From Sound to Input and Output

Music 253/CS 275A

Stanford University

Latest MIDI controllers

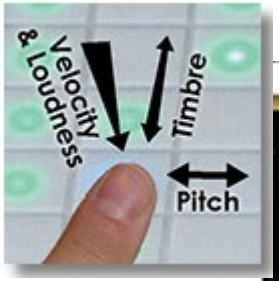
Yamaha *Tenori-on* controller for "drawing" music input

MIDI controller with iPhone cradle

Haken Audio Continuum: High-end audio

Roli Seaboard Rise: gesture

Linnstrument (expression)



Note locations in 4ths tuning. Click to expand.

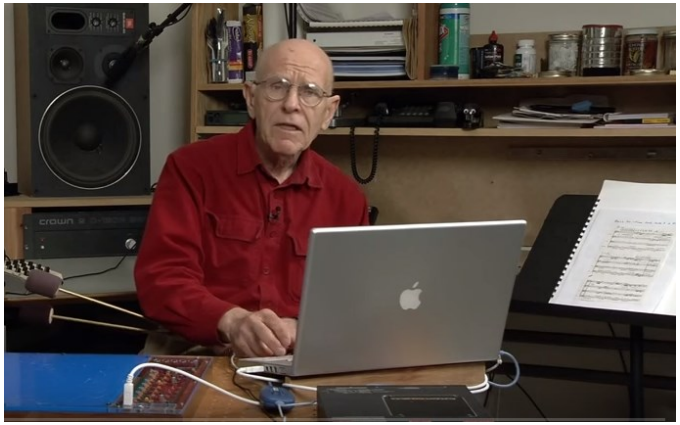
Alternative MIDI instruments

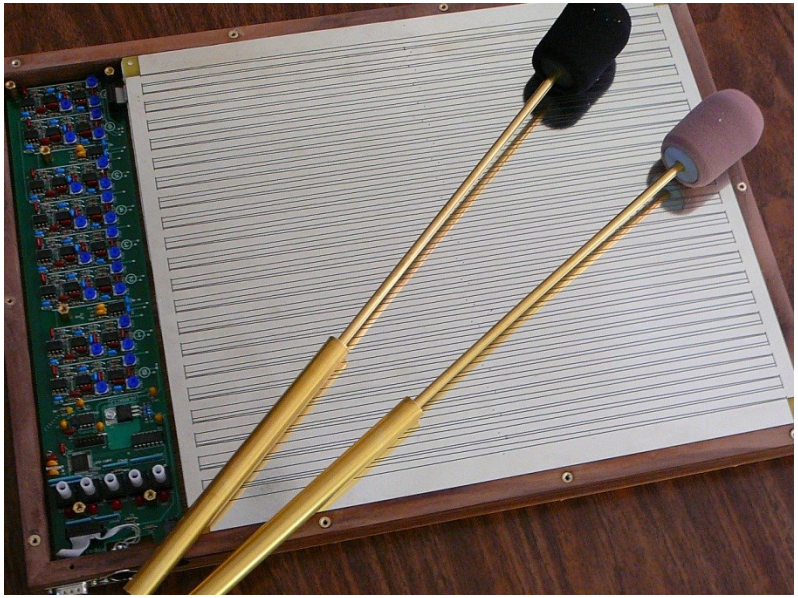
- MIDI horn: Gary Lee Nelson
- MIDI trumpet: Dexter Morrell
- MIDI chelletto (“little cello”): Chris
- MIDI violin: Yamaha
- MIDI guitar: Zeta Music/Gibson

