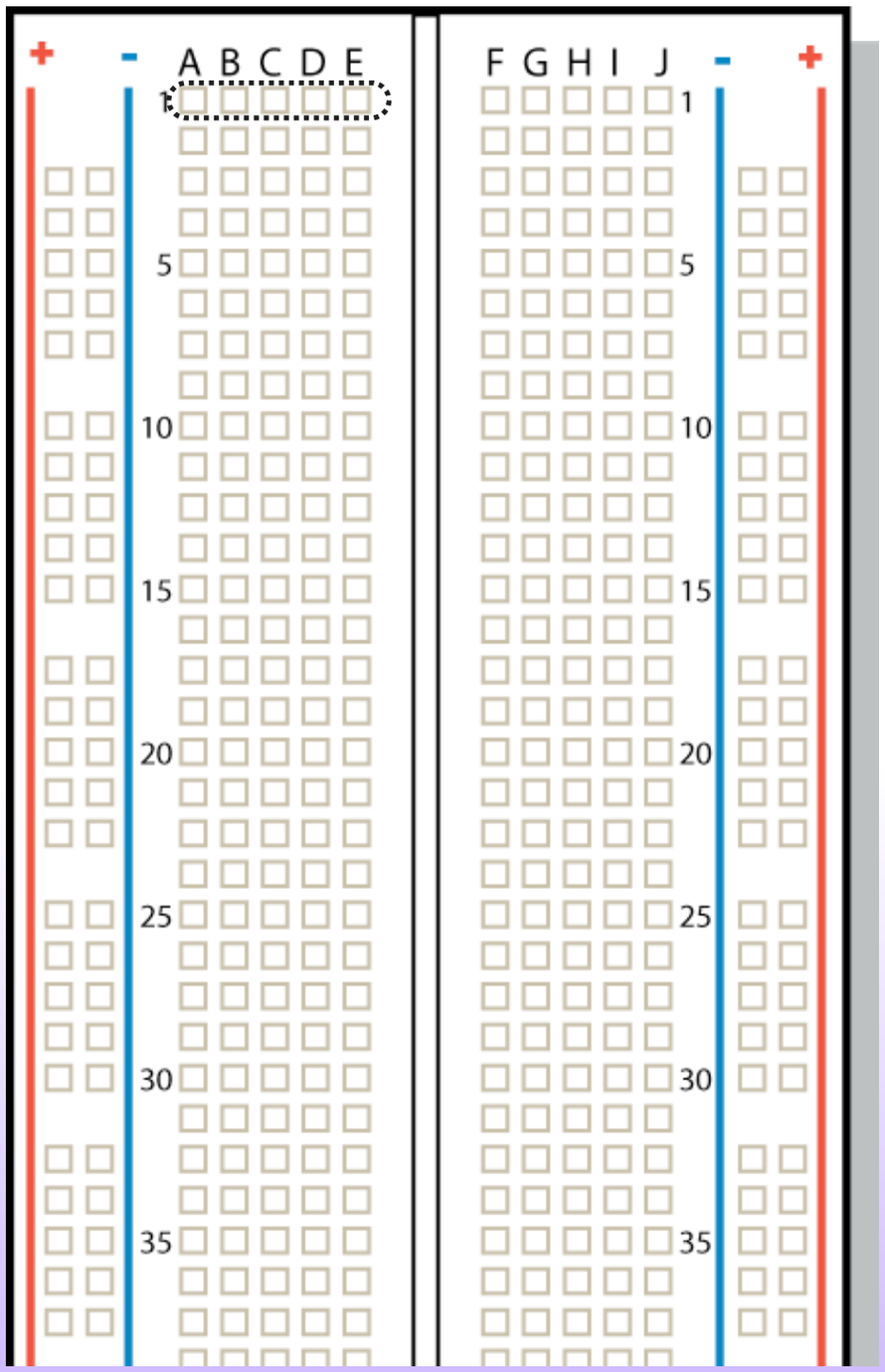
breadboard



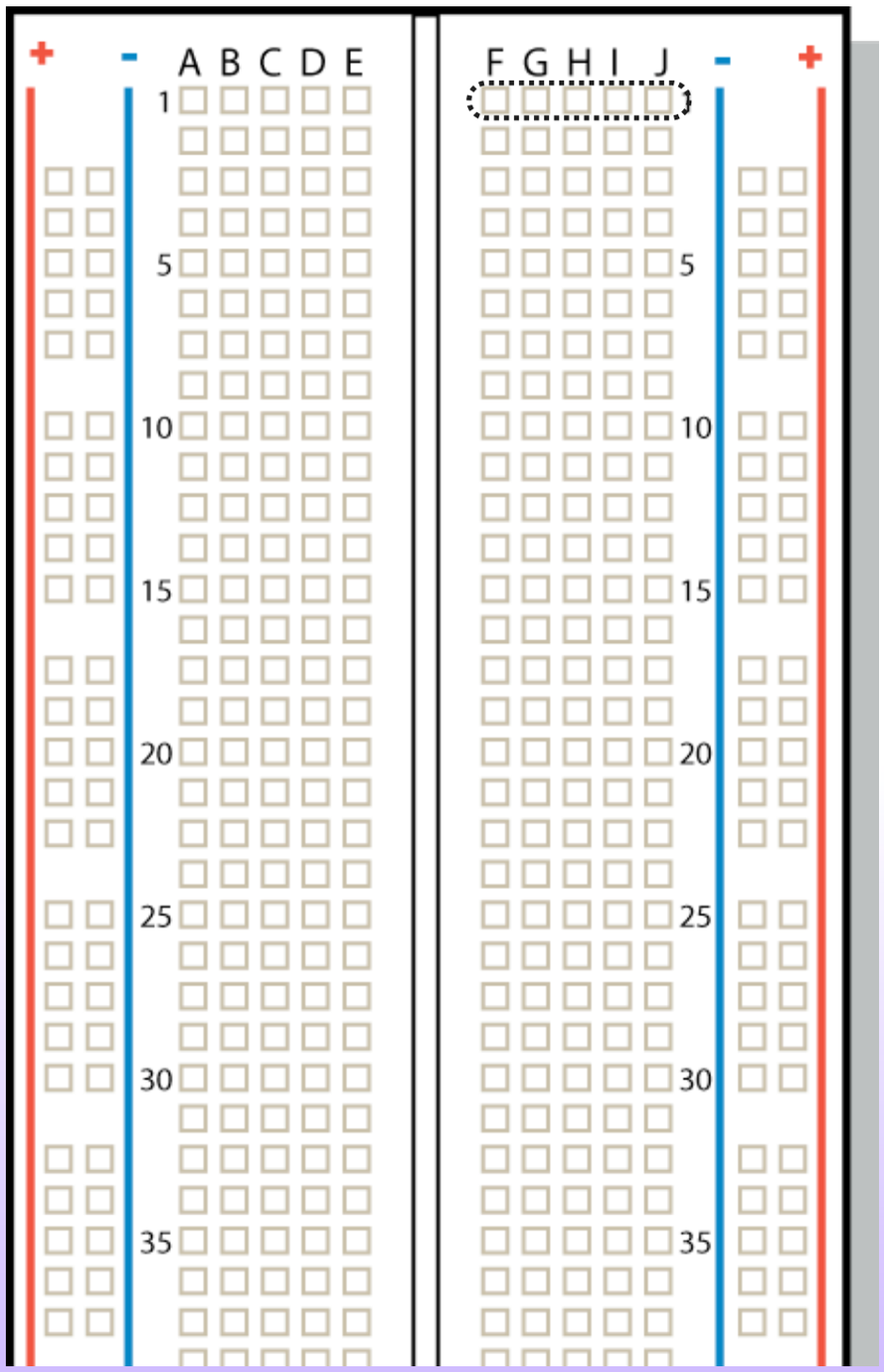
breadboard



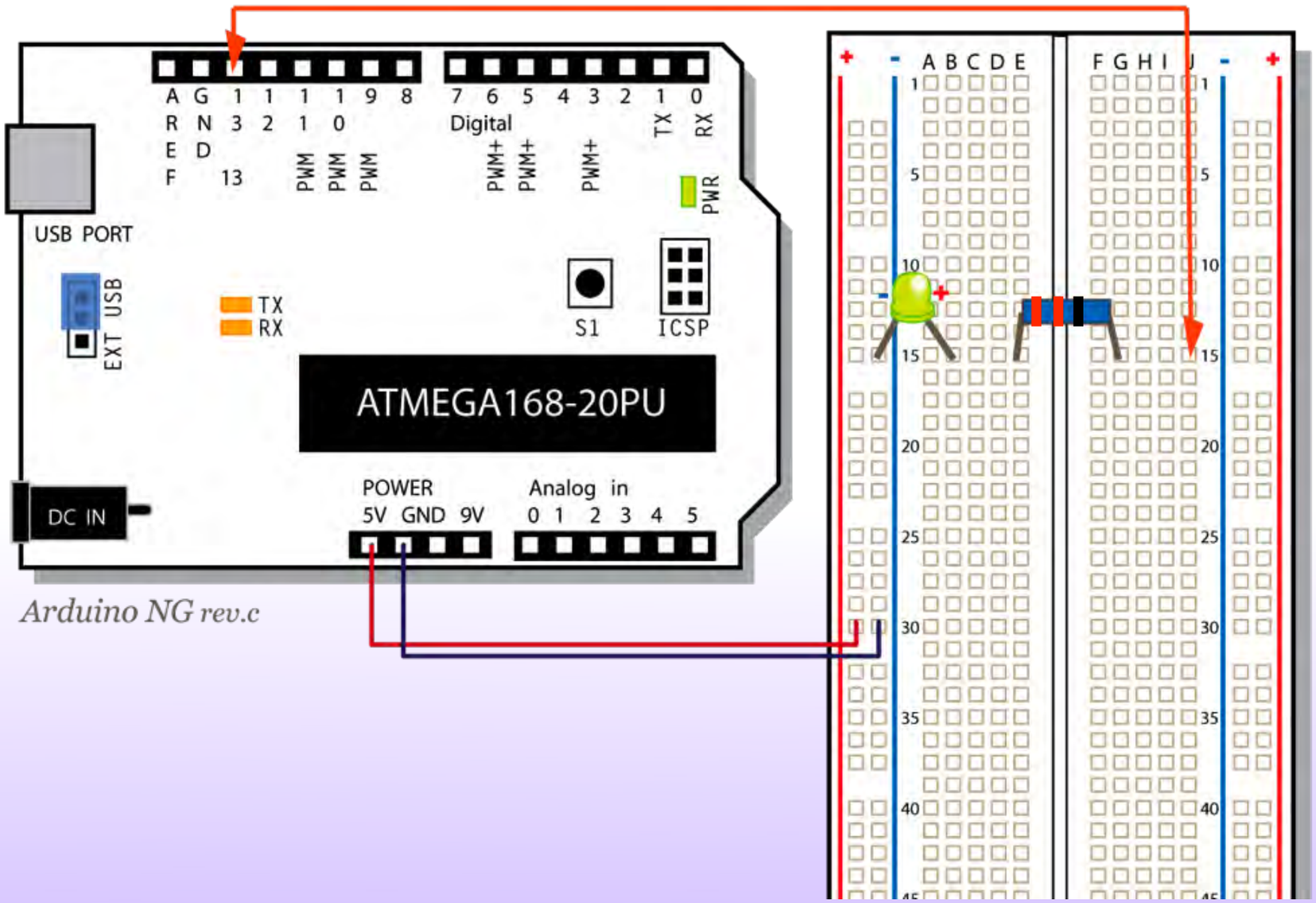
breadboard



breadboard



Blink



Arduino NG rev.c

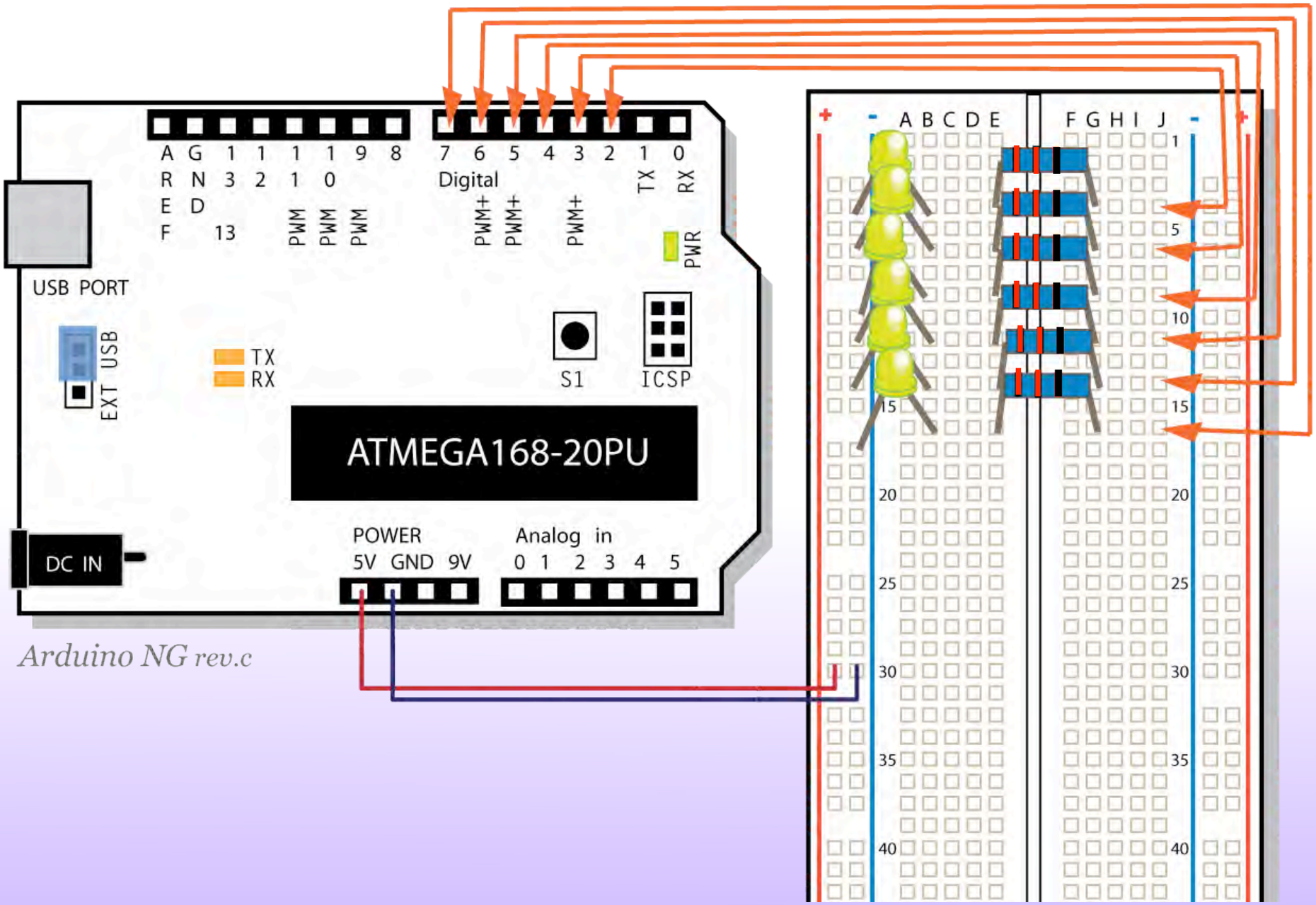
Blink

```
int ledPin = 13;                  // LED connected to digital pin 3

void setup()
{
  pinMode(ledPin, OUTPUT);        // sets the digital pin as output
}

void loop()
{
  digitalWrite(ledPin, HIGH);     // sets the LED on
  delay(1000);                    // waits for a second
  digitalWrite(ledPin, LOW);      // sets the LED off
  delay(1000);                    // waits for a second
}
```

pinMode(pin, Mode)　　digitalWrite(pin, value)　　delay(ms)

Blink的練習程式，在 File > Sketchbooks > Digital > Blink

Loop



Arduino NG rev.c

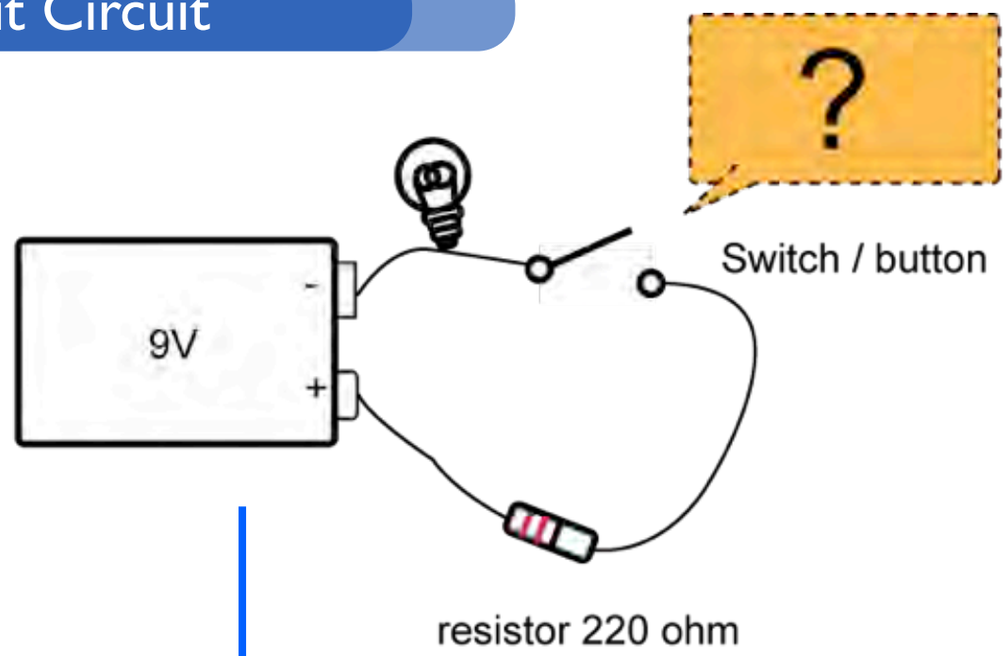
Loop

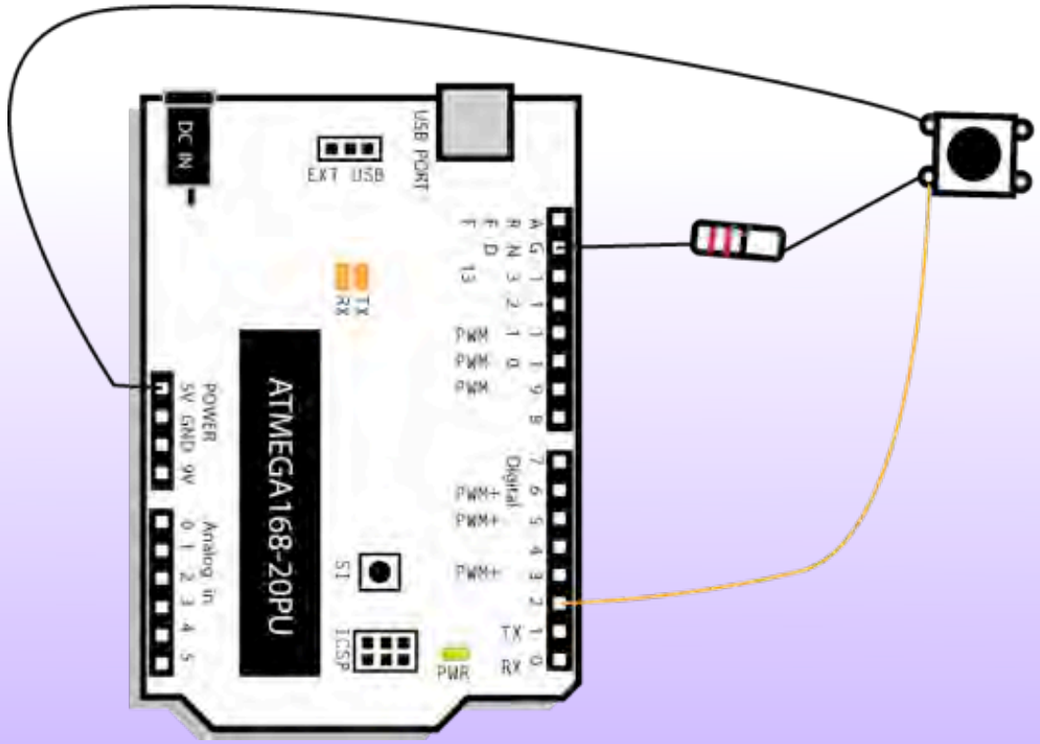
```
