Table 1. Our Current Set of 20 Simple Metrics Based On Zipf's Law

Metric	*Description*
Pitch	Rank-frequency distribution of the 128 MIDI pitches
Chromatic tone	Rank-frequency distribution of the 12 chromatic tones
Duration	Rank-frequency distribution of note durations (absolute duration in seconds)
Pitch duration	Rank-frequency distribution of pitch durations
Chromatic-tone duration	Rank-frequency distribution of chromatic tone durations
Pitch distance	Rank-frequency distribution of length of time intervals between note (pitch) repetitions
Chromatic-tone distance	Rank-frequency distribution of length of time intervals between note (chromatic tone) repetitions
Harmonic interval	Rank-frequency distribution of harmonic intervals within chord
Harmonic consonance	Rank-frequency distribution of harmonic intervals within chord based on music-theoretic consonance
Melodic interval	Rank-frequency distribution of melodic intervals within voice
Harmonic-melodic interval	Rank-frequency distribution of harmonic and melodic intervals
Harmonic bigrams	Rank-frequency distribution of adjacent harmonic interval pairs
Melodic bigrams	Rank-frequency distribution of adjacent melodic interval pairs
Melodic trigrams	Rank-frequency distribution of adjacent melodic interval triplets
Higher-order intervals	Rank-frequency distribution of higher orders of melodic intervals; first-order metric captures change between melodic intervals; second-order metric captures change between first-order intervals, and so on up to sixth order

dom number generators: a *white-noise* ($1/f^0$) source, a pink-noise ($1/f$) source, and a *brown-noise* ($1/f^2$) source. They used independent random-number generators to control the duration (half, quarter, eighth) and pitch (various standard scales) of successive notes. Remarkably, the music obtained through the pink-noise generators was much more pleasing to most listeners. In particular, the white-noise generators produced music that was "too random," whereas the brown-noise generators produced music that was "too correlated." They noted, "Indeed the sophistication of this '$1/f$ music' (which was 'just right') extends far beyond what one might expect from such a simple algorithm, suggesting that a '$1/f$ noise' (perhaps that in nerve membranes?) may have an essential role in the creative process" (1975, p. 318).

John Elliot and Eric Atwell (2000) failed to find Zipf distributions in notes extracted from audio signals. However, they used a small corpus of music pieces and were looking only for ideal Zipf distributions. On the other hand, Kenneth Hsu and Andrew Hsu (1991) found $1/f$ distributions in frequency intervals of Bach and Mozart compositions. Finally, Damián Zanette found Zipf distributions in notes extracted from MIDI-encoded music. Moreover, he used these distributions to demonstrate that as music progresses, it creates a meaningful context similar to the one found in human languages (see http://xxx.arxiv.org/abs/cs.CL/0406015).

Zipf Metrics for Music

Currently, we have a set of 40 metrics based on Zipf's Law. They are separated into two categories: simple metrics and fractal metrics.

Simple Metrics

Simple metrics measure the proportion of a particular parameter, such as pitch, globally. Table 1 shows the complete set of simple metrics we currently employ (Manaris et al. 2002). Obviously, there are many other possibilities, including size of movements, volume, timbre, tempo, and dynamics.

For instance, the *harmonic consonance* metric operates on a histogram of harmonic intervals