An Introduction to Digital Audio

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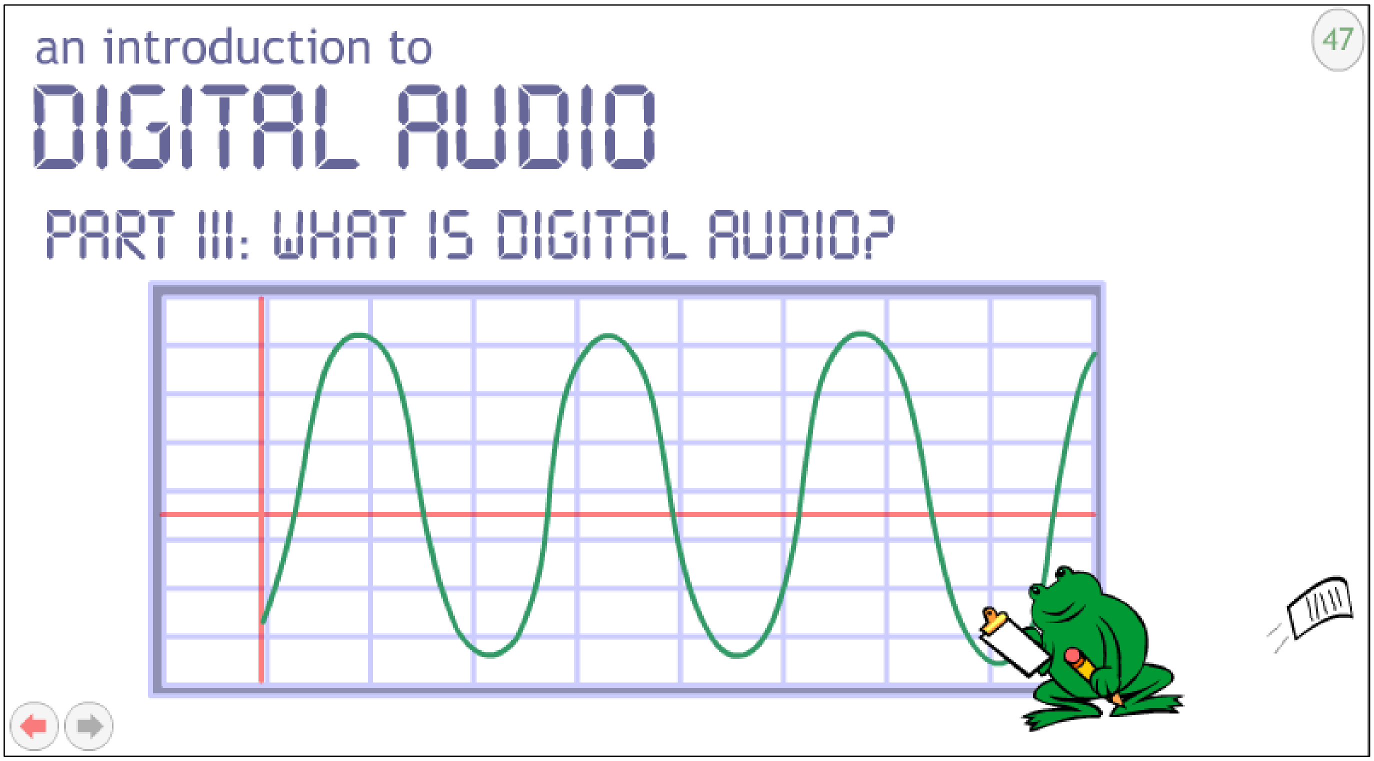


