

CompMusic project: motivation, results, reflections

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Music Technology Group

Universitat Pompeu Fabra, Barcelona

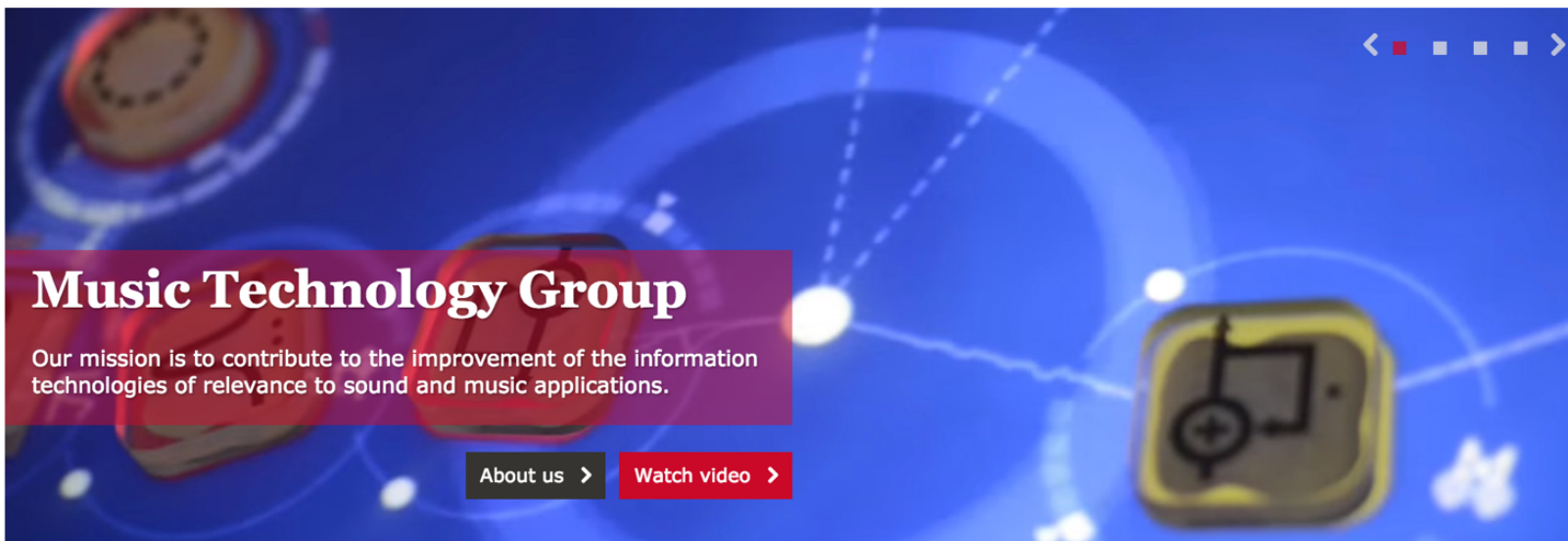
16th Brazilian Symposium on Computer Music. São Paulo, 3-6 September 2017



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Our mission is to contribute to the improvement of the information technologies of relevance to sound and music applications.

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Research

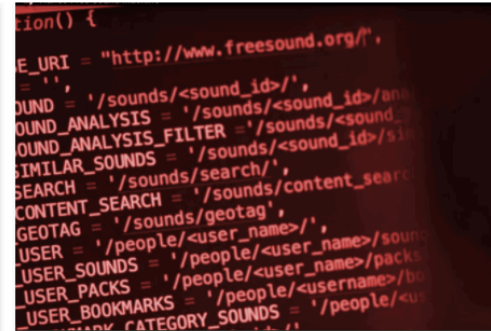
The research of the MTG is quite close to the core of the Sound and Music Computing interdisciplinarity, being especially active on topics such as audio signal processing, music information retrieval, musical interfaces, and computational musicology. The MTG is organized into four [labs](#), each one led by a faculty member. Most of the research is carried out within [projects](#) supported from a variety of [funding sources](#). The research results into [publications](#) and [software & datasets](#), while also emphasizing results of relevance in [technology transfer](#) and [outreach](#) initiatives.



Labs



Projects



Software & Datasets



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Tech transfer

A mission of the MTG is to transfer its research results to society, both through technology transfer and by [outreach activities](#). The technology transfer is done by [licensing technologies](#), through specific [industrial collaborations](#), and by creating [spin-offs](#). If you are a company interested in the work of the MTG, please [contact us](#) to know more about how to collaborate.

The MTG has been recognized as a [TECNIO center](#), a quality accreditation granted by the Catalan government that identifies the best R&D groups that offer innovative technologies to companies.



Technologies for licensing



Industrial collaborations



Spin-offs and industrial partners



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Education & Outreach

The MTG is engaged in education and outreach activities targeting a wide variety of publics, from young children interested in music to students wanting to become researchers in our field. Formal [education](#) is mainly done through the various undergraduate and graduate programs of the UPF. More general outreach activities are done through a number of [cultural programs](#) and [research dissemination](#) activities. The MTG also maintains a number of [community resources](#) of interest to the research and music communities.



Education



Community resources



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Research dissemination

Motivation



India 2010



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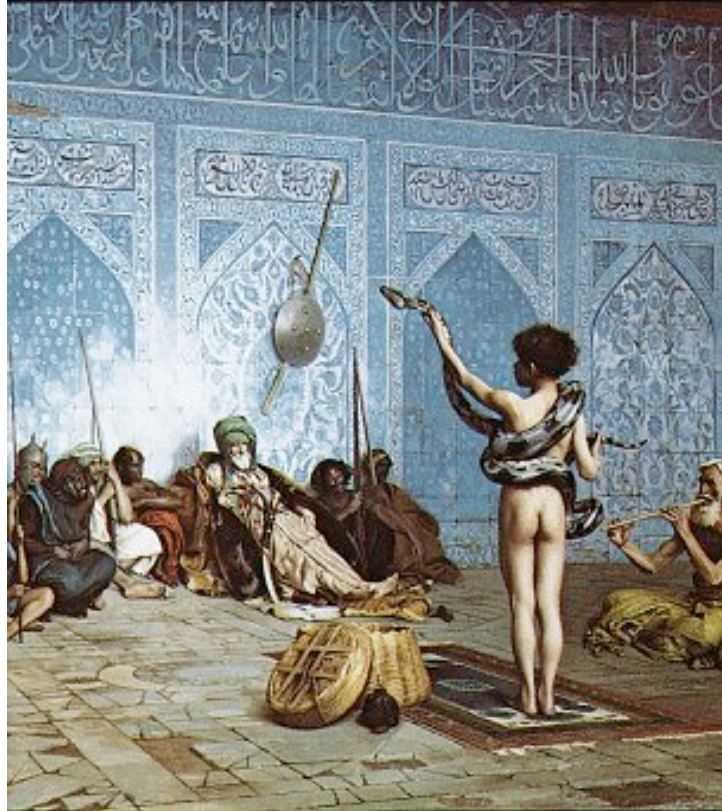
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Raga

From Wikipedia, the free encyclopedia

*This article is about melodic modes used in Indian music. It is not to be confused with **Ragga**. "**Ragam**" and "**Ragini**" redirect here. For the Indian actress, see **Ragini (actress)**. For other uses, see **Raga (disambiguation)** and **Ragam (disambiguation)**.*

A **raga** or **raag** (literally "color, hue" but also "beauty, melody"; also spelled *raag*, *ragam*; pronounced *rāga*, or *rāgam* or "raag")^[1] is one of the **melodic modes** used in traditional **South Asian music** genres such as **Indian classical music** and **qawwali**.

A raga uses a series of five to nine **musical notes** upon which a **melody** is constructed.^[2] However, the way the notes are approached and rendered in musical phrases and the mood they convey are more important in defining a raga than the notes themselves. In the Indian musical tradition, rāgas are associated with different times of day. Indian classical music is always set in a rāga. Non-classical music such as popular **Indian film music** use rāgas in their compositions.

Joep Bor of the Rotterdam Conservatory of Music defined *Raga* as "tonal framework for composition". **Nazir Jairazbhoy**, chairman of **UCLA**'s department of **ethnomusicology**, characterized ragas as **ascent** and **descent**, **transilience**, emphasized notes and register, and intonation and ornamentation. The meaning of Raga as "*love*".^[2]

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- Principal Ragas
- Rāga-Rāgini system
- Ragas and their seasons
- Notations
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Ind

Shruti



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राग

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मुक्त ज्ञानकोश विकिपीडिया से

"रागिनी" यहां पुनर्निर्देश करता है। अन्य उपयोगों के लिए रागिनी (बहुविकल्पी) देखें।

राग सुरों के आरोहण और अवतरण का ऐसा नियम है जिससे **संगीत** की रचना की जाती है। पाश्चात्य संगीत में "improvisation" इसी प्रकार की पद्धति है।

अनुक्रम [छुपाएँ]

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- शब्दावली
- राग की प्रकृति
- राग और ऋतु
- रागमालिका ग्रंथ के चित्र
- इन्हें भी देखें
- बाहरी कड़ियाँ

परिचय [संपादित करें]

'राग' शब्द **संस्कृत** की 'रंज्' **धातु** से बना है। रंज् का अर्थ है रंगना। जिस तरह एक चित्रकार तस्वीर में रंग भरकर उसे सुंदर बनाता है, उसी तरह संगीतज्ञ मन और शरीर को संगीत के सुरों से रंगता ही तो हैं। रंग में रंग जाना मुहावरे का अर्थ ही है कि सब कुछ भुलाकर मगन हो जाना या लीन हो जाना। संगीत का भी यही असर होता है। जो रचना मनुष्य के मन को आनंद के रंग से रंग दे वही राग कहलाती है।

हर राग का अपना एक रूप, एक व्यक्तित्व होता है जो उसमें लगने वाले स्वरों और लय पर निर्भर करता है। किसी राग की जाति इस बात से निर्धारित होती हैं कि उसमें कितने स्वर हैं। आरोह का अर्थ है चढना और अवरोह का उतरना। संगीत में स्वरों को क्रम उनकी ऊँचाई-निचाई के आधार पर तय किया गया है। 'सा' से ऊँची ध्वनि 'रे' की, 'रे' से ऊँची ध्वनि 'ग' की और 'नि' की ध्वनि सबसे अधिक ऊँची होती है। जिस तरह हम एक के बाद एक सीढ़ियाँ चढ़ते हुए किसी मकान की ऊपरी मंजिल तक पहुँचते हैं उसी तरह गायक सा-रे-ग-म-प-ध-नि-सां का सफर तय करते हैं। इसी को आरोह कहते हैं। इसके विपरीत ऊपर से नीचे आने को अवरोह कहते हैं। तब स्वरों का क्रम ऊँची ध्वनि से नीची ध्वनि की ओर होता है जैसे सां-नि-ध-प-म-ग-रे-सा। आरोह-अवरोह में सातों स्वर होने पर राग 'सम्पूर्ण जाति' का कहलाता है।



वसन्त रागिनी वसन्त का राग है। इस चित्र में कृष्ण गोपियों के साथ नृत्य करते दिख रहे हैं।

Results



compmusic

Computational models for the discovery of the World's Music



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[Article by Xavier Serra in Acta Musicologica](#)

20/06/2017 - 14:21

In order to reach the musicological community and explain the work done...

