
On Operationalizing the Musicological Concept of Tune Family for Computational Modeling

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Contents

- Introduction
- The WITCHCRAFT-project
- Research questions
- Interdisciplinary collaboration
- Research cycle for computational research
- Incorporating musical knowledge into abstract algorithms and data structures
- Concrete results from the WITCHCRAFT-project



Folk Song Melodies



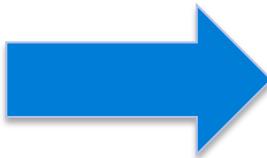
At the Meertens Institute (Amsterdam):

Onder de groene linde: c. 7000 recordings.

Recorded 1950s – 1980s by Will Scheepers and Ate Doornbosch.



Transcriptions



NLB004456_01.wce

Meta Signature Score Header Footer Comments Excel Script

r4	r4	g4 Het	g2 voe --	g4 der	g2 hoort	d4 den	f2 e --	e4 zel	d2. toe
a'4 ghees --	a sel	bes en	c2 last	bes4 daer	g be --	a2 ne --	g2. ven		
r4	r4	g4 Den	g2 knecht	g4 dat	g2 hy	d4 hem	f2 ar --	e4 beyt	d2. moe
a'4 die	a sy	bes hem	c2 broot	bes4 oock	g ghe --	a2 ghe --	g2. ven		

Lilypond Output Logs PDF

Begin End All

```
\version "2.8.2"
mBreak = { \bar "" \break }
x = { \once\override NoteHead #'style = #'cross }
\set glissando
ficta = { \once\set suggestAccidentals = ##t }
sb = { \breath }
fine = { \once\override Score.RehearsalMark #'self-alignment-X = #1 \mark \markup {\italic(Fine)} }
```

