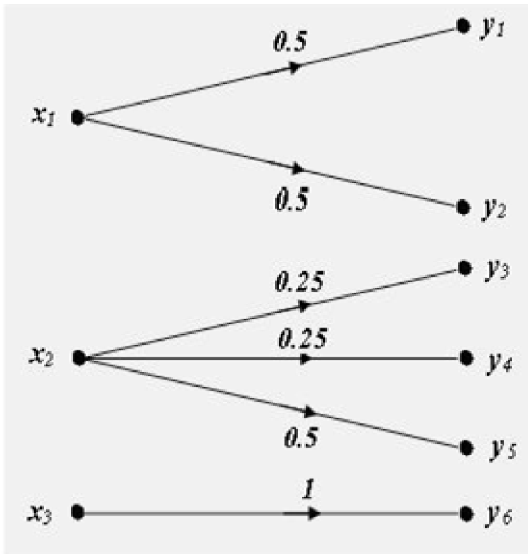
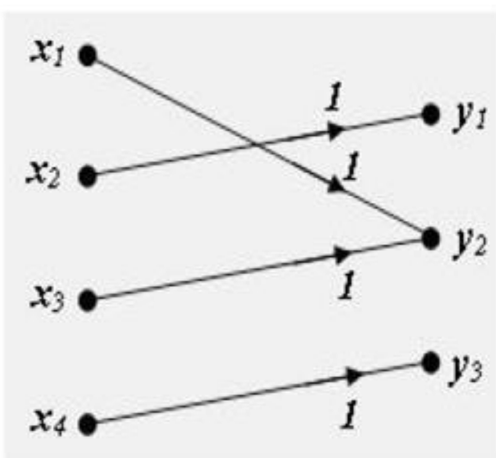
- Lossless Channel: If the channel matrix has only one nonzero entry in each column then the channel is termed as "loss-less channel".



$$P(Y|X) = \begin{bmatrix} 0.5 & 0.5 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.25 & 0.25 & 0.5 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

- Noiseless Channel: If the channel matrix has only one nonzero entry in each row (which necessarily should be a '1'), then the channel is called "deterministic channel".



$$P(Y|X) = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

✓ Channel Capacity

In electrical engineering, computer science and information theory, **channel capacity** is the tight upper bound on the rate at which information can be reliably transmitted over a communications channel. Thus, the channel capacity (C) is the highest rate for sending information (the highest value for the average mutual information) can be achieved when sending information across the Channel.

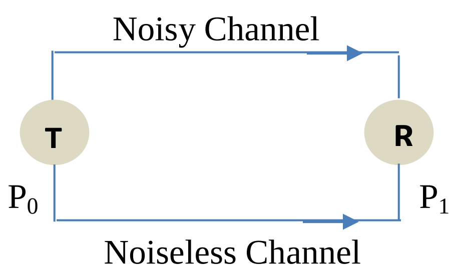
- **Information in the noise channel**

Communications system consists of a sender and recipient and a channel of communication between them. There is importance for this channel in the communication process. Communication channels are often prone to interference factors and this affects the quality of messages upon delivery, which could lead to the loss of some meaning in the information sent. The following formula can be used to measure channel information:

$$I = \log_2 (P_1 / P_0)$$

Where

P_0 : It is the probability of the event at the transmitter.
P_1 : It is the probability of the event upon delivery.



P = 1 When there is no noise, this means that the channel is ideal.
P ≃ 1 When there is little interference.

- **Measuring the transmission of information across confused channels**

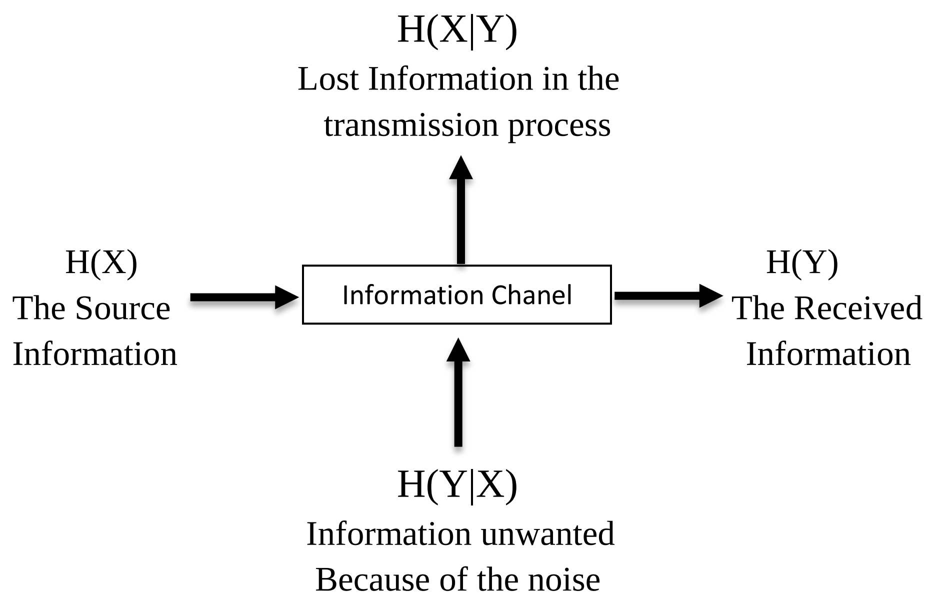
Suppose you have a series of letters sent, offset by a series of letters received. In other words, each Xi sender, there are Yi recipient. Measure the transmission of information over the confused channels is calculated using the following relationship:

$$I(x, y) = \sum_x \sum_y P(x, y) * \log_2(P(x, y)/P(x)*P(y))$$

Where

$P(x, y) = P(y|x) * P(x)$ **OR** $P(y, x) = P(x|y) * P(y)$

<u>Note</u>: The following figure shows the relationship between standards of information in a communication system



***Example1*:** A System sends signals M and spaces S as follows:

X = M M M M M M M S S S

Y = M M M M M S S S S M

Find the transmission information rate and joint entropy.

X	M	M	S	S
Y	M	S	S	M
P(x)	0.7	0.7	0.3	0.3
P(y)	0.6	0.4	0.4	0.6
P(x)P(y)	0.42	0.28	0.12	0.18
P(x, y)	0.5	0.2	0.2	0.1
P(x| y)	5/6	2/4	2/4	1/6
P(y| x)	5/7	2/7	2/3	1/3

$$I = \sum_{x,y} P(x,y) \log_2\left(\frac{P(x,y)}{P(x)*P(y)}\right)$$

$= 0.5 * 3.322 * \log_{10}(0.5/0.42) + 0.2 * 3.322 * \log_{10}(0.2/0.28)$

$+ 0.2 * 3.322 * \log_{10}(0.2/0.12) + 0.1 * 3.322 * \log_{10}(0.1/0.18)$

$= 0.126 - 0.097 + 0.147 – 0.085$

$= 0.091$ bit

$$H(X,Y) = \sum_Y \sum_X P(x,y) \log_2(1/P(x,y))$$

$= 0.5*3.322*\log_{10}(1/0.5)+ 0.2*3.322*\log_{10}1/0.2)$

$+ 0.2*3.322*\log_{10}(1/0.2) + 0.1*3.322*\log_{10}(1/0.1)$

$= 0.5 + 0.464 + 0.464 + 0.332$

$= 1.76$ bit