Getting your hands dirty with Embedded: An introduction to Arduino

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References:

- http://forefront.io/a/beginners-guide-to-arduino

1. Birth of MCU/ Microprocessor

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a. What is Arduino

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

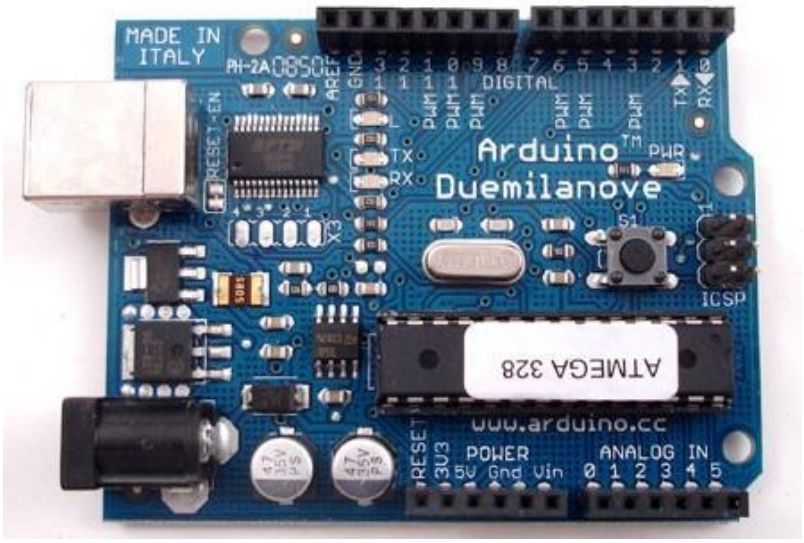
Source: http://www.arduino.cc/

b. What is microcontroller

A microcontroller is a compact microcomputer designed to govern the operation of embedded systems in motor vehicles, robots, office machines, complex medical devices, mobile radio transceivers, vending machines, home appliances, and various other devices. A typical microcontroller includes a processor, memory, and peripherals.

c. Which Arduino board we are going to use

The Arduino Duemilanove is a microcontroller board based on Atmel ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 Analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.



"Duemilanove" means 2009 in Italian and is named after the year of its release.

Summary of features provided by Duemilanove:

Microcontroller	ATmega168
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
Communication Interface	UART (Serial RX/TX), SPI, I2C.
Programming Interface	USB (using bootloader), ICSP(SPI)
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 2 KB used by boot loader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Power

The Arduino Duemilanove can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter or battery.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

Memory

The ATmega328 has 16 KB of flash memory for storing code (of which 2 KB is used for the bootloader).

Input and Output

Each of the 14 digital pins on the Duemilanove can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 K-Ohms.

In addition, some pins have specialized functions as mentioned below

1. Serial: 0 (RX) and 1 (TX)
   Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.
2. External Interrupts: 2 and 3
   These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
3. PWM: 3, 5, 6, 9, 10, and 11
   Provide 8-bit PWM output with the analogWrite() function.
4. SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK)
   These pins support SPI communication using the SPI library.
5. LED: 13
   There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Duemilanove has 6 Analog inputs, each of which provides 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function.

Additionally, some pins have specialized functionality:

1. I^2C: Analog input pins A4 (SDA) and A5 (SCL) Support I^2C (TWI) communication using the Wire library.

There are a couple of other pins on the board:

1. AREF
   This is reference voltage for the Analog inputs. Used with analogReference().
2. Reset
   Bring this line LOW to reset the microcontroller.