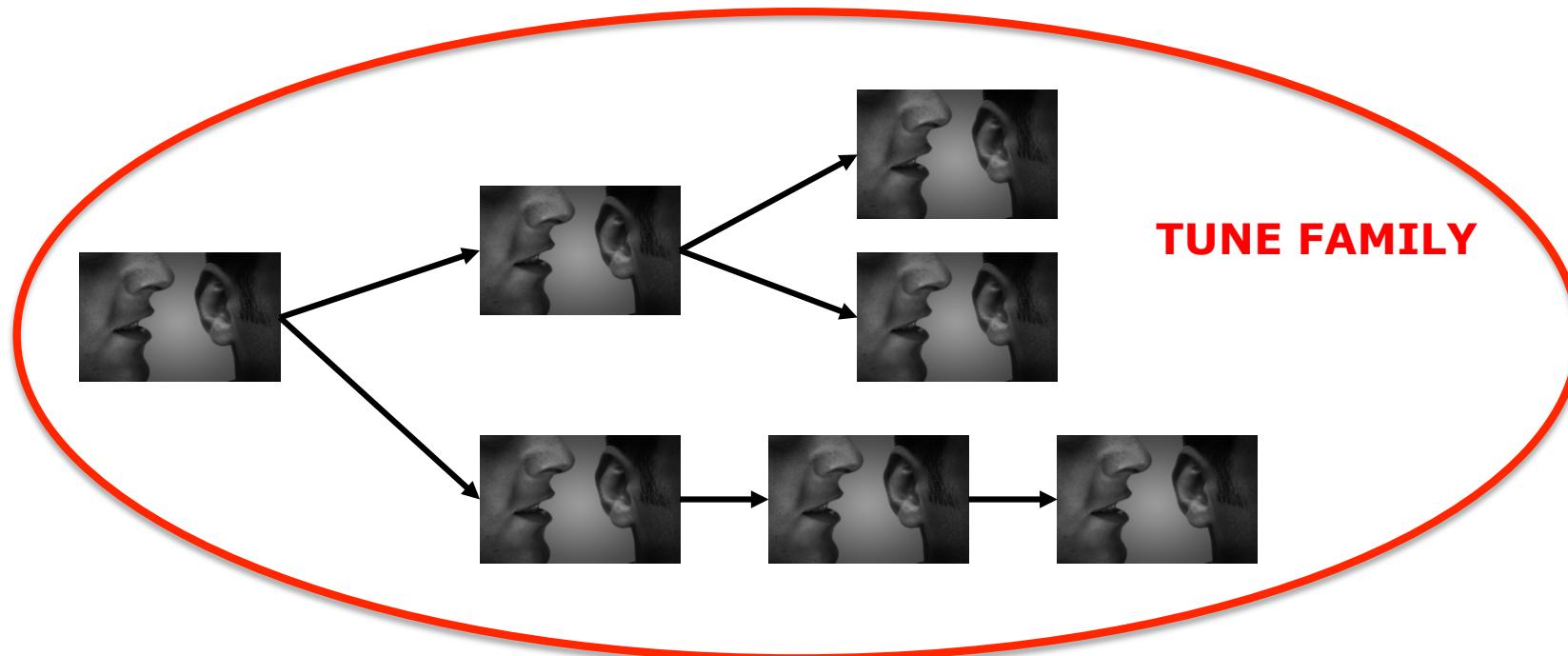
Update from Excel Update All Drawer



~ 7500 melodies

Tune Families

Most important feature of folk songs: oral transmission.



Melodies change, lyrics change.

Folk Song Melodies

Example tune family: *Soldaat kwam uit de oorlog*

Record 72103 - Strophe 1

Musical notation for Record 72103, Strophe 1. The music is in G major, 6/8 time. The lyrics are: Sol - daat kwam uit den oor - log en hoe - ra.



Record 72283 - Strophe 1

Musical notation for Record 72283, Strophe 1. The music is in G major, 6/8 time. The lyrics are: Sol - daat kwam uit den oor - log weer en hoe - ra.



Record 72284 - Strophe 1

Musical notation for Record 72284, Strophe 1. The music is in G major, 6/8 time. The lyrics are: Sol - daat kwam uit den oor - log en hoe - ra.



Record 72285 - Strophe 1

Musical notation for Record 72285, Strophe 1. The music is in G major, 6/8 time. The lyrics are: Sol - daat die kwam bui - ten den oor - log en hoe - ra.



Unknown melody



Daar was laatst een meis - je loos

Die wou gaan va - ren die wou gaan va - ren

Daar was laatst een meis - je loos

Die wou gaan va - ren al voor ma - troos.



Daar was laatst een meis - je loos meis - je loos

die wou gaan va - ren die wou gaan va - ren

daar was laatst een meis - je loos

die wou gaan va - ren als zee - ma - troos



How to find related melodies?



Dutch Song Database

Dutch Song Database

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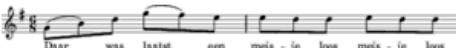
Dutch Song Database stanza search



song:

first line: Daar was laatst een meisje loos meisje loos
text norm: Daar was laatst een meisje loos

*all songs with this text
(92 songs & extra informatie)*

music: with musical notation

Daar was laatst een meis - je loos meis - je loos

find similar melodies 

recording: mp3
available: transcription

melody **tune indication:** **standard name of this melody:** Het was laatst op een zomerdag ↓
*all songs sung to this melody
(20 songs)*

source:

siglum: OPN OGL (20e eeuw)
title: Onder de Groene Linde: opnamebestand
song number: 29806
copy used: Amsterdam MI: OPN OGL
transcription number: Nederlands Volkslied-Archief 32001
singer: Huizing-Bos, Aaltje
recording: Gees 02-12-1967 by Ate Doornbosch

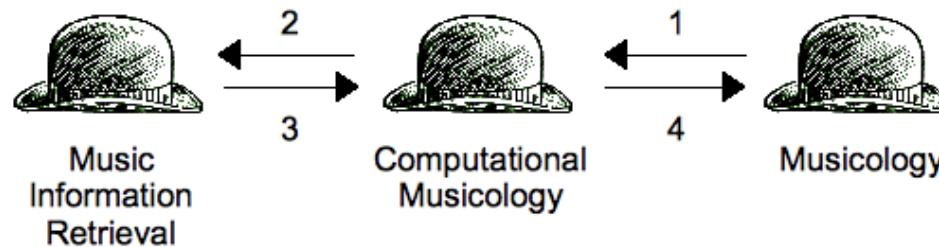
Aim of WITCHCRAFT

Develop a music retrieval system for folksong melodies

- Fully-functional
- Audio and music notation
- Building on best practices of Music Retrieval

Interdisciplinary approach needed.

