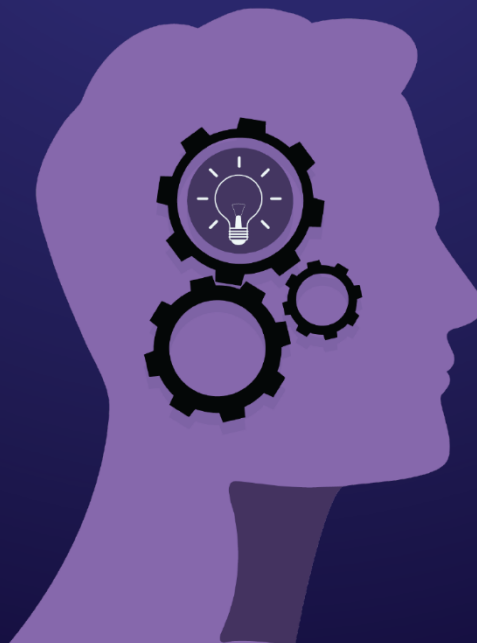




Information theory



Final 2023

1- Suppose that 3% of a population has a certain disease (D). A certain test is 99% sure of correctly returning positive if the person has the disease and 98% sure of correctly returning negative if the person does not have it. If a person got a positive test result, what is the probability that the person has the disease?

- A) 0.5 B) 0.6 C) 0.7 D) 0.8

2- A measure of the spread out of the values from the mean is known As

- A) entropy B) relative entropy C) expected value D) variance

3- If two events cannot both occur at the same time, these events are

- A) independent B) dependent C) disjoint D) complementary

4- The probability that a rolled dice shows an even number and a tossed coin shows a head is

- A) $1/2$ B) $1/3$ C) $1/4$ D) $1/6$

5- If f is a convex function and X is a random variable, then $F(E(X))$ _____ $E(F(X))$

- A) = B) \leq C) \geq D) has no relation with

6- Let $p(x) = (1/2, 1/4, 1/8, 1/8)$, $p(y) = (1/4, 1/4, 1/4, 1/4)$, and $H(x, y) = (27/8)$, what is the value of $H(x|y)$?

- A) $9/8$ B) $11/8$ C) $13/8$ D) $14/8$

7- The entropy is measured in _____, when the base of the logarithm is 2

- A) nats B) dits C) bits D) none of these

8- The maximum value of the binary entropy function: $H(x) = -p \log p - (1-p) \log(1-p)$ equals _____

- A) 0.5 **B) 1** C) 1.5 D) 2

9-The expected number of extra bits required to represent the random variable using a distribution other than the true distribution is _____

- A) entropy B) conditional entropy C) joint entropy **D) relative entropy**

10-If $I(X;Y) = 0$, then X and Y are _____

- A) independent** B) dependent C) disjoint D) reflexive

11-distribution has maximum entropy among all distributions.

- A) Normal B) Binomial **C) Uniform** D) Geometric

12-By the chain rule, $I(X;Y,Z) =$ _____

- A) $I(x;z) + I(X;Y|Z)$** B) $I(X;Y;Z) + I(Y;Z|X)$

- C) $(x;y;z) + I(X;Z|Y)$ D) $I(X;Y) + I(X;Y|Z)$

13- The conditional entropy of X given a particular value of Y ($H(X|Y=y)$) _____ $H(X)$

- A) = **B) <** C) > D) either (A), (B), or (C)

True/False:

- 1- Conditional Probability is symmetric. **T**
- 2- An event and its complement are disjoint events. **T**
- 3- If A, B are independent events, then A and B^c are independent. **T**
- 4- $H(X) \leq H(X|Y)$. **F**
- 5-Entropy is called self-information. **T**
- 6-The entropy filter is used to extract textural features from images. **T**
- 7-The entropy of a collection of random variables is the sum of the relative entropies. **F**
- 8-Relative entropy satisfies triangle inequality. **F**
- 9- $I(X;Y)$ is the relative entropy between the joint distribution and the product distribution $p(x)p(y)$. **T**
- 10-The entropy of a random variable (RV) is an upper bound on the average number of bits required to represent that RV. **F**

11-If $X \rightarrow Y \rightarrow Z$, then $I(X;Y) \geq I(X;Z)$ T.

Final 2022

1- At a certain university, 4% of men are over 6 feet tall and 1% of women are over 6 feet tall. The total student population is divided in the ratio 3:2 in favor of women. If a student is selected at random from among all those over 6 feet tall, what is the probability that the student is a woman?

- A) 0.27 B) 0.35 C) 0.44 D) 0.5

2-A dice is rolled and a coin is tossed, the probability that the dice shows an odd number and the coin shows a head is

- A) $1/2$ B) $1/6$ C) $1/3$ D) $1/4$

3- If the outcome of one event affects the outcome of another, these events are called _____ events.

- A) complementary B) disjoint C) independent D) dependent

4- When an experiment is repeated many times, the average number obtained is known as

- A) variance B) standard deviation C) entropy D) expected value

5- The maximum value of the binary entropy function: $H(x) = -p \log p - (1-p) \log(1-p)$ equals _____

- A) 0.5 B) 1 C) 1.5 D) 2

6- The entropy is measured in _____, when the base of the logarithm is e .

- A) nats B) bits C) nits D) dits

7-Let $p(x) = (1/2, 1/4, 1/8, 1/8)$, $p(y) = (1/4, 1/4, 1/4, 1/4)$, and $H(x,y) = (27/8)$, what is the value of $H(x|y)$?

- A) $9/8$ B) $11/8$ C) $13/8$ D) $14/8$

8- _____ distribution has maximum entropy among all distributions.

- A) Normal B) Binomial C) Geometric D) Uniform

9- If $I(X;Y) = 0$, then X and Y are _____.

A) independent B) dependent C) disjoint D) reflexive

10- The mutual information of a random variable with itself equals the _____ of a random variable.

A) entropy B) conditional entropy C) joint entropy D) relative entropy

11- If f is a convex function and X is a random variable, then $F(E(X))$ _____ $E(F(X))$

A) = **B) \leq** C) \geq D) has no relation with

True/False:

- 1- An event and its complement are disjoint events. (T)
- 2- The entropy of a collection of random variables is the sum of the relative entropies. (F)
- 3- $H(X) \leq H(X|Y)$. (F)
- 4- If $X \rightarrow Y \rightarrow Z$, then $I(X;Y) \geq I(X;Z)$. (T)
- 5- Mutual information is symmetric. (T)