



Course Project Report

STA 2101: Statistics & Probability

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Abstract

This project investigates the intricate relationship between academic pressure, peer influence, and coping strategies among undergraduate students. Utilizing the publicly available Kaggle dataset “*Academic Stress Level Maintenance Dataset*”, the study applies a range of statistical techniques—including descriptive statistics, probability distributions, hypothesis testing, and regression analysis—to examine patterns in students’ academic stress levels. The goal is to identify the most influential stress factors and understand how different coping mechanisms contribute to maintaining psychological well-being and academic performance.

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1 Milestone 1: Dataset Selection

- **Dataset Name:** Academic Stress Level Maintenance Dataset
- **Dataset URL:** <https://www.kaggle.com/datasets/ayeshaimran123/academic-stress-level-maintenance-dataset>
- **Description:** The *Academic Stress Level Maintenance Dataset* contains responses gathered from undergraduate students regarding various dimensions of academic stress. The variables in the dataset capture multiple aspects, including peer influence, academic expectations from family, study environment, and the coping mechanisms students adopt to manage stress. Additionally, it provides data on students' self-assessed competition levels, motivation, and overall stress index.

This dataset was selected because it offers valuable insight into how social and environmental factors influence students' academic well-being. By analyzing this data, the project aims to uncover significant trends and correlations between stress triggers and coping behaviors. The findings from this analysis may contribute to a better understanding of how universities and educators can design effective support systems to promote mental health and reduce stress in academic settings.

2 Milestone 2: Statistics Sampling

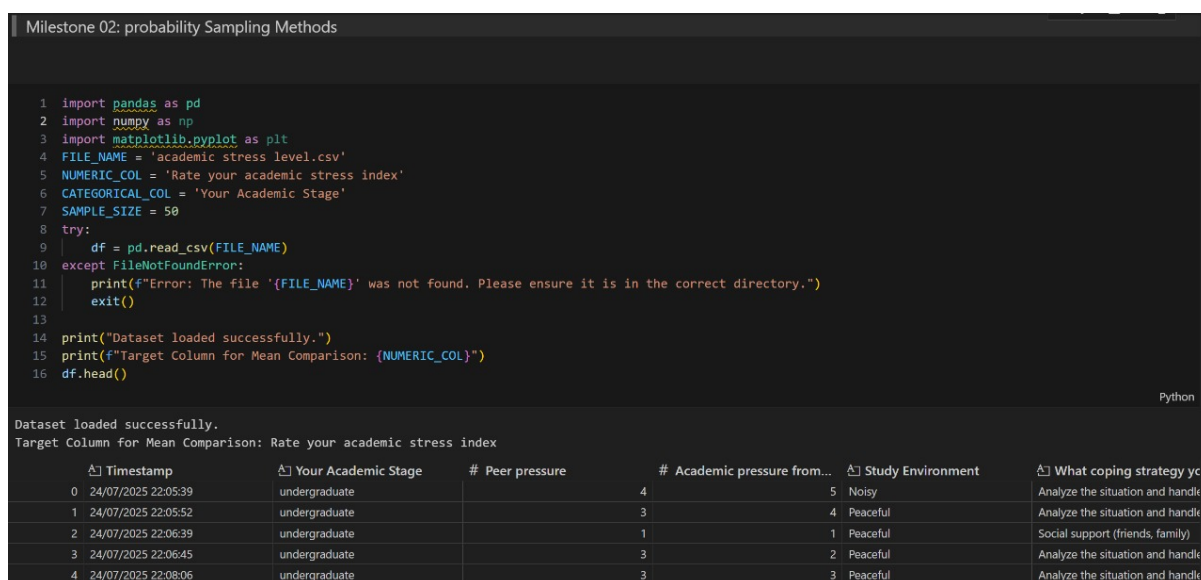


Figure 1: Overview dataset

Part A — Setup

- Report dataset size (rows, columns)

```
1 print("Dataset size (rows, columns):", df.shape)
2
3 N, M = df.shape
4 print(f"\nPopulation Size (N): {N} rows, {M} columns")
5
```

Dataset size (rows, columns): (140, 9)

