Melody and Rhythm Analysis

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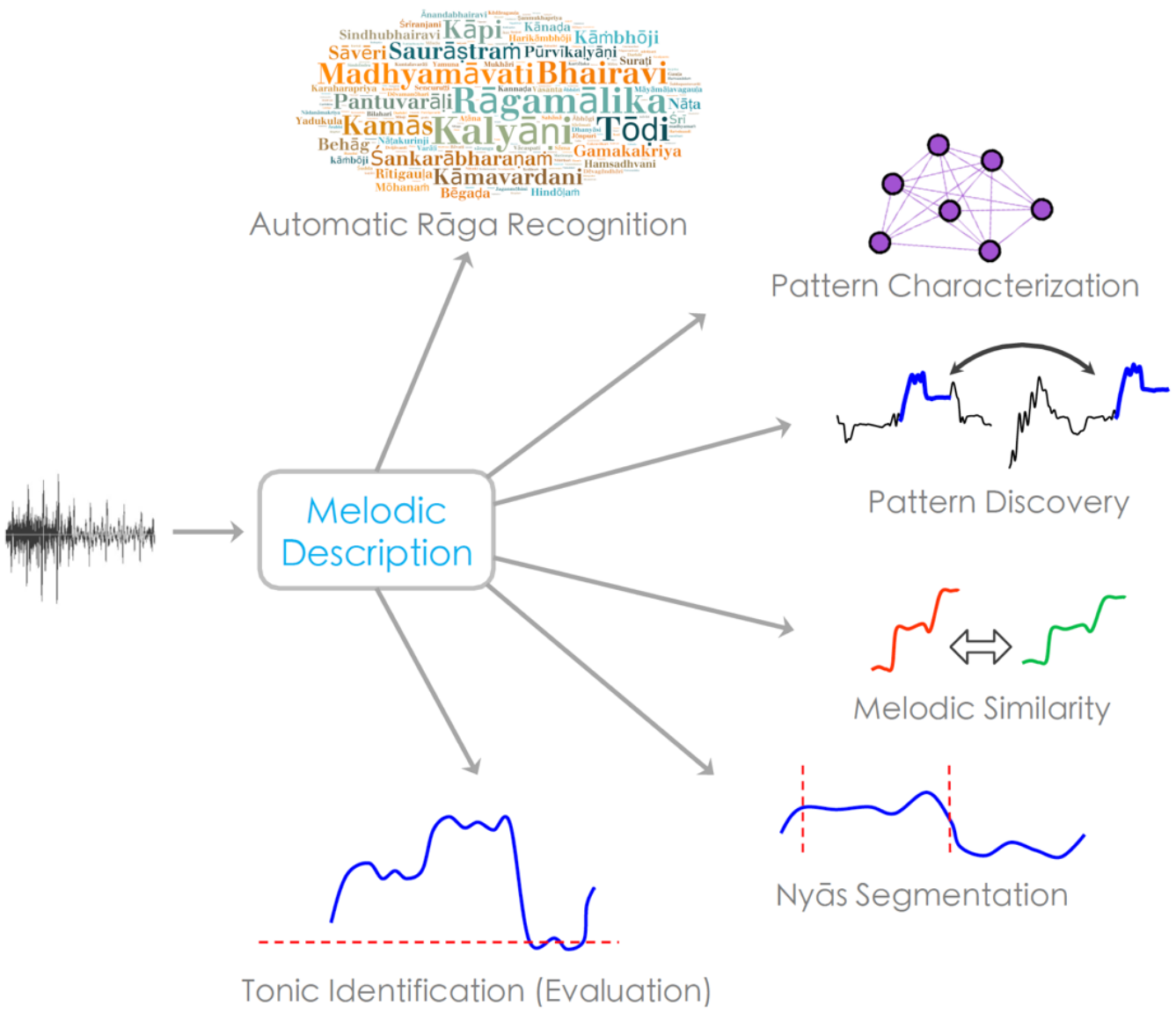
Melody analysis

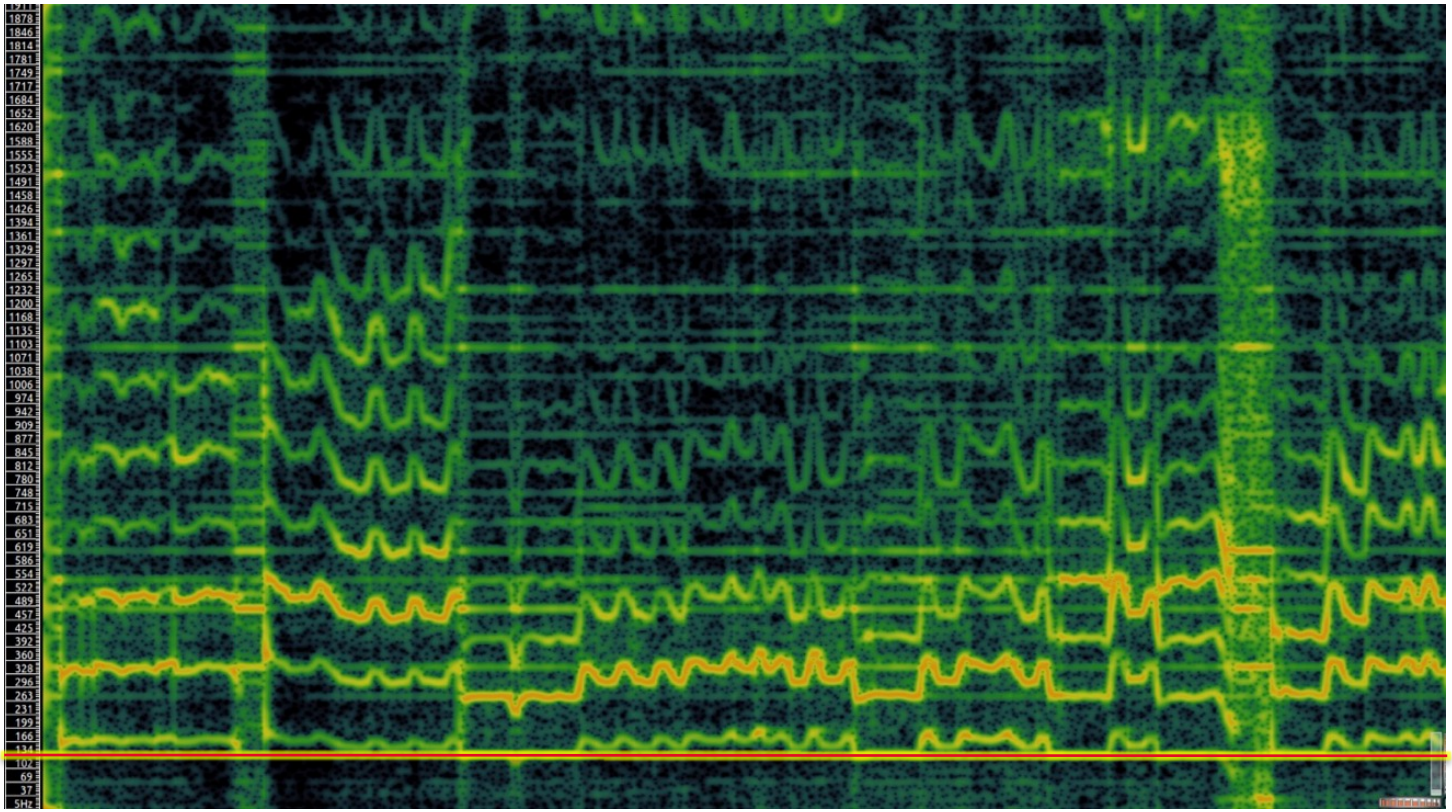
mainly based on:

- Sankalp Gulati. 2016. Computational Approaches for Melodic Description in Indian Art Music Corpora. PhD dissertation. UPF. Companion page: https://compmusic.upf.edu/node/304

Melodic analysis



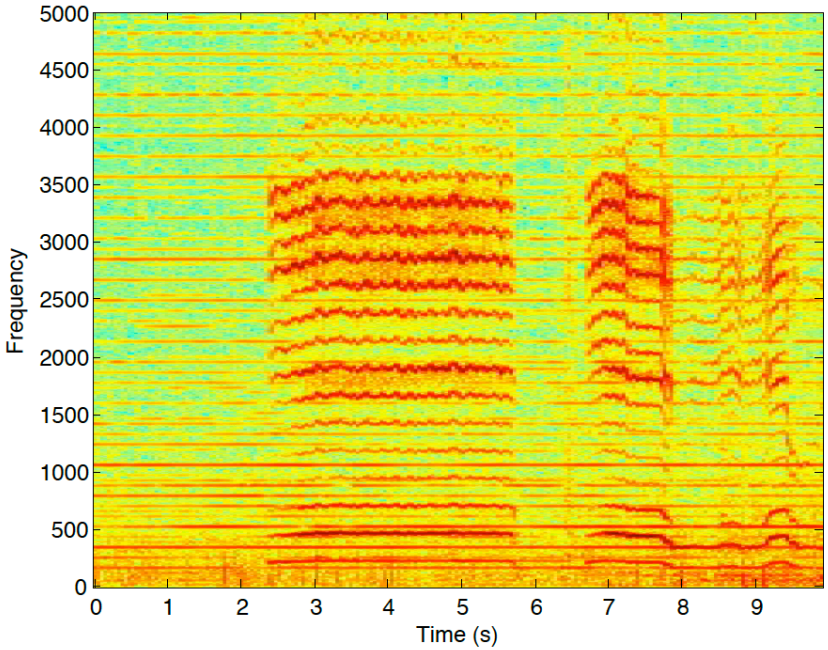
Tonic identification



Vignesh Ishwar, Varnam

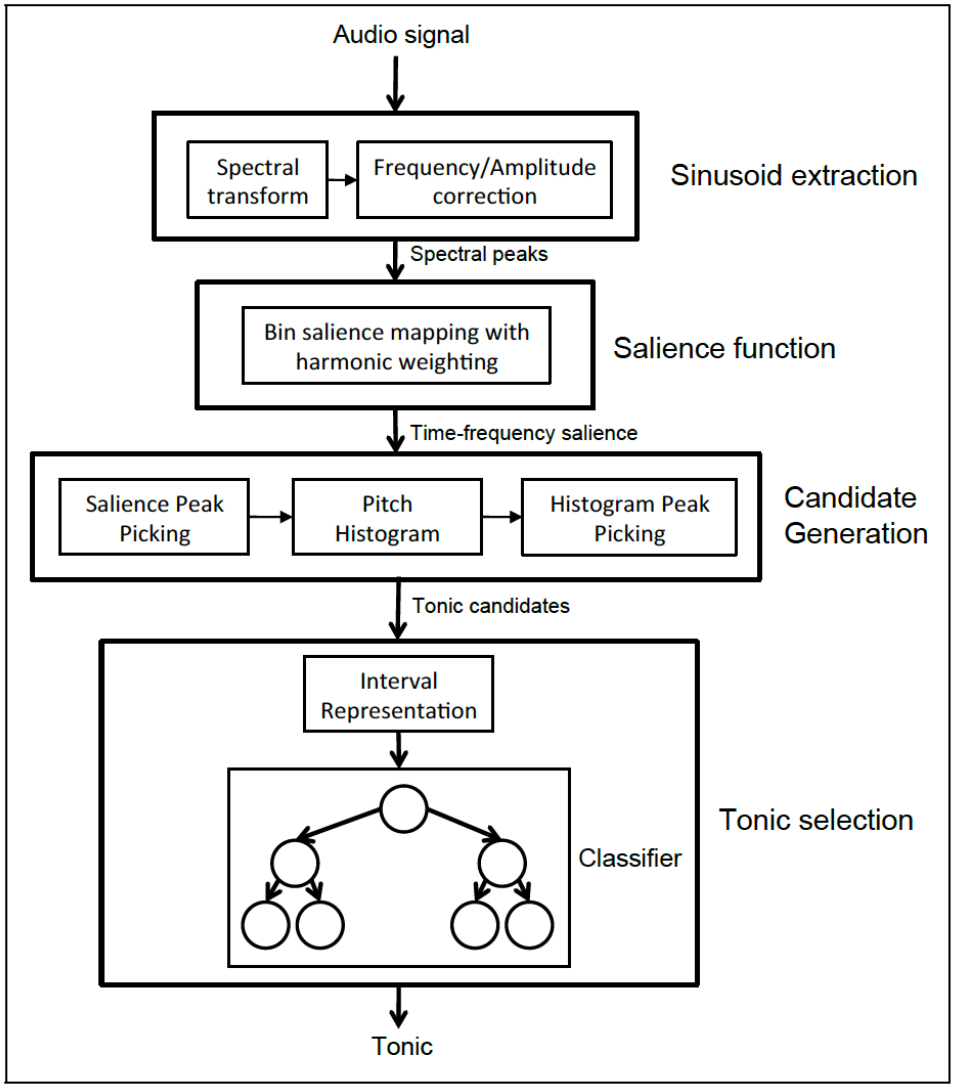
Tonic, C#

Tonic Identification: Multipitch

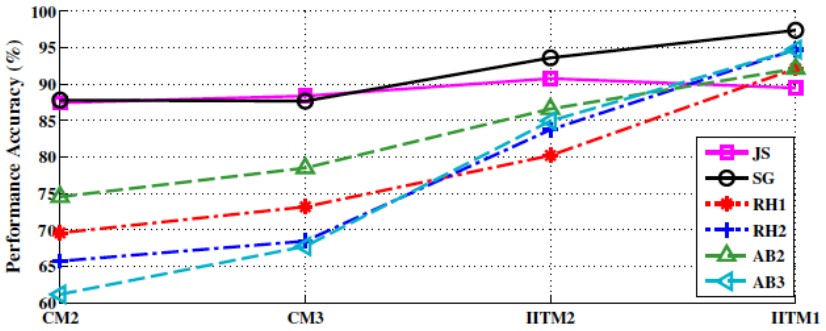


J. Salamon, S. Gulati, and X. Serra. 2012. "A Multipitch Approach to Tonic Identification in Indian Classical Music," ISMIR.

