



Classification Tasks

What can we classify?

What can we identify from music?



Classification Tasks

Genre & Emotion

Genre Classification

Where does one begin?



What does “genre” (musically) mean?

How do you describe “genre”?

Genre Classification

What assumptions do we make?

Classes are **acoustically** and **perceptually** separable

How do we go about selecting relevant acoustic features and parameters thereof?

Genre Classification

Assumption: **Classes are separable**

Perceptual



Genre 1

Genre 2



what are the perceptual features that distinguish these genres?

Genre Classification

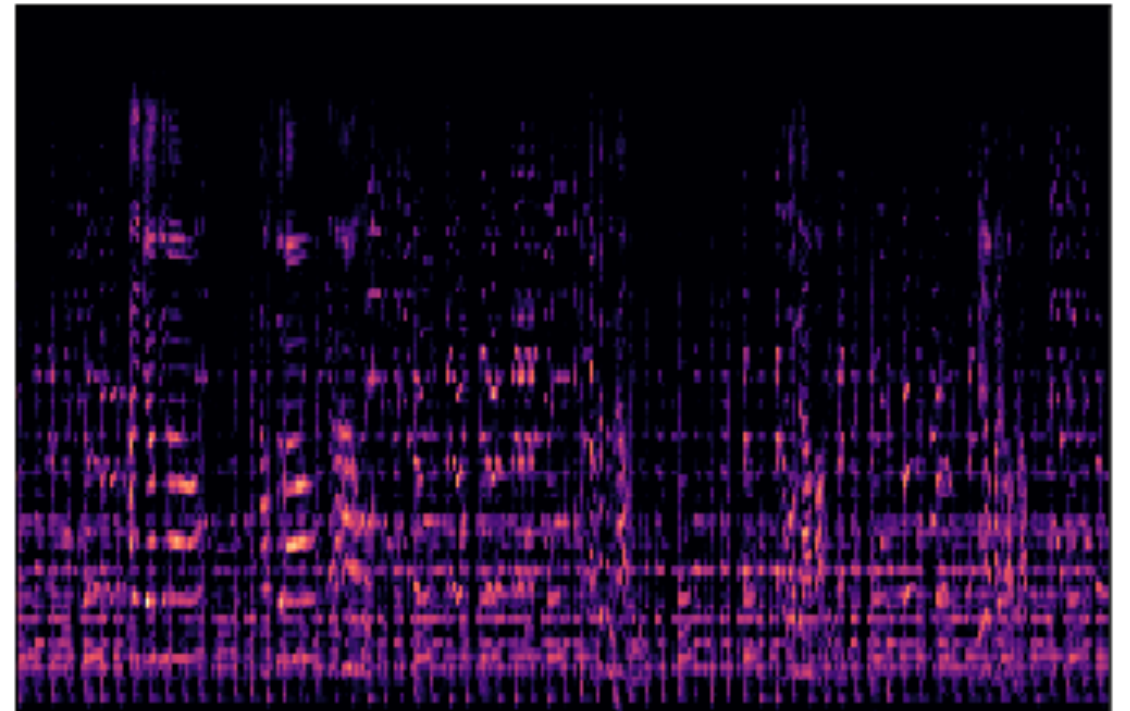
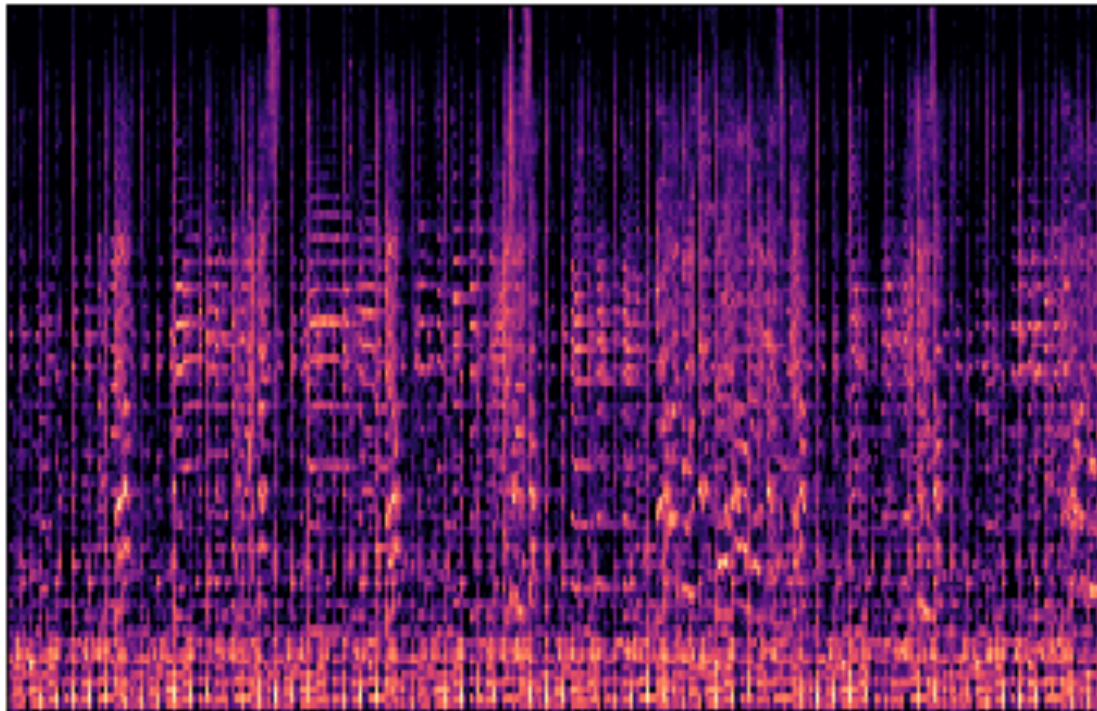
Assumption: **Classes are separable**

Genre 1



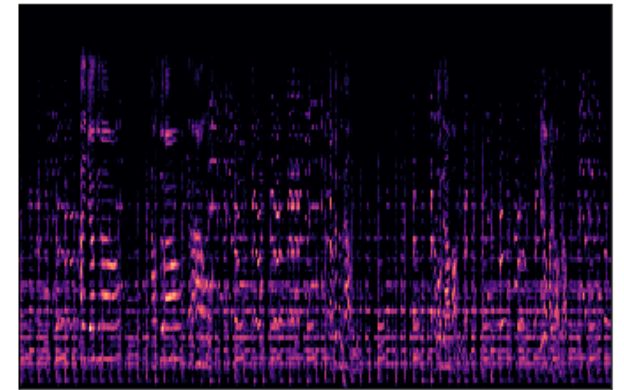
Genre 2

Acoustically

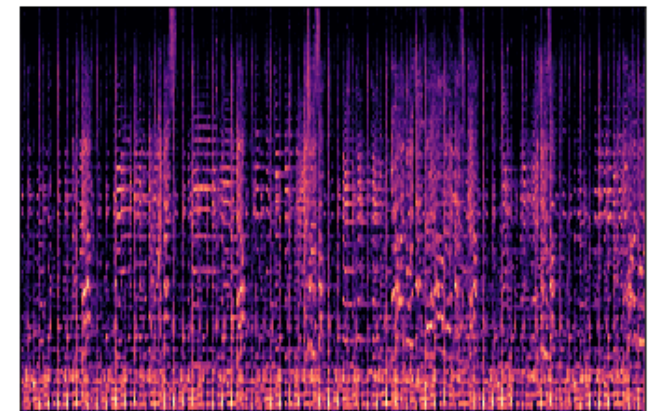


Genre Classification

based on perceptual features can you identify the acoustic features ?



Genre 1



Genre 2

Genre Classification

So what sort of features do i choose?

Timbre

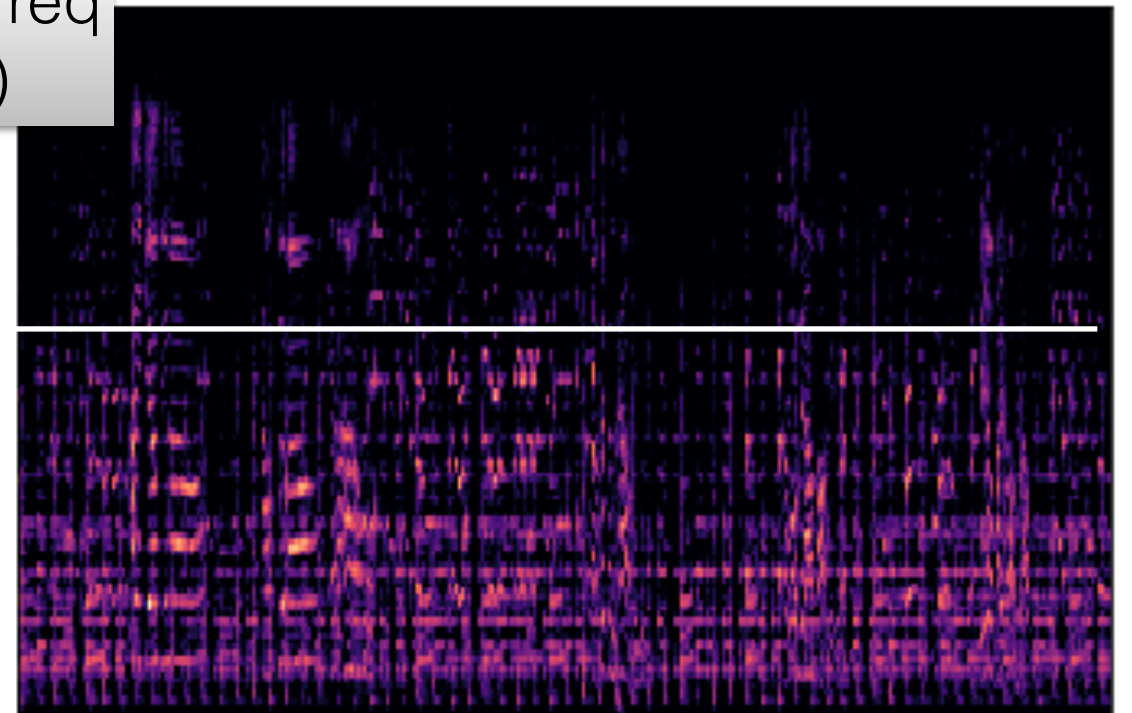
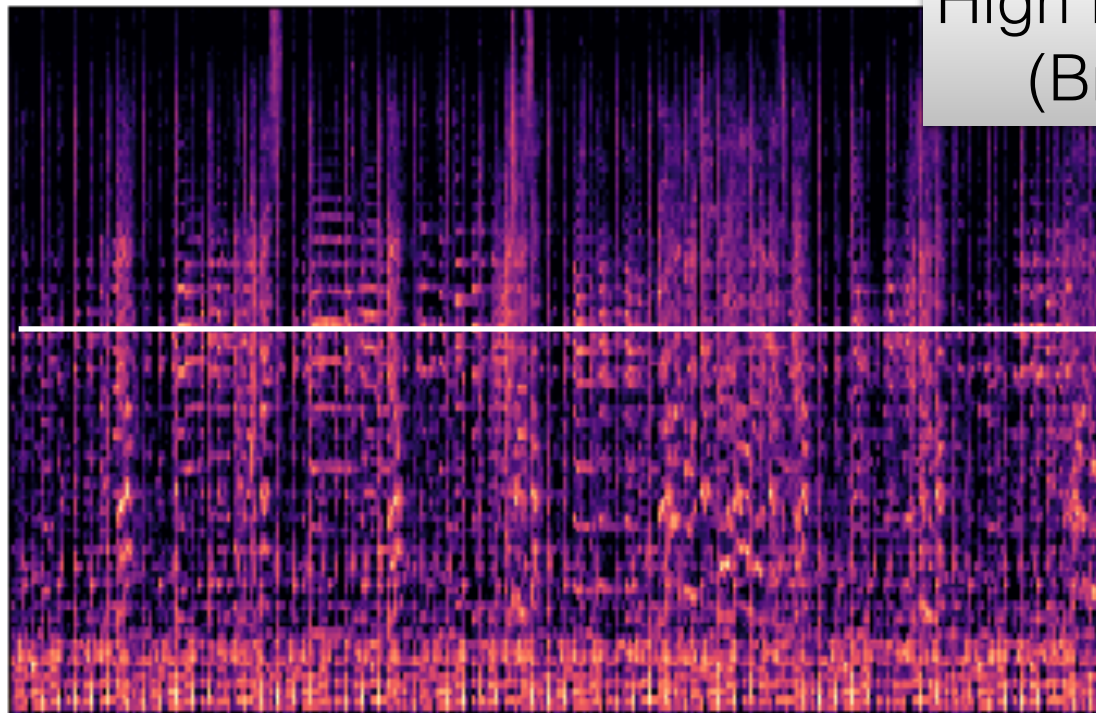
Rhythm

Key/Tonality

Genre 2

Genre 1

High freq/Low freq
(Brightness)



Spectral Centroid

Genre Classification

So what sort of features do i choose?

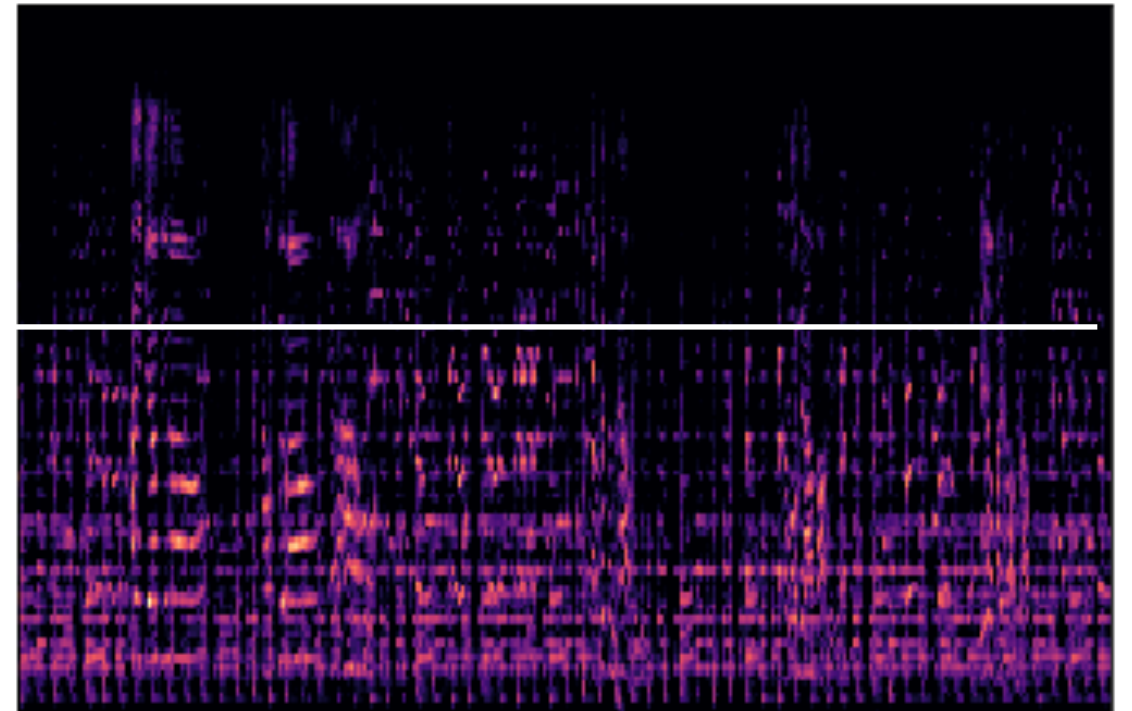
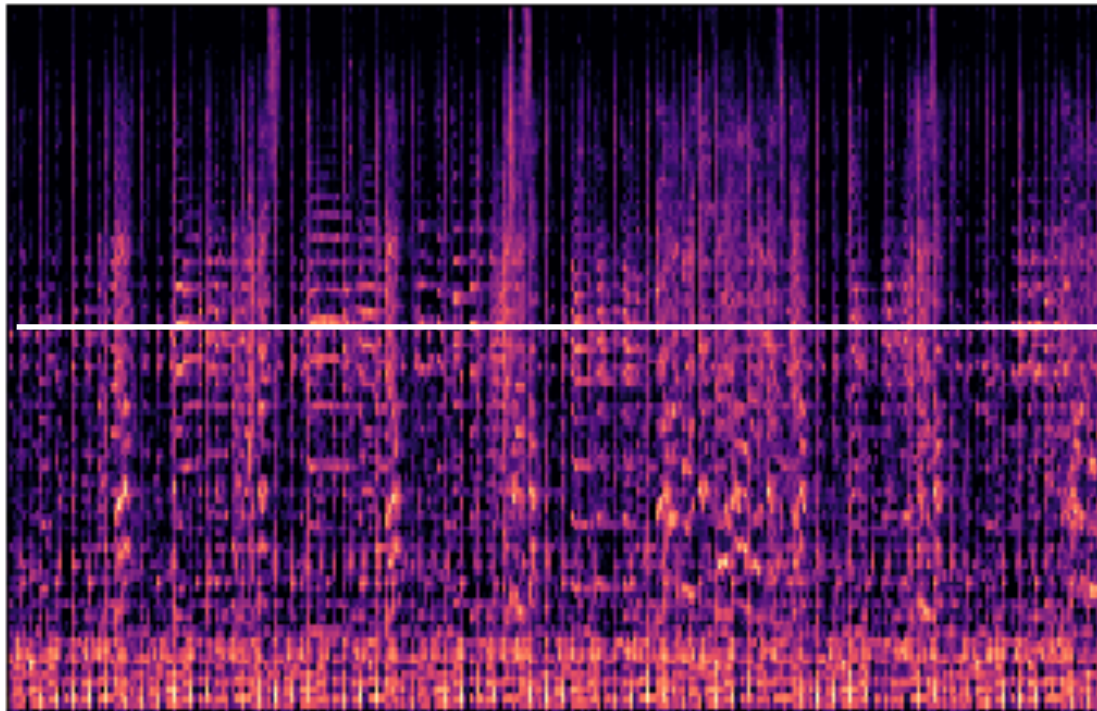
Timbre

