Pitch Analysis Workshop

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Historical Methods

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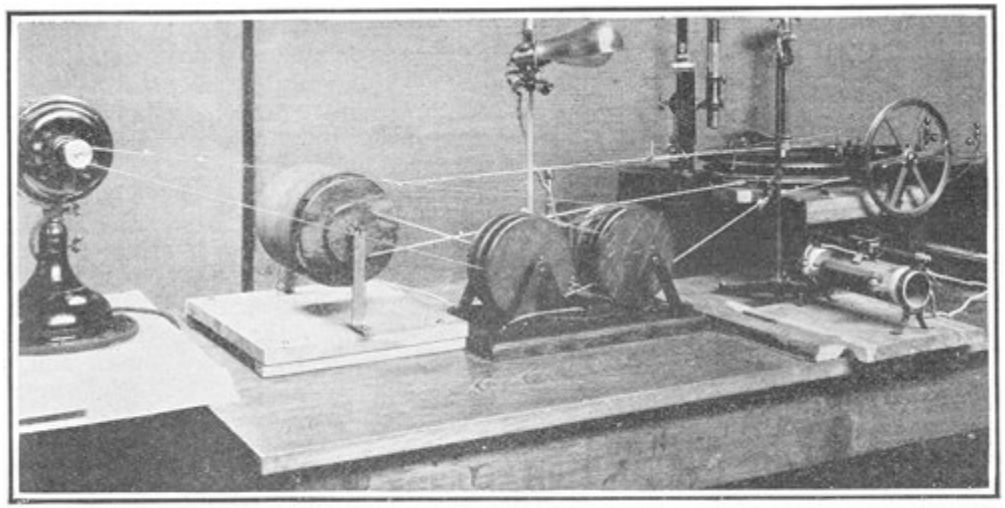
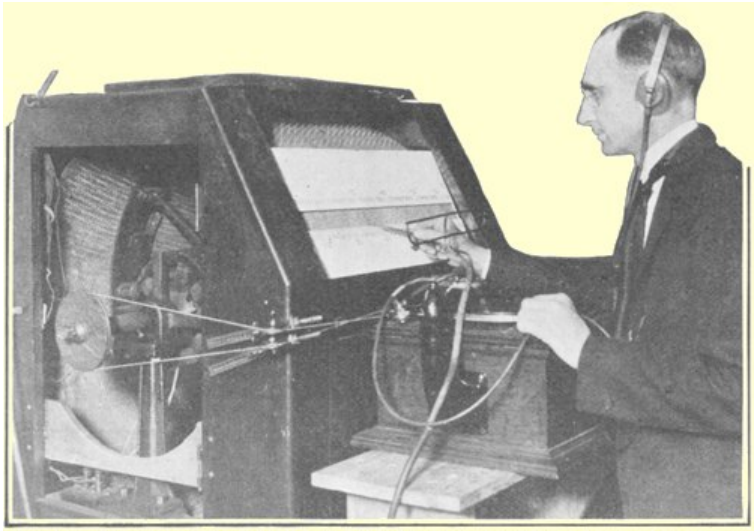
- **Carl Seashore (1938) and colleagues studied timing, dynamics, intonation, and vibrato in pianists, violinists, and singers**
  - Equipment: piano rolls, films of the movement of piano hammers during performance, phono-photographic apparati



Wave recorder for use with disk phonograph; the lever, acting like a pantograph, traces the waves on a revolving smoked drum

