



## Balancing computational means and humanities ends in computational musicology

Humanities Lectures, 11 December 2012

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**ICS** Department of Information & Computing Sciences



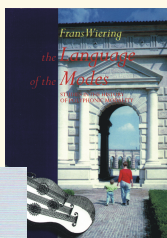
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## Self-introduction

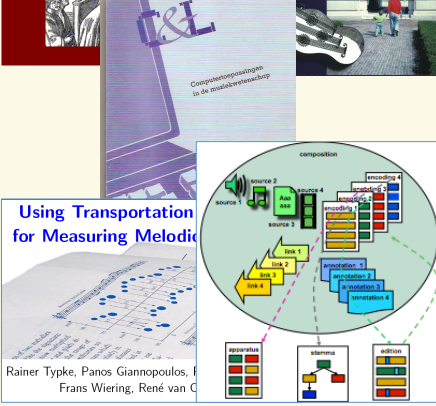
- Studies:
  - biology (1975-79)
  - musicology (1978-86)
  - PhD musicology (1995)
- Employment
  - Musicology (1985-88; 1989-93)
    - Polyphonic modality
  - Computer and Humanities (1988-89; 1994-1998)
    - Course development
    - Online Italian music treatises (TMI)
  - Information and Computing Sciences (1999-today)
    - Music information retrieval
    - Computational musicology
    - Game music technology



Pietro Aaron  
Complete Italian treatises  
Giovanni del Lago  
Breve introduzione di musica misurata




Frans Wiering  
The Architecture of the Melos



Using Transportation for Measuring Melodic

Rainer Typke, Panos Giannopoulos, Frans Wiering, René van C...



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## Audience



- musicologists: I apologise for generalisations
- computer scientists: same apology
- all: ask questions if things become too specialist



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## Music is attractive

- important form of cultural expression
- when given the chance, researchers of nearly every discipline like to research music

SCIENTIFIC REPORTS

**Pop music too loud, sounds the same**

OPEN

Measuring the Evolution of Contemporary Western Popular Music

SUBJECT AREAS: APPLIED PHYSICS, MATHEMATICS AND COMPUTING

Joan Serrà<sup>1</sup>, Álvaro Corral<sup>2</sup>, Marián Boguñá<sup>3</sup>, Martín Haro<sup>4</sup> & Josep L. Arcos<sup>5</sup>

<sup>1</sup>Artificial Intelligence Research Institute, Spanish National Research Council (IIA-CSIC), Bellaterra, Barcelona, Spain, <sup>2</sup>Complex

- **contribution to understanding music?**



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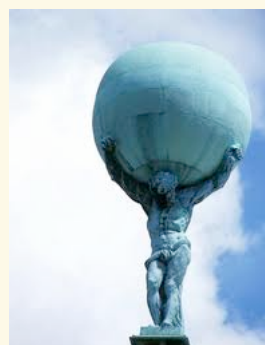
## Computing in music goes way back

- oldest known study: Bronson 1949 (folk song classification)
- stages
  - prehistory (before 1960)
  - heroic (1960-1980)
  - crisis and recovery (1980-2000)
  - Internet and MIR (1995-present)
  - towards digital musicology (2005-present)
- aims
  - examine some highlights
  - contribution to music understanding
  - generalisation to Digital Humanities?



## The heroic phase

- great ambitions
- everything seemed to fit
  - 'positivist' approach to musicology
  - classical music, notation
  - source studies
  - formalisation, automatic processing



- Arthur Mendel, Evidence and Explanation (1962)
  - the positivist programme for musicology

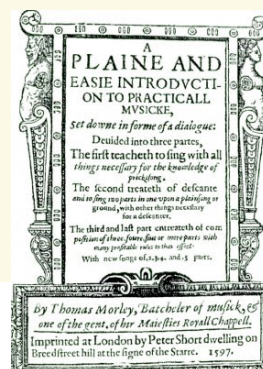


## Plaine and Easie Code

- Brook & Gould, 1964
- for music cataloguing: incipit encoding
- technology: typewriter



```
112A 1.1.1
112B pf.
112C G-2
112D xPCG
112E 2/4
112F '' '2C/!(y6DCz''B''C)!E/2D/q3D{8Cq3D8Cq3D8Cq3D8C}/y'
      '4.B''8Ez/
```



- [http://www.iaml.info/en/activities/projects/plain\\_and\\_easy\\_code](http://www.iaml.info/en/activities/projects/plain_and_easy_code)



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## RISM Répertoire International des Sources Musicales

- RISM: huge bibliographic effort for music sources (1952- )
  - motivated by massive destructions of WW II
- RISM A/II: music manuscripts after 1600
  - end date 1800, extended to 1850?
  - collecting started in 60s
  - database created in 70s?
  - incipits encoded in PAEC
- current status
  - c. 1.5M items (work instances)
  - far from complete
  - search interface at <http://opac.rism.info/>

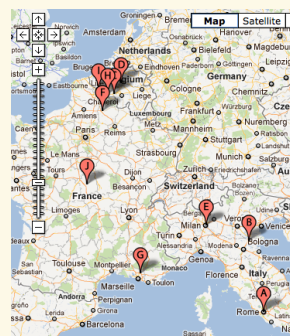


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## Princeton Josquin Project

- Josquin des Prez, c. 1450/55-1521
- international career in Low Countries, France and Italy
- author of c. 150-200 compositions
- first single-author music print ever *Missa Josquin* (1502)
- reputation of his music survived long after his death, especially in Germany
- best known for:
  - masses, motets, chansons
  - pervading imitation



[http://maps.thefullwiki.org/Josquin\\_des\\_Prez](http://maps.thefullwiki.org/Josquin_des_Prez)



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## Example: Missa de Beata Virgine

Superius  
Ky - rie

Altus  
Ky - rie

Tenor  
Ky - rie

Bassus  
Ky - rie

Superius  
Ky - ri - e, Ky - ri - e e - le - i - son, e - le - i - son,

Altus  
Ky - ri - e, Ky - ri - e, Ky - ri - e

Tenor  
Ky - ri - e, Ky - ri - e, Ky - ri - e

Bassus  
Ky - ri - e, Ky - ri - e, Ky - ri - e

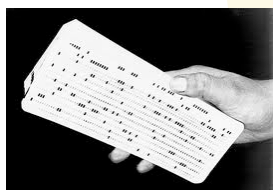
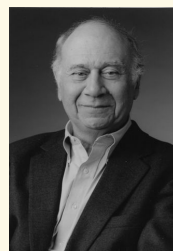


