



# 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
- ▶ What is an **incipit**? Beginning phrase
- ▶ 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?

# Non-musical search strategies

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- Probability ranking
- Sorting and 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 address bar shows the URL "http://www.nzdl.org/cgi-bin/gw". The page is titled "THE NEW ZEALAND DIGITAL LIBRARY The University of Waikato" and "MELOdy inDEX". It features a musical notation input area with the text "What you sang" and "What I heard". Below this, 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 Bhreathnach Bhéasach, S. 36	Irish	90%
A Fool Such As I	North American	90%
A Man's a Man For All That	North American	90%
Alleluia	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%

On the left side of the browser window, there is a sidebar with sections: "of sample" (with a "help" link), "collections" (with links for "an (and British) folksongs", "is and folksongs", and "and provincial songs"), and "r query" (with a "50 hits with 10 hits per page" and a "Search" button). A "RealAudio Player" window is overlaid on the bottom left, showing the title "Auld Lang Syne" and the author "Auld Lang Syne".

Example: MELDEX

# Melodic sorting (incipits)

[Ranking??]

Examples from RISM



The image displays five musical staves illustrating melodic sorting (incipits). The first three staves are in treble clef with a key signature of one sharp (F#) and a common time signature (C). The first staff is a single line. The second and third staves are connected by a blue double-headed arrow, indicating a comparison or relationship. The fourth staff is highlighted with a light blue background and is in treble clef with a key signature of one flat (Bb) and a 2/4 time signature. The fifth staff is highlighted with a light brown background and is in treble clef with a key signature of one sharp (F#) and a common time signature (C).

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  
Petrucchi Music Library Smoothing: 0 Normalized



[Keyboard shortcuts](#)

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

6 Capricen, Op.27 [YouTube](#) [score](#) pages 1,6

Kirchner, Theodor (1877)

6 Partitas [YouTube](#) [score](#) page 7

Bach, Johann Sebastian (1726) [score](#) page 5

[score](#) page 10

Piano Trio No. 7 in B-flat major

Beethoven, Ludwig van (1811)

Piano Trio [YouTube](#) [score](#) page 1

Pienné, Gabriel (1920) [score](#) pages 2,4,10

[score](#) page 4

Antigone

Mendelssohn, Felix (1841)

Giulio Cesare in Egitto [YouTube](#) [score](#) page 26

Handel, George Frideric (1724) [score](#) page 12

[more ...](#)

The Nutcracker [YouTube](#) [score](#) page 8

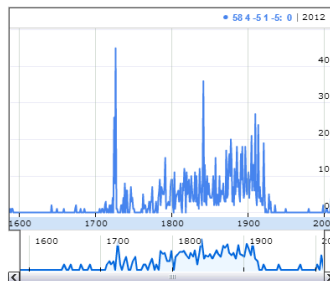
Tchaikovsky, Pyotr (1892) [score](#) page 51

[more ...](#)

Symphony No. 9 in D minor [YouTube](#) [score](#) page 23

Bruckner, Anton (1896) [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 melody Search  
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[Keyboard shortcuts](#)

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

My old home and friends [YouTube](#) [score](#) page 3

Cory Brothers (1874)

Huckleberry Finn cake walk; Two-step [YouTube](#) [score](#) page 3

Jos. Morris (1900)

Fishing for the moon; Green bird [YouTube](#) [score](#) page 5

empire Music (1907)

Mandy's ragtime waltz [YouTube](#) [score](#) page 6

Sam Fox (1912)

Dreaming dreams of you [YouTube](#) [score](#) page 4

Hamilton S. Gordon (1913)

Down among the sheltering palms [YouTube](#) [score](#) page 2

Leo Feist (1915)

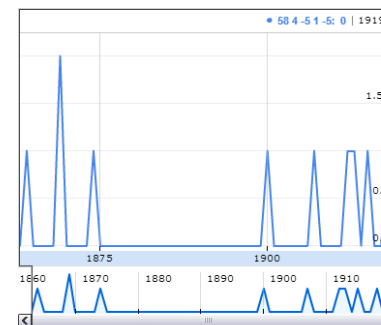
When the good Lord makes a record of a heros' [YouTube](#) [score](#) page 4

deed he draws no color line

M. Witmark & Sons (1918)

[next](#)

you can also browse using the chart



# N-grams

## Music n-gram viewer

<http://www.peachnote.com/datasets.html>



The first line tells us that in 1804, the melody occurred 94 times overall.

The format of the total counts file is identical, except that the `ngram` field is absent: there is only one value `match_count` per year.

Inside each file the `norams` are sorted alphabetically and then chronologically.

