Reverb

Coursera Week 5

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My name is Claude. I am a computer scientist and I am curious about music and computers.

This presentation is about :

- Explain the usage of the 5 most important synthesis modules: Oscillator, Filter, Amplifier, Envelope, and LFO.

Substractive synthesis is a method of sound synthesis in which an audio signal is generated and partials of the audio signal are attenuated by a filter.

Other forms of sound synthesis may add up audio signals or apply complex transformation of the waves.

The **synthesizer** consists of 5 different modules : Oscillator, Filter, Amplifier, Envelope, LFO.

An **Oscillator** or **VCO (Voltage Controlled Oscillator)** creates sounds based from geometric wave shapes.

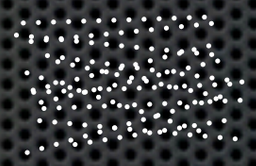
The harmonics are created by simple wave shapes.

All of the synthesizer's modules have one specific thing that changes over time, that can be modulated. For VCO this is the pitch, or frequency of the wave

For instance, when you play a keyboard, you select the correct note and the pitch modulates the oscillator frequency.

The wave shape determines how the sound is initially created and will produce different sounds :

sine 

noise 

sawtooth 

triangle 

square 

pulse 

- sine : purest of tones, energy at a single frequency.

- sawtooth : has all the harmonics. It produces a brilliant sound like a violin

- square wave : has only odd partials. It produces a hollow sound like a clarinet

- triangle : sounds like a filtered square wave

- noise : white noise is energy across all the frequency spectrum

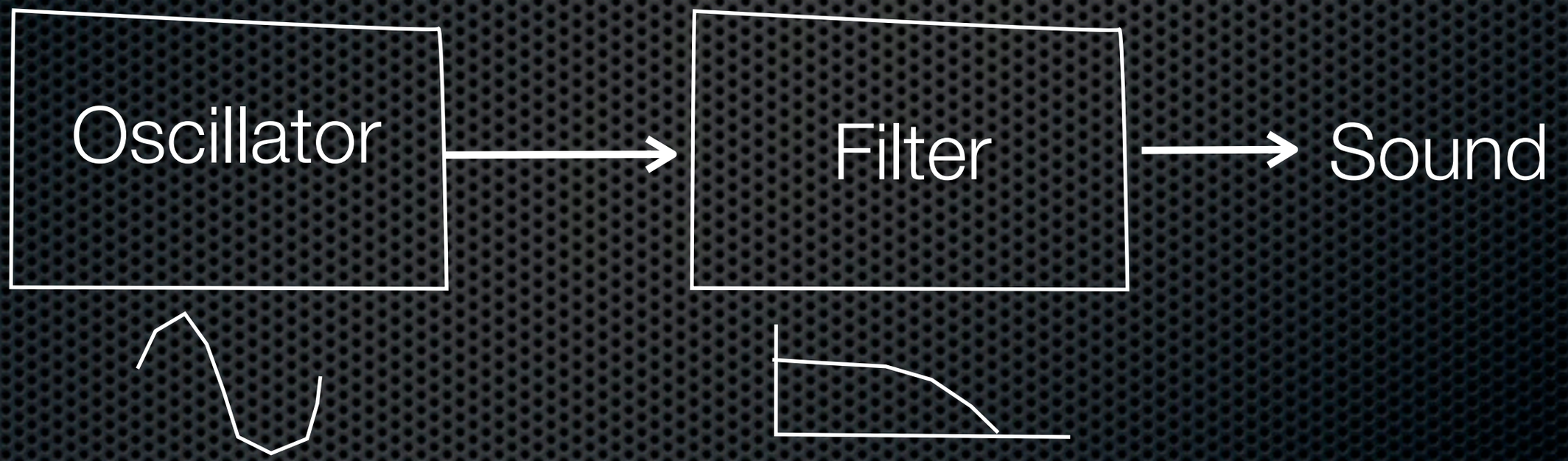
The way the sound is produced in a real world is an indication of the wave shape which is more relevant.

In a clarinet the reed opens up, closes down, like a switch turning on and off. This looks square wavish.

In a violin, the string is pulled away up to the point where the tension is too strong and it snaps back. This looks sawish.

Generally speaking, the sound of the osciallator is harsh and will need filtered later on to make a better sound.

