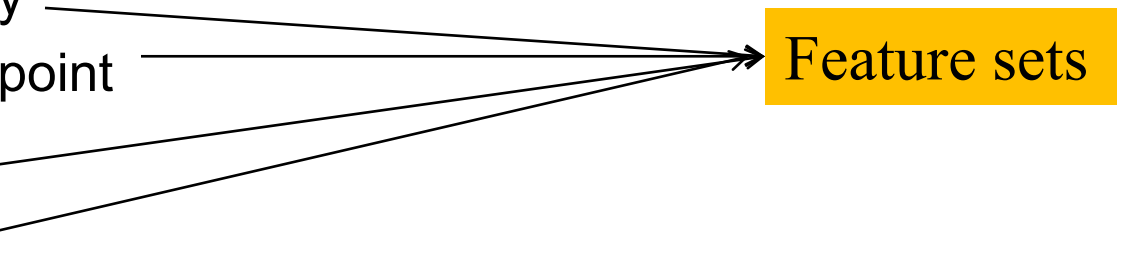
# Analytical uses of Humdrum Tools

Music 253/CS 275A

Stanford University

# Traditional categories of music analysis

- Traditional means of analysis
  - Harmony
  - Counterpoint
  - Melody
  - Rhythm



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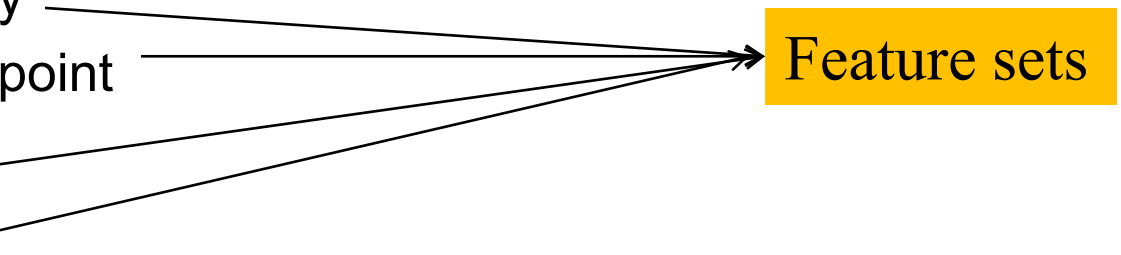
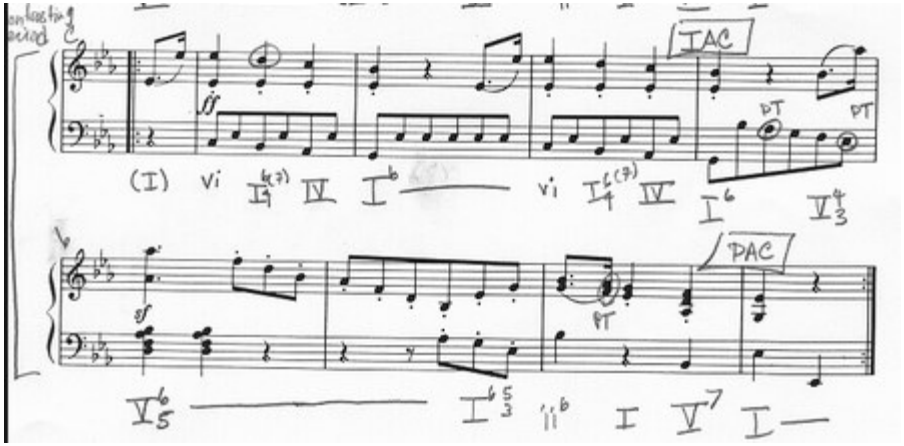



