COMSATS Institute of Information Technology

ECI750 Multimedia Data Compression

Lecture 8

Practice Problems

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Problem 1

- Given an alphabet $A = \{a_1, a_2, a_3, a_4\}$, find the entropy in the following cases:
  1. $P(a_1) = P(a_2) = P(a_3) = P(a_4) = \frac{1}{4}$
  2. $P(a_1) = \frac{1}{2}, P(a_2) = \frac{1}{4}, P(a_3) = P(a_4) = \frac{1}{8}$
  3. $P(a_1) = 0.505, P(a_2) = \frac{1}{4}, P(a_3) = \frac{1}{8}, P(a_4) = 0.12$

  Answers:

  1. $H(X) = 2\ bits$
  2. $H(X) = 1.75\ bits$
  3. $H(X) \approx 1.739\ bits$

Problem 2

- Determine whether the following codes are uniquely decodable:
  1. $\{0, 01, 11, 111\}$
  2. $\{0, 01, 110, 111\}$
  3. $\{0, 10, 110, 111\}$
  4. $\{1, 10, 110, 111\}$

Answers:

1. *Not uniquely decodable*
2. *Not uniquely decodable*
3. *Uniquely decodable*
4. *Not uniquely decodable*

Problem 3

- A source emits letters from an alphabet $A = \{a_1, a_2, a_3, a_4, a_5\}$ with probabilities $P(a_1) = 0.15, P(a_2) = 0.04, P(a_3) = 0.26, P(a_4) = 0.05, and\ P(a_5) = 0.50.$

  a) Calculate the entropy of this source.

  b) Find a Huffman code for this source.

  c) Find the average length of the code in (b) and its redundancy.

Problem 4

- For an alphabet $A = \{a_1, a_2, a_3, a_4\}$ with probabilities $P(a_1) = 0.1, P(a_2) = 0.3, P(a_3) = 0.25,$ and $P(a_4) = 0.35$, find a Huffman code
  a) Using the conventional method
  b) Using the minimum variance procedure

Comment on the difference in the Huffman codes.