



Special Module on Media Processing and Communication

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Recap



► Lecture 2

- Definitions
 - Compression Ratio
 - Fidelity Measures
- Data Redundancy
 - Coding
 - Interpixel
 - Psychovisual
- Compression Techniques
 - Symmetric and Asymmetric
 - Loss-less and Lossy



Image Compression

Variable Length Coding (Huffman Coding)

Sequence of symbols (a_1, a_2, a_3, a_4, a_5) with associated probabilities (p_1, p_2, p_3, p_4, p_5)

- Start with two symbols of the least probability
 $a_1:p_1$
 $a_2:p_2$
- Combine (a_1 or a_2) with probability (p_1+p_2)
- Do it recursively (sort and combine)
- A binary tree construction



Image Compression

Variable Length Coding (Huffman Coding)

Example:

Symbols and their probabilities of occurrence

a1 (0.2), a2 (0.4), a3 (0.2), a4 (0.1), a5 (0.1)

Sort in
probability

a2 (0.4)
a1(0.2)
a3(0.2)
a4(0.1)
a5(0.1)



Image Compression

Variable Length Coding (Huffman Coding)

Sort

a2 (0.4)

a1(0.2)

a3(0.2)

a4(0.1)

a5(0.1)



Image Compression

Variable Length Coding (Huffman Coding)

Sort combine

a2 (0.4)

a1(0.2)

a3(0.2)

a4(0.1)

a5(0.1)

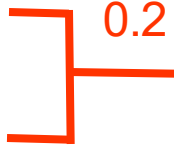




Image Compression

Variable Length Coding (Huffman Coding)

Sort combine Sort

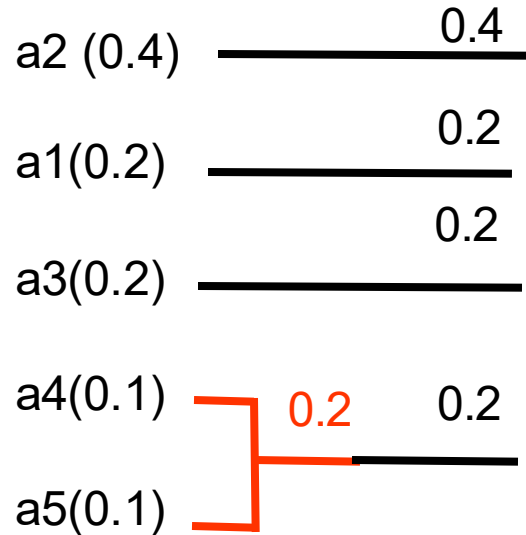




Image Compression

Variable Length Coding (Huffman Coding)

