Musical Similarity:
More perspectives and compound techniques

CS 275B/Music 254

Musical similarity

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

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**		**Harmonic-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 [theory/experiment]
- Sapp, Liu, Selfridge-Field, 2004 [practical]

"Search effectiveness measures for symbolic music queries in very large databases" ISMIR 2004:

http://ismir2004.ismir.net/proceedings/p051-page-266-paper135.pdf

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)

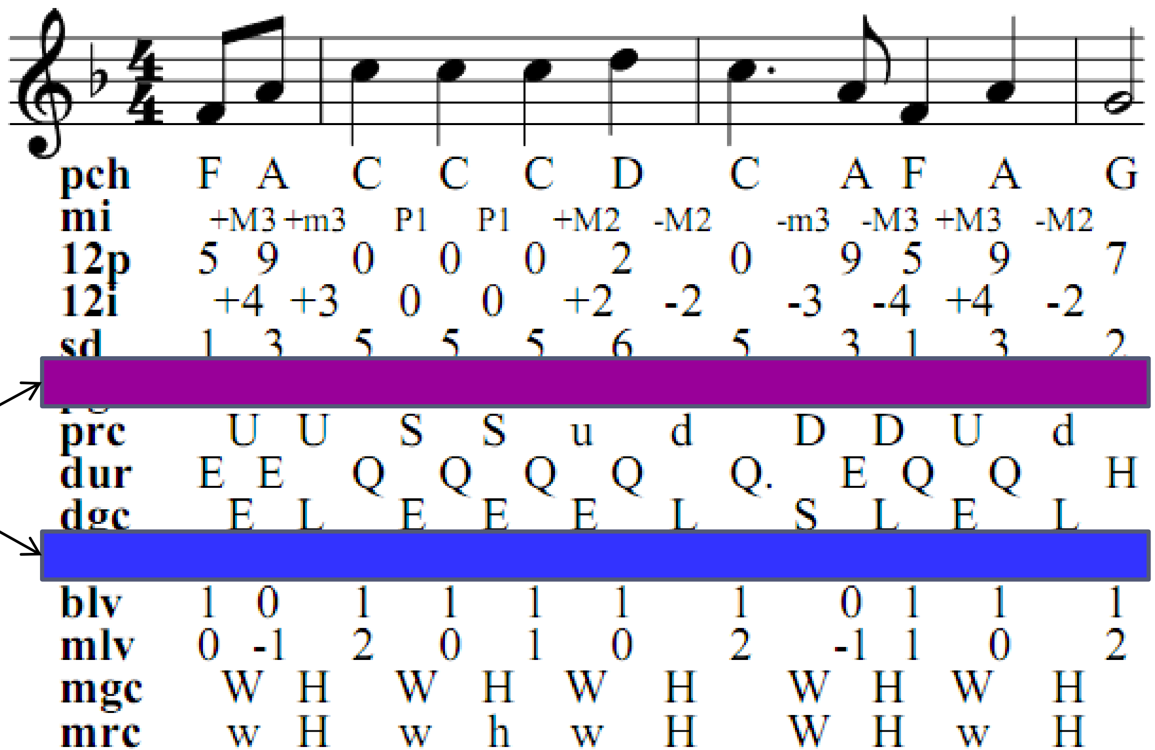
Pitch features

Meter 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
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

