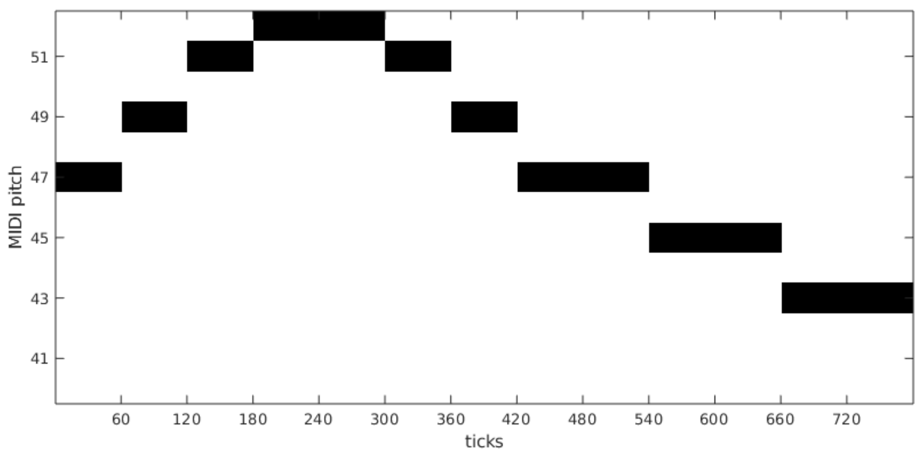
ECS7006 Music Informatics

Tutorial - Music Representations

1. You will find below the piano-roll representation for a music segment. Convert it into a list of MIDI messages, assuming a velocity of an active note to be at 100.



Solution:

TIME	MESSAGE	CHANNEL	NOTE NUMBER	VELOCITY
0	NOTE ON	1	47	100
60	NOTE OFF	1	47	0
0	NOTE ON	1	49	100
60	NOTE OFF	1	49	0
0	NOTE ON	1	51	100
60	NOTE OFF	1	51	0
0	NOTE ON	1	52	100
120	NOTE OFF	1	52	0
0	NOTE ON	1	51	100
60	NOTE OFF	1	51	0
0	NOTE ON	1	49	100
60	NOTE OFF	1	49	0
0	NOTE ON	1	47	100
120	NOTE OFF	1	47	0
0	NOTE ON	1	45	100
120	NOTE OFF	1	45	0
0	NOTE ON	1	43	100
120	NOTE OFF	1	43	0

2. Compute the centre frequencies for MIDI notes 33, 45, 57, 69, and 81.

   Solution:
   Using equation:
   $$F_{pitch}(p) = 2^{(p-69)/12} \cdot 440$$
   we obtain the following:

   - $F_{pitch}(33) = 55$ Hz
   - $F_{pitch}(45) = 110$ Hz
   - $F_{pitch}(57) = 220$ Hz
   - $F_{pitch}(69) = 440$ Hz
   - $F_{pitch}(81) = 880$ Hz

3. Common intervals in Western music include the following:

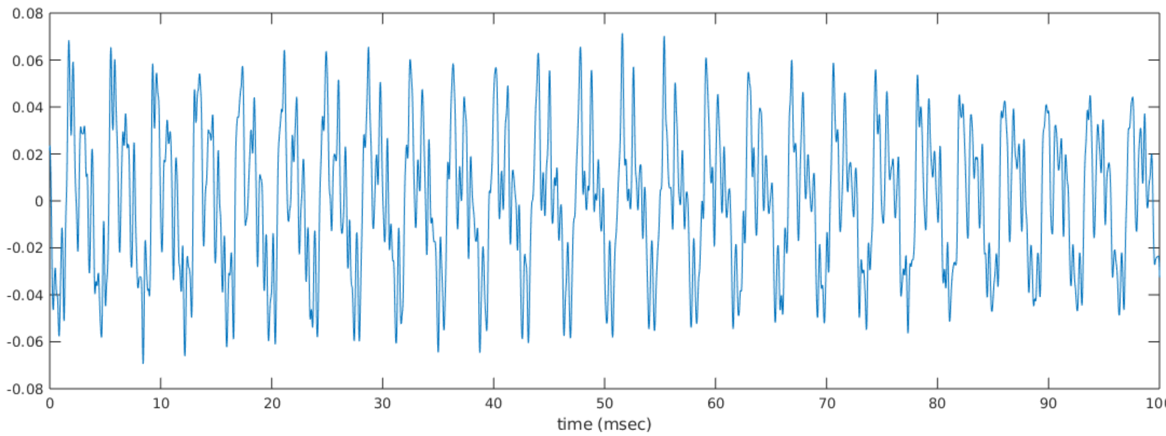
   - perfect fifth (7 semitones)
   - major third (4 semitones)
   - minor third (3 semitones)

   Compute the frequency ratio of the above mentioned intervals. What can be observed?

   Solution:

   - perfect fifth:
     $F_{pitch}(p+7)/F_{pitch}(p) = \frac{2^{(p+7-69)/12} \cdot 440}{2^{(p-69)/12} \cdot 440} = 2^{7/12} \approx 1.4983 \approx \frac{3}{2}$
   - major third:
     $F_{pitch}(p+4)/F_{pitch}(p) = \frac{2^{(p+4-69)/12} \cdot 440}{2^{(p-69)/12} \cdot 440} = 2^{4/12} \approx 1.2599 \approx \frac{5}{4}$
   - minor third:
     $F_{pitch}(p+3)/F_{pitch}(p) = \frac{2^{(p+3-69)/12} \cdot 440}{2^{(p-69)/12} \cdot 440} = 2^{3/12} \approx 1.1892 \approx \frac{6}{5}$

4. The below waveform shows a zoomed in section of a piano note:



Estimate the fundamental frequency of the above audio segment by counting the numbers of oscillation cycles. Based on the estimated fundamental frequency, compute the MIDI pitch that corresponds to the above segment.

Solution:
The figure has 26 repeated patterns over 100 msec, thus the length of one oscillation (i.e. the period) is approximately 100/26 msec = 1/260 sec. Therefore, the fundamental frequency is the reciprocal of the period, i.e. 260 Hz. Using the below formula:

$$F_{pitch} = 2^{(p-69)/12} \cdot 440$$

We can compute the MIDI pitch as:

$$p = 12 \cdot \log_2(F_{pitch}/440) + 69 = 59.8921 \approx 60$$

(fyi - MIDI pitch 60 corresponds to note C4)

5. The intensity of a sound has been increased by 30 dB. How many times has the sound intensity increased in terms of W/m^2?

Solution:
Using the equation for computing intensity in decibels, assuming that I_{ref} is the reference sound intensity:

$$dB(I) = 10 \cdot \log_{10}\left(\frac{I}{I_{ref}}\right)$$

Then:

$$\frac{I}{I_{ref}} = 10^3$$

Therefore the new sound intensity differs from the reference sound intensity by a factor of 1000.