INDUSTRIAL TRAINING

ARDUINO & IT'S INTERFACING
WITH
INTERNET OF THINGS - IOT

SHREEJI CHARAN electronics

Presented by

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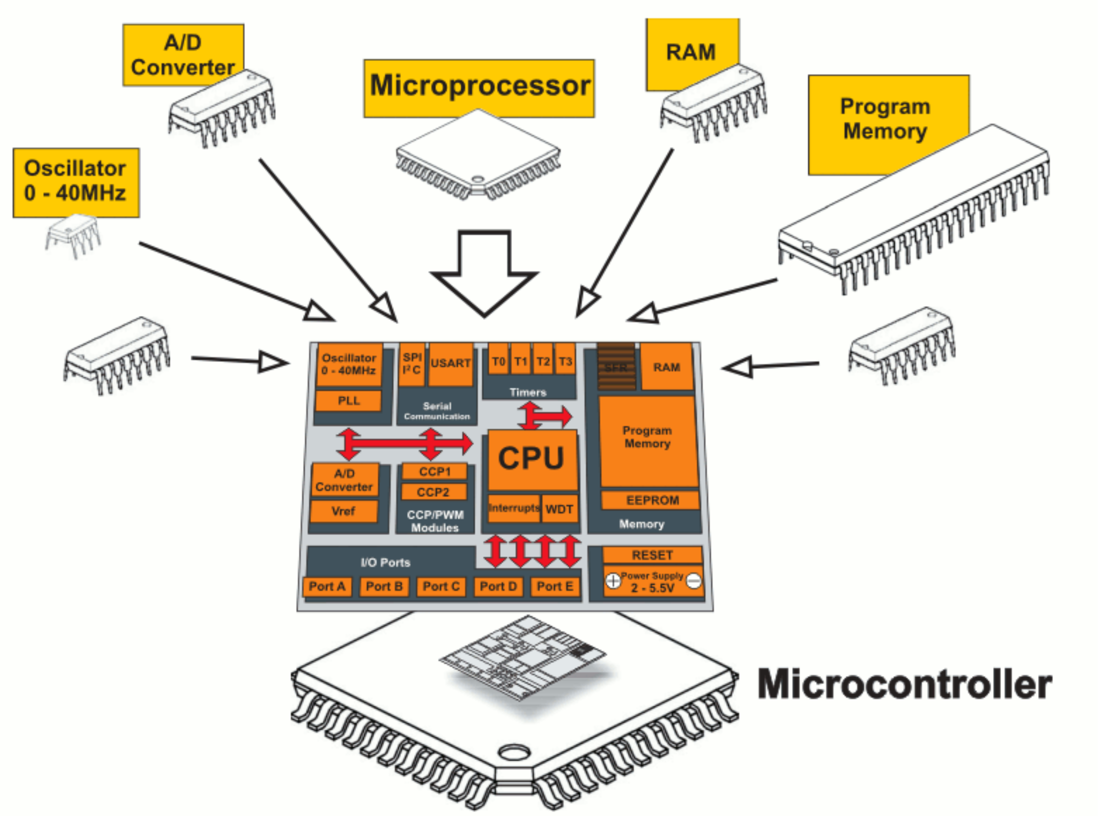
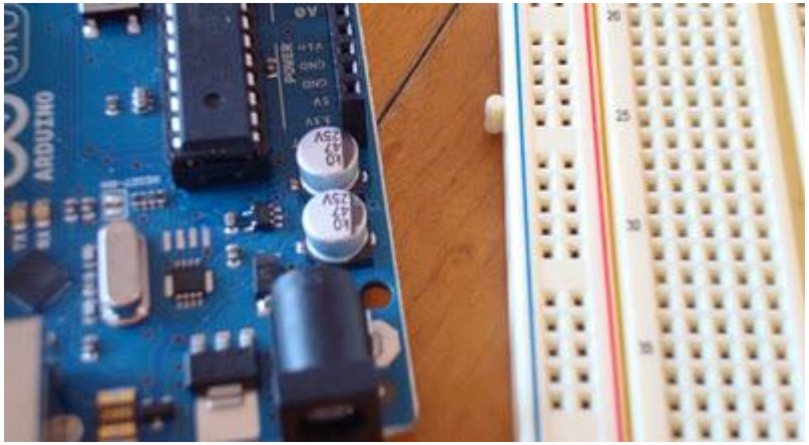
What is a Microcontroller



- A small computer on a single chip
  - containing a processor, memory, and input/output
- Typically "**embedded**" inside some device that they control
- A microcontroller is often small and low cost

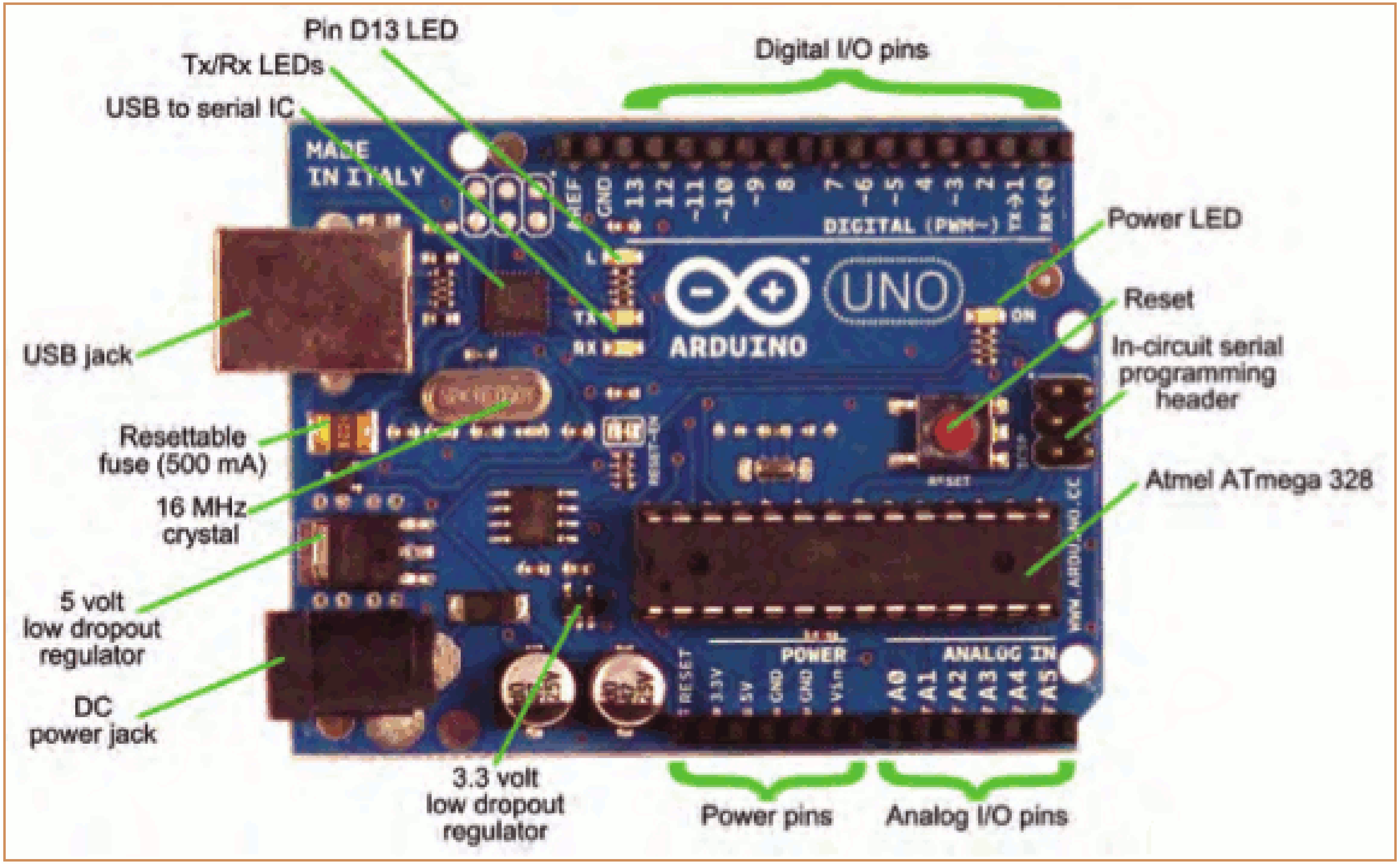
What is a Development Board



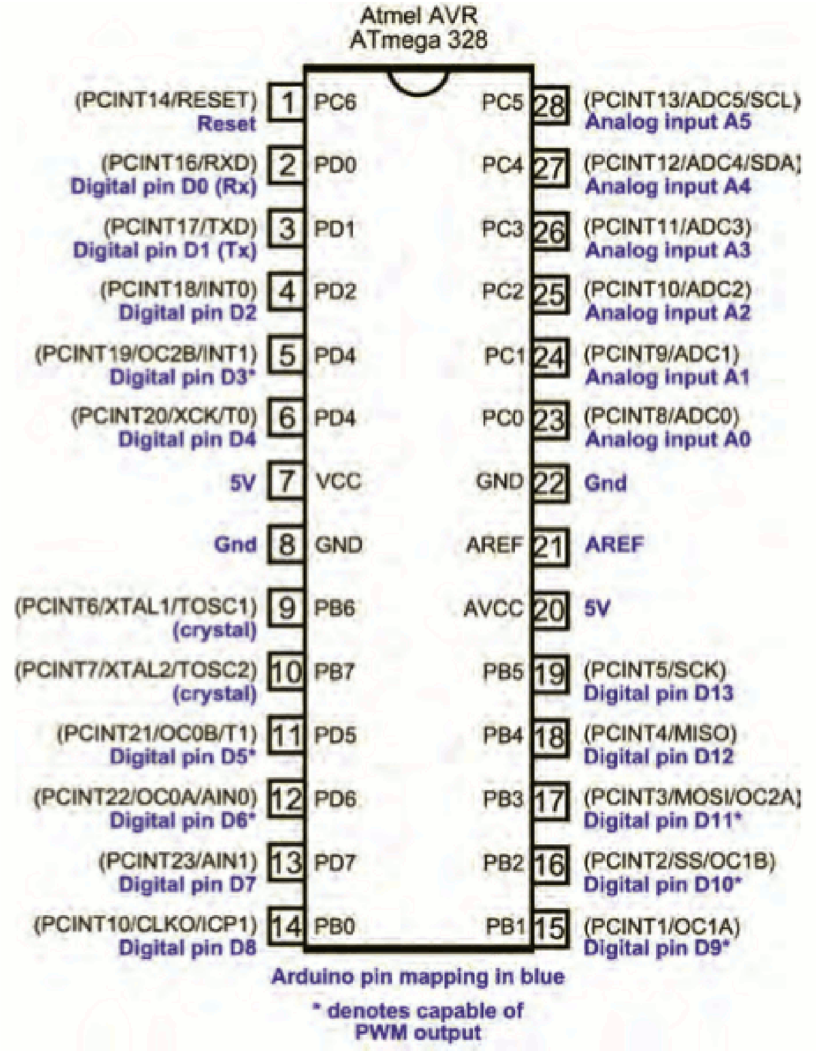
- A printed circuit board designed to facilitate work with a particular microcontroller.