**Humdrum** = Toolset
****kern** = encoding format

# >>Manual processes in music analysis

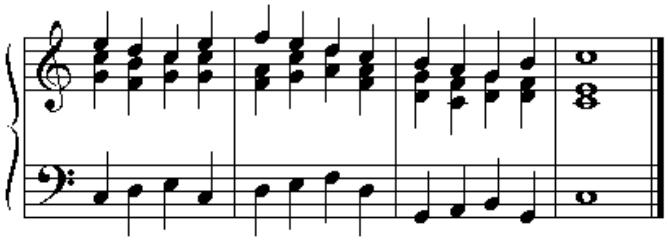
Riemann analysis




Schenkarian analysis

Agmon, Conventional Harmonic Wisdom

Ex. 6

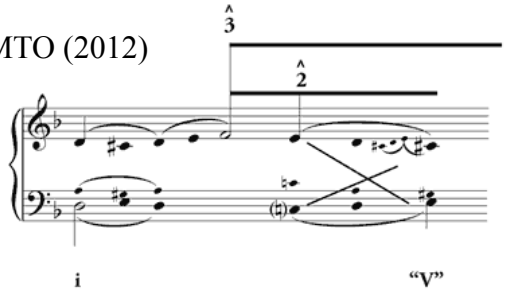


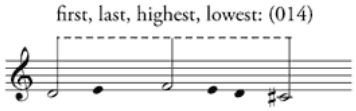
LEVEL 1: T ——— S ——— D ——— T

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

Root analysis

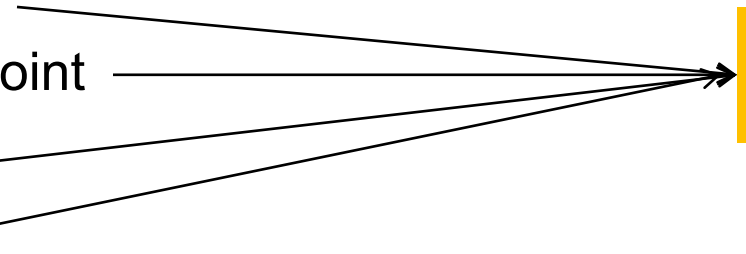
Blair Johnson, MTO (2012)



# Perspectives on music analysis: 1-2

- 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
**Disembodied information about music**

- **Audio-based** analysis

# More approaches to analysis

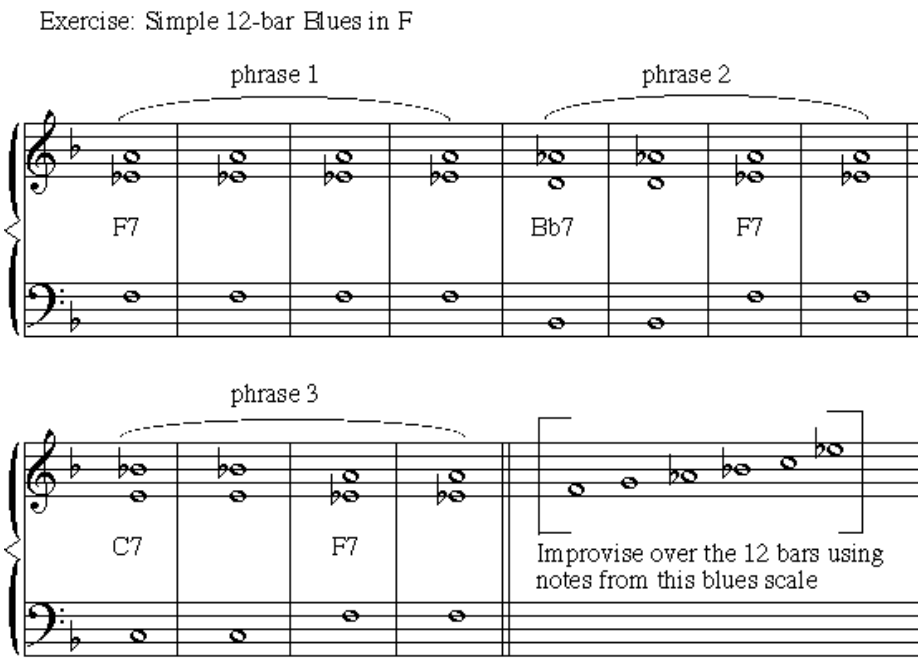
- Procedures imported from other disciplines
  - Often ***procedural*** or *structural*
  - Borrowed from
    - **Linguistics**
    - **Mathematics**
    - **Computer science**
    - **Engineering**
- **Cognitive** and perceptual studies
- **Performance-based** analysis
- **Data visualization**

