

Computational modeling for Hindustani music



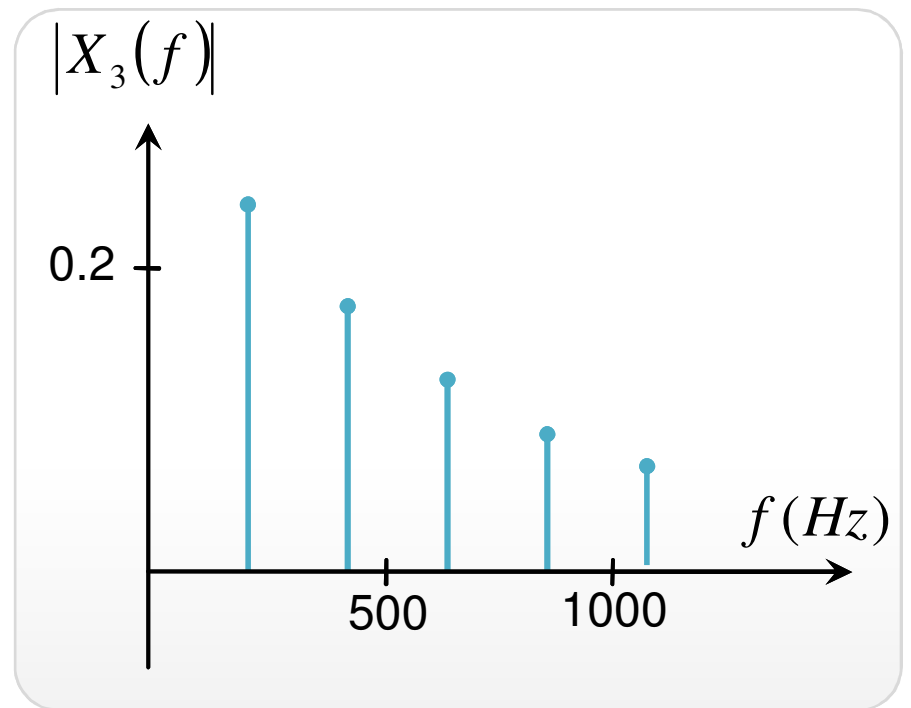
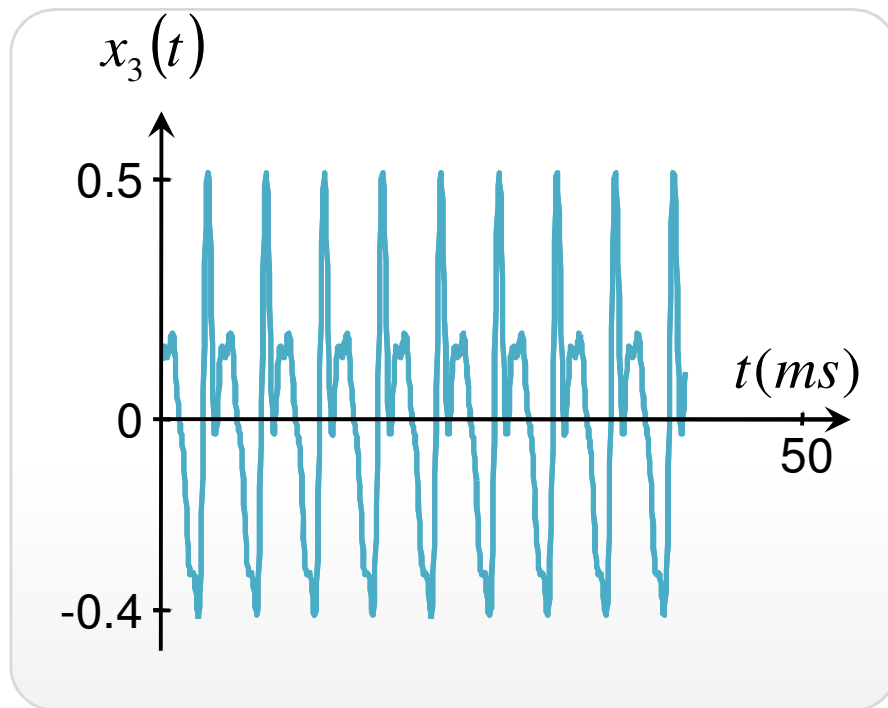
Preeti Rao