- Typical components include:
  - power circuit
  - programming interface
  - basic input; usually buttons and LEDs
  - I/O pins

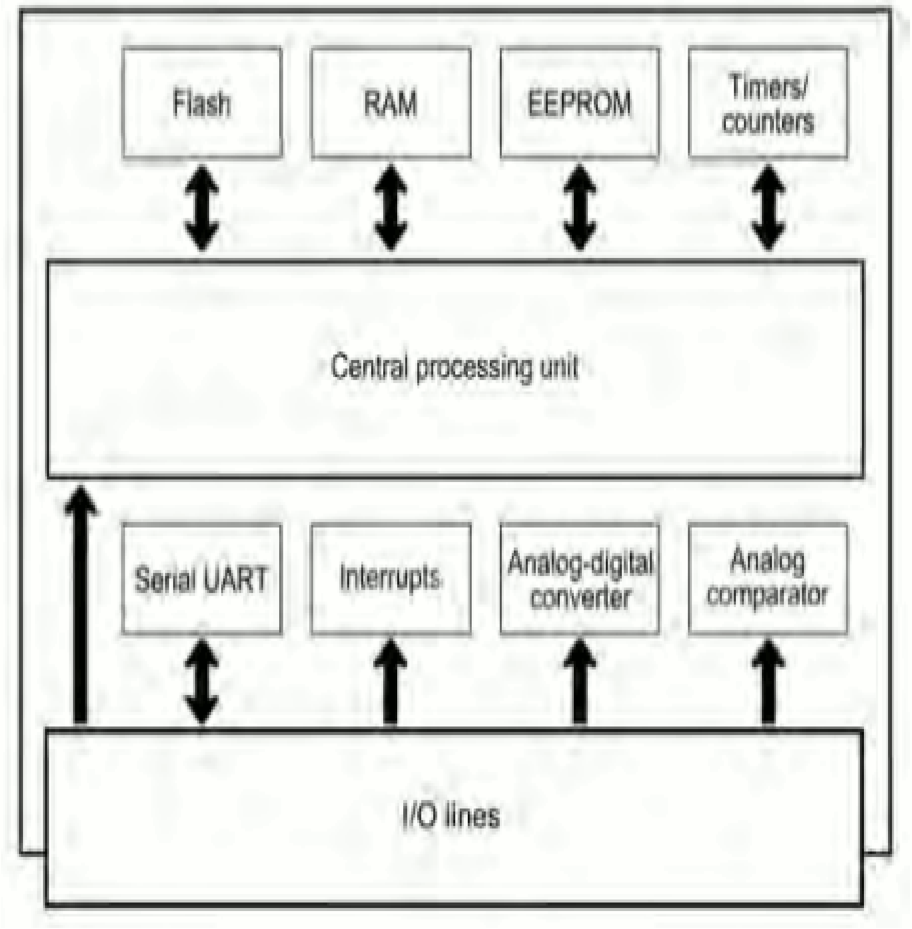
The Arduino Development Board



The Arduino Microcontroller: Atmel ARV Atmega 328



Atmel AVR
ATmega 328
(PCINT14/RESET) Reset 1 PC6
(PCINT16/RXD) Digital pin D0 (Rx) 2 PD0
(PCINT17/TXD) Digital pin D1 (Tx) 3 PD1
(PCINT18/INT0) Digital pin D2 4 PD2
(PCINT19/OC2B/INT1) Digital pin D3* 5 PD4
(PCINT20/XCK/T0) Digital pin D4 6 PD4
5V 7 VCC
Gnd 8 GND
(PCINT6/XTAL1/TOSC1) (crystal) 9 PB6
(PCINT7/XTAL2/TOSC2) (crystal) 10 PB7
(PCINT21/OC0B/T1) Digital pin D5* 11 PD5
(PCINT22/OC0A/AIN0) Digital pin D6* 12 PD6
(PCINT23/AIN1) Digital pin D7 13 PD7
(PCINT10/CLKO/ICP1) Digital pin D8 14 PB0
PC5 28 (PCINT13/ADC5/SCL) Analog input A5
PC4 27 (PCINT12/ADC4/SDA) Analog input A4
PC3 26 (PCINT11/ADC3) Analog input A3
PC2 25 (PCINT10/ADC2) Analog input A2
PC1 24 (PCINT9/ADC1) Analog input A1
PC0 23 (PCINT8/ADC0) Analog input A0
GND 22 Gnd
AREF 21 AREF
AVCC 20 5V
PB5 19 (PCINT5/SCK) Digital pin D13
PB4 18 (PCINT4/MISO) Digital pin D12
PB3 17 (PCINT3/MOSI/OC2A) Digital pin D11*
PB2 16 (PCINT2/SS/OC1B) Digital pin D10*
PB1 15 (PCINT1/OC1A) Digital pin D9*
Arduino pin mapping in blue
* denotes capable of PWM output

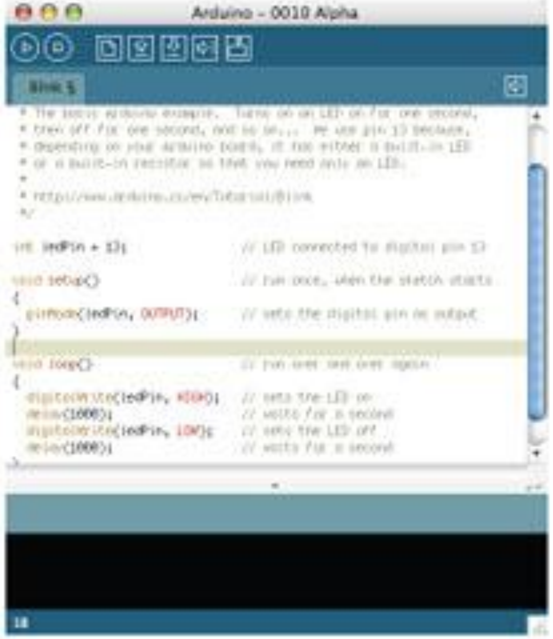


What is the Arduino

The word "Arduino" can mean 3 things

A physical piece of hardware

A programming environment



```
 * The basic Arduino example.  Turns on an LED on for one second,
 * then off for one second, and so on...  We use pin 13 because,
 * depending on your Arduino board, it has either a built-in LED
 * or a built-in resistor so that you need only an LED.
 *
 * http://www.arduino.cc/en/Tutorial/Blink
 */

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

void setup()                    // run once, when the sketch starts
{
  pinMode(ledPin, OUTPUT);      // sets the digital pin as output
}

void loop()                     // run over and over again
{
  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
}
```

A community & philosophy

Arduino playground

:: About the Arduino Playground ::

[illegible]

:: RoadMap: What Needs to be Done? ::

[illegible]

