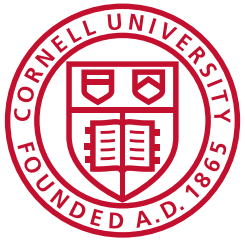
Musical Information Retrieval

Mark Gotham

Cambridge, 17 January 2019



Cornell University

Talk Contents (you are here …)

1. Scores: Metrical position usage
2. Audio: ‘Attractor tempos’
3. Teaching-led: Species or specious?
4. Teaching Resources: ‘Cut outs’

Talk Contents (you are here …)

1. **Scores: Metrical position usage**
2. Audio: ‘Attractor tempos’
3. Teaching-led: Species or specious?
4. Teaching Resources: ‘Cut outs’

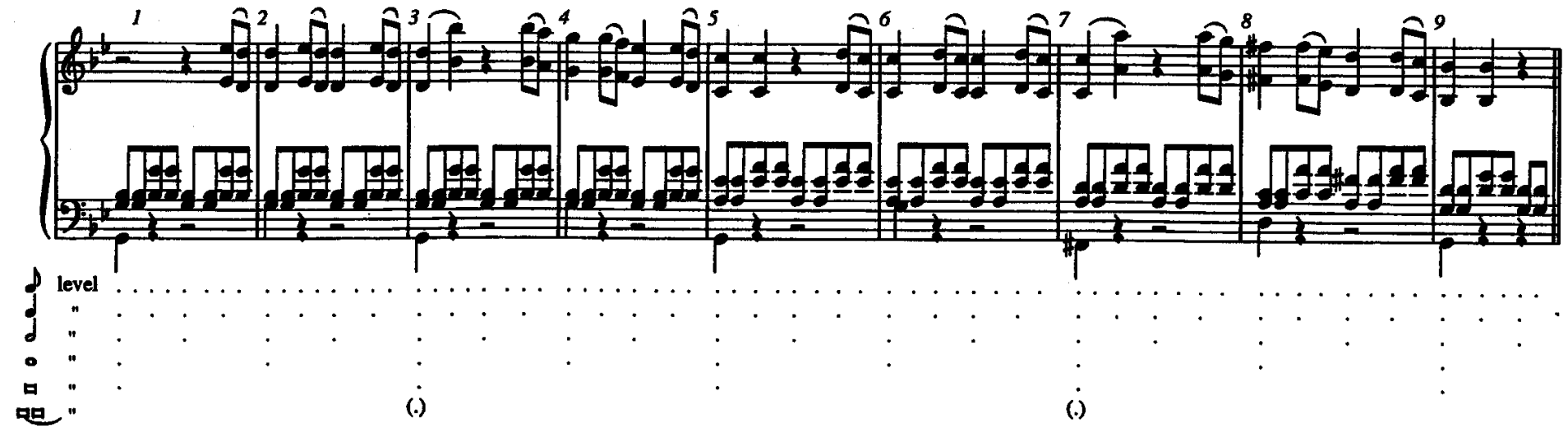
1. Scores

Hierarchies

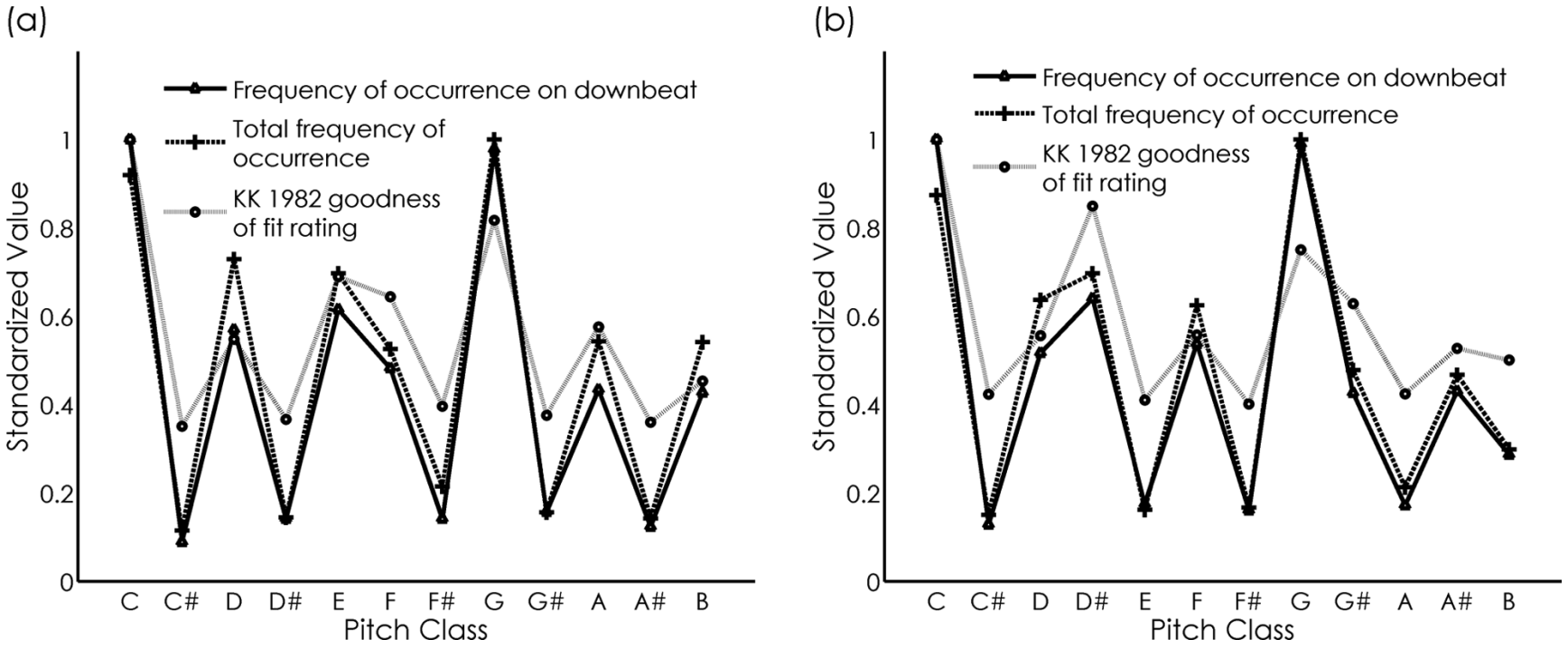
- ‘Important’ notes / beats

Assess:

- Perceptual: ‘Goodness of fit’
- Empirical: Extent of usage

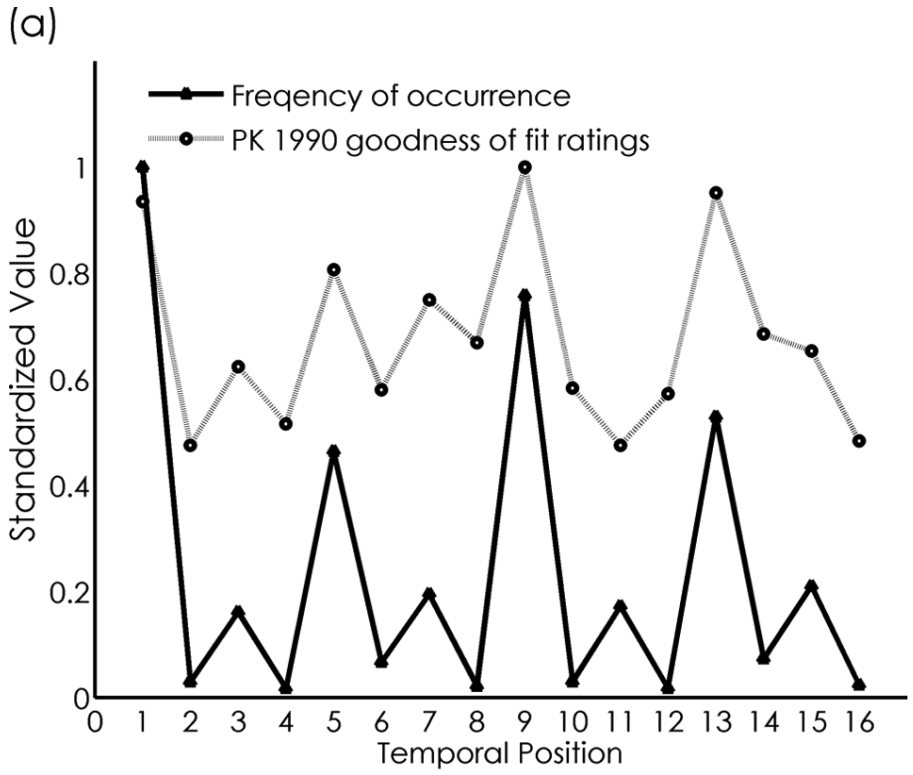


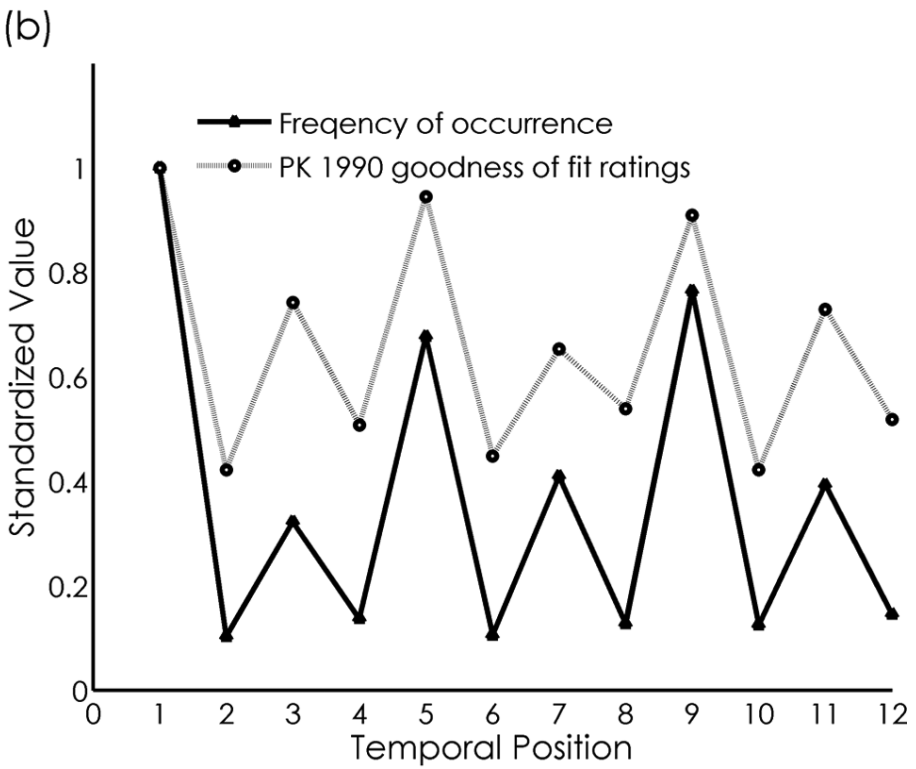
Tonal hierarchy



Source: Prince and Schmuckler: 'The Tonal-Metric Hierarchy: A Corpus Analysis' (*Music Perception* 2014). After Kessler and Krumhansl

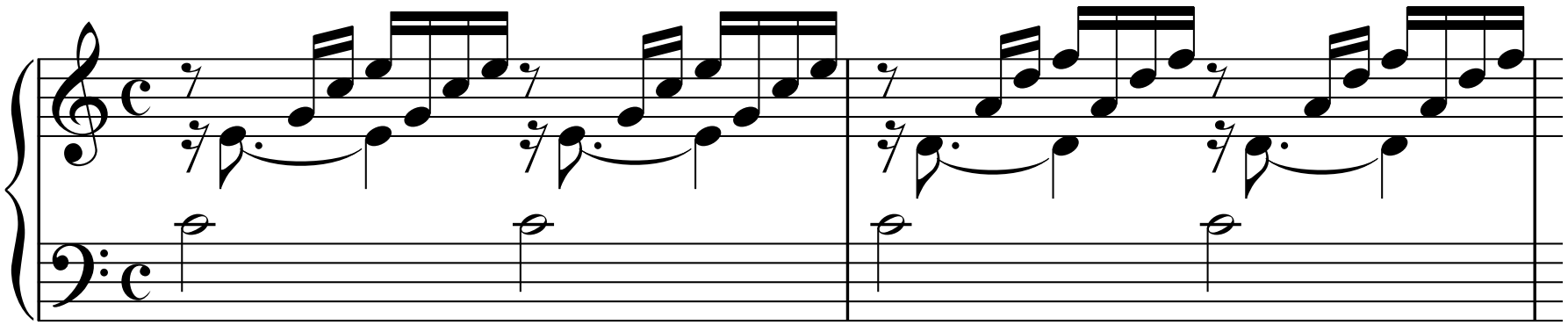
Metrical hierarchy



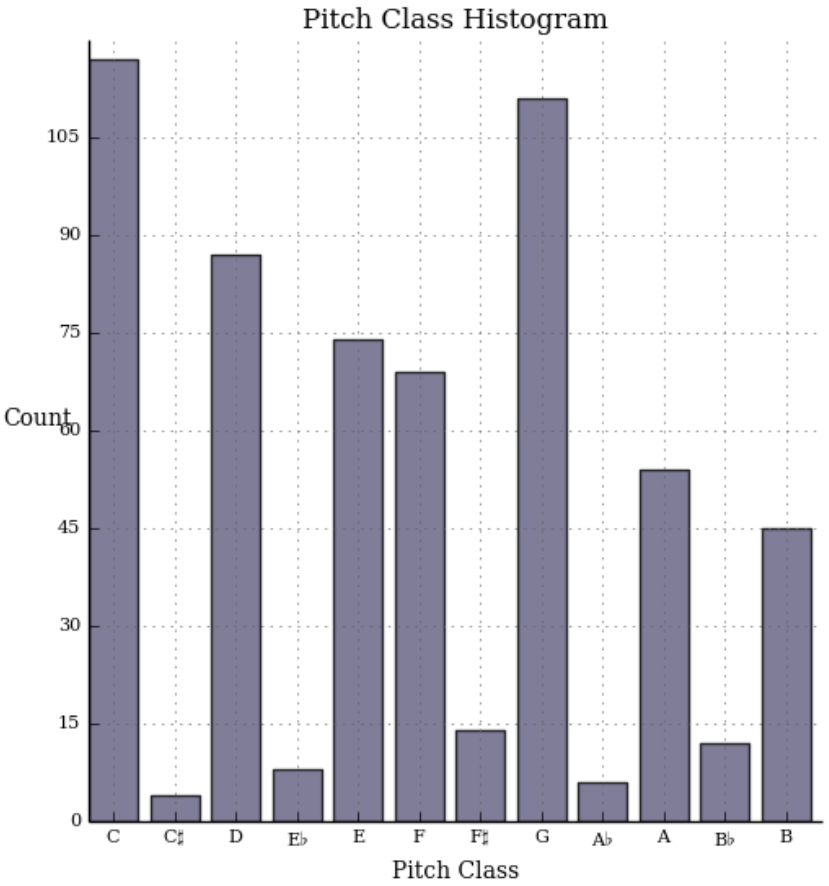


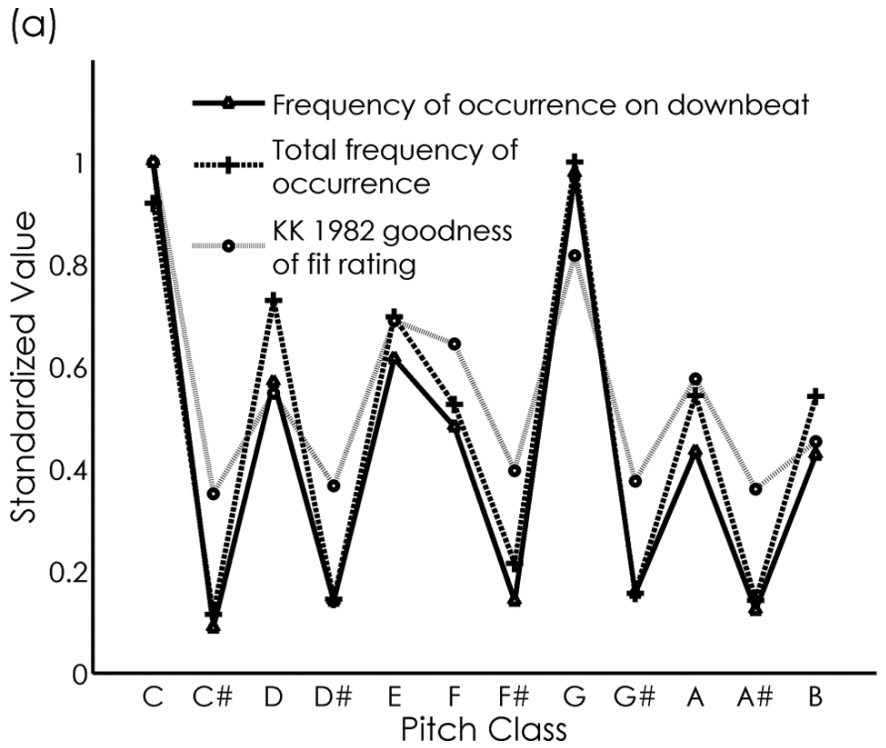
Source: Prince and Schmuckler: 'The Tonal-Metric Hierarchy: A Corpus Analysis' (*Music Perception* 2014). After Palmer and Krumhansl

