Intro to Pure Data

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What is it used for?

- Composition ('Solitude')
- Sound Design
- Video Game Audio
- Audio/Visual Performance
- Augmented Instruments
- Etc…

What is Pure Data?

- Open-source visual programming language
- Deals with:
  - Sound
  - Video
  - 2D/3D Graphics
  - Interface with Sensors
  - Input Devices
  - MIDI/OSC

Types of Pure Data

- Vanilla – “core” of PD, focus on audio and MIDI processing
- Extended – Vanilla + user-wrtitten libraries, including GEM (graphics processing)

…but what about Max/MSP?

http://dm.ncl.ac.uk/sanj/2011/06/29/a-little-fun-with-puredata/

…but what about Max/MSP?

- Pure Data is FREE and Open-Source
- Embeddable
  - Mobile Devices (libpd)
  - Microcontrollers
  - What else?

History of Pure Data

- Developed by Miller Puckette while at IRCAM
- Branch of the "Max" patcher languages

  - Named after Max Matthews

  - Originally were Audio and MIDI only
- Goal of PD: extend processing to other applications (video/web interaction)

Configuration

- Audio Drivers
- Settings
- Testing, testing…

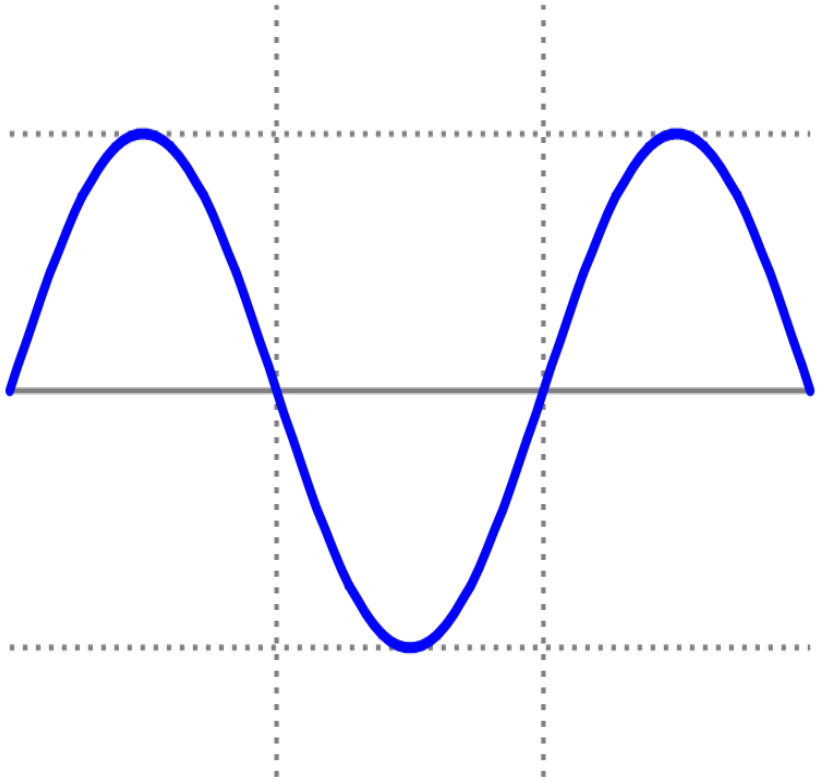
Conventional Programming

```
// Fixed amplitude is good enough for our purposes
const double amplitude = 0.25;

// Get the tone parameters out of the view controller
ToneGeneratorViewController *viewController =
    (ToneGeneratorViewController *)inRefCon;
double theta = viewController->theta;
double theta_increment = 2.0 * M_PI * viewController->frequency / viewController->sampleRate;

// This is a mono tone generator so we only need the first buffer
const int channel = 0;
Float32 *buffer = (Float32 *)ioData->mBuffers[channel].mData;

// Generate sine sample by sample
for (UInt32 frame = 0; frame < inNumberFrames; frame++)
{
    buffer[frame] = sin(theta) * amplitude;

    theta += theta_increment;
    if (theta > 2.0 * M_PI)
    {
        theta -= 2.0 * M_PI;
    }
}
```

Visual Programming

Over to PD…

…where we'll make a sine-wave generator!

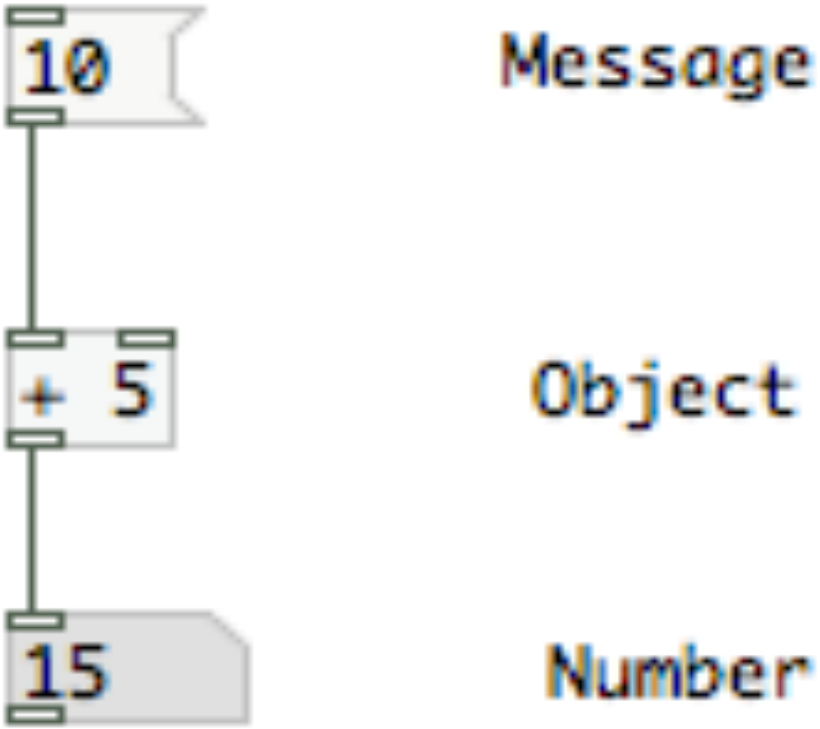


https://commons.wikimedia.org/wiki/File:Simple_sine_wave.svg

Creating Objects

- Type text into boxes.
- Text divided into atoms separated by white-space
- First atom specifies *type* of object, second atom is creation arugment (how to initialize object)
- “~” = “audio object”

