

Music Technology

Topics, Trends, Tools, Careers

Ajay Srinivasamurthy

30 Jan 2020

SAMP 2020, NITK Surathkal

ajays.murthy@gmail.com

www.ajaysrinivasamurthy.in



Agenda

- Music Technology
 - Introduction, Opportunities and Challenges
- Music Concepts
 - Objects, Elements, Indian Art Music
- MIR Problems
 - Representations, Descriptors, Tasks
- Applications and Resources
 - Data, Tools, Community
- Careers

Show of Hands!

- Music Training
 - Indian Music
 - Western Music
 - Music Production
 - Sheet Music Literates ?
- Avid Music Listeners
- Signal processing and/or Machine Learning

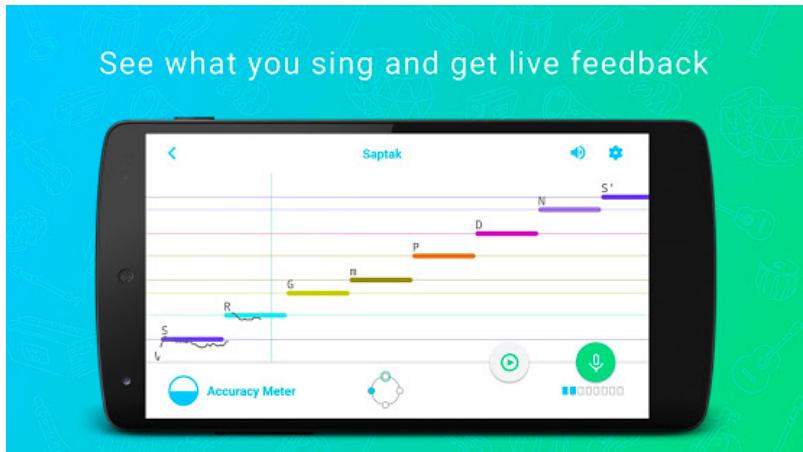
Introduction



<https://www.upf.edu/web/mtg/reactable>



<http://www.gtcmt.gatech.edu/robotic-musicianship-projects>



<https://riyazapp.com>

The Art of Music

- Music – part of most cultures, pre-historic
- Closely tied with traditions - instruments, form
- Uniquely a human creation ?!
- Music has independently developed universals
 - Melody, rhythm, harmony
- Indian Music
 - Art Music: Carnatic and Hindustani
 - Folk and film music



The Science of Music

- Broadly two directions
 - Systematic study of music – musicology and music theory
 - Understanding of music – music perception and cognition
- Basic questions
 - Why is music musical ?
 - Emotions and music
 - Culture specific v/s universal music attributes
 - Improvisation and virtuosity

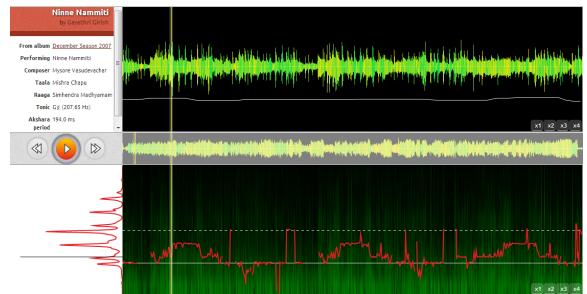


The Engineering of Music

- Not new!
- Earliest examples – Music instruments
- Last few decades – mainly supporting the music industry
 - MIDI, Synthesizers, samplers, recording and playback technologies
- More recently – Interdisciplinary Music Information Research

*Development of tools and applications for representation,
understanding, analysis and synthesis of music*

Examples



Music Technology

Music Technology enhances our experience with music by building tools and technologies to learn, teach, compose, produce, perform, record, playback, consume, analyze, understand, appreciate, store and archive music

Music Technology

Music Technology enhances our experience with music by **building tools and technologies** to learn, teach, compose, produce, perform, record, playback, consume, analyze, understand, appreciate, store and archive music

Music Technology

Music Technology enhances **our experience with music** by building tools and technologies to learn, teach, compose, produce, perform, record, playback, consume, analyze, understand, appreciate, store and archive music

Music Technology

Music Technology enhances our experience with music by building tools and technologies to **learn, teach, compose, produce, perform, record, playback, consume, analyze, understand, appreciate, store and archive music**

Music Technology

Music Technology enhances our experience with music by building tools and technologies to learn, teach, compose, produce, perform, record, **playback, consume, analyze, understand, appreciate, store and archive music**

Music Information Research (MIR)

Music Technology

Music Technology enhances our experience with music by building tools and technologies to **learn, teach, compose, produce, perform, record, playback, consume, analyze, understand, appreciate**, store and archive music

Computational Musicology

Music Information Research (MIR)

Cognitive Science

Psychology

Machine Learning

Computer Science

MIR

Signal Processing

Acoustics

Social Sciences

Music Theory

Physics

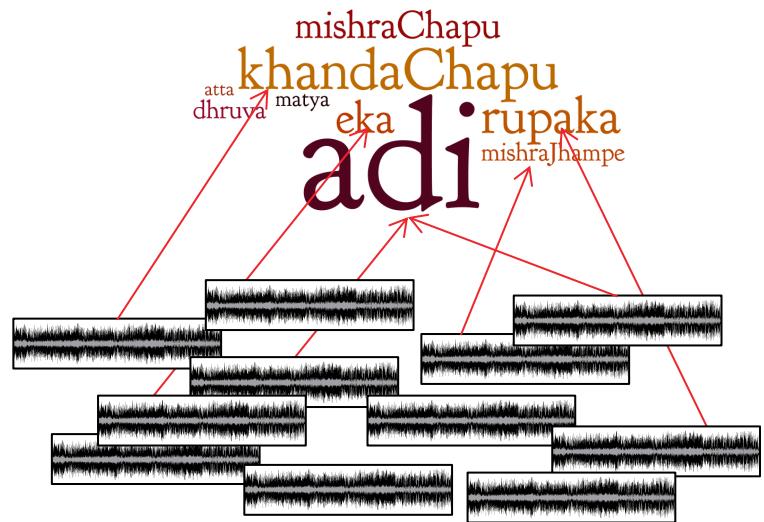
Computational Musicology

- Scholarly analysis of music – multidisciplinary
- Facets: learning, teaching, performance, listening, appreciation, aesthetics
- Perspectives: Historical, cultural, cognitive
- Computational tools for Musicology

Data-driven computational musicology

- Music-corpora level statistical analysis
 - Melody, rhythm and harmony
- Supplement and complement manual analyses
 - Scale to large corpora
 - Verify common-knowledge
 - Derive additional insights

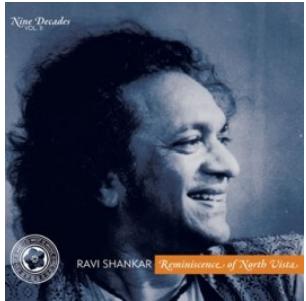
Opportunities and Challenges



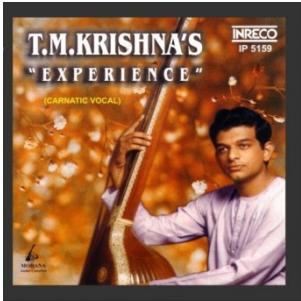
Opportunities (Challenges!?)

- Multicultural world
 - Each within its sociocultural context
- Lots of data
 - but copyrighted, unlabeled and sub-optimally organized
- Subjectivity
 - In creation, consumption and analysis
 - Music Similarity
- Interdisciplinary
 - Involve the community

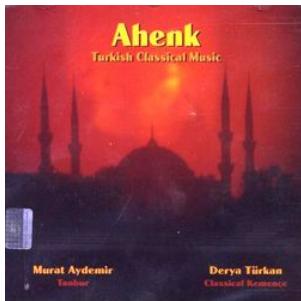
Culture aware technologies



Hindustani



Carnatic



Turkish-makam



Arab-Andalusian



Beijing Opera

- CompMusic: Culture aware Music Information Research
 - Bring music knowledge into methods
 - Musical concepts to engineering formulations
 - Involve music communities

<http://compmusic.upf.edu/>

Community

- Musicians, music students, musicologists, listeners
- Engineers, scientists and technologists
- Music producers, record labels
- Address subjectivity

Additionally . . .

- Code – Open source
- Data – Easily accessible





Computational models for the discovery of the World's Music


UNIVERSITAT
POMPEU FABRA


[HOME](#)

[DESCRIPTION](#)

[TEAM](#)

[PUBLICATIONS](#)

[CORPORA](#)

[SOFTWARE](#)

[EVENTS](#)

[BLOG](#)

[NEWS](#)

[RESOURCES](#)

[GET INVOLVED](#)



LATEST NEWS

Xavier Serra participates to a conference on Science Diplomacy

31/10/2016 - 10:42

Xavier Serra was invited to present the

COMPANION WEBPAGE FOR THE PHD THESIS OF AJAY SRINIVASAMURTHY

This page is the companion webpage for the PhD thesis titled

A DATA-DRIVEN BAYESIAN APPROACH TO AUTOMATIC RHYTHM ANALYSIS OF INDIAN ART MUSIC

Ajay Srinivasamurthy

(Last updated: 13 Nov 2016. Please click on the headings to expand.)

The dissertation document can be obtained from <http://mtg.upf.edu/node/3593>

- ▶ [EXAMPLES](#)
- ▶ [DATASETS](#)
- ▶ [PUBLICATIONS](#)
- ▶ [CODE](#)
- ▶ [RESULTS](#)

(The page <http://www.ajaysrinivasamurthy.in/phd-thesis> redirects to this page)

English ▾ 

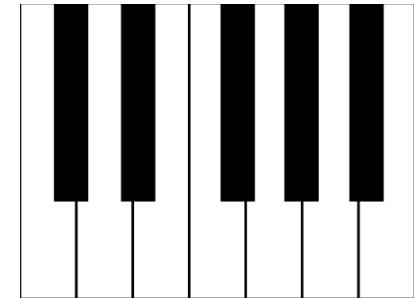
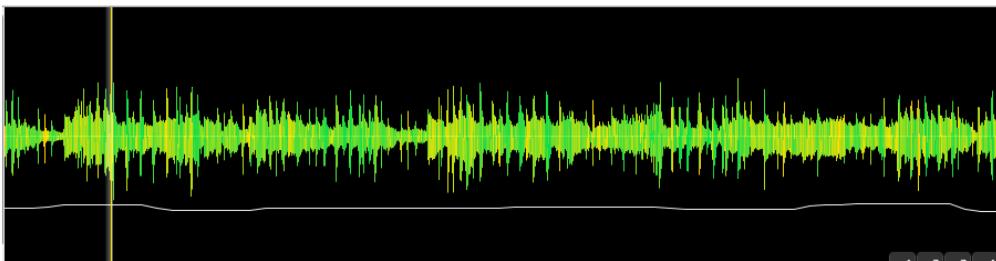
LATEST BLOGS

[Technology and Multiculturality](#) 17/04/2016 [Article published in the daily newspaper La Vanguardia on Sunday 17th 2016. English translation of the original text written in catalan.] The violin, typewriter or mobile are examples of technological devices that were born in certain contexts...

[Two evenings of Chinese traditional music](#) 27/01/2016 Last December (2015), Barcelona's Conservatori Municipal de Música hosted two sessions of Chinese traditional music, the first one devoted to the silk and bamboo music genre and the second one to jingju (Beijing opera). For this...

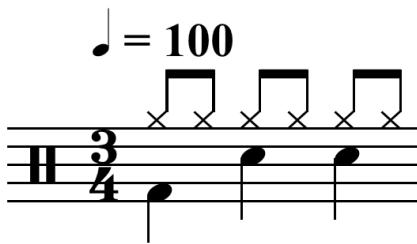
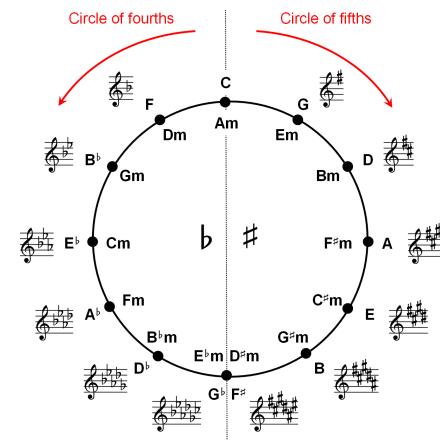
[Nila Sangita - An evening of Indian Classical Music and Dance](#)

Music Concepts



$\text{♩} = 100$

$\frac{3}{4}$

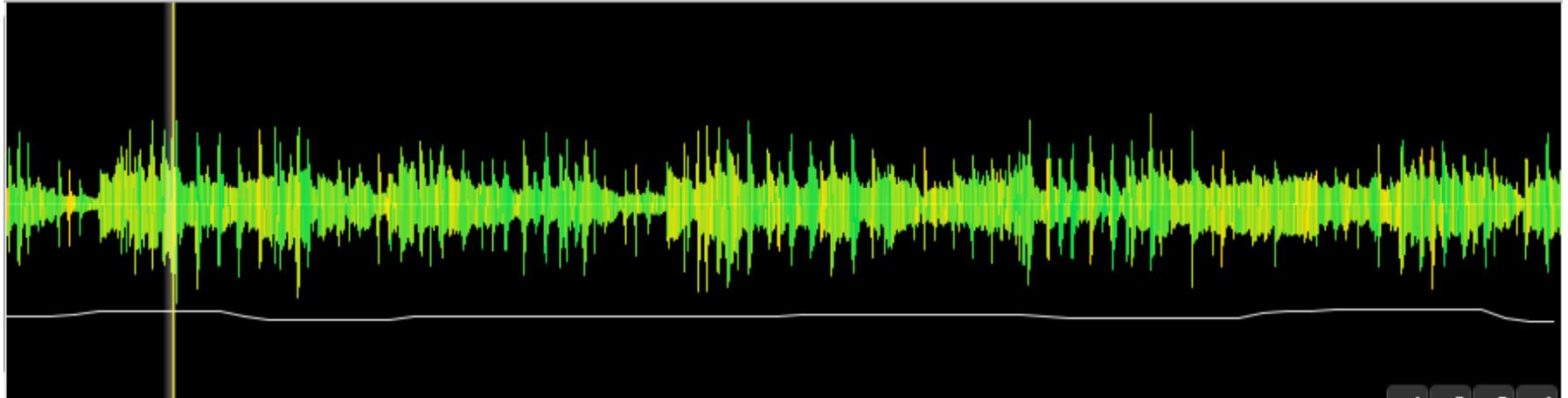



Concepts not discussed

- What is music ?
- Are there universals in music ?
- Sociocultural contexts for music

Music Objects

- Audio
 - Waveform: time sequence of amplitudes



Music Objects

- Scores
 - Prescriptive/Descriptive

Pallavi

G , R , .	S , , ,	N S R G	R R S N I
ja . la .	jā . . .	kshi. . .	nin . . .
S R S S	N P - N S R - P ,	N , S , R	
ne da . . bā .	. si . .	
G R S N	S R - P N	S R G P	G N P ,
chā . . la	. ma . .	. ru . .	. lu .
S N S G	R - S N P P G ,	R , S , R	
kon na . . di rā . .	

```

id: ravikiran2024p
vol: 2
page: 24
varnam: Jalajaakshi
raag: hamsadhwani
taal: adi
tempo: madhyalaya

// G3 - R2 - / S - - -/ N3, S R2 G3/ R2 R2 S N3,/
S R2 S S/ N3, P, N3, S/ R2 P, - N3,/ - S - R2/

// G3 R2 S N3,/ S R2 P, N3,/ S R2 G3 P/ G3 N3 P -/
S' N3' S' G3'/ R2' S' N3 P/ P G3 - R2/ - S - R2/

```



The image shows two staves of a musical score. The top staff is for Clarinet, the middle for Viola, and the bottom for Piano. Measure 94 starts with a dynamic *f*. Measure 98 begins with a dynamic *p*.

Music Objects

- Audio
- Scores
- Lyrics

Kuşâde taliim hem bahtım uygun,
Aman sâkî bana hiç durma mey sun.
Gamım yok, zevk u şevkim hadden efvun,
Aman sâkî bana hiç durma mey sun

Music Objects

- Audio
- Scores
- Lyrics
- Commentary/Critique

#14

by drshrikaanth » 20 Aug 2006, 03:47

Here is a review of a concert of the Grande Dame of HM- Gangubai Hangal. It is always invigorating to read about maestros. And in this particular review, touching as well. What a spirit!

<http://www.hindu.com/fr/2006/08/18/stor...170300.htm>

en kaDan paNi seidu kiDappadE was a line Rangaramanuja Iyengar quoted in his books (*kRti maNimAlai*). Gangubai is a living example of it. I once saw her interview and was struck by her unassuming nature. The child in her is remarkable. She reminds one so much of D.K.Pattammal who too has that beatific smile and child-like simplicity.

0 x 

<https://www.rasikas.org/forums/viewtopic.php?f=13&t=916>

Music Objects

- Audio
- Scores
- Lyrics
- Commentary/Critique
- Metadata and social information

1 Sgt. Pepper's Lonely Hearts Club Band

lead vocals: [Paul McCartney](#) (The Beatles)

producer: [George Martin](#)

has remixes: [Sgt. Pepper's Lonely Hearts Club Band \(1999 remix\)](#) by [The Beatles](#) and [Sgt. Pepper's Lonely Hearts Club Band \(2017 stereo remix\)](#) by [The Beatles](#)

mash-ups: [Razor Smile](#) by [Go Home Productions](#), [Sgt. Pepper Jerks It Out](#) by [G3RSt](#) and [Sgt. Pepper's Paradise \(The Beatles vs. Guns N' Roses\)](#) ([Best of Bootie 2005 DJ-mix](#)) by [Jimmie Jammes](#)

sampled by: [Kowalski \(GHP Bootleg Breaks remix\)](#) by [Primal Scream](#), [Strawberry Fields Forever \(Love version\)](#) by [The Beatles](#) and [The Sounds of Science](#) by [Beastie Boys](#)

recording of: [Sgt. Pepper's Lonely Hearts Club Band](#)

writer: [John Lennon](#) (The Beatles) and [Paul McCartney](#) (The Beatles)

publisher: [Northern Songs Ltd.](#) (1967)

is the basis for: [Cpl. Kipper's Barnsley Trades Club Turn](#)

later translated parody versions: [Sergent pépère](#)

later parody versions: [Sgt. Hetfield's Motorbreath Pub Band](#)

later parody versions: [Such Impressive Loving Smart Close Friends](#)

★★★★★ 2:02

Music Objects

- **Audio**
- Scores
- Lyrics
- Commentary/Critique
- Metadata and social information

Elements of Music

- Pitch (Frequency)
- Duration and Tempo (Time)
- Dynamics (Loudness)
- Timbre (Spectral envelope)
- Texture (Mix)
- Structure (Form and arrangement)

Musical Pitch

- Pitch
 - Notes and Intervals
 - Consonance and Dissonance
 - Circle of Fifths
- Tuning Systems
 - Tonic
 - Scale (Chromatic and Diatonic Scale)
- Melody
- Harmony
- Physical quantity: Frequency (Hz)

Notes and Intervals

- Note: A musical sound of a specific pitch and duration
- Interval: The pitch difference between two notes
 - Semitone and whole tone
 - Sharp (#) and flat (b) notes
- Musical intervals between notes
 - Based on a scale
 - Melodic or Harmonic

Consonance and Dissonance

- Small whole number ratios
- Unison (1:1)
- Octave (2:1)
- Perfect Fourth (4:3), Perfect Fifth (3:2)
- Major/minor thirds/sixths
- 12 semitones in an octave

Tuning and Scale

- Tonic



- Scale

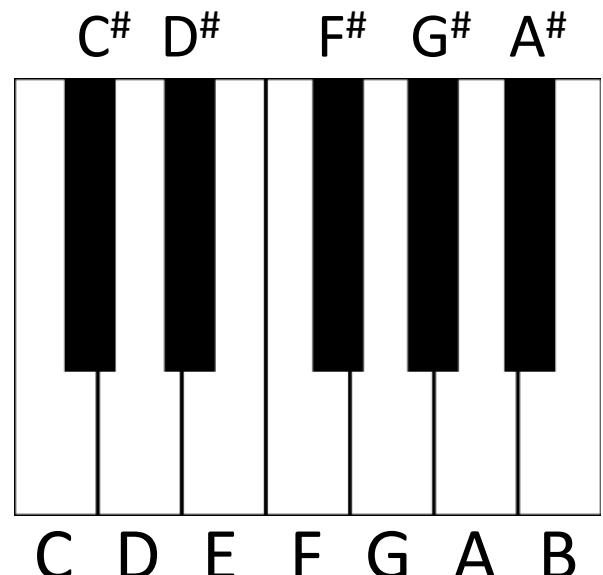
- Chromatic scale (12 notes in an octave)

- Diatonic Scale (7 notes in an octave)

- Tuning: Generating the notes

- Just intonation (ratios)

- Equal temperament (logarithmically equidistant notes)

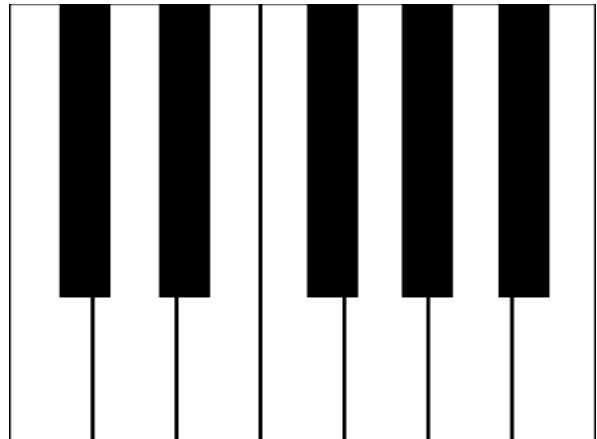


<https://freesound.org/people/Nerkamitilia/sounds/369930/>

<https://freesound.org/people/jmases1/sounds/380630/>

The cent scale

- Perceptually more relevant
- Logarithmic Scale
- 1200 cents is one octave
- 1 semitone = 100 cents
- f_{ref} - tonic (or A = 440Hz)

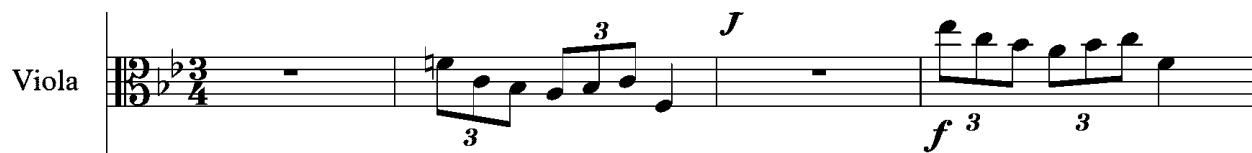


$$f(\text{cent}) = 1200 \log_2 \frac{f(\text{Hz})}{f_{ref}}$$

Melody

- Sequence of notes in time
- Melodic lines
- Predominant melody
- Melodic phrases
- Hierarchy: Melody, scale, melodic framework

Viola



The musical score for Viola consists of a single staff. It starts with a measure in common time (indicated by a '4' over a '3') followed by a measure in 3/4 time (indicated by a '3'). The melody begins with a half note, followed by a quarter note, and then a series of eighth notes grouped by a brace under three groups of three. A dynamic 'f' (fortissimo) is indicated above the next measure, which contains a sixteenth-note pattern. The score ends with a single eighth note.

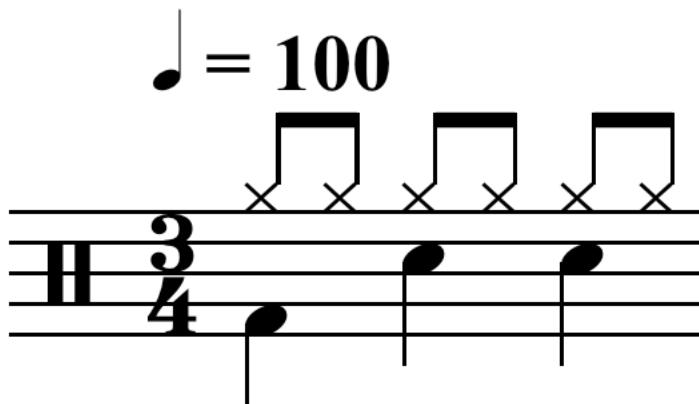
// G3 R2 S N3, / S R2 P, N3, / S R2 G3 P/ G3 N3 P -/
S' N3' S' G3'/ R2' S' N3 P/ P G3 - R2/ - S - R2/

Musical Time

- Pulse: Inherent periodicity of events in music
- Note duration and Tempo
- Rhythm and Meter
- Hierarchy: Tatum, tactus, measure/bar
 - Time Signature
 - Metrical ambiguity

Note duration and Tempo

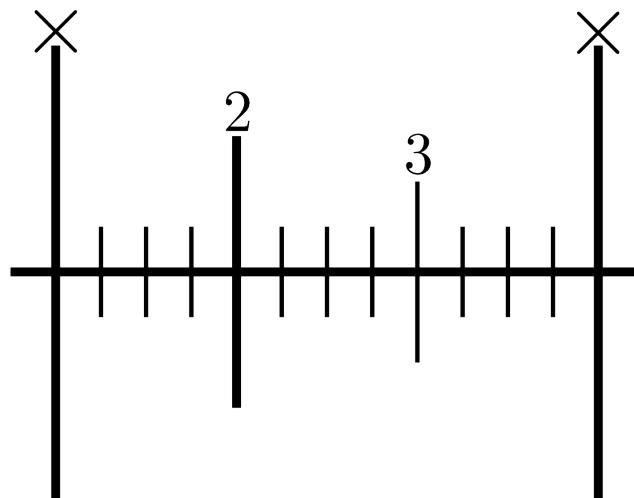
- Duration indicated in music score – Musical Time
- Tempo measured in Beats Per Minute (BPM)



Note	Name	Beats
○	Whole note	4 beats
♪	Half note	2 beats
♩	Quarter note	1 beat
♪	Eighth note	$\frac{1}{2}$ beat
♪	Sixteenth note	$\frac{1}{4}$ beat

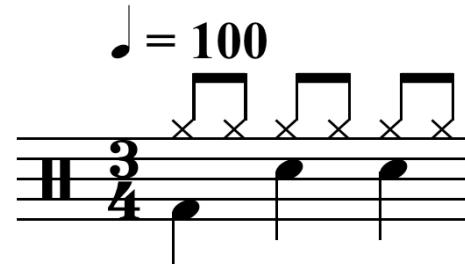
Rhythm and Meter

- Rhythm: recurrence of events in time
 - Rhythm patterns
- Meter: Hierarchical grouping of events in time
 - Rhythmic patterns with distinct hierarchy



Metrical Hierarchy

- Tatum: Lowest pulse in a music piece
- Tactus: “The foot tapping times”, called beats
- Measure/Bar: A complete repeating unit of a meter, consisting of a “downbeat” and beats
- Indicated with a time signature



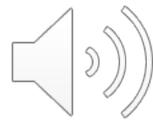
The **metronome symbol** indicates the count.

The **double bar** at the end indicates that the exercise has finished.

The **metronome symbol** indicates the count.

The **double bar** at the end indicates that the exercise has finished.

Beats – Examples



- Off-beat



- Non-isochronous beats



- Metrical level ambiguity



Timbre

- “That which distinguishes the same note from two different music instruments”
- Related to the time and spectral envelopes



Piano



Clarinet

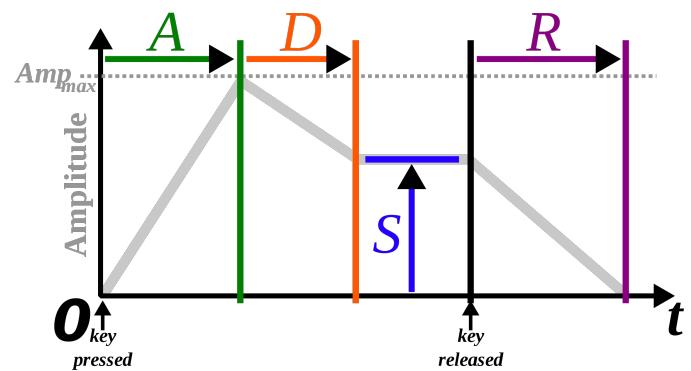


Violin



Trumpet

<https://freesound.org/people/MTG/sounds/355808/>
<https://freesound.org/people/MTG/sounds/249078/>
<https://freesound.org/people/MTG/sounds/357387/>
https://freesound.org/people/Goup_1/sounds/176449/



[https://en.wikipedia.org/wiki/Envelope_\(music\)#/media/File:ADSR_parameter.svg](https://en.wikipedia.org/wiki/Envelope_(music)#/media/File:ADSR_parameter.svg)

Indian Art Music



Carnatic Music

Vignesh Ishwar in concert at Arkay Convention Center, Chennai, India



Hindustani Music



<https://musicboxnews.files.wordpress.com/2011/09/darbar-festival-20081.jpg>

Why Indian art music ?