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

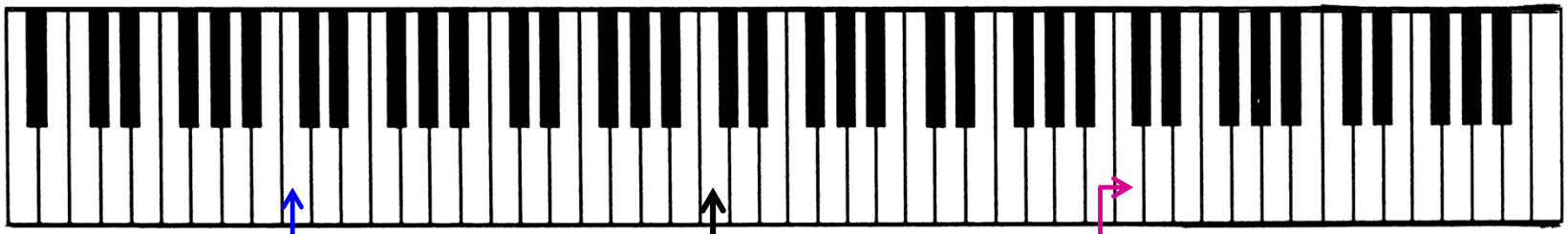




Max Mathews' Radio Baton

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

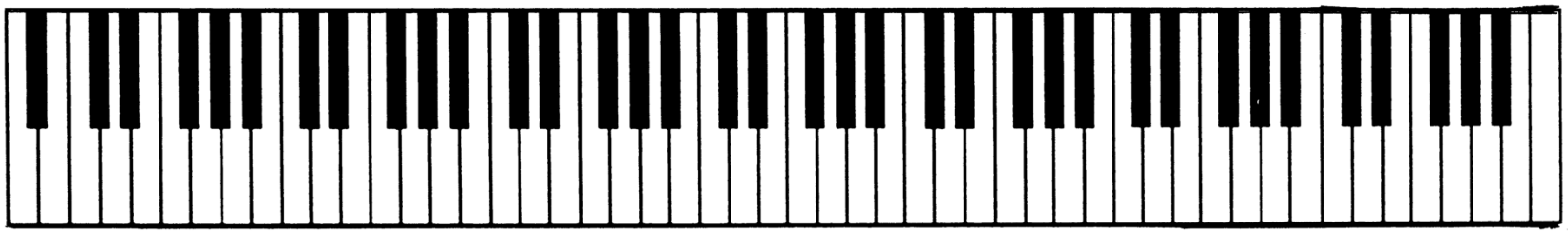
"Pitch" = key number



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

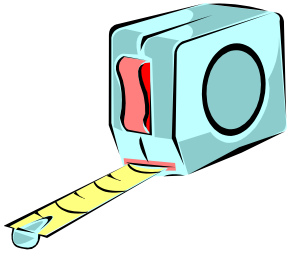
Manufacturing **variations:**
Middle C = 60
Middle C = 48

The MIDI pitch interface



Keyssolut (MIDI C'S)

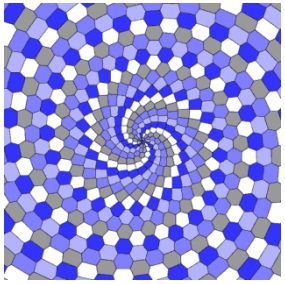
- 36
- 48
- **60**
- 72
- 84



Number-line representation

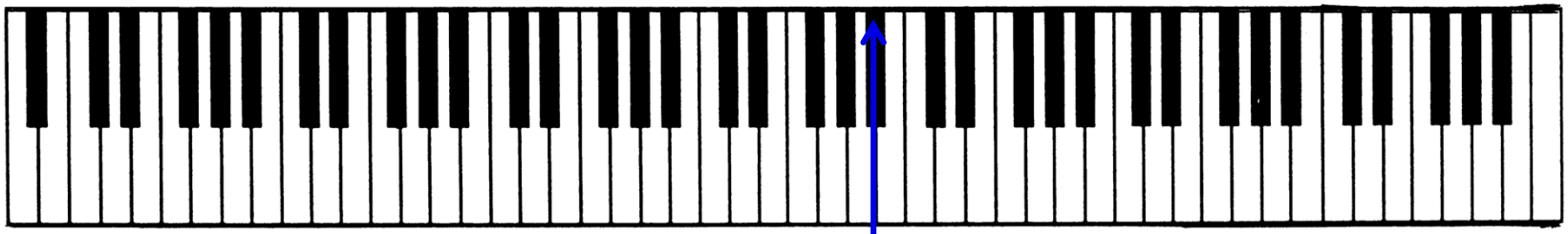
Octaves (Human being)

