Almustaqbal University
Engineering And Technical Engineering
Computer Techniques Engineering Department

Information Theory Laboratory

Class :- 4^{th}

Lectuer 4

Entropy of a Binary Source

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Experiment No. 1 "Entropy of a Binary Source"

A **binary source** is a source that produces **only two symbols**, usually:- (0 , 1)
Each symbol has a probability:

- Probability of **0 = P**
- Probability of **1 = 1− P**

Entropy is a measure of the **amount of information** produced by the source when it generates a single symbol. It reflects the **degree of uncertainty** or **randomness** in the output of the source.

The entropy of a binary source is given by the formula:- $H(p) = -p\,log_2(p) - (1-p)\,log_2(1-p)$

Summary

- A binary source outputs only **0 and 1**.
- Entropy measures the expected information per symbol.
- Maximum entropy occurs at **p = 0.5**.
- Minimum entropy occurs at **p = 0 or p = 1**.

Experiment No. 1 “Entropy of a Binary Source”

Objective :-

The objective of this experiment is to calculate and analyze the entropy of a binary source and understand how the probability of each symbol affects the amount of information produced.

❖ **Specifically, the experiment aims to:**

- Determine the entropy of a binary source using the formula:

$$H(p) = -p\,log_2(p) - (1-p)\,log_2(1-p)$$

- Observe how entropy varies with different values of
- Identify the condition at which entropy reaches its maximum and minimum values.

Experiment No. 1 “Entropy of a Binary Source”

Procedure:-

- **Define the probability range of the binary events (0 and 1).**
  - Create a probability vector for symbol **“1” or “0”** from **0 to 1** with step **0.1 :-**

```
p = 0:0.1:1;
p1 = 1 - p;
```

- **Initialize a null matrix (empty vector) to store the entropy values.**
  - m = [];

- **Calculate the entropy for each probability value using a loop.**
  - compute the binary entropy For each value of p(i) :-

```
hx = -( p(i) * log2 (p(i)) + p1(i) * log2 (p1(i)) );
```

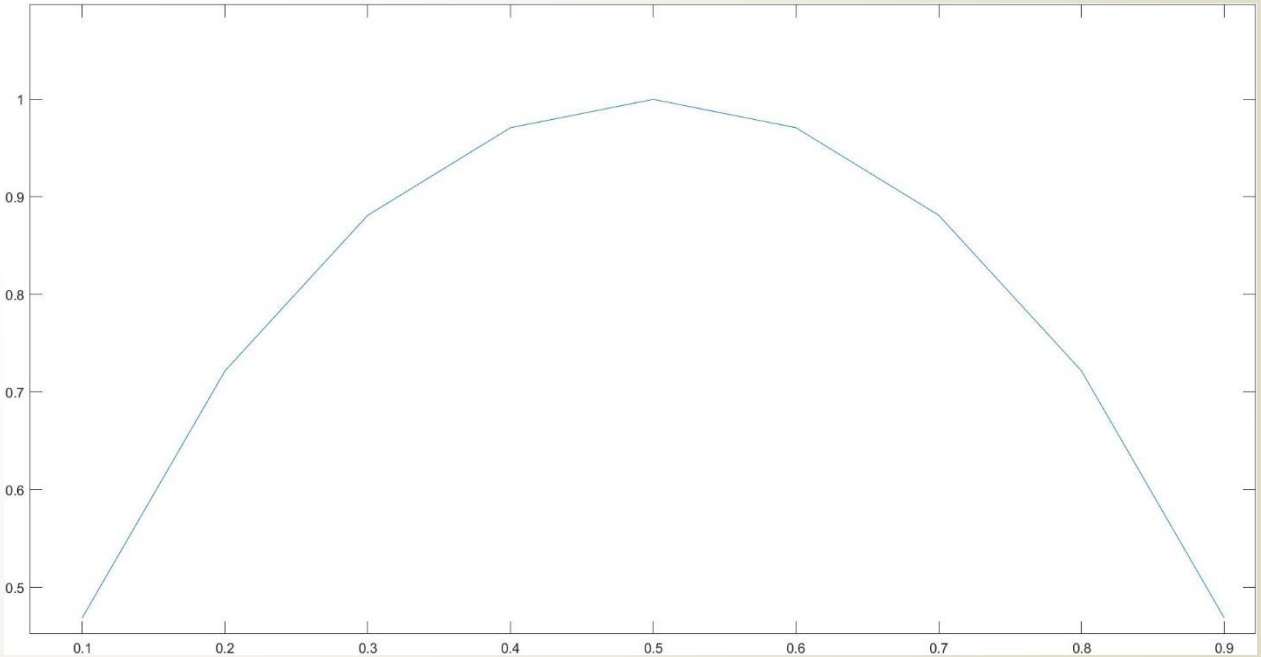
- **Display the overall entropy result vector.**
  - Print all entropy values corresponding to each probability :-

Experiment No. 1 “Entropy of a Binary Source”

MATLAB code

```
p=0:0.1:1;
p1=1-p;
m=[];
for i=1:11
hx=-(p(i)*log2(p(i))+p1(i)*log2(p1(i)));
m(i)=hx
end
m
plot(p,m)
```

Result



Experiment No. 1 “Entropy of a Binary Source”

Result

```
m =NaN
m =NaN    0.4690
m =NaN    0.4690    0.7219
m =NaN    0.4690    0.7219    0.8813
m =NaN    0.4690    0.7219    0.8813    0.9710
m =NaN    0.4690    0.7219    0.8813    0.9710    1.0000
m =NaN    0.4690    0.7219    0.8813    0.9710    1.0000    0.9710
m =NaN    0.4690    0.7219    0.8813    0.9710    1.0000    0.9710    0.8813
m =NaN    0.4690    0.7219    0.8813    0.9710    1.0000    0.9710    0.8813    0.7219
m =NaN    0.4690    0.7219    0.8813    0.9710    1.0000    0.9710    0.8813    0.7219    0.4690
m =NaN    0.4690    0.7219    0.8813    0.9710    1.0000    0.9710    0.8813    0.7219    0.4690    NaN
m =NaN    0.4690    0.7219    0.8813    0.9710    1.0000    0.9710    0.8813    0.7219    0.4690    NaN
```