int timer = 100;                          // The higher the number, the slower the timing.
int pins[] = { 2, 3, 4, 5, 6, 7 };        // an array of pin numbers
int num_pins = 6;                         // the number of pins (i.e. the length of the array)

void setup()
{
  int i;

  for (i = 0; i < num_pins; i++) {        // the array elements are numbered from 0 to num_pins - 1
    pinMode(pins[i], OUTPUT);             // set each pin as an output
  }
}

void loop()
{
  int i;

  for (i = 0; i < num_pins; i++) {        // loop through each pin...
    digitalWrite(pins[i], HIGH);          // turning it on,
    delay(timer);                         // pausing,
    digitalWrite(pins[i], LOW);           // and turning it off.
  }
  for (i = num_pins - 1; i >= 0; i--) {
    digitalWrite(pins[i], HIGH);
    delay(timer);
    digitalWrite(pins[i], LOW);
  }
}
```

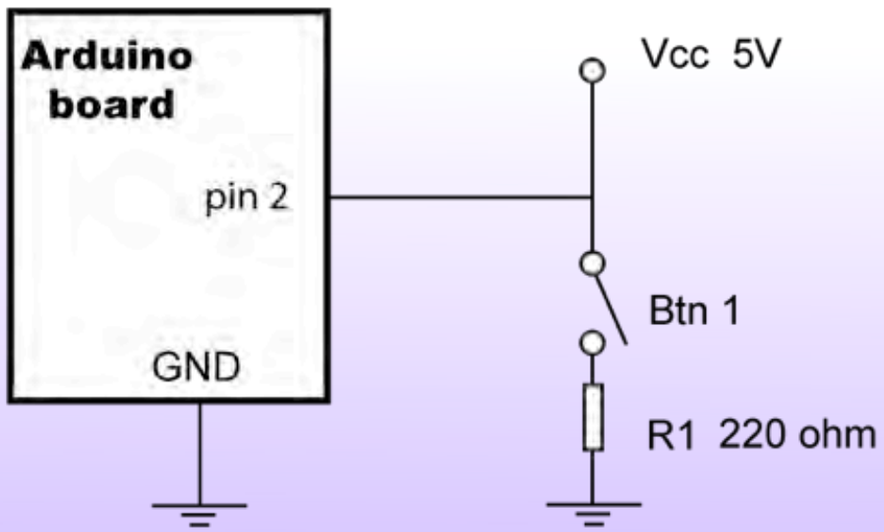
Array[ ]　　for(　;　;　)

