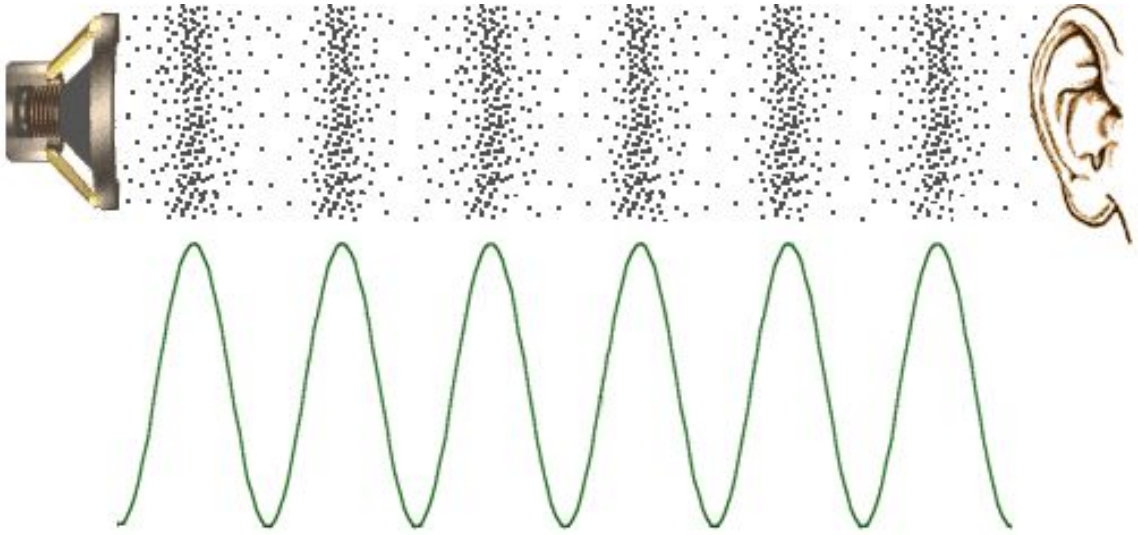
How does that sound?
An introduction to digital audio

AUDIO RECORDING CONCEPTS & HISTORY

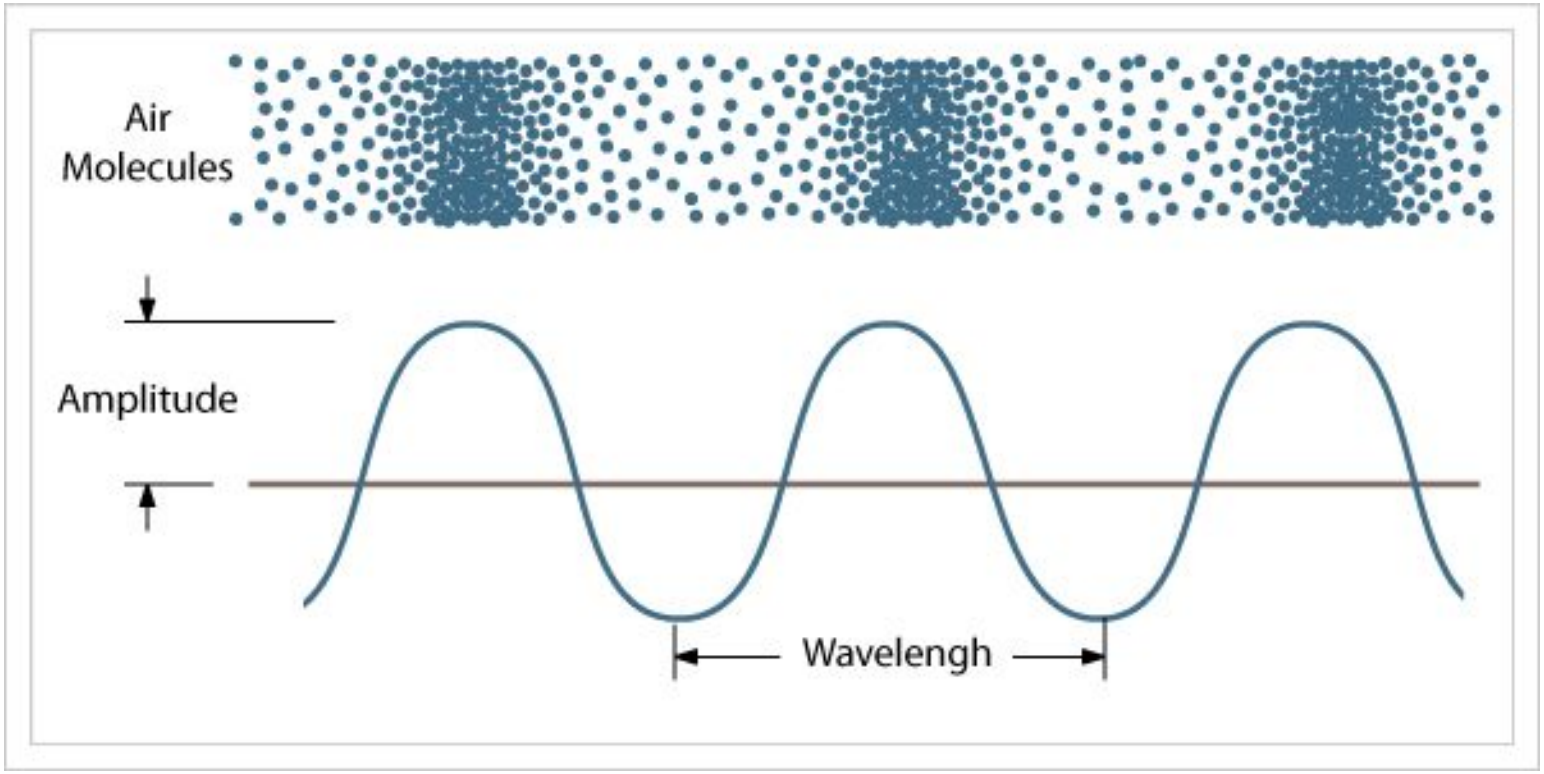
- Sound is a form of energy
- Air molecules vibrate in waves in a medium (air, water, bone)