Department of Electrical Engineering
Indian Institute of Technology Bombay

Topics Covered

- What we can do with our computing tools...
- Why it may be useful to
 - Musicological studies
 - Pedagogy
 - Access and enjoyment of music

Sounds of music: complex tone signal



Sound and Sensation

Primary sensations

- *loudness*
- *pitch*
- *timbre (“quality”)*

Physical correlates

- intensity*
- fundamental frequency*
- spectro-temporal properties*

Music concepts

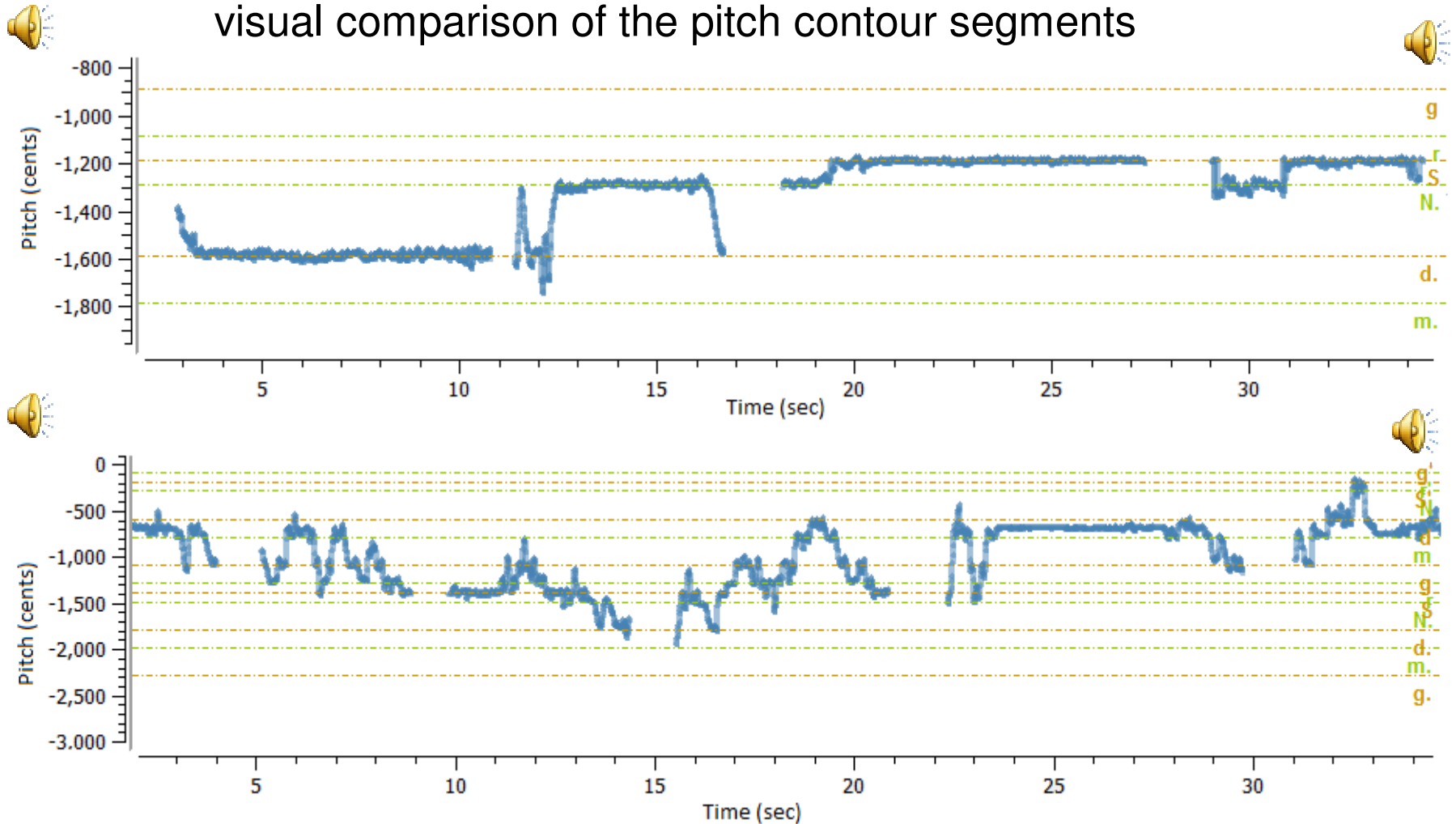
Basic dimensions of music are melody, rhythm, harmony and timbre.