Example case: BWV 846

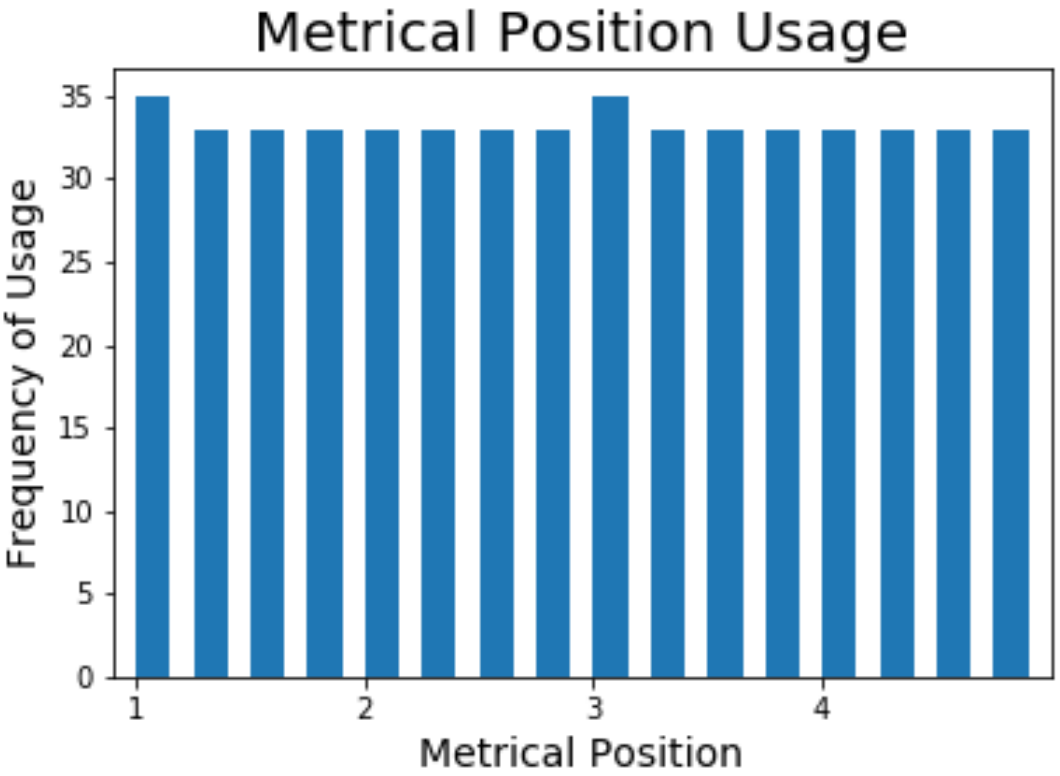


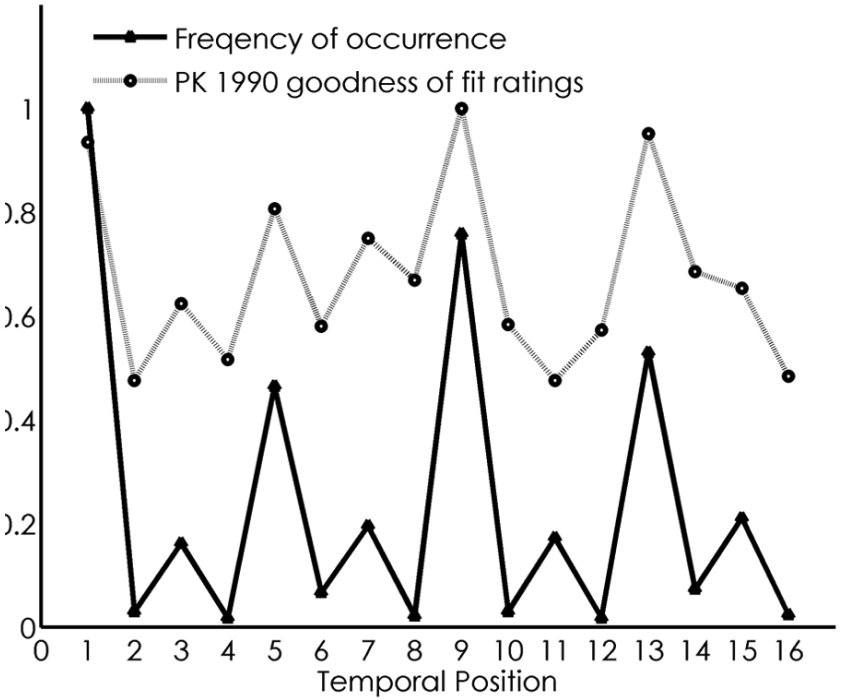
Tonal hierarchy: YES!





Metrical hierarchy: NO!



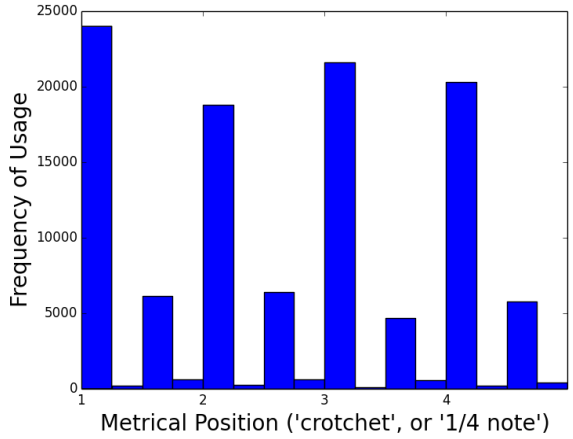


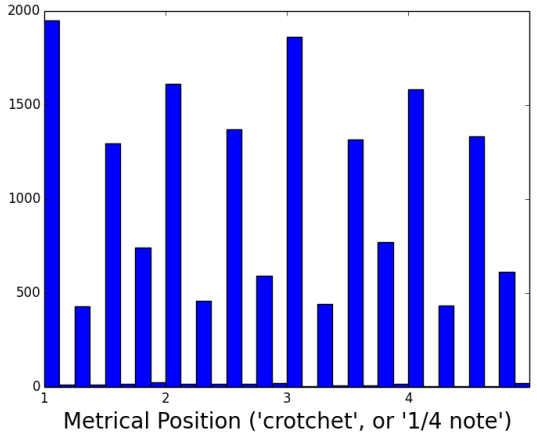
Sample Size

Chorales:

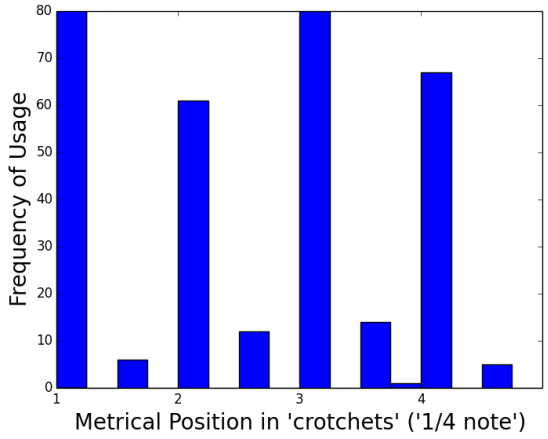
Preludes & Fugues:

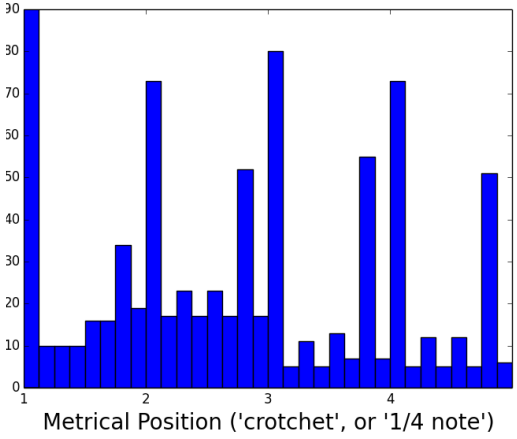
All:



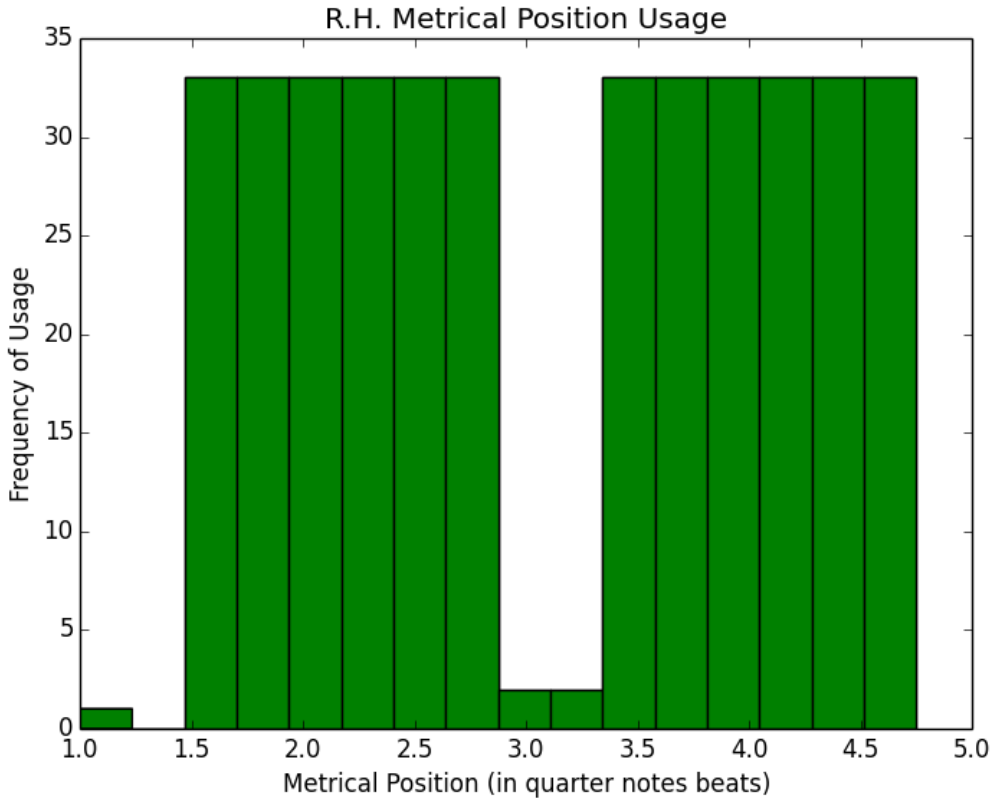


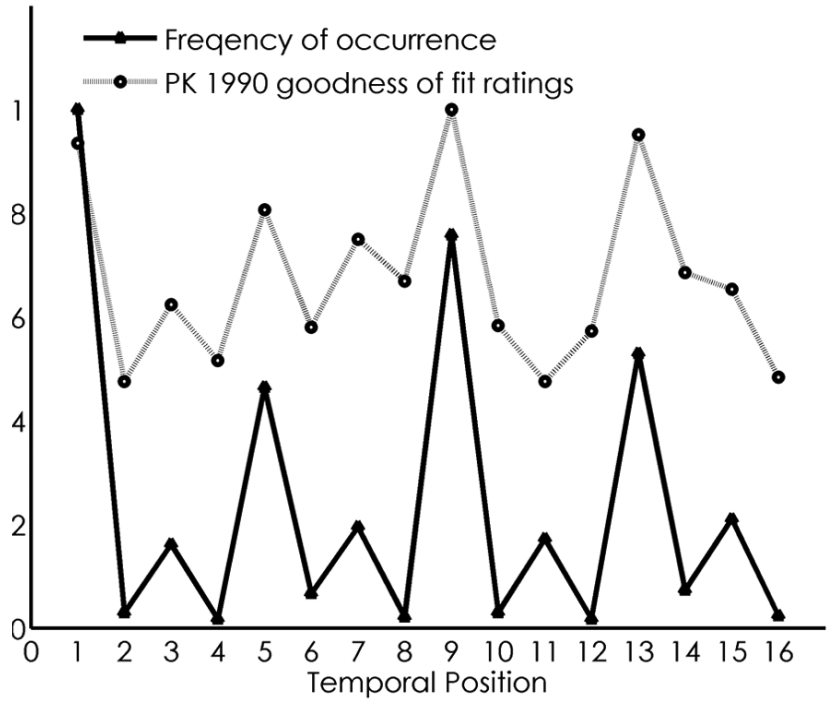
One:





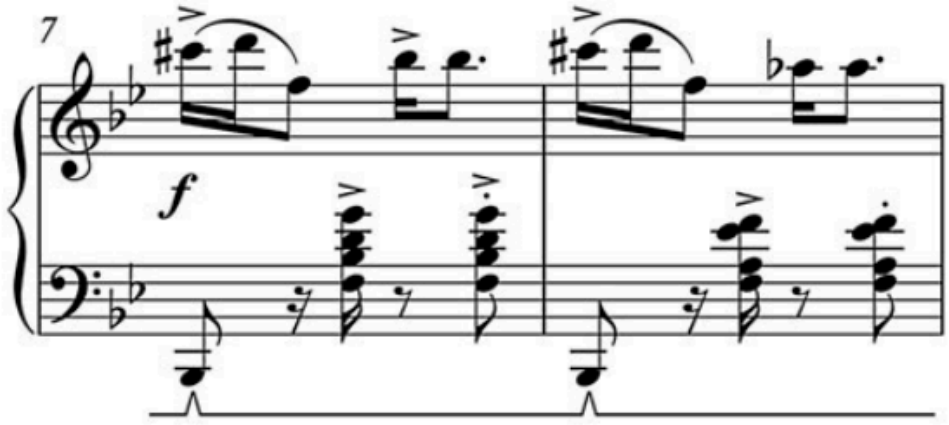
Hands together?

