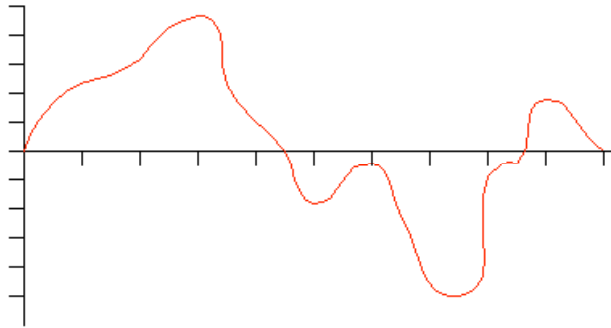


## An Intro to Sampling

Sampling is digital recording. It turns analog signals into a stream of numbers. The conversion is done by an analog-to-digital converter, or A to D converter (ADC). To play the music back, the numbers are reconverted into analog by a digital-to-analog converter or D to A converter (DAC).

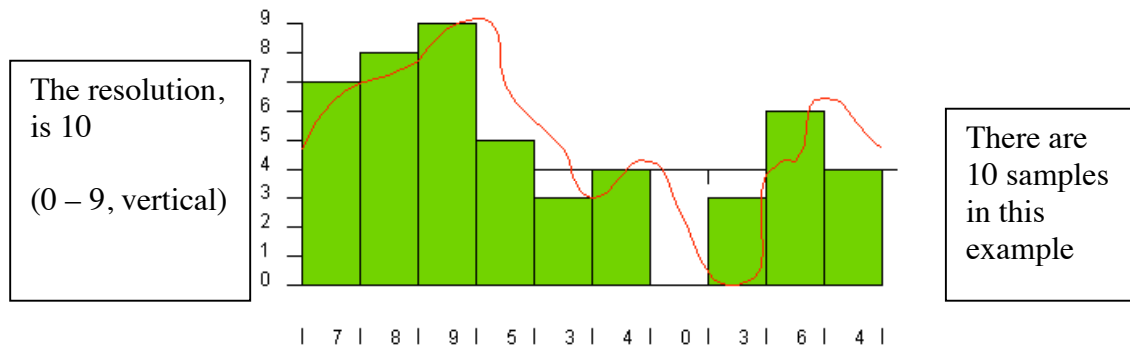
Here is a typical analog sound wave:



Before you sample the wave, you have to decide on two things:

**The sample rate** - How many samples will you take each second?

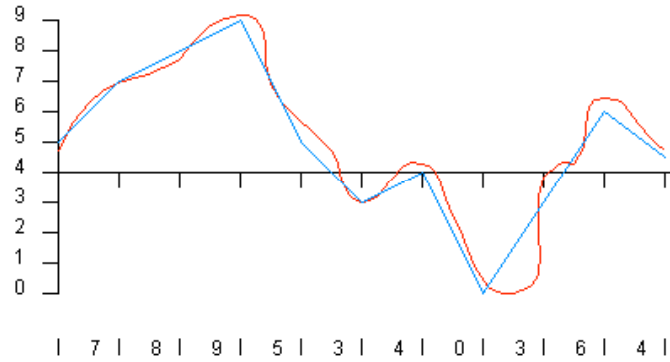
**The resolution or bit depth** - How much quality will each sample have?



Each rectangle is a sample. For each sample, the ADC 'listens to' the sound wave and tries to match it to a number between 0 and 9 (the bit depth).

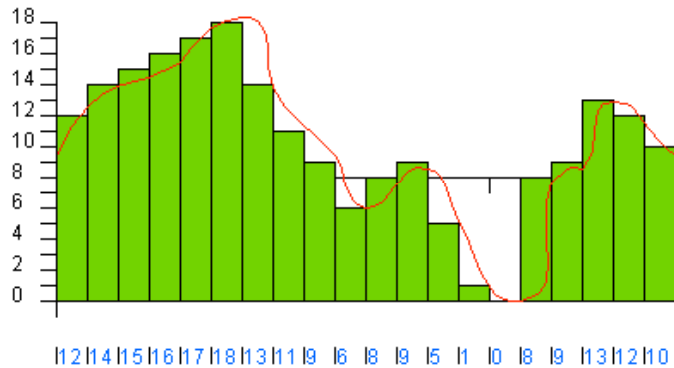
See the numbers 7-8-9-5-3-4-0-3-6-4 along the bottom of the diagram? That's the closest bit value the ADC could find to match the waveform in each sample.

When the DAC recreates the wave from these numbers, you get the jagged blue line shown in the following figure:



The jagged blue line lost a lot of the smoothness of the original waveform.

You can improve sound quality by increasing the sample rate and bit depth. See the next example? There are more green columns (samples) and more numbers up the side (resolution). The result looks a little more like the original analog waveform.



In this diagram, the sample rate and bit depth are even higher. The result looks MORE like the original waveform. This one sounds better than the previous ones.



## HOW BAD CAN IT SOUND?

**Low sampling rates** don't reproduce high frequencies very well. Low sample rates can make your sound muffled and dull, and can add an unwanted metallic sheen to the sound, called *aliasing*.

**Low bit depths** are like crappy tape. They add a lot of noise. Low bit depths make your sound grungy and noisy. They cause quantization error.

### The Nyquist Theory

*"The sample rate should be at least twice as much as the highest audio frequency."*

For example, to sample a sound whose frequency is 20kHz, the sample rate should be at least 40kHz. If the sound is 18kHz, the sampling rate should be 36 kHz. Since the upper range of human hearing is about 20kHz, the standard CD sampling rate of 44.1kHz is pretty good. But for a few reasons, it's not really good enough. Higher rates are on the way.

### Some Sample Rates to know:

**44,100/16-bit** – Audio CD standard (sometimes just called 44/16)

**48,000/16-bit** – Film & TV standard (sometimes just called 48/16)

Higher sample rates and bit depths are becoming more popular now. 24-bit is particularly good, because it represents a substantial increase in sound quality and dynamic range.