S-38.211 Signal Processing in Communications I	Amoakoh Gyasi-Agyei
Tutorial 2, 7/10/1998	Phone: 451 2204 Room: I208
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Exercise 2-1

Consider transmitting bits X_k (zeros and ones) over a channel with additive white Gaussian noise. Assume that $X_k = 0$ for $k \le 0$ and $k \ge K$. Suppose that $K = 3$ and the observation sequence is $\{y_0, y_1, y_2, y_3\} = \{0.6, 0.9, 1.3, 0.3\}$. The model for the ISI channel is $g_k = \delta_k + 0.5\delta_{k-1}$

a) Model the system as a shift register process and draw the state transition diagram. Label the arcs with the input/output pairs (X_k, S_k).

b) Draw one stage of the trellis and label with the input/output pairs (X_k, S_k).

c) Draw the trellis for the Markov model and label the transition weights. What is the ML detection of the incoming bit sequence?

d) Find the ML decision sequence $\hat{x}_k$ assuming that the additive noise is the only degradation (no ISI) and that X_k are iid (independent, identically distributed) random sequences.

Exercise 2-2

A convolutional code is given by:

$$S_\kappa^1 = X_K + X_{K-2}$$
$$S_\kappa^2 = X_K + X_{K-1} + X_{K-2}$$

where the output of the encoder at a discrete time instant k is given by: $C_K = S_\kappa^1 S_\kappa^2$

(a) Draw the block diagram of the encoder

(b) Model the system with shift registers and draw the state transition diagram with complete labeling.

(c) Draw the trellis diagram (code tree) for the length $L = 2$. (Append as many zeros as needed to the data bits.)

(d) Decode the following sequence using the **Viterbi algorithm** (or ML decoder which is optimal for an AWGN channel): 11 10 11 00.

Homework 2 ***(Submission Deadline: Wednesday, October 21, 1998 at 11.15 am)***

Assume X_k is equally likely to be 0 or 1, and the X_k are independent for all k. Assume additional additive Gaussian white noise with variance σ^2. The ISI channel is given as $g_k = \delta_k - 0.5\delta_{k-1} + 0.1\delta_{k-2}$.

a) Model the system as a shift register process and draw the state transition diagram. Label the arcs with the input/output pairs (X_k, S_k).

b) Draw one stage of the trellis and label with the input/output pairs (X_k, S_k).

c) Assume $\Psi_k = 0$ for $k \le 0$ and $k \ge 5$. Suppose the observation sequence is $\{y_0, y_1, y_2, y_3, y_4\} = \{0.5, -0.2, 0.9, 1.2, 0.1\}$. Draw a complete trellis with branch weights labeled.

d) Use the Viterbi algorithm to find the ML decision sequence!

e) What is the ML decision sequence $\hat{x}_k$ assuming only additive noise (no ISI)?