Rhythm

Key/Tonality

Genre 2

Genre 1



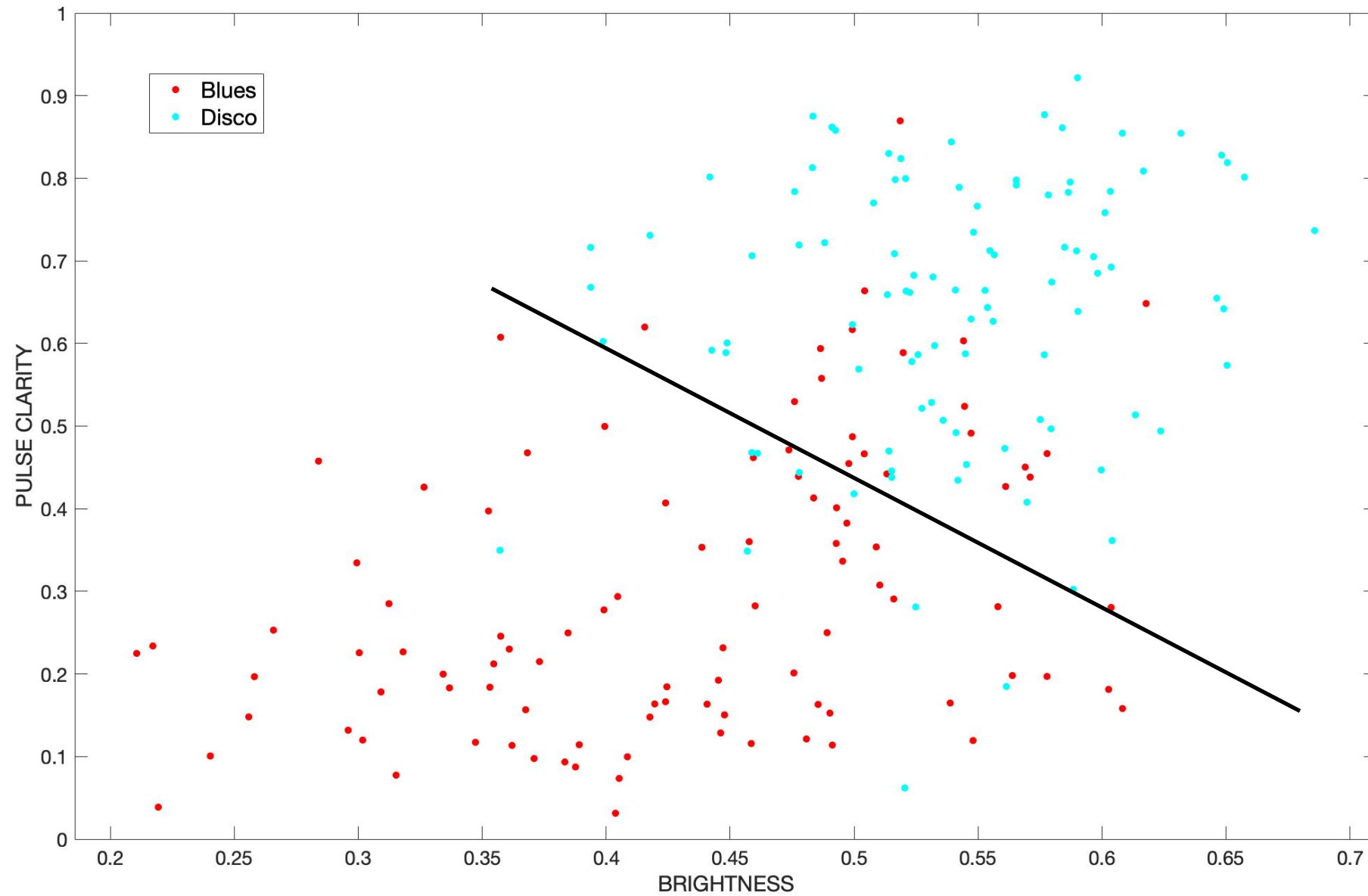
Tempo?

Pulse Clarity?

Genre Classification

Acoustic feature selection

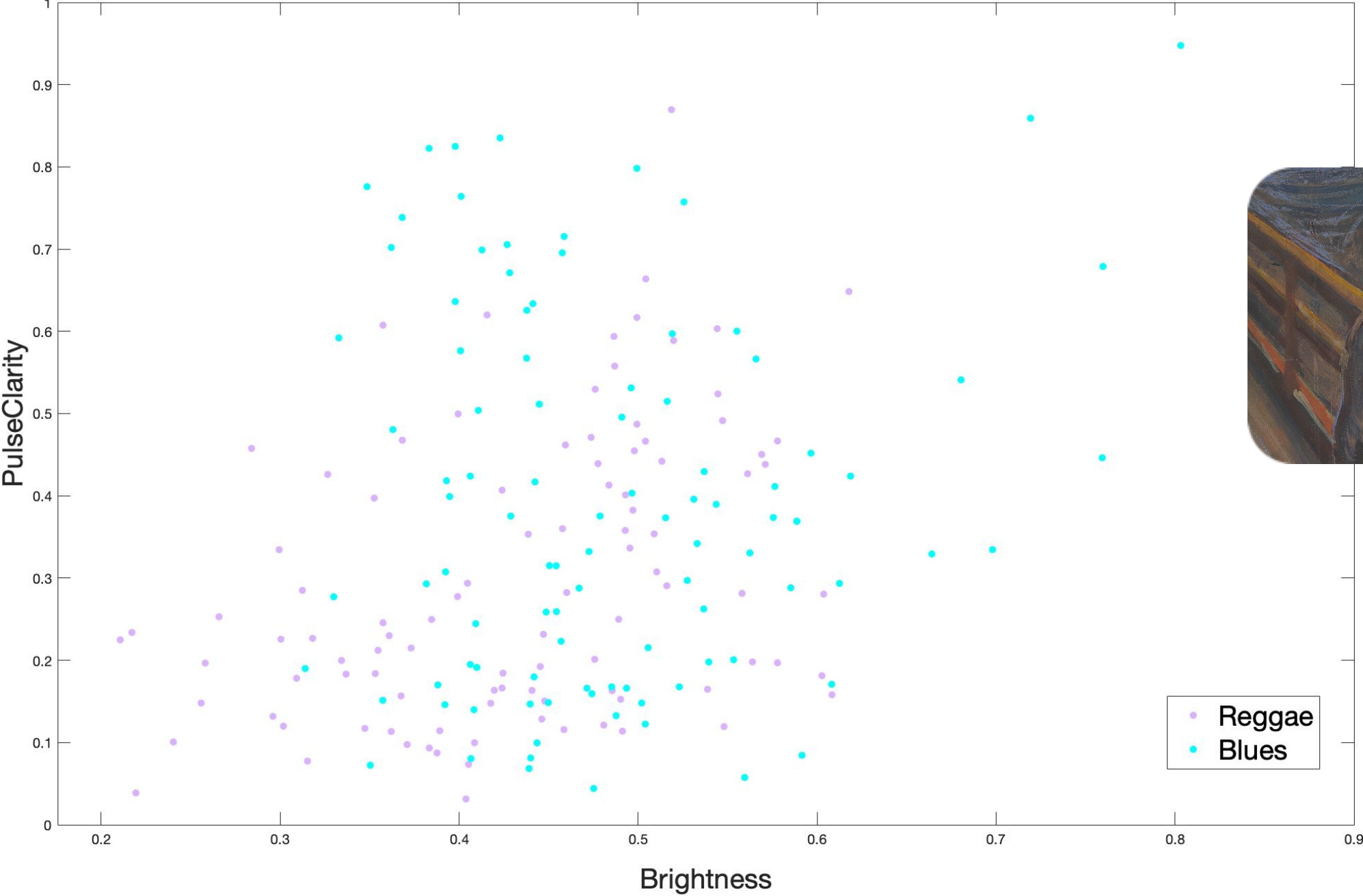
Rhythm



Timbre

Genre Classification

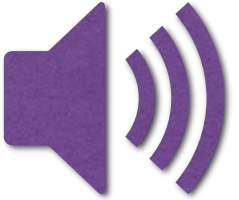
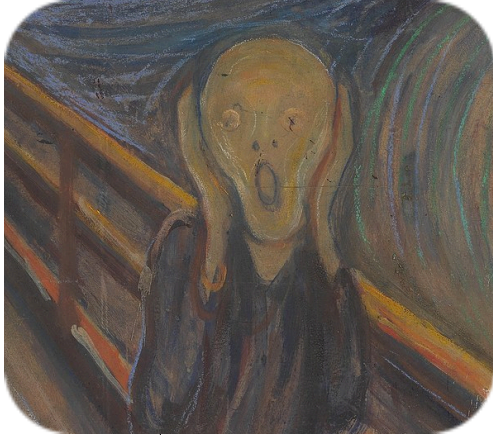
Genre 1 Acoustic feature selection **Genre 2**



Rhythm



Timbre

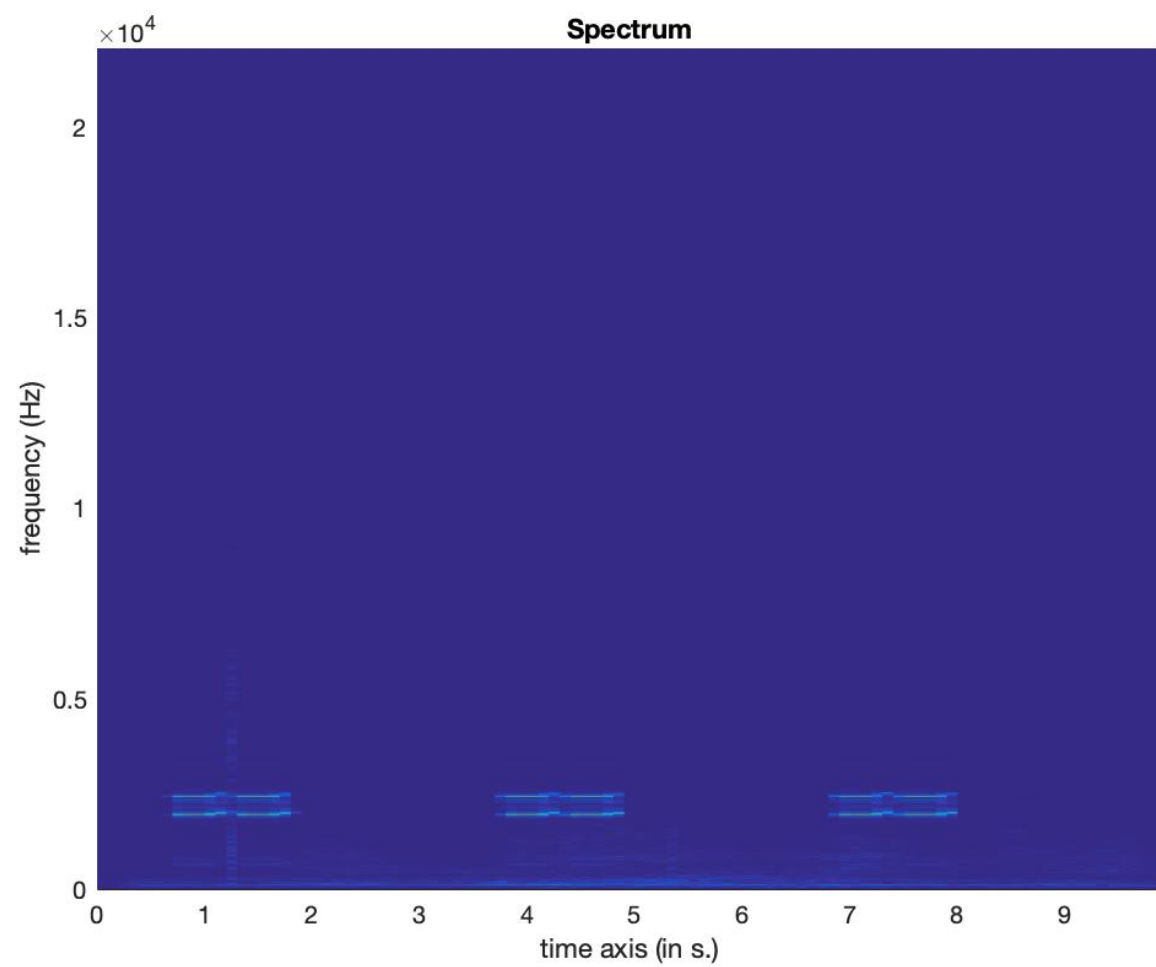




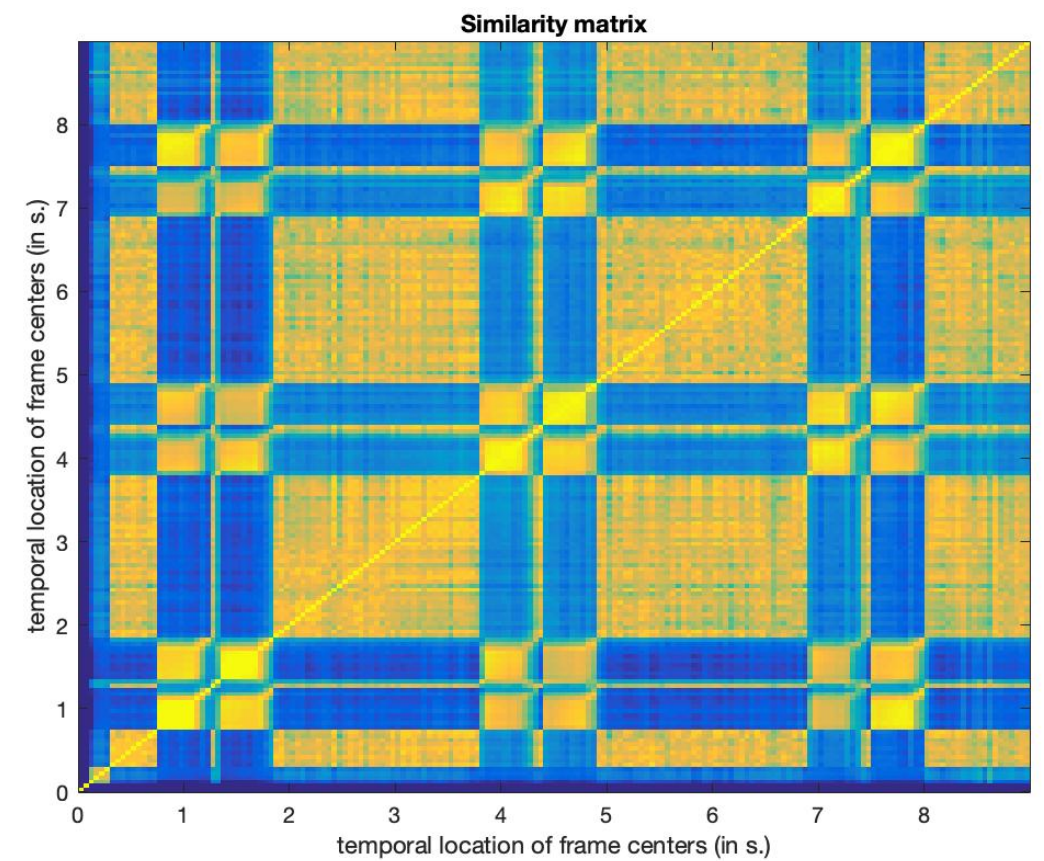
Visualizing Genres (Structure) guess the genre?