# Other legitimate projects

- **Data translation**, enrichment
- **Linking symbolic data** with MIDI, audio, structured data
- **Style evaluation**
  - generation as proof of general concept
  - Attribution studies (e.g. Josquin Research Project)
- **Deep-learning/convolutional-network** (AI) analysis

# Sample Projects, Random Order

# Algorithmic generation: 12-bar blues




Francesco Giomi, c. 1988

Is repertory highly **patterned**?

# Phrase families (centonization)

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

**Linguistic orientation**

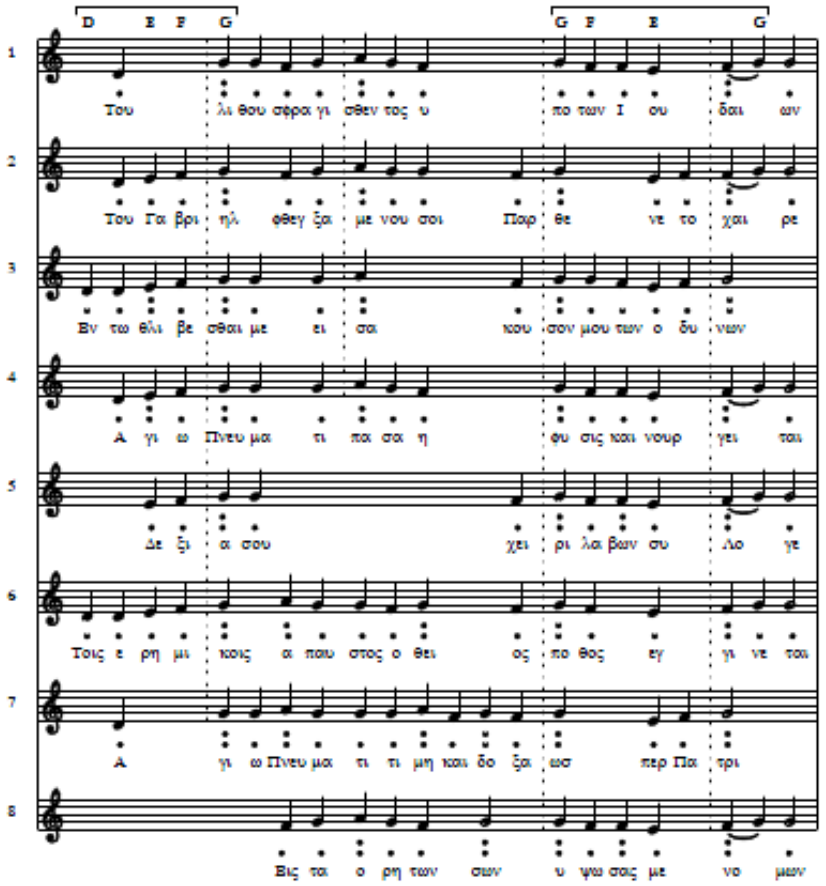
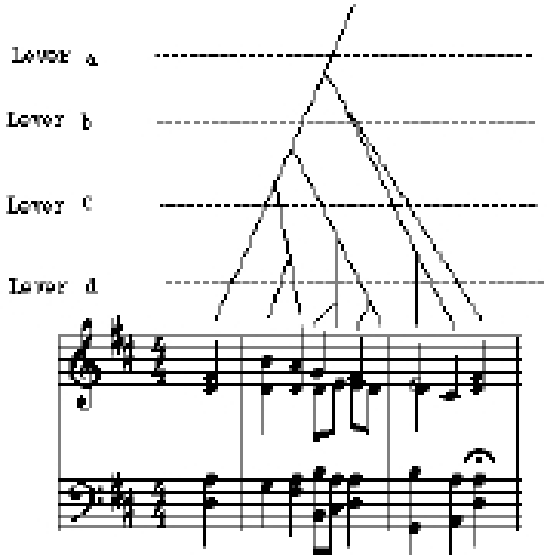
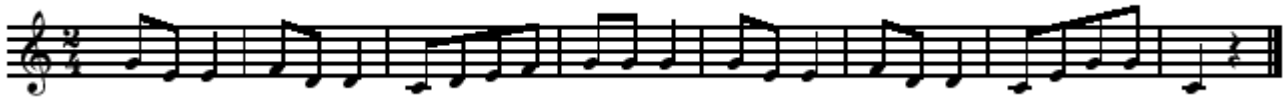



