



# Melodic Search: Strategies and Formats



CS 275B/Music 254

# Melody

# On melody

---

- ▶ 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

---

- ▶ What is a theme? **Significant content**
- ▶ What is an incipit? **Beginning 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? **Sometimes**
- ▶ Is melody one-dimensional? **Most of the time**
- ▶ How can we isolate a melody algorithmically? **???**
- ▶ \*

# Musical similarity (in general)

# Kinds of musical similarity

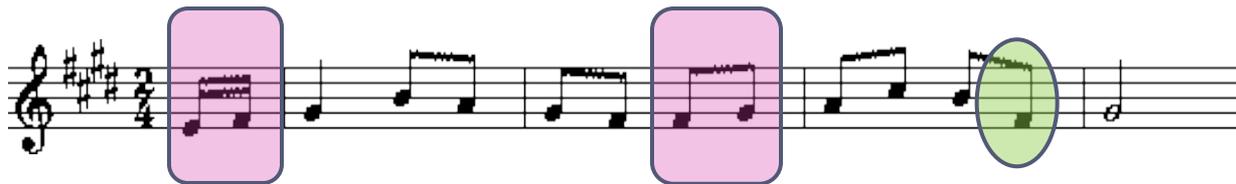
---

- ▶ Librarians: titles, metadata (rism)
  - ▶ Meter
  - ▶ Mode
- ▶ Cognitive psychologists: weighted features
  - ▶ Duple vs triple vs other meter
- ▶ Audio engineers, recommendation services:
  - ▶ Affect: Crosses repertoires in bizarre ways
  - ▶ Timbre:
  - ▶ Dynamics:
  - ▶ Tempo:
- ▶ Ear-worms: attentional elements

# What is an attentional feature?

---

- ▶ Anything unexpected event
  - ▶ An atypical duration
  - ▶ An atypical pitch
  - ▶ A sudden change in tempo
  - ▶ A sudden change of register



Beethoven

# Non-musical search strategies

# Non-musical search strategies

---

- **Probability** ranking
- **Sorting** and categorization
- **String matching**, edit distance
- **N-grams**
- **Dynamic** programming
- **“Pattern detection”**

# Probability ranking (L. Smith, 1995)

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

The screenshot shows a Netscape browser window displaying the MELDEX website. The browser title is "Netscape: Tune Matches: 1-10". The page content includes a search interface with a "What you sang" section showing a musical staff with notes. Below this, a "QUERY RESULTS" section displays a table of matches. A RealAudio Player window is overlaid on the bottom left, showing the title "Auld Lang Syne".

Tune	Database	Match
Auld Lang Syne	North American	100%
The Bonny Lass of Fyvie	North American	100%
A Bhrannalla Bheasach, S. 36	Irish	90%
A Feel Such As I	North American	90%
A Man's a Man For All That	North American	90%
Aleluia	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%

Example: MELDEX



# Melodic sorting (Schlichte, 1997)

[Ranking??]

Examples from RISM

Three staves of musical notation. The first staff is in G major (one sharp) and common time (C). The second and third staves are in G major (one sharp) and 2/4 time. Arrows point from the first staff to the second and third staves.

A single staff of musical notation in B-flat major (two flats) and 2/4 time signature, highlighted with a light blue background.

A single staff of musical notation in G major (one sharp) and common time (C), highlighted with a light brown background.

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

# 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

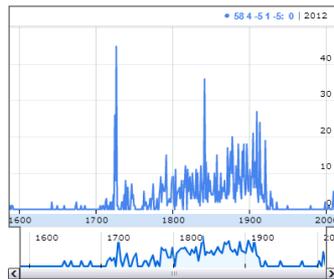
Petrucci Music Library    Smoothing: 0     Normalized