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



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***

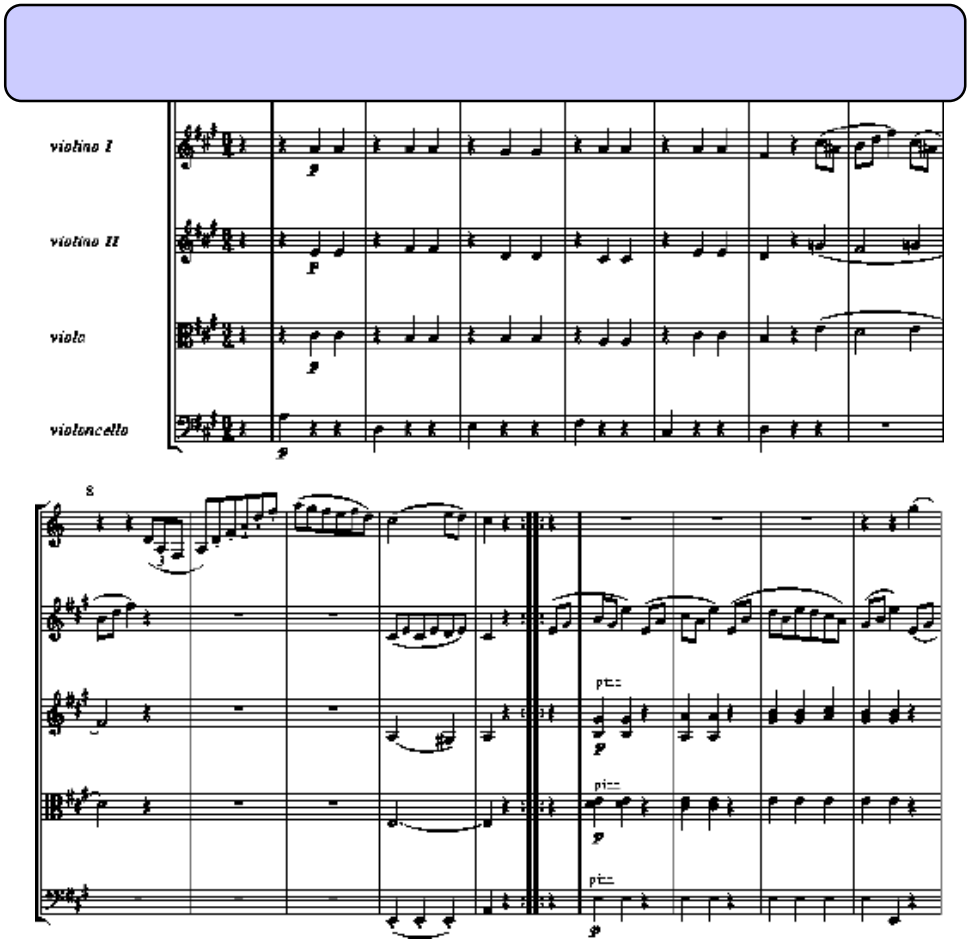
- CC
- C
- c (Middle C)
- c'
- c"

Data divergence (sound/notation)