[Georgi Dzhambazov defends his PhD thesis](#)

20/06/2017 - 14:09

On June 28th 2017, Georgi Dzhambazov

HOME

CompMusic is a research project funded by the European Research Council from 2011 to 2017 and coordinated by Xavier Serra from the Music Technology Group of the Universitat Pompeu Fabra in Barcelona (Spain). It aims to advance in the automatic description of music by emphasizing cultural specificity, carrying research within the field of music information processing with a domain knowledge approach. The project focuses on five music traditions of the world: Hindustani (North India), Carnatic (South India), Turkish-makam (Turkey), Arab-Andalusian (Maghreb), and Beijing Opera (China).

dunya.compmusic.upf.edu



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Dunya comprises the music corpora and related software tools that have been developed as part of the CompMusic project. These corpora have been created with the aim of studying particular music traditions and they include audio recordings plus complementary information that describes the recordings. Each corpus has specific characteristics and the developed software tools allow to process the available information in order to study and explore the characteristics of each musical repertoire.

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[Final Report](#) 24/08/2017

CompMusic has finished, and our funding agency, ERC, asked us to write a brief report. Here is it. Achievements along the main objectives/activities The CompMusic project has been a big and long project with many achievements...

[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...

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Turkish-makam



Hindustani



Carnatic



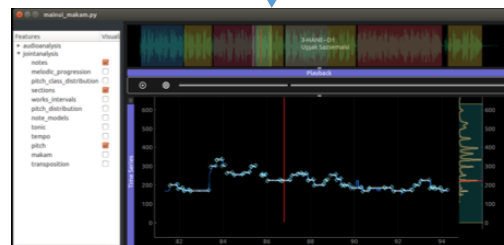
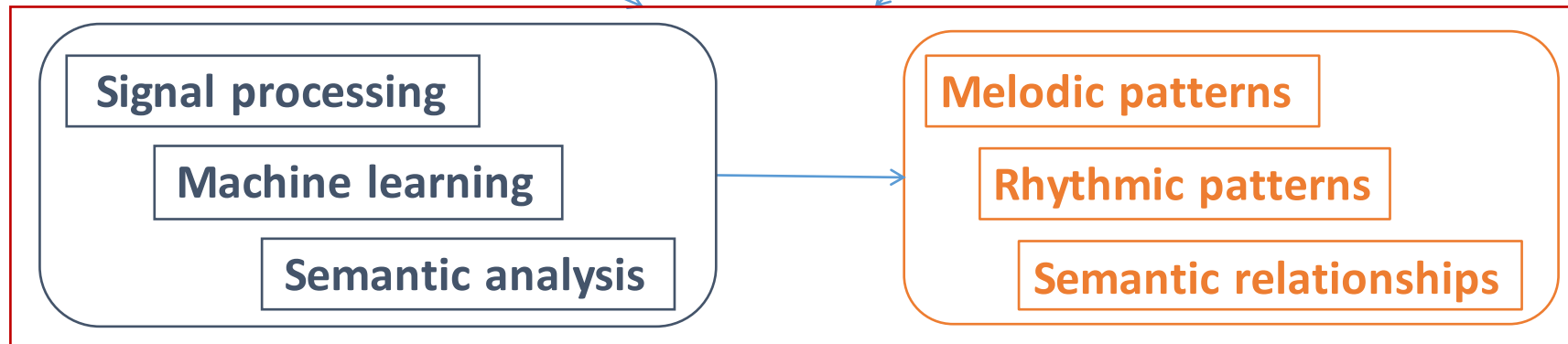
Beijing Opera





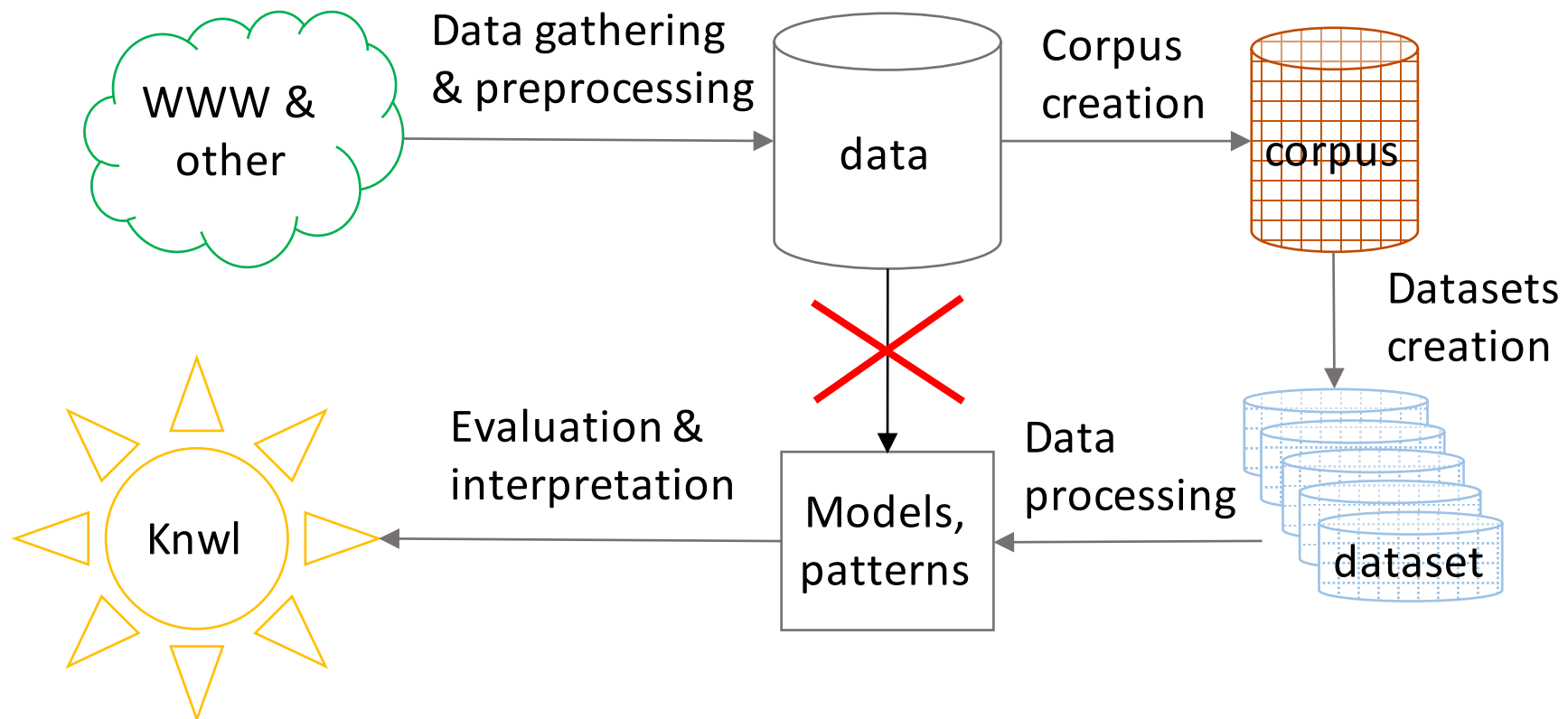


Release	Artist	Format	Tracks	Date	Country	Label	Catalog#	Rating
All India Radio Archival Release Vol. 3	Vijay Ramesh Khan	CD	2	1960	IN	T-Series	SVCCD 126	*****
Echoes of a Golden Voice	Jayaj	CD	4	1982	IN	Saanathree Enterprises	PX001	*****
A Life in Music	Anur Khan	CD	2	1984	IN	Saregama	CON150641A00	*****
An Urdung Parampara Vol. 1	Dinkarnath Thakur	CD	3	1987	IN	Rhythm House	CD 240261	*****
The Sanctity of Parampara	Harik Bhada	CD	2	1987	IN	Rhythm House	CD 240267	*****
Tribute To Nriya	Vijaya Sankarabodhi	CD	2	1987	IN	Rhythm House	CD 240 369	*****
Tansen Vol. 1	Vijaya Sankarabodhi	CD	2	1987	IN	Rhythm House	CD 240 370	*****
An Urdung Parampara Vol. 2	Dinkarnath Thakur	CD	3	1988	IN	Rhythm House	CD 240274	*****
An Urdung Parampara Vol. 3	Dinkarnath Thakur	CD	3	1989	IN	Rhythm House	CD 240381	*****



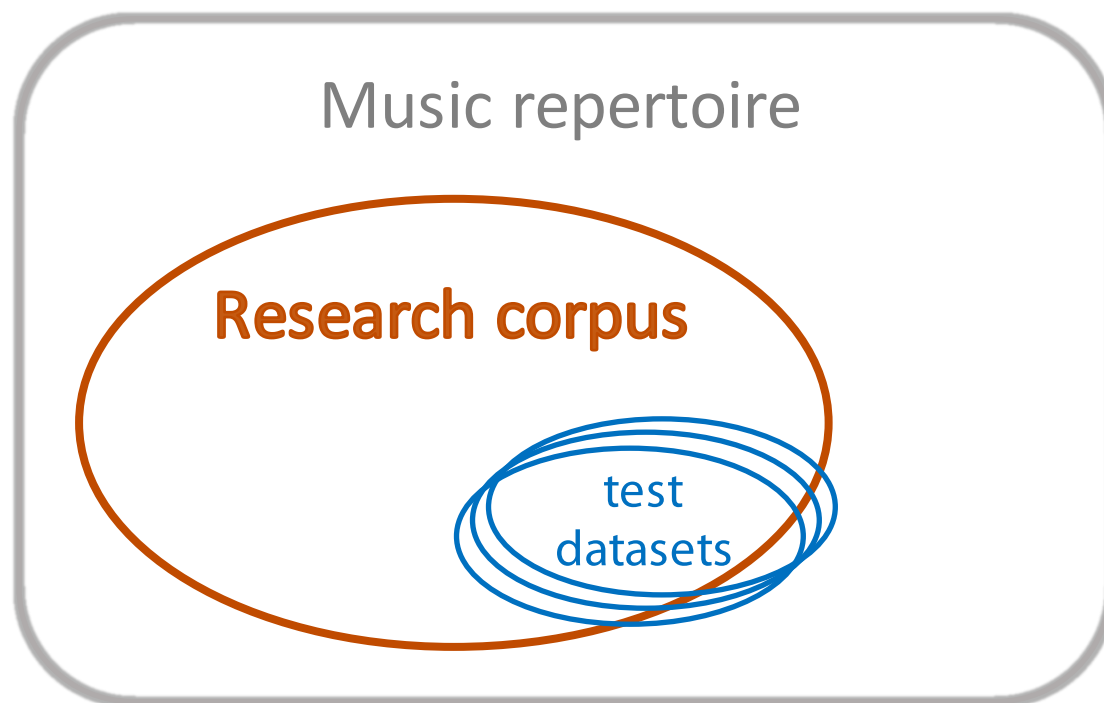
X. Serra. "A Multicultural Approach in Music Information Research." ISMIR 2011.

Corpus based research



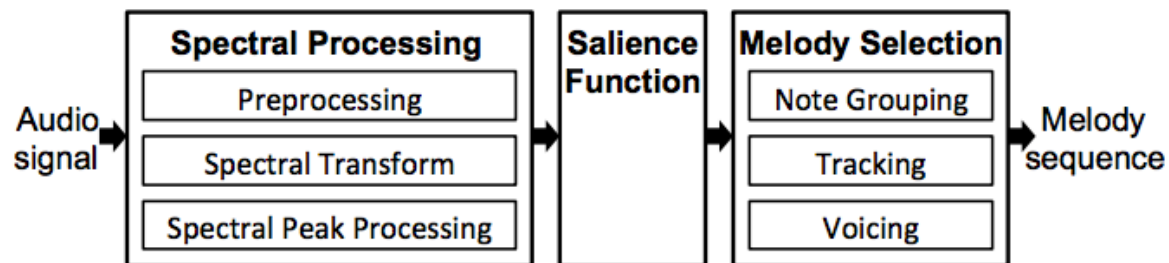
X. Serra. "The computational study of a musical culture through its digital traces." *Acta Musicologica* 2017.