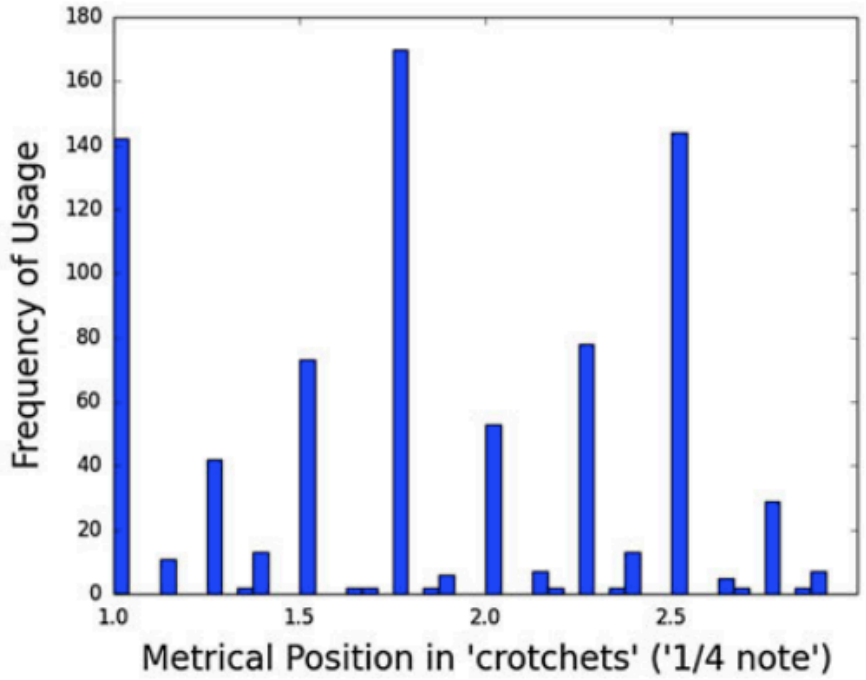




Hands together?

Gershwin Prelude no.1

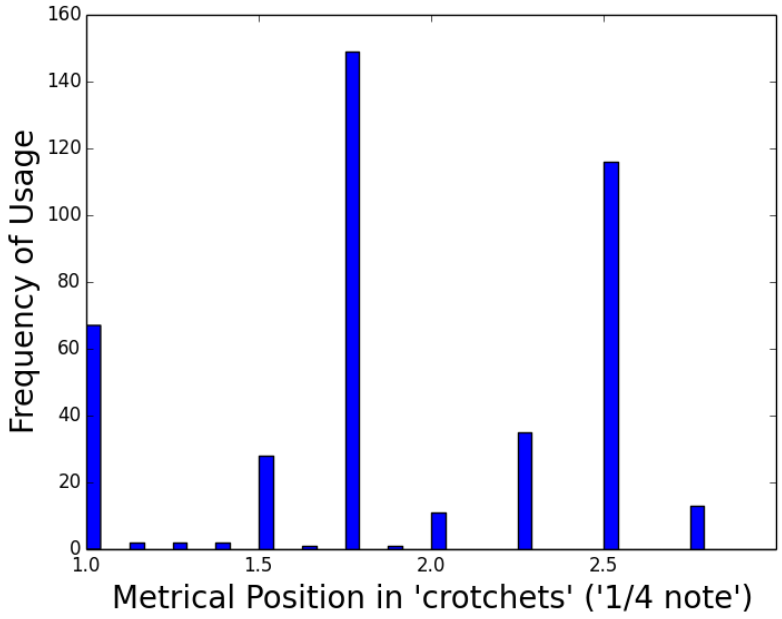




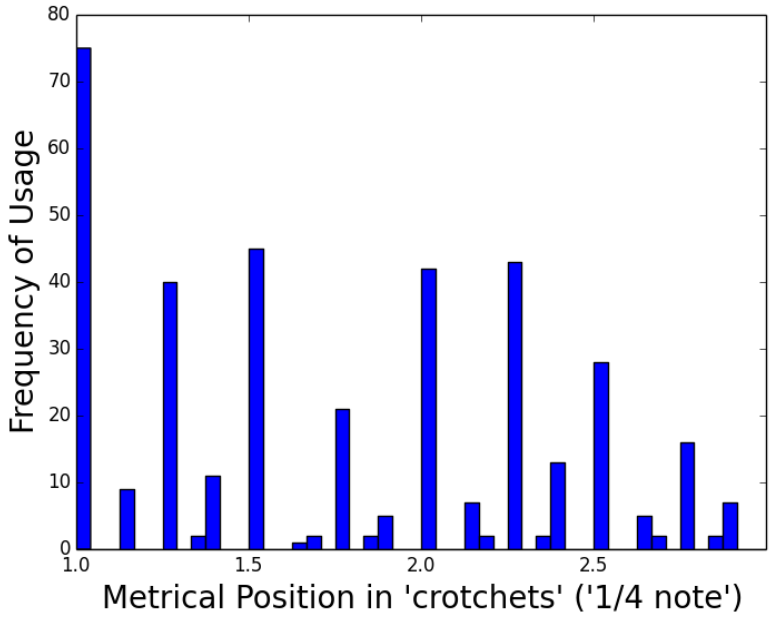
Hands together?

Gershwin Prelude no.1

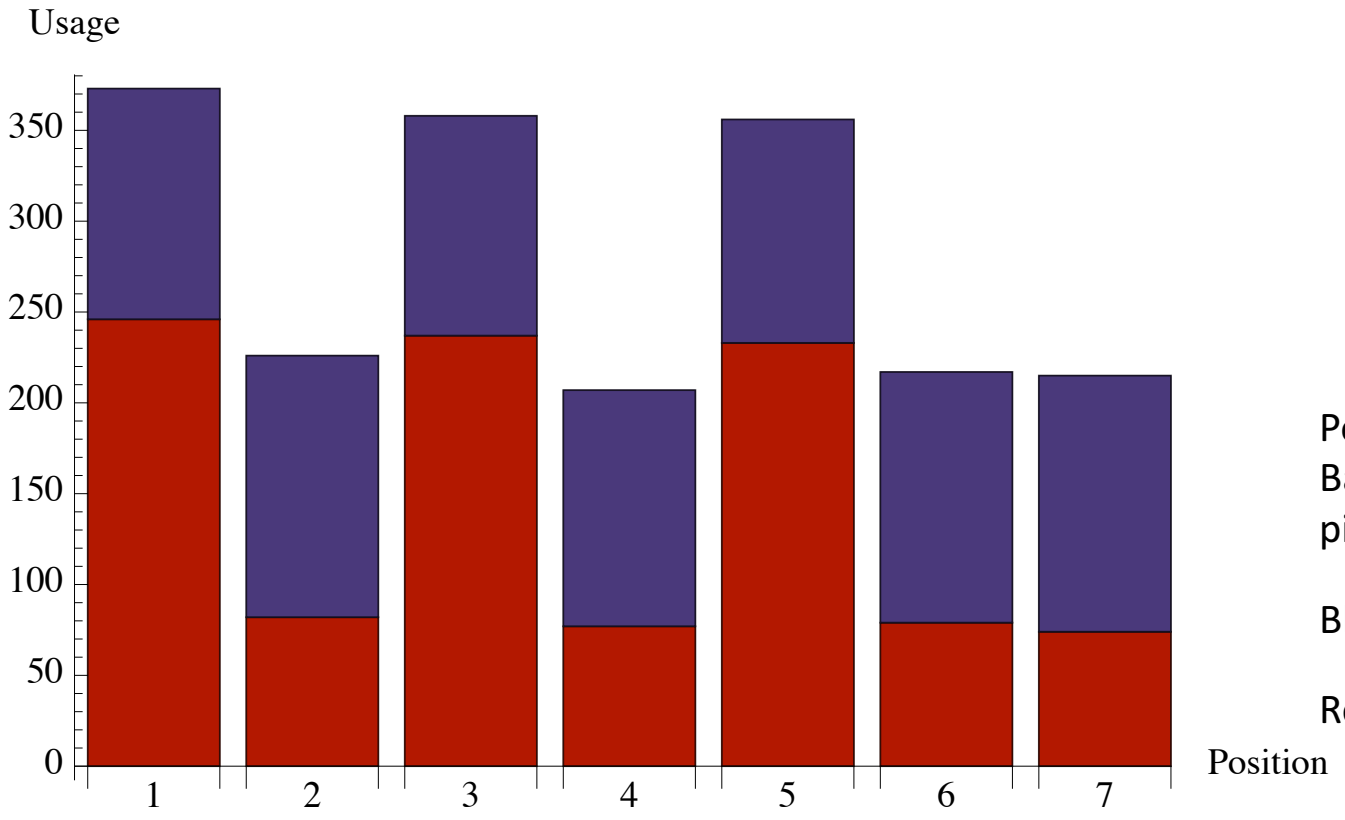
LH: 3,3,2 ‘metre’?



RH: 11213 rhythm?



‘Mixed’ metrical hierarchy



Position usage in Bartok’s 7/8 (223) piano pieces.

Blue: RH

Red: LH

Source: Gotham 2017: ‘Hierarchy and position usage in mixed metres’ *Journal of New Musicological Research*, 46/2.

Part 1: Summary

Possibilities

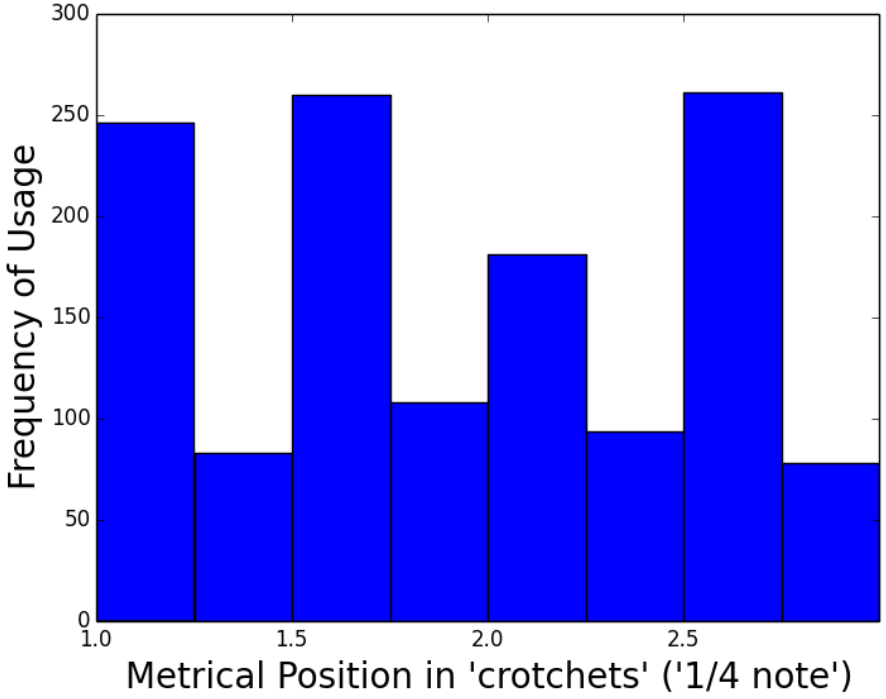
- Insights into cognition and ‘style’
- Automation of search/find/segment

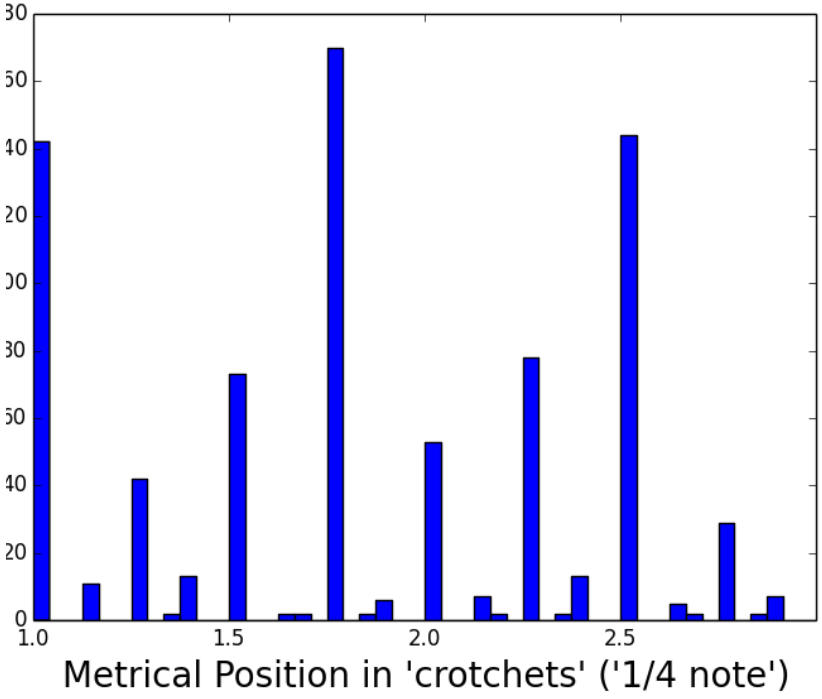
Pitfalls

- Methodology
- Error spotting

Style categorization?

Joplin and Gershwin. Similar styles?





