

From Sound to Input and Output

Music 253/CS 275A
Stanford University

Latest MIDI controllers



Yamaha *Tenori-on* controller
for “drawing” music input

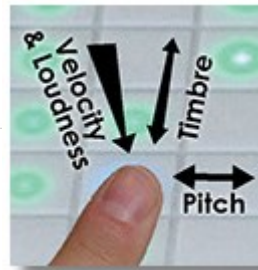
MIDI controller
with iPhone cradle



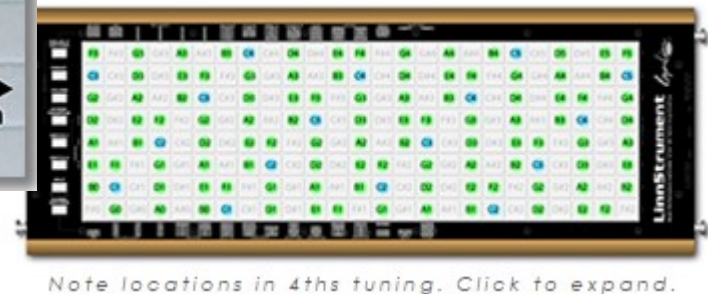
Haken Audio Continuum:
High-end audio



Roli Seaboard Rise:
gesture



Linnstrument
(expression)



Alternative MIDI instruments

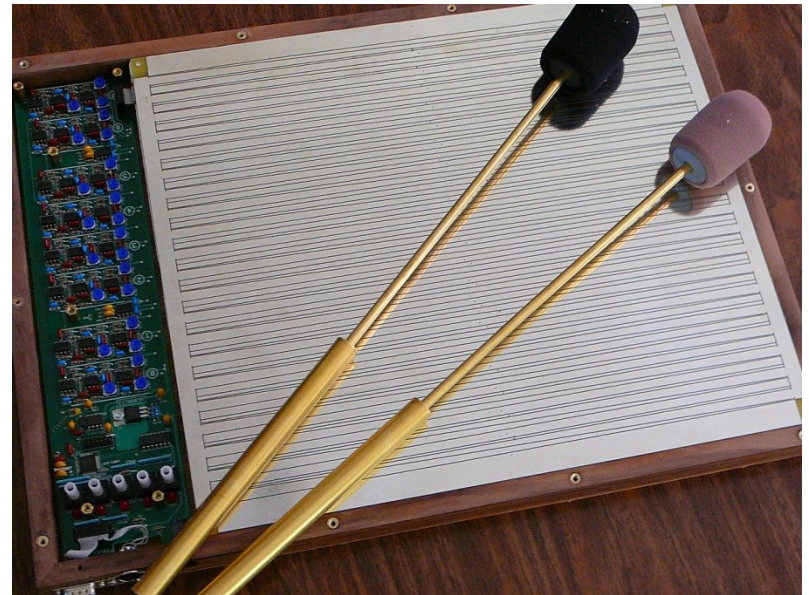
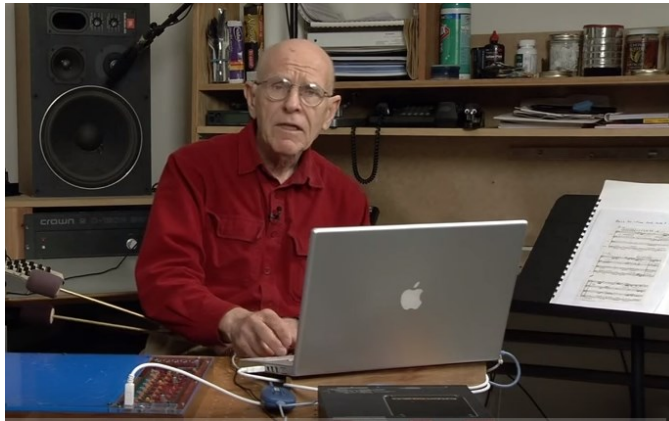
- ❑ MIDI horn: Gary Lee Nelson
- ❑ MIDI trumpet: Dexter Morrell
- ❑ MIDI chelletto (“little cello”): Chris
- ❑ MIDI violin: Yamaha
- ❑ MIDI guitar: Zeta Music/Gibson



Akai wind
Controller
(2016)