- Music
 - Predominantly oral traditions
 - Sophisticated and structured, scope for improvisation
 - Wide variety of instruments and variations
 - In practice, continues to evolve
- Community
 - A large dedicated audience
 - Significant musical literature
- Unique challenges

Indian Art Music

- Carnatic and Hindustani music
 - Some common concepts and terminology
 - Differences in practice
- Carnatic Music
 - Southern parts of the Indian sub-continent
- Hindustani music
 - Northern parts of the Indian sub-continent
- Centuries of evolution
 - Sophisticated melodic and rhythmic structures

Svaras in Indian art music

Carnatic		Western Scale Degree (Note)	Hindustani	
Name	Notation		Notation	Name
Śadja	S	C	S	Śadж
Śuddha R̥ṣabha	R1	Db	r	Kōmal R̥ṣab
Catu:śṛti R̥ṣabha	R2	D	R	Shuddh R̥ṣab
Śuddha Gāndhāra	G1	D	R	-
Ṣaṭśṛti R̥ṣabha	R3	Eb	g	-
Sadharana Gāndhāra	G2	Eb	g	Kōmal Gāndhār
Antara Gāndhāra	G3	E	G	Shuddh Gāndhār
Śuddha Madhyama	M1	F	M	Shudh Madhyam
Prati Madhyama	M2	F#	m	Tīvr Madhyam
Pañcama	P	G	P	Pañcam
Śuddha Dhaivata	D1	Ab	d	Kōmal Dhaivat
Catu:śṛti Dhaivata	D2	A	D	Śuddha Dhaivat
Śuddha Niṣāda	N1	A	D	-
Ṣaṭśṛti Dhaivata	D3	Bb	n	-
Kaishiki Niṣāda	N2	Bb	n	Kōmal Niṣād
Kakali Niṣāda	N3	B	N	Śuddha Niṣād

Carnatic music



Vignesh Ishwar in concert at Arkay Convention Center, Chennai, India

Melody in Carnatic music

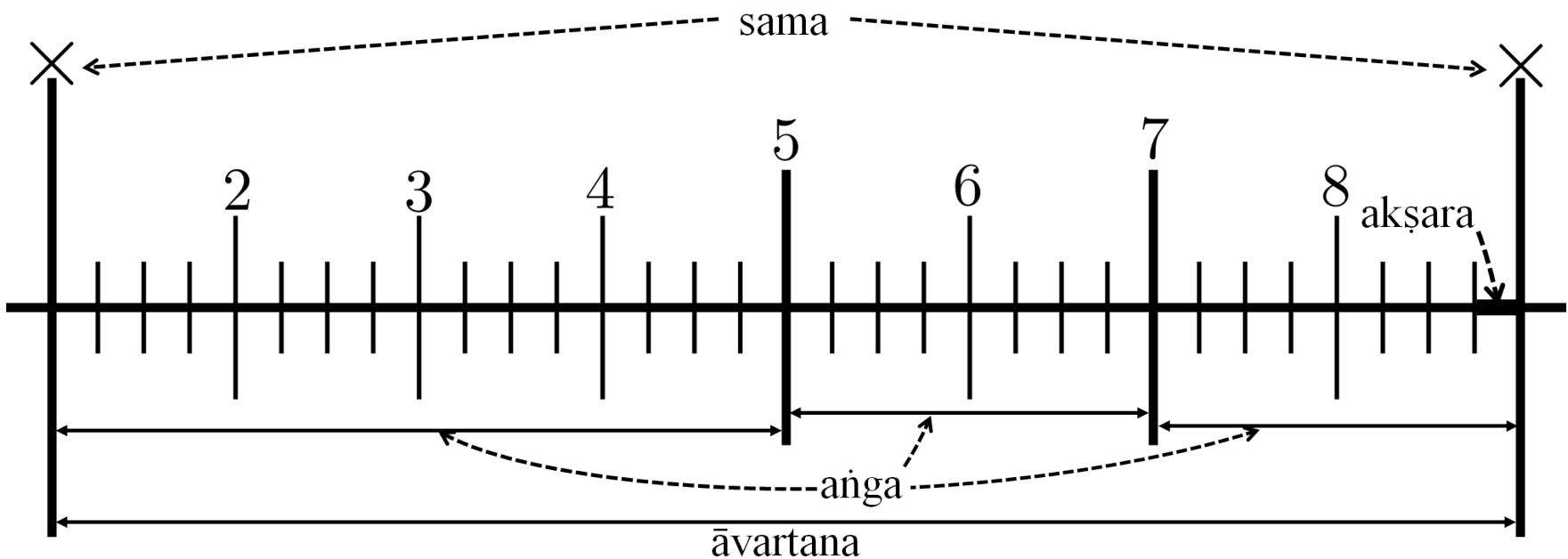
- Heterophonic
- Flexible tonic
- Sruti – smallest perceivable interval
- Svara – note
- Raga

Rāga

- Melodic framework in Carnatic music
- More flexible than a melody, but more rigid than a scale
- Melodic phrases: Sequence and intonation of the notes
- Gamakas: ornaments

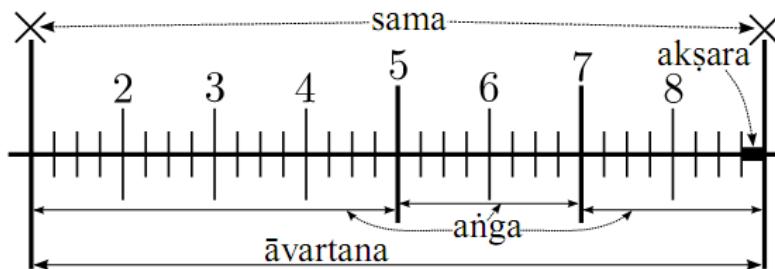
Tāla in Carnatic music

- Time cycles
 - Broad structure for rendition and repetition of melodic and rhythmic phrases, motifs, and improvisations
 - Akṣara, “beats”, sama (downbeat), aṅga (section)

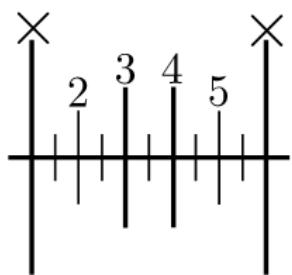


Popular tālas

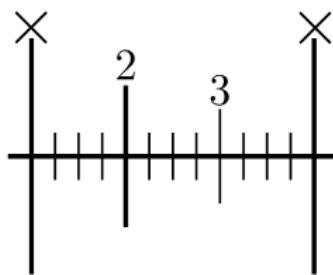
Tāla	# beats	nađe	# Akşara
Ādi	8	4	32
Rūpaka	3	4	12
Miśra chāpu	7	2	14
Khaṇḍa chāpu	5	2	10



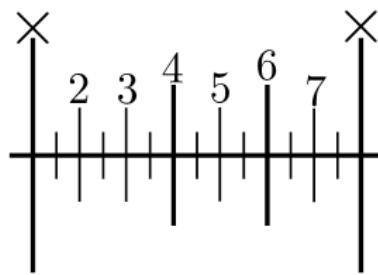
(a) Ādi tāla, illustrated



(b) Khaṇḍa chāpu tāla

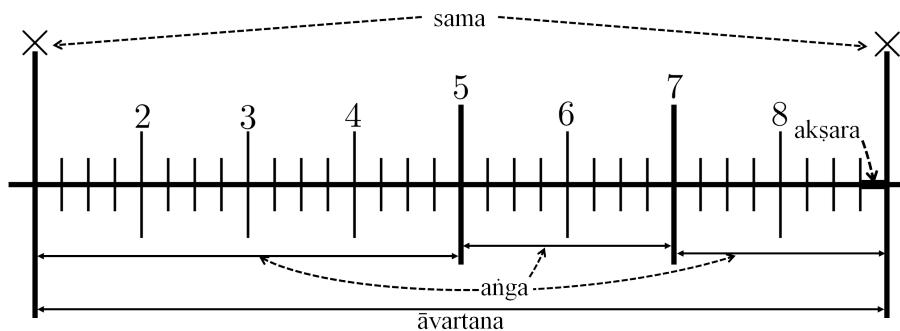
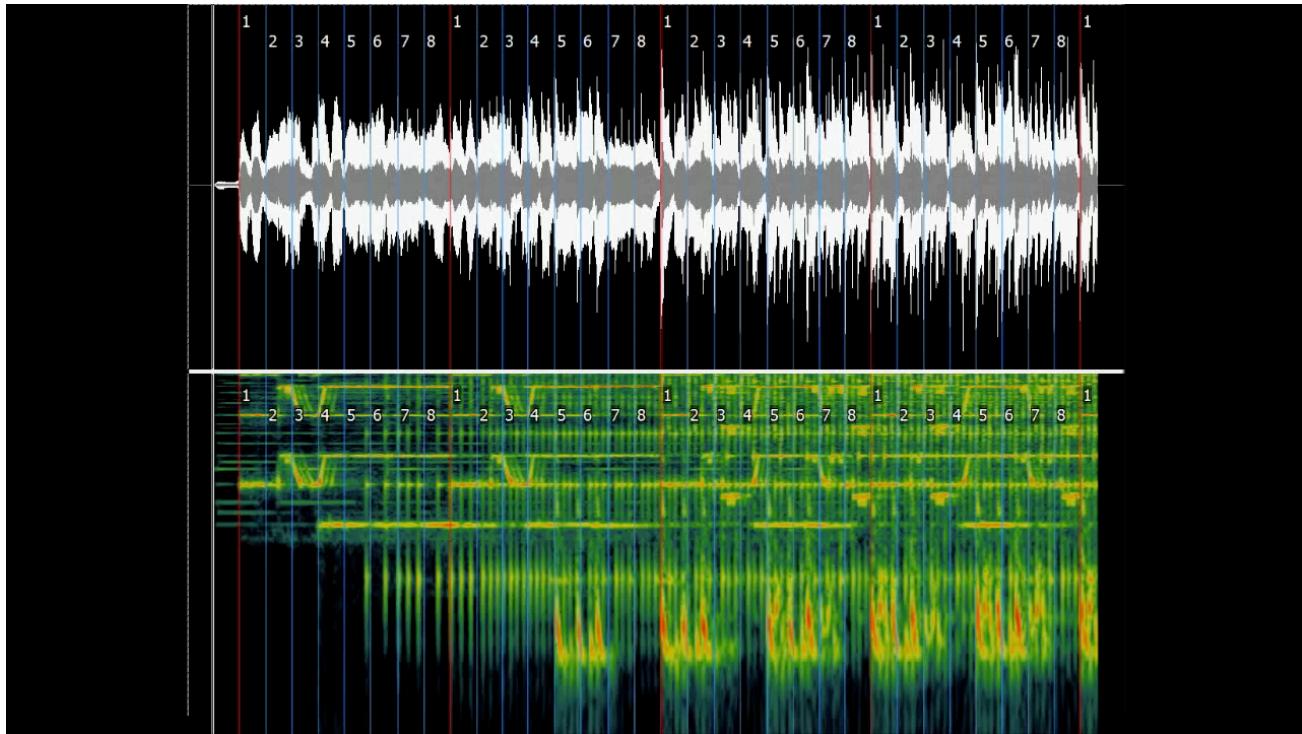


(c) Rūpaka tāla



(d) Miśra chāpu tāla

Example - adi tala



<https://compmusic.upf.edu/examples-taala-carnatic>



Hindustani music



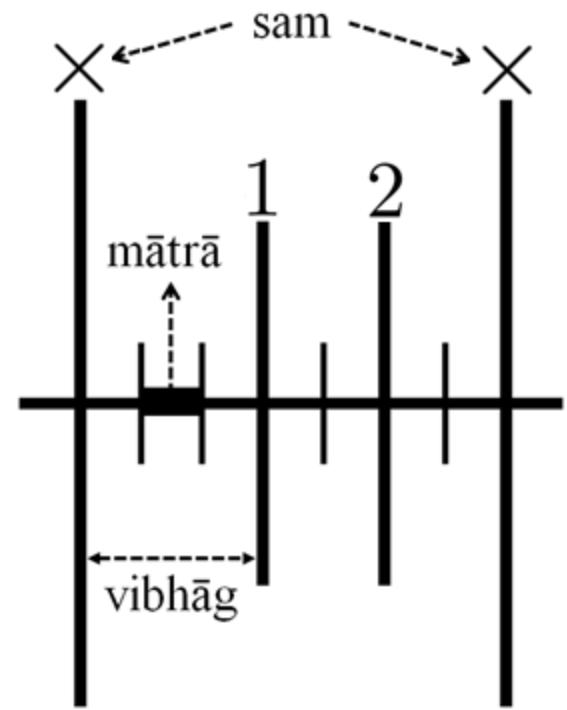
<https://musicboxnews.files.wordpress.com/2011/09/darbar-festival-20081.jpg>

Rāg in Hindustani music

- Melodic scale and phrase based
- Melodic ornaments
- Time of the day ?

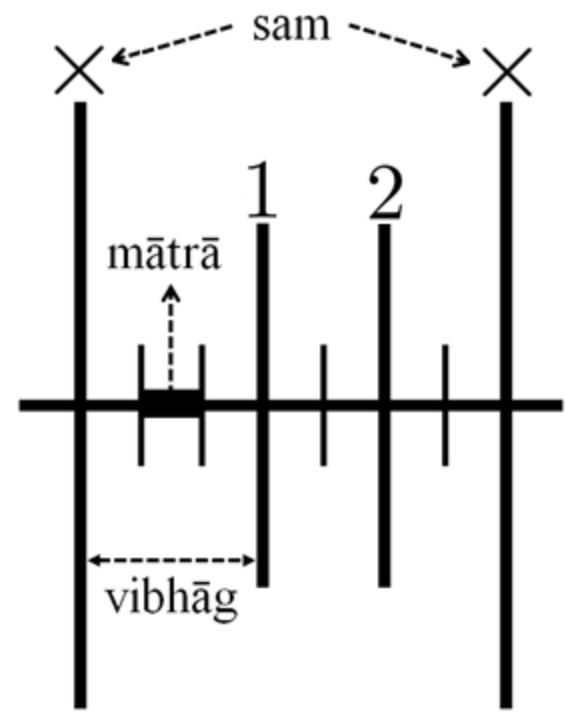
Tāl in Hindustani music

- Metrical time cycles
 - Broad structure for rendition and repetition of melodic and rhythmic phrases, motifs, and improvisations
 - **mātrā** (beat), **sam** (downbeat), **vibhāg** (section)
- Tempo classes (lay)
 - Wide range of tempi
 - Slow (vilābit): 10-60 mātrā per minute (MPM)
 - Medium (madhya): 60-150 MPM
 - Fast (drut): >150 MPM



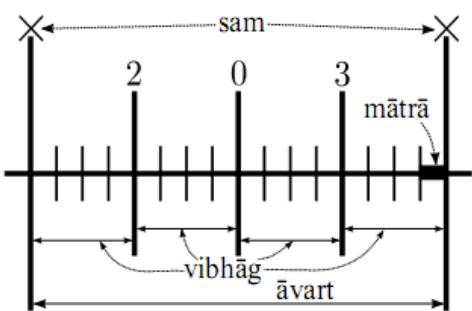
Tāl in Hindustani music

- Metrical time cycles
 - Broad structure for rendition and repetition of melodic and rhythmic phrases, motifs, and improvisations
 - *mātrā* (beat), *sam* (downbeat), *vibhāg* (section)
- Tempo classes (lay)
 - Wide range of tempi
 - Slow (vilābit): 10-60 *mātrā* per minute (MPM)
 - Medium (madhya): 60-150 MPM
 - Fast (drut): >150 MPM

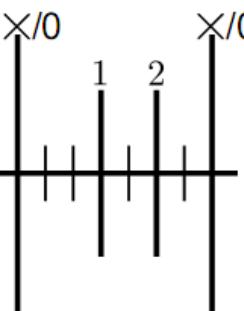


Popular tāls

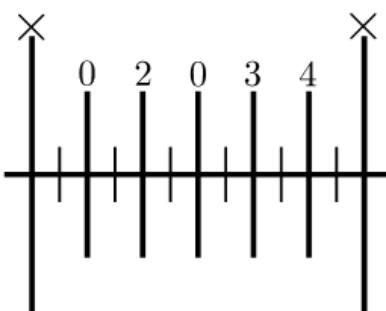
Tāl	# vibhāg	# mātrās	mātrā grouping
Tīntāl	4	16	4,4,4,4
Ēktāl	6	12	2,2,2,2,2,2
Jhaptāl	4	10	2,3,2,3
Rūpak tāl	3	7	3,2,2



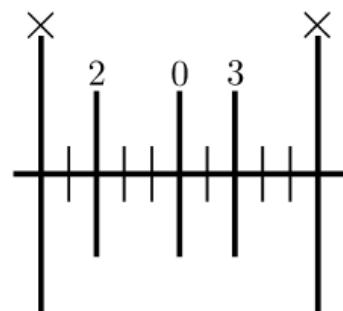
(a) Tīntāl, illustrated



(b) Rūpak tāl

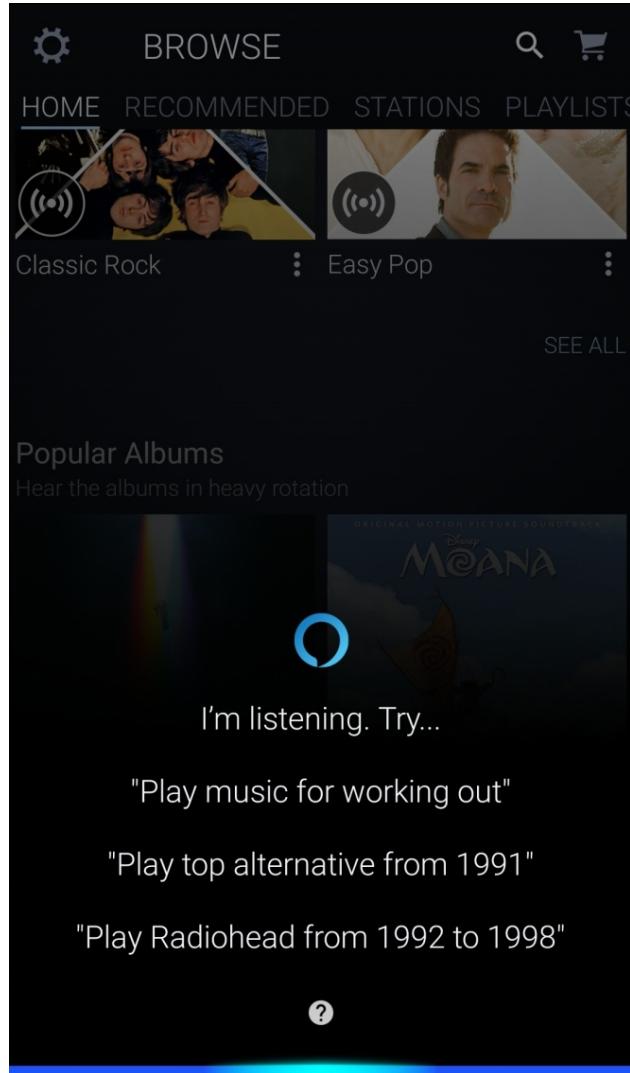


(c) Ēktāl



(d) Jhaptāl

Data: Organizing music collections



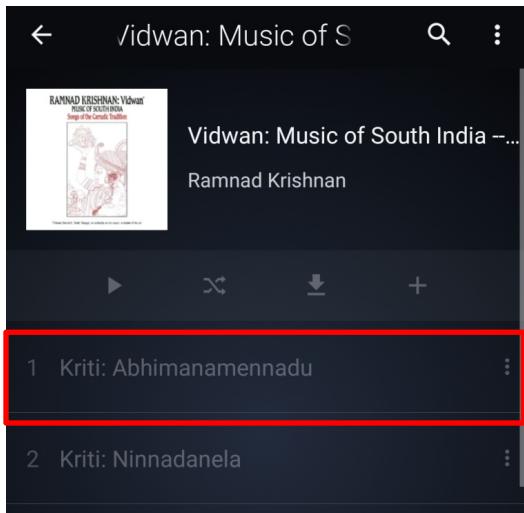
Artist -> Album -> Title 

Play a slow kriti in mohana raga and mishra
chapu tala

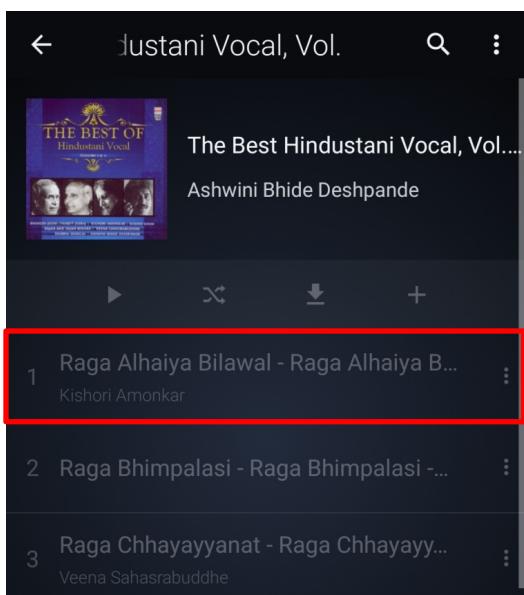
Make a playlist of drut teental bandish that
contain improvisatory sections

Get other songs that have similar rhythmic
passages

Editorial metadata – partially available



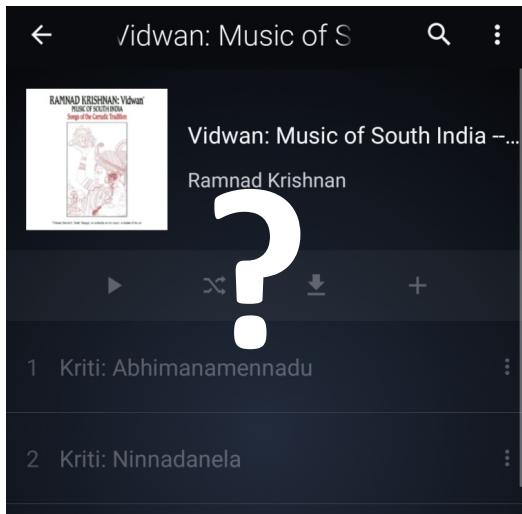
Play a slow **kriti** in **mohana raga** and **mishra chapu tala**



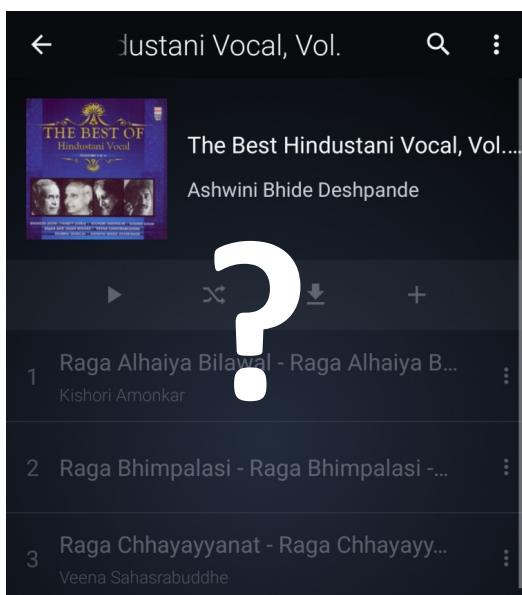
Make a playlist of drut **teental bandish** that contain improvisatory sections

Get other songs that have similar rhythmic passages

Content based descriptors and similarity



Play a **slow** kriti in mohana raga and mishra chapu tala



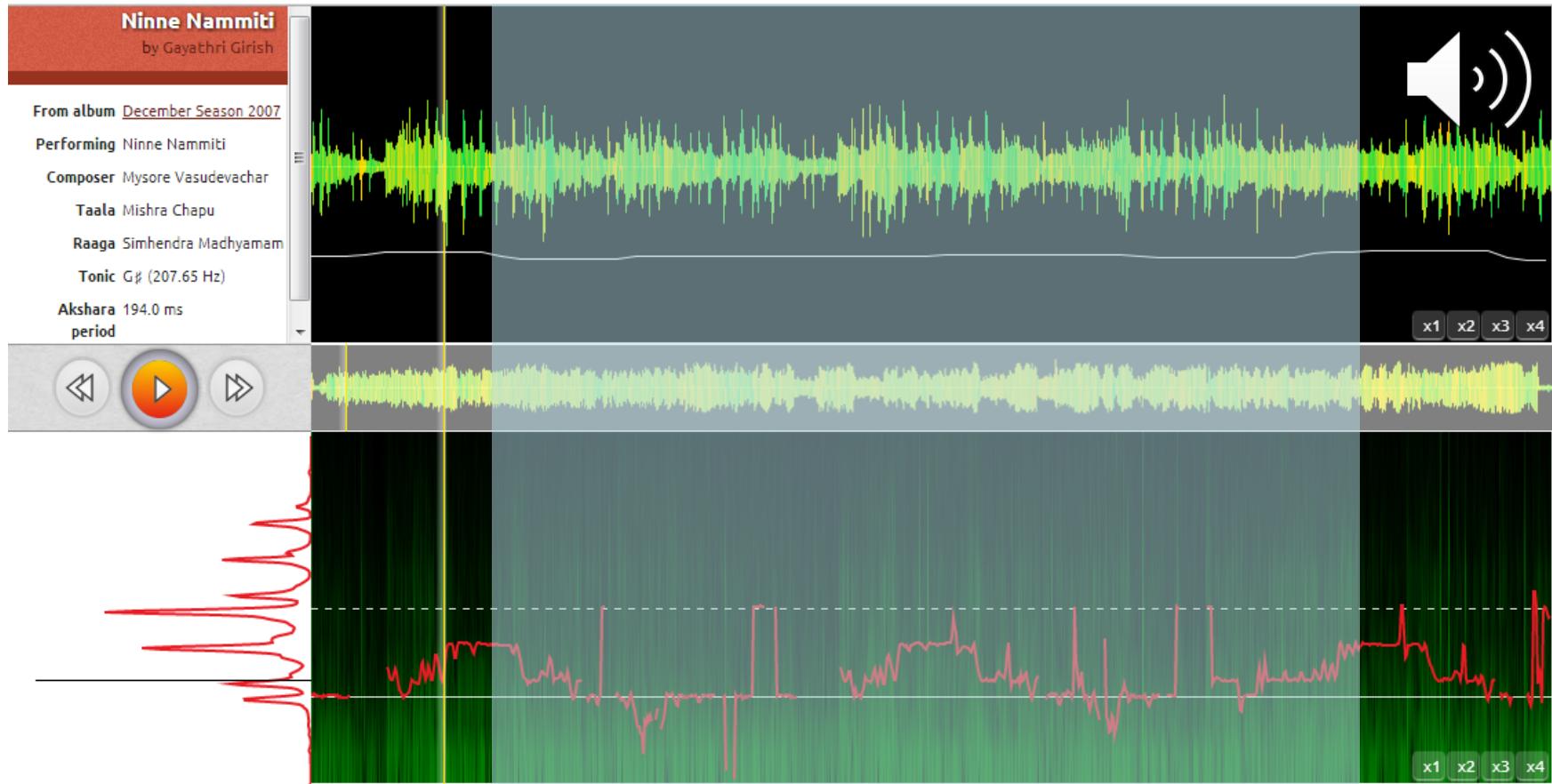
Make a playlist of drut teental bandish that contain **improvisatory sections**

Get other songs that have **similar rhythmic passages**

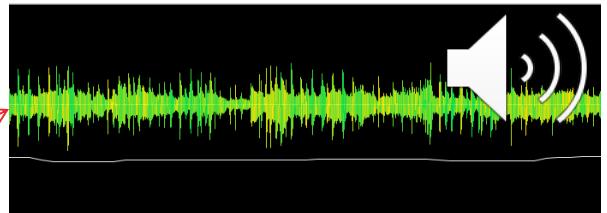
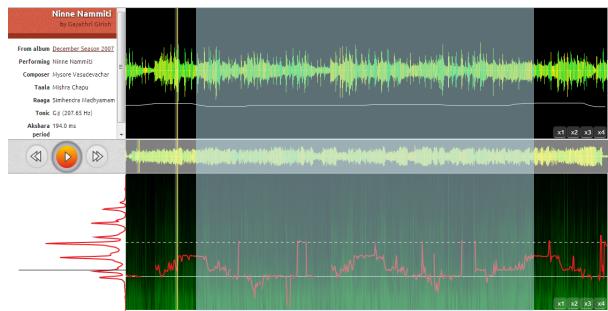
Enriched Interaction with Music

- Editorial metadata and **content based descriptors**
- Large collections – enriched with musically relevant metadata and organized using “similarity measures”
- Indian Art Music
 - Melody: Descriptors related to the rāga
 - Rhythm: Descriptors related to the tāla

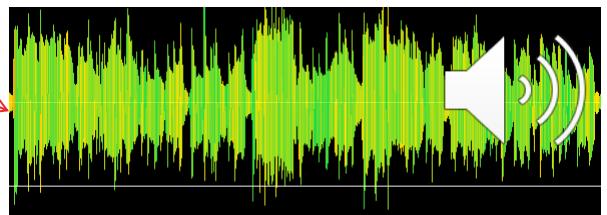
Similarity: in the future...



From Ninne Nammiti, December Season 2007, Gayathri Girish

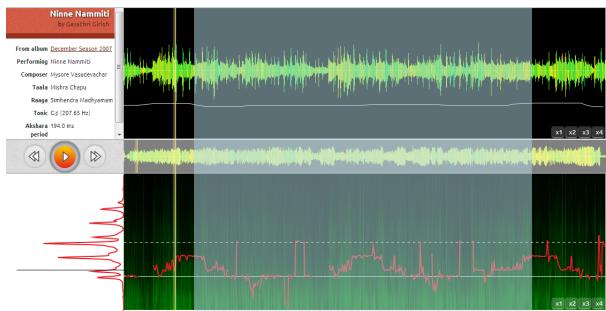


From Ninne Nammiti, Paddhatti - K V Narayanaswamy & N Ramani, by K V Narayanaswamy & N Ramani, 2003

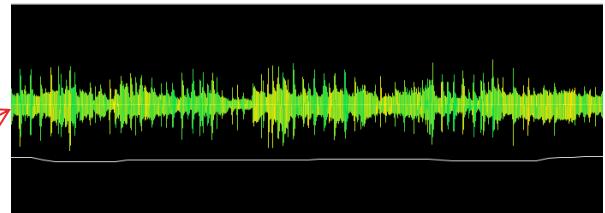


From Ninne Nammi Nanu,
December Season 2003, O.S.
Thyagarajan

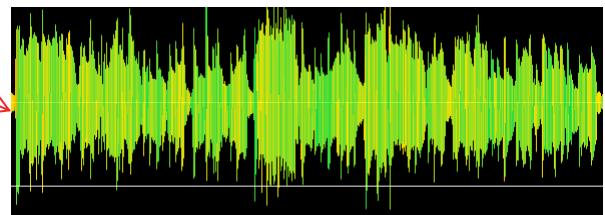
Similarity ?



?

