



Melodic Search: Strategies and Formats



CS 275B/Music 254

Melody: preliminaries

- ▶ 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?**

Themefinder (1996-97)

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

[Take the Quartet Quiz.](#)

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

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

Three repertories

- *Classical* = themes
- *Folk* = incipits
- *Renaissance* = incipits

Credits

- David Huron
- Andreas Kornstaedt
- Craig Sapp
- Many Stanford students

Themefinder

(<http://www.themefinder.org>)

Literal search

Intervallic search

Scale-degree search

Gross contour

Refined contour

Filters:

- key
- mode
- meter

The screenshot shows the Themefinder website interface. At the top, the title "Themefinder" is displayed in a large, dark red font. Below the title are two lines of navigation links: "[About | Search options | Help]" and "[New Links | Composers | Random]". A horizontal line separates the header from the main content area. Below the line, the text ".Take the Quartet Quiz." is centered. The main search area is a light yellow box containing several search criteria on the left and a list of search options on the right. The search criteria include: "Repertory" (a dropdown menu set to "Classical"), "Pitch" (a text input field), "Interval" (a text input field), "Scale Degree" (a text input field), "Gross Contour" (a text input field), "Refined Contour" (a text input field), "Location" (radio buttons for "beginning of theme only, or" and "anywhere in theme"), "Key" (a dropdown menu set to "Any"), "Mode" (a dropdown menu set to "Any"), and "Meter" (a text input field with a slash). A "Submit Search" button is located at the bottom of the search area. The search options on the right include: "type of music to search", "A-G, sharp=#, flat=-" (with example "e.g. C E- G F#"), "maj=M, min=m, aug=A, dim=d per=P", "fifth=5, up=+, down=-" (with example "e.g. +m9 -P8 +M3 P1"), "do=1, re=2, mi=3, fa=4, so=5, la=6, ti=7" (with example "mode insensitive). e.g. 34554321"), "up=/, down=\, unison=-" (with example "e.g. //\-/ or uudsu"), "up step=u, up leap=U", "down step=d, down leap=D, same=s" (with example "e.g. uUDsdu"). At the bottom of the page, it says "Sponsored by the Center for Computer Assisted Research in the Humanities".

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

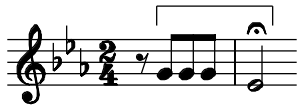
<http://www.themefinder.org>

Search strategies imported from other fields

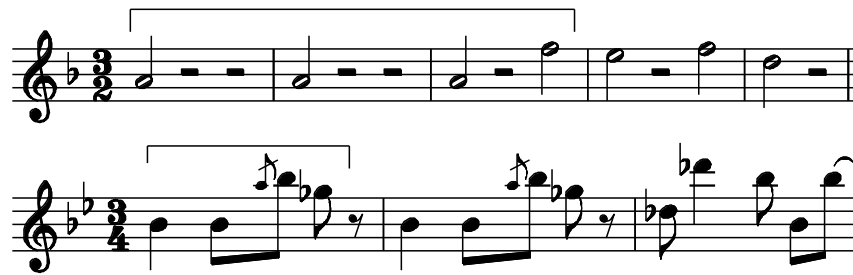
- Recombinant approaches
- Deep analysis
- Sorting, clustering (CS plus....)
- String matching, edit distance (industrial psychology)
- N-grams (computational linguistics; unix sort)*
- Dynamic programming (mathematics, optimization)
- Pattern detection (engineering, AI)
- Classification (statistics, machine learning)
- Probability ranking (statistics)

Vulnerabilities: Directional information, rhythm

Query



Target: 3331



Pattern-matching without:

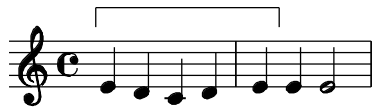
- Rests
- Register considerations
- Repeated notes

What is the minimum length of a query?

4, 6, 8 notes?