Blink的練習程式，在 File > Sketchbooks > Digital > Loop

Digital Input Circuit







Arduino的Digital Out，一般High為 5V、LOW為 0V

Arduino
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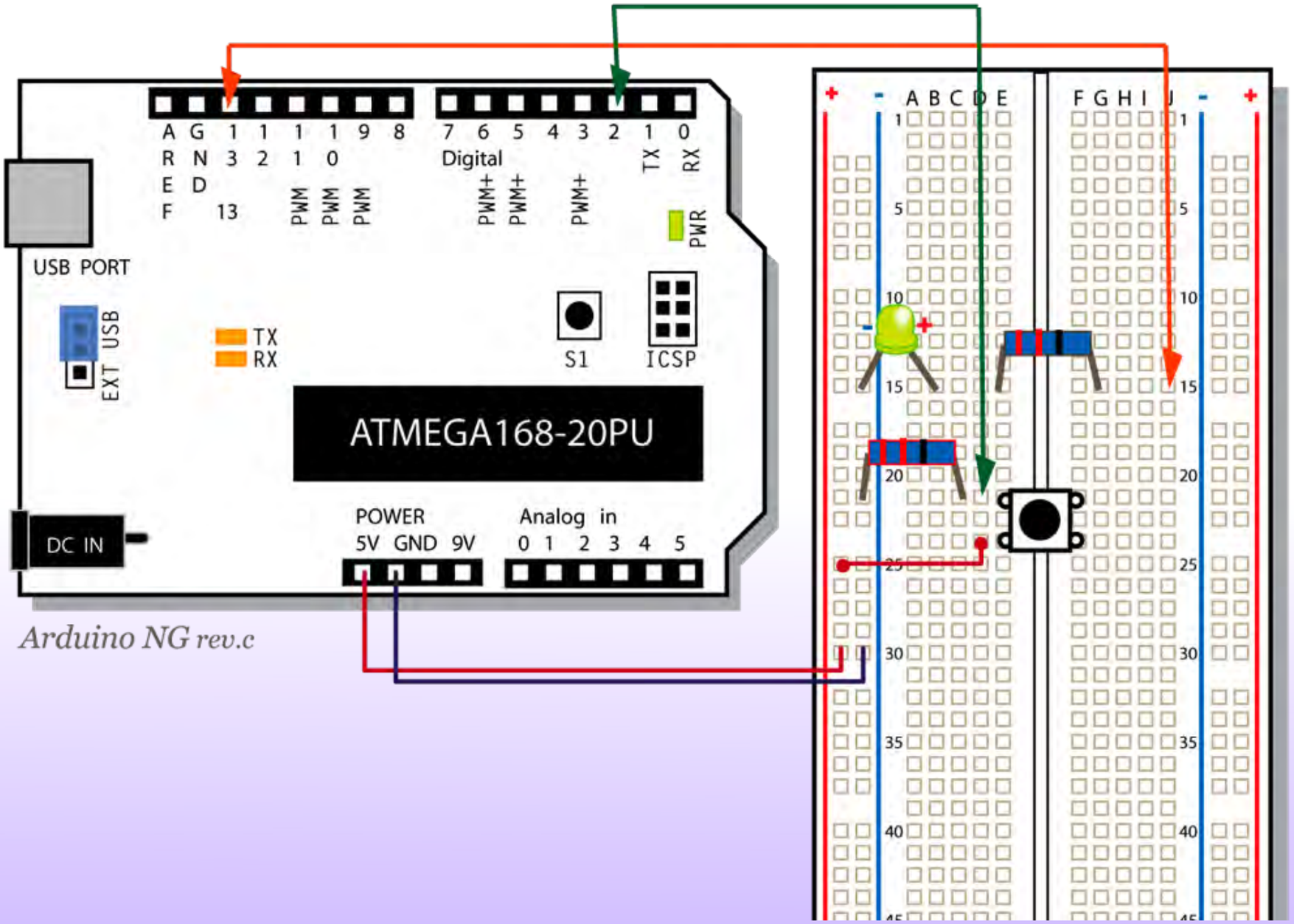
Button



Arduino NG rev.c

Button

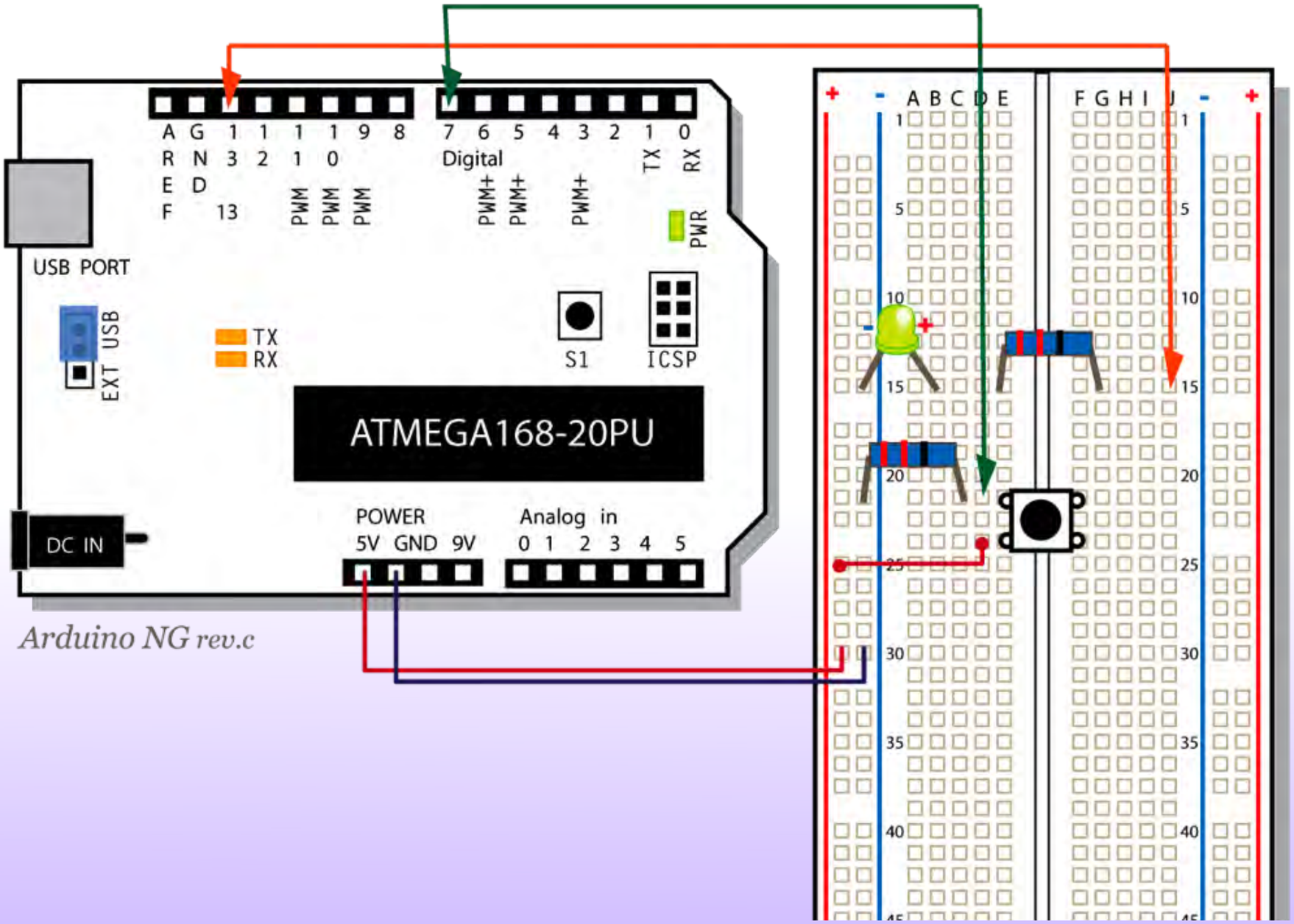
```
int ledPin = 13;                  // choose the pin for the LED
int inputPin = 2;                 // choose the input pin (for a pushbutton)
int val = 0;                      // variable for reading the pin status

void setup() {
  pinMode(ledPin, OUTPUT);        // declare LED as output
  pinMode(inputPin, INPUT);       // declare pushbutton as input
}

void loop(){
  val = digitalRead(inputPin);    // read input value
  if (val == HIGH) {              // check if the input is HIGH
    digitalWrite(ledPin, LOW);    // turn LED OFF
  } else {
    digitalWrite(ledPin, HIGH); // turn LED ON
  }
}
```

digitalRead(pin)

Blink的練習程式，在 File > Sketchbooks > Digital > Button

Arduino
Let's Interacting in Arduino

Debounce



Arduino NG rev.c

Debounce

```
int inPin = 7;          // the number of the input pin
int outPin = 13;        // the number of the output pin

int state = HIGH;       // the current state of the output pin
int reading;            // the current reading from the input pin
int previous = LOW;     // the previous reading from the input pin

long time = 0;          // the last time the output pin was toggled
long debounce = 200;    // the debounce time, increase if the output flickers

void setup()
{
  pinMode(inPin, INPUT);
  pinMode(outPin, OUTPUT);
}

void loop()
{
  reading = digitalRead(inPin);

  if (reading == HIGH && previous == LOW && millis() - time > debounce) {
    // ... invert the output
    if (state == HIGH)
      state = LOW;
    else
      state = HIGH;

    // ... and remember when the last button press was
    time = millis();
  }

  digitalWrite(outPin, state);

  previous = reading;
}
```

millis()