Population Size (N): 140 rows, 9 columns

Figure 2: Part A Setup

Part B — Simple Random Sampling

```
1 import difflib, pandas as pd
2
3 EXPECTED_COL, sample_size = 'Rate your academic stress index', 50
4 ANALYSIS_COL = EXPECTED_COL if EXPECTED_COL in df.columns else difflib.get_close_matches(EXPECTED_COL, df.columns, n=1, cutoff=0.5)[0]
5
6 df[ANALYSIS_COL] = pd.to_numeric(df[ANALYSIS_COL], errors='coerce')
7 srs = df.sample(sample_size, random_state=42)
8
9 pop_mean, sample_mean = df[ANALYSIS_COL].mean(), srs[ANALYSIS_COL].mean()
10 sample_means = {'Simple Random Sample (SRS)': sample_mean}
11
12 print(f"\n=== Simple Random Sample (SRS) ===\nColumn: {ANALYSIS_COL} | Sample Size: {sample_size}\n")
13 print(srs.head(), "\n")
14 print(f"Population Mean: {pop_mean:.4f} | Sample Mean: {sample_mean:.4f}\n")
15
```

Figure 3: Part B : Simple Random Sampling

```

...
=== Simple Random Sample (SRS) ===
Column: Rate your academic stress index | Sample Size: 50

Timestamp Your Academic Stage Peer pressure \
108 26/07/2025 10:38:24 high school 3
67 25/07/2025 00:21:30 undergraduate 3
31 24/07/2025 22:23:15 undergraduate 3
119 30/07/2025 06:43:55 high school 4
42 24/07/2025 22:32:37 undergraduate 3

Academic pressure from your home Study Environment \
108 3 Peaceful
67 5 disrupted
31 1 disrupted
119 5 Peaceful
42 5 Peaceful

What coping strategy you use as a student? \
108 Analyze the situation and handle it with intel...
67 Emotional breakdown (crying a lot)
31 Emotional breakdown (crying a lot)
119 Analyze the situation and handle it with intel...
42 Analyze the situation and handle it with intel...
...
42 5

Population Mean: 3.7214 | Sample Mean: 3.9400

```

Figure 4: output: Random Sampling

Part C — Systematic Sampling

```

1 import numpy as np
2
3 sample_size = 50
4 N = len(df)
5 k = N // sample_size
6 start = np.random.randint(0, k)
7 sys_sample = df.iloc[start:k][:sample_size]
8
9 pop_mean = df[ANALYSIS_COL].mean()
10 sample_mean = sys_sample[ANALYSIS_COL].mean()
11 sample_means['Systematic Sample'] = sample_mean
12
13 print(f"\n=== Systematic Sampling ===")
14 print(f"Sample Size: {sample_size} | Interval (k): {k} | Random Start: {start}\n")
15 print(sys_sample.head(), "\n")
16 print(f"Population Mean : {pop_mean:.4f}")
17 print(f"Sample Mean      : {sample_mean:.4f}\n")
18

```

Figure 5: Part C : Systematic Sampling

```

=== Systematic Sampling ===
Sample Size: 50 | Interval (k): 2 | Random Start: 1

    Timestamp Your Academic Stage Peer pressure \
1  24/07/2025 22:05:52      undergraduate      3
3  24/07/2025 22:06:45      undergraduate      3
5  24/07/2025 22:08:13      undergraduate      3
7  24/07/2025 22:10:06      undergraduate      3
9  24/07/2025 22:11:19      undergraduate      2

    Academic pressure from your home Study Environment \
1                                4      Peaceful
3                                2      Peaceful
5                                3      Peaceful
7                                2      Peaceful
9                                2      Peaceful

    What coping strategy you use as a student? \
1  Analyze the situation and handle it with intel...
3  Analyze the situation and handle it with intel...
5  Analyze the situation and handle it with intel...
7                                Social support (friends, family)
9  Analyze the situation and handle it with intel...
...

Population Mean : 3.7214
Sample Mean      : 3.5400

```

Figure 6: output demo : Syatematic Sampling

Part D — Stratified Sampling

Generate + Code + Markdown

```

1 strata_col = 'Your Academic Stage'
2 sample_size = 50
3 frac = sample_size / len(df)
4
5 stratified_sample = df.groupby(strata_col, group_keys=False).sample(frac=frac, random_state=42)
6
7 pop_mean = df[ANALYSIS_COL].mean()
8 sample_mean = stratified_sample[ANALYSIS_COL].mean()
9 sample_means['Stratified Sample'] = sample_mean
10
11 print(f"\n=== Stratified Sampling ===")
12 print(f"Stratification Column: {strata_col} | Sample Size: {sample_size}\n")
13 print(stratified_sample.head(), "\n")
14 print(f"Population Mean : {pop_mean:.4f}")
15 print(f"Sample Mean      : {sample_mean:.4f}\n")
16

