Technische Universität München **Winter99**
Institut für Informatik
Data Compression
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Problem Set One
Due: December 21, 1999

Problem 1

Consider $S = \{s_1, \ldots, s_6\}$ with the probability given in the table:

s_i	$p(s_i)$
s_1	0.3
s_2	0.2
s_3	0.2
s_4	0.1
s_5	0.1
s_6	0.1

a) Construct a ternary Huffman code for the source S, and calculate L (the average code word length) of the obtained code.

b) Calculate H(S) and compare it to L.

Problem 2

In many communication applications, it is desirable that the number of ones and zeros transmitted over the channel are about the same. However, if we look at Huffman codes, many of them seem to have many more ones than zeros or vice versa. Does this mean that Huffman coding leads to inefficient channel usage?

Hint: Use S and the probability distribution of Problem 1 (with a binary Huffman encoding).

Problem 3

Given $640 \times 480 \times 8$ bit digitized television frames, each with a $1,024$ byte label, and a lossless compression algorithm having a compression ratio of 3.25. In other words, the original (uncompressed) image representation uses 8 bits/pixel.

- **a)** How many seconds of (30 frame/second) video can you store on a disk drive with 240 megabytes of available space without compression?
- **b)** Same question as a) but with compression.

Problem 4

Consider the Adaptive Huffman Coding Algorithm. Assume that the source characters consist of the 26 lowercase letters of the English alphabet.

Show how the tree develops when the sequence of characters in "tennessee" is transmitted.

Problem 5

Which of these codes cannot be Huffman codes for any probability assignment? Why?

- **a)** $\{0, 10, 11\}$.
- **b)** $\{00, 01, 10, 110\}$.
- **c)** $\{01, 10\}$.

Problem 6

Assuming that LZ77 has a sliding window of size 20 with lookahead of size 10, use it to encode:

- **a)** alf eastman easily grows alfalfa in his garden
- **b)** alf eastman easily yells aaaaaaaaaaaah

Use c(x) to denote the encoding of symbol x.

Problem 7

Use LZ78 to compress:

a) alf eastman easily grows alfalfa in his garden
b) alf eastman easily yells aaaaaaaaaaaah

Show the encoded stream and the new entries being added in the dictionary.

Problem 8

Use procedure LZW-encode to compress:

a) alf eastman easily grows alfalfa in his garden
b) alf eastman easily yells aaaaaaaaaaaah

Show the output and the new entries being added in the dictionary.

Problem 9

Use Burrows-Wheeler algorithm to compress “mississippi”.