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## Josquin and the computer

- first composer to be subjected to large-scale computational research
- all (?) works encoded in 1960s-70s for Princeton Josquin project, directed by Arthur Mendel and Lewis Lockwood
- most technical work probably by Michael Kassler
  - punch cards, IML (or Fast Code)
  - “simple enough to learn in five to ten minutes”



**Benedictus.**

Superius.  
Be - ne - dic -

Altus.  
Be - ne - dic -

tus, be - ne - dic -

tus, be - ne - dic -

tus, be - ne - dic -

tus, be - ne - dic -

```
'=COMPOSER JOSQUIN DES PREZ' '=TITLE MISSA AVE MARIS STELLA'
'=SUBTITLE BENEDICTUS' '=LINE 1-SUPERIUS 2-ALTUS'
$1$1$1 '=CLEF G' '=KEY F' '=TIME (C-)' ' D1 ,BE, UE(T)2 ,NE, *LD2 ,DIC,/
D4* C4 B4 B4 UE(T)2 *LD2/ $3$ D2* C4/B4/A1/ $4$ *LD1/ D11*// 'FIRST
ALTUS STAFF FOLLOWS DOUBLE SLASH' $2$1$ '$CLEF C3' '=KEY AT' '=TIME
(C-)' *UF11 ,BE,/ F11*/ $2$3$ E1. F2/ G1 A2, NE, *C2, DIC,/ G4* F4
G4 E4 A2 *G2// 'NOTE THAT CLEF AND KEY ARE NOT REPEATED' $1$6$ LC11
,TUS,/ UA1 'ITALICIZED TEXT WILL NOT BE RECORDED' B2 *A2/ A4* G4 A4
F4 B2 *A2/ A2* G4 F4 E2 *A2/A2* $10$ B2 G2 B2/ A2 B2 G2 *B2// $2$6$
UG2* F4 E4 LD1/ *C11/ C11*/ B11 ,TUS,/ C1 D(T)2 *C2/ $2$11$ C4* B4 C4
A4 DT2 *C2// $1$12$ B2* A4 G4 F2 *C2/ C4* B4 C2 D2 UF2/ E2 F2 LD2 *UF
2/ $1$15$ F2* E4 LD4 C(S)4 D4 UE4 LC4/ *D11/ D11*// 'SUPERIUS ENDS'
C2* B4 A4 G1/ $2$13$ R2 UG2 A2 *G2/ G4* F4 C4 E4 A2 *G2/ G2* F4 E4
LD1/ *C11/ C11*// 'THE BENEDICTUS ENDS HERE'
```

4. Input of written music to a computer (after T. D. Robison; see Heckmann, pp.108 f): Benedictus from Missa 'Ave maris stella' by Josquin Desprez ('Werken: Missen', ii, ed. A. Smijers), with IML key-punchable transcription below

## Example research topics

- notation issues
- *musica ficta*
- counterpoint and dissonance
- authorship attribution based on frequency of consonances
- *L'homme armé super voces musicales, Et in spiritum*
  - only in one late source
  - 'fullest' consonance of all movements
- based on Mendel, 1969

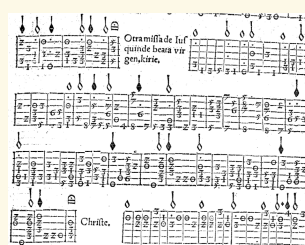
MOVEMENT	A:3&6 &4&5	B:TRIADS & INVERSIONS	A/B
Kyrie 1	13	68	0.19
Christe	17	70	0.24
Kyrie 2	12	61	0.20
KYRIE	15	67	0.22
Gloria	24	56	0.43
Qui tollis	14	61	0.23
GLORIA	19	56	0.34
Credo	16	59	0.27
Et incarnatus	14	79	0.18
Et in spiritum	8	75	0.11
Confiteor	25	45	0.55
CREDO	15	66	0.23
Sanctus	31	49	0.63
Hosanna	14	60	0.23
SANCTUS	24	54	0.44
Agnus Dei 1	21	60	0.35
Agnus Dei 3	10	60	0.17
AGNUS DEI	11	60	0.18
MISSA L'H. A.	15	62	0.24

Fig. 4 Four-Voiced Simultaneities (Percentages of Total Duration)



## Editorial support

- *Missa de Beata Virgine*
  - 5 movements, 30 minutes
  - symphonic proportions
- 69 known sources
  - 27 more or less complete
  - 27 incomplete
  - 15 lute intabulations of a section
- no two sources have same 'text'
  - very many variants
  - which variants represent composer's intentions?
- important issues for New Josquin Edition
  - major UU share (Utrecht Josquin Archive, Willem Elders)







## DARMS project

- Digital Alternate Representation of Musical Scores
- previously known as Ford-Columbia Code
  - Columbia University, sponsored by Ford (1964)
- created by
  - Stefan Bauer-Mengelberg (1927-1996): mathematician, conductor
  - Melvin Ferentz: computer scientist, CUNY
  - (later) Raymond Erickson: music, CUNY
- ambitions:
  - completeness (Erickson 1976)
  - formalisation
  - universality
- technology: mainframe, punch cards, 6-bit encoding



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## DARMS code examples

(4. (5)) ((3 0)) (8 (5 2)) (4 2 (5 (6 7 8)) 9)

- designed for musically untrained data typists
- simple codes are really simple
- but can become very complex

Kazuo Fukushima, *Requiem per flauto solo*, mm. 1-6.

Lento rubato *poco rit.*

*mp* *mf* *pp* *p*

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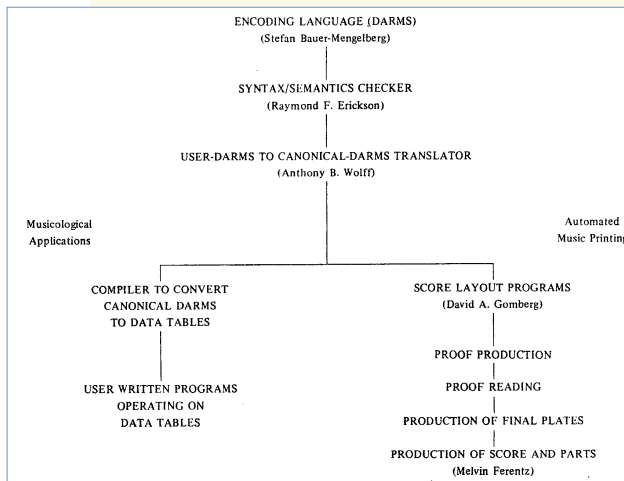
```
!3E3:Q !5S5:Q
!G !M4:4,00@Lento Rubato$ 7HJL1,VMP<1 (7 9J) Q3,<2 9#E3,_V> /
!HJ,VMP Q3L2 9-E3L1,V< (6E3,VMF>1 30E3.L2,V>2) RS3 / 5HJO;AE#,VMF
(5D 5-D',_V>1 4D',_V>2) RE; / 31-HJL1,VMP<1 E3,V<2 34Q3,_V> (9,_V<1
9#,_V<2 / 35H1,VMP<1 ((S5L2,V<2 35-'L1,VPP 33',V>1 30' 5',V<2))
((6#',V<1 32-',V<2>1 38'L2,V>2)) RS / ((4-L1,VP) 0.J) H.L2: /;
```



