A notation-based query language for searching in symbolic music

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Motivation

- Symbolic music corpora are growing, thanks to:
  - Manual encoding (e.g., OpenScore [1])
  - Improvements in OMR [2]

[1] Mark Gotham, Peter Jonas, Bruno Bower, William Bosworth, Daniel Rootham, and Leigh VanHandel. 2018. Scores of Scores: An OpenScore Project to Encode and Share Sheet Music. In *Proceedings of the 5th International Conference on Digital Libraries for Musicology*. Paris, France, 87–95.

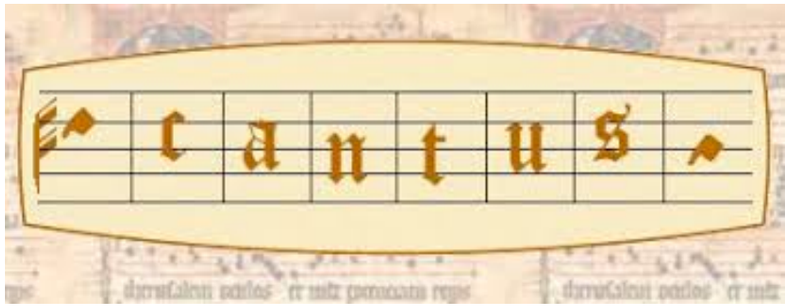
[2] Jan Hajič jr., Marta Kolárová, Alexander Pacha, and Jorge Calvo-Zaragoza. 2018. How Current Optical Music Recognition Systems Are Becoming Useful for Digital Libraries. In *Proceedings of the 5th International Conference on Digital Libraries for Musicology*. Paris, France, 57–61.

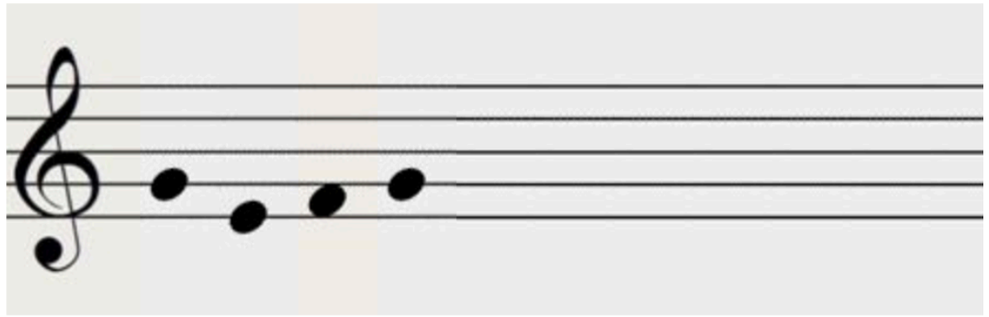
Symbolic music search

Approaches:

- Exact matching (pitches/intervals/rhythm)
- Similarity-based (“fuzzy” matching)
- Pattern-based