Vulnerabilities: Length of query

Query



Target (scale degree): 32123



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

Recent (oversimplified) strategies

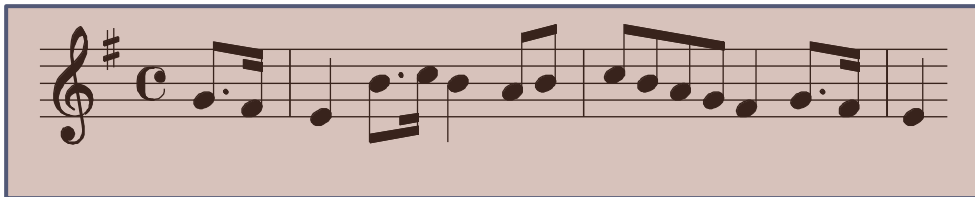
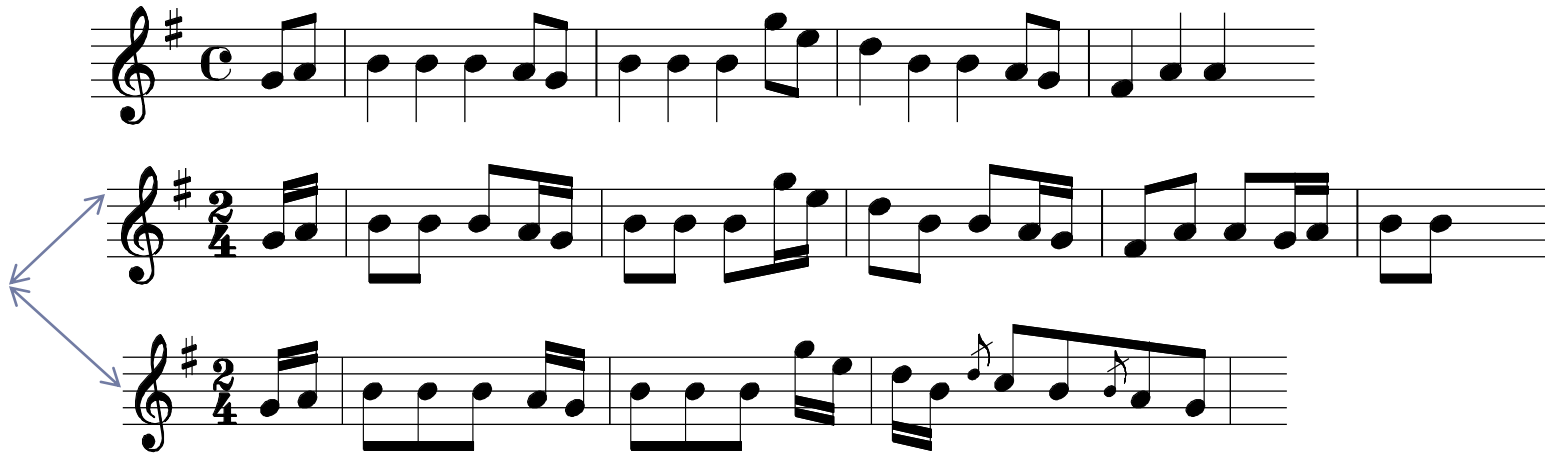
- ▶ Pitch-string only, base 7 (A, B, C, D, E, F, G)
- ▶ Creation of one million artificial “melodies” in “public domain”
- ▶ Enshrined in European copyright Directive 17
- ▶ What is missing in definition of **melody**?
 - ▶ **Scale degree search: 32123** **97 matches**
 - ▶ **Scale degree search: 3212333** **2 matches**

Melodic sorting (incipits)

Examples from RISM

[Ranking??]

<https://opac.rism.info/main-menu-/kachelmenu>



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

RISM music search

- ▶ Advanced search:m

<https://opac.rism.info/metaopac/start.do?View=rism&SearchType=2&Language=en>


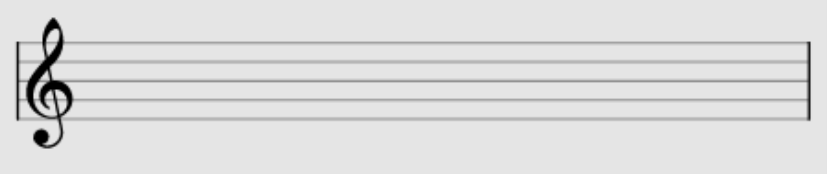
Digital copies only: All source types

All Fields All Fields

and Title Title

and Composer Composer

and Beginning of incipit using piano keyboard (with transposition) Beginning of incipit using piano keyboard (with transposition)

Clear Search

Edit distance: textual example

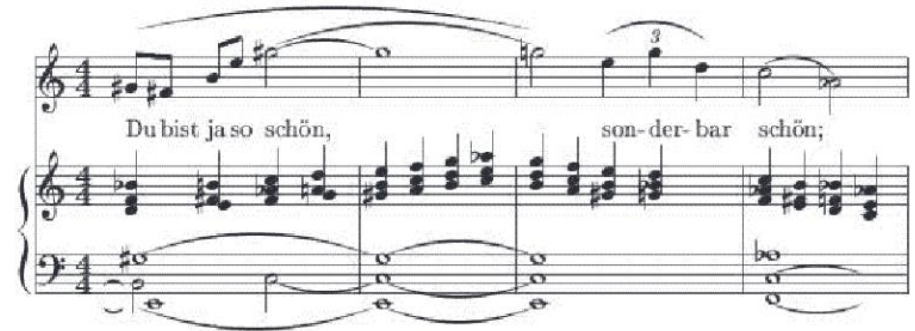
1. Token-by-token comparison
2. Penalties for
 - substitutions
 - insertions
 - deletions