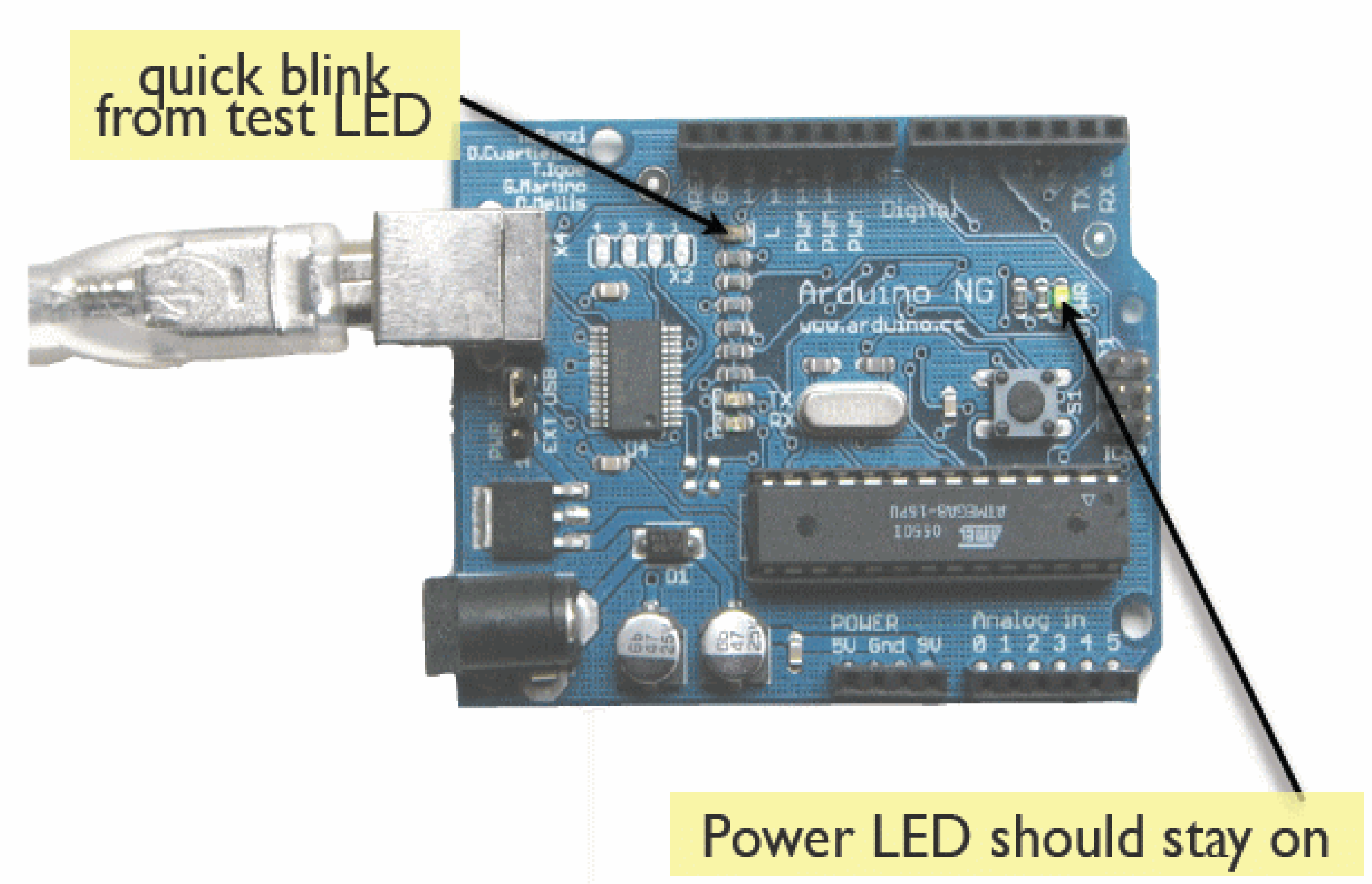
todbot.com/blog/bionicarduino

Getting Started

- Check out: http://arduino.cc/en/Guide/HomePage

1. **Download & install the Arduino environment (IDE)**
2. **Connect the board to your computer via the UBS cable**
3. **If needed, install the drivers (not needed in lab)**
4. **Launch the Arduino IDE**
5. **Select your board**
6. **Select your serial port**
7. **Open the blink example**
8. **Upload the program**

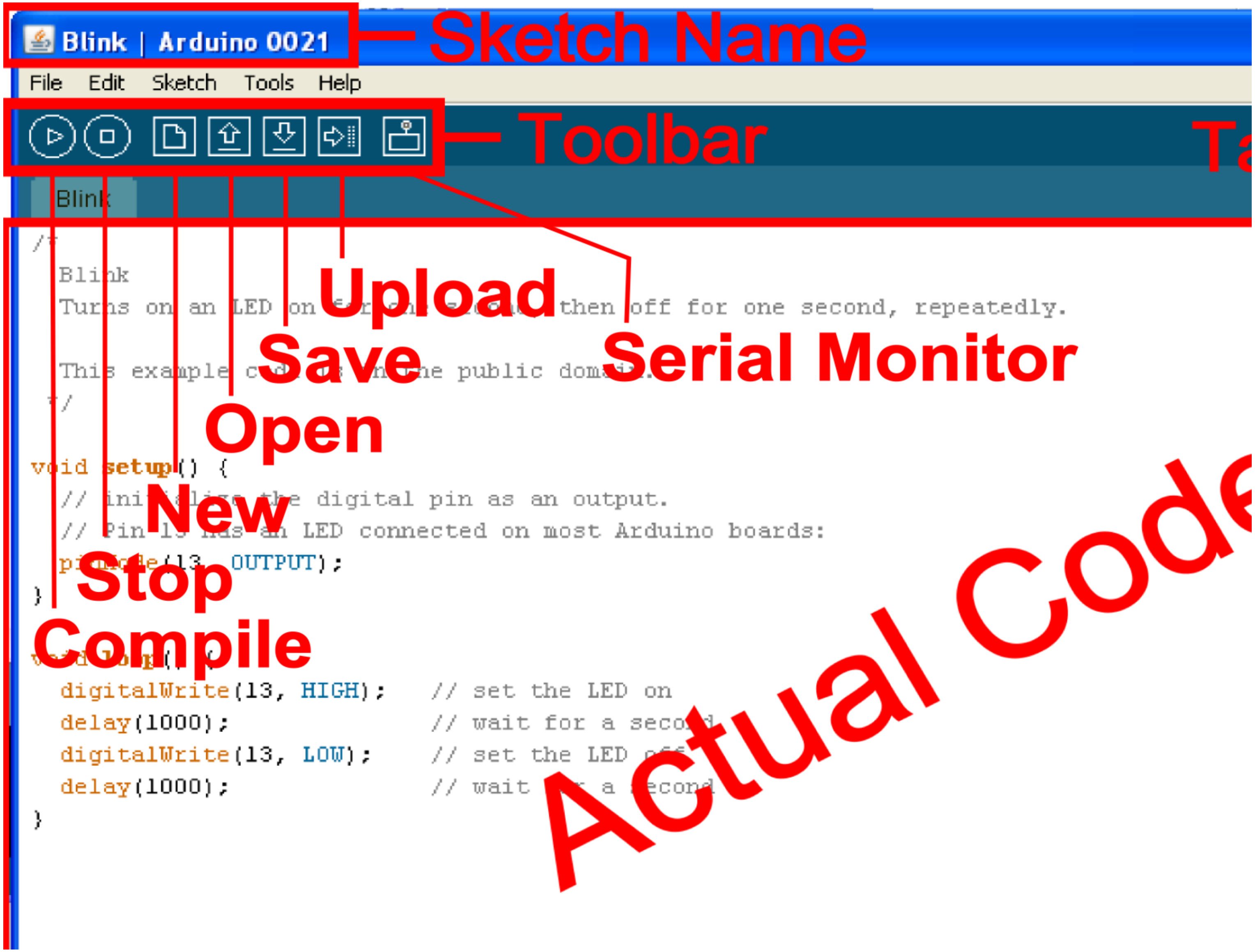
Try It: Connect the USB Cable



quick blink from test LED

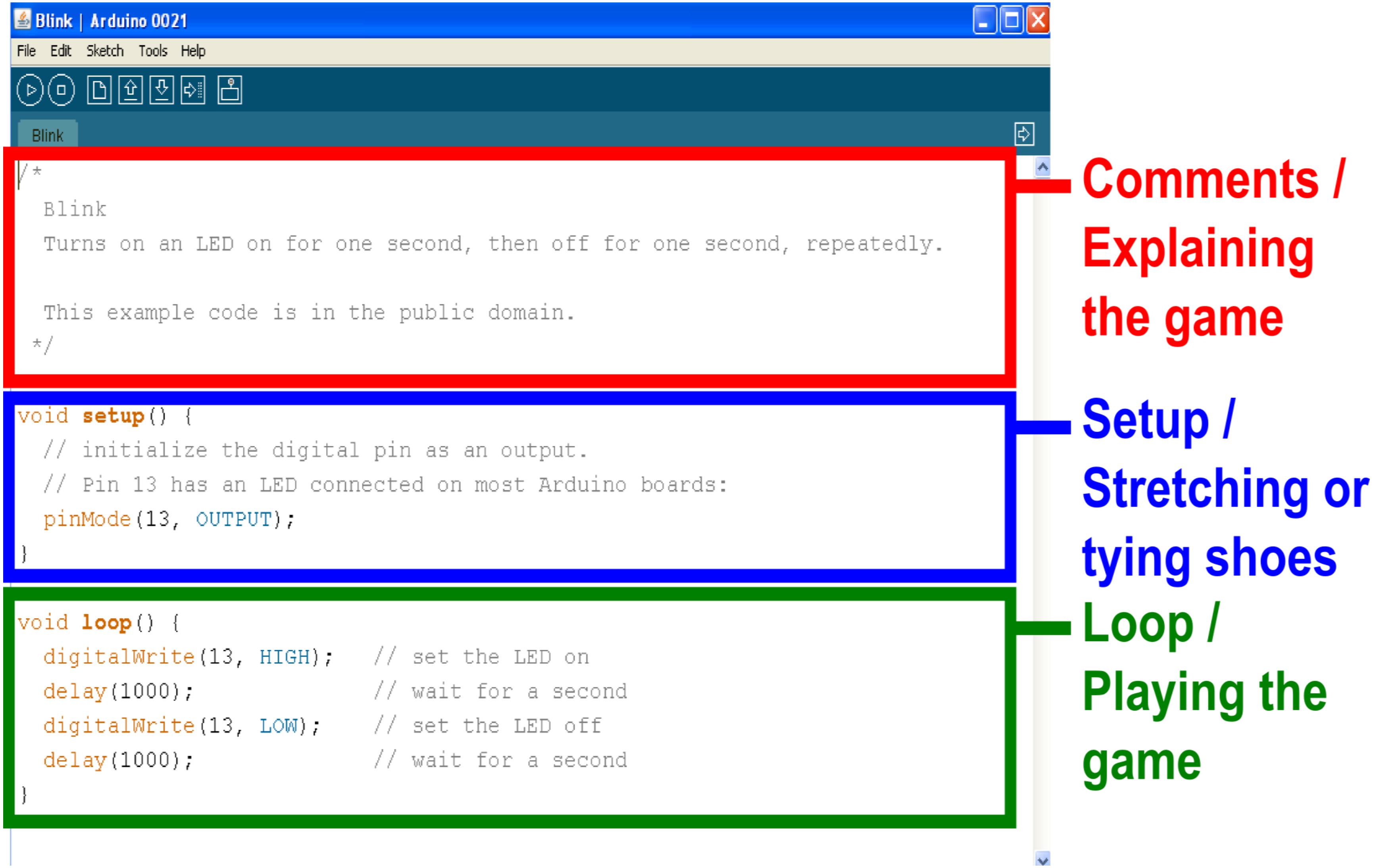
Power LED should stay on

The Environment



```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  This example code is in the public domain.
 */

void setup() {
  // initialize the digital pin as an output.
  // Pin 13 has an LED connected on most Arduino boards:
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);   // set the LED on
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // set the LED off
  delay(1000);              // wait for a second
}
```

Parts of the Sketch



```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  This example code is in the public domain.
 */
```

```
void setup() {
  // initialize the digital pin as an output.
  // Pin 13 has an LED connected on most Arduino boards:
  pinMode(13, OUTPUT);
}
```

```
void loop() {
  digitalWrite(13, HIGH);   // set the LED on
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // set the LED off
  delay(1000);              // wait for a second
}
```