Exact matching

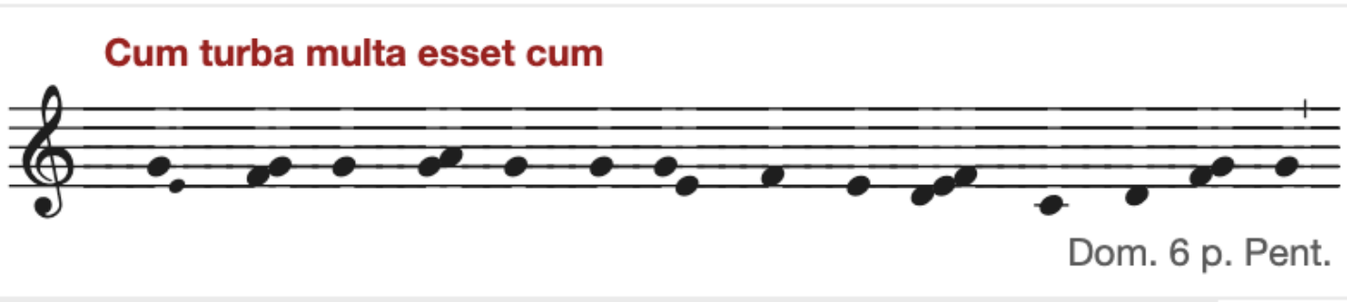


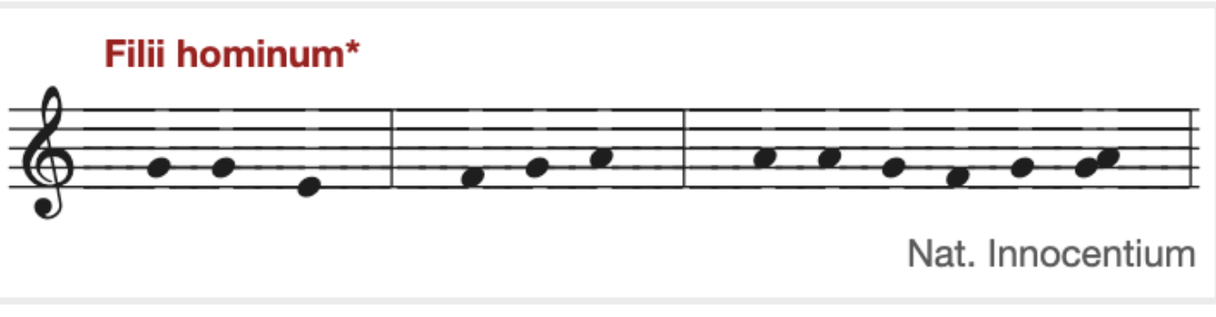


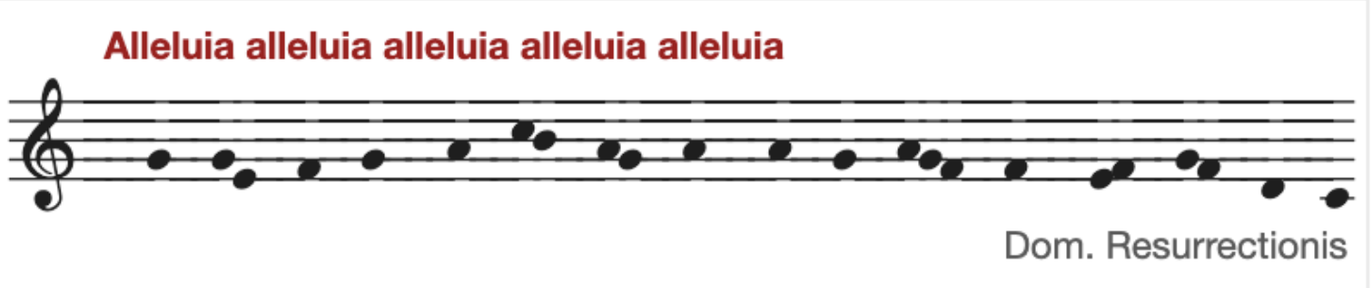
Delete 1 note | Delete all notes

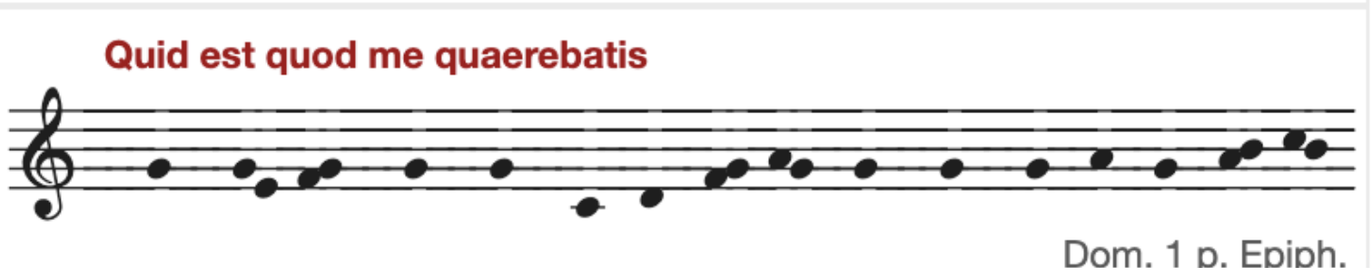
Source siglum | **Text search** | **Genre** | **Feast**

- (•) Search the beginning of the melody
- ( ) Search anywhere in the melody
- (•) Exact matches
- ( ) Exact matches + transpositions









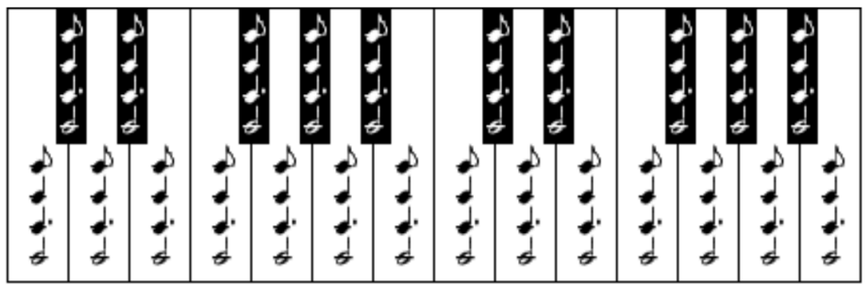
http://cantus.uwaterloo.ca/melody (Lacoste 2012)

