Assignment 2

Q1)

Samples	Approximatid (Quantized)	Quantized level	Bitsvalue
5.8	5.75	22	10110
6.2	6.25	24	11000
6.2	6.25	24	11000
7.2	7.25	28	11100
7.3	7.25	28	11100
7.3	7.25	28	11100
6.5	6.5	25	11001
6.8	6.75	26	11010
6.8	6.75	26	11010
6.8	6.75	26	
5.5	5.5	21	10101
5.0	5.0	19	10011
5.2	5.25	20	10100
5.2	5.25	20	10100
5.8	5.75	22	10110
6.2	6.25	24	11000
6.2	6.25	24	11000
6.2	6.25	24	11000
5.9	6.00	23	10111
6.3	6.25	24	11000
5.2	5.25	20	10100
4.2	4.25	16	10000
2.8	2.75	10	01010
2.8	2.75	10	01010
2.3	2.25	8	01000
2.9	3.00	11	01011
1.8	1.75	6	00110
2.5	2.5	9	01001
2.5	2.5	9	01001
3.3	3.25	12	01100
4.1	4.00	15	01111
4.9	5.00	19	10011

→ we need 5 bits to transmit the sequence.

→ DPCM coding

5.8	0.4
6.2	0
6.2	1
7.2	0.1
7.3	0
7.3	−0.8
6.5	0.3
6.8	0
6.8	0
6.8	−1.3
5.5	−0.5
5.0	0.2
5.2	0
5.2	0.6
5.8	0.4
6.2	0
6.2	0
6.2	−0.3
5.9	0.4
6.3	−1.1
5.2	−1
4.2	−1.4
2.8	0
2.8	−0.5
2.3	0.6
2.9	−01.1
1.8	0.6
2.5	0
2.5	0
2.5	0.8
3.3	0.8
4.1	0.8
4.9	

Difference values.

1	− MAX
0.8	
0.6	
0.4	
0.3	
0.2	
0.1	
0	
−0.3	
−0.5	
−0.8	
−1	
−1.1	
−1.3	
−1.4	− MIN

→ Assuming the above range, we need 4 bits to encode each value.

→ MIN = −1.4

→ MAX = 1

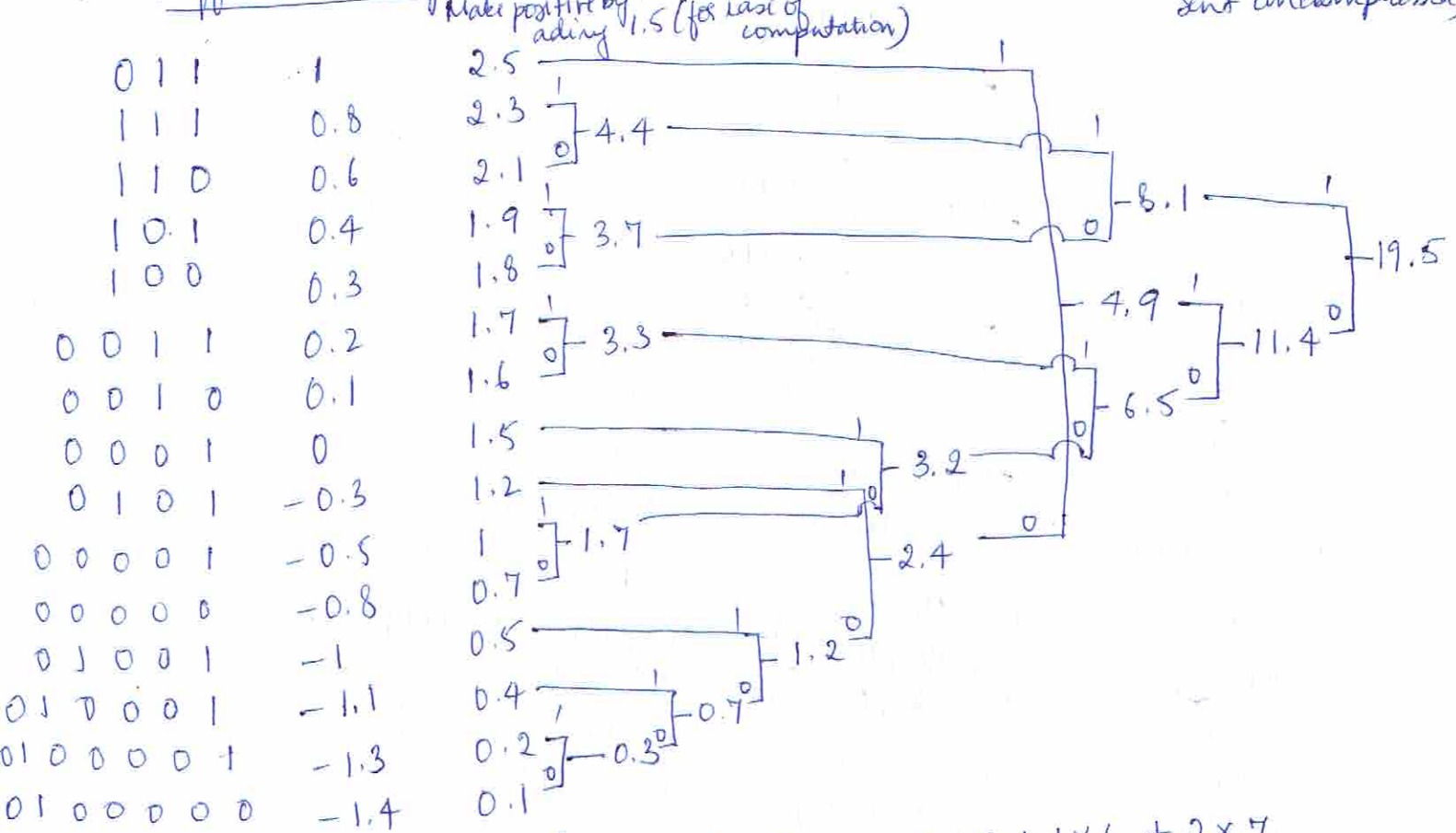
→ Compression ratio = $\frac{\text{Original signal length}}{\text{Compressed signal length}}$

