

Symbolic Representations of Music



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Computer representation of music by application category

- ❖ Score-based
 - ❖ DARMS, CMN, Score, SMDL, NIFF, GUIDO, MEI
- ❖ Analytical
 - ❖ Humdrum / **kern
- ❖ Gestural
 - ❖ MIDI
- ❖ Compositional
 - ❖ Music N (Csound), Smoke, Nyquist, OpenMusic, Elody
- ❖ Audio
 - ❖ MP3, au, wav, sdii, ra, qt, snd
- ❖ Descriptive
 - ❖ MPEG 4, MPEG 7, MPEG 21

Score-based Formats

❖ Binary formats

- ❖ Sibelius (Proprietary)
- ❖ Enigma (Finale - proprietary?)
- ❖ NIFF (Notation Interchange File Format)
- ❖ Score (Leland Smith)

❖ ASCII / Unicode formats

- ❖ DARMS (1963)
- ❖ cmn
- ❖ GUIDO
- ❖ LilyPond (GNU project)
- ❖ Music Encoding Initiative (MEI)
- ❖ HTML / XML

Examples



❖ GUIDO

[`\clef<"treble"> \meter<"4/4"> d/4 e/8 f# g a b c#2 d/2 _/2]`]

❖ DARMS

`!!1 !G !M4/4 0Q 1E 2# 3 4 5 6# 7H RH`

❖ cmn

(`staff treble d4 q e4 e fs4 e a4 e b4 e cs5 d5 h half-rest`)

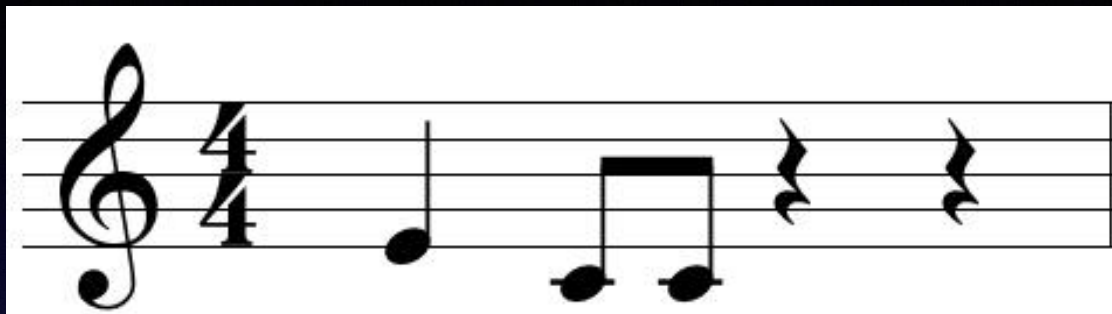
HTML / XML

- ❖ SMDL (Hytime, SGML)
- ❖ MHTML
- ❖ MusicML
- ❖ MusiXML
- ❖ MusicXML
- ❖ MusiqueXML
- ❖ Xmusic
- ❖ Etc.

Example of MusicXML

```
<note>  
  <pitch>  
    <step>A</step>  
    <octave>4</octave>  
  </pitch>  
  <type>half</type>  
  <stem>up</stem>  
  <notations>  
    <slur type="start" number="1"/>  
    <tied type="start"/>  
  </notations>  
</note>
```

MEI (Music Encoding Initiative)



```
<measure>
  <staff>
    <layer>
      <note pname="e" oct="4" dur="4"/>
      <beam>
        <note pname="c" oct="4" dur="8"/>
        <note pname="c" oct="4" dur="8"/>
      </beam>
      <rest dur="4"/>
      <rest dur="4"/>
    </layer>
  </staff>
</measure>
```

Analytical (Humdrum /** kern)

Represents *syntactic* rather than *orthographic* (visual) information. Designed for analysis rather than printing.