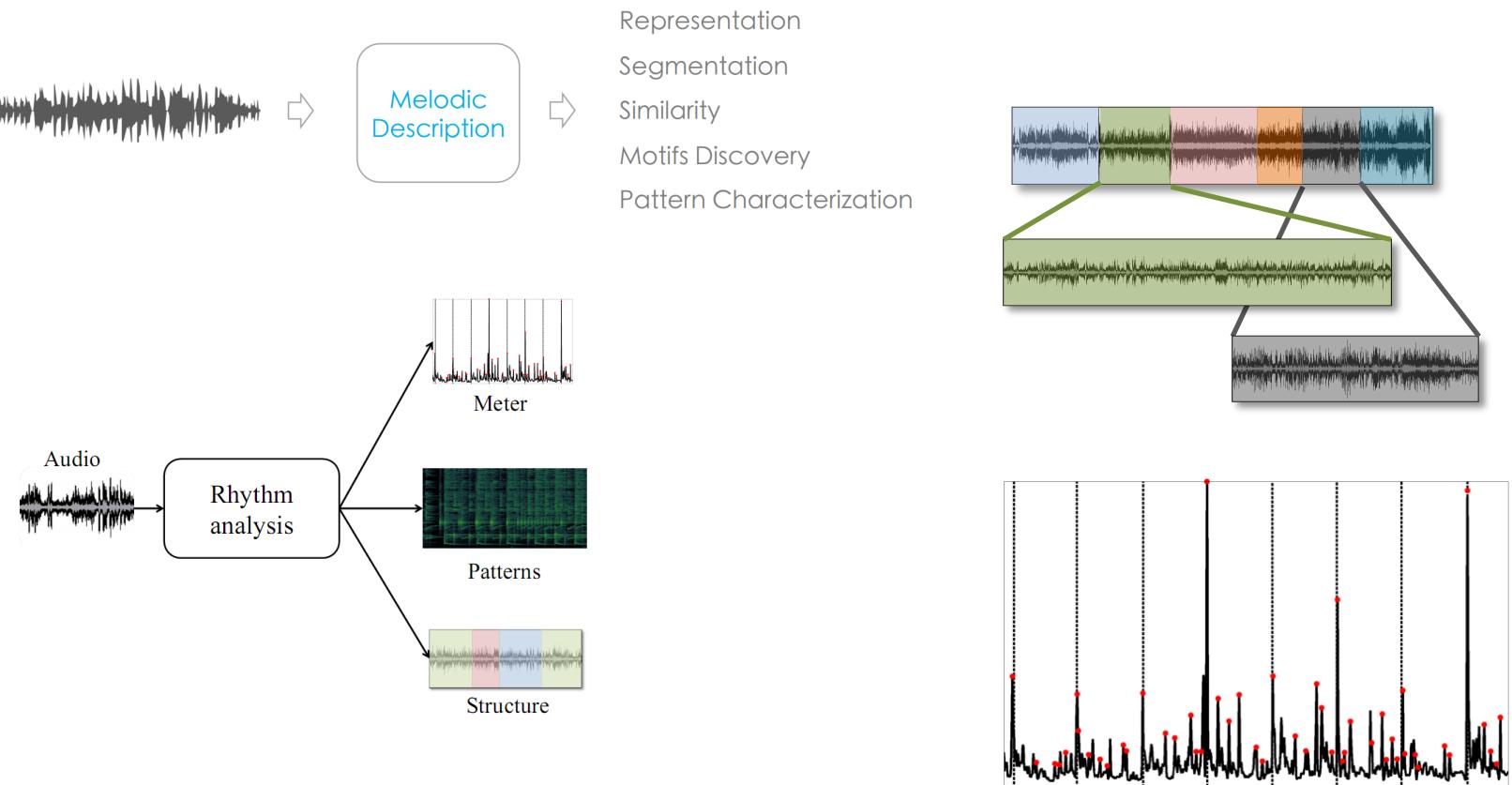


From Ninne Nammiti, Paddhatti - K V Narayanaswamy & N Ramani, by K V Narayanaswamy & N Ramani, 2003



From Ninne Nammi Nanu,
December Season 2003, O.S.
Thyagarajan

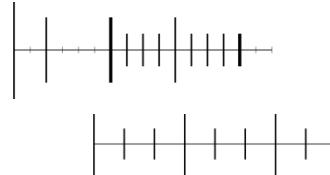
MIR Problems



Content description

Similarity

Complex

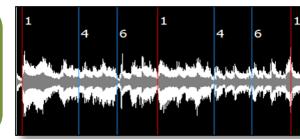


Pattern analysis

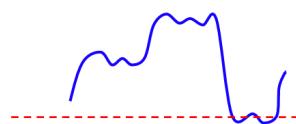
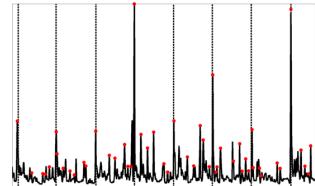
Segmentation



Meter/Melody



Onset/Pitch



Simple

Content description

Similarity

Pattern analysis

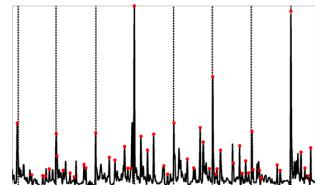
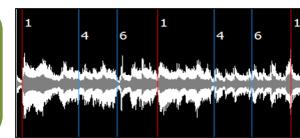
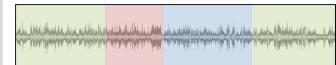
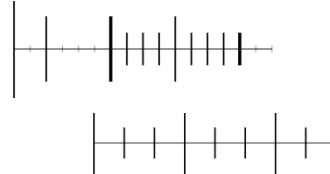
Segmentation

Meter/Melody

Onset/Pitch

Complex

Simple



Music Representations

- Representations help to interpret, transmit and archive music
- Representations can vary with content, and can be lossy!
 - Represent some/all elements of music
- Symbolic representations
 - Music Scores, Piano rolls, MIDI
 - Prescriptive or descriptive
- Acoustic representations
 - Waveforms
 - Spectrograms
 - compressed audio (MP3, e.g.)
 - Features from audio – descriptors

Music descriptors

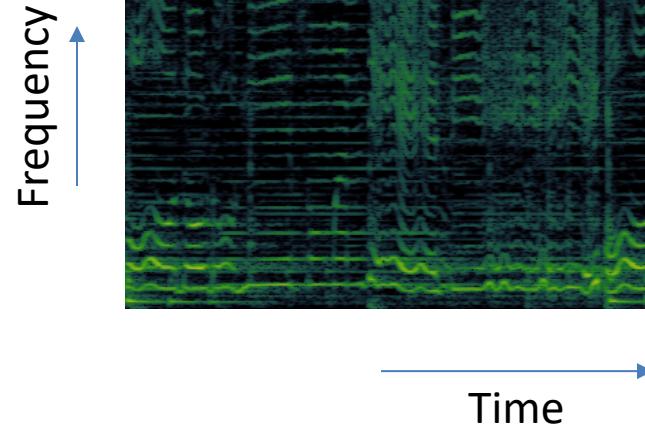
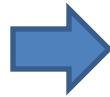
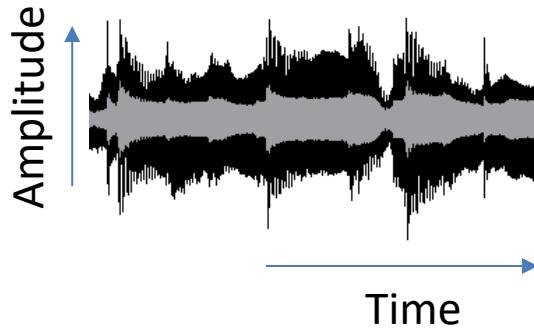
- Derived from both symbolic and acoustic representations
- Any metric/measure/information that we extract from an audio music recording or a corpus
 - ~~Descriptors from symbolic music~~
- Descriptors for different elements of music
 - Pitch: Predominant melody, tonic, melodic patterns
 - Time: Onsets, Tempo
 - Harmony: Chroma, HPCP

Acoustic Representations for Music

- The ubiquitous music recording
 - LP, Tape, CDs, Streaming
 - Time-varying amplitude of sound
- Acoustic signal: Physical Time; Frequency
 - Time-Frequency representations are the most suitable
- Descriptors from audio signal
 - Audio descriptors for Manual Analysis/Machine Learning

Audio Signal

- Waveform: Time-varying amplitude
- Music Signal
 - Events in both time and frequency
 - Time + Frequency + Amplitude



Sinusoids

$$x[n] = A \cos(\omega nT + \phi) = A \cos(2\pi f nT + \phi)$$

A : amplitude

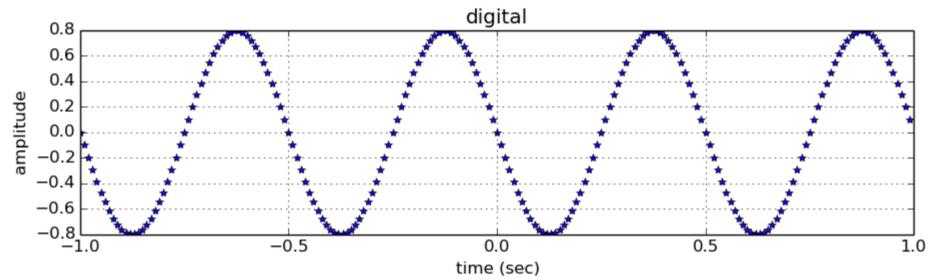
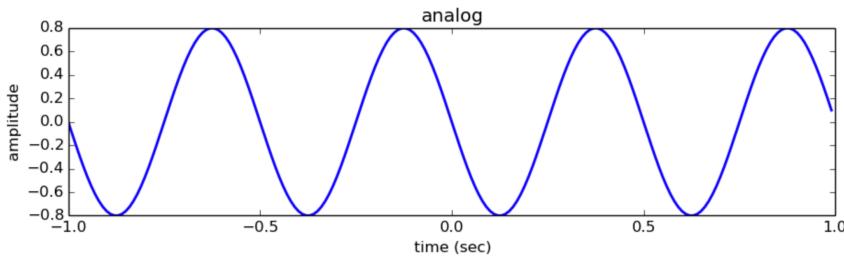
ω : angular frequency in radians/seconds

$f = \omega / 2\pi$: frequency in Hertz (cycles/seconds)

ϕ : initial phase in radians

n : time index

$T = 1/f_s$: sampling period in seconds ($t = nT = n/f_s$)

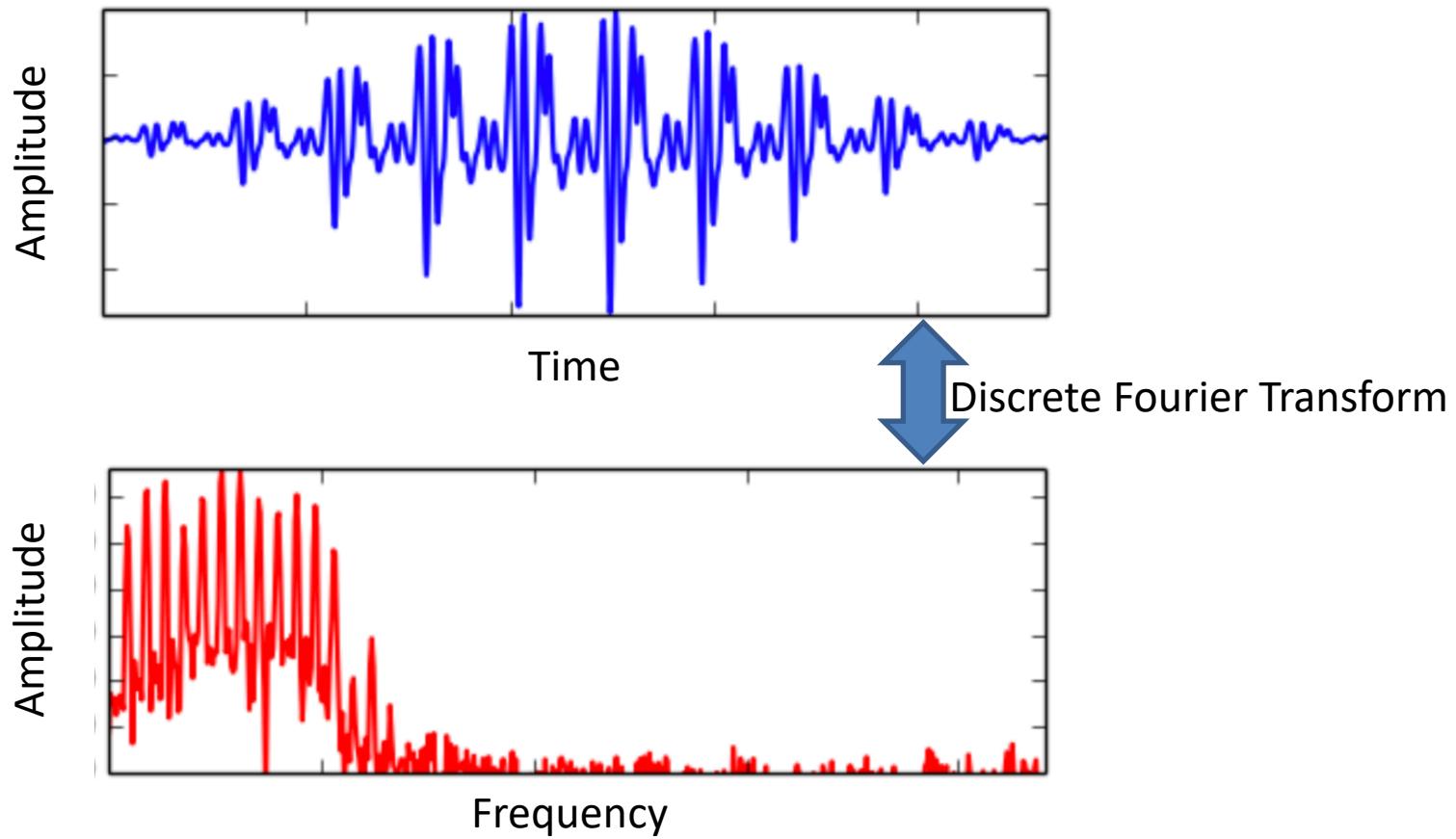


Sinusoidal Analysis

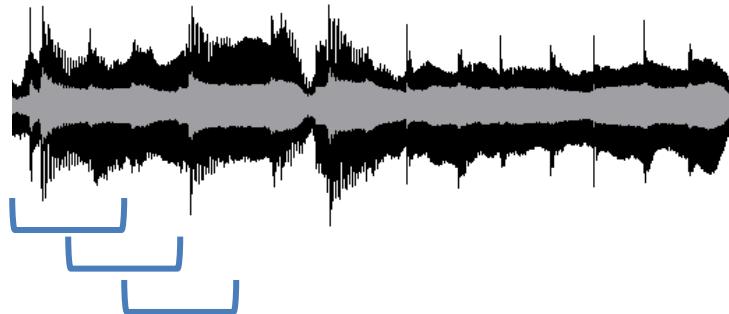
- Time domain
 - Weighted sum of amplitude at different times
- Frequency domain
 - Weighted sum of sinusoids at different frequencies
- Music Signal
 - Partials, Sinusoids, Harmonics
 - Harmonic series
- Short-time analysis
 - Stationarity assumption

Fourier Analysis – Idea

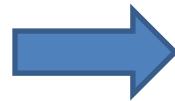
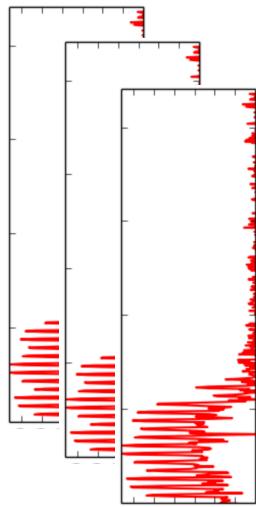
- Time domain <-> Frequency Domain
- Time – Frequency Duality



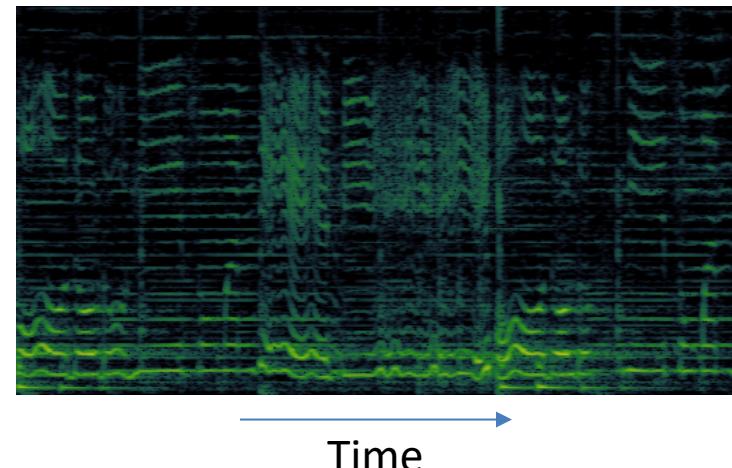
Spectrogram: Short-time Fourier Analysis



Short analysis windows in time; Fourier analysis on each window of signal

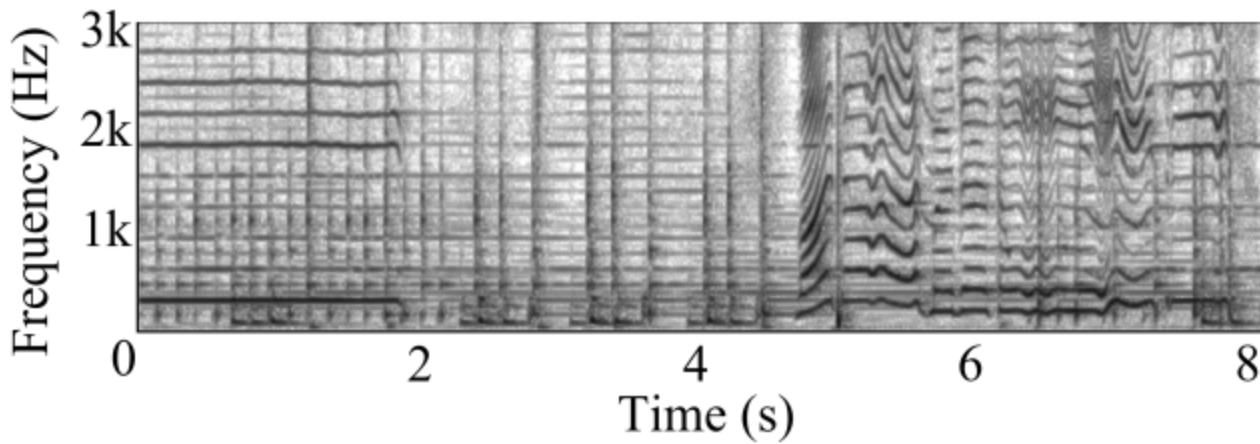


Frequency ↑

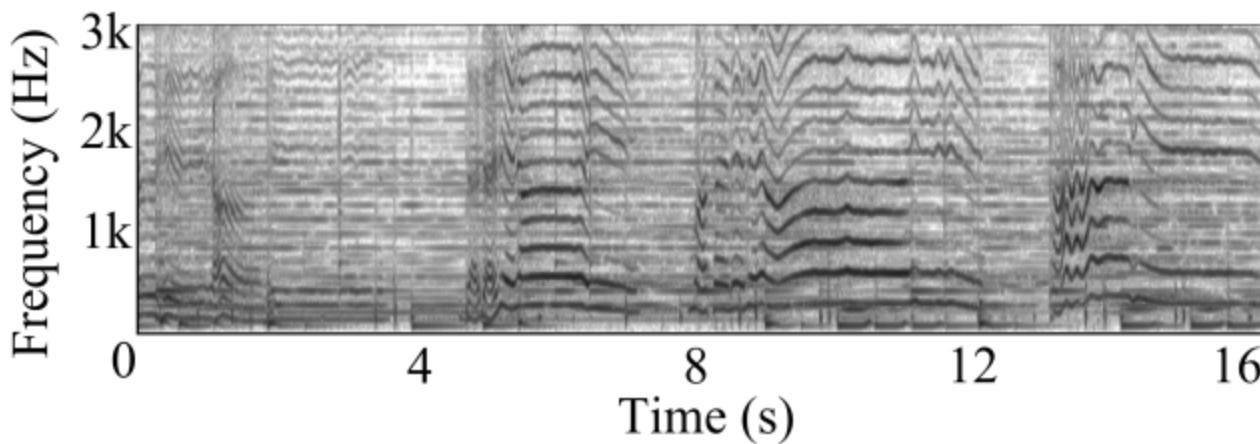


Time-varying frequency content of a signal

Characteristics of Indian Art Music



(a) Carnatic music

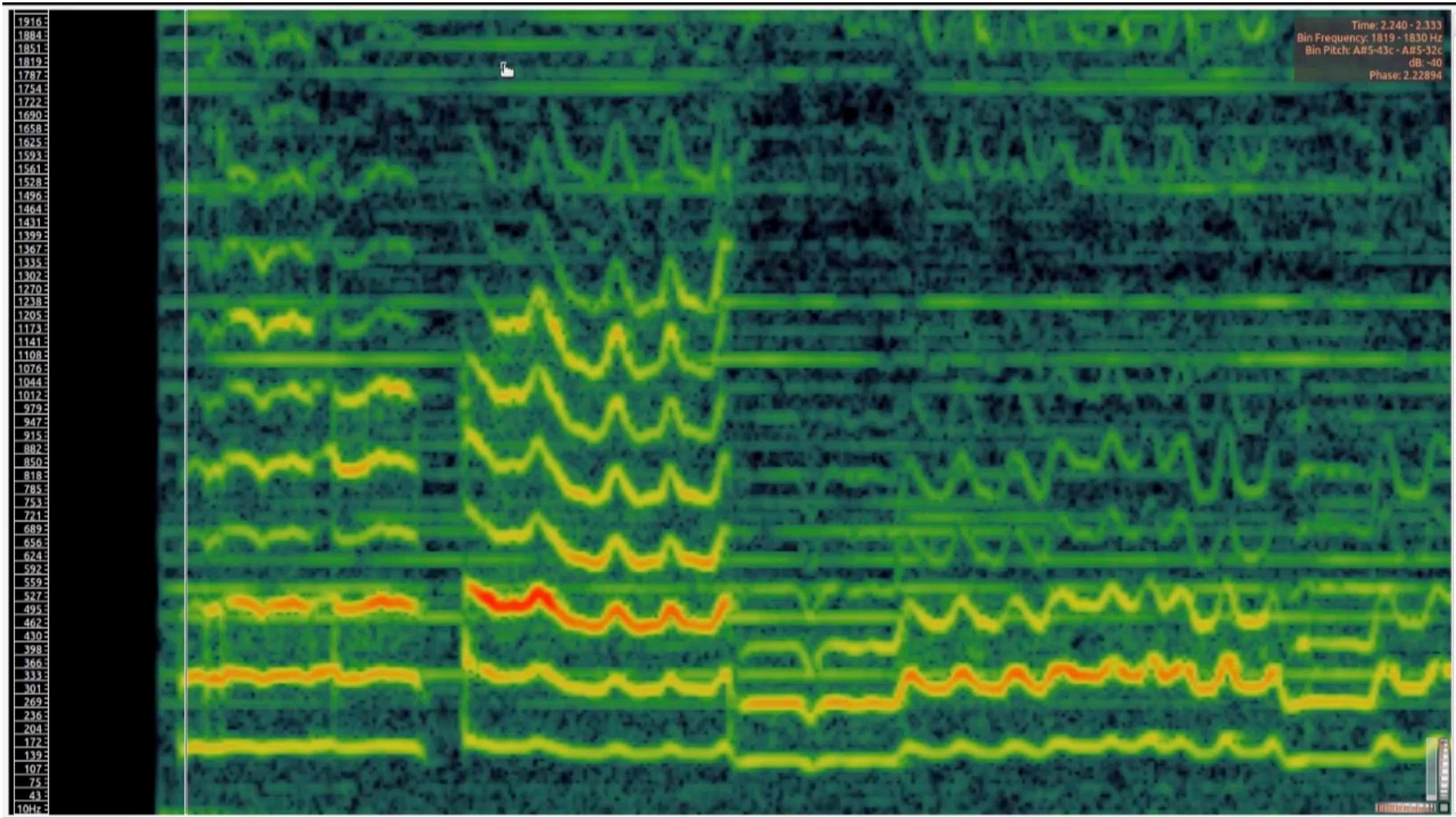


(b) Hindustani music

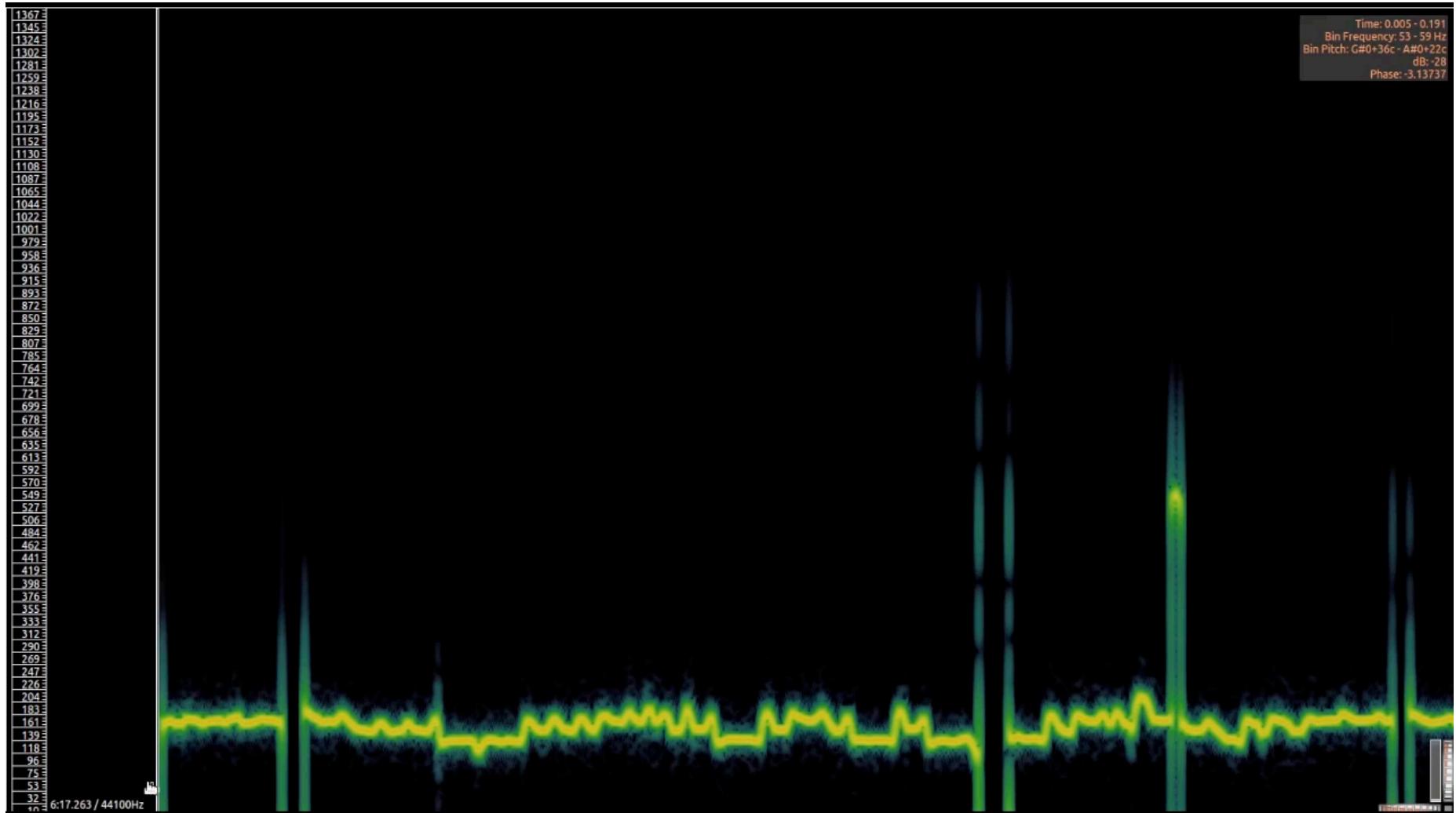
Predominant Melody Extraction

- What is predominant melody ?
 - Fundamental Frequency (F0)
- What is a complete representation for melody ?
 - Sequence of frequency values (pitch contours) ?
 - Sequence of notes ?
- Pitch estimation
 - Solo instrument vs multiple instruments
 - Melodic contour characteristics
 - Dual melodic lines in Indian art music

