Arduino Part 1:
Type and Blink
- Last class, solder and blink

But…
- How do you change it?
- How can you really use this?
- What could you use?
Arduino Overview:
Arduino Overview:

IT'S A SMALL MIRACLE HOW HEWLETT-PACKARD
PUT 656K OF MEMORY, LOTUS 1-2-3, WORD
PROCESSING, A TELECOMMUNICATIONS MODEM
AND COMPLETE IBM CONNECTABILITY INTO

A 9-POUND COMPUTER.

THE PORTABLE.

For years business people had to choose
between the power of a desktop computer and the
limited capabilities of the first portables. That
problem was solved when Hewlett-Packard intro-
duced The Portable.

The Portable is designed with more total
memory than most leading desktop personal
computers...656K in fact. That includes 256K of
user memory. So, The Portable's built-in
business software can work with enormous
amounts of data.

1-2-3 from Lotus, America's most popular
spreadsheet, file management and business
graphics program, is permanently built into The
Portable. So is Hewlett-Packard's word processing
program, MemoMaker. Just press the key and
you're ready to work.

The Portable even has a built-in modem and
easy-to-use telecommunications software to send
or receive data using a standard telephone jack.

If you own a Hewlett-Packard Touchscreen
PC, IBM® PC XT or an IBM compatible you'll
be glad to know that your desktop and The
Portable can talk to each other with the simple
addition of the Hewlett-Packard Portable
Desktop Link.

The Portable's rechargeable battery gives
you 16 hours of continuous usage on every charge.

Finally, you can work comfortably on a full
size keyboard and an easy-to-read 16-line by 96
character screen. And it all folds shut to turn The
Portable into a simple nine-pound box.

The Portable: A small miracle...perhaps.
But then consider where it came from.

See The Portable and the entire family of
personal computers, software and peripherals at
your authorized Hewlett-Packard dealer. Call
800-345-0000 for the dealer nearest you.

HEWLETT
PACKARD

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Arduino Overview:

"Designing a revolutionary concept in software demanded a computer with extraordinary performance. The Tandy 2000 delivered."

Bill Gates
Chairman of the Board, Microsoft

Bill Gates has been at the leading edge of personal computing since the very beginning. His company is a leading producer of microcomputer software.

"Our newest software product, MSWindows, is an integrated windowing system. It will let personal computer users combine individual programs into a powerful, integrated system.

"When we set out to design MSWindows, in color, we knew that the Tandy 2000 computer would let us turn an extraordinary product into a work of art. The graphics are sharp and crisp, and give us a degree of variability like nothing before.

"Our engineers were quite impressed with the processing speed of the Tandy 2000's 8088 microprocessor too. And while the finished product will utilize the 8088's DeskMouse, the well laid out keyboard has helped us speed through the design stage.

"We're proud of our work. So when we want to show someone how great MSWindows really is, we give them a demonstration. On the Tandy 2000.

"It is time you enjoyed peak performance from a personal computer. Can you wish to watch how much faster today's most sophisticated programs run on the high-technology Tandy 2000?

"You can choose from the latest programs around, too, with our exclusive Express-Order Software service.

"Tandy 2000 systems start at $2,000, and can be leased for only $50/month! Get in today and see what you've been missing.

Radio Shack
Computer Centers

Engineered for Excellence!

We've introduced the latest in technology for our users. The Tandy 2000 offers twice the speed of the Apple II, and the storage of other MS-DOS systems.

Radio Shack
Computer Centers

Our new 1985 computer catalog is yours for the asking at any Radio Shack Computer Center or participating Radio Shack store or dealer. Check out our complete line of microcomputers—from pocket models to laptop portables, from powerful desktop computers to multi port office systems. We have it all. That's why we invite comparison!
**Arduino Overview:**

**General Purpose computer**
- Usually has a human in the loop
- Can be reconfigured to do any number of tasks (excel, email, music)

**Embedded Systems**
- Human input not required all the time
  - Takes specific inputs and computes outputs for a very specific application
- Meets real-time goals
  - Heart monitor
  - Automatic braking systems (ABS)
CoDR Template is on the Website – DUE 7 AM 10-02-12

New HW #5 on Website – DUE in class 10-04-12

Announcements:
CoDR Template is on the Website – DUE 7 AM 10-02-12

New HW #5 on Website – DUE in class 10-04-12

Announcements:
Bit nervous how this might go…
Arduino Overview:

What’s under the hood?

- **USB**
- **5.0 V Regulator**
- **9V DC Power In**
- **GND**
- **14 Digital Input/Outputs**
- **External Interrupts**
- **Serial I/O**
- **ATmega328**
  - 10 Bit ADC
  - 16 MHz
  - 32 KB Flash
  - I2C & SPI
  - 40 to +85C
- **3.3 V**
- **5.0 V**
- **GND**
- **6 Analog Inputs**
Arduino Overview:
Arduino Overview:

- So what does all that mean?
**Arduino Overview:**

**The Easy Stuff...**

- **USB**
- **5.0 V Regulator**
- **9V DC Power In**
- **3.3 V**
- **5.0 V GND**
Arduino Overview:

[Diagram of Arduino Uno Rev3 circuit]

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[Diagram of Arduino pinout]

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Arduino (TM) UNO Rev3

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[Additional diagrams and text]
Arduino Overview:

The Chip…

ATmega328
- 10 Bit ADC
- 16 MHz
- 32 KB Flash
- I2C & SPI
- 40 to +85C
Arduino Overview:

Other...