SETUP and LOOP brief Introduction

Source: http://arduino.cc/en/Reference/HomePage

Arduino Commands

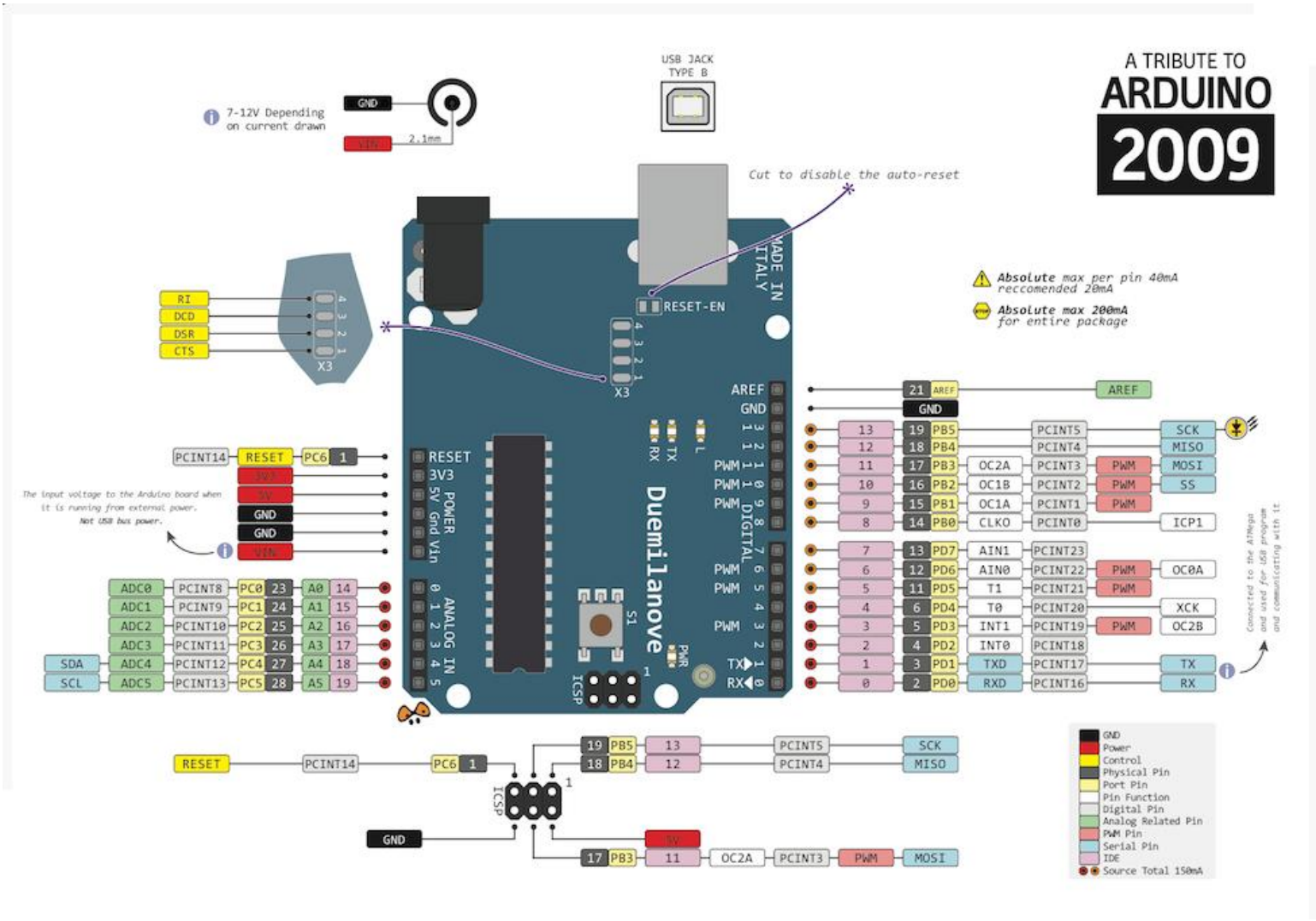
Setup

Command	**Explanation and usage**
pinMode(pin , mode)	Used to direct given Arduino pin as Input or Output Ex : `pinMode(13, OUTPUT); //`would set Arduino pin 13 as output
Serial-UART	
Serial.begin(baudrate)	Used to initialize serial communication. Input is baud rate at which communication takes place.