Corpora and datasets



- Purpose
- Coverage
- Completeness
- Quality
- Reusability

Prominent pitch analysis



PitchMelodia

standard mode | Pitch category

Inputs

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

Outputs

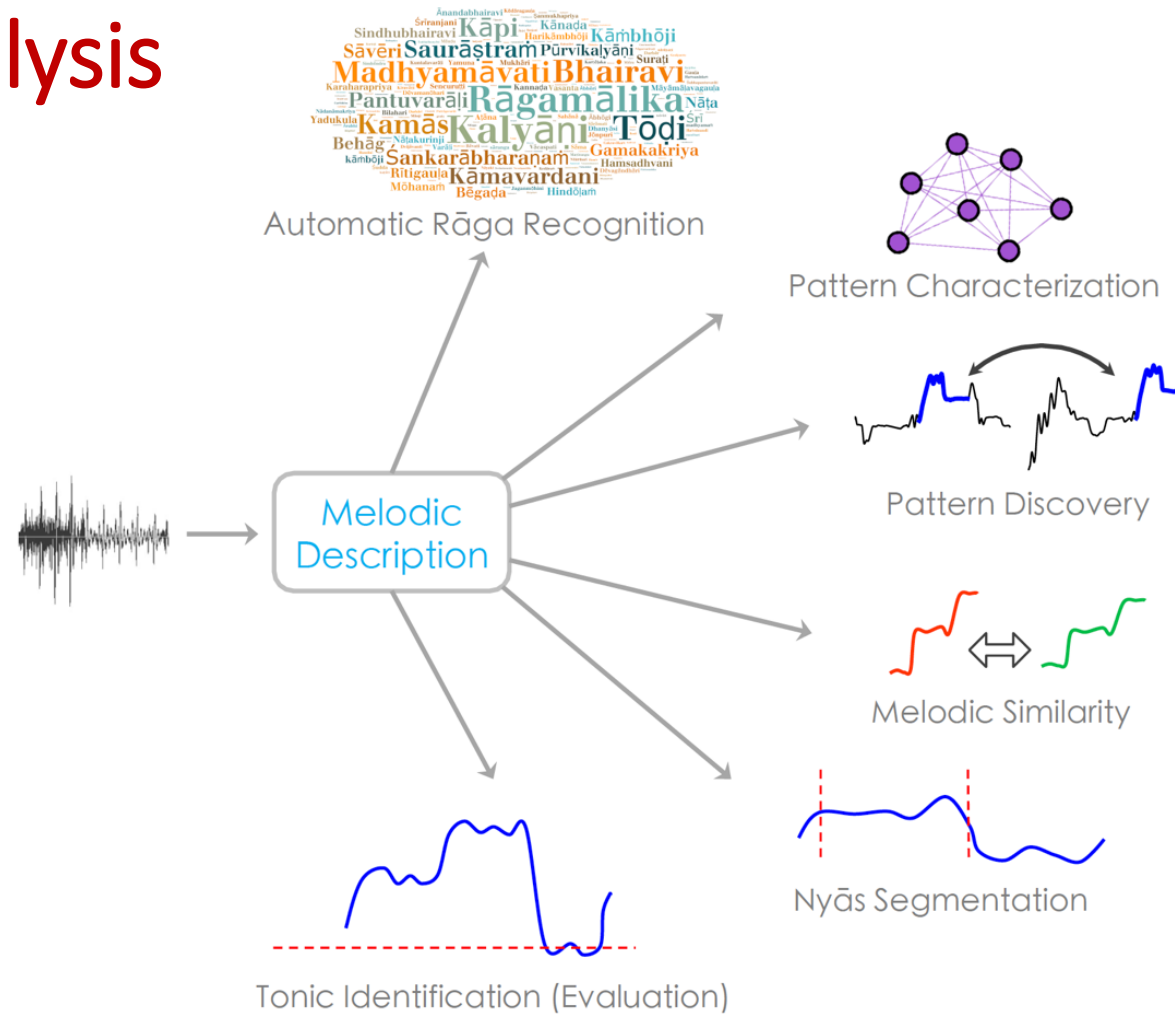
- **pitch** (*vector_real*) - the estimated pitch values [Hz]
- **pitchConfidence** (*vector_real*) - confidence with which the pitch was detected

Parameters

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

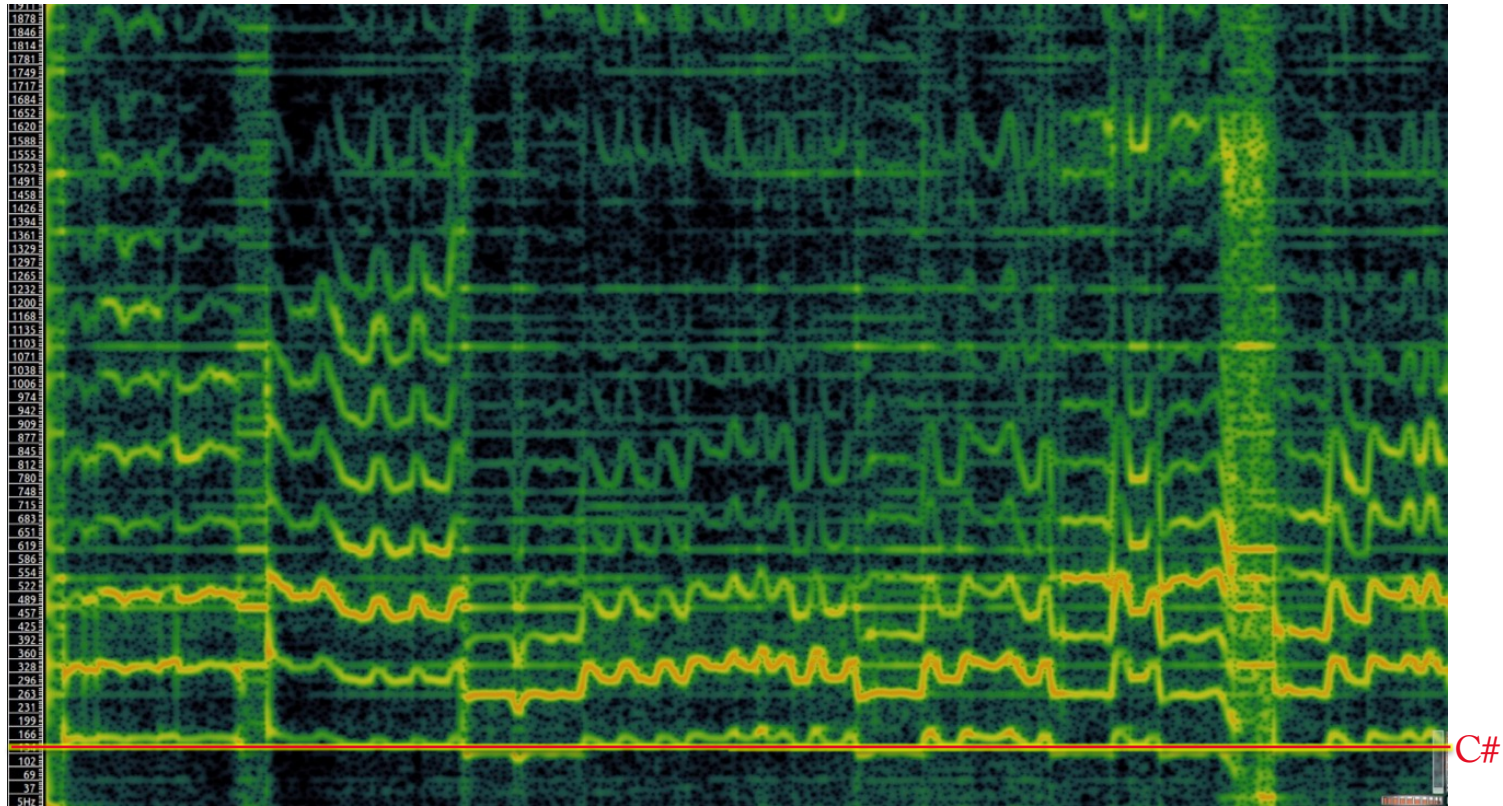
J. Salamon and E. Gómez, "Melody extraction from polyphonic music signals using pitch contour characteristics." IEEE TASLP 2012.

Melodic analysis




S. Gulati. Computational Approaches for Melodic Description in Indian Art Music Corpora. PhD Thesis 2016.

Tonic identification

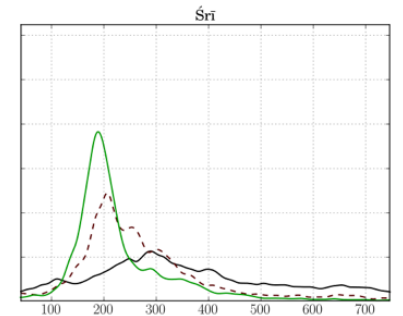
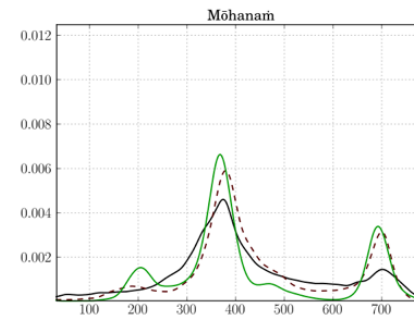
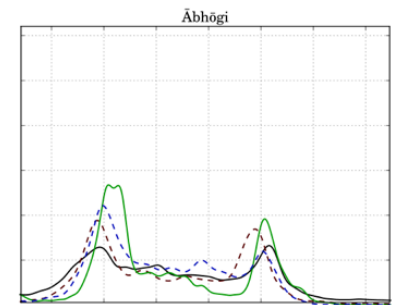
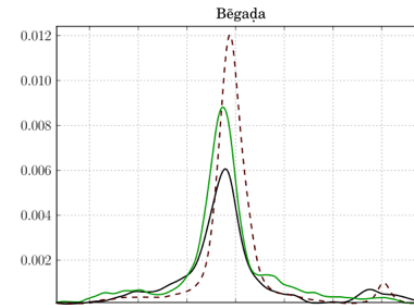
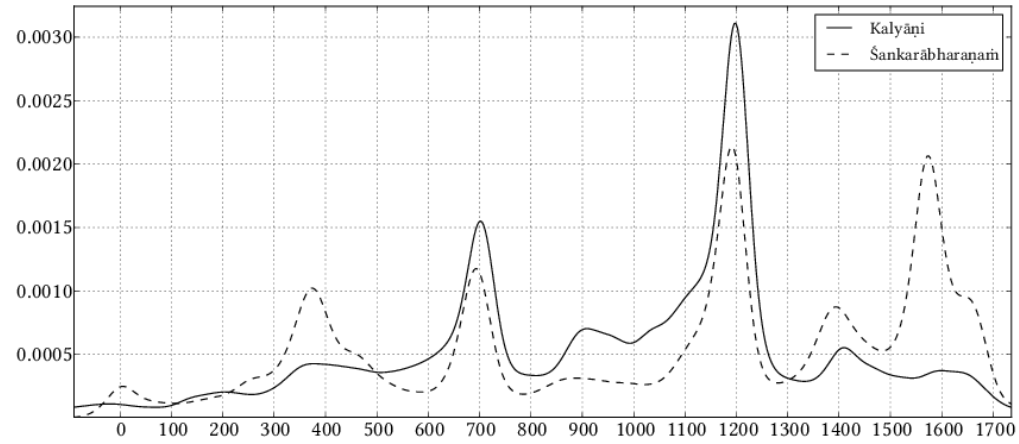