Part 1: Summary

Possibilities

- Insights into cognition and ‘style’
- Automation of search/find/segment

Pitfalls

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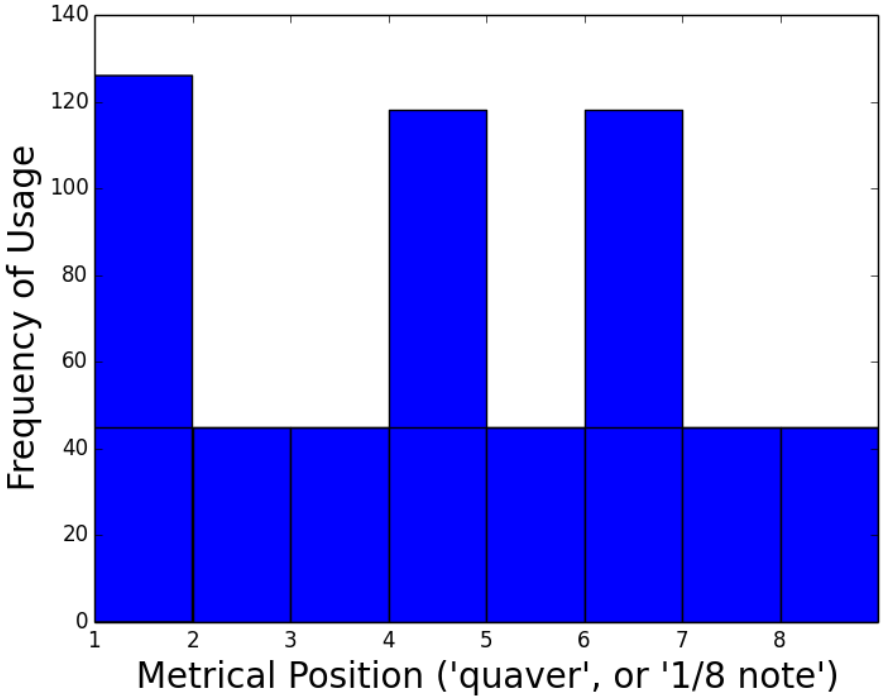
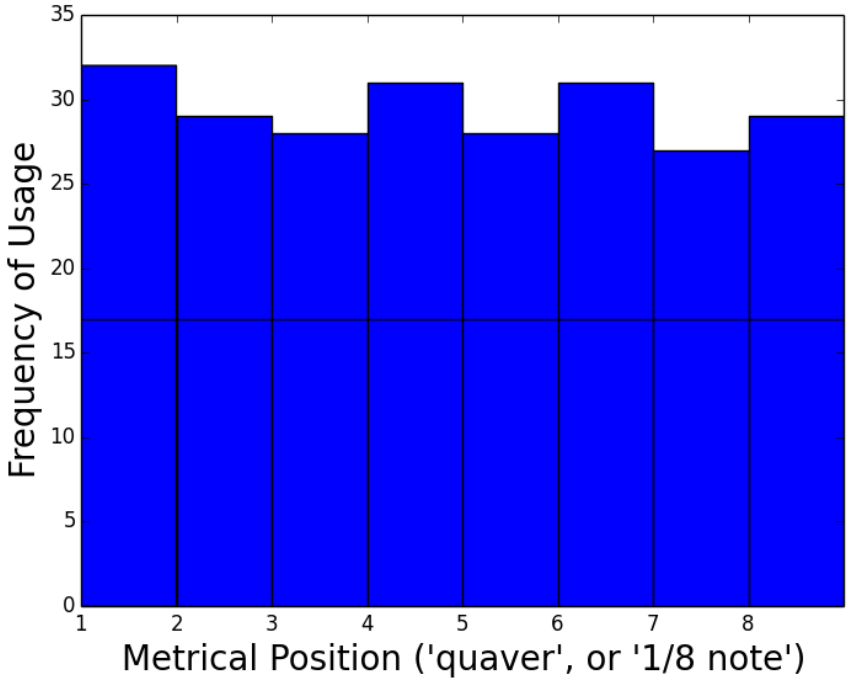
Section changes

Ligeti. *Fanfares* Etude. Two sections:





Part 1: Summary

Possibilities for:

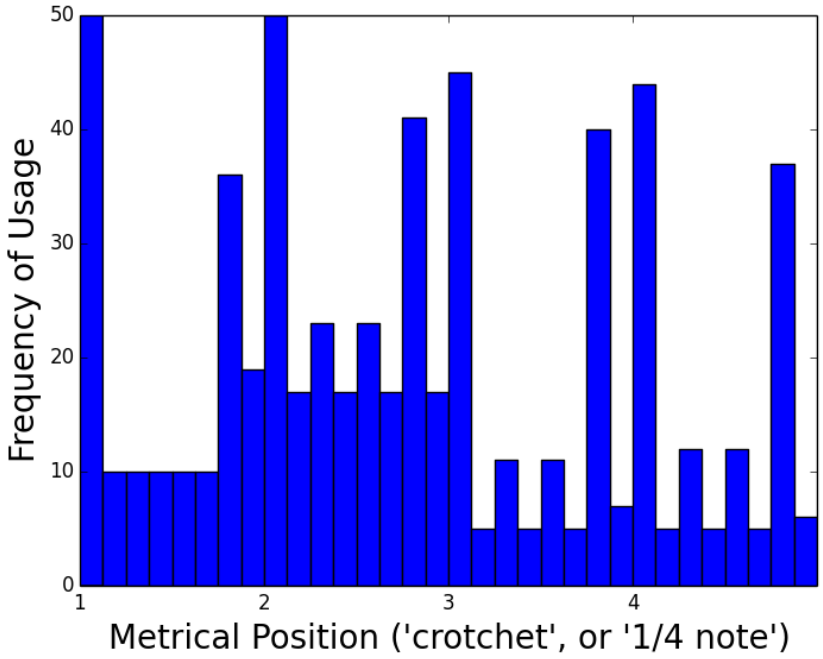
- Insight into cognition
- Automation of search/find/segment

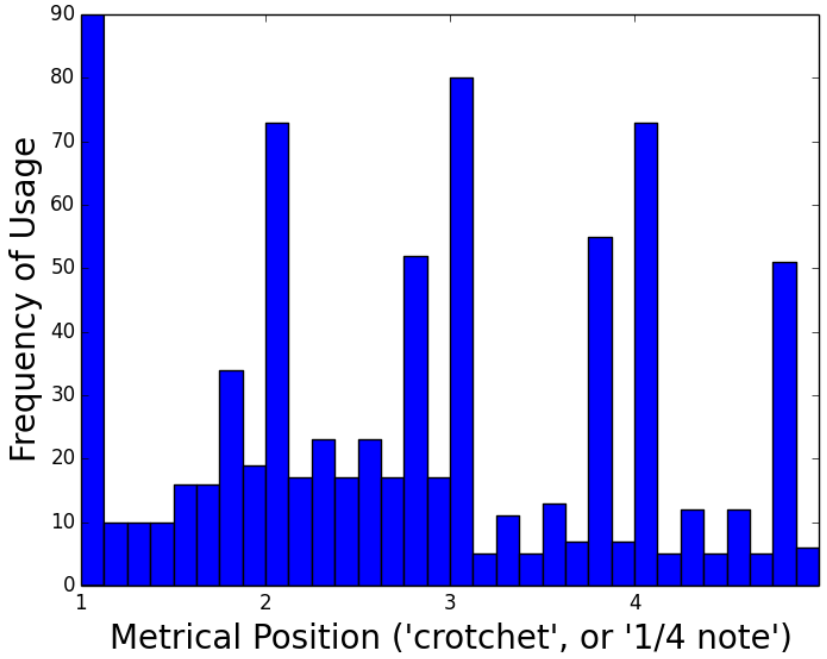
Pitfalls include

- Methodology
- Error spotting

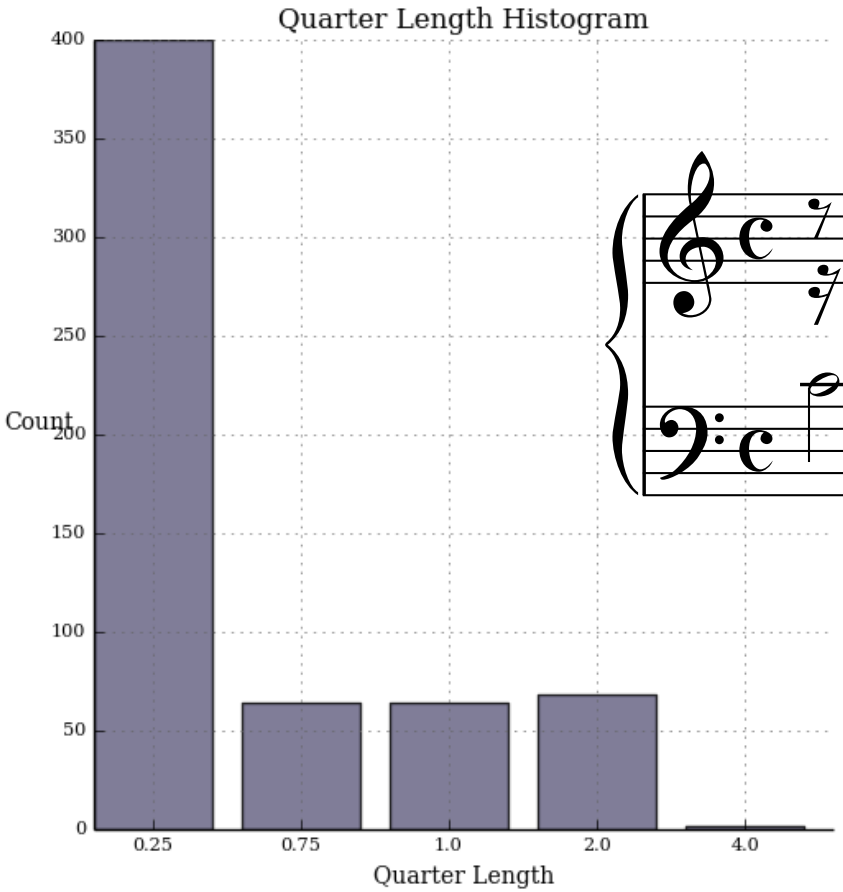
How to count (?!)

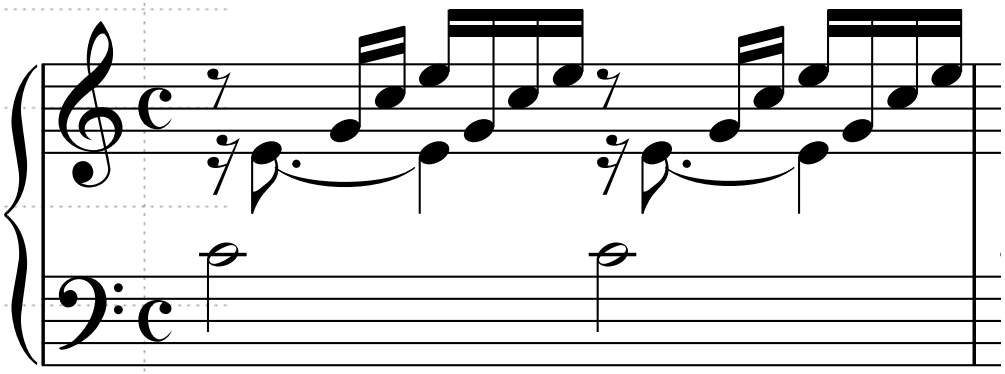
One count per chord (left), or one for each onset /





Technical errors





Spot the mistake …

Talk Contents (you are here …)

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2. **Audio: ‘Attractor tempos’**

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4. Teaching Resources: ‘Cut outs’

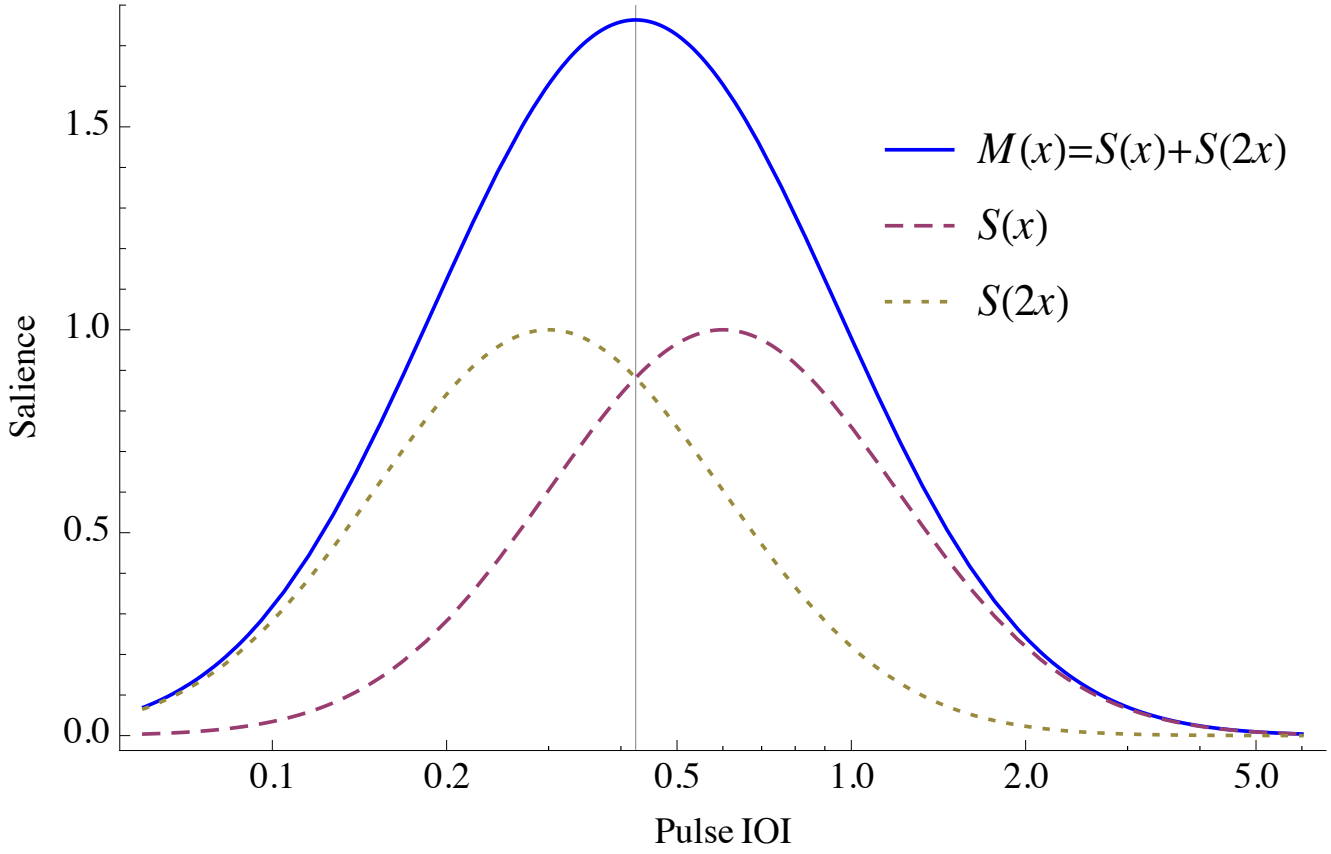
‘Attractor Tempos’

‘Attractor tempos’ *

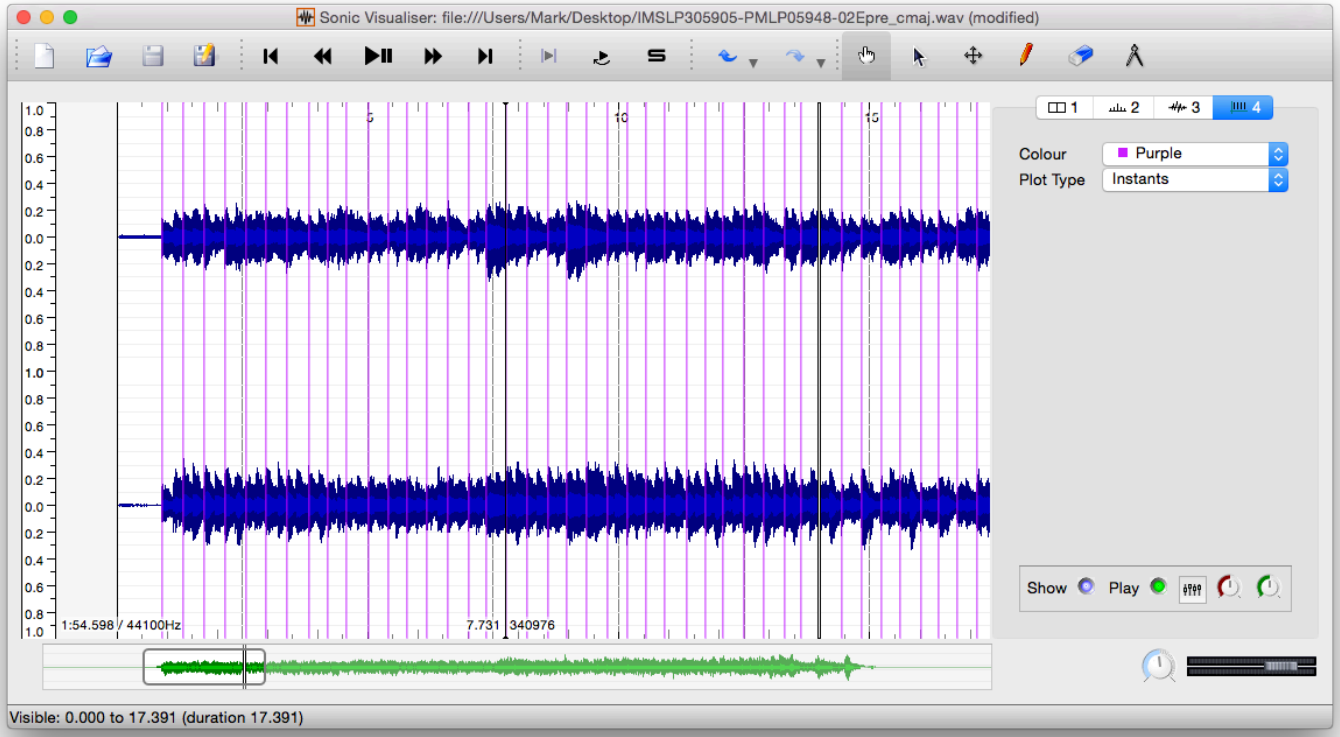
- Pulse preference in abstract (0.6 seconds);
- Useful range (0.01 – 6 seconds);
- Model based on compromise (max. sum)

*Source: Gotham ‘Attractor Tempos for Metrical Structures’, *Journal of Mathematics and Music*, 9/1 (March 2015).