- Melody, harmony -> based on pitch content
- Rhythm -> based on timing information
- Timbre -> relates to instrumentation, texture

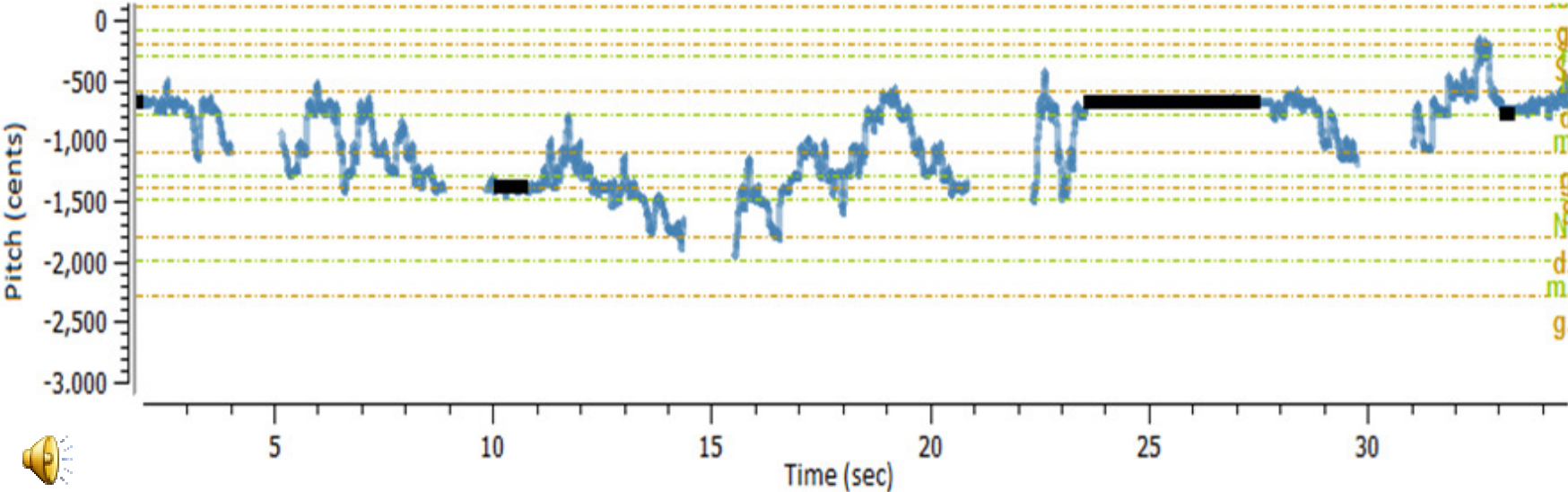
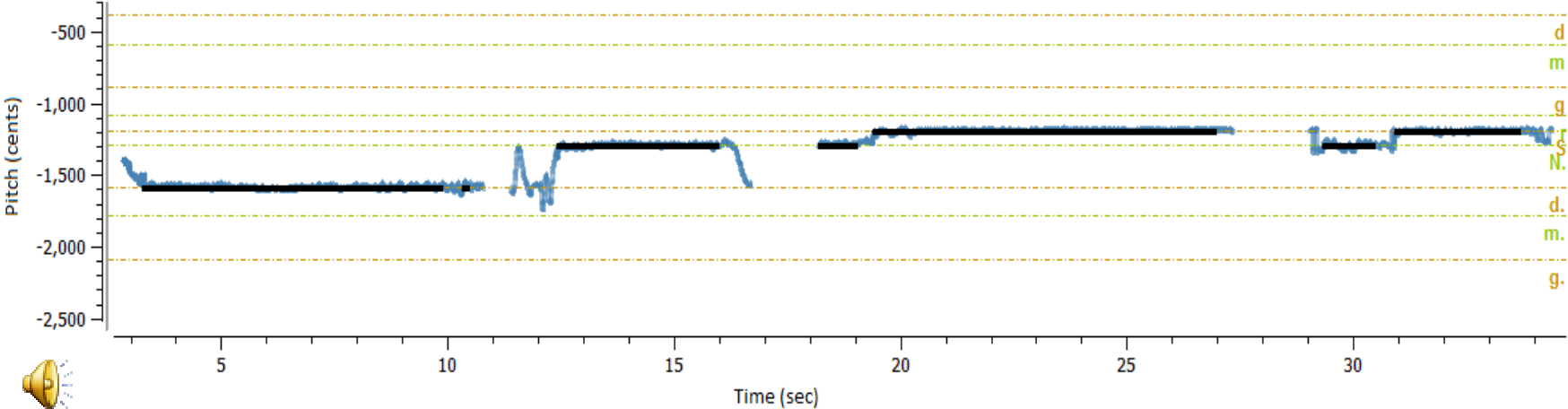
A **representation** of these high-level attributes can be obtained from pitch and timing information extracted by audio signal analysis.