Keyboard shortcuts

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

- 6 Capricen, Op.27 [\[score\]](#) pages 1,6  
**Kirchner, Theodor** (1877)
- 6 Paritias [\[score\]](#) page 7  
**Bach, Johann Sebastian** (1726)
- Piano Trio No. 7 in B-flat major [\[score\]](#) page 1  
**Beethoven, Ludwig van** (1811)
- Piano Trio [\[score\]](#) page 1  
**Pienné, Gabriel** (1920)
- Antigone [\[score\]](#) pages 31,34  
**Mendelssohn, Felix** (1841)
- Giulio Cesare in Egitto [\[score\]](#) page 26  
**Handel, George Frideric** (1724)
- The Nutcracker [\[score\]](#) page 8  
**Tchaikovsky, Pyotr** (1892)
- Symphony No. 9 in D minor [\[score\]](#) page 23  
**Bruckner, Anton** (1896)



### 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

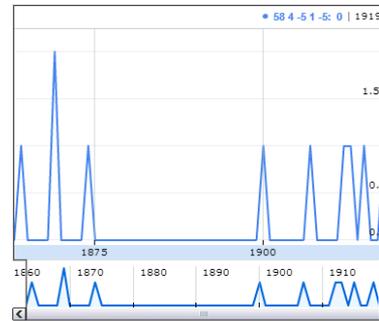
Duke University Library    Smoothing: 0     Normalized



Keyboard shortcuts

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

- My old home and friends [\[score\]](#) page 3  
**Cory Brothers** (1874)
  - Huckleberry Finn cake walk; Two-step [\[score\]](#) page 3  
**Jos. Morris** (1900)
  - Fishing for the moon; Green bird [\[score\]](#) page 5  
**empire Music** (1907)
  - Mandy's ragtime waltz [\[score\]](#) page 6  
**Sam Fox** (1912)
  - Dreaming dreams of you [\[score\]](#) page 4  
**Hamilton S. Gordon** (1913)
  - Down among the sheltering palms [\[score\]](#) page 2  
**Leo Feist** (1915)
  - When the good Lord makes a record of a heros' [\[score\]](#) page 4  
deed he draws no color line  
**M. Witmark & Sons** (1918)
- [next](#)  
you can also browse using the chart



# N-grams (Vero)



## 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 ngrams are sorted alphabetically and then chronologically.

### IMSLP Music Search by Peachnote



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

58 4 -5 1 -5 melody Search

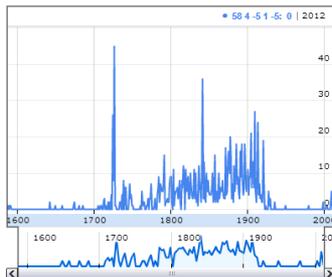
Petrucci Music Library Smoothing: 0 Normalized



Keyboard shortcuts

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

- 6 Capricen, Op.27 [\[score\]](#) pages 1,6  
**Kirchner, Theodor** (1877)
- 6 Paritias [\[score\]](#) page 7  
**Bach, Johann Sebastian** (1726)
- Piano Trio No. 7 in B-flat major [\[score\]](#) page 1  
**Beethoven, Ludwig van** (1811)
- Piano Trio [\[score\]](#) page 1  
**Piérné, Gabriel** (1920)
- Antigone [\[score\]](#) pages 31,34  
**Mendelssohn, Felix** (1841)
- Giulio Cesare in Egitto [\[score\]](#) page 26  
**Handel, George Frideric** (1724)
- The Nutcracker [\[score\]](#) page 8  
**Tchaikovsky, Pyotr** (1892)
- Symphony No. 9 in D minor [\[score\]](#) page 23  
**Bruckner, Anton** (1896)



### 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

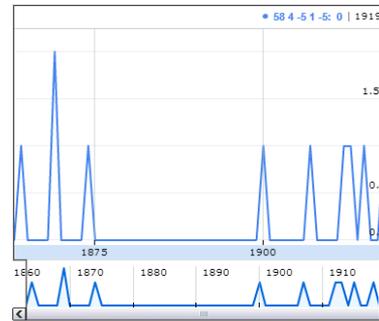
Duke University Library Smoothing: 0 Normalized