Acoustics

Source: http://www.mediacollege.com/audio/01/sound-waves.html

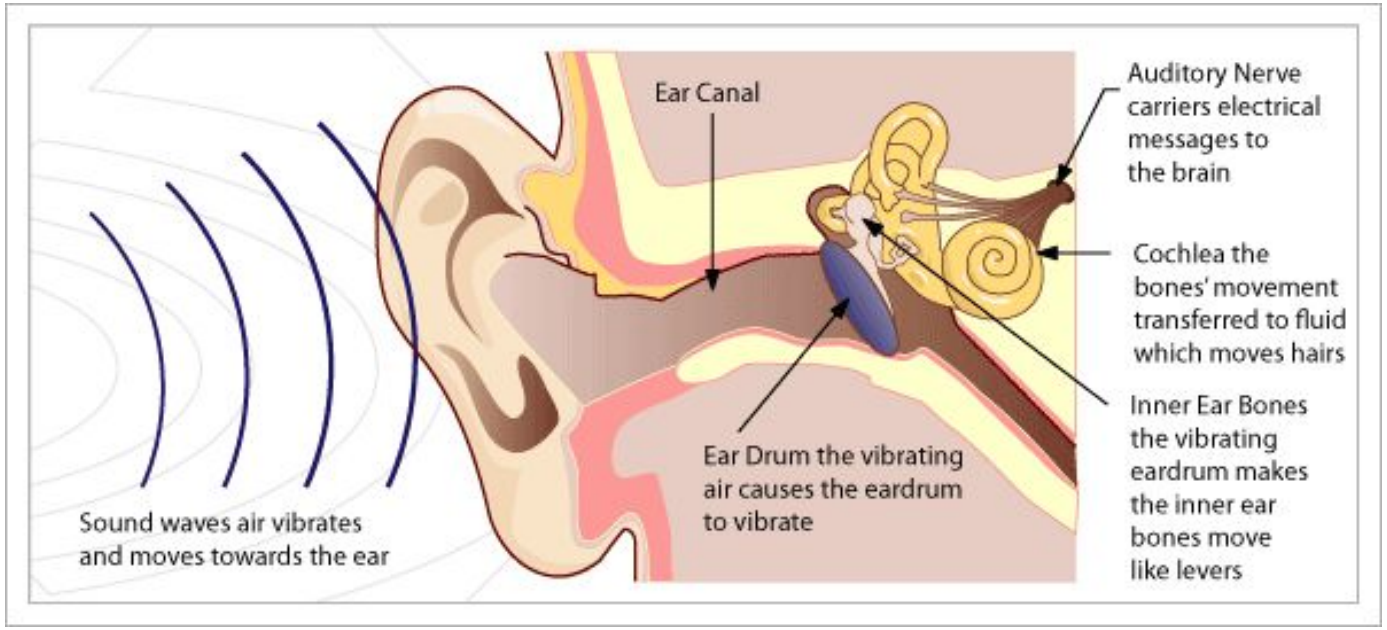
- amplitude (volume)
- wavelength (speed)
- frequency (pitch)