Event-based system

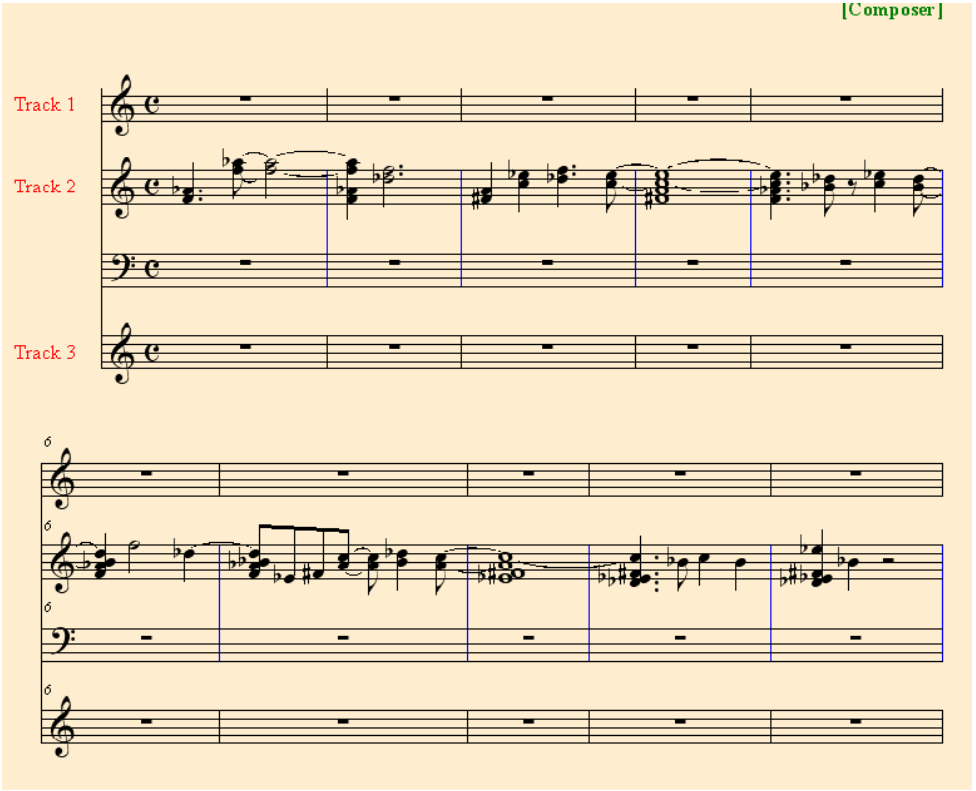
Sounding pitch captured

in MIDI



Pitch in MIDI transcription

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



The MIDI duration interface

Clock time (absolute)

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

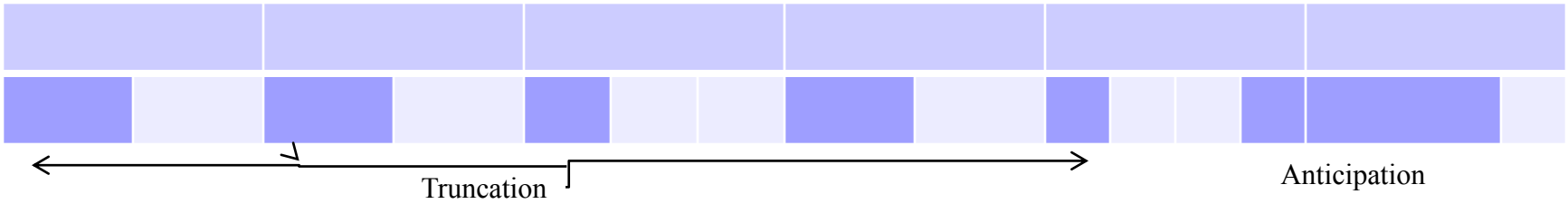
Linear rep.

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]