Keyboard shortcuts

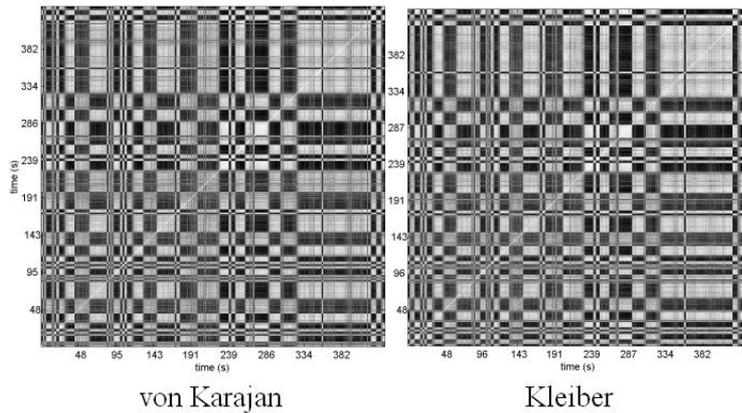
filter search results (e.g. Mozart, winds, or quartet)

- My old home and friends [\[score\]](#) page 3  
**Cory Brothers** (1874)
  - Huckleberry Finn cake walk; Two-step [\[score\]](#) page 3  
**Jos. Morris** (1900)
  - Fishing for the moon; Green bird [\[score\]](#) page 5  
**empire Music** (1907)
  - Mandy's ragtime waltz [\[score\]](#) page 6  
**Sam Fox** (1912)
  - Dreaming dreams of you [\[score\]](#) page 4  
**Hamilton S. Gordon** (1913)
  - Down among the sheltering palms [\[score\]](#) page 2  
**Leo Feist** (1915)
  - When the good Lord makes a record of a heros' [\[score\]](#) page 4  
deed he draws no color line  
**M. Witmark & Sons** (1918)
- [next](#)  
you can also browse using the chart



# Dynamic programming (Foote, 2002)

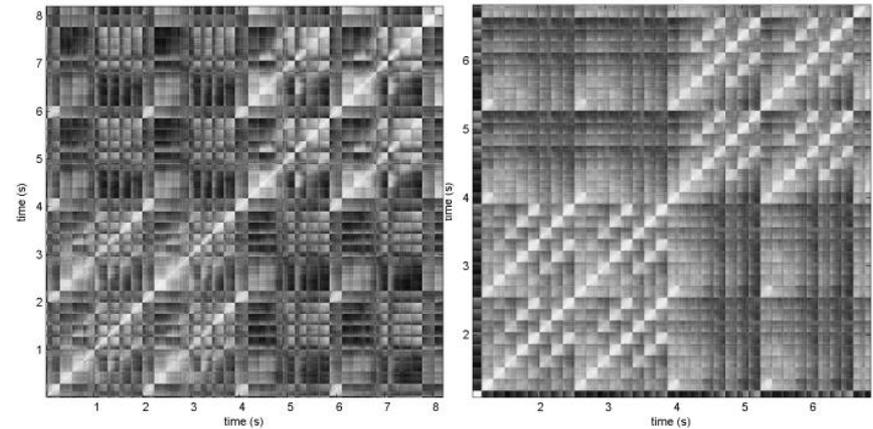
Example: 2 performances of Beethoven's  
*Symphony No. 5*



Performance-based  
self-similarity matrices

Examples: Jonathan Foote

Example: Bach



Glenn Gould 

MIDI 

Rhythmic similarity

# Pattern detection

# Pattern detection: parameters

---

## ▶ **Types**

- ▶ Rhythmic cells
- ▶ Melodic cells
- ▶ Word-tone relations

## ▶ **Confounds**

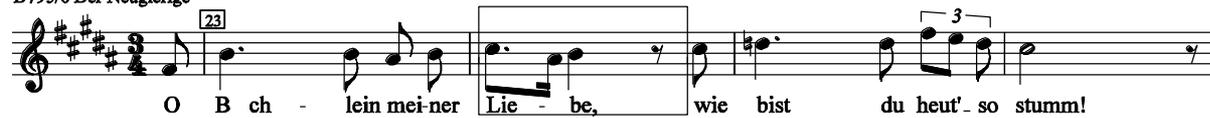
- ▶ Boundary issues
- ▶ “Noise” issues
- ▶ ... many more

# Pattern detection: word-tone

## Settings of the word "Liebe"

Nettheim: MuSearch (SCORE)

D795/6 Der Neugierige



O B ch - lein mei-ner Lie - be, wie bist du heut' - so stumm!