*Figure 3. A Phrase family in Echos 1, illustrating formulaic variation. Brackets above the staff mark the family's opening and closing formulas.*

# Hierarchical systems: Lerdahl-Jackendoff



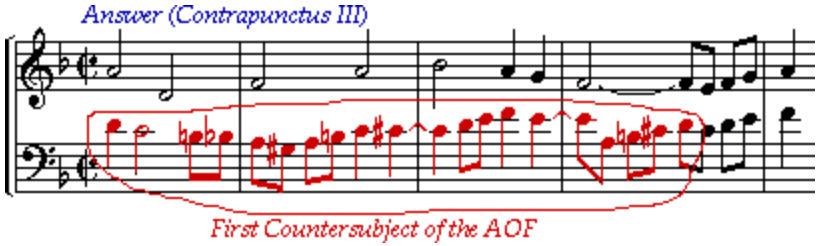

Generative theories
of musical grammar (1984)



| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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´ | | | |

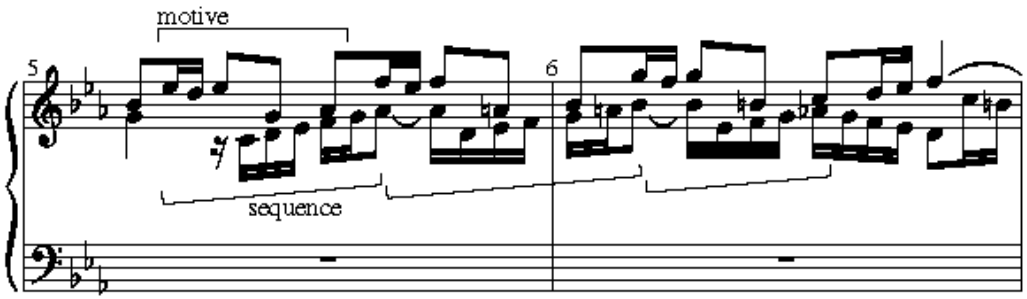
# Linear systems (species counterpoint)


