

A computational approach to the identification of folk tunes

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NWO
Nederlandse Organisatie voor Wetenschappelijk Onderzoek



Transcriptions



~ 6000 melodies

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Folk Song Melodies



At the Meertens Institute (Amsterdam):

Onder de groene linde: c. 7000 recordings from the Netherlands.
Recorded 1950s – 1980s by Will Scheepers and Ate Doornbosch.

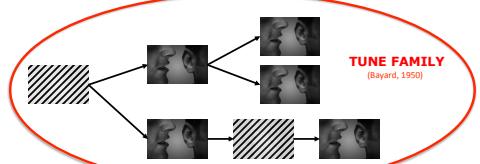


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Tune Families

Most important feature of folk songs: oral transmission.



TUNE FAMILY
(Bayard, 1950)

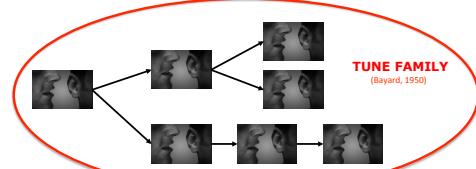
Melodies change, lyrics change.

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Tune Families

Most important feature of folk songs: oral transmission.



Melodies change, lyrics change.

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Folk Song Melodies

Example tune family: *Soldaat kwam uit de oorlog*

Record 72284 - Strophe 1



Record 72284 - Strophe 1



Record 72283 - Strophe 1



Record 72285 - Strophe 1



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Unknown melody

Daar was laastet een meis - je loos
Die wou gaan va - ren die wou gaan va - ren
Daar was laastet een meis - je loos
Die wou gaan va - ren al voor ma - troen.

Daar was laastet een meis - je loos
die wou gaan va - ren die wou gaan va - ren
daar was laastet een meis - je loos
die wou gaan va - ren als zee - ma - troos

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How to find related melodies?



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Dutch Song Database (liederenbank.nl)

song: Daar was laastet een meis - je loos
Artist: Onder de Grinde Lieden spraakmeestdard
Music: with musical notation
Recording: mp3
Melody: Name indication: standard name of this melody
Available: transcription
Source: OPRN DGL (Drie weken)
Title: Onder de Grinde Lieden spraakmeestdard
Category: Volkslied
City: Amsterdam NL; OPRN DGL
Description: Nederlandse Volkslied-Archief 32001
Performer: Meertens Institute
Recorder: Hanzing Boe, Aaltje
Recording: Gees (2-12-1987) By Aaltje Drentvecht

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Basic Question

How to compare two melodies automatically?

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Aim of the WITCHCRAFT-project

WITCHCRAFT-project

What Is Topical in Cultural Heritage;
Content-based Retrieval Among Folksong Tunes

Aim: develop a **music retrieval system** for folksong melodies

Interdisciplinary approach needed.

Collaboration: Utrecht University (Computer Science)
Meertens Institute (Ethnology / Musicology)

Team: Postdoc, Ph.D. Student, Scientific Programmer.
2006-2010

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Interdisciplinarity: three-role model



Role	Interest	Method
Music information retrieval	Music information systems	Computer science
Musicology	(Folk) music	Musicology
Computational musicology	(Folk) music	Computer science

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Computational Musicology

Tasks for Computational Musicology:

- Analyze musical concepts to derive implementable models.
- Design data structures for music
- Design algorithms for processing of musical data that are interpretable from a musical point of view (no black boxes).
- Man-in-the-middle between information science and musicology

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Research Cycle

1. Understanding the musical problem
 - Knowing relevant musical literature
 - Knowing relevant musical academic traditions
 - Knowing the specific discussion
2. Designing musically meaningful data-structures and algorithms: the computational model as hypothesis
3. Musical interpretation of the algorithmic output (where is the failure?)
4. Revision of the model (go back to 2)
5. Integration of the results in the musical discourses

Partly based on: McCarty, W. (2005). *Humanities Computing*. Basingstoke: Palgrave Macmillan.

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Formalization

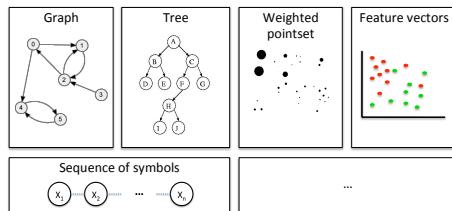
How to represent a musical artifact in a formal, machine-understandable way?

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Designing data-structures and algorithms

There are many **abstract** data structures. Some examples:

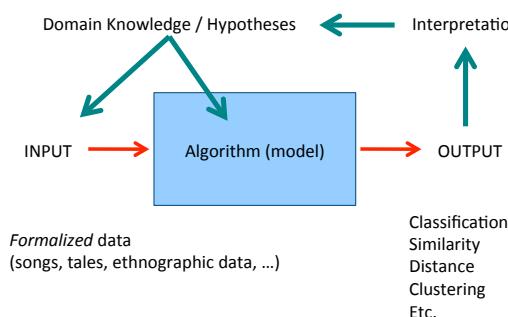


There are many algorithms that operate on these data structures.

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Computational Model



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Evaluation

Question: How to evaluate results of an algorithm?

Problematic

Common MIR/CS/AI approach:

1. Assemble example data, that shows **correct** results.
2. Compare the result of the algorithm with the examples.

"We asked a musicologist to provide ..."