‘Attractor Tempos’

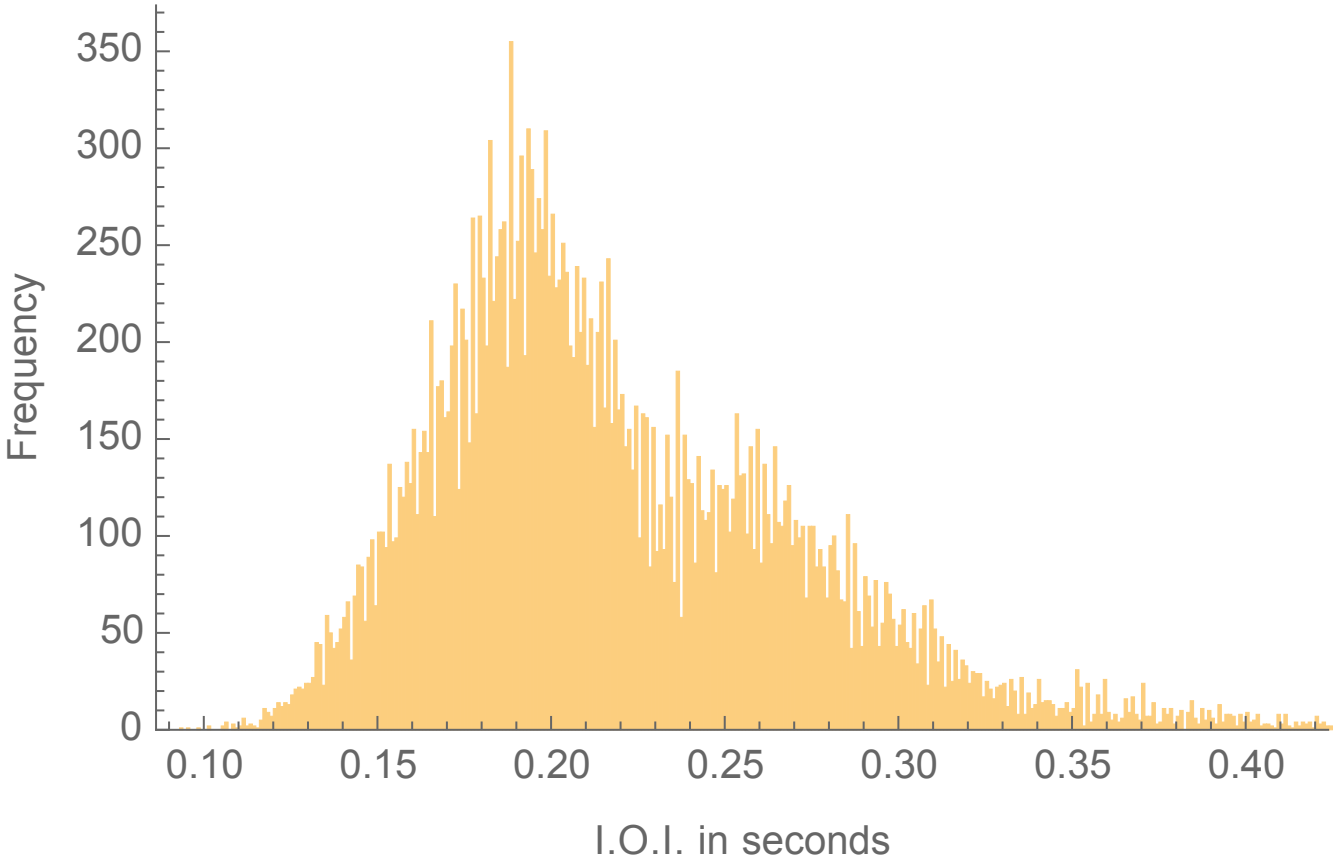


Method: ‘Sonic Visualiser’



Automatic beat recognition in ‘Sonic Visualiser’ (Cannam et al., QMUL, UK)
(One recording of the Bach example: BWV 846.)

Spot ‘the’ tempo



After data from Benadon and Zanette, (M.P.R. vol.7, 2015.)

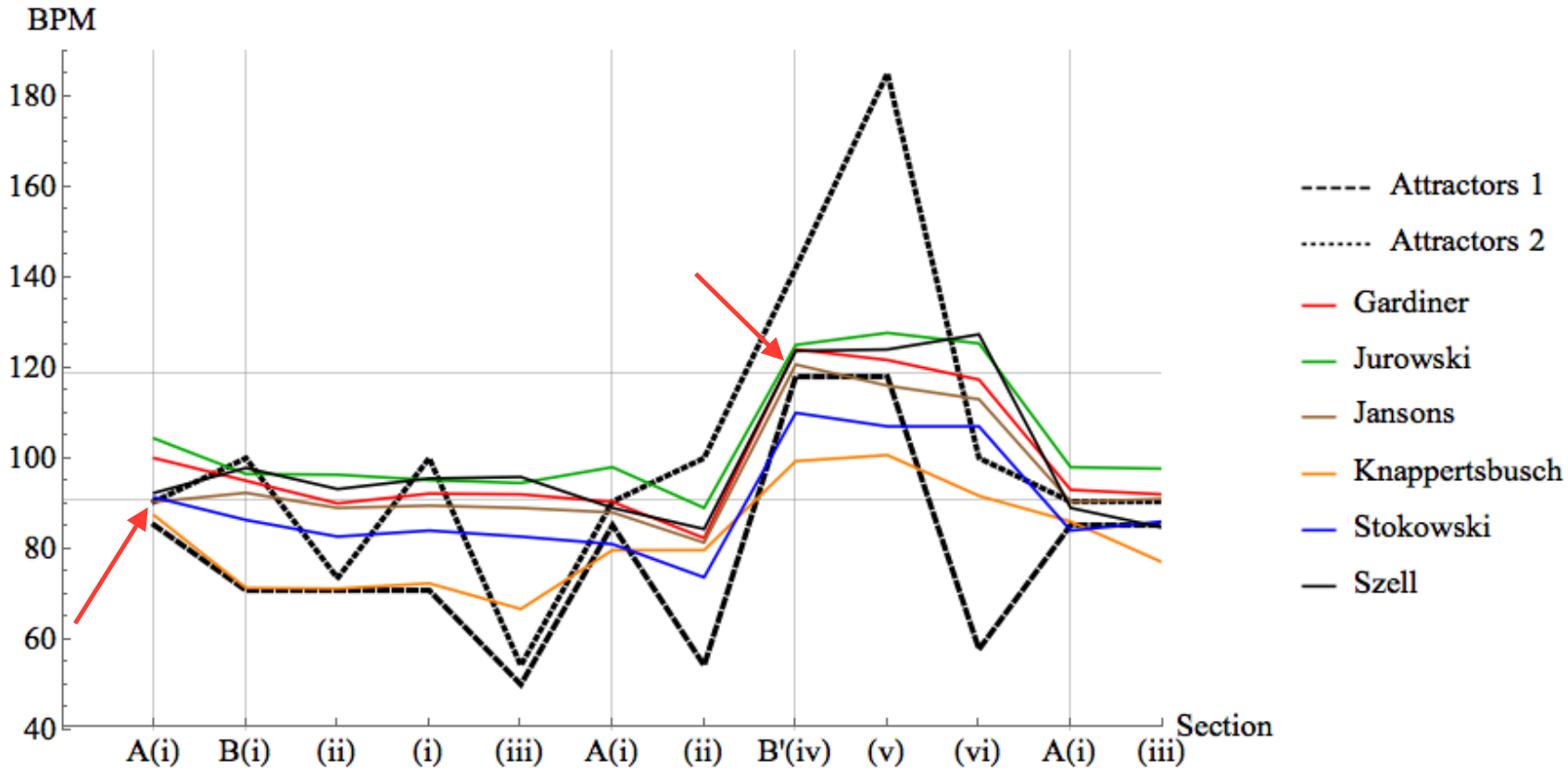
‘Attractor Tempos’ in Brahms

Brahms 2/iii: *

- Frequent changes of metre (and level usage);
- Many of these sections nominally equivalent;
- Two choices of tempo (which may also be related).

*Source: Gotham 2018: ‘Attractor Tempos in Brahms 2/iii’, *Music Theory Spectrum*

‘Attractor Tempos’ in Brahms



Part 2: Summary / Outlook

Summary

- Attractors: ‘tempo dissonance’ heuristic.

Methodology

- On tempo: ‘average’?
- Of whole or ‘steady-state?’

Future work

- Measure of relative level usage (weighted).

Talk Contents (you are here …)

1. Scores: Metrical position usage
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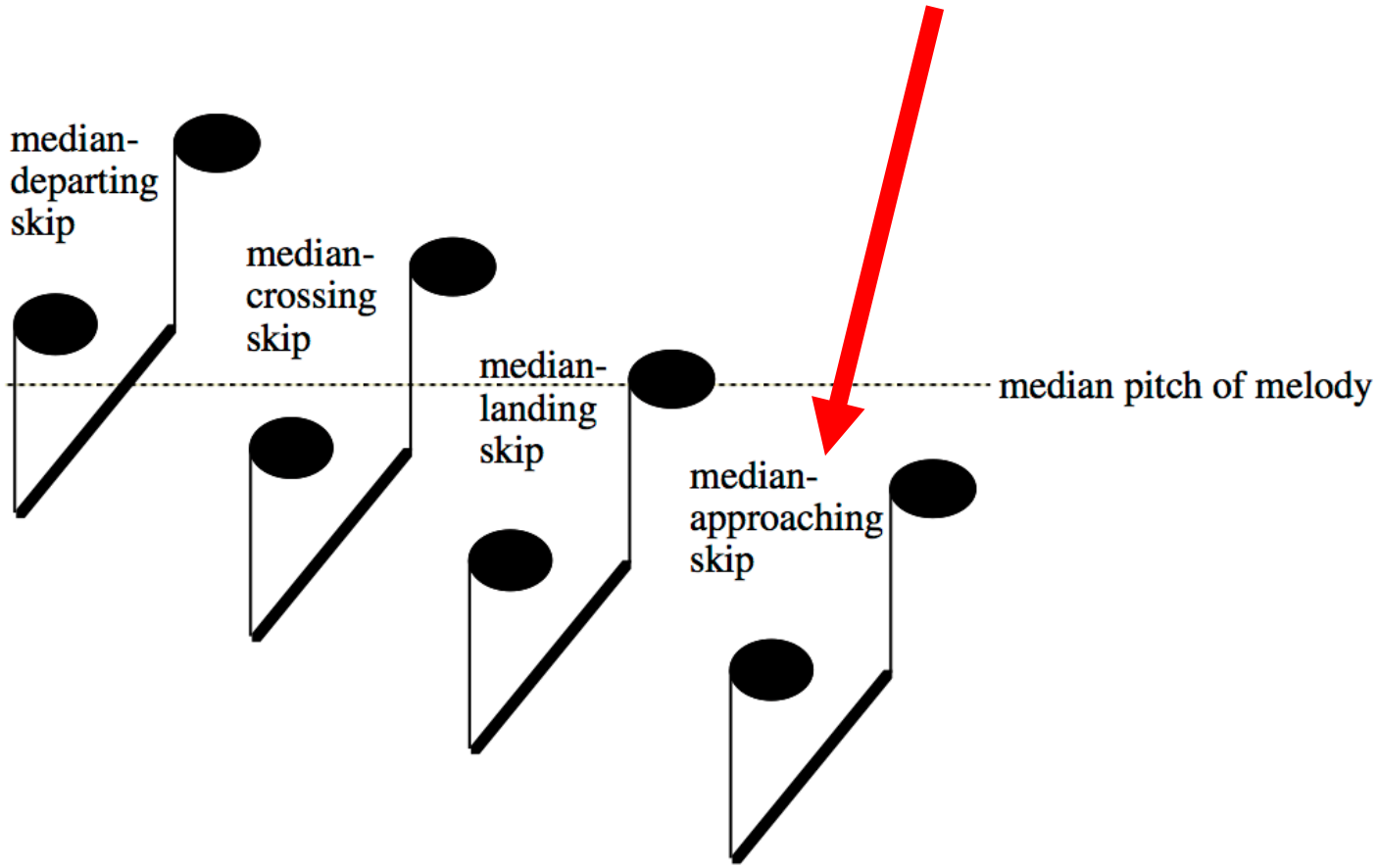
3. **Teaching-led: Species or specious?**
4. Teaching Resources: ‘Cut outs’

3a. Gap-fill VS Regression



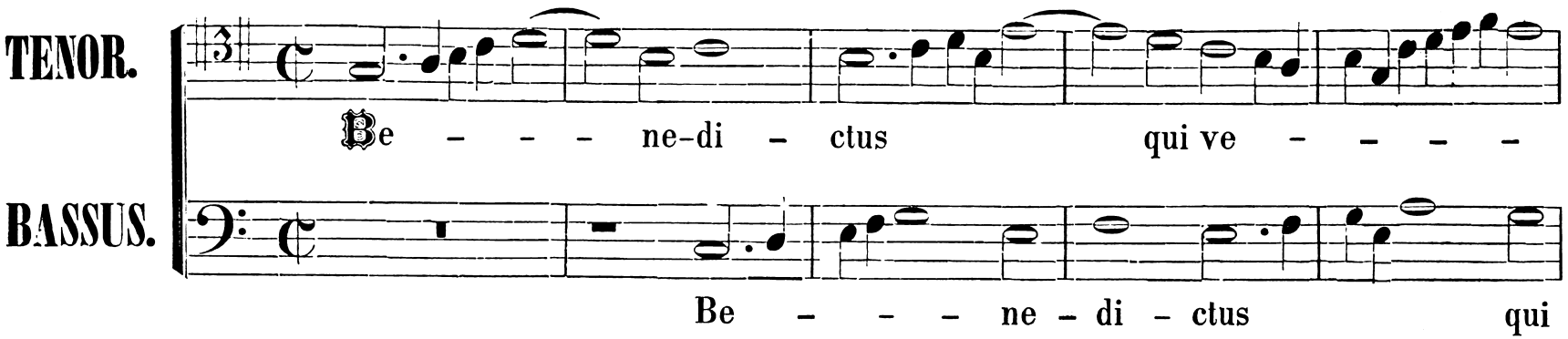
3a. Gap-fill VS Regression

	Gap-fill	R. to mean	Difference	P value / significance	
Chant	52	254	- 66.0%	e-31	****
Ars Nova	12,961	12,644	+ 1.05%	0.046	*
JRP	19,391	16,708	+ 7.4%	e-45	****
Palestrina	7,761	7,444	+ 2.1%	0.00507	**
Monteverdi	475	389	+10.0%	0.00172	**
Bach Chorales	850	1,262	- 19.5%	e-19	****
German Art Song	1,429	2,657	- 30.1%	e-82	****
Essen minus Han	3,076	8,365	- 46.2%	0 (< e-308)	****
Han Chinese	1,605	4,140	- 44.1%	e-245	****

3b. Too large to fall?