A **Filter** or **VCF (Voltage Controller Filter)** alters the sound created by the oscillator by attenuating or boosting frequencies.



A synthesizer may have multiple filters.

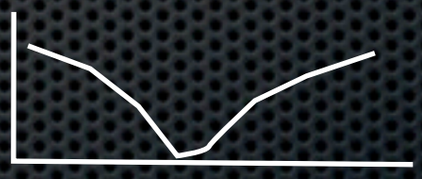
- Low pass : the 24 db low pass filter is the most important filter. It cuts all frequencies above the cutoff frequency and removes bright upper sounds

- There are other types of filter shapes :

High pass

Band pass

Notch



Comb

There are multiple things that can be modulated in a filter.

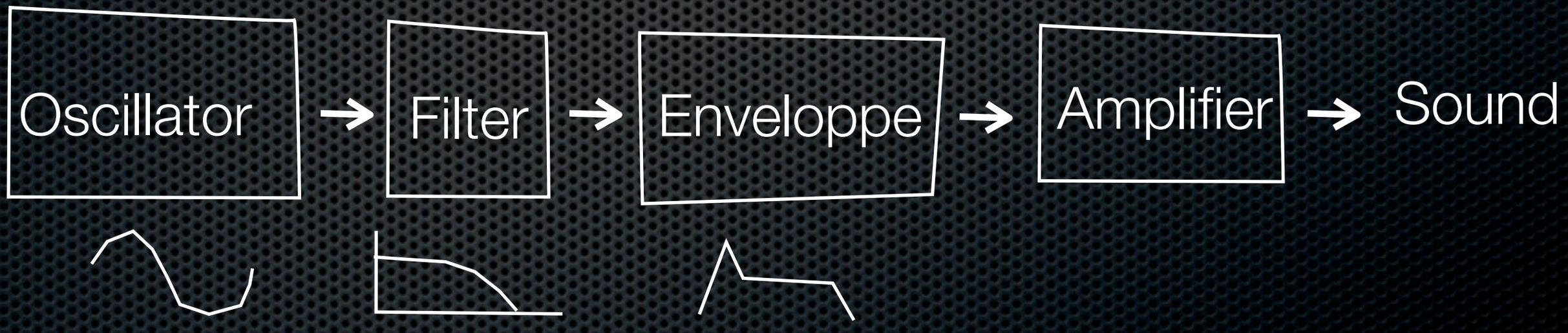
- the cutoff frequency : the most important parameter. It select which frequencies the filter will accept. When this range varies over times this produces bright to dull sounds, or wah wah sounds

- resonance : filters are made of delays. Resonance relates to feedback on the delay line. It emphasize the sound of the filter