Blink的練習程式，在 File > Sketchbooks > Digital > Debounce

Digital Input & Output

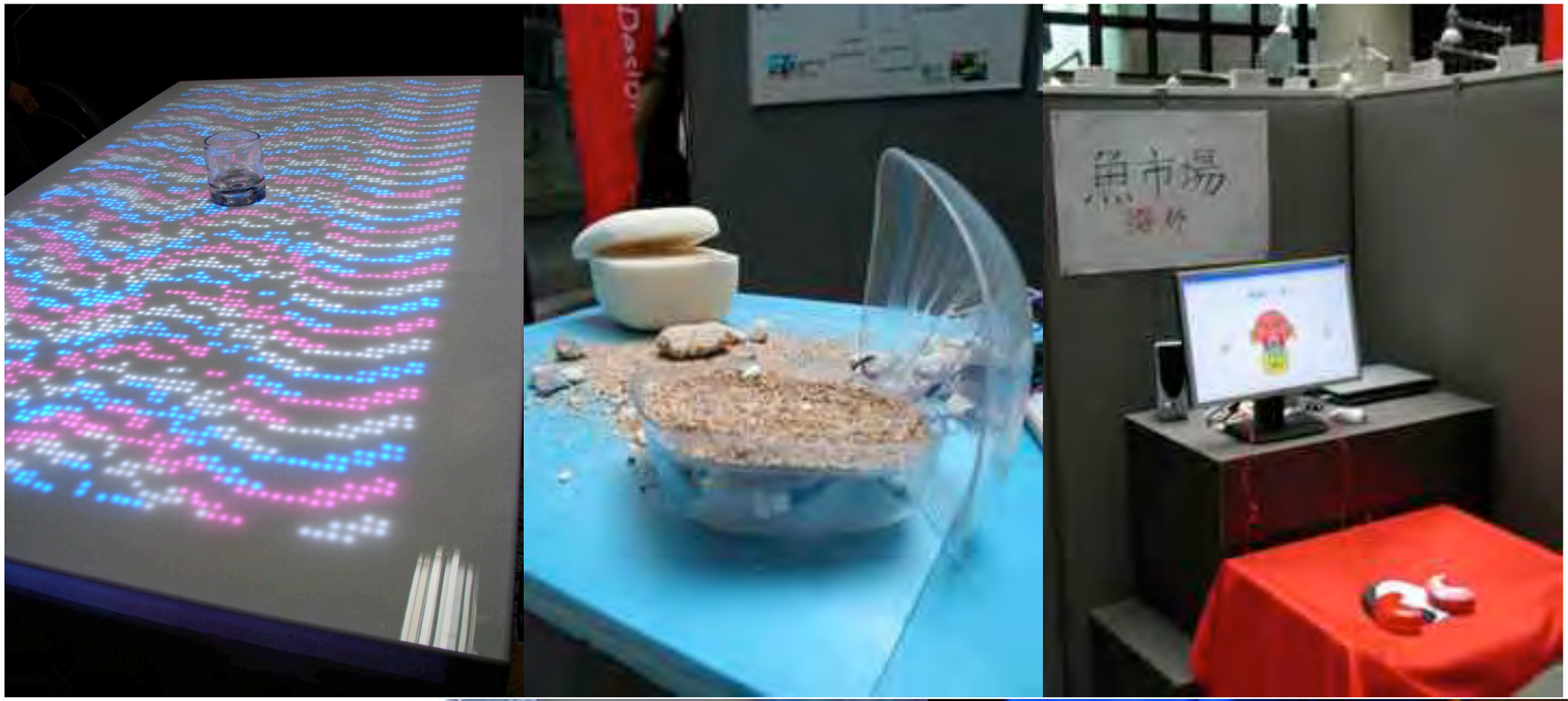


Fig. 2& 3 via IDCID 2007 workshop

Reference

Web:

• Arduino官網	http://www.arduino.cc/
• Arduino Playground	http://www.arduino.cc/playground/
• Arduino 樂園	http://arduino.tw/
• MSM	http://203.68.163.135/msm/
• DesignLab	http://designlab.tw/
• ITP Physical Computing	http://itp.nyu.edu/physcomp/
• sparkfun ELECTRONICS	http://www.sparkfun.com/
• Adafruit Industries	http://www.adafruit.com/
• Thinkerlog	http://tinkerlog.com/

Book:

• Pysical Computing: Sensing and Controlling the Physical World with Computer, Tom Iqoe & Dan O'Sullivan. (2004)

• 圖解電氣迴路, 稻見辰夫 & 稻見昌彥 著, 宋家豪 & 陳曉梅 譯. (2006)

Arduino

Let's Interacting in Arduino

[Class 2]

April 15 2008 , MAO

what’s for Today?

- **模擬現實？**
  ～ Analog Input & Output

- **電腦的介入～**
  ～ Communication: Computer ⇄ Arduino

- Flash？！
  ～ Tools help the Arduino talk with Flash.

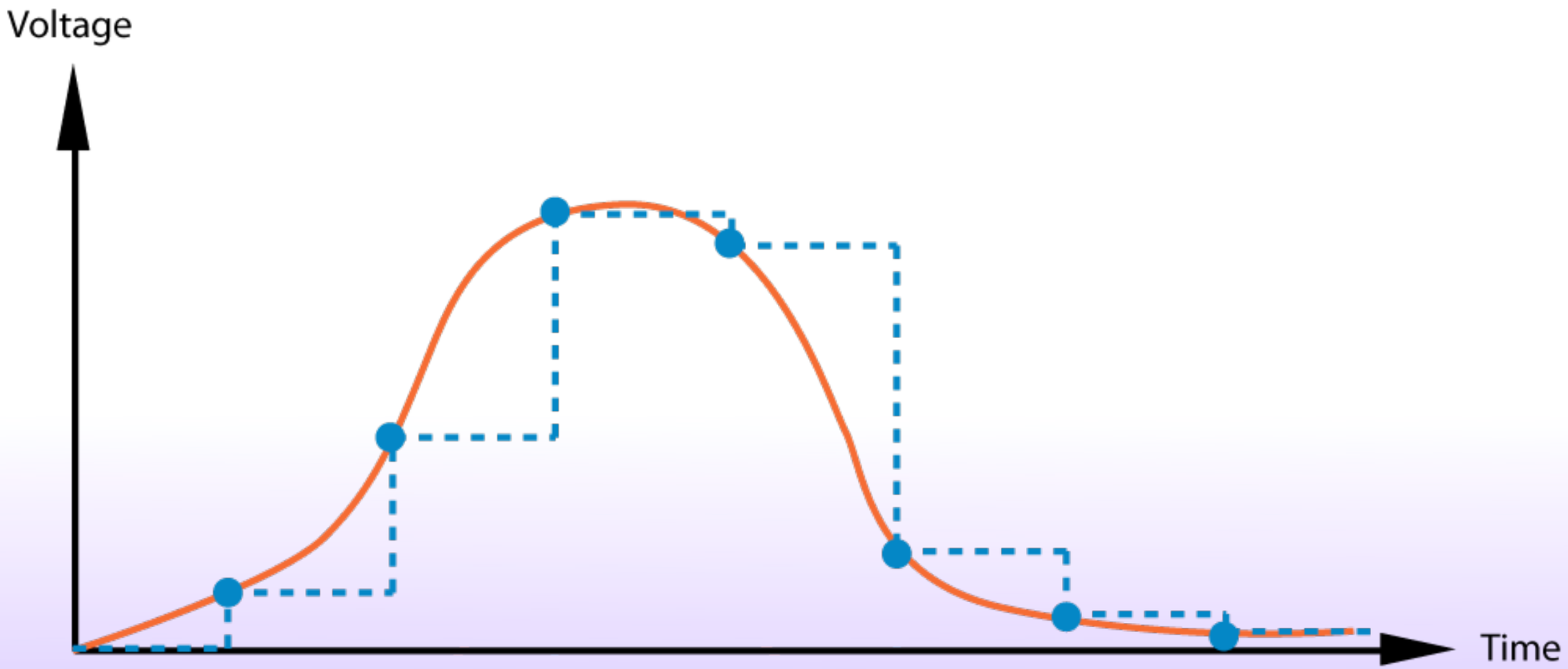
先到http://wiki.arch.nctu.edu.tw/Arduino/Arduino 下載今天所要用到的上課檔案。

Analog

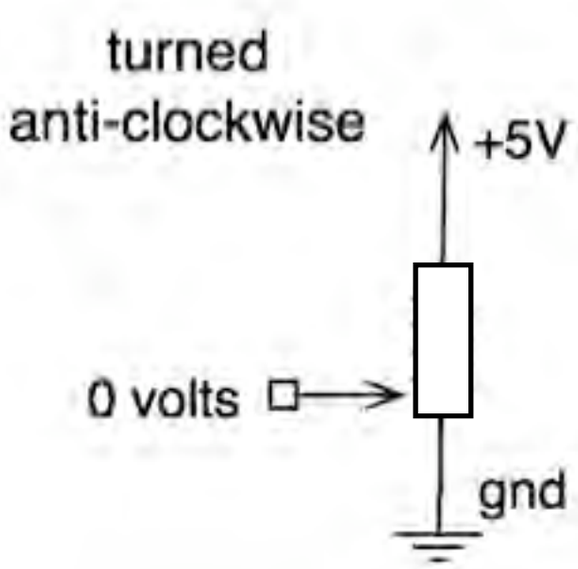
What is Analog ?

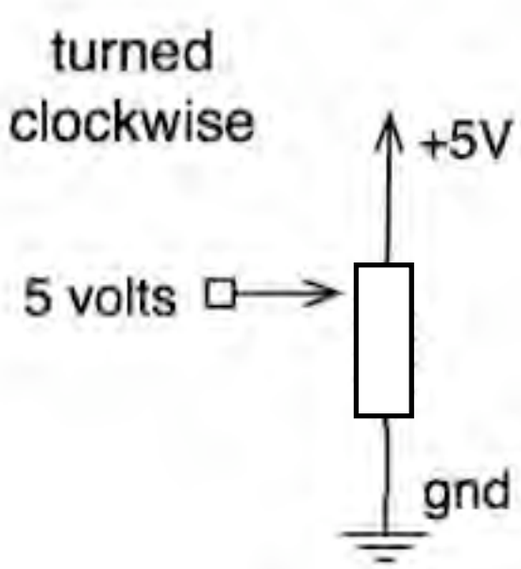
Image via http://www.gearfuse.com/digital-clock-is-all-hands-no-face/

