

# Uses of Humdrum

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Music 253/CS 275A  
Stanford University

# Traditional categories of music analysis

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## □ Traditional means of analysis

■ Harmony

■ Counterpoint

■ Melody

■ Rhythm

Feature sets

# Analytical styles

Riemann analysis

computational graphing,  
ethnomusicology

Handwritten musical score for piano with Riemann analysis annotations. The score is in G major and 4/4 time. The first system is marked with a box labeled 'IAC' and the second system with a box labeled 'DAC'. The annotations include Roman numerals and figured bass notation: (I) vi I<sup>(b7)</sup> IV I<sup>b</sup> — vi I<sup>(b7)</sup> IV I<sup>b</sup> V<sup>4</sup>/<sub>3</sub> and V<sup>6</sup>/<sub>5</sub> — I<sup>b</sup> I<sup>5</sup>/<sub>3</sub> I<sup>b</sup> I V<sup>7</sup> I.

Agmon, Conventional Harmonic Wisdom

Ex. 6

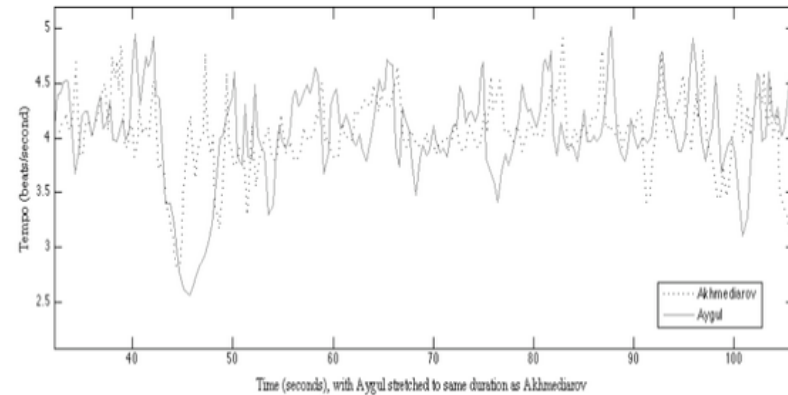
Musical score for Ex. 6 showing chord progressions in G major. The score is in 4/4 time and consists of two systems of chords.

LEVEL 1: T — S — D — T

LEVEL 2: T D T T D T T D T

Root analysis

Figure 1. Instantaneous tempo curves of two performances of a composition for the Kazakh *dombra* (time-stretched for alignment as they have different durations).