Several systems

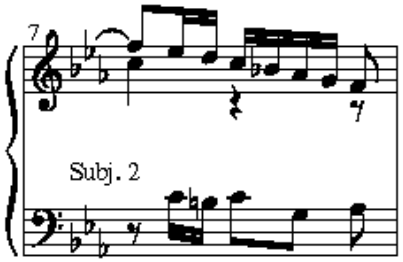


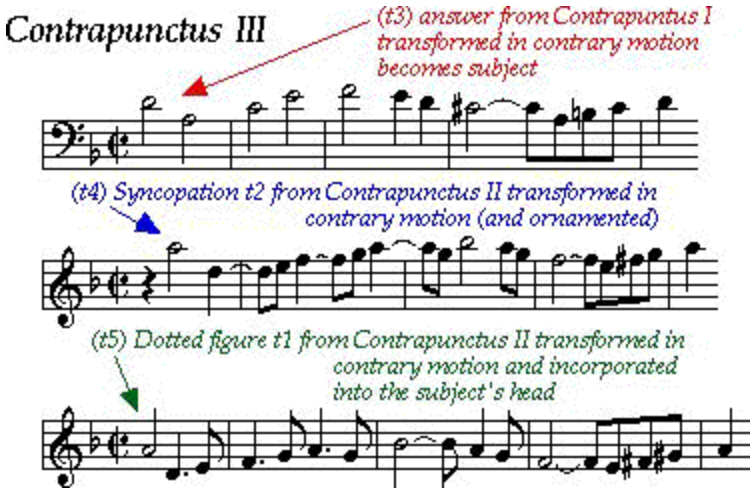

## Pedagogical orientation

# Imitative systems (18th-century counterpoint)




Timothy Smith, NAU

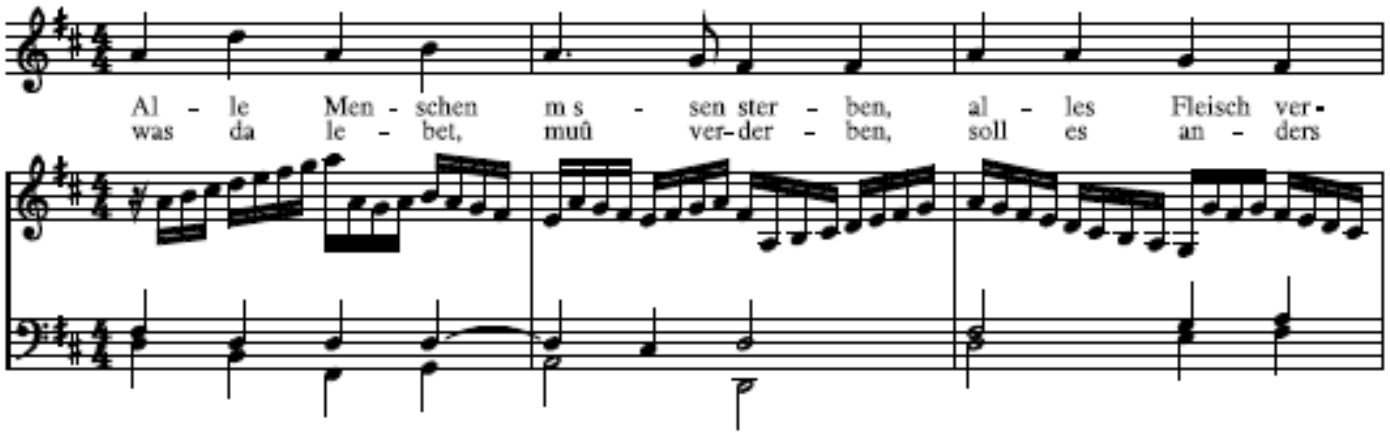



## Music-theory applications

# Generative chorale variations

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




**Chorale elaboration**

# Rhythm, Meter, Tempo (performance)

Simon Dixon, Gerhard Widmer, Walter Göbl (2004)

