

CS101 Lecture 16: Computer Generated Music

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1 March 2013



What You'll Learn Today



- Music encoding schemes
- Programmable music playback machines
- Computer generated music

Other Ways to Represent Music:

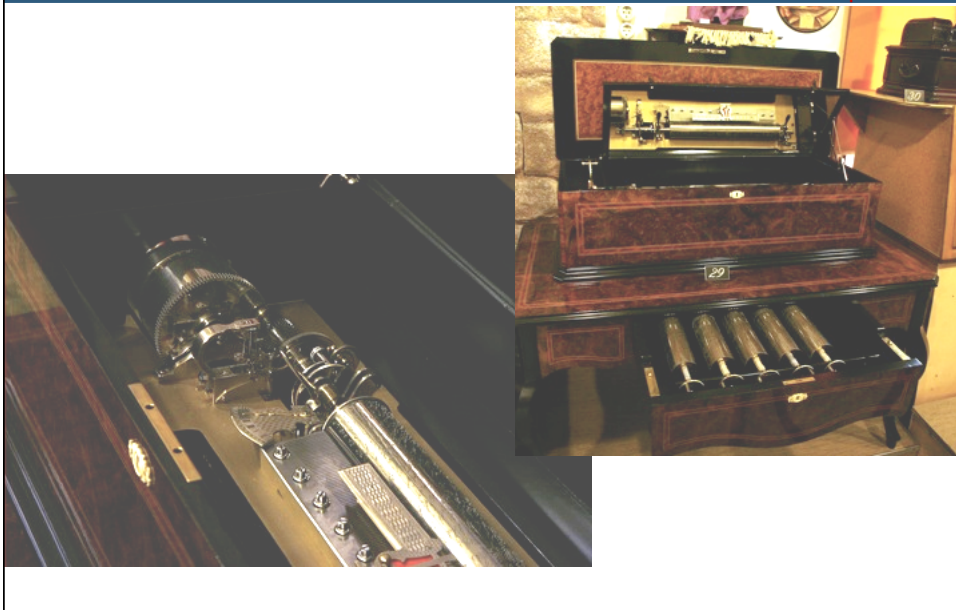


Prelude 1 in C Major J.S. Bach

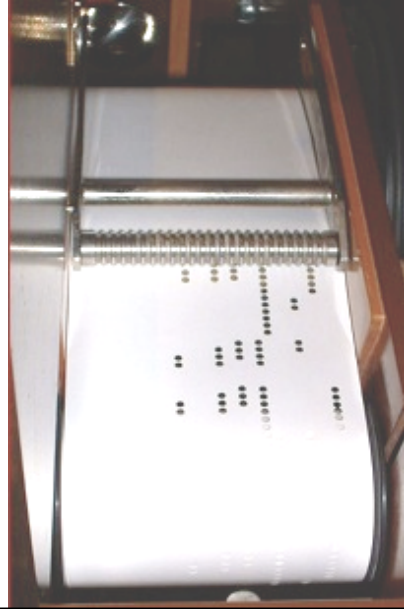
C Dm II G7

C Am II

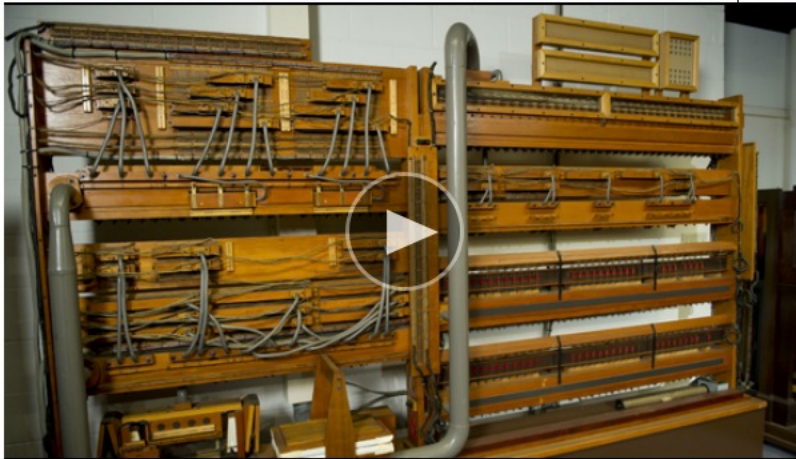
How does a music box work?