MIDI as an adjunct to other sound tech

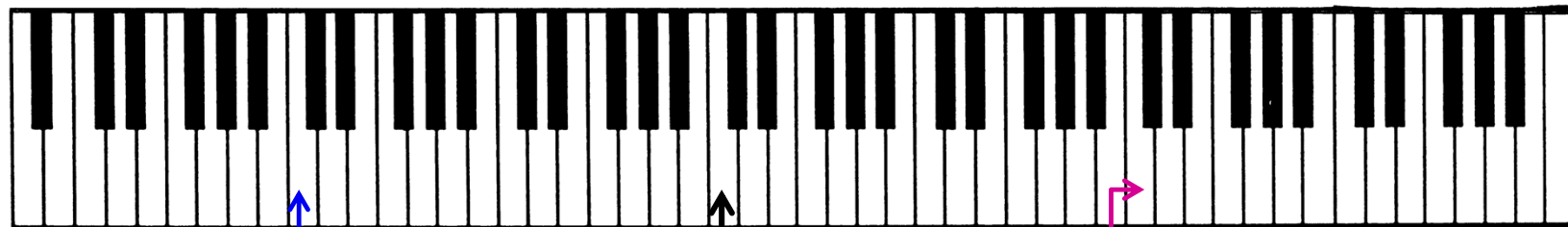
- MIDI data can be synchronized with other kinds of data
 - Video, animations
 - Electronic instruments
 - Software routines



Max Mathews' Radio Baton

<https://www.youtube.com/watch?v=3ZOzUVD4oLg>

“Pitch” = key number



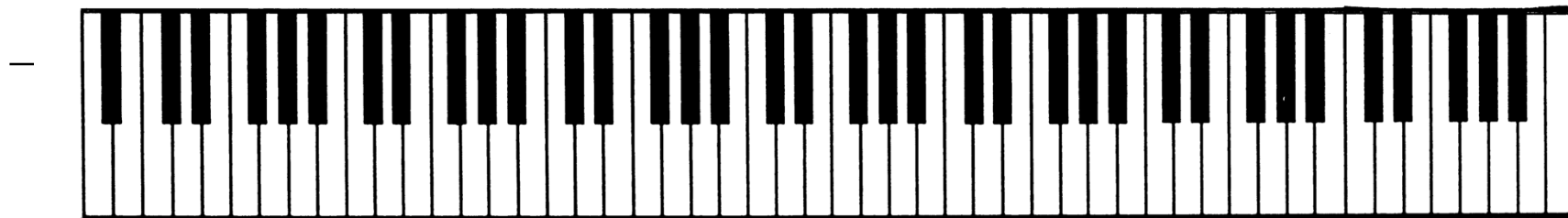
- Absolute (MIDI C's)
 - **36 etc.**
 - 48 C 8ve below Middle C
 - **60 Middle C**
 - 72 C 8ve above Middle C
 - **84 etc.**

Manufacturing
variations:

Middle C = 60

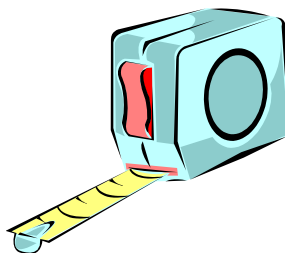
Middle C = 48

The MIDI pitch interface



Keysolut (MIDI C'S)

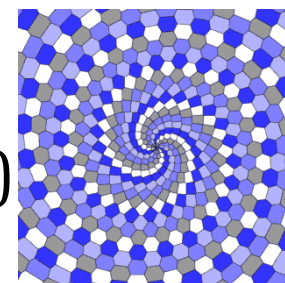
- 36
- 48
- 60
- 72
- 84



Octaves

- CC #
- C)
- c (Middle C)
- c'
- c''

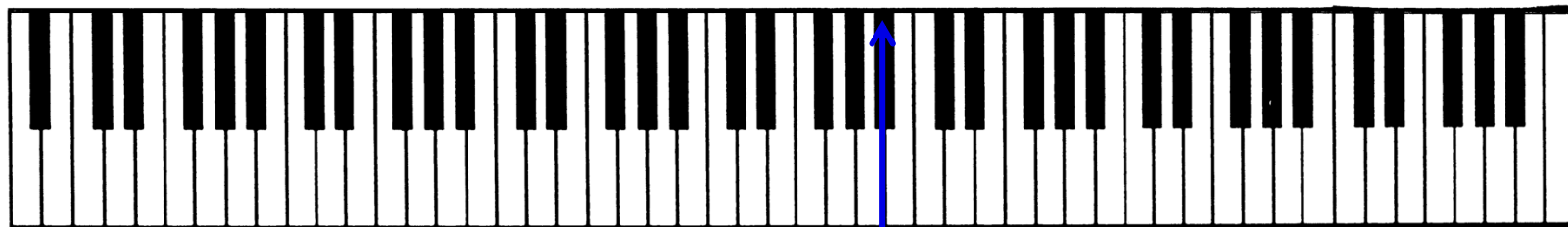
(Human being)



Number-line representation

Cyclical representation Bb

Key-number pitch is *absolute* tonal music notation is *relative*



□ Absolute key number

- 36 etc.
- 48 C 8ve below Middle C
- 60 Middle C
- 72 C 8ve above Middle C
- 84 etc.

