



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](#)

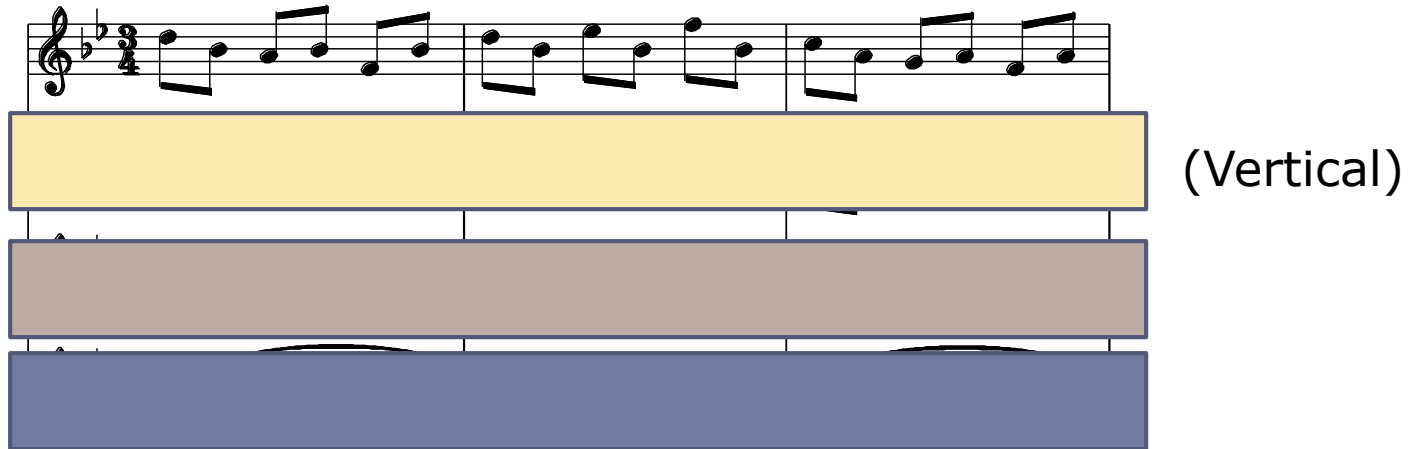


or ...



Reductionist approaches: melodic simplification

Target: 3452



The diagram illustrates a reductionist approach to melodic simplification. At the top, a musical staff in 3/4 time with a key signature of one flat (B-flat) shows a target melody. The melody consists of three measures: the first measure has a quarter note on B4, a quarter note on C5, and an eighth note on D5; the second measure has a quarter note on C5, a quarter note on B4, and an eighth note on A4; the third measure has a quarter note on A4, a quarter note on G4, and an eighth note on F4. Below the staff are three horizontal bars: a yellow bar, a brown bar, and a blue bar. The yellow bar is labeled "(Vertical)" to its right. The brown and blue bars are empty. The diagram suggests a process of simplifying the melody into vertical blocks of sound.

Time-span reduction

German folksong

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

Substitution of one pitch for each bar

D E F# G A B C D

Work of Helmut Schaffrath and pupils (Essen)

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

Time-span reduction

German folksong



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

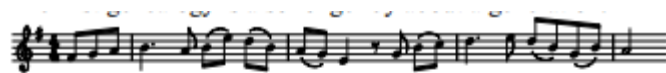


Figure 6. Beginning of the verse of the Londonderry Aire/ Danny Boy (E).



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.

	Family					
Feature preserved	A	B	C	D	E	Totals
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)

unten Zahlen- bzw. Zeichenfolgen leicht ge- der Tonnoten:

Haydn, 94



Mit dem Pfeil



Haydn, 94	H:	g	g	h	h	d	d	h	c	c	a	a	$\sharp f$	$\sharp f$	<u>d</u>
Mit dem Pfeil	H:	g	g	h	h	d	h	c	c	h	a	h	a		
Differenz	Δ_o :	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	
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		

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

Pitch-time space: Lerdahl, Krumhansl (2007)

