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

A probability distribution is a mathematical function that describes the likelihood of different outcomes or events occurring. While individual values drawn from a probability distribution are random, the distribution itself provides information about the probabilities associated with each outcome, allowing for predictions based on the overall pattern of probabilities.

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

Yes, there is a distinction between true random numbers and pseudo-random numbers. True random numbers are generated from a source of true randomness, such as atmospheric noise, while pseudo-random numbers are generated using deterministic algorithms. Pseudo-random numbers are considered "good enough" for many practical purposes because they exhibit statistical properties similar to truly random numbers and can be efficiently generated and replicated.

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

The two main factors that influence the behavior of a "normal" probability distribution are the mean and the standard deviation. The mean determines the central tendency or average value of the distribution, while the standard deviation measures the spread or variability of the data around the mean. These two parameters define the shape, location, and characteristics of a normal distribution.

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

One real-life example of a normal distribution is human height. In a large population, heights tend to follow a normal distribution. Most people fall around the average height, which represents the peak of the distribution, while fewer individuals deviate significantly from the mean in either direction. This distribution is symmetric, bell-shaped, and commonly observed in various biological and social characteristics.

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?

In the short term, the behavior of a probability distribution can be unpredictable. Individual outcomes may deviate from the expected probabilities due to randomness. However, as the number of trials increases, the distribution tends to converge to its theoretical probabilities. This phenomenon is described by the law of large numbers, which states that the average of a large number of independent and identically distributed trials will approach the expected value.

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

The `random.shuffle` function in Python can be used to shuffle the elements of a mutable sequence or collection. This includes objects such as lists, arrays, and other data structures that can be modified in place. By applying `random.shuffle`, the elements of the sequence are rearranged randomly, resulting in a different order or permutation of the original elements.

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

The math package in Python provides various categories of functions:

1. Basic mathematical operations: Functions like `abs`, `min`, `max`, `round` for basic arithmetic and rounding operations.

2. Trigonometric functions: Functions like `sin`, `cos`, `tan`, and their inverses, along with other related functions.

3. Exponential and logarithmic functions: Functions like `exp`, `log`, `log10`, `sqrt` for exponential, logarithmic, and square root calculations.

4. Constants: Constants such as `pi` and `e` for mathematical calculations.

These categories encompass a wide range of mathematical operations in the math package.

Q8. What is the relationship between exponentiation and logarithms?

Exponentiation and logarithms are inverse operations of each other. When exponentiation is performed, a number (base) is raised to a certain power (exponent), resulting in the product. Logarithms, on the other hand, determine the exponent to which a base must be raised to obtain a given number. In essence, logarithms "undo" the effects of exponentiation, allowing us to solve equations involving exponential relationships.

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

Python supports three logarithmic functions in the math module:

1. `math.log(x)`: Natural logarithm (base e) of x.

2. `math.log10(x)`: Base-10 logarithm of x.

3. `math.log(x, base)`: Logarithm of x with a custom base. The base argument is specified as the second parameter, allowing calculations with logarithmic bases other than e or 10.