What about a player piano?



BU's John R. Silber Organ



<http://www.bu.edu/today/2011/icons-among-us-the-john-r-silber-symphonic-organ/>
<http://www.bu.edu/buniverse/view/?v=1FTkaLbT>

Musical Instrument Digital Interface



The MIDI protocol provides a way to specify music as instructions.

What kind of computer instructions do we need to explain this sound?



(play a few seconds of the song “Thunderstruck”)

Musical Instrument Digital Interface



Each MIDI instruction (“event”) specifies:

- timestamp
- action, for example: NoteOn, NoteOff
- note, for example: 59 is B, 63 is D#.
- velocity (volume)

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1, Min:Sec:Frames=0:00:00, TrackName: Track 3
2, Min:Sec:Frames=0:00:00, ChannelPrefix, channel prefix: 0
3, Min:Sec:Frames=0:00:00, ResetAllControllers, chan: 1, value: 0
4, Min:Sec:Frames=0:00:00, TimeSignature, Time signature: 4, 2, 24, 8
5, Min:Sec:Frames=0:00:13, ChannelVolume, chan: 1, value: 90
6, Min:Sec:Frames=0:00:13, BankSel, chan: 1, value: 0
7, Min:Sec:Frames=0:00:13, ProgramChange, chan: 1, value: 29
8, Min:Sec:Frames=0:00:13, EffectsDepth, chan: 1, value: 45
9, Min:Sec:Frames=0:00:13, ChorusDepth, chan: 1, value: 0
10, Min:Sec:Frames=0:02:03, NoteOn, chan: 1, note: 59, vel: 98, dur: 58
11, Min:Sec:Frames=0:02:07, NoteOff, chan: 1, note: 59
12, Min:Sec:Frames=0:02:07, NoteOn, chan: 1, note: 63, vel: 101, dur: 57
13, Min:Sec:Frames=0:02:10, NoteOff, chan: 1, note: 63
14, Min:Sec:Frames=0:02:10, NoteOn, chan: 1, note: 59, vel: 110, dur: 58
15, Min:Sec:Frames=0:02:13, NoteOff, chan: 1, note: 59
16, Min:Sec:Frames=0:02:13, NoteOn, chan: 1, note: 66, vel: 105, dur: 57
17, Min:Sec:Frames=0:02:17, NoteOff, chan: 1, note: 66
18, Min:Sec:Frames=0:02:17, NoteOn, chan: 1, note: 59, vel: 102, dur: 57
19, Min:Sec:Frames=0:02:20, NoteOff, chan: 1, note: 59
20, Min:Sec:Frames=0:02:20, NoteOn, chan: 1, note: 63, vel: 101, dur: 58
21, Min:Sec:Frames=0:02:23, NoteOff, chan: 1, note: 63
22, Min:Sec:Frames=0:02:23, NoteOn, chan: 1, note: 59, vel: 108, dur: 58
23, Min:Sec:Frames=0:02:27, NoteOff, chan: 1, note: 59
24, Min:Sec:Frames=0:02:27, NoteOn, chan: 1, note: 66, vel: 101, dur: 55
25, Min:Sec:Frames=0:03:00, NoteOff, chan: 1, note: 66
26, Min:Sec:Frames=0:03:00, NoteOn, chan: 1, note: 59, vel: 99, dur: 58
27, Min:Sec:Frames=0:03:00, NoteOff, chan: 1, note: 59

```

MIDI Note Numbers



Octave #	Note Numbers											
	C	C#	D	D#	E	F	F#	G	G#	A	A#	B
-1	0	1	2	3	4	5	6	7	8	9	10	11
0	12	13	14	15	16	17	18	19	20	21	22	23
1	24	25	26	27	28	29	30	31	32	33	34	35
2	36	37	38	39	40	41	42	43	44	45	46	47
3	48	49	50	51	52	53	54	55	56	57	58	59
4	60	61	62	63	64	65	66	67	68	69	70	71
5	72	73	74	75	76	77	78	79	80	81	82	83
6	84	85	86	87	88	89	90	91	92	93	94	95