Melodic Pitch Contours

- Differences in the two melodic styles are observed by the visual comparison of the pitch contour segments



Discrete notes?



Melodic contour: applications

- Musicological studies such as [intonation](#)
- Melodic phrase matching for pedagogy: both for “emulation” and improvisation.
- Melodic similarity for music classification and retrieval including visualization.
- Transcription to aid studies deriving from symbolic notation of music

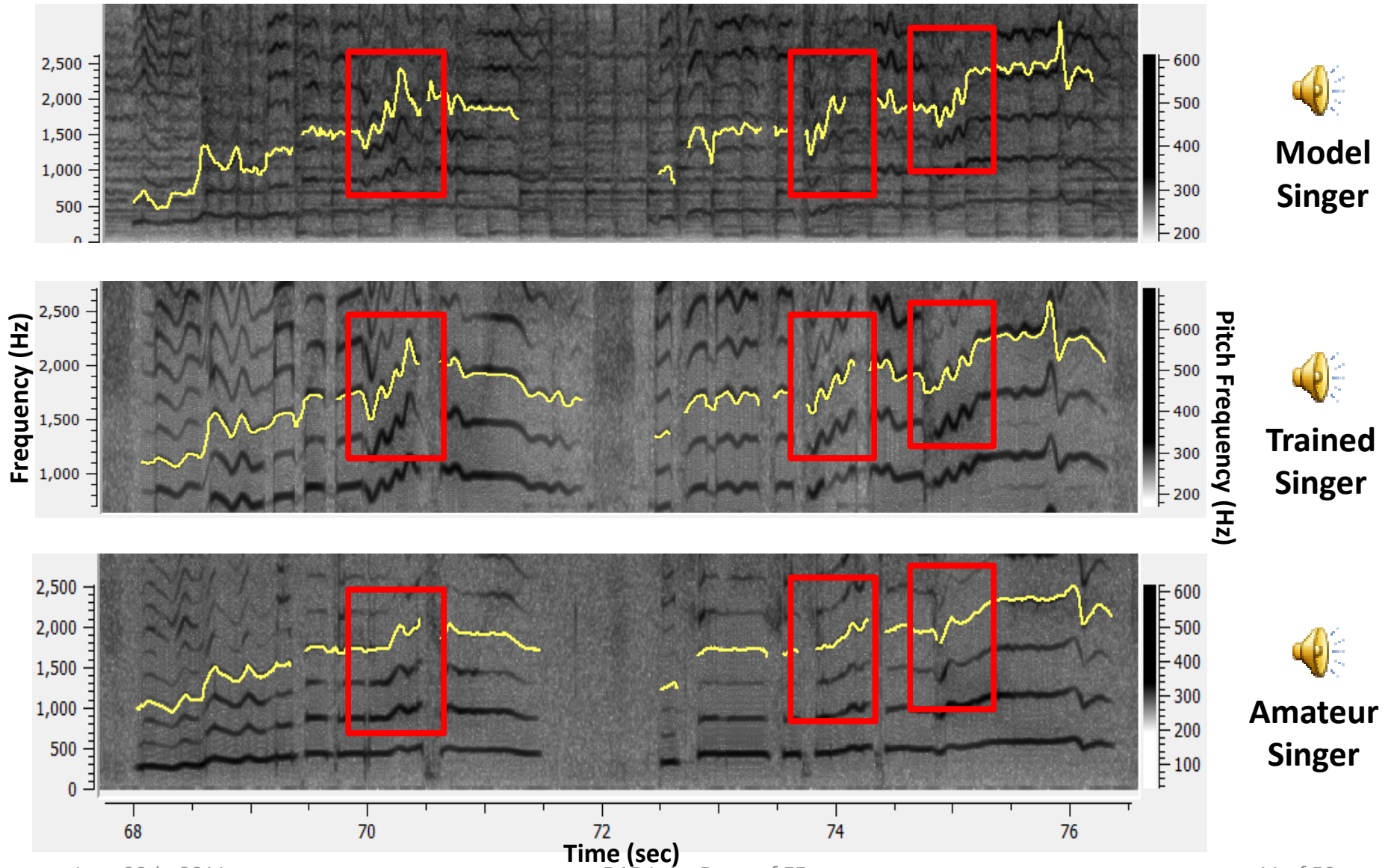
- Intonation (shruti is all important. Should be accurate for given raga, style.....)
- Pitch class distributions (past work)

