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HW 8 Source Coding Report

Github URL: [hambroise01/Communication-Systems (github.com)]

1. Using Matlab's *huffmandict* function, create a Huffman encoder for a source with an alphabet with the following properties:
    - Symbols: 0, 1, 2, 3, 4, 5, 6
    - Probabilities of the symbols: 0.1, 0.2, 0.1, 0.4, 0.05, 0.05, 0.1
2. What is the minimum number of bits needed to represent the symbols? Hint: Use ceil(log2(max()))
3. Create a source that emits the following symbols:
    - source symbols: 1, 3, 2, 3, 5, 3, 3, 1, 6, 3, 1, 0, 3, 6, 2, 3, 4, 0, 1, 3
4. How many bits does it take to transmit these symbols without source coding?
5. Use the previously created encoder in the form of a dictionary, use *huffmanenco* to encode the source symbols.
6. How many bits does it take to transmit the encoded symbols?
7. Use *huffmandeco* to decode the code.
8. Verify that the output result matches the source symbols.
9. Repeat steps 4-8 but using an input signal created using *randsrc* that is 10,000 symbols long. Answer 4 & 6 for this case.
10. What is the entropy of the source? Hint: use -sum(p.*log2(p))
11. What is the average rate? Hint: iterate over the dictionary cell array and calculate the length of the arrays in the second column. Do not forget to weight the values according to the probabilities.

We start by creating a Huffman encoder for a source with an alphabet using certain properties. The symbols used were 0, 1, 2, 3, 4, 5, and 6 while the probabilities of the symbols used were 0.1, 0.2, 0.1, 0.4, 0.05, 0.05 and 0.1. After this we run the code in order to generate the minimum number of bits needed to represent the symbols.

2. What is the minimum number of bits needed to represent the symbols?

The minimum number of bits needed was 3 bits.

After creating the Huffman encoder, the next step is to create a source that emits the following symbols which are [1 3 2 3 5 3 5 1 6 3 1 0 3 6 2 3 4 0 1 3]. When the source coding isn't used 60 bits would be needed in order to transmit the symbols. However when using the encoder, the huffmanenco function compressed it to 54 bits.

4. How many bits does it take to transmit these symbols without source coding?

60 bits are needed in order to transmit the symbols without source encoding.

6. How many bits does it take to transmit the encoded symbols?

The amount of bits needed to transmit the encoded symbols is 54 bits.

We will repeat the same process with a signal that is generated using randsrc which contains 10,000 symbols. When transmitting the signal without the source coding requires 30,000 bits. When I apply the Huffman encoding with huffmanenco, this is reduced to 24,915 bits.

The last step we take is to calculate the entropy and the average rate. The source entropy was found by using the formula -sum(p.log2(p)), where the p is the symbol probabilities which was 2.421928. The average rate is the average bits per symbol which was calculated by iterating the dictionary cell array.

9. Repeat steps 4-8 but using an input signal created using *randsrc* that is 10,000 symbols long. Answer 4 & 6 for this case.

It required 30,000 bits in order to send the large signal without source coding being used.

It requires 25,118 in order to send the encoded large signal.

10. What is the entropy of the source?

The entropy of the source is 2.421928.

11. What is the average rate?

The average rate is 2.5 bits.