Vignesh Ishwar, Varnam 

Tonic, C# 

S. Gulati et al. "Automatic Tonic Identification in Indian Art Music: Approaches and Evaluation." JNMR 2014.

Intonation

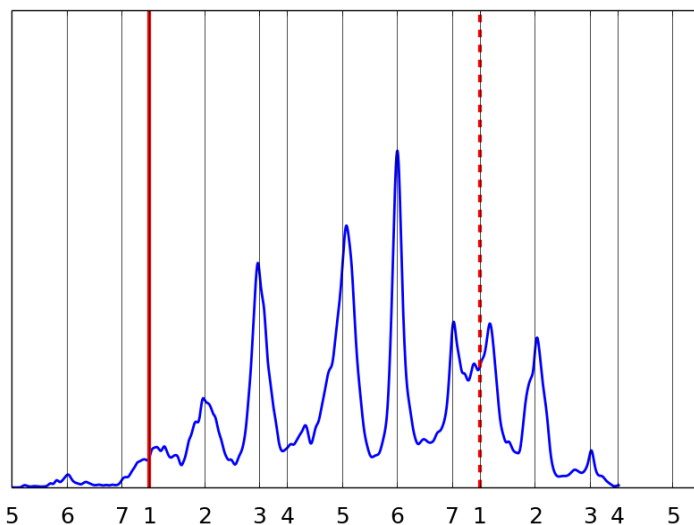


G. K. Koduri et al. "Intonation analysis of rāgas in Carnatic music." JNMR 2014.

Intonation



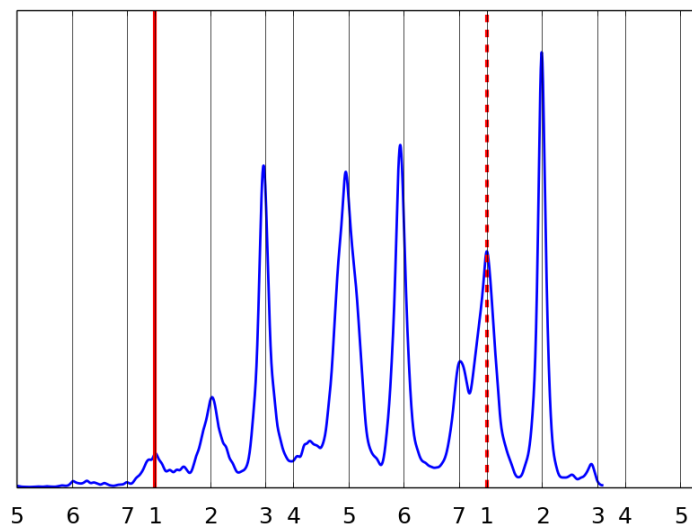
Mei school



1 = 332.56 Hz (E4 + 15.33 cents)



Cheng school

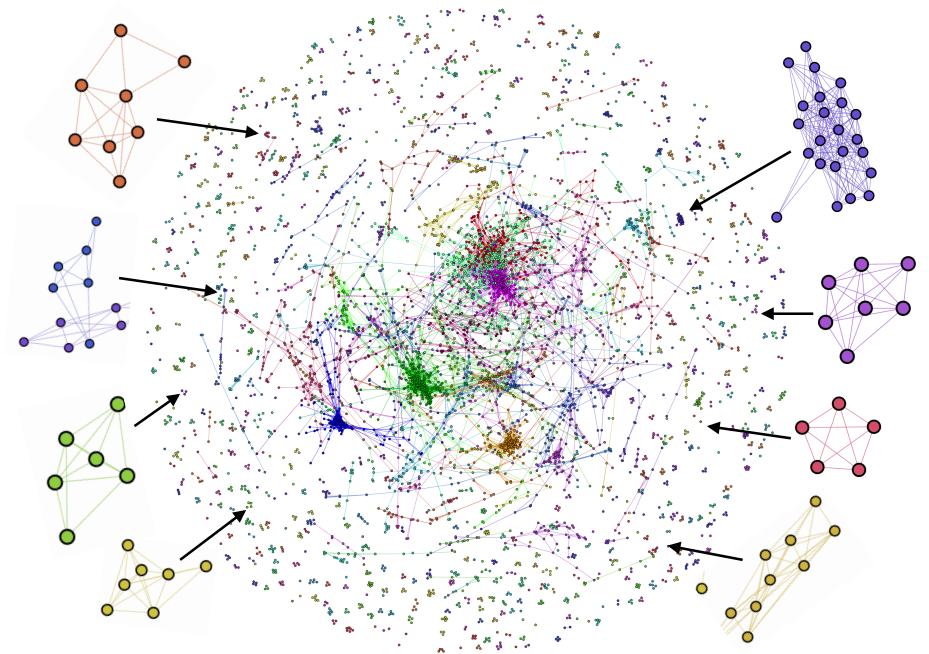
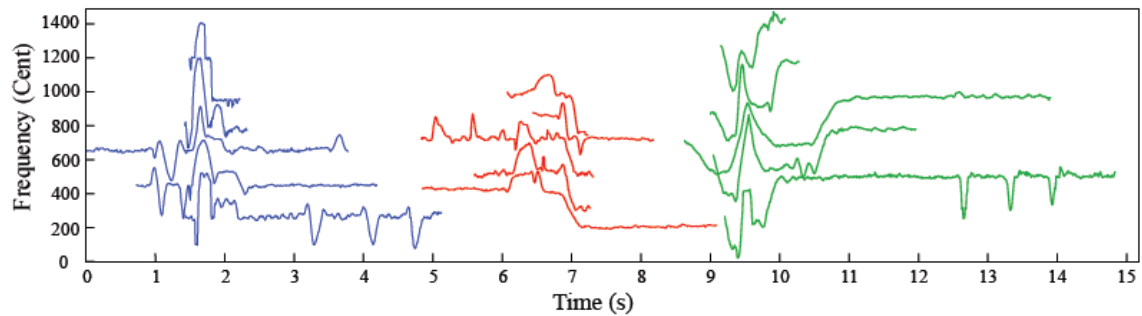


1 = 326.80 Hz (E4 - 14.92 cents)