**Comparative performance analysis**

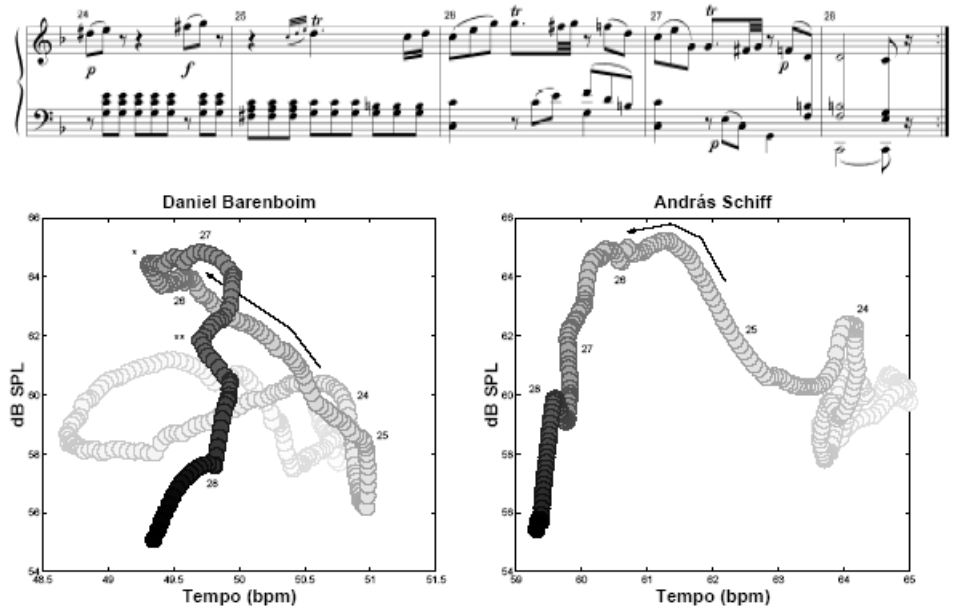



**Figure 4.** Expression trajectories over the last bars (mm.24–28) of the Mozart piano sonata K.279, second movement, first section, as played by Daniel Barenboim (left) and András Schiff (right). *x* axis: tempo in beats per minute; *y* axis: dynamics ('loudness') in decibel. The darkest point represents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

# Computation perception

Gerhard Widmer, *Motherboard* (2016)

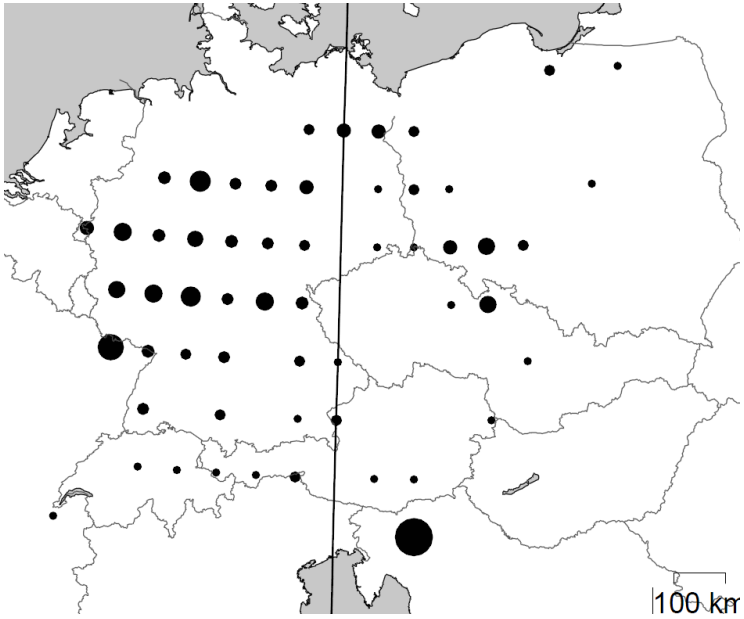
MACHINES | By Michael Byrne | Oct 9 2016, 11:00am

## Computer Scientist Publishes Manifesto for Expressive Algorithmic Music

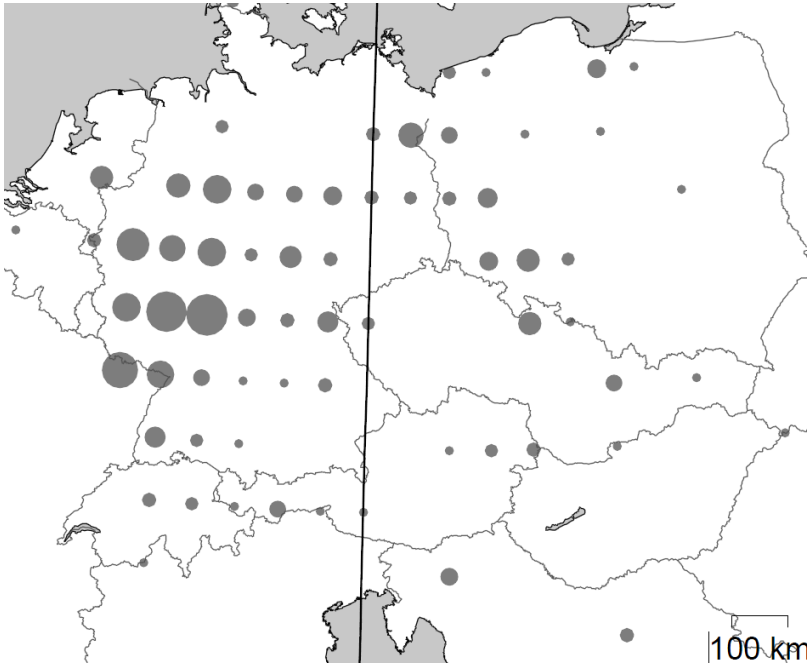
**A new five-year research project aims to u
how humans compute music.**