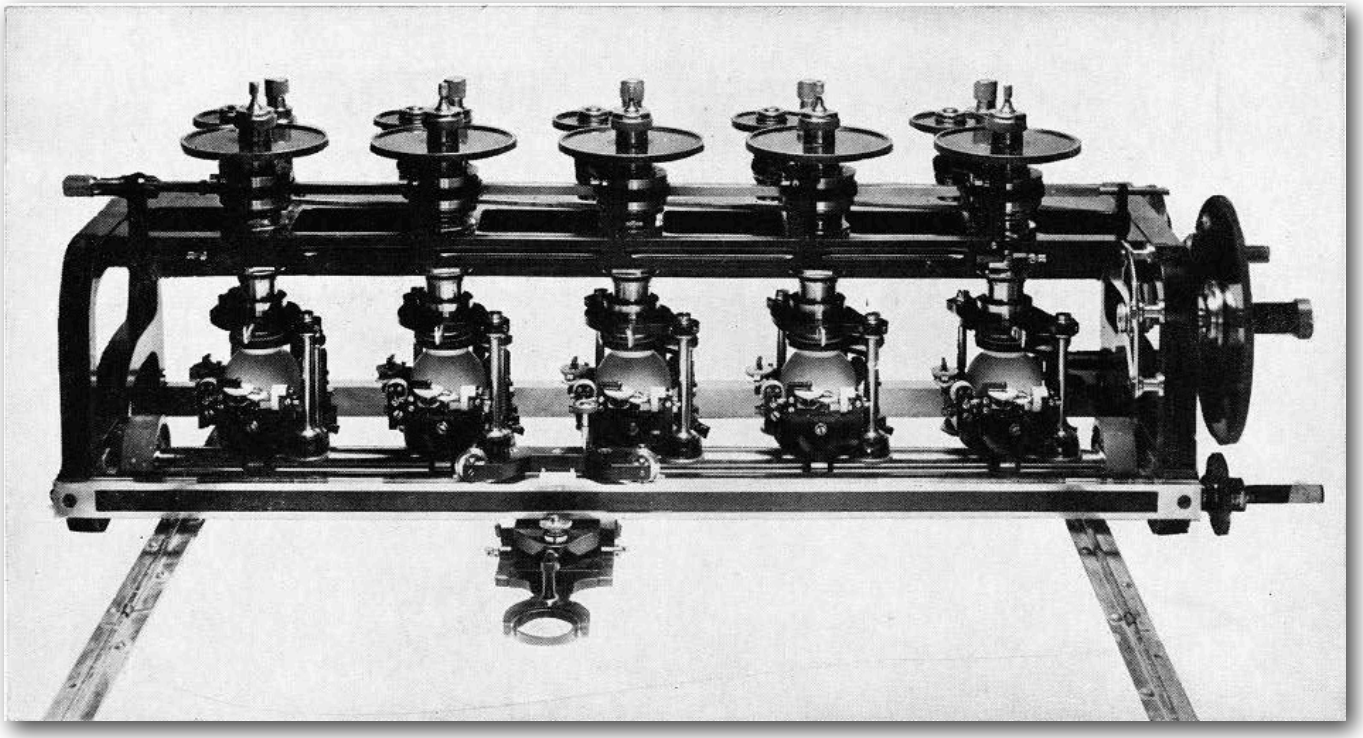


The tonoscope for analyzing the pitch of the tones on a disk phonograph record

Cary (1922)

Historical Methods

Phonophotography technique



Henrici Harmonic Analyzer

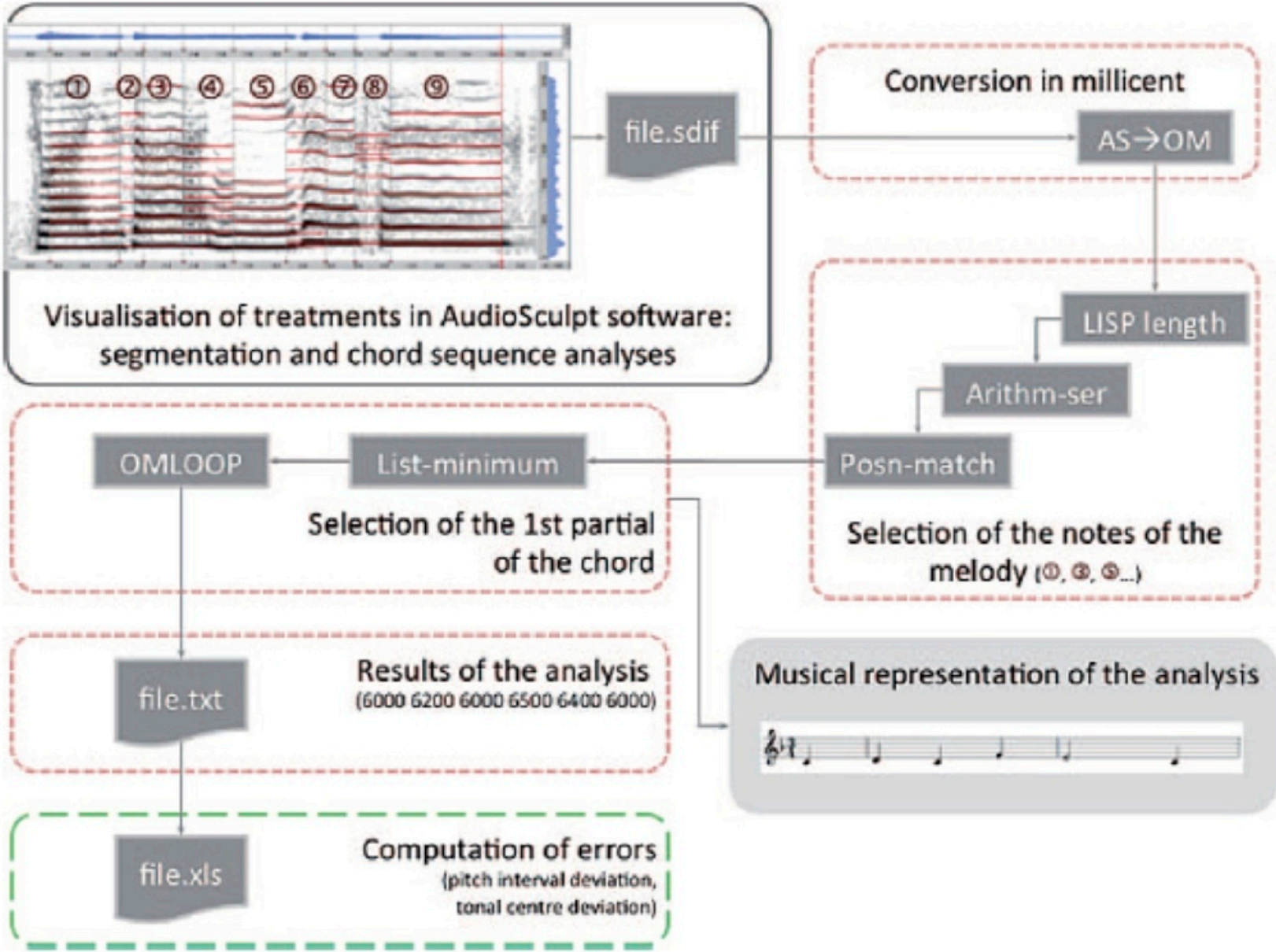
Seashore (1937)