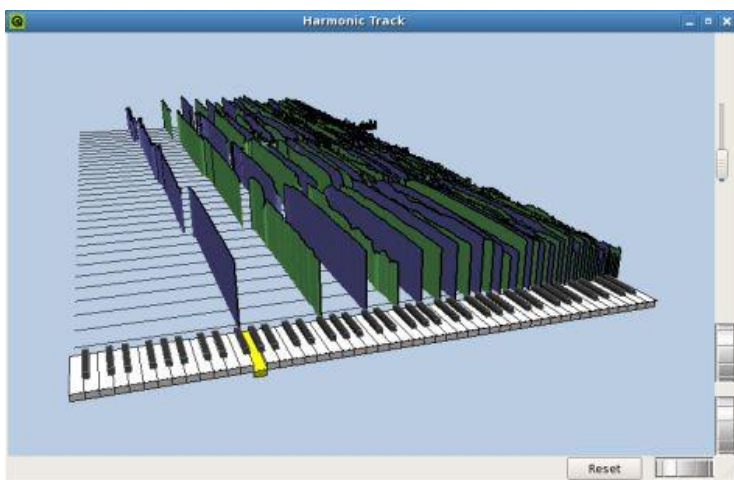
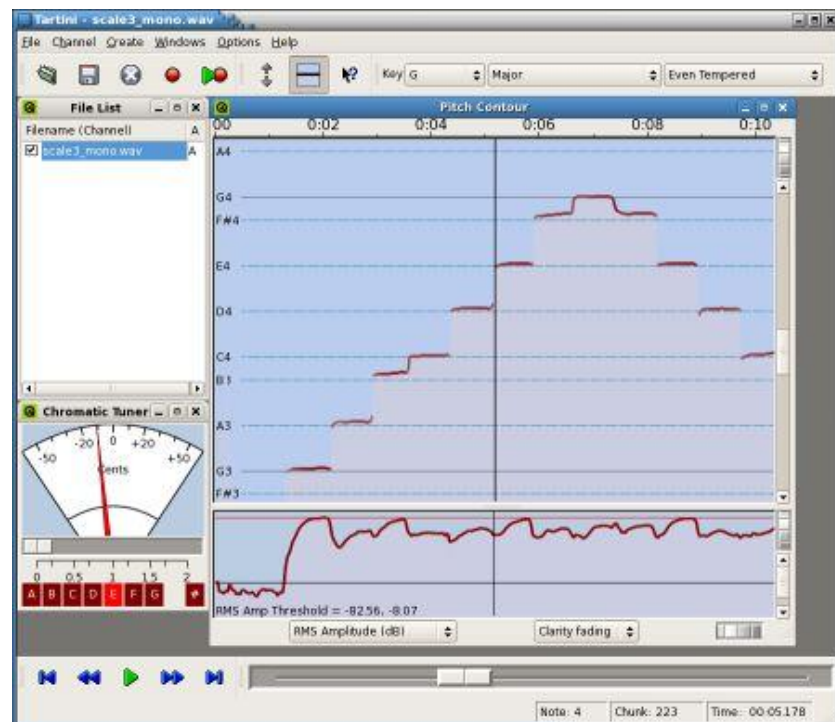
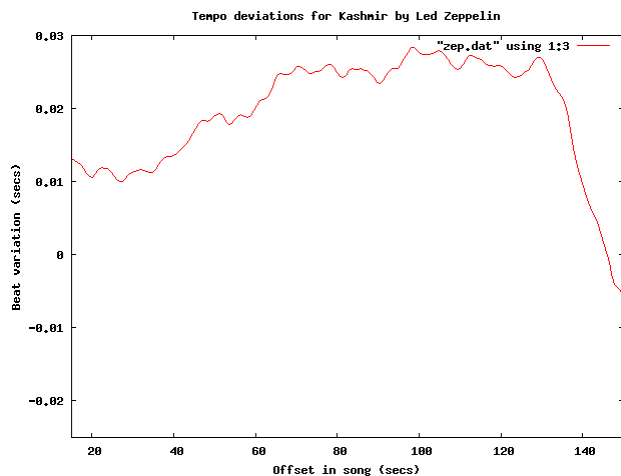
Blair Johnson, MTO (2012)

Musical score for Blair Johnson, MTO (2012) with Schenkarian analysis annotations. The score is in G major and 4/4 time. The annotations include Roman numerals and figured bass notation: I<sup>3</sup> and I<sup>2</sup>.

Schenkarian analysis

Musical score for Blair Johnson, MTO (2012) showing the first, last, highest, and lowest notes. The score is in G major and 4/4 time. The notes are G, A, B, C, D, E, F, G.

# Music analysis without music



Tartini (sw)

# Perspectives on music analysis: 1-2

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## □ Traditional (*theoretical, historical*) means of analysis

- Harmony

- Counterpoint

- Melody

- Rhythm

Feature sets:  
results related to **score**

## □ Statistical (*systematic*) approaches

Feature sets:  
results reported in tables, charts, graphs

# More approaches to analysis

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- Imported procedures
  - Often *procedural* or *structural*
  - Borrowed from
    - Linguistics
    - Mathematics
    - Computer science
    - Engineering
- Cognitive studies
- Performance-based analysis
- Data visualization

# Other legitimate projects

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- Data translation, enrichment
- Linking symbolic data with MIDI or audio
- Style evaluation (and generation as proof of concept)



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# Sample Projects, Random Order