### IMSLP Music Search by Peachnote



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



5 8 4 -5 1 -5 melody Search  
Petrucchi 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 6  
[score](#) page 10

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

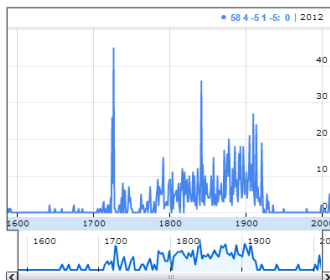
Piano Trio  
Piermé, Gabriel (1920) [YouTube](#) [score](#) page 1  
[score](#) pages 2,4,10  
[score](#) page 4

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 61  
more ...

Symphony No. 9 in D minor  
Bruckner, Anton (1896) [YouTube](#) [score](#) page 2  
more ...



### Duke University Library Music Search by Peachnote



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



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Duke University Library Smoothing: 0 Normalized



Keyboard shortcuts

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My old home and friends  
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Fishing for the moon; Green bird  
empire Music (1907) [YouTube](#) [score](#) page 5

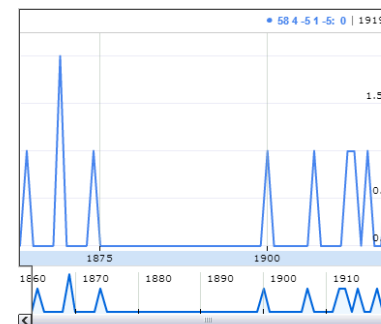
Mandy's ragtime waltz  
Sam Fox (1912) [YouTube](#) [score](#) page 6

Dreaming dreams of you  
Hamilton S. Gordon (1913) [YouTube](#) [score](#) page 4

Down among the sheltering palms  
Leo Feist (1915) [YouTube](#) [score](#) page 2

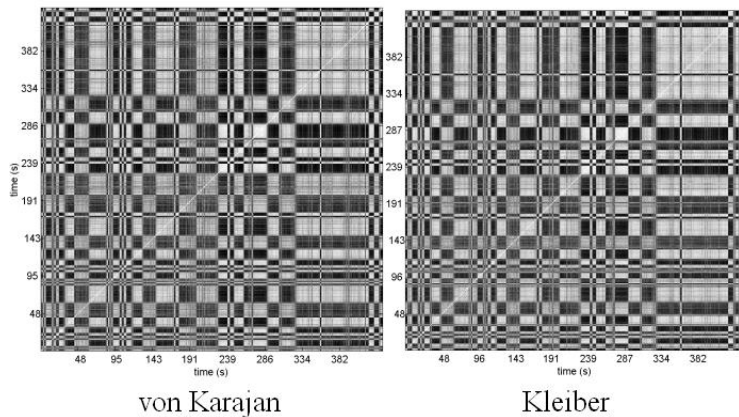
When the good Lord makes a record of a heros' deed he draws no color line  
M. Witmark & Sons (1918) [YouTube](#) [score](#) page 4

[next](#)  
you can also browse using the chart



# Dynamic programming

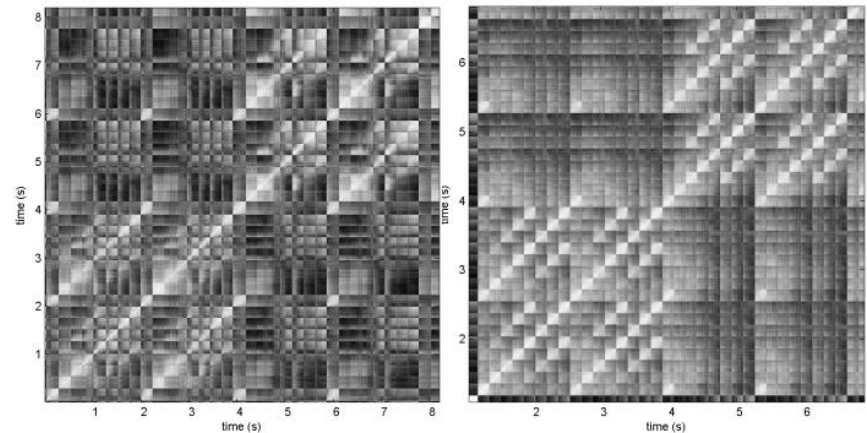
Example: 2 performances of Beethoven's  
*Symphony No. 5*