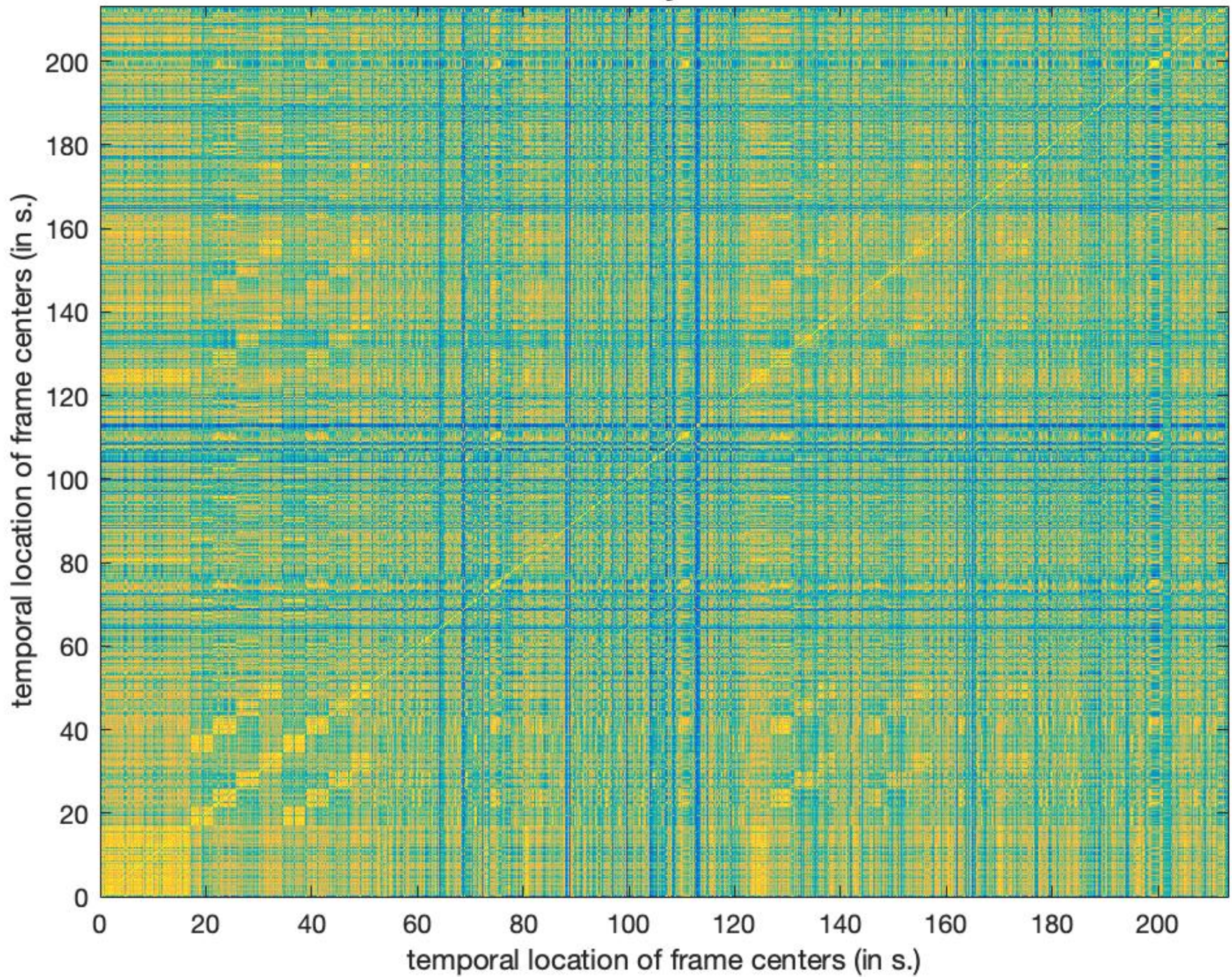
**Musical Feature(s)
to
Musical Structure**



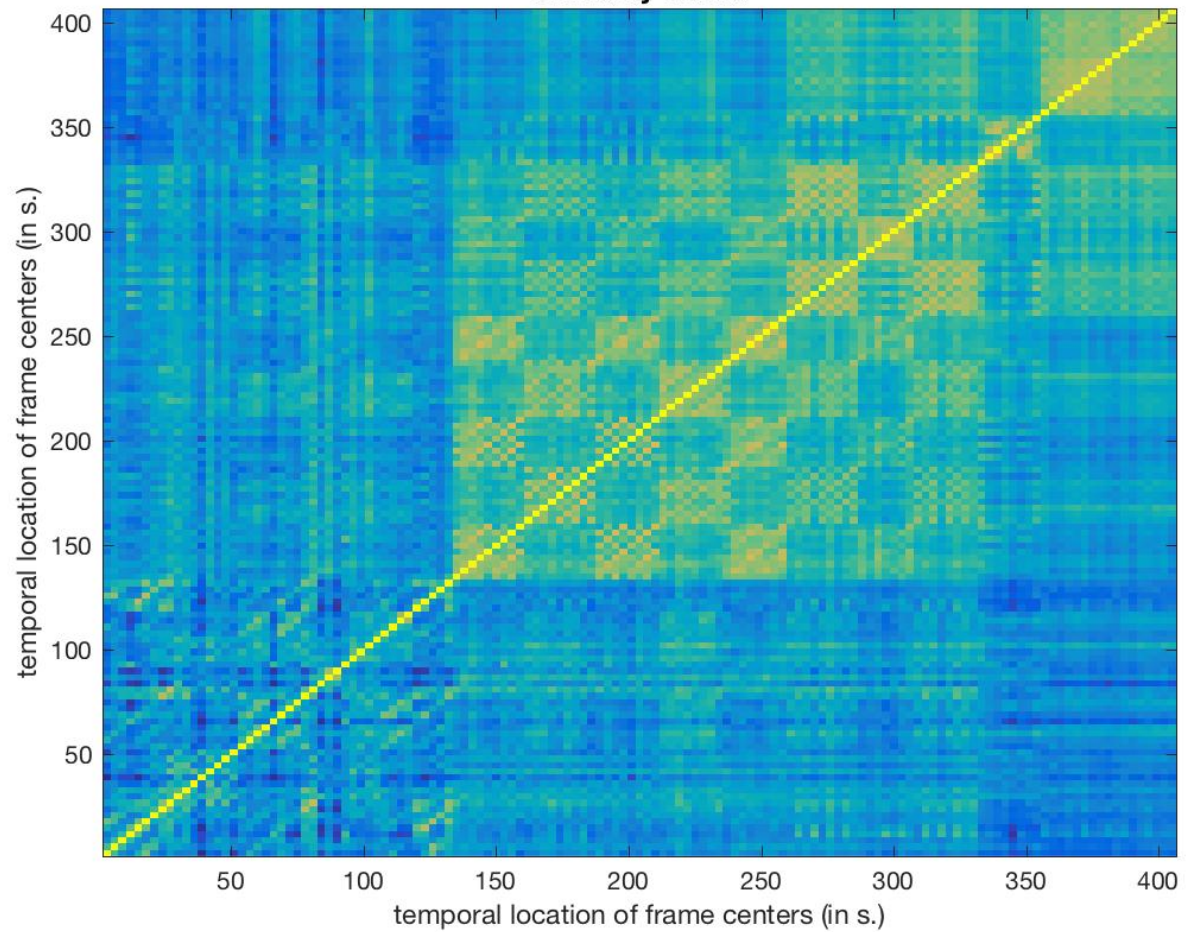
How does the structure of this part of the piece look like?



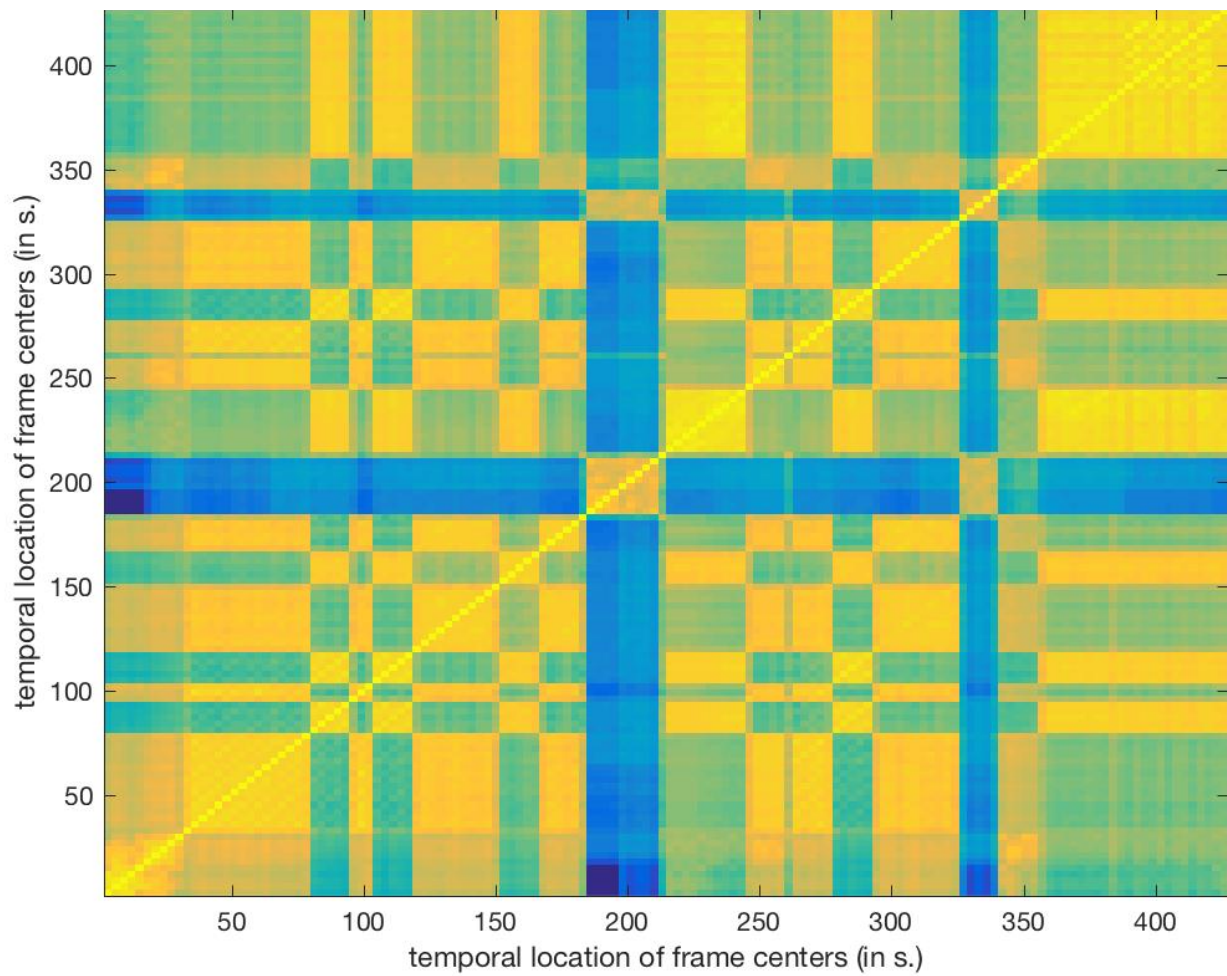
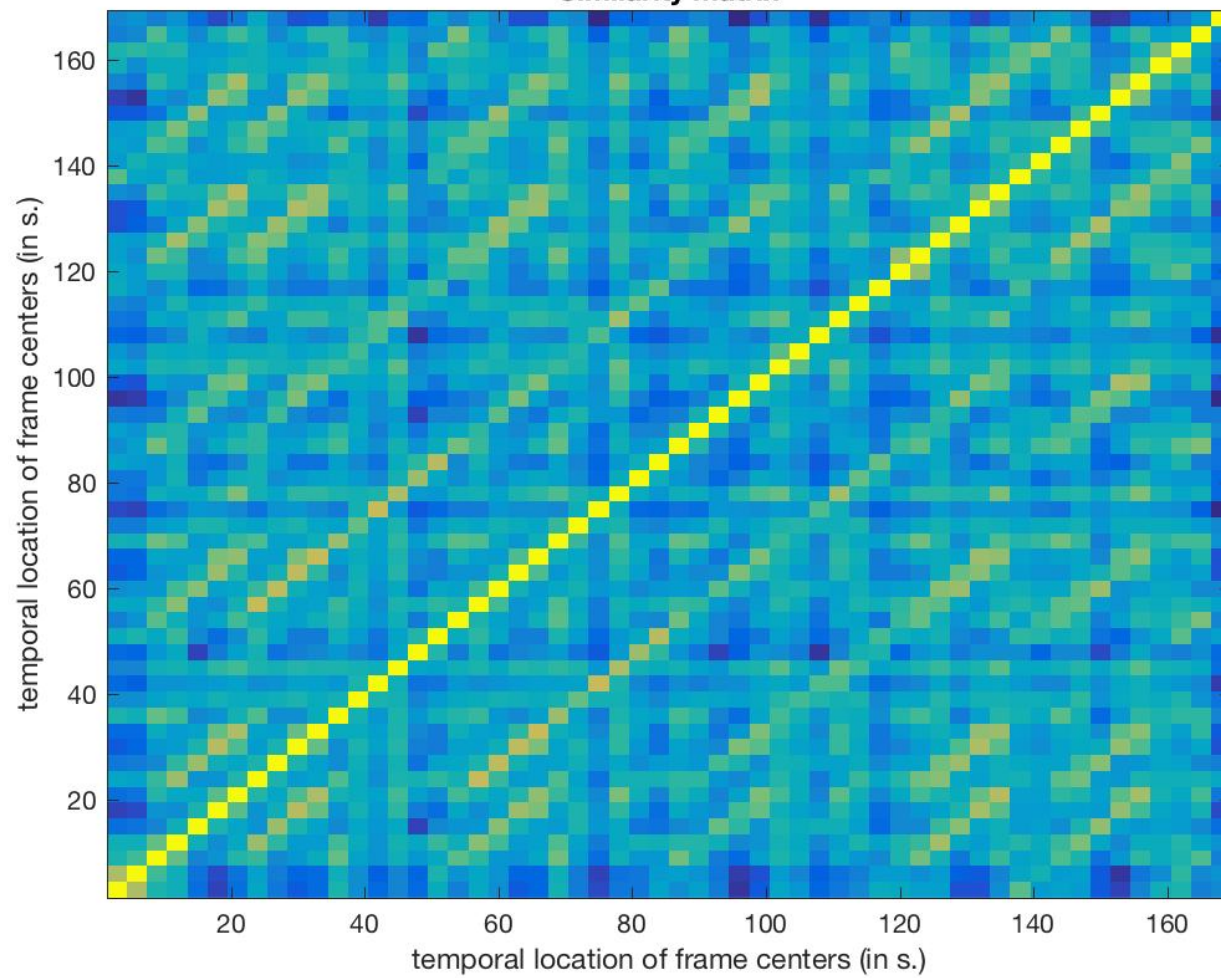
Similarity matrix