Interval (semi-t.)		Proportion First:Second	Observations All (Each)	Rule (yes / no)
First	Second			
7	3	10.636	128 (117:11)	Y
4	3	7.284	555 (488:67)	Y
5	4	4.462	142 (116:26)	Y
-4	-5	3.846	126 (100:26)	Y
7	5	3.733	71 (56:15)	Y
5	3	3.057	142 (107:35)	Y
-5	-7	2.027	448 (300:148)	Y
-3	-4	1.425	1552 (912:640)	Y
-7	**-3**	**1.105**	**120 (63:57)**	**N**
-3	-5	1.064	97 (50:47)	Y

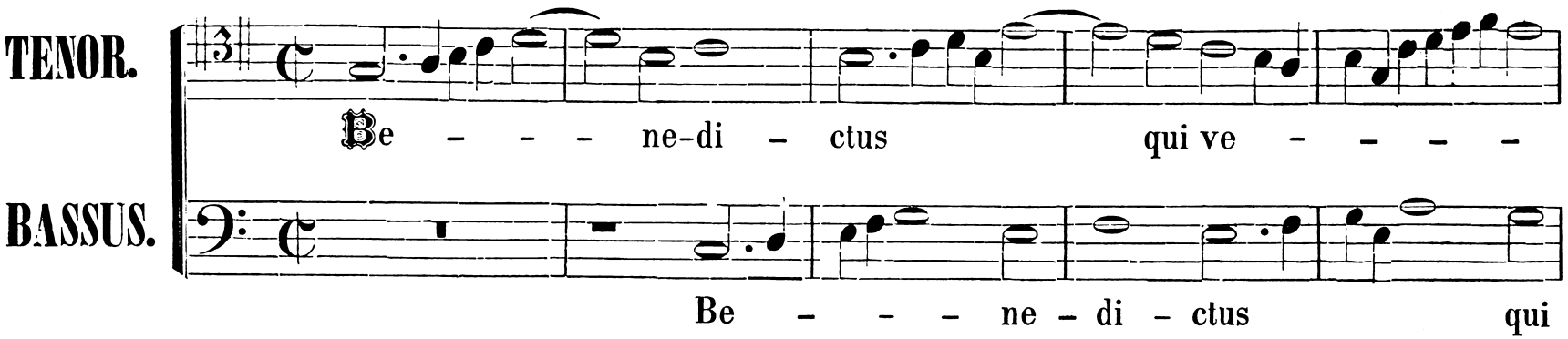
3c. Imitation



a) Temporal interval:

b) Pitch interval:

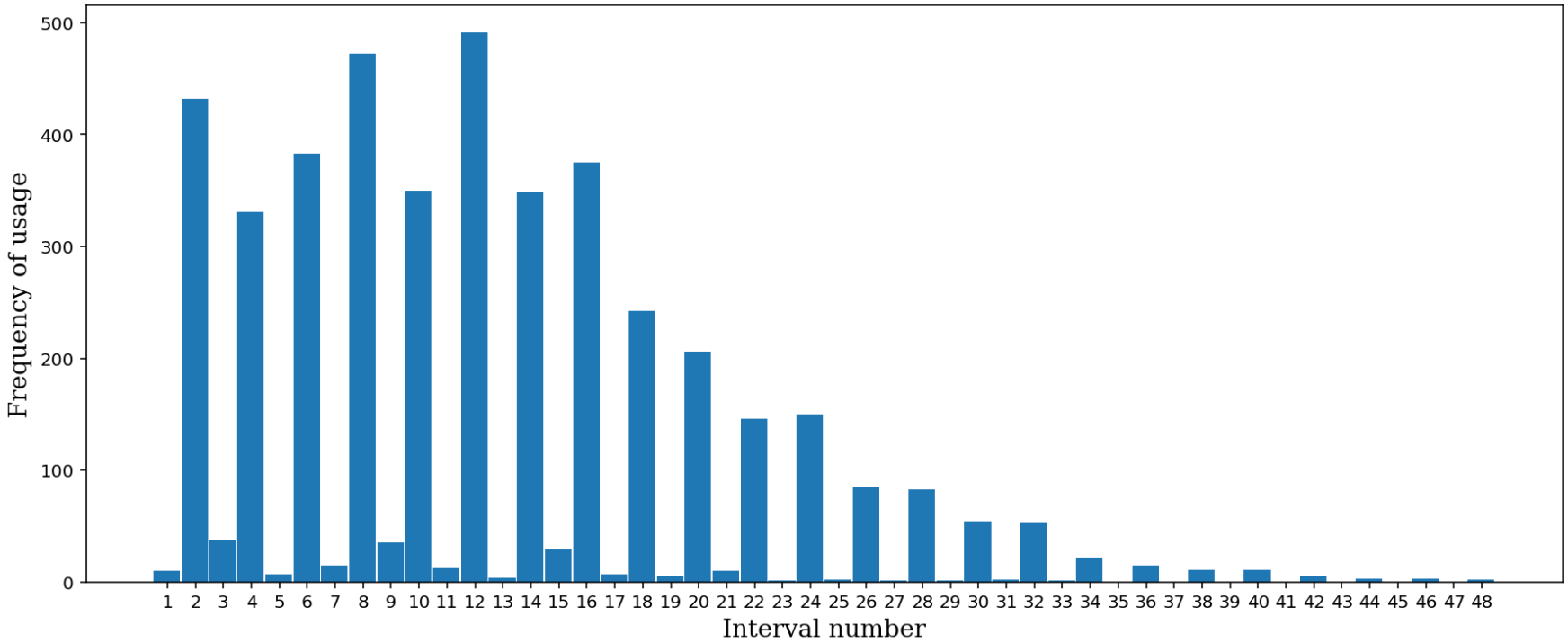
3c. Imitation



a) Temporal interval: 6 beats (strong to strong)

b) Pitch interval: Perfect 5th (down)

3c. Imitation–Temporal



3c. Imitation–Pitch

Forte Class	#	Source for anomalies	
		Mass. *Missa:*	Movement, ref, notes
1-1	13		
2-5	341		
3-11A	1	*Sine nomine (1599)*	Credo(_52_a): ACECE
3-11B	1	*Inviolata*	X. Gloria_77_b. Noise. Really 2-5
3-4A	1	*Sine nomine (1599)*	Agnus(_I_46). EAAEF
3-6	1	*Sacerdotes Domini*	Sanctus(_47_b: Pleni sunt). CDE
3-7B	1	*Sine nomine (1599)*	Benedictus(_53_b: Pleni sunt). AEG
3-9	39		
4-14A	2	*Sacerdotes Domini*	Credo(_46_a). DADDEF
			Agnus(_I_41). DADDEF
4-22A	1	*Sacerdotes Domini*	Kyrie(_52). GDDCDE
4-23	1	*Nigra sum*	X. Sanctus(_87_c). Noise. Really 3-9.
5-23A	1	*Sacerdotes Domini*	Gloria(_48). GDAEFA
5-35	1	*Sacerdotes Domini*	Sanctus(_47_a). GDACDE
Total:	**404**		

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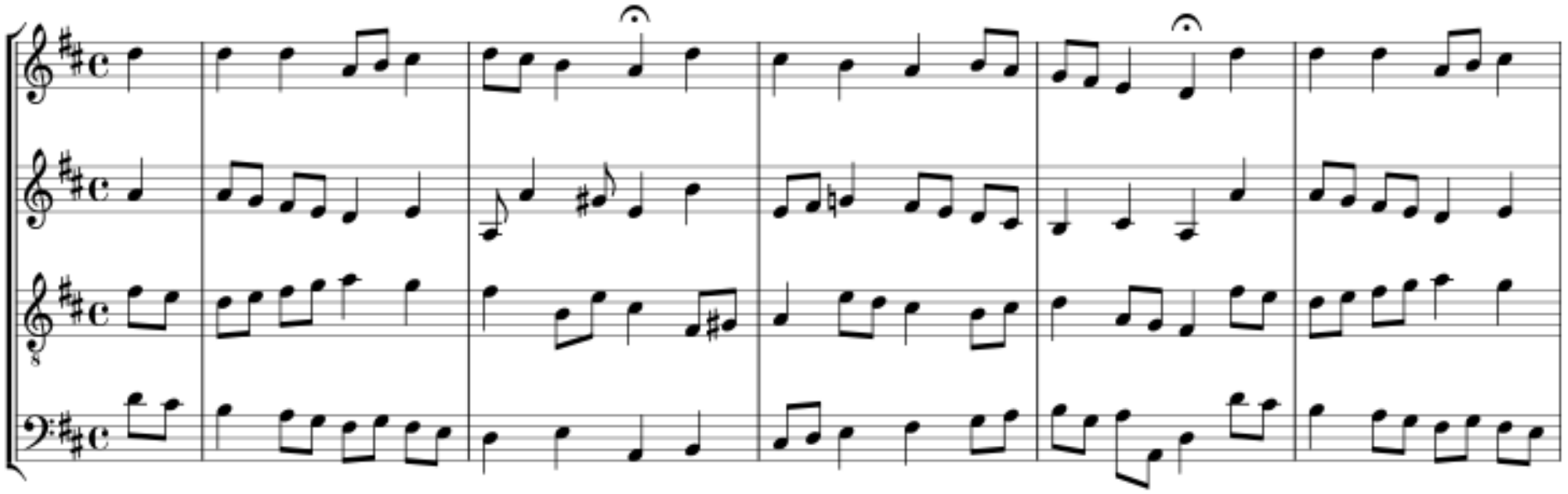
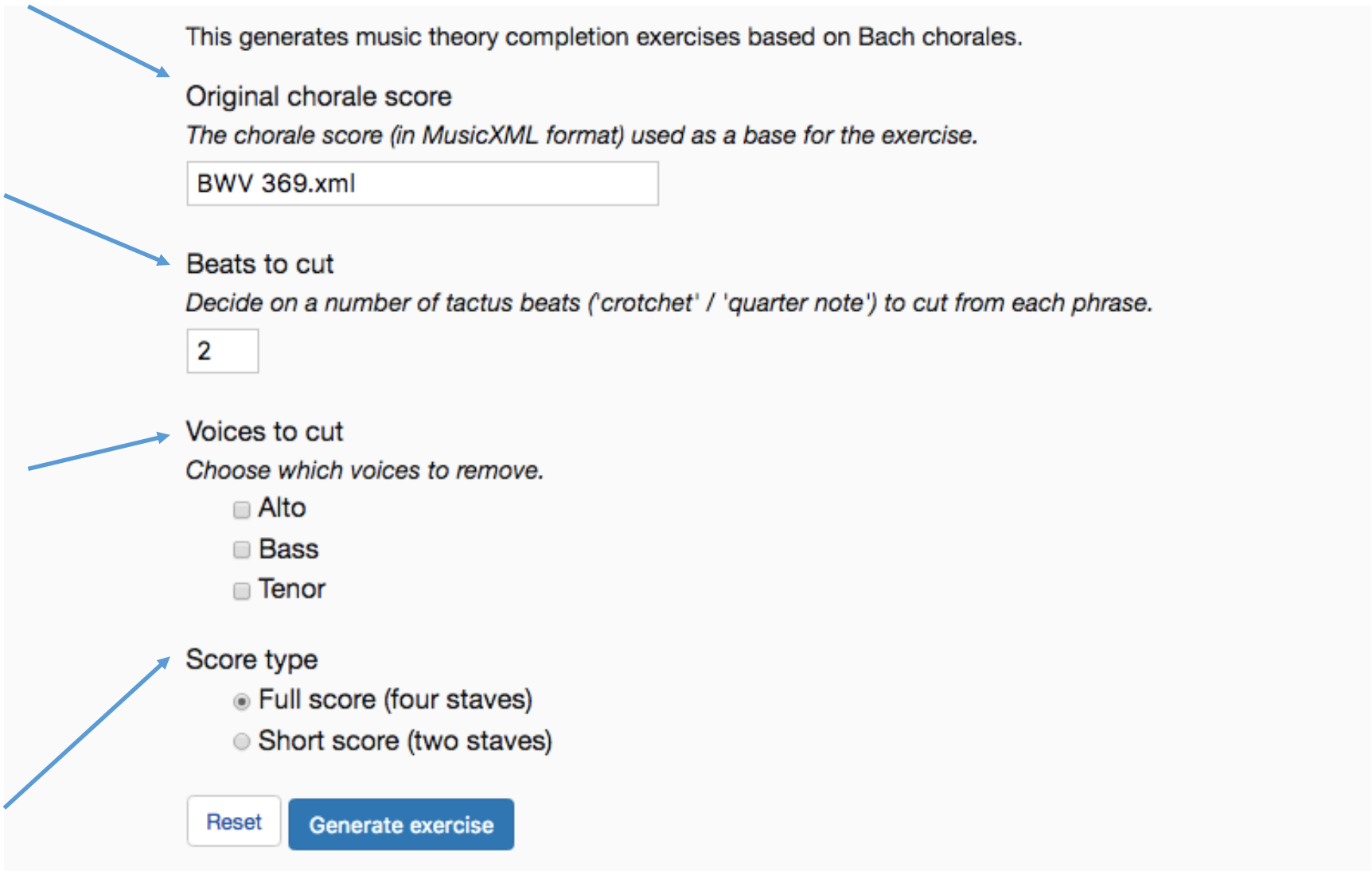
1. Scores: Metrical position usage
2. Audio: ‘Attractor tempos’
3. Teaching-led: Species or specious?
4. **Teaching Resources: ‘Cut outs’**

