



# Melodic Search: Strategies and Formats



CS 275B/Music 254

# On melody

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- ▶ What is a **theme**?
- ▶ What is an **incipit**?
- ▶ Are all themes incipits?
- ▶ Can you tell the key from a melody?
- ▶ Can you tell whether something you hear begins at the beginning?
- ▶ Is melody one-dimensional?
- ▶ How can we isolate a melody algorithmically?

# On melody

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- ▶ What is a **theme**? Significant content that identifies a piece
- ▶ What is an **incipit**? Opening phrase
- ▶ Are all themes incipits? No
- ▶ Can you tell the key from a melody? Sometimes
- ▶ Can you tell whether something you hear begins at the beginning? ??
- ▶ Is melody one-dimensional?
- ▶ How can we isolate a melody algorithmically?

# Imported search strategies

# Imported search strategies

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- Probability ranking
- Sorting, clustering, categorization
- String matching, edit distance
- N-grams
- Dynamic programming
- Pattern detection

# Probability ranking

“Query-by-humming”: work of Lloyd Smith et al, c. 1995.

The screenshot shows a Netscape browser window titled "Netscape: Tune Matches: 1-10". The browser's address bar shows the URL "http://www.nzdl.org/cgi-bin/gw". The page content is from "THE NEW ZEALAND DIGITAL LIBRARY" and features the "MELOdy inDEX" logo. A musical notation of a melody is displayed, with the text "What you sang" and "What I heard" below it. The "QUERY RESULTS" section states "Your melody matched 77 tunes". A table lists the top matches:

Tune	Database	Match
Auld Lang Syne	North American	100%
The Bonny Lass of Fyvie	North American	100%
A Bhàrd Mòr Bhràasach, S. 36	Irish	90%
A Peel Such As I	North American	90%
A Man's a Man For All That	North American	90%
Allèluia	North American	90%
BONEY	North American	90%
Ballad of Richard III	North American	90%
Banks of Allan Water	North American	90%
Before They Close the Minstrel Show	North American	90%

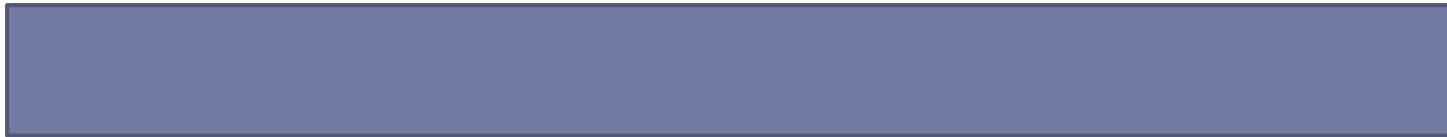
In the background, another window shows the "RealAudio Player" interface, displaying the title "Auld Lang Syne" and the author "Auld Lang Syne".

Example: MELDEX

# Melodic sorting (incipits)

[Ranking??]

Examples from RISM



John Howard, "Strategies for sorting melodic incipits," CM 11 (1998).

# Edit distance: text

## 1. Item-by-item comparison

## 2. Penalties for

- substitutions
- insertions
- deletions

Bag  
Bat  
Cat  
Catch

Target=**bag**  
Matches=**bag**, Bag, BAG  
Non-matches [different order]=gab, abg, bga  
  
Direction of comparison=**L**→**R**  
Match=**L**→**R**  
Non-matches [different direction]=**R**→**L**; **T**→**B**; **B**→**T**;  
**ZZ**  
  
Literal content required for match=**bag**  
Matches=**bag**gage, cab**bag**e  
Non-matches [different literal content]=beagle, bang, bad  
and good



# Edit distance (music)

## Ambiguities

- iteration (accent invariant)
- polyphonic involvement
- decoration (accent invariant)

Target=b a g

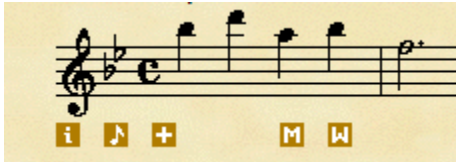
Sound matches:



Symbolic matches:



# N-grams



Beethoven: Archduke Trio

## Method

Pick a string length  
Seek all its permutations

### IMSLP Music Search by Peachnote



Please enter a melody or a sequence of [chords \(advanced use\)](#)



