Construct the Huffman Code for the following data:



Encode the text **DAD** and decode the text **10011011011101**

**Solution:**

First, we need to Construct Huffman tree by following below steps of Huffman algorithm:

**Step1:** Create 5- one node trees with symbol and its frequency as weight

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0.35 |  | 0.1 |  | 0.2 |  | 0.2 |  | 0.15 |
| A |  | B |  | C |  | D |  | \_ |

**Step 2:** Arrange the above nodes in ascending order of their weights

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0.1 |  | 0.15 |  | 0.2 |  | 0.2 |  | 0.35 |
| B |  | \_ |  | C |  | D |  | A |

**Step 3:** Construct the Huffman tree by repeating the following operation until a single tree is obtained.

* Find two trees with the smallest weight.
* Make them the left and right subtree of a new tree and record the sum of their weights in the root of the new tree as its weight.
* Rearrange the nodes again in ascending order of weights

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0.1 |  | 0.15 |  | 0.2 |  | 0.2 |  | 0.35 |
| B |  | \_ |  | C |  | D |  | A |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0.2 |  | 0.2 |  | |  | | --- | |  | |  |  |  | 0.35 |
| C |  | D |  |  |  |  |  | A |
|  |  |  |  | 0.1 |  | 0.15 |  |  |
|  |  |  |  | B |  | \_ |  |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | |  | |  |  |  | 0.35 |  | |  | | --- | |  | |  |  |
|  |  |  |  | A |  |  |  |  |
| 0.1 |  | 0.15 |  |  |  | 0.2 |  | 0.2 |
| B |  | \_ |  |  |  | C |  | D |
|  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | |  | |  |  |  | |  | | --- | |  | |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 0.2 |  | 0.2 |  |  |  |  |  | 0.35 |
| C |  | D |  |  |  |  |  | A |
|  |  |  |  | 0.1 |  | 0.15 |  |  |
|  |  |  |  | B |  | \_ |  |  |

**1.0**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | |  | |  |  |  | |  | | --- | |  | |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 0.2 |  | 0.2 |  |  |  |  |  | 0.35 |
| C |  | D |  |  |  |  |  | A |
|  |  |  |  | 0.1 |  | 0.15 |  |  |
|  |  |  |  | B |  | \_ |  |  |

Now, Assign the label **0** to left edges and label **1** to right edges to the above Huffman tree to generate codeword.

**1.0**

1

0

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0   |  | | --- | |  | |  | |  | | --- | | 1 | |  |  | 0 |  |  | 1 |
|  |  |  |  |  |  |  |  |  |
| 0.2 |  | 0.2 |  | 0 |  | 1 |  | 0.35 |
| C |  | D |  |  |  |  |  | A |
|  |  |  |  | 0.1 |  | 0.15 |  |  |
|  |  |  |  | B |  | \_ |  |  |

* The codeword for the given symbol is as follows

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Symbol** | A | B | C | D | \_ |
| **Codeword** | 11 | 100 | 00 | 01 | 101 |

* Encode the text **DAD**, the bit string is **011101**
* **Decode the string 10011011011101**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 100 | 11 | 01 | 101 | 11 | 01 |
| B | A | D | \_ | A | D |

The text for the above string BAD\_AD