The musical score for D795/6 Der Neugierige is in G major and 2/4 time. It features a treble clef and a key signature of one sharp (F#). The melody is marked with a box around the word 'Lie-be' and a triplet of eighth notes for 'du heut' - so stumm!'. The number 23 is in a box above the first measure.

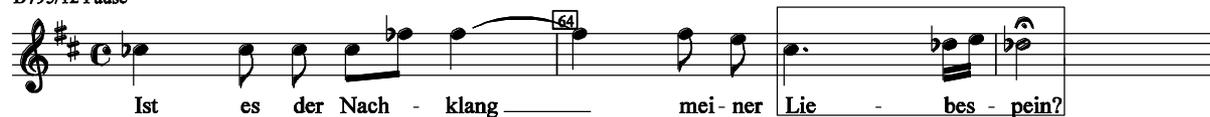
D795/9 Des Müllers Blumen



der - Bach, - der ist - des Müllers Freund und hell - blau Lieb - chens Au - ge scheint,

The musical score for D795/9 Des Müllers Blumen is in G major and 3/8 time. It features a treble clef and a key signature of one sharp (F#). The melody is marked with a box around the word 'Lieb - chens' and a fermata over the final note. The number 11 is in a box above the first measure.

D795/12 Pause



Ist es der Nach - klang - - - - - mei-ner Lie - bes - pein?

The musical score for D795/12 Pause is in G major and 2/4 time. It features a treble clef and a key signature of one sharp (F#). The melody is marked with a box around the word 'Lie - bes - pein?' and a fermata over the final note. The number 64 is in a box above the first measure.

D795/19 Der Müller und der Bach



ach, B ch - lein, a - ber weisst du wie Lie - - - be thut? --

The musical score for D795/19 Der Müller und der Bach is in G major and 3/8 time. It features a treble clef and a key signature of one sharp (F#). The melody is marked with a box around the word 'Lie - - - be' and a fermata over the final note. The number 66 is in a box above the first measure.

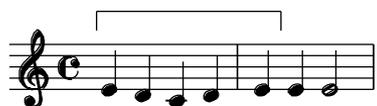
## Pattern realms

- Lyrics
- Pitch
- Duration
- Phrase structure

# Vulnerabilities: rhythms differentiate melodies

---

Query



Target (scale degree): 32123

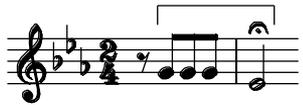


Pitch (scale-degree) matching without **rhythmic, metric invariance**

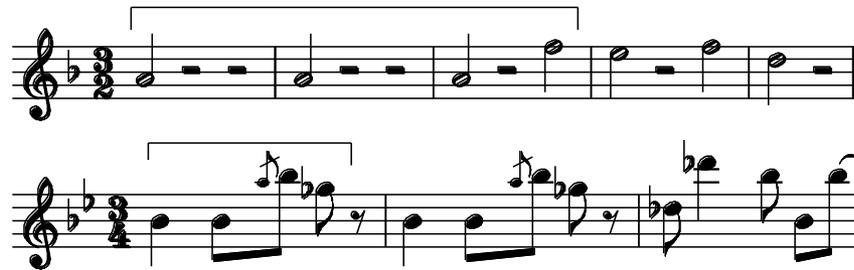
# Vulnerabilities: register confounds

---

Query



Target: 3331



Pattern-matching without:

- Rests
- Register considerations
- Repeated notes

# Themefinder

A search application for melodic data

# Themefinder (themefinder.org)

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

---

[.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=u, 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>

---

Sponsored by the  
[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

---

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

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