14 Digital Input/Outputs
6 Analog Inputs
External Interrupts
Serial I/O
Arduino Overview:

Arduino (TM) UNO Rev3
Analog vs. Digital
**Analog:**

- Voltage, continuous, real-world
Digital:

- Bits and Bytes, On/Off, 1 or 0, high or low, non-continuous
Digital:

- A state is one unique combination of bits
  - 1 bit – 0 or 1 = 2 states = $2^1$
  - 2 bits – 00, 01, 10, 11 = 4 states = $2^2$
  - 4 bits – 0000, 0001….1111 = 16 States = $2^4$
  - 8 bits = 00000000….11111111 = 256 states = $2^8$
  - 16 bits = 0000000000000000…1111111111111111
    = 65,536 states = $2^{16}$

- More bits provides more precision over a given voltage range

- If it is necessary to record small changes, more precision (bits), is required

- 8 bits is a byte
- 10 bits is how many bytes?
Digital:
- Bits and Bytes, On/Off, 1 or 0, high or low, non-continuous

Red line – 2 bits = less info
Green line – 4 bits = more info
Analog vs. Digital

- What is the difference between 8-bit and 10-bit conversions?
  
  - An 8-bit conversion has $2^8$ (0 to 255) possible values,
  
  - Resolution is $1/(2^8 - 1) \times 5V = 1/255 \times 5V = 0.0196 V$
Analog vs. Digital

- A 10-bit conversion has $2^{10}$ (0 to 1024) possible values

  - Resolution is $\frac{1}{(2^{10} - 1)} \times 5V = \frac{1}{1023} \times 5V = 0.00489$ V

- For a device that is very precise, a 10-bit conversion allows for a higher resolution on the data (high-range accelerometers)
Analog vs. Digital

Real World

42.0 C temp
Real World

Real World to
Analog Voltage

0C = 0V
50C = 5V

3 =
11 binary

4.20V = 4

(4.20V / 5.0V * 4) = 3.36
= 3

5V = 3
0V = 0

Storage for later use

4.20V = 42.0 C

2 bit ADC

5V = 3

ADC = Analog to Digital Converter
= Voltage to Binary
Sensor & Storage

42.0°C temp
Real World

Real World to
Analog Voltage

4.20V = 42.0°C

0°C = 0V
50°C = 5V

860 = 1101011100 binary

4.20V = 860

(4.20V / 5.0V * 1024)
= 860.14
= 860

Storage for later use

ADC = Analog to Digital Converter
= Voltage to Binary

5V = 1023
0V = 0

10 bit ADC
Arduino Overview:

Let’s take it for a drive…

- **USB**
- **5 V Regulator**
- **9V DC Power In**
- **3.3 V**
- **5.0 V**
- **GND**
- **14 Digital Input/Outputs**
- **Serial I/O**
- **External Interrupts**
- **ATmega328**
  - 10 Bit ADC
  - 16 MHz
  - 32 KB Flash
  - I2C & SPI
  - 40 to +85C
- **6 Analog Inputs**
**Arduino Overview:**

- Launch the Arduino Software **1.0.1**

- Sketch
Arduino Overview:

- File/Examples/01.Basics/BareMinimum
Arduino Overview:

- Compile
- Upload
- Serial Monitor
- Code
- Message Box
Arduino Overview:

```c
void setup() {
    // put your setup code here, to run once:
}

void loop() {
    // put your main code here, to run repeatedly:
}
```
**Arduino Overview:**

- Connect your Arduino Uno to your laptop via the USB cable

- Select right board = **Tools/Board/Arduino Uno**
Arduino Overview:

1. Compile code and check for messages

2. Upload code to Arduino (checking communication with board)
**Arduino Overview:**

- Any problems?

- Everyone, please wait until this has been completed
**Arduino Overview:**

- Add the following to the sketch...

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

  This example code is in the public domain.
*/

// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;
```
**Arduino Overview:**

- Add the following to the sketch...

```cpp
void setup() {
    // put your setup code here, to run once:
    // initialize the digital pin as an output.
    pinMode(led, OUTPUT);
}
```
Arduino Overview:

- Add the following to the sketch…

```c
void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(led, HIGH);  // turn the LED on (HIGH is the voltage level)
  delay(1000);              // wait for a second
  digitalWrite(led, LOW);   // turn the LED off by making the voltage LOW
  delay(1000);              // wait for a second
}
```
Arduino Overview:

1. Compile code and check for messages
2. Upload code to Arduino (checking communication with board)
- Does LED blink?

- Change the delay in the sketch and try again

- Do you see a change?
Arduino Overview:

- If you can Blink an LED, you can do anything

- Why?