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

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

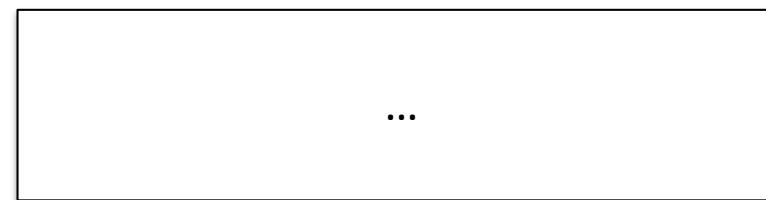
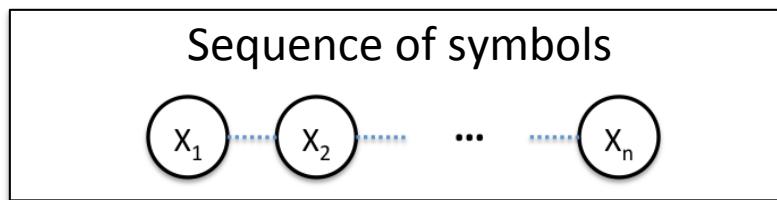
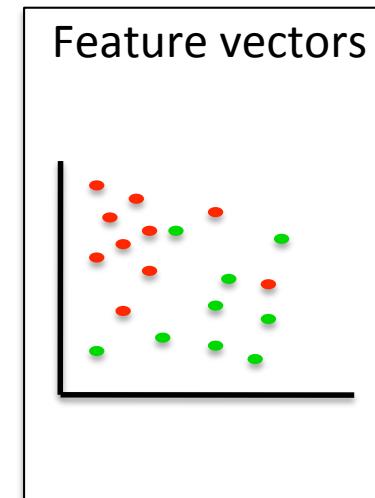
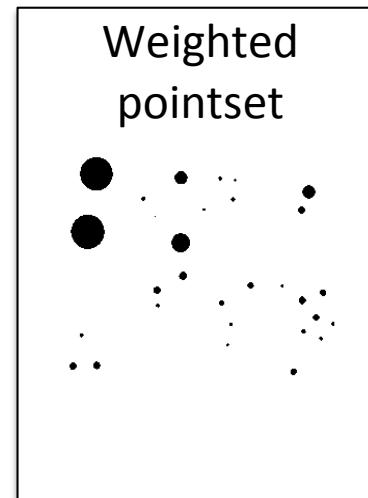
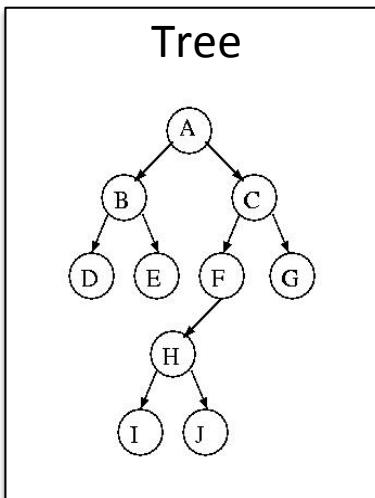
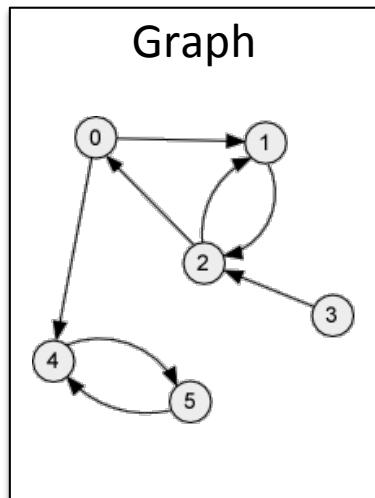
Research Cycle

1. Understanding the musical problem
 - Knowing relevant musicological literature
 - Knowing relevant musicological 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 musicological discourses

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

Designing data-structures and algorithms

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



There are many algorithms that operate on these data structures.