Performance-based  
self-similarity matrices

Examples: Jonathan Foote

Example: Bach



Rhythmic similarity

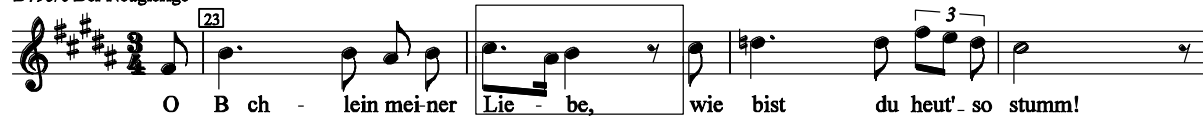
# Pattern detection

# Pattern detection

## Settings of the word "Liebe"

Nettheim: MuSearch (SCORE)

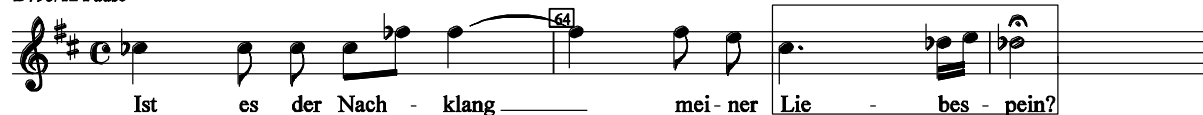
D795/6 Der Neugierige



D795/9 Des M llers Blumen



D795/12 Pause



D795/19 Der M ller und der Bach



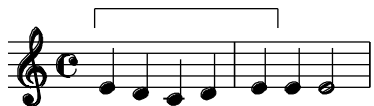
## Pattern realms

- Lyrics
- Pitch
- Duration
- Phrase structure

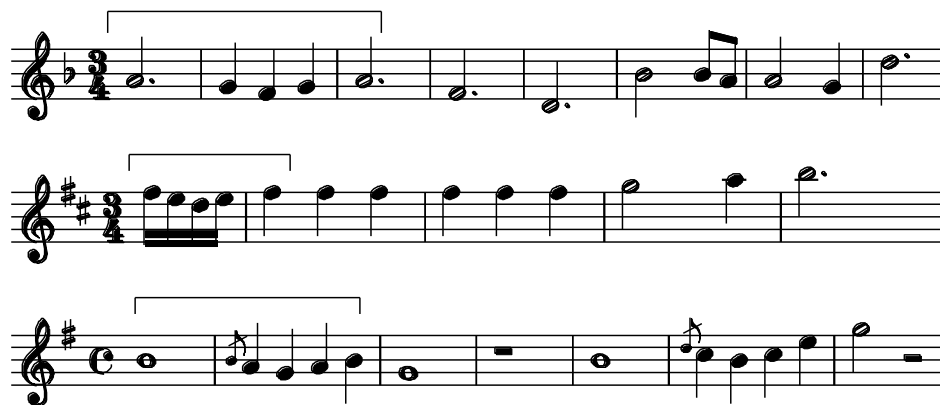
# Vulnerabilities

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Query



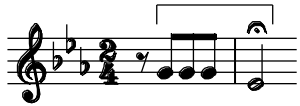
Target (scale degree): 32123



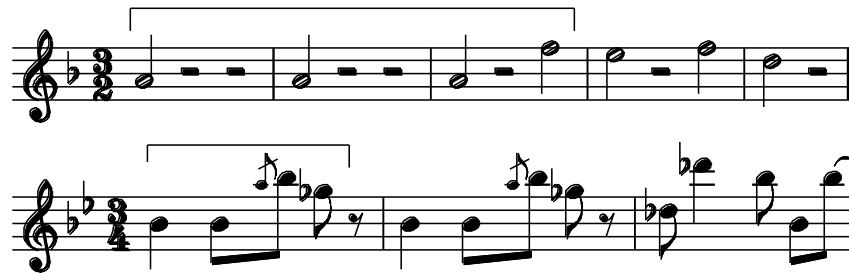
Pitch (scale-degree) matching without **rhythmic, metric invariance**

# Vulnerabilities

## Query



Target: 3331



## Pattern-matching without:

- Rests
- Register considerations
- Repeated notes



# 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"/>	<b>?</b> type of music to search
<b>Pitch</b>	<input type="text"/>	<b>?</b> A-G, sharp=#, flat=- e.g. C E- G F#
<b>Interval</b>	<input type="text"/>	<b>?</b> 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"/>	<b>?</b> 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"/>	<b>?</b> up=/, down=\, unison=-. e.g. //\-/ or uudsu
<b>Refined Contour</b>	<input type="text"/>	<b>?</b> 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>?</b>
<b>Key</b>	Any <input type="text"/> Mode: Any <input type="text"/>	<b>?</b>
<b>Meter</b>	<input type="text"/> / <input type="text"/>	<b>?</b>

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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 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 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)