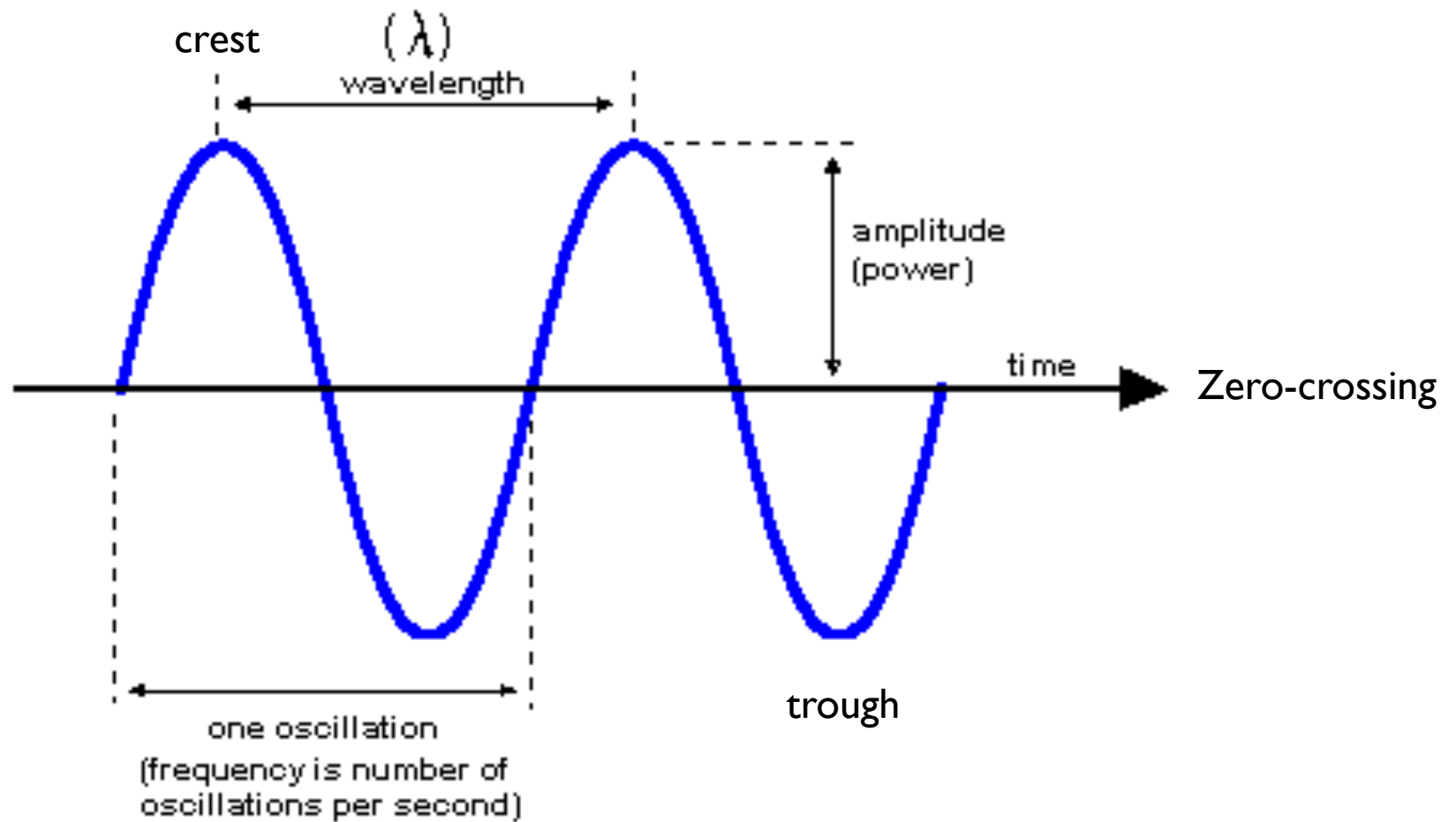


# MUS421–571.1

## Electroacoustic Music Composition

Kirsten Volness – 23 Jan 2018

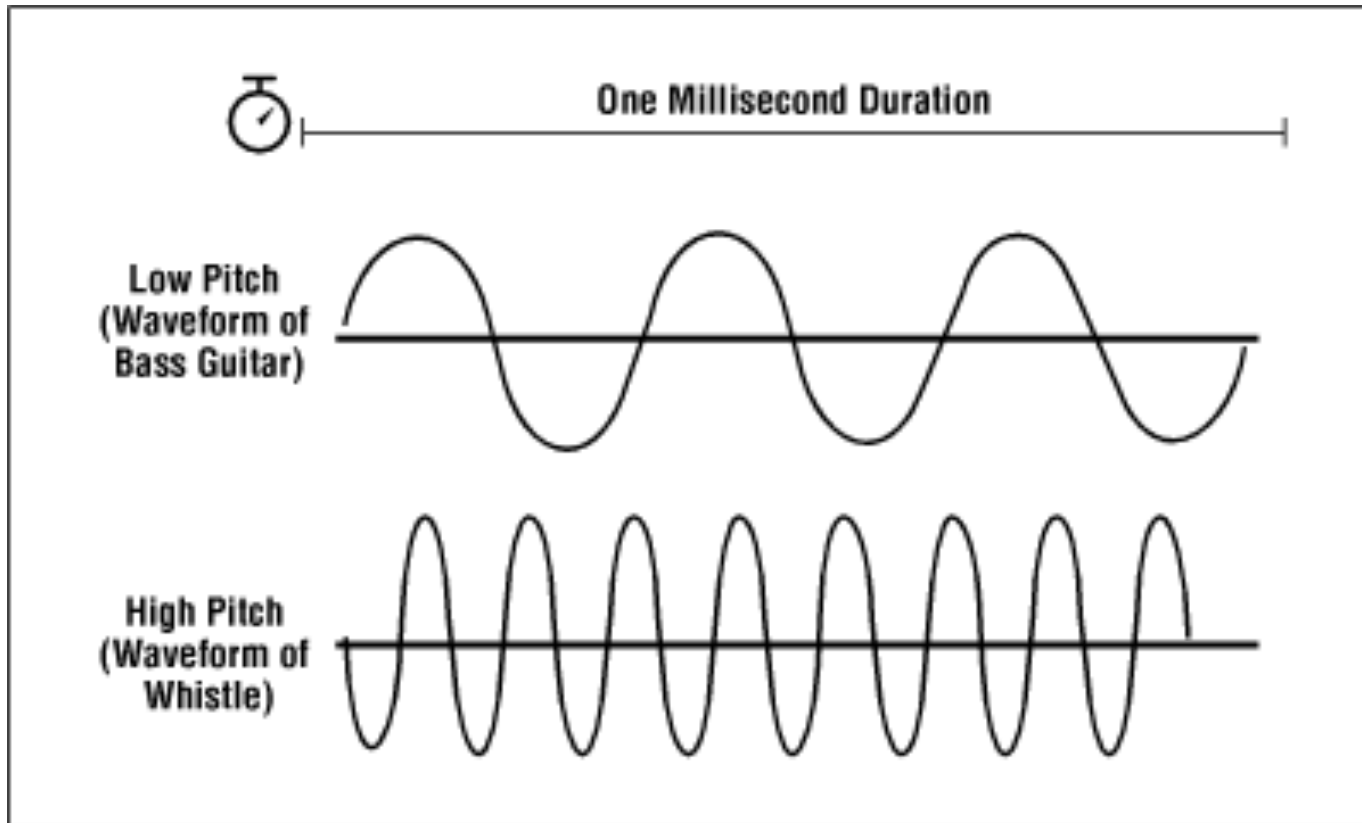
# Sound Waves



also known as "cycle" or "period"