- **Frequency graphed in 10 cent units**
- **Intensity graphed in decibels**
- **Timing information as a function of linear space**

Manual Annotation by Tapping

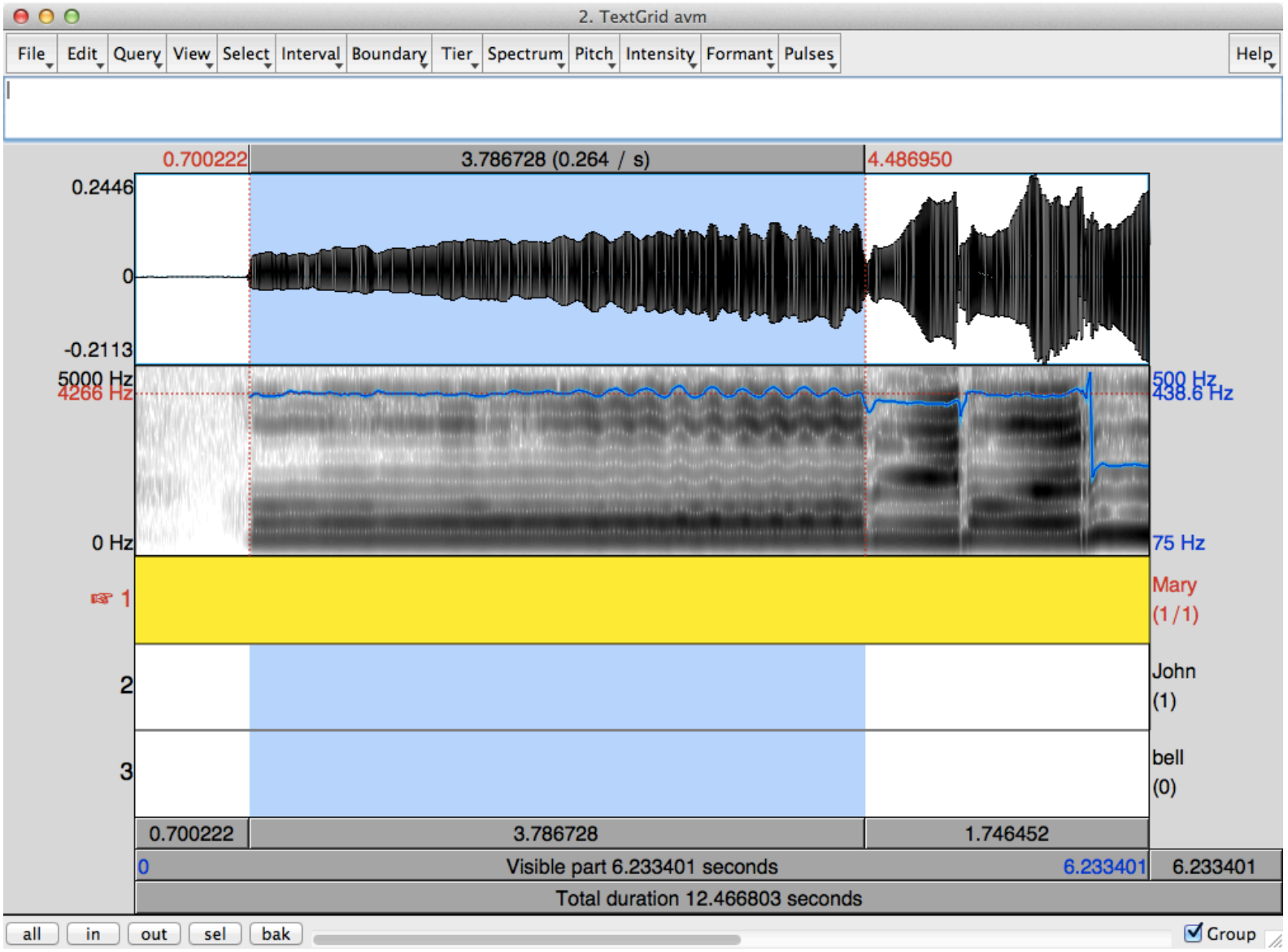
Manual Annotation with Software

Audio Sculpt + Open Music



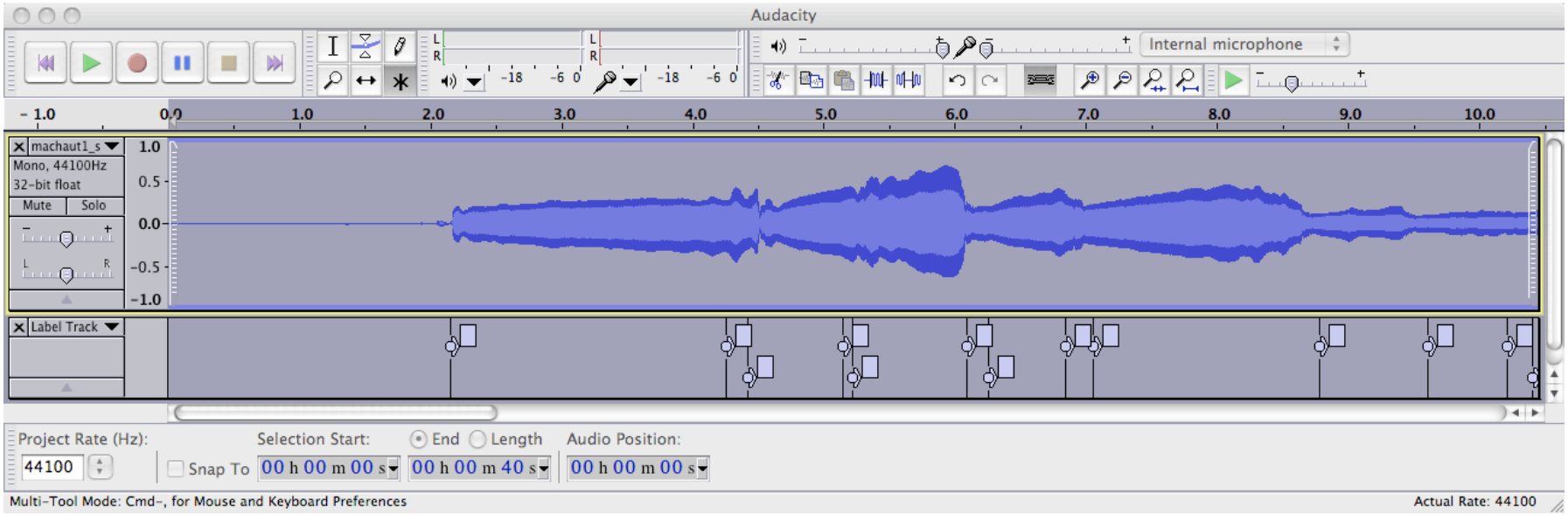
Manual Annotation with Software

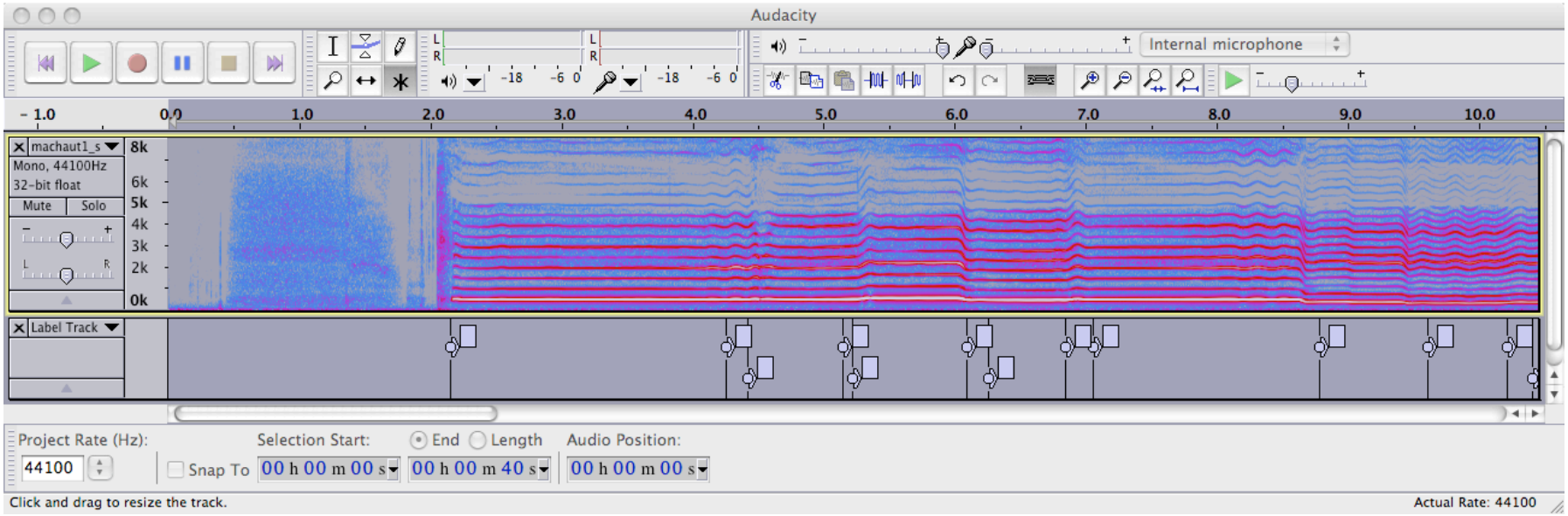
PRAAT



Manual Annotation with Software

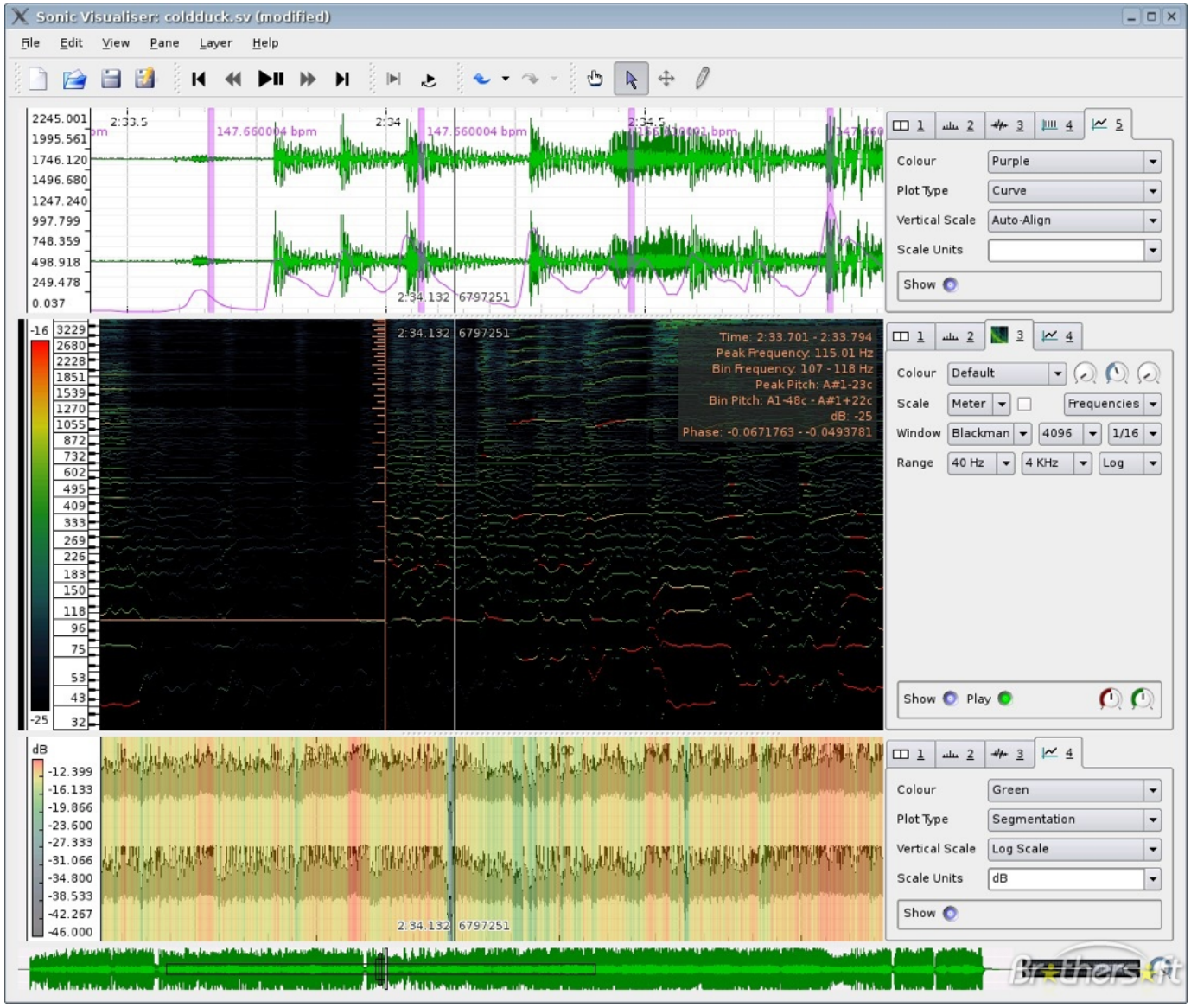