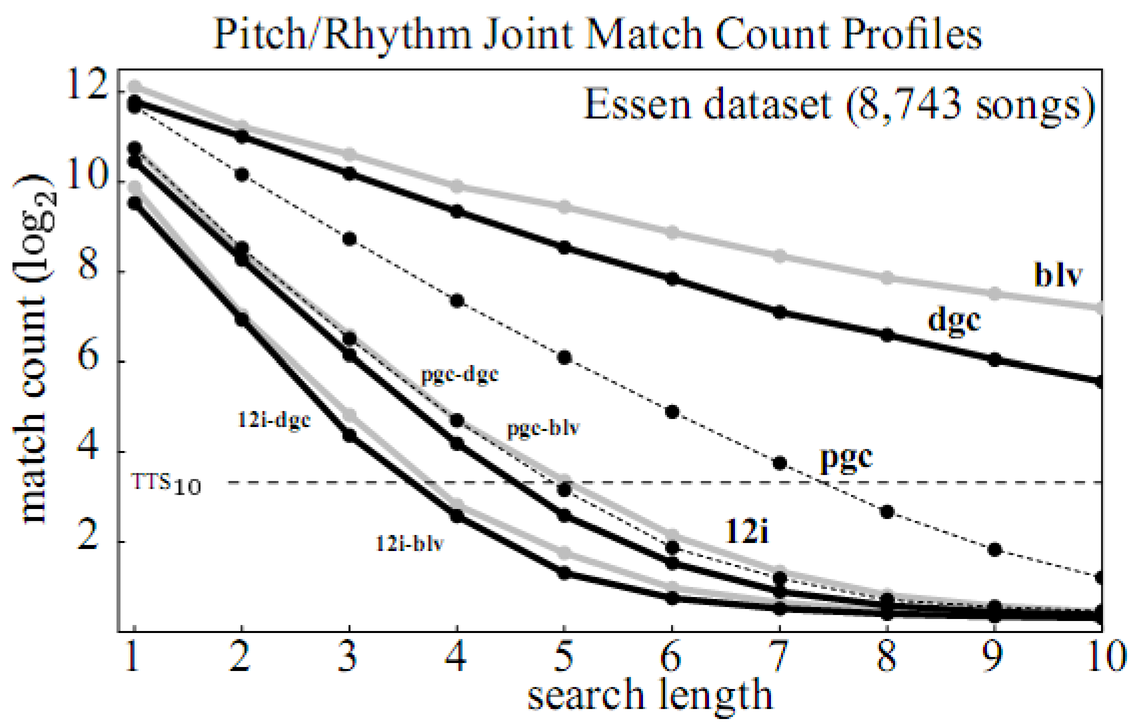
Search Effectiveness (3)

Sample search



Coupled search

Results


Pitch/Rhythm Joint Match Count Profiles
Essen dataset (8,743 songs)
match count (log2)
search length
12
10
8
6
4
2
1
2
3
4
5
6
7
8
9
10
blv
dgc
pgc
12i
pgc-dgc
pgc-blv
12i-dgc
12i-blv
TTS10

Search Effectiveness (1)

Sapp, Liu, Selfridge-Field (ISMIR 2004)

Data

	Dataset	Genre	Orig. Code	# Incipits
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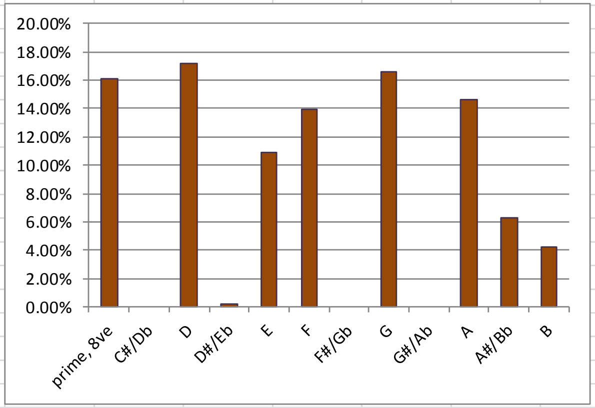
•	Classical*	Instr., Vocal	MIDI	10,718
	Total			100,299