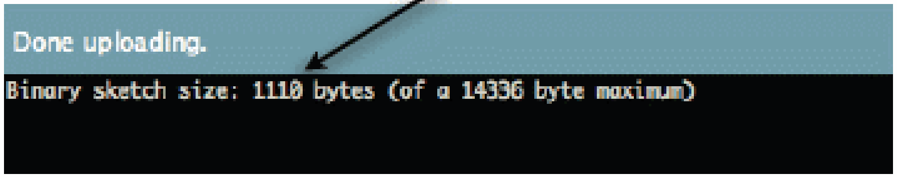
Comments / Explaining the game

Setup / Stretching or tying shoes

Loop / Playing the game

Status Messages

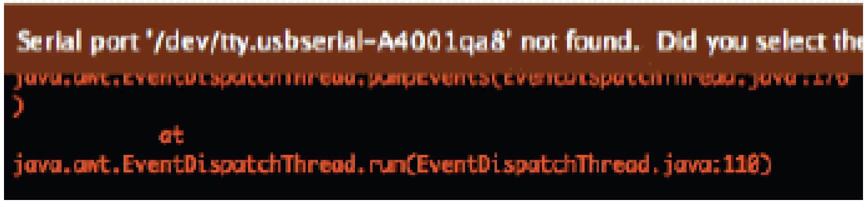
Uploading worked



Size depends on
complexity of your sketch

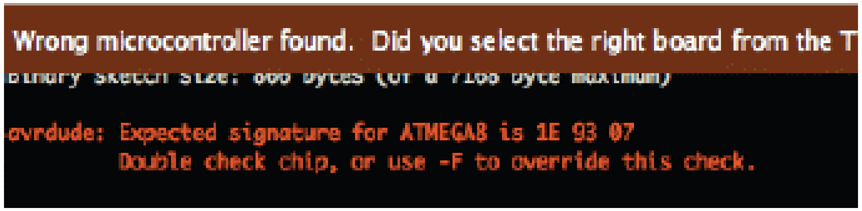
```
Done uploading.
Binary sketch size: 1110 bytes (of a 14336 byte maximum)
```

Wrong serial port selected



```
Serial port '/dev/tty.usbserial-A4001qa8' not found.  Did you select the
java.awt.EventDispatchThread.pumpEvents(EventDispatchThread.java:170
)
            at
java.awt.EventDispatchThread.run(EventDispatchThread.java:110)
```

Wrong board selected

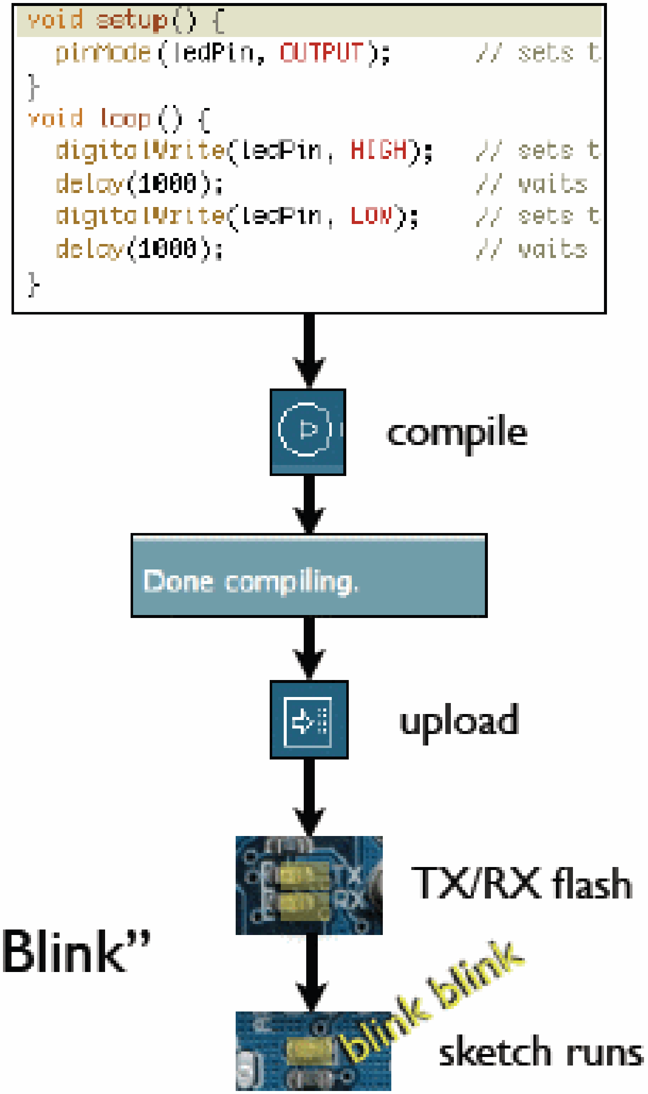


```
Wrong microcontroller found.  Did you select the right board from the T
Binary sketch size: 666 bytes (of a 7168 byte maximum)

avrdude: Expected signature for ATMEGA8 is 1E 93 07
         Double check chip, or use -F to override this check.
```

nerdy cryptic error messages

Using Arduino

- Write your sketch
- Press Compile button (to check for errors)
- Press Upload button to program Arduino board with your sketch



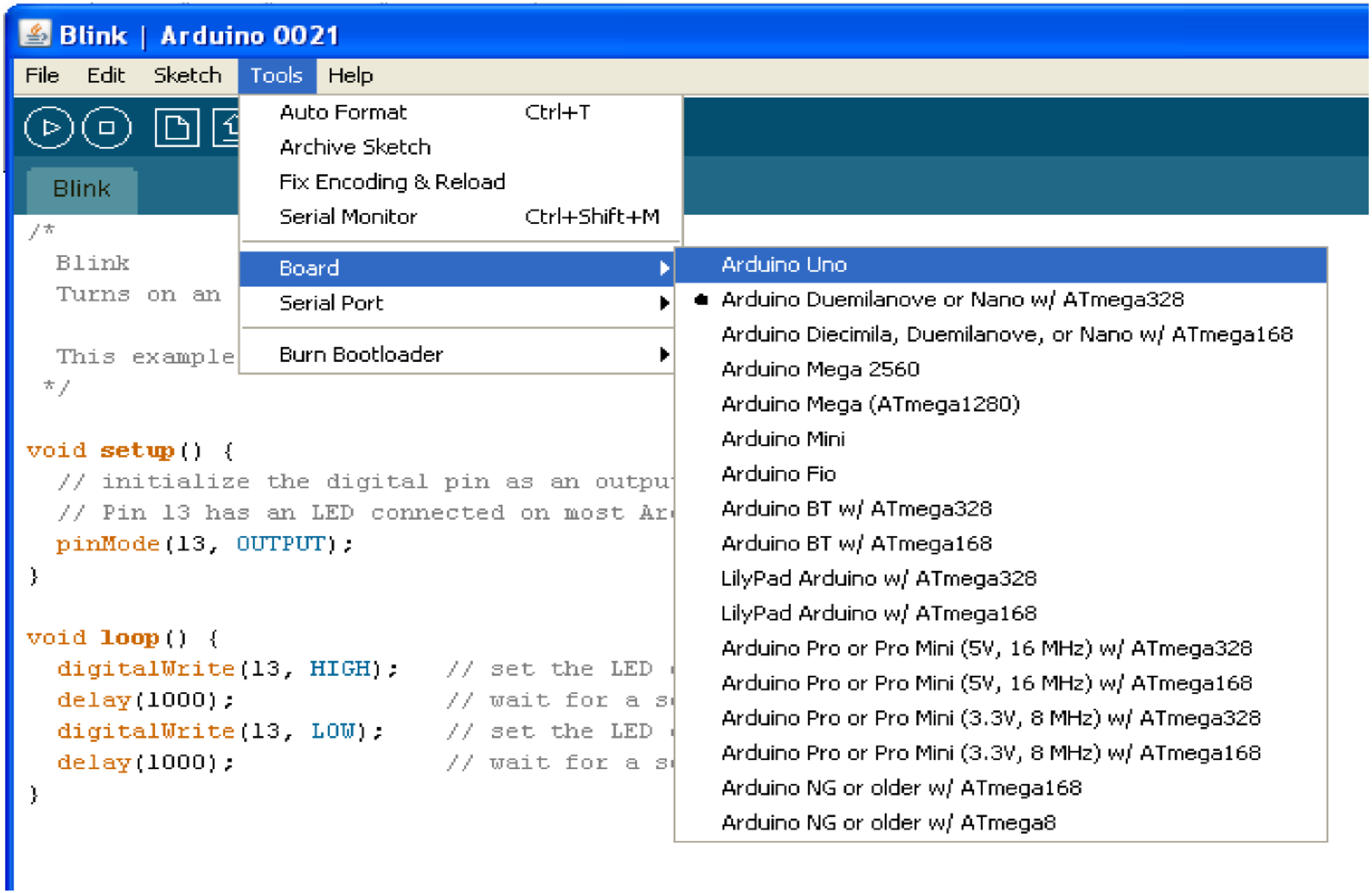
```
void setup() {
  pinMode(ledPin, OUTPUT);       // sets t
}
void loop() {
  digitalWrite(ledPin, HIGH);    // sets t
  delay(1000);                   // waits
  digitalWrite(ledPin, LOW);     // sets t
  delay(1000);                   // waits
}
```

Done compiling.

Try it out with the "Blink" sketch!

