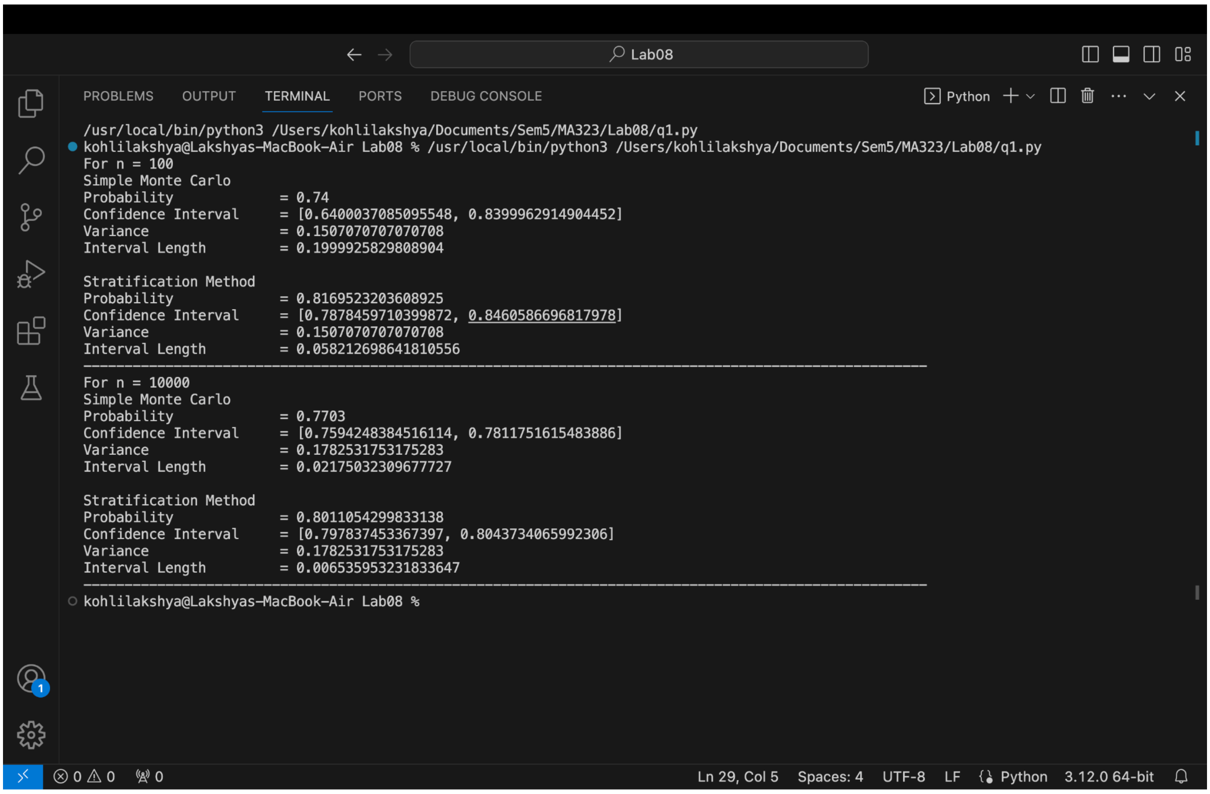
Monte Carlo Simulation - MA 323

# Lab 08 - Report - Lakshya Kohli - 210123077

## Answer 1.

In the presented model, having a lot of storms in the next month (S>=6) is a rare occurrence because of the comparatively low value of λ ( λ = 2.9), hence grouping S>=6 into one strata is justified. Due to its rarity, the likelihood of such incidents is low. Combining them into a single strata makes the stratification procedure easier, expands the sample size within the strata, and boosts the calculation's overall efficiency. It also makes the analysis more useful and computationally efficient.



## Observations:

➢ Stratification improved precision by grouping rare events, resulting in more stable probability estimates as we might be able to do better still by oversampling within the important strata and under-sampling those in which f is nearly constant.

➢ The stratification method typically led to narrower 99% confidence intervals, enhancing result reliability, by reducing the variance.

➢ Stratification optimised sample utilisation and computational efficiency when dealing with rare events.

➢ The analysis has practical applications in water resource management, aiding proactive planning based on probability estimates.

## Answer 2.

The code effectively calculates the probability μ = 0.02636 using the conditional Monte Carlo technique.

## Observations:

➢ The problem involves generating random variables from a Dirichlet distribution with specific alpha parameters, which is essential for probability estimation.
➢ The code utilises the gamma distribution to generate random variables with shape parameters corresponding to the given alpha values, facilitating the calculation of the Dirichlet random variable.➢ The code conditions on the value of Y19 (associated with alpha[18]) to determine if it is the largest Yj, simplifying the probability calculation.
➢ The approach is computationally efficient and avoids the need to calculate the Dirichlet density directly.

```
kohlilakshya@Lakshyas-MacBook-Air Lab08 % /usr/local/bin/python3 /Users/kohlilak
shya/Documents/Sem5/MA323/Lab08/q2.py
Value of μ = P( X19 = max i (Xi)) using conditional monte carlo technique is 0.0257
Conditional Expectation (using scipy library) is: 0.026266
```

## Answer 3.

# Observations:

➢ The code successfully implements the covariate technique to estimate μ = E(f(X)), considering specific log-normal random variables.
➢ It allows users to specify parameters (μ and σ^2) for each log-normal distribution, offering flexibility for different scenarios.
➢ A function to sample log-normal variables is defined, making it reusable and aligned with the chosen parameters.
➢ Samples are generated for each log-normal variable, with a substantial sample size (n = 10,000) for accurate estimation.
➢ The code features a dedicated function for estimating μ using the covariate technique, considering the maximum of the specific function f(X).
➢ The estimated value of μ is printed to the console, providing a numerical result for the problem.

```
kohlilakshya@Lakshyas-MacBook-Air Lab08 % /usr/local/bin/python3 /Users/kohlilak
shya/Documents/Sem5/MA323/Lab08/q3.py
mu_values : [1.1, 1.2, 0.9, 1.5, 1.3]
sigma2_values : [0.3, 0.2, 0.15, 0.1, 0.25]
Total number of iteration to estimate actual expectation is 100000
Estimated mean using covariate method comes out to be 3.650870727246618
```