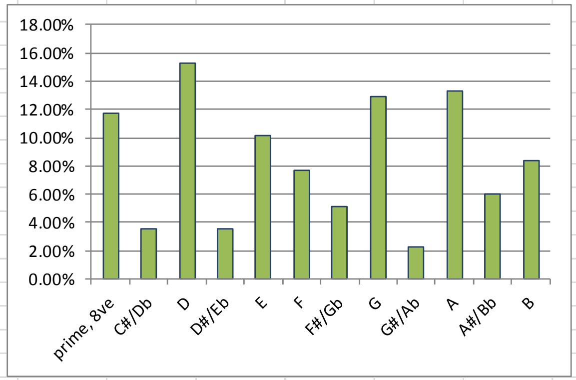
Stats from 2004 study

Repertory	Repeated pitch intervals	Up intervals	Down intervals	Symbols/theme	Total incipits
15-16th cent/Latin	29,916	66,026	67,151		18,947
15th-16th cent/Polish	57,006	130,030	157117		6016
17-18th cent/US RISM	110,478	344,621	399,079		55,491
18th-19 cent/classical	19,241	80,166	86,430		10,722
Essen Europe	43,581	53,033	58,815		6,232
Essen Asia	16,441	54,577	65,684		2,240
Luxembourg	4,355	9,720	11,927		612
	281,018	738,173	846,203		100,260