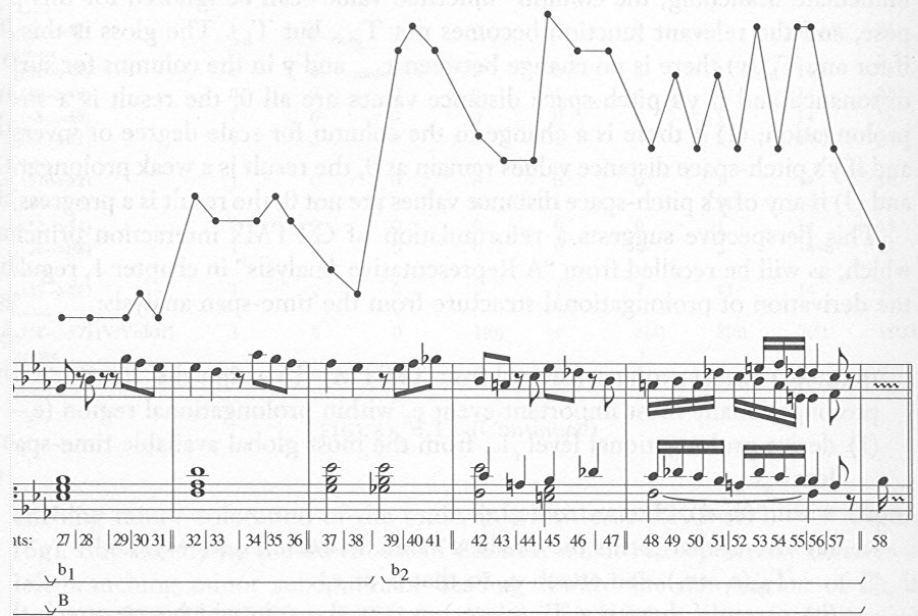
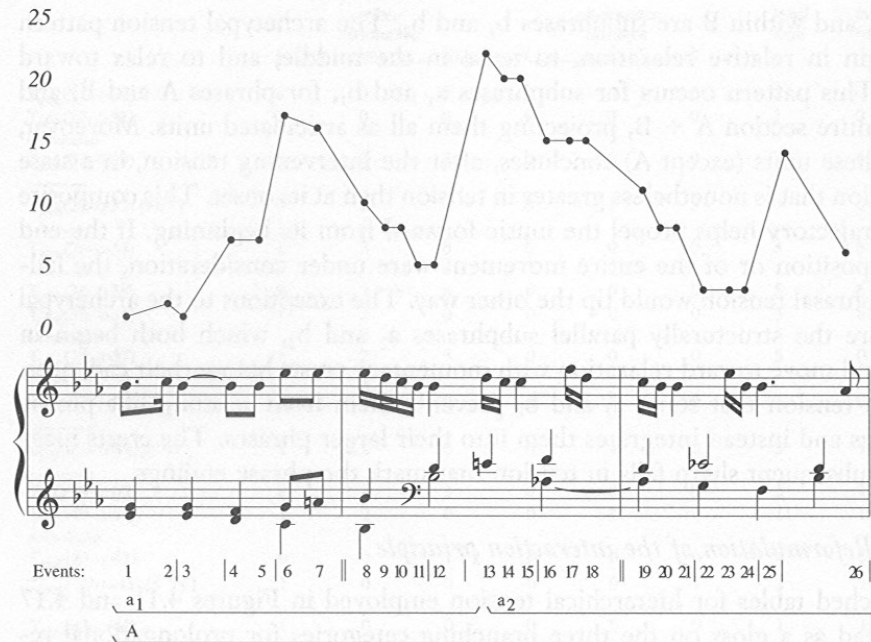
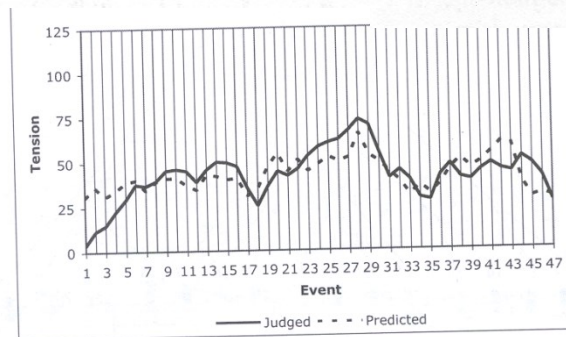


FIGURE 4.18 Graphic representation of the hierarchical tension values in Figure 4.17.

