



Musical Similarity: More perspectives and compound techniques



CS 275B/Music 254

Musical similarity

- ▶ Similarity studies in general
- ▶ Reductionist approaches
- ▶ Social cognition
- ▶ Timbral confounds
- ▶ Compound search techniques
- ▶ Cognitive distance metrics
- ▶ Affective similarity

Timbral confounds

The Haydn/Mozart String Quartet Quiz

Can you tell the difference between the musical styles of Haydn and Mozart?

This website tests how well you can distinguish between the string quartets of these two composers. You will listen to randomly selected movements composed by either [Mozart](#) or [Haydn](#). Then, you will choose the composer you think wrote the music you have just heard.

Click the start button below to answer some questions about your musical knowledge and then start the quiz...

start

- [View current identification statistics](#)



or ...



Reductionist approaches: melodic simplification

Target: 3452

The image displays a musical score with four staves, all in 3/4 time and a key signature of two flats (B-flat and E-flat). The first staff contains a melodic line with eighth and quarter notes. The second staff is a simplified version of the first, with some notes replaced by rests. The third staff shows further simplification, with only a few notes and rests. The fourth staff features a single note with a long, sweeping slur that spans across the entire duration of the piece, representing a highly reduced melodic form.

(Vertical)

Time-span reduction

German folksong

Der Mai tritt ein mit Freu - den, es — flieht der Win - ter Kalt, —
die Bl mlein auf der Hei - den, die bl - hen man - nig - falt

Substitution of one pitch for each bar

Lerdahl-Jackendoff approach
more nuanced

Work of Helmut Schaffrath and pupils (Essen)

cf. <http://www.esac-data.org>

Social cognition

Morris tune

is shown in Figure 1, a later one in Figure 2.



Figure 1. The Morris tune (A), Strains 1 and 2, as given by Thomas Weelkes (1608).



Figure 2. The Morris tune (A), both strains as given by Edward Jones (1802).

Danny Boy



Figure 6. Beginning of the verse of the Londonderry Aire/ Danny Boy (E).



Figure 7. Early example of what became the chorus of the Londonderry Aire/Danny Boy (E₁).

The Folia



Figure 9. The Folia treble (B₁), all iterations but last.



Figure 10. The Folia bass (B₂), last iteration.



Figure 11. Start of a keyboard variation by A. Scarlatti on B_{1,2} ("La Folia di Spagna").

Social cognition, cont.

Table 1. Tune families examined.

Code	Title	Earliest known use
A	The Morris Tune	Dance (duple meter)
B	The Folia	Dance (triple meter)
C	The Dance of Mantua	Dance (duple meter)
D	Go Tell Aunt Rhody	Gavotte in operetta (?)
E	Danny Boy	Folksongs (2)

A, B = title-driven

C, D, E = content-driven

Table 2. Persistence of specific features within tune families.

Feature preserved	Family					Totals
	A	B	C	D	E	
Title	1	2	4	4	3	14
Composer attribution	4	4	3	3	3	17
Social function	1	3	4	4	4	16
Meter	1	1	2	1	3	8
Mode	1	1	2	1	2	7
Pitch contour	1	3	2	2	2	10
Pitches on accented beats	3	3	2	3	2	13
Pitches initiating and terminating phrases	2	3	1	3	3	12
Totals	14	20	20	21	22	

Key

always	1
usually	2
sometimes	3
Rarely or never	4

Co-ordinated pitch/duration similarity

Manfred Leppig (German mathematician)

unterschiedlichen Zahlen- bzw. Zeichenfolgen leicht geordnet werden können:

Haydn, 94

Mit dem Pfeil

The image shows two musical staves in G major. The top staff is labeled 'Haydn, 94' and has handwritten numbers and question marks below it: 1 1 3 3 5 ? 3 4 4 ? 2 ? ? ?. The bottom staff is labeled 'Mit dem Pfeil' and has handwritten numbers and question marks below it: 1 1 3 3 5 ? 3 4 4 ? 2 ? ? ?.