```

Figure 7: part D : Stratified Sampling

```

...
=== Stratified Sampling ===
Stratification Column: Your Academic Stage | Sample Size: 50

Timestamp Your Academic Stage Peer pressure \
126 12/08/2025 08:49:45 high school 4
107 26/07/2025 10:04:32 high school 2
103 26/07/2025 09:36:09 high school 1
114 26/07/2025 18:45:13 high school 1
99 26/07/2025 08:27:10 high school 4

Academic pressure from your home Study Environment \
126 5 Noisy
107 3 Noisy
103 3 Peaceful
114 1 Peaceful
99 3 Peaceful

What coping strategy you use as a student? \
126 Emotional breakdown (crying a lot)
107 Social support (friends, family)
103 Social support (friends, family)
114 Emotional breakdown (crying a lot)
99 Analyze the situation and handle it with intel...
...

Population Mean : 3.7214
Sample Mean : 3.7000

```

Figure 8: output demo : Stratified Sampling

Part E — Cluster Sampling

Generate
+ Code
+ Markdown

```

1 import numpy as np
2
3 num_clusters, clusters_to_select = 10, 2
4 cluster_size = len(df) // num_clusters
5 df['cluster_id'] = df.index // cluster_size
6
7 selected_clusters = np.random.choice(df['cluster_id'].unique(), clusters_to_select, replace=False)
8 cluster_sample = df[df['cluster_id'].isin(selected_clusters)]
9
10 pop_mean = df[ANALYSIS_COL].mean()
11 sample_mean = cluster_sample[ANALYSIS_COL].mean()
12 sample_means['Cluster Sample'] = sample_mean
13
14 print(f"\n=== Cluster Sampling ===")
15 print(f"Total Clusters: {num_clusters} | Selected Clusters: {clusters_to_select}")
16 print("Chosen Cluster IDs:", selected_clusters, "\n")
17 print(cluster_sample.head(), "\n")
18 print(f"Population Mean : {pop_mean:.4f}")
19 print(f"Sample Mean : {sample_mean:.4f}\n")
20

```

Figure 9: Part E : Cluster Sampling

```

...
=== Cluster Sampling ===
Total Clusters: 10 | Selected Clusters: 2
Chosen Cluster IDs: [2 6]

Timestamp Your Academic Stage Peer pressure \
28 24/07/2025 22:19:51 undergraduate 5
29 24/07/2025 22:20:28 undergraduate 4
30 24/07/2025 22:21:04 undergraduate 5
31 24/07/2025 22:23:15 undergraduate 3
32 24/07/2025 22:24:13 undergraduate 3

Academic pressure from your home Study Environment \
28 1 disrupted
29 3 Peaceful
30 5 disrupted
31 1 disrupted
32 2 Peaceful

What coping strategy you use as a student? \
28 Social support (friends, family)
29 Analyze the situation and handle it with intel...
30 Emotional breakdown (crying a lot)
31 Emotional breakdown (crying a lot)
32 Emotional breakdown (crying a lot)
...

Population Mean : 3.7214
Sample Mean : 3.7857

```

Figure 10: output demo : Cluster Sampling

Part F — Comparison & Reflection

The analysis focused on sampling the **academic stress index** score. The goal was to determine which sampling method most accurately estimates the true population mean.

- **Stratified Sampling** performs well when the stratification column (Academic Stage) is highly correlated with the target variable (Stress Index), as it ensures that all key subgroups are proportionally represented.
- **Simple Random Sampling (SRS)** provides an unbiased estimate, but its accuracy depends purely on chance.
- **Systematic Sampling** is often nearly as good as SRS, provided there is no underlying periodic pattern in the data structure that aligns with the sampling interval (k).
- **Cluster Sampling** (selecting only two clusters) often results in the largest difference because the sample is highly concentrated within a few groups, which may not represent the overall diversity of the population.

Based on the generated comparison table, the sampling method with the smallest **Absolute Difference** is considered the most accurate for this specific sample run. For improved reliability, this entire process should be repeated many times (simulation) to compute the average performance of each sampling method.