Loop

Command	**Explanation and usage**
GPIO's	
digitalWrite(pin, value)	Write a HIGH (5v) or a LOW (0v) value to a digital pin Ex: digitalWrite(13, HIGH); // would set the pin 13 as HIGH(5v)
digitalRead(pin)	Used to read the status of pin which is defined in input mode using pinMode command.
Delay	
delay(ms)	ms: the number of milliseconds to pause (*unsigned long*) Ex: delay(1000); // waits for 1000 millisecond
ADC	
analogRead(pin)	Reads the value from the specified Analog pin and returns integer (0-1023) Ex: value = analogRead(3); // read the pin 3 and save the value in value
analogReference(type)	Configures the reference voltage used for Analog input (i.e. the value used as the top of the input range). The options are: - DEFAULT: the default Analog reference of 5 volts (on 5V Arduino boards) - EXTERNAL: the voltage applied to the AREF pin (0 to 5V only) is used as the reference.
PWM	
analogWrite(pin, value)	The frequency of the PWM signal on most pins is approximately 490 Hz Pin: the pin to write to. Value: the duty cycle: between 0 (always off) and 255 (always on). Ex: analogWrite(9, 255); // analogWrite values from 0 to 255
Serial –UART	
Serial.write(byte)	Byte: Character byte supposed to be sent through serial communication.

Arduino Duemilanove Pin out Diagram



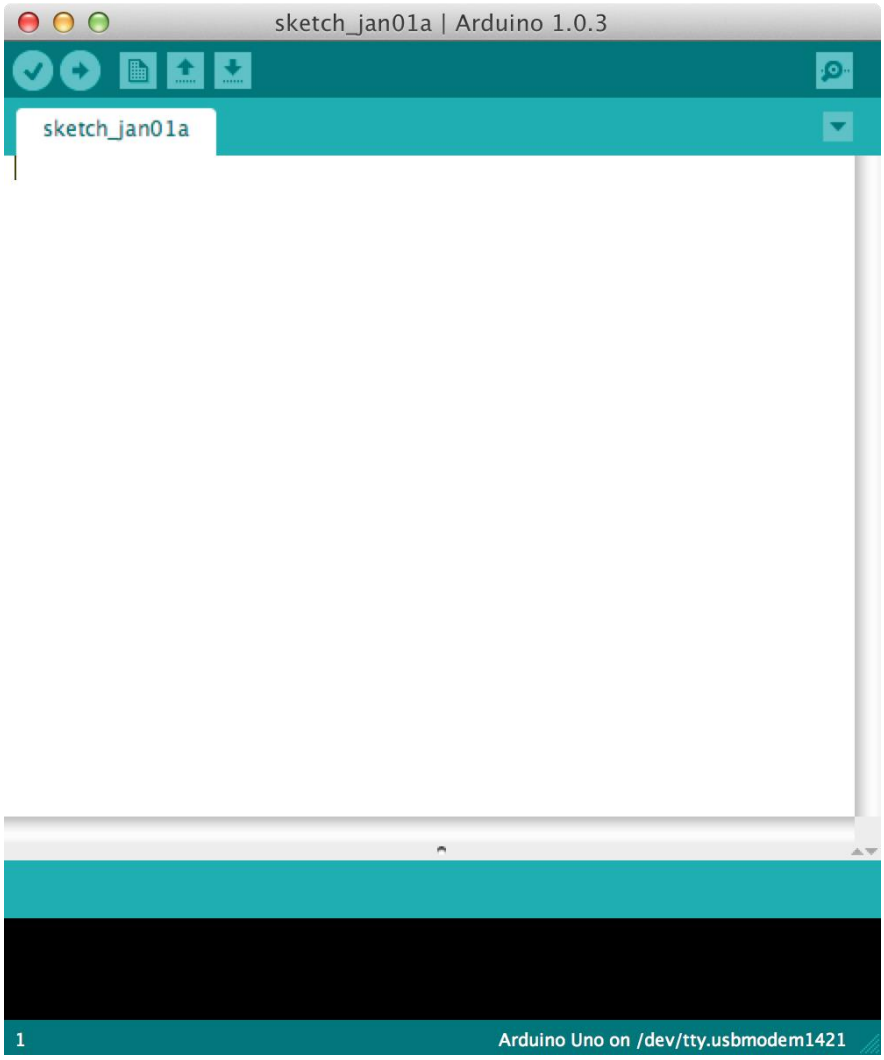
Source: http://arduino.cc/en/Main/arduinoBoardDuemilanove

