Music + Math: Lecture 2 Summary

Def: **Fundamental Frequency** - Lowest frequency in the sum of pure tones
- perceived pitch, ear tends to hear fund. freq., regardless of amplitude

Overtones/Harmonics - Any frequency greater than fundamental frequency

Analog Vs. Digital Sound

Analog Recording - An analog recording is made by capturing a sound with an analog device, such as a microphone, and then printing the analog signal onto a master tape (via magnetization) or a master record (via grooves).

Digital Recording - Takes analog signal + converts it into a digital representation of the sound that the pc can understand, store + play back
* Our goal for this section is to learn how analog audio is converted to digital audio.

Computer Science Background

All data in a computer is stored as "bits".

Def: Bit - The smallest unit of storage (like an atom)
- A bit stores a 0 or 1
- the # of bits determines how much information can be stored

Ex:

# bits	Diff. Patterns	# of patterns
1	0 1	2
2	00 01 10 11	4
3	000 001 010 011 100 101 110 111	8

In general, for n bits there are 2^n different patterns.

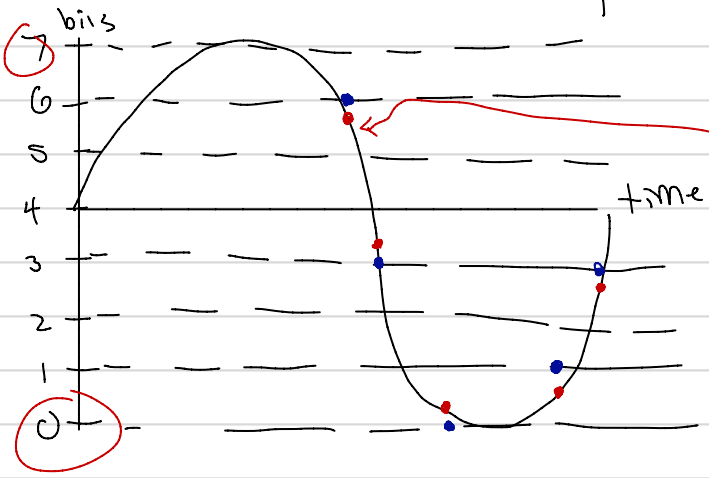
Ex Let $n = 8$. Then there are $2^8 = 256$ diff patterns.

00000000] each group of 8 bits = byte
10000000
01000000
00100000
⋮
11111111

Storing Sound

The bits are used to store the "height" values (y-axis)
- Recall: y-axis represents air pressure
- So essentially the pc is storing different variations in air pressure by using the diff. bit patterns

Ex: 3 bit = 2^3 = 8 patterns = 8 diff. possible air variations
the y-axis can be divided into
(think about as decibels)

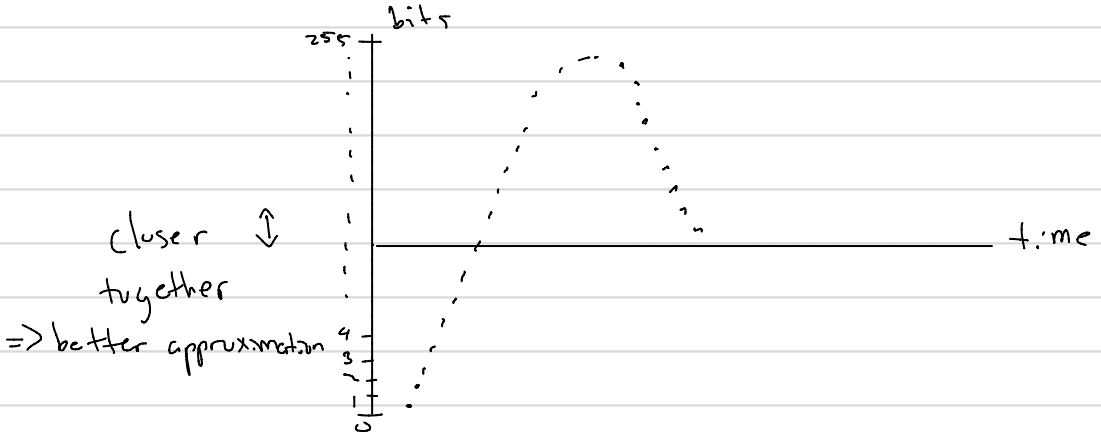


Start at 0, end at 7

What if you are here (red dot)?
then pc brings the dot to closest line (blue dot)
- process is called quantization

Red dot = Where you want to sample audio
Blue dot = What the pc actually stores (approximates red dot)

Ex 8 bit = 256 variations = divide y-axis into 256 equal portions

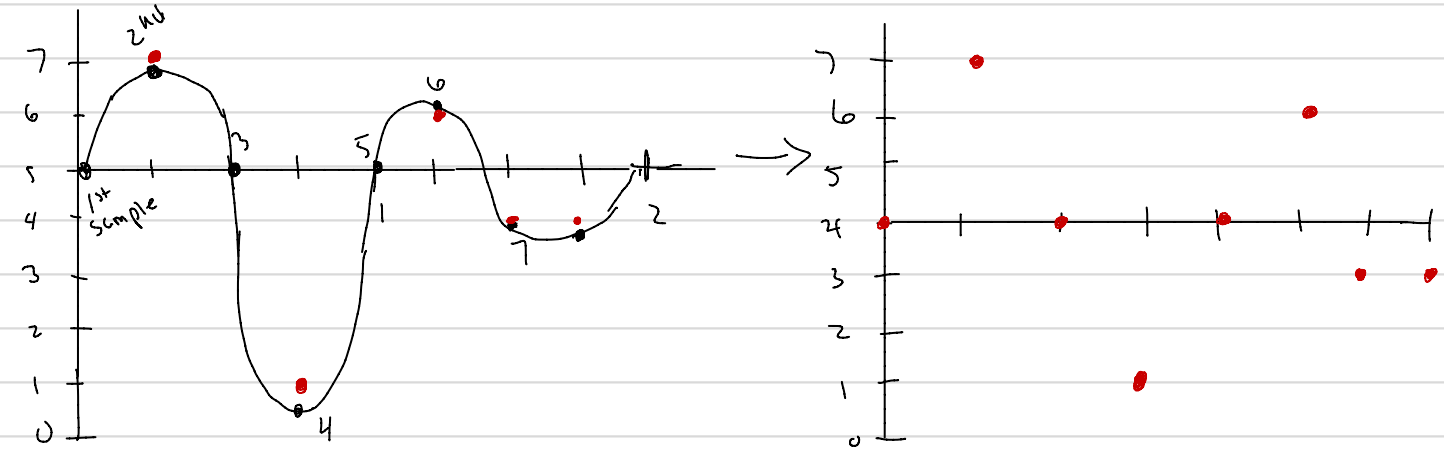


* So we divided the y-axis into finitely many possibilities. How about x-axis?

The x-axis is time, and since pc's don't have unlimited storage, we cannot store sound data at every point in time.

Def: Sampling Rate - the # of equally spaced points, or samples, the computer records every second (measured in samples/s)

Ex: 3 bit, 4 samples/s



Black dots = where we want to sample audio
Red dots = what values the pc stores