□ Absolute pitch = “70”

□ Single factor

Tonal pitch names are **contextual**
A#/Bb

*Guido: separation of
name and inflection*

- CC
- C
- c (Middle C)
- c'
- c''

Data divergence (sound/notation)

Event-based system

Sounding pitch captured
in MIDI

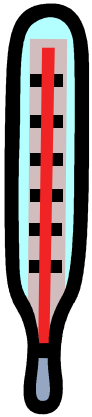
The image displays two systems of musical notation. The top system is enclosed in a light blue rectangular header. It features four staves labeled 'violino I', 'violino II', 'viola', and 'violoncello'. Each staff begins with a treble clef and a key signature of one sharp (F#). The notation includes various musical symbols such as notes, rests, and dynamic markings like 'p' (piano) and 'f' (forte). The bottom system is a continuation of the score, separated by a double bar line. It includes staves for 'S' (Soprano), 'pt:' (Piano), 'pi:' (Piano), and 'pt:' (Piano). The notation continues with notes, rests, and dynamic markings. The overall layout is clean and professional, typical of a musical score.

“Black notes” only
representation
means **no distinction**
between
A#/Bb

2019 Eleanor Selfridge-Field

The MIDI duration interface

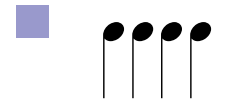
Clock time (absolute)



- Clock ticks/measure
(120, 192, 240)
- Ticks/quarter note
(30, 48, 60)
- No rests!

Linear rep.

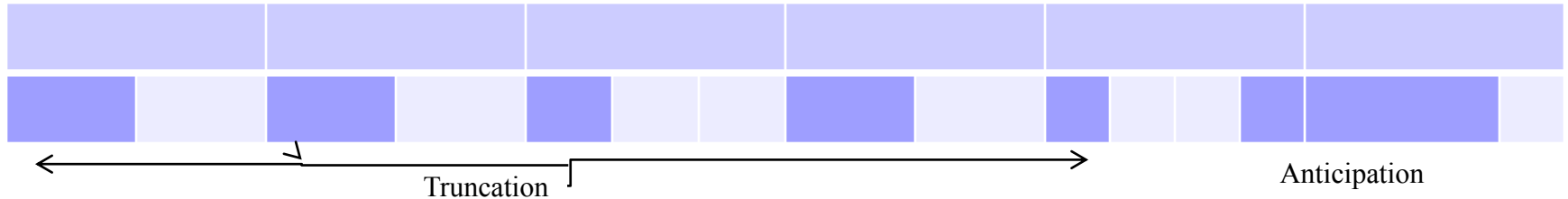
Intuitive musical time (relative)



Hierarchical rep.



Duration: Implied vs. real (MIDI)



Upper row: The first six notes of this piece are written in notes of equal duration. == **Quantized**

Lower row: The actual sounding durations are variable. == **Unquantized**

[Bear in mind complex nature of temporal value]

Tempo and quantization

- ❑ Software may have tempo controls; MIDI hardware does not
- ❑ **Quantized MIDI files** suited to transcription
- ❑ **Unquantized MIDI files:** expressive, not suited to transcription