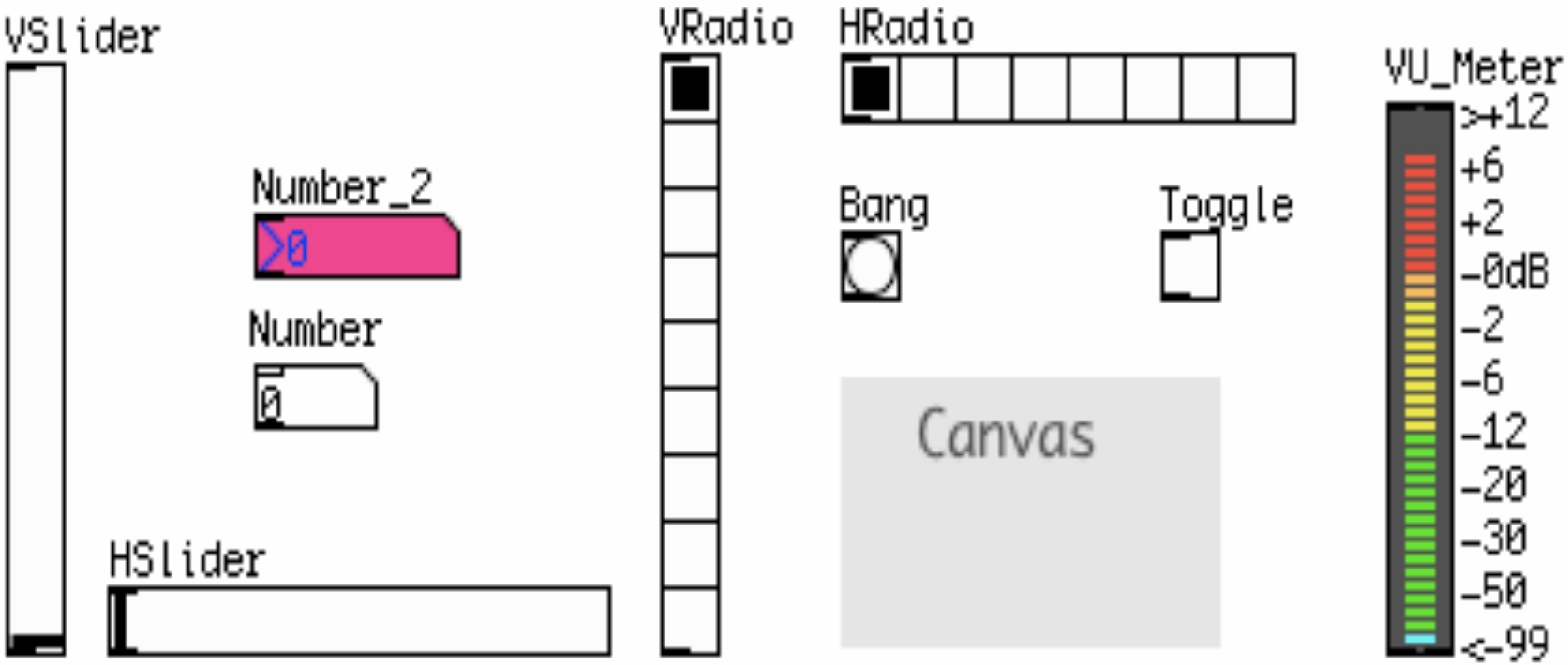
Messages, Objects, Numbers, Comments



Cables

- Signal (thick)
  - Audio data
- Control (thin)
  - Number data

GUI Objects



http://en.flossmanuals.net/pure-data/the-interface/the-interface/

Building A Synthesizer

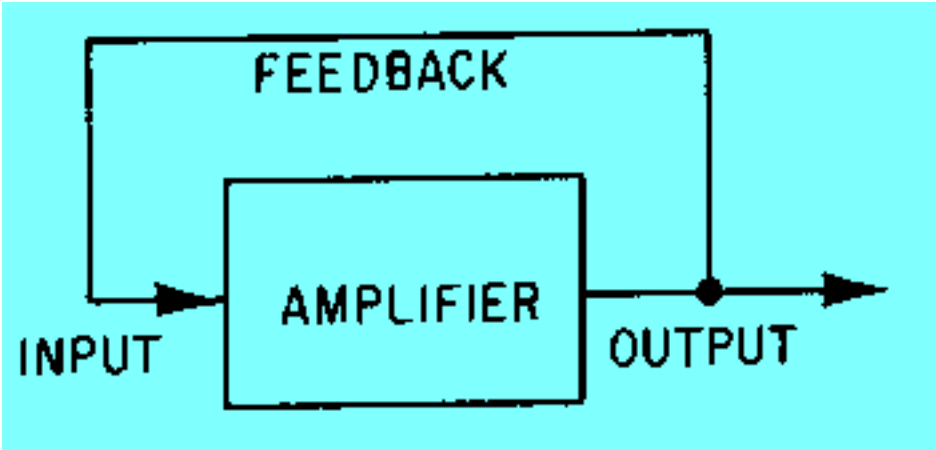
- **Oscillators** – generate tones
- **LFO** – modulates oscillator/filter
- **Filter** – emphesizes/removes frequencies
- **Envelope Generator** – controls changes over a note duration (ADSR)
- **Amplifier** – controls gain of the synth

Building a Synth!