7	96	97	98	99	100	101	102	103	104	105	106	107
8	108	109	110	111	112	113	114	115	116	117	118	119
9	120	121	122	123	124	125	126	127				

Note: The MIDI specification only defines note number 60 as "Middle C", and all other notes are relative. The absolute octave number designations shown here are based on Middle C = C4, which is an arbitrary assignment.



SOURCE:
<http://www.harmony-central.com/MIDI/Doc/table2.html>

Anvil Studio (free software)



Thunderstruck - Track 3 - Anvil Studio - version 2009.10.08

File Edit Track View Practice Help Back

Time: 0:00:00 Duration: 4:03:00

Unswaved step sync REC Ctrl

Track Name	Type	On	Device	Channel	Instrument	Vol	Pan	In
Track 2	Instrument	on	General MIDI	4	Ovevdriven Guitar	11	11	fx
Track 3	Instrument	on	General MIDI	1	Ovevdriven Guitar	11	11	fx
Track 4	Instrument	on	General MIDI	2	Electric Bass (Finger)	11	11	fx
Track 5	Instrument	on	General MIDI	3	Ovevdriven Guitar	11	11	fx
Track 6	Instrument	on	General MIDI	5	Acoustic Grand	11	11	fx
Track 7	Instrument	on	General MIDI	6	Acoustic Grand	11	11	fx
Track 8	Instrument	on	General MIDI	7	Acoustic Grand	11	11	fx
Track 9	Instrument	on	General MIDI	8	Acoustic Grand	11	11	fx
Track 10	Instrument	on	General MIDI	9	Acoustic Grand	11	11	fx
Track 11	Instrument	on	General MIDI	11	Acoustic Grand	11	11	fx
Track 12	Instrument	on	General MIDI	12	Acoustic Grand	11	11	fx
Track 13	Instrument	on	General MIDI	13	Acoustic Grand	11	11	fx
Track 14	Instrument	on	General MIDI	14	Acoustic Grand	11	11	fx
Track 15	Instrument	on	General MIDI	15	Acoustic Grand	11	11	fx
Track 16	Instrument	on	General MIDI	16	Hardy-Tank	11	11	fx

Staff

Key: C Major Time: 4/4 Show: 10th notes Style: Treble-Bass

View / Composer (for Instrument tracks)

This screen shows the music for the active track, selected in the Mixer screen. Since the track's Type attribute is set to Instrument, it shows sheet music. If you would rather edit a Piano Roll format, click the field that says Staff and change it to Piano Roll.

Why use MIDI?



Writing instructions takes a lot less space than sampling the waveforms:

Thunderstruck.mid	Oct 15, 2009 1:21 PM	53 KB
Thunderstruck.mp3	Jul 21, 2009 9:12 AM	7 MB

$53,000 / 7,000,000 = 0.007$ data ratio, better than 99% savings.

When should we use MIDI?

Compare sampled vs. MIDI to raster vs. vector graphics



The same is true for sampled music vs. MIDI.

What You Learned Today



- Music notation
- Music playback machines
- MIDI - encoding

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Announcements and To Do



Readings:

- Wong ch 4, pp 102-117 (today)
- Reed ch 3, pp44-50 (for Monday)

HW 7 due Wednesday 3/6

QUIZ 3 will be on Friday 3/8

- HTML forms, CSS, frames, images, audio

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