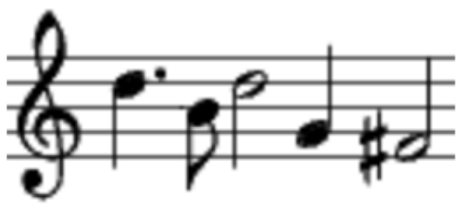
Easy to use

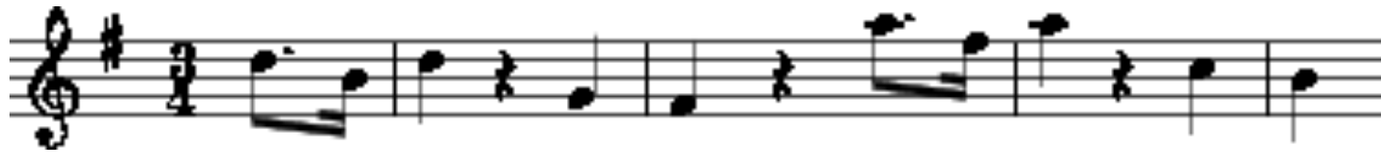
Limited expressivity

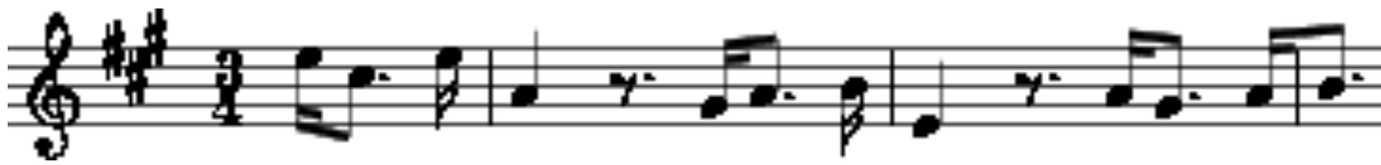
Similarity-based

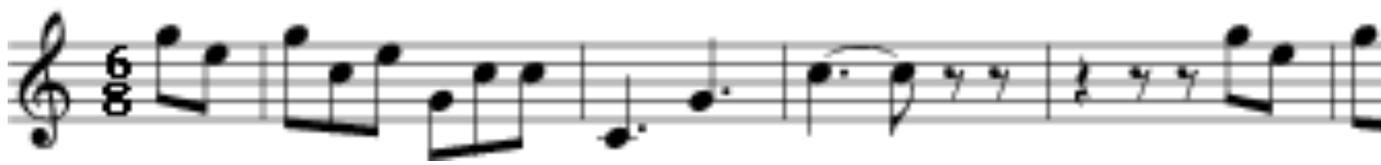
musipedia
The Open Music Encyclopedia











https://www.musipedia.org (Prechelt and Typke 2001)

Imprecise by design

Useful for retrieval tasks

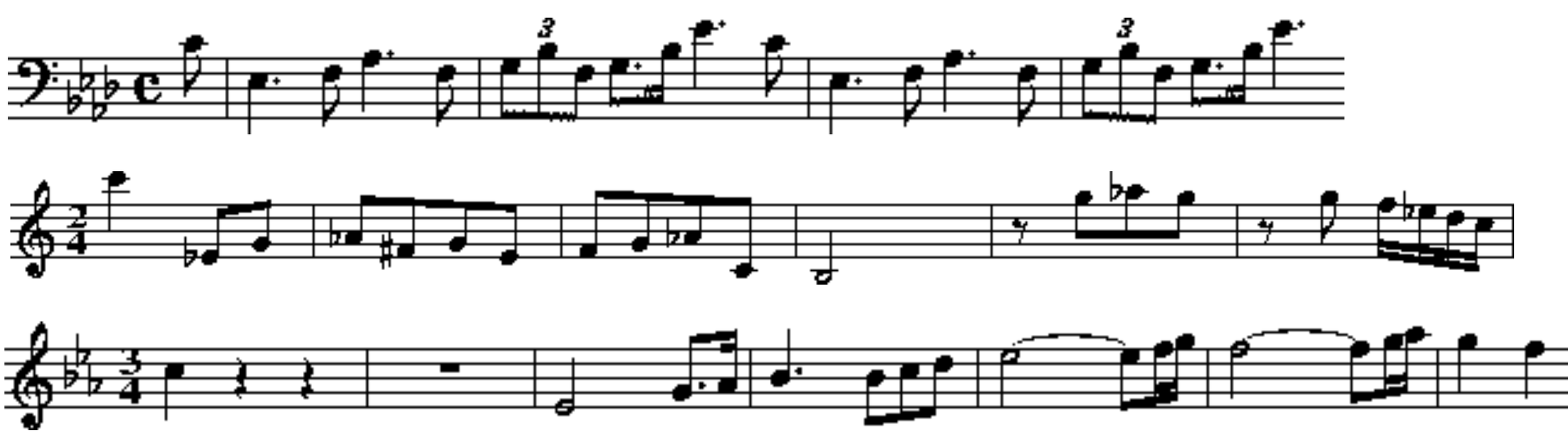
Pattern-based

- Precise matching
- Complex queries with wildcards
- Useful for musicological tasks:
  - Voice leading patterns (parallel fifths, cadences)
  - Motivic patterns (rhythmic and/or melodic)

Pattern-based

Themefinder

Pitch	C E- . A-	**A-G**, *sharp*=**#**, *flat*=**-** *e.g.* **C E- G F#**
Gross Contour	\/	*up*=**/**, *down*=****, *unison*=**-**. *e.g.* **//\-/** or **uudsu**