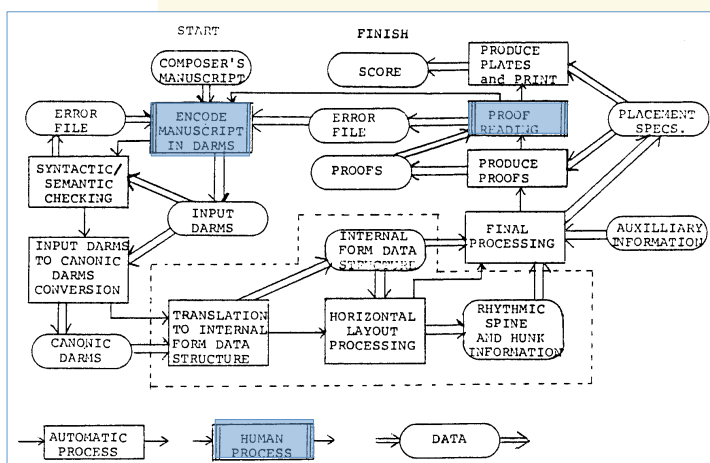
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## DARMS: ambitions



## DARMS: printing system



## What was realised?

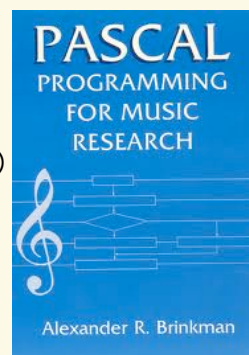
- code never finished
- envisioned complete systems not realized



Stephen Dydo playing the qin

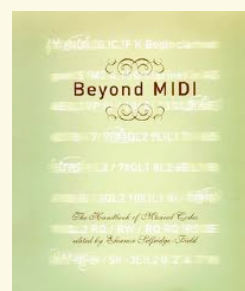


- music printing programs based on DARMS dialect
  - The Note Processor (Stephen Dydo, mid-1980s)
  - A-R Editions (Thomas Hall, since 1981-until ???)
- musicological applications
  - indexing 16th c. madrigal and motet prints (Lincoln 1988, 1993)
  - Pascal programs by Brinkman (1990)
    - powerful internal representation
    - still mainframe oriented



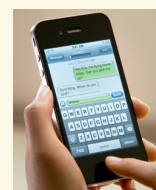
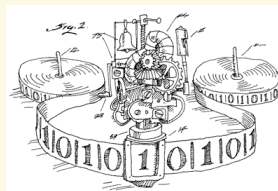
## Heroic phase: conclusion

- lots of activity
  - Brook's bibliography (1970): 617 publications
  - RISM A/II seems only survivor
- encoding of music notation big issue
  - from 2D notation to 1D encoding
  - extreme reinvention of the wheel
- mostly about data formats
  - internal representations and processing requirements barely considered
  - **lesson for today's digitization projects: processability of digitised materials**
- mega ambitions
  - unrealistic?
  - driven by individual researchers, no consolidation
  - realities and threats of technology change
- computability paradigm of computer science



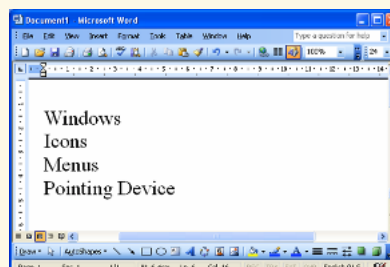
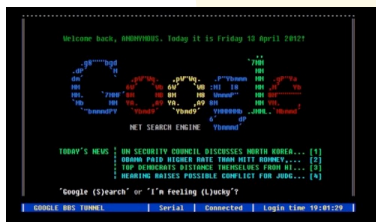
## Computer science paradigms

- Algorithmic paradigm
  - emphasis on computability, mathematical proof
  - 'autistic' behaviour in closed world
  - solve problem by:
    - representation of information
    - algorithm to process it
  
- Interactive paradigm
  - interaction with real world, sense of history
  - only partial, empirical proof of computational properties
  - more powerful than algorithmic paradigm (Wegner 1997)



## Changes in computing, 1980-2000

- just a few of them...
  - introduction of the Personal Computer
  - digital data storage
  - command line interfaces replaced by interactive WIMP interfaces
  - Internet

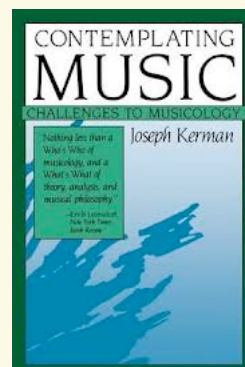


[http://www.youtube.com/watch?v=O8vCEg5k\\_d4](http://www.youtube.com/watch?v=O8vCEg5k_d4)



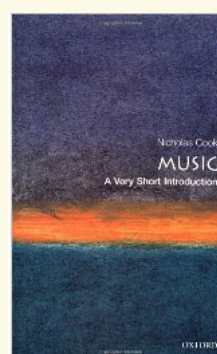
## New musicology

- Joseph Kerman, *Contemplating music: Challenges to musicology* (1985)
  - defining moment in musicology
  - *importance of criticism, value judgements*
- starting-point of wave of critical approaches
  - music and meaning
  - gender, sexuality, power
  - ...
- 'positivist musicology' discredited
  - shown to be the product of a repressive ideology
  - loaded with implicit value judgements



## Victims

- music as autonomous art
  - related to capitalist economic model (Cook 2000, 15)
  - not relevant to most musics
    - primacy of text (early and religious music)
    - occasional and functional music
  - instead: study of musical behaviour
- the work concept
  - composition = art work
  - presupposes strong separation between composition and performance
  - not true for early music, popular music
- *musical works (and musical data) no longer focus of musicological attention*