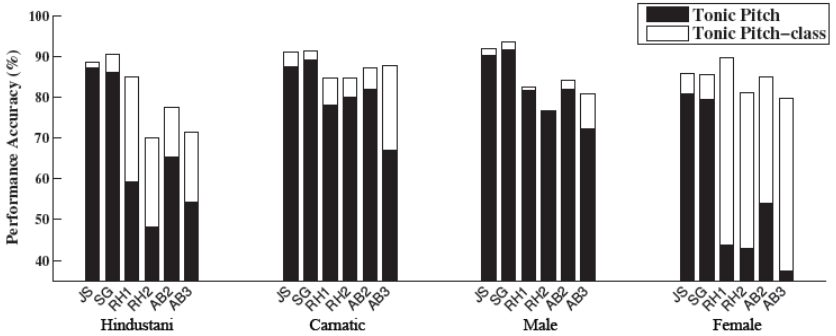
in Essentia:
https://essentia.upf.edu/documentation/reference/std_TonicIndianArtMusic.html



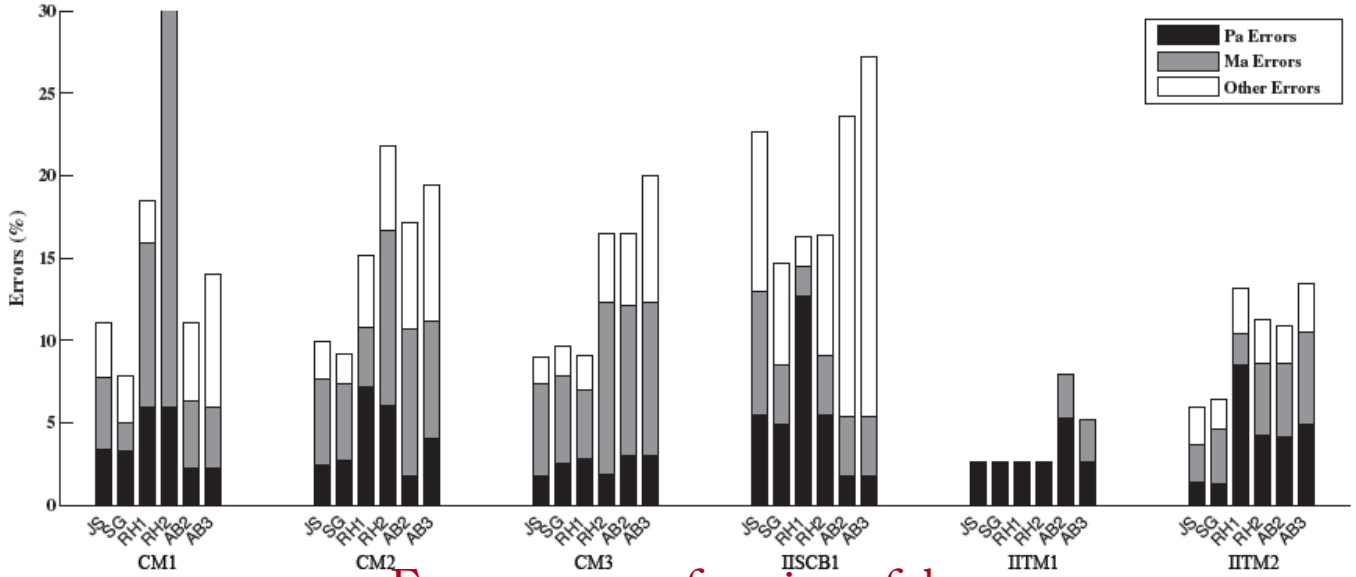
Tonic Identification: state of the art



Performance as a function of length



Performance as a function of category



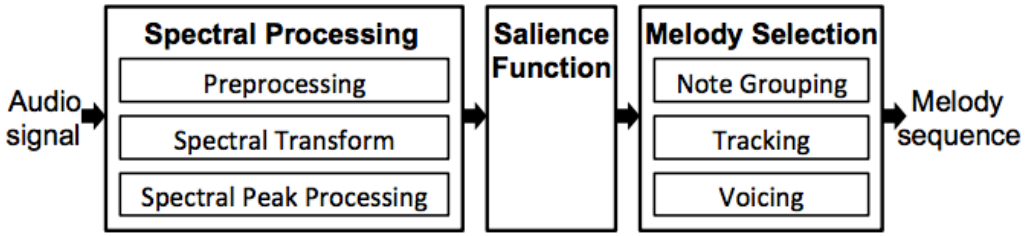
Error type as a function of dataset

S. Gulati, A. Bellur, J. Salamon, Ranjani H. G, V. Ishwar, H. Murthy, and X. Serra. 2014. “Automatic Tonic Identification in Indian Art Music: Approaches and Evaluation”. JNMR.

Melody extraction: Melodia

J. Salamon, and E. Gómez. 2012. "Melody extraction from polyphonic music signals using pitch contour characteristics." IEEE.

in Essentia: https://essentia.upf.edu/documentation/reference/std_PitchMelodia.html



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PitchMelodia

standard mode | Pitch category

Inputs

- **signal** (*vector_real*) - the input signal

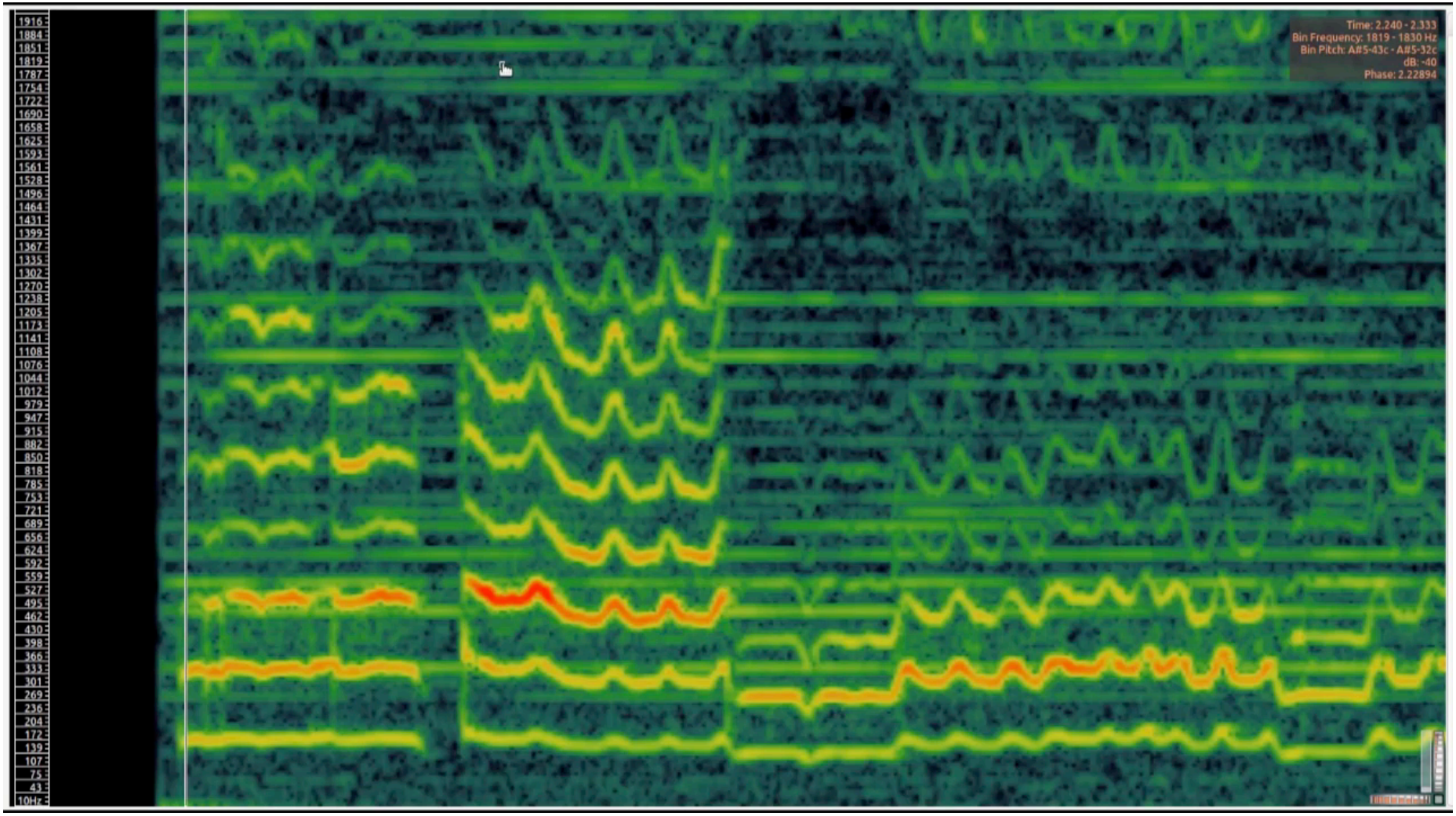
Outputs

- **pitch** (*vector_real*) - the estimated pitch values [Hz]
- **pitchConfidence** (*vector_real*) - confidence with which the pitch was detected

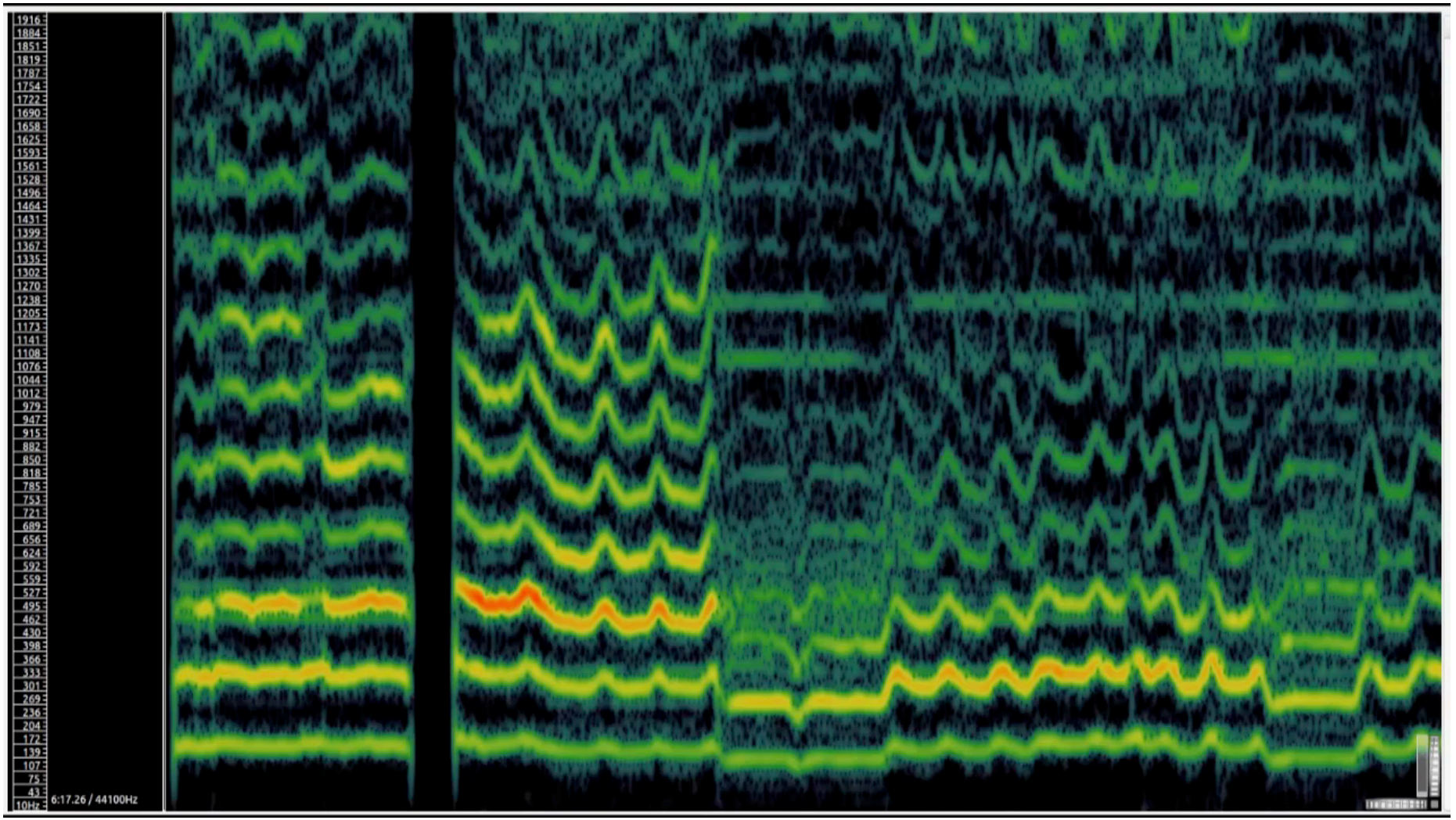
Parameters

- **binResolution** (*real ∈ (0, ∞), default = 10*) :
  salience function bin resolution [cents]
- **filterIterations** (*integer ∈ [1, ∞), default = 3*) :
  number of iterations for the octave errors / pitch outlier filtering process
- **frameSize** (*integer ∈ (0, ∞), default = 2048*) :
  the frame size for computing pitch saliecnce
- **guessUnvoiced** (*bool ∈ {false, true}, default = false*) :
  estimate pitch for non-voiced segments by using non-salient contours when no salient ones are present in a frame
- **harmonicWeight** (*real ∈ (0, 1), default = 0.8*) :
  harmonic weighting parameter (weight decay ratio between two consequent harmonics, =1 for no decay)
- **hopSize** (*integer ∈ (0, ∞), default = 128*) :
  the hop size with which the pitch salience function was computed

