



# SNS COLLEGE OF TECHNOLOGY

Coimbatore-35  
An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

### 19ECB301 – ANALOG AND DIGITAL COMMUNICATION

III B.E. ECE<sub>1</sub> / V SEMESTER

### UNIT 5 – INFORMATION THEORY AND ERROR CONTROL CODING

TOPIC – HUFFMAN CODING



## HUFFMAN CODING



- The most popular technique for removing coding redundancy is due to Huffman (1952)
- When coding the symbols of an information source individually, Huffman coding yields the smallest possible number of code symbols per source symbol
- In terms of the noiseless coding theorem, the resulting code is optimal for a fixed value of  $n$ , subject to the constraint that the source symbols be coded one at a time





## HUFFMAN CODING



The first step in Huffman's approach is

- To create a series of source reductions by ordering the probabilities of the symbols under consideration
- Combining the lowest probability symbols into a single symbol that replaces them in the next source reduction



# HUFFMAN CODING

## Huffman Coding

**Example:** Calculate the Huffman Codes for the set of symbols as shown in table.

Symbols	A	B	C	D
Probability	0.4	0.3	0.2	0.1

**Solution:**

Symbol	Probability
A	0.4
B	0.3
C	0.2
D	0.1

Handwritten notes and diagram illustrating Huffman coding:

Code words  $\rightarrow$  length of code word  $l(r_k)$

A  $\rightarrow$  1  $\rightarrow$  1  
 B  $\rightarrow$  01  $\rightarrow$  2  
 C  $\rightarrow$  000  $\rightarrow$  3  
 D  $\rightarrow$  001  $\rightarrow$  3

Diagram showing the merging process:

- Initial probabilities: 0.4 (A), 0.3 (B), 0.2 (C), 0.1 (D)
- Step 1: Merge C (0.2) and D (0.1) into a node with probability 0.3. This node is assigned bit 0 to C and bit 1 to D.
- Step 2: Merge B (0.3) and the node from step 1 (0.3) into a node with probability 0.6. This node is assigned bit 0 to B and bit 1 to the subtree.
- Step 3: Merge A (0.4) and the node from step 2 (0.6) into the root node with probability 1.0. The root node is assigned bit 0 to A and bit 1 to the subtree.

Final Huffman codes: A=0, B=10, C=110, D=111

no. avg. of bits used to represent message

$$L_{avg} = \sum l(r_k) P(r_k)$$

$$= 1 \times 0.4 + 2 \times 0.3 + 3 \times 0.2 + 3 \times 0.1$$

$$= 1.9 \text{ bits/symbols}$$





## HUFFMAN CODING



### HUFFMANN CODING

1. To Find the average code word length

$$L = \sum_{k=1}^5 P_k [\text{length of } m_k \text{ in bits}]$$

2. To Find the Entropy of the source

$$H = \sum_{k=1}^5 P_k \log_2 \left( \frac{1}{P_k} \right)$$

3. Code efficiency  $\eta = \frac{H}{L} \times 100 \%$



Thank  
you!