# Algorithmic generation: 12-bar blues

Exercise: Simple 12-bar Blues in F

phrase 1

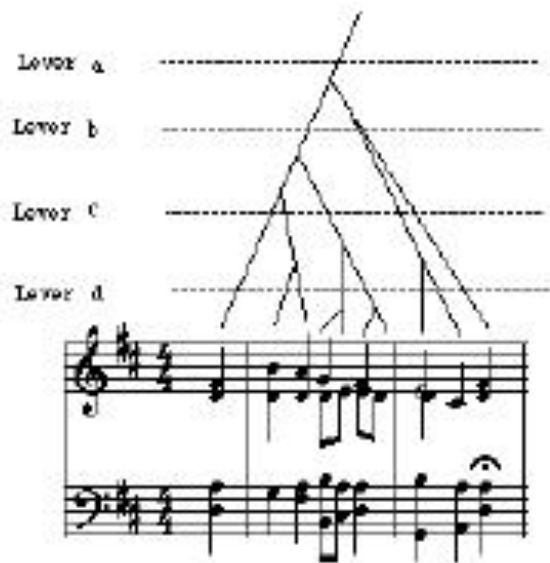
phrase 2

phrase 3

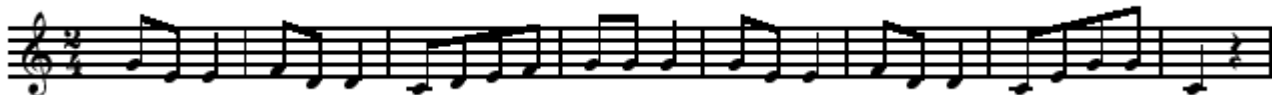
Improvise over the 12 bars using notes from this blues scale

Francesco Giomi, c. 1988

# Hierarchical systems: Lerdahl-Jackendoff



Generative theories  
of musical grammar (1984)



Harmonic Structure	T	T	D	D	T	T	D	D	T	T	D	D	T	D	T
Motif Structure	a		a'		b		c		a		a'		b'		c'
Phrase Structure	A				B				A				B'		

# Phrase families (centonization)

- Panos Mavromatis (2006)
  - N.B. Lerdahl-Jackendoff touch

The musical score displays eight staves of music. Above the first staff, a bracket labeled 'D E F G' spans the first four measures. Above the fifth staff, a bracket labeled 'G F E G' spans the last four measures. Vertical dashed lines separate the staves into four groups of two, corresponding to the letters D, E, F, and G. Each staff contains Greek lyrics with dots above certain characters, indicating specific formulaic elements. The lyrics are:
   
1: Του λιθου σφραγισθεντος υπο των Ιουδαϊων
   
2: Του Γαβριηλ εθελξα με νουσαι Παρθε νε το χαριρε
   
3: Εντω θλιβεσθαι με εισαι κουσον μου των οδυνων
   
4: Αγιω Πνευματι πασαι η φυσις και νουρ χειται
   
5: δεξιαι σου χειρι λαβων σου λογε
   
6: Τους ερημικους αιπου στας ο θεος ποθος εγχι νεται
   
7: Αγιω Πνευματι τιμη και δοξα ωσπερ Πατρι
   
8: Εις τα ορητων σων υψωσας με νομιαν

Figure 3. A Phrase family in *Echos 1*, illustrating formulaic variation. Brackets above the staff mark the family's opening and closing formulas.

# Linear systems (species counterpoint)

## Two-Voice Analysis

Vincentino: *L'artico musica* Vol. 4

Several systems

*Answer (Contrapunctus III)*

*First Countersubject of the AOF*

## Three-Voice Analysis

Robert Kelley

# Imitative systems (18<sup>th</sup>-century counterpoint)

motive

sequence

Timothy Smith, NAU

Subj. 2

Contrapunctus III

(t3) answer from Contrapunctus I transformed in contrary motion becomes subject

(t4) Syncopation t2 from Contrapunctus II transformed in contrary motion (and ornamented)

(t5) Dotted figure t1 from Contrapunctus II transformed in contrary motion and incorporated into the subject's head

# Generative chorale variations

- Dominik Hörnel (2005): Pachelbel
  - Keyboard elaboration generated from chorale melody

Al - le Men - schen m s - sen ster - ben, al - les Fleisch ver -  
was da le - bet, muß ver - der - ben, soll es an - ders

The image displays a musical score for a chorale variation. It consists of three staves. The top staff is a vocal line in G major and 4/4 time, with lyrics in German. The middle staff is a keyboard elaboration, featuring a complex, flowing melodic line in the right hand and a simpler bass line in the left hand. The bottom staff is a bass line, likely for a keyboard instrument, consisting of simple chords and single notes.

