ELEC6151: Information Theory and Source Coding
Final
June 19, 2010

1) A Gaussian source with zero mean and variance $\sigma^2 = 1$ is being quantized and transmitted over a Gaussian channel with noise power $N = 0.1$ at a power level $P = 1.5$. What is the minimum achievable distortion? (7 Marks) What is the number of bits per sample? (1 Mark) What is the number of quantization levels? (2 Marks)

2) Consider three independent Gaussian sources with zero mean and variance $\sigma_1^2 = 1$, $\sigma_2^2 = 2$ and $\sigma_3^2 = 3$. Find the number of bits required to represent these sources,

a) if a total distortion of $D = 1$ is required (7 Marks).

a) if a total distortion of $D = 3$ is required (7 Marks).

3) Consider a Binary Symmetric Channel with crossover probability $\varepsilon = 0.1$ and a binary erasure channel with erasure probability $\delta = 0.2$.

a) Find the capacity of the channel formed by cascading the two channels as in Figure 1 (8 Marks).

b) What is the capacity of the resulting channel if the two channels are used as in Figure 2, i.e., with a *processor* (consisting of a decoder and an encoder) in between without any constraint on the complexity of the processor (6 Marks).

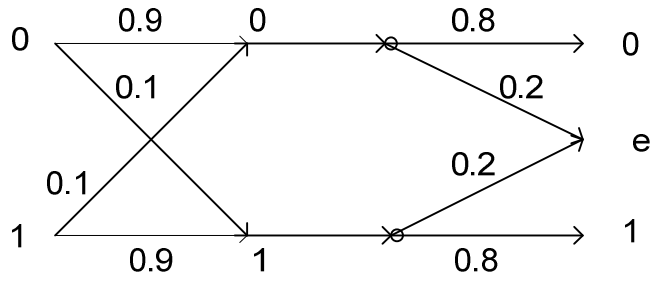

Figure 1

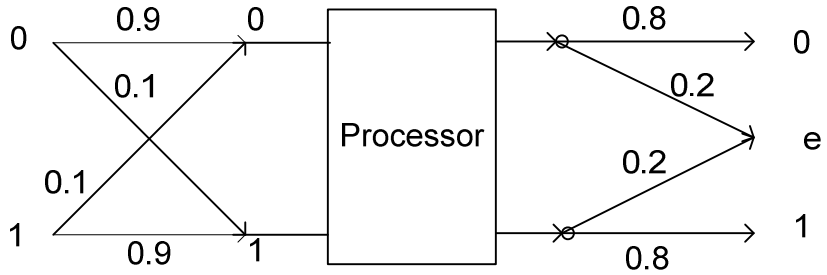

Figure 2

4) Consider a Gaussian multiple access channel with two users with powers P_1 and P_2. The noise power is N. Find the relationship between P_1 and P_2 in order for the two users to transmit at the same rate (10 Marks). Is your answer unique? Explain (2 Mark).

5) Consider a multiple access channel whose output is $Y = X_1 X_2$ where $X_1 \in \{0, 1\}$ and $X_2 \in \{1, 2, 3, 4\}$ are the inputs. Find the sum rate capacity of the channel, i.e., the maximum possible value of the sum of the two rates (10 Marks).