Evaluation

Question: How to evaluate results of an algorithm?

Common MIR/CS/AI approach:

1. Assemble ground-truth data, which is **the correct result**.
2. Compare the result of the algorithm with the ground-truth.

Problematic

“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).

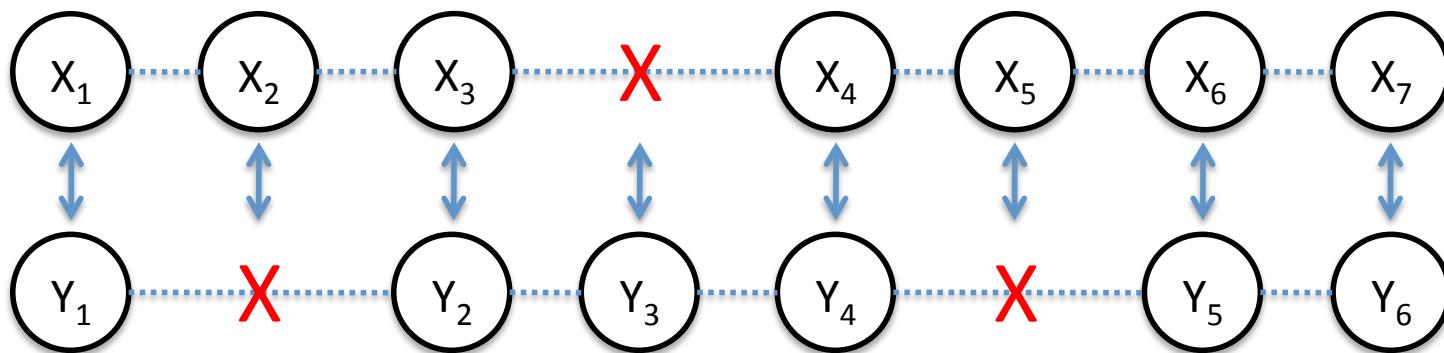
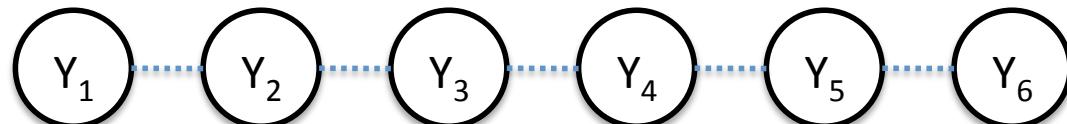
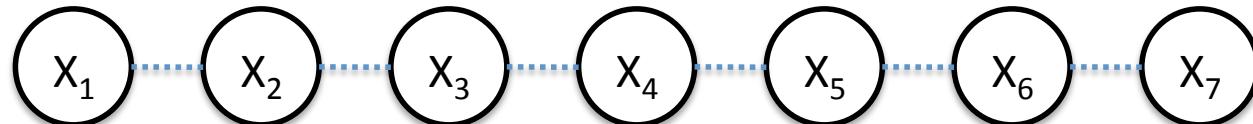
Evaluation

Question: How to evaluate results of an algorithm?