# Frequency (pitch)

Measured in Hertz (Hz) = number of cycles per second



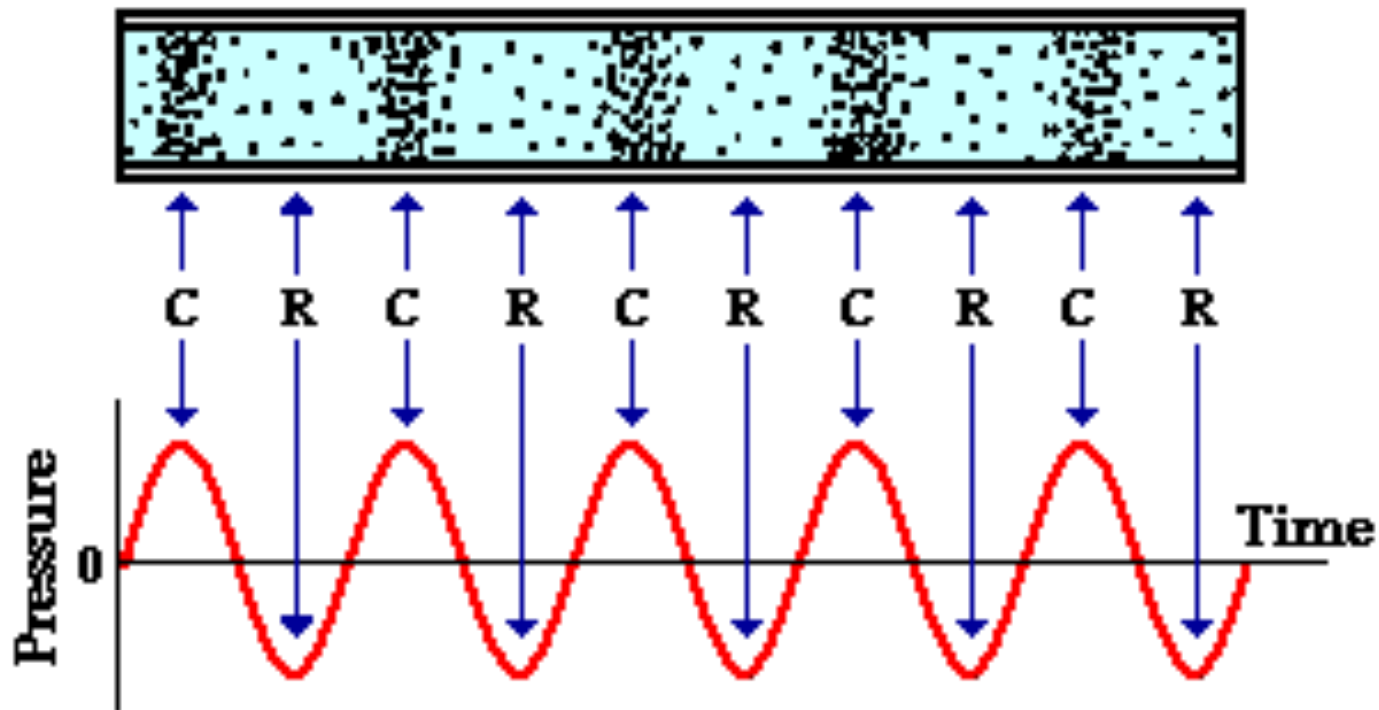
Human range of hearing is 20 Hz to 20 kHz