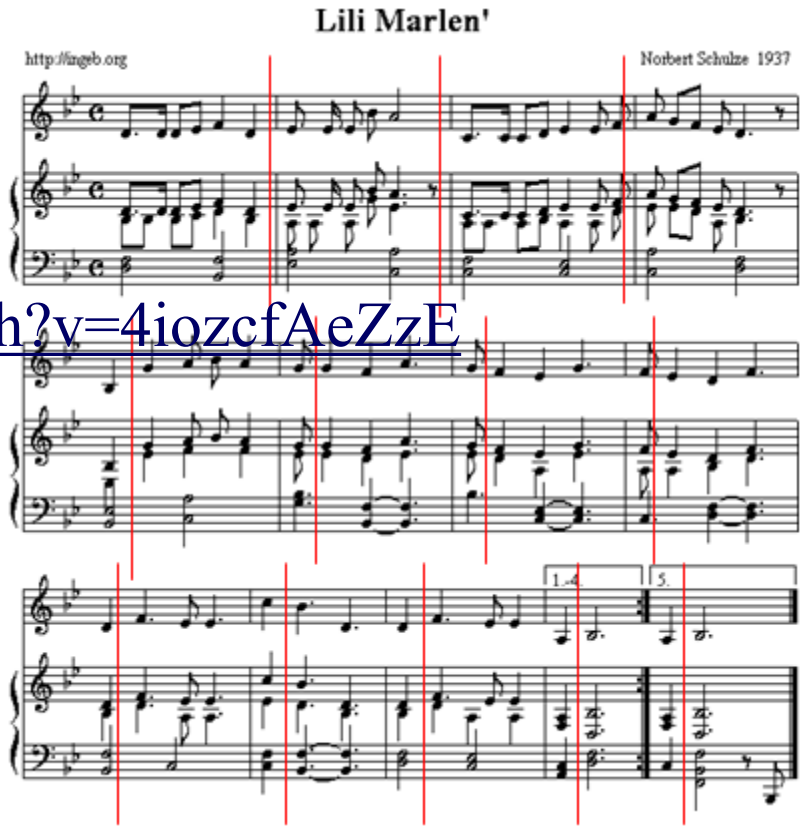
Tempo and quantization

- 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

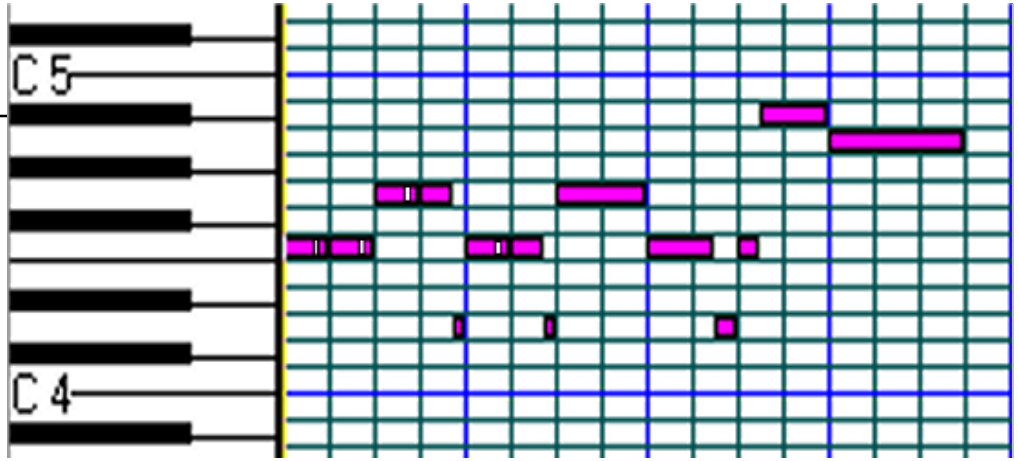


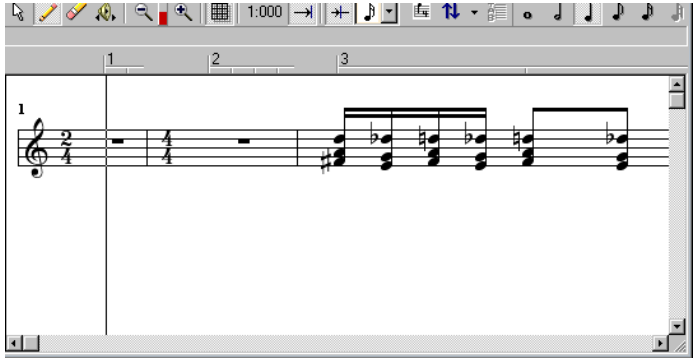
https://www.youtube.com/watch?v=4iozcfAeZzE