3 Milestone 3: Data Visualization

Add graphs and figures using LaTeX. Example:

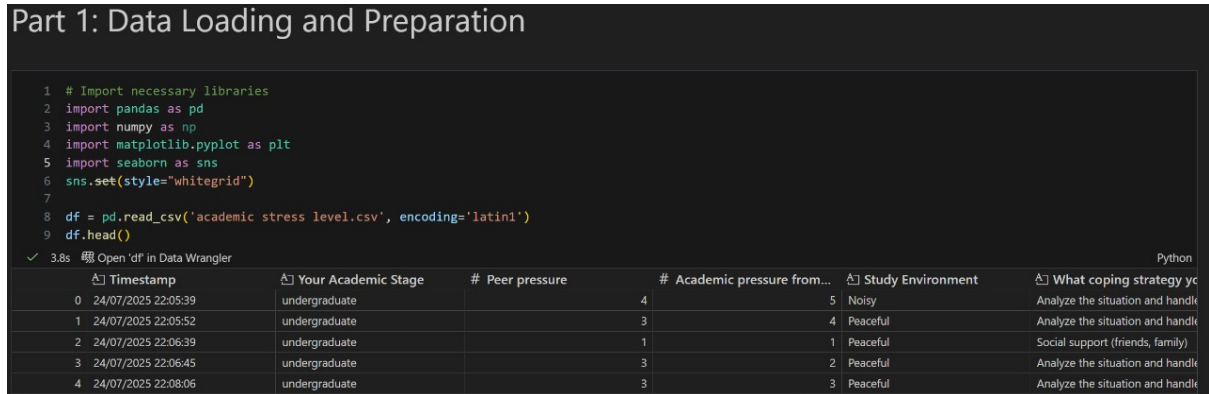


Figure 11: Data Loading and Preparation

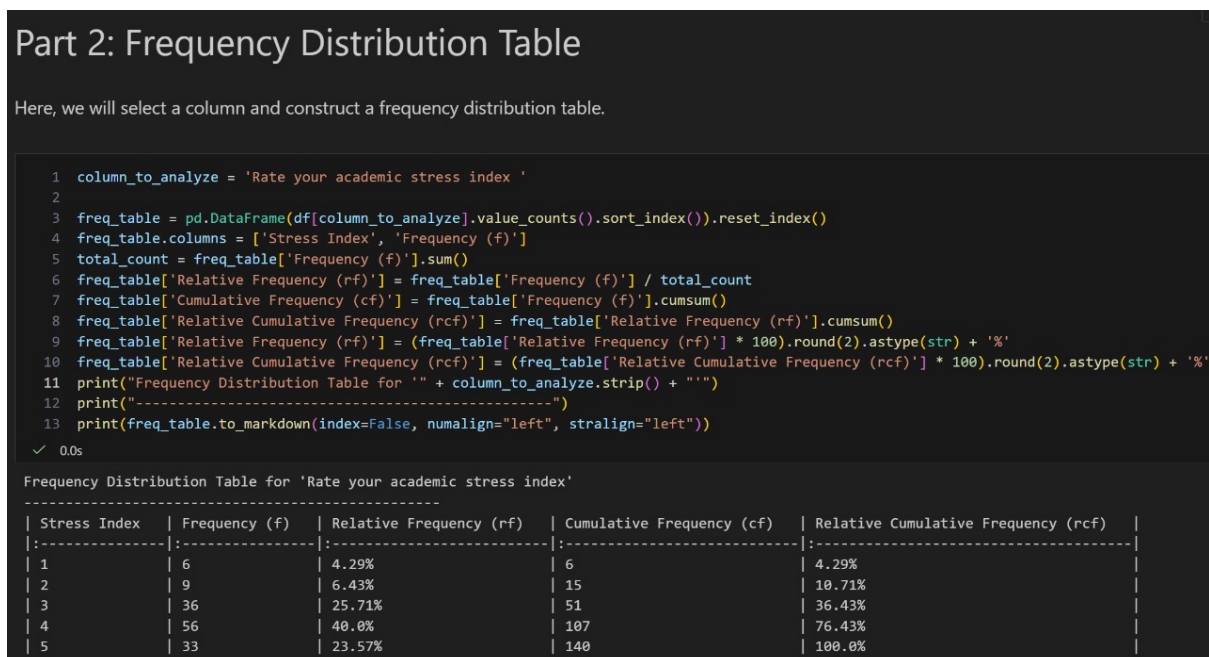


Figure 12: Frequency Distribution Table

Part 3: Graphical Representation

In this section, we will visualize the data distribution using various charts.