# Tuning fork creating sound wave



# Compression & Rarefaction

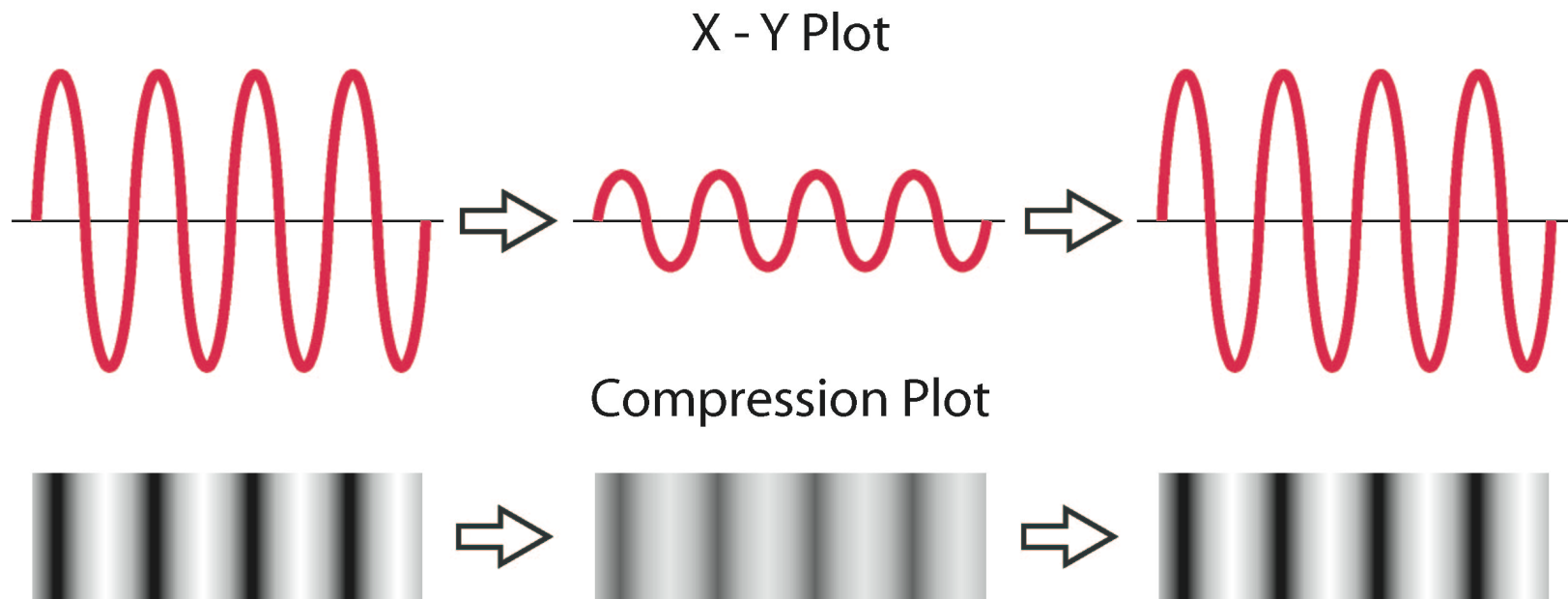
Sound is a Pressure Wave



**NOTE:** "C" stands for compression and "R" stands for rarefaction

# Amplitude (signal strength)

measured in degree of change + or –  
of the sound pressure level (SPL)



# Gain

measured in Decibels (dB)



A logarithmic measurement reflecting our tremendous range of hearing (volume).

# Measuring Gain

dB	power ratio	amplitude ratio
100	10 000 000 000	100 000
90	1 000 000 000	31 620
80	100 000 000	10 000
70	10 000 000	3 162
60	1 000 000	1 000
50	100 000	316.2
40	10 000	100
30	1 000	31.62
20	100	10
10	10	3.162
3	1.995	1.413
1	1.259	1.122
0	1	1
-10	0.1	0.316 2
-20	0.01	0.1
-30	0.001	0.031 62
-40	0.000 1	0.01
-50	0.000 01	0.003 162
-60	0.000 001	0.001
-70	0.000 000 1	0.000 316 2
-80	0.000 000 01	0.000 1
-90	0.000 000 001	0.000 031 62
-100	0.000 000 000 1	0.000 01

An example scale showing power ratios  $x$  and amplitude ratios  $\sqrt{x}$  and dB equivalents  $10 \log_{10} x$ . It is easier to grasp and compare 2- or 3-digit numbers than to compare up to 10 digits.