Values projected
vs values judged



Tension attraction

Prototypical (elusive) melodies (Narmour)

Hypothetical melody: 

Mozart Piano Sonata in G Major

Actualities



Possible reductions



Narmour: Theory of Melody (and melodic **implication**;

implication-realization model)

Five musical staves (a-e) illustrating Narmour's Theory of Melody. Each staff shows a sequence of notes with various interval and direction labels above them. Labels include IP (Interval Prediction), P (Pitch), ID (Interval Direction), (VR) (Voice Range), (x) (cross), (h) (half), (os) (octave), (h,os) (half-octave), (d) (down), and (os) (octave). Staff 'a' starts with a piano (p) dynamic and ends with a forte (f) dynamic. Staff 'b' includes a half note (h) and a cross (x). Staff 'c' includes an octave (os) and a half-octave (h,os). Staff 'd' includes a down-bow (d) and a cross (x). Staff 'e' includes an octave (os) and a cross (x).

A musical staff showing harmonic progression. The staff is divided into four measures. The first measure is labeled 'I' (tonic). The second measure is labeled 'V₆' (dominant seventh). The third measure is labeled 'V_{3/4}' (dominant triad). The fourth measure is labeled 'I' (tonic). Above the staff, there are two horizontal lines labeled 'IP' (Interval Prediction) spanning the first two measures and the last two measures.

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

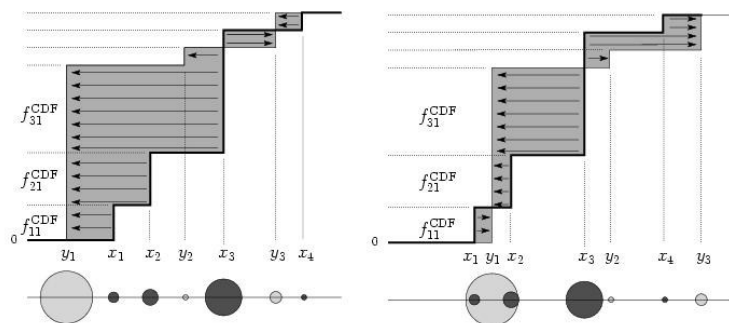
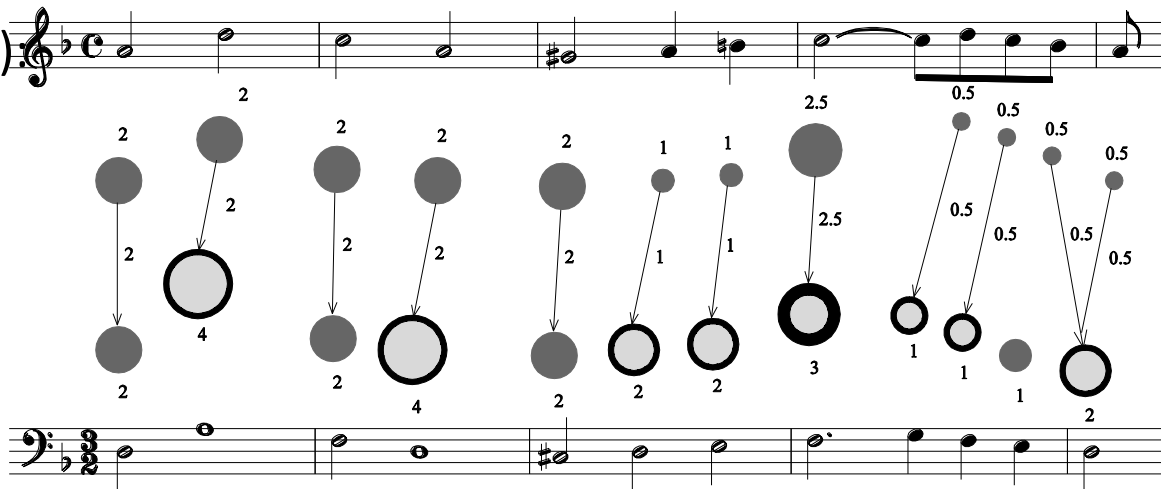
Cf. *Themefinder* refined contour search

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 (human-subject research)

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"

Anomalous listener-defined similarities identified among [isolated moments in] works of different genres in the **Aucouturier-Pachet** research. (Sony labs, Paris)

Similarities depend on tempo, dynamics, timbre

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	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	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
•	Classical*	Instr., Vocal	MIDI	10,718
Total				100,299

Search Effectiveness (2)

Pitch features

	Abbr.	Search type	# states
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	pgc	pitch gross contour	3
p7	prc	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	mgc	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
pre	U	U	S	S	u	d	D	D	U	d	
dur	E	E	Q	Q	Q	Q	Q.	E	Q	Q	H
dgc	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

