**SE SEM IV**

**Subject ITC 401: Engineering Mathematics IV**

**2024-25**

**March 2025**

**Title**: Mini Project for ITC 401 Engineering Mathematics IV

**Academic Year**: 2024-25

**Name of Team:** Infinity Squad

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**Acknowledgement**

We, as a group, would like to express our sincere gratitude to **Dr. Revathy Sundararajan** from the **Department of Basic Science and Humanities** for her invaluable guidance and unwavering support throughout this project. Her insightful advice, encouragement, and expertise have been instrumental in its successful completion. Her dedication and willingness to assist at every stage have truly been a source of inspiration. We are deeply grateful for her time, effort, and valuable suggestions, which have significantly contributed to the quality of our work.

**Abstract**

This project investigates the statistical distribution of even numbers in randomly generated one-digit numbers through repeated trials. Initially, 100 one-digit numbers were randomly generated, and the frequency distribution of digits was analysed. The number of even numbers in this set was recorded. The experiment was repeated for multiple trials (10, 20, 30, ..., 1000), and the distribution of even-number occurrences was studied. Data visualization techniques, including **frequency curves, bar charts, and statistical plots**, were used to analyse the trends. The results demonstrate that while individual trials show some variation, the distribution stabilizes with more trials, converging toward a **Binomial distribution** initially and approximating a **Normal distribution** as the number of trials increases. These findings align with the **Law of Large Numbers** and the **Central Limit Theorem**, making this study a valuable practical example of probability and statistical principles.

1. **Introduction**

In this study, we analyse the distribution of even numbers obtained from randomly generating one-digit numbers and explore the statistical properties that emerge when performing multiple trials. The objective is to understand the behaviour of randomly generated numbers and identify patterns that arise as the number of trials increases.

**Problem Statement:**

The problem requires generating 100 random one-digit numbers and counting how many of them are even. This process is repeated over multiple trials (10, 20, 30, ..., 1000), and the results are analysed to identify the distribution pattern of even-number occurrences. The goal is to examine whether the distribution follows a well-known statistical model, such as the normal distribution.

**Challenges Tackled:**

Random Number Generation – Ensuring the randomness of digits while keeping track of even numbers in each trial.

Data Collection and Analysis – Storing and analysing the frequency of even numbers across different trials.

Graphical Representation – Visualizing results using histograms and frequency curves to identify distribution patterns.

Statistical Interpretation – Understanding how the data fits into known statistical distributions and what conclusions can be drawn from it.

**Random Number Generation Process**

The random number generation for the project was implemented using Python and NumPy. The following steps outline the process:

**Defining the Trials**

The program generates 1000 trials, each consisting of 100 random one-digit numbers (0-9).

The numbers were generated using np.random.randint(0, 10, num\_digits), which produces an array of 100 random integers between 0 and 9.

**Recording Even Numbers**

After generating the numbers, the count of even numbers (0, 2, 4, 6, 8) in each trial was determined.

This was achieved using df\_trials.apply(lambda col: (col % 2 == 0).sum()), which counts the even numbers in each column (i.e., each trial).

**Frequency Analysis**

The frequency of digits (0-9) across all trials was calculated.

A dictionary was created where each key corresponds to a trial, and the values represent the counts of each digit.

The results were stored in a Pandas DataFrame and saved in an Excel file for further analysis.

**Saving the Data**

The generated data was saved into an Excel file, random\_trials.xlsx, with two sheets:

"Trials" Sheet: Contains raw data of all 1000 trials.

"Frequency" Sheet: Shows the frequency of digits across all trials and the total even number count.

1. **Information Gathering and Analysis**

For this project, a structured approach was followed to collect, analyse, and interpret data regarding the frequency distribution of even numbers in randomly generated one-digit numbers. The methodologies applied include random number generation, data recording, statistical visualization, and inference based on the observed distributions.

Methodologies Used are:

**1. Random Number Generation**

The experiment required generating random one-digit numbers (0–9) and counting how many of them were even (0, 2, 4, 6, 8). This was done using a computational approach where a python based random number generator was used to simulate multiple trials.

Step 1: Generate 100 one-digit numbers in a single trial.

Step 2: Count how many of these numbers are even.

Step 3: Repeat for multiple trials (10, 20, 30, ..., 1000).

Step 4: Store results for statistical analysis.

**2. Data Collection and Organization**

For each trial, the number of even numbers obtained was recorded. The results were systematically stored in tables and spreadsheets, ensuring accuracy in tracking the frequency of different outcomes.

**3. Graphical Representations and Their Conclusions**

**(a) Histogram: Even Number Count vs Frequency**

A histogram was plotted to visualize how frequently different counts of even numbers appeared in each trial.

The most common count of even numbers per trial was around 50 (since the probability of a number being even is 50%).

The distribution was approximately bell-shaped, meaning most trials had even counts clustered around the mean, with fewer extreme cases.

As the number of trials increased, the shape of the histogram became smoother and more symmetric, resembling a normal distribution.

**(b) Frequency Curve: Count vs Trial Size**

A frequency curve was drawn to analyse the variation of even-number occurrences as the number of trials increased.

**Observations:**

Initially, with fewer trials (10, 20, 30), the data showed fluctuations in the counts of even numbers.

As more trials were conducted (100, 500, 1000), the frequency distribution stabilized, further confirming a normal distribution pattern.

This indicated that as the number of trials approached infinity, the results would converge to a predictable statistical pattern, supporting the Central Limit Theorem (CLT).

**4. Inferences Drawn from the Analysis**

Statistical Consistency: Over a large number of trials, the even-number count consistently centred around 50 (expected value for 100 random digits).

Normal Distribution Behaviour: The distribution of even-number occurrences followed a Gaussian (normal) distribution, meaning the probability of getting a count far from 50 decreased symmetrically.

Law of Large Numbers: The more trials conducted, the closer the observed results matched the expected statistical distribution, demonstrating that randomness evens out over time.

Real-World Applications: This experiment reflects real-world scenarios such as system reliability, performance modelling, and data analytics, where distributions help in predicting probabilities and making informed decisions.