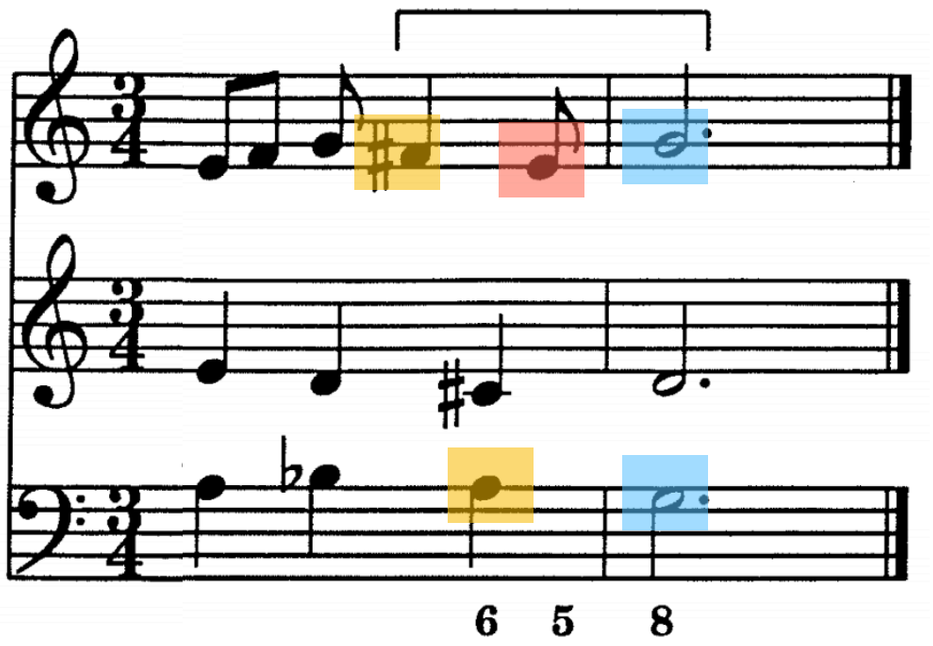
http://www.themefinder.org (Kornstädt 1998)

Pattern-based

Humdrum

- Text-based music encoding format
- Comes with powerful set of manipulation tools
- Can be searched using regular expressions (regexes)

http://www.humdrum.org (Huron 1994)




```
ditto -s ^= inputfile | hint -l > temp1
deg inputfile > temp2
assemble temp1 temp2
```

```
**kern  **kern  **kern  **hint  **deg  **deg  **deg
*clefF4 *clefG2 *clefG2 *       *     *     *
*M3/4   *M3/4   *M3/4   *M3/4   *M3/4 *M3/4 *M3/4
=       =       =       =       =     =     =
4A      4e      8e      P5 P5   v2    v6    ^6
.       .       8f      P5 m6   .     .     ^7-
4B-     4d      8g      M3 M6   ^3-   v5    ^1
.       .       4f#     M3 A5   .     .     v7
4A      4c#     .       M3 M6   v2    v4+   .
.       .       8e      M3 P5   .     .     v6
=       =       =       =       =     =     =

2.G     2.d     2.g     P5 P8   v1    ^5    ^1
==      ==      ==      ==      ==    ==    ==
*-      *-      *-      *-      *-    *-    *-
```

```
[Mm]6
P5.*v6
P8.*\^1
```

Regular expressions are extremely powerful

Steep learning curve for musicians and musicologists

Text manipulation

When I search for music

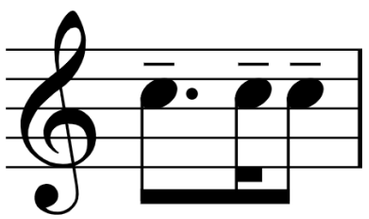
I want my query to look like music

Our approach

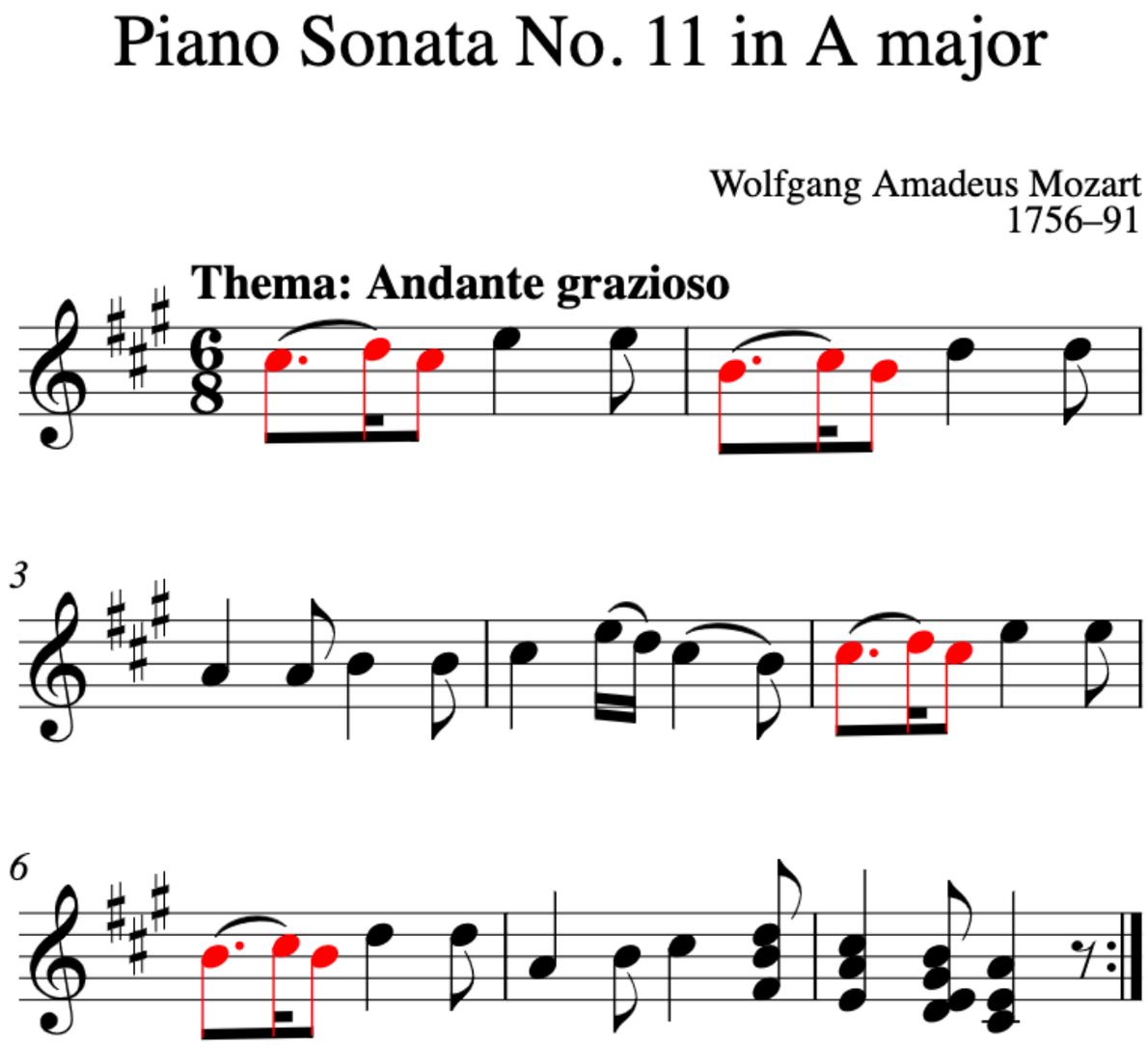
- Query primitives
  - Inspired by regular expressions
  - Extension of standard music notation
- Encoding – extension of MEI
- Execution engine
- Query interface
- Not “finished”