Ornamentation

- Style, emotions, *gharana* (school/style) characteristics, *raga* characteristics and even the personal characteristics influence the ornaments.
- **Ornaments** enhance the basic melodic contour and contribute to musicality/ expressiveness.
e.g. grace note, a glide between two notes, multiple oscillations of a single note, oscillation between notes....
- Of the ornaments, those that are often transcribed in notation are *Meend*, *Andolan*, *Khatka*, *Murki*, *Gamak*, *Zamzama*

[ITC SRA site: <http://www.itcsra.org/alankar/alankar.html>]

Visualization and pedagogy



Observed differences

- The “notes” rendered by both, trained and amateur singers, are similar to the reference



Model Singer



Trained Singer



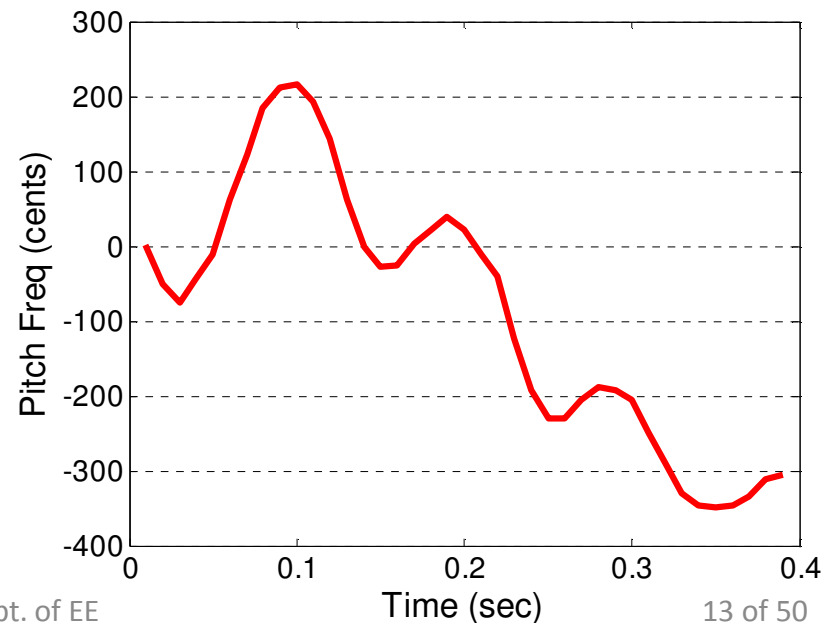
Amateur Singer

- The differences lie between the notes...

