1. [3+3+3+3 points] Define the following concepts:
   (a) semiadaptive model
   (b) compression boosting

What is the main connection between the following pairs:
   (c) wavelet tree and compressed permutation
   (d) Burrows–Wheeler transform and move-to-front encoding

A few lines for each part is sufficient.

2. [6+6 points] Let \{a, b, c, d, e, f, g, h\} be the alphabet with the probability distribution

\[
\begin{array}{cccccccc}
\text{symbol} & a & b & c & d & e & f & g & h \\
\text{probability} & 0.10 & 0.15 & 0.15 & 0.05 & 0.25 & 0.10 & 0.15 & 0.05 \\
\end{array}
\]

(a) Construct a Huffman code for the above symbol distribution.

(b) Show that the code of (a)-part satisfies Kraft’s inequality with equality.

3. [12 points] Describe Shannon’s Noiseless Coding Theorem and discuss its significance for data compression. Your answer should cover both the lower bound and the upper bound part of the theorem.

4. [6+3+3 points] Consider a black-and-white image of \(n \times n\) pixels with \(m\) black pixels, where \(m\) is much smaller than \(n^2/2\). One method for compressing such an image is to encode the number of white pixels in-between each pair of consecutive black pixels (in row-by-row order, for example) using the gamma code.

   (a) What is the asymptotic size of the compressed image in the worst case (poorest compression) for a given \(n\) and \(m\)? *Hint:* The worst case arises when the black pixels are evenly distributed.

   (b) What is the asymptotic size in the best case?

   (c) Would using the delta code instead of gamma code change the asymptotic size in either the worst case or the best case?

Justify all your answers.

5. [6+6 points] Encode the text `woodchuck_could_and_would_chuck_wood` using

   (a) LZ77

   (b) Re-Pair.