Audacity





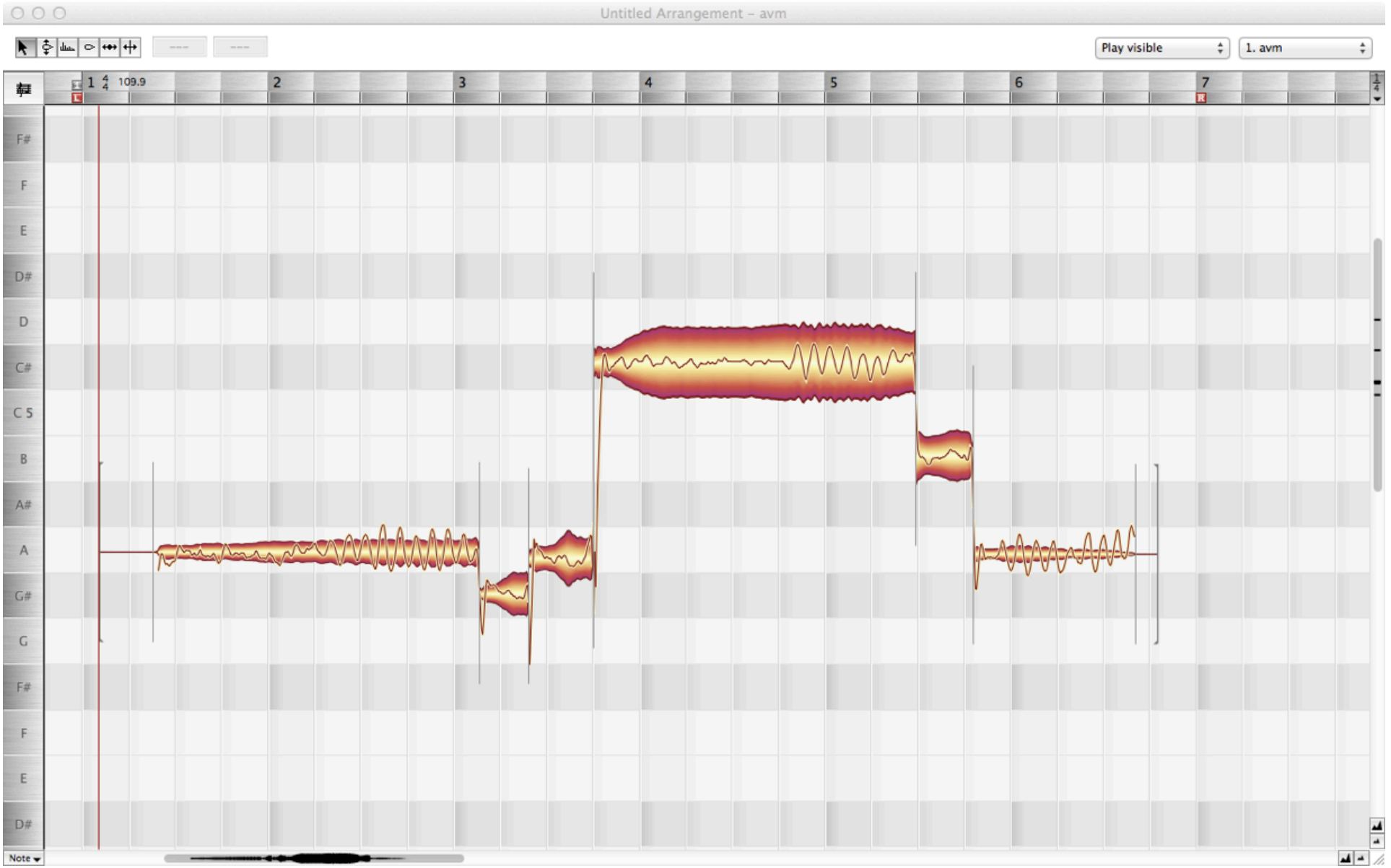
Automatic Annotation

Sonic Visualiser

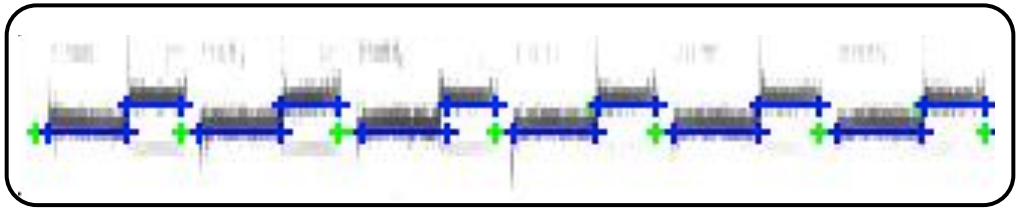


Automatic Annotation

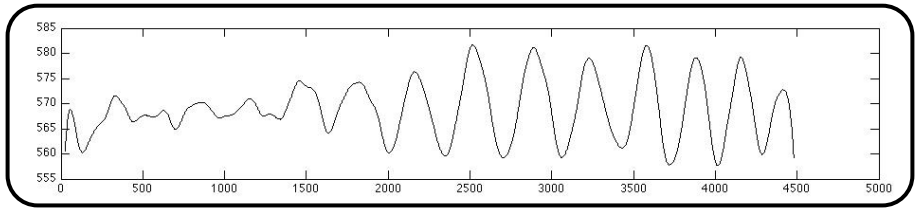
Melodyne



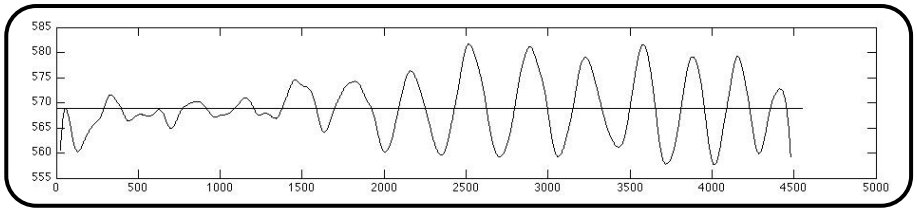
Identify Note Onsets and Offsets



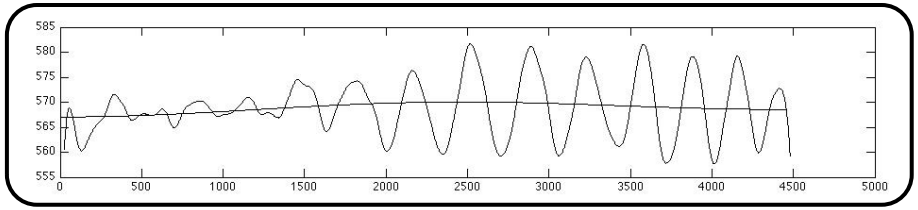
Fundamental Frequency (F_0) Estimation



Perceived Pitch



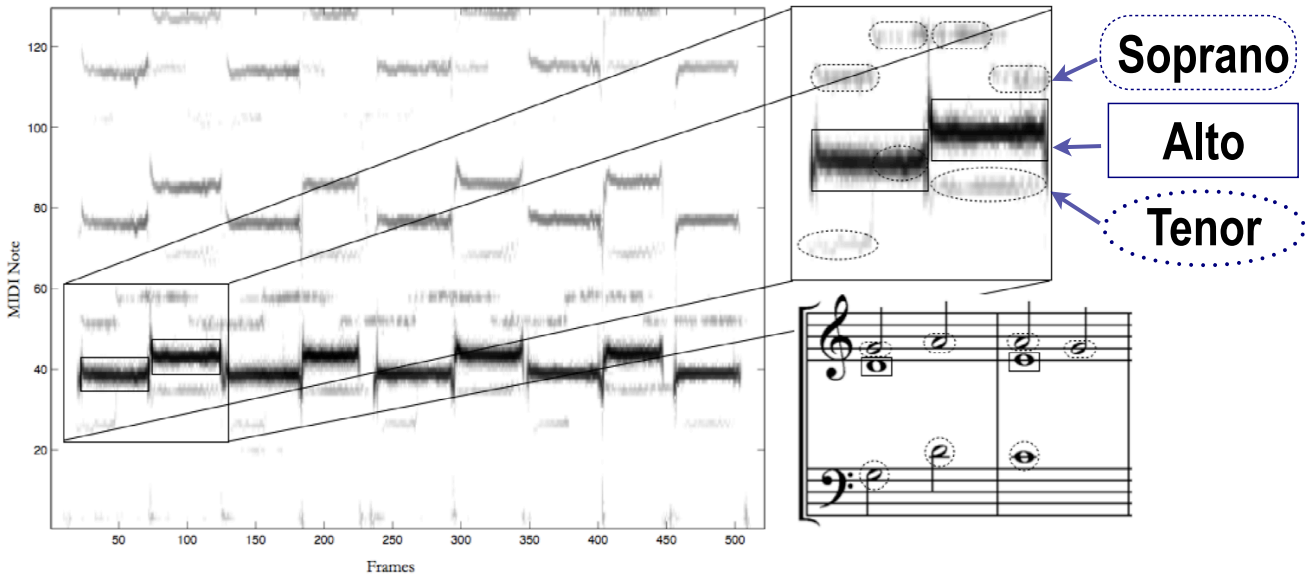
Evolution of F_0