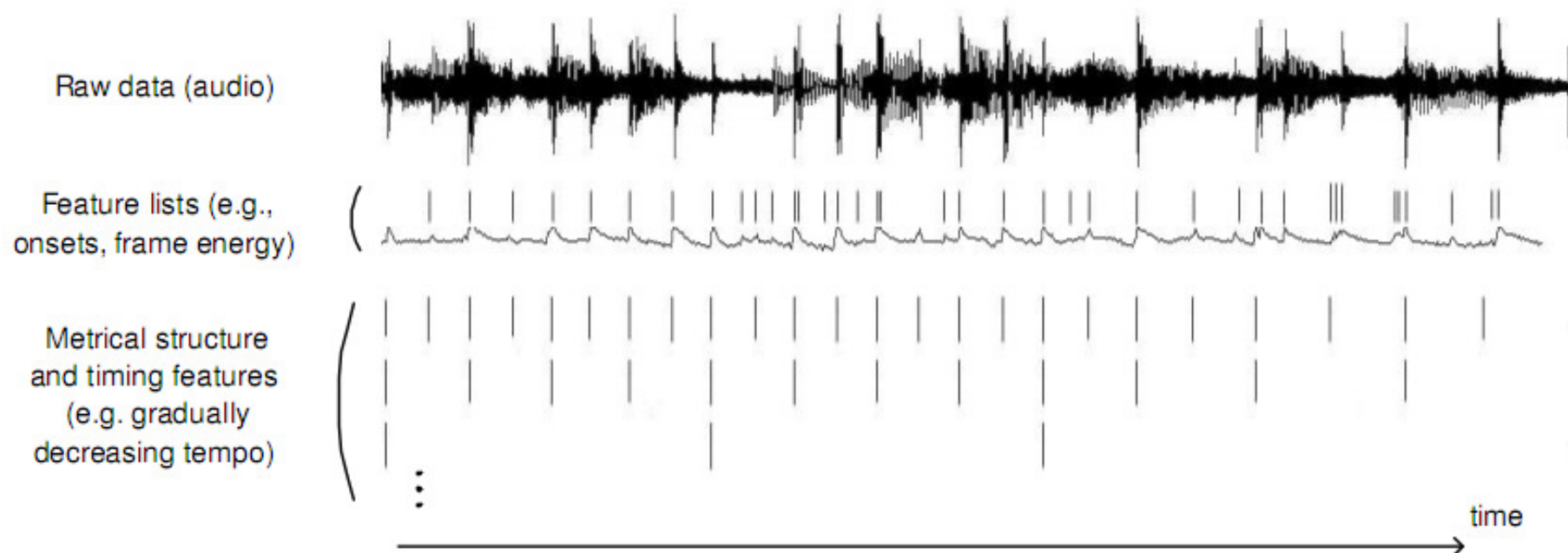
Gamak: Oscillations-on-Glide

- Periodic oscillations riding on a glide-like transition from one note to another (may or may not be of uniform amplitude)
- **Gamak** in Indian classical music as defined in [SRAsite]
 - : “A *gamak* can be defined as a fast *meend* (spanning 2-3 notes normally) delivered with deliberate force and vigor and repeated in an oscillatory manner”

- Possible attributes:
 - Glide - overall monotonic trend
 - Oscillation - pure vibration around the glide
 - **Amplitude**
 - **Rate**