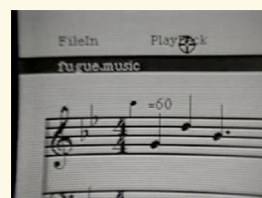
## Crisis and recovery (1980-2000)

- everything attained so far in Computational Musicology had become obsolete
- lots of work had to be redone (or not)
- answer to most technical challenges were somehow produced
  - generally, CM remained true to the computability paradigm
- no consistent answer to challenges of new musicology

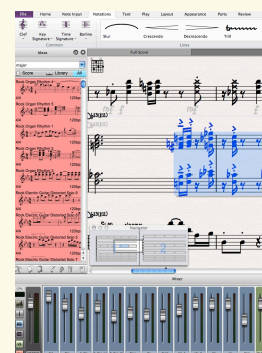


## Consumer music software

- first interactive music editor  
 prototype: Mockingbird by Severo Ornstein and John T. Maxwell (Xerox)
  - <https://www.youtube.com/watch?v=Xu3r5IZds0>
- many such programs emerged, for various platforms
  - best known today: Finale, Sibelius
  - each with its own storage format (often undocumented)
- sequencers: MIDI/sound oriented
  - MIDI = Musical Instrument Digital Interface
  - (too) simple, but documented



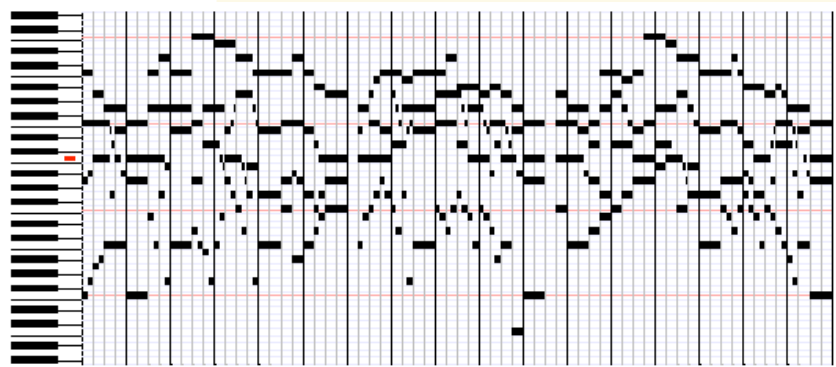
Mockingbird



Sibelius



## MIDI representation of music



core MIDI info: key number and onset-offset times



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## Humdrum toolkit

- first music-analytical toolkit for end-users
- created by David Huron
  - primary interest: music psychology
- must-reads:
  - *Tone and Voice: A Derivation of the Rules of voice-leading from Perceptual Principles* (2001)
  - *Sweet anticipation* (2006)
- properties
  - UNIX platform, central role for *grep*
  - large set of tools doing basic operations
  - tools can be pipelined for complex tasks
- still widely used:
  - <http://www.musiccog.ohio-state.edu/Humdrum/>
  - alternative for today's environments: music21, <http://mit.edu/music21/>



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## \*\*kern representation

- 2D: time on vertical axis
- define codes for whatever you need
- \*\*kern predefined
- many pieces available in \*\*kern:  
<http://kern.ccarh.org/>  
– collected by Craig Sapp

```

!!!COM: Bach, Johann Sebastian
!!!CDT: 1685/3//~1750/7/28/
!!!OTL@DE: Hilf, Herr Jesu, lass gelingen
!!!SCT: BWV 248
**kern **kern **kern **kern
*M3/4 *M3/4 *M3/4 *M3/4
=1- =1- =1- =1-
4.F 4.f 4.a 4.cc
8F 8f 8a 8cc
8A 8c 8f 8a
8A 8c 8f 8a
=2 =2 =2 =2
4.C 4.c 4.f 4.g
8C 8c 8f 8g
8C 8c 8e 8g
8C 8c 8e 8g
=3 =3 =3 =3
4.G 4.B- 4.d 4.b-
8G 8B- 8d 8b-
8E- 8B- 8g 8cc
8E- 8B- 8g 8cc
=4 =4 =4 =4
4.BB- 4.c 4.f 4.dd
8BB- 8c 8f 8dd
8D 8B- 8f 8dd
8D 8B- 8f 8dd
=5 =5 =5 =5

```



## Musical grammars

- emerged around 1980
- influenced by linguistics, Chomsky in particular

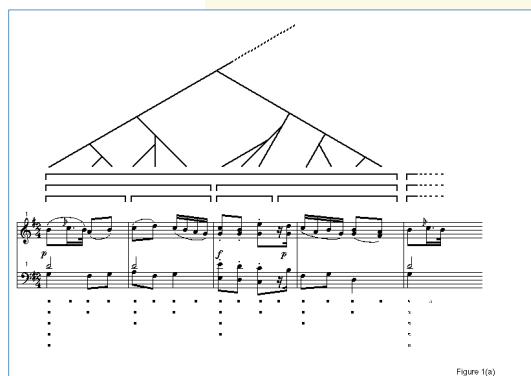


Figure 1(a)

- Lerdahl and Jackendoff, *Generative Theory of Tonal Music* (1983)

time span reduction

grouping structure

metrical structure





## Types of rules in GTTM

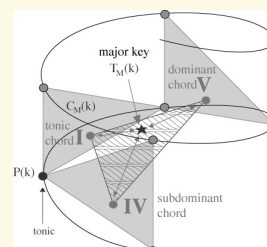
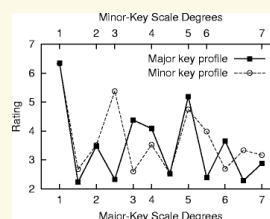


- wellformedness rules, e.g.
  - If a group  $G1$  contains part of a group  $G2$ , it must contain all of  $G2$
- preference rules
  - Prefer grouping analyses that most closely approach the ideal subdivision of groups into two parts of equal length
- GTTM proved very difficult to implement
- wellformed vs. preference rules very influential
  - D. Temperley. *Cognition of basic musical structures* (2001)
  - *Melisma* software, <http://www.link.cs.cmu.edu/music-analysis/>



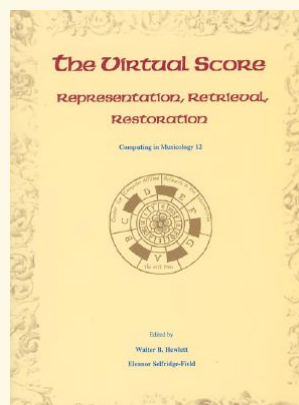
## Impact

- generally, musical grammars were not very successful
- represent fundamental reorientation
  - puts human competence in the centre of attention
  - computational modelling of human musical skills
  - moves away from art work / creator focus
  - room for appreciation, emotion, value judgements
- some highlights
  - Krumhansl-Kessler profiles (1990)
  - Elaine Chew's spiral model (2002)
- must-read: Aucouturier & Bigand 2012
  - computational performance vs. musical insight
  - wonderful account of interdisciplinary (mis)understanding