Load "File/Sketchbook/Examples/Digital/Blink"

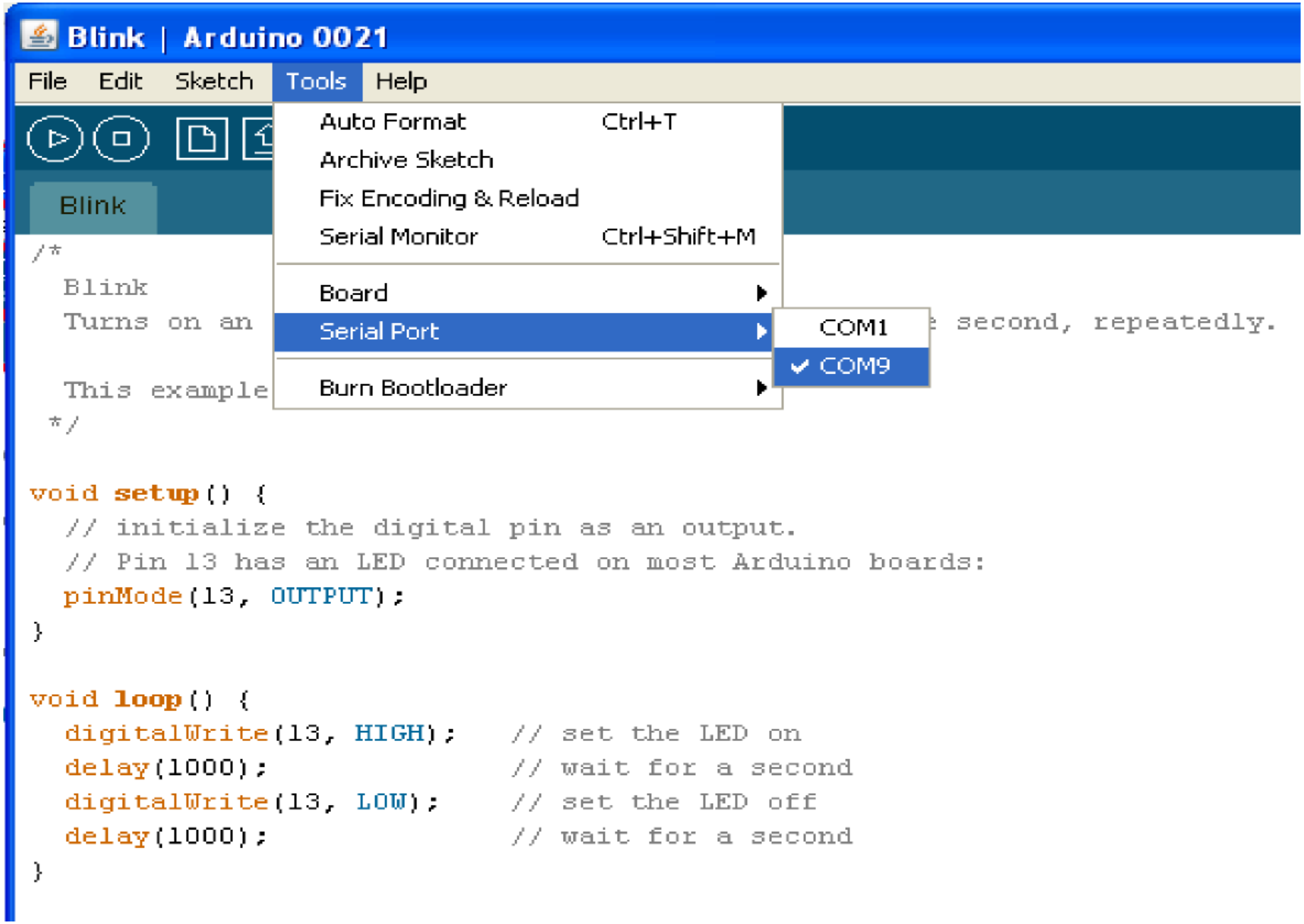
Board Type



Blink | Arduino 0021
File
Edit
Sketch
Tools
Help
Blink
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
Board
Serial Port
Burn Bootloader
Arduino Uno
● Arduino Duemilanove or Nano w/ ATmega328
Arduino Diecimila, Duemilanove, or Nano w/ ATmega168
Arduino Mega 2560
Arduino Mega (ATmega1280)
Arduino Mini
Arduino Fio
Arduino BT w/ ATmega328
Arduino BT w/ ATmega168
LilyPad Arduino w/ ATmega328
LilyPad Arduino w/ ATmega168
Arduino Pro or Pro Mini (5V, 16 MHz) w/ ATmega328
Arduino Pro or Pro Mini (5V, 16 MHz) w/ ATmega168
Arduino Pro or Pro Mini (3.3V, 8 MHz) w/ ATmega328
Arduino Pro or Pro Mini (3.3V, 8 MHz) w/ ATmega168
Arduino NG or older w/ ATmega168
Arduino NG or older w/ ATmega8

```
/*
  Blink
  Turns on an

  This example
 */

void setup() {
  // initialize the digital pin as an outpu
  // Pin 13 has an LED connected on most Ar
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);   // set the LED
  delay(1000);              // wait for a s
  digitalWrite(13, LOW);    // set the LED
  delay(1000);              // wait for a s
}
```

Serial Port / COM Port



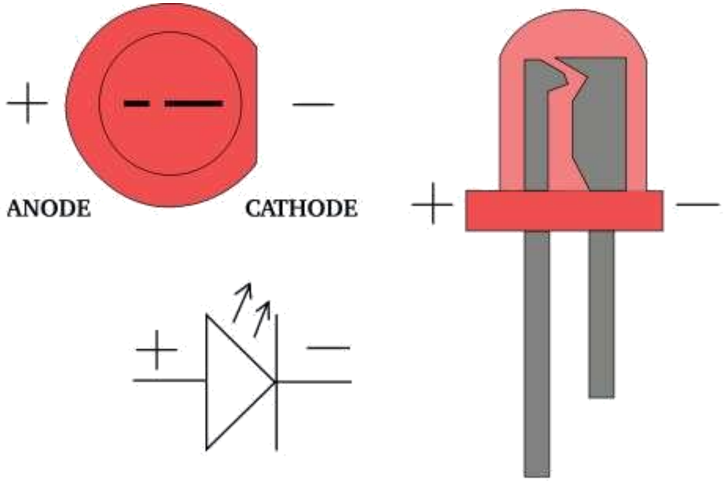
```
/*
  Blink
  Turns on an                                  second, repeatedly.

  This example
 */

void setup() {
  // initialize the digital pin as an output.
  // Pin 13 has an LED connected on most Arduino boards:
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);   // set the LED on
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // set the LED off
  delay(1000);              // wait for a second
}
```

Comments

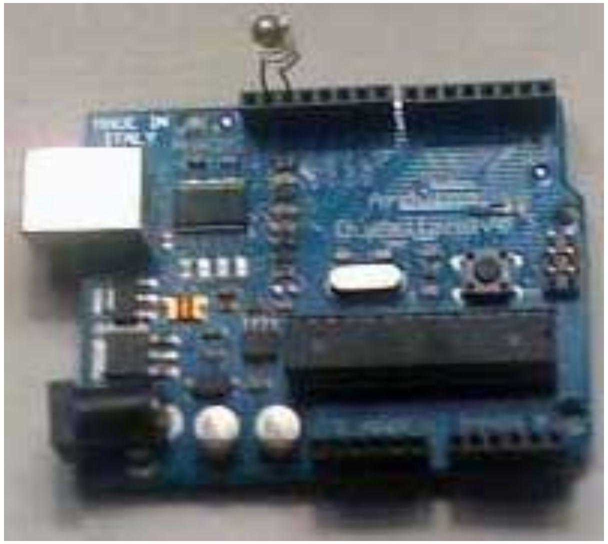
- Comments can be anywhere
- Comments created with // or /* and */
- Comments do not affect code
- You may not need comments, but think about the community!
- Code is case sensitive
- Statements are commands and must end with a semi-colon
- Comments follow a // or begin with /* and end with */
- loop and setup

Add an External LED to pin 13

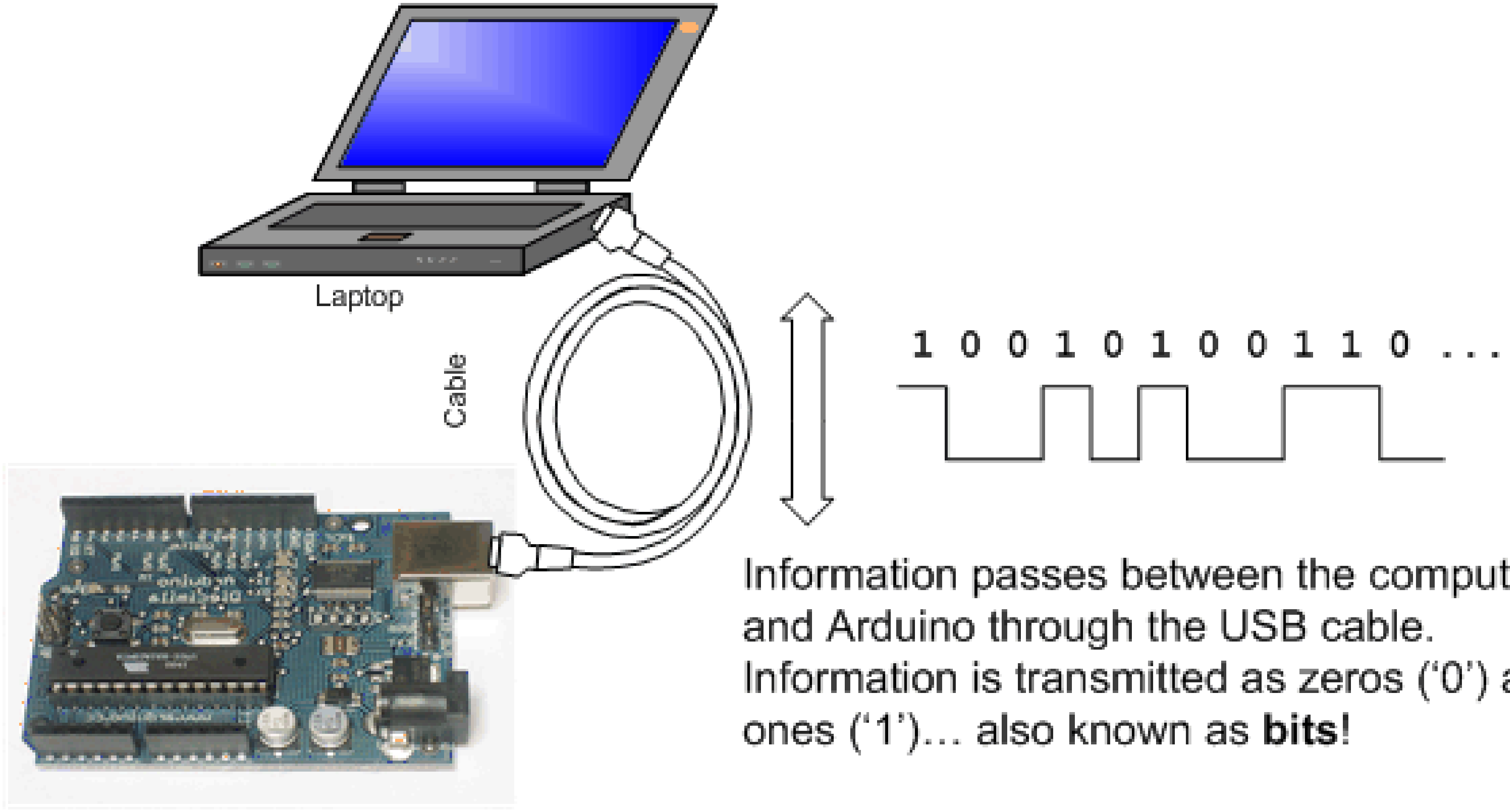
- **File > Examples > Digital > Blink**
- LED’s have polarity
  – Negative indicated by flat side of the housing and a short leg



www.instructables.com



Serial Communication



Information passes between the computer and Arduino through the USB cable. Information is transmitted as zeros ('0') and ones ('1')… also known as **bits**!