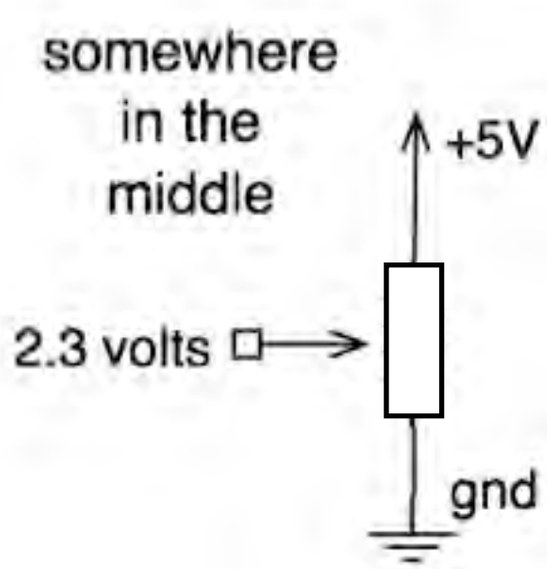
Analog Input



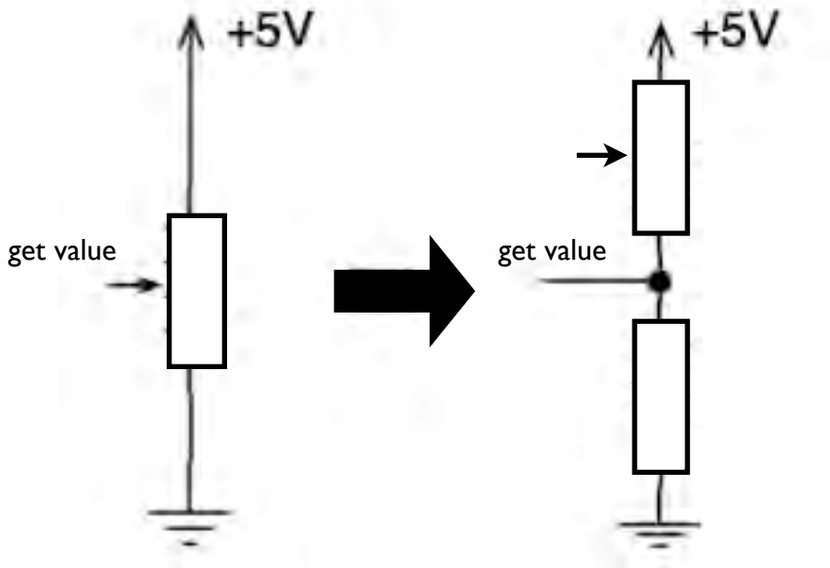
Potentiometer

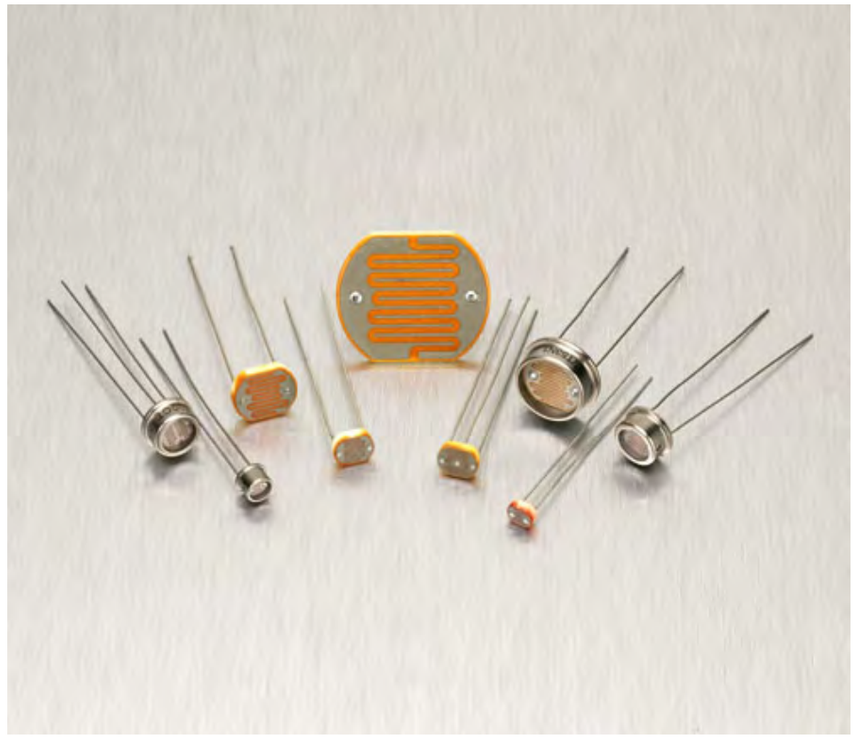


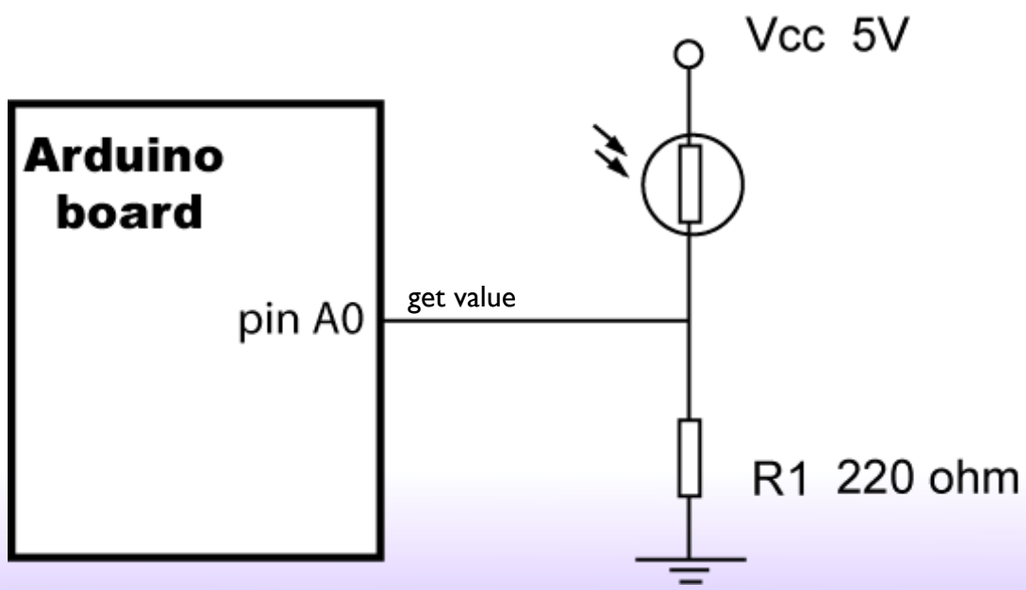




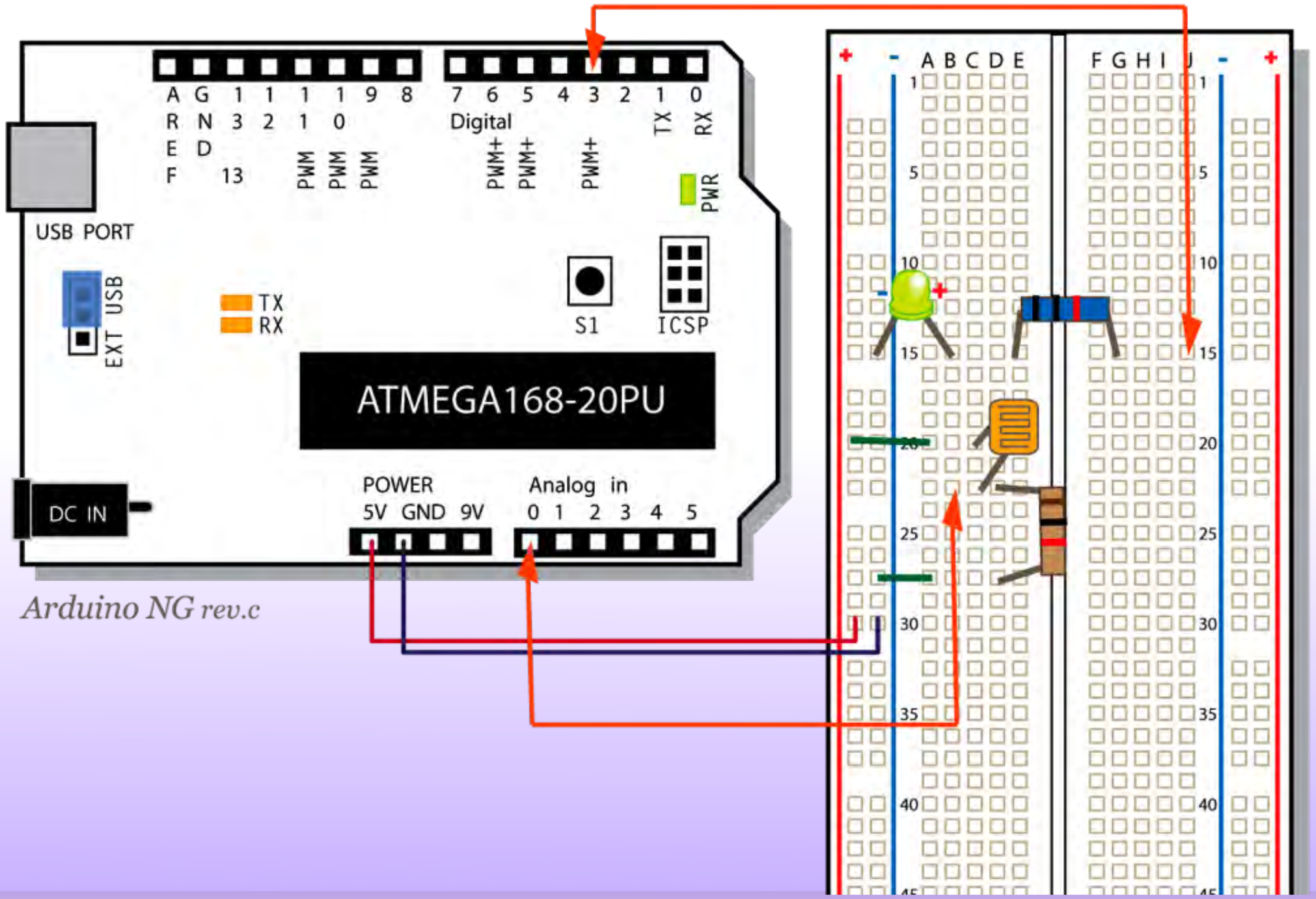
Photocell


+5V
get value
+5V
get value




Vcc 5V
Arduino board
pin A0
get value
R1 220 ohm

Analog Input



Arduino NG rev.c

Analog Input

```
int ledPin = 3;                    // LED connected to digital pin 2
int analogPin = 0;                    // photocell connected to analog pin 0
int val = 0;

void setup()
{
  pinMode(ledPin, OUTPUT);         // sets the digital pin as output
}

void loop()
{
  val = analogRead(analogPin);        // read the value from the sensor
  if(val<80) {
     digitalWrite(ledPin, HIGH);  // sets the LED on
  }
  else {
     digitalWrite(ledPin, LOW);   // sets the LED off
  }
  delay(50);
}
```

analogRead(pin)　　if...else...