R. Caro Repetto et al. "Comparison of the singing style of two jingju schools." ISMIR 2015.

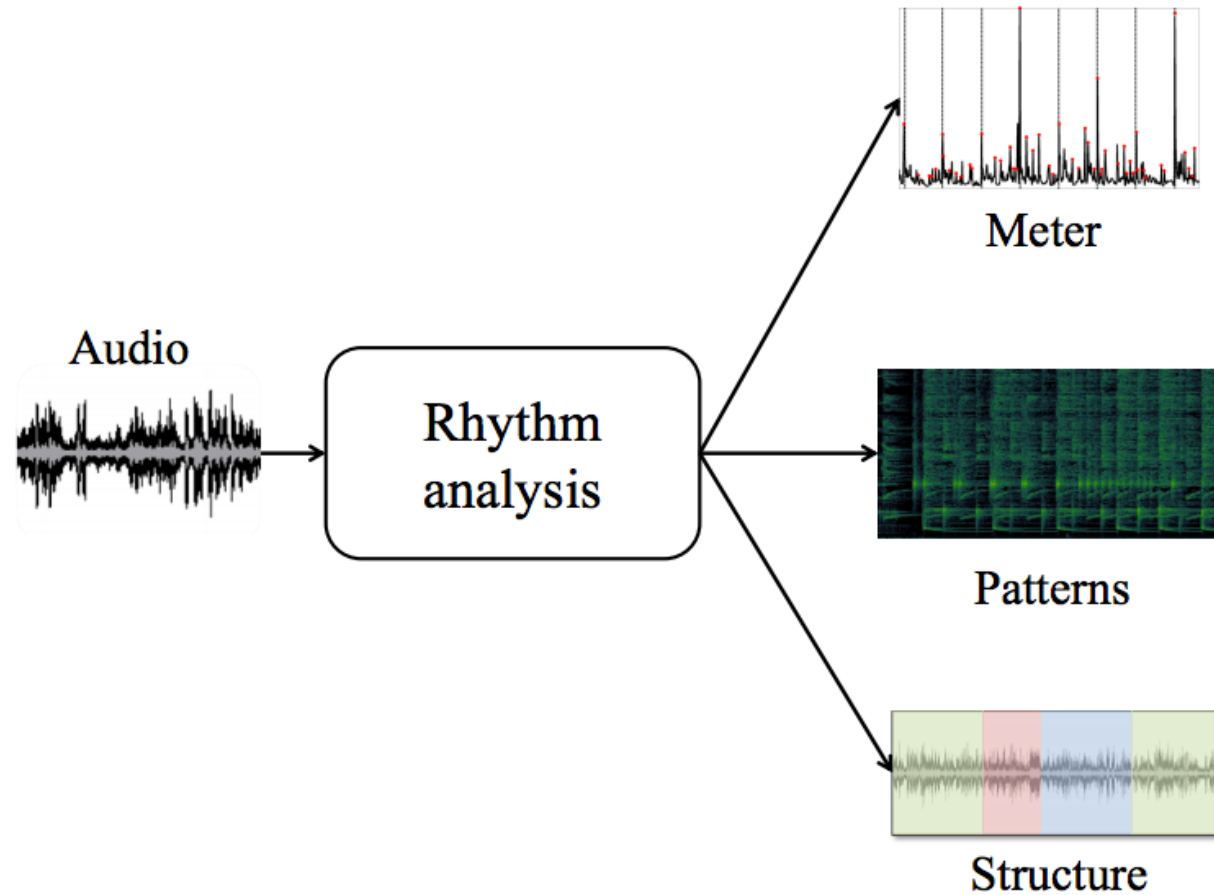
Musical similarity measures

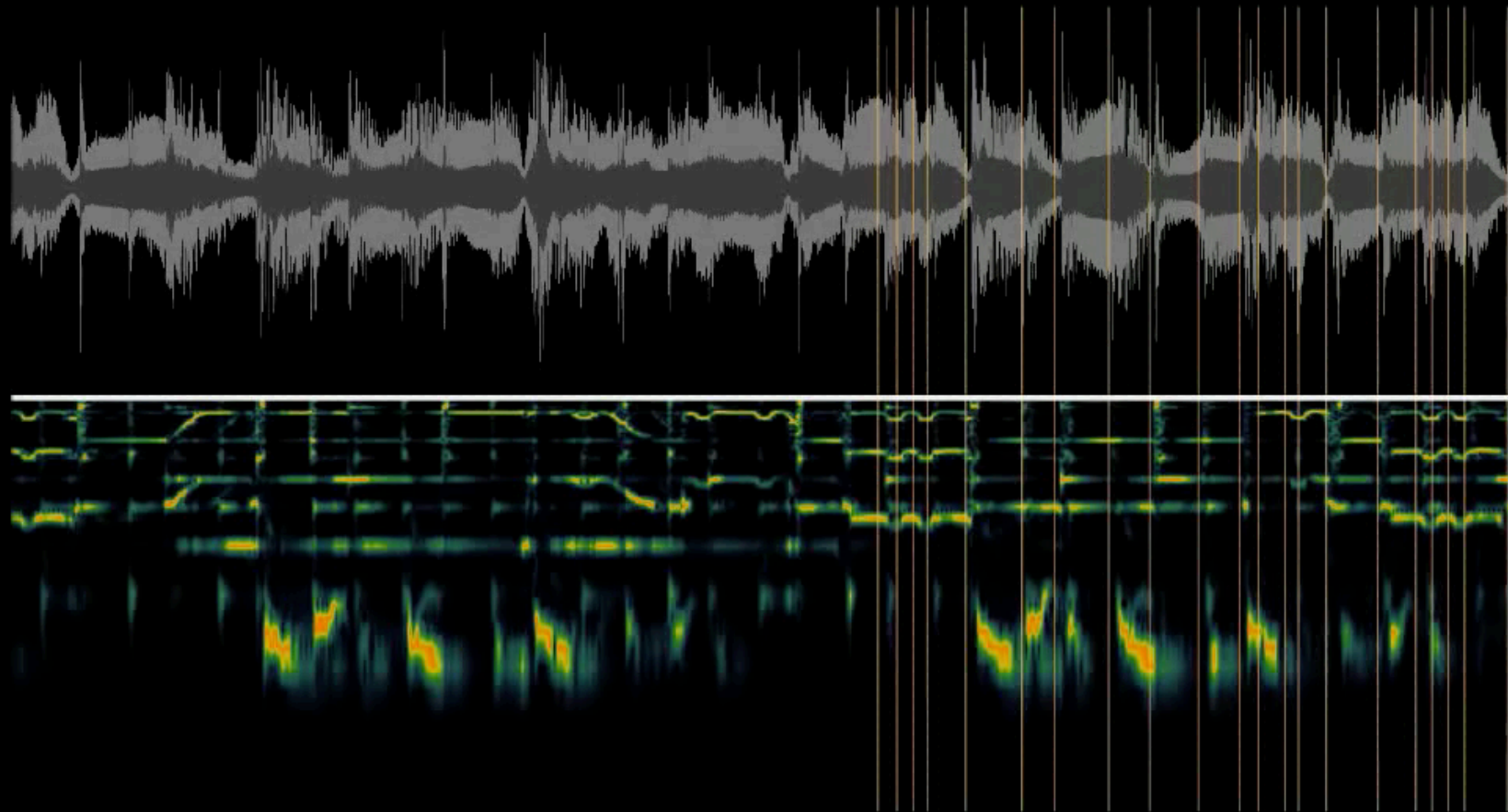
Original:  Similar 1:  Similar 2: 

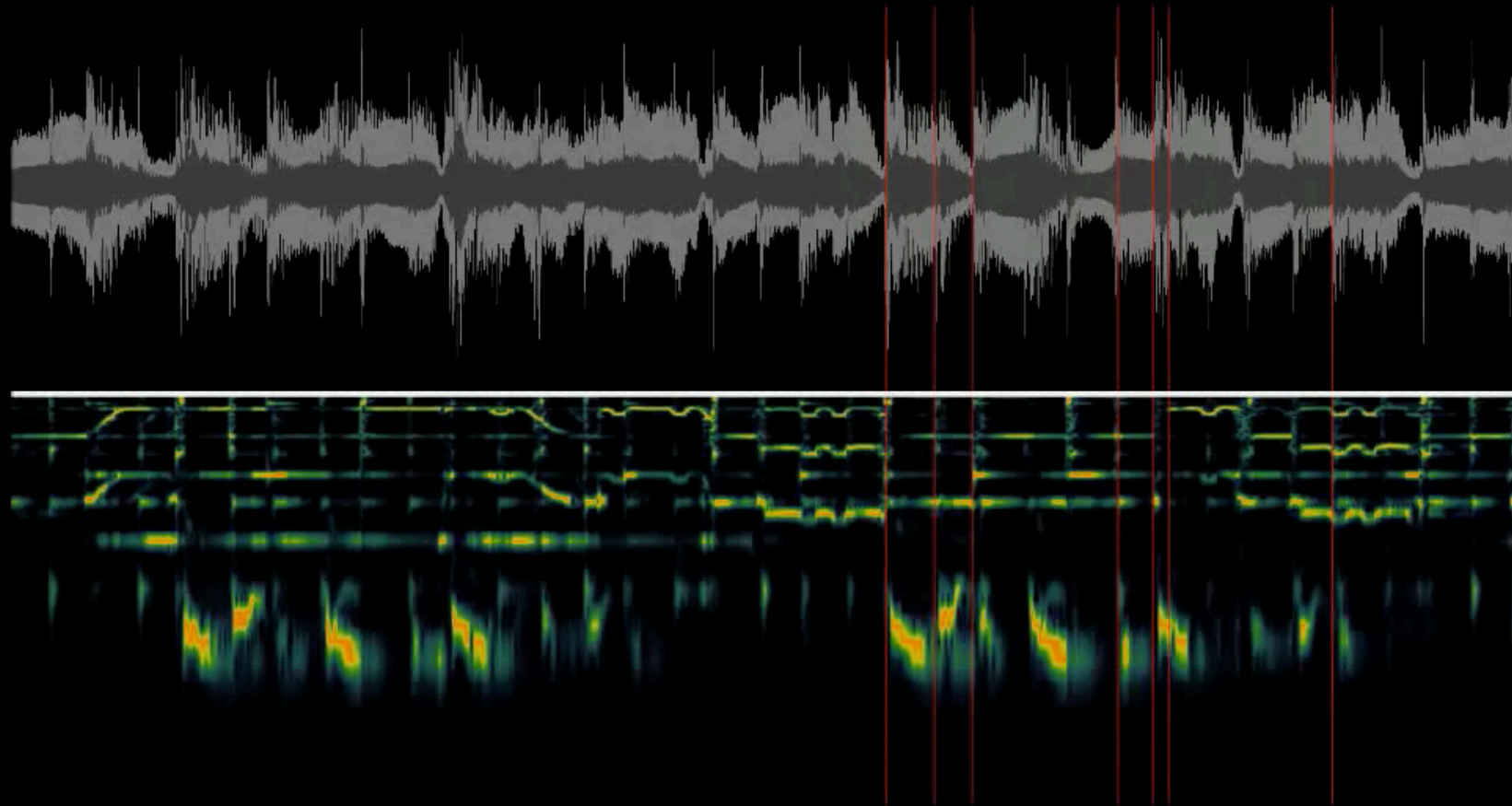


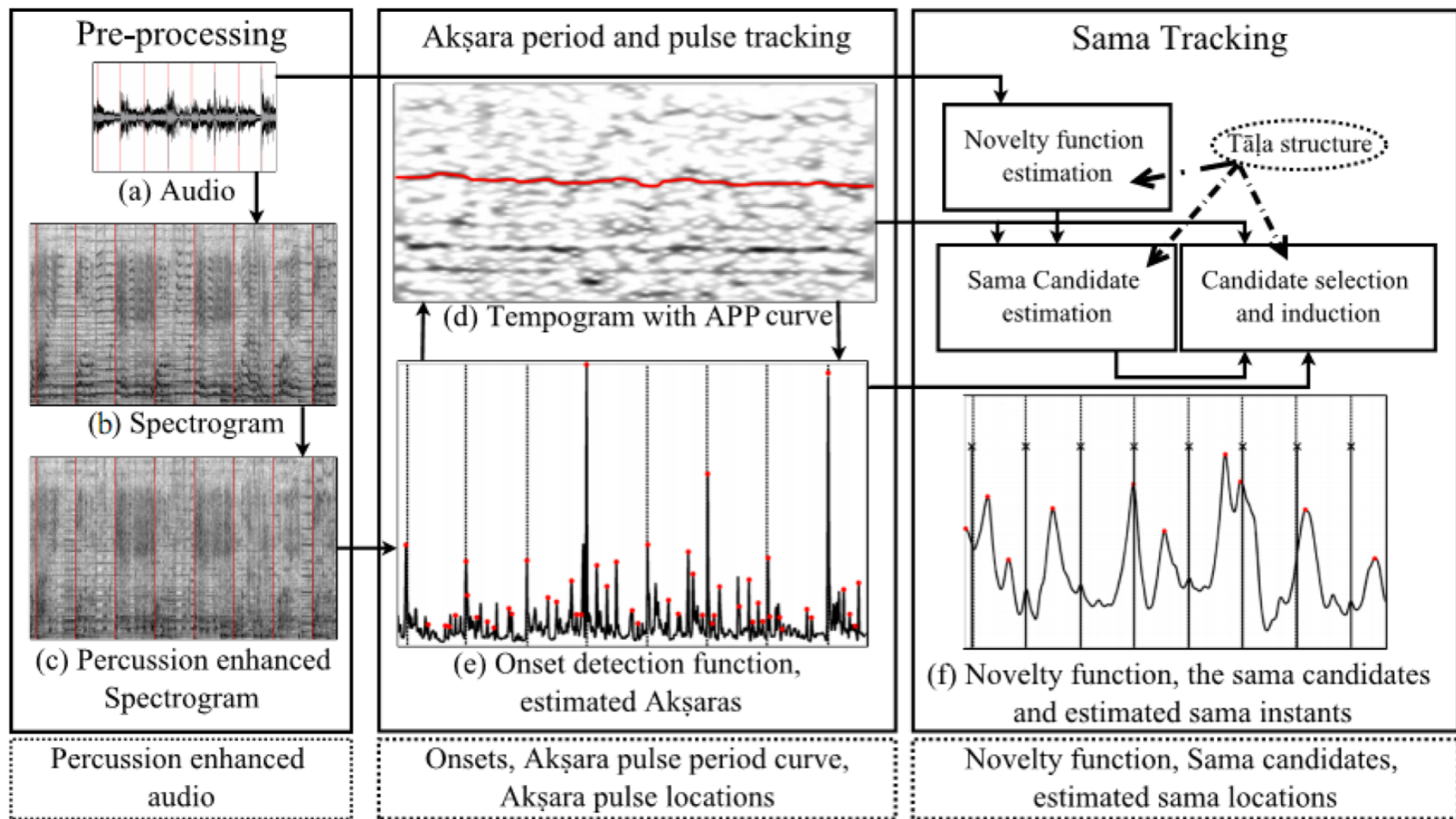
S. Gulati et al. "Improving Melodic Similarity in Indian Art Music using Culture-Specific Melodic Characteristics." ISMIR 2015.