58 4 -5 1 -5

melody

Search

Petrucci Music Library

Smoothing: 0

☐ Normalized



[Keyboard shortcuts](#)

filter search results (e.g. Mozart, winds, or quartet)

6 Capricen, Op.27  
**Kirchner, Theodor** (1877)

[YouTube](#) [score](#) pages 1,6

6 Partitas  
**Bach, Johann Sebastian** (1726)

[YouTube](#) [score](#) page 7  
[score](#) page 5  
[score](#) page 10

Piano Trio No. 7 in B-flat major  
**Beethoven, Ludwig van** (1811)

[YouTube](#) [score](#) page 1  
[score](#) page 1  
more ...

Piano Trio  
**Pienné, Gabriel** (1920)

[YouTube](#) [score](#) page 1  
[score](#) pages 2,4,10  
[score](#) page 4

Antigone  
**Mendelssohn, Felix** (1841)

[YouTube](#) [score](#) pages 31,34,35

Giulio Cesare in Egitto  
**Handel, George Frideric** (1724)

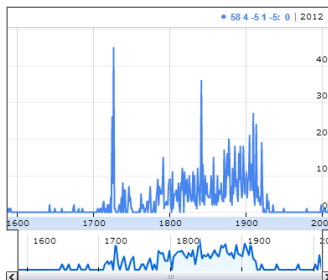
[YouTube](#) [score](#) page 26  
[score](#) page 12  
more ...

The Nutcracker  
**Tchaikovsky, Pyotr** (1892)

[YouTube](#) [score](#) page 8  
[score](#) page 51  
more ...

Symphony No. 9 in D minor  
**Bruckner, Anton** (1896)

[YouTube](#) [score](#) page 23  
[score](#) page 2  
more ...



### Duke University Library Music Search by Peachnote



Please enter a melody or a sequence of [chords \(advanced use\)](#)



58 4 -5 1 -5

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[Keyboard shortcuts](#)

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My old home and friends  
**Cory Brothers** (1874)

[YouTube](#) [score](#) page 3

Huckleberry Finn cake walk; Two-step  
**Jos. Morris** (1900)

[YouTube](#) [score](#) page 3

Fishing for the moon; Green bird  
**empire Music** (1907)

[YouTube](#) [score](#) page 5

Mandy's ragtime waltz  
**Sam Fox** (1912)

[YouTube](#) [score](#) page 6

Dreaming dreams of you  
**Hamilton S. Gordon** (1913)

[YouTube](#) [score](#) page 4

Down among the sheltering palms  
**Leo Feist** (1915)

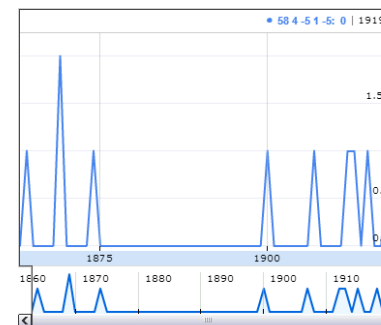
[YouTube](#) [score](#) page 2

When the good Lord makes a record of a heros' deed he draws no color line  
**M. Witmark & Sons** (1918)

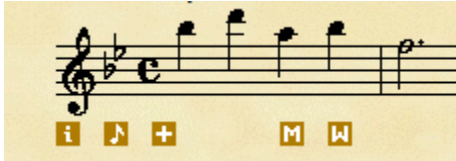
[YouTube](#) [score](#) page 4

[next](#)

you can also browse using the chart



# N-grams



## IMSLP Music Search by Peachnote



Please enter a melody or a sequence of [chords \(advanced use\)](#)



58 4 -5 1 -5 melody Search  
Petrucchi Music Library Smoothing: 0 Normalized



[Keyboard shortcuts](#)

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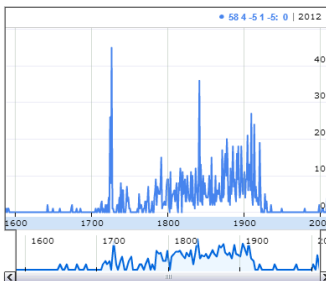
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Please enter a melody or a sequence of [chords \(advanced use\)](#)