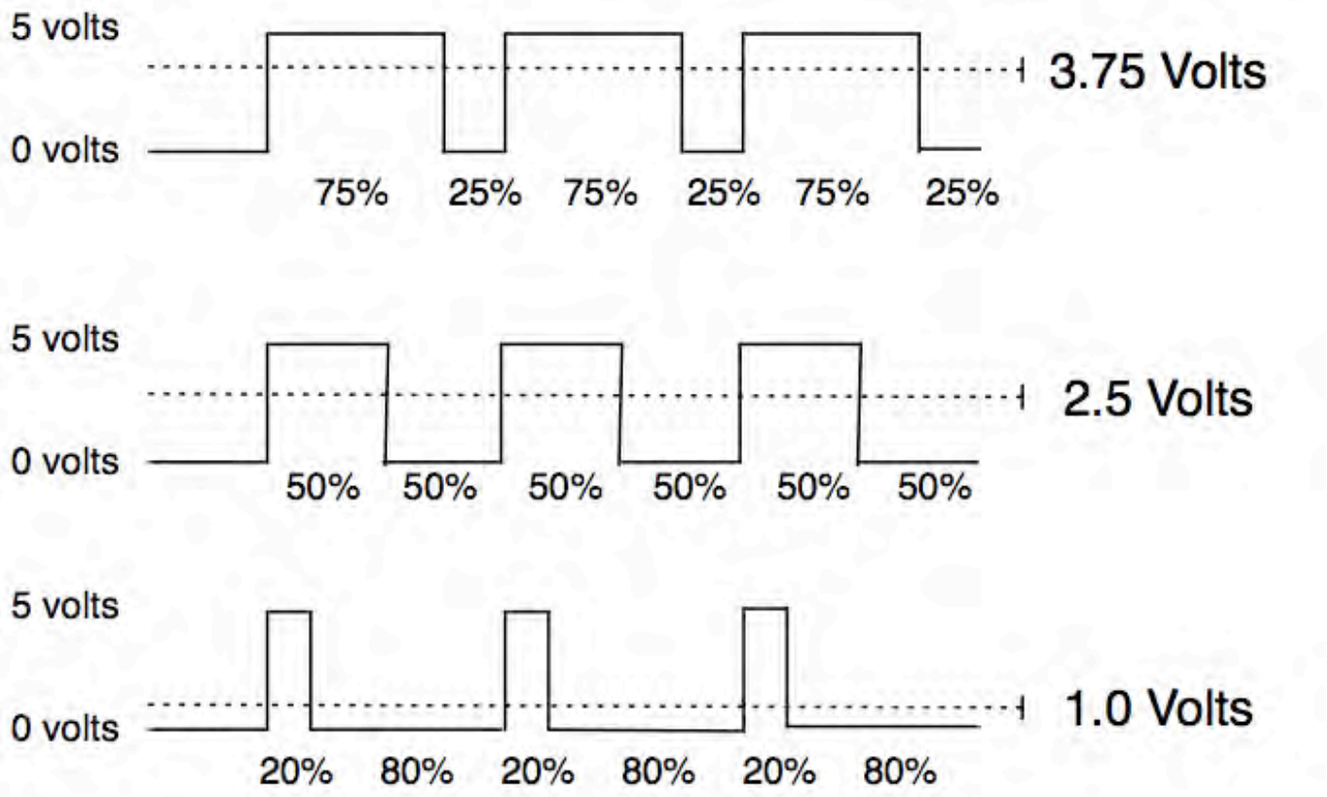
Arduino的Analog Input的值介於0~1023

PWM (Pulse Width Modulation)

電腦與微處理器是不可能實際輸出類比的電壓(僅能0~5V)。

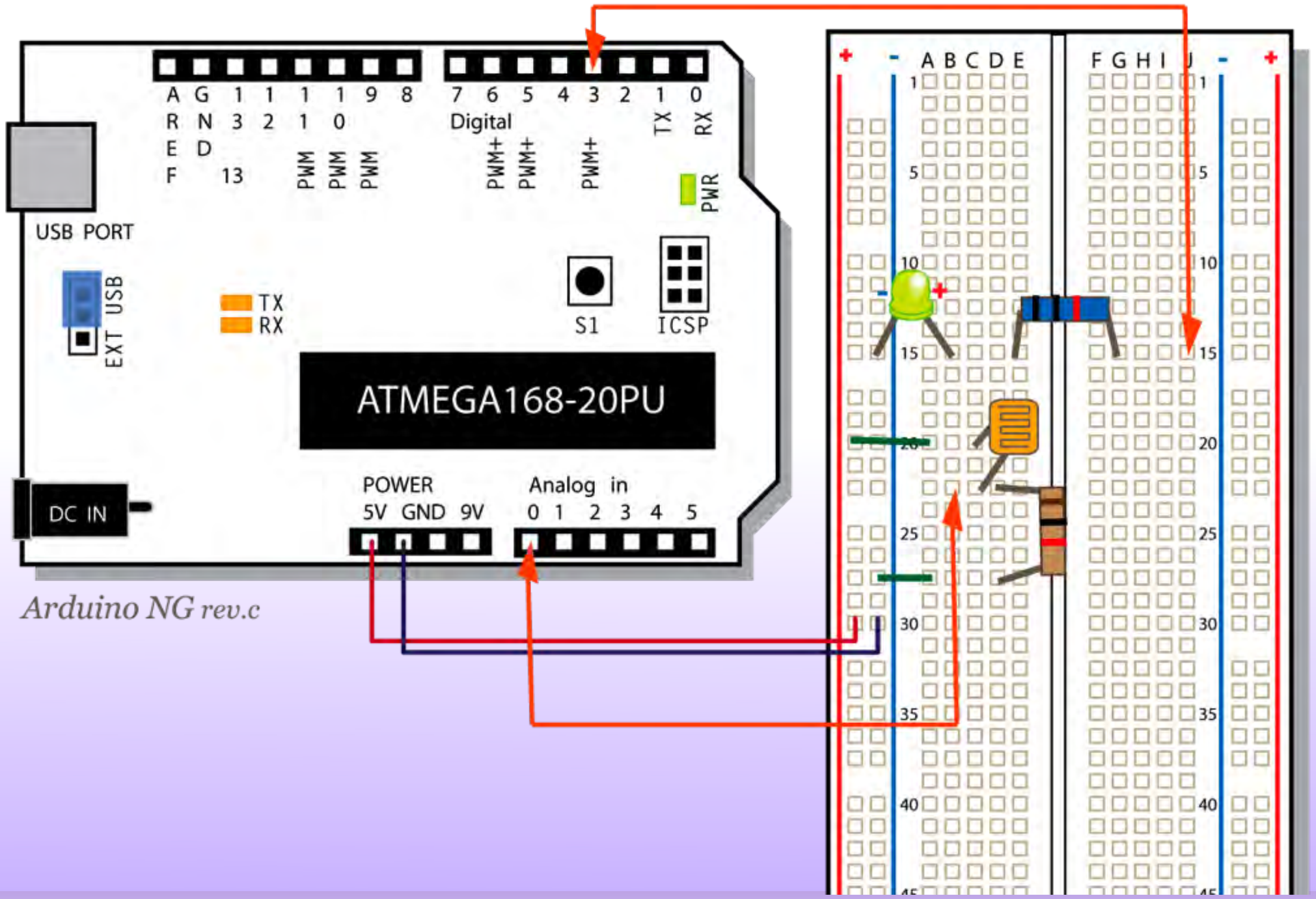
但我們可以假造出類似的效果。
若快速在兩個電壓中做切換，我們可以得到一個平均值：

Output Voltage = High_time(%) * Max_Voltage



Arduino 的PWM pin只有3,5,6,9,10,11

Analog Output



Arduino NG rev.c

Analog Output

```
int ledPin = 3;                    // LED connected to digital pin 2
int analogPin = 0;                    // photocell connected to analog pin 0
int val = 0;

void setup()
{
  pinMode(ledPin, OUTPUT);         // sets the digital pin as output
}

void loop()
{
  val = analogRead(analogPin);          // read the value from the sensor
  analogWrite(ledPin, val/4);        // set the output value 0~255
  delay(50);
}
```

analogWrite(pin)

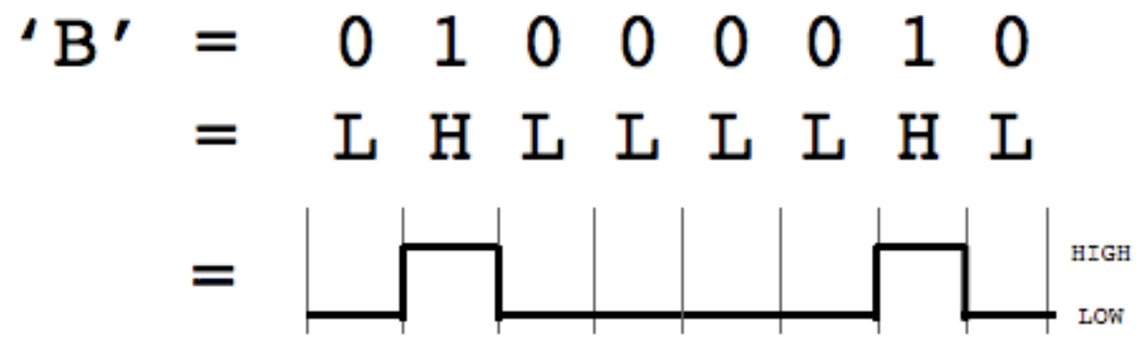
Arduino的Analog Output的值介於0~255

Communication

Serial

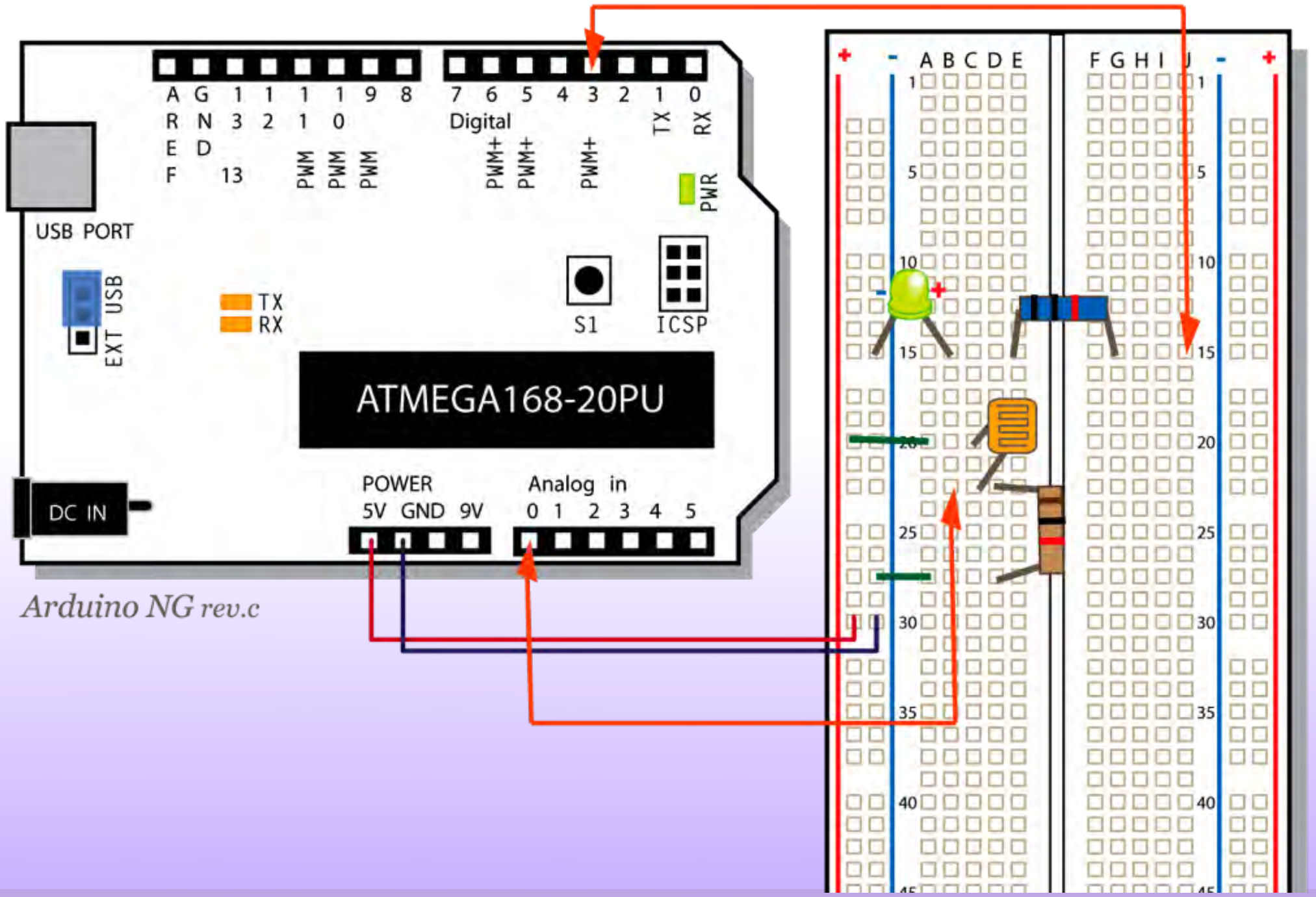
Arduino 並不是真的透過USB來跟電腦溝通，而是透過RS-232 Serial的方式。