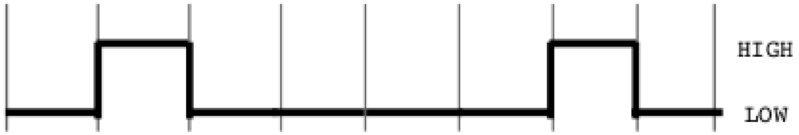
Serial Communications

- “Serial” because data is broken down into bits, each sent one after the other down a single wire.
- The single ASCII character ‘B’ is sent as:

‘B’ = 0 1 0 0 0 0 1 0

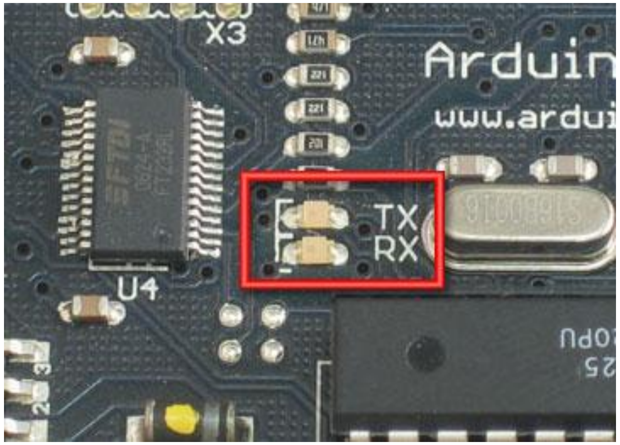
= L H L L L L H L

=



- Toggle a pin to send data, just like blinking an LED
- You could implement sending serial data with `digitalWrite()` and `delay()`
- A single data wire needed to send data. One other to receive.

Serial Communication

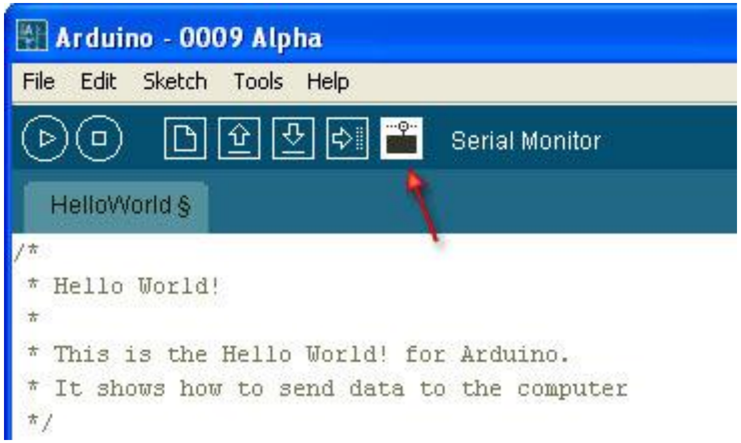


- ***Compiling*** turns your program into binary data (ones and zeros)
- ***Uploading*** sends the bits through USB cable to the Arduino
- The two LEDs near the USB connector blink when data is transmitted
  - **RX** blinks when the Arduino is receiving data
  - **TX** blinks when the Arduino is transmitting data

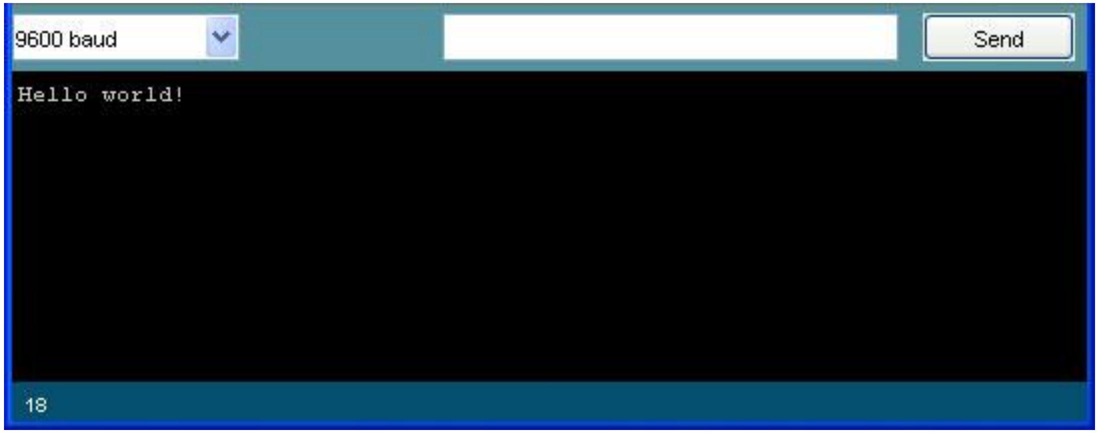
First Program

```
/*
*   Hello World!
*   From www.ladyada.net
*  It shows how to send data to the computer
*/
void setup()                     // run once, when the sketch starts
{
   Serial.begin(9600);               // set up Serial library at 9600 bps
   Serial.println("Hello world!");    // prints hello with a line break
}
void loop()                                   // run over and over again
{                                                // do nothing!
}
```

Open the Serial Monitor and Upload the Program



```
/*
 * Hello World!
 *
 * This is the Hello World! for Arduino.
 * It shows how to send data to the computer
 */
```



9600 baud

```
Hello world!
```

Embedded C Programming

- Operators
- Variables
- Setup & Loop Function
- Conditions

  a. If… Else

- Basic Repetition

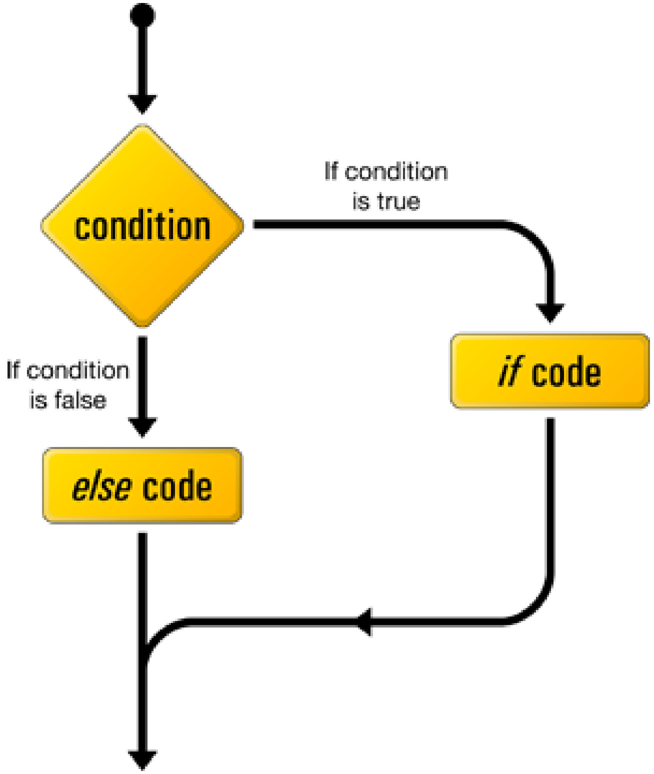
  a. Loop

  b. For

  c. While

- Function

Conditional Statement



modelect.wordpress.com

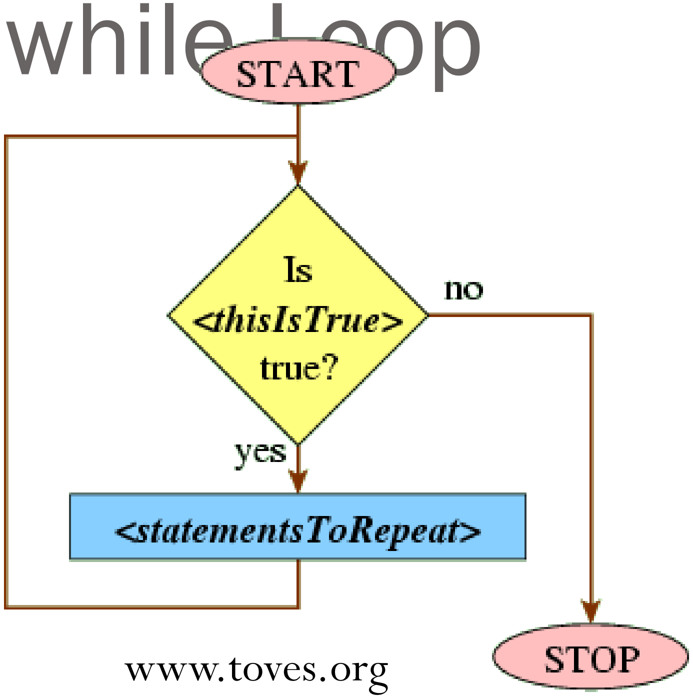
```
if (someCondition) {
   // do stuff if the condition is true
} else {
   // do stuff if the condition is false
}
```

Conditional Statement

```
int printMessage = 1;
void setup()
{   Serial.begin(9600);
}

void loop()
{
   if (printMessage == 1)  {
        Serial.println("Message");
        printMessage= 0;
   }
}
```

```
int printMessage = 1;
void setup()
{   Serial.begin(9600);
}
void loop()
{
 if (printMessage == 1)  {
  Serial.println("Message");
  printMessage= 0;
 }
 else {
  Serial.println("NO Message");
  printMessage= 1;
 }
}
```

while Loop



www.toves.org

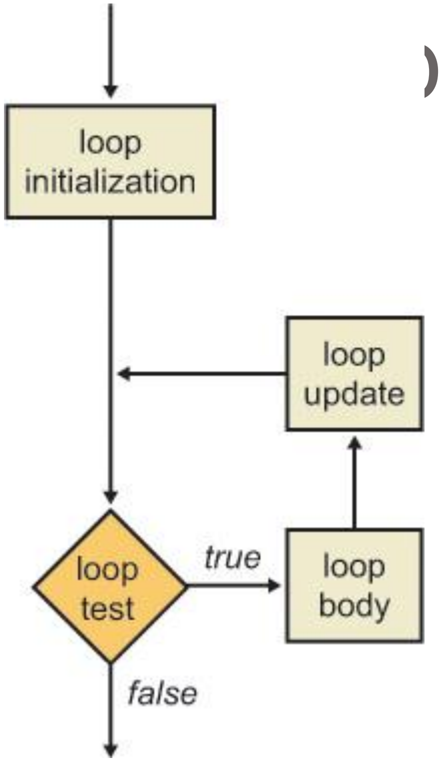
```
while(expression){
    statement(s);
 }
```