Sort combine Sort combine Sort combine Sort combine

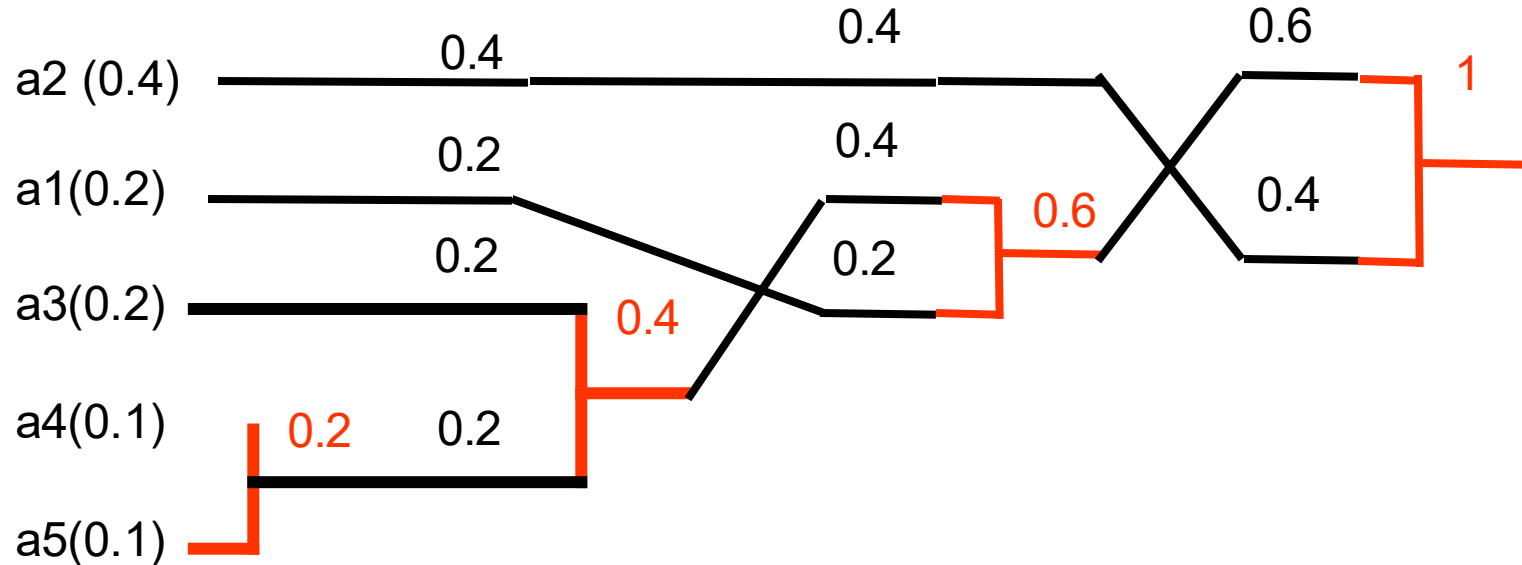




Image Compression

Variable Length Coding (Huffman Coding)

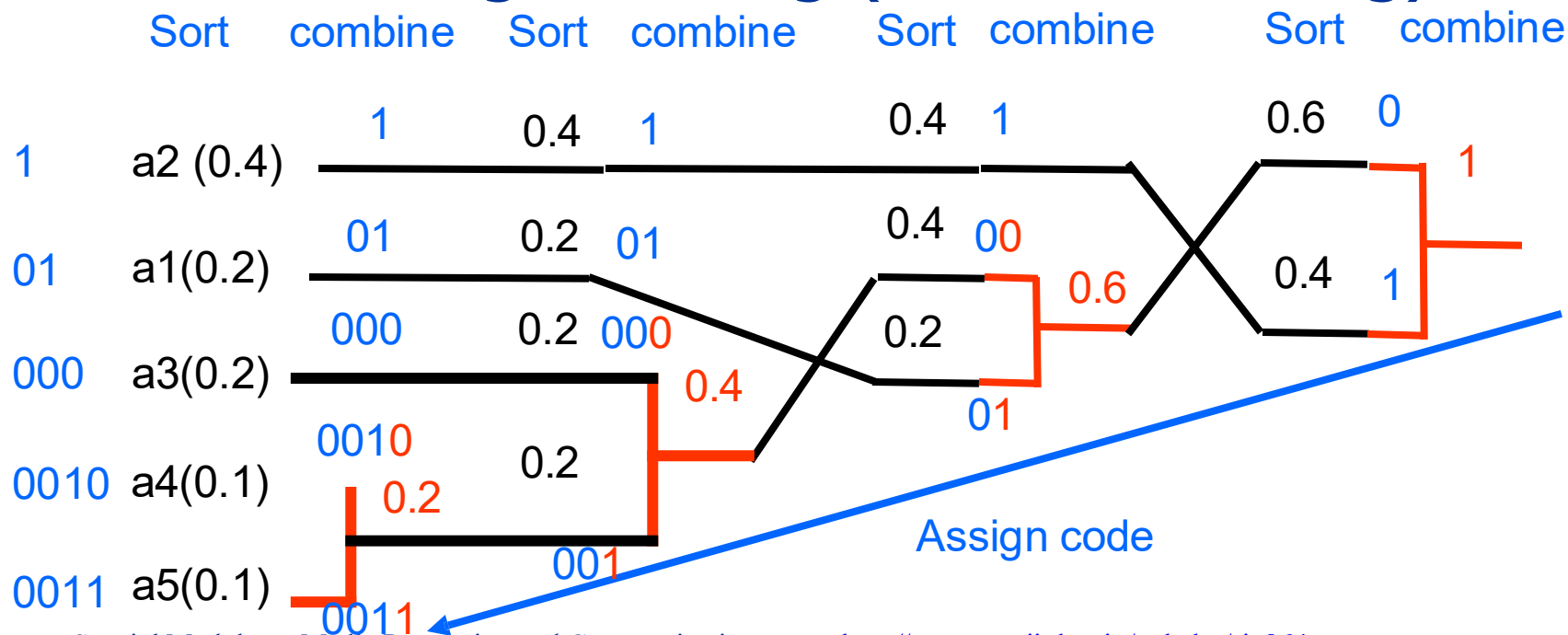




Image Compression

Variable Length Coding (Huffman Coding)

Example:

Avg length code:

$$0.4 \times 1 + 0.2 \times 2 + 0.2 \times 3 + 0.1 \times 4 + 0.1 \times 4 \\ = 2.2 \text{ bits}$$



Image Compression

Variable Length Coding (Huffman Coding)

Example:

Entropy

A measure of information that captures uncertainty
[$I(e) = \log (1/P(e))$]

$$H = - \sum_{i=0}^{L-1} p(a_i) \log_2 p(a_i) \quad \text{bits / symbol}$$



Image Compression

Variable Length Coding (Huffman Coding)

Example: Decoding

00111010001

?