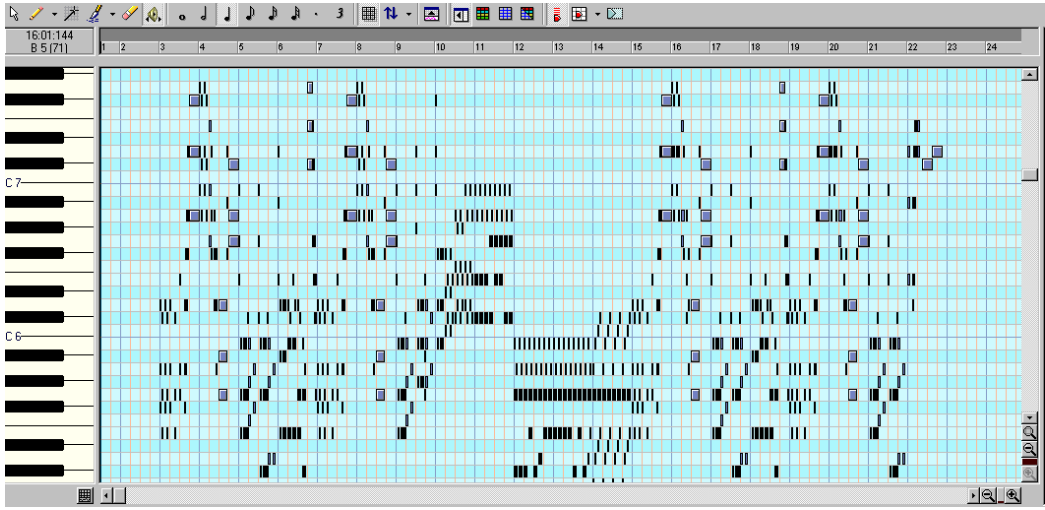
https://en.wikipedia.org/wiki/Lili_Marleen

Sequencers

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





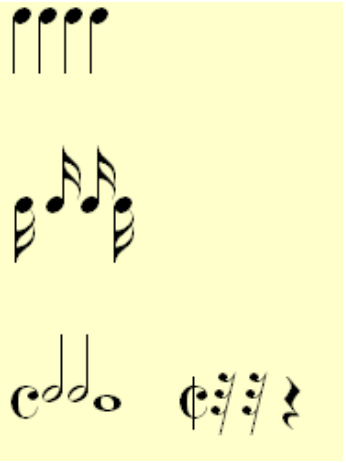


Clock-time in MIDI Event List

Absolute (machine)

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

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 Piar
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