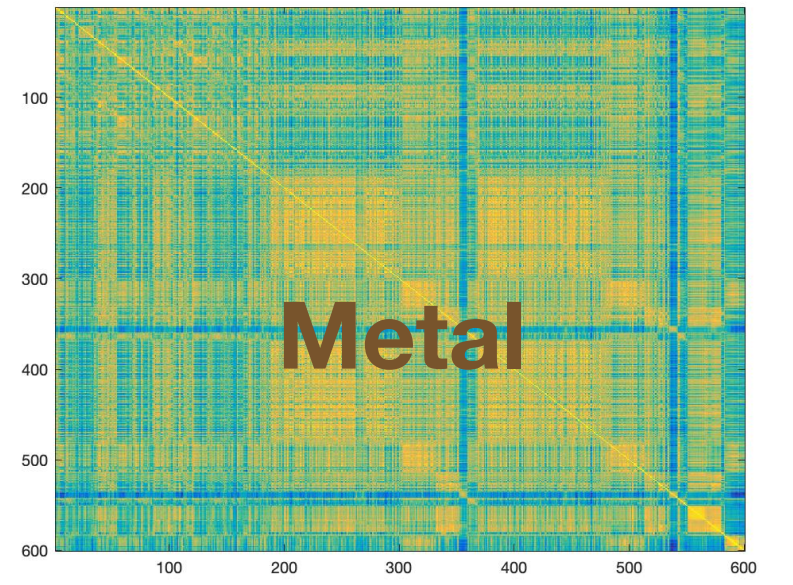
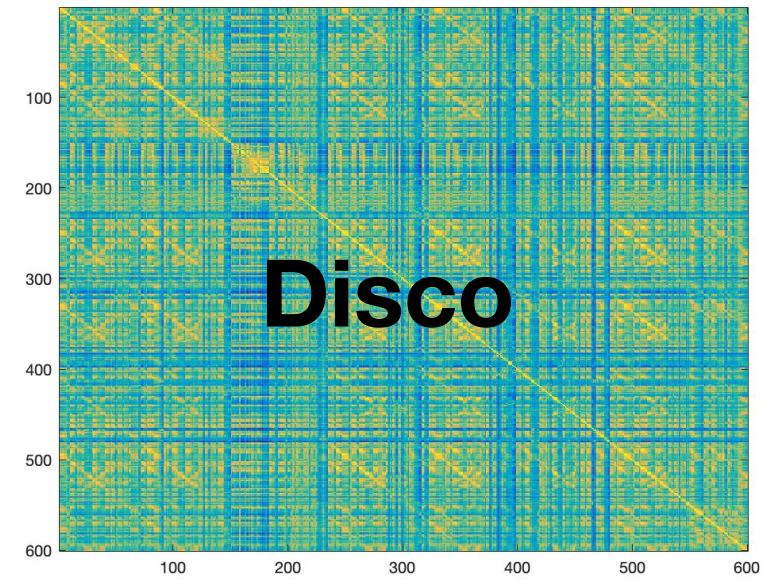
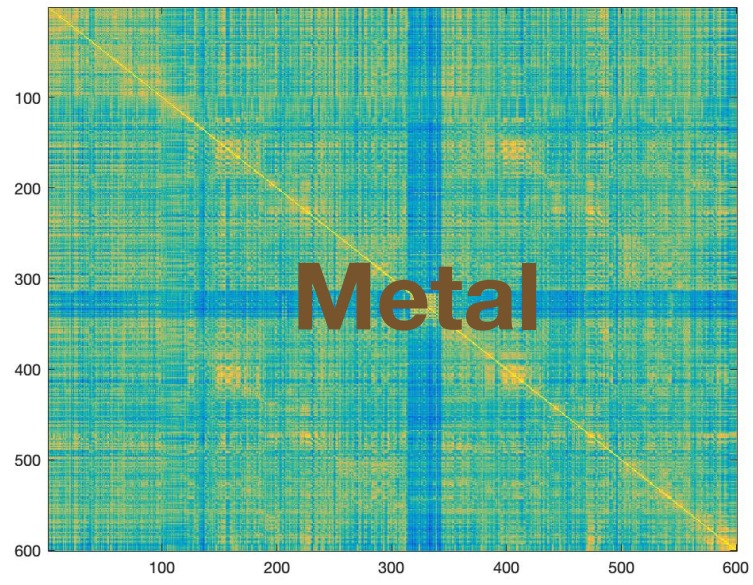
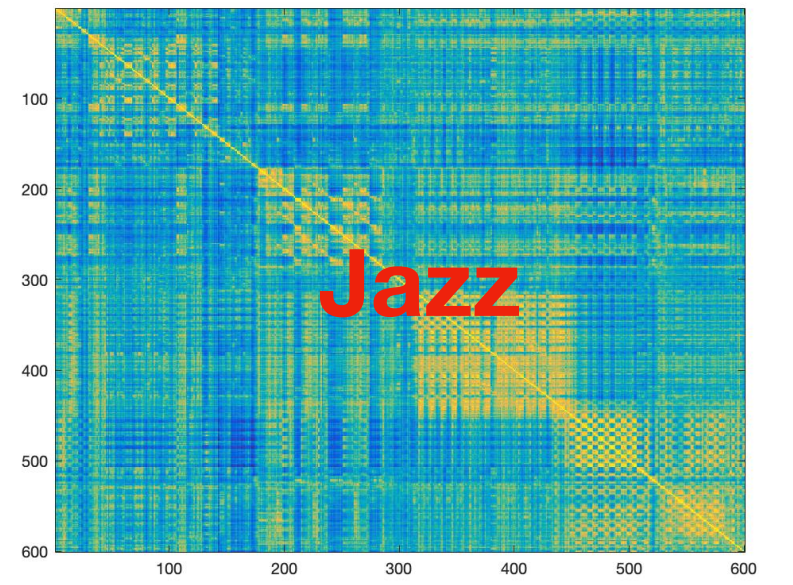
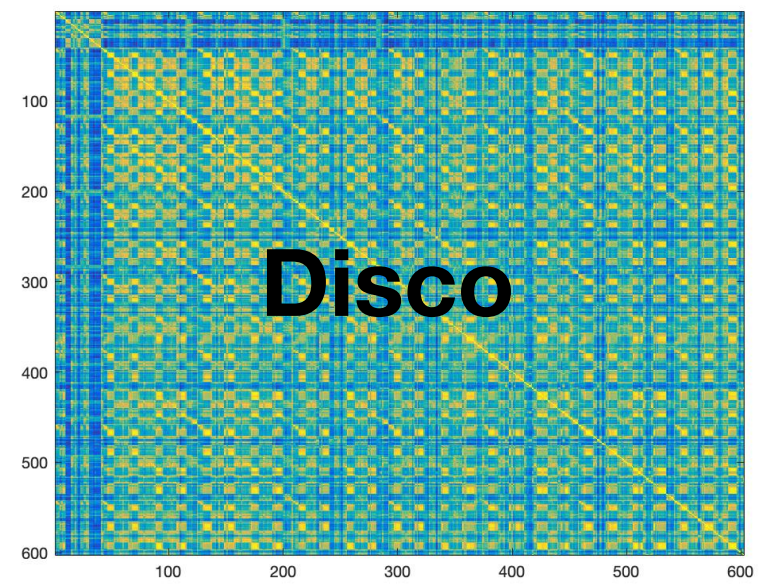
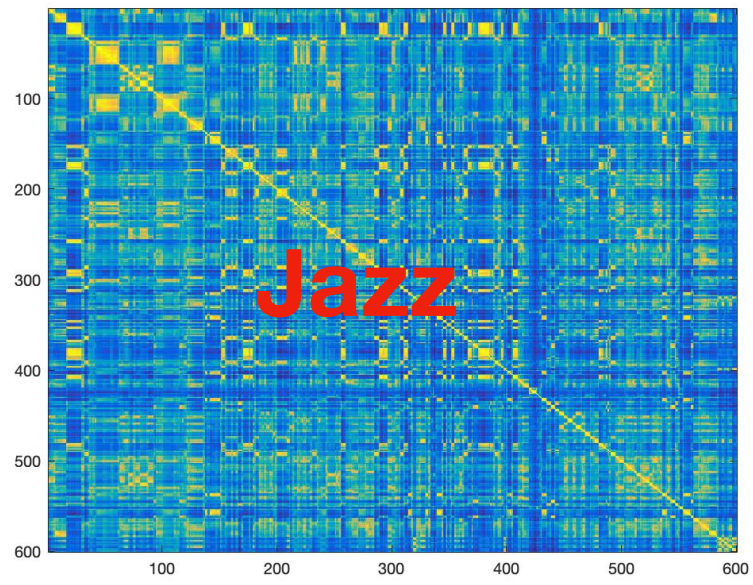
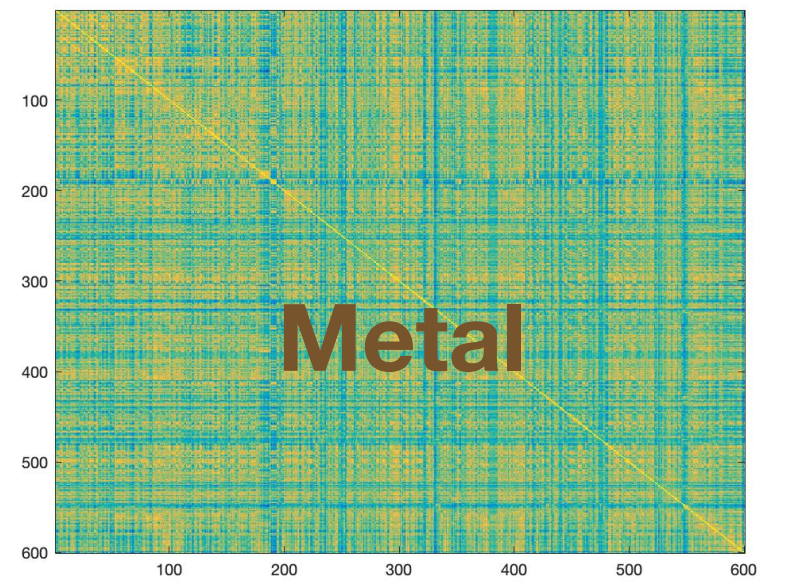
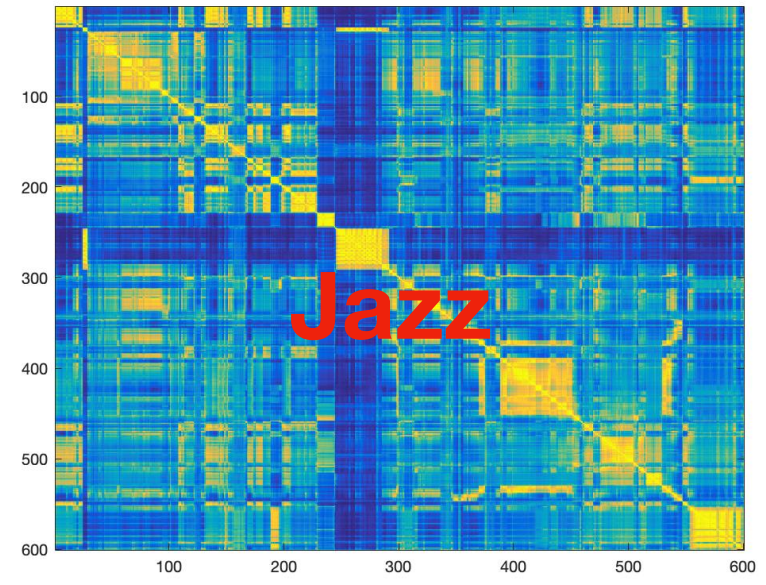
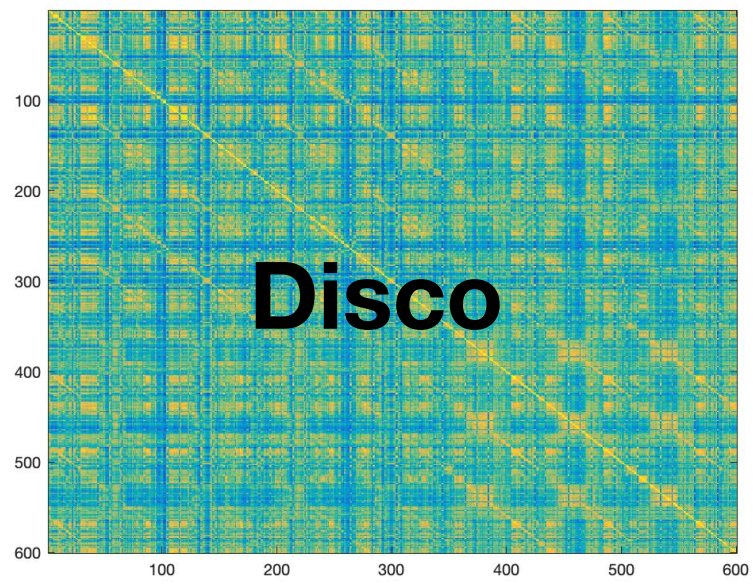


Similarity matrix



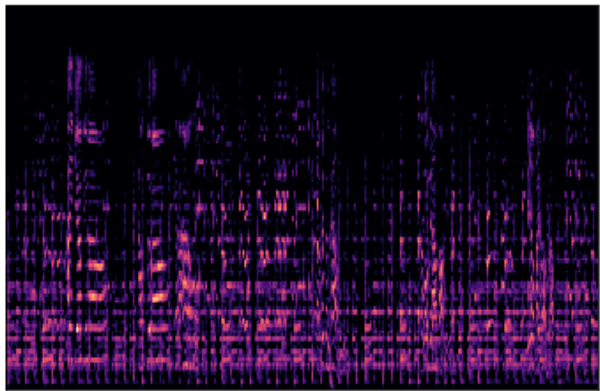
Similarity matrix



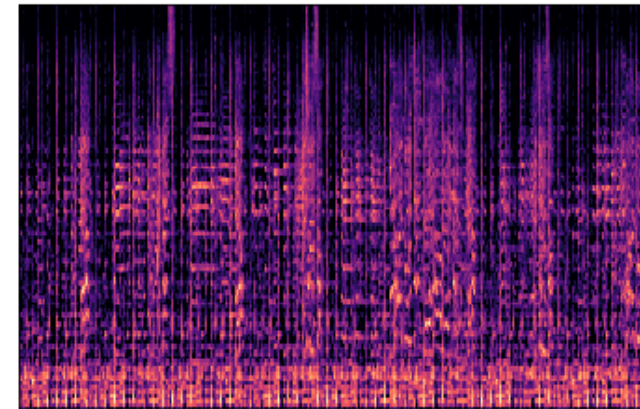


Genre Classification

can lyrics-based similarity matrices be used to identify genres ?



