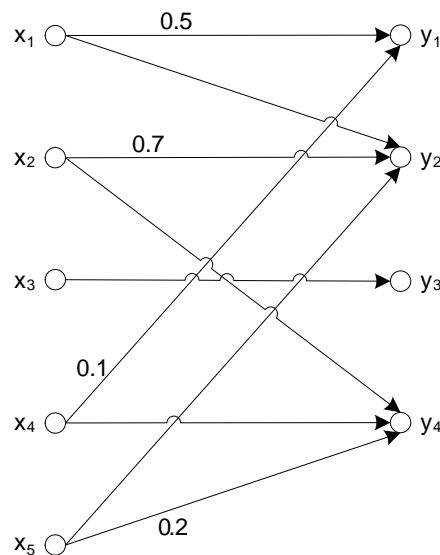# Information Theory

Laboratory Exercise: Information Channels

- This Laboratory session is NOT assessed.
- As you proceed with this investigation, you must complete a personalized lab answer sheet and submit it before you leave this laboratory.
- You must also keep your own notes of your observations and results.

Aims: This lab session is designed to give you some practical experience of estimating information and entropy measures in real-life examples, and to enhance your understanding of the fundamental concepts of Information Theory in general.
Equipment: Software: Matlab.

Exercise 01: Given the source $X=\{x_1, x_2, x_3, x_4, x_5\}$ with $P_X=\{0.05, 0.10, 0.15, 0.30, 0.40\}$ and the channel with diagram as shown below

Estimate
  a) The entropy of the input source X
  b) the channel matrix $P_{Y|X}$
  c) the entropy of the output source Y
  d) The entropy of the joint source XY. *Hint: use function diag().*
  e) The conditional entropies H(X|Y) and H(Y|X)
  f) The mutual information between X and Y.

Exercise 02: Consider a source X={x_1, x_2, x_3, x_4, x_5} with P_X={0.10, 0.10, 0.20, 0.25, 0.35} and the channels

$$P_{Y|X}^1 = \begin{bmatrix} 0.5 & 0.5 & 0 \\ 0.2 & 0 & 0.8 \\ 0 & 0.9 & 0.1 \\ 0 & 0 & 1 \\ 0.3 & 0.7 & 0 \end{bmatrix}, \; P_{Y|X}^2 = \begin{bmatrix} 0.4 & 0.6 & 0 \\ 0 & 0.5 & 0.5 \\ 0.8 & 0 & 0.2 \end{bmatrix}, \; P_{Y|X}^3 = \begin{bmatrix} 0 & 0.5 & 0.5 & 0 \\ 0 & 0 & 0.6 & 0.4 \\ 0.7 & 0.3 & 0 & 0 \end{bmatrix}$$

For the following interconnection

source X → Channel 1 → Channel 2 → Channel 3 → receiver Y

Estimate
   a) The entropy of the source X
   b) The probability distribution of Y
   c) the entropy of source Y
   g) the joint entropy XY. *Hint: use function diag().*
   d) The conditional entropies H(X|Y) and H(Y|X)
   e) The mutual information between X and Y.