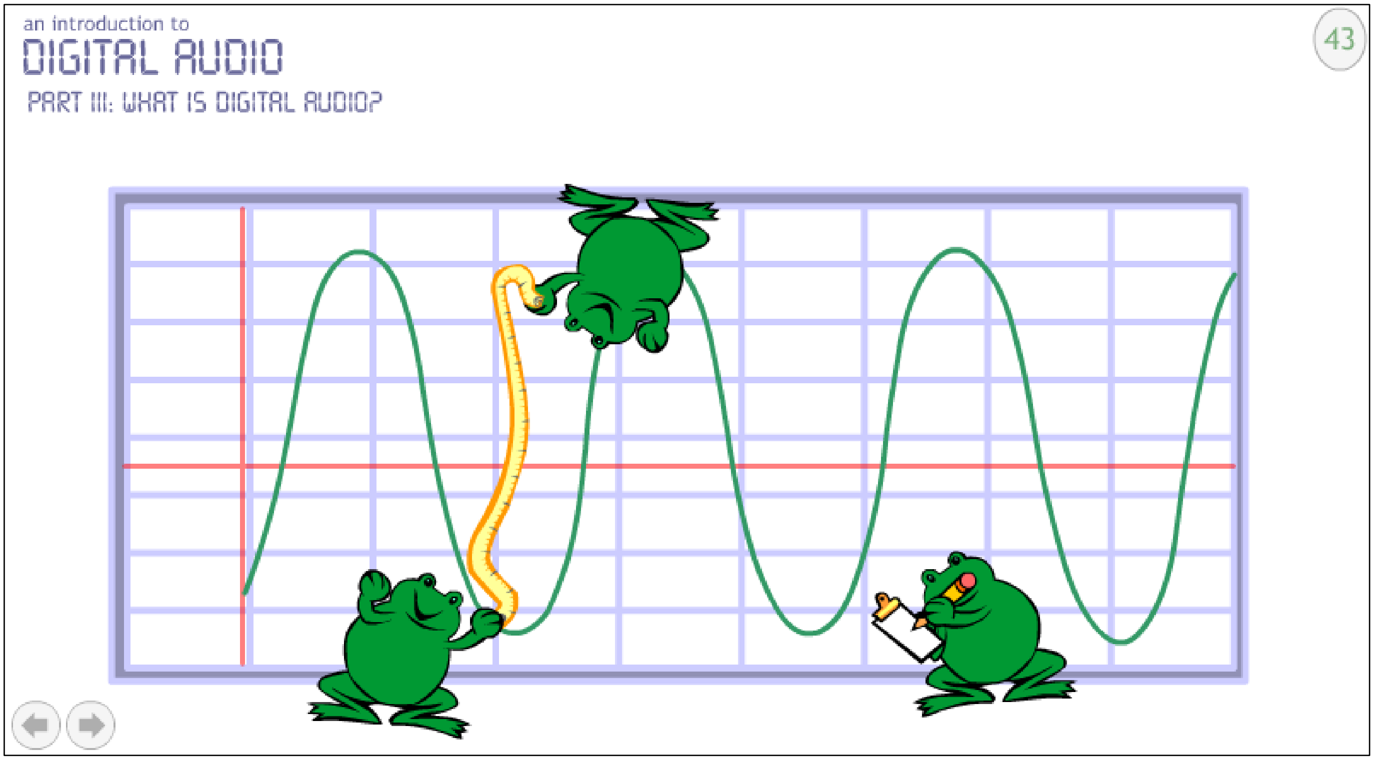
Sample Rate and Bit Depth

To record a sound digitally, a computer requires a numeric description of the sound wave.

Remember from our earlier discussion that even the most complex sound is just a continuous variation in air pressure over the course of time. With this in mind, we should be able to measure and record the air pressure at regular intervals in time, and then reconstruct the sound wave from that data. Here's how this might work:

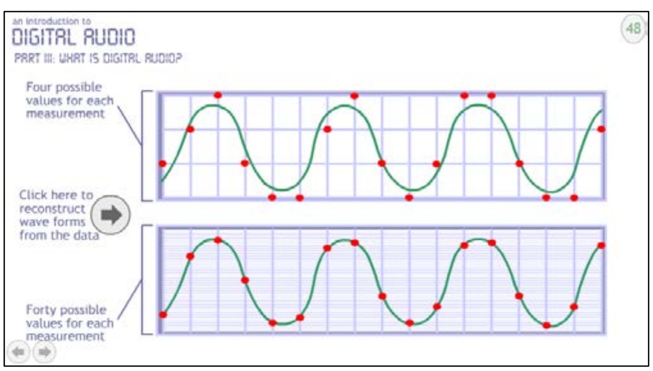
A microphone generates a small electrical current whose strength varies with changes in air pressure. If we record the strength of the current frequently enough, we'll be able to reconstruct the sound wave.

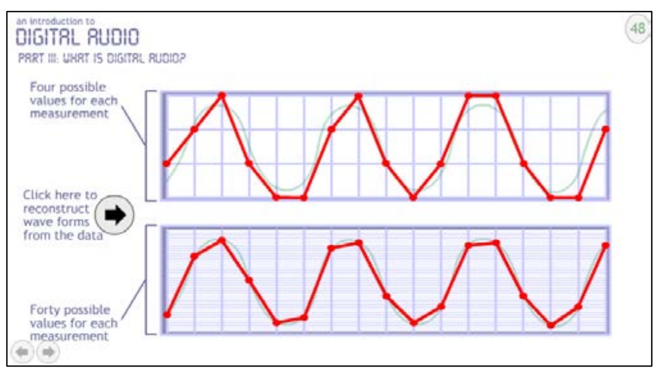
For example, we might measure a sound whose vibration frequency is 440 cycles per second. We'll need to take numerous measurements during each cycle to accurately reconstruct the shape of the wave.