https://en.wikipedia.org/wiki/File:Minimoog.JPG

Oscillators

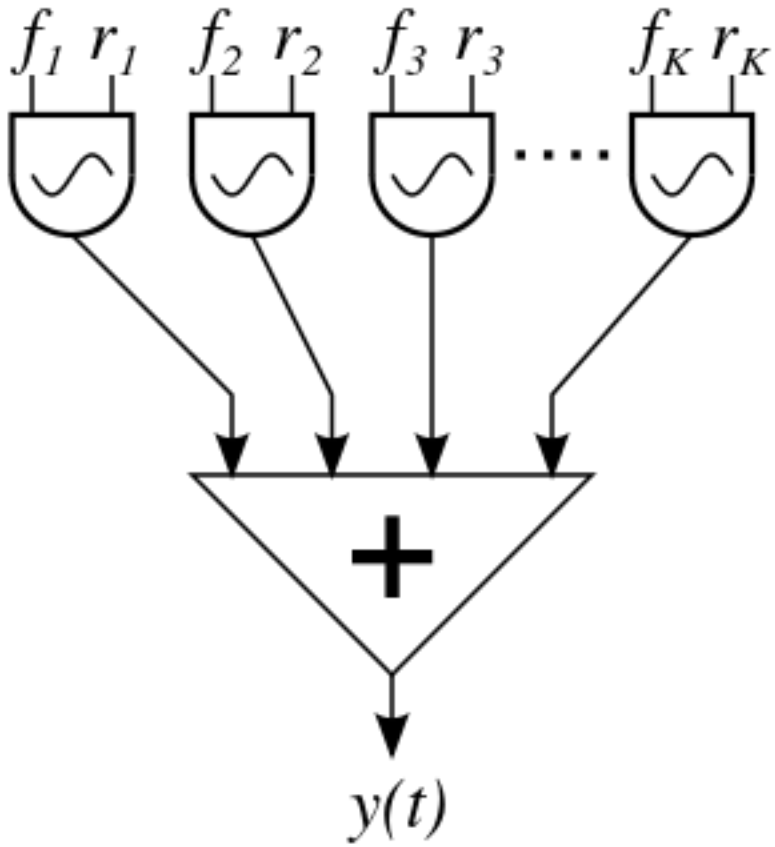
- Sine/Cosine
- Sawtooth
- Square



http://www.tpub.com/neets/book9/35.htm

Synthesis Types

- Additive
- Subtractive
  - Filters
- AM
- FM



https://en.wikipedia.org/wiki/File:Additive_synthesis.svg

Effects

Tremolo

http://proguitarshop.com/boss-tr-2-tremolo-pedal.html

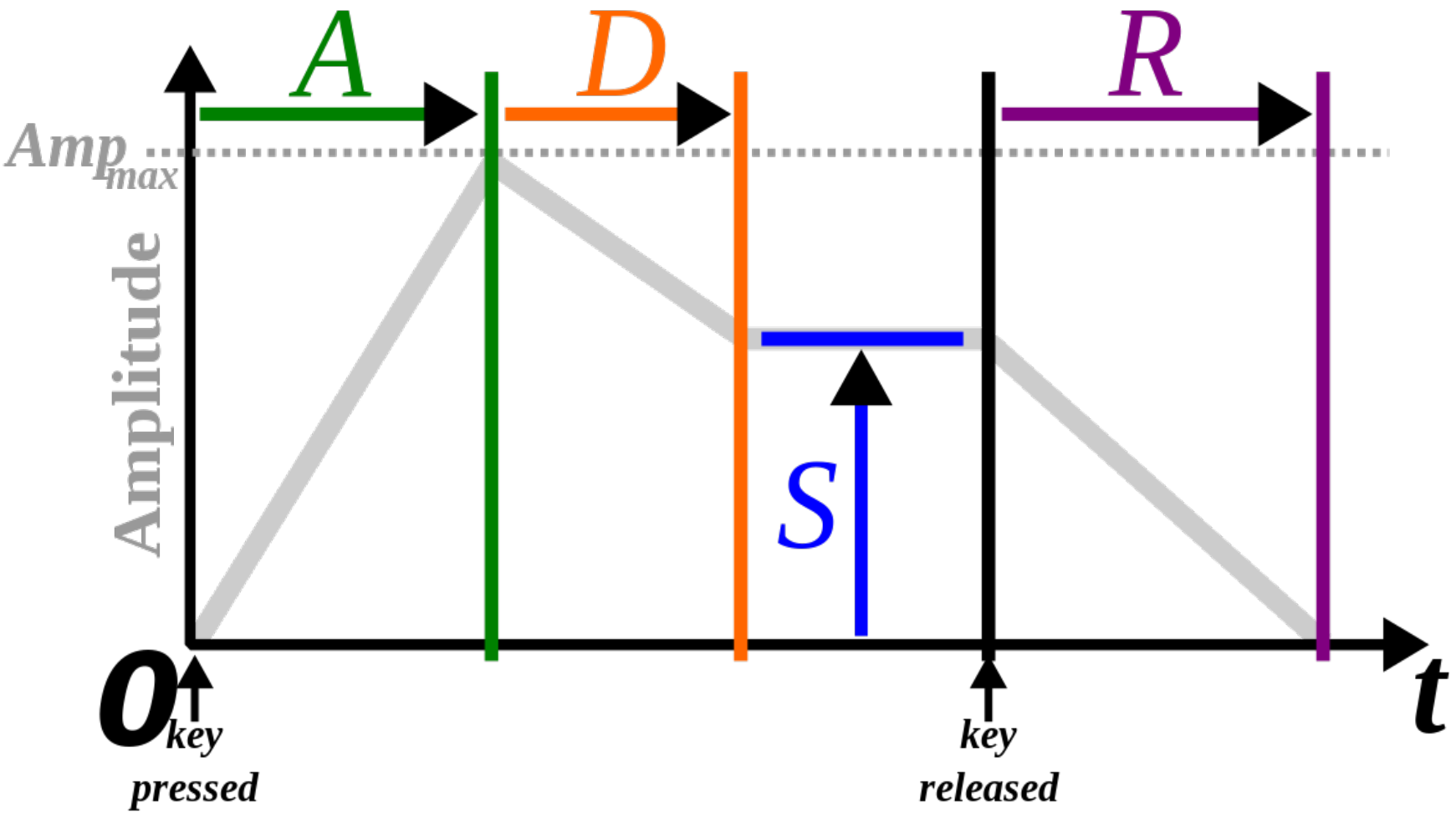
Ring Modulation

http://proguitarshop.com/electro-harmonix-frequency-analyzer-ring-modulator.html

ADSR

- **A**ttack
- **D**ecay
- **S**ustain
- **R**elease

ADSR



https://en.wikipedia.org/wiki/File:ADSR_parameter.svg

Sequencer

http://www.vintagesynth.com/arp/2500.php

Hot and Cold Inlets