Haydn, 94	H:	g	g	h	h	d	d	h	c	c	a	a [#]	f [#]	f	d
Mit dem Pfeil	H:	g	g	h	h	d	h	c	c	h	a	h	a		
Differenz	Δ_0 :	0	0	0	0	0	1	1	0	1	0	1	1		

Leppig vs Riess Jones

Manfred Leppig (1987)

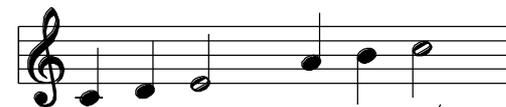


1: 1 3 5 8 6 86 5 4 5 3 1 2 1
 2: 1 1 5 5 6 6 5 4 4 3 3 223 1
 D: 0 2 0 3 0 2 0 0 1 0 -2 0 0

mathematics

psychology

Mari Riess Jones (OSU)



Note name:	C	D	E	A	B	C
Beat no:	•	•	•	•	•	•
	1	2	3	4	5	6
Melodic accent:	m	•	•	•	m	•
Temporal accent:	↑	•	↑	•	•	↑
Joint- accent structure:	a'''	a'	a''	a	a''	a'

Pitch-time space: interval reductions

Suk Won Yi, UCLA, (1992)



Interval	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	8.00	0.00
Duration	0.25	0.25	0.50	0.25	0.25	0.50	0.25	0.25	0.50	1.00
Coefficient of Melodic Activity	2.61	1.91	1.91	2.61	1.91	1.91	2.61	1.91	3.48	0.53

Pitch	9	8	8	9	8	8	9	8	8	16
Duration	.25	.25	.5	.25	.25	.5	.25	.25	.5	.5

Pitch-time space: Lerdahl, Krumhansl (2007)

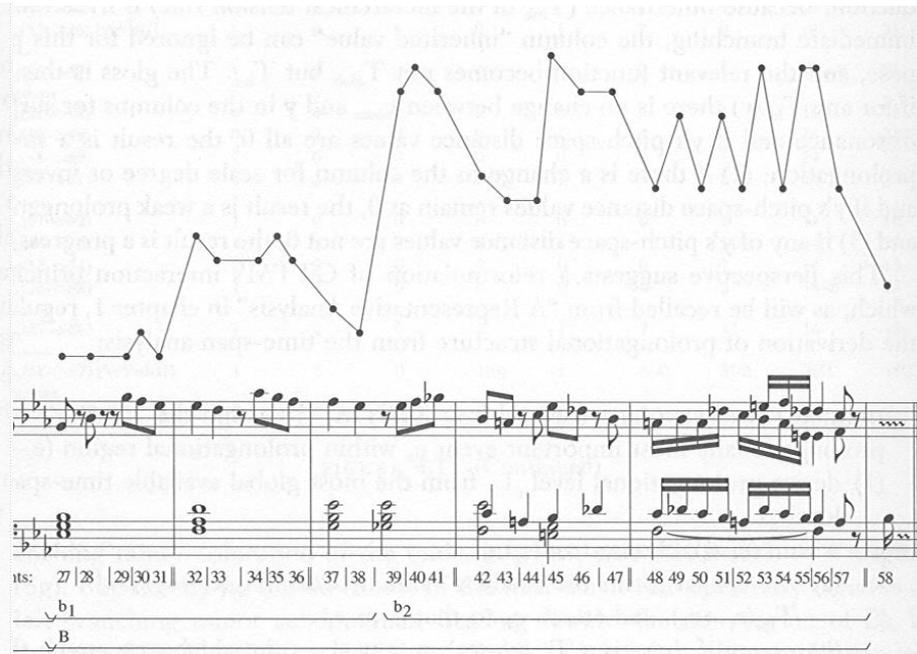
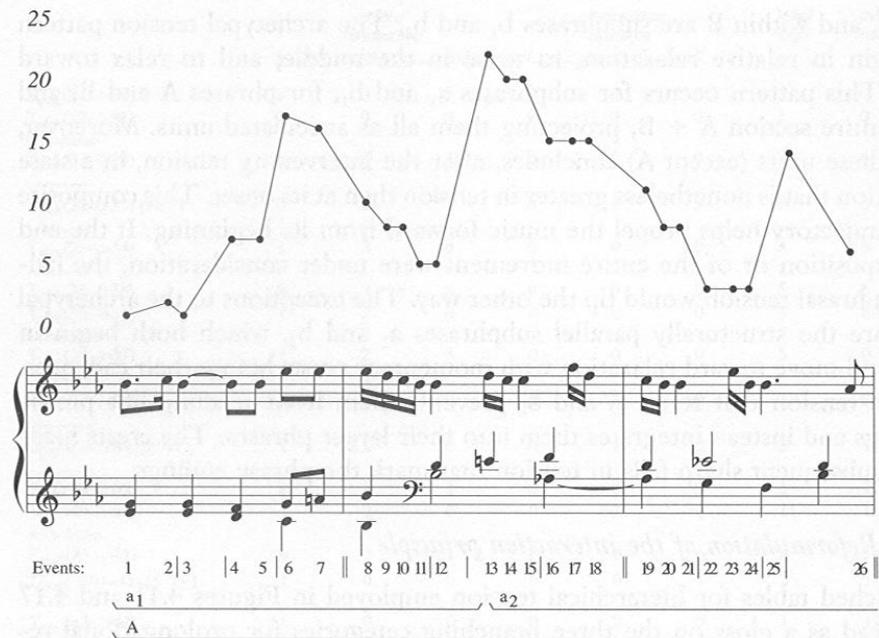
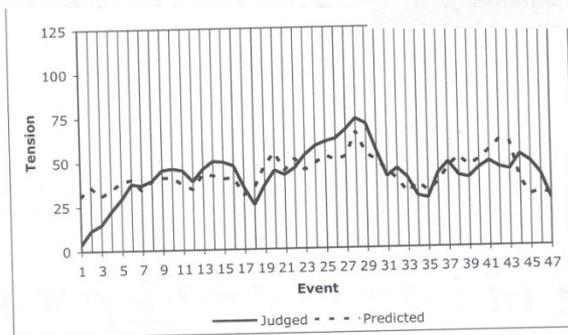