# Rhythm, Meter, Tempo (performance)

Simon Dixon, Gerhard Widmer, Walter Göbl (2004)

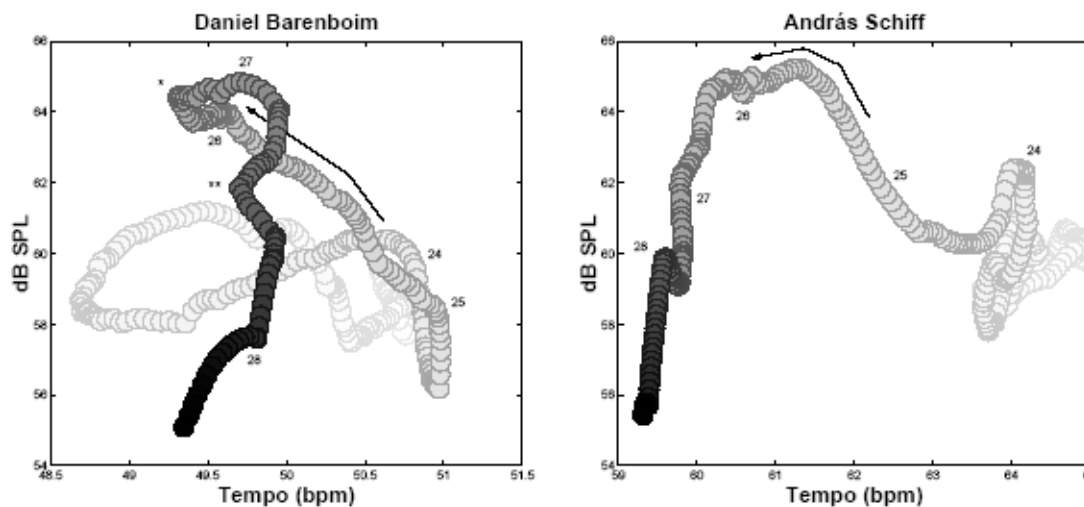
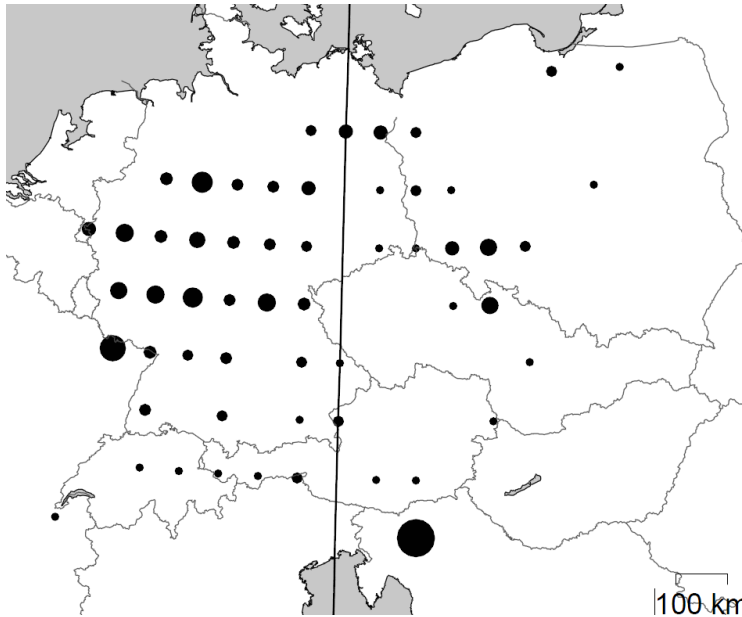


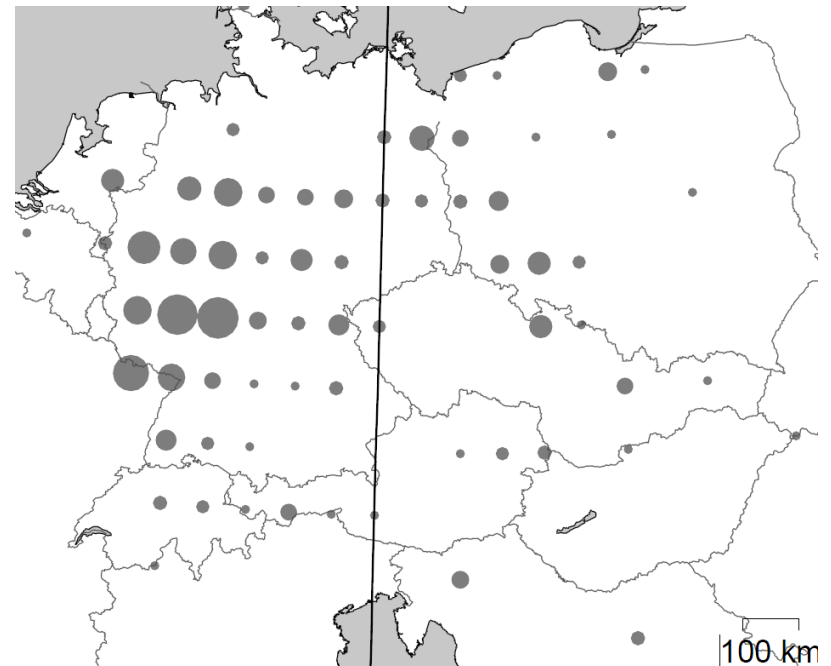
Figure 4. Expression trajectories over the last bars (mm.24–28) of the Mozart piano sonata K.279, second movement, first section, as played by Daniel Barenboim (left) and András Schiff (right).  $x$  axis: tempo in beats per minute;  $y$  axis: dynamics ('loudness') in decibel. The darkest point represents the current instant (third beat of m.28), while instants further in the past appear fainter.