Image Compression

Variable Length Coding (Huffman Coding)

Example:

00111010001

Decoding

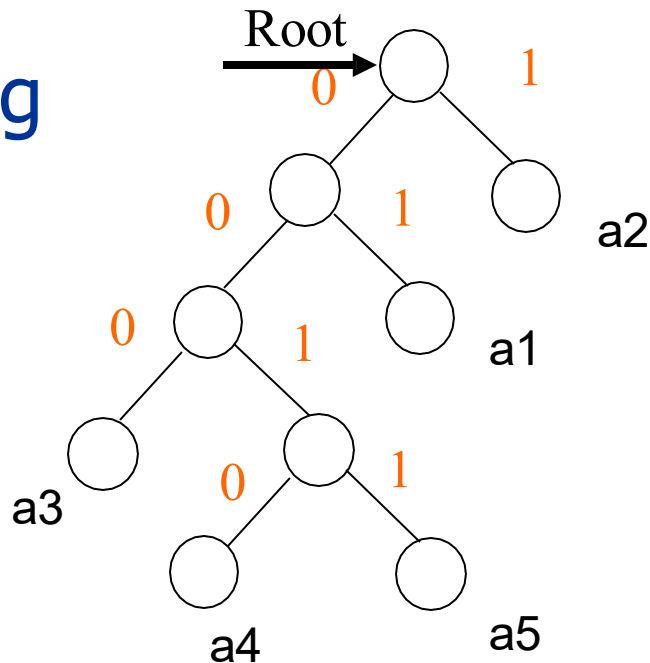
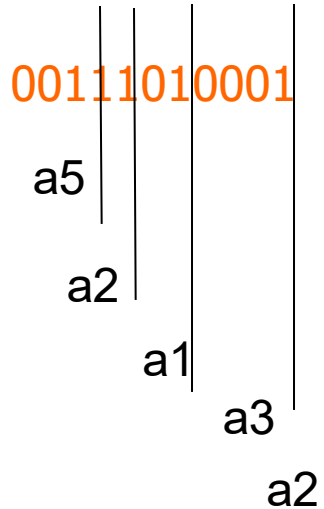




Image Compression

Variable Length Coding (Huffman Coding)

Example:



Decoding

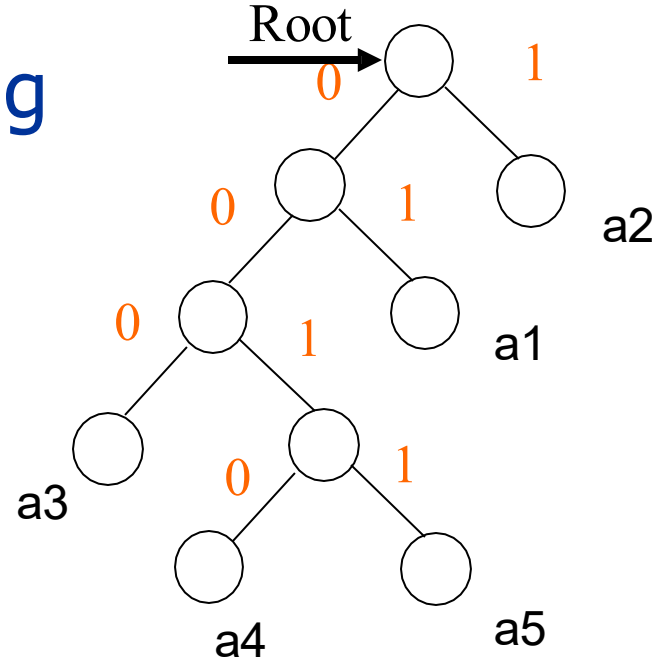




Image Compression

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PROCEEDINGS OF THE I.R.E.

September

A Method for the Construction of Minimum-Redundancy Codes*

DAVID A. HUFFMAN⁺, ASSOCIATE, IRE

Summary—An optimum method of coding an ensemble of messages consisting of a finite number of members is developed. A minimum-redundancy code is one constructed in such a way that the average number of coding digits per message is minimized.

INTRODUCTION

ONE IMPORTANT METHOD of transmitting messages is to transmit in their place sequences of symbols. If there are more messages which might be sent than there are kinds of symbols available, then some of the messages must use more than one symbol. If it is assumed that each symbol requires the same time for transmission, then the time for transmission (length) of a message is directly proportional to the number of symbols associated with it. In this paper, the symbol or sequence of symbols associated with a given message will be called the "message code." The entire

will be defined here as an ensemble code which, for a message ensemble consisting of a finite number of members, N , and for a given number of coding digits, D , yields the lowest possible average message length. In order to avoid the use of the lengthy term "minimum-redundancy," this term will be replaced here by "optimum." It will be understood then that, in this paper, "optimum code" means "minimum-redundancy code."

The following basic restrictions will be imposed on an ensemble code:

- (a) No two messages will consist of identical arrangements of coding digits.
- (b) The message codes will be constructed in such a way that no additional indication is necessary to specify where a message code begins and ends once the starting point of a sequence of messages