CS 576 – Assignment 2 – Answers

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Question 1:

- [22, 24, 24, 28, 28, 28, 25, 26, 26, 26, 21, 19, 20, 20, 22, 24, 24, 24, 23, 24, 20, 16, 10, 10, 8, 11, 6, 9, 9, 12, 15, 19]

- 160 bits. Because $32 = 2^5$, so we need 5 bits per signal, in total 32*5 = 160 bits.

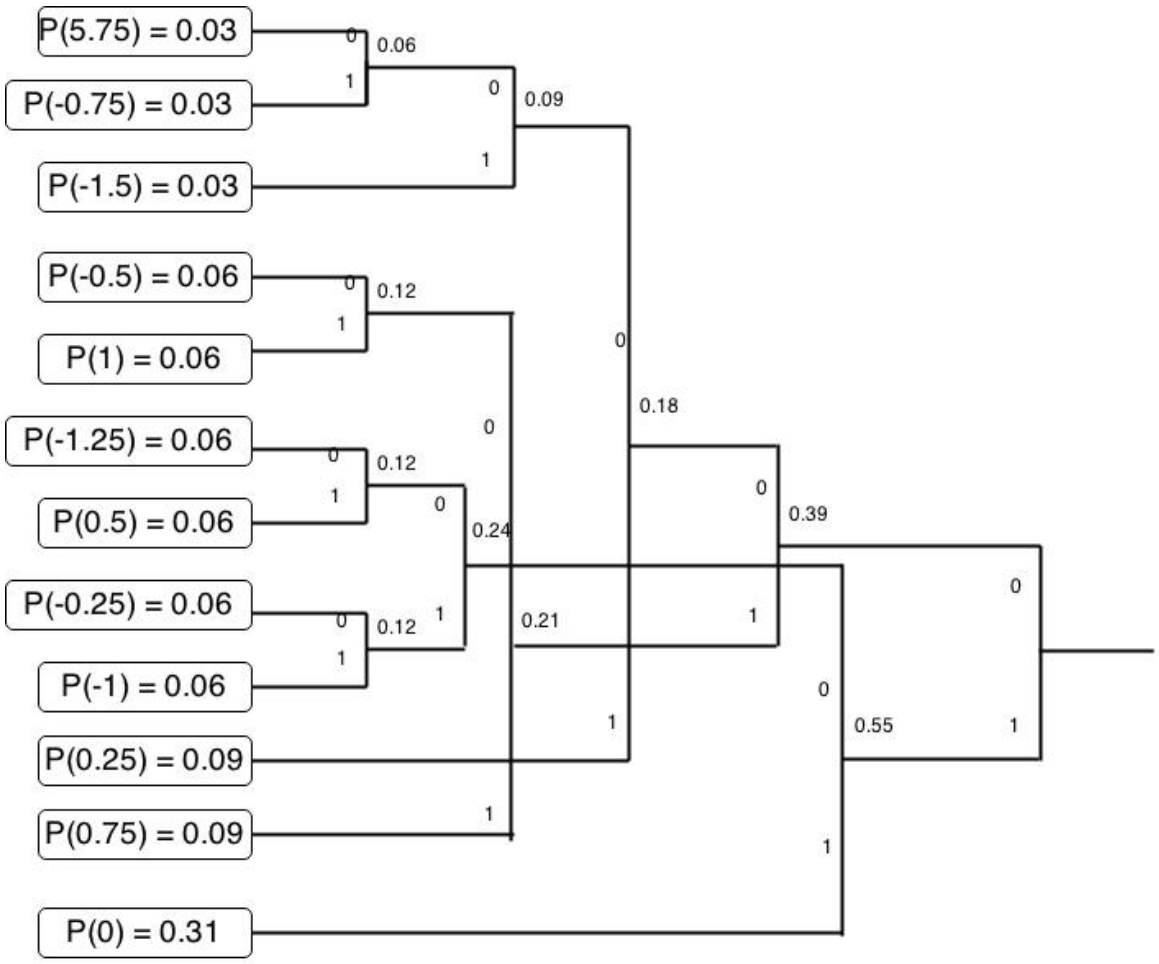
- Differences: 5.75, -0.5, 0, 1, 0, 0, -0.75, 0.25, 0, 0,
  -1.25, -0.5, 0.25, 0, 0.5, 0.5, 0, 0, -0.25, 0.25,
  -1, -1, -1.5, 0, -0.5, 0.75, -1.25, 0.75, 0, 0.75,
  0.75, 1

  Maximum Difference: 1
  Minimum Difference: -1.5

  128 bits. Because $12 = 2^{3.58}$ we have 11 uniformly distributed levels between [-1.5, 1] and 1 more level for the first signal, so we need 4 bits per signal, in total 32*4 = 128 bits.

- The compression ratio is 5-to-4

- Huffman coding for the differences, so we have following charts. Totally 103 bits for these signals.

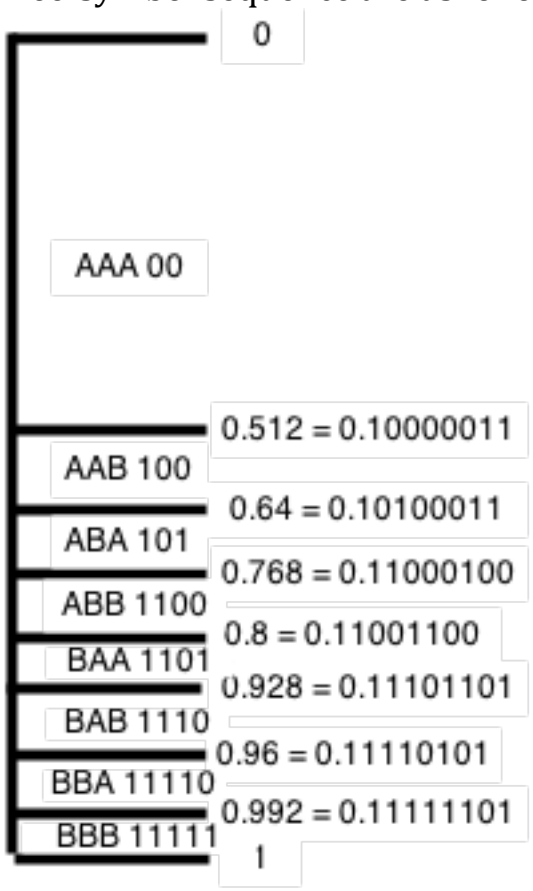


Symbol	Probability	Huffman Code	Code length
5.75	0.03	00000	5
-0.75	0.03	00001	5
-1.5	0.03	0001	4
-0.5	0.06	0100	4
1	0.06	0101	4
-1.25	0.06	1000	4
0.5	0.06	1001	4
-0.25	0.06	1010	4
-1	0.06	1011	4
0.25	0.09	001	3
0.75	0.09	011	3
0	0.31	11	2

- The compression ratio is 160-to-103 = 1.6

Question 2:

- Totally 8 types of different outcomes. They are AAA: 0.512; AAB: 0.128; ABA: 0.128; ABB: 0.032; BAA: 0.128; BAB: 0.032; BBA: 0.032; BBB: 0.008.
- See the arrangement of symbols and arithmetic code for the three-symbol sequence are as follows:



- The average code word length is: (2+3+3+4+4+4+5+5)/8 = 3.375. It is optimum.
- Bits for the message "ABA(3)BBA(5)ABB(4)AAA(2)BBB(5)" is 3+5+4+2+5 = 19 bits.
- By preventing the shrinking when the interval bounds get too close can improve above code length.