## CCARH

- Center for Computer Assisted Research in the Humanities
  - founded 1984 by Walter Hewlett
  - Humanities = Music
  - other key staff members:
    - Eleanor Selfridge-Field
    - Craig Sapp
- organisational infrastructure for CM
  - journal *Computing in Musicology* since ?1986
  - IMS Study Group on Musical Data and Computer Applications
  - visiting scholarships



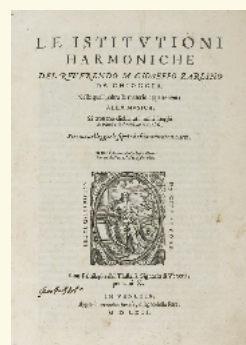
## Corpus creation

- nearly everything from before 1980 was lost
- closed storage representations of commercial products
- creation of open research corpora
  - classical
    - MuseData (CCARH) c. 1000 works, high quality
    - KernScores (already encountered) 10.000 works
  - folk song
    - ESAC data (Steinbeck, Schaffrath, Dahlig) c. 20.000 songs
  - non-standard notation types
    - ECOLM: lute tablatures ([www.ecolm.org](http://www.ecolm.org))
- often created together with dedicated software



## Text corpora

- access to music treatises from the past
- *Thesaurus musicarum latinarum*
  - <http://www.chmtl.indiana.edu/tml/start.html>
  - texts dating from 3<sup>rd</sup>-17<sup>th</sup> century
  - ASCII text searchable (157Mb)
- *Thesaurus musicarum italicarum*
  - Utrecht-based
  - c. 30 Italian texts, 16<sup>th</sup>-17<sup>th</sup> century
  - SGML hypertext
    - seemed more modern, but now legacy technology
  - 2 CD-ROMS, website at <http://euromusicology.cs.uu.nl/index.html>



## Conclusion: late 1990s

- partly recovered from crisis
  - contours of infrastructure emerging
  - but for what???
  - tiny amounts of data and software
- adherence to computability paradigm
  - except maybe music printing
- increasing separation from mainstream musicology
- anchoring the discipline elsewhere
  - music psychology: cognition and perception (e.g. Huron)
  - Internet, Music Information Retrieval





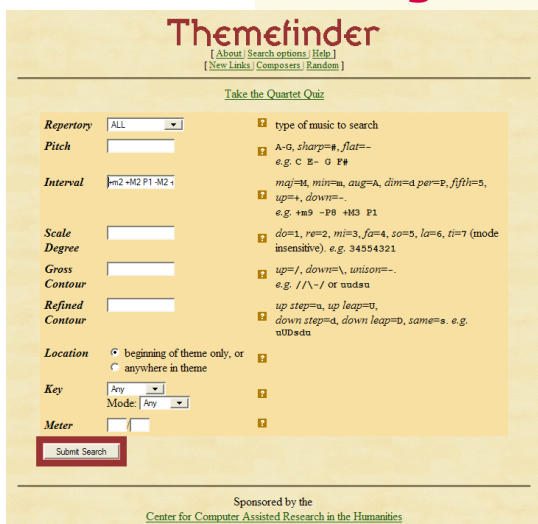
## Online collections, MIDI and others

- MIDI archives appeared in the mid 1990s
- soon many other community initiatives, e.g.
  - [www.cpd.org](http://www.cpd.org) (PDF)
  - [www.lilypond.org](http://www.lilypond.org) (open source music printing)
- finally, large scale data creation
  - serious quality issues
  - copyright problems emerge, esp. for audio



<http://www.classicalarchives.com/>

## themefinder.org



- CCARH service, 1999
- based on Humdrum tools
- ca. 40.000 themes
- 1D search
  - pitch
  - interval
  - contour
  - rhythm

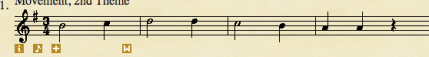
## Themefinder output

**Themefinder Results**


[ 1 | 2 ] search, feedback

Matches = 11


1. Bach, Johann Sebastian (1685-1750), Jesu, Joy of Man's Desiring (from Cantata 147), 1st Movement, 2nd Theme



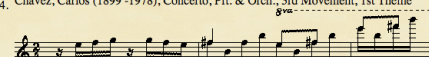
2. Beethoven, Ludwig Van (1770-1827), Symphony No. 9, in D Minor, Op. 125, 4th Movement, 1st Theme



3. Beethoven, Ludwig Van (1770-1827), Trio in B Flat, Vn., Cello & Pft. (Little Trio in B Flat), 1st Theme



4. Chavez, Carlos (1899-1978), Concerto, Pft. & Orch., 3rd Movement, 1st Theme




## Music Information Retrieval

- emerged in 1960s (Kassler 1966), maturing since late 1990s
- definition (Downie 2004)
  - a *multidisciplinary* research endeavor that strives to develop innovative content-based *searching* schemes, novel *interfaces*, and evolving *networked delivery* mechanisms in an effort to make the world's vast store of music *accessible* to all
- three founding disciplines
  - (music) computing
  - library science
  - musicology



## MIR as a community

- annual ISMIR conference (since 2000)
  - 250-300 attendants/year
  - Open Access to full papers
    - <http://www.ismir.net/proceedings/>
    - over 1000 entries in database
- International Society for Music Information Retrieval ([www.ismir.net](http://www.ismir.net))



Don Byrd



Tim Crawford



Stephen Downie




Universiteit Utrecht

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## MIR topics and applications

- search engines
  - *Query By Humming*; folksong and thematic databases
- audio identification
  - fingerprinting of *instances*
- audio classification
  - genre, artist, emotion
- audio alignment
  - syncPlayer, automatic accompaniment, performance study
- tagging and recommendation
  - labelling by end users, user profiling and push technology
- supporting technology
  - audio transcription, interfaces, visualisation