Search | Clear | Examples

```
<beam>
    <note dur="8" dots="1"
          query:any-pitch="true" />
    <note dur="16"
          query:any-pitch="true" />
    <note dur="8"
          query:any-pitch="true" />
</beam>
```



Music | Text | Score



<note> Matches a single note

Exact match

```
<note pname="e" oct="5" dur="4" />
```

Pitch-only

```
<note pname="e" oct="5"
      query:any-duration="true" />
```

Rhythm-only

```
<note dur="4" query:any-pitch="true" />
```

Any accidental

```
<note pname="e" oct="5" dur="4"
      query:any-accidental="true" />
```

<note> Matches a single note

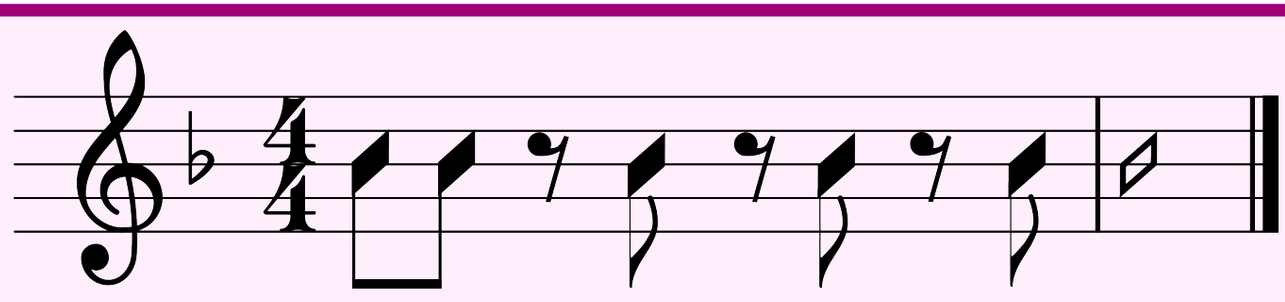
Exact match

```
<note pname="e" oct="5" dur="4" />
```