Rhythm analysis

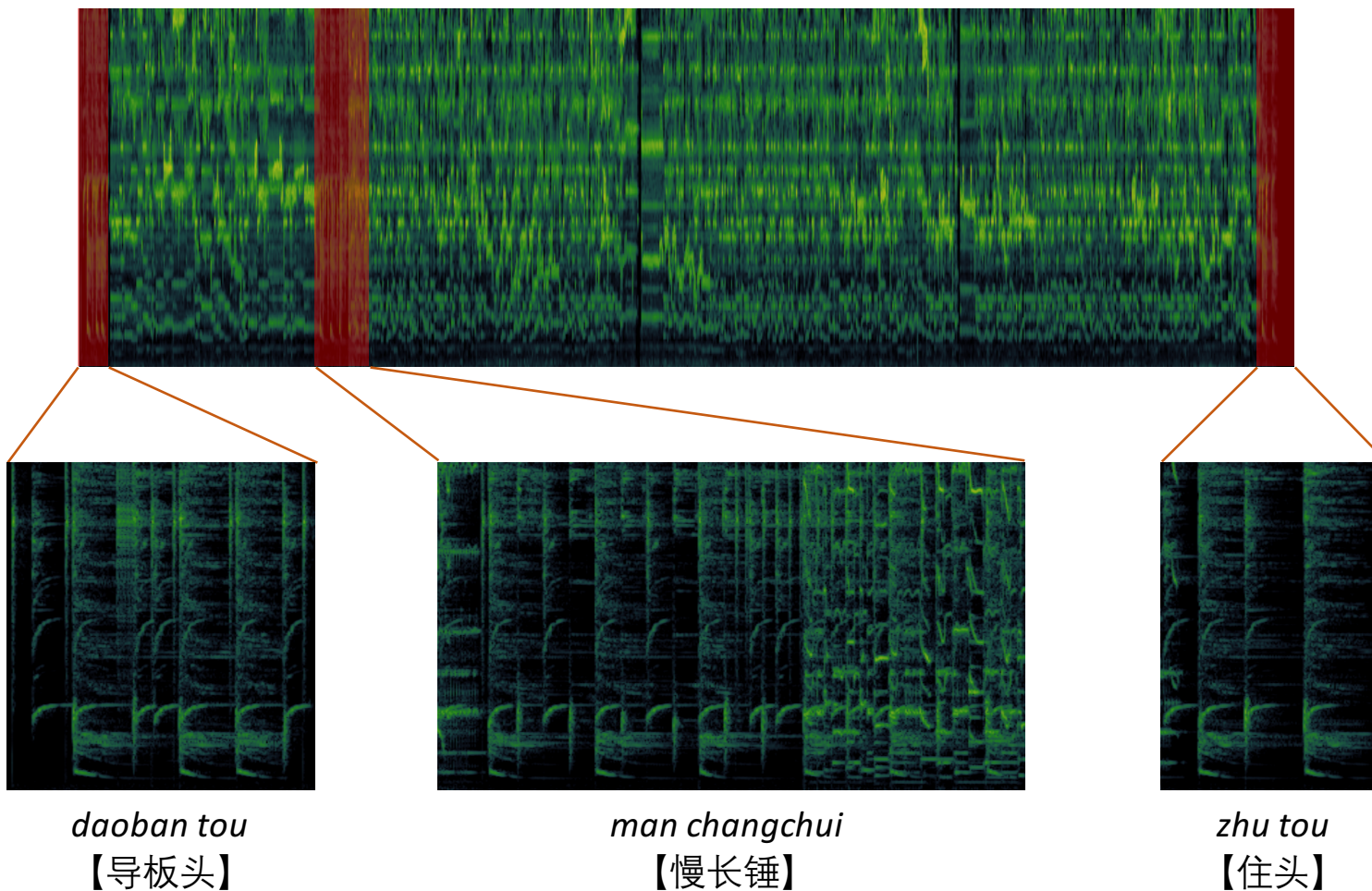








Percussion patterns analysis (beijing opera)



Percussion patterns analysis (beijing opera)

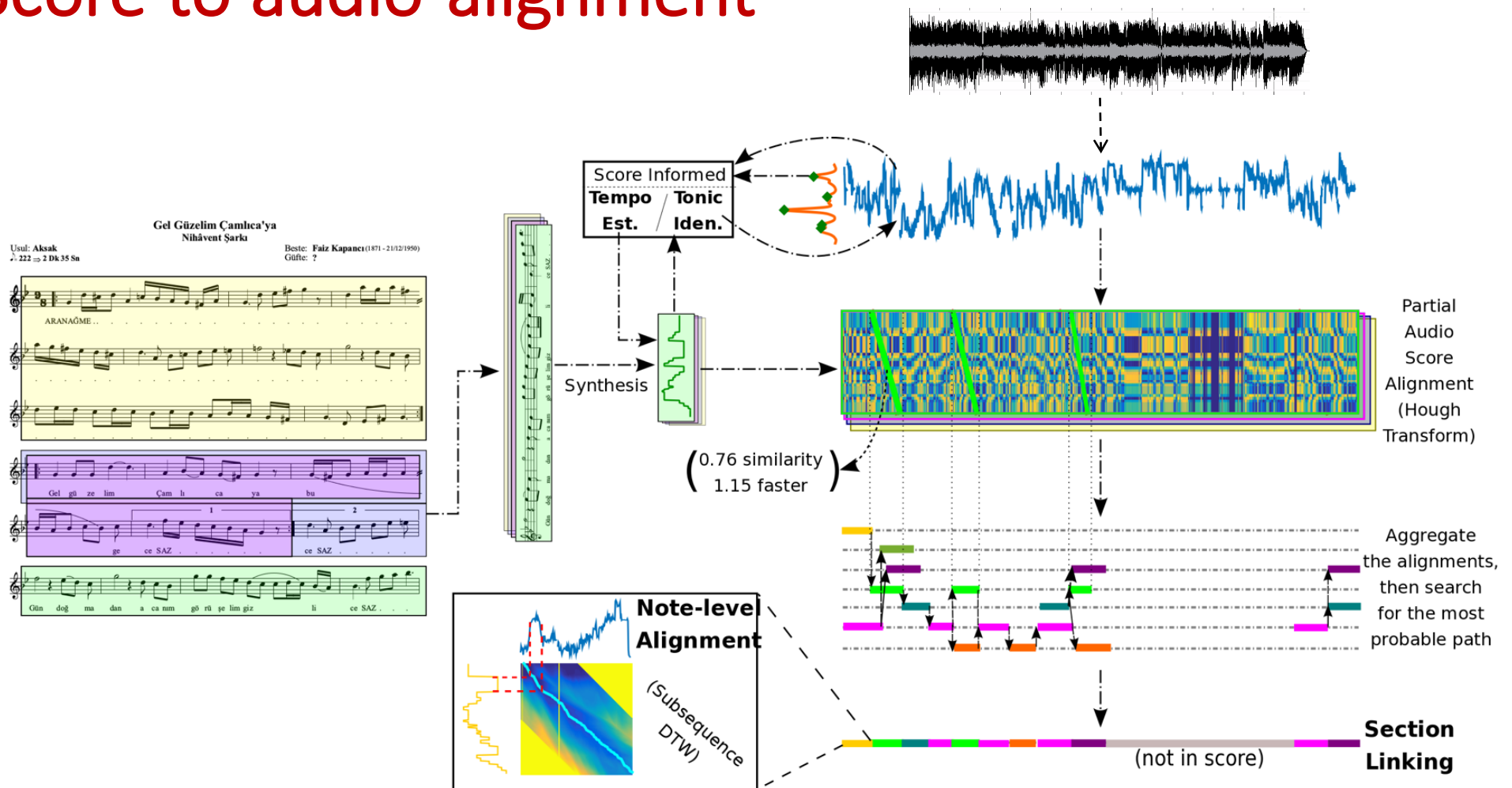
- Search in corpus:

《京剧之星

Pattern	No.
【导板头】	234
【慢长锤】	154
【夺头】	30
【小锣夺头】	66
【闪锤】	53

Album / Track	Ini.	Dur.
京剧之星：包飞专辑/10玉门关：说什么敌众我寡难取胜	0.00	5.75
京剧之星：包飞专辑/10玉门关：说什么敌众我寡难取胜	182.75	11.25
京剧之星：安平专辑/04赤桑镇：恨包勉初为官贪赃枉上	149.75	4.75
京剧之星：安平专辑/06将相和：在金殿定官职是非难辨	258.00	5.5
京剧之星：安平专辑/14姚期：老臣年迈如霜降	0.00	4.75
京剧之星：宋小川专辑/04柳荫记：我好似万箭穿心	0.00	9.25
京剧之星：宋小川专辑/07罗成叫关：勒马停蹄站城道	644.75	5.50
京剧之星：张克专辑/04李逵碑：叹杨家秉衷心大宋扶保	750.00	3.50
京剧之星：张克专辑/06空城计：我正在城楼观山景	0.00	9.00
京剧之星：李军专辑/02珠帘寨：太保推杯换大斗	0.00	4.00
京剧之星：李军专辑/06秦琼卖马：站立店中用目洒	0.00	4.25
京剧之星：李宏图专辑/11白门楼：某一见貂蝉女心如烈火	0.00	8.00
京剧之星：李海燕专辑/05英台抗婚：（祝英台）纸钱飞香烟袅珠泪盈盈	0.00	5.50
京剧之星：李海燕专辑/06龙凤呈祥：（孙尚香）昔日里梁鸿配孟光	7.00	4.25
京剧之星：杜镇杰专辑/02李陵碑：叹杨家秉忠心大宋扶保	802.00	5.00
京剧之星：江其虎专辑/06罗成托兆：黑暗暗雾沉沉随风飘荡	132.75	4.00
京剧之星：王珮瑜专辑/01捉放曹：听他言吓得我心惊胆怕	0.00	8.25
京剧之星：王珮瑜专辑/07搜孤救孤：白虎大堂奉了命	66.25	3.00
京剧之星：王珮瑜专辑/11珠帘寨：昔日有个三大贤	31.75	3.50
京剧之星：耿巧云专辑/10春草闯堂：好话说了千千万	0.00	3.75
京剧之星：袁慧琴专辑/01对花枪：我的家祖居南阳地	948.50	6.50
京剧之星：赵秀君专辑/06楚宫恨：费无极说话太无赖	73.25	3.25
京剧之星：迟小秋专辑/06锁麟囊：一霎时把七情俱已昧尽	641.00	4.50
京剧之星：郑子茹专辑/03对花枪：空盼望气难忍我好心伤	124.50	3.50
京剧之星：陈俊杰专辑/03姚期：老臣年迈如霜降	0.00	4.25
京剧之星：陈俊杰专辑/05将相和：在金殿定官职是非难辨	210.00	6.50
京剧之星：靳学斌专辑/05周仁献嫂：一霎时心儿内横穿万箭	0.00	4.50
京剧之星：黄炳强专辑/04海瑞背纤：与国公替万岁算一算清帐	0.00	4.50
京剧之行：管波专辑/16诤妻嫁妹：素秋女只哭得泪如雨降	372.00	4.50
京剧之行：管波专辑/17诤妻嫁妹：事事万般难猜想	0.00	5.25

Score to audio alignment



S. Şentürk et al. "Towards Alignment of Score and Audio Recordings of Ottoman-Turkish Makam Music." FMA 2014.



Funded by the
European Research Council



Hüseyini Peşrev

by Ahmet Kadri Rizeli

Album

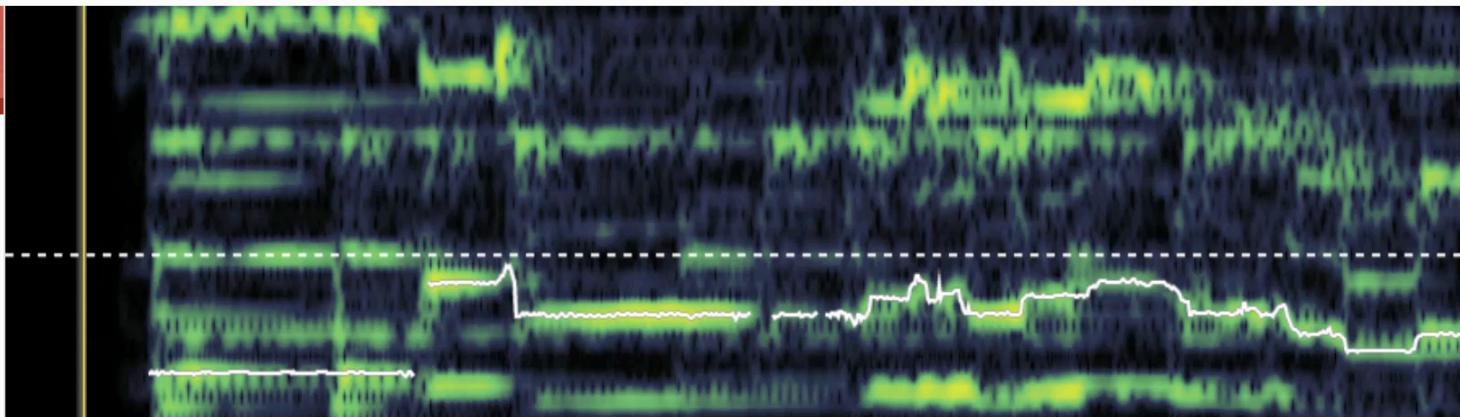
Rum Bestekârlar
(Various Artists)