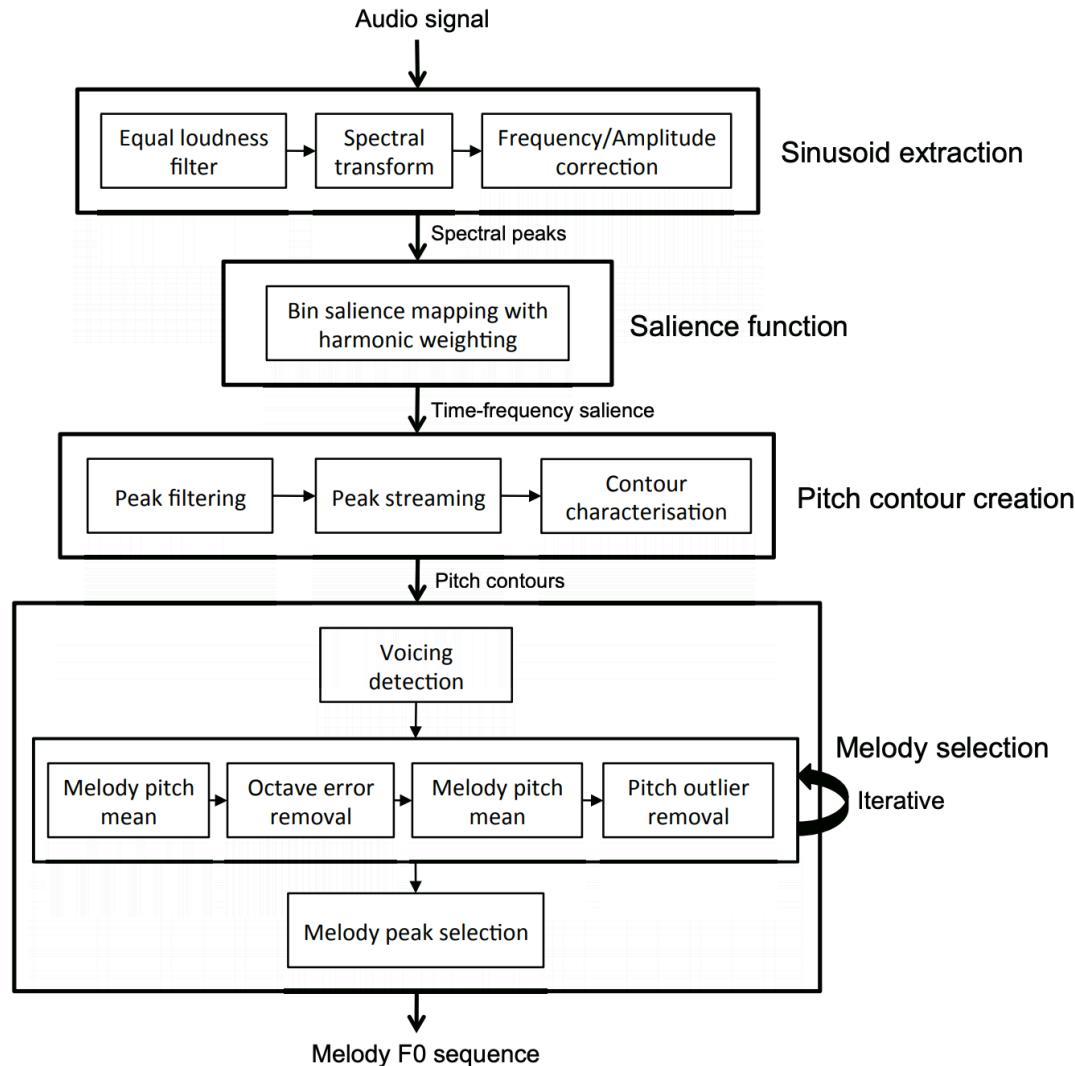
Example: Melody Extraction



Example: Melody Extraction

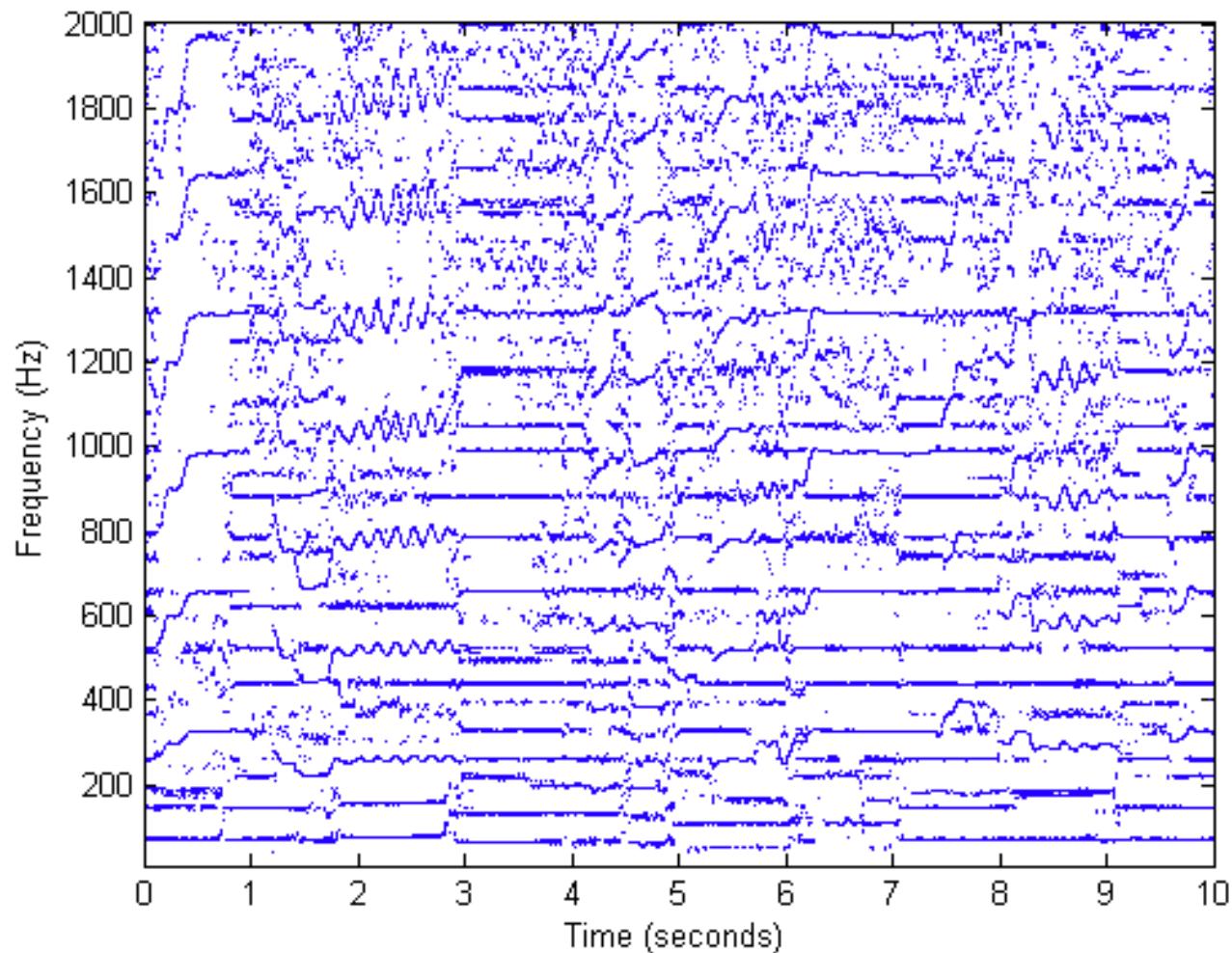


Melodia: Predominant Melody Extraction

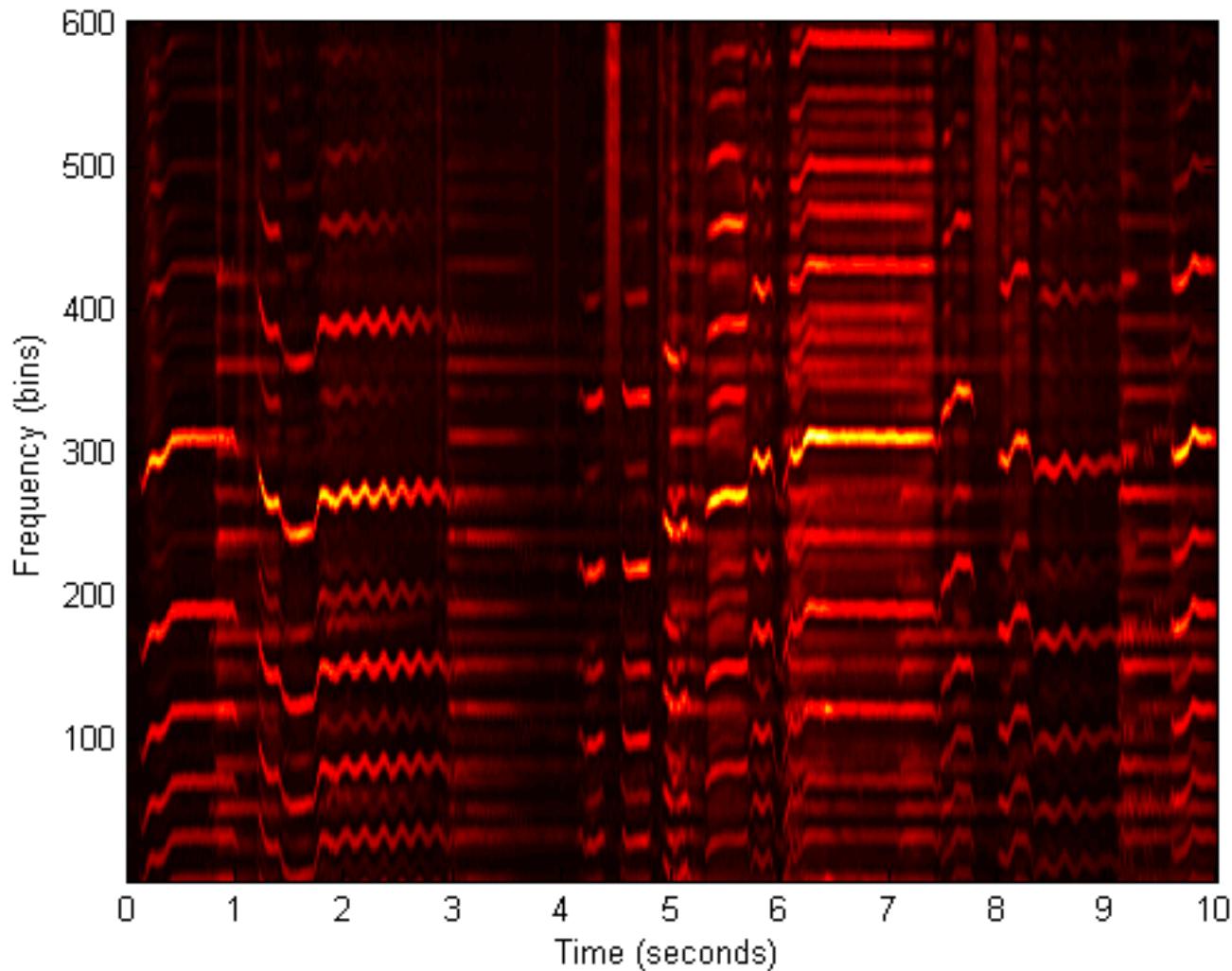


<http://www.justinsalamon.com/melody-extraction.html>

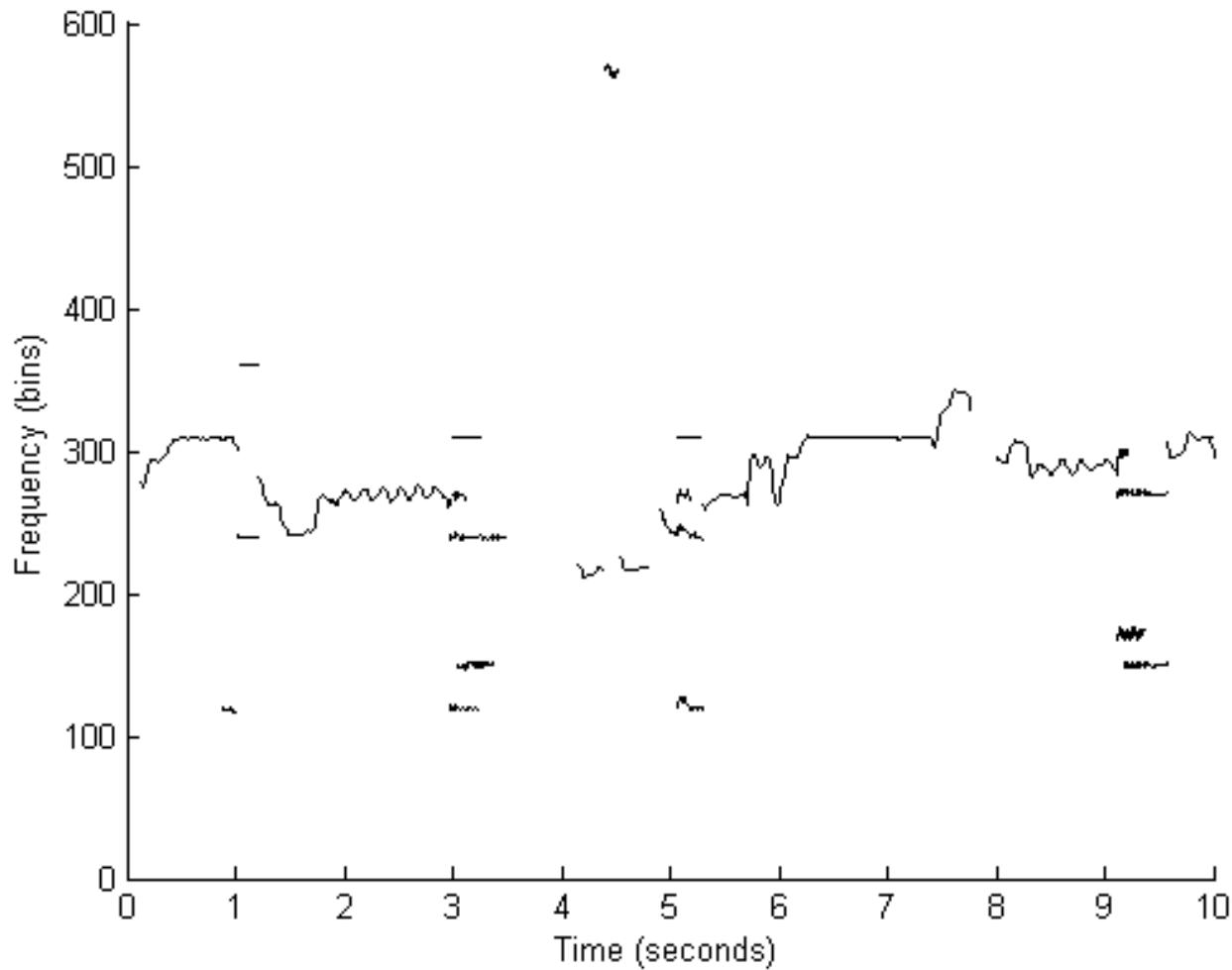
Melodia: Sinusoids



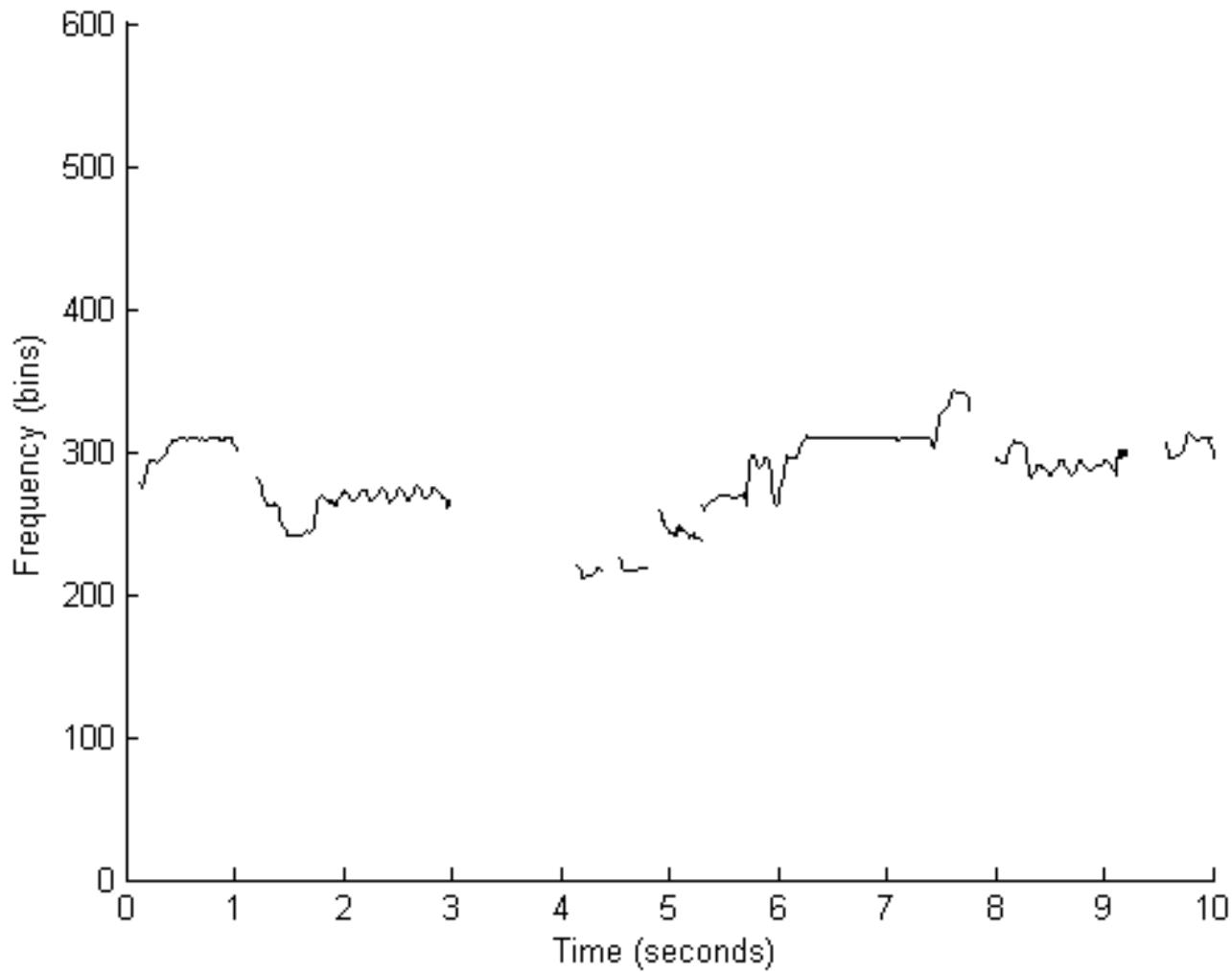
Melodia: Salience Function



Melodia: Pitch Contours

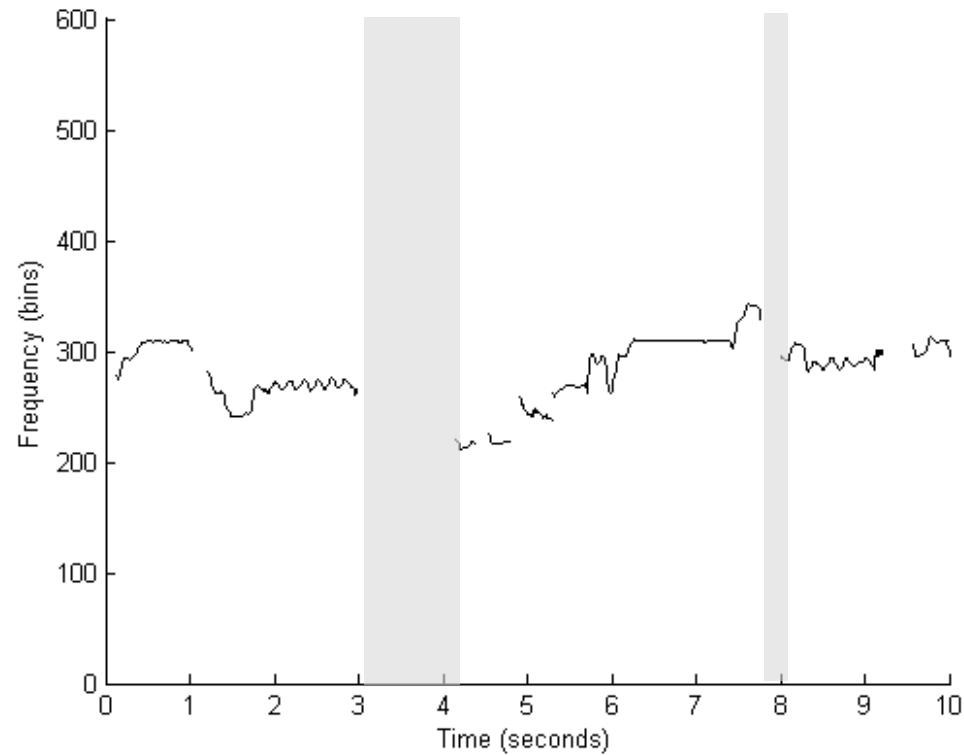


Melodia: Melody Selection



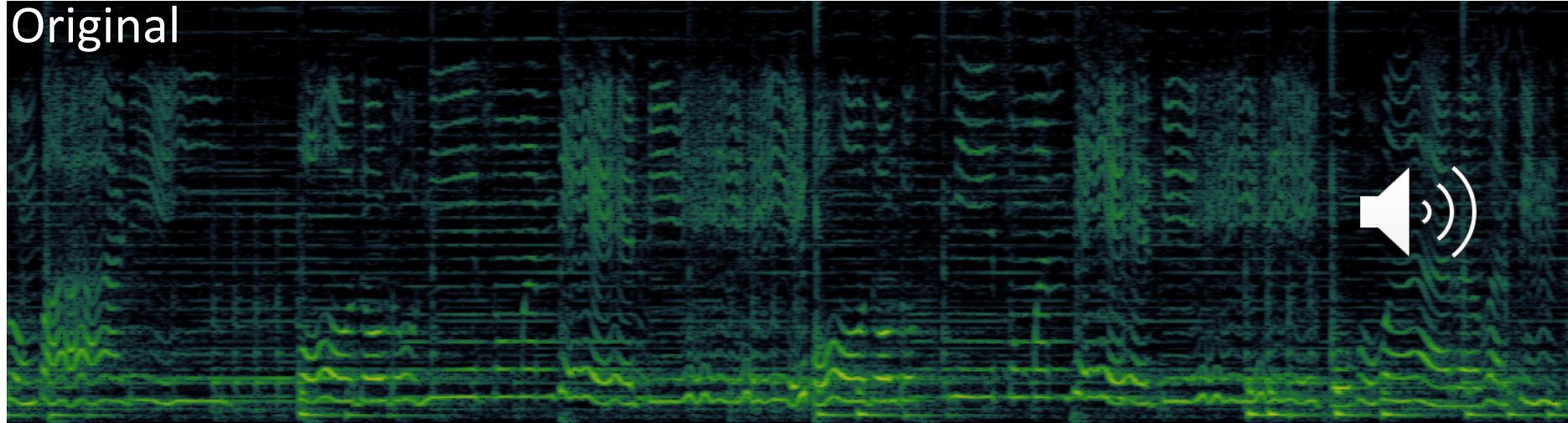
Melodia: Parameters

- Frequency range, voicing threshold
- Negative pitch values: Unvoiced - remove

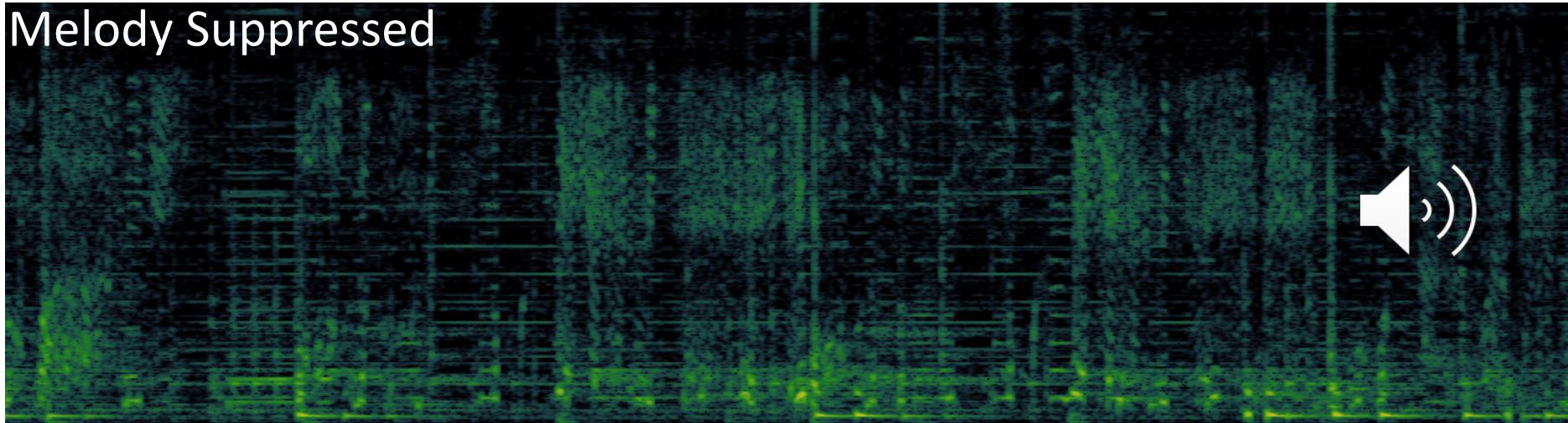


An application: Melody Suppression

Original



Melody Suppressed

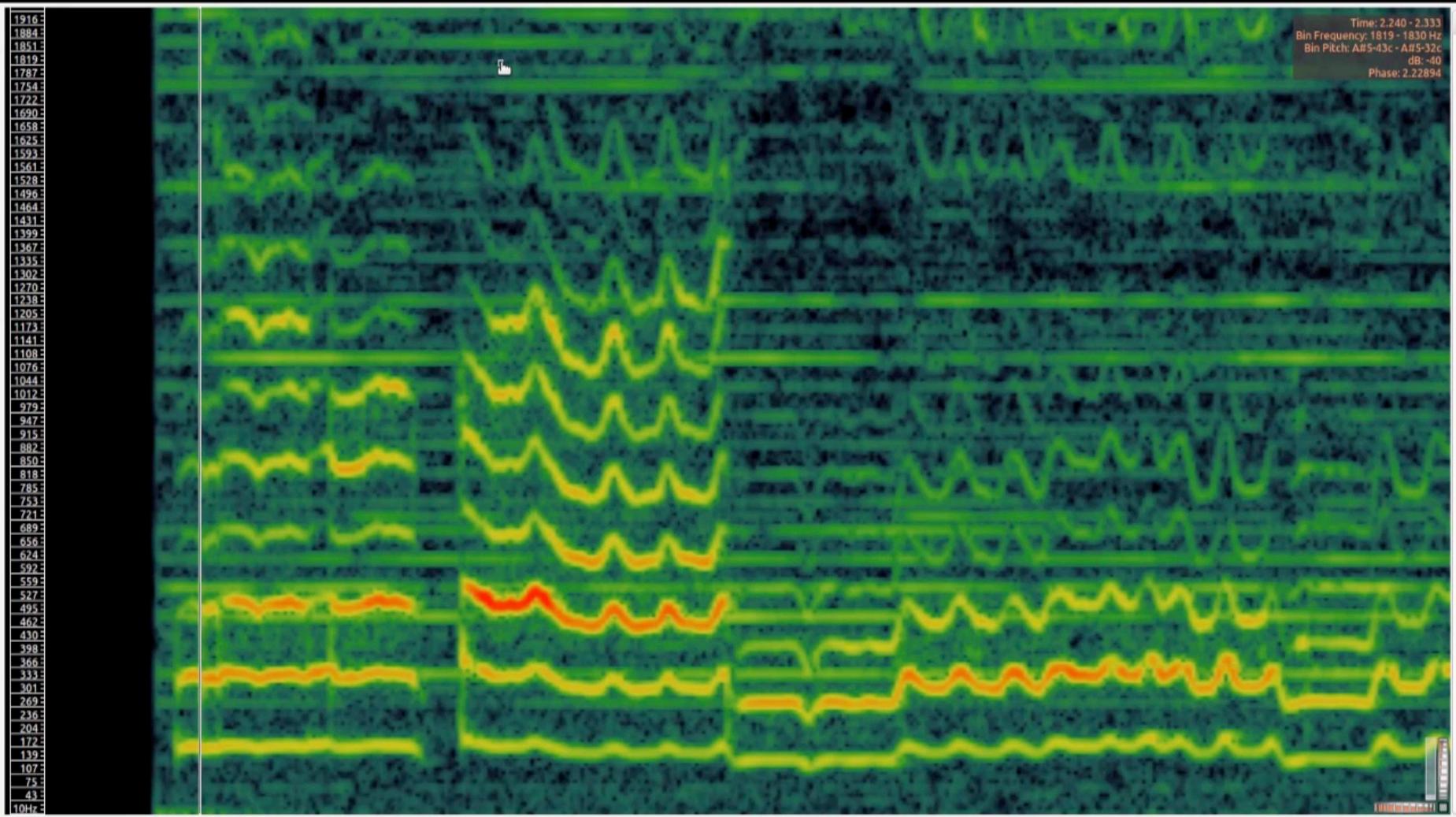


Jagadanandakaraka, Pure Expressions by Aneesh Vidyashankar
<http://musicbrainz.org/recording/2a8bb9e0-f048-4c12-9e75-407b0c828995>

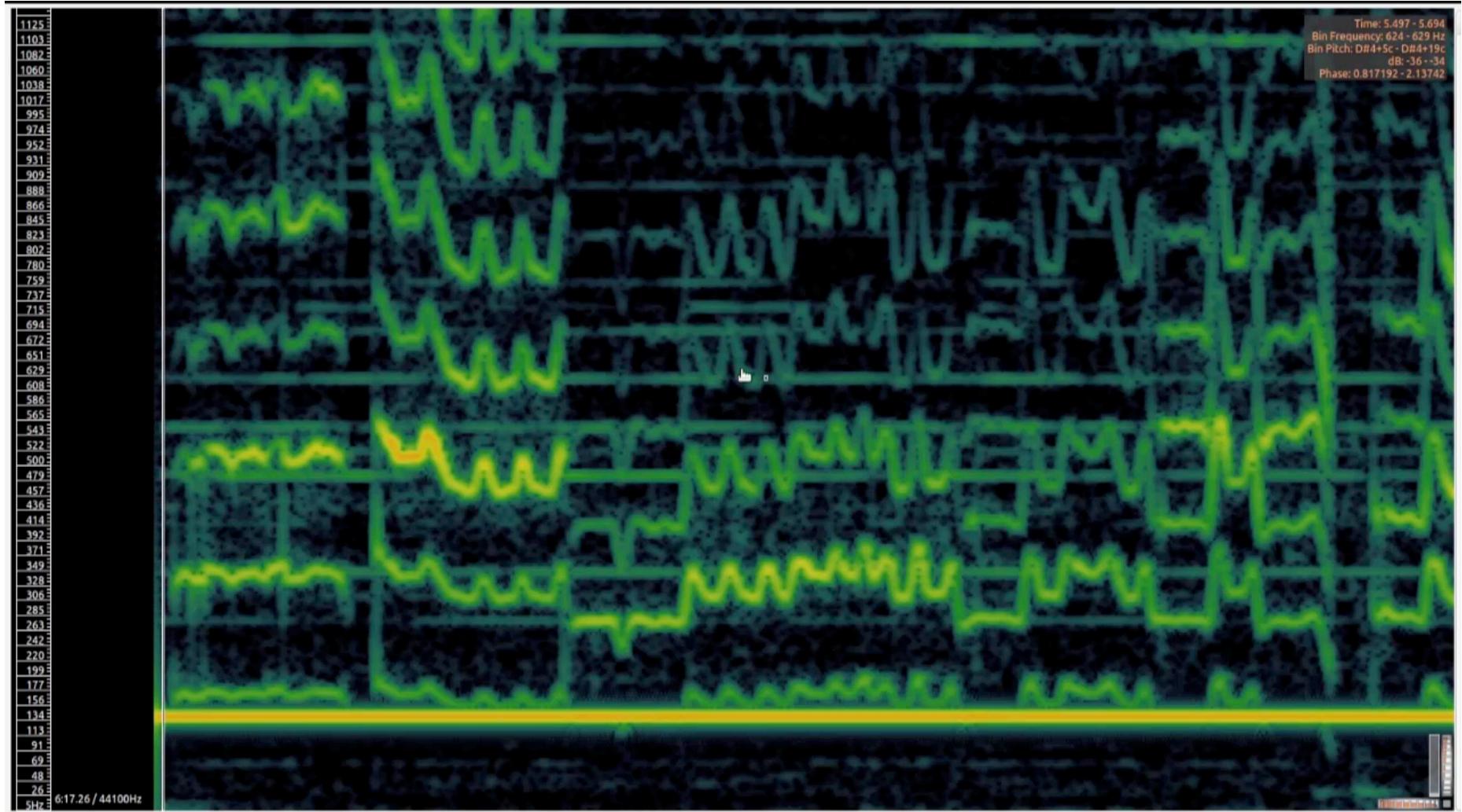
Tonic Identification

- Tonic in Indian Art Music
 - Flexibly chosen by the lead musician
 - Tanpura/Tambura: drone tuned to the tonic
 - All instruments tuned to the tonic
- Fundamental task in Indian Art Music analysis
 - Useful to define melodic patterns
 - Intonation analysis
 - Extract raga information