Sound Waves

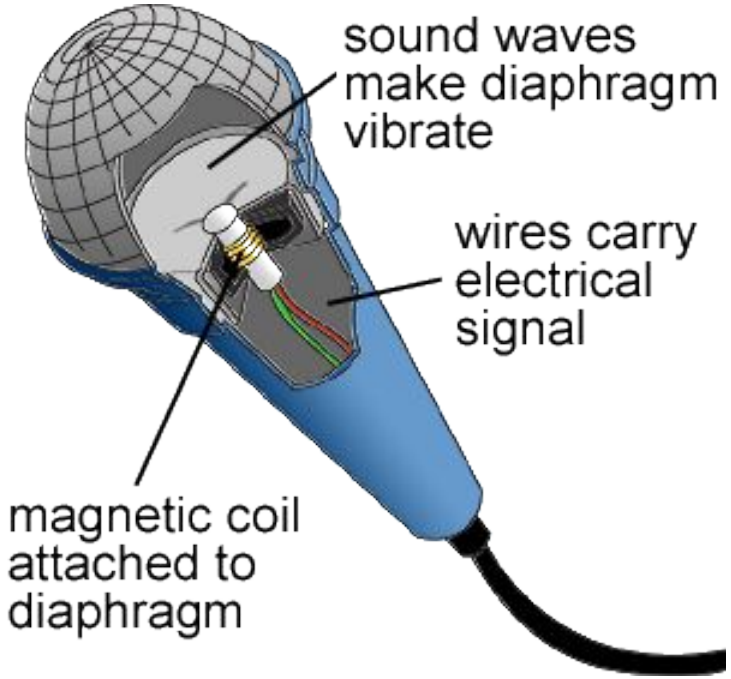
Source: http://www.soundproofingcompany.com/soundproofing101/what-is-sound/

Sound waves → Ear flap & canal → Ear drum → Cochlea → Cochlear nerves → Brain



Catching Sound Waves

Source: http://www.soundproofingcompany.com/soundproofing101/what-is-sound/



Microphones

Mechanical (analog)	Electric (analog)	Digital
Needles scratch on tinfoil, wax, vinyl, shellac 	Continuous voltages stored on magnetic tape or wire 	Voltages sampled and stored on disk, or memory as a sequence of discrete numbers 

Recording: Trapping Soundwaves

TALKING MACHINE

That Talks Talk!

$15

Complete with Records.

GRAM-O-PHONE

LATEST AND MOST REMARKABLE INVENTION OF EMILE BERLINER.

Simple beyond belief.
No complicated mechanism. Nothing to get out of order.
No electricity—no battery—no adjustments. No objectionable ear-tubes.
A child can operate it. The "Records" practically indestructible.

Gramophone does not imitate, but actually reproduces with lifelike fidelity, purity of tone, distinctness of articulation, all the varying modulations of pitch, quality, and volume of the **Human Voice** in **Speech** or **Song,** the **Music** of **Bands, Orchestras, Solo Instruments** of **every conceivable kind,** in fact, everything within the range of sound. Its repertoire is limitless, and its possessor has at his command, at merely nominal cost, all of the latest *songs, operatic airs, instrumental solos, and choral selections,* as rendered by the most popular artists. Thus the device remains forever **New.**

It's expensive to hire an orchestra to come to your home and play for you, or a famous singer to sing for you, but if you have a **Gramophone** you can buy a "record" of that orchestra's playing or that singer's singing for fifty cents, and you can listen to it and entertain your friends with it as often as you please.

The Gramophone is intended solely for the entertainment of the home circle or for public exhibition. Its "Records" are in the form of discs of practically indestructible material, can be safely sent through the mails, will last indefinitely.

Reproductions for the **Gramophone** are given forth through a horn or amplifier, and are loud enough and distinct enough to be plainly heard in a large public place of entertainment.

AGENTS WANTED to sell the Gramophone. Everywhere it gets a hearing, and where it's heard it sells, both price and quality placing it entirely beyond all competition.

IF THERE IS NO DEALER IN YOUR TOWN WE WANT ONE, BUT MEANWHILE, TO INTRODUCE THE INSTRUMENT (FOR A SHORT TIME ONLY), WE WILL, ON RECEIPT OF PRICE, SEND IT, EXPRESS PREPAID, TO ANY POINT IN THE UNITED STATES EAST OF COLORADO. IF THE INSTRUMENT IS NOT SATISFACTORY IT CAN BE RETURNED IMMEDIATELY, AND, IF IN GOOD ORDER, YOUR MONEY WILL BE REFUNDED, LESS EXPRESS CHARGES BOTH WAYS.