3. Arduino sketches and internals

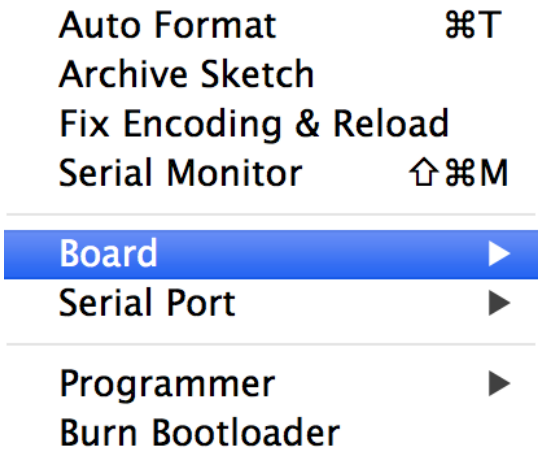
Arduino IDE Version 0022 works smoothly with Arduino Duemilanove (Link).

Steps for using the Arduino IDE are mentioned below:

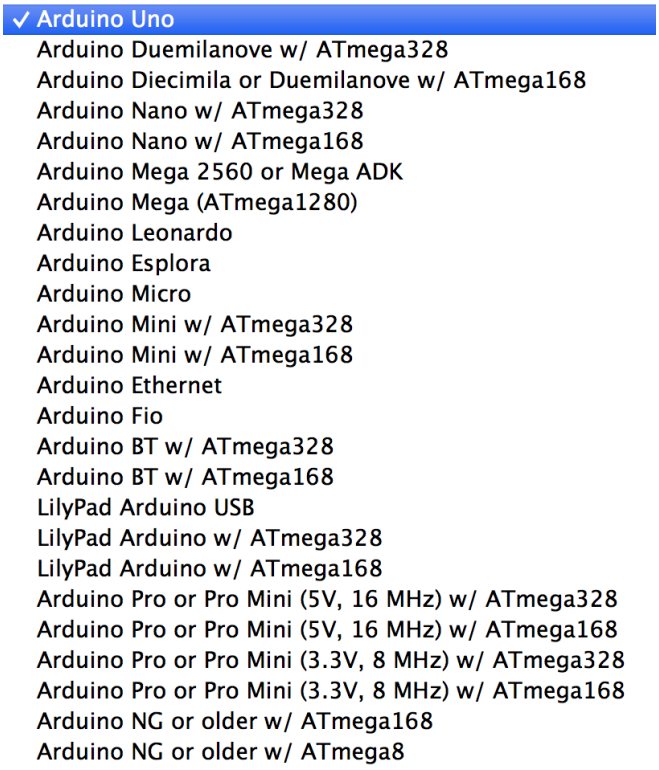
1. Start with new Arduino sketch



2. Initial setup:
   Select the board Go to **Tools** menu and select **Board**



Then select the type of Arduino you want to program, in our case it's the **Arduino** Duemilanove.



3. The Code

The codes you write for your Arduino are known as **sketches**. Every sketch needs two *void type functions*, `setup()` and `loop()`. A void type function doesn't return any value. The `setup()` method is ran once at the just after the Arduino is powered up and the `loop()` method is ran continuously afterwards. The `setup()` is where you want to do any initialisation steps, and in `loop()` you want to run the code you want to run over and over again.

So, your basic sketch or program should look like this:

```
void setup()
{

}

void loop()
{

}
```

4. Blinking LED example

The onboard LED we want to control is on pin 13. In our code above the `setup()` method let's create a variable called `ledPin`. In Arduino we need to state which type our variable is beforehand, in this case it's an integer, so it's of type `int`.

```
int ledPin = 13;

void setup()
{

}

void loop()
{

}
```

Each line is ended with a semicolon (`;`).