Pitch-only

```
<note pname="e" oct="5"
      query:any-duration="true" />
```

Rhythm-only

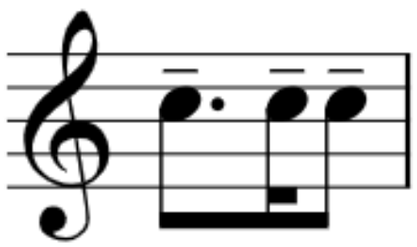


Any accidental

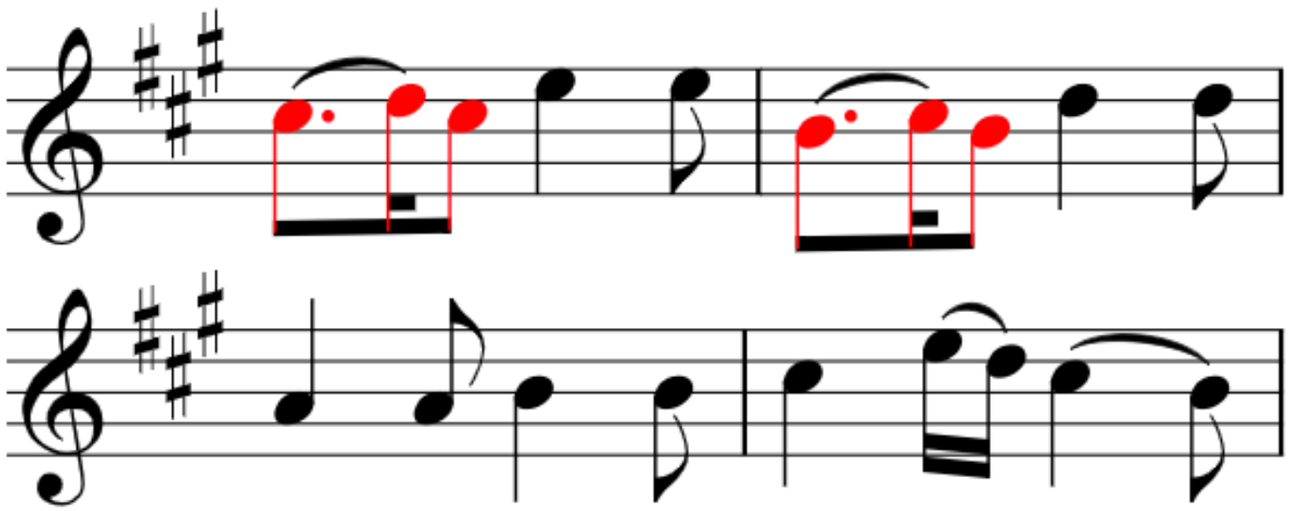
```
<note pname="e" oct="5" dur="4"
      query:any-accidental="true" />
```

Example: rhythm-only

Query:



Results:

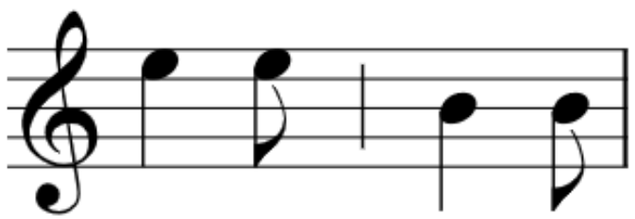


Query encoding:

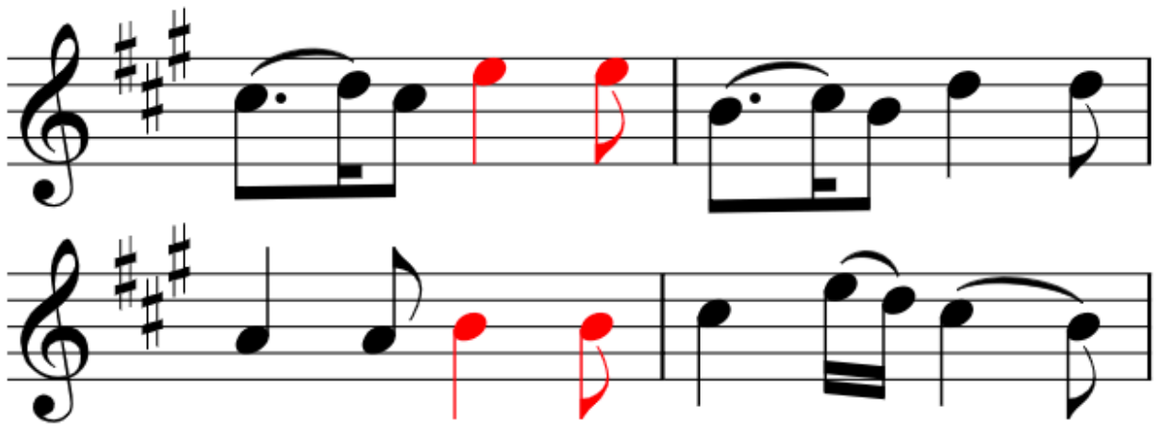
```
<beam>
   <note dur="8" dots="1" query:any-pitch="true" />
   <note dur="16" query:any-pitch="true" />
   <note dur="8" query:any-pitch="true" />
</beam>
```

<query:or> Matches either of two patterns

Query:



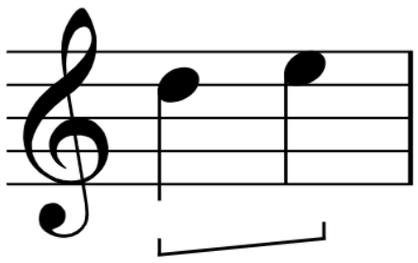
Results:



Query encoding:

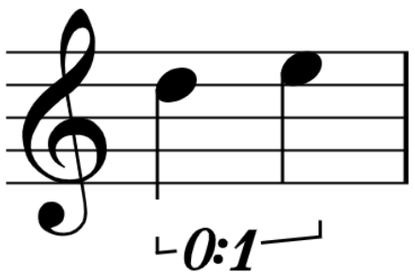
```
<note pname="e" oct="5" dur="4" />
<note pname="e" oct="5" dur="8" />
<query:or />
<note pname="b" oct="4" dur="4" />
<note pname="b" oct="4" dur="8" />
```