Example

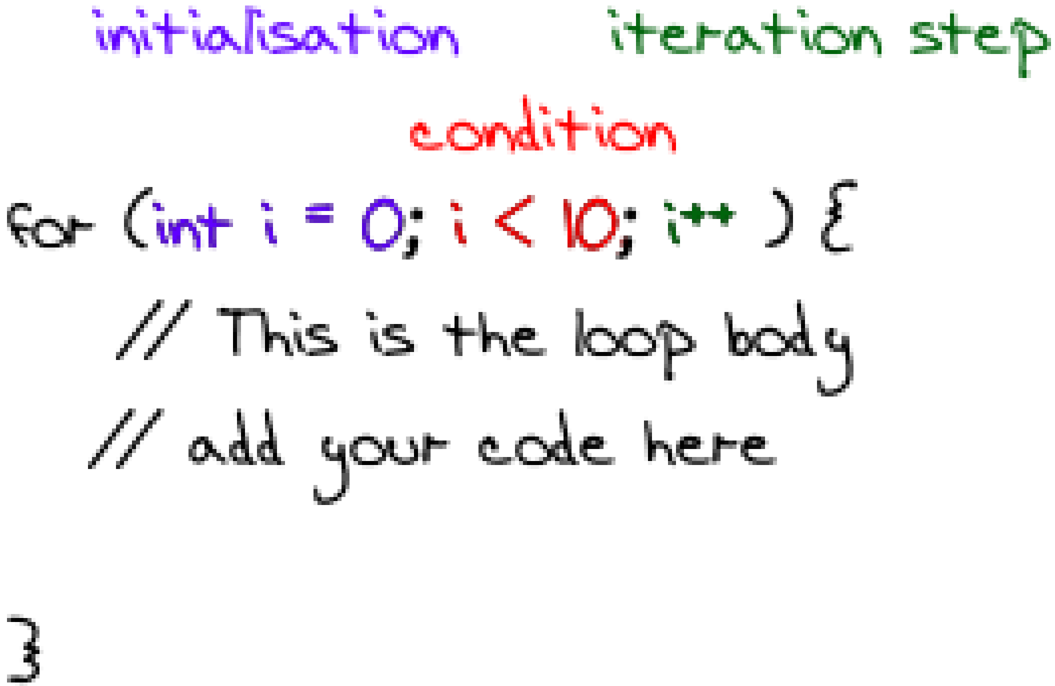
```
int var = 0;
while (var < 200) {
   // do something repetitive 200 times
   var = var + 1;
}
```

while Loop

```
void setup()
{   Serial.begin(9600);
    int count = 0;
    while (count < 5)  {
         Serial.println("Hello world!");
         count = count +1;
     }
}

void loop()
{
}
```



www.visualcplusdotnet.com


initialisation
iteration step
condition

```
for (int i = 0; i < 10; i++ ) {
    // This is the loop body
    // add your code here


}
```

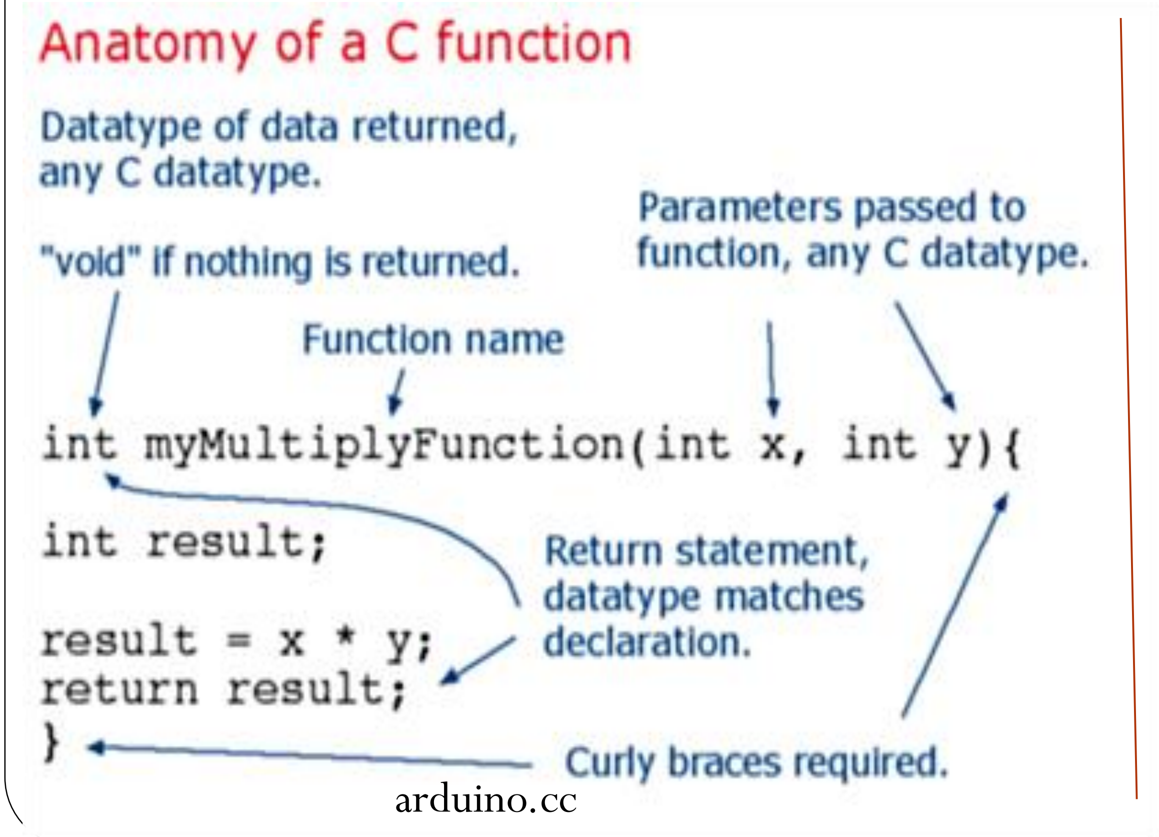
martin-thoma.com

for Loop

```
void setup()
{
  Serial.begin(9600);
  for (int count = 0; count < 5; count++)  {
      Serial.println("Hello world!");
  }
}

void loop()
{
}
```

Functions

- loop() and setup() are procedures
- You can create you own functions



Anatomy of a C function

Datatype of data returned, any C datatype.

"void" if nothing is returned.

Function name

Parameters passed to function, any C datatype.

```
int myMultiplyFunction(int x, int y){

int result;

result = x * y;
return result;
}
```

Return statement, datatype matches declaration.

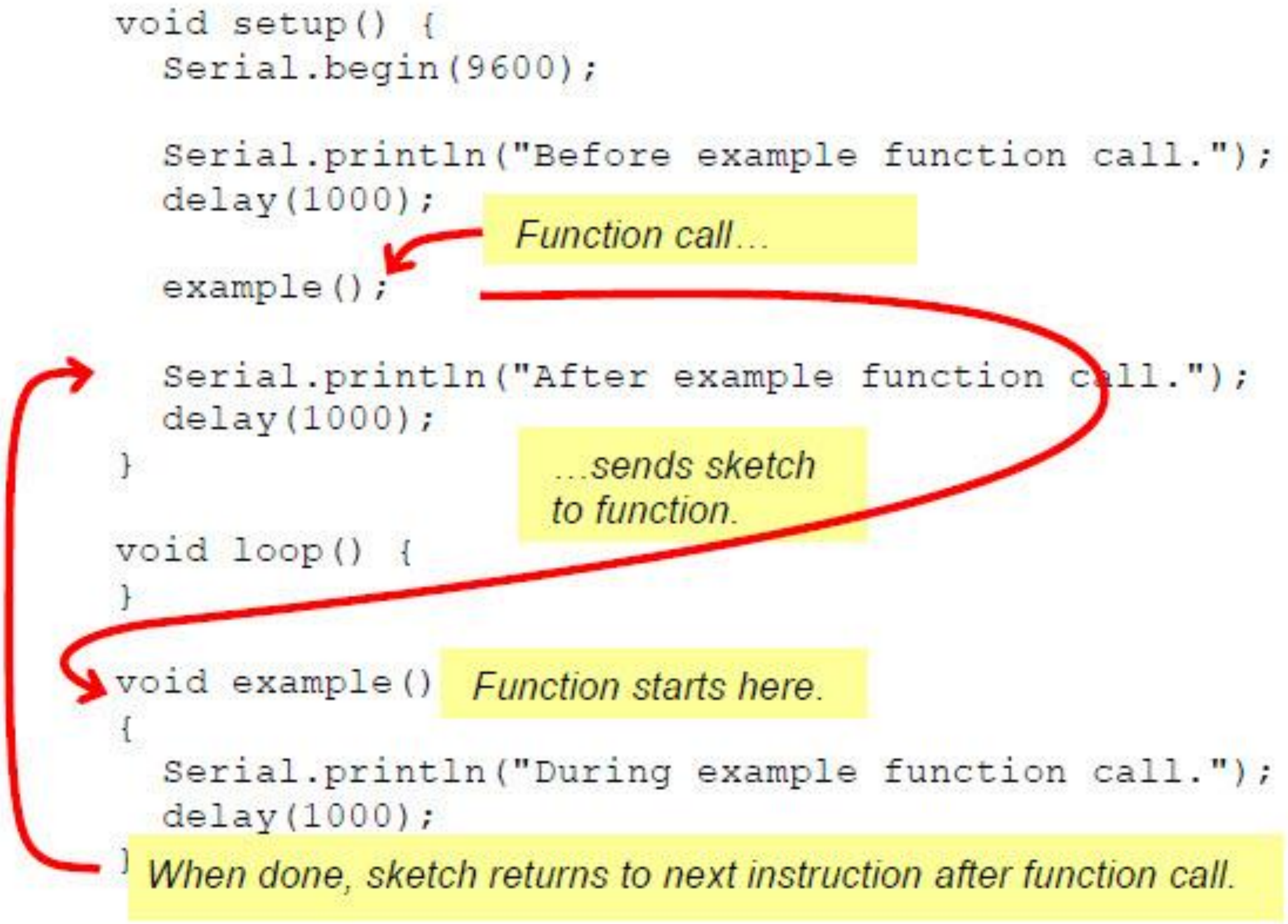
Curly braces required.