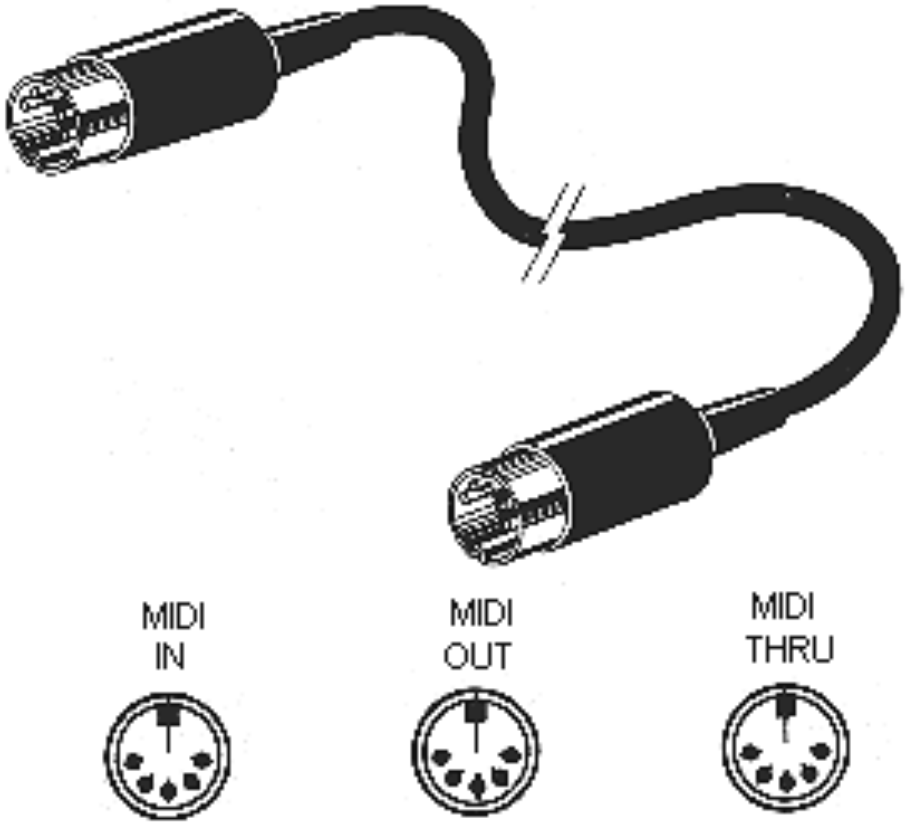
- Hot - leftmost inlet of an object
  - Messages to left inelts result in output messages
- Cold - rightmost
  - Used to store single values (numbers or symbols)

Final Synthesizer w/Keyboard Input

- Input
- Oscillator
- Filter
- Amp

MIDI

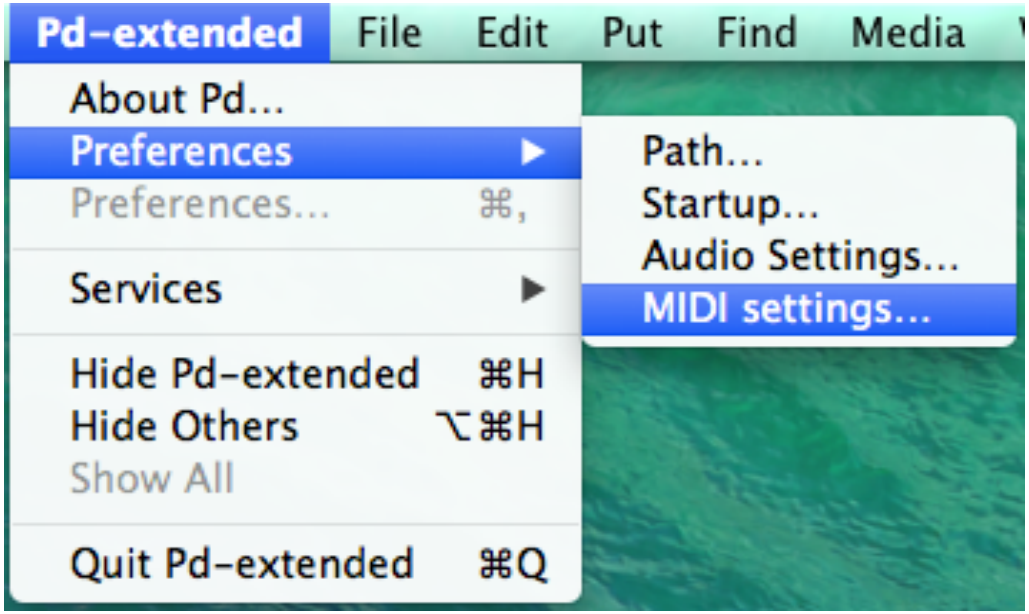
- **M**usical
- **I**nstrument
- **D**igital
- **I**nterface



http://mididrumfiles.com/content/wp-content/uploads/2010/03/MIDI2.gif

Configuration (MIDI)

- What OS do you use?
- OSX: PD > Preferences > MIDI Settings
- Linux/Windows: Media > MIDI Settings



MIDI Controllers

- [ctlin] object
  - Reads all channels as default
- [notein] object
  - Reads in note data