<query:group> Nested or repeated patterns



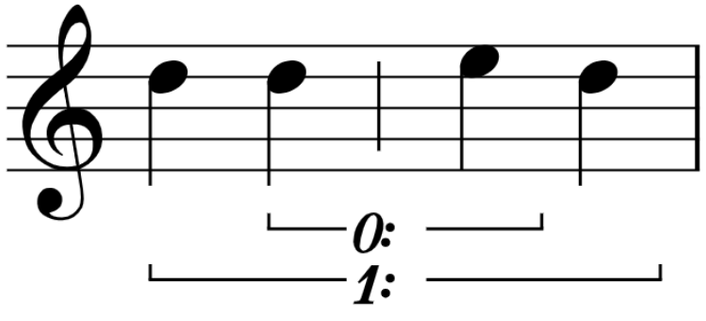
```
<query:group>
   <note … />
</query:group>
```

Quantifiers




```
<query:group min-occurrences="0"
                    max-occurrences="1">
   <note … />
</query:group>
```

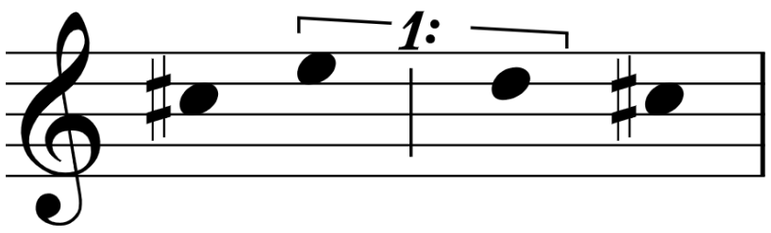
Nested groups



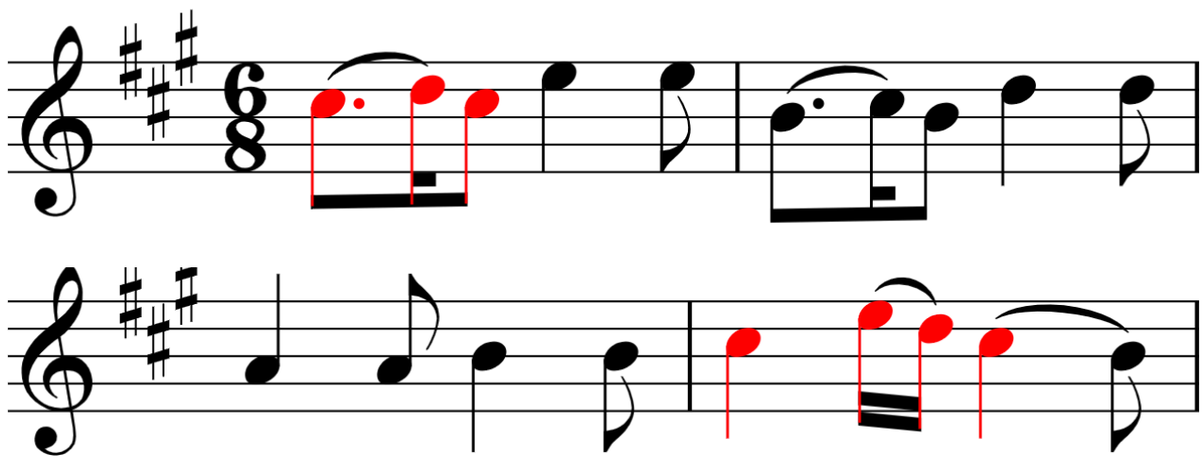

```
<query:group min-occurrences="1">
   <note … />
   <query:group min-occurrences="0">
      <note … />
   </query:group>
   <note … />
</query:group>
```

Example: group

Query:



Results:



Query encoding:

```
<note pname="c" oct="5" accid="s" query:any-duration="true" />
<query:group min-occurrences="1">
   <note pname="e" oct="5" query:any-duration="true" />
   <query:or />
   <note pname="d" oct="5" query:any-duration=“true" />
</query:group>
<note pname="c" oct="5" accid="s" query:any-duration="true" />
```

Rendering

- In the browser using Verovio (Pugin et al. 2014)
- Extended MEI is transformed to standard MEI

```
<note query:any-duration="true" />
```

```
<note stem.visible="false" />
```

Execution engine

- Query primitives can be mapped directly to regexes
- Avoid re-inventing the wheel: Use existing regex engine
- Query transformed to regex and executed on Humdrum representation of score (***kern*)

Execution engine

Query

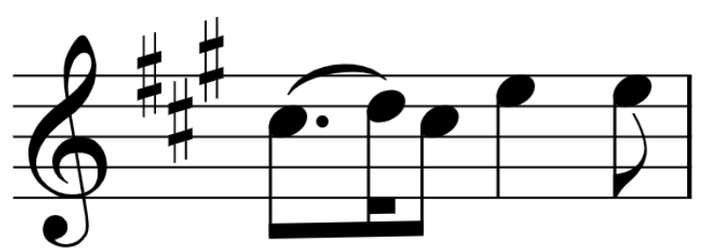
<note pname="e" oct="5"
query:any-duration="true" />

[0-9]+\.*ee

Duration **Pitch**

(^|\t)(&?{)?(&?\()?\[?[0-9]+\.*ee(?!
[a-gA-G#\-n]).*
(^[!.*=].*
)*?

