

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 ABCDAE  
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

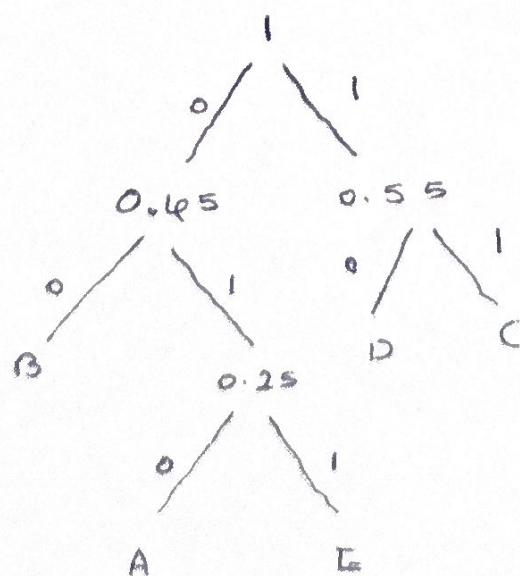
$$\text{combine } B(0.2) + AE(0.25) = 0.45$$

(iii) New set 0.25, 0.3, 0.45

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

(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

Total Compressed bits =  $3 + 2 + 2 + 3 + 2 + 3 = 15$  bits

Step 4: Compression ratio

original dataset compressed bits = 3 bit per symbol  $\times$  6 symbols  
 $= 3 \times 6 = 18$  bits

15 bits from Huffman coding

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