# Geospatial mapping of musical features

- Bret Aarden (1998), from EsAC data




Minor mode

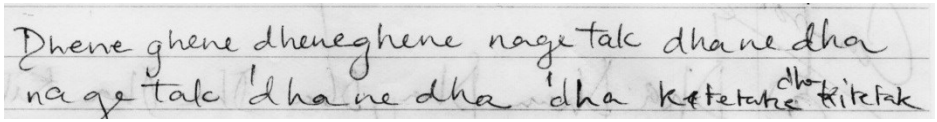



Triple meter

# Tabla drumming

Parag Chordia: bol processor (2006)

## Non-Western repertories


+ dhenegene dheneghene taketake dha ne
dha kite takedha kitetake dha

+ kr dhin o na kitetake dheneghene
na kite ta dhe te dha

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

+ dha

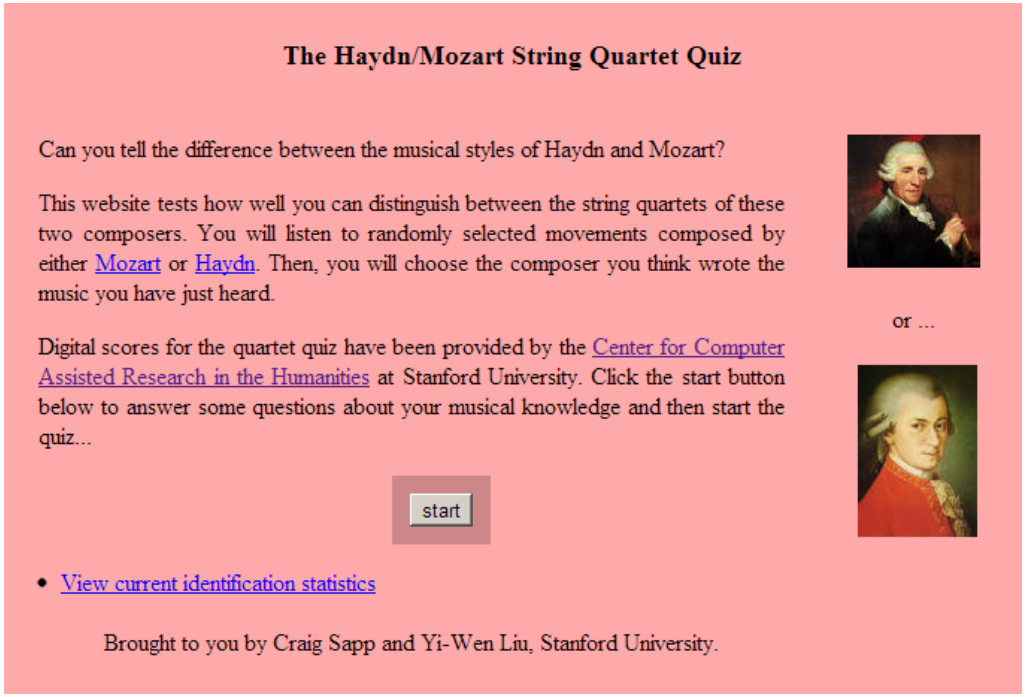
dha nagetake dha ne dha
dhet ta kitetake ta