Other MIDI Objects

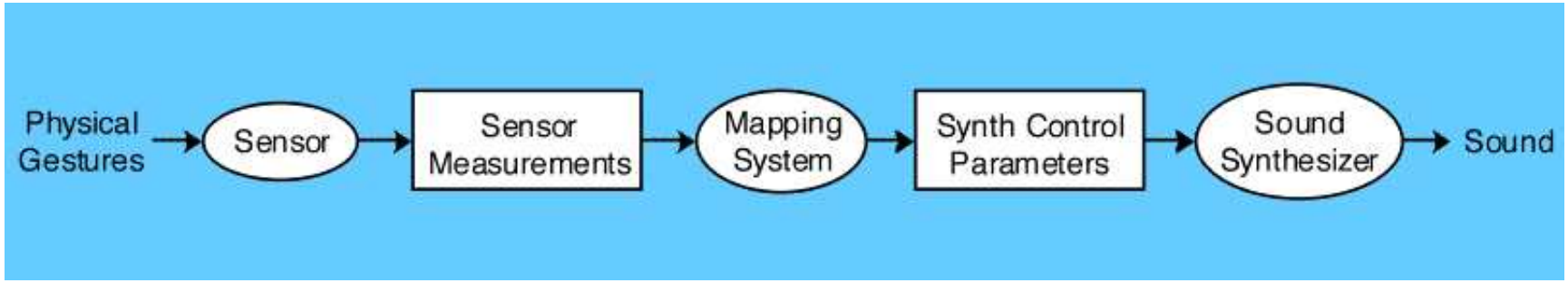
- [pgmin] / [pgmout]
  - Program changes (MIDI sound)
- [bendin] / [bendout]
  - Pitch bend information

OSC

- **O**pen
- **S**ound
- **C**ontrol

Specification

Application Areas

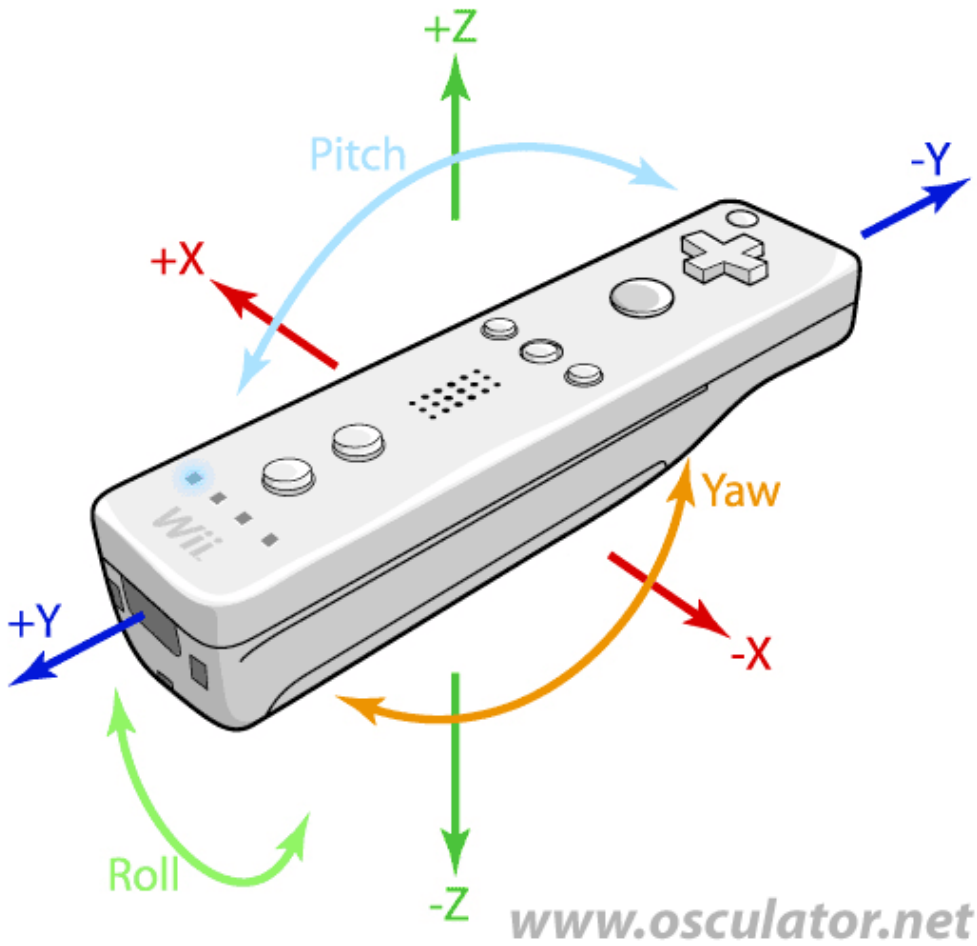


OSC + WiiMote

- OSCulator (MAC)
- GlovePIE (PC)

http://archive.roaringapps.com/app:2718

WiiMote Movement Parameters



http://www.osculator.net/doc/faq:wiimote

OSC + WiiMote

- Make sure to turn on Bluetooth
- Set parameters and type/value
- PD patch: localhost 9000
- More effects

GEM

- “Graphics Environment for Multimedia”
- PD Library
- Included in PD-Extended
- Based on OpenGL

Videopedia

Visual Recital Demo

GEM Setup

- [gemwin] – represents window
  - Set frame-rate
- [gemhead] – start of render chain
  - Moves downward