**Unity Gain = 0**  
(full signal strength)

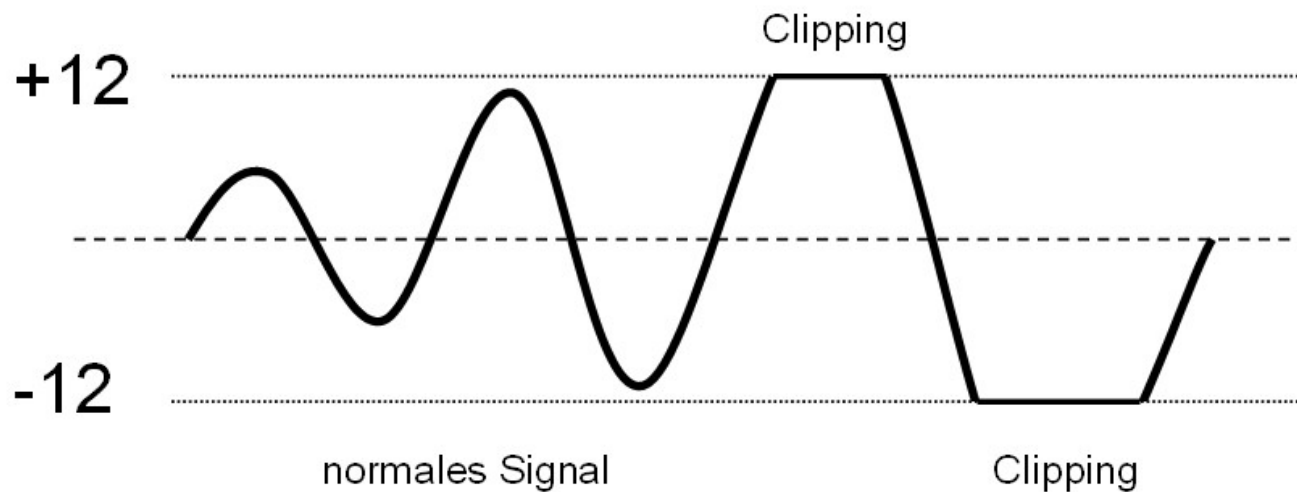
3 dB = 2x as loud

10 dB = 10x as loud

Usually + or – 12 dB is limit

# Clipping (aka Peaking)

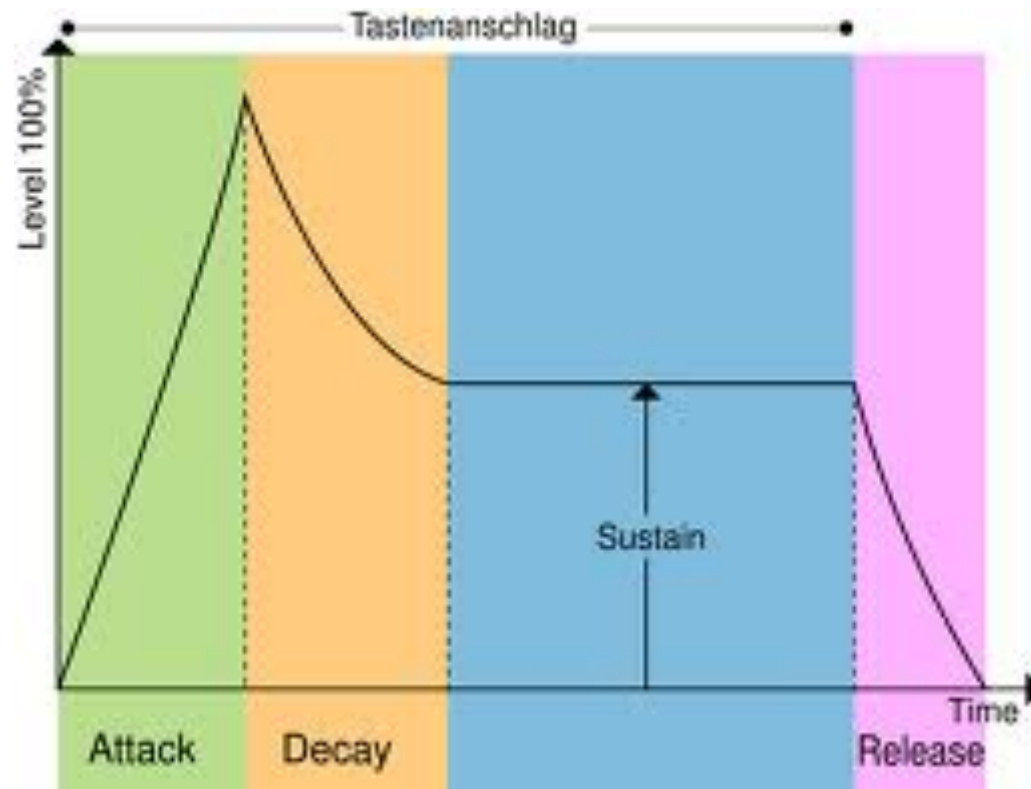
Distortion occurs when the peak and trough of the signal exceed a threshold.



Be sure to leave some **headroom** so the red light doesn't go on.