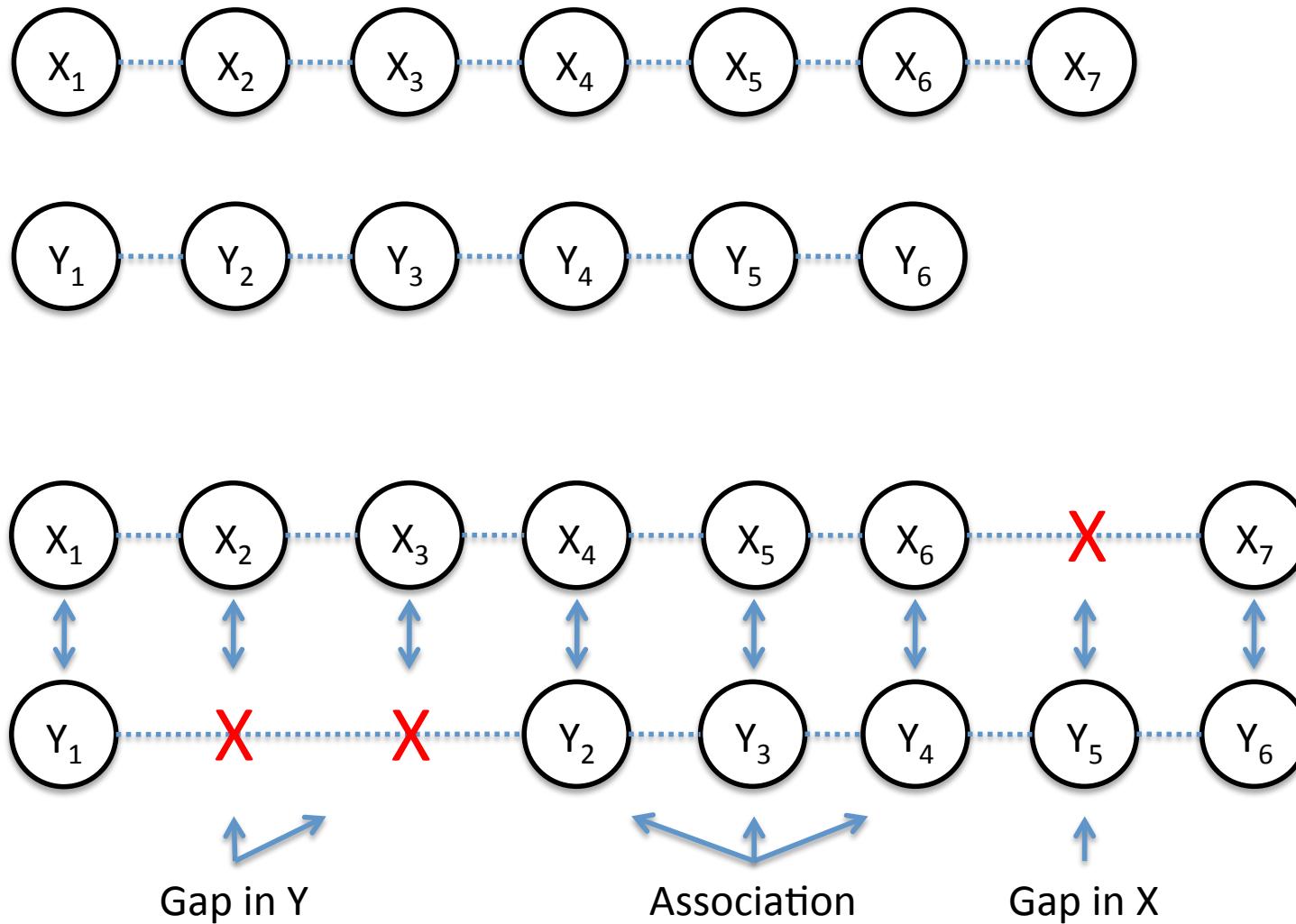
Study *both* the algorithmic output and the data.

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

Alignment



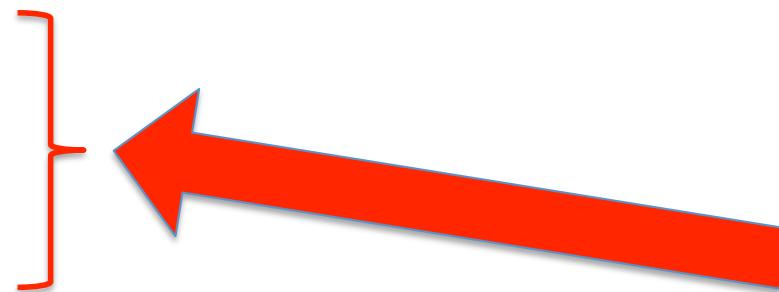
Alignment



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.