Practical consequences of time precision

Recorded sound vs
MIDI-based notation

<https://www.youtube.com/watch?v=4iozcfAeZzE>

Lili Marlen'

http://fingeb.org Norbert Schulze 1937

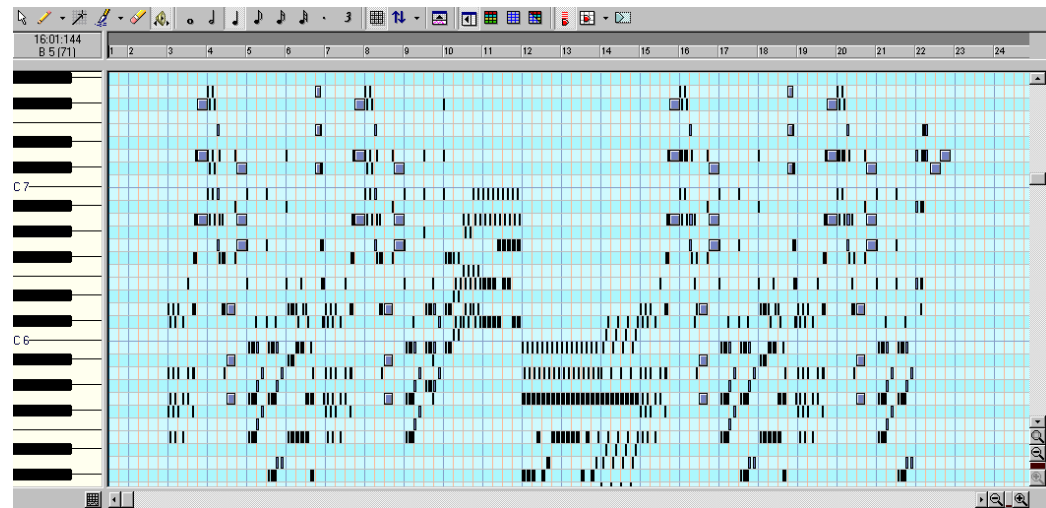
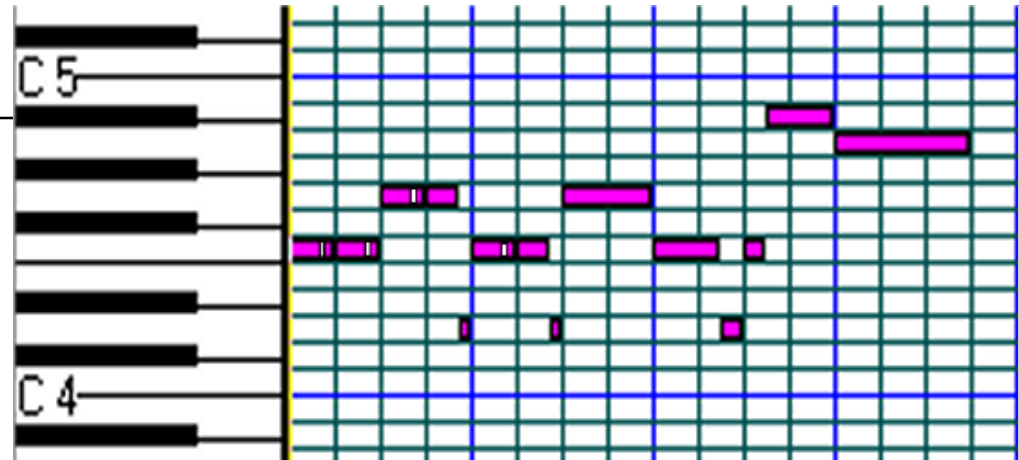
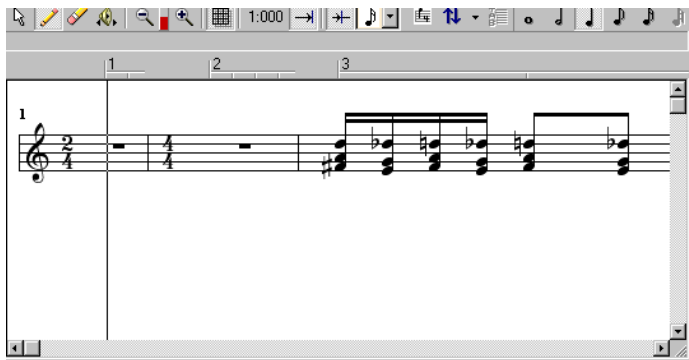
The image shows a musical score for the song 'Lili Marlen' by Norbert Schulze (1937). The score is in 2/4 time and features a vocal line and piano accompaniment. Vertical red lines are drawn through the score, indicating specific time points or measures. The score is divided into two systems, each with a first ending (1. 4.) and a second ending (2. 5.).