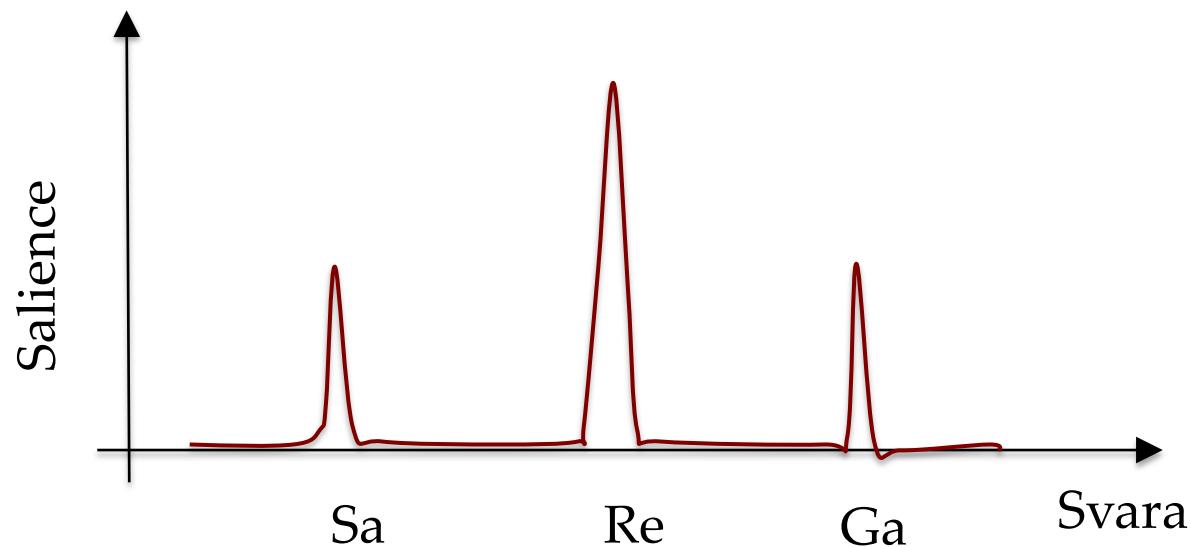
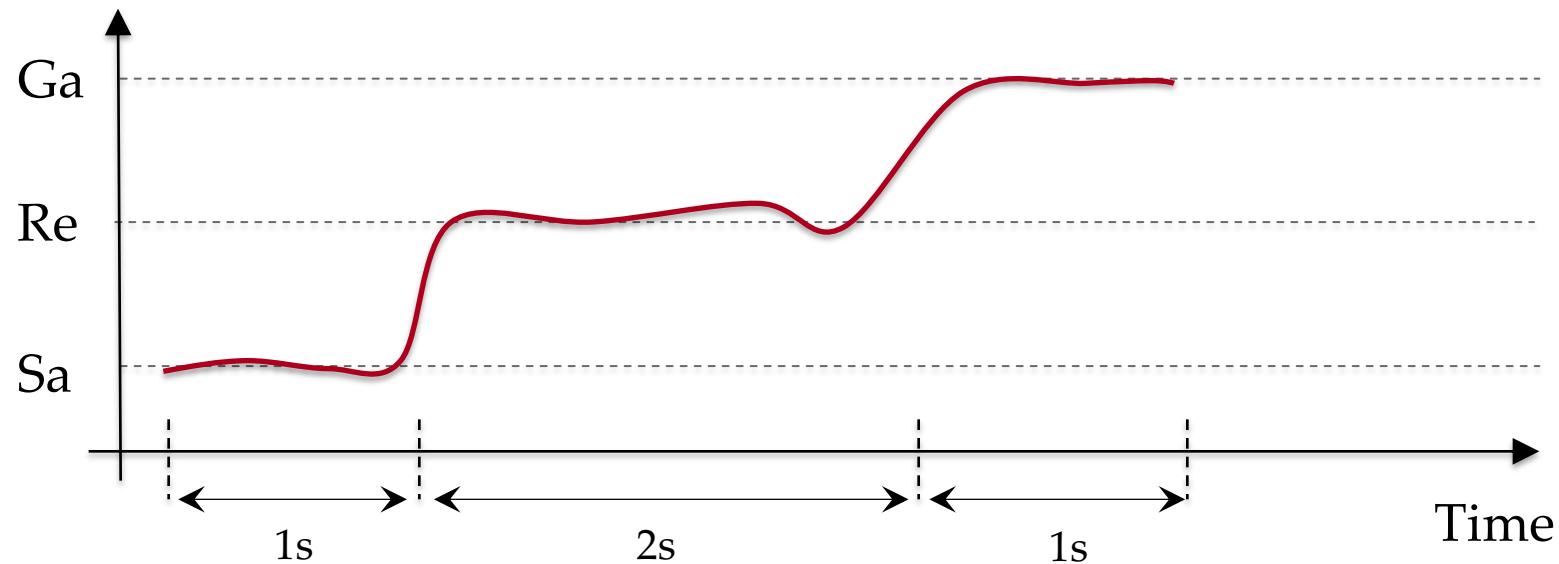
Tonic Identification



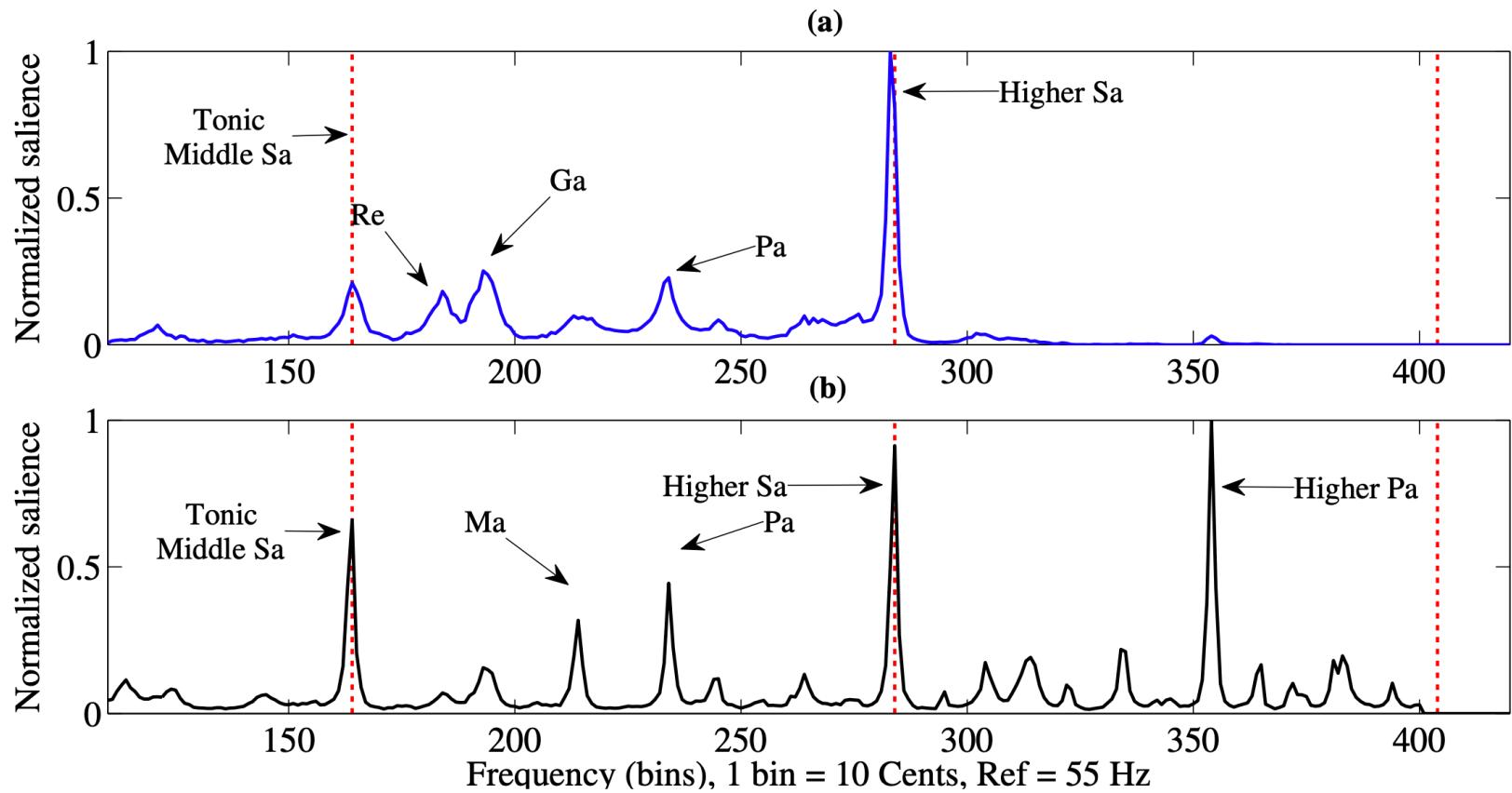
Tonic Identification



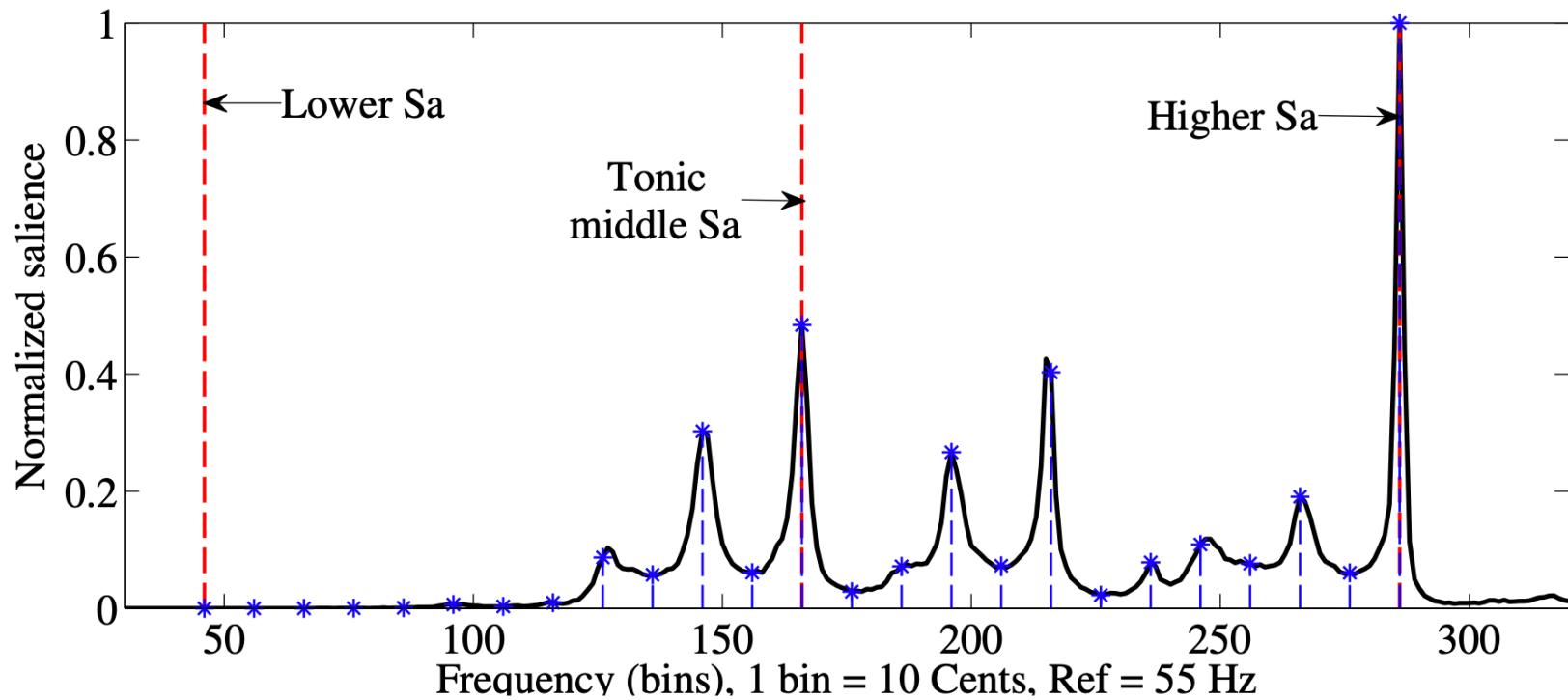
Pitch Histogram



Peaks in Pitch Histogram

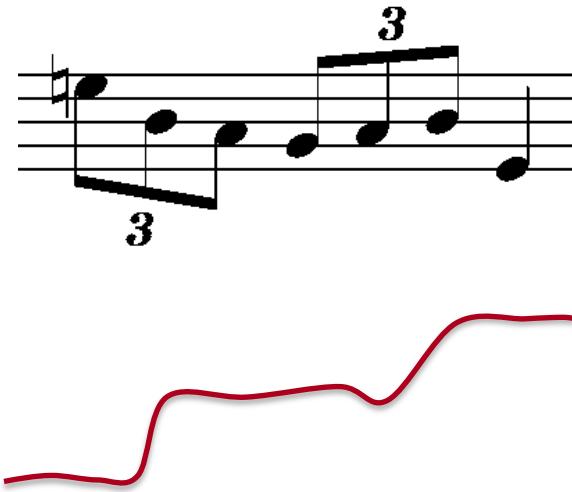


Pitch Histogram: Tonic search

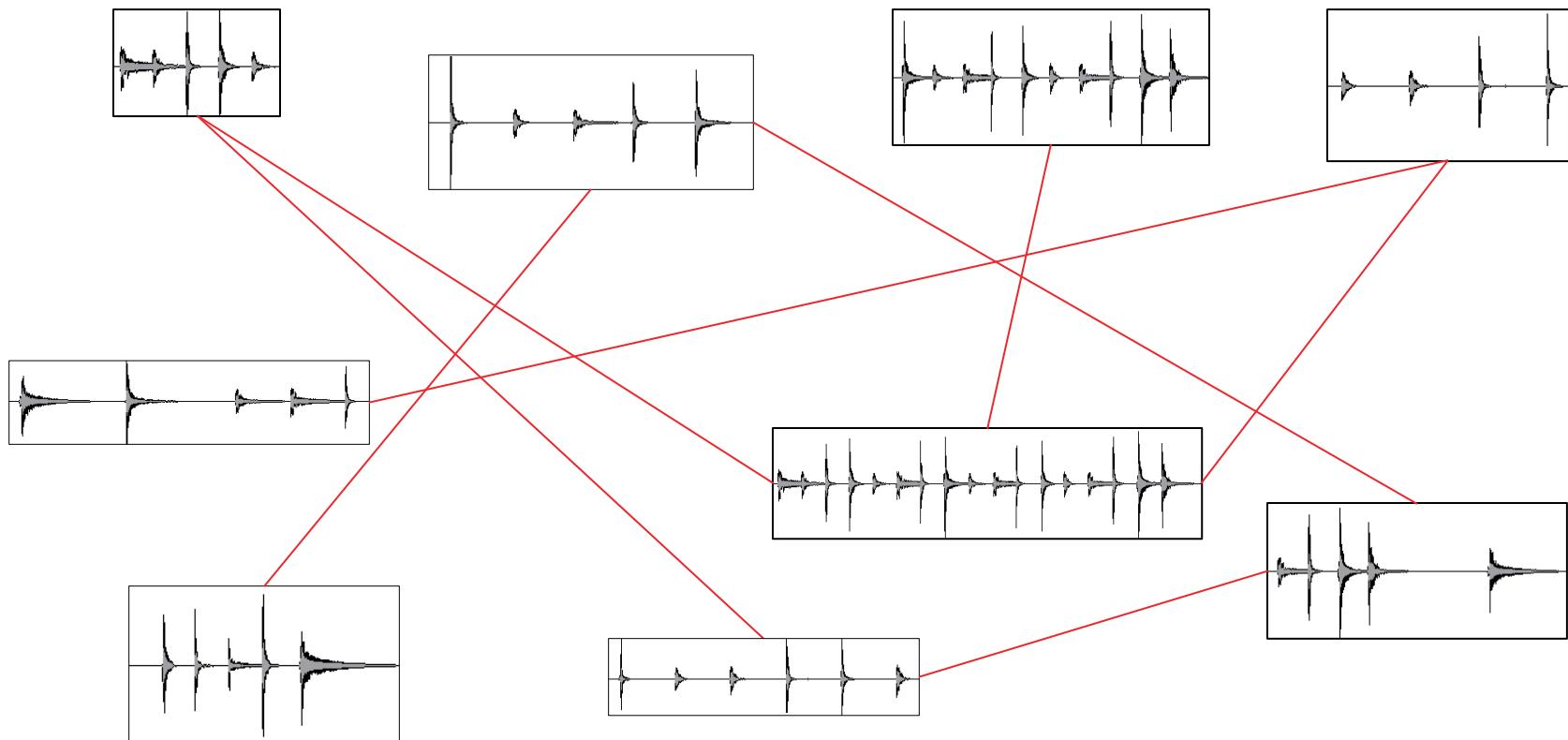


Melodic motifs/phrases

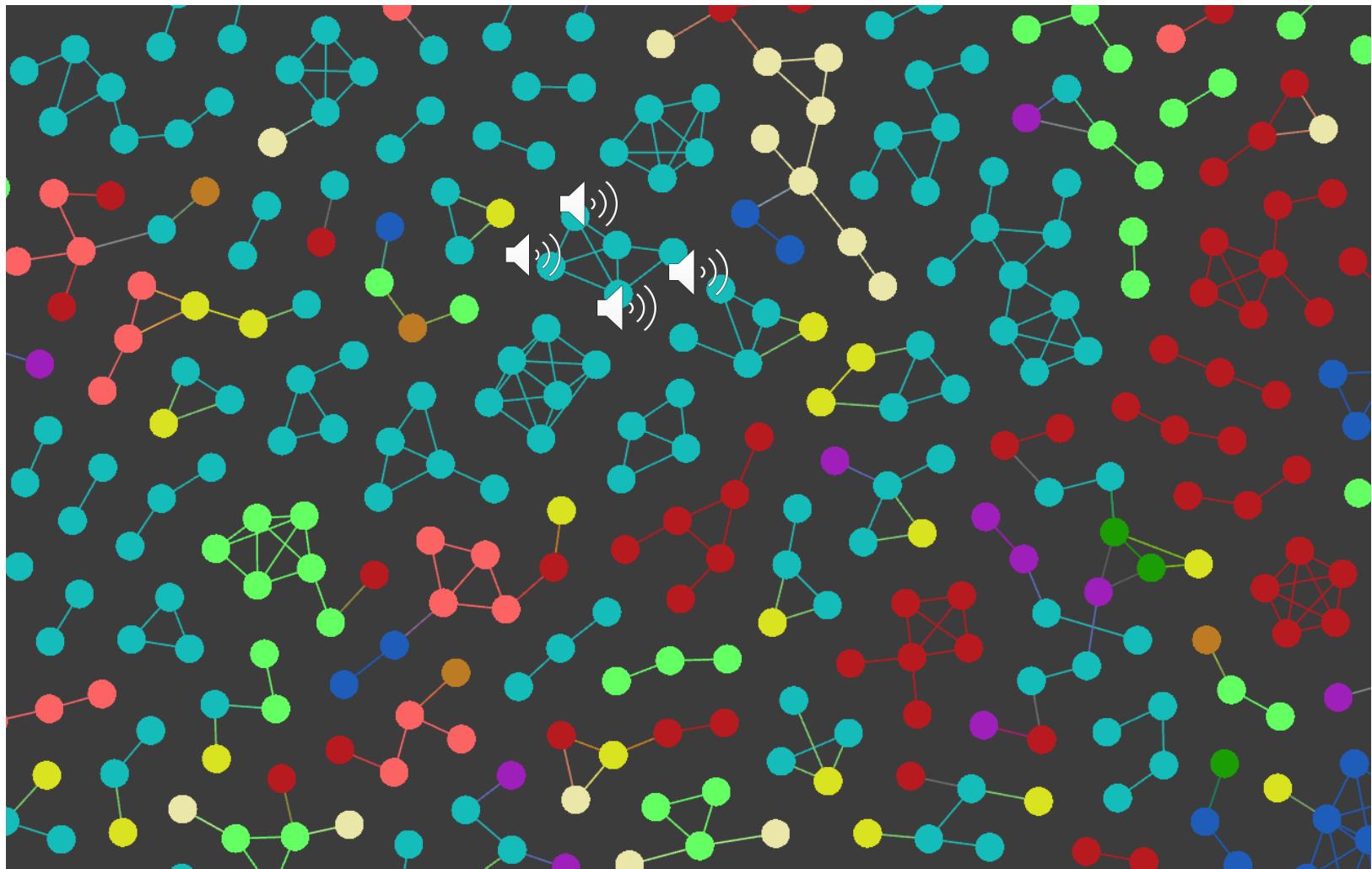
- Short segments of melody
 - Sequence of notes
 - Pitch contours
- Characteristic melodic phrases
 - Repeated within and across music pieces
 - Characteristic of a raga



Pattern extraction and analysis



Melodic motif discovery

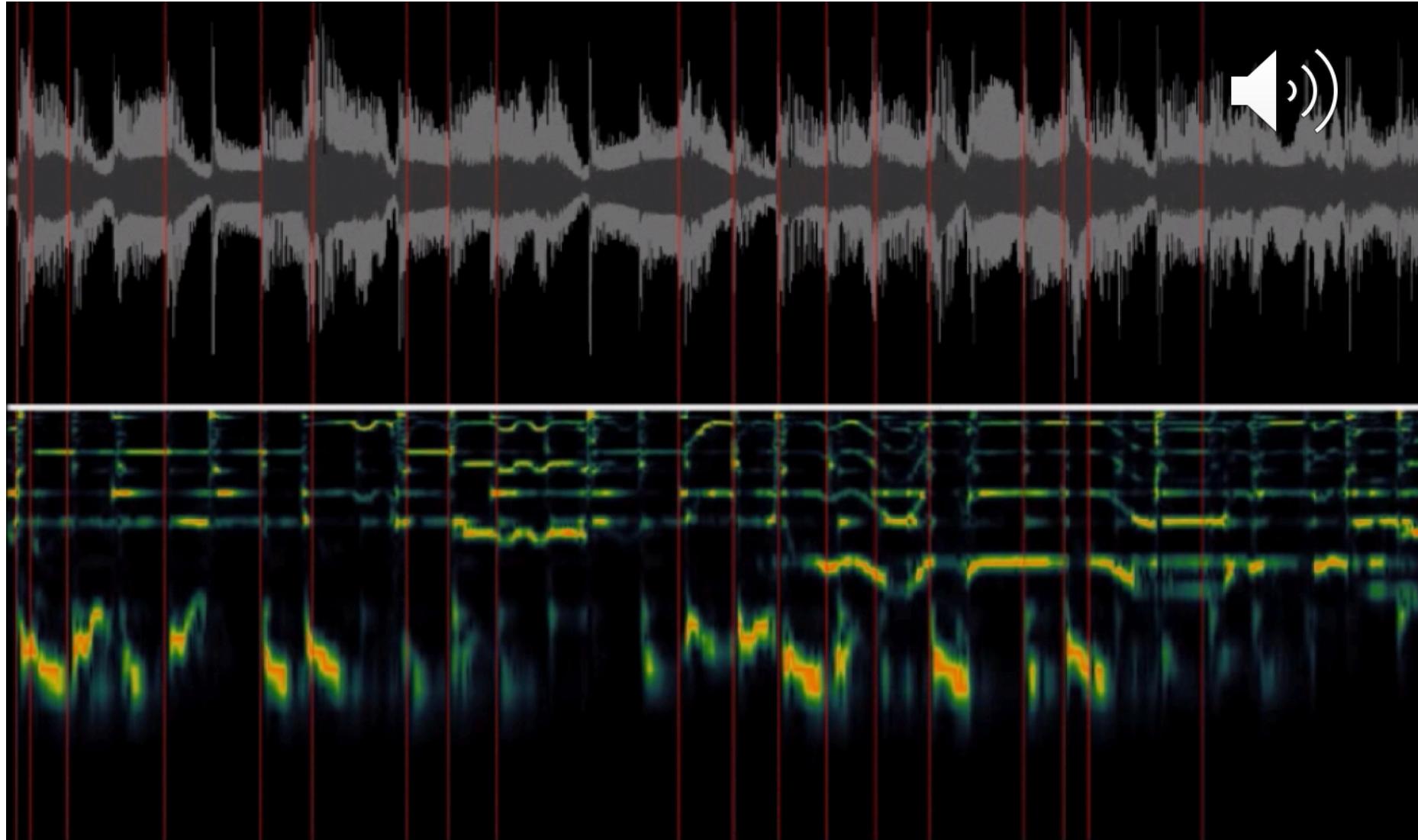


https://dunya.compmusic.upf.edu/pattern_network/

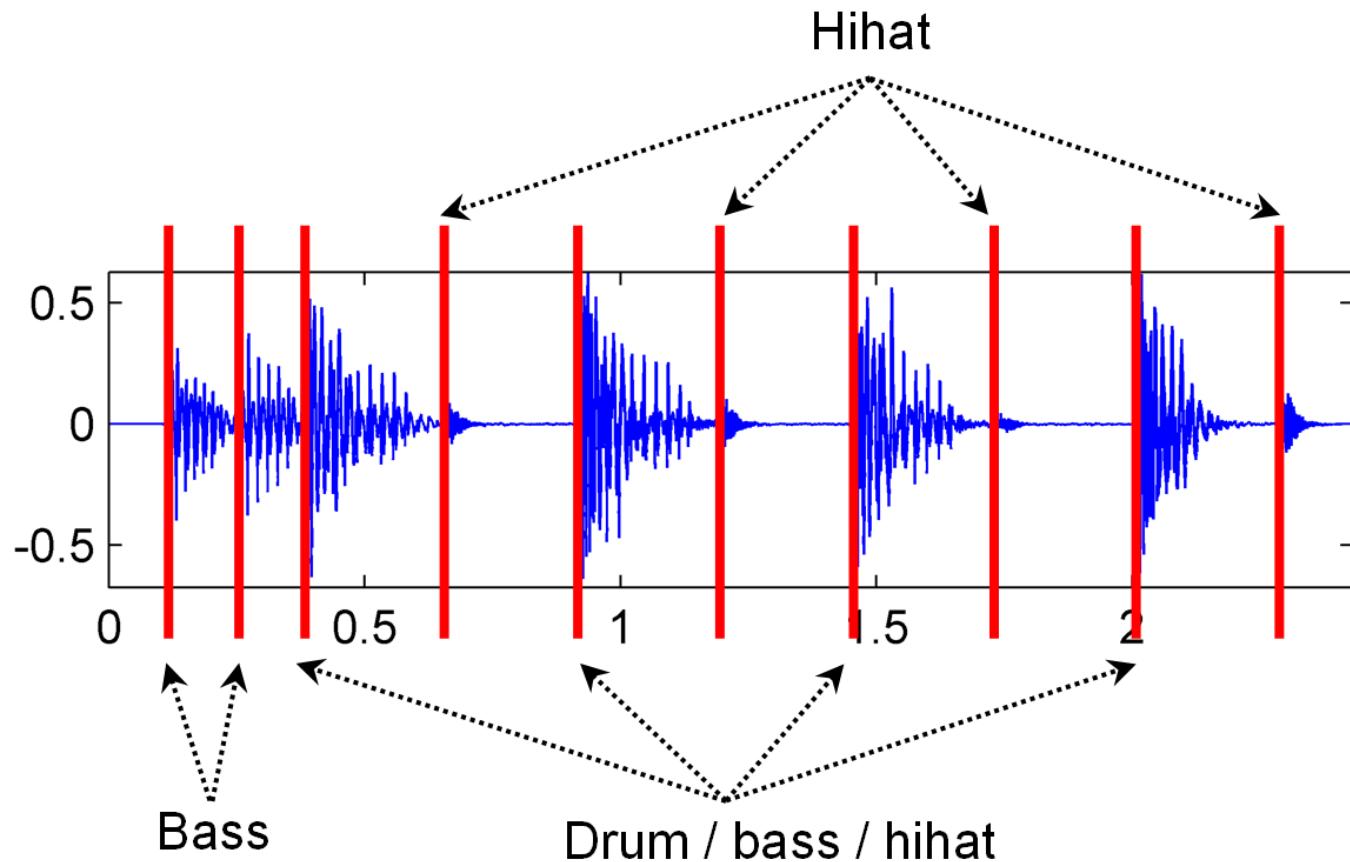
Onsets and Tempo

- Onset: Note event
 - Basic events in time
 - Grouped to form beats, bar . . .
- Tempo
 - Median Inter-onset interval: good estimate of tempo
 - Possibly time-varying: local averages