Cut Outs: Chorales

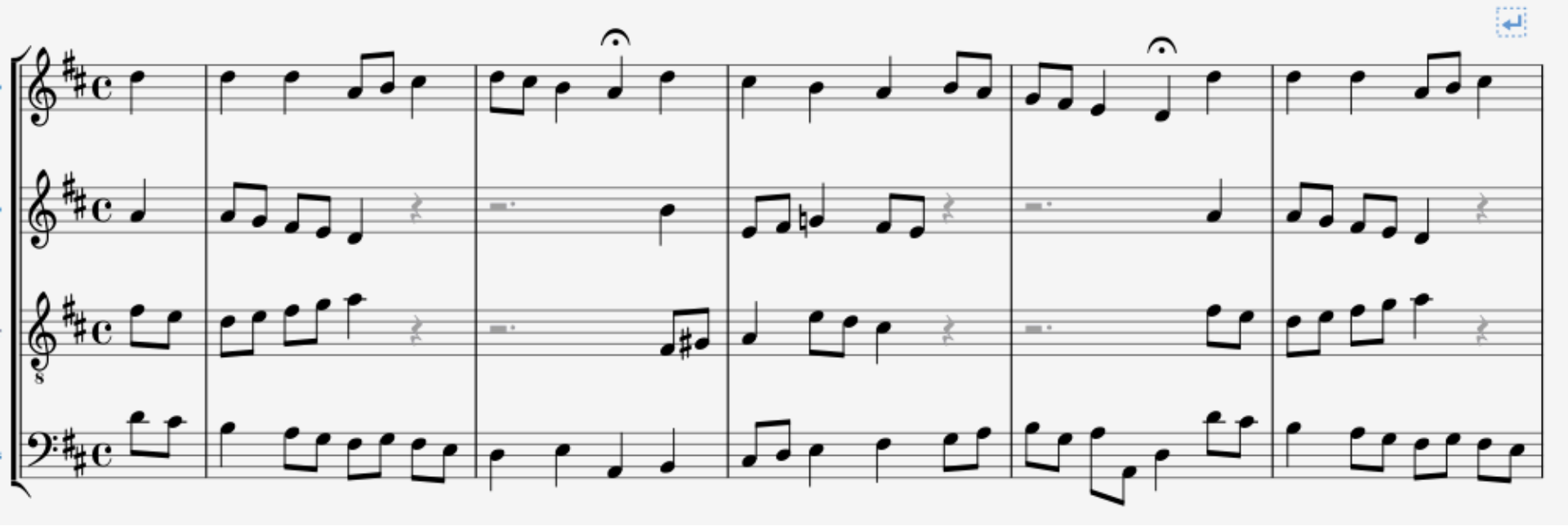
1. Take a score




This generates music theory completion exercises based on Bach chorales.
Original chorale score
The chorale score (in MusicXML format) used as a base for the exercise.
BWV 369.xml
Beats to cut
Decide on a number of tactus beats ('crotchet' / 'quarter note') to cut from each phrase.
2
Voices to cut
Choose which voices to remove.
Alto
Bass
Tenor
Score type
Full score (four staves)
Short score (two staves)
Reset
Generate exercise

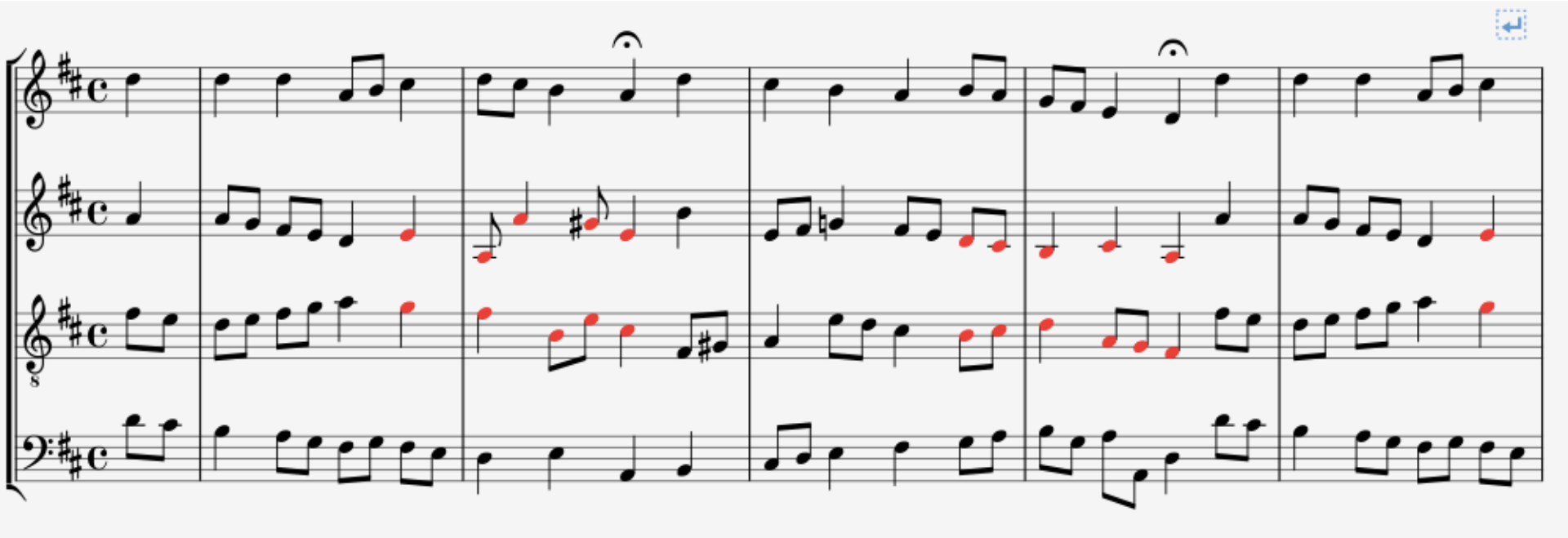
Cut Outs: Chorales

1. Take a score
2. Cut parts out (Exercise)



Cut Outs: Chorales

1. Take a score
2. Cut parts out … or colour them red (solution)



Cut Outs: Lieder

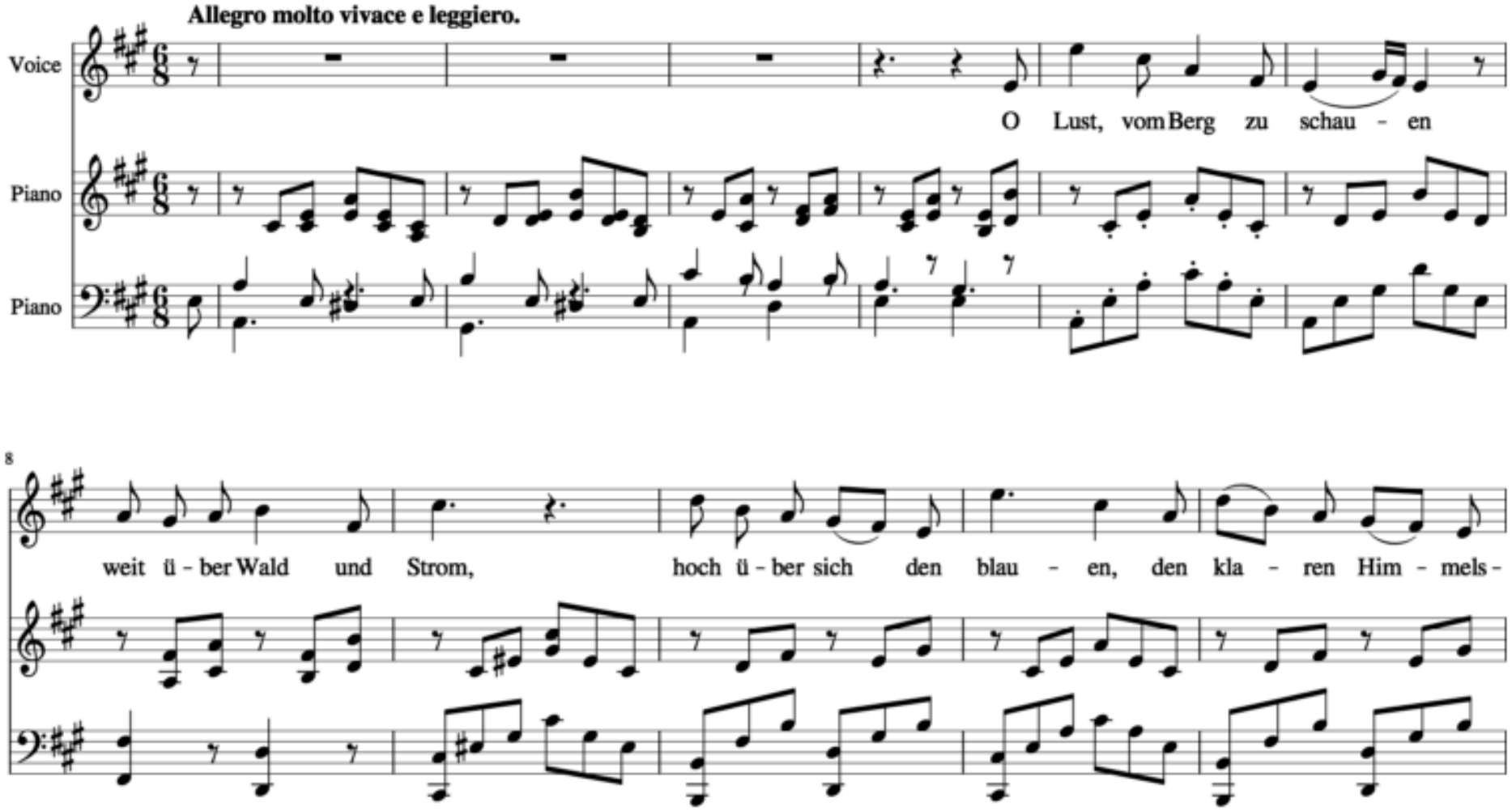
1. Take a score

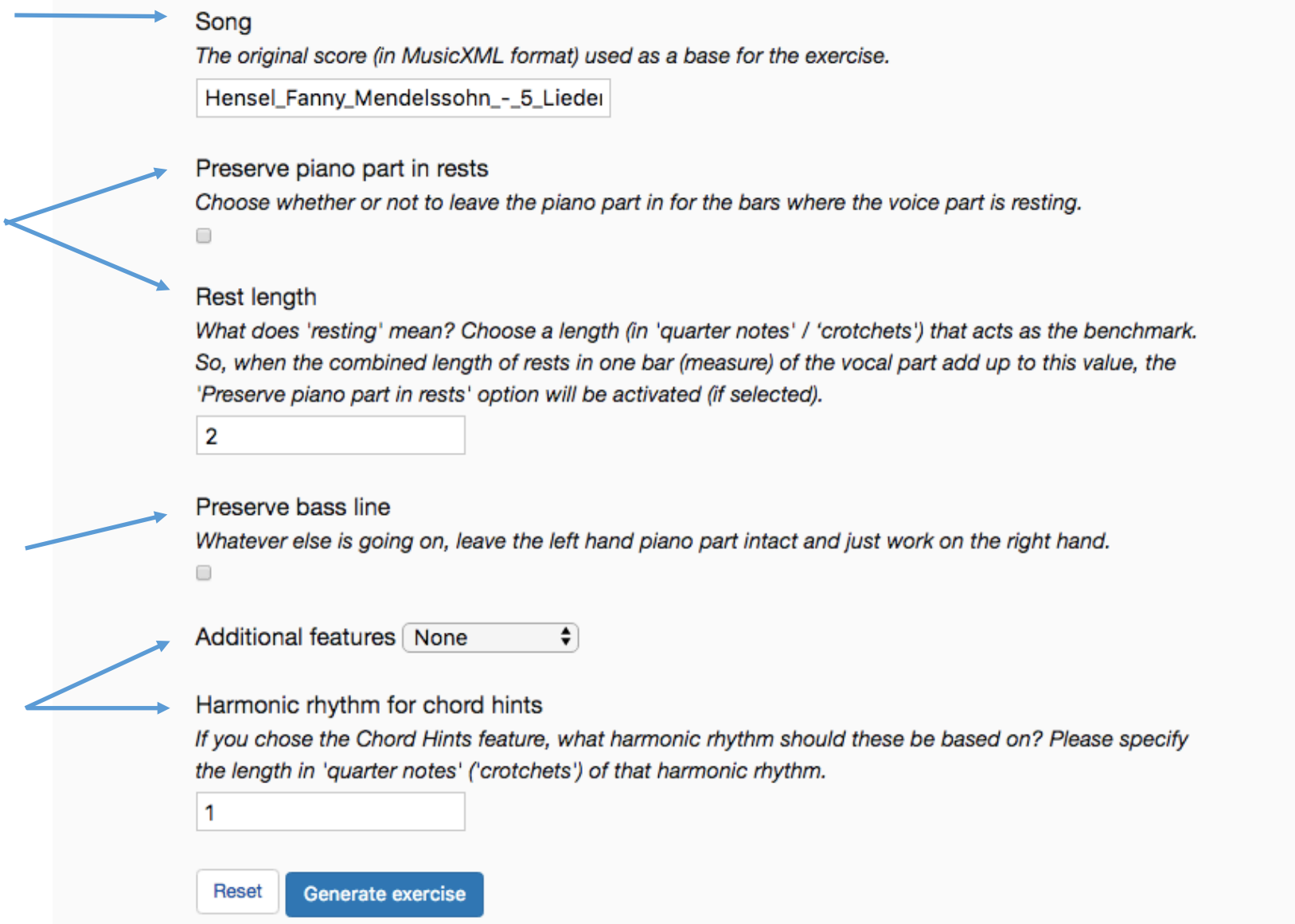
5 Lieder, Op.10

5. Bergeslust

Joseph von Eichendorff

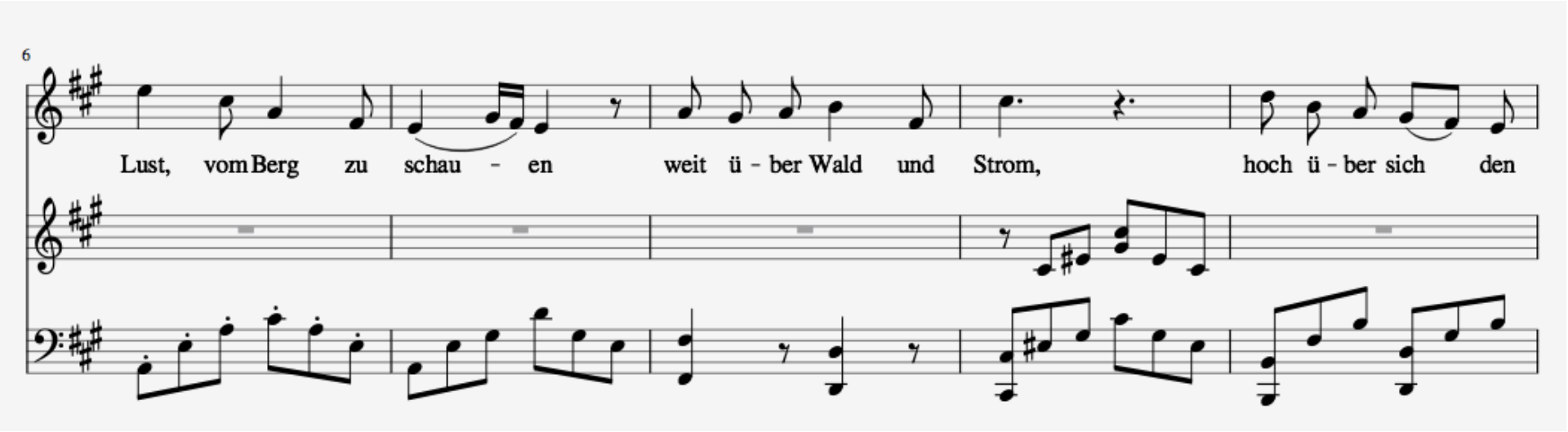
Fanny (Mendelssohn) Hensel




Song
The original score (in MusicXML format) used as a base for the exercise.
Hensel_Fanny_Mendelssohn_-_5_Liede
Preserve piano part in rests
Choose whether or not to leave the piano part in for the bars where the voice part is resting.
Rest length
What does 'resting' mean? Choose a length (in 'quarter notes' / 'crotchets') that acts as the benchmark. So, when the combined length of rests in one bar (measure) of the vocal part add up to this value, the 'Preserve piano part in rests' option will be activated (if selected).
2
Preserve bass line
Whatever else is going on, leave the left hand piano part intact and just work on the right hand.
Additional features
None
Harmonic rhythm for chord hints
If you chose the Chord Hints feature, what harmonic rhythm should these be based on? Please specify the length in 'quarter notes' ('crotchets') of that harmonic rhythm.
1
Reset
Generate exercise