# Geospatial mapping of musical features

## □ Bret Aarden (1998)



Minor mode



Triple meter



# Tabla drumming

Parag Chordia: bol processor (2006)



*Dhene ghene dheneghene nage tak dhane dha  
na ge tak 'dhane dha 'dha ketetake kitetak*

+ dhene gene dhene ghene taketake dha ne  
dha kite takedha kitetake dha

+ kr dhin na kitetake dhene ghene  
na kite ta dhe te dha

+ gerenage na kite ta dhe te  
kitetak gerenage na kite ta

+ dha

dha nagetake dha ne dha  
dhet ta kitetake ta

natete dhet kitetak gerenage  
ta gadigene dha kitetak

dha ta gadigene dha  
dhe te dha ta gadigene

```
8.0 2.0 0.0 -36 0.0 0.0 -1.0
t 2 6 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dha
t 2 21.582 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 28.26 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 36.058 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04kr
t 2 42.722 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dhe
t 2 53.824 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 60.502 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dhe
t 2 101.5 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 108.178 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 114.856 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04kre
t 2 124.474 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dhe
t 2 136.696 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 143.374 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dha
t 2 154.476 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 158.914 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04re
t 2 163.632 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04ki
t 2 167.468 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
```

# Themefinder (melodic search)

- Huron, Kornstädt, Sapp, et al. (1996)

themefinder.org

[Take the Quartet Quiz.](#)

<i>Repertory</i>	<input type="text" value="Classical"/>	? type of music to search
<i>Pitch</i>	<input type="text"/>	? A-G, sharp=#, flat=- e.g. C E- G F#
<i>Interval</i>	<input type="text"/>	? maj=M, min=m, aug=A, dim=d per=P, fifth=5, up=+, down=-. e.g. +m9 -P8 +M3 P1
<i>Scale Degree</i>	<input type="text"/>	? do=1, re=2, mi=3, fa=4, so=5, la=6, ti=7 (mode insensitive). e.g. 34554321
<i>Gross Contour</i>	<input type="text"/>	? up=/, down=\, unison=-. e.g. //\-/ or uudsu
<i>Refined Contour</i>	<input type="text"/>	? up step=u, up leap=U, down step=d, down leap=D, same=s. e.g. uUDsdu
<i>Location</i>	<input checked="" type="radio"/> beginning of theme only, or <input type="radio"/> anywhere in theme	?
<i>Key</i>	Any <input type="text"/> Mode: Any <input type="text"/>	?
<i>Meter</i>	<input type="text"/> / <input type="text"/>	?

# Haydn-Mozart Quartet Quiz

(machine learning/information theory)

## 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.

Digital scores for the quartet quiz have been provided by the [Center for Computer Assisted Research in the Humanities](#) at Stanford University. Click the start button below to answer some questions about your musical knowledge and then start the quiz...

start

- [View current identification statistics](#)

Brought to you by Craig Sapp and Yi-Wen Liu, Stanford University.



or ...



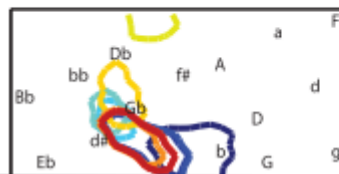
Yi-Wen Liu,  
C. Sapp (2002-04)  
-entropy study (EE)  
[\[qq.themefinder.org\]](http://qq.themefinder.org)

# Neuromusicology

- Carol Krumhansl: Tonal, harmonic understanding
  - Their physiological correlated
- Petr Janata: specific-key perception
  - Neural correlates
- Petri Toiviainen
  - Spatial-temporal music cognition



Half-decay time constant  
0.2 s



B: I-IV-iii-ii6-V-I

Half-decay time constant  
2.0 s