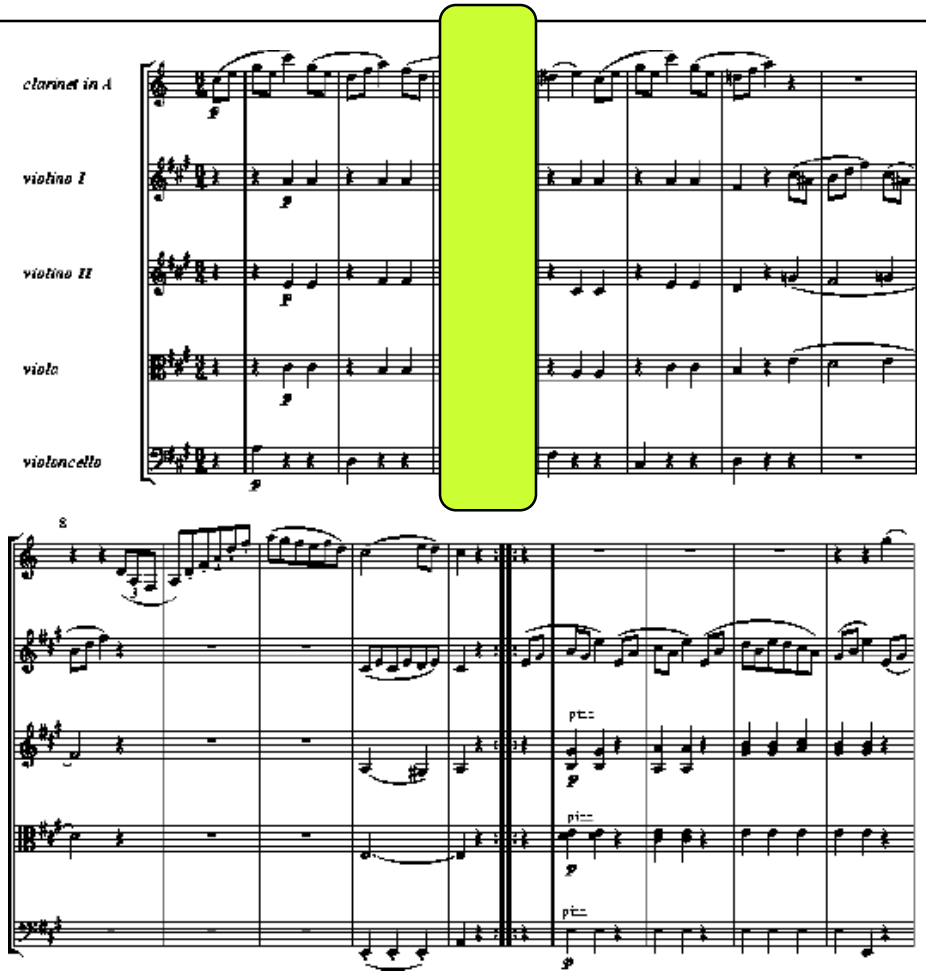
Midi time stamps

MIDI data organization (sound)

Event-based system

Part- major systems

Affects *Finale, Sibelius*



Early MIDI file types

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

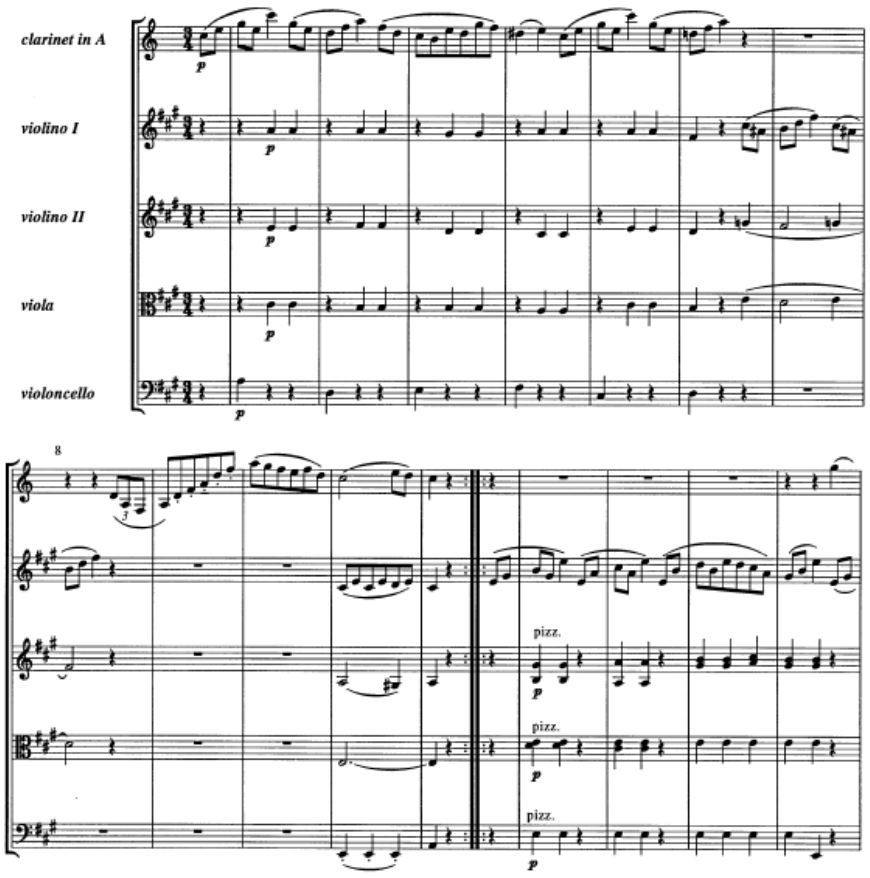
See MMA file: http://www.midi.org/aboutmidi/tut_midifiles.php

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 whole12345
- Meta-events
  - Key signature
  - Meter signature
  - Lyrics
  - Copyright notice



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-event**s (see above; often textual)
      - **System-exclusive event**s (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)