58 4 -5 1 -5 melody Search  
Duke University Library Smoothing: 0 Normalized



[Keyboard shortcuts](#)

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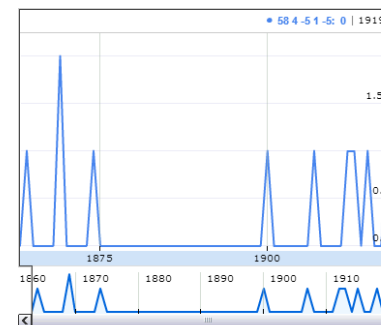
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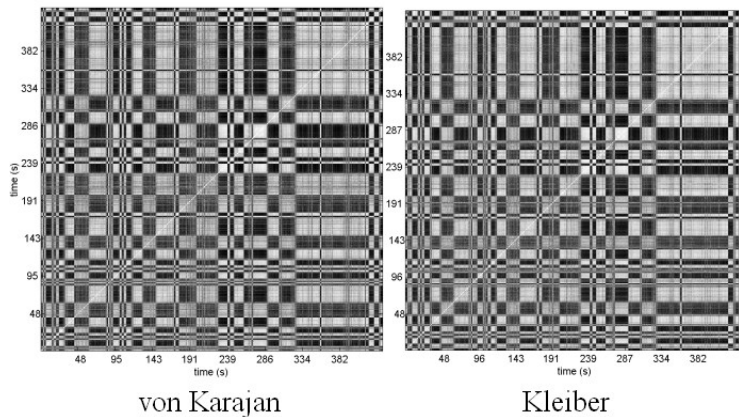
[next](#)

you can also browse using the chart



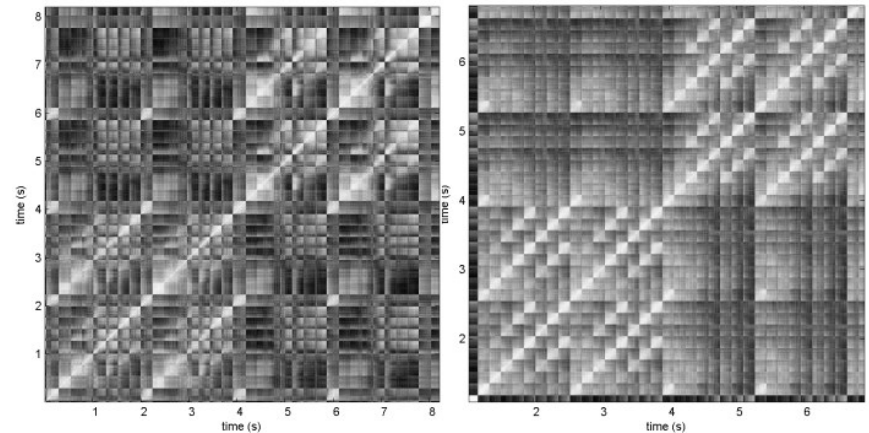
# Dynamic programming

Example: 2 performances of Beethoven's  
*Symphony No. 5*



Examples: Jonathan Foote

Example: Bach



Glenn Gould



MIDI



Rhythmic similarity

Performance-based  
self-similarity matrices

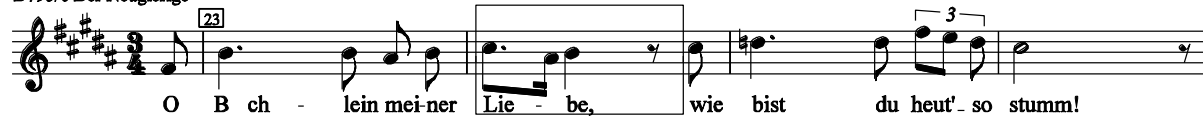
# Pattern detection

# Pattern detection

## Settings of the word "Liebe"

Nettheim: MuSearch (SCORE)

