

# From Sound to Input and Output

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MUSIC 253/CS 275A

STANFORD UNIVERSITY

A solid purple horizontal bar at the bottom of the slide.

# Experimental MIDI controllers



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

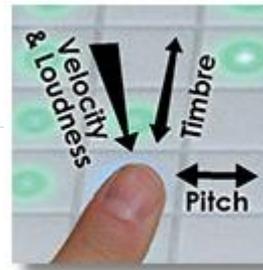
MIDI controller with iPhone cradle



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 Chafe Chafe

MIDI violin: Yamaha

MIDI guitar: Zeta Music/Gibson



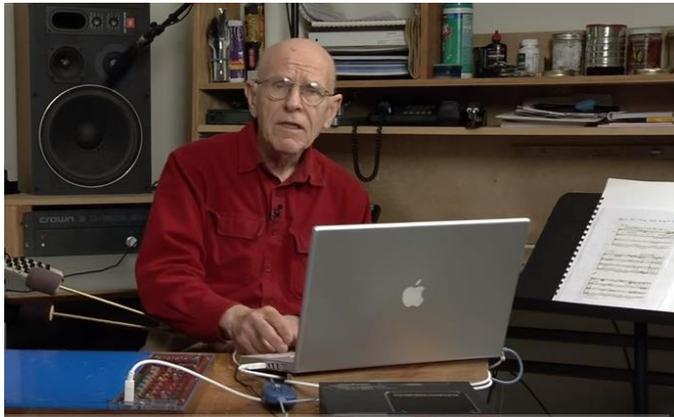
Akai wind  
Controller  
(2016)

# MIDI as an adjunct to other sound tech

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MIDI data can be synchronized with other kinds of data

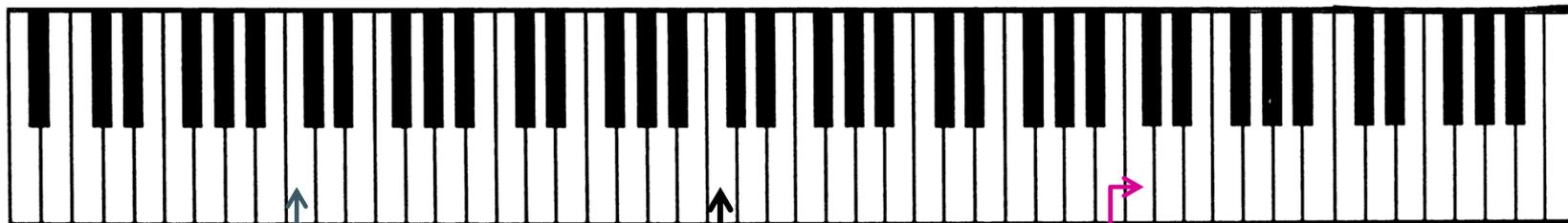
- Video, animations
- Electronic instruments
- Software routines



Max Mathews' Radio Baton

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

# “Pitch” in MIDI = key number



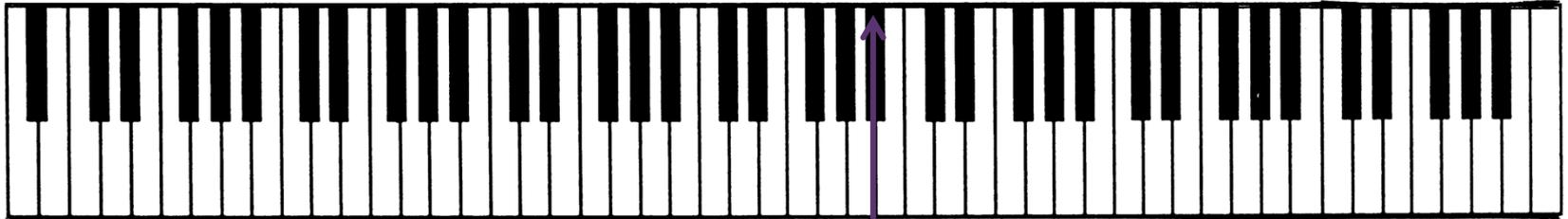
- Absolute (MIDI C's)
  - 36 etc.
  - 48 C 8ve below Middle C
  - **60 Middle C**
  - 72 C 8ve above Middle C
  - **84 etc.**

## Manufacturing variations:

Middle C = 60

Middle C = 48

# Key-number pitch is *absolute*; Tonal music notation pitch 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

**Transposing  
instruments**

The image displays a musical score for a string quartet and a clarinet. The top staff is labeled "clarinet in A" and is highlighted with a purple background. Below it are four staves for the string quartet: "violino I", "violino II", "viola", and "violoncello". The score is written in 2/4 time with a key signature of one sharp (F#). The clarinet part features a melodic line with slurs and accents. The string parts provide harmonic support with various rhythmic patterns and dynamics. A double bar line is present in the middle of the score, after which the string parts are marked with "pt==" and "p".