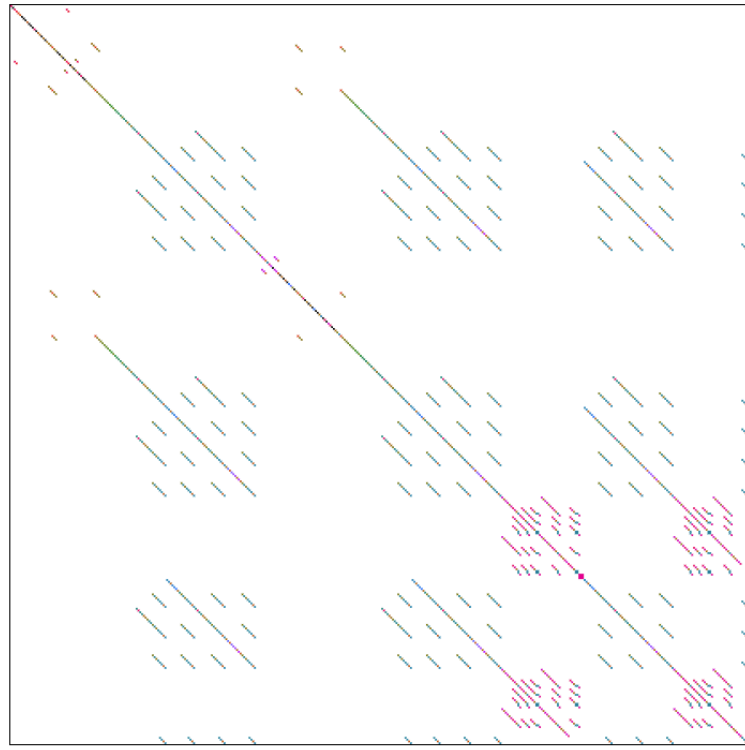
Genre 1



Genre 2

Visualizing Lyrical Structure

Vex



Color Mode

black & white colorful color title

Single-word matches

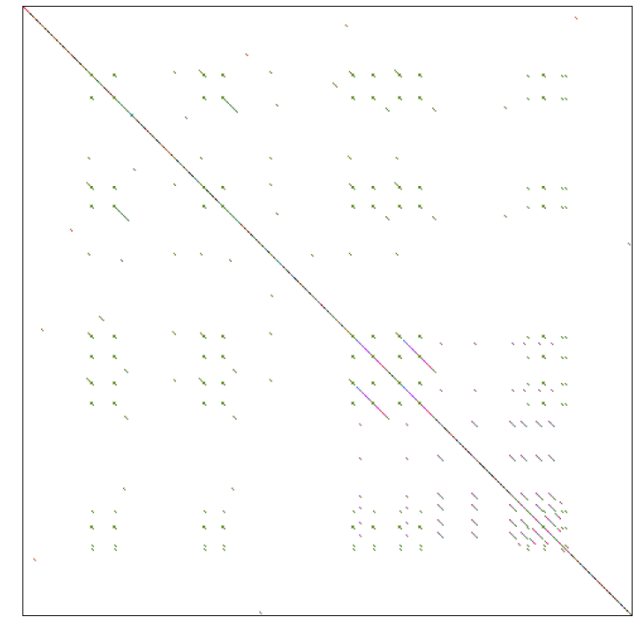
show all ignore all ignore stopwords

Mobile mode



Carly Rae Jepsen - Call Me Maybe

I threw a wish in the well, Don't ask me, I'll never tell I looked to you as it fell, And now you're in my way I'd trade my soul for a wish, Pennies and dimes for a kiss I wasn't looking for this, But now you're in my way Your stare was holdin', Ripped jeans, skin was showin' Hot night, wind was blowin' Where you think you're going, baby? Hey, I just met you, And this is crazy, But here's my number, So call me, maybe! It's hard to look right At you baby, But here's my number, So call me, maybe! Hey, I just met you, And this is crazy,	And this is crazy, But here's my number, So call me, maybe! And all the other boys, Try to chase me, But here's my number, So call me, maybe! You took your time with the call, I took no time with the fall You gave me nothing at all, But still, you're in my way I beg, and borrow and steal At first sight and it's real I didn't know I would feel it, But it's in my way Your stare was holdin', Ripped jeans, skin was showin' Hot night, wind was blowin' Where you think you're going, baby? Hey, I just met you, And this is crazy,	But here's my number, So call me, maybe! It's hard to look right At you baby, But here's my number, So call me, maybe! Hey, I just met you, And this is crazy, But here's my number, So call me, maybe! And all the other boys, Try to chase me, But here's my number, So call me, maybe! Before you came into my life I missed you so bad I missed you so bad I missed you so, so bad Before you came into my life I missed you so bad And you should know that	I missed you so, so bad (bad, bad) It's hard to look right At you baby, But here's my number, So call me, maybe! Hey, I just met you, And this is crazy, But here's my number, So call me, maybe! And all the other boys, Try to chase me, But here's my number, So call me, maybe! Before you came into my life I missed you so bad I missed you so bad I missed you so, so bad Before you came into my life I missed you so bad And you should know that So call me, maybe!
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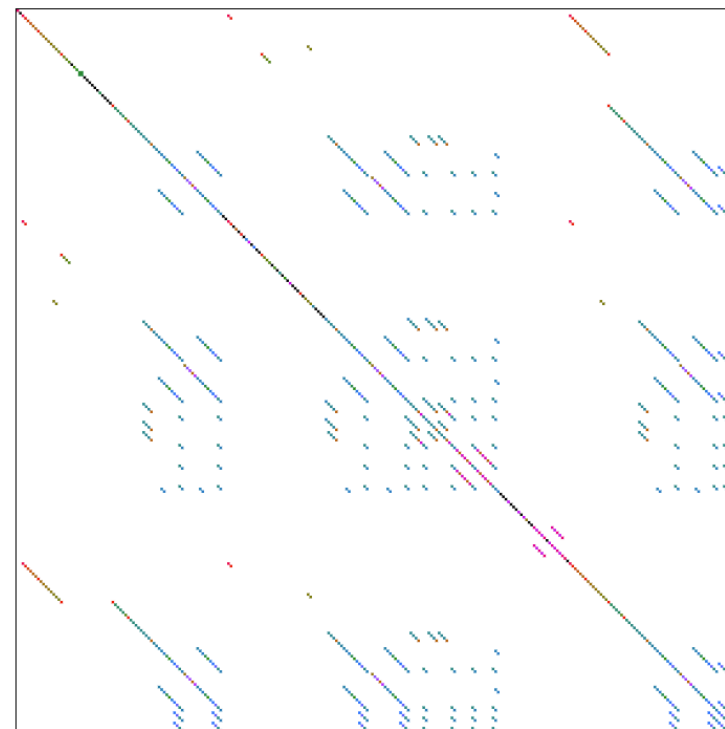
Color Mode

black & white colorful color title

Permalink

Single-word matches

show all ignore



Color Mode

Single-word matches

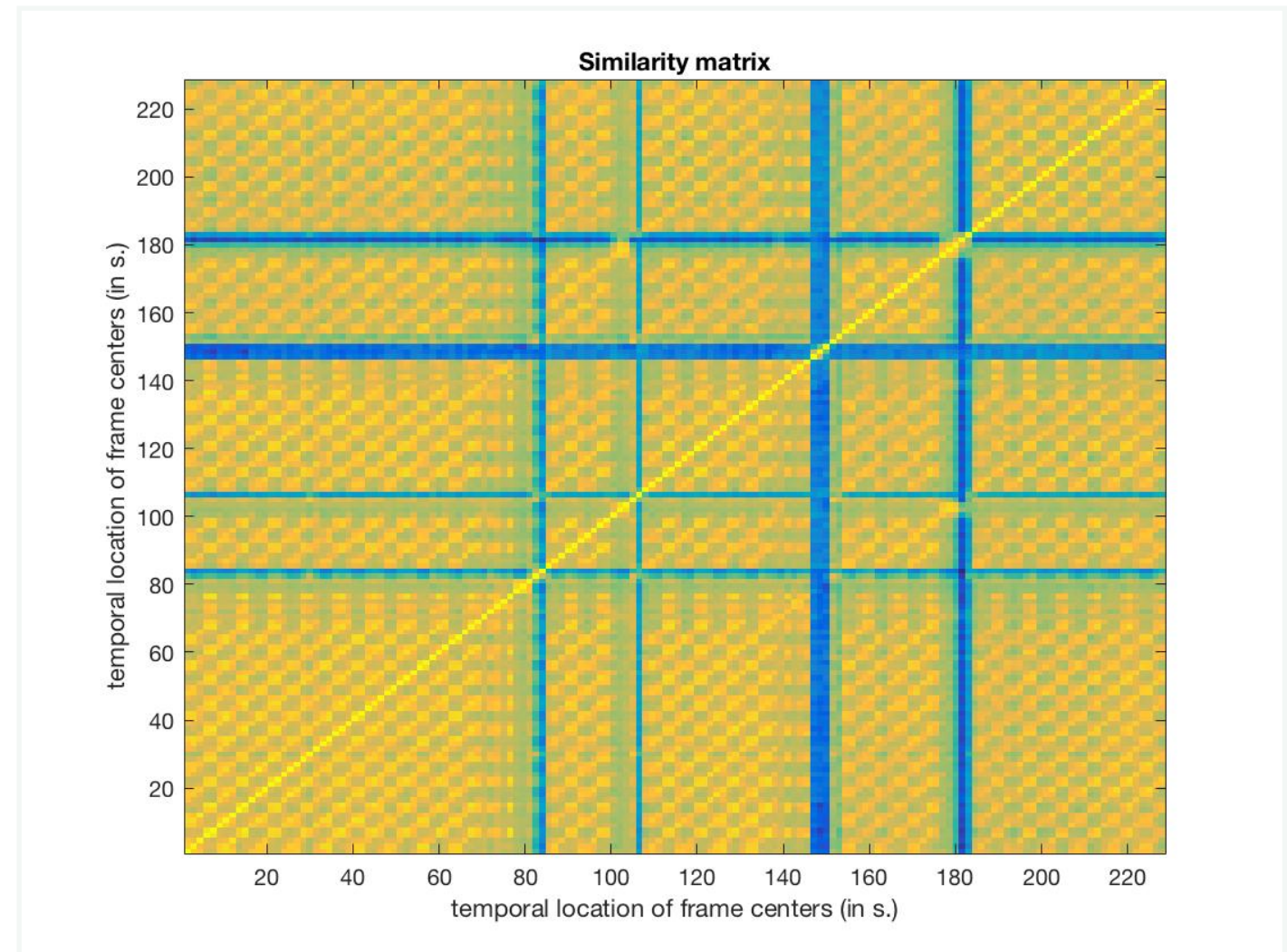
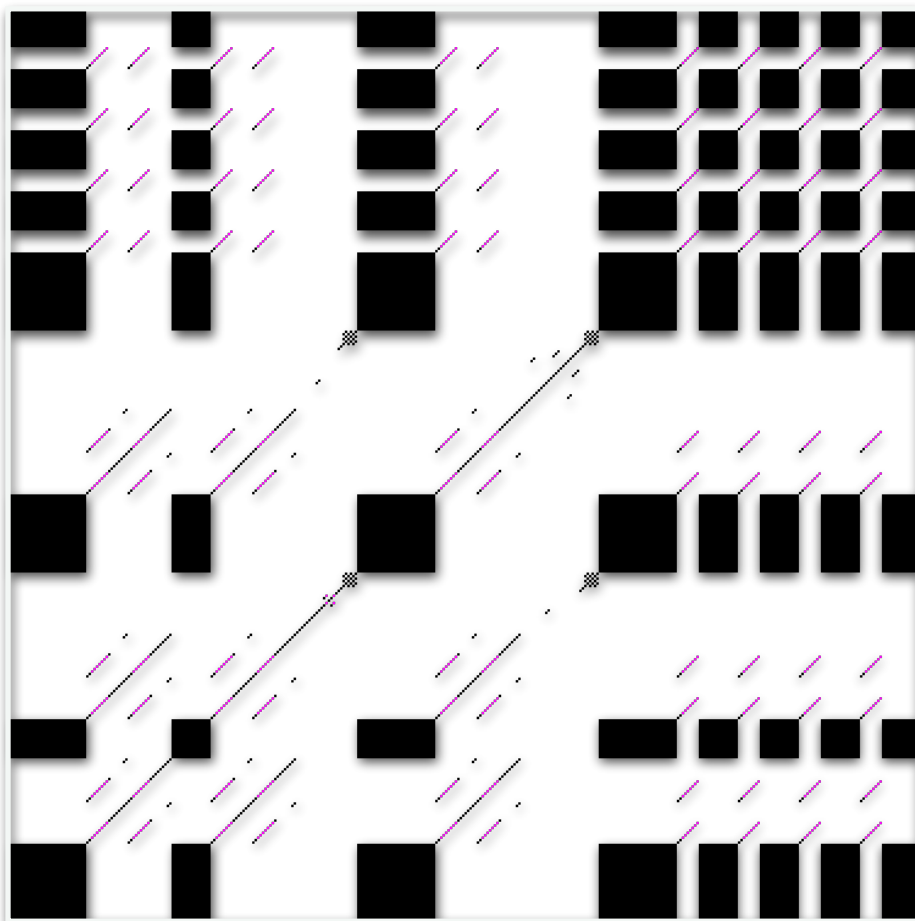
Mobile mode



Custom

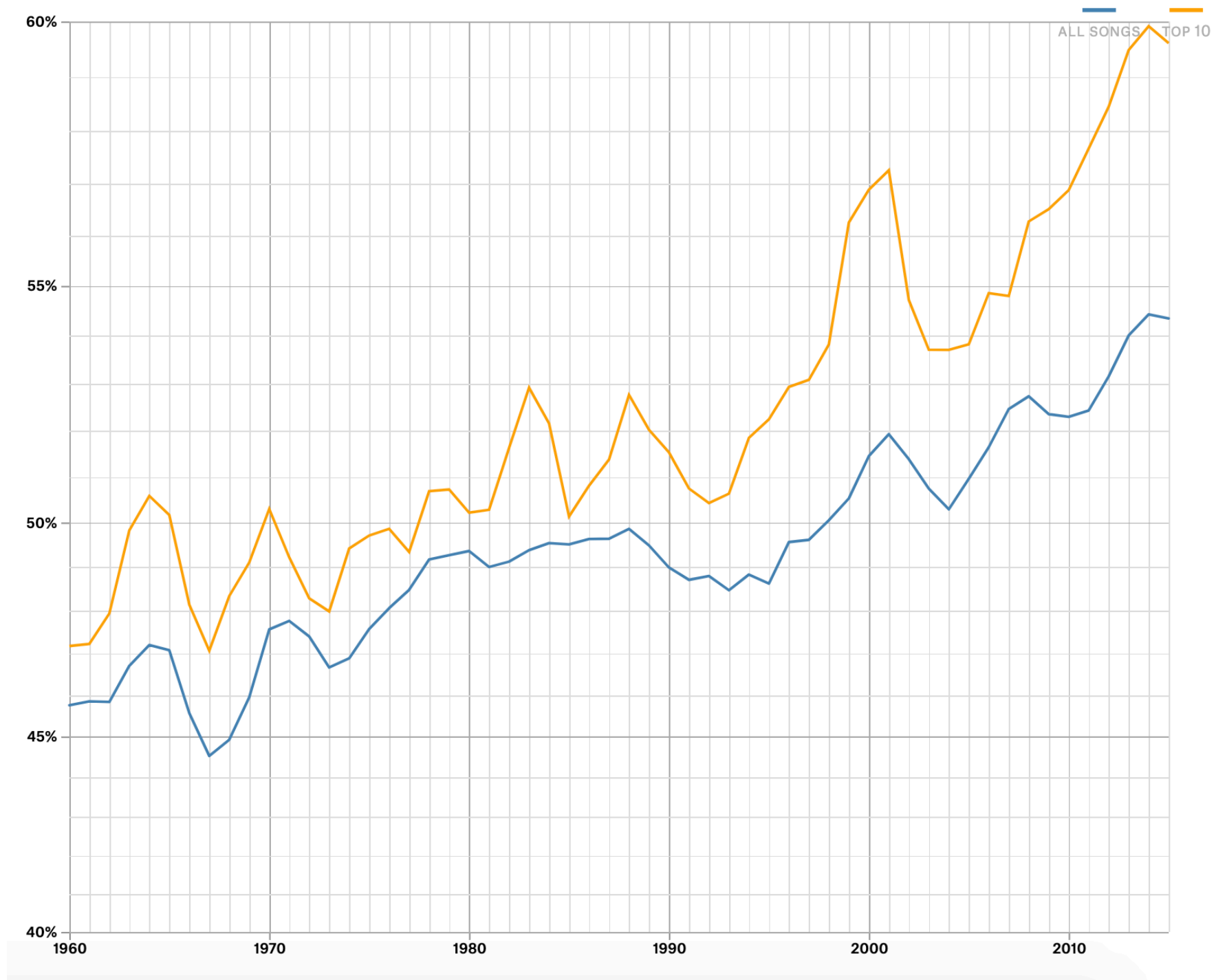
Agg Lavan Majboori Nu Aan Jaan Di Pasoori Nu Zehar Bane Haan Teri Pee Jaavan Main Poori Nu Aana Si Oh Nah Aaya Dil Bang Bang Mera Takraya Kaga Bol Ke Dass Jaave Paawan Gheyo Dee Choori Nu Ranwan Ch Banwan Ch Oh Nu Lukavan Koyi Mainu Na Roke Mere Dhol Judaiyan Di Tainu Khabar Kivein Hove Aa Jaave Dil Tera Poora Vi Na Hove Haan Baniya Baniyan Di Galbaat Kivein Hove Aa Jaave Dil Tera	Poora Vi Na Hove Bhool Gayi Majboori Nu Duniya Di Dastoori Nu Saath Tera Hai Bathera Poora Kar Zaroori Nu Aana Si Oh Nah Aaya Raasta Na Dikhlaya Dil Humara De Sahara Khwahishat Adhoori Nu Waari Main Jaavan Main Tainu Bulawan Gall Saari Taan Hove Mere Dhol Judaiyan Di Tainu Khabar Kivein Hove Aa Jaave Dil Tera Poora Vi Na Hove Oh Haan Baniya Baniyan Di Galbaat Kivein Hove	Aa Jaave Dil Tera Poora Vi Na Hove Mere Dhol Judaiyan Di Sardaari Na Hove Mere Dhol Judaiyan Di Sardaari Na Hove Dildaran Di Sab Yaaran Di Aazaari Na Hove Dildaran Di Sab Yaaran Di Aazaari Na Hove Aa Chale Leke Tujhe Hai Jahan Silsile Tu Hai Wahin Hai Teri Kami Banade Saja De Panaah De Humain Bana De Saja De Panaah De Humain	Agg Lavan Majboori Nu Aan Jaan Di Pasoori Nu Zehar Bane Haan Teri Pee Jaavan Main Poori Nu Ranwan Ch Banwan Ch Oh Nu Lukavan Koyi Mainu Na Roke Mere Dhol Judaiyan Di Tainu Khabar Kivein Hove Aa Jaave Dil Tera Poora Vi Na Hove Haan Baniya Baniyan Di Galbaat Kivein Hove Aa Jaave Dil Tera Poora Vi Na Hove Poora Vi Na Hove Poora Vi Na Hove
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Repetition in Music