!! Fux: "Gradus ad Parnassum"

**kern

*M4/4

*k []

=1-

2d/

4f/

4a/

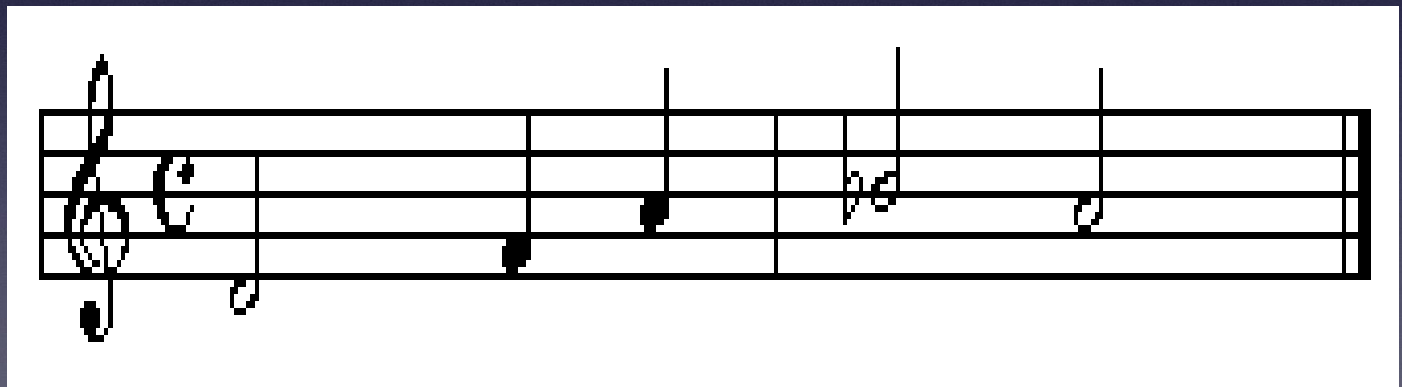
=2

2b-/

2a/

==|!

*-



VerovioHumdrumViewer

← → ↺ Not Secure verovio.humdrum.org

VerovioHumdrumViewer Mozart, Piano Sonata No. 11 in A major, K 331 (300i), Mvmt. 1a



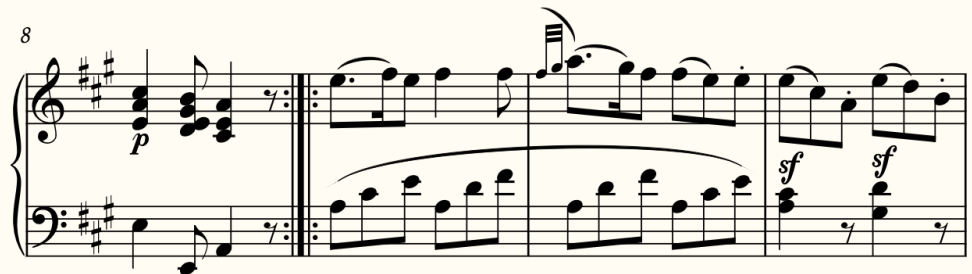
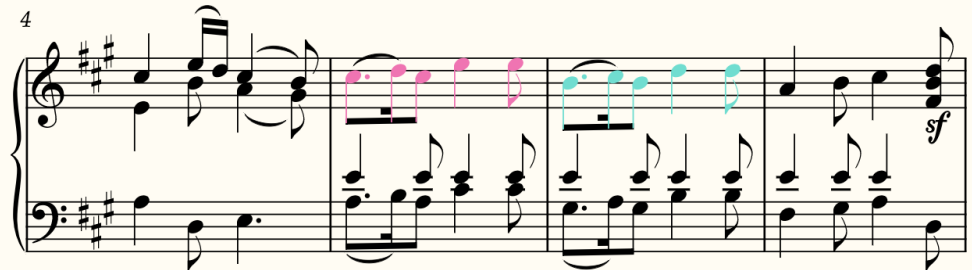
? Play

```
1  !!!filter: msearch -qcdcee -c hotpink
2  !!!filter: msearch -qcbdd -c turquoise -mN
3  !!!COM: Mozart, Wolfgang Amadeus
4  !!!CDT: 1756/01/27/-1791/12/05/
5  !!!CNT: German
6  !!!OTL: Piano Sonata No. 11 in A major
7  !!!SCT1: K1 331
8  !!!SCT2: K6 300i
9  !!!OMV: Mvmt. 1a
10 !!!OMD: Thema: Andante grazioso
11 !!!ODT: 1778-1873///
```

```
12 **kern          **kern          **dynam
13 *staff2          *staff1          *staff1/2
14 *>[A,A,B,B]      *>[A,A,B,B]      *>[A,A,B,B]
15 *>norep[A,B]     *>norep[A,B]     *>norep[A,B]
16 *>A              *>A              *>A
17 *clefF4          *clefG2          *clefG2
18 *k[f#c#g#]       *k[f#c#g#]       *k[f#c#g#]
19 *A:              *A:              *A:
20 *M6/8            *M6/8            *M6/8
21 *MM72            *MM72            *MM72
```

```
22 =1-             =1-             =1-
23 *^              *
24 4e               (8.AL           (8.cc#L      p
25 .                16Bk)          16ddk)      .
26 8e               8AJ            8cc#J        .
27 4e               4c#            4ee            .
28 8e               8c#            8ee            .
29 =2               =2             =2
30 4e               (8.G#L         (8.bL        .
31 .                16Ak)          16cc#k)      .
32 8e               8G#J           8bJ          .
33 4e               4B             4dd            .
34 8e               8B             8dd            .
35 =3               =3             =3
36 4e               4F#            4a            .
```