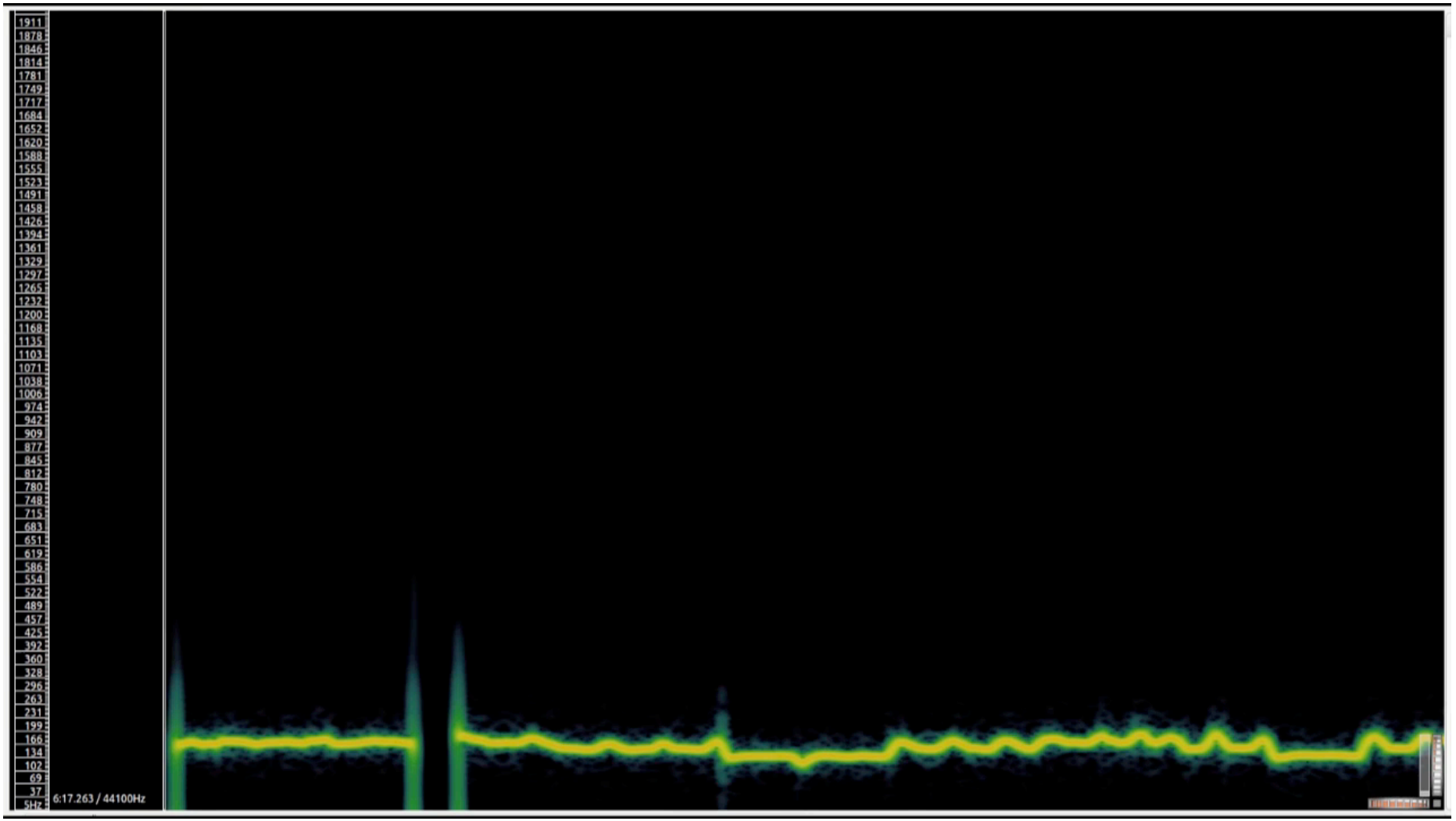
Melody extraction: original audio



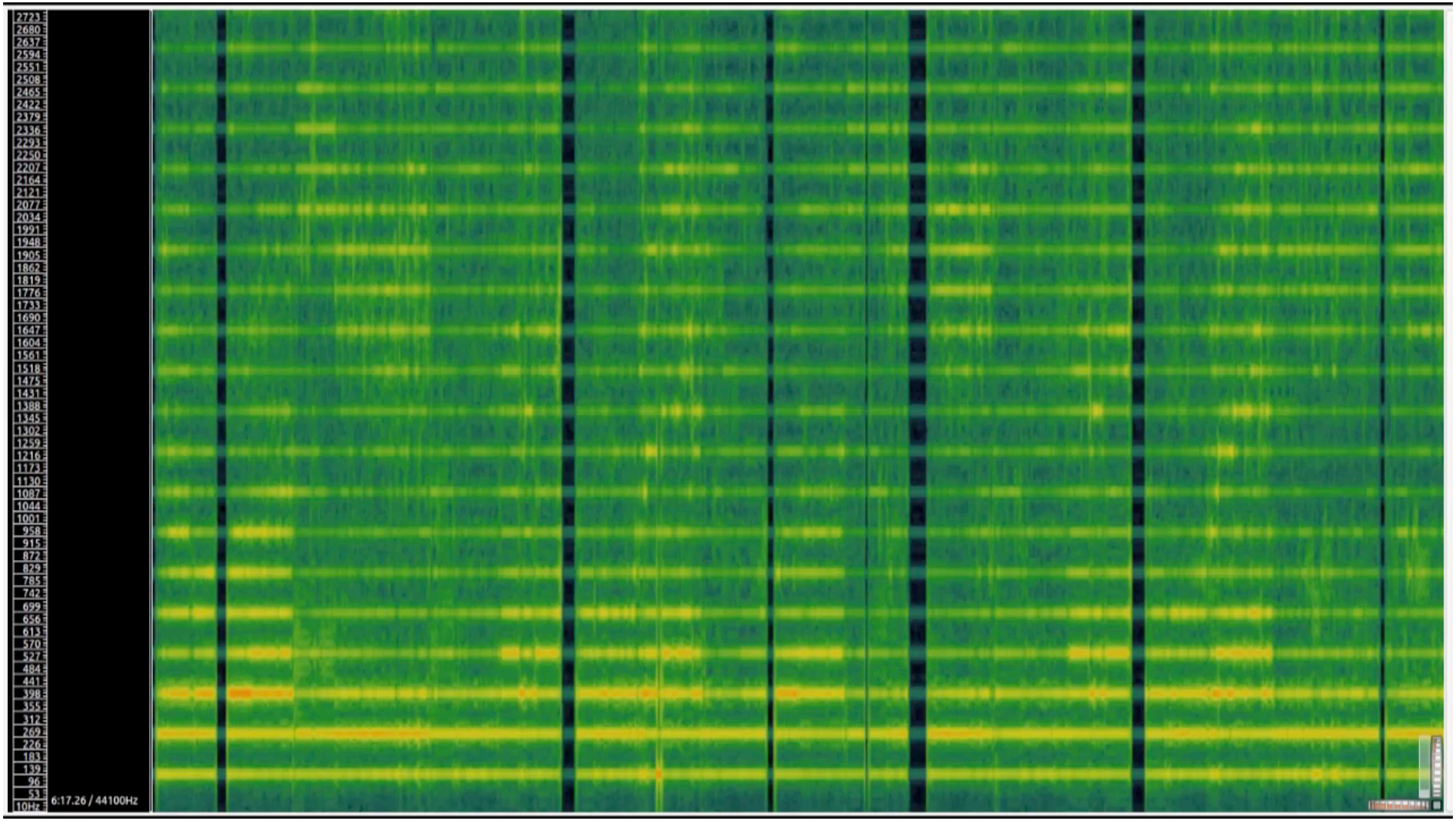
Melody extraction: predominant voice



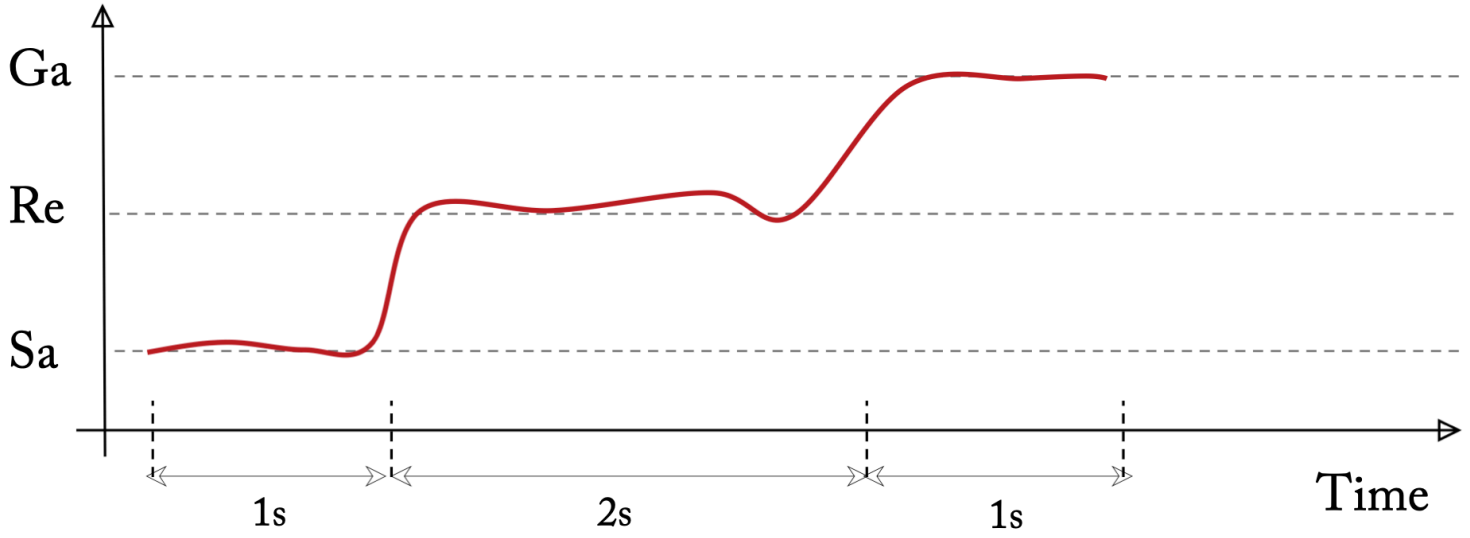
Melody extraction: F0

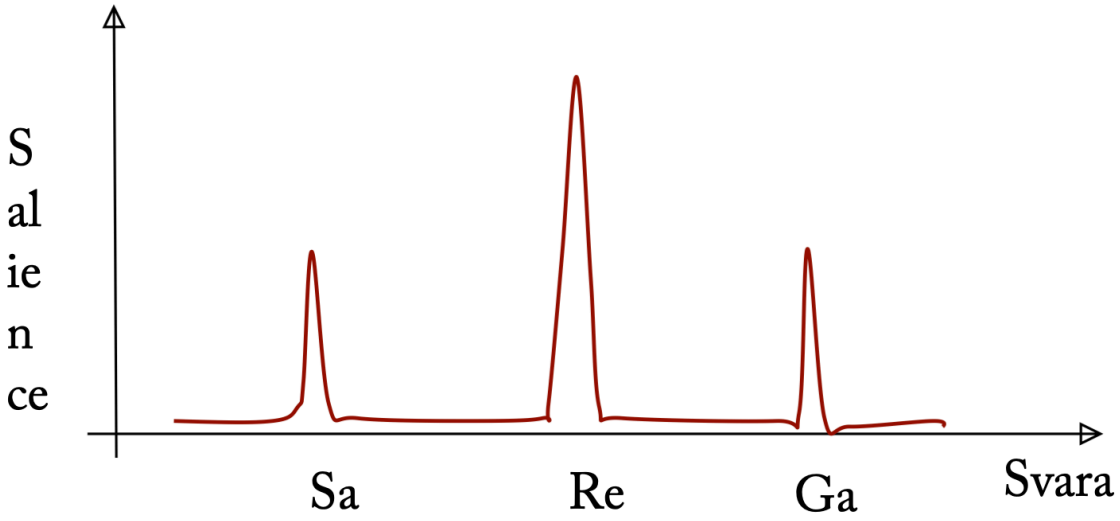


Loudness and Timbral Facets



Pitch histogram





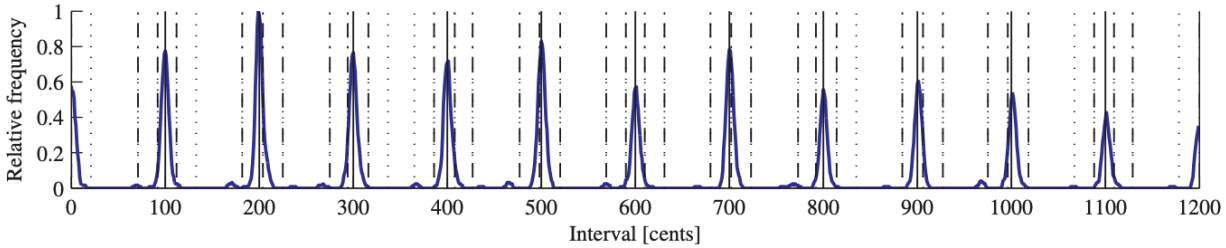


Figure 1. Interval histogram for synthetic equal-tempered data ($\mathbf{h}_E$; bold line). Vertical black lines correspond to the theoretical interval values of equal temperament (solid lines), just intonation (dash-dotted lines) and the 22 shrutis (dotted lines). The last two overlap at many places (see text).

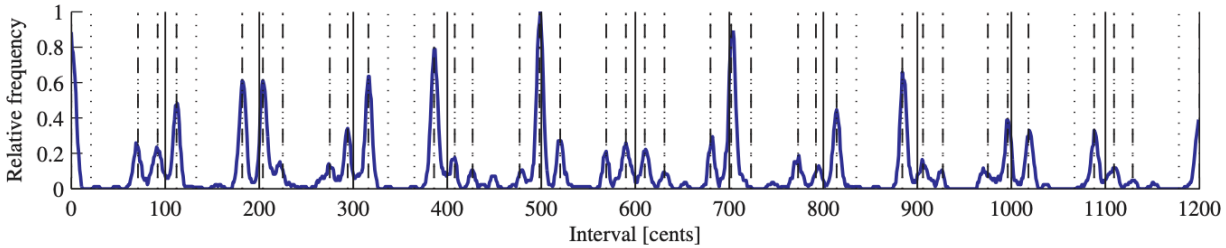


Figure 2. Interval histogram for synthetic just intonation data ($\mathbf{h}_J$; bold line).

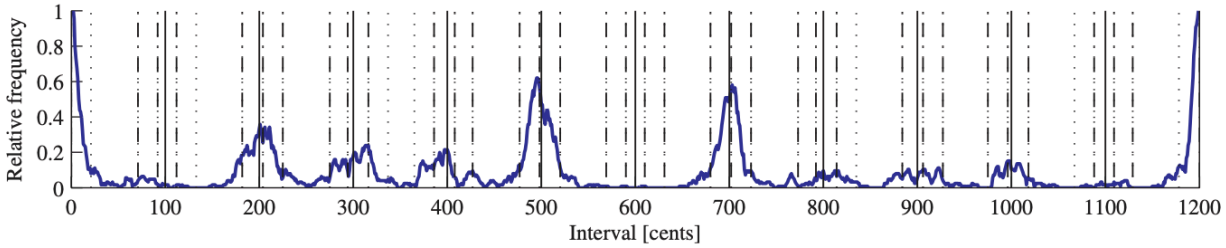


Figure 3. Interval histogram for Carnatic music ($\mathbf{h}_C$; bold line).