Alignment of Melodies

One way of doing it

Symbols:

Pitch:	a ¹	b ¹	c ²	d ²	e ²	f ²	e ²	d ²
Duration:	1/4	1/8	1/8	1/4	1/4	1/8	1/8	1/4
Scoretimetime:	0	1/4	3/8	2/4	3/4	4/4	9/8	5/4
BarTime:	0	1/4	3/8	0	1/4	0	1/8	1/4
Onset:	0	2	3	4	6	8	9	10
Bar:	0	0	0	1	1	2	2	2
Phrase:	0	0	0	0	0	0	0	0
Upbeat:	false							
Meter:	2/4	2/4	2/4	2/4	2/4	2/4	2/4	2/4
Free meter:	false							
Accented:	true	false	false	true	false	true	false	false
IOI ratio:	[1]	0.5	1	2	1	0.5	1	2
Metr. weight:	1	0.853	0.382	0.853	1	0.853	0.382	0.853
Phrasepos:	0	0.2	0.3	0.4	0.6	0.8	0.9	1

$X_1 \quad X_2 \quad \dots \quad X_8$

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

Alignment of Melodies

Record 70089 - Strophe 1

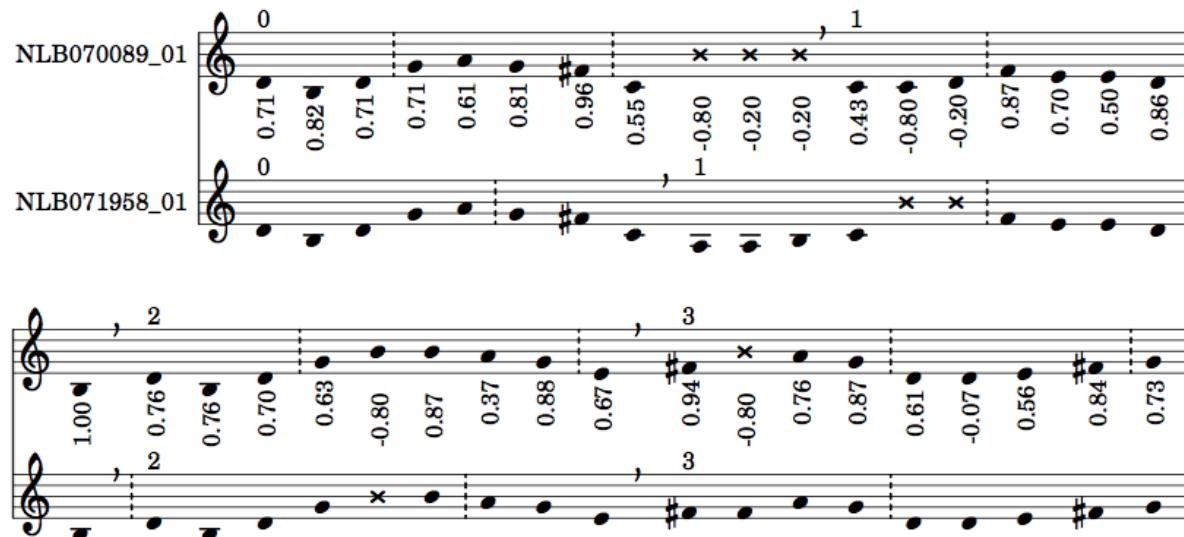
Musical notation for Record 70089 - Strophe 1. The melody is in common time (indicated by 'C') and G major (indicated by a sharp symbol). The lyrics are:

De den - ne - boom stond eens in't dal
van on - dren breed van bo - ven smal
daar on - der zat in stil - le vreugd
een min - nend paar vol liefd' en deugd.