In the `setup()` method we want to set the `ledPin` to the output mode. We do this by calling a special function called `pinMode()` which takes two variables, the first the pin number, and second, whether it's an input or output pin. Since we're dealing with an

output we need to set it to a constant called `OUTPUT`. If you were working with a sensor or input it would be `INPUT`.

```
int ledPin = 13;

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

void loop()
{

}
```

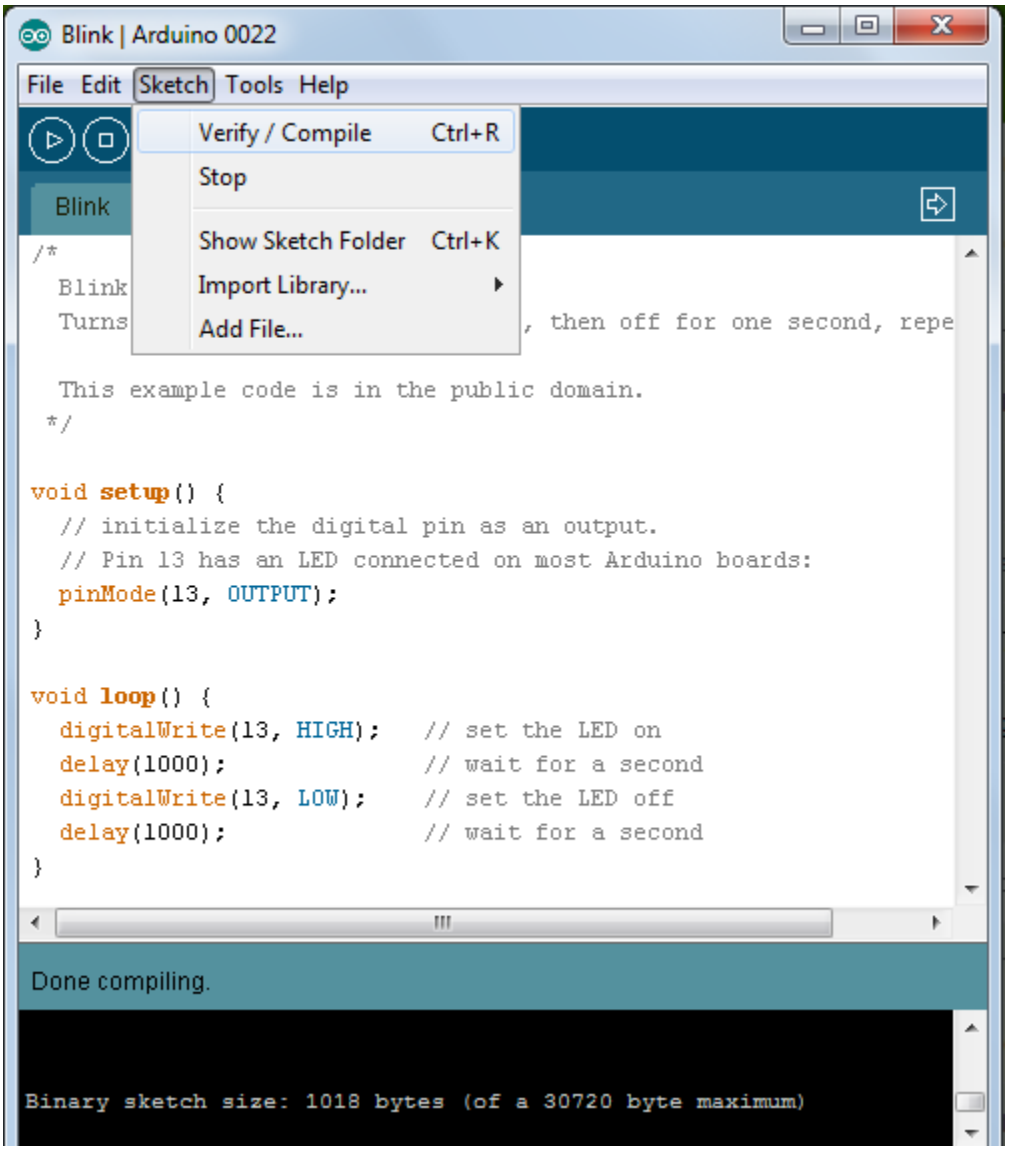
In our loop we are going to first switch off the LED to make sure our program is being transferred to the chip and overriding the default.
We do this by calling another special method called `digitalWrite()`. This also takes two values, the pin number and the level, `HIGH` or the on state or `LOW` the off state.