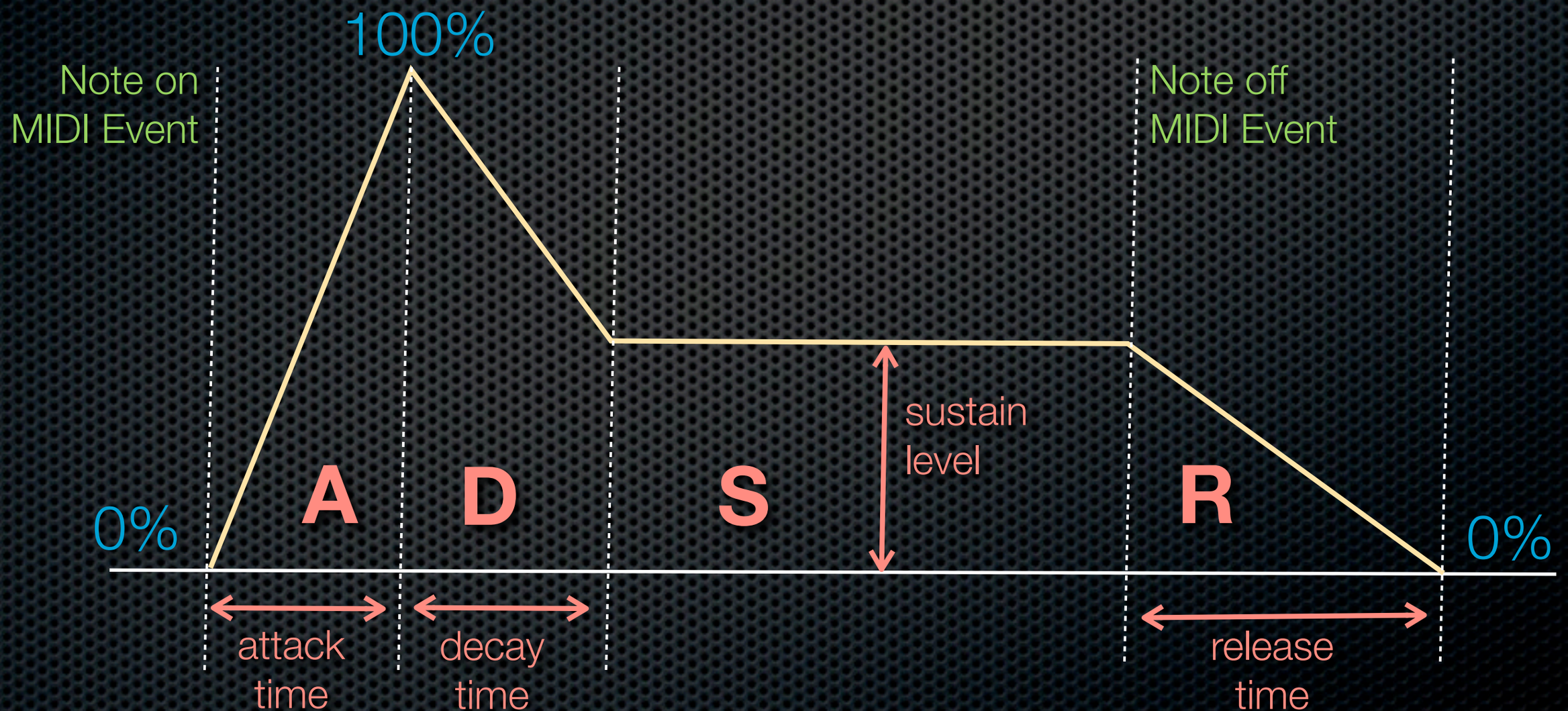
There are other things that may modulate the filters such as key positions.

The **Amplifier** or **VCA (Voltage Controlled Amplifier)** shapes the volume.

Its goal is not to change the overall gain. It changes the amplitude of the sound over time very rapidl. Change pattern is based on some pre-set path. The path is given by a modulator that acts as an **envelope follower**.



There is always an **envelope** defined and it controls how the ampliier modifies the amplitude by 4 controls : ADSR



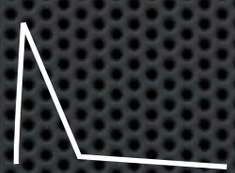
- Sustain level represents the steady state. As opposed to other controls the sustain level is a level not a time.

- Attack time is the time it takes to go up to 100% when the key is hit

- Decay time is the time it takes to reduce the amplitude to the sustain level after 100% is reached

- Release time is the time is takes to reduce the amplitude to 0% after the key is released

Envelope defines the timbre of an instrument.