<https://www.youtube.com/watch?v=4iozcfAeZzE>

https://en.wikipedia.org/wiki/Lili_Marleen

Sequencers

- Piano roll
- Event list
- Staff notation
- Virtual keyboard



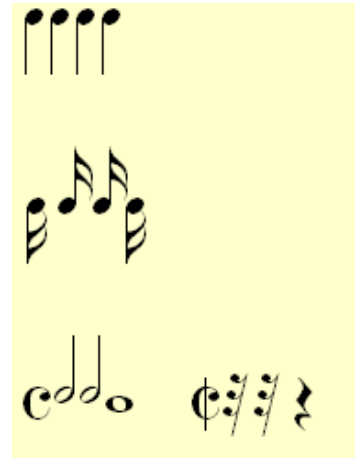
Clock-time in MIDI Event List

Absolute (machine)

- Clock ticks/measure
(120, 192, 240)
- Ticks/quarter note
(30, 48, 60)

Midi time stamps

| Trk | HMSF | MBT | Ch | Kind | Data | |
|-----|-------------|----------|----|---------|---------------------------|---------------------|
| 1 | 00:00:01:16 | 2:01:000 | 1 | Control | 7-Volume | 63 |
| 1 | 00:00:01:16 | 2:01:000 | 1 | Patch | Normal | Acoustic Grand Pian |
| 1 | 00:00:01:16 | 2:01:000 | 1 | Control | 91-External Effects depth | 64 |
| 1 | 00:00:01:16 | 2:01:000 | 1 | Control | 7-Volume | 63 |
| 1 | 00:00:01:18 | 2:01:030 | 1 | Control | 7-Volume | 62 |
| 1 | 00:00:01:18 | 2:01:030 | 1 | Control | 7-Volume | 64 |
| 1 | 00:00:01:18 | 2:01:030 | 1 | Control | 7-Volume | 64 |
| 1 | 00:00:01:19 | 2:01:050 | 1 | Control | 7-Volume | 64 |
| 1 | 00:00:01:19 | 2:01:050 | 1 | Control | 7-Volume | 66 |
| 1 | 00:00:01:20 | 2:01:060 | 1 | Control | 7-Volume | 66 |
| 1 | 00:00:01:21 | 2:01:080 | 1 | Control | 7-Volume | 67 |
| 1 | 00:00:02:14 | 2:02:000 | 1 | Patch | Normal | 1 Flute |
| 1 | 00:00:04:09 | 2:04:000 | 1 | Control | 0 | 0 |
| 1 | 00:00:04:09 | 2:04:000 | 1 | Control | 32 | 1 |
| 1 | 00:00:05:07 | 3:01:000 | 1 | Note | D 6 | 100 60 |
| 1 | 00:00:05:07 | 3:01:000 | 1 | Note | A 5 | 100 60 |
| 1 | 00:00:05:07 | 3:01:000 | 1 | Note | F#5 | 100 60 |
| 1 | 00:00:05:14 | 3:01:120 | 1 | Note | Db6 | 100 60 |
| 1 | 00:00:05:14 | 3:01:120 | 1 | Note | G 5 | 100 60 |
| 1 | 00:00:05:14 | 3:01:120 | 1 | Note | E 5 | 100 60 |
| 1 | 00:00:05:21 | 3:01:240 | 1 | Note | D 6 | 100 60 |
| 1 | 00:00:05:21 | 3:01:240 | 1 | Note | A 5 | 100 60 |
| 1 | 00:00:05:21 | 3:01:240 | 1 | Note | F#5 | 100 60 |
| 1 | 00:00:05:28 | 3:01:360 | 1 | Note | Db6 | 100 60 |
| 1 | 00:00:05:28 | 3:01:360 | 1 | Note | G 5 | 100 60 |
| 1 | 00:00:05:28 | 3:01:360 | 1 | Note | E 5 | 100 60 |
| 1 | 00:00:06:05 | 3:02:000 | 1 | Note | D 6 | 100 60 |
| 1 | 00:00:06:05 | 3:02:000 | 1 | Note | A 5 | 100 60 |
| 1 | 00:00:06:05 | 3:02:000 | 1 | Note | F#5 | 100 60 |
| 1 | 00:00:06:18 | 3:02:240 | 1 | Note | Db6 | 100 60 |
| 1 | 00:00:06:18 | 3:02:240 | 1 | Note | G 5 | 100 60 |
| 1 | 00:00:06:18 | 3:02:240 | 1 | Note | E 5 | 100 60 |
| 1 | 00:00:07:02 | 3:03:000 | 1 | Note | E 6 | 100 60 |
| 1 | 00:00:07:02 | 3:03:000 | 1 | Note | A 5 | 100 60 |
| 1 | 00:00:07:02 | 3:03:000 | 1 | Note | G 5 | 100 60 |
| 1 | 00:00:07:16 | 3:03:240 | 1 | Note | D 6 | 100 60 |
| 1 | 00:00:07:16 | 3:03:240 | 1 | Note | A 5 | 100 60 |
| 1 | 00:00:07:16 | 3:03:240 | 1 | Note | F#5 | 100 60 |
| 1 | 00:00:07:20 | 3:03:300 | 1 | Note | F#6 | 100 60 |
| 1 | 00:00:07:20 | 3:03:300 | 1 | Note | D 6 | 100 60 |
| 1 | 00:00:07:20 | 3:03:300 | 1 | Note | A 5 | 100 60 |
| 1 | 00:00:07:23 | 3:03:360 | 1 | Note | A 6 | 100 60 |
| 1 | 00:00:07:23 | 3:03:360 | 1 | Note | F#6 | 100 60 |
| 1 | 00:00:07:23 | 3:03:360 | 1 | Note | D 6 | 100 60 |
| 1 | 00:00:07:26 | 3:03:420 | 1 | Note | D 7 | 100 60 |
| 1 | 00:00:07:26 | 3:03:420 | 1 | Note | A 6 | 100 60 |
| 1 | 00:00:07:26 | 3:03:420 | 1 | Note | F#6 | 100 60 |
| 1 | 00:00:08:00 | 3:04:000 | 1 | Note | F#7 | 100 1:000 |



