**Case Study – Simulation**

In this assignment, you will apply simulation techniques to estimate quantities of interest.

Submit a report (PDF or Word) that includes:

* Answers to the questions below with relevant visualizations/outputs.
* R/Python code corresponding to each question (attach the code under each answer).

Problem 1 - Emergency Room (ER) Patient Flow Analysis (13pts)

An emergency room (ER) receives patients randomly throughout the day. The number of patients arriving per hour follows a Poisson distribution with parameter 10 (10 patients per hour). Due to hospital capacity limitations, the ER becomes overcrowded when more than 15 patients arrive in a single hour. You will simulate patient arrivals and estimate probabilities related to ER overcrowding.

1. Use simulation to estimate the probability that the ER experiences overcrowding (more than 15 patients in an hour).
2. Simulate 100 days, each consisting of 24 hours of patient arrivals, estimate the proportion of days where the ER is overcrowded for at least 4 hours.
3. Using the data simulated in the previous question, compute the mean of 24 hourly arrivals in each day, then you will have 100 average arrivals. Compare it to a normal distribution using QQ plot.

Problem 2 - Estimating Bias Using Nonparametric Bootstrap (12pts)

You are given a dataset containing the annual salaries (in $1000s) of 250 employees in a company. The dataset is stored as a csv file(employee\_salaries.csv).

1. Load the dataset and visualize the distribution of salaries using a histogram and a boxplot.
2. Compute the observed sample mean, median, and standard deviation of salaries.
3. Bootstrap estimation of the bias for the median:
   1. Perform 1,000 bootstrap resamples (sampling with replacement from the dataset)
   2. Compute the bootstrap median for each resample
   3. Estimate the bias of the sample median