透過一連串HIGH / LOW的編碼訊號，可以轉換成我們要的訊息：



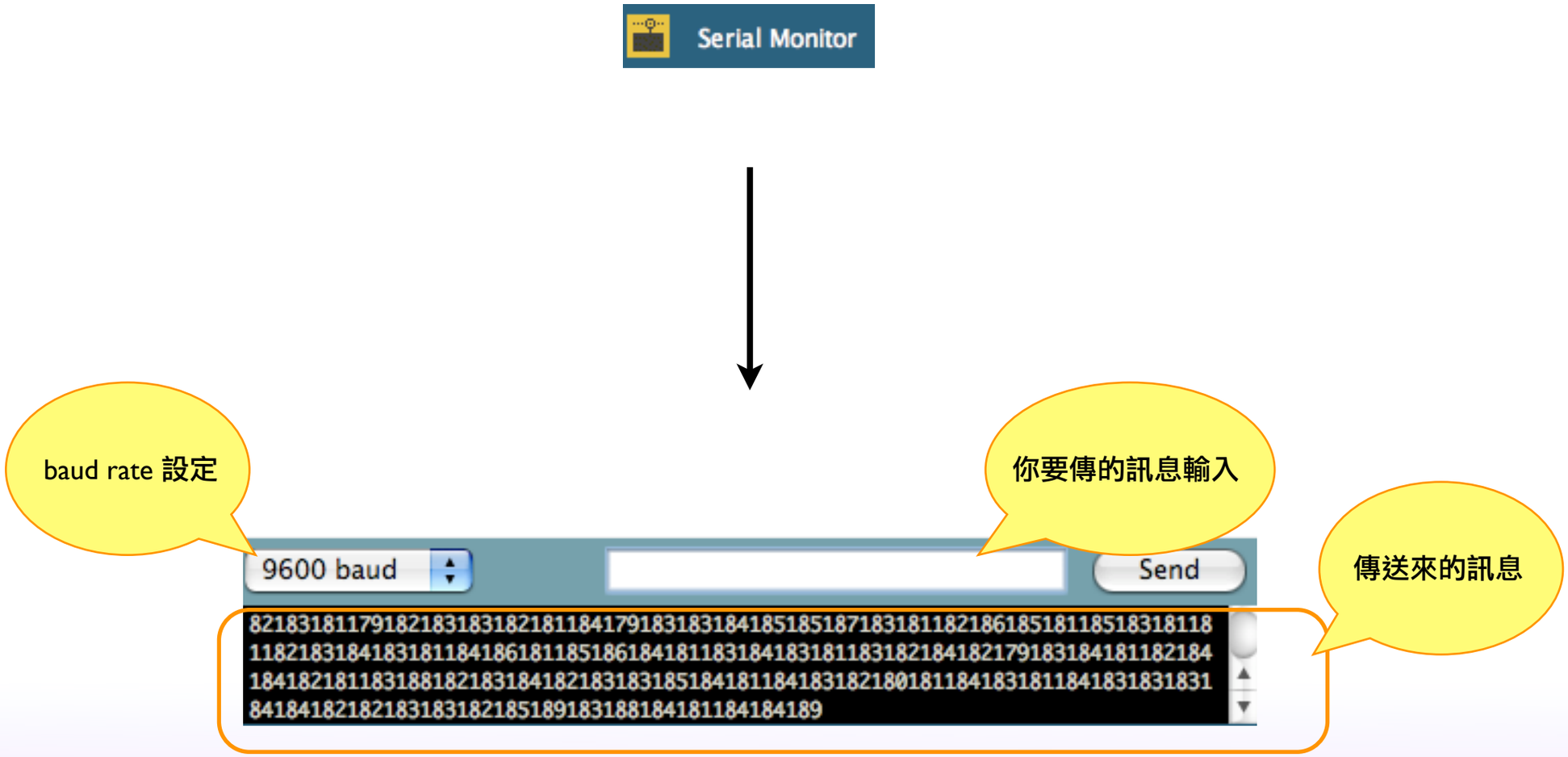
不論電腦端用什麼軟體，只要能透過Serial port傳送訊息，就可以跟Arduino溝通。
故我們可以用 C/C++, VB, MAX/MSP, VVVV, Processing 或是FLASH(需要第三方軟體的幫助)

Arduino → Computer



Arduino NG rev.c

Arduino → Computer



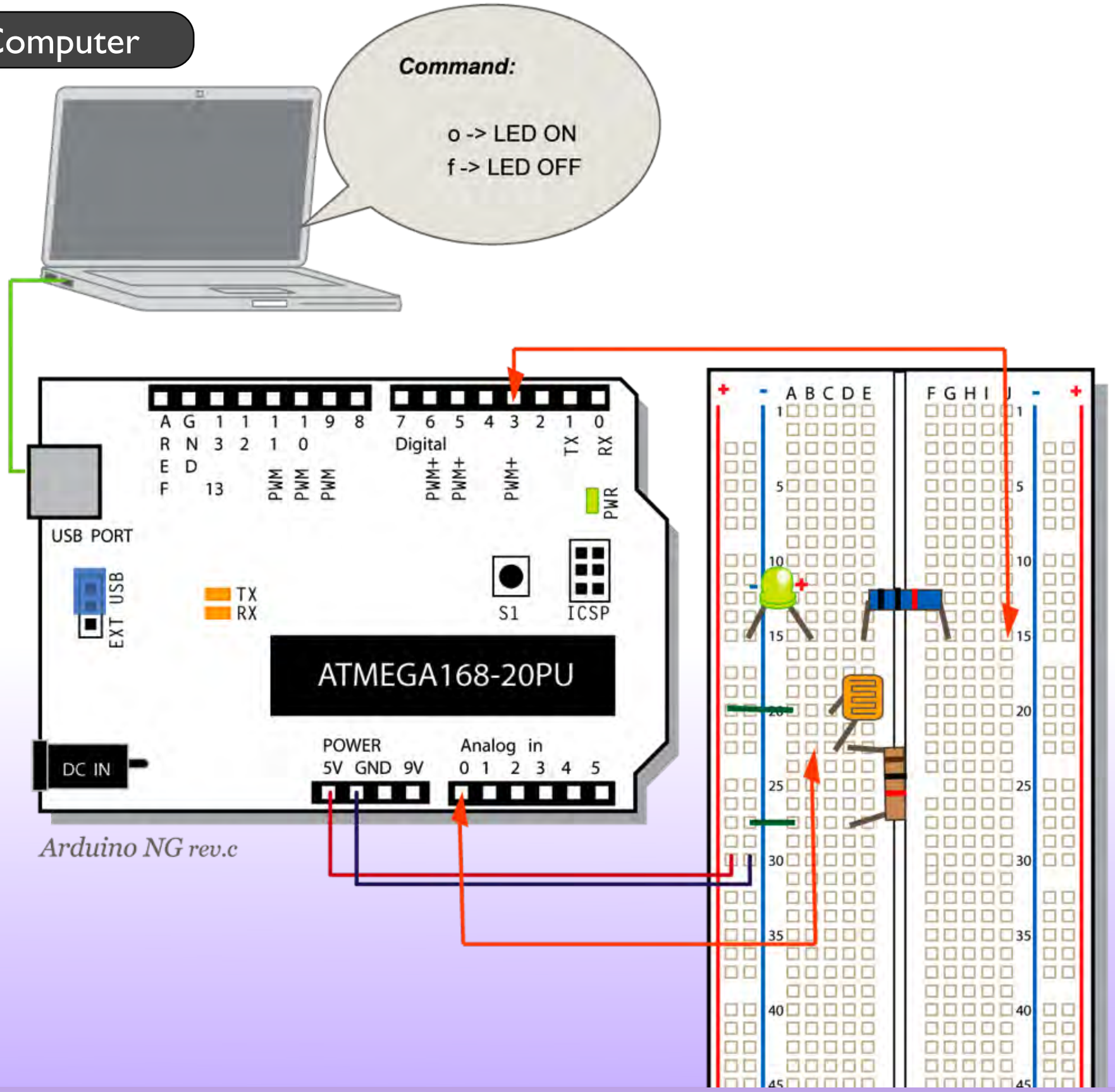
我們可以先用Arduino Software提供的Serial Monitor來先測試Arduino板子端是否運作正確。

Arduino → Computer

```
int ledPin = 3;                    // LED connected to digital pin 2
int analogPin = 0;                    // photocell connected to analog pin 0
int val = 0;

void setup()
{
  pinMode(ledPin, OUTPUT);         // sets the digital pin as output
  Serial.begin(9600);
}

void loop()
{
  val = analogRead(analogPin);        // read the value from the sensor

  Serial.println(val);

  analogWrite(ledPin, val/4);       // set the output value 0~255
  delay(50);
}
```

Serial.begin(speed) , Serial.println(str)

