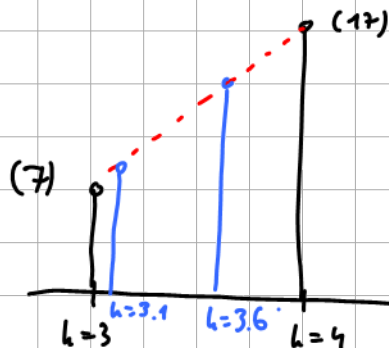


1)



linear interpolation

$$X(h) = m \cdot h + n$$

$$m = \frac{17-7}{4-3} = 10$$

$$7 = 10 \cdot 3 + n \quad (\Leftrightarrow) \quad n = 7 - 30 = -23$$

$$\Rightarrow X(h) = 10 \cdot h - 23$$

$$X(h=3.1) = 10 \cdot 3.1 - 23 = 31 - 23 = 8$$

$$X(h=3.6) = 10 \cdot 3.6 - 23 = 36 - 23 = 13$$

2) One Bandpass per Bark \Rightarrow 24 Bandpasses

10 ms hop size \Rightarrow 100 Spectra per second

$$\Rightarrow \text{Data rate} = 100 \frac{\text{Spectra}}{\text{s}} \cdot 24 \frac{\text{Bandpasses}}{\text{Spectrum}} \cdot 4 \frac{\text{Byte}}{\text{Bandpass}}$$

$$= 100 \cdot 24 \cdot 4 \cdot \frac{\text{Byte}}{\text{s}} = 9600 \frac{\text{Byte}}{\text{s}}$$

$$\text{Audio CD: } 2 \cdot 44100 \cdot 16 \frac{\text{Bit}}{\text{s}} \cdot \frac{1}{8} \frac{\text{Byte}}{\text{Bit}} = 176400 \frac{\text{Byte}}{\text{s}}$$

MP3 roughly factor 10 more compact than Audio CD:

$$17640 \frac{\text{Byte}}{\text{s}}$$

$$\text{Voice Codec for GSM: roughly } 12000 \frac{\text{Bit}}{\text{s}}$$

$$= 1500 \frac{\text{Byte}}{\text{s}}$$

3) Yes, for a wide range of the stretching human voice stays understandable.

Human speakers also use different speed when they are talking.

4) Yes, human speech stay understandable for a wide range of pitches.

Humans are able to understand children (which usually has the highest frequencies) and people with very low pitches, like bass-singers.

5) Transmitting only the envelope of local spectra results in very low quality but human speech stays understandable (in general).

6) For smaller values of number of bandpasses per bark, the local envelope is approximated in a more coarse way.

By decreasing the number of bandpasses per bark, the quality decreases a lot, but human voice stay understandable.

Therefore, it can be concluded, that the local envelope of the spectrum is sufficient for speech intelligibility.

7) Pitch is irrelevant, human voice stays understandable, even if the pitch is modified.

The speed of talking is irrelevant: human voice stays understandable for slow speakers and fast speakers in a wide range of talking speed.

The envelope of the local spectrum is relevant for voice understanding, as shown by reducing the number of bandpasses per bark to a very small value.