Bag
Bat
Cat
Catch

Lemstrom, Pienimäki (2007)

“Edit distance vs geometric methods”
For music, *Musica Scientiae*

Ex: opera *Thomas* (1985) by Rautavaara

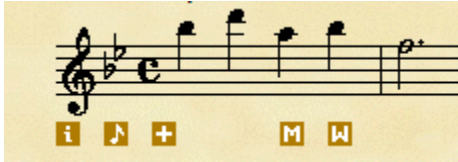


When the music at hand does not contain clear voicing, but it is rather perceived as a progression of chords, forcing the musical data into monophonic voices may result in a musically meaningless representation. Moreover, a pragmatic problem is that the representation does not support the problem depicted in Figure 2.b, where one wishes to find occurrences of the query pattern that may be distributed across the voices of the score.

Non-interleaved, interleaved
encodings (MIDI)

- a) (0,68) (1,66) (2,71) (3,76) (4,80) %
 (0,70) (2,71) (4,72) (6,74) %
 (0,65) (2,66) (4,68) (6,69) %
 (0,62) (2,64) (4,66) (6,67) %
 (0,56) % (0,47) (4,48) % (0,40) %
- b) (0,68) (1,66) (2,71) (3,76) (4,80) %
 (0,70) (2,71) (4,72) (6,74) %
 (0,65) (2,66) (4,68) (6,69) %
 (0,62) (2,64) (4,66) (6,67) %
 (0,56) % (0,47) (4,48) % (0,40) %

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

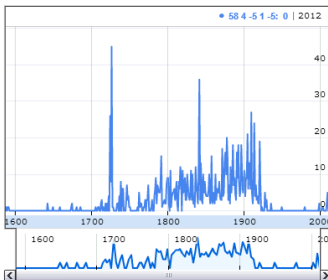
Petrucci Music Library Smoothing: 0 Normalized



[Keyboard shortcuts](#)

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

- 6 Capricen, Op.27 [YouTube](#) [score](#) pages 1,6
Kirchner, Theodor (1877)
- 6 Parlitas [YouTube](#) [score](#) page 7
Bach, Johann Sebastian (1726) [score](#) page 5 [score](#) page 10
- Piano Trio No. 7 in B-flat major [YouTube](#) [score](#) page 1
Beethoven, Ludwig van (1811) [score](#) page 1
more ...
- Piano Trio [YouTube](#) [score](#) page 1
Pienné, Gabriel (1920) [score](#) pages 2,4,10 [score](#) page 4
- Antigone [YouTube](#) [score](#) pages 31,34,35
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

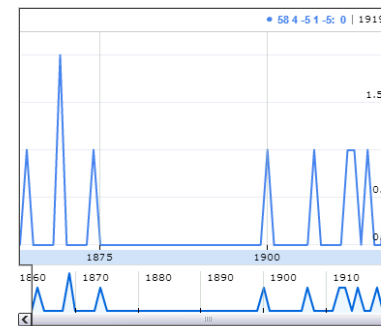
Duke University Library Smoothing: 0 Normalized



[Keyboard shortcuts](#)

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

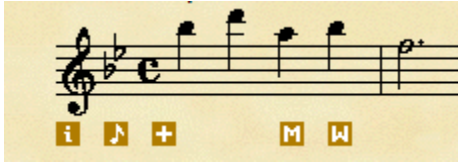
- My old home and friends [YouTube](#) [score](#) page 3
Cory Brothers (1874)
 - Huckleberry Finn cake walk; Two-step [YouTube](#) [score](#) page 3
Jos. Morris (1900)
 - Fishing for the moon; Green bird [YouTube](#) [score](#) page 5
empire Music (1907)
 - Mandy's ragtime waltz [YouTube](#) [score](#) 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' deed he draws no color line [YouTube](#) [score](#) page 4
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 `year` 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

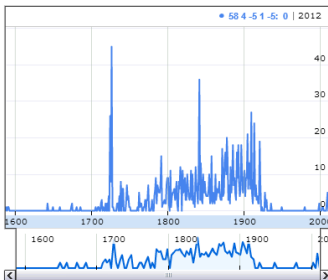
Petrucci Music Library Smoothing: 0 Normalized