GRAMOPHONE, including Amplifying Trumpet, Case for Machine and Selections, $15.00.
Extra Selections, 50c. each.

NATIONAL GRAMOPHONE CO., 874 Broadway, New York.

FRANK SEAMAN, Proprietor.

Recording in the past: Mechanical

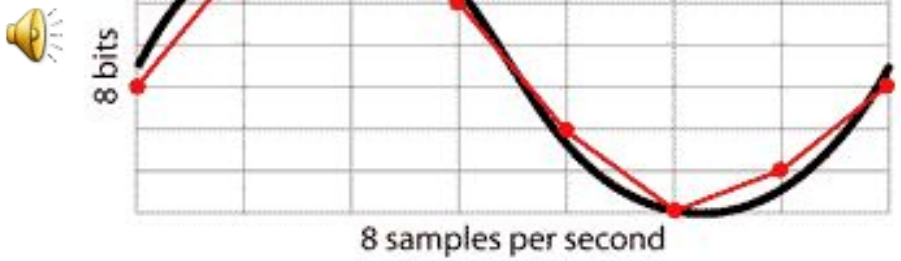
Recording in the past: Electrical

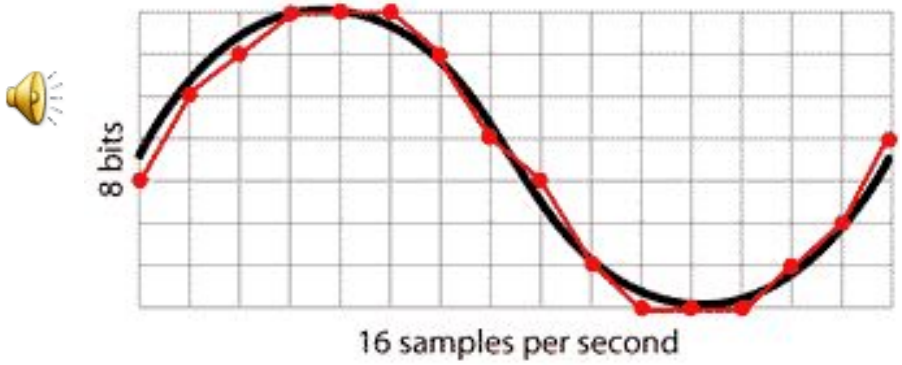
Recording Today: Digital

- Environment