Onsets

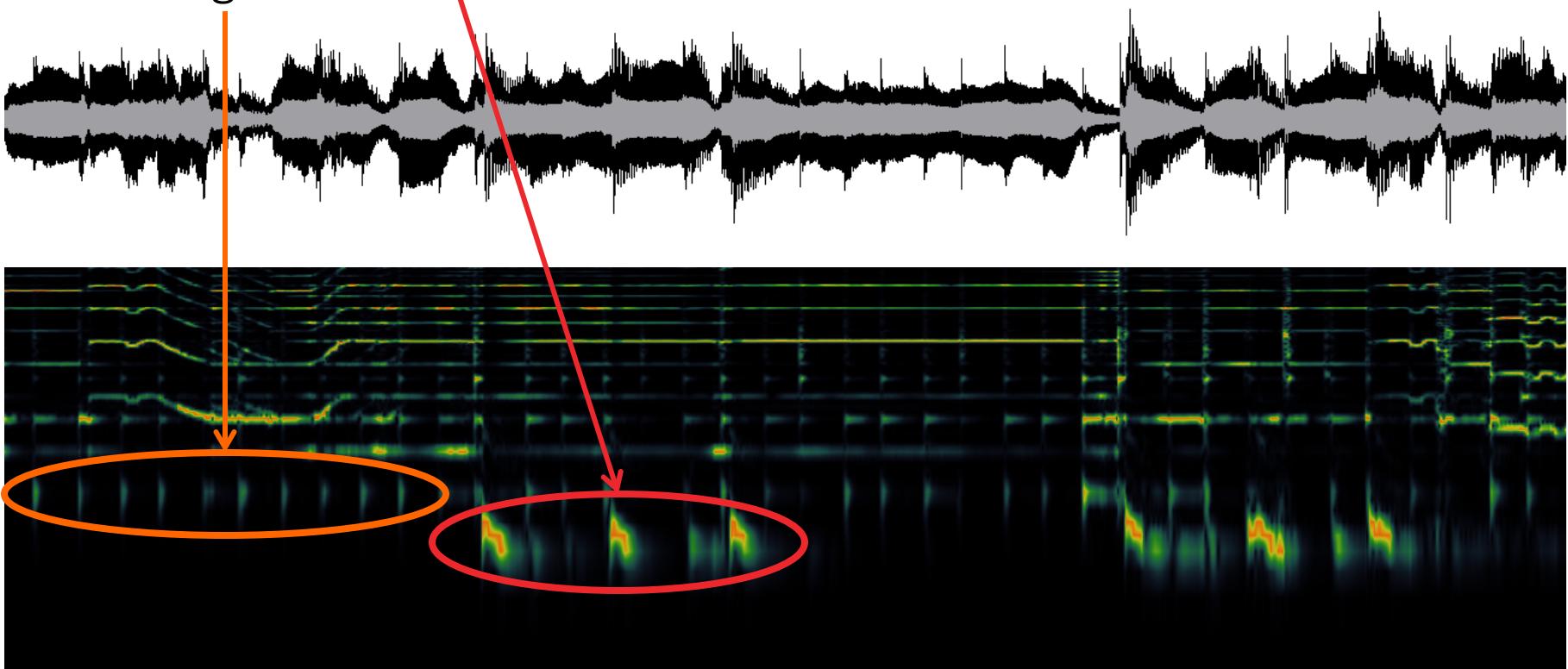


Onsets

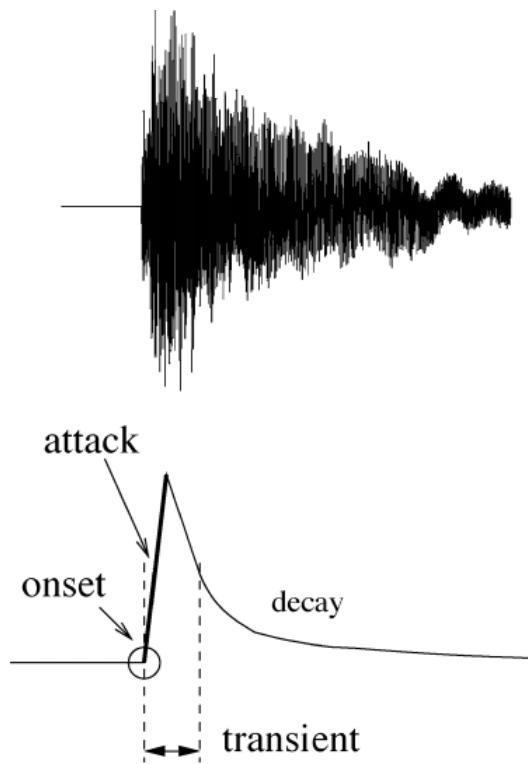


Onset Detection

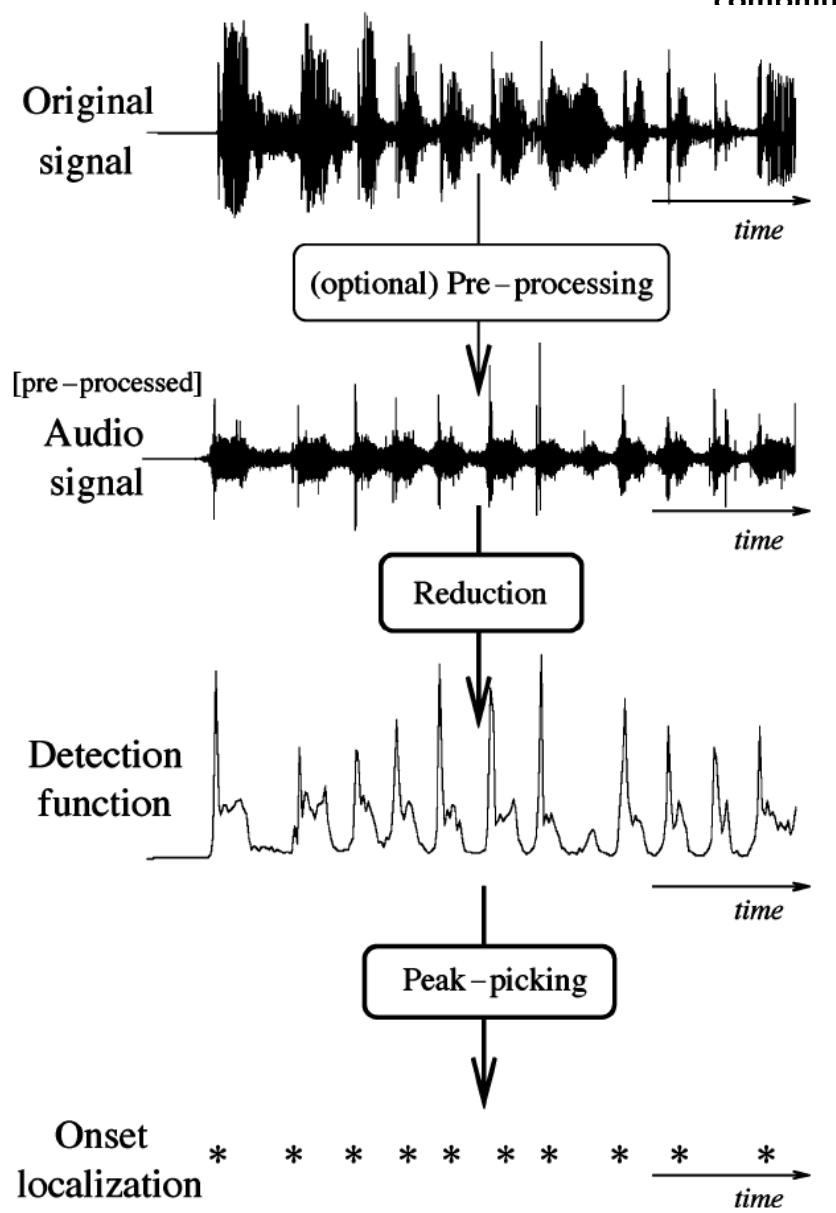
- Mridangam stroke onsets
 - Right and Left



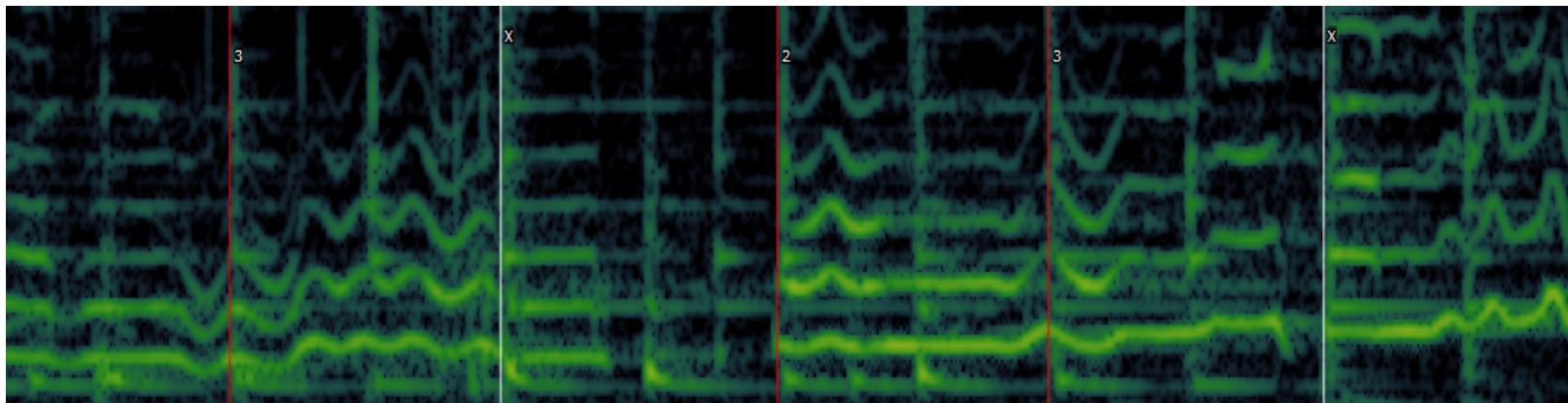
Onset detection



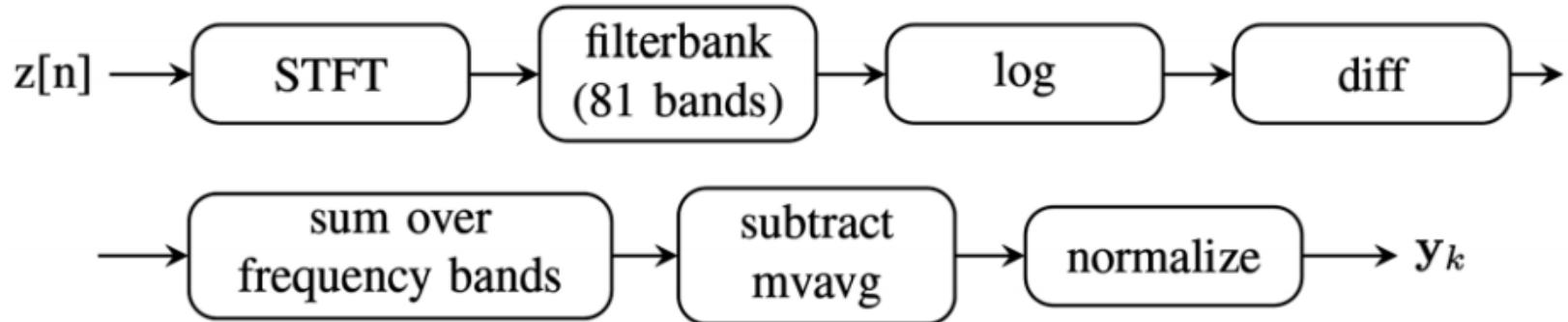
- Temporal and spectral features
- Band-wise spectral flux
 - Spectral magnitude change



Onset features



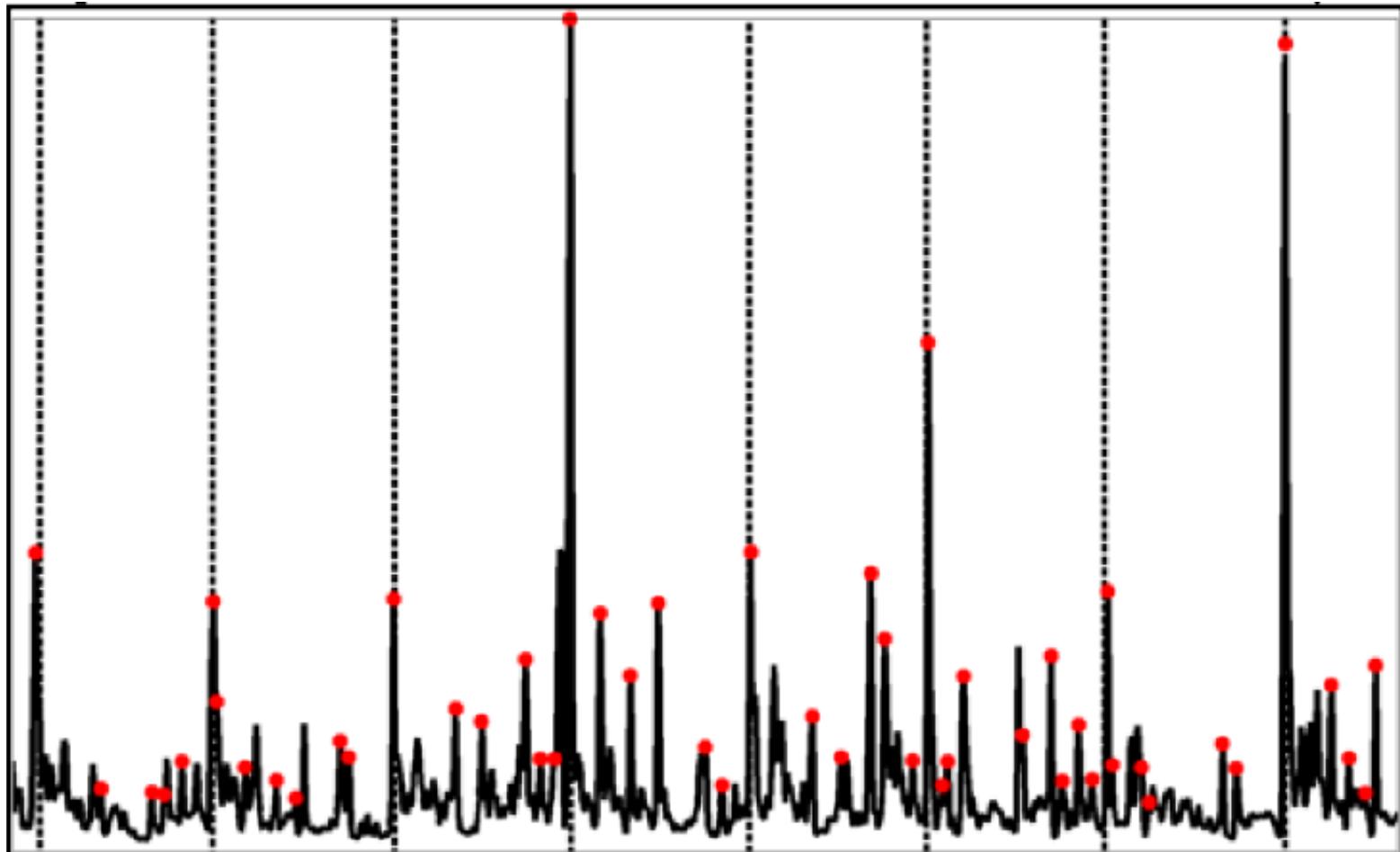
- Spectral flux



J. Bello et al., "A tutorial on onset detection in music signals." *IEEE Transactions on Speech and Audio Processing*, 13(5), 2005: 1035-1047.

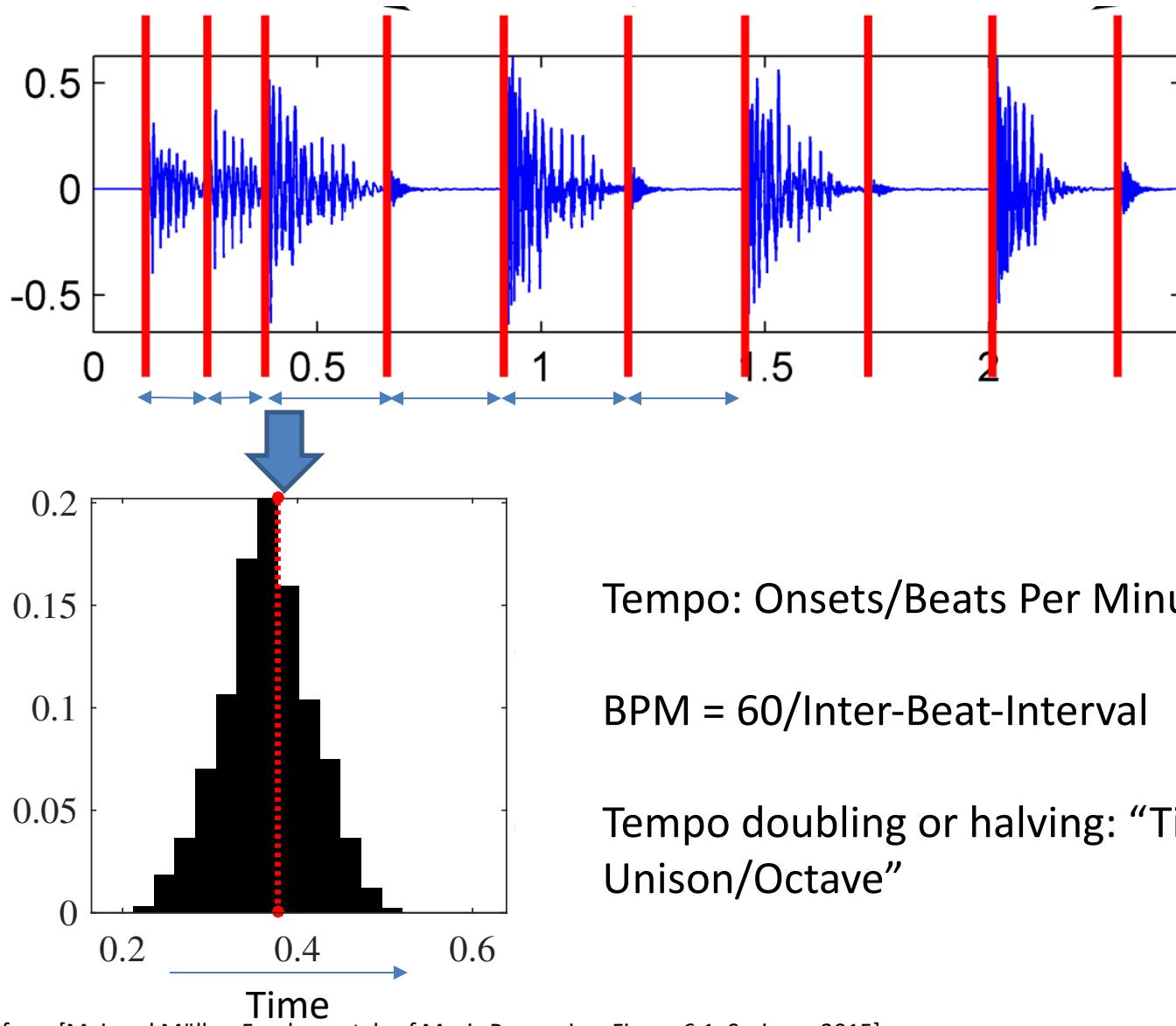
F. Krebs, S. Bock, and G. Widmer , "Rhythmic pattern modeling for Beat and Downbeat Tracking in Musical Audio," Proc. of the 14th International Society for Music Information Retrieval Conference (ISMIR), Curitiba, Brazil, 2013.

Onset Detection Function



Onset detection function

Onset Interval Histogram: Tempo



Tempogram: Basics

- Fourier Analysis of the Onset Detection Function

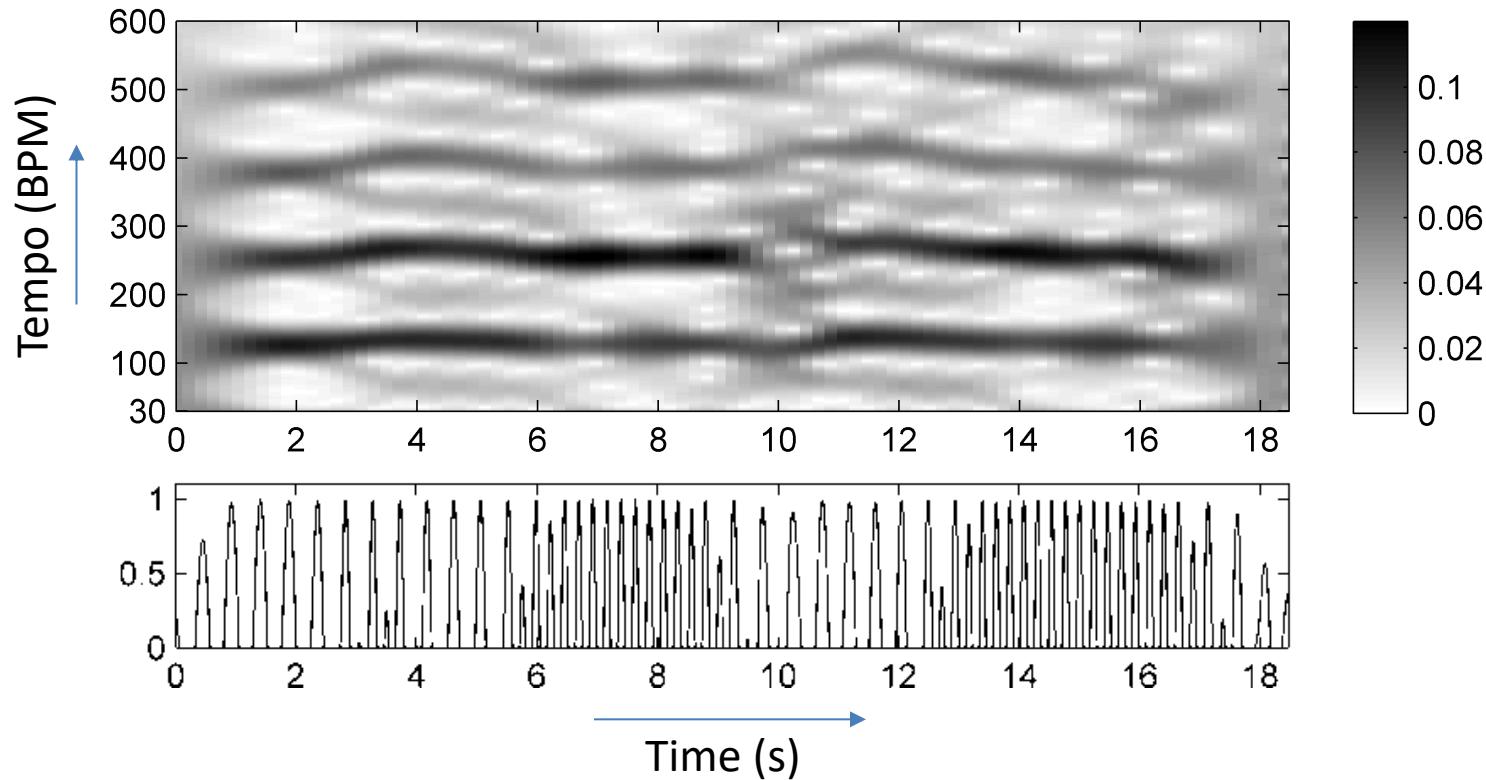
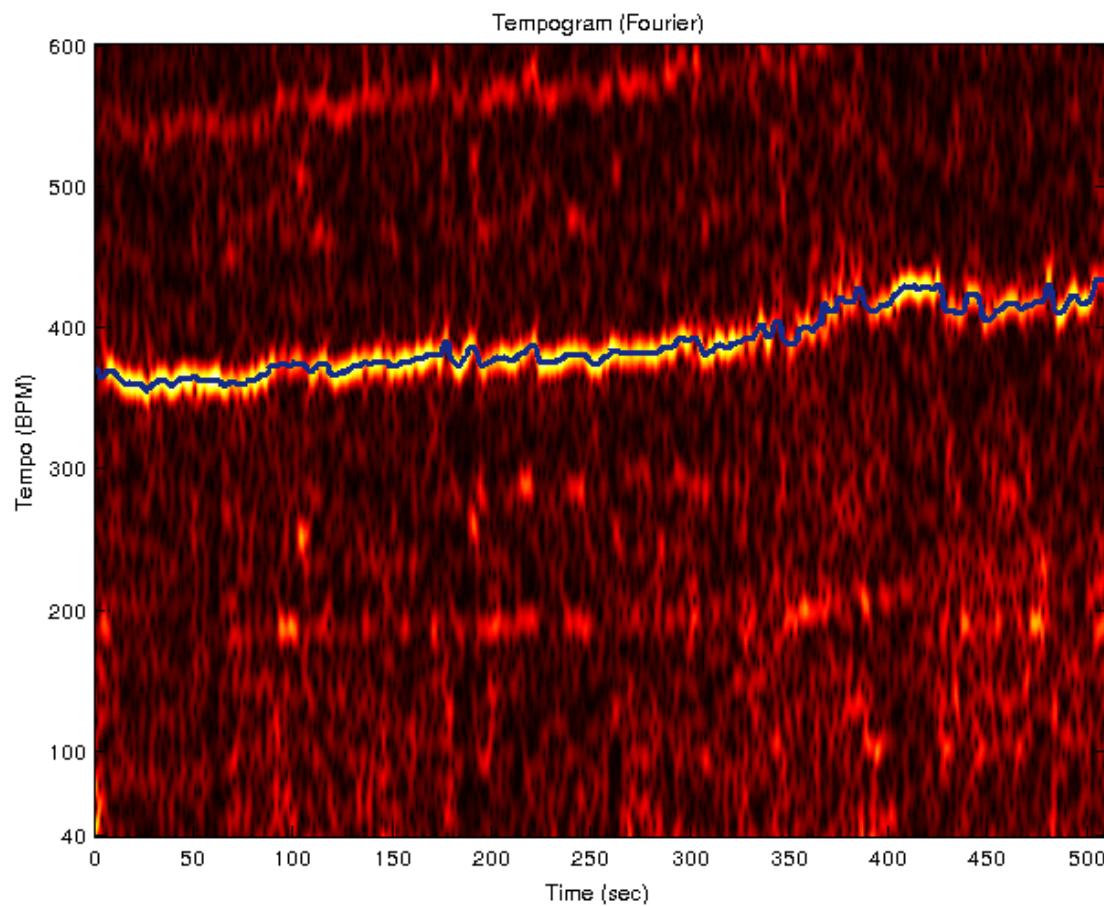


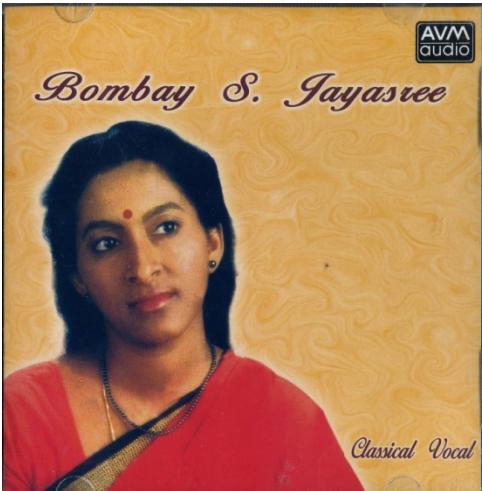
Figure taken from [Meinard Müller, Fundamentals of Music Processing, Figure 6.20, Springer 2015]

Tempogram

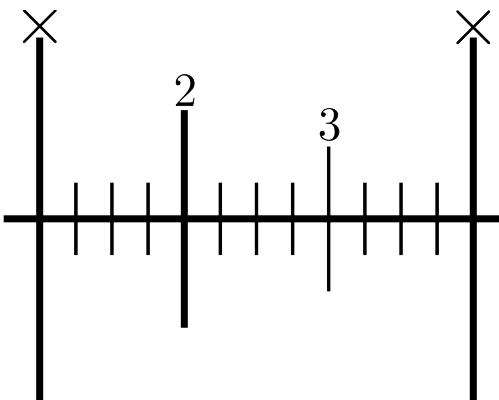
- Tracking time-varying tempo



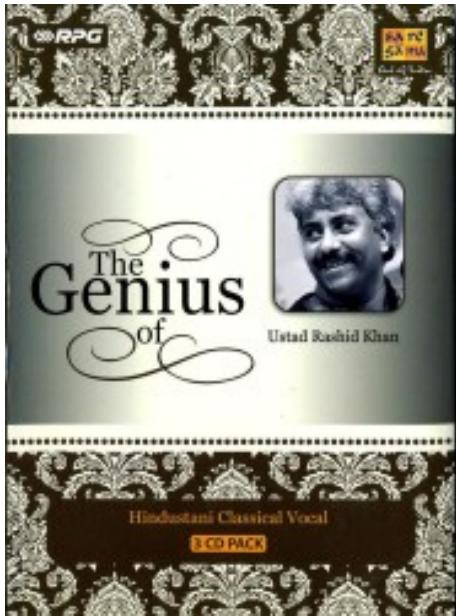
Tāla tracking – Carnatic music



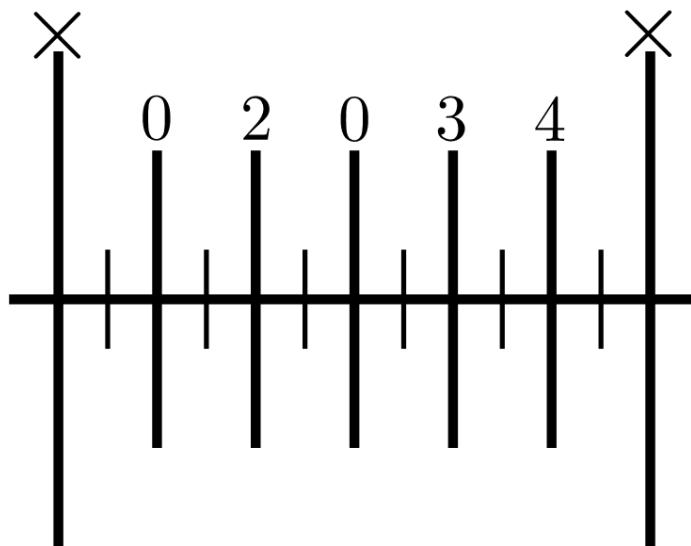
Artist: Bombay Jayasree (vocal)
Release: Classical Vocal
Composition: Śaṅkari nīvē
Composer: Subbaraya Sastry
Rāga: Bēgada
Tāla: Rūpaka (Cycle of 12 akṣara)



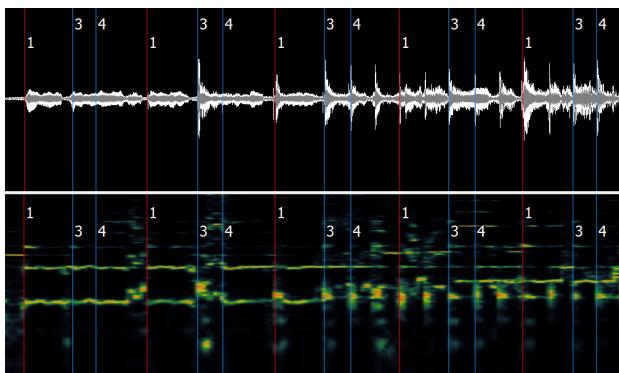
Tāl tracking – Hindustani music



Artist: Rashid Khan (vocal)
Release: The Genius Of Ustad Rashid Khan
Composition: Rasiya Maara Ama Laara
Rāga: Ahir Bhairav
Tāla: Ektāl (Cycle of 12 mātrās)



Meter inference and tracking



TESI DOCTORAL UPF / 2016

upf. Universitat Pompeu Fabra Barcelona

A Data-driven Bayesian Approach to Automatic Rhythm Analysis of Indian Art Music

Ajay Srinivasamurthy

Chapter 5

Meter inference and tracking

...the first beat (sam) is highly significant structurally, as it frequently marks the coming together of the rhythmic streams of soloist and accompanist, and the resolution point for rhythmic tension.

Clayton (2000, p. 81)

Meter analysis of audio music recordings is an important MIR task. It provides useful musically relevant metadata not only for enriched listening, but also for pre-processing of music for several higher level tasks such as section segmentation, structural analysis and defining rhythm similarity measures.

To recapitulate, meter analysis aims to time-align a piece of audio music recording with several defined metrical levels such as tatum, tactus, measure (bar). In addition, it also tags the recording with additional meter and rhythm related metadata such as time signature, median tempo and salient rhythms in the recording. Within the context of Indian music, meter analysis aims to time-align and tag a music recording with tala related events and metadata.

