Python Advanced Assignment-21

Q1. What is a probability distribution, exactly? If the values are meant to be random, how can you predict them at all?

Ans.

A probability distribution is a mathematical function that describes the likelihood of different outcomes in an experiment. It gives the probabilities of occurrences of different possible outcomes. Even though the values are random, probability distributions allow us to predict the overall behavior of the system by specifying how often each outcome is likely to occur. For example, in rolling a fair die, while the individual result is random, the probability distribution tells us that each number (1 through 6) has a 1/6 chance of being rolled.

Q2. Is there a distinction between true random numbers and pseudo-random numbers? Why are the latter considered “good enough”?

Ans.

Yes, there is a distinction:

- True random numbers are generated by a physical process (like radioactive decay or thermal noise) and are truly unpredictable.

- Pseudo-random numbers are generated by algorithms, which means they are deterministic but simulate randomness by following complex patterns that are difficult to predict without knowing the initial conditions (seed).

Despite being algorithmically generated, pseudo-random numbers are considered "good enough" for most practical applications because they are statistically indistinguishable from true randomness in most contexts, and they are faster and easier to generate.

Q3. What are the two main factors that influence the behavior of a "normal" probability distribution?

Ans.

The two main factors that influence the behavior of a normal distribution (also called a Gaussian distribution) are:

1. Mean (μ) – This determines the central location or the peak of the distribution.

2. Standard deviation (σ) – This controls the spread or width of the distribution, indicating how much the data varies around the mean.

Q4. Provide a real-life example of a normal distribution.

Ans.

A real-life example of a normal distribution is human heights. In a large population, the heights of individuals tend to cluster around a mean value (average height), with fewer individuals being extremely short or extremely tall. Most people have a height that is near the average, and as you move away from the average, the number of people with that height decreases.

Q5. In the short term, how can you expect a probability distribution to behave? What do you think will happen as the number of trials grows?

Ans.

In the short term, a probability distribution can exhibit considerable variation due to randomness, and you might see unusual or unexpected outcomes. However, as the number of trials increases, the outcomes tend to follow the expected probability distribution more closely, in accordance with the law of large numbers. For example, if you flip a fair coin many times, the proportion of heads and tails will approach 50% each as the number of flips grows.

Q6. What kind of object can be shuffled by using `random.shuffle`?

Ans.

The `random.shuffle` function can be used to shuffle mutable sequences such as lists in Python. It randomly reorders the elements of the list in-place. Immutable sequences like strings or tuples cannot be shuffled directly.

Q7. Describe the `math` package's general categories of functions.

Ans.

The `math` package in Python provides several general categories of functions:

1. Basic arithmetic operations: Functions for addition, subtraction, multiplication, and division.

2. Trigonometric functions: `sin()`, `cos()`, `tan()`, and their inverse functions.

3. Logarithmic and exponential functions: `log()`, `exp()`, etc.

4. Special functions: Functions like `factorial()`, `gcd()`, and `comb()`.

5. Constants: Mathematical constants such as `pi` and `e`.

Q8. What is the relationship between exponentiation and logarithms?

Ans.

Exponentiation and logarithms are inverse operations. If you have an expression \(a^b = c\), then the logarithmic form is \(b = \log_a(c)\). In other words, a logarithm answers the question: "To what power must the base be raised to produce a certain value?"

Q9. What are the three logarithmic functions that Python supports?

Ans.

Python's `math` module supports three logarithmic functions:

1. `math.log(x)` – The natural logarithm (logarithm base e).

2. `math.log10(x)` – The logarithm base 10.

3. `math.log2(x)` – The logarithm base 2.