Autek

8005535 Signal Compression
Examination on December 2000

- (2 point) How one can encode a binary tree? (this is needed e.g. for sending the information on which prefix code was used for coding) Use an example of tree with maximum depth equal to 3.

- (4 point) We want to encode the data string *bccb* from the ternary alphabet $\{a, b, c\}$, using arithmetic coding, and the decoder knows that we have to send 4 symbols.

  Explain the adaptive zero-model order of assigning probabilities to symbols.

- (3 points) An arithmetic encoder produced the decimal string 0.2572167752. The source is known to have 9 symbols, with the probabilities specified in the left table below. The decoder started to process the received string, as shown in the right table below. Continue the decoding process.

Character	Probability	Range
SPACE	1/10	0.00 - 0.10
A	1/10	0.10 - 0.20
B	1/10	0.20 - 0.30
E	1/10	0.30 - 0.40
G	1/10	0.40 - 0.50
I	1/10	0.50 - 0.60
L	2/10	0.60 - 0.80
S	1/10	0.80 - 0.90
T	1/10	0.90 - 1.00

Received Number	Output Symbol	Low	High	Range
0.2572167752	B	0.2	0.3	0.1
0.572167752	I	0.5	0.6	0.1
0.72167752	L	0.6	0.8	0.2
0.6083876	L	0.6	0.8	0.2
0.041938	SPACE	0.0	0.1	0.1
0.41938	G	0.4	0.5	0.1

- (3 point) Explain briefly the Move-to-Front transformation. What is its role in the BW compression method?

- (3 point) You are given a Bernoulli source with $p = 0.9$ and asked to design a Tunstall tree with 8 leaves. What is the rate of the code?

- (1 point) What predictor is used in JPEG-LS?

- (1 point) What is the residual distribution assumed in JPEG-LS?

- (1 point) Why the matrix W of the linear transformation obtained with discrete wavelet transform must be unitary for progressive coding?

- (1 point) How efficient is an arithmetic coder in encoding the bitstream produced by SPIHT method?

- (2 points) Explain briefly how region of interest (ROI) is encoded with a progressive coder (e.g. SPIHT). What is the side information to be transmitted?

see next page →

- (3 points) Consider an 512×512 digital image where each pixel $x(i,j)$ is represented with eight bit per pixel. Suppose that the image has the particular feature that each pixel $x(i,j)$ (except the one with $(i=1, j=1)$) has at least one neighbour (either to the left, $x(i,j-1)$ or above it, $x(i-1,j)$) with a magnitude variation of at most 1, i.e. either $-1+x(i,j-1) \leq x(i,j) \leq 1+x(i,j-1)$ or $-1+x(i-1,j) \leq x(i,j) \leq 1+x(i-1,j)$. Describe an efficient lossless compression scheme which encodes the image row by row.

- (4 points) Consider a random variable X with values in the set $\{0,1,2,3\}$ with probabilities $\left(\frac{1}{3}, \frac{1}{3}, \frac{1}{4}, \frac{1}{12}\right)$.
  - Construct a Huffman code for this random variable.
  - Is the codeword length assignments $(1,2,3,3)$ optimal? What about the codeword length assignments $(2,2,2,2)$?

- (2 points) The length of the Golomb-Rice code with parameter k when the non-negative value y is encoded is:

$$\left\lfloor \frac{y}{2^k} \right\rfloor + k + 1$$

  Compute the code length and write the codeword when $y = 255$ and $k = 3$. Write a short comment on the result taking into account that the binary representation of y is 8 bit-long.

Autek