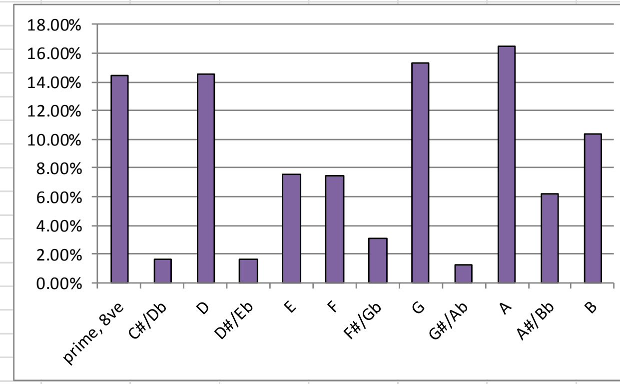
Normalized pitch usage by repertory



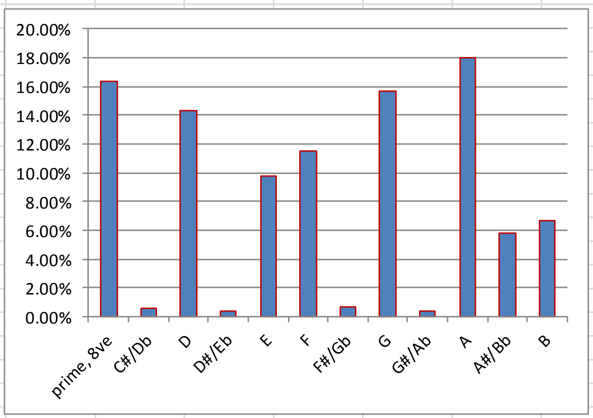
Latin motets



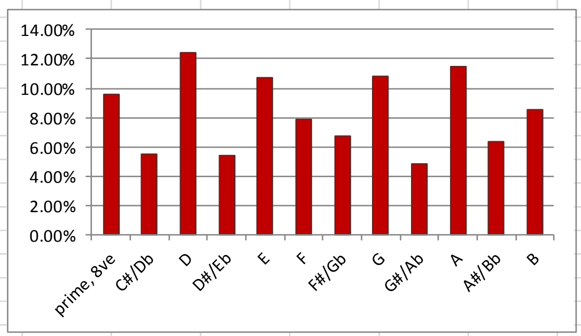
US RISM



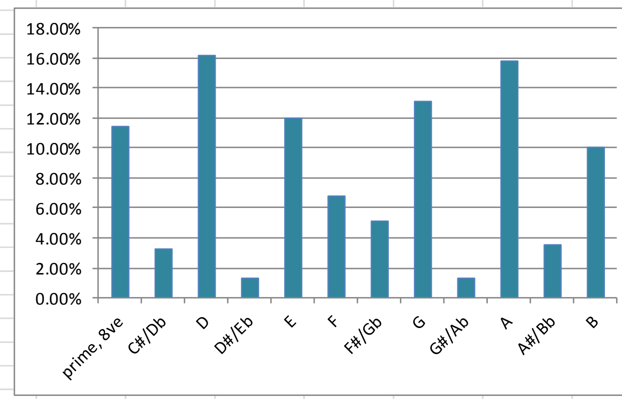
Essen Europe



Polish



Classical



Essen Asia

Form: Boundary strength

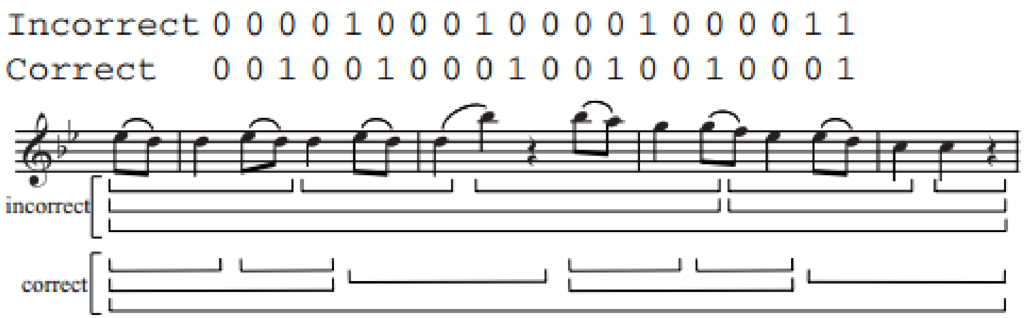
- **Markus Pearce, Daniel Müllensiefen, Geraint Wiggins** (Goldsmith): et al: "Melodic Grouping in Music Information Retrieval"

GPR	Description	n	Boundary Strength
2a	Rest		absolute length of rest (semibreve = 1.0)
2b	Attack-point	length	$\begin{cases} 1.0 - \frac{n_1+n_3}{2\times n_2} & \text{if } n_2 > n_3 \wedge n_2 > n_1 \\ \perp & \text{otherwise} \end{cases}$
3a	Register change	pitch height	$\begin{cases} 1.0 - \frac{\lvert n_1-n_2\rvert+\lvert n_3-n_4\rvert}{2\times\lvert n_2-n_3\rvert} & \text{if } n_2 \neq n_3 \wedge \lvert n_2-n_3\rvert > \lvert n_1-n_2\rvert \wedge \lvert n_2-n_3\rvert > \lvert n_3-n_4\rvert \\ \perp & \text{otherwise} \end{cases}$
3d	Length change	length	$1.0 - \begin{cases} n_1/n_3 & \text{if } n_3 \geq n_1 \\ n_3/n_1 & \text{if } n_3 < n_1 \end{cases}$

After Frankland and Cohen (2004)

Binary (?) melodic segmentation

- Melodic segmentation (binary~)



Pearce's "ground truth" tests using Essen ERK data with binary segmentation(s)

Marcus T. Pearce, Daniel Müllensiefen, and Geraint A. Wiggins,

"Melodic Grouping and Music Information Retrieval" (2010)

[same], "A Comparison of Statistical and Rule-Based Models and Melodic Segmentation", ISMIR (2008).

Pearce results (Springer Verlag, 2010)

- GPR2a preference rules work
- Temperley 2001 also useful
- Synthesis of Grouper, LBDM, GPR2a, and Thom better that any one individually
- Unsupervised learned performed better than any statistical method

Pearce et al software and articles

- Idyom software:

https://code.soundsoftware.ac.uk/projects/idyom-project

- Perceptual segmentation of melodies:

  http://www.doc.gold.ac.uk/~mas03dm/papers/icmpc08_PearceMullensiefenWiggins.pdf

- Expectation in audio boundaries:

  http://www.ncbi.nlm.nih.gov/pubmed/21180358