16.36 Communication Systems Engineering

Spring 2009

16.36: Comm. Sys. Engineering
Problem Set No. 3

**Problem 1:** Text Problem 6.22
    Assume the source alphabet $\{a_1, a_2, a_3, a_4\}$ has corresponding probabilities $\{.15, .2, .3, .35\}$

**Problem 2:** Text Problem 6.23

**Problem 3:** Text Problem 6.25
    Assume a source with output alphabet probabilities of $\{.05, .1, .15, .1, .25, .15, .2\}$

**Problem 4: Matlab Exercise**

   In this exercise, you will take the quantized waveform from Problem Set 2 and compress
   it using the Lempel-Ziv algorithm.

   a) Modify your `quantize` function from the last assignment (or the solution posted
      online if you prefer) to also produce an encoded output in bits, as opposed (or in
      addition) to the real-valued midpoints from before. The output in bits should
      correspond to the level that was decided upon. If the quantization was for two bits
      (which means four levels), each output should only be two bits long; assign '00' to
      the first level, '01' to the second level, etc.
      This can be done in a number of different ways in Matlab. The easiest way may be to
      create a string of bits using the `dec2bin` (decimal to binary) function and specifying
      the number of bits to output (see function help for more details).

   b) For three-bit quantization (N=3), create a dictionary using the Lempel-Ziv algorithm
      for the encoded bit-stream outputted from `quantize`. If you create a string of bits as
      the output from the `quantize` function, then you may be interested in the `strcmp`
      (sting compare) function and using cells as opposed to arrays to store your dictionary
      contents. See Matlab help for details on both.

   c) From the dictionary that you created in part b, create a set of codewords using the
      Lempel-Ziv algorithm. Again, you may find it easier to use cells to store your
      codewords, as opposed to an array.

   d) Discussion: How many entries are in the dictionary? How many bits is each
      codeword? How many bits are needed to transmit the entire compressed waveform?
      What is the compression ratio between the compressed and uncompressed waveform?

   Note: This may take up to 15 minutes to run (which is why only N=3 is asked, N=8 can
   take hours). You may want to test on smaller sequences first, such as the example given
   in section 6.3.2 of the text.