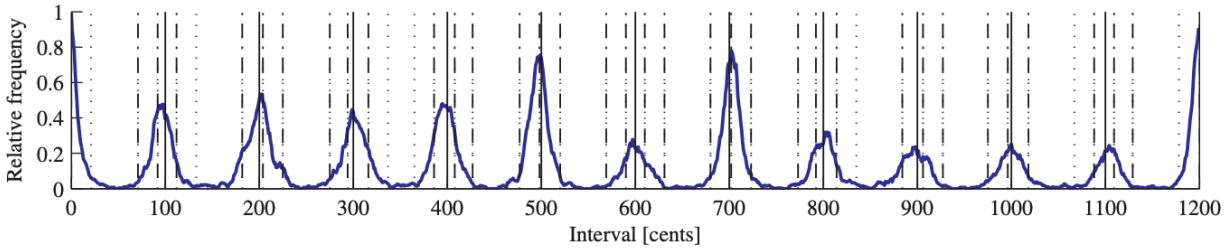
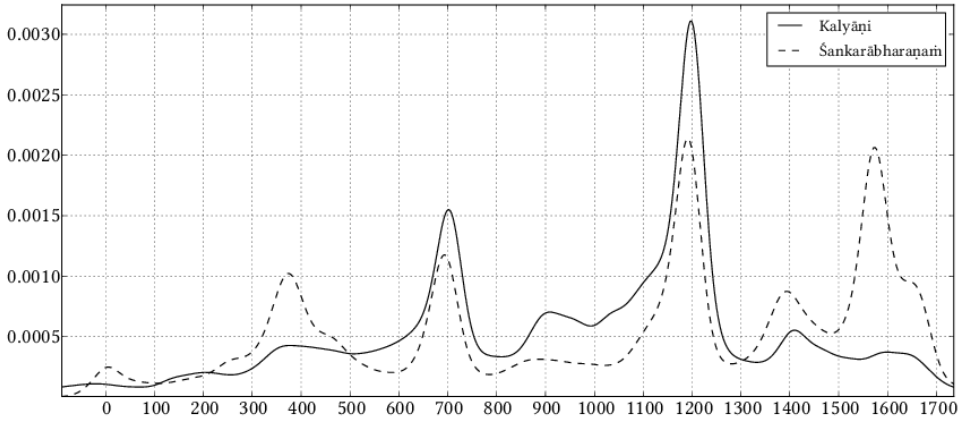
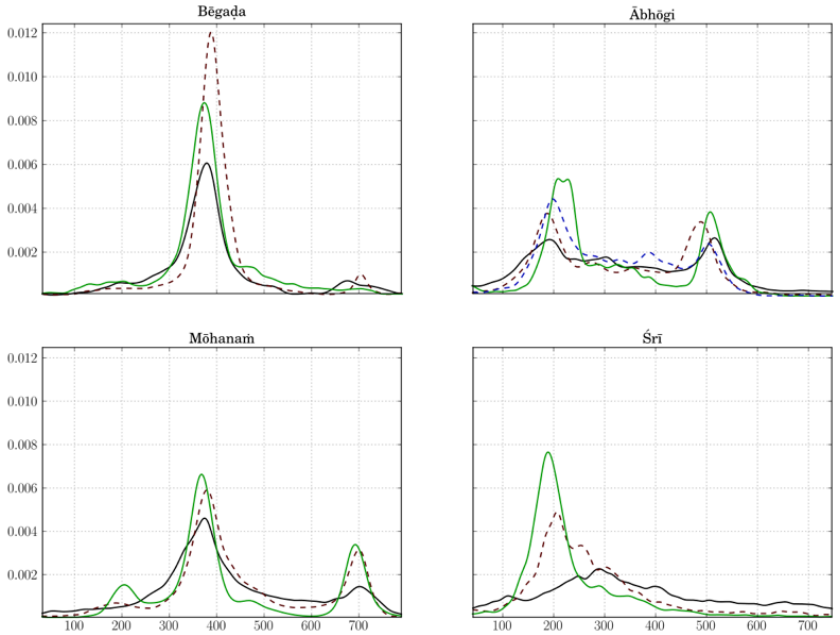


Figure 4. Interval histogram for Hindustani music ($\mathbf{h}_H$; bold line).

J. Serrà, G. K. Koduri, M. Miron, & X. Serra. 2011. "Assessing the tuning of sung Indian classical music", ISMIR.

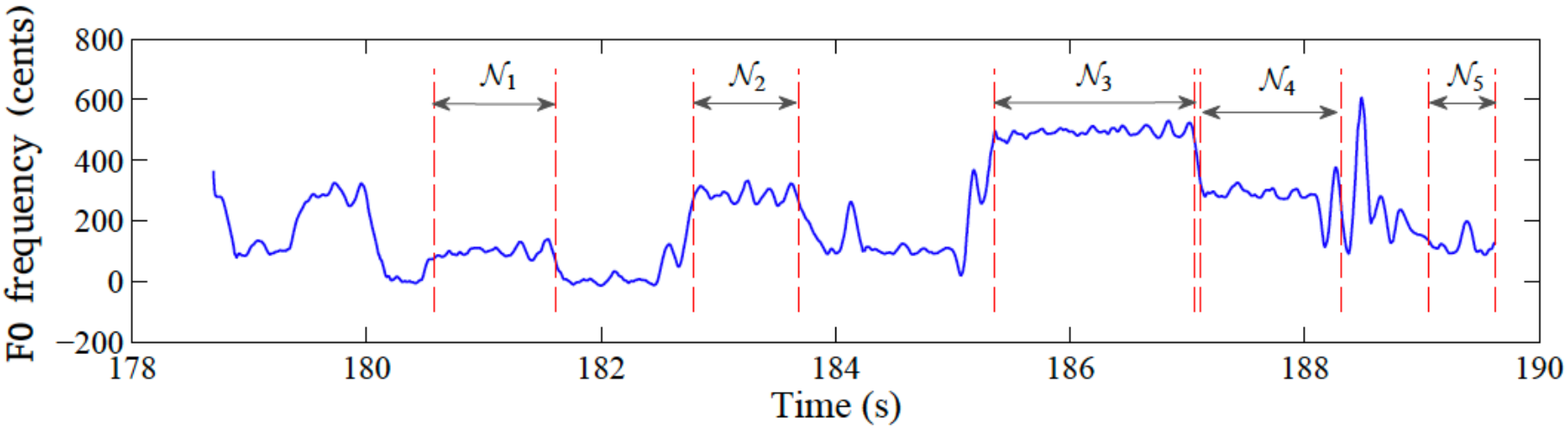
Pitch histogram





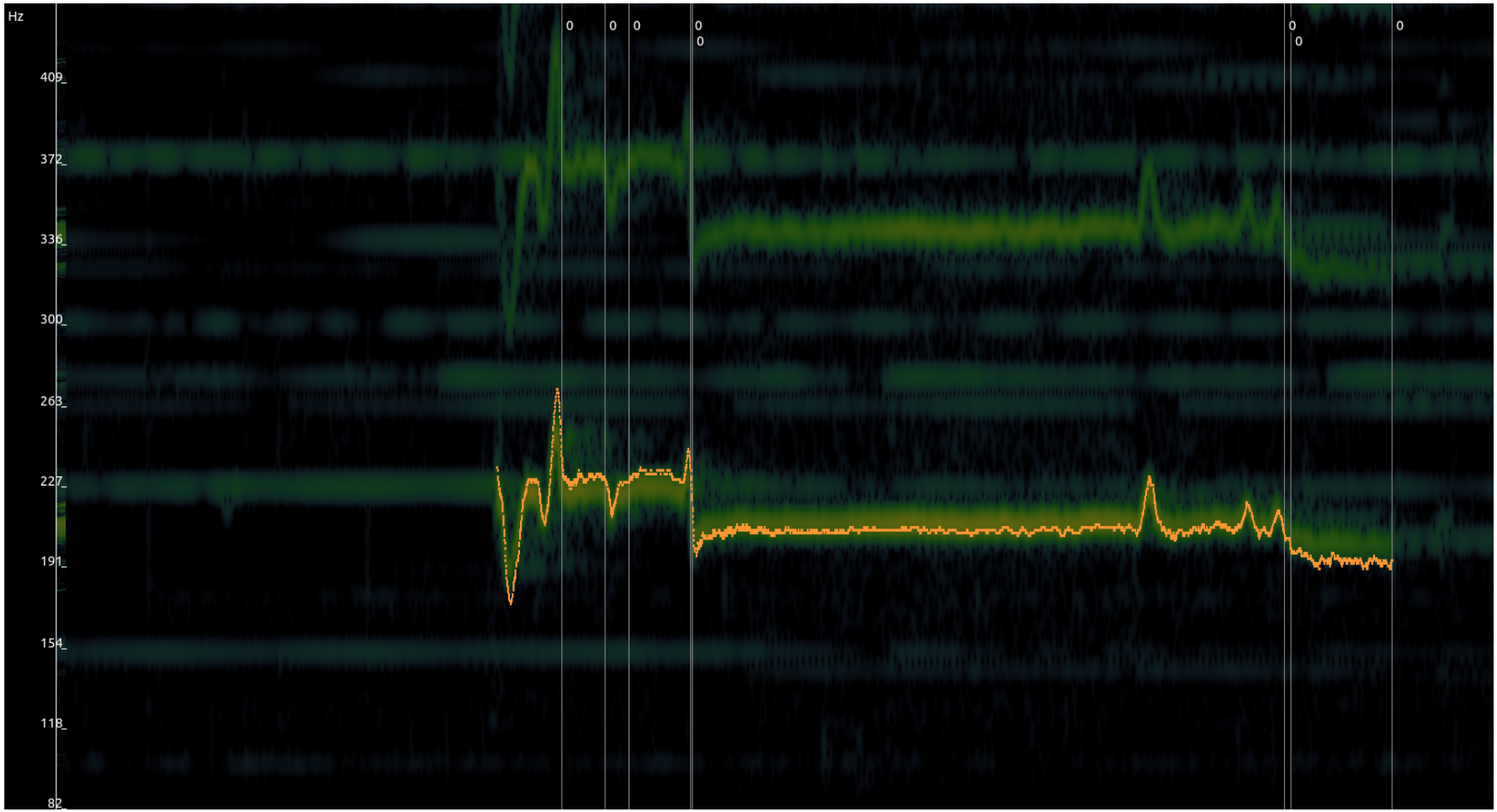
G. K. Koduri, J. Serrà, and X. Serra. 2012. "Characterization of Intonation in Carnatic Music by Parametrizing Pitch Histograms," ISMIR.

Nyas Svar Segmentation

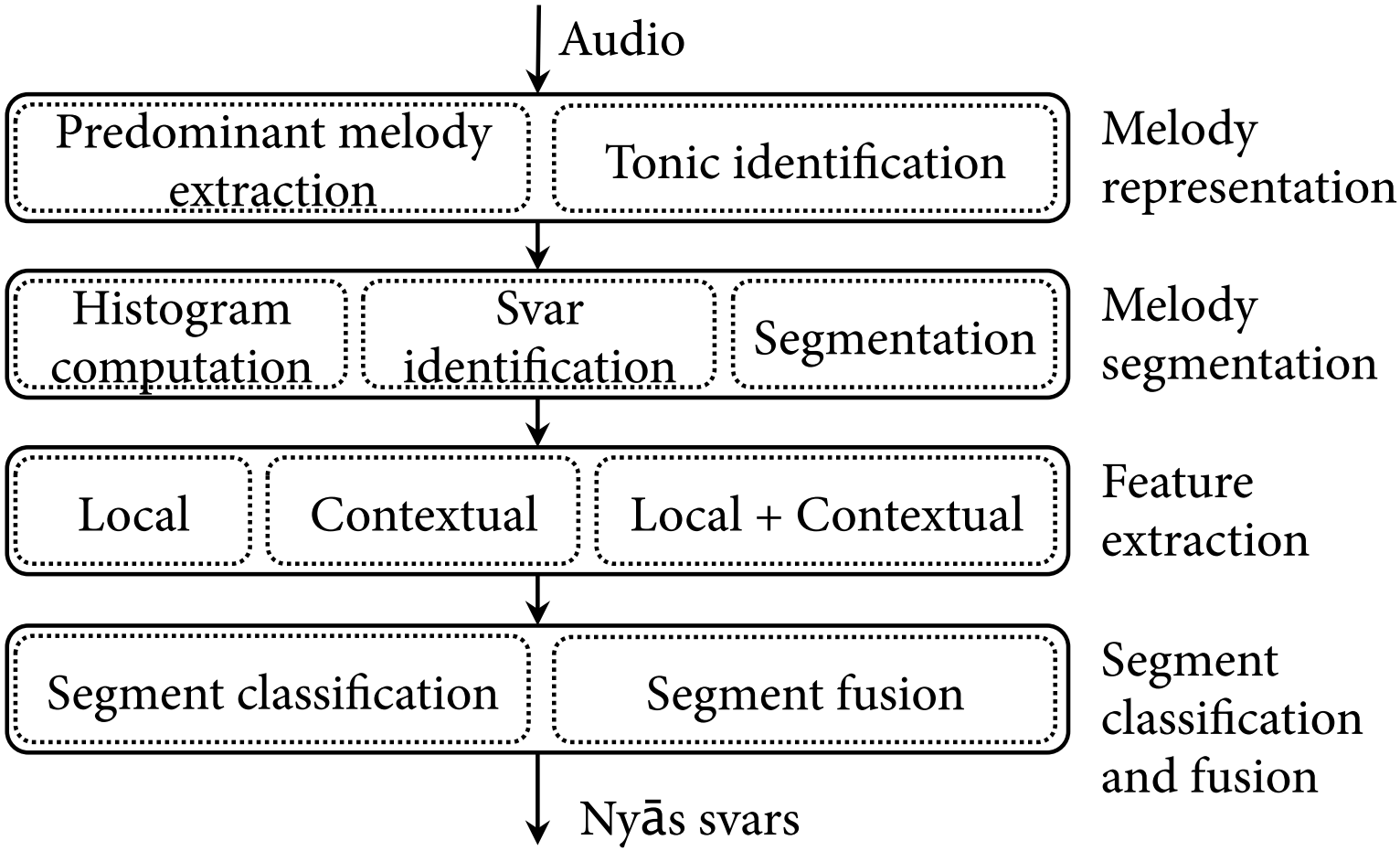


S. Gulati, J. Serrà, K. K. Ganguli, and X. Serra. 2014. “Landmark detection in Hindustani music melodies”. ICMC-SMC.

Nyas Svar Segmentation



Nyas Identification



Nyas Identification: Results

Boundary

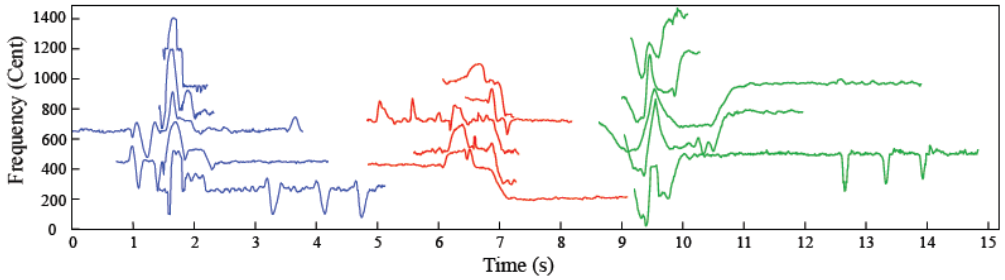
Segmentation	Feat.	DTW	Tree	k-NN	NB	LR	SVM
PLS	$\mathcal{F}_L$	0.356	0.407	0.447	0.248	0.449	0.453
	$\mathcal{F}_C$	0.284	0.394	0.387	0.383	0.389	0.406
	$\mathcal{F}_L$+$\mathcal{F}_C$	0.289	0.414	0.426	0.409	0.432	0.437
Proposed	$\mathcal{F}_L$	**0.524**	0.672	**0.719**	0.491	**0.736**	**0.749**
	$\mathcal{F}_C$	0.436	0.629	0.615	**0.641**	0.621	0.673
	$\mathcal{F}_L$+$\mathcal{F}_C$	0.446	**0.682**	0.708	0.591	0.725	0.735