Anonymus  
 Ah vous dirai-je maman

Anonymus  
 Confidence, La. Arr

Anonymus  
 Variations

Montean  
 Variations

Fux, Peter 1753-1831  
 Variations

Stievenard, [Alexandre] 1769c-1855  
 Variations

Janitsch, [Anton?] 1753-1812  
 Variations

Vogler, [Georg Joseph] 1749-1814  
 Variations



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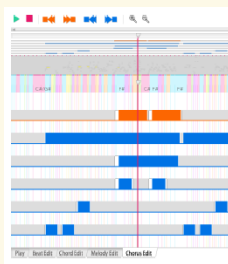
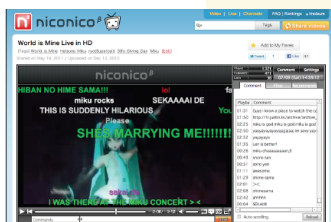
## MIR audio services



shazam



soundhound

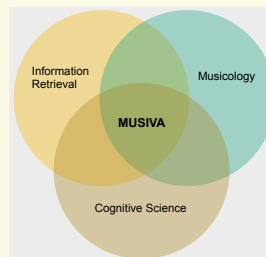


songle



## Music similarity

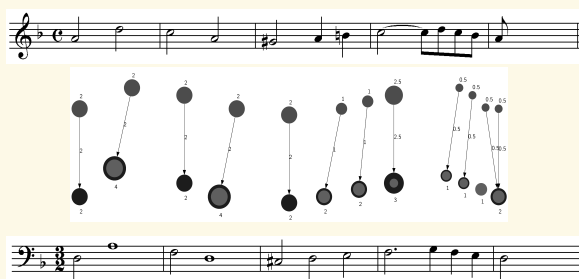
- central concept (and problem) in MIR
  - single pieces of music vary basic materials
  - different performances of same piece
  - cover songs
  - allusions, meaning generation (Bolero/Bolerish)
- several projects at ICS
  - VIDI project MUSIVA (2011-2016)
    - Modelling **M**USical **S**Imilarity over time through the **V**ariation principle
    - Principal Investigator: Anja Volk





## Melody: geometrical models

- idea: capture melodic contour
- 2-dimensional space (pitch, time)
- e.g. EMD/PTD
- weight represents duration (or other features)



Earth Mover's Distance (EMD)

- note that modelling is reduction—many aspects ignored
- used in RISM A/II incipit search
  - <http://yahmuugle.cs.uu.nl>
- R. Typke, F. Wiering, R.C. Veltkamp 2007



## Geometrical models

- pros
  - OK handling of variation and ornamentation
  - suitable for patterns in polyphony
  - suitable for very large collections
- cons
  - how to extend feature space (everything becomes weight)
  - optimal weight flow need not be musically meaningful
  - insertions and deletions not handled well

1. Anonymus: Roslin Castle (1582?) - Distance: 0
2. Anonymus: Roslin Castle - Distance: 0.371133
3. Anonymus: Roslin Castle - Distance: 0.371133
4. Anonymus: Roslin Castle - Distance: 0.512389
5. Anonymus: Roslin Castle - Distance: 0.551804
6. Anonymus: Roslin Castle - Distance: 0.551804
7. Anonymus: Roslin Castle - Distance: 0.551804
8. Anonymus: Roslin Castle - Distance: 0.551804
9. Anonymus: Roslin Castle - Distance: 0.600147
10. Anonymus: Roslin Castle - Distance: 0.667794
11. Anonymus: Roslin Castle - Distance: 0.739229
12. Joseph Aloys Schainbator (1718-1809): Lauda Sion - Dist.: 0.798707
13. Logroscion, Nicola Ruffacio (1698-1765c): Ollivande - D.: 1.09449
14. Christoph Graupner: M'in vita a la caccia - Distance: 1.10299
15. Johann Franz Xaver Stelzel (1750-1817): Il Farnace, Sc. II - 1.13149
16. Georg Friedrich Händel: Hymne "O be joyful" HWV: 279 - 1.24449
17. Anonymus: Roslin Castle - Distance: 1.27669



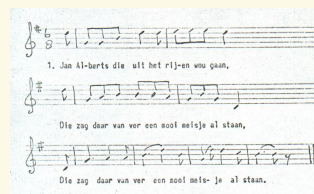
## The WITCHCRAFT Project



- *What Is Topical in Cultural Heritage: Content-based Retrieval Among Folksong Tunes*
  - NWO-CATCH project, 2006-2010
  - Wiering et al. 2009.
- Aim: to design content-based retrieval methods for large collections of melodies
  - *practical*: melody search engine
  - *scientific*: methods for measuring musical similarity
  - *musicological*: enabling folksong research

## Onder de groene linde

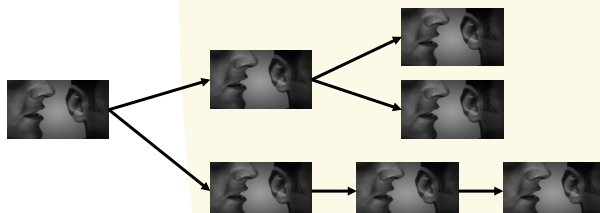
- field recordings of folk songs collected by Ate Doornbosch and others
  - 1950-1984
  - example (with interesting noise?)
  - quality
  - transcription
- Preserved at the Meertens Institute as part of the Dutch Song Database
  - [www.liederenbank.nl](http://www.liederenbank.nl)
  - metadata of c. 130.000 songs
  - full content being added



OGL 19202

## Oral transmission

- Most important feature of folk songs

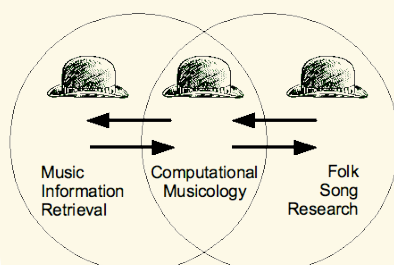


- Melodies change, texts change
- Related songs constitute tune family (*melodienorm*)
- How can we find related melodies?
- Aim: search engine that enables oral transmission research

## Ground truths

- How to evaluate a search engine for folk song melodies?
- MIR answer: create ground truth
  - perfect answer set or perfect classification created by human experts
- But there is a problem
  - A ground truth is based on choices, assumptions, hypotheses, theories about music, musical intuition, etc.
  - The use of empirical data as a hermetic “ground truth” prevents Music Information Retrieval from being relevant for music research

## Solution: three-role model



Role	Interest	Method
Music information retrieval	Music information systems	Computer science
Folksong research	Folk music	Musicology
Computational musicology	Folk music	Computer science

## Understand tune families

- Tune families: groups of melodies that supposedly have a common origin
  - variants caused by oral transmission
  - in absence of historical sources: classification based on similarity judgements by experts
- Experts' working method was studied
  - trace features, e.g. presence of characteristic motive(s)
  - assign values to those features
- Annotated corpus of 360 melodies
  - ground truth *and* arguments
  - Volk & Kranenburg 2012