# Enharmonic notation in MIDI transcription

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

[Composer]

The image displays a MIDI transcription of a musical passage across three tracks. Track 1 is empty. Track 2 contains the main melody, written in treble clef with a common time signature. It features a sequence of chords and notes, including a prominent A# (black key) and Bb (black key) which are enharmonic equivalents. Track 3 is also empty. The notation uses black notes to represent these enharmonic equivalents, illustrating how MIDI transcription does not distinguish between them. The background is a light yellow color.

# MIDI transcription

Debussy: "Clair de lune"

- Via MIDI transcription
- Via print

PIANO

*Andante très expressif*

*pp* con sordina



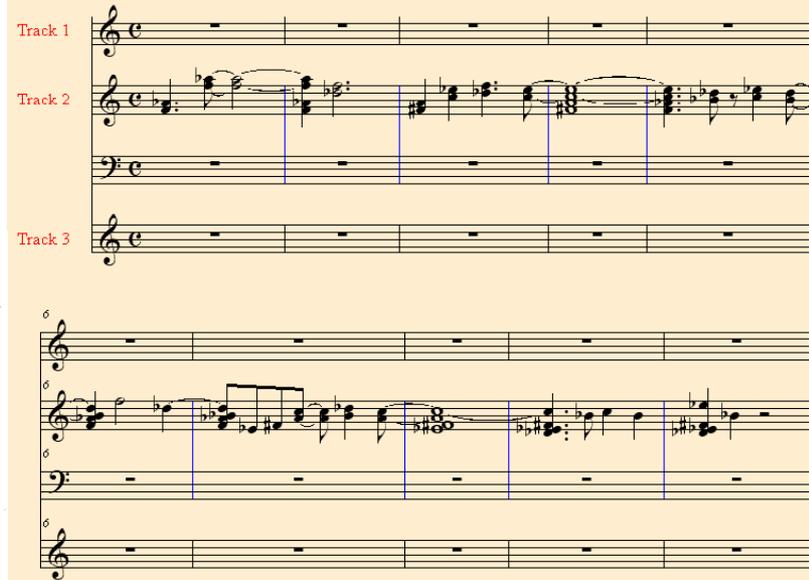
The image shows the first system of the piano score for Debussy's 'Clair de lune'. It features a treble and bass clef with a 9/8 time signature. The tempo is marked 'Andante très expressif' and the dynamics are 'pp' (pianissimo) with 'con sordina' (with sostenuto pedal). The music consists of a flowing melody in the right hand and a supporting bass line in the left hand.

[Composer]

Track 1

Track 2

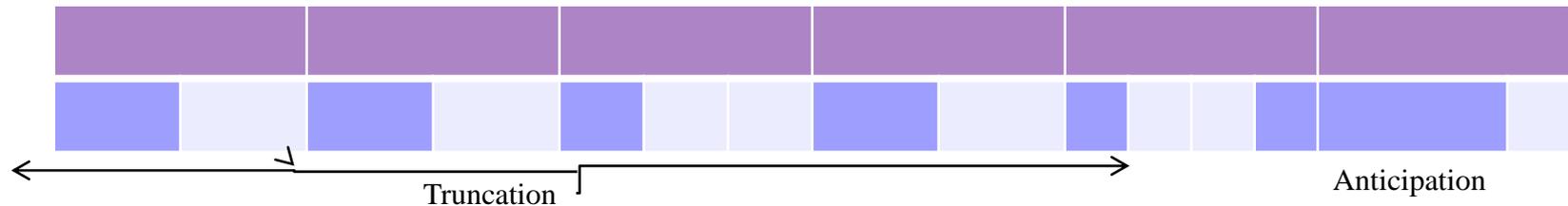
Track 3



The image displays a MIDI transcription of the first system of 'Clair de lune'. It is presented as three tracks on a yellow background. Track 1 is a treble clef staff with a whole rest. Track 2 consists of two staves: a treble clef staff with the main melody and a bass clef staff with the bass line. Track 3 is a treble clef staff with a whole rest. The notation includes notes, rests, and dynamic markings.

