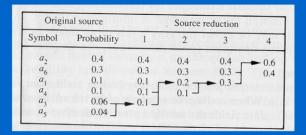
## Huffman Coding (cont'd)

- Forward Pass
  - 1. Sort probabilities per symbol
  - 2. Combine the lowest two probabilities
  - 3. Repeat *Step2* until only two probabilities remain.



## Huffman Coding (cont'd)

Backward Pass

Assign code symbols going backwards

| Original source  |  |  |                                 | Source reduction               |                          |                       |                     |               |            |   |
|--|--|--|---------------------------------|--------------------------------|--------------------------|-----------------------|---------------------|---------------|------------|---|
| Sym.   | Prob.                                    | Code                                     | 1                               |                                | 2                        |                       | 3                   |               | 4          |   |
| a <sub>2</sub><br>a <sub>6</sub><br>a <sub>1</sub><br>a <sub>4</sub><br>a <sub>3</sub><br>a <sub>5</sub> | 0.4<br>0.3<br>0.1<br>0.1<br>0.06<br>0.04 | 1<br>00<br>011<br>0100<br>01010<br>01011 | 0.4<br>0.3<br>0.1<br>0.1<br>0.1 | 1<br>00<br>011<br>0100<br>0101 | 0.4<br>0.3<br>0.2<br>0.1 | 1<br>00<br>010<br>011 | 0.4<br>0.3<br>— 0.3 | 1<br>00<br>01 | 0.6<br>0.4 | 0 |

## Huffman Coding (cont'd)

• L<sub>avg</sub> assuming Huffman coding:

$$L_{avg} = E(l(a_k)) = \sum_{k=1}^{6} l(a_k)P(a_k) =$$

3x0.1 + 1x0.4 + 5x0.06 + 4x0.1 + 5x0.04 + 2x0.3 = 2.2 bits/symbol

## Redundancy - revisited

• Redundancy: R =

$$R = L_{avg} - H$$

where:  $L_{avg} = E(l(r_k)) = \sum_{k=0}^{L-1} l(r_k)P(r_k)$ 

**Note:** if  $L_{avg}$ = H, then R=0 (no redundancy)

$$R_D = 1 - \frac{1}{C_R}$$