GEM Examples

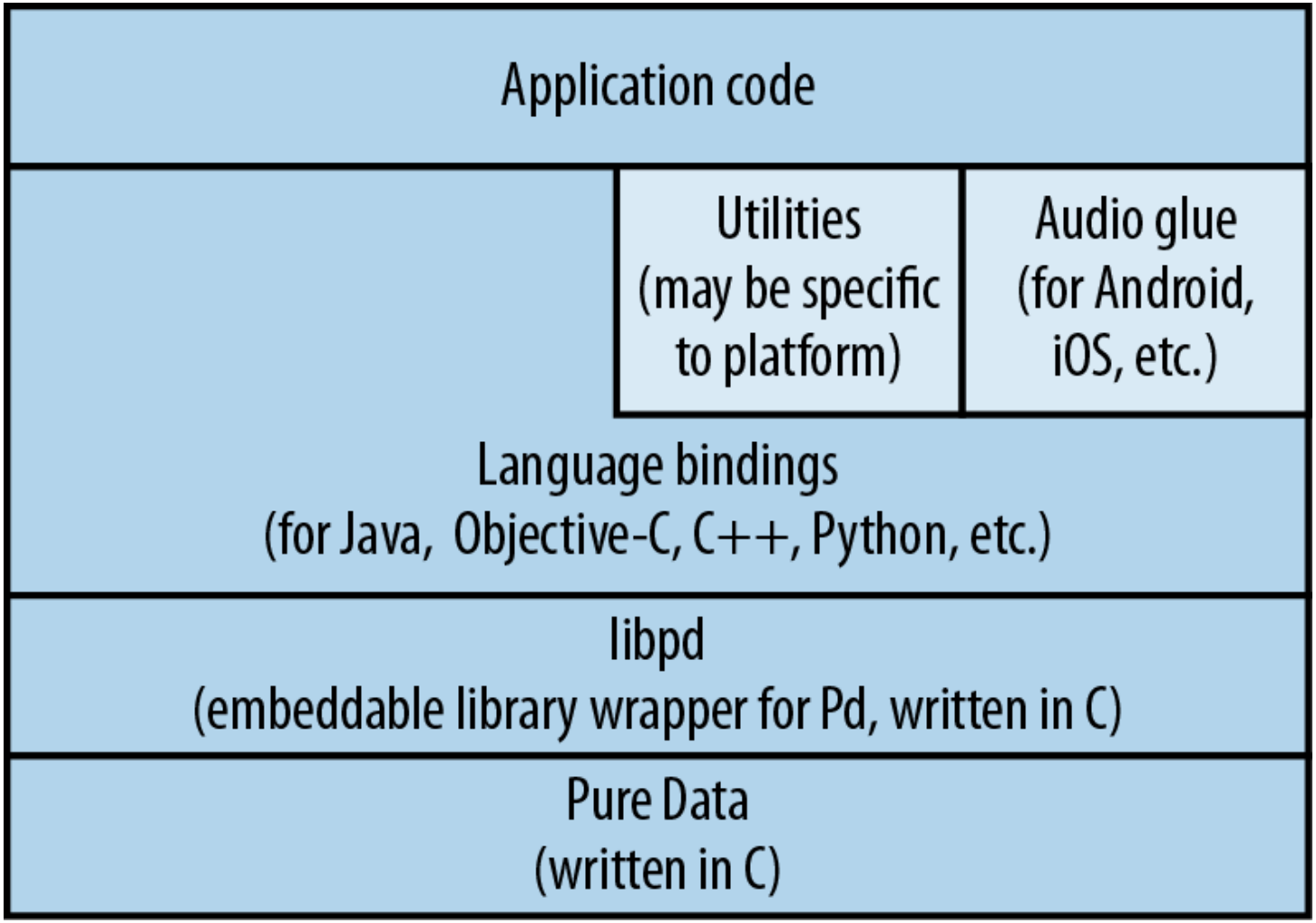
- Video Playback
- Camera Input
- Video Mixer
- Video Synthesis
- VJ Set

libpd

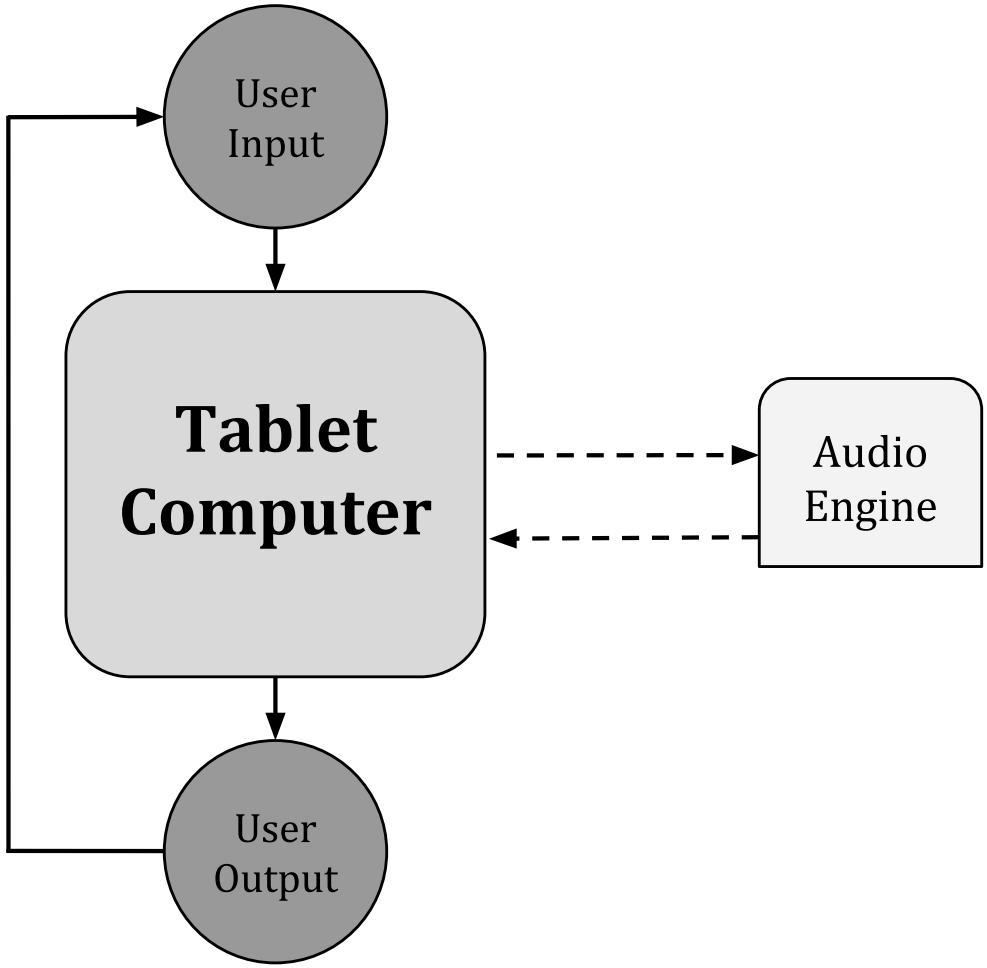
- Based on PD-Vanilla
- Links PD and mobile platforms
- Java (Android) and Objective-C (iOS)