Record 71958 - Strophe 1

Musical notation for Record 71958 - Strophe 1. The melody is in common time (indicated by 'C') and G major (indicated by a sharp symbol). The lyrics are:

't Was op een koe - len zo - mer - dag
toen ik in het bos een scha - duw zag
't Was op een koe - len zo - mer - dag
toen ik in het bos een scha - duw zag

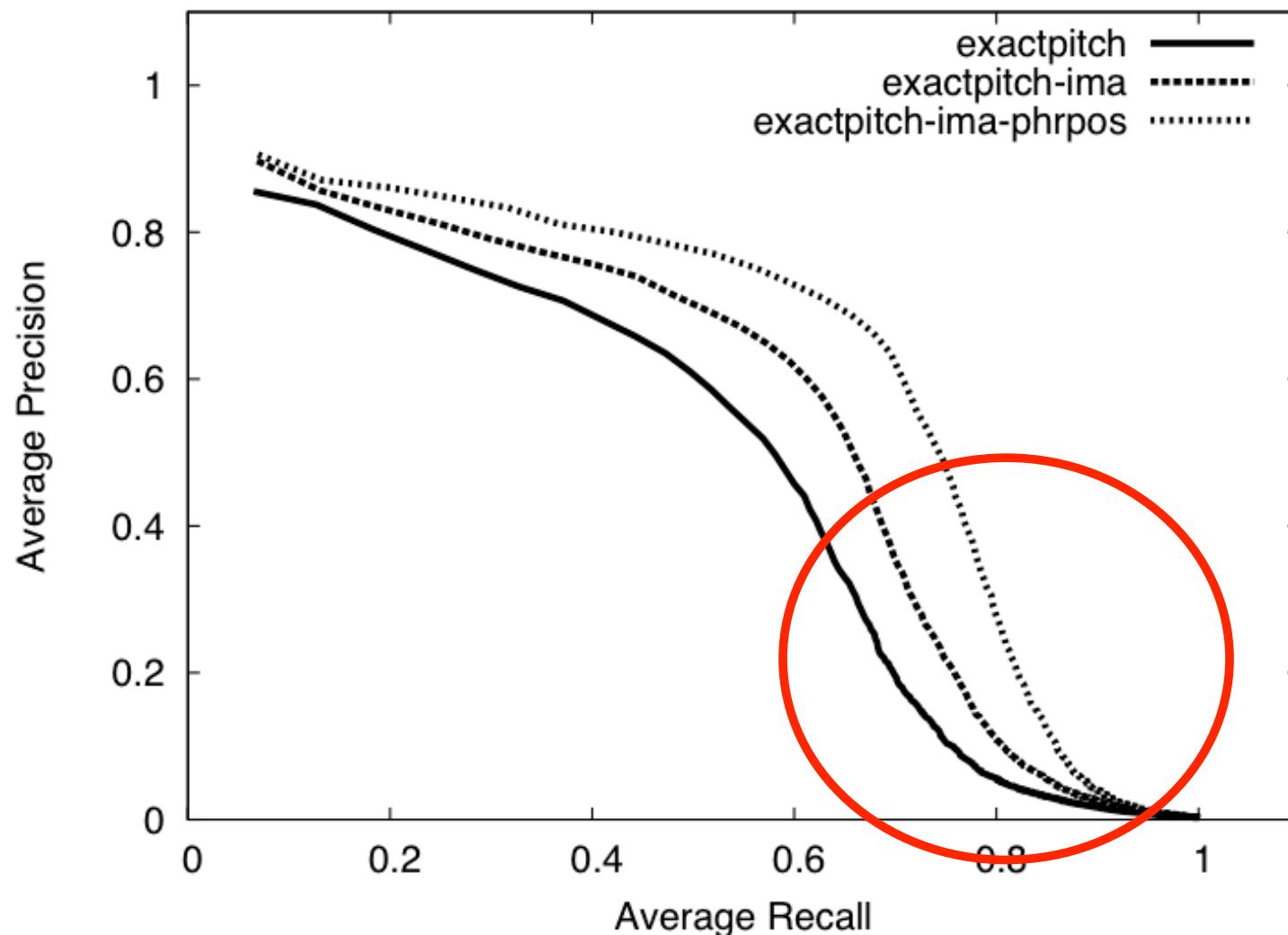


Employ alignment for Retrieval

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.