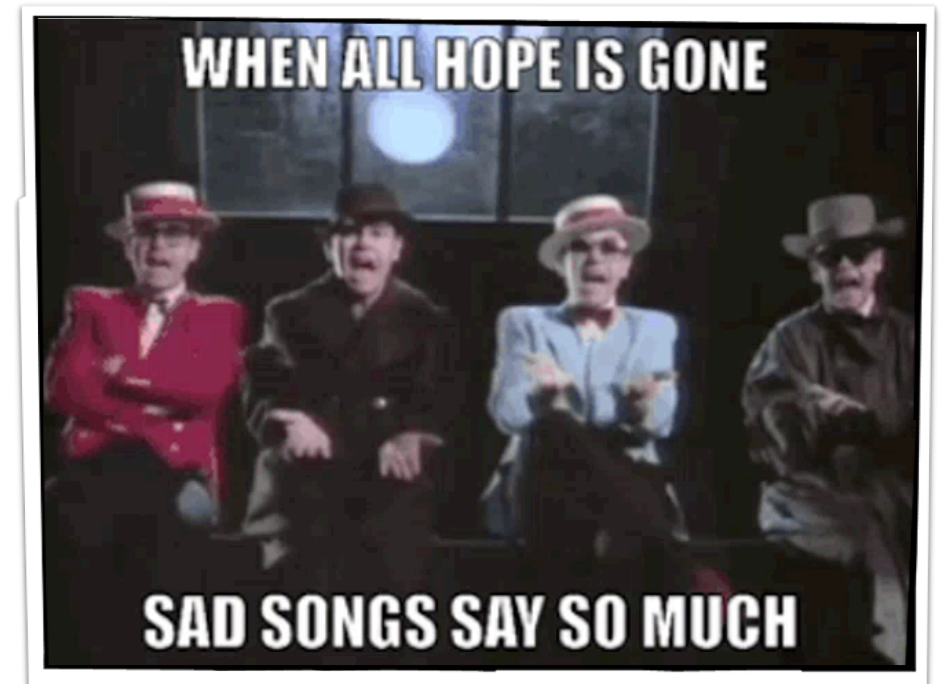
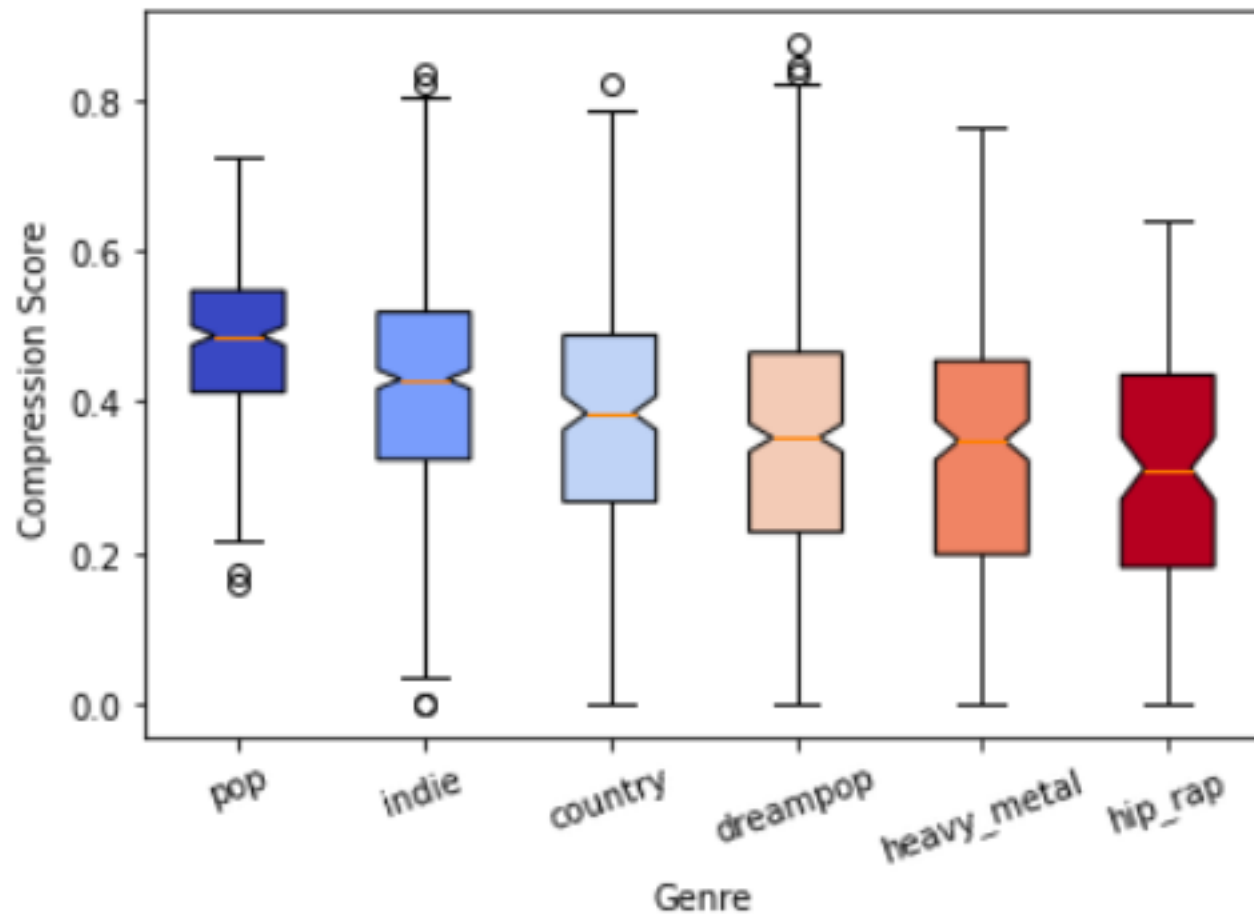


Repetition in Music

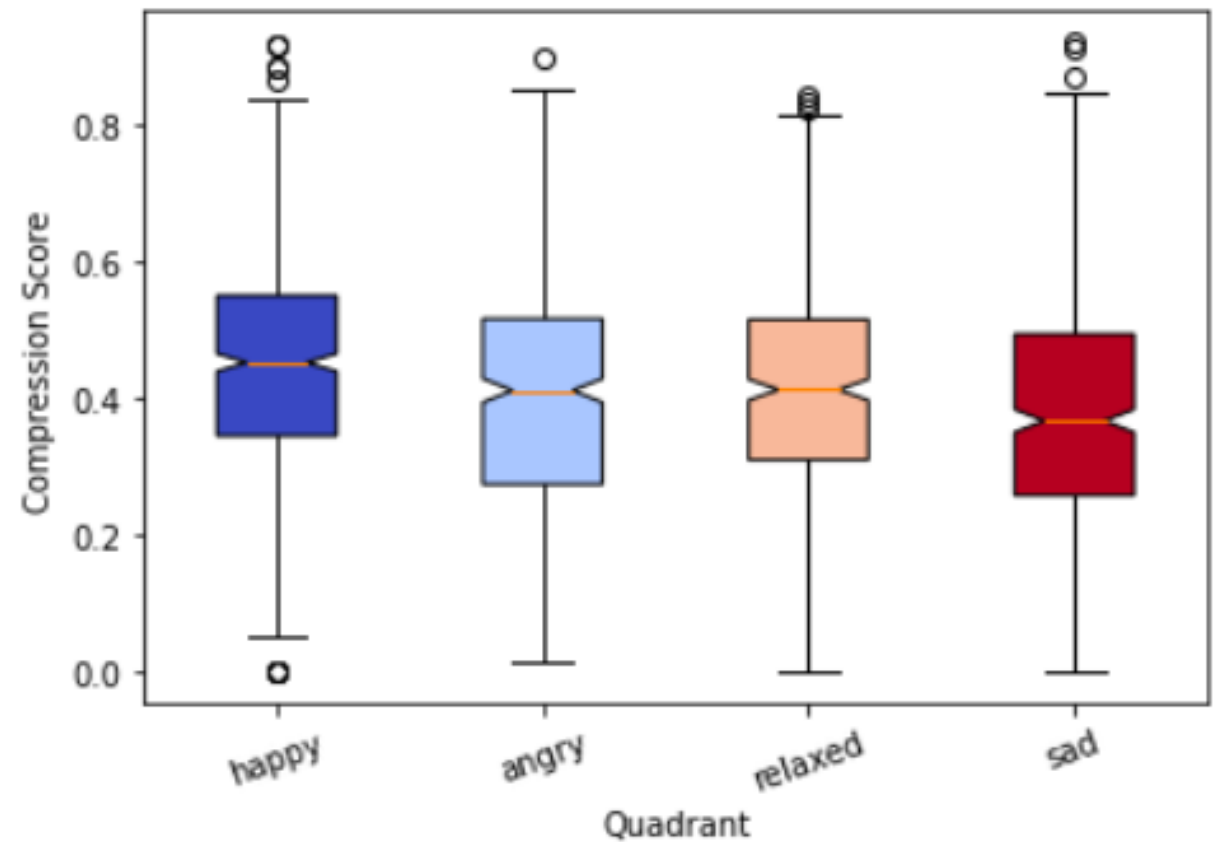
Repetition of Popular Music, by Year



Compressibility in Music



Which genres can be separated based on lyrical structure?



Genre Classification Demo

IEEE TRANSACTIONS ON SPEECH AND AUDIO PROCESSING, VOL. 10, NO. 5, JULY 2002

293

Musical Genre Classification of Audio Signals

George Tzanetakis, *Student Member, IEEE*, and Perry Cook, *Member, IEEE*

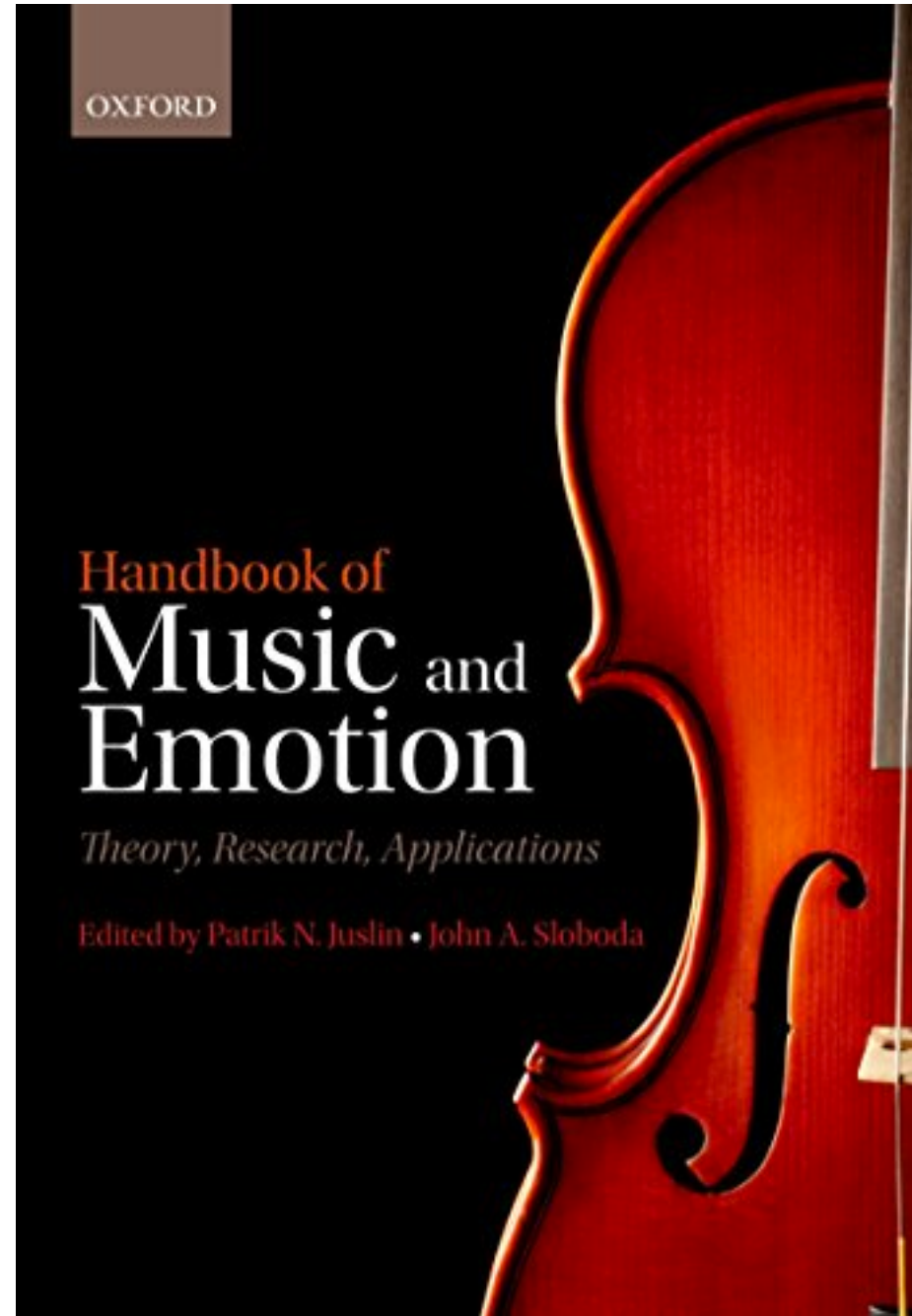
Emotion Classification

OXFORD

Handbook of
**Music and
Emotion**

Theory, Research, Applications

Edited by Patrik N. Juslin • John A. Sloboda





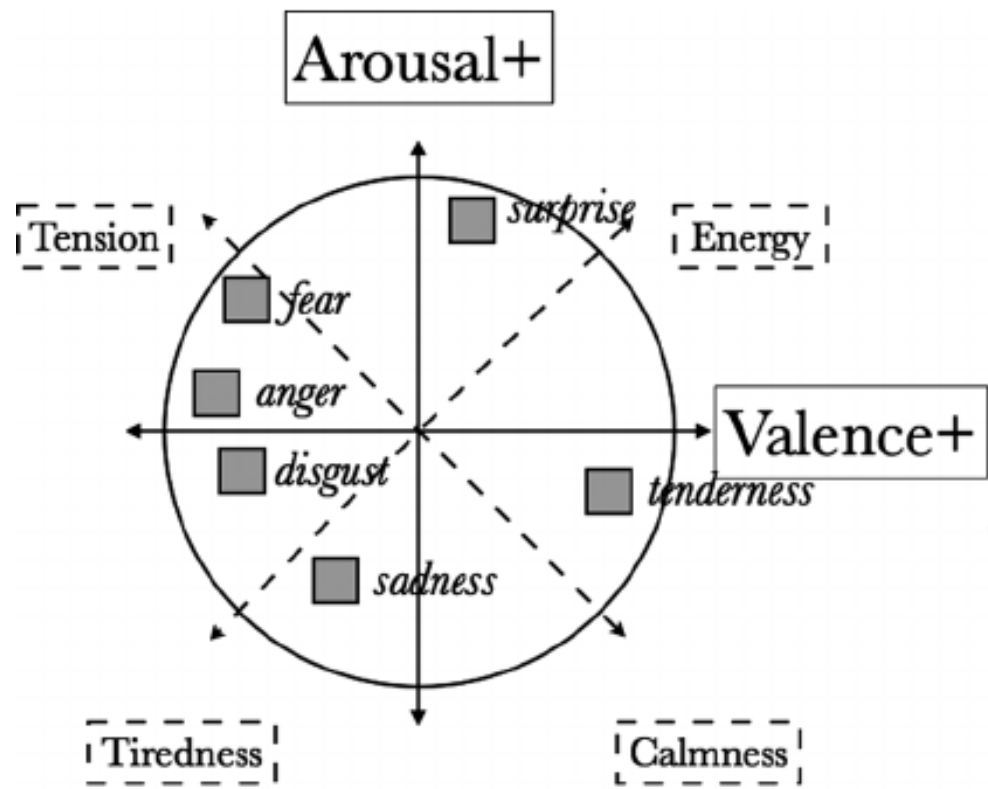
Emotions? Emotional Space?



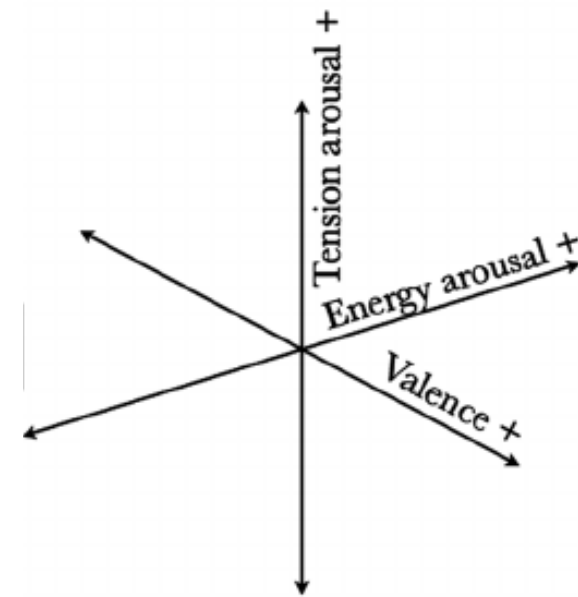
What emotions can music express?

Table 3. Frequencies with which various emotion labels were selected in response to the question “What emotions can music express?” ($N = 141$).

