Information and Coding Theory CO349

Tutorial

Sheet 2 - Questions

Exercise 1 (Biggs Ex 3.13) *Construct a binary Shannon-Feno Code for the source* $(S, \mathbf{p})$ *with* $S = \{s_1, s_2, s_3, s_4, s_5, s_6\}$ *and*

$$\mathbf{p} = (0.25, 0.10, 0.15, 0.05, 0.20, 0.25).$$

What is the entropy and what is the average word-length?

Exercise 2 (Biggs Example 4.1,Slide 26) *Consider the source* $(S, \mathbf{p})$ *and different block codes.*

- *single symbol code* $c : \mathbb{B} \to \mathbb{B}^*$ *with distribution:* $\mathbf{p}_1 = (0.9, 0.1)$ *on* $S = \mathbb{B} = \{0, 1\}$.
- *two symbol code* $c : \mathbb{B}^2 \to \mathbb{B}^*$ *with distribution* $\mathbf{p}_2 = (0.81, 0.09, 0.09, 0.01)$ *on* $S = \mathbb{B} \times \mathbb{B} = \{00, 01, 10, 11\}$.
- *three symbol code* $c : \mathbb{B}^3 \to \mathbb{B}^*$ *with distribution* $\mathbf{p}_3 = (0.729, 0.081, 0.081, 0.009, 0.081, 0.009, 0.009, 0.001)$ *on* $S = \mathbb{B} \times \mathbb{B} \times \mathbb{B}$.
- *etc.*

What is the entropy, the average code length and a Huffman code for each of these cases? What is the relationship between $\mathbf{p}_i$*'s?*

Exercise 3 (Biggs, Ex 3.15) *Consider again the source from Example 1* $(S, \mathbf{p})$ *with* $S = \{s_1, s_2, s_3, s_4, s_5, s_6\}$ *and*

$$\mathbf{p} = (0.25, 0.10, 0.15, 0.05, 0.20, 0.25).$$

Construct the Huffman Code. What is the average word-length? How are entropy and the average word-length for the Shannon-Fano and Huffamn Code related?

Exercise 4 (Cover&Thomas Ex 5.6.1) *Consider a source with*

$$\mathbf{p} = (0.25, 0.25, 0.2, 0.15, 0.15).$$

Construct a Huffman code and give the average word-length compared to the entropy.

Exercise 5 (Cover&Thomas Ex 5.6.2/3) *Try to generalise the Huffman rules for tenary codes, i.e.* $T = \{0, 1, 2\}$*. Construct the tenary Huffman code for*

$$\mathbf{p}_1 = (0.25, 0.25, 0.2, 0.15, 0.15)$$

and

$$\mathbf{p}_2 = (0.25, 0.25, 0.2, 0.1, 0.1, 0.1).$$

and their average word-length.

Exercise 6 *Consider the alphabet* $S = \{U, V, W, X, Y, Z\}$ *and LZW coding (data compression). Use LZW to encode the following message:*

$$WWWWXWWWXWWXW$$

Specify the directory D_m *for each step.*