- Microphone quality
- Sample rate
- Quantization
- Headroom

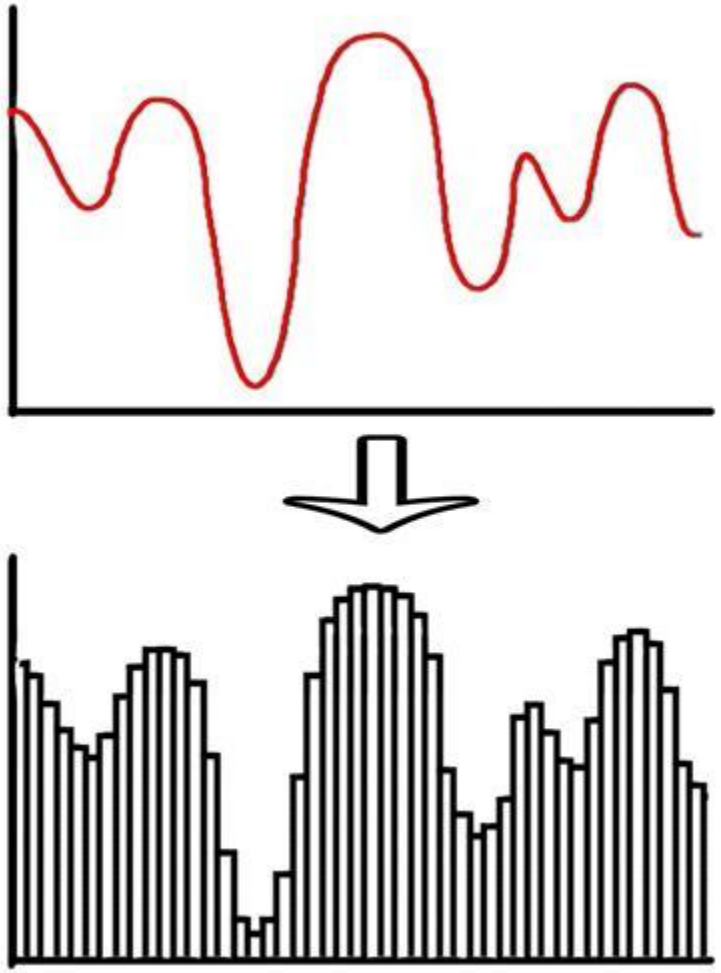
Digital Recording Quality Factors

Environment and Microphone





Source: http://streaming.wisconsin.edu/creation/st_tech/audio_editing_SF2.html

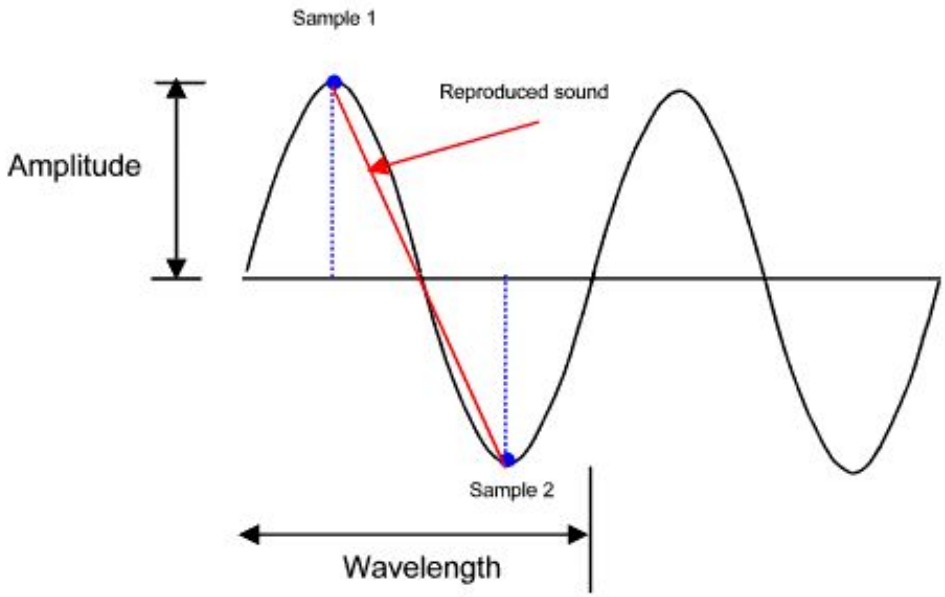


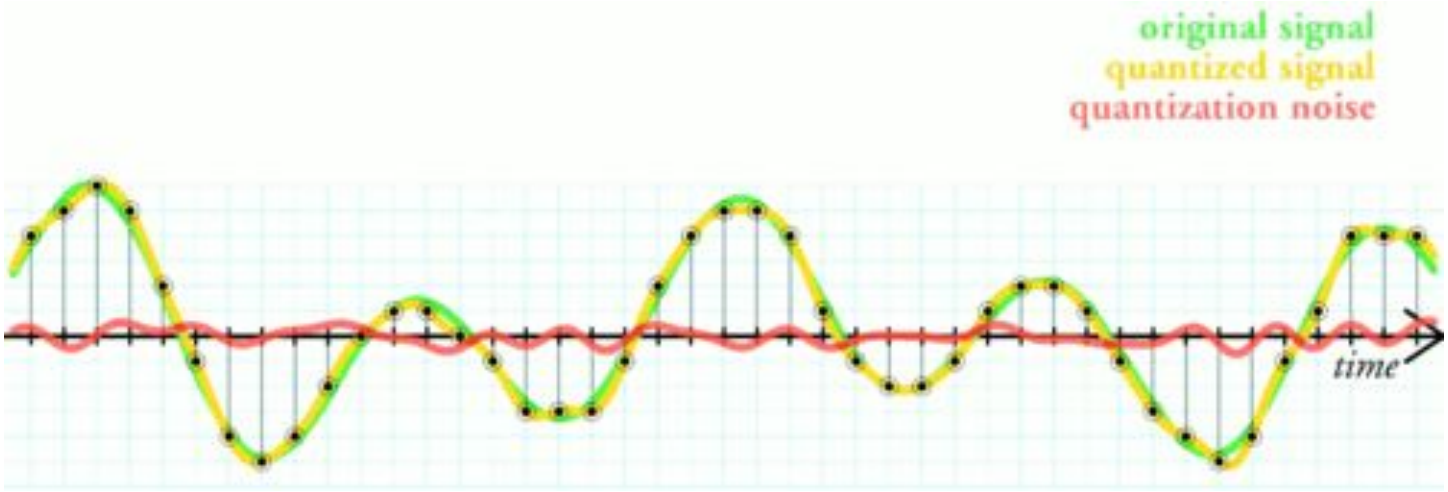
Source: http://larouchepac.com/node/17173