= $\frac{\text{Quantized length}}{\text{DPCM encoded length}}$

= $\frac{33 \times 5}{32 \times 4} = 1.28$

(ignoring first value which will be sent uncompressed)

→ Huffman coding



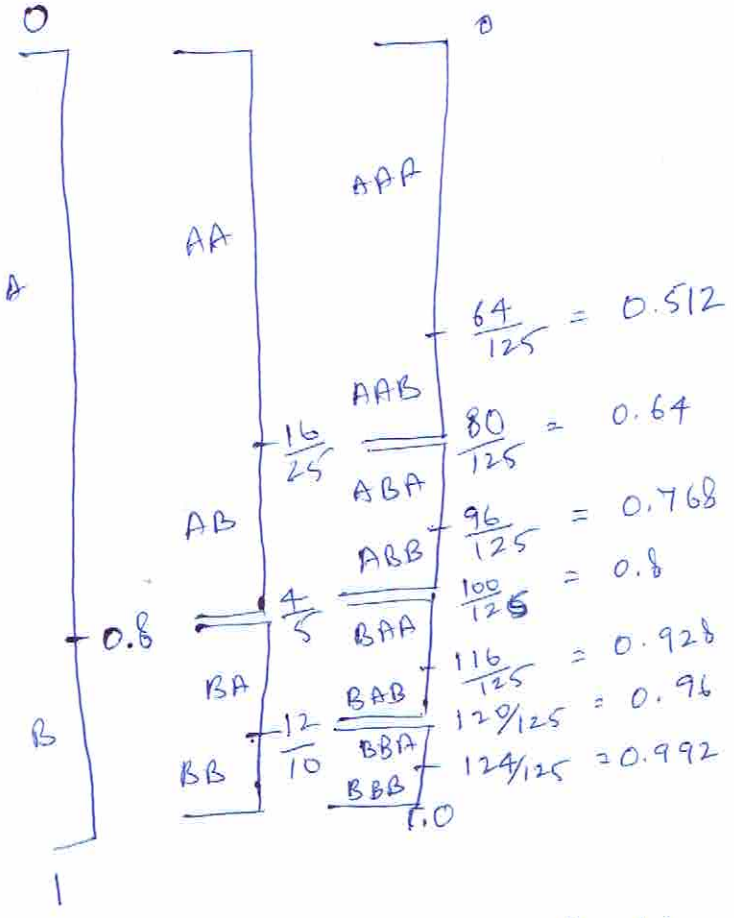
Average length of symbol = $\frac{5\times3 + 4\times4 + 3\times5 + 1\times6 + 2\times7}{15}$

= 4.4 ≈ 4.

∴ Compression ratio = $\frac{33\times5}{33\times4} = 1.25$

Q2)

Symbols	Probability
A	0.8
B	0.2



→ when N = 3 then all 8 combinations.

Combination	Interval	Binary value of smallest value	Codeword
AAA	[0, 0.512]	0	0
AAB	[0.512, 0.64]	0.1000	100
ABA	[0.64, 0.768]	0.10100	101
ABB	[0.768, 0.8]	0.110000	11000
BAA	[0.8, 0.928]	0.11001	11001
BAB	[0.928, 0.96]	0.1110	1110
BBA	[0.96, 0.992]	0.11110	11110
BBB	[0.992, 1]	0.11111	11111

Average codeword length $= \frac{1\times1 + 3\times2 + 4\times1 + 5\times4}{8}$

$= 3.8 \approx 4$

→ we can code the sequence as

ABA	BBA	ABB	AAA	BBB
101	11110	11000	0	11111

→ 19 bits

→ with further iteations of the coding process we can get a better code length.