Download

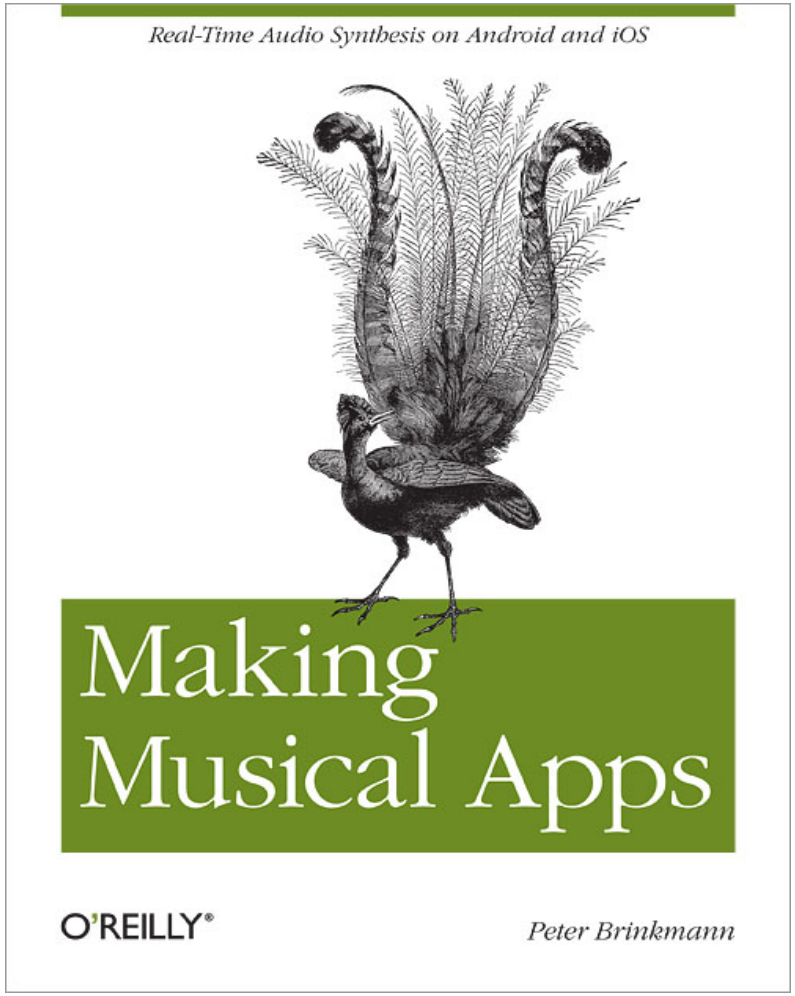
libpd


Application code
Utilities
(may be specific
to platform)
Audio glue
(for Android,
iOS, etc.)
Language bindings
(for Java, Objective-C, C++, Python, etc.)
libpd
(embeddable library wrapper for Pd, written in C)
Pure Data
(written in C)