Thema: Andante grazioso



Gesture / Performance

- ❖ Piano roll
- ❖ MIDI (SMF)
 - ❖ Ubiquitous
 - ❖ Keyboard -centric (note and velocity)
- ❖ SKINI (Synthesis toolKit Instrument Network Interface)

Compositional

- ❖ Music N (Csound)
- ❖ SmOke (Smalltalk)
- ❖ Nyquist (Lisp)
- ❖ Max/MSP (visual object-oriented graphical programming environment)
- ❖ Elody (java, MIDI, visual functional programming environment)
- ❖ OpenMusic (visual Lisp-based programming environment)
- ❖ SuperCollider, Kyma, etc.

Csound example

❖ Orchestra file

```
instr 1
    asig oscil 1000, cpspch(p5), 1
    out asig
endin
```

❖ Score file

```
f1 0 256 10 1 ; a sine wave table
; a pentatonic scale
;      start dur    amp    pitch
i1      0      .5     0      8.01
i1     0.5      .     .     8.03
i1     1.0      .     .     8.06
i1     1.5      .     .     8.08
i1     2.0      .     .     8.10
```

SmOke example

Smallmusic Object Kernel (Stephen T. Pope)

```
[(EventList newNamed: #test1)
 add: (0 => (Event dur: 1/4 pitch: 'c3' ampl: 'mf'));
 add: (1 => ((Event new) dur: 6 ampl:0.3 sound: #s73bw))]
```

"C-minor fugue theme."

```
((0.5 beat => ((1/4 beat), ('c3' pitch),
                (voice: 'harpsichord'))),
 ((1/4 beat), ('b2' pitch)),
 ((1/2 beat), ('c3' pitch)),
 ((1/2 beat), ('g2' pitch)),
 ((1/2 beat), ('a-flat2' pitch)) )
```

Nyquist

(Roger Dannenberg)

Example I: Sequences

```
(defun note (pitch dur)
  (osc pitch dur *table*))

(play (seq (note c4 i)
           (note d4 i)
           (note f4 i)
           (note g4 i)
           (note d4 q))))
```

Nyquist

Example II: Transformation

; env-note produces an enveloped note. The duration defaults to 1.0, but stretch can be used to change the duration.

```
(defun env-note (p)
  (mult (note p 1.0)
    (env 0.05 0.1 0.5 1.0 0.5 0.4)))
```

; now use stretch to play different durations

```
(play (seq (stretch 0.25 (seq (env-note c4) (env-note d4)))
  (stretch 0.5 (seq (env-note f4) (env-note g4)))
  (env-note c4)))
```

Descriptive / compression

- ❖ MPEG 4

 - ❖ structured audio (SAOL)

- ❖ MPEG 7

 - ❖ a standard for describing features of multimedia content

- ❖ MPEG 21

 - ❖ an open framework for multimedia delivery and consumption

Music Representation by Humans

❖ Symbolic?

❖ Search

❖ Recall

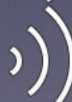
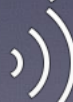
Music Representation by Humans

❖ Symbolic?

❖ Search

❖ Recall

❖ Identification

❖ Example 1					
❖ Example 2					
❖ Example 3					
❖ Example 4					
❖ Example 5					