Alexandria University
Faculty of Engineering

CS 112: Statistics
Spring 2025
Lab 2
Assigned: 28/3/2025
Due: 17/4/2025

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# Estimating Parameters of a Gamma Distribution

## Objective

The objective of this lab is to estimate the parameters of a Gamma distribution using **Maximum Likelihood Estimation (MLE)** and the **Method of Moments Estimation (MME)** and to compare their performance. By analyzing the differences between these two estimation methods and visualizing the results, students will gain a deeper understanding of parameter estimation techniques and their applications in statistical inference.

## Requirements

- Write and run an interactive Python notebook (ipynb)
- You can use Colab or your local machine
- Write a clean and commented code and do the explanations in markdown cells.
- Use matplotlib, numpy, scipy, seaborn or stats libraries

## Submission

- You have to submit the ipynb
- Work on this lab individually

## Problem Statement

Given a dataset sampled from a Gamma($\alpha$, β) distribution, implement a program that estimates the parameters using:

1. Maximum Likelihood Estimation (MLE)
2. Method of Moments Estimation (MME)

# Steps to Implement

## Data

- Simulate a sample data of size **n** from a Gamma($\alpha$, **β**) distribution using known parameters
- Use at least five different size scales for **n** and use 10 different settings of $\alpha$ and **β**

## MLE

- Obtain the log-likelihood of the gamma function. **HINT: You can use the stats.gamma.logpdf function**
- Minimize the negative log-likelihood using the **scipy minimize** function

## MME

- Knowing that E[X] = $\alpha\beta$ and Var(X) = $\alpha\beta^2$. Find the moment estimators for $\alpha$ and **β**.

## Reporting

- Tabulate the results obtained from the combination of sample sizes, $\alpha$, and **β** comparing the true, MLE, and MME.
- Plot the estimated distributions over a histogram of the sample data for each row of the table.
- You will be graded on code readability, functionality, cleanliness, robustness, standardization, and organization.
- You will be graded on plot readability, organization, and interpretability.
- Use latex or markdown to type the MLE function of the gamma distribution and the obtained MME estimators of $\alpha$ and **β**