A screenshot of a software interface for song annotation. It has tabs for 'Songs', 'Comparisons', and 'Motifs'. Under 'Songs', there are sub-tabs for 'Song', 'Optional Features', and 'Custom Feature Types'. A search bar shows 'Q- All'. A table lists three items with columns for Name, Score ID, and Ogl ID. Below the table are 'Fetch', 'Remove', and 'Add' buttons. Further down, there are input fields for 'Melody Norm', '(Popup) Song Name', 'WCE Score ID', 'Melody Form', '(Ogl ID)', and '(Custom Features)'. A 'Comments' field is at the bottom.

annotation environment

## Melody: sequence alignment

En daar reed eris een heer, en hij was wellegemoed En daar reed eris een heer, en hij was wellegemoed En hij droeg er d' r rozekrans on er zijn hoed En hij droeg er een ro - zekrans on erre zijn hoed.

Daar reed er een heer die was wel didel don die was wel don da don didel on don Daar reed er een heer die was wel dergemoed

Computed optimal alignment, showing substitution and gap scores:

- determine optimal alignment between 2 sequences of symbols
  - insertion, deletion and substitution scores
  - scoring mechanisms based on expert annotations
- implemented in folk song search engine
  - <http://www.liederenbank.nl/index.php?wc=true>
- PhD. thesis Peter van Kranenburg, 2010.

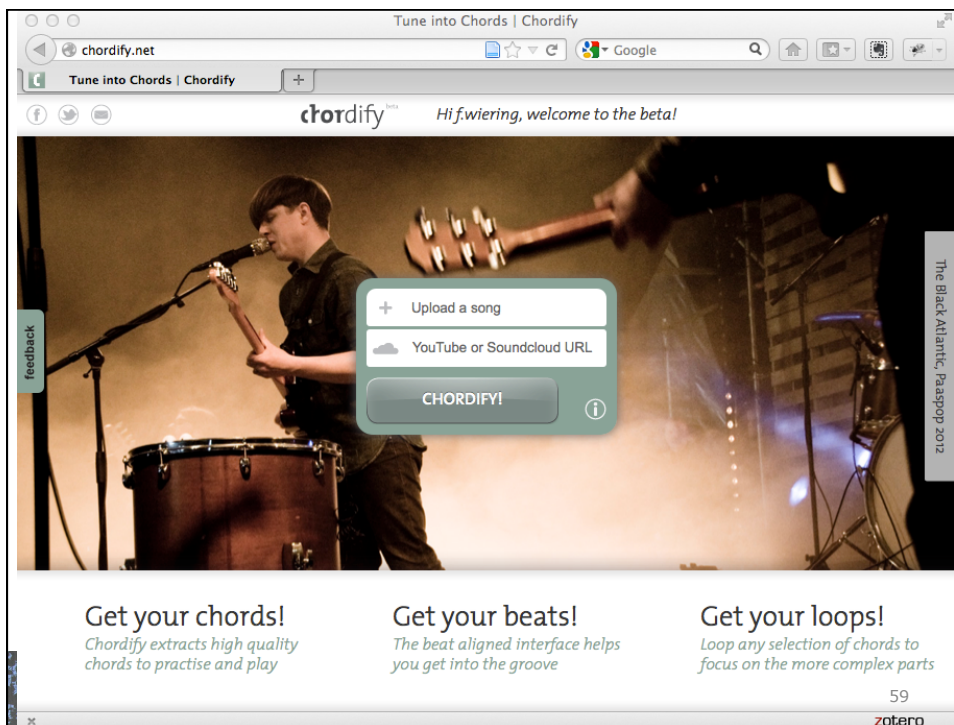


## Sequence alignment

- pros
  - raters for new features easy to add
  - handles insertions and deletions well
- cons
  - restricted to monophony or 1-dimensional sequence
  - not yet tested outside folk song

[En wat] baart de liefde veel smarten / En al van [...]	<i>In Frankrijk buiten de poorten (2)</i>	mp3 transcr.
OPN OGL 407: opname Houtigehage 1950		
Daar reed er een heer	<i>Daar reed een jonkheer (1)</i>	mp3 transcr.
OPN OGL 30306: opname Enschede 1968		
In Veendam daar staat er een herberg / Een [...]	<i>In Frankrijk buiten de poorten (2)</i>	mp3 transcr.
OPN OGL 19304: opname Hoogkerk 1961		
In Veendam en daar staat er een herberg	<i>In Frankrijk buiten de poorten (2)</i>	mp3 transcr.
OPN OGL 20515: opname Hoogkerk 1961		
In Frankrijk buiten de poorten	<i>In Frankrijk buiten de poorten (2)</i>	mp3 transcr.
OPN OGL 26321: opname Blijham 1966		
In Frankrijk staat een herberg	<i>In Frankrijk buiten de poorten (2)</i>	mp3 transcr.
OPN OGL 33312: opname Muntendam 1969		

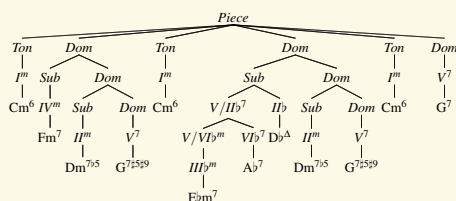




## Chordify!

- spinoff of UU MIR research
- PhD thesis Bas de Haas on harmony-based retrieval (2012)
  - uses error-correcting context free grammar

- 4  $Ton_{Maj} \rightarrow I_{Maj} | I_{Maj} IV_{Maj} I_{Maj}$
  - 5  $Ton_{Min} \rightarrow I_{Min}^m | I_{Min}^m IV_{Min}^m I_{Min}^m$
  - 6  $Dom_m \rightarrow V_m^7 | V_m$
  - 7  $Sub_{Maj} \rightarrow IV_{Maj}^m | II_{Maj}^m | \dots$
  - 8  $Sub_{Min} \rightarrow IV_{Min}^m | II_{Min}^m | \dots$
- $c \in \{\emptyset, m, 7, 0\}$



**Figure 2.** An analysis of the jazz standard *Blue Bossa* in C minor. Every chord belongs to a Tonic, Dominant, or Subdominant category (*Ton*, *Dom*, or *Sub*) and the  $V/X^7$  denote chains of secondary dominants.