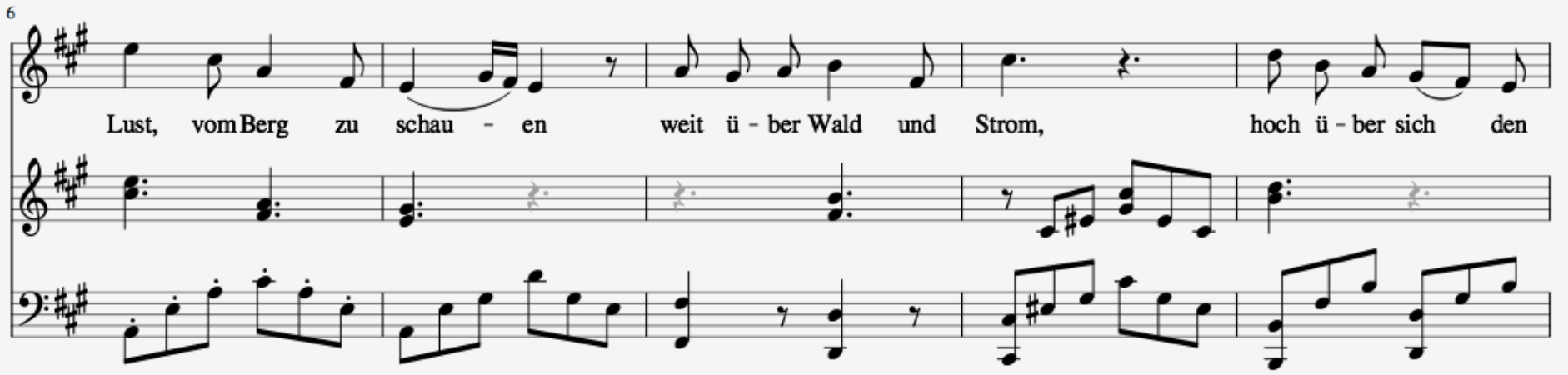
Cut Outs: Lieder

1. Take a score
2. Cut parts out



Cut Outs: Lieder

1. Take a score
2. Cut parts out
3. Add parts in

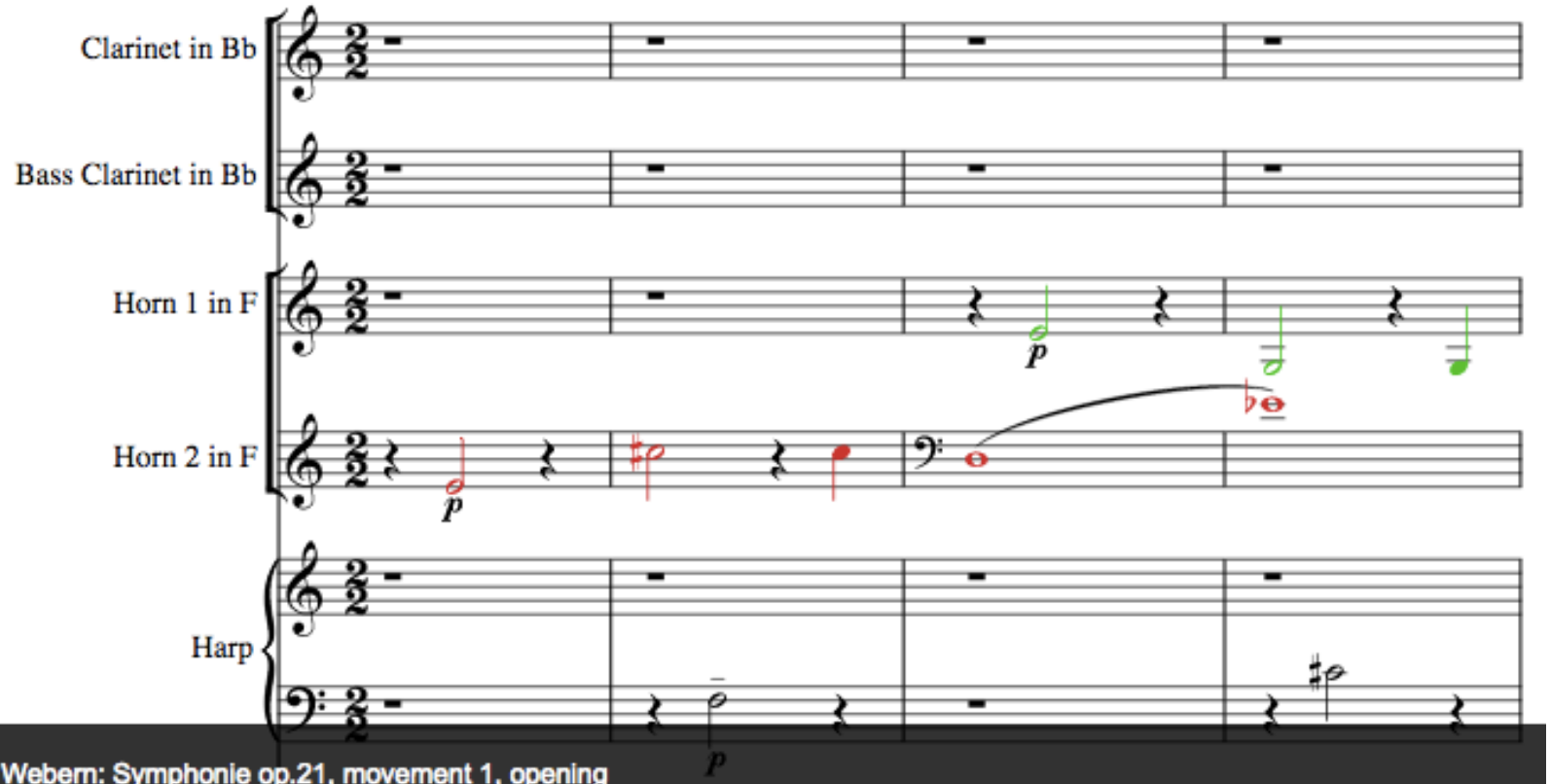


More Teaching Resources

Interactive Teaching Resources

Three Examples:

1. **Interactive scores**
2. A Guide to the Pedal Harp
3. A Metre of Metrical Dissonance



Webern: Symphonie op.21, movement 1, opening

This opening section is a double canon in inversion.
Press 1 to show the first part (dux) of the first canon in red.
Press 2 to show the second part (comes) of the first canon in green.
Press 3 to show the first part (dux) of the second canon in blue.
Press 4 to show the first part (comes) of the first canon in orange.

Throughout, the instruments are paired: clarinet and bass clarinet; the two horns; the two hands (staves) of the harp; Vln1 with viola; Vln1 with VC.
Corresponding material appears in those matching parts.
Press any of 5, 6, 7, 8, 9 to show blocks of that material (in their original colours) in the first canon.

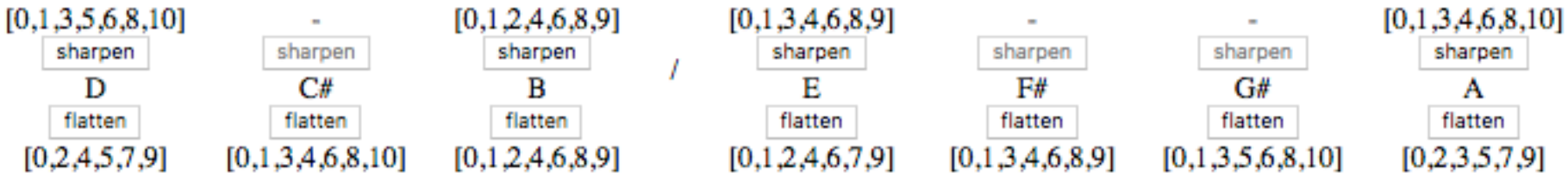
Each pitch class consistently appears in the same octave, for instance, A always sounds as 'A3', just below middle C.
The exceptional pitch class is Eb which appears as both Eb3 and Eb4 (either side of the A3).
This is part of a symmetrical pattern of pitches centred on that A3.
A and Eb have a special, central role for other reasons, for instance, they're the only pitches to be simultaneously by the same instrument.
Press 0 to show each A and Eb in this passage in all parts.

Teaching Resources

Interactive Teaching Resources

Three Examples:

1. Interactive scores
2. **Pedal Harp**

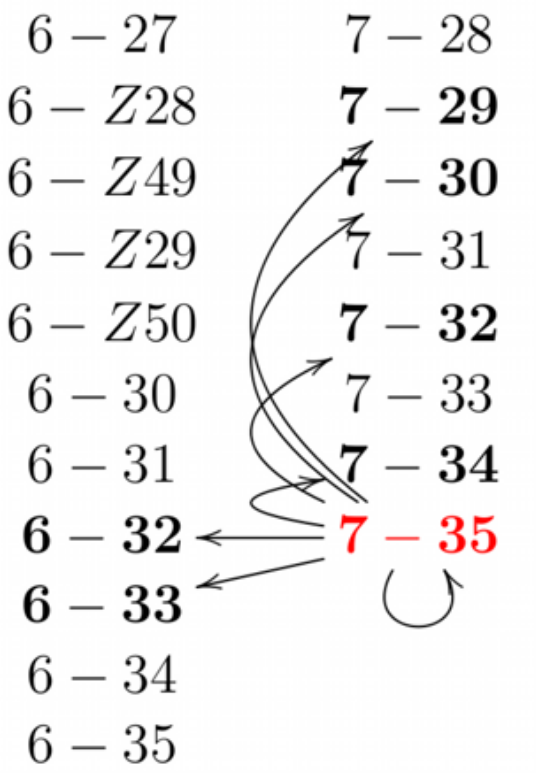


Teaching Resources

Interactive Teaching Resources

Three Examples:

1. Interactive scores
2. **Pedal Harp**
3. Metrical Dissonance



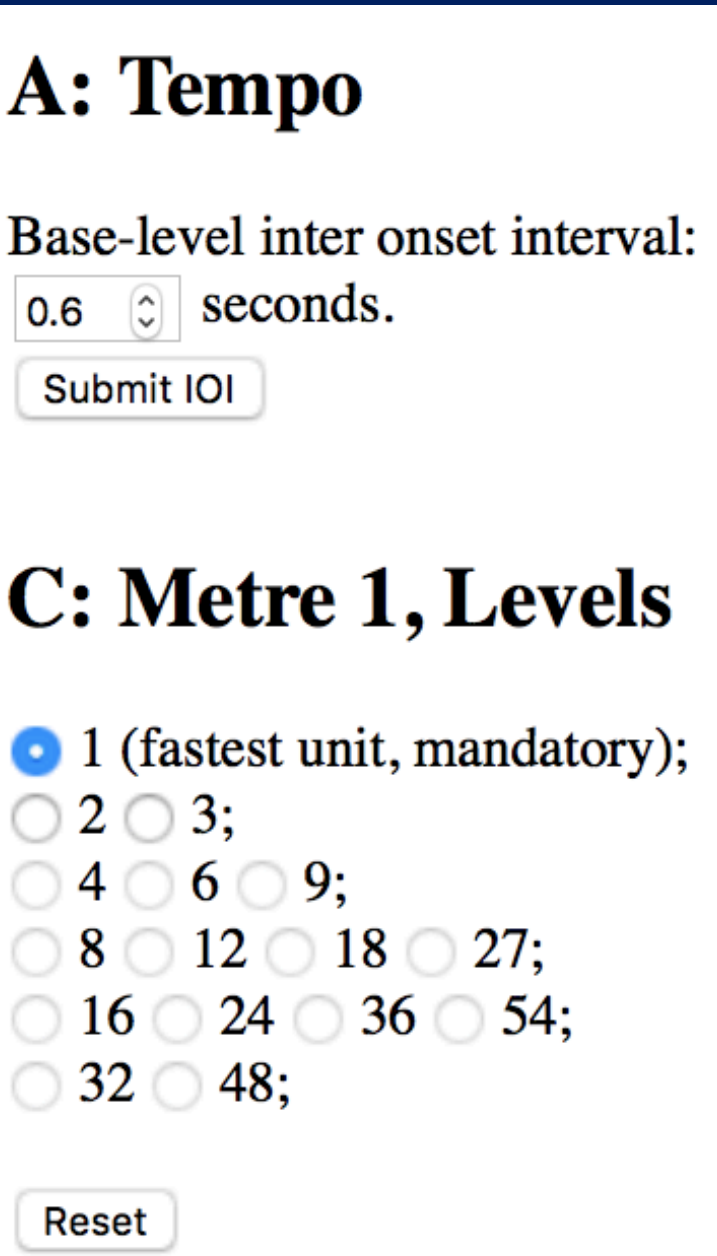
Gotham and Gunn 2016: 'Pitch Properties of the Pedal Harp, with an Interactive Guide', *Music Theory Online*, 22/4.

Teaching Resources

Interactive Teaching Resources
Three Examples:

1. Interactive scores
2. Pedal Harp
3. **Metrical Dissonance**

Forthcoming: 'Towards a Cognitively-Based Quantification of Metrical Dissonance', in Doffman, Payne, and Young eds *The Oxford Handbook of Time in Music*, O.U.P.



Talk Contents (you are here …)

1. Scores: Metrical position usage
2. Audio: ‘Attractor tempos’
3. Teaching-led: Species or specious?
4. Teaching Resources: ‘Cut outs’

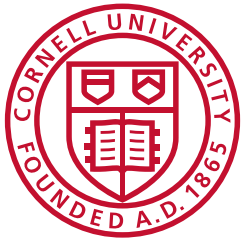
Final Summary / Outlook

What else is going on in the field?

https://github.com/MarkGotham/MusoRepo

Thank you!

Mark Gotham
Cambridge, 17 January 2019



Cornell University