Score



**kern

(8.cc#L
16ddk)
8cc#J
4ee
8ee

Benchmark

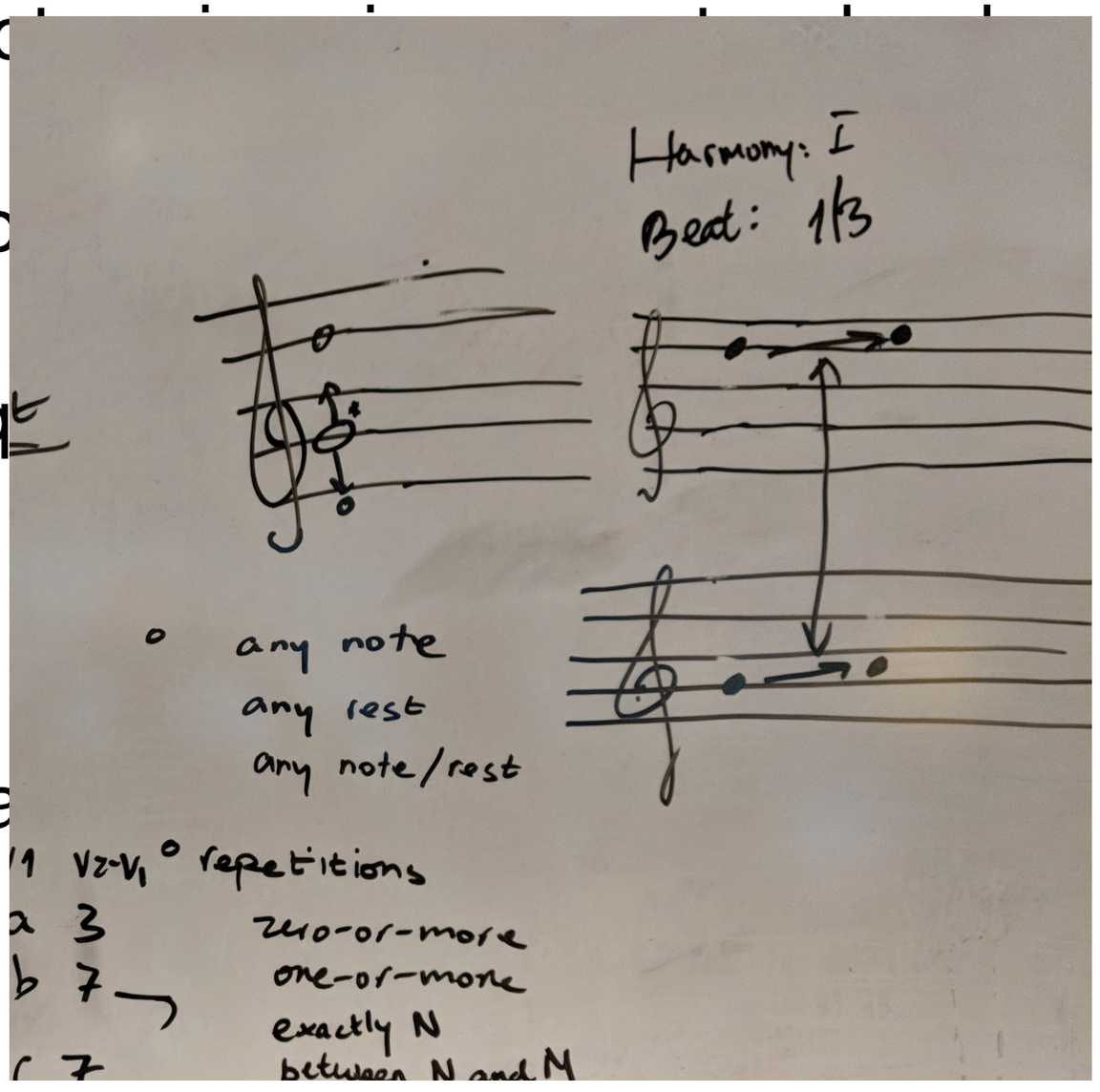
- Tested on Essen Folksong Collection (Schaffrath 1995) (8,473 scores)
- Simple query took ~0.75 seconds to complete
    - Produced 4,738 matches in 2,369 scores
- For larger corpora, execution can be parallelized

Future work

- Transposition invariance, octave invariance, rests, chords
- Layers (scale degree, contour, harmony, lyrics…)
- Graphical query input! (Requires Verovio functionality)
- Server-side searching
- Polyphonic music – constraint-based?

Future work

- Transposition invariance, oc
- Layers (scale degree, conto
- Graphical query input! (Req
- Server-side searching
- Polyphonic music – constra



What motivates a musical query?

"The only common thread in music-query motivations, broadly defined, is – alas – human curiosity. Unless we lose that, **designers of music-query software**  **can expect to cater for an unending stream of "special" needs**, as musical preferences continue to evolve and change."

Eleanor Selfridge-Field. 2000. What Motivates a Musical Query? In *Proceedings of the 1st International Symposium on Music Information Retrieval*. Plymouth, MA, USA.

Try it!

https://www.matangover.com/musicquery

Thank you

https://www.matangover.com/musicquery