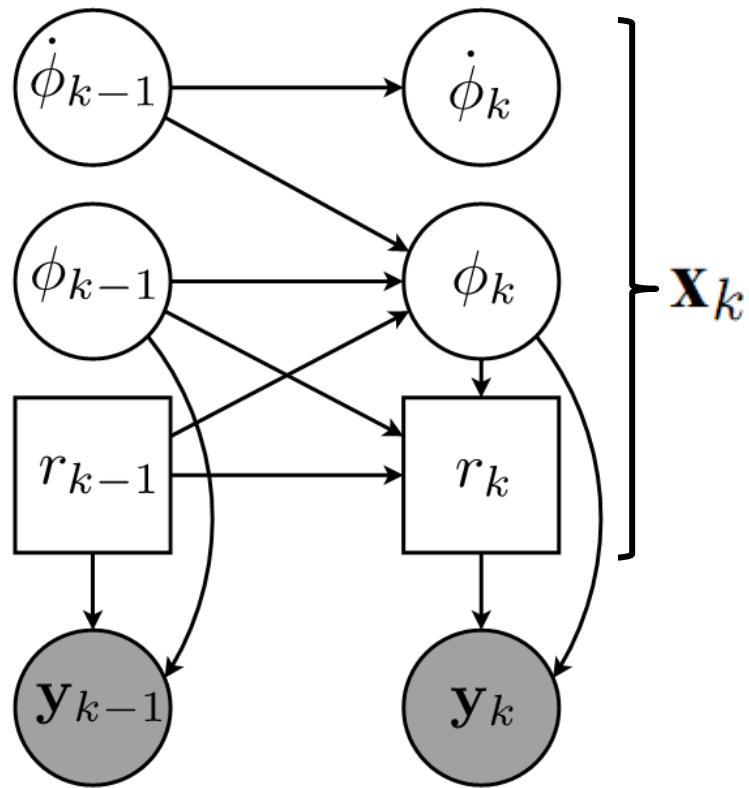
This chapter aims to address some of these important tasks related to meter analysis within the context of Indian art music, presenting several approaches and a comprehensive evaluation of those

177

<https://compmusic.upf.edu/phd-thesis-ajay>

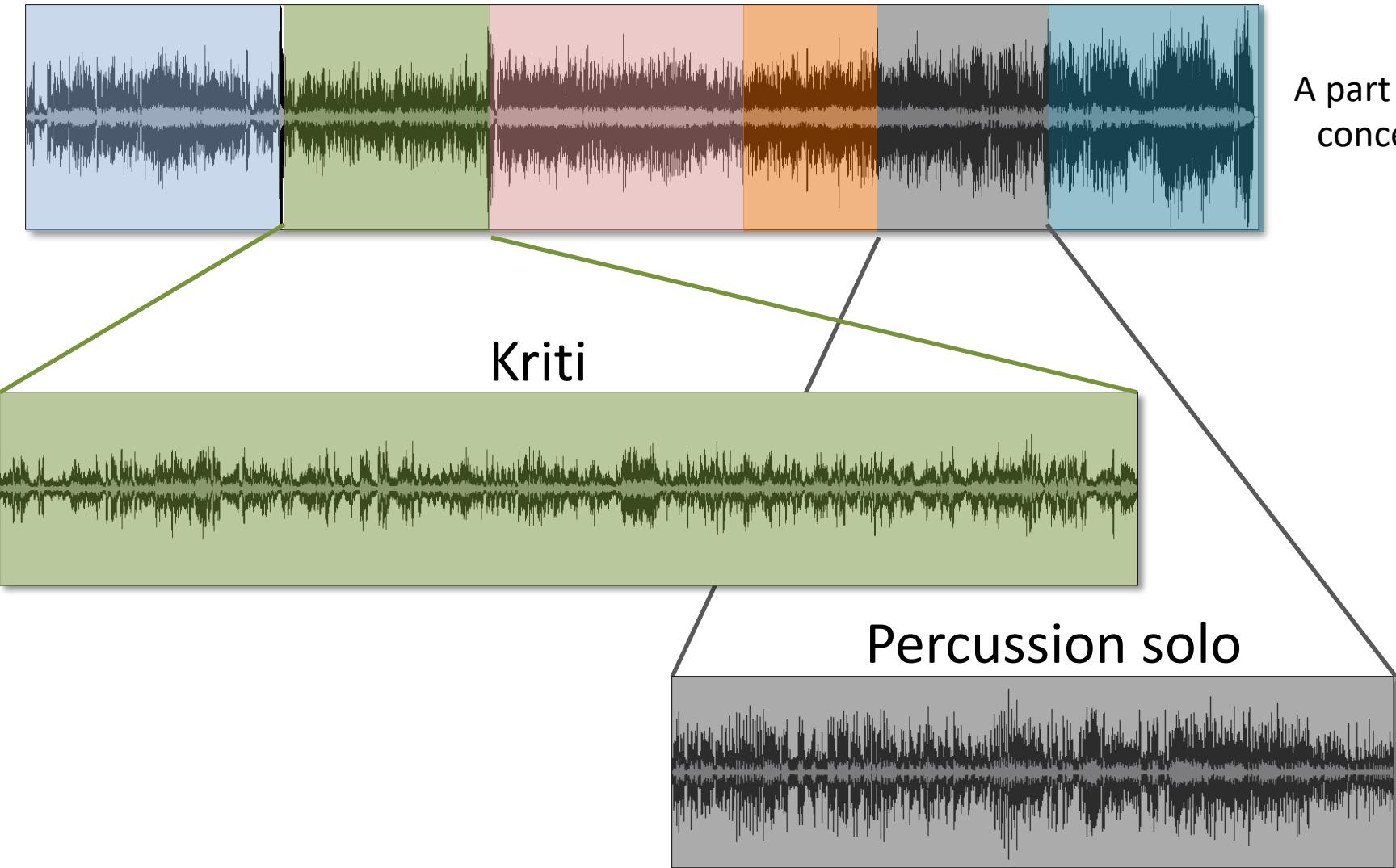
Bar pointer model

- Dynamic Bayesian Network (DBN)

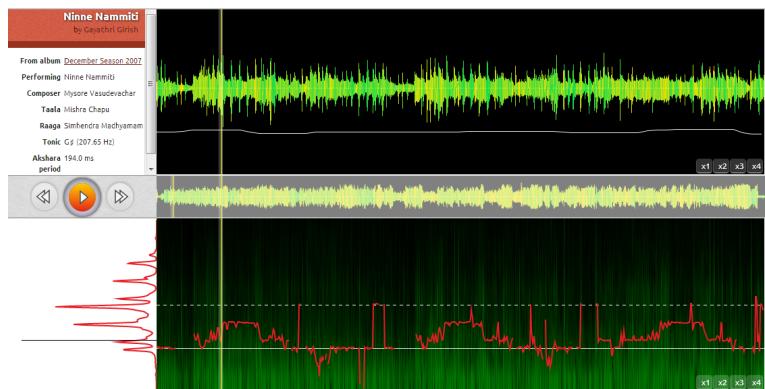
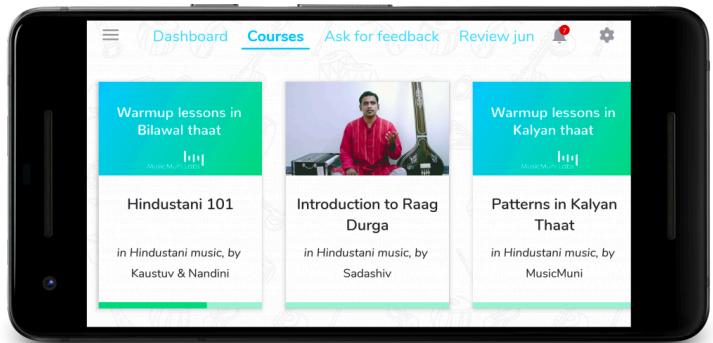


N. Whiteley, A. T. Cemgil, and S. Godsill (2007). Sequential inference of rhythmic structure in musical audio. In Proc. of the 33rd ICASSP, vol. 4, pp. 1321–1325.

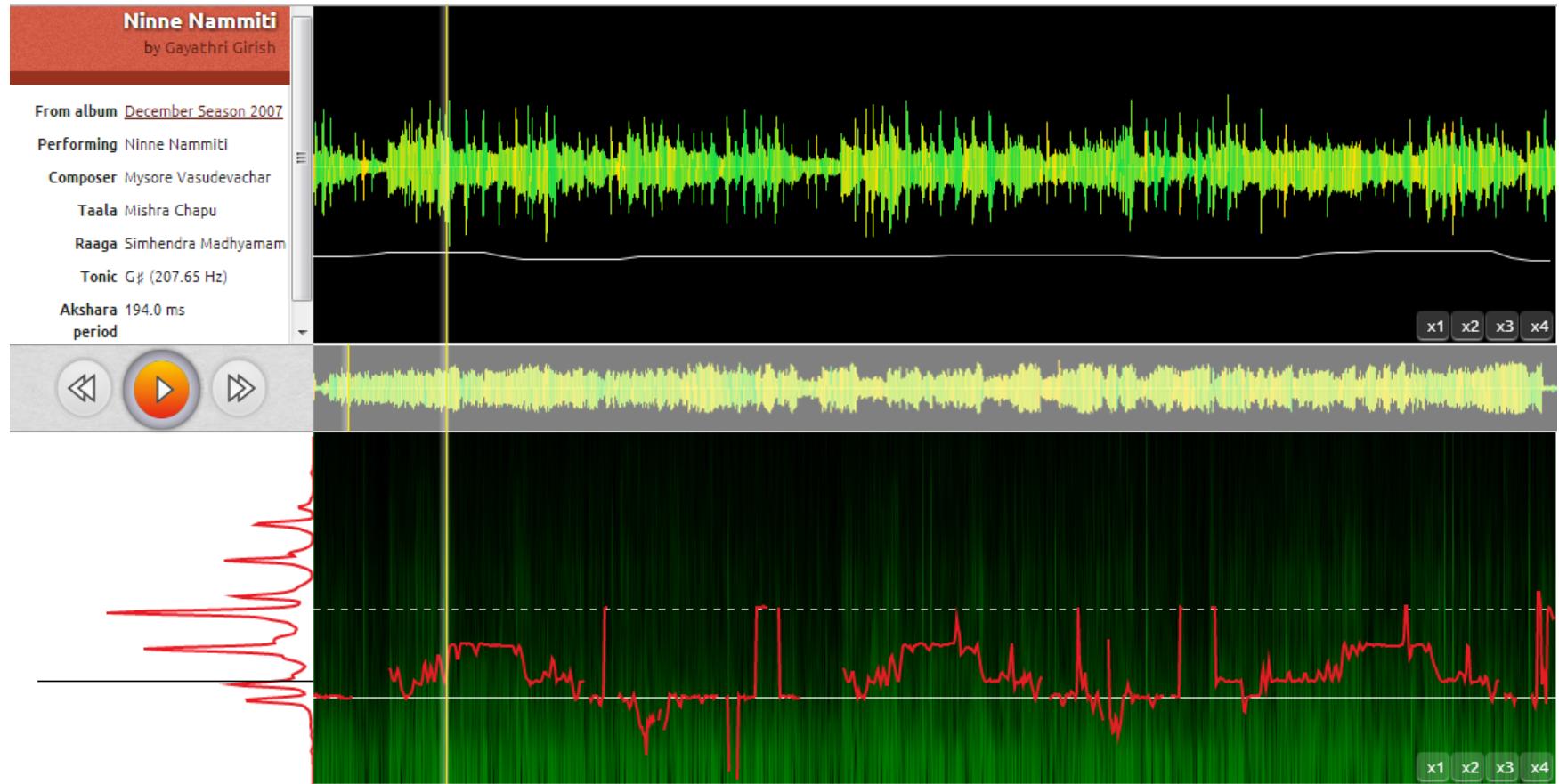
Structural segmentation: Concert



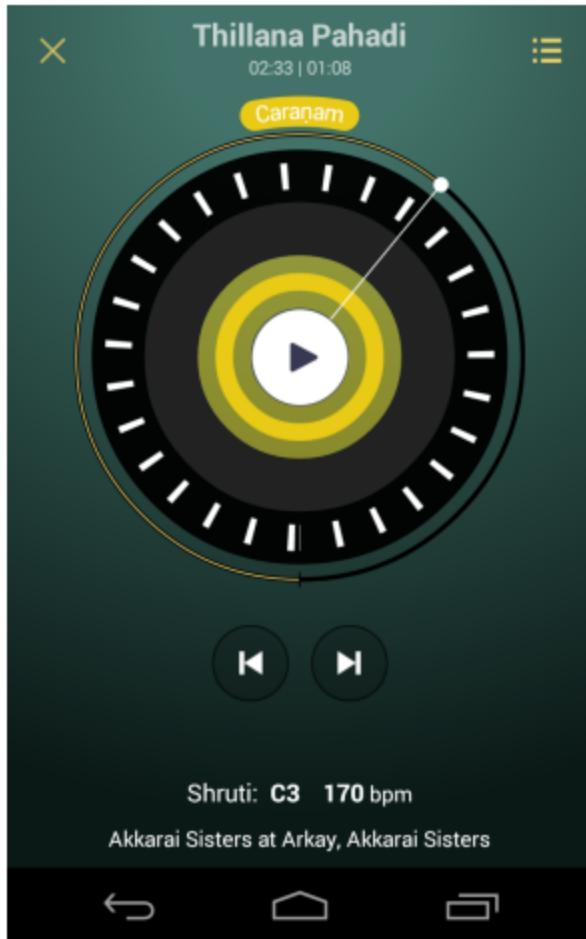
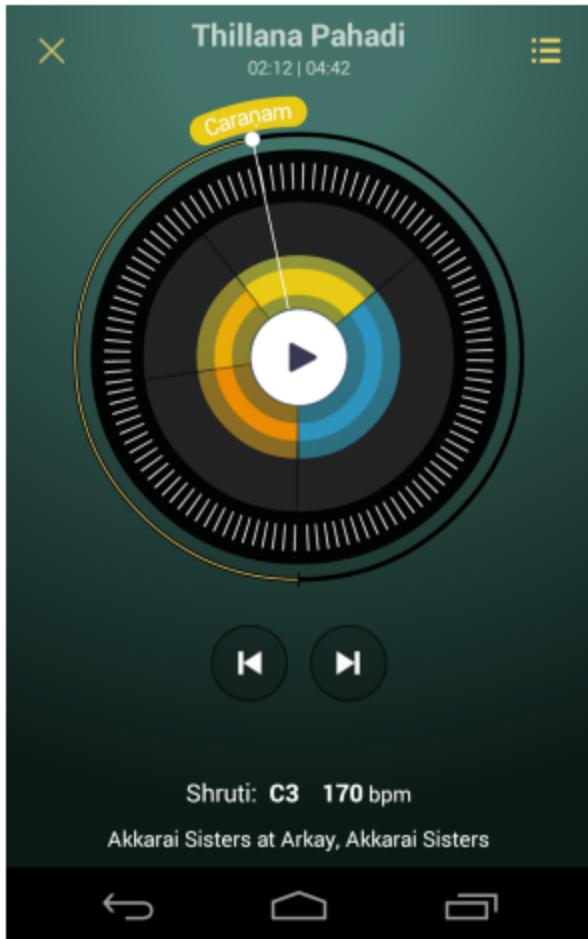
Applications



Dunya: Enriched music listening



Sarāga



<http://musicmuni.com/>

“Intelligent” Music Applications



Resources



compmusic

- [HOME](#)
- [DESCRIPTION](#)
- [TEAM](#)
- [PUBLICATIONS](#)
- [CORPORA](#)
- [SOFTWARE](#)
- [EVENTS](#)
- [BLOG](#)
- [NEWS](#)
- [RESOURCES](#)
- [GET INVOLVED](#)

[LATEST NEWS](#)

Xavier Serra participates to a conference on Science Diplomacy
31/10/2018 - 10-42
Xavier Serra was invited to present the

Computational models
for the discovery of the World's Music

UNIVERSITAT POMPEU FABRA 

English 

COMPANION WEBPAGE FOR THE PHD THESIS OF AJAY SRINIVASAMURTHY

Ajay Srinivasamurthy

(Last updated: 13 Nov 2016. Please click on the headings to expand.)

The dissertation document can be obtained from <http://mtg.upf.edu/node/3593>

► EXAMPLES

► DATASETS

► PUBLICATIONS

► CODE

► RESULTS

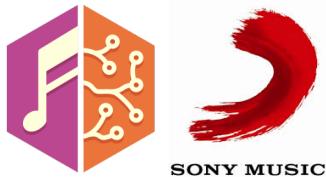
(The page <http://www.ajaysrinivasamurthy.in/phd-thesis> redirects to this page)

LATEST BLOGS

Technology and Multiculturality 17/04/2016 [Article published in the daily newspaper *Vanguardia* on 17th 2016. English translation of the original text written in catalan.] The violin, typewriter or mobile are examples of technological devices that were born in certain contexts... Two evenings of Chinese traditional music 27/01/2016 Last December (2015) Barcelona's Conservatori Municipal de Música hosted two evenings of Chinese traditional music, the first one devoted to the silk and bamboo music genre and the second one to jingju (Beijing opera). For this... Nila Sangita - An evening of Indian Classical Music and Dance

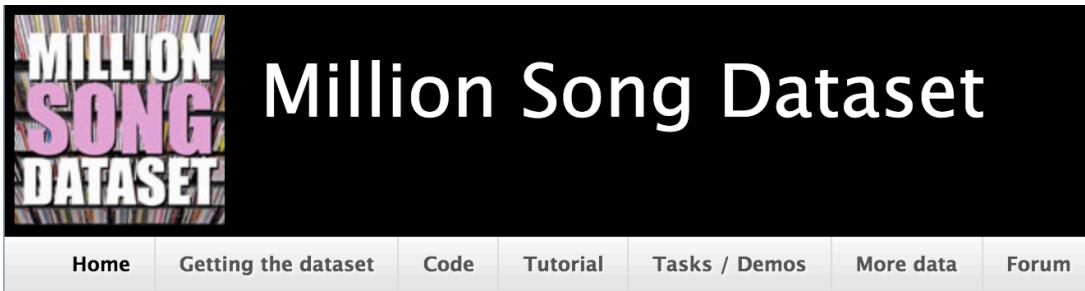
Data

- Music Community
- Music Audio
- Music Metadata



Datasets for MIR

- <https://www.audiocontentanalysis.org/data-sets/>
- Million Song Dataset

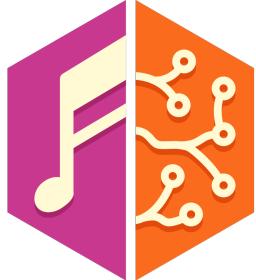


The screenshot shows the homepage of the Million Song Dataset. At the top left is the logo 'MILLION SONG DATASET' with a background of vertical bars. To its right is the title 'Million Song Dataset'. Below the title is a navigation bar with links: Home, Getting the dataset, Code, Tutorial, Tasks / Demos, More data, and Forum. Underneath the navigation bar, the text 'Home » Home' is displayed. A large 'Welcome!' heading is followed by a paragraph about the dataset: 'The **Million Song Dataset** is a freely-available collection of audio features and metadata for a million contemporary popular music tracks.' Below this, the text 'Its purposes are:' is followed by a bulleted list:

- To encourage research on algorithms that scale to commercial sizes
- To provide a reference dataset for evaluating research
- As a shortcut alternative to creating a large dataset with APIs (e.g. The Echo Nest's)
- To help new researchers get started in the MIR field

<https://labrosa.ee.columbia.edu/millionsong/>

MusicBrainz and AcousticBrainz



<https://musicbrainz.org>

MusicBrainz

[Log In](#) [Create Account](#)

[About Us](#) ▾ [Products](#) ▾ [Search](#) ▾ [Documentation](#) ▾

Welcome to MusicBrainz!

MusicBrainz is an open music encyclopedia that collects music metadata and makes it available to the public.

MusicBrainz aims to be:

1. **The ultimate source of music information** by allowing anyone to contribute and releasing the data under open licenses.
2. **The universal lingua franca for music** by providing a reliable and unambiguous form of [music identification](#), enabling both people and machines to have meaningful conversations about music.

Like Wikipedia, MusicBrainz is maintained by a global community of users and we want everyone — including you — to [participate and contribute](#).

[More Information](#) — [FAQs](#) — [Contact Us](#)

MusicBrainz is operated by the [MetaBrainz Foundation](#), a California based 501(c)(3) tax-exempt non-profit corporation dedicated to keeping MusicBrainz [free and open source](#).

AcousticBrainz

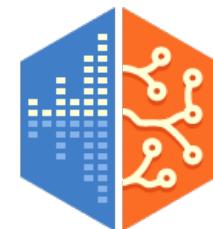
[About](#) ▾ [Downloads](#) [API/Data](#) [Datasets](#) ▾



Welcome to AcousticBrainz!

The AcousticBrainz project aims to crowd source acoustic information for all music in the world and to make it available to the public. This acoustic information describes the acoustic characteristics of music and includes low-level spectral information and information for genres, moods, keys, scales and much more. The goal of AcousticBrainz is to provide music technology researchers and open source hackers with a massive database of information about music. We hope that this database will spur the development of new music technology research and allow music hackers to create new and interesting recommendation engines.

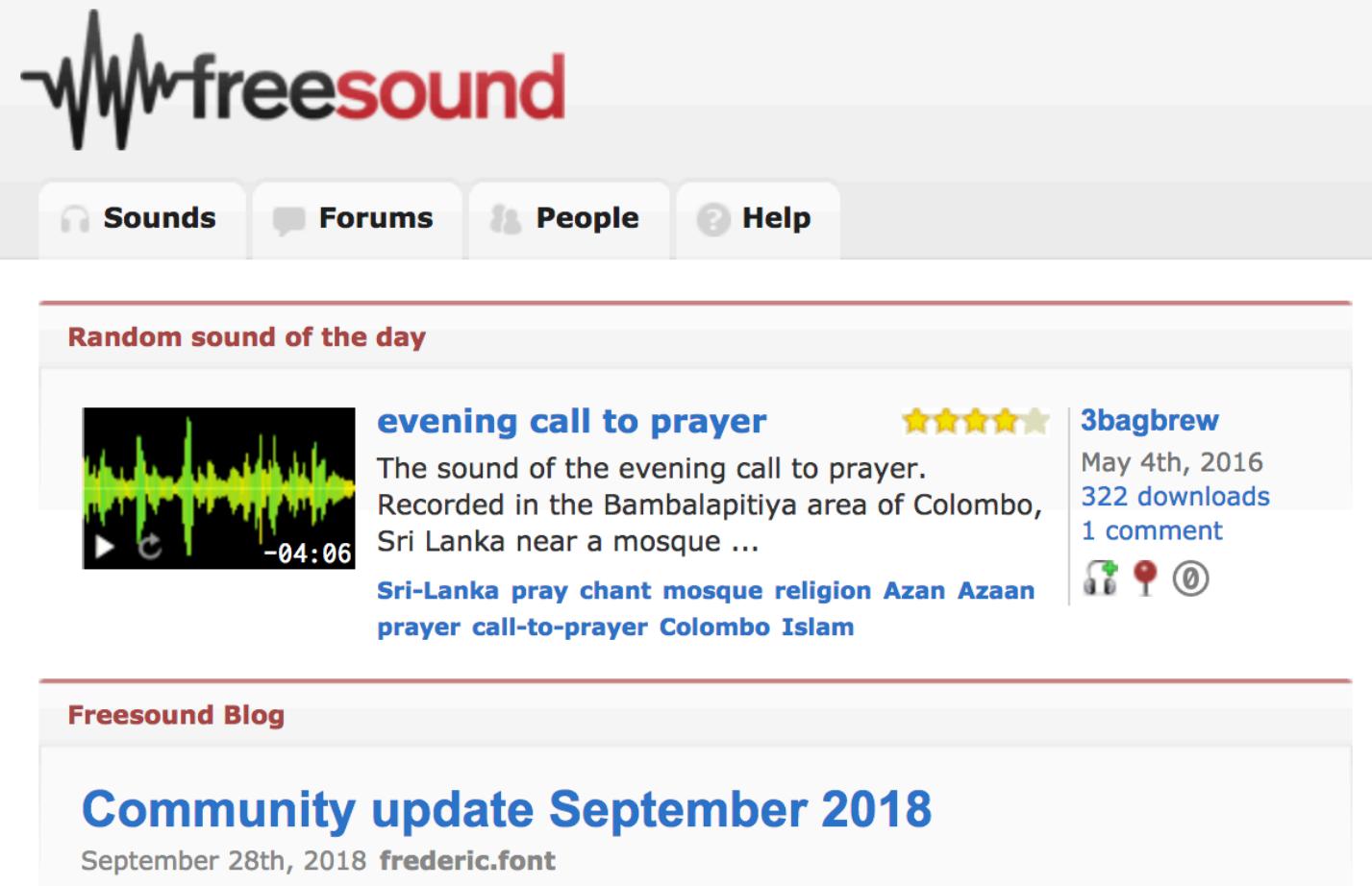
AcousticBrainz is a joint effort between [Music Technology Group](#) at [Universitat Pompeu Fabra](#) in Barcelona and the [MusicBrainz](#) project. AcousticBrainz was originally envisioned by Xavier Serra, the founder and head of the MTG. At the heart of this project lies the [Essentia toolkit](#) from the MTG – this open source toolkit enables the automatic analysis of music. The output from Essentia is collected by the AcousticBrainz project and made available to the public.



AcousticBrainz

<https://acousticbrainz.org>

Creative Commons Sounds

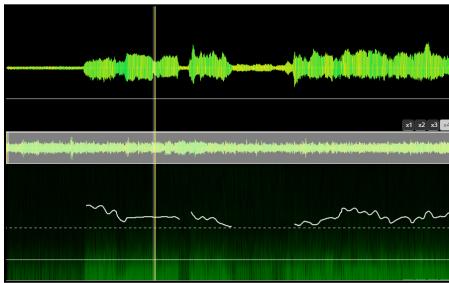


The screenshot shows the homepage of the freesound website. At the top, there's a navigation bar with icons for Sounds, Forums, People, and Help. Below the navigation, a red banner reads "Random sound of the day". Underneath, there's a preview of a sound file titled "evening call to prayer" by "3bagbrew". The preview includes a green waveform, a play button, a volume icon, and a timestamp "-04:06". The description below the preview says: "The sound of the evening call to prayer. Recorded in the Bambalapitiya area of Colombo, Sri Lanka near a mosque ...". Below the description, there's a list of tags: "Sri-Lanka pray chant mosque religion Azan Azaan prayer call-to-prayer Colombo Islam". To the right of the preview, there are user statistics: "3bagbrew", "May 4th, 2016", "322 downloads", and "1 comment". Below these stats are three small icons: a green headphones icon, a red download icon, and a grey comment icon. At the bottom of the screenshot, there's a section titled "Freesound Blog" with a post titled "Community update September 2018" by "frederic.font" dated "September 28th, 2018".

Hi again... ...and welcome back to our community update post! This month we don't have any major user-ready features to show, but there are a number of things we've been doing in the background which will allow nice new stuff ... Continue reading → [Read Full Entry](#)

<https://freesound.org>

CompMusic Carnatic corpus



Recording: audio,
annotated and
derived features



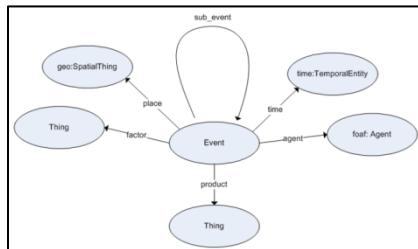
The screenshot shows the Discogs website with the following details for the recording:

- Title:** O Jagadamba
- Artist:** G.N. Balasubramaniam
- Length:** 3:15
- Release Date:** 2007
- Country:** IN
- Label:** Carnatica
- Catalogue Number:** CAR CD 1200/07
- Relationships:** A Centenary Retrospective
- Related works:** O Jagadamba
- Recording Information:** lead vocals: G.N. Balasubramaniam, recording of: O Jagadamba (1930 - 1940)
- Metadata Fields:** File, Length, Release Title, Release Artist, Date, Country, Label, Catalogue Number, Relationships, Related works, Recording Information.

Metadata: artists, raga,
tala, composer, ...

	TOPICS	POSTS	LAST POST
General Discussions	3897	70284	by ksr 13 Sep 2014 23:14
Raga & Alapana	652	9826	by kal 10 Sep 2014 13:29
Tala & Laya	208	2849	by msakella 10 Aug 2014 19:49
Anniversaries and obituaries	17	823	by satyabalu 13 Sep 2014 19:23
Technical Discussions	243	5058	by shankaran 10 Sep 2014 09:44
Event Announcements	1093	6665	by rshankar 13 Sep 2014 21:35
Kutcheri Reviews & Recordings	6304	56871	by makhavishnu 13 Sep 2014 23:36
Album Reviews	80	339	by musicmantra 23 Jun 2014 14:44

Community: Forums
and discussion
(rasikas.org)



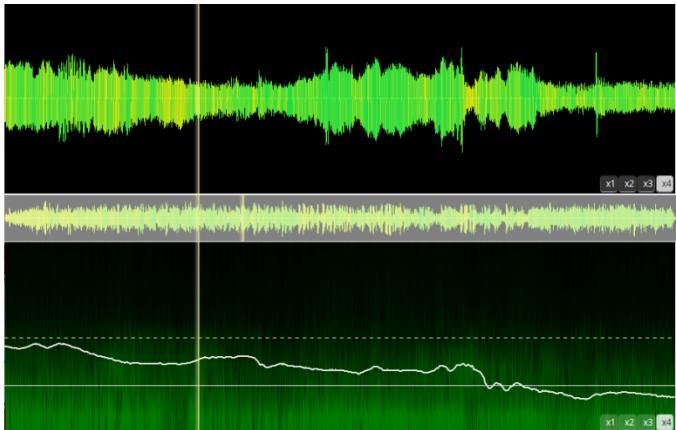
Ontology of the music
concepts

G	,	R	,	S	,	,	,
ja	.	la	.	jā	.	.	.
S	R	S	S	N	P	-	N
ne	da	.
G	R	S	N	S	R	-	N
chā	.	la	.	.	.	ma	.
ś	N	ś	g	ṛ	-	s	n
kon	.	.	.	na	.	.	

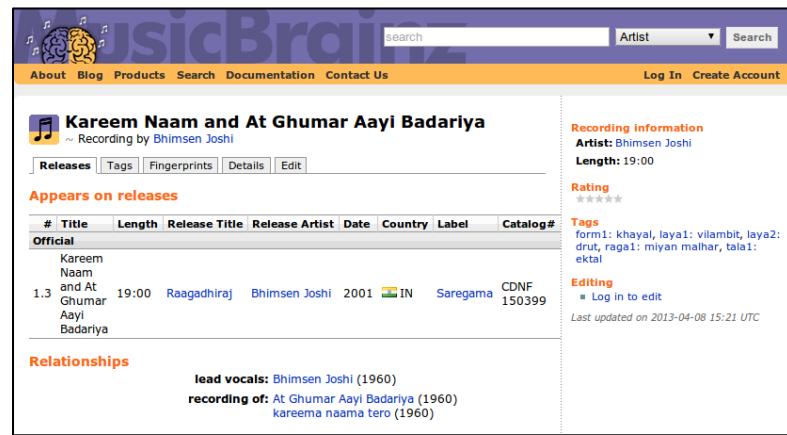
Lyrics and scores

Contextual Information

CompMusic Hindustani corpus



Recording: audio, annotated and derived features



Metadata: artists, rāga, tāla, composer, ...