Arduino ← Computer



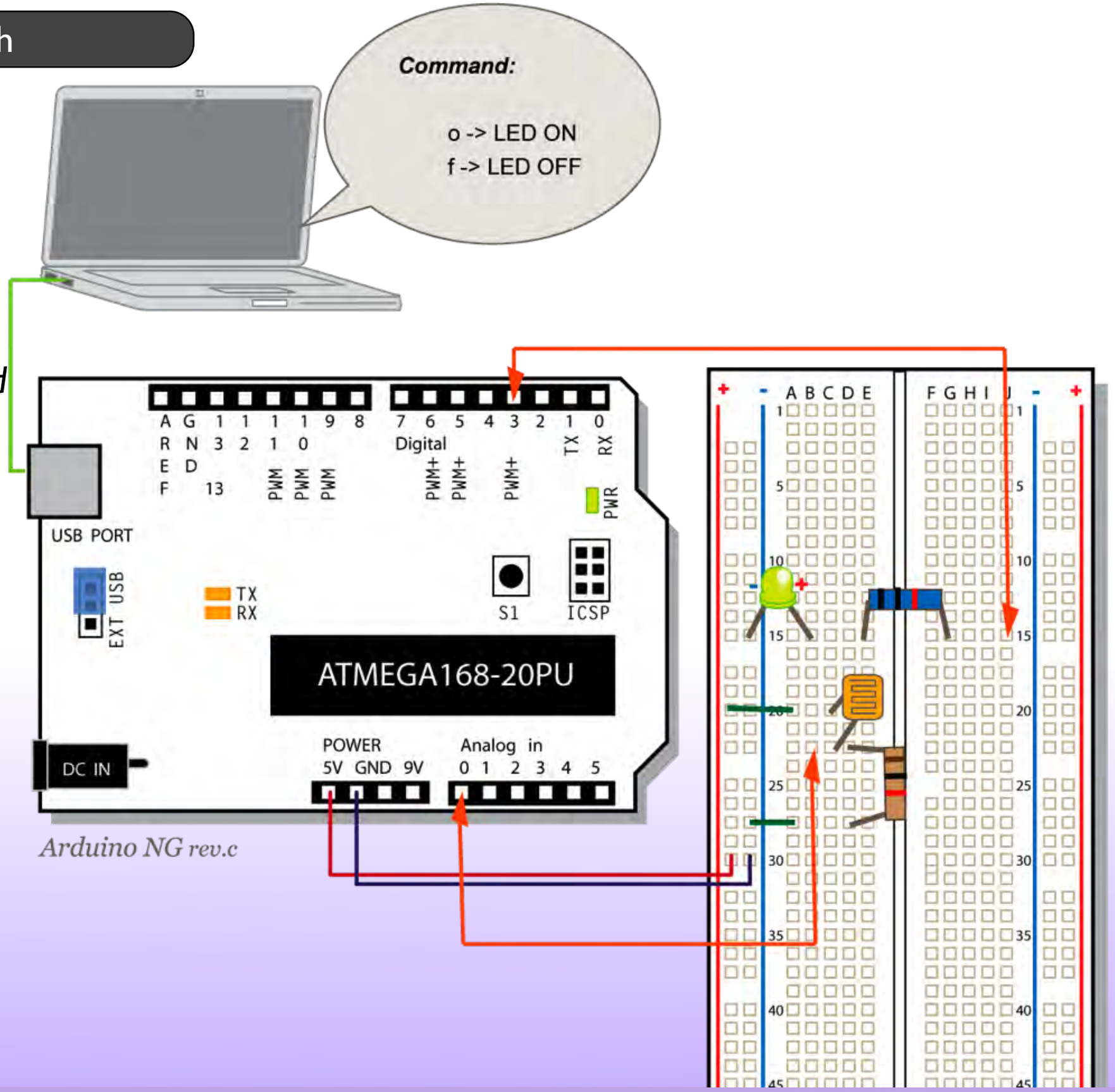
Arduino → Computer

```
int ledPin = 3;                          // LED connected to digital pin 2
int analogPin = 0;                          // photocell connected to analog pin 0
int activeLED = 0;

void setup()
{
  pinMode(ledPin, OUTPUT);           // sets the digital pin as output
  Serial.begin(9600);
}

void loop()
{
  if(Serial.available()>0) {
        activeLED = Serial.read();
        if(activeLED=='o') {
            digitalWrite(ledPin, HIGH);
        }
        if(activeLED=='f') {
            digitalWrite(ledPin, LOW);
        }
   }
   delay(50)
}
```

Serial.availabe() , Serial.read()

How about FLASH?

Arduino2Flash



```
int ledPin = 3;
int analogPin = 0;
int activeLED = 0;
int val = 0;

void setup()
{
  pinMode(ledPin, OUTPUT);
  Serial.begin(9600);
}

void loop()
{
  if(Serial.available()>0) {
        activeLED = Serial.read();
        if(activeLED=='o') {
            digitalWrite(ledPin, HIGH);
        }
        if(activeLED=='f') {
            digitalWrite(ledPin, LOW);
        }
   }

   val = analogRead(analogPin);
   printInteger(val);                  //print interger
   printByte(0);                       //print \0 as end mark of the XML message

   delay(50);
}
```

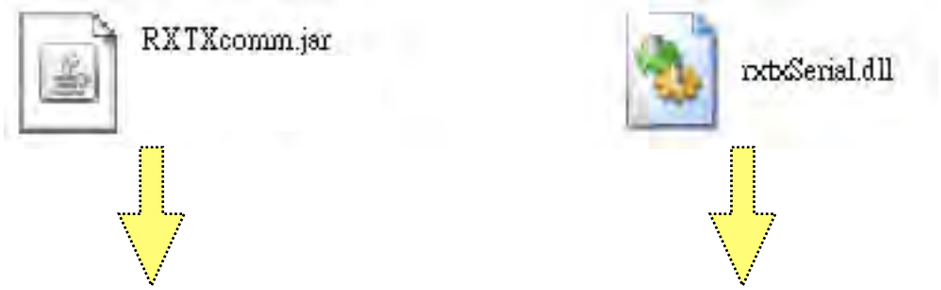
Serial Server

Serial Server需要java才能執行，故window必須先安裝好java執行環境(MAC OSX已經內建了)。

Win XP:

1. 下載並安裝JRE

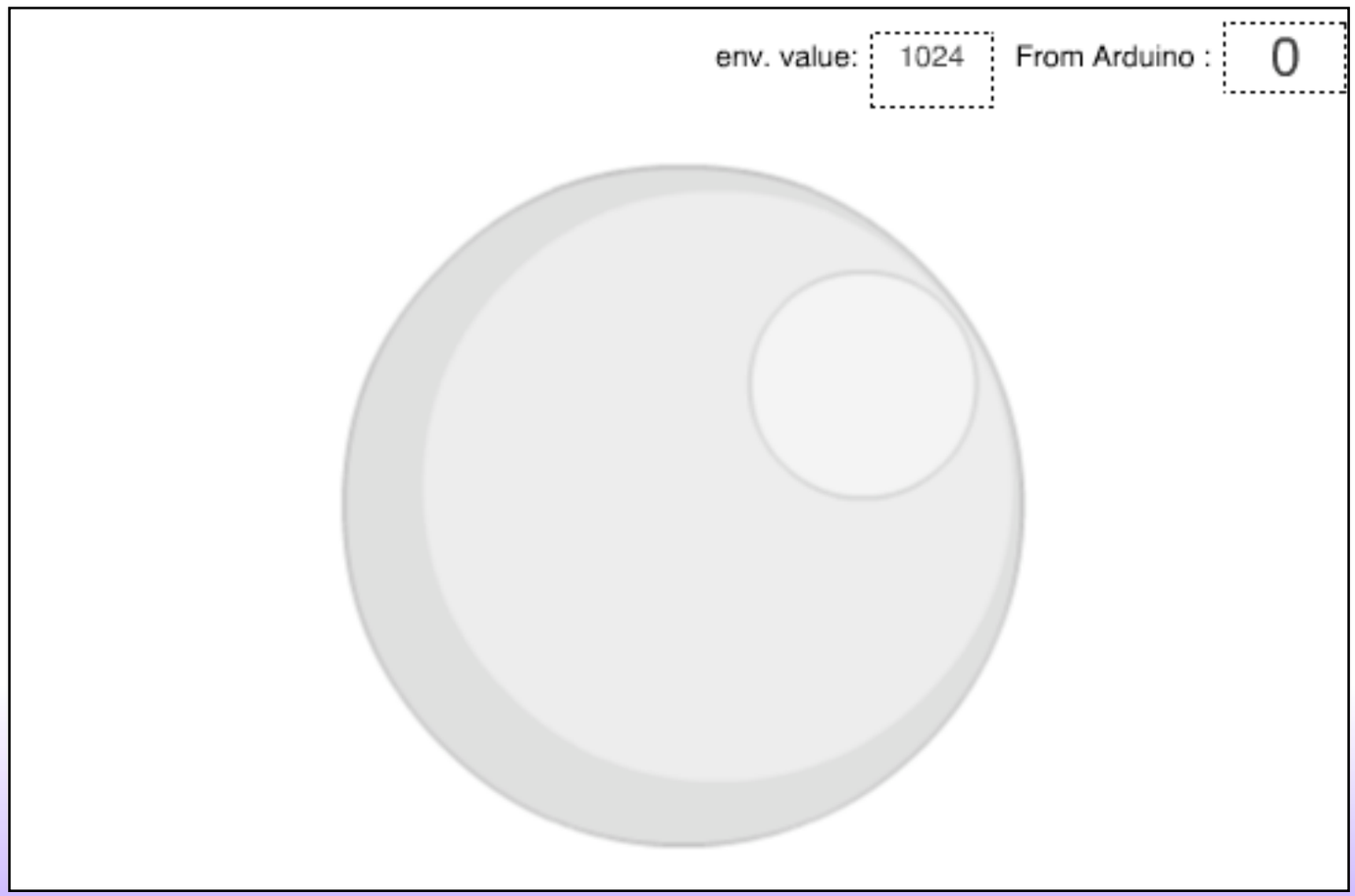
2. 下載Serial Server，並解壓縮，解完後，在第一層目錄可以看到ss6.jar，這是執行檔，但我們得先作好環境設定，到 serialserver/rxtx_drivers/Windows/ 可以看到 RXTXcomm.jar 和 rxtxSerial.dll。



3. 找到並點選打開 ss6.jar，將左方的socket改成5333， 並將右方port選為你Arduino板的COM port，下方的數字改成9600。

FLASH

開啟Flash2Arduino.fla檔案。



```
//建立物件
aListener = new Object();

aListener.onConnect = function() {
    //與arduino連線
    trace("OK");
}
aListener.onConnectError = function() {
    //連線失敗
    trace("Failed");
}
aListener.onDisconnect = function() {
    //失去連線
    trace("disconnected");
}


//實作,並建立5334 port
var ar_to_fl:Arduino = new Arduino(5333);
ar_to_fl.addEventListener("onConnect",aListener);
ar_to_fl.addEventListener("onConnectError",aListener);
ar_to_fl.addEventListener("onDisconnect",aListener);
ar_to_fl.addEventListener("onReceiveData",aListener);
```

```
//實作,並建立5334 port
var ar_to_fl:Arduino = new Arduino(5333);
ar_to_fl.addEventListener("onConnect",aListener);
ar_to_fl.addEventListener("onConnectError",aListener);
ar_to_fl.addEventListener("onDisconnect",aListener);
ar_to_fl.addEventListener("onReceiveData",aListener);


//接收從Arduino的數值
aListener.onReceiveData = function(evtObj:Object){
    //取得Arduino的值
    var ArduinoInt = evtObj.data;
    //trace(ArduinoInt);
    r_msg.text = ArduinoInt;
    var b_scale:Number = Math.floor((Number(ArduinoInt)/Number(env_txt.text))*400);
    trace(b_scale);
    ball_mc._xscale = ball_mc._yscale = b_scale;
}

//送出到Arduino
var _Setlight:Boolean = false;
ball_mc.onRelease = function() {
    trace(ball_mc.currentFrame());
    if(_Setlight) {
        ball_mc.gotoAndPlay("LED_OFF");
        ar_to_fl.send("f");
    }else {
        ball_mc.gotoAndPlay("LED_ON");
        ar_to_fl.send("o");
    }
    _Setlight = !_Setlight;
}
```

Reference

Web:

• Arduino官網	http://www.arduino.cc/
• Arduino Playground	http://www.arduino.cc/playground/
• Arduino 樂園	http://arduino.tw/
• MSM	http://203.68.163.135/msm/
• DesignLab	http://designlab.tw/
• ITP Physical Computing	http://itp.nyu.edu/physcomp/
• sparkfun ELECTRONICS	http://www.sparkfun.com/
• Adafruit Industries	http://www.adafruit.com/
• Thinkerlog	http://tinkerlog.com/

Book:

• Pysical Computing: Sensing and Controlling the Physical World with Computer, Tom Iqoe & Dan O'Sullivan. (2004)

• 圖解電氣迴路, 稻見辰夫 & 稻見昌彥 著, 宋家豪 & 陳曉梅 譯. (2006)