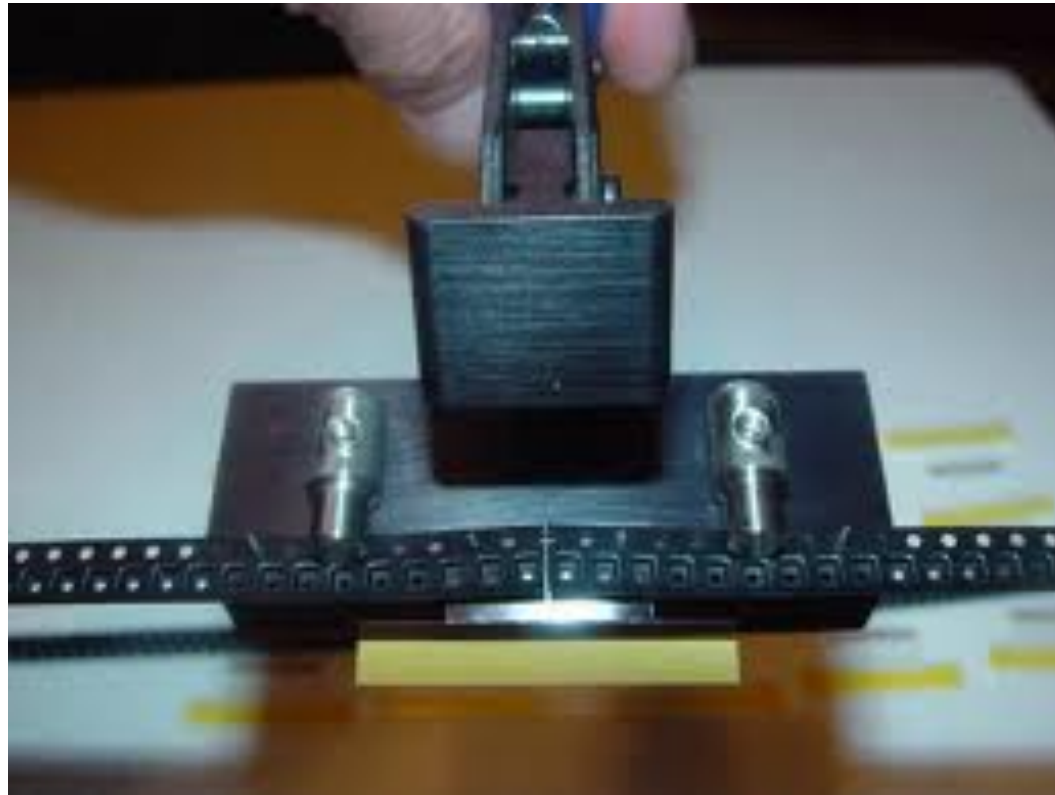
# The Envelope (ADSR)

Every sound has an Attack, Decay, Sustain, and Release – the resulting shape is called its envelope.



# Splicing

Refers to the technique of editing magnetic tape or film by cutting it and taping it back together.



# Pops / Clicks

(to be avoided)

Occurs when the wave cycle  
(one crest, one trough) is interrupted.

- Two crests/troughs in a row
- Stopping the wave at any point other than the zero-crossing.

# Fade In / Fade Out

Ensures the beginning and end of wave line up with the zero-crossing. May be achieved with a volume envelope or more easily with the the fade function.

NB: It's generally good to round off the edges of any spliced sound files to avoid sloppy clicks.

## Crossfade

Allows for a smooth transition between two sounds. May be achieved by fading one sound out on one track while the second fades in on another track, or the crossfade function on one track (not available in Audacity).

# Digital Signal Processing (DSP)

## Destructive Edits (Audacity)

When processed, the original file is overwritten into its resulting form.

Especially useful for:

Normalization

Pitch Shift

Reverse

Invert

# Normalization

Increases the amplitude of a signal to a level described by the percentage of the maximum threshold before clipping occurs.

- 80% for clean signals (leave headroom for further DSP)
- less for noisier ones – use trial and error or noise reduction

# Pitch Shift

Changes the frequency of the sound by coarse increments (half steps) or fine increments (cents).

If “time correction” is not checked, the duration will become shorter when shifted up, longer when shifted down.

The original quality/timbre of the sound is more likely to be retained if no time correction is applied.

# Digital Signal Processing

## Non-Destructive Edits (Reaper FX)

Plug-ins allow us to

1. Apply an effect to an entire track
2. Edit the resulting sound output without affecting the original source
3. Automate various parameters of the process to sculpt a dynamic result

This also means that we are required to **bounce** down / render / “make a new take” of the file as affected by the processing to save it (and CPU processing power).

Especially good for everything else!

Reverb, EQ, Delay, Modulation, Compression, etc.

# Audio Examples

notes & recordings available on blog

- Francis Dhomont – *Espace – Escape*
- Jason Bolte – *Change in the Summation*
- Kirsten Volness – *Gaia*
- Alexandra Gardner – *Luminoso*
- Blevin Blectum – *Real Live Escargot*
- Aphex Twin – *Girl / Boy Song*
- Sufjan Stevens – *Dear Mr. Supercomputer (at break)*
- Nine Inch Nails – *March of the Pigs*
- Mark Applebaum – *Precomposition*
- Múm – *We Have a Map of the Plane*
- Amon Tobin – *Creatures*