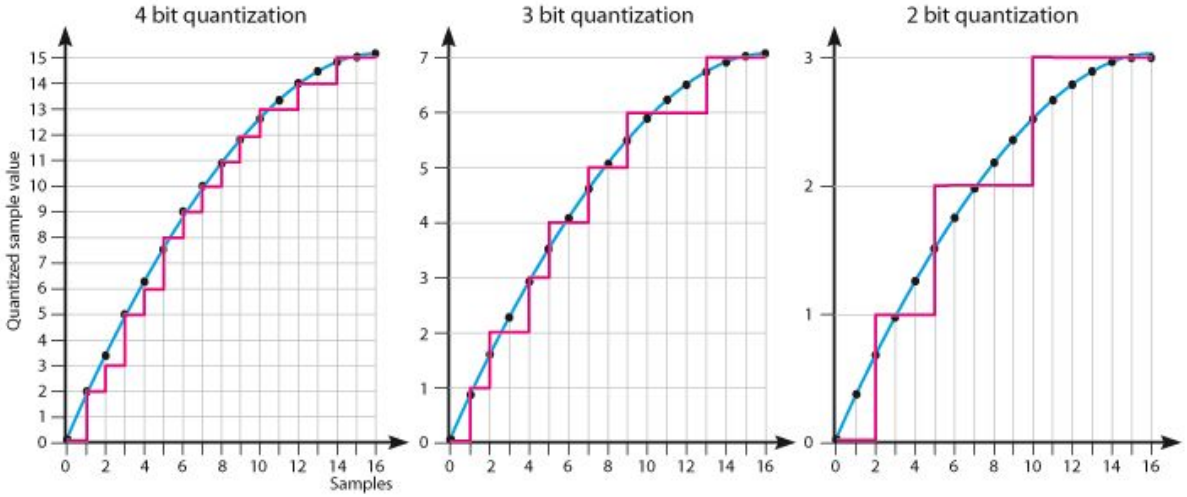
Recording Quality: Sample Rate

Nyquist Theorem

- Named for Harold Nyquist, an electrical engineer
- Accurate reproduction of a waveform = at least 2 samples per cycle (or wavelength)
- So, to capture a 20khz signal frequency, we need at least a 40khz sampling frequency







