Practise session 10: Image coding and compression.

1. Wavelet transform. (1p)
   The continuous wavelet transform (CWT) can be used to analyze features of a signal. Apply CWT to a 1D signal
   $$f(x) = \psi_{1,10}(x) + \psi_{6,80}(x)$$
   where $\psi_{s,t}(x)$ is the Mexican hat function
   $$\psi_{s,t}(x) = \frac{1}{\sqrt{s}}\psi\left(\frac{x-t}{s}\right)$$
   and
   $$\psi(x) = \left(\frac{2}{\sqrt{3}}\pi^{-1/4}\right)(1-x^2)e^{-x^2/2}$$
   So, the signal is the sum of two Mexican hats where the first one is scaled by 1 and translated by 10 units, and the latter part is scaled by 6 and translated by 80 units. Which properties of the signal are found in the CW-transform domain?

2. Huffman coding. (1p)
   The following 4x8, 8-bit image is given:

21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243

   a) What is the entropy of the image?
   b) Compress the image using Huffman coding.
   c) Compute the compression ratio and the effectiveness of the Huffman coding.
   d) Create a new “image” where the entries consist of pairs of adjacent pixels from the original image. What is the entropy of this new “image”?
   e) Create a new “image” where the entries come from the differences between two adjacent pixels. What is the entropy for this new “image”?

3. Image compression. (2p)
   The image in Fig. 1 is given. What would be suitable approach to compress the image losslessly (image coding) and then in a lossy manner? In the latter case (in lossy compression) what is the quality of the reconstructed image?

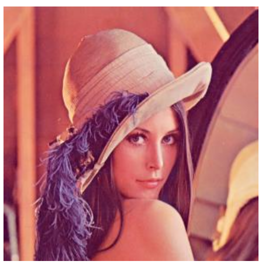

Fig. 1. Image for compression.