Arduino: What is it? What can it do?

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What is an Arduino?

According to Arduino:

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

According to Wikipedia:

Arduino is a single-board microcontroller designed to make the process of using electronics in multidisciplinary projects more accessible.

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What is an Arduino?

- Open Source
  - Reference designs for hardware
  - Firmware
  - Programming tools + GUI
- Mostly based around 8-bit Atmel AVR chips
- There is also a variant based on an ARM Cortex-M3
- Several 'official' varieties with different chips, extra functionality, different shapes and sizes
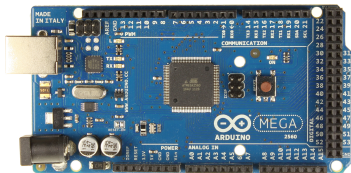
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Arduino Uno

- ATmega328
- 14 Digital I/O Pins (6 can do PWM)
- 6 Analog Input Pins
- 32 KB Flash Memory, 2 KB SRAM, 1 KB EEPROM
- 16 MHz Clock
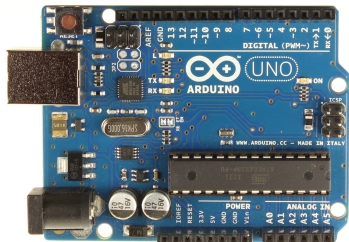
Arduino Mega2560

- ATmega2560
- 54 Digital I/O Pins (15 can do PWM)
- 16 Analog Input Pins
- 256 KB Flash Memory, 8 KB SRAM, 4 KB EEPROM
- 16 MHz Clock

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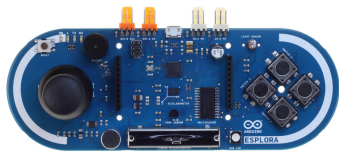
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LilyPad Arduino

- ATmega168V or
  ATmega328V
- 14 Digital I/O Pins (6 can
  do PWM)
- 6 Analog Input Pins
- 16 KB Flash Memory, 1
  KB SRAM, 512 bytes
  EEPROM
- 8 MHz Clock
- Thin, probably washable

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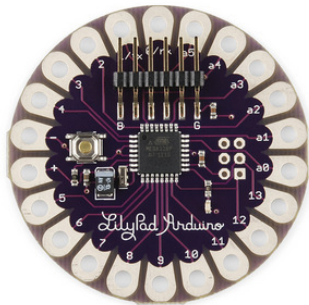
Arduino Esplora

- ATmega32u4
- Lots of onboard stuff:
  - Analog joystick + button, D-pad
  - 3-axis linear accelerometer
  - Linear potentiometer
  - TinkerKit connectors
  - Headers designed to connect to a TFT module available from Arduino

- Can present itself as a serial device, or as keyboard/mouse

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Arduino Due

- AT91SAM3X8E (ARM
  Cortex-M3)
- 54 Digital I/O Pins (12
  can do PWM)
- 12 Analog Input Pins, 2
  Analog Output pins
- 512 KB Flash Memory, 96
  KB SRAM
- 84 MHz Clock

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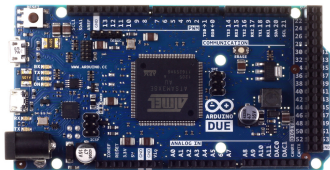
Arduino Shields

- Extension boards that stack on top of other Arduino boards
    - Only works for the rectangular boards: Uno, Mega, Due etc.
- Add extra hardware that communicates with the Arduino using some of the existing I/O pins
- Pins not used by the shield are typically passed through
- Allows connections to other components using the uppermost board of the stack.

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Arduino Shields

- Ethernet/WiFi/XBee + SD Card shields
  - SD card for file transfers
  - Ethernet + WiFi libraries support TCP and UDP and will do DNS lookups
  - Libraries provide support for acting as a server
- Motor shield
  - Separate power supply
  - PWM speed control
  - Can brake motors rather than free-wheeling when speed reduced
  - Motor current can be read by Arduino
- GSM shield
  - Supports voice, data + SMS
  - Controlled with AT Commands
  - Replaceable SIM card

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Programming Arduino devices

- Programs (*Sketches*) written in C or C++
- Require two functions: setup() and loop()
- setup() is run once when the board is reset
- loop() is (as the name suggests) run repeatedly

In other words, the bootloader runs this:

```
void main() {
    setup();
    do {
        loop();
    } while(1);
}
```

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Language features

- Usual C style flow control and variable types:
    - `if`, `for`, `while`, `do`, `switch`, `goto`
    - `int`, `int`, `char`, `long`, `short`, `float`, `double`
    - Simple arrays - `int foo[5]`
    - `char foo[10]` style strings
- Also supports `String` objects
- Comments (Not sure what these are)
- Lots of features provided by library code
- Can just use C/C++, with some caveats
  No `libstdc++`, no `new` or `delete` ...

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A simple example

Blink an LED at 1Hz:

```
int led = 13; // Most boards have an LED on pin 13

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

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

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Serial communication

```
/*
Reading a serial ASCII-encoded string.
Circuit:
 * Common anode
 * Red cathode: digital pin 3
 * Green cathode: digital pin 5
 * blue cathode: digital pin 6
 * anode: +5V

 created 13 Apr 2012
 by Tom Igoe

 This example code is in the public domain.
 */
const int redPin = 3;
const int greenPin = 5;
const int bluePin = 6;

void setup() {
  Serial.begin(9600);
  pinMode(redPin, OUTPUT);
  pinMode(greenPin, OUTPUT);
  pinMode(bluePin, OUTPUT);
}
```

```
void loop() {
 while (Serial.available() > 0) {
   int red = Serial.parseInt();
   int green = Serial.parseInt();
   int blue = Serial.parseInt();

   if (Serial.read() == '\n') {
     red = 255 - constrain(red, 0, 255);
     green = 255 - constrain(green, 0, 255);
     blue = 255 - constrain(blue, 0, 255);

     analogWrite(redPin, red);
     analogWrite(greenPin, green);
     analogWrite(bluePin, blue);

     Serial.print(red, HEX);
     Serial.print(green, HEX);
     Serial.println(blue, HEX);
   }
 }
}
```

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What are people doing with Arduino?

- Lots of examples listed at
  http://playground.arduino.cc
- GardenBot: Open source garden monitoring system
  http://gardenbot.org/
- OpenEnergyMonitor: Modular power monitoring system
  http://openenergymonitor.org/emon/
- Beer bottle opener:
  Uses an Arduino to control a 2.8hp two stroke engine to
  open swing top bottles
  https://www.youtube.com/watch?v=0Yrnya6z410
- ArduPlane/ArduCopter: Fixed-wing and rotary-wing UAVs
  http://www.ardupilot.co.uk/

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Much of the material for this talk was stolen/reused from:

- http://arduino.cc/
    - In particular, http://arduino.cc/en/Guide/

- https://en.wikipedia.org/wiki/Arduino

Slides will be available at
http://sucs.org/~tswsl1989/talks/

Thanks for listening

Any questions?