Score-guided performance data extraction

Monophonic and quasi-polyphonic

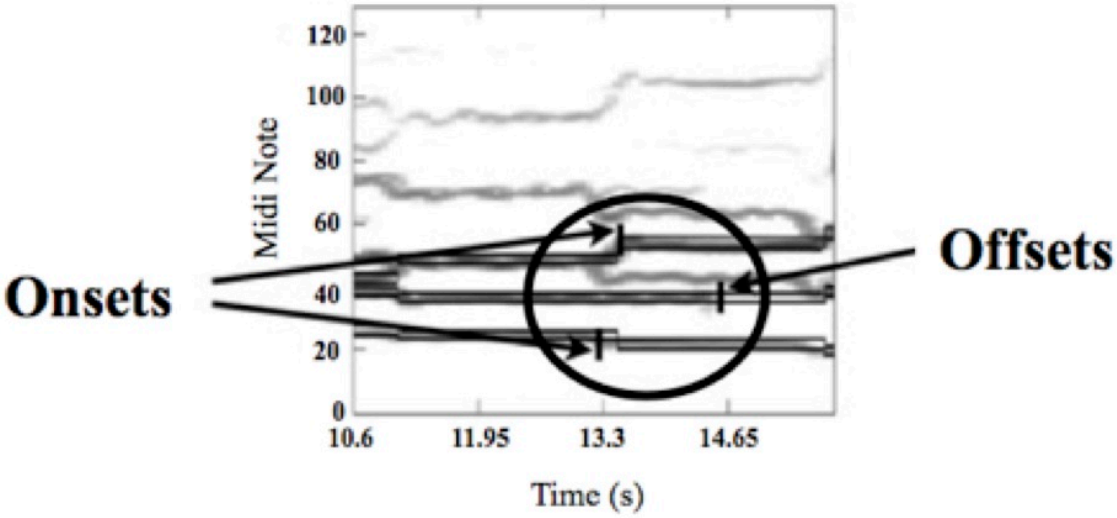
- **Timing information is available via MIDI/audio alignment**
- **Fundamental frequency (F_0), and amplitude can be reliably extracted**



Devaney, Mandel, and Ellis (2009)

Score-guided performance data extraction

Polyphonic



- **Timing information (including asynchronies between lines) is available in the alignment**
- **F_0 and amplitude are harder to extract**
