1 A memoryless binary source emits zeros and ones with probabilities 0.8 and 0.2. Design source codes for blocks of $n = 1, 2, 3, 4$ symbols, evaluate the average code lengths, and compare with the source entropy. Use $l_i = \lceil \log 1/p_i \rceil$ and the Huffman code.

2 For the above source consider the following parsing: 1,01,001,000. Encode these four messages with 2 bits (this is variable length to fixed length encoding). Evaluate the average cost per message. Then try also the Huffman code (this is variable length to variable length encoding).

3 A memoryless source has an alphabet of five equiprobable messages. Design source codes for blocks of $n = 1, 2, 3$ symbols, evaluate the average code lengths, and compare with the source entropy. You can use $l_i = \lceil \log 1/p_i \rceil$, or the Huffman code (use the Matlab function \texttt{huffmandict.m}).

4 A memoryless ternary source, with equiprobable symbols, is encoded in blocks of $n = 3$ symbols. Find a suitable code and its average length. Compare with the source entropy.

5 A memoryless binary source emits zeros and ones with probabilities 0.9 and 0.1. Encode a block of six zeros with 0, and any other block of six bits $xyztuv$ with 1$xyztuv$. Find the average length of this code, and compare with the source entropy.

6 For the above source, use Huffman codes for blocks of size $n = 1, 2, 3, 4, 5, 6$. Find the average length (Matlab needed, for large $n$).

7 A memoryless binary source emits zeros and ones with probabilities 1/3 and 2/3. Find source codes for blocks of $n = 5$ symbols, evaluate the average code length, and compare with the source entropy.

8 A first-order Markov source with binary alphabet has $P(x_2 = x_1) = 0.8$ and (of course) $P(x_2 \neq x_1) = 0.2$. Evaluate the source entropy. Find a good code for blocks of $n = 2$ source bits (pay attention to the right probabilities for each pair), and evaluate the average code length. Then consider using two different codes (conditional to the last symbol emitted by the source) for blocks of $n = 2$ source bits. Find the average length of this code. Comment: are two different codes really needed? This is can be considered differential encoding.

9 We have a quaternary first-order Markov source. Given the message $x_k$, $x_{k+1} = x_k$ with probability 1/2, and is equal to any other symbol with probability 1/6. Note that the four symbols are equiprobable (why?). Evaluate the source entropy.

10 A memoryless binary source emits zeros with probability 0.9. We use a run-length code, that encodes the blocks 1, 01, 001, ..., 0000001, and 00000000. The block of all zeros is encoded with one bit, and the other ones with four bits. Verify that this is the Huffman code for the above set of symbols. Find the average number of source bits, and the average number of coded bits per coding pass. Then find the average cost, in bits per source symbol. Compare with the source entropy.