arduino.cc

```
void setup() {
}
 void loop() {
 }
```

Both setup() and loop() have no parameters and return no values

Functions: Example 1



```
void setup() {
  Serial.begin(9600);

  Serial.println("Before example function call.");
  delay(1000);

  example();

  Serial.println("After example function call.");
  delay(1000);
}

void loop() {
}

void example()
{
  Serial.println("During example function call.");
  delay(1000);
}
```

Function call…

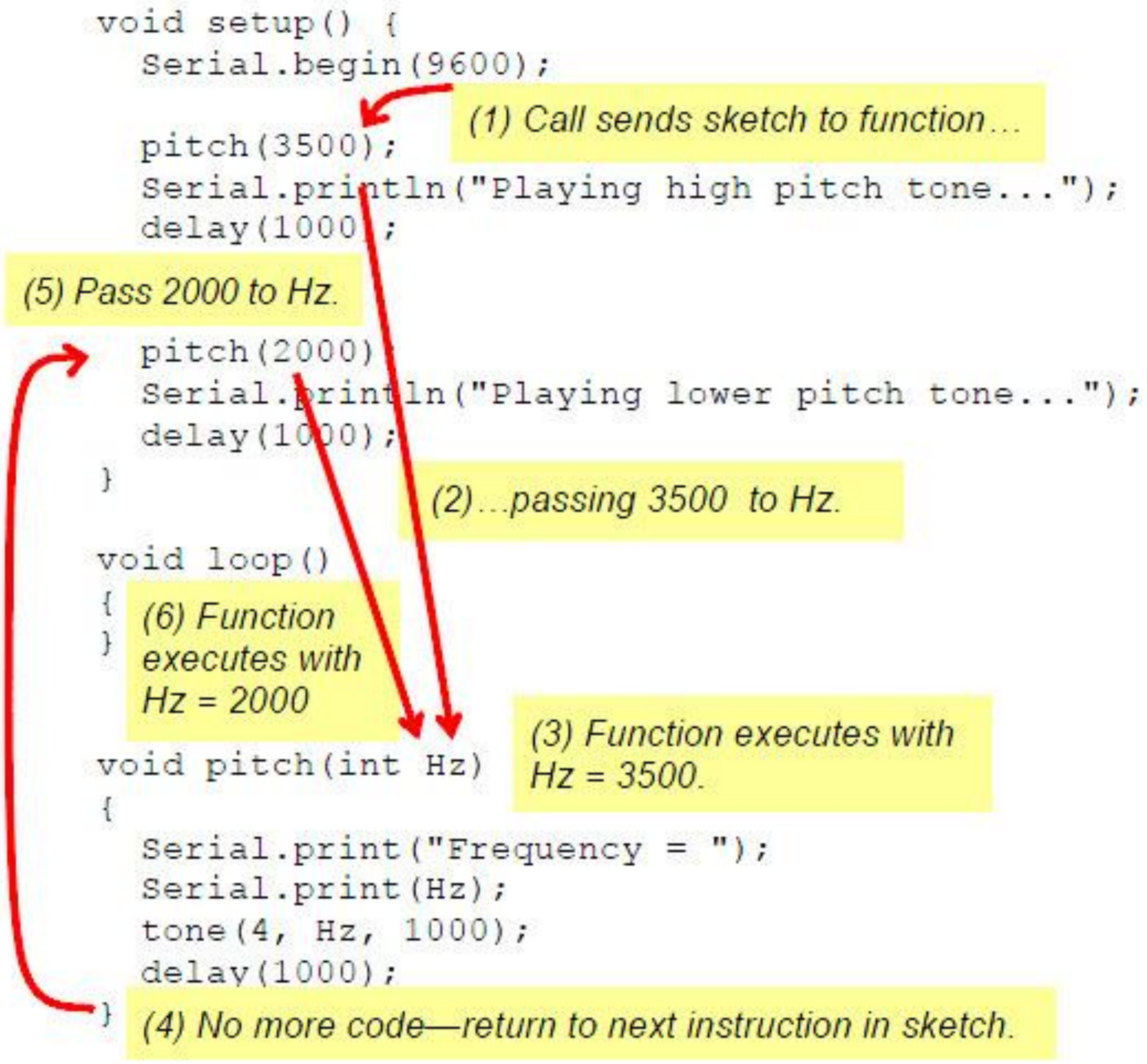
…sends sketch to function.

Function starts here.

When done, sketch returns to next instruction after function call.

learn.parallax.com

Functions: Example 2



```
void setup() {
  Serial.begin(9600);

  pitch(3500);
  Serial.println("Playing high pitch tone...");
  delay(1000);


  pitch(2000);
  Serial.println("Playing lower pitch tone...");
  delay(1000);
}

void loop()
{
}

void pitch(int Hz)
{
  Serial.print("Frequency = ");
  Serial.print(Hz);
  tone(4, Hz, 1000);
  delay(1000);
}
```

(1) Call sends sketch to function…

(2)…passing 3500 to Hz.

(3) Function executes with Hz = 3500.

(4) No more code—return to next instruction in sketch.

(5) Pass 2000 to Hz.

(6) Function executes with Hz = 2000

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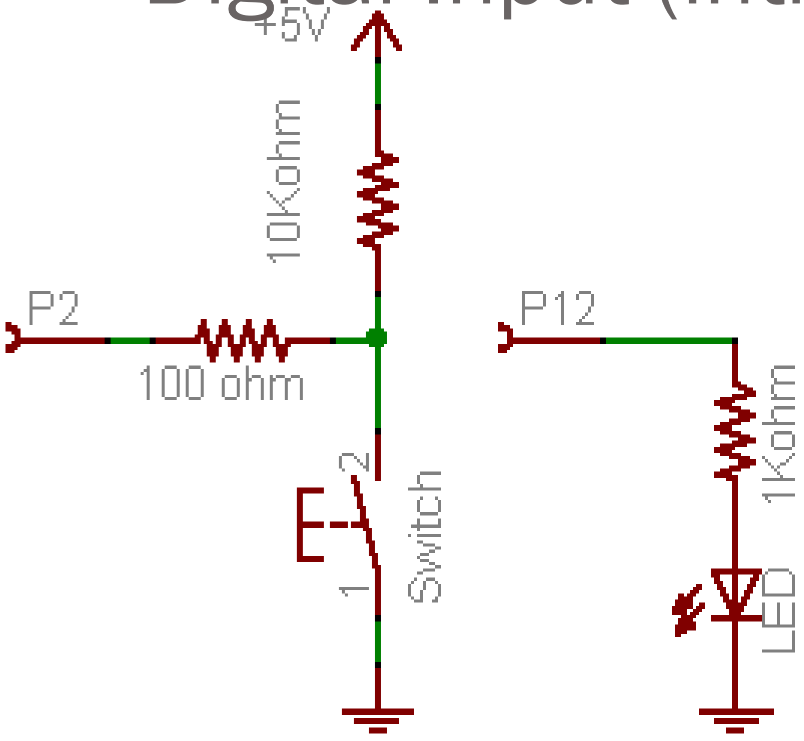
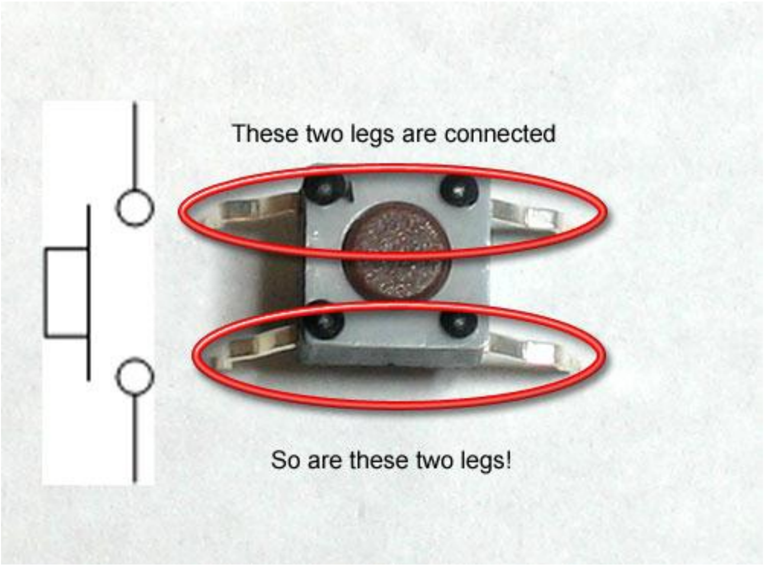
Digital Input (introducing the switch)



www.ladyada.net/



push-button switch

Create the circuit above and then run File -> Examples -> Digital -> Button

Thank You

Embedded C Programing Fundamentals

- What is the difference between flash memory, EPROM, and EEPROM?
- What is the difference between Volatile & Non Volatile Memory?
- What are the differences between a union and a structure in C?
- What is the difference between RS232 and UART?
- Is it possible to declare struct and union one inside other? Explain with example.
- How to find the bug in code using the debugger if the pointer is pointing to an illegal value.
- What is watchdog timer?
- What is the DMA?
- What is RTOS?
- What are CAN and its uses?
- Why is CAN having 120 ohms at each end?
- Why is CAN message-oriented protocol?
- What is the Arbitration in the CAN?
- Standard CAN and Extended CAN difference?
- What is the use of bit stuffing?
- How many types of IPC mechanism do you know?
- What is semaphore?
- What is the spinlock?
- Convert a given decimal number to hex.
- What is the difference between heap and stack memory?
- What is socket programming?
- How can a double pointer be useful?
- What is the difference between binary semaphore and mutex?