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
```

# Haydn-Mozart Quartet Quiz
## (machine learning/information theory)



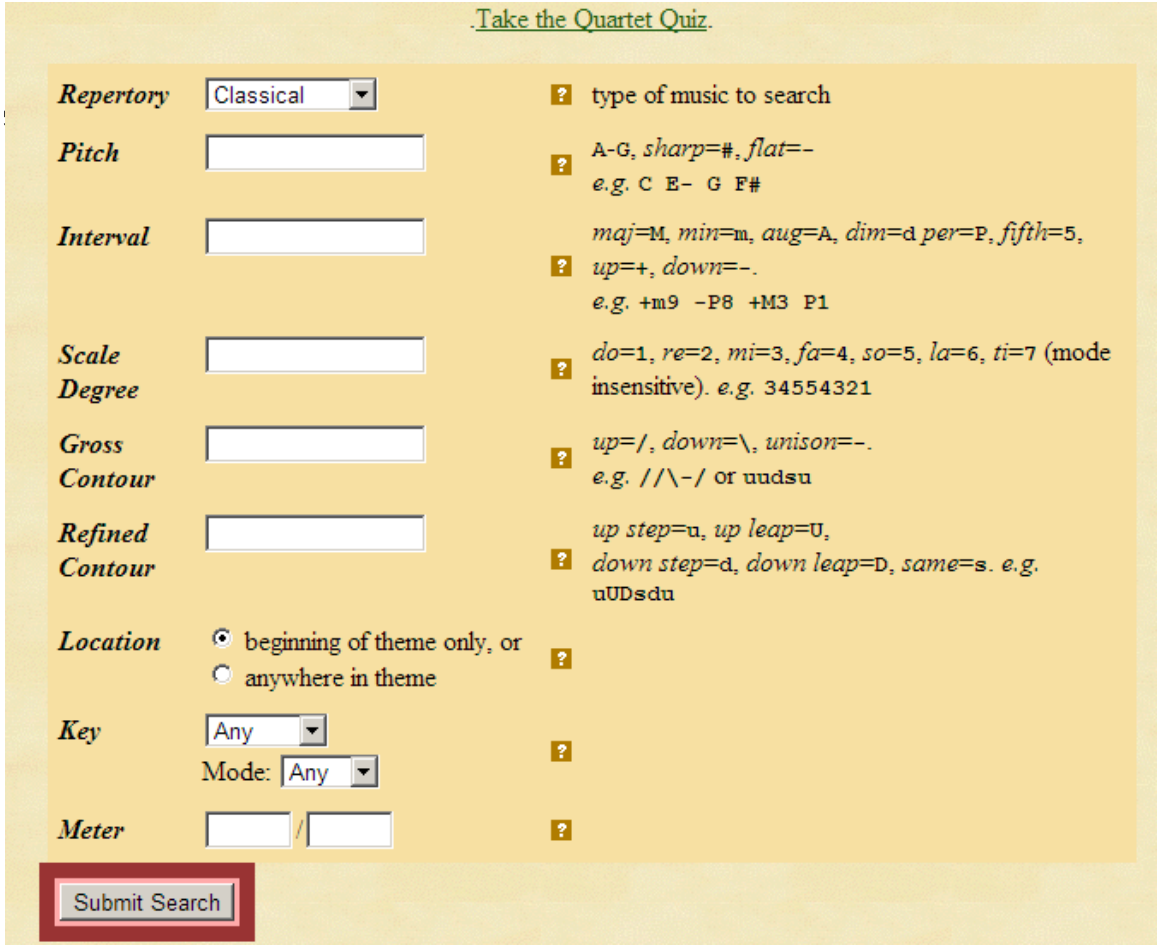

Yi-Wen Liu,
C. Sapp (2002-04)
-**entropy study (EE)**
[*qq.themefinder.org*]

# *Themefinder* (melodic search)

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

themefinder.org

**Similarity studies**



# Computer methodologies in music search

- Music geohash
- Counterpoint/surfacing crawling
- Musical structure discovery via deep-learning algorithms (2016)
- Currently runs ETLeap (data extraction, transformation, loading)

# Melodic search in big data

- Sapp, Liu, Selfridge-Field (ISMIR, 2004)
- Search Effectiveness

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

- Uses 100,000 musical incipits

- Also: Sapp, Shanahan: Rhythmic search in 1m+ incipits

# Studies comparing analytical tools

- Claire Arthur

MEI Proceedings (2015)

- Compares, Humdrum, MEI

- Johanna Devaney, Hugh Gauvin (Springer Verlag, 2016)
- Advocates extensions to Humdrum and MEI

# Neuromusicology

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