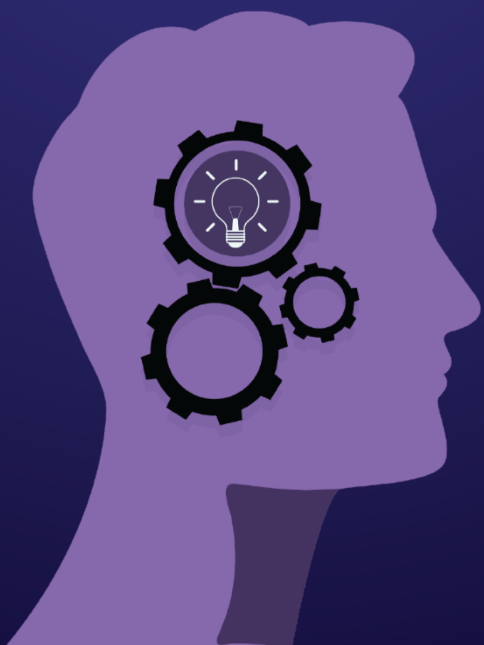
Information theory



Lecture 01

=>INTRO

1-**Who is considered the father of information theory**?

A) Claude Shannon

B) Sherif Barakat

C) Albert Einstein

D) Newton

2- **What are the main question that information theory seeks to answer regarding data transmission**?

A) How much can data be compressed?

B) How fast can data be reliably transmitted over a noisy channel?

C) Both of them

D) None of them

3- **What are the basic "point-to-point" communication theorem?**

A) Source coding theorem

B) Channel coding theorem

C) Both of them

D) None of them

4- **What are the Applications of Information theory**?

A) Data compression

B) Error correcting coding

C) Transmission and modulation

D) Image processing: texture

E) Information security

F) All of them

5- ……………… is a sequence of symbols that can be interpreted as a message?

A) Information

B) Data

C) uncertainty

D) Entropy

6- ……………… is what you get when your uncertainty about something is reduced?

A) Information

B) Data

C) uncertainty

D) Entropy

7- ……………… is what you get when your uncertainty about something is reduced?

A) uncertainty

B) Data

C) Information

D) Entropy

=>AMOUNT OF INFORMATION

-Let **X** be an information source with **M** possible outcomes. The amount of information I(X) is given by:

$$I(X) = \log(M)$$

-The base of logarithm used in this course is base 2

-The amount of information is measured in bits.

8- **When you flip a fair coin, Calculate the amount of information received....**

A) 1 bit

B) 2 bit

C) 3 bit

D) 4 bit

Ans: $I(X) = \log_2 2 = 1$ bit

For a fair coin with two possible outcomes, we have one bit of uncertainty. When it lands we lose that uncertainty and gain one bit of information.

9- **When you flip an unfair coin, Calculate the amount of information received....**

A) 5 bit

B) 10 bit

C) 0 bit

D) 1 bit

Ans: $I(X) = \log_2 1 = 0$ bit

For an unfair coin that always lands on heads, it has only one possible outcome.

10- **When you roll a dice, Calculate the amount of information received....**

A) 7.458 bit

B) 6.789 bit

C) 0 bit

D) 2.585 bit

Ans: $I(X) = \log_2 6 = 2.585$ bits

Since the last example has more outcomes, the amount of uncertainty increases. Therefore, the amount of information 1s bigger than that of the coin examples.

=>If the outcomes are not equally likely?

Let symbols = {a1 , a2 , ... , aM} be the possible outcomes of an information source, the probabilities associated with these symbols be {p1 , p2 , ... , PM}. The amount of information that we receive when we get a specific symbol ai is:

$$I(a_i) = \log(\frac{1}{p_i})$$

11- **A fair coin with a set of two probabilities {0.5, 0.5},**

What's is I(a1)?

A) 5 bit

B) 6 bit

C) 0 bit

D) 1 bit

Ans: $I(a_1) = \log\left(\frac{1}{0.5}\right) = 1\ bit$

the first probability is the probability of getting head and the second one is the probability of getting tail.

12- **An unfair coin that always comes up as heads, what's is I(a1)?**

A) 9 bit

B) 3 bit

C) 0 bit

D) 1 bit

Ans: $I(a_1) = \log\left(\frac{1}{1}\right) = 0\ bit$

13- **A biased coin with probabilities of {0.99, 0.01}, what's I(a1), I(a2) respectively?**

A) 9 bit, 1 bit

B) 1 bit, 1 bit

C) .014 bit, 6.644 bit

D) .145 bit, .4.687 bit

Ans:

$$I(a_1) = \log\left(\frac{1}{0.99}\right) = 0.014\ bit$$

$$I(a_2) = \log\left(\frac{1}{0.01}\right) = 6.644\ bit$$

=>**Entropy**

14- ……………… **the average number of bits required to represent an information source?**

A) Information

B) Data

C) uncertainty

D) Entropy

- The entropy of an information source (X) is called H(X)

$$H(X) = \sum_{i=1}^{M} p_i \log\left(\frac{1}{p_i}\right) = -\sum_{i=1}^{M} p_i \log(p_i)$$

15- **Fair coin with probabilities of {0.5, 0.5}, What's H(X)?**

A) 9 bit

B) 3 bit

C) 0 bit

D) 1 bit

Ans: $H(X) = 0.5 \times \log(\frac{1}{0.5}) + 0.5 \times \log(\frac{1}{0.5}) = 1\ bit.$

17- **Biased coin with probabilities of {0.75, 0.25}, What's H(X)?**

A) 1.11 bit

B) .0147 bit

C) .811 bit

D) 4.568 bit

Ans: $H(X) = 0.75 \times \log(\frac{1}{0.75}) + 0.25 \times \log(\frac{1}{0.25}) = 0.811\ bits.$

18- **Unbalanced dice with probabilities of {0.1, 0.1, 0.1, 0.5, 0.1, 0.1}, What's H(X)?**

A) 2.161 bit

B) 1.458 bit

C) .894 bit

D) 2.887 bit

Ans: $H(X) = 5 \times (0.1 \times \log(\frac{1}{0.1})) + 0.5 \times \log\left(\frac{1}{0.5}\right) = 2.161\ bit$

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