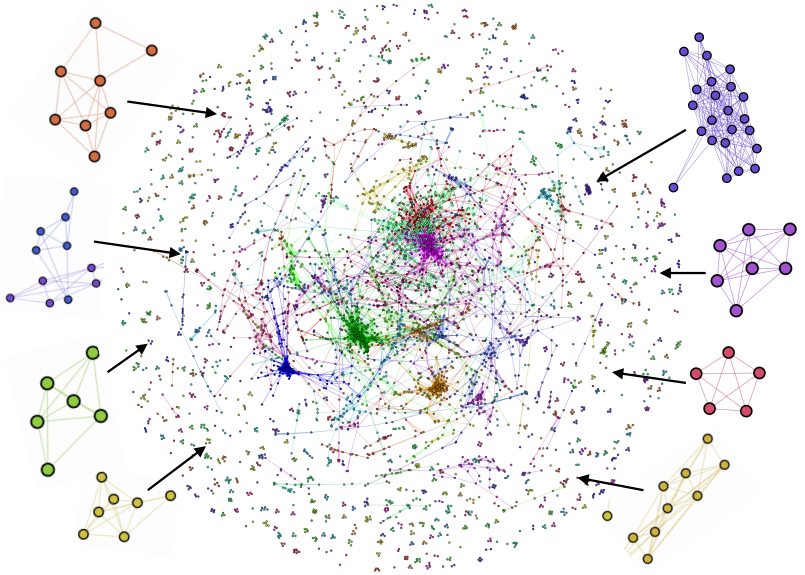
Label

Segmentation	Feat.	DTW	Tree	k-NN	NB	LR	SVM
PLS	$\mathcal{F}_L$	**0.553**	0.685	0.723	0.621	0.727	0.722
	$\mathcal{F}_C$	0.251	0.639	0.631	0.690	0.688	0.674
	$\mathcal{F}_L$+$\mathcal{F}_C$	0.389	0.694	0.693	0.708	0.722	0.706
Proposed	$\mathcal{F}_L$	0.546	**0.708**	**0.754**	0.714	**0.749**	**0.758**
	$\mathcal{F}_C$	0.281	0.671	0.611	0.697	0.689	0.697
	$\mathcal{F}_L$+$\mathcal{F}_C$	0.332	0.672	0.710	**0.730**	0.743	0.731

Musical similarity measures

Original: **Similar 1:** **Similar 2:**





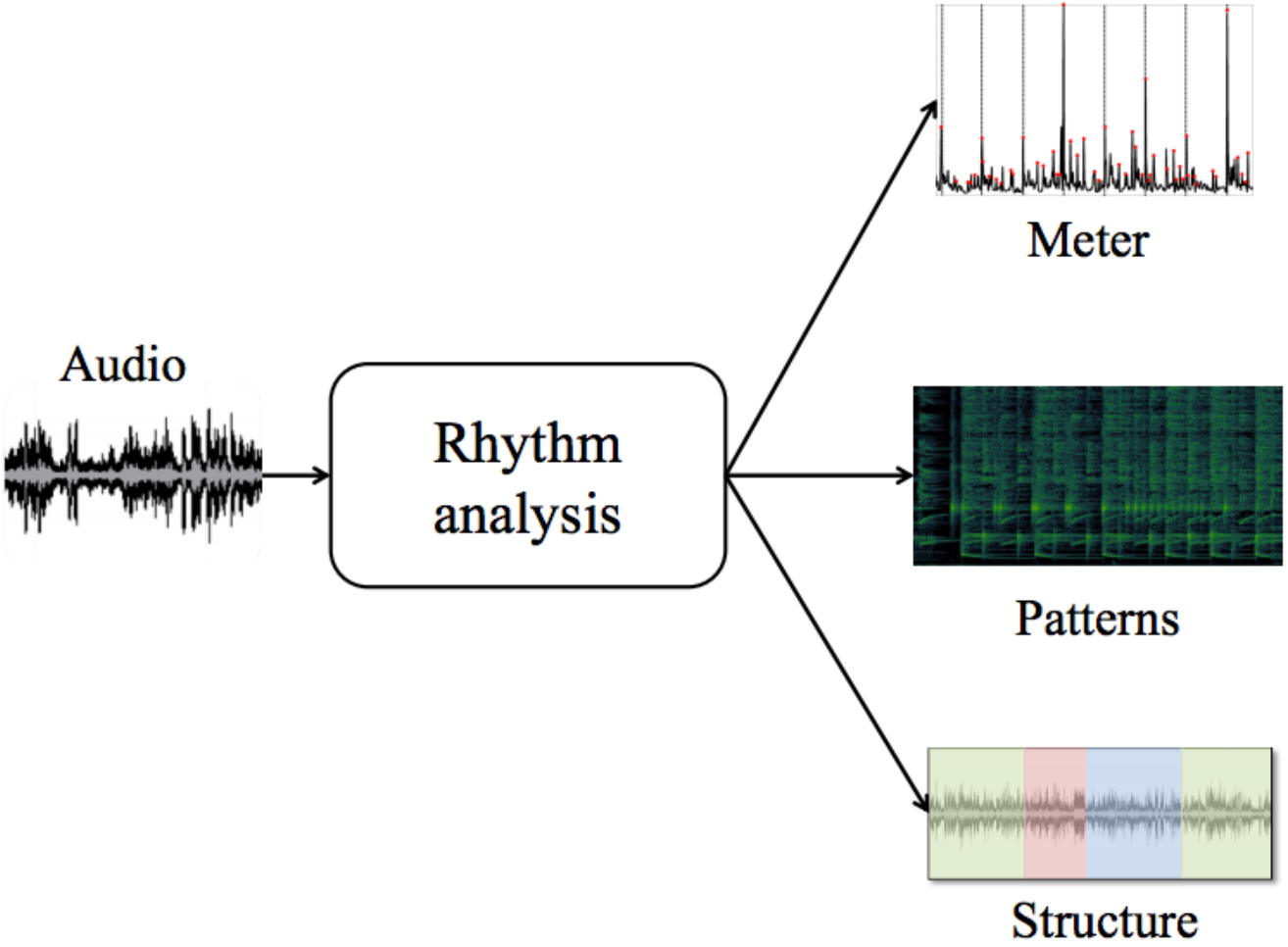
S. Gulati, J. Serra, and X. Serra. 2015. “Improving Melodic Similarity in Indian Art Music using Culture-Specific Melodic Characteristics.” ISMIR.

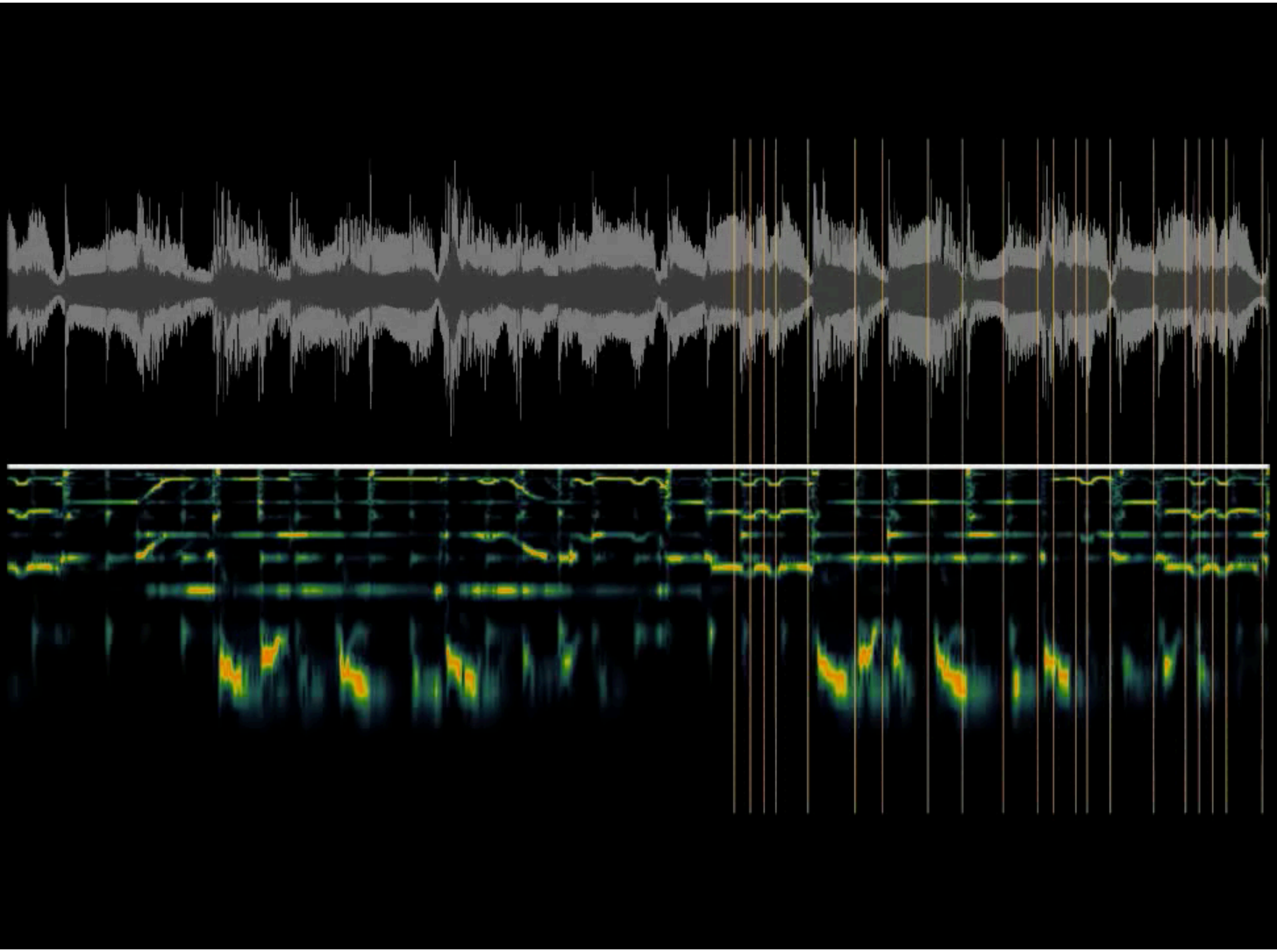
Rhythm analysis

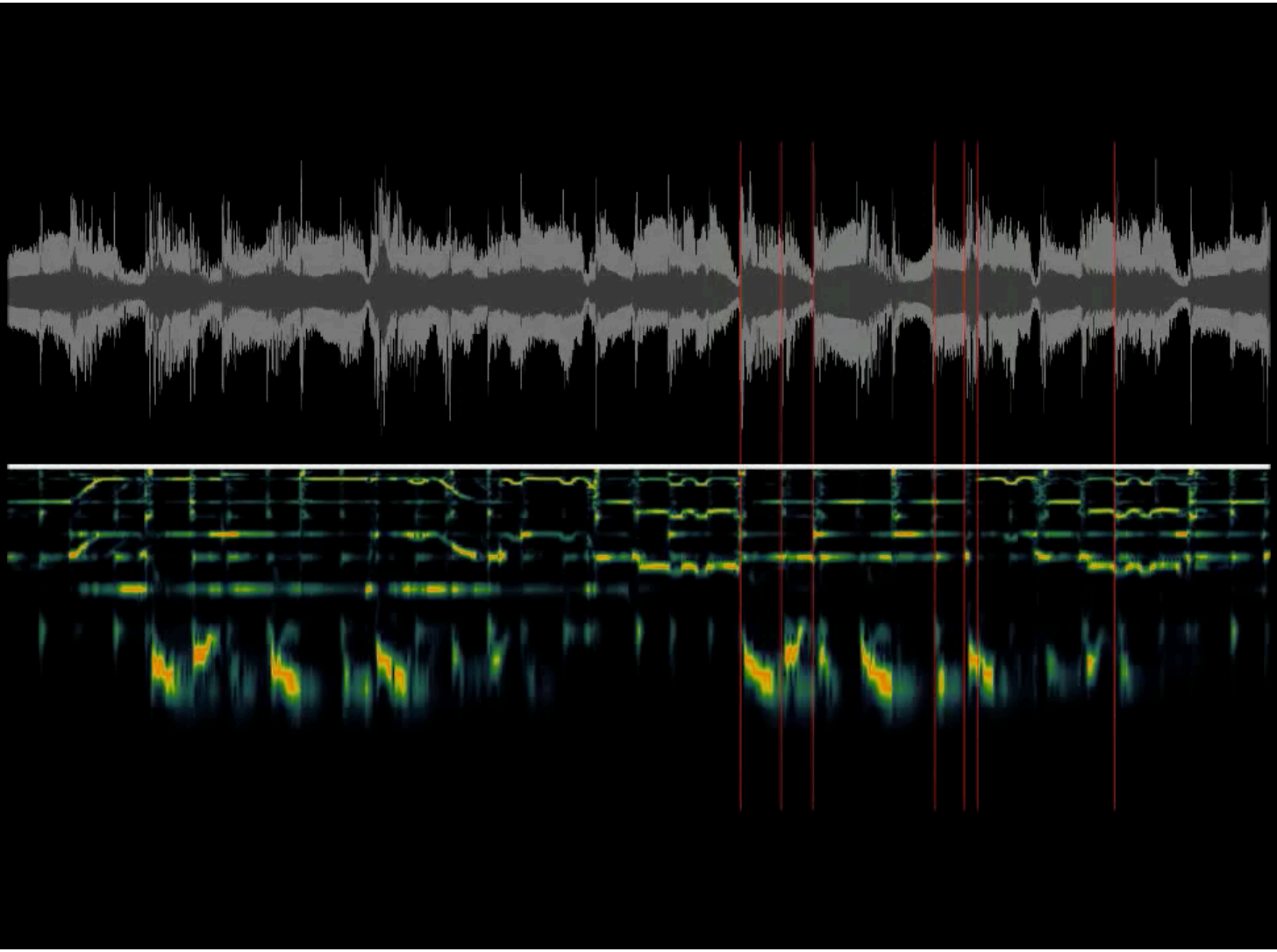
mainly based on:

- Ajay Srinivasamurthy. 2016. A Data-driven Bayesian Approach to Automatic Rhythm Analysis of Indian Art Music. PhD dissertation. UPF. Companion page: https://compmusic.upf.edu/phd-thesis-ajay