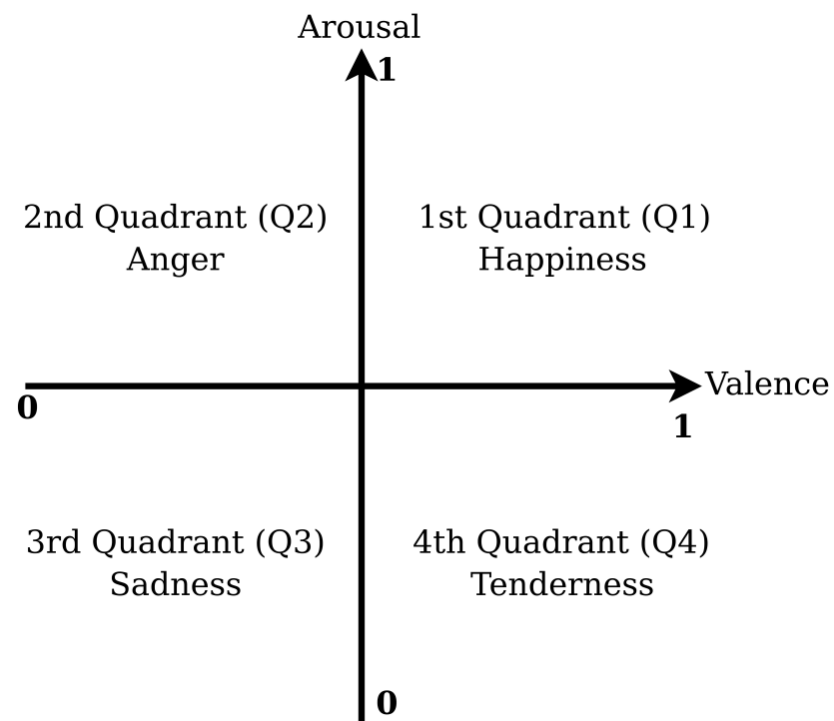
Emotion	Freq.	Emotion	Freq.	Emotion	Freq.
Joy	99% (98%)	Pride	71% (69%)	Curiosity	46% (63%)
Sadness	91% (91%)	Pain	70% (86%)	Boredom	45% (47%)
Love	90% (89%)	Desire	69% (74%)	Disappointment	43% (49%)
Calm	87% (89%)	Hope	67% (70%)	Guilt	42% (43%)
Anger	82% (83%)	Nostalgia	67% (76%)	Satisfaction	42% (57%)
Tenderness	82% (86%)	Fear	63% (79%)	Admiration	37% (37%)
Longing	77% (71%)	Contempt	55% (53%)	Jealousy	35% (42%)
Solemnity	76% (73%)	Tiredness	55% (52%)	Sympathy	34% (39%)
Anxiety	75% (90%)	Regret	53% (56%)	Shame	31% (39%)
Hate	74% (69%)	Expectancy	51% (66%)	Trust	30% (33%)
Humour	74% (87%)	Confusion	49% (65%)	Interest	29% (44%)
Loneliness	73% (79%)	Disgust	47% (51%)	Humiliation	28% (31%)
Tension	72% (89%)	Surprise	47% (68%)	Other	10% (16%)

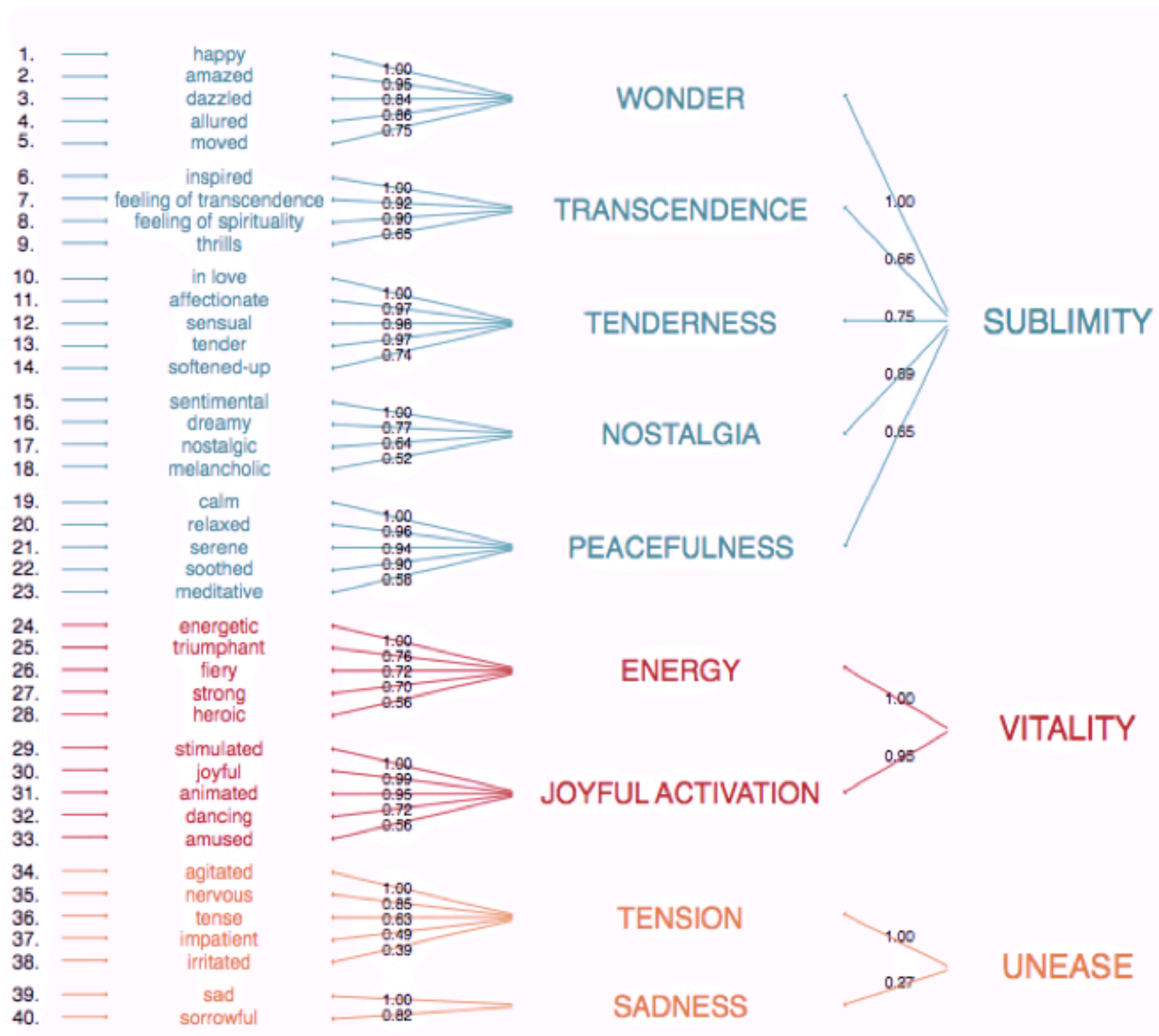


Russell's circumplex model ———
 Thayer's model - - -
 Basic emotion terms ■



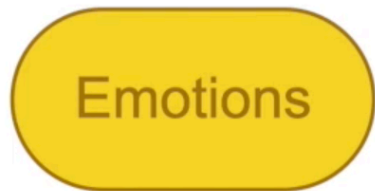
Schimmack & Grob model





The Geneva Emotional Music Scales (GEMS)

Theory



A Discrete

Happy, sad, anger, fear, disgust (e.g., Ekman, 1992)

B Dimensional

Activity & valence (Russell, 1980)
Tension & energy (Thayer, 1989)

C Aesthetic

joy	happiness	joy
peaceful	love	beautiful
spirituality	surprise	amusing
tenderness	calm	energetic
wonder	awe	dreamy
nostalgia	interest	triumphant
nostalgia	nostalgia	calm
power	pride	erotic
tension	disgust	anxious
sad	anger	indignant
	anxiety	scary
	sad	annoying
	sad	sad
Zentner et al (2008)	Juslin et al (2011)	Cowen et al (2020)



How is music able to
communicate emotional
meaning?



How can music **induce**
emotions?

How is music able to
communicate emotional
meaning?

... in the absence of lyrics?

Cues used to express (and infer) emotions in other human domains

- **Speech and vocal expression of emotion** (Juslin & Laukka, 2003)
 - Music communicates emotional meaning to listeners by exploiting the acoustic code for vocal expression of emotions
 - Many similarities between musical and vocal expression of emotion in terms of acoustic features, recognition accuracy

Cues used to express (and infer) emotions in other human domains



potential problems: cultural differences, mild/subtle cues, contextual & personal factors

Musical features



- Distinct structural and performance features contribute to the expression of different emotions
 - **Sadness:** ?
 - **Happiness:** ?
 - **Anger:** ?
 - **Tenderness:** ?

Musical features



- Distinct structural and performance features contribute to the expression of different emotions
 - **Sadness:** minor mode, low tempo, low pitch, narrow melodic range, low sound level, little sound level variability, soft timbre, and legato articulation
 - **Happiness:** major mode, regular rhythm, fast tempo, high pitch, wide melodic range, consonant harmonies, and staccato articulation
 - **Anger:** fast tempo, high sound level & sound level variability, low key clarity/atonality, fast tone attacks, and microstructural irregularity
 - **Tenderness:** major mode, slow tempo, low sound level, little sound level variability, low pitch level, little pitch variability, smooth rhythm, and slow tone attacks

Musical features



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 - **Tenderness:** major mode, slow **tempo**, low **sound level**, little sound level variability, low pitch level, little pitch variability, smooth rhythm, and slow tone attacks



Control panel for a music application, likely iTunes, showing playback controls, a library list, and a store section.

Playback Controls: Play/Pause, Previous, Next, and Volume slider. The volume is set to approximately 75%. The current track is "I'll Work For You" by Bruce Springsteen, with a duration of 0:00.

KIRJASTO (Library):

- Musiikki
- Elokuvat
- TV-ohjelmat
- Podcastit (9 items)
- iTunes U
- Kirjat
- Ohjelmat (11 items)
- Radio

STORE

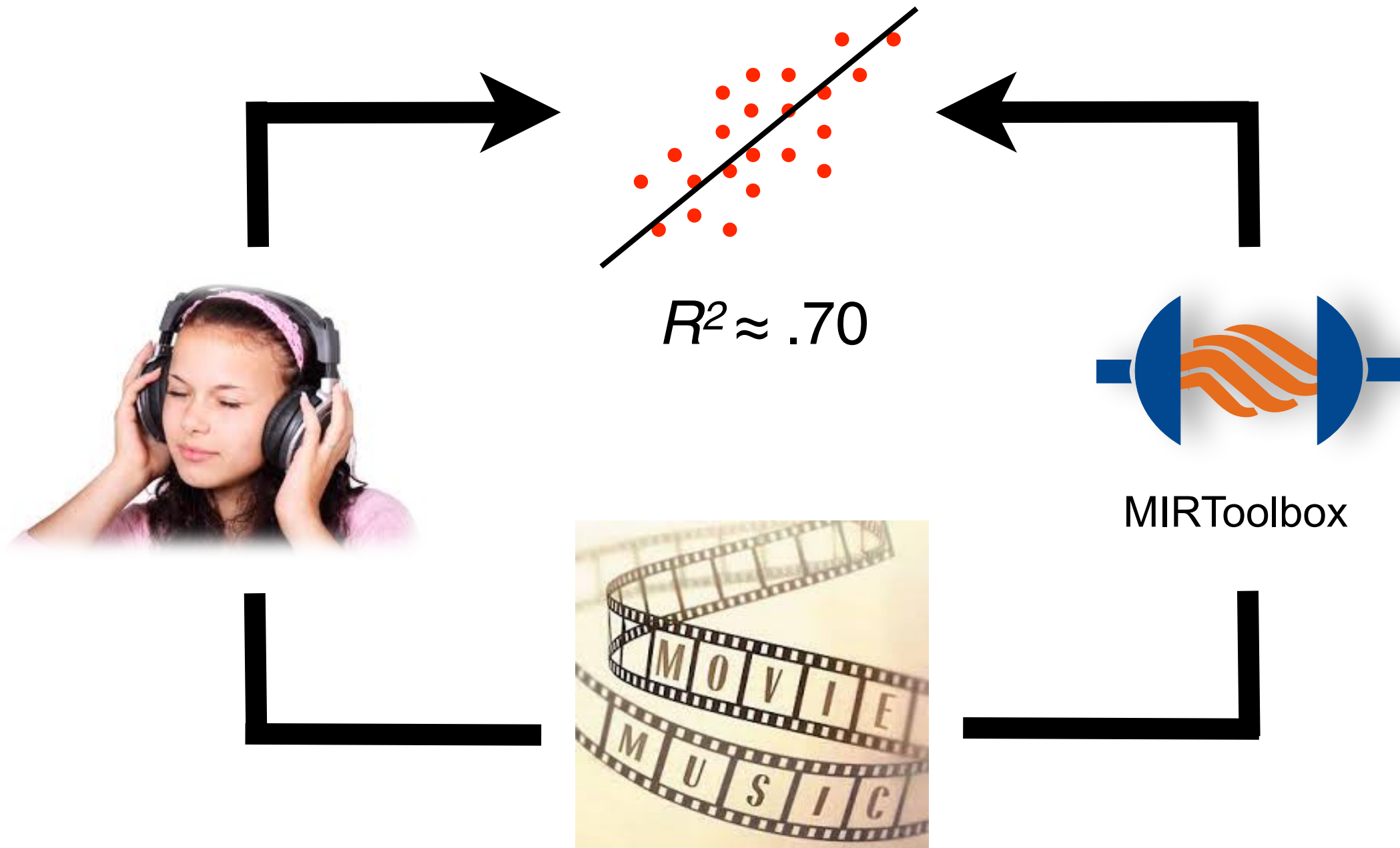
Toistettava (Repeating):

BRUCE SPRINGSTEEN MAGIC

RG

8 kappaletta

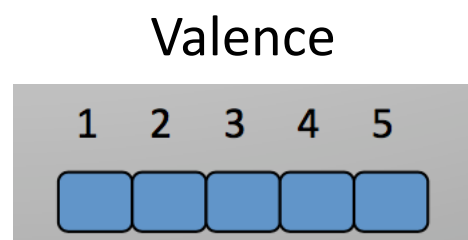
MIR & emotion prediction



Eerola, T., Lartillot, O., & Toiviainen, P. (2009) **Prediction Of Multidimensional Emotional Ratings In Music From Audio Using Multivariate Regression Models.** In proc. of 10th International Society for Music Information Retrieval Conference (ISMIR).