# Duration: Implied vs. real (MIDI)

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*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**

# Tempo and quantization

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Software may have tempo controls; MIDI hardware does not

**Quantized MIDI files** suited to transcription

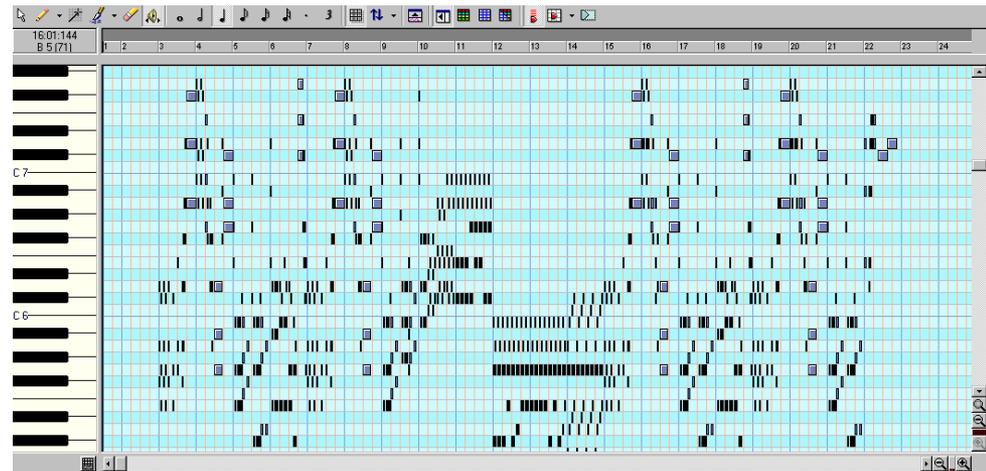
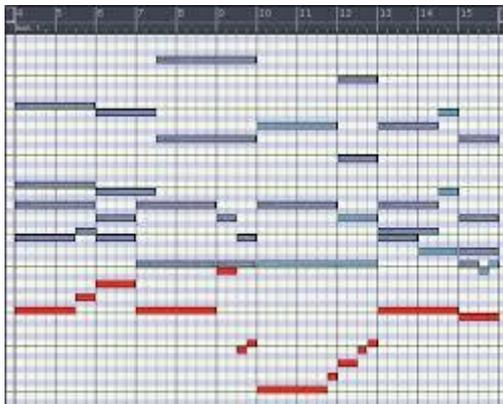
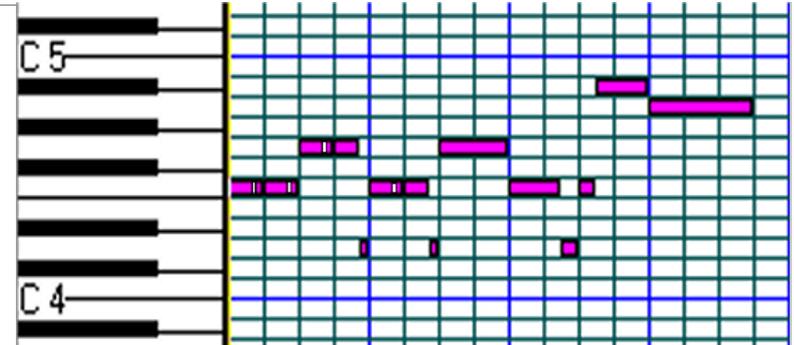
**Unquantized MIDI files:** expressive, not suited to transcription

# Sequencers

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

Online sequencer:

<https://onlinesequencer.net/>



# MIDI data organization

Event-based system

Part- major systems

Affects *Finale, Sibelius*

The image displays a musical score for Sibelius' *Finale*. The score is organized into two systems of staves. The first system includes staves for 'clarinet in A', 'violina I', 'violina II', 'viola', and 'violoncello'. A vertical yellow highlight covers a specific section of the music across all five staves. The second system continues the score with a section marked '8' at the beginning. This system includes staves for 'violina I', 'violina II', 'viola', and 'violoncello', with dynamic markings 'p' and 'pt= p' visible. The score is written in a key signature of one sharp (F#) and a 2/4 time signature.

# Early MIDI file types

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## 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](http://www.midi.org/aboutmidi/tut_midifiles.php)

# 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 shows a musical score for the second trio from the Mozart Clarinet Quintet, K. 581. The score is in 3/4 time and G major. It features five staves: clarinet in A, violin I, violin II, viola, and violoncello. The clarinet part is marked with a piano (p) dynamic. The string parts also have piano markings, with some pizzicato (pizz.) markings for the violins and viola. The score includes various musical notations such as slurs, ties, and dynamic markings.

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

# Standard MIDI File Format (SMFF)

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## “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):

# Standard MIDI File Format (SMFF)

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## “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

GENERAL MIDI

String

Woodwind

Brass

Percussion

Voice

**Standard MIDI file format**

**Level 1 1988**

**Level II—1999**

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)