Lossless and Lossy Compression

Media files such as audio and video tend to be *very* large. For example, 1 minute of CD-quality stereo audio is 10MB. When you want to carry around a lot of music, or put a 5.1 surround mix into a DVD movie, you probably need to compress the audio data to fit it in.There are many audio compression types. MP3 is probably the best-known example.

The combined process of compression and decompression is called a **codec** (**co**mpression/**dec**ompression). MP3 is a very popular codec. Codecs are also called **compression schemes**.

Lossless compression temporarily eliminates audio data in a special way that makes it possible to restore the data later. Lossless compression isn't as popular as Lossy compression like MP3, because Lossless can't make as small a file as Lossy. This is slowly changing, but for now (2010) it is true.

There are some lossless compression schemes that are fairly common – TTA (True Audio), FLAC (Free Lossless Audio Codec), Dolby TrueHD and Apple Lossless are examples.

Lossy compression permanently eliminates audio data, and it is impossible to restore the data later. This limitation also makes it possible to get rid of more data than Lossless compression, so you can make smaller files.

The most popular lossy compression codec is the MP3. MP3 compression works by removing sonic elements from the music that are seen as 'expendable'.

Many audio codecs are based on psychoacoustics. ***Psychoacoustic*** means that our brains play a large role in how we perceive a sound. It's not just about measurements like frequency or amplitude or phase. It's also about what you can perceive easily, and what you can't really perceive or don't notice.

Psychoacoustic Effect #1 - At a party with loud music, a friend speaks to you in a conversational voice from a few feet away. You know she's speaking but the sound of the party masks out her voice. The sound data corresponding to your friend's voice in an audio recording of the party could be fudged, or even removed, without being really noticeable.

Psychoacoustic Effect #2 – In a mix, there's a short bit of reverb after every snare hit, but because it happens immediately after the snare sound itself, you may not notice it so well. The sound data corresponding to the reverb could be fudged, or even removed, without being really noticeable.

The MP3 codec shrinks an audio file by analyzing the audio from a psychoacoustic point of view and removing what it deems to be unnecessary. The missing sound data can't be recovered. This is why it's called **lossy compression**. During playback, the decompressed MP3 will sound different than the original audio file. *The damage done by MP3 compression is permanent.*

Although MP3 is a lossy codec, it can yield good quality audio files if used carefully. In other words, pretty good sound for such a small file! MP3 codecs are improving too, as researchers figure out better ways of to use MP3.

MP3s use bit rates to describe their quality, like regular audio files use sample rates. A typical MP3 file might be encoded at 128 kbps (kilo*bits* per second). This rate of 128 kbps used to be called 'CD quality'. But most audio-smart people prefer kbps rates that are much higher, such as 192 kbps, or 320 kbps. Of course, he higher the bit rate, the larger the file. Better sound, bigger file!

The bit rate can either be constant or it can be variable. It if is always the same, you have a **constant bit rate (CBR)**. The bit-rate doesn't change over time. This is the way that linear audio like WAV and AIF works too.

But an MP3 can also vary its bit rate according to the complexity of the audio. If the music is very complex, a higher bit rate is needed. But when the music is very simple, or when there is silence, a lower bit rate is sufficient. This is called **variable bit rate** (**VBR)**.

Currently, the best-known audio codec is MP3. But there are a few others: OGG, Windows Media, AAC, and RealAudio are some of them.

OGG (from a company called Vorbis) offers MP3-like audio compression. The advantage of OGG is that it is open source. So it doesn't require licensing.

Windows Media is a Microsoft product. Some audio programs can't open Windows Media files. So it's not a good idea to produce Windows Media unless you are working for a web-based company that wishes to use the format.

AAC is a codec developed by Apple. It uses a process similar to MP3, but claims better results, especially at lower bit rates.

RealAudio is a proprietary format. This means you must deal directly with the RealAudio company to make use of their format. RealAudio was one of the first streaming audio formats on the Internet.