Compositions

Hüseyini Peşrev

Performers

- [unknown] (Tanbur)
- [unknown] (Ney)
- [unknown] (Kanun)
- [unknown] (Percussion)



A4: 247 Hz

00:00 00:02 00:04 00:06 00:08

[Download data used on this page](#)

2
7 **3. HANE**

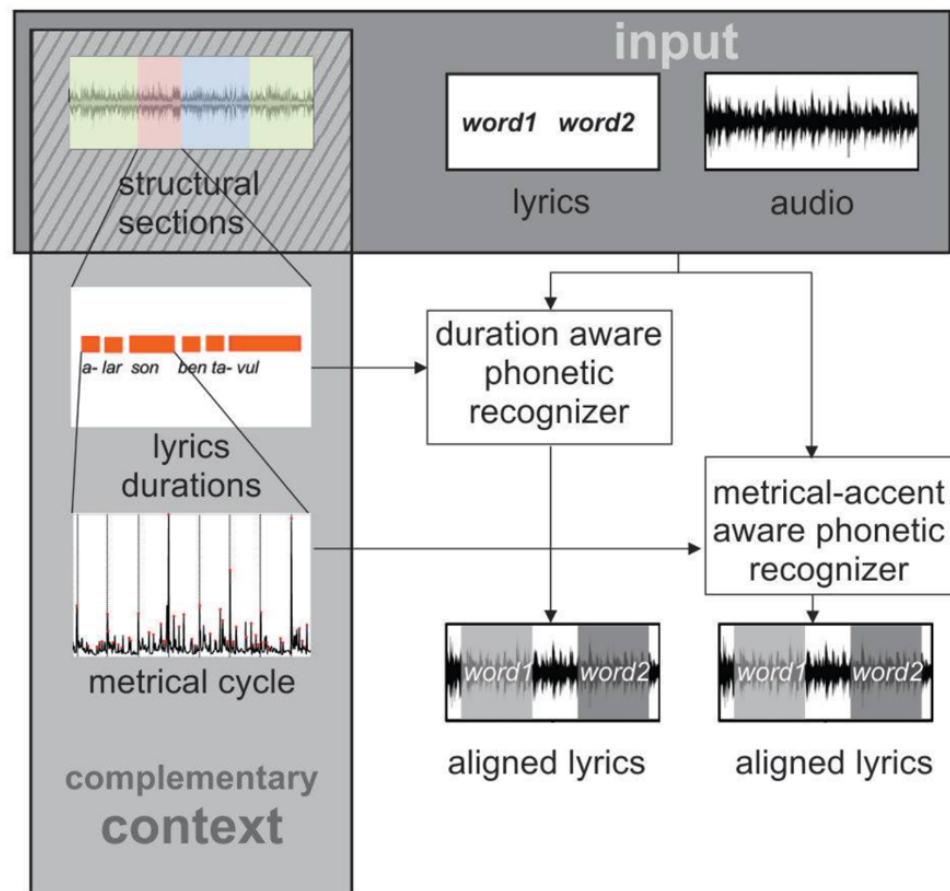
8

9 **TESLİM**



00:00
06:05

Lyrics to audio alignment



G. Dzhambazov. Knowledge-based Probabilistic Modeling for Tracking Lyrics in Music Audio Signals. PhD thesis 2017.



Gel Güzelim Çamlıca'ya

by Münir Nurettin Selçuk

Album

Geçmişten
Günümüze Türk
Müziği - Kalplerden
Dudaklara (Various
Artists)

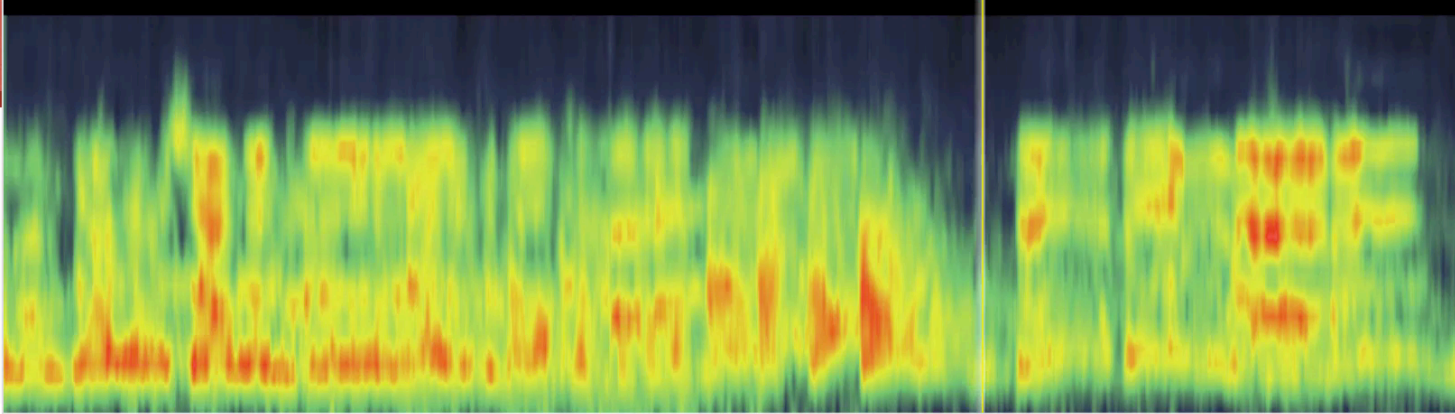
Compositions

Gel Güzelim
Çamlıca'ya



Performers

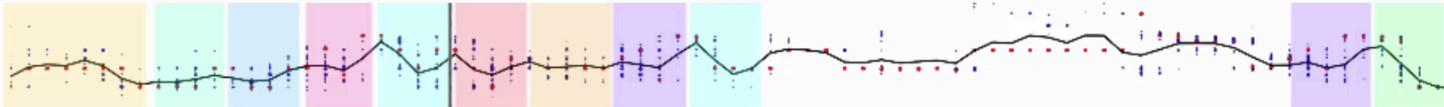
Münir Nurettin
Selçuk(Voice)



00:56 00:58 01:00 01:02 01:04

Gel güzelim Çamlıcaya bu gece
Gel güzelim Çamlıcaya bu gece
Gün doğmadan a canım görüşelim gizlice
Gün doğmadan a canım görüşelim gizlice
Bülbüllerin efganını dinleyelim yanyana
Bülbüllerin efganını dinleyelim yanyana
Kumru gibi a canım sevişelim can cana
Kumru gibi a canım sevişelim can cana

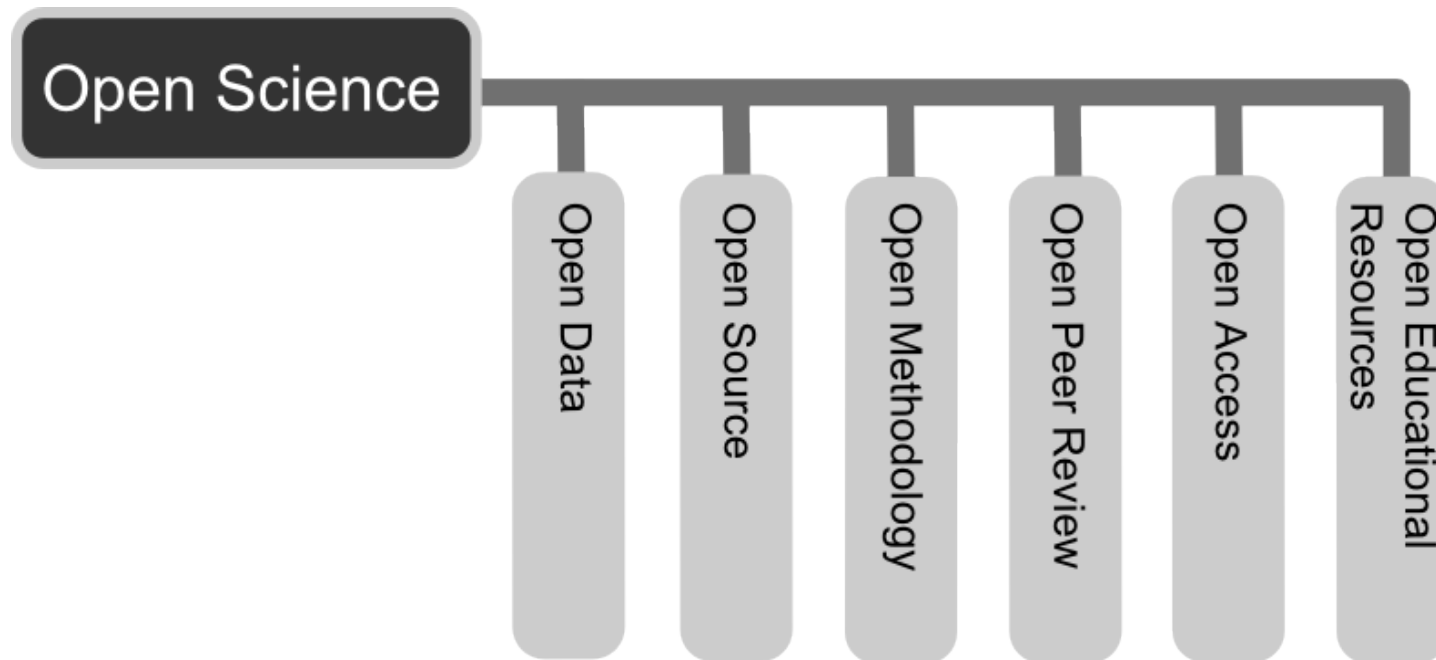
[Return to scores player](#)



01:01

03:16

Open Science (plus reproducibility)



By Andreas E. Neuhold - Own work, CC BY 3.0, <https://commons.wikimedia.org/w/index.php?curid=33542838>



[Contact](#) [About](#) [Register](#) [Developers](#)

Dunya comprises the music corpora and related software tools that have been developed as part of the CompMusic project. These corpora have been created with the aim of studying particular music traditions and they include audio recordings plus complementary information that describes the recordings. Each corpus has specific characteristics and the developed software tools allow to process the available information in order to study and explore the characteristics of each musical repertoire.