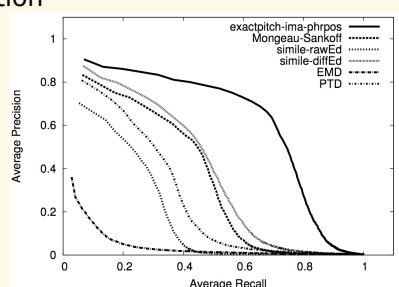
## chordify! demo

- <http://chordify.net/chords/dat-gaat-nu-met-de-pelikaan-dairyman716>
- <https://www.youtube.com/watch?v=-v-RBGQq6j8>



## MIR evaluation

- MIR has a strong focus on evaluation
  - engineering perspective
  - effectivity of technology
  - e.g. precision and recall curves



- yearly MIREX campaign
- Stephen Downie's brainchild
- [http://www.music-ir.org/mirex/wiki/MIREX\\_HOME](http://www.music-ir.org/mirex/wiki/MIREX_HOME)
- algorithms evaluated for selected tasks
  - melody extraction, chord labelling, genre classification
- difficult to say what results mean for realistic applications



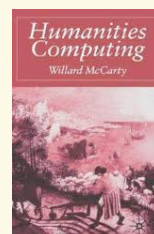
## What has MIR delivered?

- bad news
  - engineering approach (whatever it takes to get the best results)
    - lower explanatory value
  - not many successful applications
    - often solution in search of problem
  - little attention for user oriented research
    - usability = beauty contest
- good news
  - lots of computational methods waiting to be exploited
  - audio-based research now serious possibility
  - ready to deal with data-rich potential of the Internet



## Towards digital musicology (2005-)

- term obviously modelled on Digital Humanities
- so what happened there recently?
  - mass digitisation of cultural heritage
  - Internet as a scholarly resource
  - interoperability
  - digital media studies
  - builds on 'normal' digital literacy
  - end users become end makers (McCarty 2005)
- much more serious about interactive paradigm





## Digital Musicology

- similar re-orientation possible for Musicology?
  - exploit the Internet
  - creative use of existing technologies
  - not primarily about notation data processing
  - support musicological work processes
  - interactive paradigm
- digital musicology = computational musicology in reverse
  - human-centred design rather than closed systems
  - subdiscipline *and* general professional skill



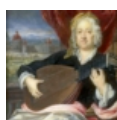
## Where is this happening?

- (some) emerging topics of digital musicology
  - folk song research
  - performance research
  - source studies, digital critical editions
  - lute music research
- each characterised by
  - sizeable community
  - fairly high level of computer literacy

*EsAC*  
Essen Associative  
Code and  
Folksong Database



MUSIC ENCODING  
**MEI**  
INITIATIVE

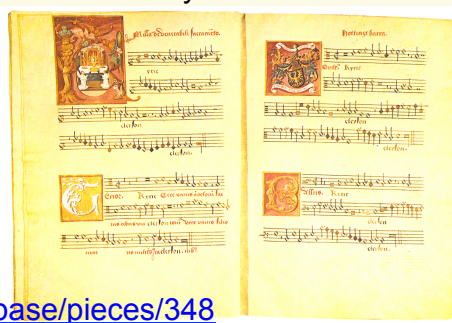


THE  
**. C . M . M . E .**  
PROJECT computerized mensural music editing



## . C . M . M . E .

- Computerized Mensural Music Editing
  - initiated and led by Theodor Dumitrescu
  - based at Musicology, Utrecht
- high-quality electronic publication of early music scores
  - view original and modern notation
  - add and study variants
  - ambitions:
    - search
    - interactive analysis
    - linked data



- <http://www.cmme.org>
- <http://www.cmme.org/database/pieces/348>



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## DIAMM

- Digital Image Archive of Medieval Music
  - Julia Craig-McFeely
  - high-quality images + excellent metadata
  - standard resource for musical medievalists



- digital restoration:
  - <http://www.youtube.com/watch?v=QQjMT7p4QVg>



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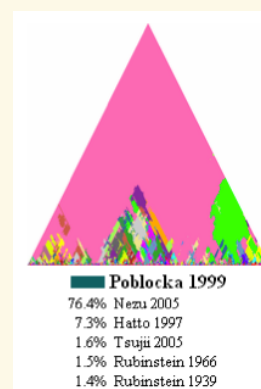
## Lute music research

- not a profitable market for publishers
  - early adoption of technology
- community-driven developments
  - home-made software and encodings
  - online publication and distribution
- top-down initiatives
  - digital preservation
  - ECOLM ([www.ecolm.org](http://www.ecolm.org))
- collaboration in crowd-sourcing
  - beta version announced last week
- emerging requirements
  - improving transcription
  - version alignment
  - searching
- **continuum between digital musicology as a skill and a subdiscipline**



## CHARM

- Centre for the History and Analysis of Recorded Music
  - 2004-2009
  - Nicholas Cook, Craig Sapp and many others
- Mazurka Project: pianists' timing of rubato
  - manually annotate beats
  - automatically create timescape plots
  - visualise tempo at different levels
- role in discovery of Joyce Hatto scam
  - over 100 recordings falsely attributed
  - [http://www.newyorker.com/reporting/2007/09/17/070917fa\\_fact\\_singer](http://www.newyorker.com/reporting/2007/09/17/070917fa_fact_singer)



from Sapp 2007



## Apologies again

- all the interesting work I haven't mentioned
- music21, Python module for music processing, <http://mit.edu/music21/>
- everything from McGill University, Montreal
  - Optical Music Recognition
  - SIMSSA ('Google Music minus Google')
  - Billboard Data Set
- Million Song Database
- many other things...



## Conclusions

- for computational/digital musicology
  - strangely unconnected to Digital Humanities
  - no lack of technological ingredients
  - find communities, study workpractices in musicology
- for Digital Humanities
  - vulnerability of technology in times of crisis/change
  - digitisation and storage less important than designing the automatic processing
  - fully-automatic processing often not feasible for complex humanities tasks
  - science and engineering can solve very difficult problems with very useful outcomes (as in audio research)
  - interest from science and engineering is good, but developing shared values is better



## Finally...

- if this has simulated your appetite
  - talk to me, e.g. about possibilities for internship
- if not, then in any case read this!

### MEL CEPSTRUM & ANN OVA: THE DIFFICULT DIALOG BETWEEN MIR AND MUSIC COGNITION

Jean-Julien Aucouturier & Emmanuel Bigand

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aucouturier@gmail.com; bigand@u-bourgogne.fr

- <http://ismir2012.ismir.net/event/papers/397-ismir-2012.pdf>



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