Rhythm representation



F. Gouyon, S. Dixon

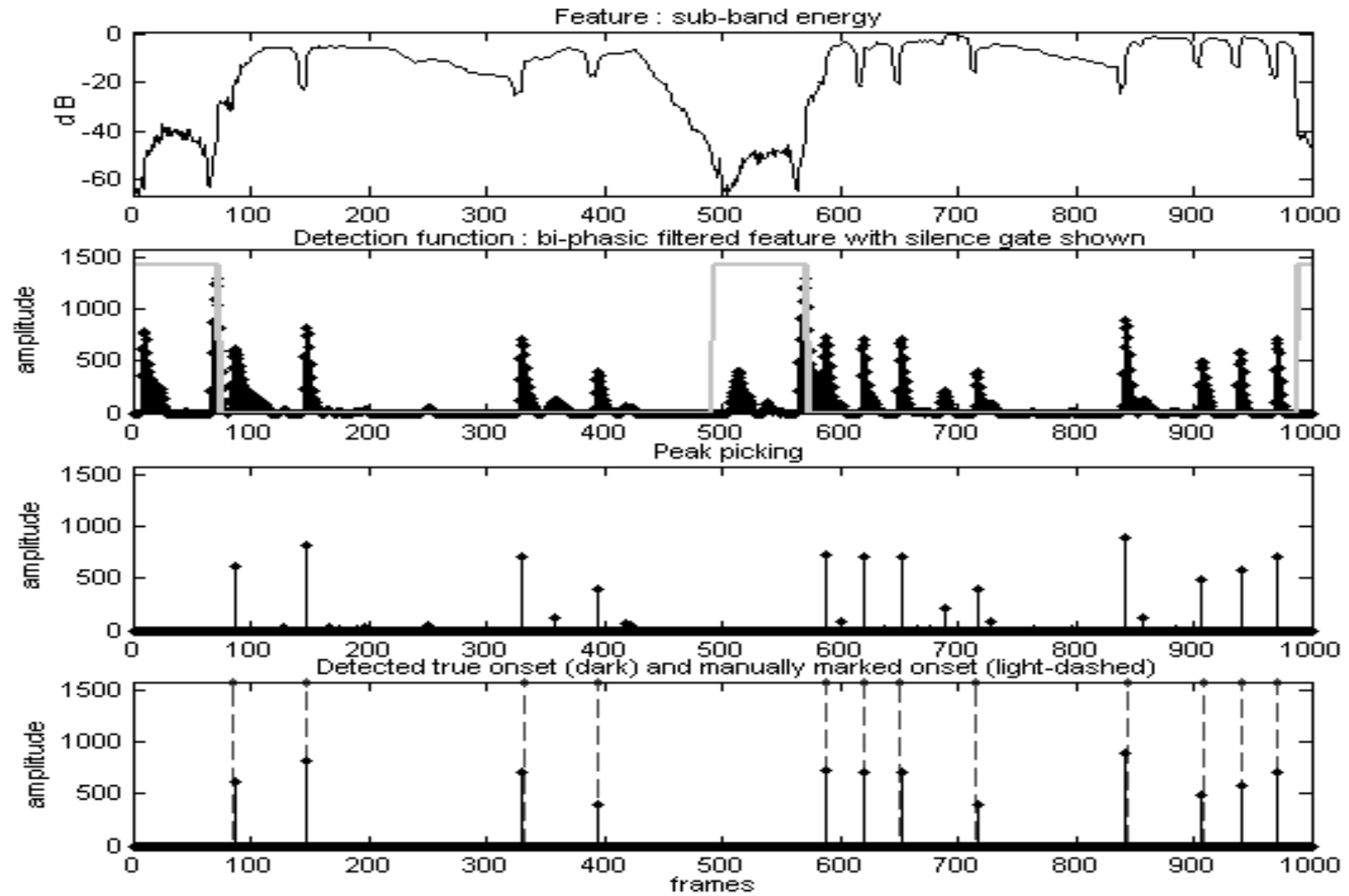
ISMIR 2006 Tutorial: Computational rhythm description

International Conference on Music Information Retrieval, 2006

Rhythm

- Rhythm refers to the periodic and hierarchic framework that embeds the **timing of events** (onsets) within the audio signal.
- Rhythm detection involves detecting events at each **metrical level**.
 - Tatum
 - Tactus
 - Measure
- Onsets are detected via abrupt increases in loudness, or equivalently, abrupt energy changes within frequency bands. Rhythm is represented by the detected periodicities of the sequence of onsets.

Note onset detection



- Transcription