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- 6 Capricen, Op.27 [Kirchner, Theodor](#) (1877) [\[score\]](#) pages 1,6
- 6 Parlitas [Bach, Johann Sebastian](#) (1726) [\[score\]](#) page 7 [\[score\]](#) page 5 [\[score\]](#) page 10
- Piano Trio No. 7 in B-flat major [Beethoven, Ludwig van](#) (1811) [\[score\]](#) page 1 [\[score\]](#) page 1 more ...
- Piano Trio [Pierné, Gabriel](#) (1920) [\[score\]](#) page 1 [\[score\]](#) pages 2,4,10 [\[score\]](#) page 4
- Antigone [Mendelssohn, Felix](#) (1841) [\[score\]](#) pages 31,34,35
- Giulio Cesare in Egitto [Handel, George Frideric](#) (1724) [\[score\]](#) page 26 [\[score\]](#) page 12 more ...
- The Nutcracker [Tchaikovsky, Pyotr](#) (1892) [\[score\]](#) page 8 [\[score\]](#) page 51 more ...
- Symphony No. 9 in D minor [Bruckner, Anton](#) (1896) [\[score\]](#) 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 melody Search

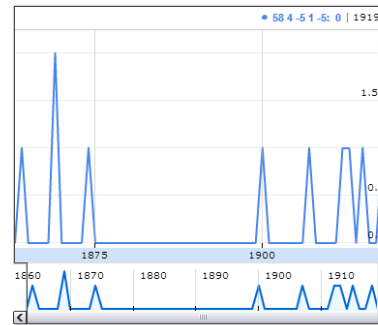
Duke University Library Smoothing: 0 Normalized



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




Pattern detection

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 starts with a quarter note G4, followed by a dotted quarter note A4, and then a quarter note B4. A box highlights the phrase "Lie - be," starting on a dotted quarter note G4 and ending on a quarter note B4. The word "Lie" is on a dotted quarter note G4, and "be," is on a quarter note B4. The rest of the phrase "wie bist du heut' - so stumm!" is on a half note G4. A triplet of eighth notes (G4, A4, B4) is marked with a "3" above it.

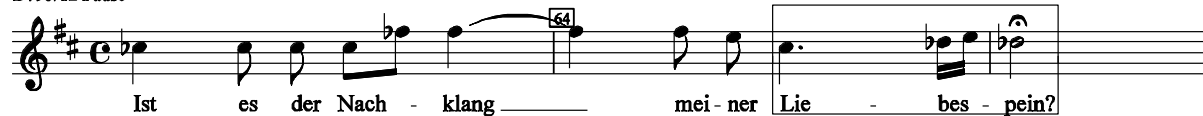
D795/9 Des M llers Blumen



der . Bach, - der ist - des M l - lers Freund und hell - blau Lieb - chens Au - ge scheint,

The musical score for D795/9 Des M llers Blumen is in G major and 3/8 time. It features a treble clef and a key signature of one sharp (F#). The melody starts with a quarter note G4, followed by a quarter note A4, and then a quarter note B4. A box highlights the phrase "Lieb - chens" starting on a quarter note G4 and ending on a quarter note B4. The word "Lieb" is on a quarter note G4, and "chens" is on a quarter note B4. The rest of the phrase "Au - ge scheint," is on a half note G4. A triplet of eighth notes (G4, A4, B4) is marked with a "3" above it.

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 3/4 time. It features a treble clef and a key signature of one sharp (F#). The melody starts with a quarter note G4, followed by a quarter note A4, and then a quarter note B4. A box highlights the phrase "Lie - bes - pein?" starting on a quarter note G4 and ending on a quarter note B4. The word "Lie" is on a quarter note G4, "bes" is on a quarter note A4, and "pein?" is on a quarter note B4. The rest of the phrase "Ist es der Nach - klang - - - mei-ner" is on a half note G4. A triplet of eighth notes (G4, A4, B4) is marked with a "3" above it.

D795/19 Der M ller und der Bach



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

The musical score for D795/19 Der M ller 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 starts with a quarter note G4, followed by a quarter note A4, and then a quarter note B4. A box highlights the phrase "Lie - - - be" starting on a quarter note G4 and ending on a quarter note B4. The word "Lie" is on a quarter note G4, and "be" is on a quarter note B4. The rest of the phrase "thut? - -" is on a half note G4. A triplet of eighth notes (G4, A4, B4) is marked with a "3" above it.

Pattern realms

- Lyrics
- Pitch
- Duration
- Phrase structure

Data = SCORE]



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)