Rhythm analysis

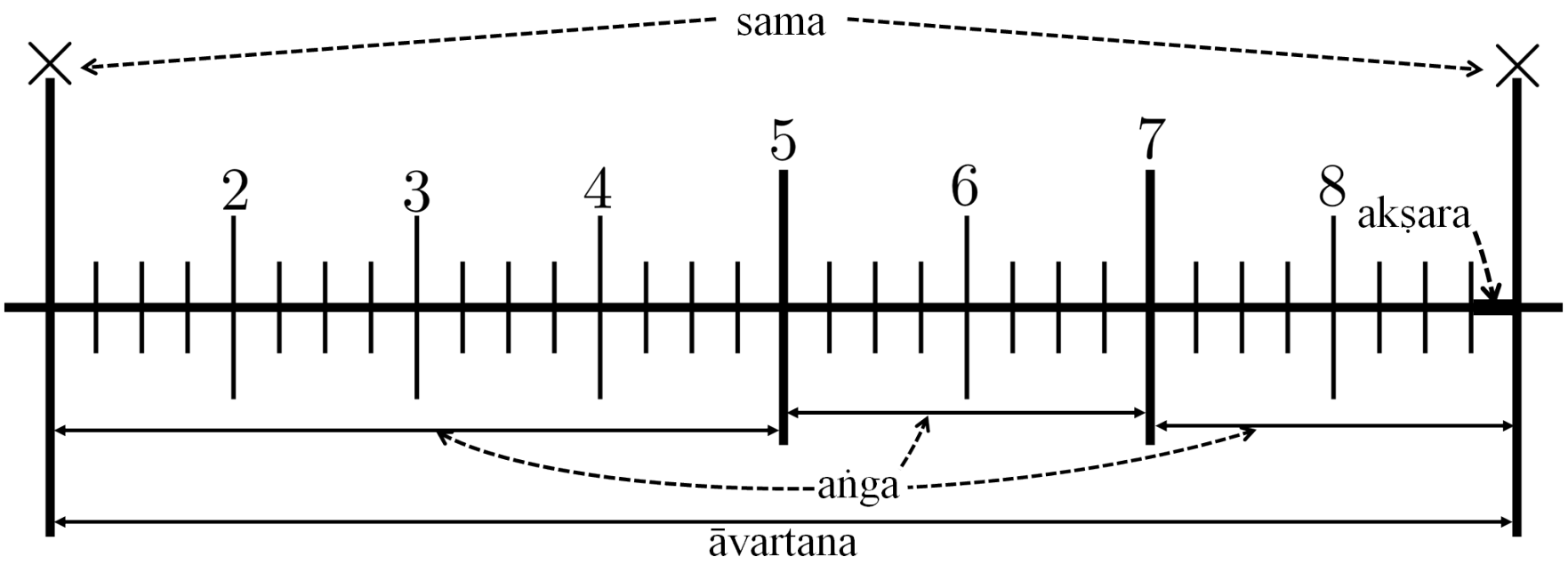






Tāla tracking

- Tracking events in the tāla cycle
  - Akshara, beat and the sama : musically well-defined rhythmic events
- Supervised



Preliminary check – MIR state of the art

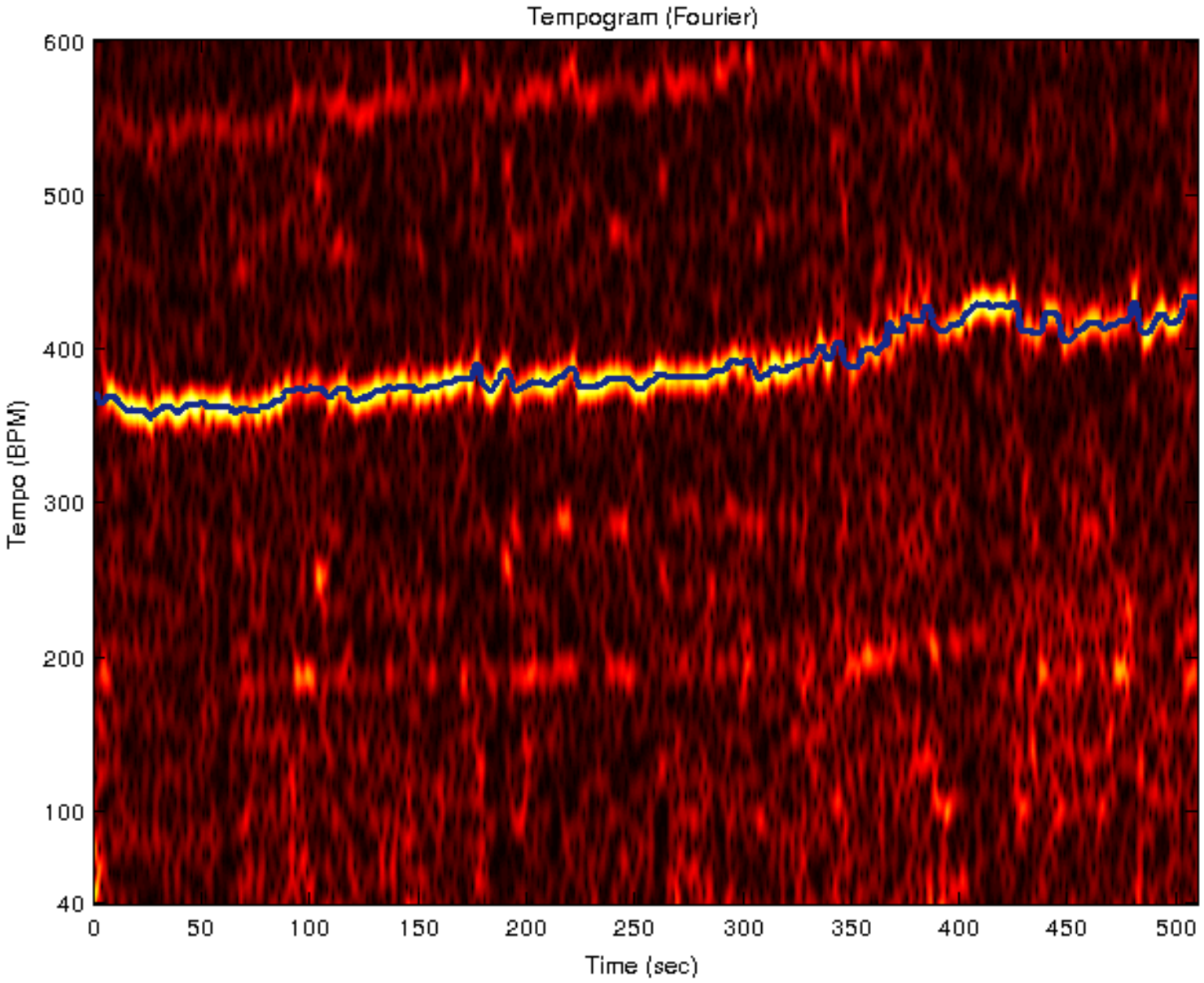
	CML (%)			AML (%))		
Dataset	L_{mb}	L_{ms}	L_{bs}	L_{mb}	L_{ms}	L_{bs}
Turkish	1.30	27.82	0	31.30	27.83	10.00
Carnatic	11.06	8.76	4.15	34.10	45.16	25.81
Hindustani	0	25.4	0	45.22	46.50	32.48

"Cycle length" estimation

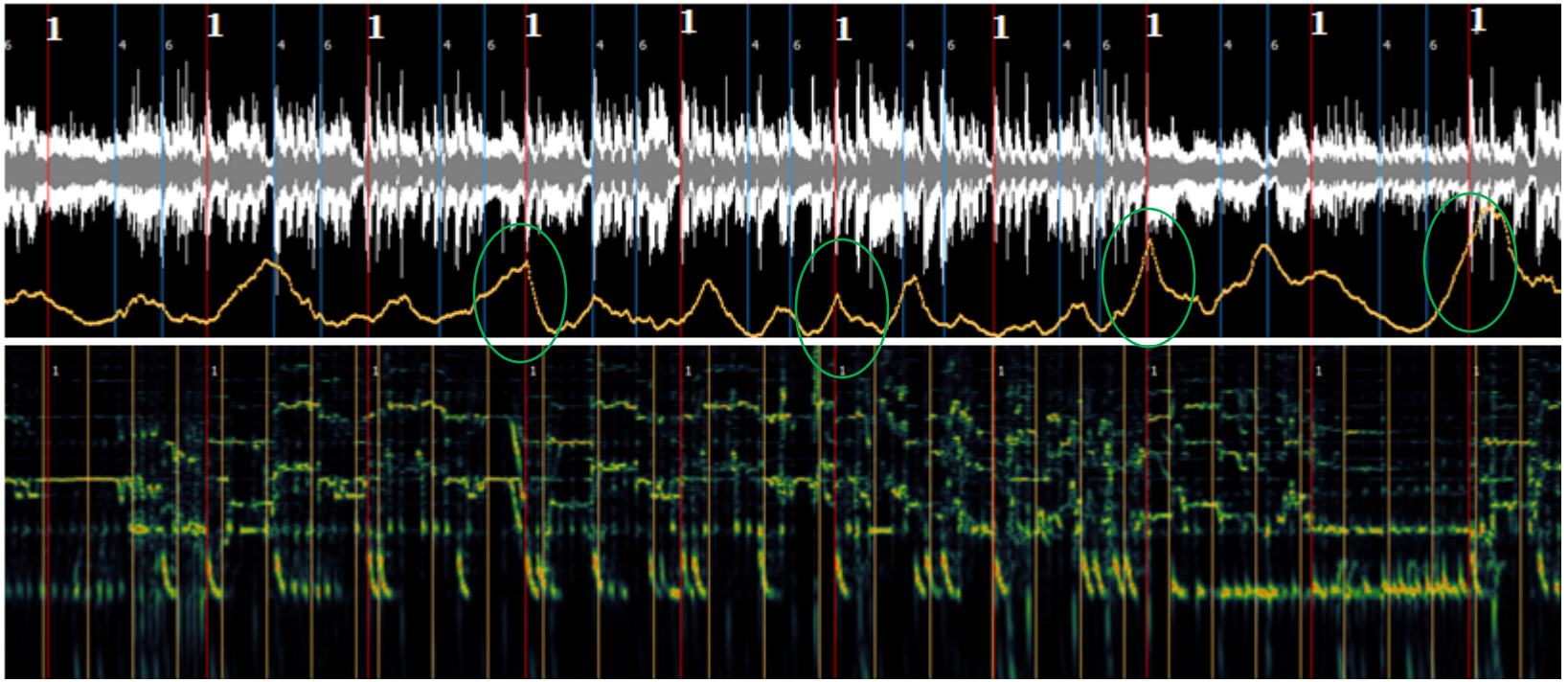
- Poor, insufficient performance
- Lack of engineering definitions for music concepts
- Similarity between rhythm concepts of Turkish and Indian art music

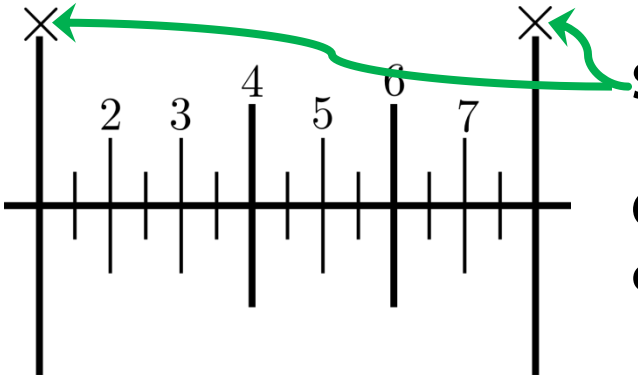
A. Srinivasamurthy, A. Holzapfel, and X. Serra. 2013. "In Search of Automatic Rhythm Analysis Methods for Turkish and Indian Art Music". JNMR

Akshara pulse period tracking



Audio descriptors for sama

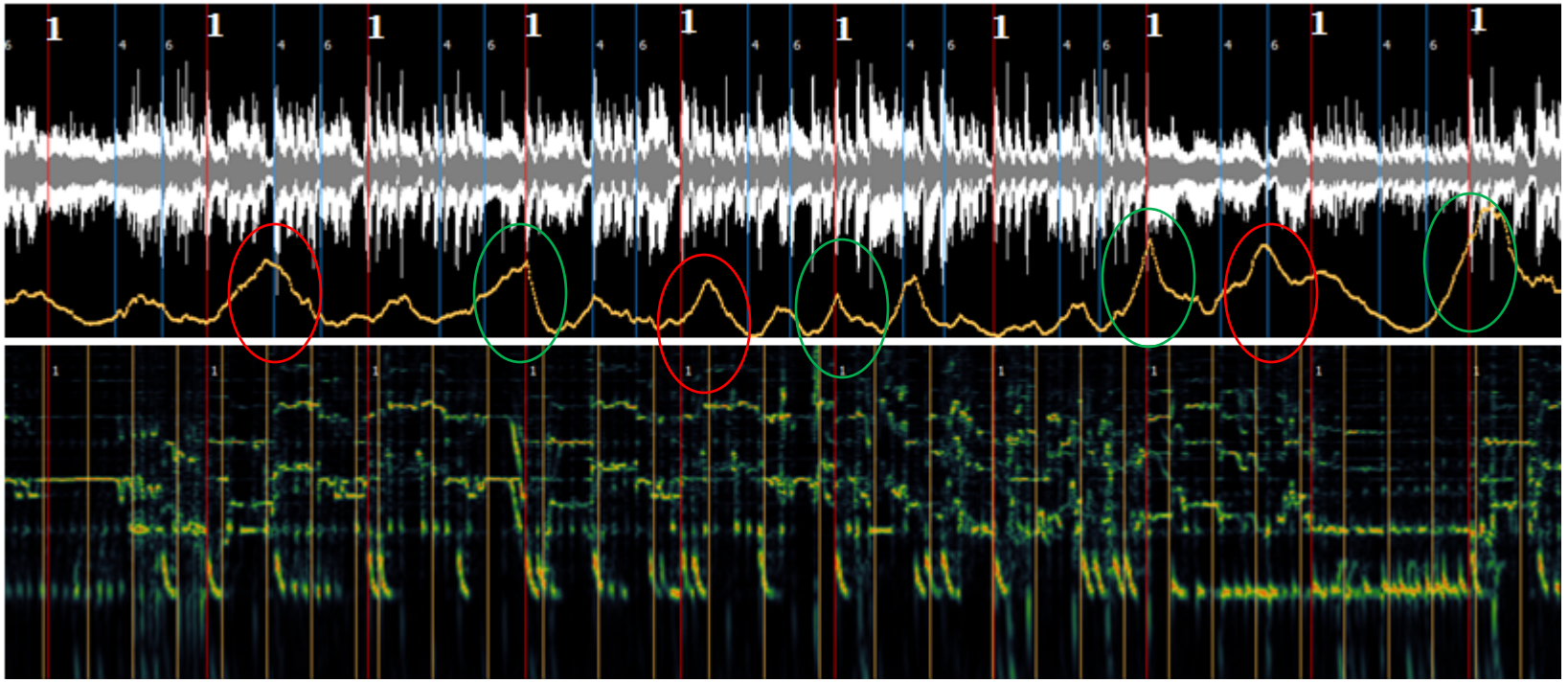


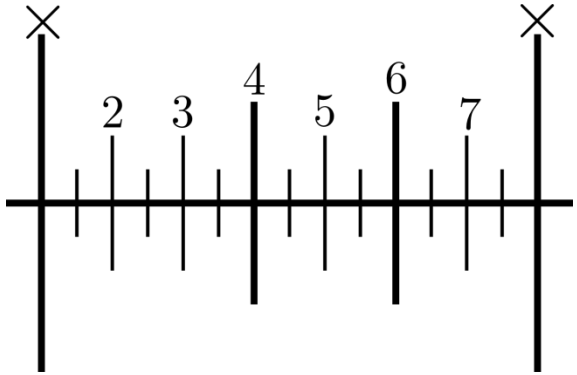


Sama: Beginning/end of the tāla cycle

Change point detection: Novelty functions computed from feature similarity matrix