SAMPLE RATE
In fact, to make a digital audio recording that is convincing to the ear, we must take measurements over 40,000 times per second. Each measurement is called a ***sample*** – we're grabbing a sample measure of the air pressure at that moment. How often we take the measurements is known as the ***sample rate***. Music CDs use a sample rate of 44,100 times per second, or 44.1 kilohertz.

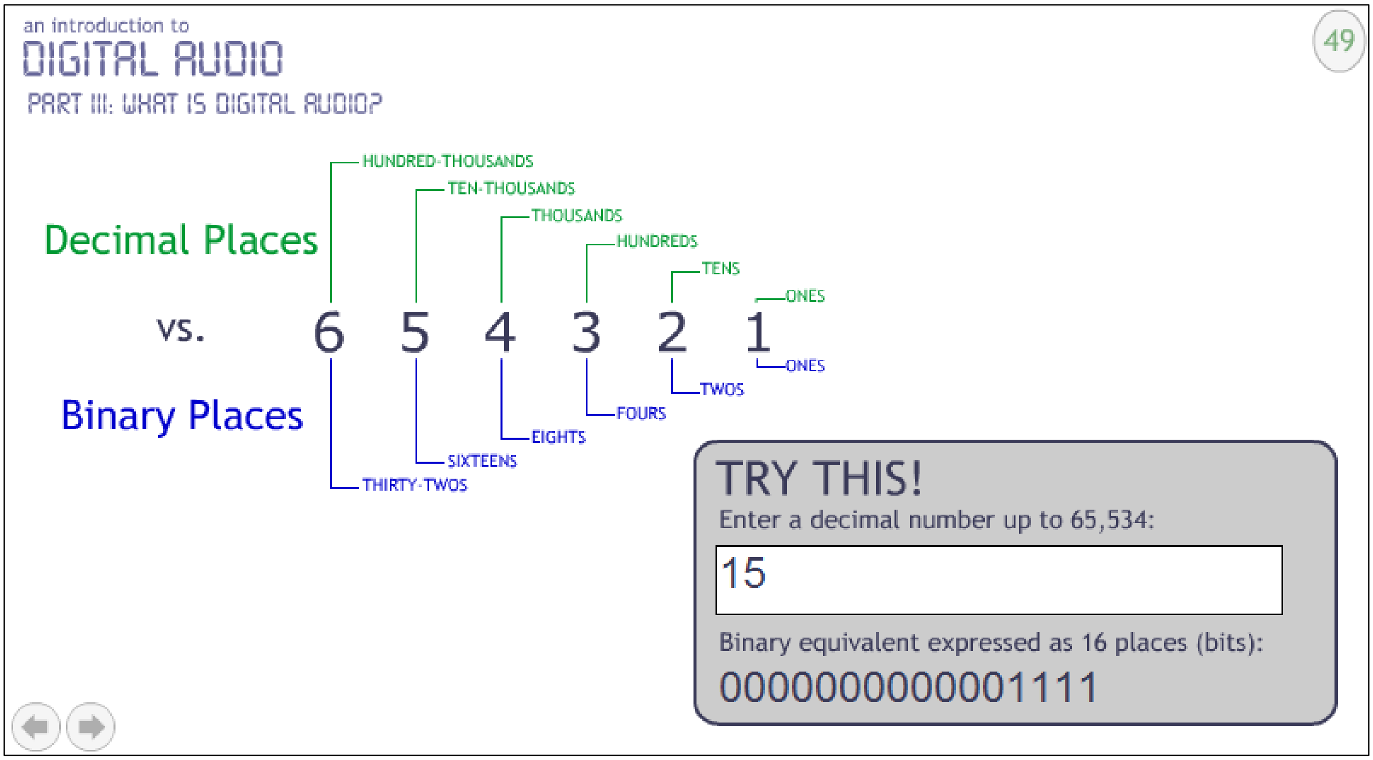
BIT DEPTH
In addition to sample rate, there's a second factor that contributes to the accuracy of a digital recording. It's the range of values, or numbers, that we use to record each sample. The more values available for each measurement, the more descriptive our data will be.





For example, in these two illustrations, we've measured a wave and represented each sample by one of ten values. We've measured it a second time using forty possible values. When I click each one, you can see how each wave gets reconstructed from the resulting data. And even though neither looks quite like the original, the one using more values is closer to reality.

Digital values are represented in binary code, in which every column is worth twice as much as the column to its right. Each column holds a one or a zero and is referred to as a single *bit*. With four bits, we can count from zero to fifteen [type 15 in the text box].



This isn't nearly enough to accurately represent audible sound waves. Audio CDs are recorded at 16-*bit depth*, which means every sample has over 65,000 values to choose from.