- **Currently exploring the using High Resolution methods with Roland Badeau for the task of score-guided extracting of frequency and loudness information in polyphonic audio**

Devaney and Ellis (2009)
Devaney (2014)

Perceived Pitch

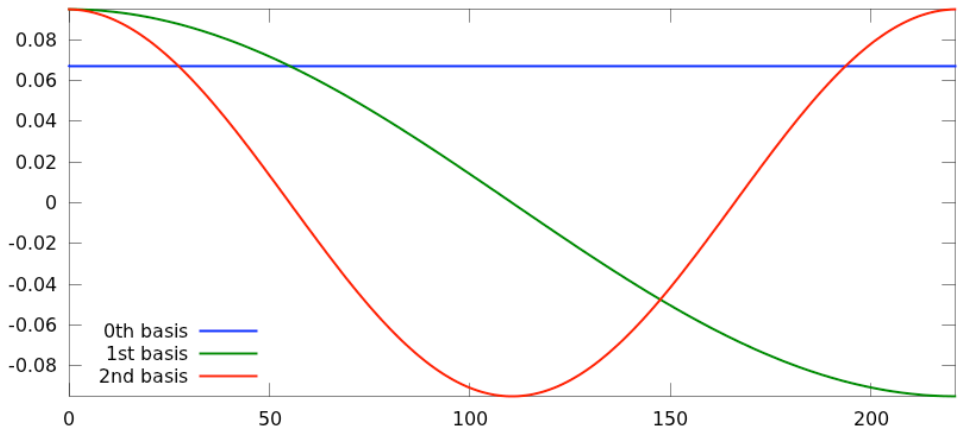
Possible calculation methods

Shonle and Horan (1980)	• Geometric mean over the duration of the note
Iwamiya, Kosugi, and Kitamura (1983)	• Center frequency between peaks and troughs in vibratos and symmetrical trills • In asymmetrical trills pitch shifts according to the direction of the asymmetry
D'Alessandro and Castellengo (1994, 1995)	• F_0 at the end of the note was more significant for the pitch perception than the beginning of the note. • Mean of the steady-state portion oft he note rather than the mid-point between the maximum and minimum frequencies
Gockel, Moore, and Carlyon (2001)	• Weighted mean based on the fundamental frequencies' rate of change, with higher weightings for frames that had a smaller rate of change

Evolution of F_0

Modeling note trajectories

- **Characterizing F_0 trajectories is under-studied**
- **One option is to decompose of F_0 trace with the Discrete Cosine Transform to estimate slope and curvature**



Devaney, Mandel and Fujinaga (2011)
Devaney and Wessel (2013)

AMPACT

Automatic Music Performance and Comparison Toolkit

www.ampact.org