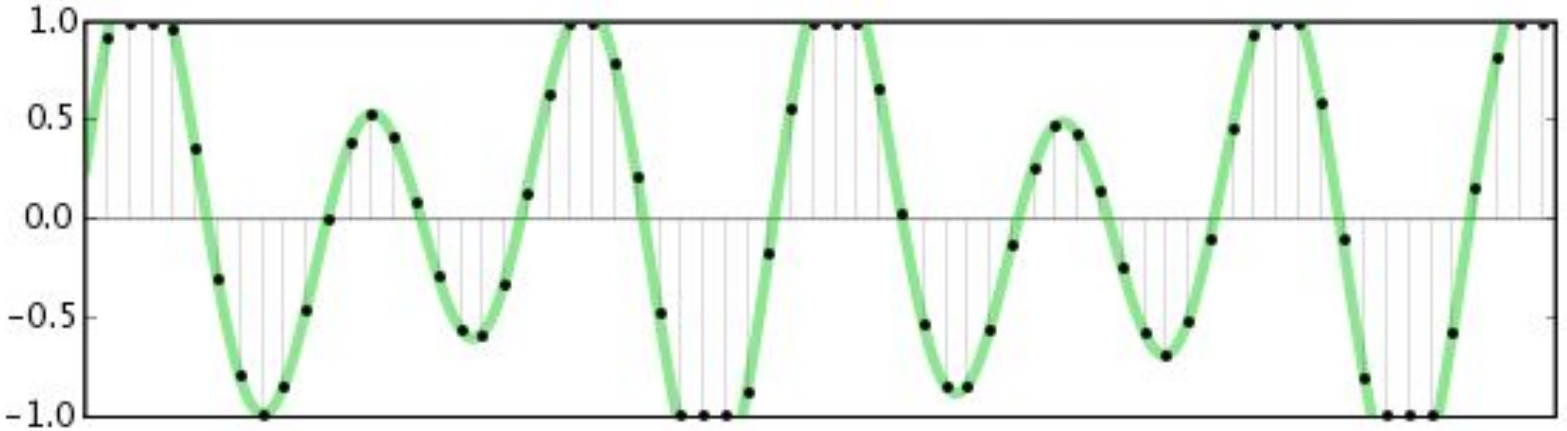
8 bit

4 bit

2 bit

Recording Quality: Quantization

http://community.calrec.com/basics-of-digital-sampling-part-2-in-60-seconds/

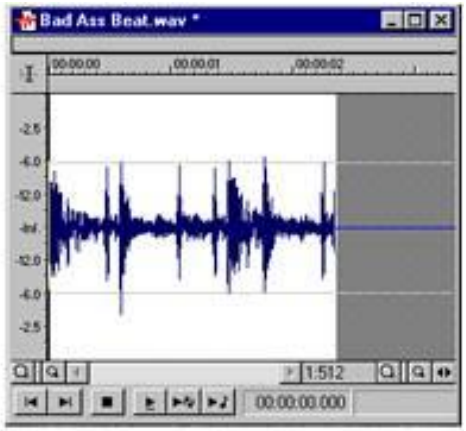


http://manual.audacityteam.org/man/File:WaveformClippingAbstract.png

Recording Quality: Headroom

Stereo	Mono
2 Channels	1 channel
Simulates depth and perception	Done mostly with one microphone
Movies, television, music players, FM radio, games	Radio talk shows, AM radio, telephone conversations, hearing aids

Stereo Sound



Mono Sound

Mono and Stereo Sound

5.1/7.1 Surround	Dolby Atmos
5/7 Full Channels, 1 Low-Frequency	Up To 128 Channels
Proper Localization	Highly Configurable Localization
Movies, television, 1st/3rd Person 3D games	Movies, 1st/3rd Person 3D games

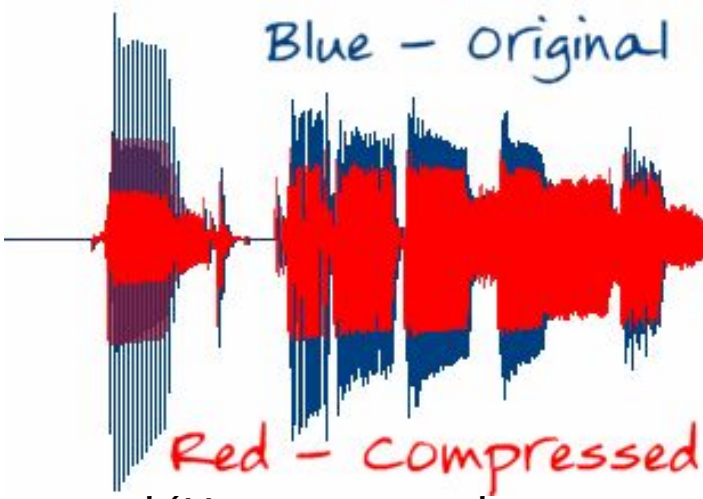
Mono and Stereo Sound

- 44,100 samples a second (44.1 kHz)
- 2 audio channels
- Quantization: 16 bits

“CD” quality

Wickiemedia's Digital Audio Tutorial

- Raw audio leads to big files
- Compressing saves space and bandwidth
- Attempts to get decoded signal close to original signal