Thus, an algorithm is evaluated concerning its ability to **reproduce** the ground-truth instead of **understanding** it (lack of interdisciplinarity).

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Evaluation

Question: How to evaluate results of an algorithm?

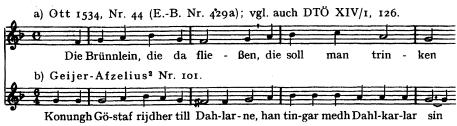
Study *both* the algorithmic output and the data.

E.g., confront the algorithmic output with (observational) data and study the differences. Adapt the model (or the data) accordingly.

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Comparing Melodies

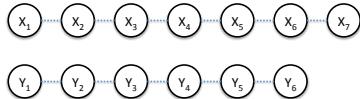


Wiora, W. (1941). Systematik der musikalischen Erscheinungen des Umsingens. *Jahrbuch für Volksliedforschung*, 7, 128–195.

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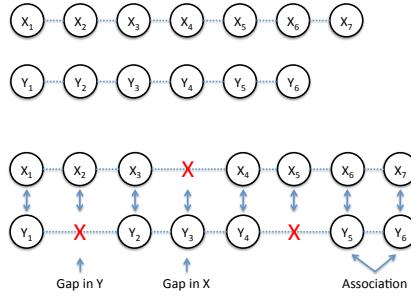
Alignment



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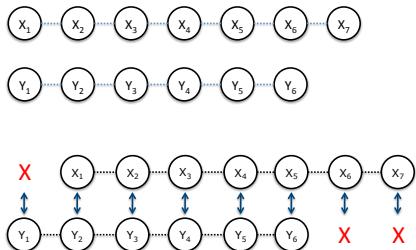
Alignment



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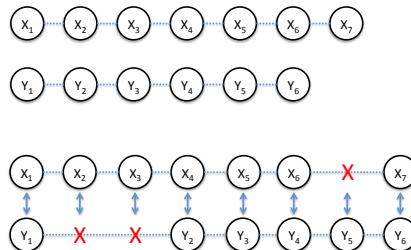
Alignment



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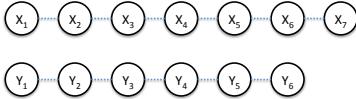
Alignment



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Best Alignment?

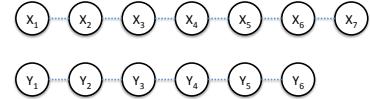


Which is the best / desired alignment?

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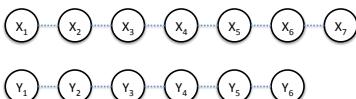
Alignment



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Best Alignment?



Which is the best / desired alignment?

Assign scores to associations and gaps.

The best alignment is the one with the highest score.

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Alignment Algorithm

There is an algorithm that given

- two sequences of symbols
- a association scoring function
- a gap scoring function

finds the optimal alignment efficiently.

Needleman, S. B. & Wunsch, C. D. (1970). A general method applicable to the search for similarities in the amino acid sequence of two proteins. *Journal of Molecular Biology*, 48 (3), 443–453.

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Alignment of Melodies

One way of doing it



Symbols:

Pitch:	a ¹	b ¹	c ²	d ²	e ²	f ²	g ²	a ²	d ³
Duration:	1/4	1/8	1/4	1/4	1/8	1/8	1/8	1/4	1/4
Scoretime:	0	1/4	3/8	2/4	3/4	4/4	9/8	5/4	
Start:	0	1/4	3/8	2/4	3/4	4/4	9/8	5/4	1/4
Onset:	0	2	3	4	6	8	9	10	
Bar:	0	0	1	1	2	2	2	2	0
Phase:	0	0	1	2	2	2	2	2	0
Offbeat:	false								
Metric weight:	2/4	2/4	2/4	2/4	2/4	2/4	2/4	2/4	2/4
Free meter:	true	false							
Accented:	true	false	false	true	false	true	false	false	false
IOI ratio:	[1]	0.5	2	1	0.5	2	0.5	2	
Metric weight:	0.453	0.382	0.453	0.382	0.453	0.382	0.453	0.382	0.453
Phraseweight:	0	0.2	0.3	0.4	0.6	0.8	0.9	1	

X₁ X₂ ... X₈

Scoring: The better the pitch, the metric weight and the position within the phrase correspond, the higher the association score.
Gap penalty is affine.

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Alignment of Melodies



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Alignment of Melodies



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Employ alignment for Retrieval

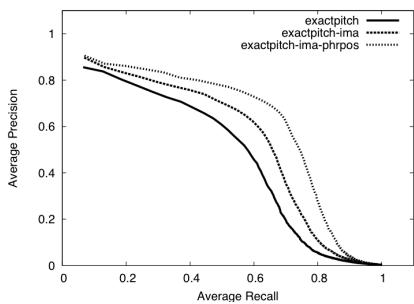
1. Compute alignment scores of all melodies to the query melody.
2. Sort all melodies according to these distances.

We test with 360 melodies in 26 tune families within a larger corpus of 4480 melodies.

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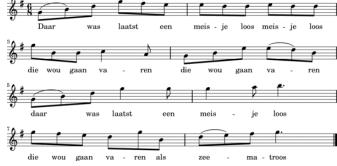
Average Precision-Recall



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Unknown melody



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Integration in Dutch Song Database

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Integration in Dutch Song Database

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Thank you