The Cooper Union Department of Electrical Engineering
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ECE300 Communication Theory
**Problem Set IX: Viterbi Algorithm**
November 15, 2021

1. Refer to the convolutional coder shown below. We will denote the state as:

$$\begin{array}{ccc} a & b & c \\ d & e & f \end{array}$$

   (a) Specify the code rate and constraint length.

   (b) List all the *previous states* and the corresponding input bits that transition *into* the state:

$$\begin{array}{ccc} 0 & 1 & 1 \\ 1 & 0 & 1 \end{array}$$

   (c) If we were to implement the Viterbi algorithm to decode this convolutional coder:

   1. How many ACS operations per unit time are necessary?
   2. What is the total size of the traceback buffer per unit time step?
   3. How large should the cost buffer be (i.e., how many entries to represent all present costs)?
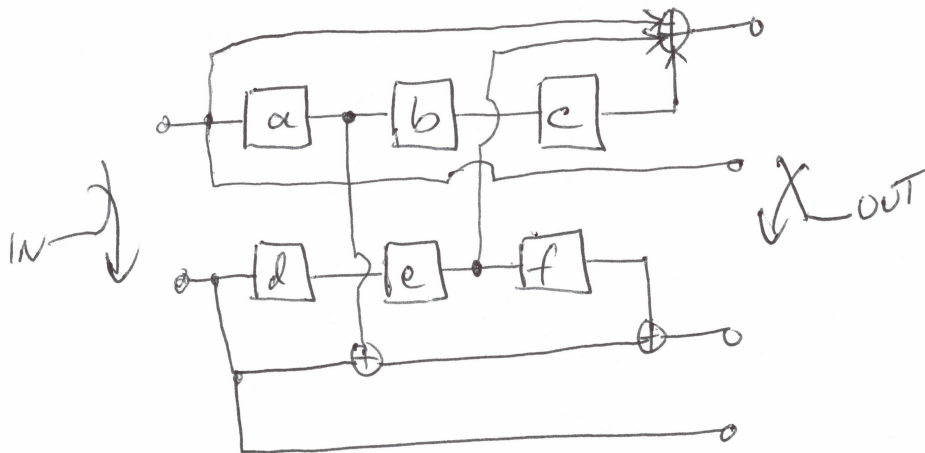

2. Given the following channel model for a digital communication scheme that employs 8-PSK, where v_i represents AWGN:

$$y_i = 0.02a_i - 0.3a_{i-1} + a_{i-2} + 0.2a_{i-3} - 0.04a_{i-4} + v_i$$

   (a) If we use the Viterbi algorithm to combat ISI: how many states are there? for a given present state, how many possible previous states are there?

   (b) Suppose we employ soft decision decoding with 4 bits per soft symbol. How many bits TOTAL is the traceback buffer per unit time, and how many bits TOTAL is the present cost buffer?

3. Given the following convolutional coder. Determine one "time slice" of the trellis diagram. [Your picture should look similar to the figure in the next problem].
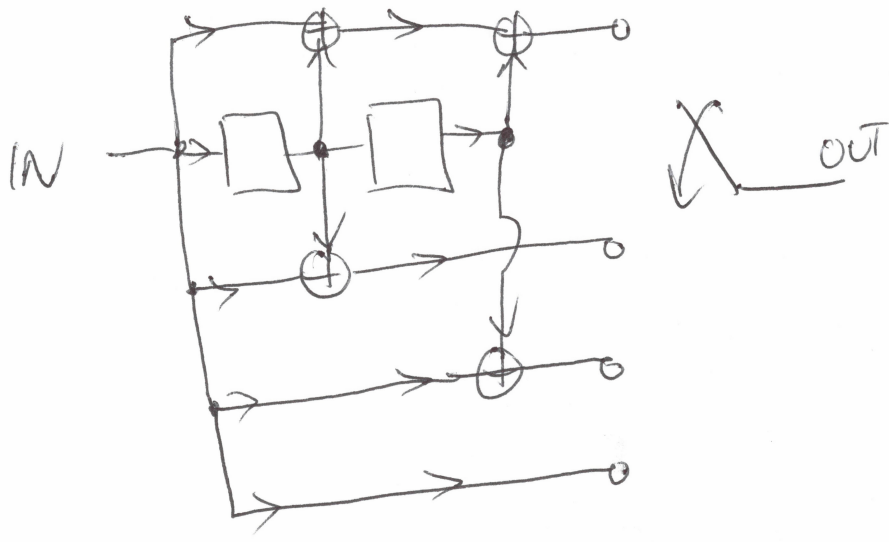
4. Given the following trellis diagram for a rate $1/n$ convolutional coder.

   (a) Specify n and the constraint length L.

   (b) The system starts in the all 0 state, the coded bits are sent over a BSC, and the following is the received sequence:

$$010\ 001\ 110\ 010\ 100$$

   Use the Viterbi algorithm to recover the input data sequence. You should show the trellis diagram in the form as in the notes (all the survivor paths, but only the survivors, shown, with associated costs; ACS operations should be shown separately as "scratch" work; indicate your terminal decision, show your final path selection).