

Musical timbre: matching acoustic features to human perception

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Machine listening

- ▶ Elicit information which corresponds to human percepts
 - ▶ Loudness
 - ▶ Direction
 - ▶ Distance
 - ▶ Speech recognition
 - ▶ Cocktail-party effect
- ▶ *Musical* machine listening
 - ▶ Pitch
 - ▶ Timbre
 - ▶ Instrument identification
 - ▶ Beat tracking
 - ▶ Music similarity

Human music perception

The three major auditory attributes of sounds:

1. Pitch

- ▶ Univariate, continuous
- ▶ Subtle relationship to fundamental frequency
- ▶ Good ways to measure pitch by machine (e.g. autocorrelation)

2. Loudness

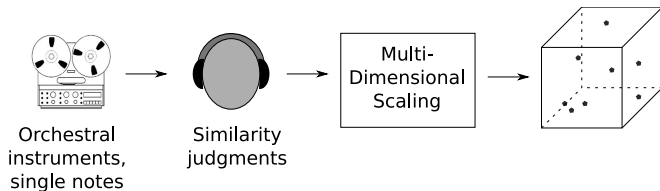
- ▶ Univariate, continuous
- ▶ Subtle relationship to signal amplitude
- ▶ Good ways to measure loudness by machine

3. Timbre

- ▶ Question of definition (e.g. ASA 1960)
- ▶ Not univariate. Metric? Continuous? Categorical?
- ▶ Various possible approaches to measurement

Musical timbre experiments

Grey (1977), Grey & Gordon (1978), McAdams *et al.* (1995)

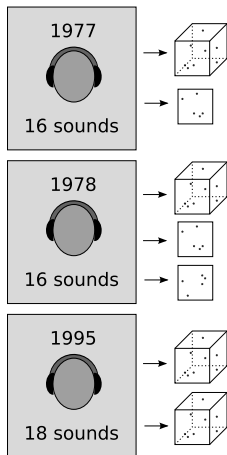


What “are” the axes?

- ▶ Traditional acoustic correlates
 - ▶ Pearson correlation against simple spectral/temporal statistics
 - ▶ Spectral centroid; log attack time; ...
- ▶ Many other acoustic features
 - ▶ Perceptual (e.g. Mel-Frequency Cepstral Coefs)
 - ▶ Production-based (e.g. Linear Prediction Coefs)
 - ▶ Harmonic (e.g. odd vs. even harmonic energy)
- ▶ Which fit best?

The combinatorial problem

Acoustic timbre features
25-30



Feature
selection

Feature selection: other approaches

- ▶ Independence (information-theoretic)
 - ▶ Mutual information, conditional entropy
 - ▶ Select features which provide the most “unique” information

- ▶ Robustness
 - ▶ Apply typical audio degradations (crowd noise, feedback echo)
 - ▶ Select features whose values are most stable

- ▶ Not perceptual