

12 For the following set of symbols and probabilities,
construct a binary Huffman tree:

Symbols: A, B, C, D, E

Probability: A = 0.1, B = 0.2, C = 0.3, D = 0.25, E = 0.15

use the Huffman tree to encode the message ABCDADE
calculate the compression ratio if each symbol
in the original dataset was stored using a fixed -
length code of 3 bits

Step 1 - construct Huffman Tree

(i) combine smallest probabilities

$$A(0.1) + E(0.15) = 0.25$$

(ii) New set: 0.2, 0.25, 0.25, 0.3

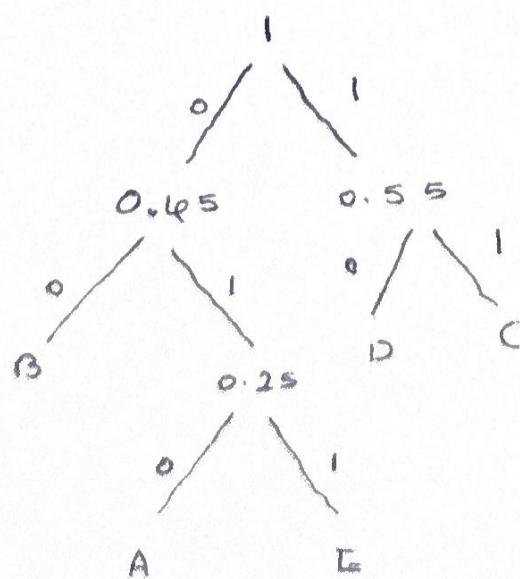
$$\text{combine } B(0.2) + AE(0.25) = 0.45$$

(iii) New set 0.25, 0.3, 0.45

$$\text{combine } D(0.25) + ((0.3)) = 0.55$$

(iv) Final combine

$$0.45 + 0.55 = 1$$



Step 2: Assign Huffman Codes

| symbol | Huffman code | length (bits) |
|--------|--------------|---------------|
| A | 010 | 3 |
| E | 011 | 3 |
| B | 00 | 2 |
| D | 10 | 2 |
| C | 11 | 2 |

Step 3: Encode message ABCADE

| symbol | Huffman code | length (bits) |
|--------|--------------|---------------|
| A | 010 | 3 |
| B | 00 | 2 |
| C | 11 | 2 |
| A | 010 | 3 |
| D | 10 | 2 |
| E | 011 | 3 |

$$\text{Total compressed bits} = 3+2+2+3+2+3 = 15 \text{ bits}$$

Step 4: compression ratio

$$\begin{aligned}\text{original dataset compressed bits} &= 8 \text{ bit per symbol} \times 6 \text{ symbols} \\ &= 3 \times 6 = 18 \text{ bits}\end{aligned}$$

15 bits from Huffman coding

$$\text{Hence compression ratio} = \frac{18}{15} = \underline{\underline{1.2}}$$