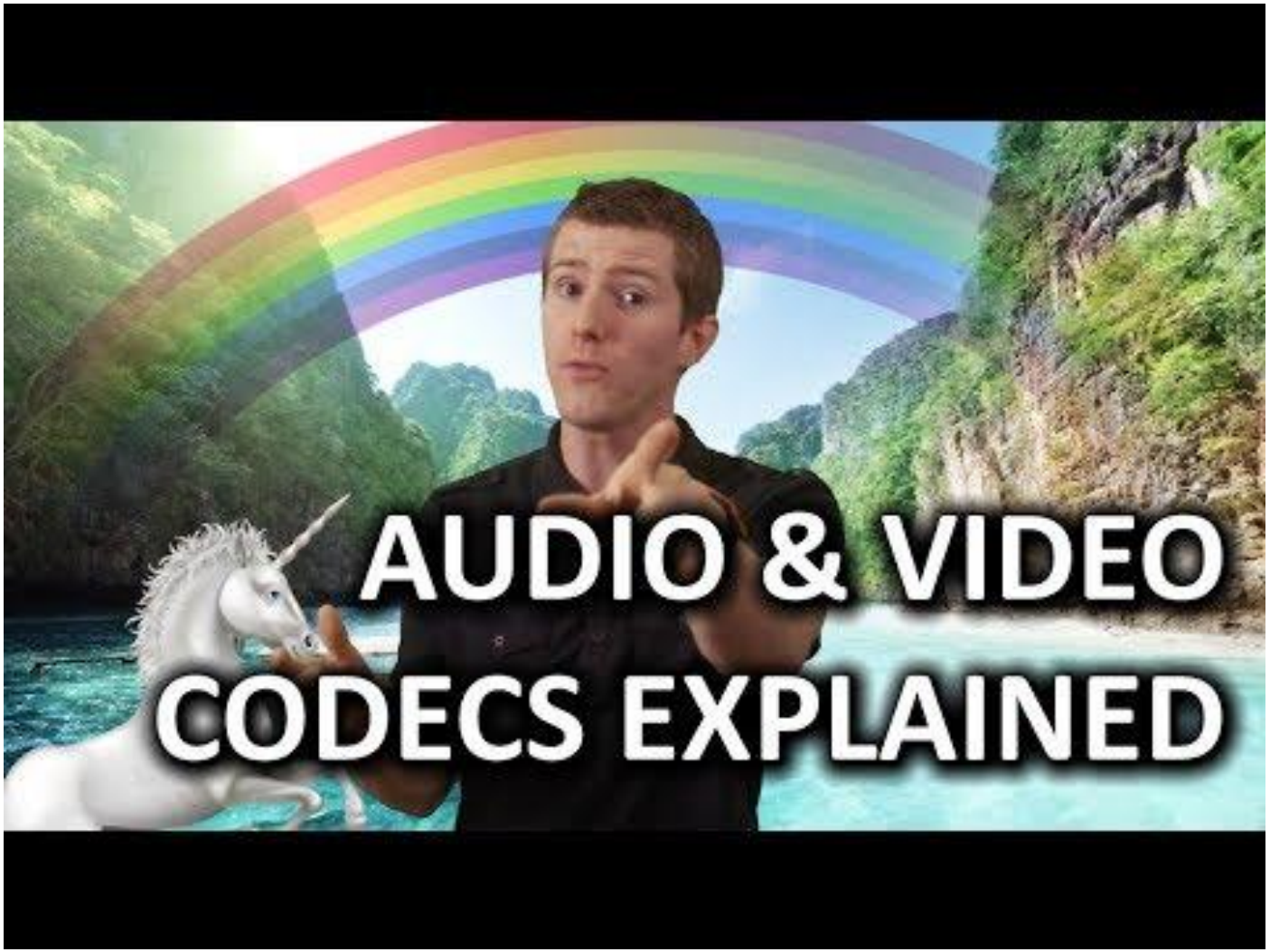


- Lossy vs. Lossless
  - Lossless reconstructs original file, minimal space saved (Uncompressed: AIFF, WAV; Compressed: FLAC, ALAC)
  - Lossy – save more space but can't reconstruct original file, (MP3, AAC, OGG)
  - As always, it's a quality vs. size tradeoff

Compression / Codecs

- MPEG (Motion Picture Experts Group)
- MPEG-1 or 2, layer 3
- Sampling rate: usually 44.1 kHz (CD quality)
- Patented
- Common audio format
- Can use a constant, variable, or average bit rate

Lossy Compression: MP3



Techquickie's Codec Tutorial

- Program or device that encodes or decodes a digital signal into a specific format
- This is not the same as a compression format
- Coder-decoder

Codec

“Sound and music make up more than half of communicating a story, greater even than what you’re seeing…”

-Steven Spielberg

Emotion


The Legion Returns
Heroes of the Alliance, I write to you in Azeroth's darkest hour. From the maw of hell, the burning armies of the Legion have returned.
Our fleets depart for the Broken Isles at once. As a grand lance, we will pierce the Legion's lines and drive them back to the nether that spawned them.
Your ship awaits in the Stormwind Harbor. Make haste.
King Varian Wrynn
Quest Objectives
Check in with Recruiter Lee at Stormwind Harbor
Accept
King Varian Wrynn
Heroes of the Alliance, I write to you in Azeroth's darkest hour. From the maw of hell, the burning armies of the Legion have returned.

Content

Adaptive Soundtracks

- Complete Audacity tutorial

- Bring one of the following
  - Headphones & USB microphone
    OR
  - A USB headset
    OR
  - A device with a microphone (laptop, tablet, gaming headphones, smartphone)

For Next Class