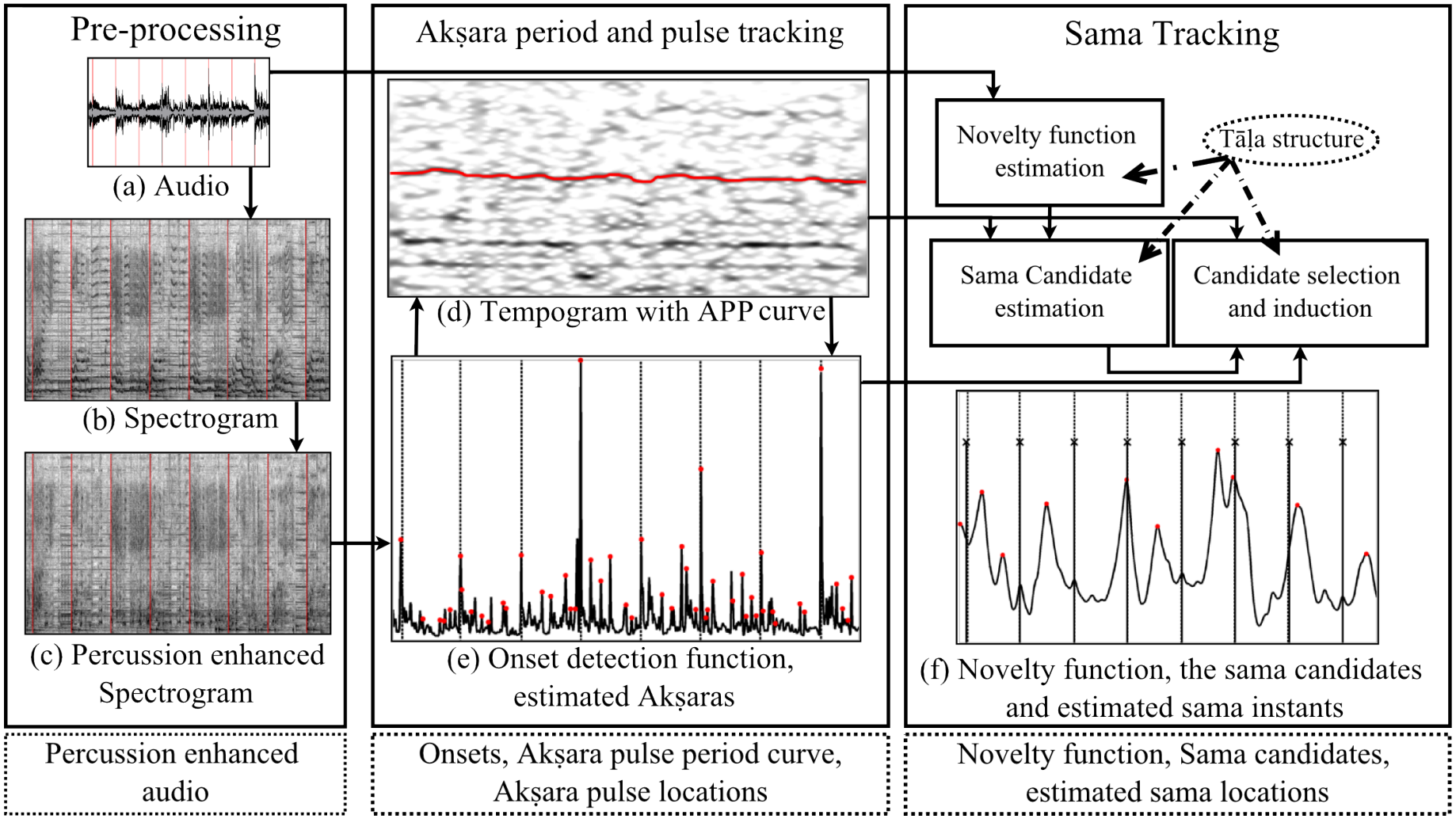
Audio descriptors for sama





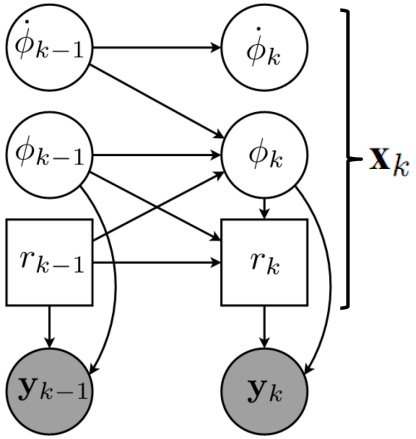
False positives, many !

Tala tracking: Akshara and Sama



A. Srinivasamurthy and X. Serra, "A Supervised Approach to Hierarchical Metrical Cycle Tracking from Audio Music Recordings", ICASSP.

Dynamic Bayesian Network

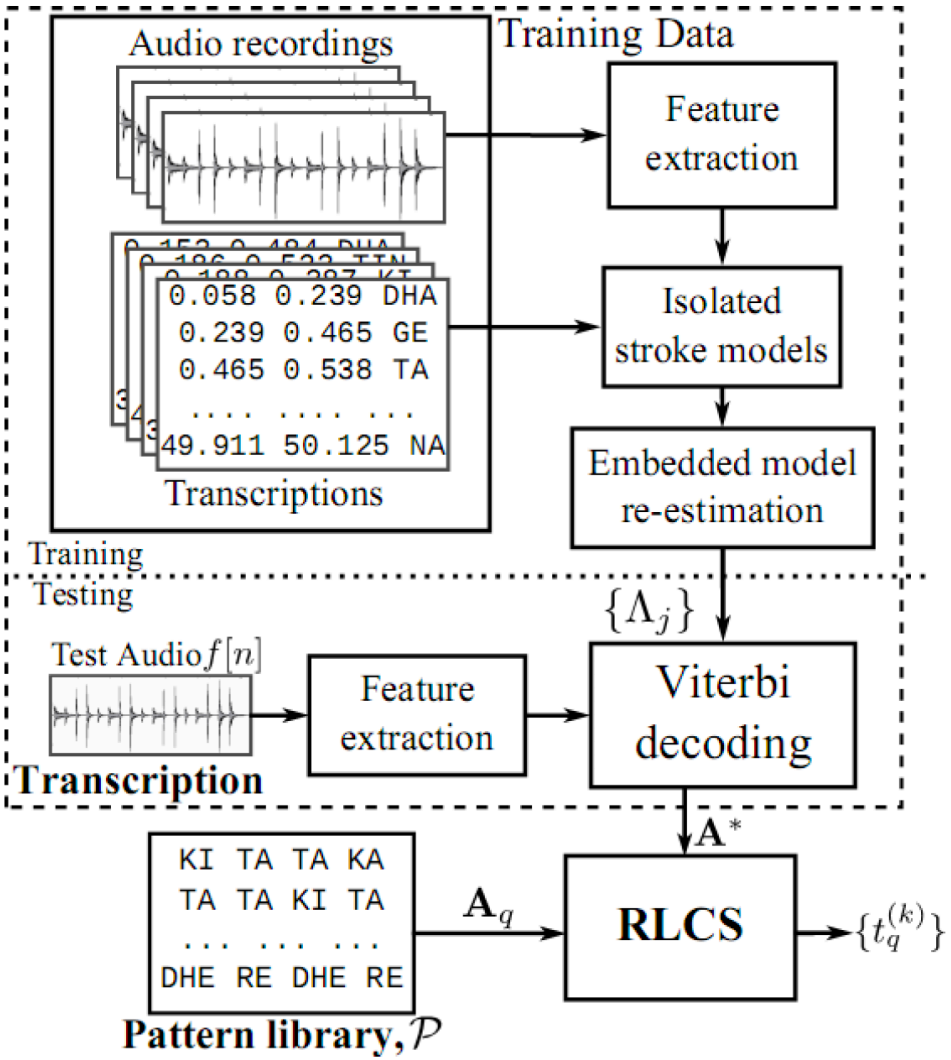


Meter inference results

	Algo.	f_b	$AML_{t,b}$	$\mathfrak{I}_b$ Bits	f_s	Tempo CML	Tempo AML	Tāḷa %
CMR	HMM_0	0.718	0.722	1.44	0.440	0.718	0.938	64
	$AMPF_0$	0.825	0.906	2.17	0.574	0.802	1.000	68
HMR_s	HMM_0	0.759	0.698	1.21	0.551	0.533	0.721	60
	$AMPF_0$	0.828	0.834	1.54	0.569	0.714	0.946	63
HMR_l	HMM_0	0.338	0.225	0.77	0.280	0.119	0.350	37
	$AMPF_0$	0.390	0.427	1.35	0.268	0.350	0.740	27
Blrm.	HMM_0	0.853	0.910	2.52	0.666	0.755	0.988	91
	$AMPF_0$	0.813	0.850	2.15	0.529	0.709	0.957	89

A. Srinivasamurthy, A. Holzapfel, A. T. Cemgil, and X. Serra. 2016. “A generalized Bayesian model for tracking long metrical cycles in acoustic music signals”. ICASSP.

Rhythmic pattern discovery



S. Gupta, A. Srinivasamurthy, M. Kumar, H. Murthy, and X. Serra. 2015. “Discovery of Syllabic Percussion Patterns in Tabla Solo Recordings”. ISMIR.

Datasets

https://compmusic.upf.edu/datasets

- Indian Music Tonic Dataset
- Carnatic Varnam Dataset
- Carnatic Music Rhythm Dataset
- Hindustani Music Rhythm Dataset
- Mridangam Stroke Dataset
- Mridangam Tani-avarthanam Dataset
- Saraga: research datasets of Indian Art Music
- Tabla Solo Dataset

MusicalBridges

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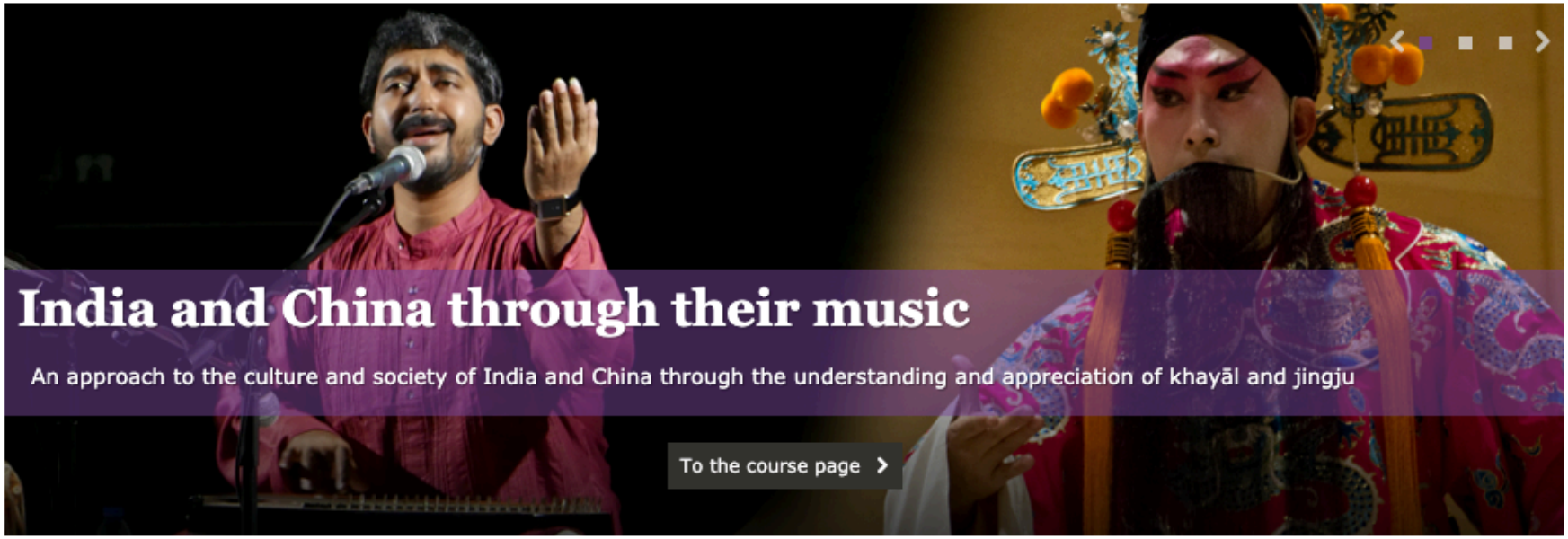