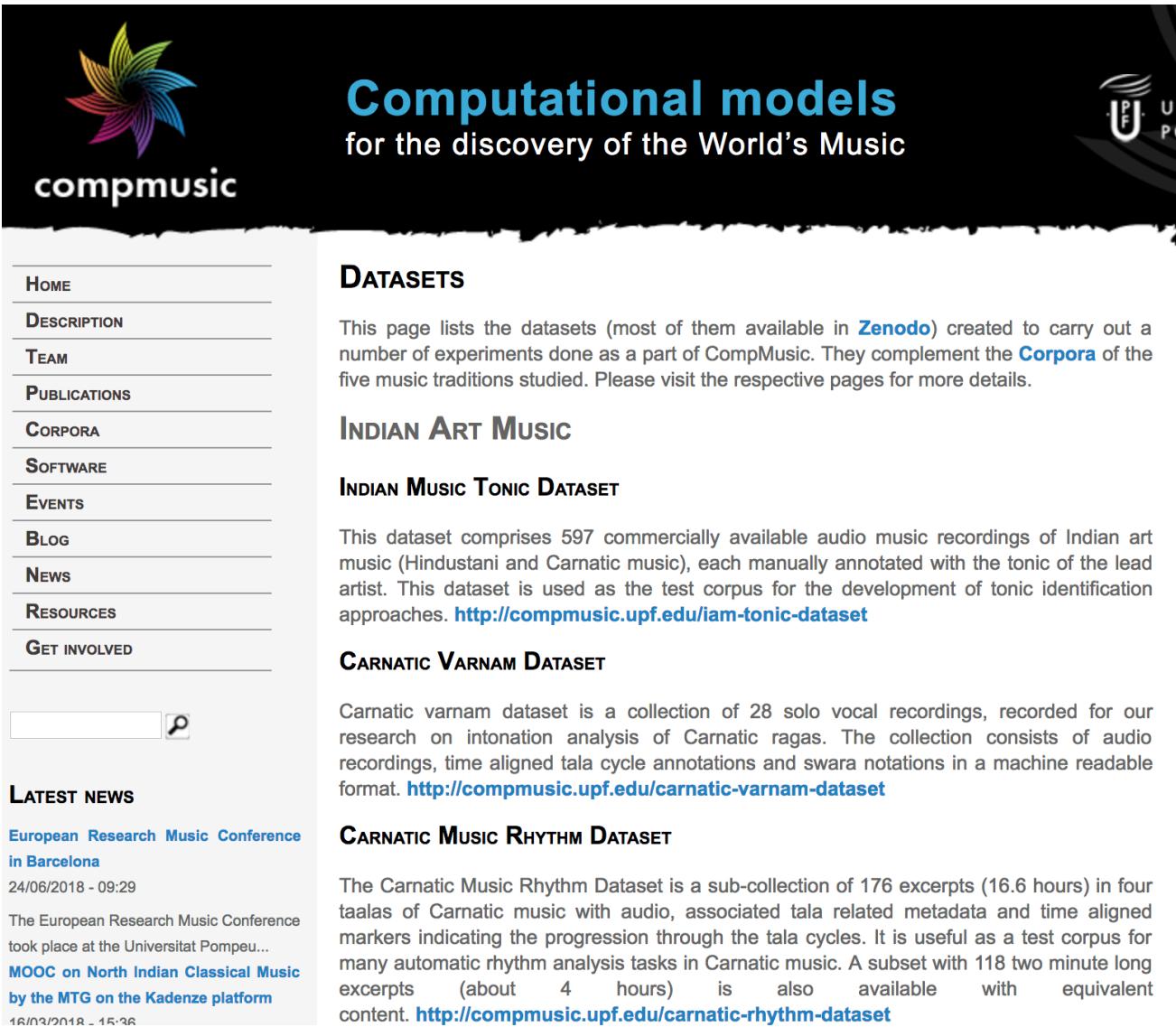
नि	- प	- ग	म रे	रे सा	- रे	सा नि-
तू	स है	स मं	स म	द शा	स द	
×	o	2	o	3	4	
सा	- -	रे म	रे प	- -	निनि पम्	प
बा	स स	र ८	नि जा	स ८	म८ ८८	उ
×	o	2	o	3	4	
सा	- -	प	प निप्	म८ ८८	ग —	म
दी	स स	न ८	सु जास	ss ८८	न ८	८
×	o	2	o	3	4	

Lyrics and scores



Contextual Information

CompMusic datasets



The screenshot shows the Compmusic website's datasets page. At the top, there is a banner with the text "Computational models for the discovery of the World's Music". On the left, there is a sidebar with links to Home, Description, Team, Publications, Corpora, Software, Events, Blog, News, Resources, and Get Involved. Below the sidebar is a search bar and a "LATEST NEWS" section. The main content area contains sections for Indian Art Music, Indian Music Tonic Dataset, Carnatic Varnam Dataset, and Carnatic Music Rhythm Dataset.

Computational models
for the discovery of the World's Music

HOME

DESCRIPTION

TEAM

PUBLICATIONS

CORPORA

SOFTWARE

EVENTS

BLOG

NEWS

RESOURCES

GET INVOLVED

LATEST NEWS

[European Research Music Conference in Barcelona](#)
24/06/2018 - 09:29
The European Research Music Conference took place at the Universitat Pompeu...

[MOOC on North Indian Classical Music by the MTG on the Kadenze platform](#)
16/03/2018 - 15:38

DATASETS

This page lists the datasets (most of them available in [Zenodo](#)) created to carry out a number of experiments done as a part of Compmusic. They complement the [Corpora](#) of the five music traditions studied. Please visit the respective pages for more details.

INDIAN ART MUSIC

INDIAN MUSIC TONIC DATASET

This dataset comprises 597 commercially available audio music recordings of Indian art music (Hindustani and Carnatic music), each manually annotated with the tonic of the lead artist. This dataset is used as the test corpus for the development of tonic identification approaches. <http://compmusic.upf.edu/iam-tonic-dataset>

CARNATIC VARNAM DATASET

Carnatic varnam dataset is a collection of 28 solo vocal recordings, recorded for our research on intonation analysis of Carnatic ragas. The collection consists of audio recordings, time aligned tala cycle annotations and swara notations in a machine readable format. <http://compmusic.upf.edu/carnatic-varnam-dataset>

CARNATIC MUSIC RHYTHM DATASET

The Carnatic Music Rhythm Dataset is a sub-collection of 176 excerpts (16.6 hours) in four taalas of Carnatic music with audio, associated tala related metadata and time aligned markers indicating the progression through the tala cycles. It is useful as a test corpus for many automatic rhythm analysis tasks in Carnatic music. A subset with 118 two minute long excerpts (about 4 hours) is also available with equivalent content. <http://compmusic.upf.edu/carnatic-rhythm-dataset>

<https://compmusic.upf.edu/datasets>

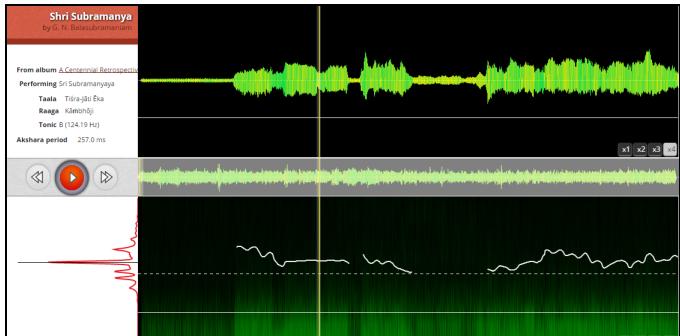
Open access Indian music corpora



Hours	41	44
Rāgas	97	61
Recordings	197	108
Artists	57	36

Availability of corpus and datasets

- Dunya Browser



- Dunya API

```
import compmusic.dunya as dn
import compmusic.dunya.carnatic as dncar
dn.set_token("9450e2b376d6b20a1f86191257b389e5ba0897a4")

artistList = dncar.get_artists()
for aIndex, artist in enumerate(artistList):
    artistInfo = dncar.get_artist(artist[u'mbid'])
    artInstList.append(artistInfo['instruments'])
print len(artistInfo[u'concerts']), aIndex, len(artistList)
```

- Audio

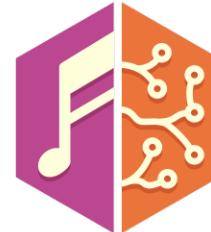
- Commercial audio: easily available
- Open audio collection: Underway

- Extracted features and software: Open licenses

- Editorial metadata: MusicBrainz

- Annotations: publicly available

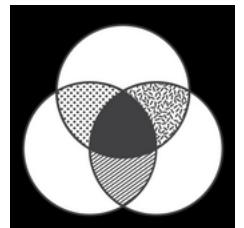
<https://github.com/MTG/Ismir2018TutorialNotebooks/tree/master/notebooks>



Community

- ISMIR mailing list
 - <https://groups.google.com/a/ismir.net/forum/#!forum/community>
- CompMusic mailing list
 - <https://groups.google.com/a/llista.upf.edu/forum/#!forum/compmusic-friends>
- SMC Network
 - <http://www.smcnetwork.org/>
 - Roadmap: <http://www.smcnetwork.org/index.html#roadmap>
- Music Tech Community India
 - <https://musictechcommunityindia.wordpress.com>

ISMIR



Tools for analysis

- Sonic Visualizer: <https://www.sonicvisualiser.org>
 - Visualization: Waveform, spectrogram
 - Analysis: Vamp Plugins
 - Annotations
- Essentia: <https://essentia.upf.edu>
 - Audio and music analysis
 - Extract audio descriptors
- sms-tools: <https://github.com/MTG/sms-tools>
 - Sound analysis/synthesis tools for music applications
- Google Magenta
- Echonest API



The Echo Nest / Spotify APIs

Build your music apps with the industry's best music APIs.



Essentia

ESSENTIA

Documentation

Algorithms reference

Applications

News

License

Download

Github

Search

Essentia

Open-source library and tools for audio and music analysis, description and synthesis

GET STARTED

DOWNLOAD

Extensive collection of reusable algorithms

Flexible and easily extendable algorithms for common audio analysis processes and audio and music descriptors

Cross-platform

Linux, Mac OS X, Windows, iOS, Android, and JavaScript

Fast prototyping

Python's scientific environment and command-line audio analysis tools

Optimized for computational speed

Used in industrial real-time applications

<https://essentia.upf.edu>

sms-tools

MTG / sms-tools

Watch ▾ 156 Star 950 Fork 514

Code Issues 9 Pull requests 2 Projects 0 Wiki Security Insights

Sound analysis/synthesis tools for music applications <https://www.upf.edu/web/mtg/sms-tools>

jupyter-notebook sound-analysis python sound-synthesis teaching-materials

491 commits 2 branches 0 releases 20 contributors AGPL-3.0

Branch: master ▾ New pull request Create new file Upload files Find file Clone or download ▾

xserra Merge pull request #90 from kokimame/patch-1 ... Latest commit b3cb098 9 hours ago

assignments	no change	2 months ago
lectures	edited slides	2 months ago
notebooks	modified all the notebooks	2 months ago
software	Fixed typo	2 days ago
sounds	removed an additional readme in sounds	4 years ago
workspace	Added new folder workspace_dev	4 years ago
.gitignore	Initial test upload of first 3 notebooks	2 years ago
AUTHORS	Update AUTHORS	4 years ago
LICENSE	Initial commit	6 years ago
README.md	edited text	2 months ago

<https://github.com/MTG/sms-tools>

MIREX: MIR Evaluation eXchange

[main page](#)[discussion](#)[view source](#)[history](#)[log in](#)

mirex by year

- [MIREX 2018](#)
- [MIREX 2017](#)
- [MIREX 2016](#)
- [MIREX 2015](#)
- [MIREX 2014](#)
- [MIREX 2013](#)
- [MIREX 2012](#)
- [MIREX 2011](#)
- [MIREX 2010](#)
- [MIREX 2009](#)
- [MIREX 2008](#)
- [MIREX 2007](#)
- [MIREX 2006](#)
- [MIREX 2005](#)

results by year

- [MIREX 2018 Results](#)
- [MIREX 2017 Results](#)
- [MIREX 2016 Results](#)
- [MIREX 2015 Results](#)
- [MIREX 2014 Results](#)
- [MIREX 2013 Results](#)
- [MIREX 2012 Results](#)

MIREX HOME

Contents [hide]

- 1 [Welcome to MIREX 2018](#)
- 2 [Task Leadership Model](#)
- 3 [MIREX 2018 Deadline Dates](#)
- 4 [MIREX 2018 Submission Instructions](#)
- 5 [MIREX 2018 Evaluation](#)
 - 5.1 [Note to New Participants](#)
 - 5.2 [Runtime Limits](#)
 - 5.3 [Note to All Participants](#)
 - 5.4 [Software Dependency Requests](#)
- 6 [Getting Involved in MIREX 2018](#)
 - 6.1 [Mailing List Participation](#)
 - 6.2 [Wiki Participation](#)
- 7 [MIREX 2005 - 2017 Wikis](#)

Welcome to MIREX 2018

This is the main page for the eleventh running of the Music Information Retrieval Evaluation eXchange (MIREX 2018). The International Music Information Retrieval Systems Evaluation Laboratory (IMIRSEL) at [School of Information Sciences](#), University of Illinois at Urbana-Champaign ([UIUC](#)) is the principal organizer of MIREX 2018.

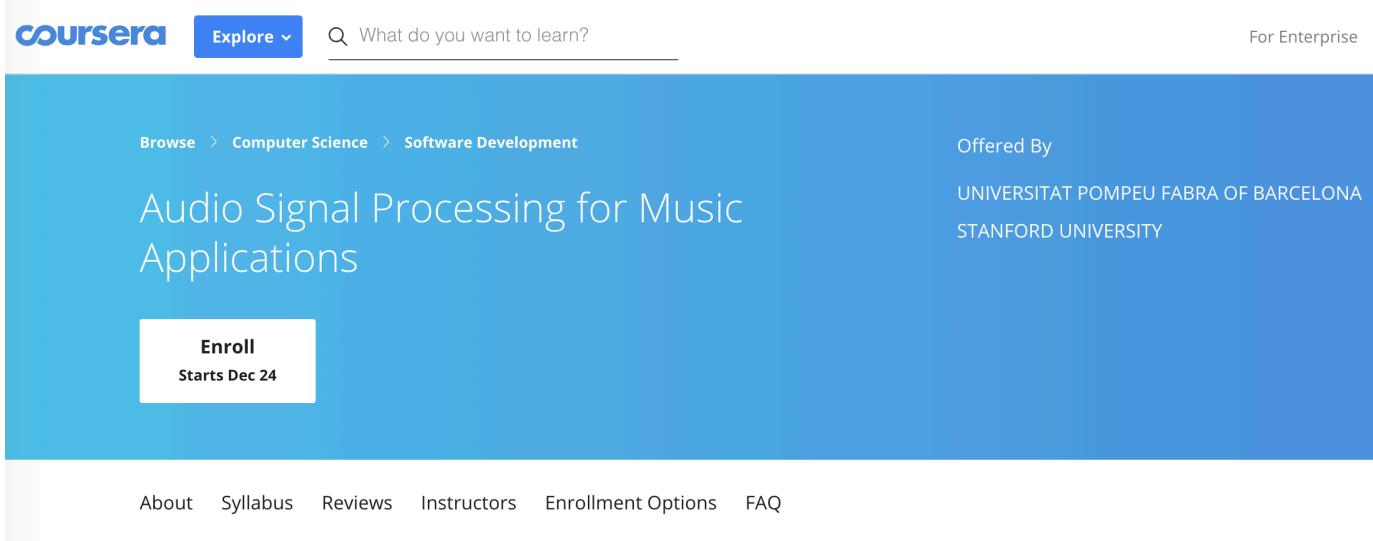
The MIREX 2018 community will hold its annual meeting as part of [The 19th International Society for Music Information Retrieval Conference](#), ISMIR 2018, which will be held in Paris, France, September 23-27, 2018.

J. Stephen Downie
Director, IMIRSEL

https://www.music-ir.org/mirex/wiki/MIREX_HOME

Learn

■ Audio Signal Processing for Music Applications on Coursera



The screenshot shows the Coursera course page for 'Audio Signal Processing for Music Applications'. At the top, there's a navigation bar with the Coursera logo, a search bar containing 'What do you want to learn?', and a 'For Enterprise' link. Below the navigation is a breadcrumb trail: 'Browse > Computer Science > Software Development'. The main title 'Audio Signal Processing for Music Applications' is displayed prominently. To the right, it says 'Offered By' followed by 'UNIVERSITAT POMPEU FABRA OF BARCELONA' and 'STANFORD UNIVERSITY'. A large 'Enroll' button is visible, along with a note that it 'Starts Dec 24'. At the bottom of the main section, there are links for 'About', 'Syllabus', 'Reviews', 'Instructors', 'Enrollment Options', and 'FAQ'.

About this Course

★★★★★ 4.8 182 ratings • 50 reviews

In this course you will learn about audio signal processing methodologies that are specific for music and of use in real applications. We focus on the spectral processing techniques of relevance for the description and transformation of sounds, developing the basic theoretical and practical



100% online
Start instantly and learn at your schedule.

<https://www.coursera.org/learn/audio-signal-processing>

Learn

- ISMIR proceedings
 - <https://dblp.uni-trier.de/db/conf/ismir/index.html>
- ISMIR Tutorials
 - <http://ismir2018.ircam.fr/pages/events-tutorials.html>
- Audio signal processing books
 - https://ccrma.stanford.edu/~jos/pasp/Book_Series_Overview.html
- Meinard Müller, Fundamentals of Music Processing, Springer 2015
 - <http://www.music-processing.de/>
- Resources on Indian Art Music
 - <https://compmusic.upf.edu/>

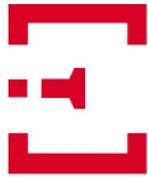
Build and Contribute

Music hackdays and hackathons

<https://www.musichackday.org>

HAMR@ISMIR (Hacking audio music research)

<https://labrosa.ee.columbia.edu/hamr>



<http://essentia.upf.edu>



AcousticBrainz

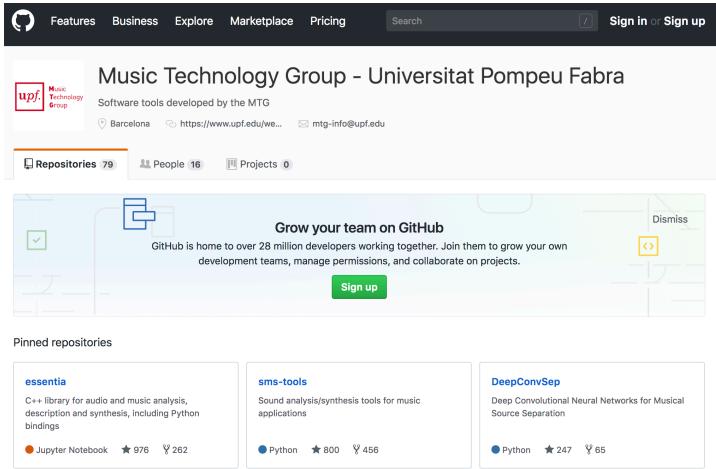
<https://acousticbrainz.org>



<https://freesound.org>



<https://musicbrainz.org>



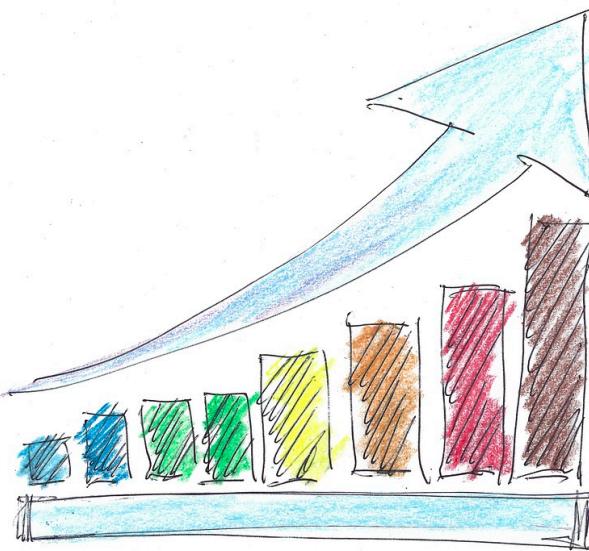
The screenshot shows the GitHub profile for the MTG group. At the top, there's a header with the group's name, 'upf Music Technology Group', and a link to their website. Below the header, there are sections for 'Repositories' (79), 'People' (16), and 'Projects' (0). A prominent 'Sign up' button is located in the top right corner. The main area displays a grid of repository cards. One card for 'essentia' is visible, showing it's a C++ library for audio and music analysis. Other cards include 'sms-tools' for sound analysis/synthesis and 'DeepConvSep' for deep convolutional neural networks for musical source separation.

<https://github.com/MTG>

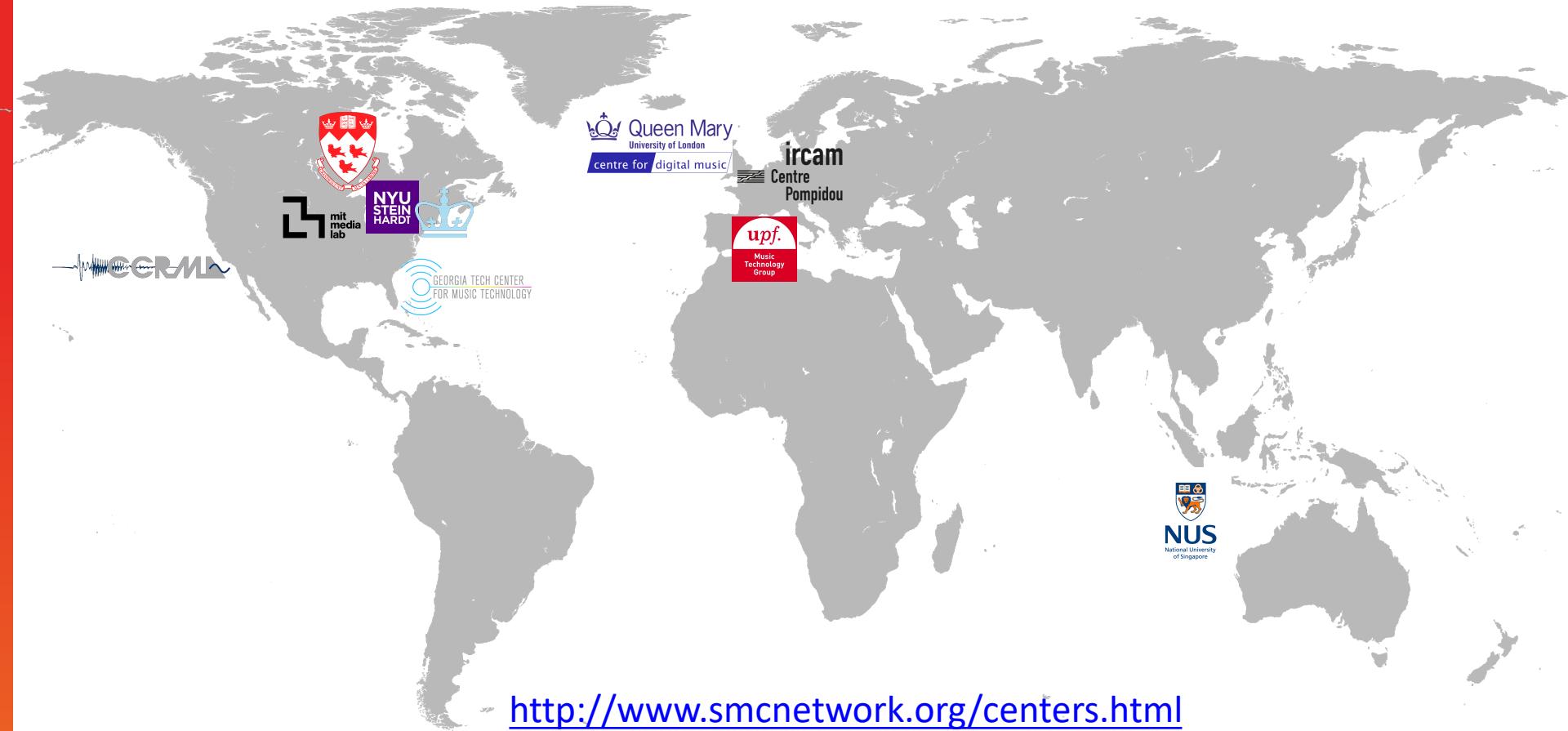
Meet

- ISMIR conferences
 - <https://www.ismir.net/conferences/>
 - 2019: Delft, The Netherlands
 - 2020: Montreal, Canada
- ISMIR 2021 will be in IISc, Bengaluru, India!
- Music Tech Community India
 - <https://musictechcommunity.org/>

Careers in Music Technology

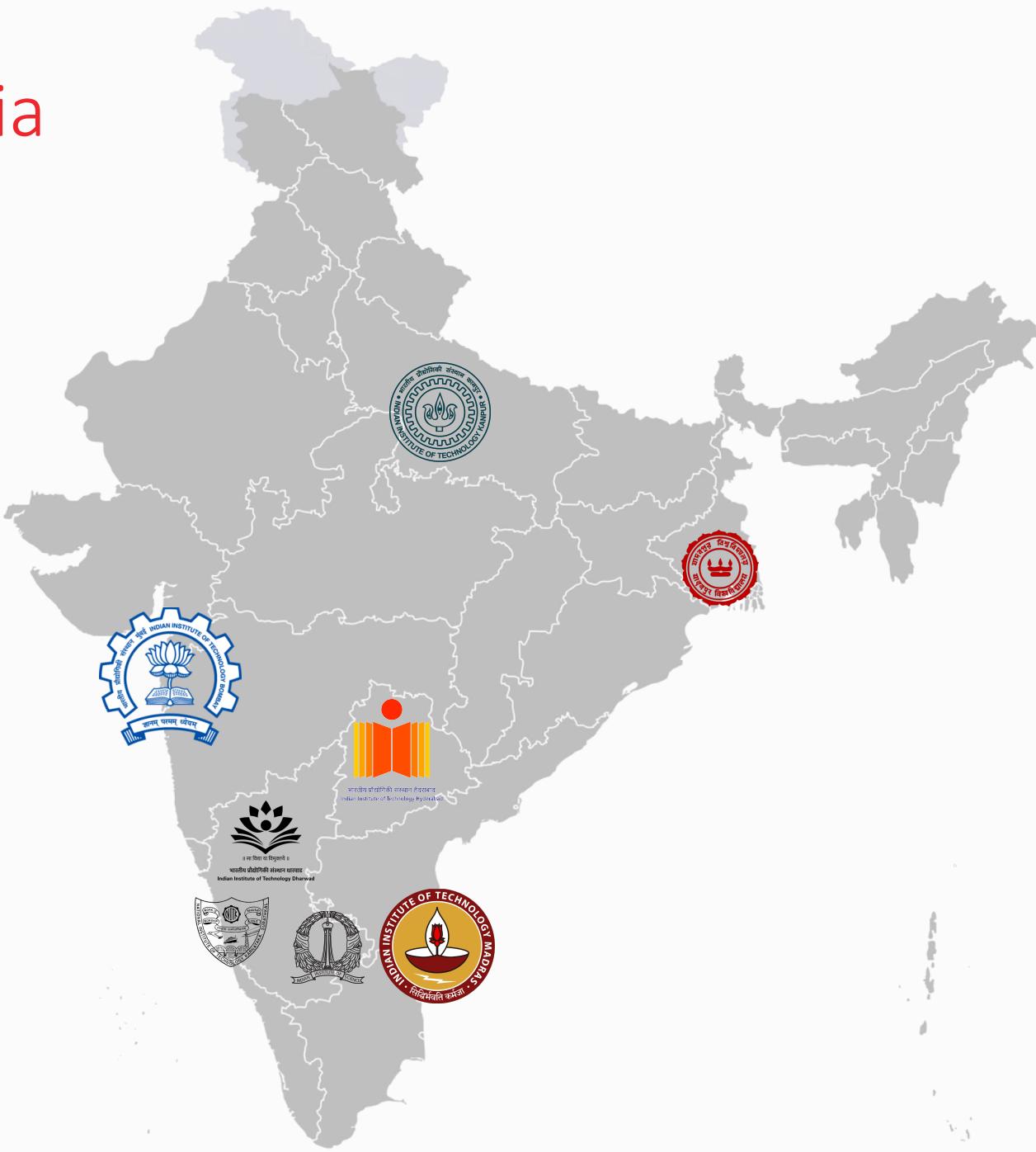


Labs and Research Centers



<http://www.smcnetwork.org/centers.html>

In India



Industry – Audio and Music Technology

- Audio Hardware: Bose, Sony, Dolby, Yamaha
- Music Production: Avid, Ableton, Steinberg



Spotify®



ISMIR 2021 – Bengaluru, India

ISMIR

[Conferences](#)

[Transactions of ISMIR](#)

[Women in MIR](#)

[Resources](#)

[About the Society](#)

[Membership](#)

[Community Statistics](#)

[Contact](#)



Copyright © ISMIR, 2000-2019

Upcoming Conferences

- [ISMIR 2019](#) November 4-8, Delft, The Netherlands
- ISMIR 2020, October 12-16, Montreal, Canada
- [ISMIR 2021, November 8-12, Bangalore, India](#)

We are [welcoming bids](#) for 2022!

Transactions of the ISMIR

The open-access journal of the MIR community, the Transactions of the International Society for Music Information Retrieval (TISMIR), is [open for submissions](#).

Who are we?

The International Society for Music Information Retrieval (ISMIR) is a non-profit organisation which, among other things, oversees the organisation of the ISMIR Conference. The ISMIR conference is held annually and is the world's leading research forum on processing, searching, organising and accessing music-related data.

The Society reports recent activities at the yearly ISMIR Community Meeting held during the Conference. The slide decks for past conferences are [found here](#).

<https://ismir.net/>

Acknowledgements



Music Technology

Topics, Trends, Tools, Careers

Ajay Srinivasamurthy

30 Jan 2020

SAMP 2020, NITK Surathkal

ajays.murthy@gmail.com

www.ajaysrinivasamurthy.in