MIDI data organization (sound)

Event-based system

Part- major systems

Affects *Finale*, Sibelius

The image displays a musical score for Sibelius's 'Finale'. The score is organized into two systems. The first system includes staves for 'clarinet in A', 'violina I', 'violina II', 'viola', and 'violoncello'. The second system includes staves for 's' (soprano), 'pt= p' (piano), 'pi= p' (piano), and 'pt= p' (piano). A vertical yellow highlight is placed over the middle of the first system, spanning all five staves. The score is written in 2/4 time and features various musical notations, including notes, rests, and dynamic markings.

Early MIDI file types

- Vertically organized
 - 0 = monophonic music [merged single track]
 - 1 = polyphonic music [multiple tracks]
- Horizontally organized
 - 2 = accommodates rhythmically independent tracks

See MMA file: http://www.midi.org/aboutmidi/tut_midifiles.php

Standard MIDI File Format (SMFF)

- “Chunks” (file sections)
 - **Header chunks (MThd):** what to expect in the data
 - Byte segments address
 - Chunk type
 - Header length
 - Number of tracks
 - Meaning of *delta* times
 - Time code
 - Slight differences by format type (0, 1, 2)
 - Track chunks (MTrk):

MIDI data for notation

- “Pitch” < **Key number**
- “Duration” = **Clock time**
 - Articulation
 - But pizzicato = Gen. MIDI 45
 - Staccato
- Dynamic range < velocity
- “Tempo”
 - < ratio of quarter to whole 12345
- **Meta-events**
 - Key signature
 - Meter signature
 - Lyrics
 - Copyright notice

The image displays a musical score for the second trio from the Mozart Clarinet Quintet, K. 581. The score is written for five instruments: clarinet in A, violin I, violin II, viola, and violoncello. The key signature is one sharp (F#) and the time signature is 3/4. The clarinet part is marked with a piano (p) dynamic. The violin and viola parts also have piano markings. The violoncello part has a pizzicato (pizz.) marking. The score includes various musical notations such as notes, rests, and articulation marks.

Example 1.1 Second trio from the Mozart Clarinet Quintet, K. 581 (“Mozart trio”).

Standard MIDI File Format (SMFF)

- “Chunks” (file sections)
 - Header chunks (MThd)
 - **Track chunks (MTrk)**: sequential data
 - Iterative process
 - Delta [*difference*] time [elapsed time since last even]
 - Event
 - Event types
 - **MIDI events** (note on, note off et al.)
 - **Meta-events** (see above; often textual)
 - **System-exclusive events** (hardware-specific, proprietary)

General MIDI “instruments”

Timbre

- String
- Woodwind
- Brass
- Percussion
- Voice

Level II—1999

General MIDI

- 256 slots (extended set)
 - 128 standard
 - 128 proprietary
- Many synthetic slots
- Quality varies by category
 - Strings
 - Woodwind
 - Brass
 - Percussion
 - Tuned and/or “dry” percussion
 - Voice (try MIDI Oohs and aahs)

Sample files

Quantized

Unquantized (recorded)