

Information Theory

Spring semester, 2025

Assignment 3

Assigned: Wednesday, April 3, 2025

Due: Friday, April 10, 2025

M. Skoglund

Problem 3.1: Cover & Thomas 5.28 (p. 150)

Problem 3.2:

Consider a coin with a fixed, but unknown, probability of turning up heads. Treat the unknown parameter as a random variable with a uniform prior. Given a sequence of independent flips of such a coin, derive a simple expression for the probability that the next flip will be a head.

Problem 3.3:

The binary sequence

$$s = 111111111000000111111111111111100001 = 1^9 0^6 1^{16} 0^4 1$$

was generated by a stationary two-state Markov chain with transition probabilities $p_{1|0} = p_{0|1} = 0.2$. Encode s using

- (a.1) a Huffman code for 3-bit symbols based on the source model,
- (a.2) a Huffman code for 3-bit symbols based on relative frequencies in s ;
- (b.1) a Shannon-Fano-Elias code *or* an arithmetic code for 3-bit symbols based on the source model,
- (b.2) a Shannon-Fano-Elias code *or* an arithmetic code for 3-bit symbols based on relative frequencies in s ;
- (c.1) an arithmetic stream code (as described in CT or class) based on the source model,
- (c.2) an adaptive arithmetic stream code (as described in class; use Prob. 2), based on s ;
- (d.1) the “basic” Lempel-Ziv algorithm (CT),
- (d.2) the “modified” Lempel-Ziv algorithm (class).
- (e) Relate your answers to the entropy rate of the Markov source and the entropy of s based on relative frequencies.

You need not solve every problem by pen and paper. The arithmetic stream codes get quickly out of hand. If you choose to write a program, please turn in your “source code” with your solutions.