FIGURE 4.18 Graphic representation of the hierarchical tension values in Figure 4.17.

Values projected vs values judged



Tension attraction

Prototypical (elusive) melodies

Hypothetical melody: 

Mozart Piano Sonata in G Major

Actualities



Possible reductions



Narmour: Theory of Melody (and melodic implication)

Five musical staves (a-e) illustrating Narmour's theory of melody. Each staff shows a melodic line with various annotations:

- a**: Annotations include IP, P, ID, P, (VR), and (x). Dynamics *p* and *f* are marked.
- b**: Annotations include IP, P, (h), IP, P, (VR), and (x).
- c**: Annotations include IP, P, (os), IP, P, ID, and (h,os).
- d**: Annotations include IP, P, P, (h), IP, ID, P, (d), and (x).
- e**: Annotations include ID, P, ID, P, ID, P, and (os).

A musical diagram showing a sequence of chords: I, V₆, V₃⁴, I. An IP annotation is placed above the first two chords (I and V₆).

If interval < fourth
stepwise departure likely
If interval \diamond fourth
directional change likely

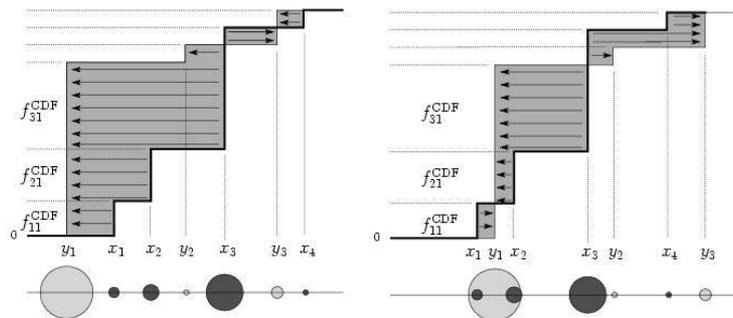
Cf. *Themefinder* refined contour search

Transportation distance

Joint pitch and duration metric

► Wiering, Typke et al. (2005)

- Earth Mover's Distance



EMD: S. Cohen et al., SU Robotics, 1999

Affective similarity

Performing medium	Genre contrast	Classical title	Other title
Piano	Classical-contemporary	Rachmaninov: Moment Musical Op 16, No. 2	Ligeti: Concerto for Piano and Orchestra
Piano	Classical-jazz	Schumann: Kreisleriana Op 16, No. 5	Gershwin: "I loves you, Porgy" (Porgy and Bess)
Orchestral	Classical-jazz	Prokofiev: Symphonie Op 100, No. 5, movement I	Gershwin: Porgy and Bess
Orchestral	Classical-pop	Beethoven: Romance for Violin and Orchestra Op 50, No. 2	Beatles: "Eleanor Rigby"
	Classical-musical	Beethoven: Romance for Violin and Orchestra Op 50, No. 2	Nacio Herb Brown: "Singin' in the Rain"

Table 2. Anomalous listener-defined similarities among works of different genres in the Aucouturier-Pachet research.

