1)

The function poisson\_pmf calculates the probability mass function (PMF) for a Poisson distribution. Here's an explanation of the parameters and the logic used in the function:

1. **k:** This parameter represents the number of events (successes) in a fixed interval for which we want to calculate the probability. It is a non-negative integer.
2. **lambda\_val:** This parameter is the average rate or mean number of events in the fixed interval. It determines the shape and central tendency of the Poisson distribution.

The probability mass function (PMF) for a Poisson distribution is given by:

P(X=k)=λke−λk!P(X=k)=k!λke−λ​

where:

* P(X=k)P(X=k) is the probability of observing exactly kk events in the fixed interval.
* λ is the average rate of events per interval.
* e is the mathematical constant (approximately 2.71828).
* !k! is the factorial of k

2)

The function poisson\_cdf calculates the cumulative distribution function (CDF) for a Poisson distribution. Here's an explanation of the parameters and the logic used in the function:

1. **k:** This parameter represents the number of events (successes) for which we want to calculate the cumulative probability. It is a non-negative integer.
2. **lambda\_val:** This parameter is the average rate or mean number of events in the fixed interval. It determines the shape and central tendency of the Poisson distribution.

The cumulative distribution function (CDF) for a Poisson distribution is the sum of the individual probabilities up to and including the specified value kk:

P(X≤k)=∑i=0kλie−λi!P(X≤k)=∑i=0k​i!λie−λ​

where:

* P(X≤k)P(X≤k) is the cumulative probability that the number of events is less than or equal to kk.
* λλ is the average rate of events per interval.
* ee is the mathematical constant (approximately 2.71828).
* i!i! is the factorial of ii.

The poisson\_cdf function iterates through the values from 0 to kk, accumulating the individual probabilities obtained from the poisson\_pmf function. The result is the cumulative probability up to and including kk in the Poisson distribution.

3)

The function poisson\_expectation calculates the expected value (or mean) of a Poisson distribution. Here's an explanation of the parameter and the logic used in the function:

1. **lambda\_param:** This parameter represents the average rate or mean number of events in a fixed interval. It is a key parameter that determines the shape and central tendency of the Poisson distribution.

The expected value of a Poisson distribution is equal to its average rate:

E(X)=λE(X)=λ

where:

* E(X)E(X) is the expected value of the Poisson distribution.
* λλ is the average rate of events per interval.

In the context of a Poisson distribution, the expected value represents the average number of events one would expect to observe in a fixed interval based on the specified average rate.

4)

The function poisson\_variance return the variance of the poisson distribution   
 Var(X) is the variance of the Poisson distribution.

 λ is the average rate of events per interval.

5)

1. **PMF Calculation:** The function computes the Probability Mass Function (PMF) values for a Poisson distribution with parameter λ (average rate) for a range of unique values.
2. **Visualization:** It uses Matplotlib to create a scatter plot and bar plot of the PMF values, showing the probability of each unique value. The x-axis represents the number of events (kk), and the y-axis represents the probability.
3. **Title and Labels:** The function sets appropriate labels and a title for the plot, including the specified average rate (λ), and then displays the plot.

6)

1. **CDF Calculation:** The function calculates the Cumulative Distribution Function (CDF) values for a Poisson distribution with parameter λ (average rate) for a range of unique values.
2. **Visualization:** Using Matplotlib, it creates a step plot of the CDF values, illustrating the cumulative probability up to each unique value. The x-axis represents the number of events (kk), and the y-axis represents the cumulative probability.
3. **Title and Labels:** The function sets appropriate labels and a title for the plot, including the specified average rate (λλ), and then displays the plot.