```
int ledPin = 13;

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

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

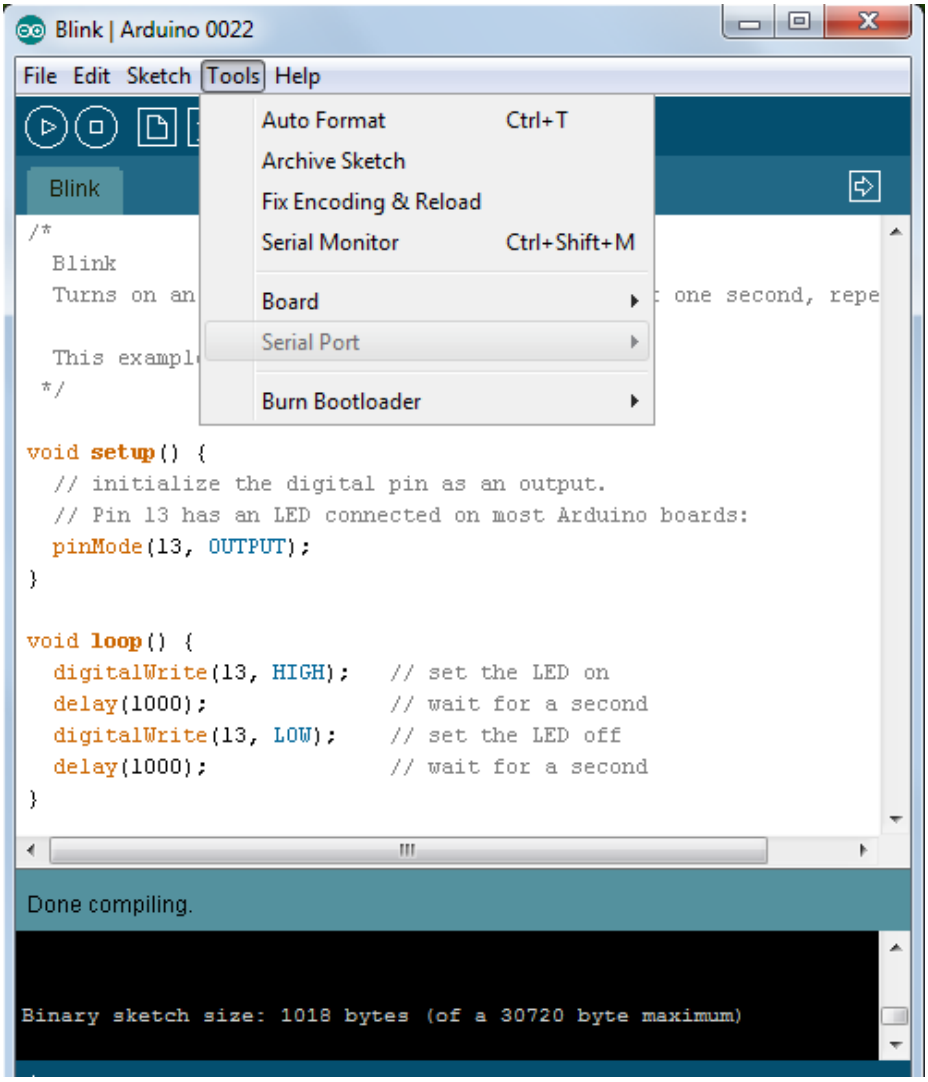
Next we want to compile to machine code and deploy or *upload* it to the Arduino.

5. Compiling the Code

Go to **Sketch** select **Verify/Compile** the sketch will start compiling



6. Selecting COM port for Arduino board: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Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
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*/
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
}
Done compiling.
Binary sketch size: 1018 bytes (of a 30720 byte maximum)

7. Press download button to load firmware (hex file) in to flash memory.