Average Precision-Recall



False Negatives

Song ID	Tune Family	Median rank	Average similarity rating
15569_01	Maagdje	49.5	1.208
70078_01	Stavoren	755	1.08
71666_01	Maagdje	331	1.417
71957_03	Ruiter 1	4157	0.733
72253_01	Halewijn 4	849	0.867
72851_01	Ruiter 1	3672.5	0.55
72851_02	Ruiter 1	3433	0.8
73277_01	Boom	1249	1.267
73929_01	Jonkheer	599.5	0.917
74603_01	Halewijn 4	984.5	0
75525_01	Stil	1518.5	1.033
76271_01	Vrouwltje	72.5	1.625
76495_01	Femmes	867.5	1.333

False Negatives

Use the problematic song as query

Song ID	Tune Family	Median rank	Average similarity rating
15569_01	Maagdje	49.5	1.208
70078_01	Stavoren	755	1.08
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False Negatives

Reconsider tune family membership

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15569_01	Maagdje	49.5	1.208
70078_01	Stavoren	755	1.08
71666_01	Maagdje	331	1.417
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Problematic Songs

111 hard to classify songs

42 classified

32 relation found

37 no related melodies found

Unknown melody

The musical notation consists of four staves of music in G major, 6/8 time. The lyrics are written below each staff:

Daar was laatst een meis - je loos meis - je loos

die wou gaan va - ren die wou gaan va - ren

daar was laatst een meis - je loos

die wou gaan va - ren als zee - ma - troos



Integration in Dutch Song Database

Dutch Song Database

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Dutch Song Database stanza search

song:
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title: Onder de Groene Linde: opnamebestand
song number: 29806
copy used: Amsterdam MI: OPN OGL
transcription: Nederlands Volkslied-Archief 32001
number:
singer: Huizing-Bos, Aaltje
recording: Gees 02-12-1967 by Ate Doornbosch

Integration in Dutch Song Database

Dutch Song Database

www.liederenbank.nl/resultaatlijst.php?recordids=73946,72754,74104,72607,743

engine based on the WITCHCRAFT prototype.

1-30 of 97

first next 30 last map

Daar was laatst een meisje loos meisje loos

OPN OGL 29806: recording Gees 1967

Het was laatst op een zomerdag

mp3
transcr.

Het was laatst op een zomerdag

OPN OGL 21934: recording Rockanje 1959

Het was laatst op een zomerdag

mp3
transcr.

Het was op een oudejaarsavond laat avond laat

OPN OGL 30819: recording Groningen 1968

Het was laatst op een zomerdag

mp3
transcr.

Er was een ruiter al met zijn meid

OPN OGL 21210: recording Onderdendam 1965

De ruiter met zijn blanke zwaard (3)

mp3
transcr.

Dicht bij de Leek en daaromtrent

OPN OGL 32415: recording Rottevalle 1968

Het was laatst op een zomerdag

mp3
transcr.

Daar woonde een meisje op het land op het land

OPN OGL 31305: recording Nieuwe Pekela 1968

Het was laatst op een zomerdag

mp3
transcr.

Dichter bij Nijveenstermond omtrent -mond omtrent

OPN OGL 41106: recording Nieuw-Dordrecht 1973

Het was laatst op een zomerdag

mp3
transcr.

The screenshot shows a window titled 'Dutch Song Database' with a list of songs. Each song entry includes the title in red, a recording note, and two links for 'mp3' and 'transcr.'. To the right of each title is a small musical note icon. The application has a menu bar at the top and a sidebar on the left with navigation buttons like 'first', 'next 30', 'last', and 'map'. The main area contains ten song entries, each with a title, recording details, and a musical notation snippet below it.

Thank you