Explore our collections



Carnatic



Hindustani



Makam



Jingju



Andalusian

dunya.compmusic.upf.edu

Dunya-desktop

Ottoman-Turkish Makam Music Corpus

COLLECTIONS

- MainCollection
- ussak

Filtering: Acem, Form, Composer, Performer

Title	Artist
Bir Şeh ki Tac-daran Olmakta Hak-i Rahi	[unknown], Bekir Sıdkı
Bir Şeh ki Tac-daran Olmakta Hak-i Rahi	[unknown], Bekir Sıdkı Sezgin
Bir Şeh ki Tac Daran Olmakta Hak-i Rahi	[unknown], Bekir Sıdkı Sezgin
Acem Peşrev (Mansur Ney)	Salih Bilgin
Acem Peşrev (Kız Ney)	Salih Bilgin
Ruhlerin Seyredelim Berki Gül-i Ter Yerine	[unknown], Bekir Sıdkı Sezgin
Kudümün Rahmet Ü Zevk U Safadır Ya Rasulallah	Ahmet Şahin, Bekir Reha Sağbaş, Mehmet Kemiksiz, Derya Türkan, Fatih Zulfikar, Ozer Özel, Sadrettin Özçimi, Ferruh Yarkin
Acem Peşrev	Hamdi Demirci, Dilek Zertunç, Erol Deran, Bosphorus, Gürsel Koçak Gülses, Hürşit Ungay, Firuz Han, Fatih...at Türkelman, Hakan Alvan
Acem Peşrev	Murat Aydemir
Acem Ağırsemai / Efendimsin Cihanda İtibarım Varsa Sendendir	Ahmet Şahin, Atilla Akintürk, Mehmet Kemiksiz, Savaş Ş. Barkçin, E Murat Salim Tokaç, Murat Irkilata
Efendimsin Cihanda İtibarım Varsa Sendendir	Serkan Mesut Halili, Gül Yazıcı, İlhan Yazıcı, Enver Mete Aslan, Çiğdem Kemal Karaoz, Veysel Dalsaldi, Sercan ...Istanbul, Özgür Özgüler, P
Efendimsin Cihanda İtibarım Varsa Sendendir	[unknown], Bekir Sıdkı Sezgin
Saba ki Dest ura Ol Zülfe Muskinab Kokar	[unknown], Bekir Sıdkı Sezgin
Sabaki Dest-ura Ol Zülfe Müşk-i Nab Kokar	[unknown], Bekir Sıdkı Sezgin
Saba ki Dest ura Ol Zülfe Müşkinab Kokar	[unknown], Bekir Sıdkı Sezgin
Ya İlahi. Senden Uddet	Mehmet Kemiksiz, Ersin Çelik, Bezmârâ, Kamil Bilgin, Adem Tosunog Karakaya, Didem Dermen, Bekir Baloğlu...ay Başar, Kemal Caba, Fil

mainui_makam.py

Features: audioanalysis, jointanalysis, notes, melodic_progression, pitch_class_distribution, sections, works_intervals, pitch_distribution, note_models, tonic, tempo, pitch, makam, transposition

3-HANE-D1 Uşşak Sazsemâisi

Time Series: Frequency (Hz) vs Time

1. HANE

MÜLÂZİME

MÜLÂZİME

H. S. Atılı et al. "Synthesis of Turkish Makam Music Scores Using An Adaptive Tuning Approach." FMA 2017.

Reflections

music research
can be
fun...



...and
relevant...



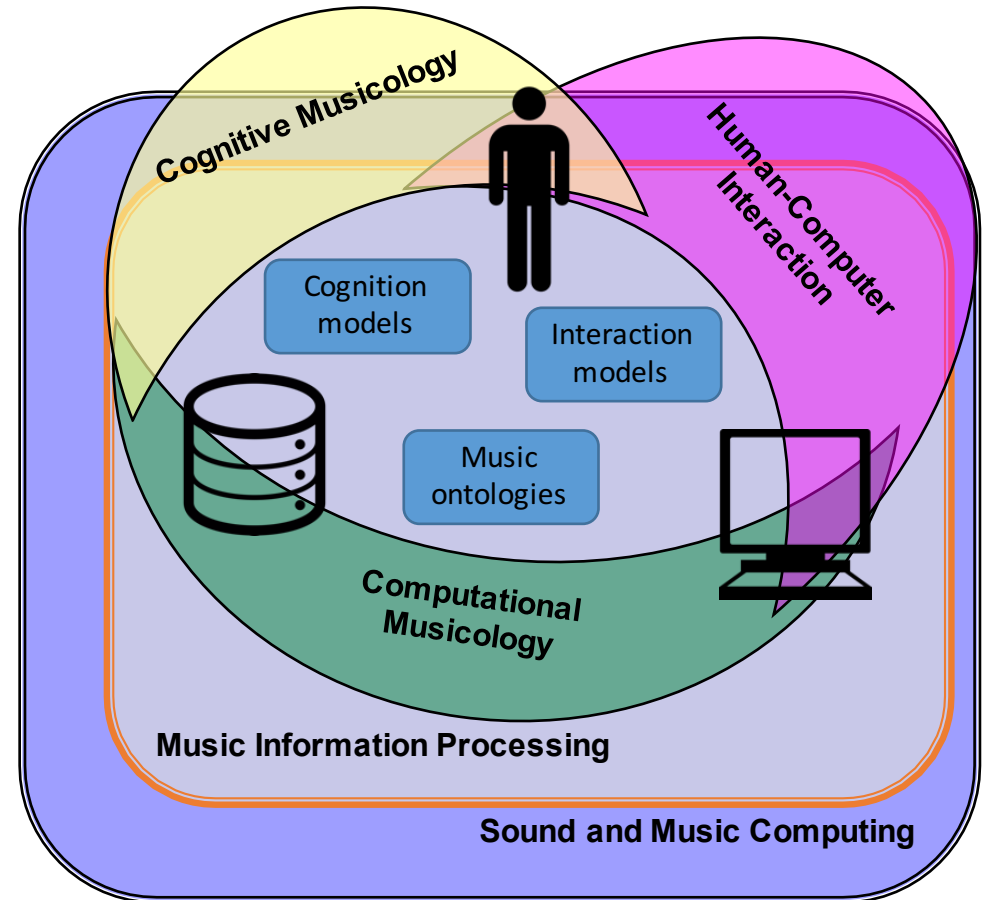
...and
academically
competitive



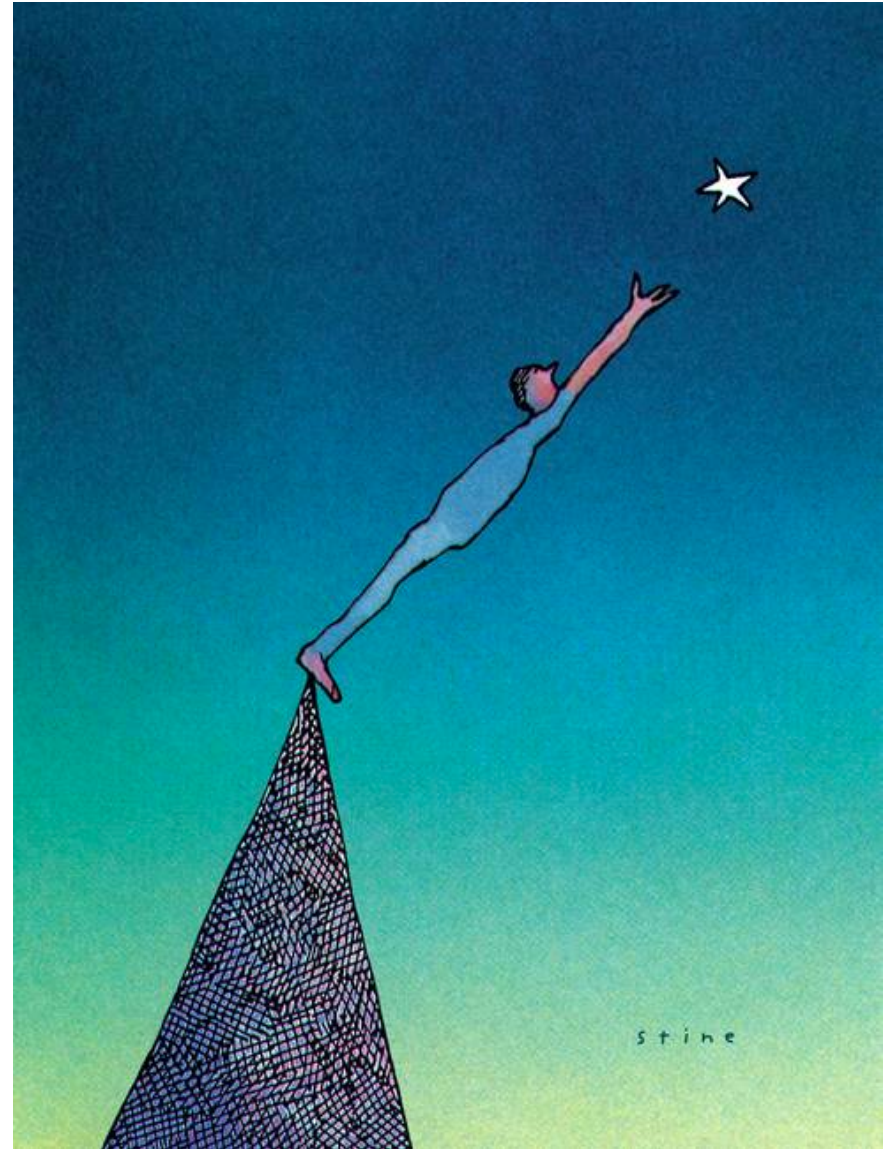
multiculturality



Interdisciplinarity



ambition



impact



open science



continuity



(Perfect) Authentic

in E flat major: I V I

Musical notation for a (Perfect) Authentic cadence in E flat major. The key signature has two flats (Bb and Eb). The time signature is common time (C). The notation is in grand staff (treble and bass clefs). The first measure contains a whole chord (I), the second measure contains a whole chord (V), and the third measure contains a whole chord (I). Vertical lines are placed below the bass clef staff to indicate the root notes of each chord: Eb in the first measure, Bb in the second measure, and Eb in the third measure.

Plagal

in G major: vi IV I

Musical notation for a Plagal cadence in G major. The key signature has one sharp (F#). The time signature is common time (C). The notation is in grand staff (treble and bass clefs). The first measure contains a whole chord (vi), the second measure contains a whole chord (IV), and the third measure contains a whole chord (I). Vertical lines are placed below the bass clef staff to indicate the root notes of each chord: B in the first measure, D in the second measure, and G in the third measure.

Half-cadence

in F major: I M7 II7 V

Musical notation for a Half-cadence in F major. The key signature has one flat (Bb). The time signature is common time (C). The notation is in grand staff (treble and bass clefs). The first measure contains a whole chord (I), the second measure contains a whole chord (M7), the third measure contains a whole chord (II7), and the fourth measure contains a whole chord (V). Vertical lines are placed below the bass clef staff to indicate the root notes of each chord: F in the first measure, F in the second measure, Ab in the third measure, and C in the fourth measure.

(Perfect) Authentic

in D minor: III ii° i V i

Musical notation for a (Perfect) Authentic cadence in D minor. The key signature has two flats (Bb and Eb). The time signature is common time (C). The notation is in grand staff (treble and bass clefs). The first measure contains a whole chord (III), the second measure contains a whole chord (ii°), the third measure contains a whole chord (i), the fourth measure contains a whole chord (V), and the fifth measure contains a whole chord (i). Vertical lines are placed below the bass clef staff to indicate the root notes of each chord: D in the first measure, D in the second measure, D in the third measure, D in the fourth measure, and D in the fifth measure.

in C major: IV M7 V7 I
(temporary modulation to V)

Thanks!!