Cognitive distance metric (1)

I. Basic Pitch-Accent Structure		Range = 0-4
A.	If meter matches target	Max = 1.00
	and If subunit (e.g. quarter note) is the same	Score = 1.00
	or If subunit is different (e.g., 4/8 vs. 2/4)	Score = 0.50
	Else	Score = 0.00
B. Percentage of matched pitches on primary beats*		Max = 2.00
	If matching number of scale degrees=100%	Score = 2.00
	or If matching number of scale degrees =>90%	Score = 1.33
	or If matched number of notes/unit =>80%	Score = 0.67
	Else	Score = 0.00
C. Percentage of matched pitches on secondary beats		Max = 1.00
	If matching number of scale degrees=100%	Score = 1.00
	or If matching number of scale degrees=>90%	Score = 0.67
	or If matched number of notes/unit =>80%	Score = 0.33
	Else	Score = 0.00

Cognitive distance metric (2)

II. Basic Harmonic-Accent Structure		Range = 0-6
A. Mode of work (major, minor, other)		Max = 1.00
	If modes match	Score = 1.00
	Else	Score = 0.00
B. Percentage of matched chords on downbeat**		Max = 2.50
	If unambiguous matches on primary beats =>90%	Score = 2.50
	or If unambiguous matches on primary beats =>80%	Score = 2.00
	or If unambiguous matches on primary beat =>70%	Score = 1.50
	Else	Score = 0.00
C. Percentage of matched chords on secondary beats**		Max = 2.00
	If unambiguous matches =>90%	Score = 2.00
	or If unambiguous matches =>80%	Score = 1.50
	or If unambiguous matches =>70%	Score = 1.00
	Else	Score = 0.00
D. Percentage of matched chords on tertiary beats		Max = 0.50
	If unambiguous matches =>90%	Score = 0.50
	Else	Score = 0.0

Cognitive distance metric (3)

Example	Pitch-Accent score		Harmony-Accent score		Total score (additive)	
	Raw	Ranked	Raw	Ranked	Raw	Ranked
2a	3.67	2	5.5	3	9.17	2
2b	3.67	2	5.0	4	8.67	3
2c	2.67	6	6.0	1	8.67	3
2d	1.17	9	4.5	5	6.67	8
2e	2.67	6	4.0	9	6.67	8
2f	2.33	8	4.5	5	6.83	7
2g	1.00	10	2.0	11	3.00	11
2h	3.50	4	4.5	5	8.00	6
2i	4.00	1	4.5	5	8.50	5
2j	1.00	10	4.0	9	5.00	10
2k	3.33	5	6.0	1	9.33	1

Evaluating search viability and efficiency

- ▶ Krumhansl, 2000 [theoretical]
- ▶ Sapp, Liu, Selfridge-Field, 2004 [practical]

Search Effectiveness (1)

Sapp, Liu, Selfridge-Field (ISMIR 2004)

Data

Dataset	Genre	Orig. Code	# Incipits
• US RISM A/II	Instrumental, Vocal (17th–18th cents.)	Plaine & Easie	55,490
• Renaissance (Italy)*	Motets (16th cent.)	DARMS	18,946
• Classical*	Instr., Vocal	MIDI	10,718
• Essen European*	Folksongs	EsAC	6,232
• Polish religious monophony	Devotional songs, 16th, 19th cents.	EsAC	6,060
• Essen Asian*	Folksongs (China)	EsAC	2,241
• Luxembourg*	Folksongs	EsAC	612
Total			100,299

Search Effectiveness (2)

	Abbr.	Search type	# states
Pitch features	p1	pch enharmonic pitch class	35
	p2	mi musical interval	(35)
	p3	12p 12-tone pitch class	12
	p4	12i 12-tone pitch interval	(12)
	p5	sd scale-degree (diatonic pitch class)	7
	p6	pge pitch gross contour	3
	p7	pre pitch refined contour	5
Meter features	r1	dur duration	?
	r2	dgc duration gross contour	3
	r3	drc duration refined contour	5
	r4	blv beat level	2
	r5	mlv metric level	?
	r6	mge metric gross contour	3
	r7	mrc metric refined contour	5

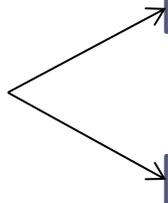
Search Effectiveness (3)

Sample search



pch	F	A	C	C	C	D	C	A	F	A	G
mi		+M3 +m3	P1	P1	+M2	-M2		-m3	-M3	+M3	-M2
12p	5	9	0	0	0	2	0	9	5	9	7
12i		+4	+3	0	0	+2	-2	-3	-4	+4	-2
sd	1	3	5	5	5	6	5	3	1	3	2
pge	U	U	S	S	U	D	D	D	U	D	
pre	U	U	S	S	u	d	D	D	U	d	
dur	E	E	Q	Q	Q	Q	Q.	E	Q	Q	H
dge	E	L	E	E	E	L	S	L	E	L	
drc	E	l	E	E	E	l	S	l	E	l	
blv	1	0	1	1	1	1	1	0	1	1	1
mlv	0	-1	2	0	1	0	2	-1	1	0	2
mge	W	H	W	H	W	H	W	H	W	H	
mrc	w	H	w	h	w	H	W	H	w	H	

Coupled search



Results