libpd

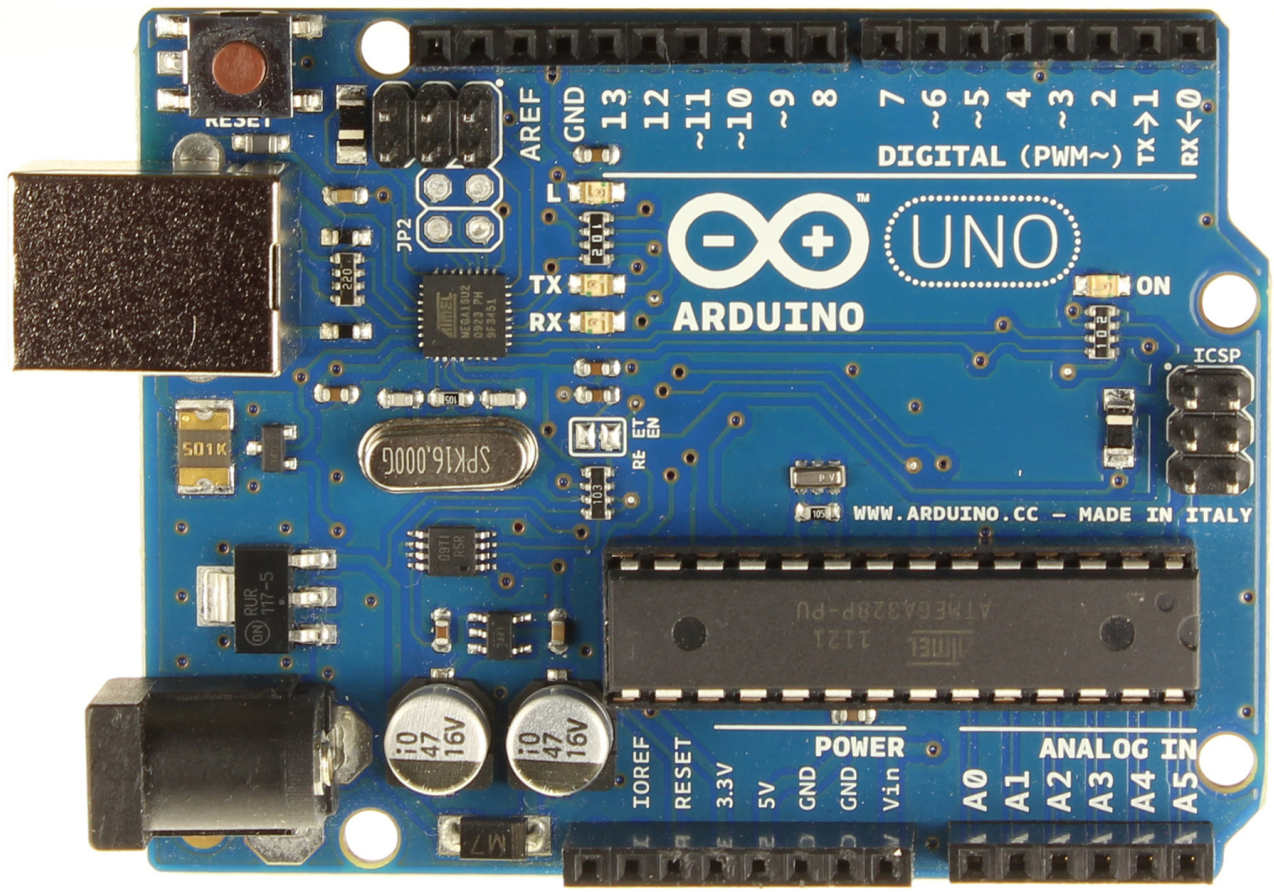


libpd



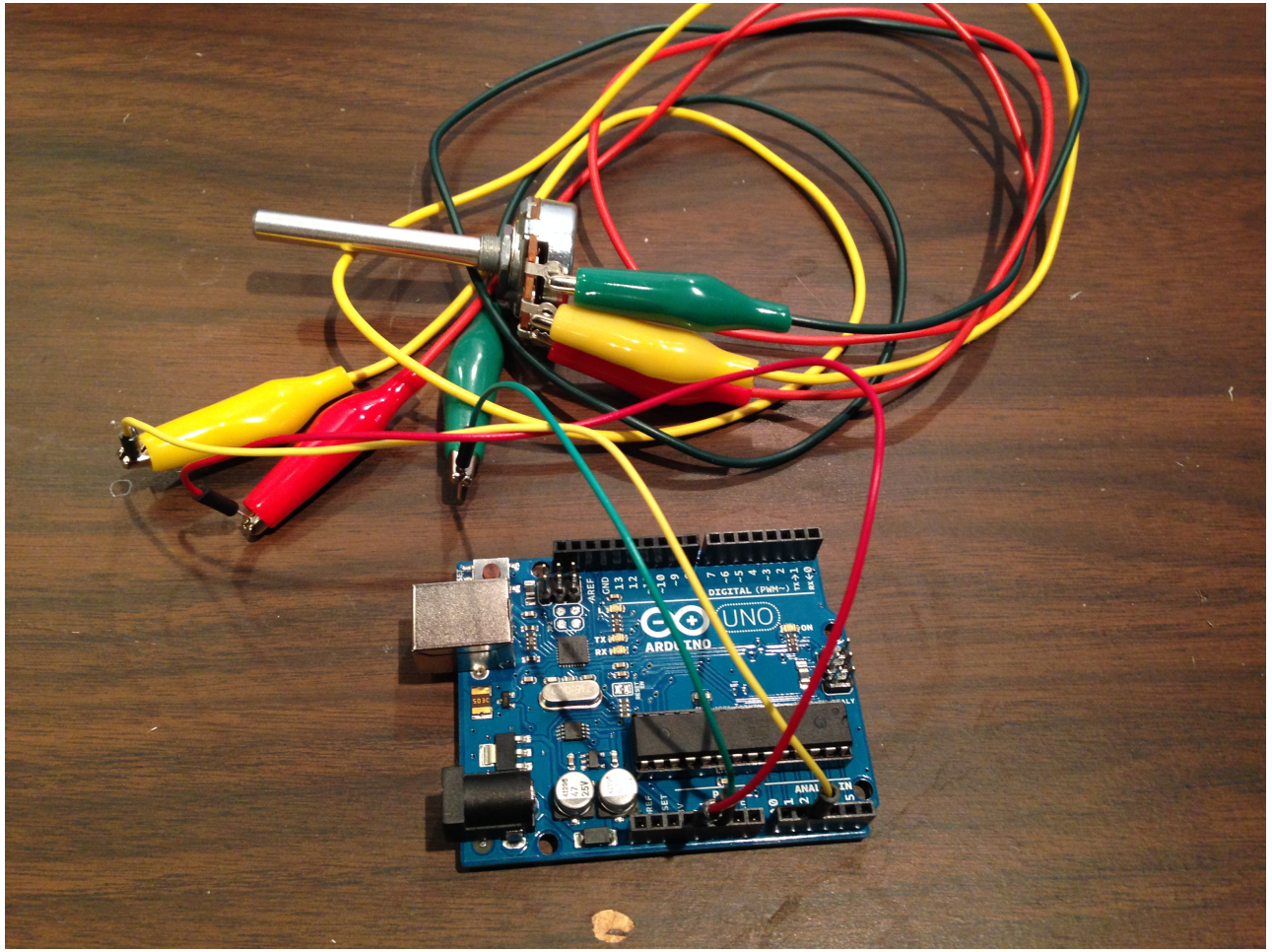
…Here's an example!

Arduino



http://arduino.cc/en/uploads/Main/ArduinoUno_R3_Front.jpg

Our Circuit



Setting Up

- Download pduino
- FIRMATA – firmware protocol
  - Already included in Aruino download
- Wiring
- Set up correct port
- Detailed tutorial

Best Practices

- Dataflow should be vertical
- Comments necessary if collaborating
- Modularization

CAN Article

Sub-Patching

- Help with organisation
- Can be copied
- Can have inlets (~) and outlets (~)

Abstractions

- Reusable code
- Where to save them?
- Open by making an *instance* in an object box

Further Resources

- The “Help” Browser
- FLOSS Manual
- “Programming Electronic Music in PD”
- “The Theory and Technique of Electronic Music”
- Andy Farnell’s site
- Mailing List