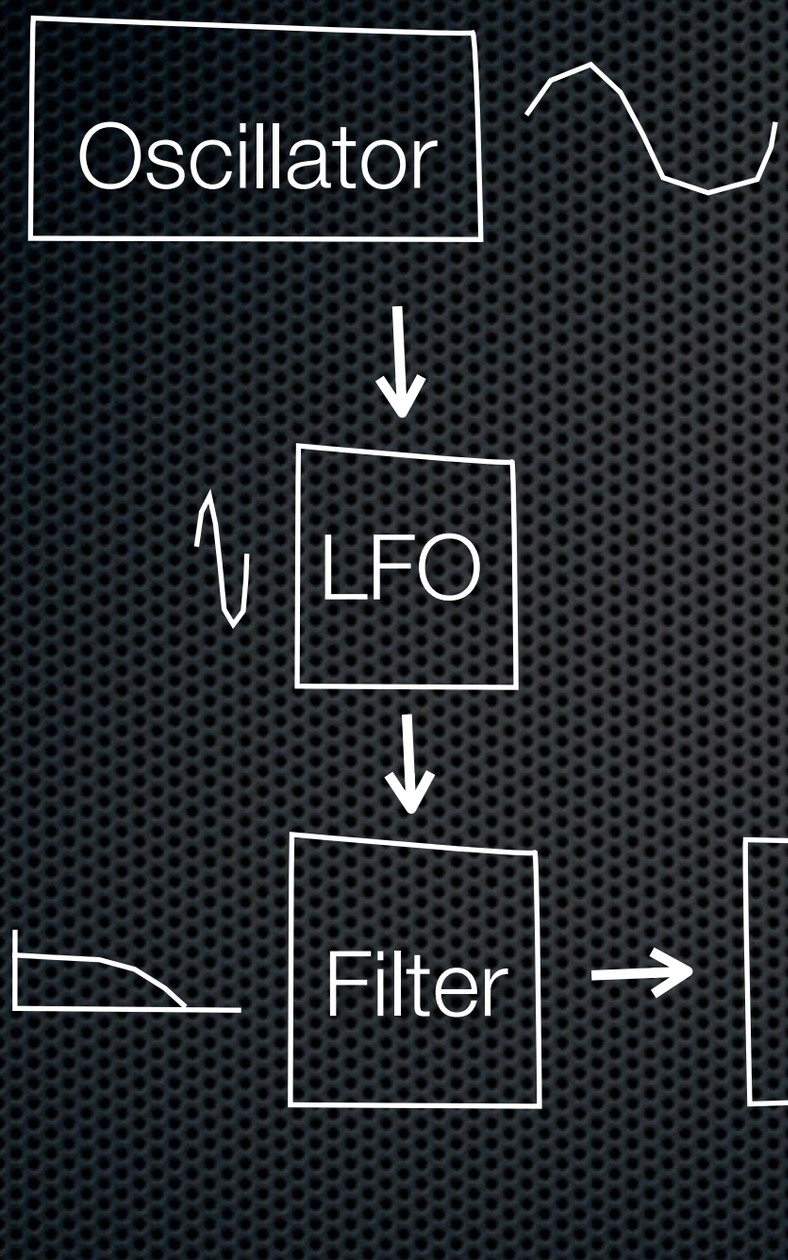
Switch envelopes sound like an organ	Percusive envelopes produce plucky or hit sounds	Damped percusive envelopess ounds like a piano	Strings or brass need sustain and use all the phases
			
A 0 D 0 S 100% R 0	A 0 D >0 S 0% R 0	A 0 D >0 S 0% R = D	A 0 D >0 S >0 R >0

LFO stands for Low Frequency Oscillator.

It is a cyclic modulator that goes up and down all the time very rapidly and follow a cycle defined by a wave shape.

Its oscillation rate is very low, usually from 0 to 20% Hz, below audible range.

We don’t ear it directly. It is meant to be used to modulate another voltage controller module.



The most frequent use is to create a vibrato. In a complex synthesizer it may also control multiple destinations like an amplifier because the vibrato also alters the amplitude.

ES1

simple mono synth

defines how LFO or Modulation enveloppe respond to wheel (MIDI control 1) and velocity

ES2

poly synth

defines how modules are wired

Reflection

I took that course initially because I've tried to use Overtone, a Clojure interface to the SuperCollider synthesizer.

http://http://overtone.github.io/

I found it pretty cool to write music in a programming language I master. However I what completely lost and clueless.

Reflection

```
;; listen to the joys of a simple sine wave
    user=> (demo (sin-osc))

;; or something more interesting...
user=>(demo 7 (lpf (mix (saw [50 (line 100 1600 5) 101 100.5]))
          (lin-lin (lf-tri (line 2 20 5)) -1 1 400 4000)))
```

Huh ?

I am not puzzled by all these parentheses, but by the API.
I can guess what sin-osc does. But saw ? line ? lpf ?

Reflection

The documentation was not reaaly helpful at that time.
After a very simple Getting Started Is stumbeld upon

Chapter 1 : Synthesis

- oscillators
- filters
- delays
- envelopes and controls
- multi-channel expansion, stereo and panning
- fx chains

Now I understand most of the content of chapter 1 and chapter 2 that is roughly about MIDI instruments.

Reflection

I would like to thank Loudon Stearns and Berklee College. Lectures are clear and motivating, I liked the process of doing a presentation of a subject and reviews by peer.

Special thanks also as a non native english listener. Sound is really neat and Loudon speaks slowly enough for me to understand everything (quite everything).

Thanks all the teams and reviewers.