SMALL SATELLITES

Introduction to Programming for Arduino

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What Is Arduino?

- It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.
- Inexpensive (~\$30 board)
- Platform agnostic
- Easy to program in Processing (C/C++)
- Open source software Software where the source code is made freely available
- Open source hardware Hardware where the design specifications are made freely available



Yeah, but what does it do?



Arduino does all that you see here

Ok, but how?



- USB Data (including compiled code) to and from computer
- Power Supply Runs devices when not powered through USB
- Power Pins Supplies power for external devices and sensors
- Analog pins Receive signal from analog devices
- Digital pins receive binary from digital devices
- Serial pins Communicate with other serial devices

Step 1 – Configure Hardware



Step 2 – Write Code (Sketch)

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//includes	•						
<pre>#include <softwareserial.h></softwareserial.h></pre>							
///afinitiona							
int led = 13:							
// the setup routine runs once when you press reset:							
void setup() {							
// initialize the digital pin as an output.	// initialize the digital pin as an output.						
prinode(red, correct);							
// the loop routine runs over and over again forever:							
<pre>void loop() {</pre>							
<pre>digitalWrite(led, HIGH); // turn the LED on (HIGH is the voltage level)</pre>							
delay(1000); // wait for a second							
digitalWrite(led, LOW); // turn the LED off by making the voltage LOW							
detay(1000); // wait for a second							
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Step 3 – Load Code onto Device



Step 4 – Rejoice!





- Attach Arduino to USB port as shown
- Load the Arduino Integrated Development Environment (IDE) to begin coding
- If you haven't downloaded Arduino yet, you can get the software at <u>http://arduino.cc/en/main/software</u>
- If your computer does not recognize the Arduino automatically, you might need extra help getting drivers installed

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	New	Ctrl+N	
	Open	Ctrl+0	
	Sketchbook	•	S4_Accelerometer
	Examples	۱.	S4_All_Sensors
	Close	Ctrl+W	S4_Barometric
	Save	Ctrl+S	S4_GPS
	Save As	Ctrl+Shift+S	S4_Humidity
	Upload	Ctrl+U	S4_Magnetometer
	Upload Using Programmer	Ctrl+Shift+U	S4_OpenLog
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- Sketchbook is a collection of prewritten Arduino programs
- Select the Serial
 Monitor Sketch to
 load the code for
 this activity
 automatically
- Double-check that on the bottom of your screen you see Arduino Uno and a COM port

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S4_SerialMonitor	
void setup()	A
{	
<pre>Serial.begin(9600);</pre>	
}	
void loop()	
{	
Serial.println("Hello World");	
delay(1000);	
}	
	+
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Compiling sketch	
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- Press the upload button at the top of the Arduino IDE this will:
 - Compile the code into a binary file that the computer can understand
 - Upload that binary file to the Arduino and begin execution
- When the upload is complete, the Arduino IDE will say "Done Uploading" at the bottom of the code window
- If there is a mistake in your code, or a problem uploading it to the Arduino, you will notice a message in the output window below the code window (black background)

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File Edit Sketch Tools Help			Send
	<mark>.</mark>	Hello World	
S4 SerialMonitor		Hello World	
		Hello World	
void setup()	<u>^</u>	Hello World	
{		Hello World	
<pre>Serial.begin(9600);</pre>		Hello World	
}		Hello World	
<pre>void loop()</pre>		Hello World	
{		Hello World	
<pre>Serial.println("Hello World");</pre>		Hello World	
delay(1000);		Hello World	
}		Hello World	
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1 Ardu	uino Uno on COM9	V Autoscroll No line ending 👻	9600 baud 🛛 👻

Once your code has uploaded, open the Serial Monitor to see the output of your code

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- Code is being executed on Arduino, not your computer
- Output is being sent back over the same USB cable you use to program your device
- Serial Monitor is two way communication

Anatomy of an Arduino Sketch



- Sketches always have at least two functions, setup and loop
- Setup gets run once and only once right after the device is started or restarted
- Loop is run continuously thereafter for as long as the device is active.
- Serial.begin tells the Arduino that we will be sending data at a speed (baud rate) of 9600 characters per second.
- Serial.println prints a line of text to the serial port for the computer to read
- Delay makes the Arduino wait 1,000 milliseconds.

Programming Terminology

- Variable An object that has been allocated in memory to save a certain type of value; it could be a number, some text, or a more complicated object
- Function A block of code that preforms a specific task and is wrapped in curly brackets { }
- **Return type** The kind of value that is output by a function. If a function returns no value, its return type is Void.
- Parameter The value or values that are input to a function.
 If a function expects no parameters, its parameters are said to be empty

Functions: Parallels to Mathematics



This is the same function being expressed in a standard mathematics notation and in a pseudo code notation. Both functions expect a value to be supplied to them (x) and return a value based on x. In Mathematics, all values are number, but in programming they could be other things, so we must specify.

Declaring Variables



- Declaring variable allocates space in memory that we can assign values to or read values from
- Variable are declared with a type
- Types can be simple, like double or string
- Types can be complex like S4Sensor
- Variables are defined at a certain scope, like Global or within a function

Using Libraries

- Libraries save time by reusing code written by other programmers
- Include a library with the #include syntax. The header file and associated .cpp file must be present in your libraries folder to call a library.
- Once included, the functions and classes of that library are available to you
- Many useful libraries have been included for you
- You can create your own libraries, but it's outside the scope of this training.



Programming Challenge!

Create a program that (as it loops) prints out the values of the Fibonacci sequence

$$F_n = F_{n-1} + F_{n-2},$$

Your results should look like this

 $0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, \ldots$



- Arduino Playground A user community with many good tutorials and documents for beginning Arduino developers <u>http://arduino.cc/playground/</u>
- Make Magazine Organizers of the Make Fair and big promoters of Open-Source software/hardware like Arduino http://blog.makezine.com/arduino/
- Liquidware Open Source Hardware Vendor http://www.liquidware.com/
- Sparkfun Open Source Hardware Vendor http://www.sparkfun.com/
- Adafruit Open Source Hardware Vendor http://adafruit.com/