News

Talk and Concert of Hindustani Classical Bansurī

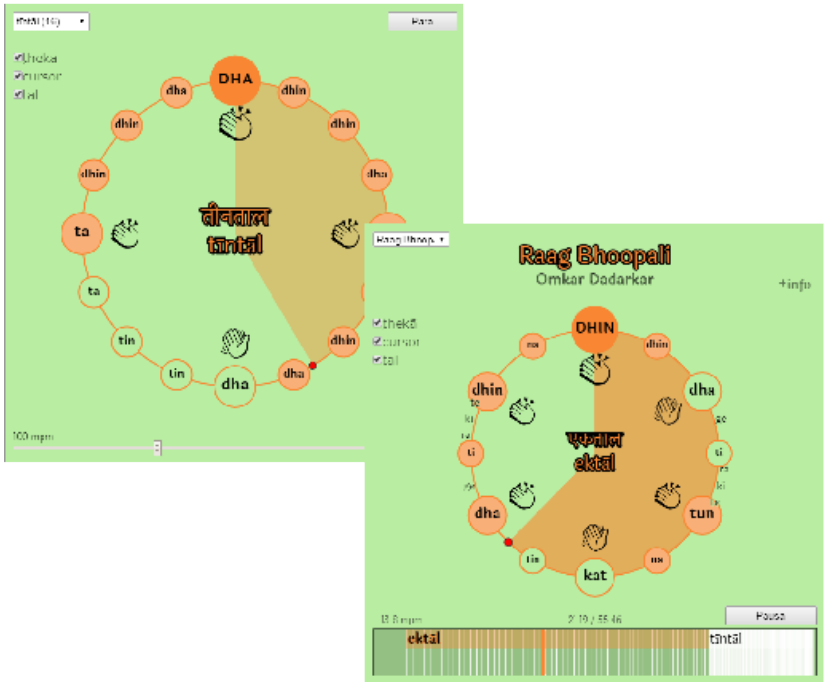
12.02.2019

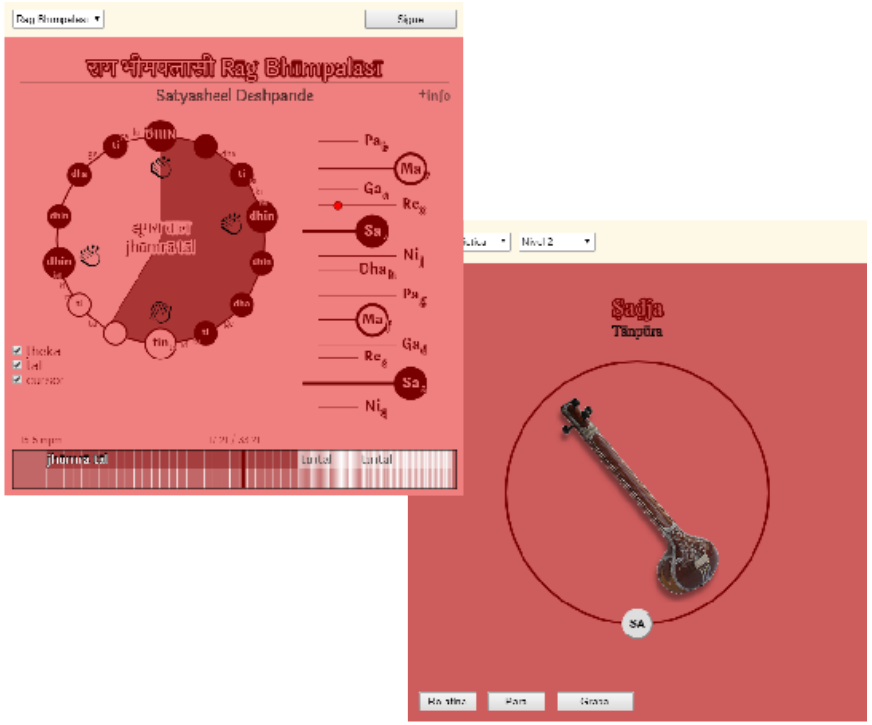
Cat Música

Interview with Musical Bridges researcher Rafael Caro in Catalunya Música

Nitin Amin featured by Revista Musical Catalana

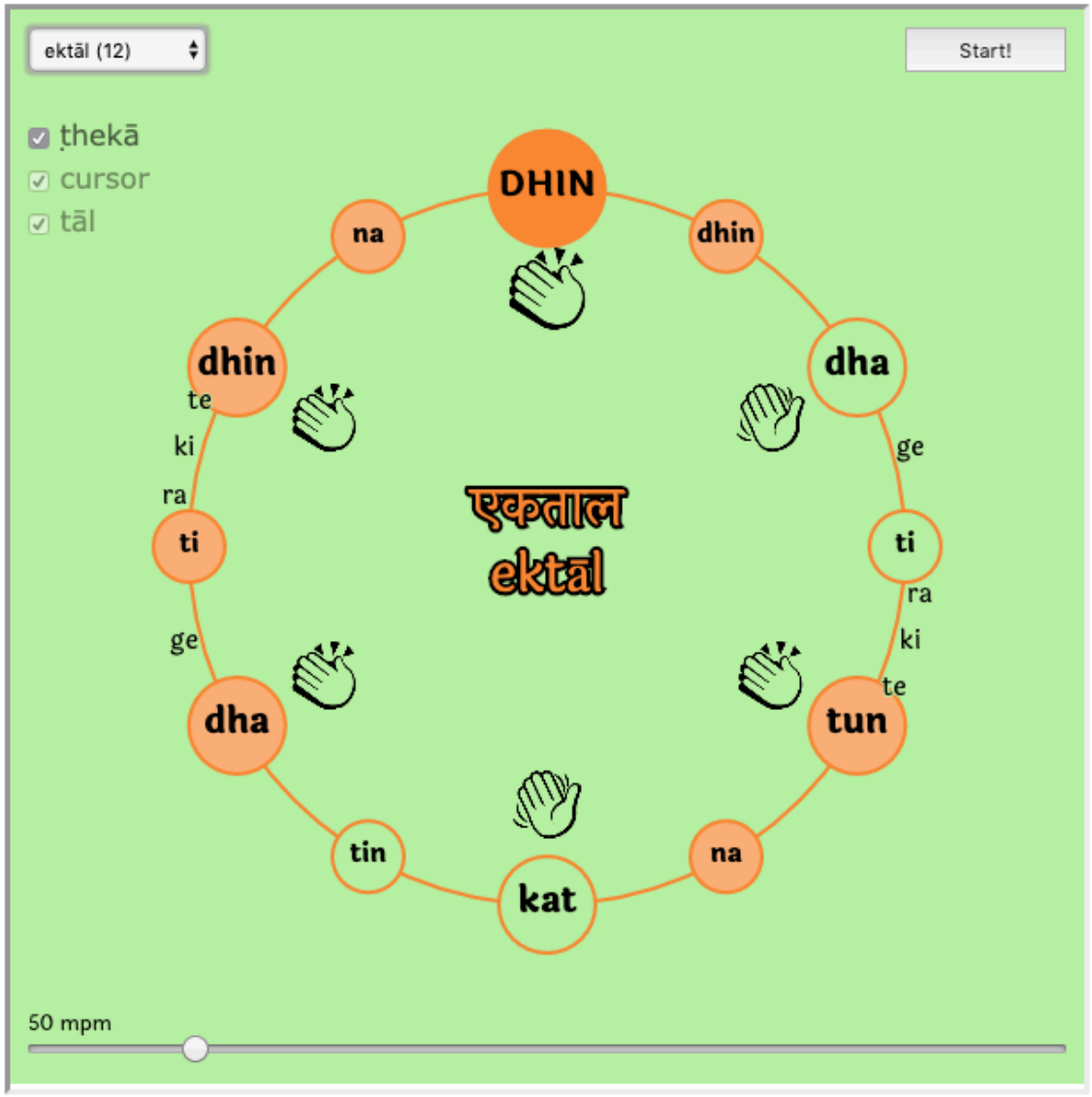
Tools for understanding Hindustani Classical Music





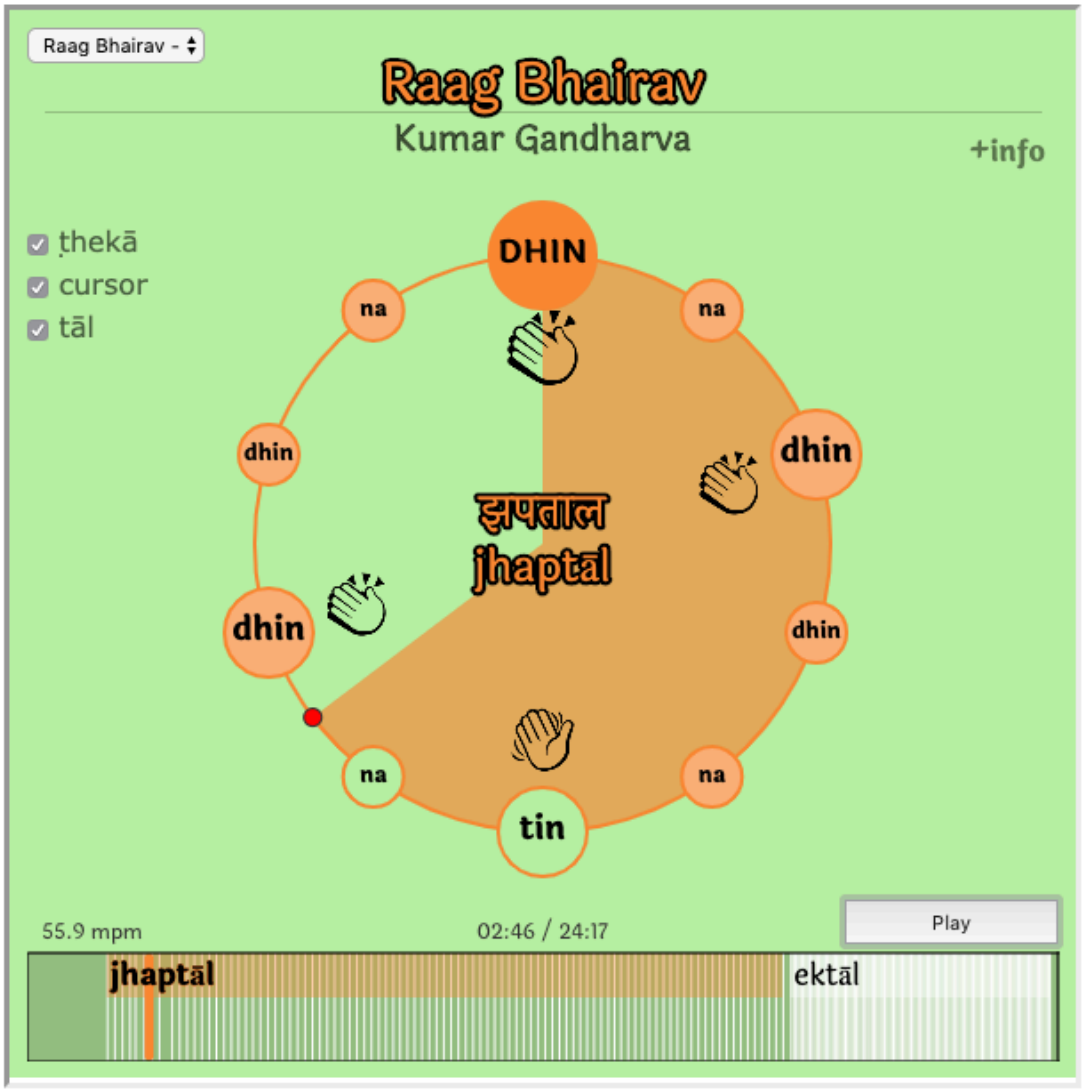
Tāl laboratory

This "laboratory" allows to dissect, explore and interact with some of the most representative tāls used in Hindustani classical music. Read the instructions below.



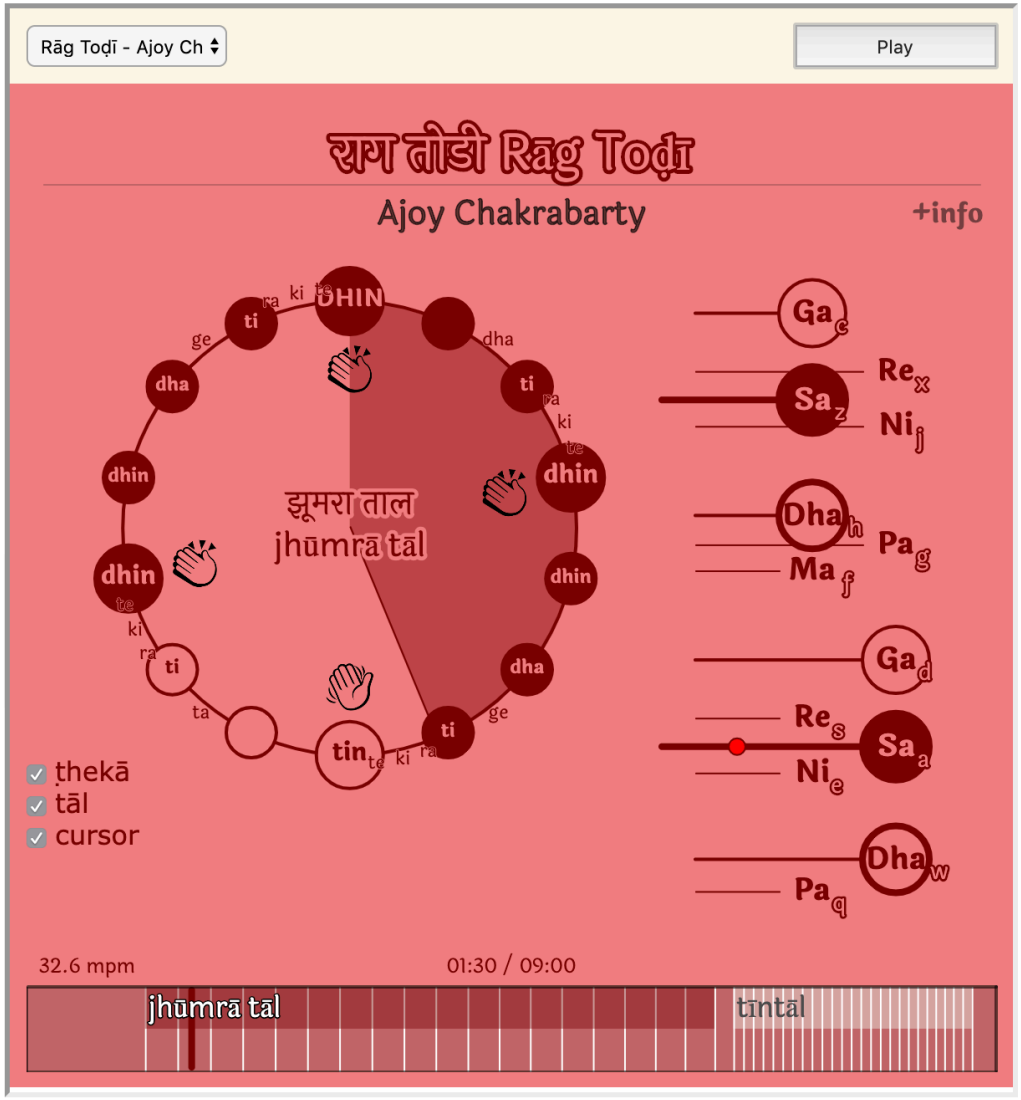
Tāl visualizer

This visualizer allows to observe how the tāls studied in the laboratory are used in the real performance of a *khayāl*. Read the instructions below.



Rāg and tāl visualizer

The melody in any *khayāl* performance is determined by the rāg, whose correct and moving expression is the main goal of the singer in this genre. This visualizer allows to follow the melodic progression through a rāg in real performances of *khayāl*, as well as the progression of the tāl cycles. Read the instructions below.



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