basic emotion
concepts and
dimensional ratings,
on Likert scales



Low

High

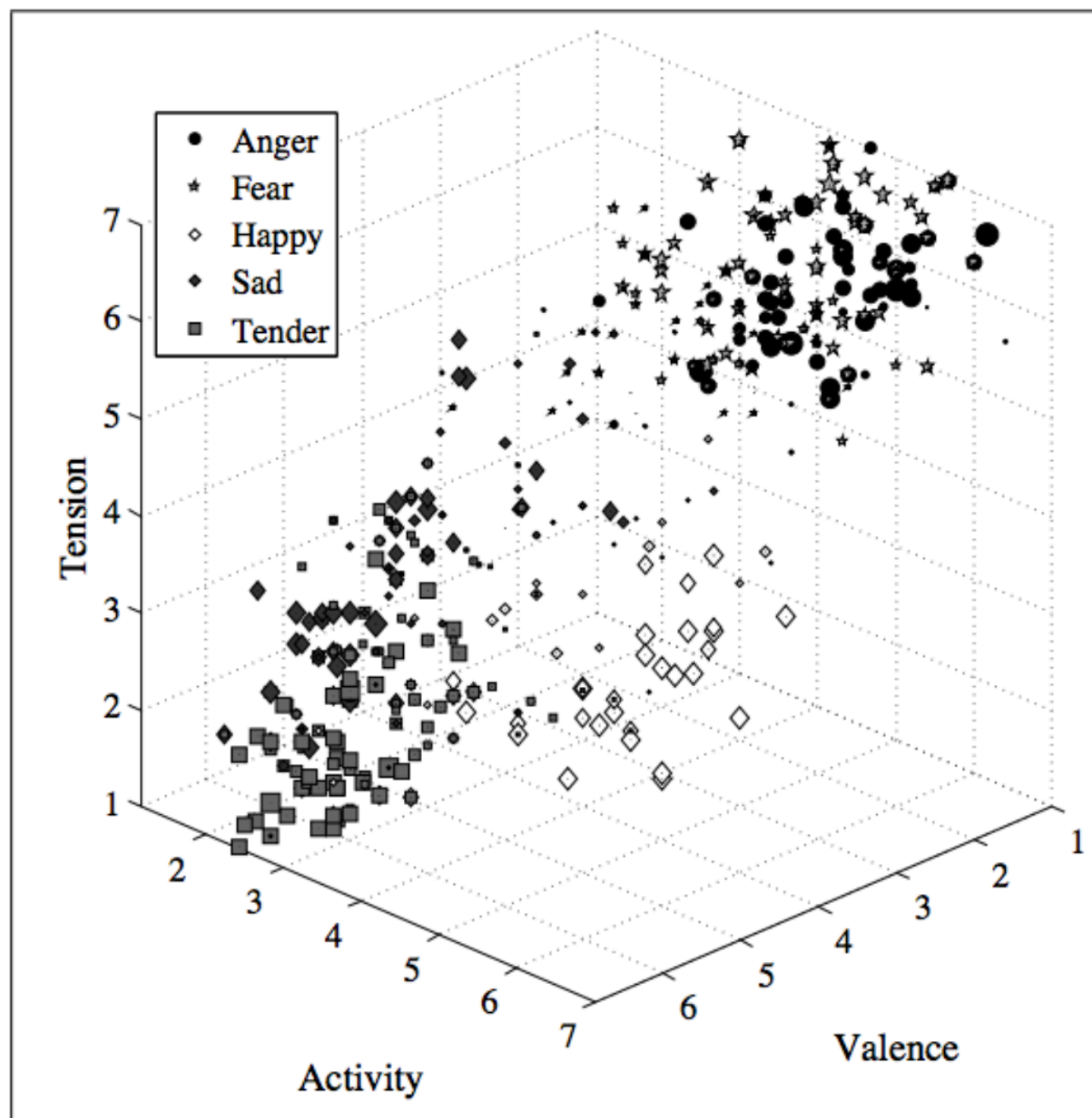
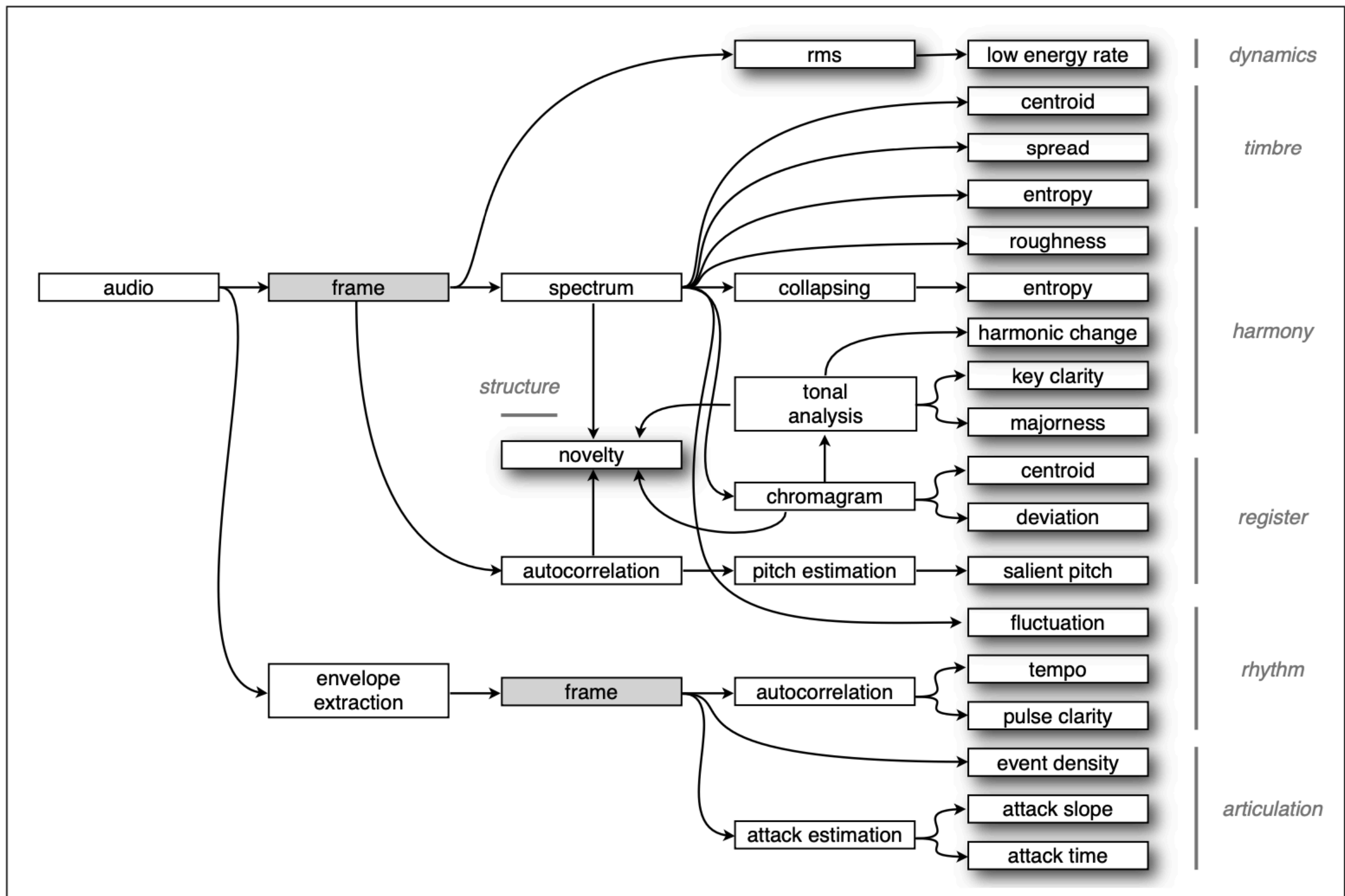


Figure 1. Average ratings of the three dimensions and basic emotions for the 360 soundtrack excerpts.



Eerola, T., Lartillot, O., & Toiviainen, P. (2009) **Prediction Of Multidimensional Emotional Ratings In Music From Audio Using Multivariate Regression Models.** In proc. of 10th International Society for Music Information Retrieval Conference (ISMIR).

	Prediction rate (R^2)		
Model	Valence	Activity	Tension
MLR	.64	.75	.67
PCA	.42	.74	.51
PLS	.70	.77	.71
MLR $_{\lambda}$	.66	.74	.69
PCA $_{\lambda}$	.51	.73	.63
PLS $_{\lambda}$	.72	.85	.79

	Prediction rate (R^2)				
Model	Angry	Scary	Happy	Sad	Tender
MLR	.46	.55	.46	.38	.38
PCA	.66	.67	.60	.59	.54
PLS	.66	.62	.61	.61	.50
MLR $_{\lambda}$	.56	.55	.63	.54	.45
PCA $_{\lambda}$	.56	.47	.53	.52	.45
PLS $_{\lambda}$	.70	.74	.68	.69	.58

Cues used to express (and infer) emotions in other human domains

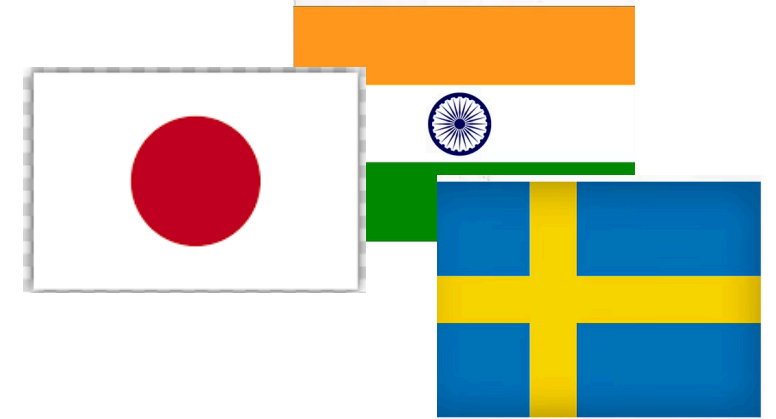


- **Human movement & gesture**
 - All sounds from traditional acoustics instruments are produced by human movement -> we can "hear" this movement in music
 - Music emulates the speed, posture, and smoothness/jerkiness of human movement and gestures when experiencing/expressing emotions (Jackendoff & Lerdahl, 2006)

Other cues

- **Culturally learned cues**
 - Mode (minor/major)
 - Pitch (high/low)
 - Contextual associations (e.g., wedding and funeral music)
 - Frequent pairing with narrative content (song lyrics, films, TV, opera)

Other cues



- **Culturally learned cues**

- better identification of basic emotions (anger, fear, happiness, and sadness) than non-basic ones (e.g., solemnity, humor, and longing)

- better able to identify the intended emotions in music from their own culture

peacefulness,
longing,
neutral solemnity,
affection,
happiness,
spirituality, fear,
humor, sadness, anger,

Other cues

- **Human characteristics/virtual person**
 - Music is assigned attributions that normally would be assigned to a person -> music creates a "virtual person"? (Watt & Ash, 1998)

“.....a piece of music can be assigned an attribution that has the value female rather than male. This need not imply that the music is female, just that the attribution that is made has more of the quality of female rather than of the quality of male. These attributions are made to the music, not to the composer or the performer. Loosely speaking, music creates a virtual person. “

How is music able to
communicate emotional
meaning?



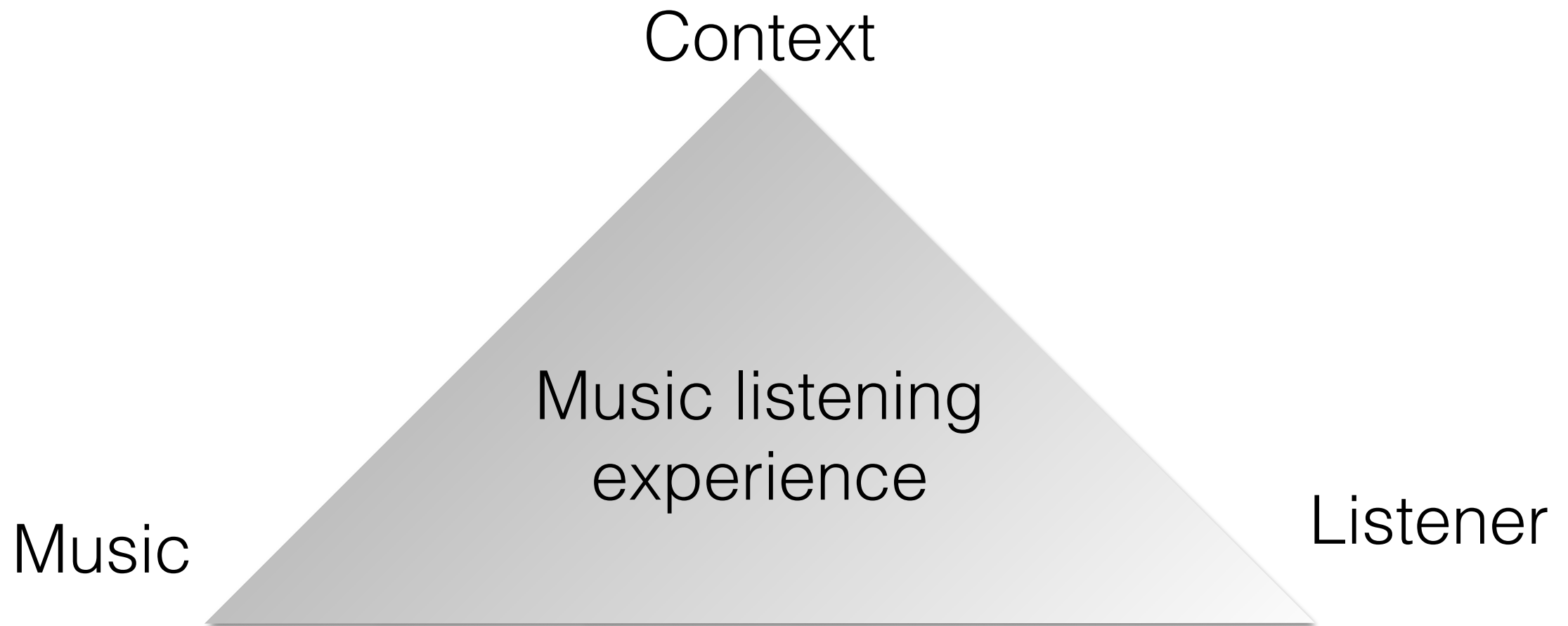
How can music
induce emotions?

Mechanisms:

- **B**rain stem reflexes
- **R**hythmic entrainment
- **E**valuative conditioning
- Emotional **C**ontagion
- **V**isual imagery
- **E**pisodic memory
- **M**usical expectancy
- **A**esthetic Judgement

Different mechanisms may be at function simultaneously, and lead to differing emotional responses (i.e., mixed emotions)

Relevance of context



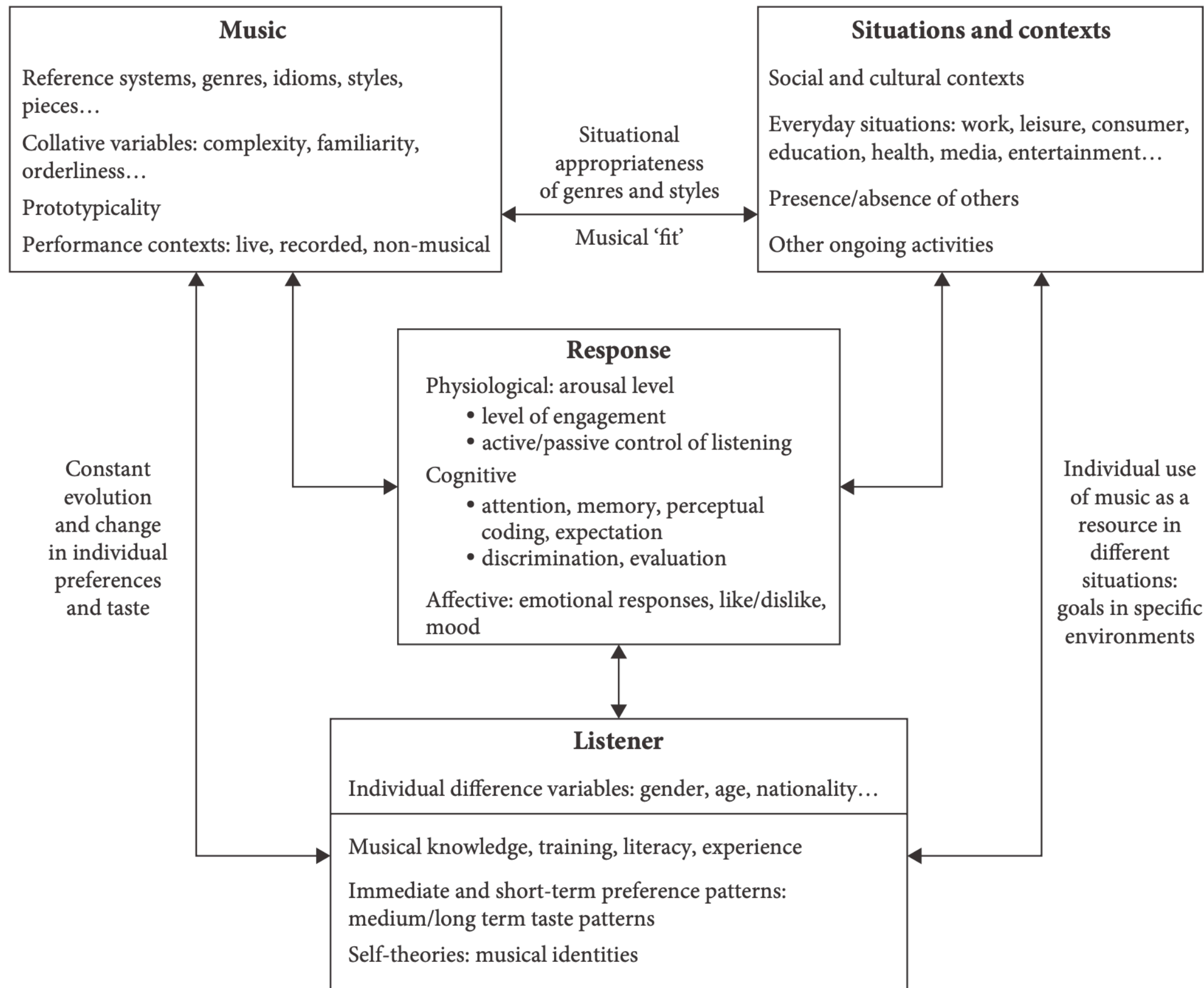


FIGURE 17.2 Reciprocal feedback model of musical response.

The logo for WISSAP 2023 features a stylized 'W' icon on the left, composed of several curved lines that resemble a crown or a series of arches. To the right of the icon, the text 'iSSAP 2023' is written in a bold, black, sans-serif font. The 'i' is lowercase, while 'SSAP' and '2023' are uppercase.

iSSAP 2023

Classification Tasks

Genre & Emotion

<https://pudding.cool/2017/05/song-repetition/>