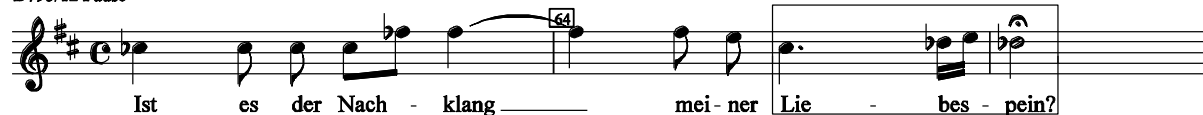
D795/6 Der Neugierige



D795/9 Des M llers Blumen



D795/12 Pause



D795/19 Der M ller und der Bach



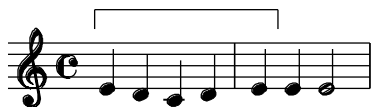
### Pattern realms

- Lyrics
- Pitch
- Duration
- Phrase structure

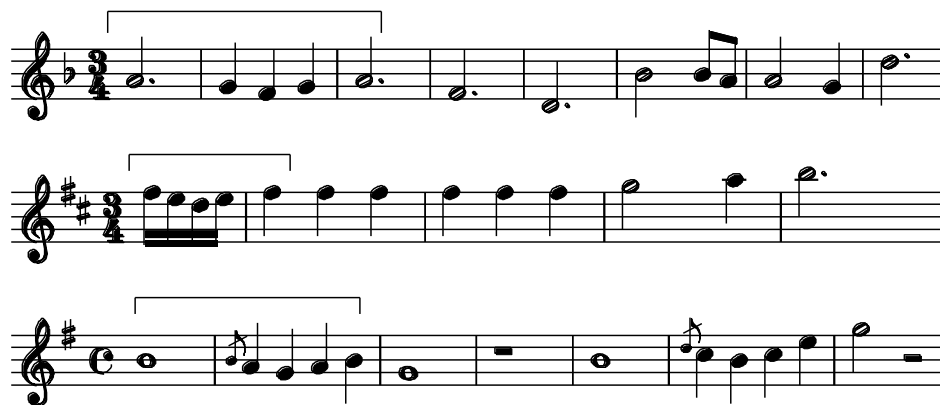
# Vulnerabilities

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Query



Target (scale degree): 32123

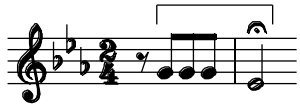


Pitch (scale-degree) matching without **rhythmic, metric invariance**

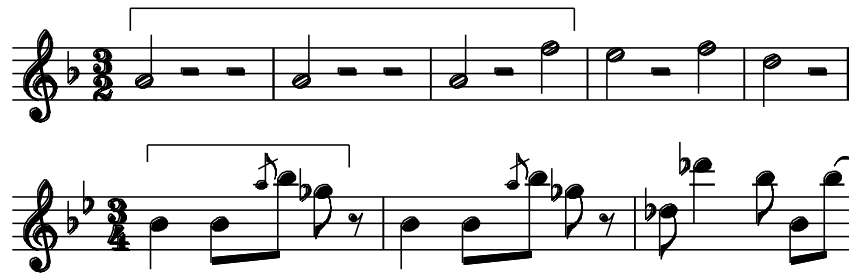
# Vulnerabilities

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Query



Target: 3331



Pattern-matching without:

- Rests
- Register considerations
- Repeated notes



A vertical blue bar is located on the left side of the slide, partially overlapping the title box.

# Themefinder

A search application for melodic data

# Themefinder

**Themefinder**  
[ [About](#) | [Search options](#) | [Help](#) ]  
[ [New Links](#) | [Composers](#) | [Random](#) ]

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[Take the Quartet Quiz.](#)

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

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[Center for Computer Assisted Research in the Humanities](#)

Classical = themes  
Folk = incipits  
Renaissance = incipits

# Search examples

...in decreasing order of precision



pitch: D A G F E D D D D D D C#

interval: +P5 -M2 -M2 -m2 -M2 +P8 P1 P1 P1 P1 P1 -m2

scale degree: 1 5 4 3 2 1 1 1 1 1 1 7

gross contour: / \ \ \ \ / - - - - - \

refined contour: U d d d d U s s s s s s d

<http://www.themefinder.org>

# Thought for the day

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- ▶ “The dictionary describes melody as a series of notes strung together in a *meaningful* sequence.”

Source: U.S. Patent application  
20060254411 (Nov. 16, 2006)