3.1 Bar Chart / Histogram

```
1 plt.figure(figsize=(10, 6))
2 column_to_analyze = 'Rate your academic stress index '
3 stress_order = freq_table['Stress Index'].tolist()
4 sns.countplot(data=df,
5               x=column_to_analyze,
6               order=stress_order,
7               palette='viridis')
8 plt.title(f'Bar Chart: Frequency Distribution of Academic Stress Index', fontsize=16)
9 plt.xlabel('Academic Stress Index (1 = Low Stress, 5 = High Stress)', fontsize=12)
10 plt.ylabel('Frequency (Number of Students)', fontsize=12)
11 plt.xticks(ticks=[0, 1, 2, 3, 4], labels=stress_order, rotation=0)
12 ax = plt.gca()
13 for p in ax.patches:
14     ax.annotate(f'{int(p.get_height())}', (p.get_x() + p.get_width() / 2., p.get_height()),
15               ha='center', va='center', fontsize=10, color='black', xytext=(0, 5),
16               textcoords='offset points')
17 plt.tight_layout()
18 plt.show()
```

Figure 13: Graphical Representation

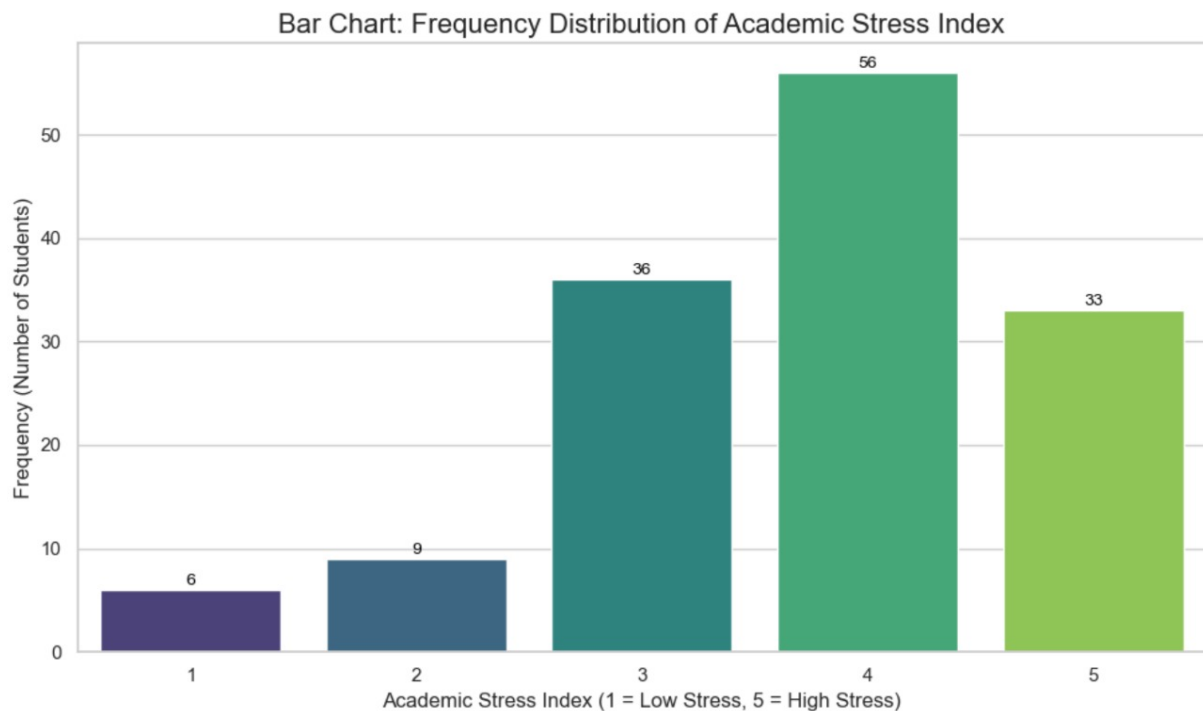


Figure 14: Bar chart

3.2 Line Chart / Frequency Polygon

```
1 plt.figure(figsize=(10, 6))
2 plt.plot(freq_table['Stress Index'], freq_table['Frequency (f)'],
3         marker='o',
4         linestyle='--',
5         color='#4c72b0',
6         linewidth=2,
7         markersize=8)
8 for i, row in freq_table.iterrows():
9     plt.annotate(f'{row["Frequency (f)"]}',
10               (row['Stress Index'], row['Frequency (f)']),
11               textcoords="offset points",
12               xytext=(0,10),
13               ha='center')
14 plt.title(f'Frequency Polygon: Distribution of Academic Stress Index', fontsize=16)
15 plt.xlabel('Academic Stress Index (1 = Low Stress, 5 = High Stress)', fontsize=12)
16 plt.ylabel('Frequency (Number of Students)', fontsize=12)
17 plt.xticks(freq_table['Stress Index'])
18 plt.ylim(0, freq_table['Frequency (f)'].max() + 10)
19 plt.grid(axis='y', linestyle='--')
20 plt.tight_layout()
21 plt.show()
```

✓ 0.2s

Figure 15: Line Chart / Frequency Polygon

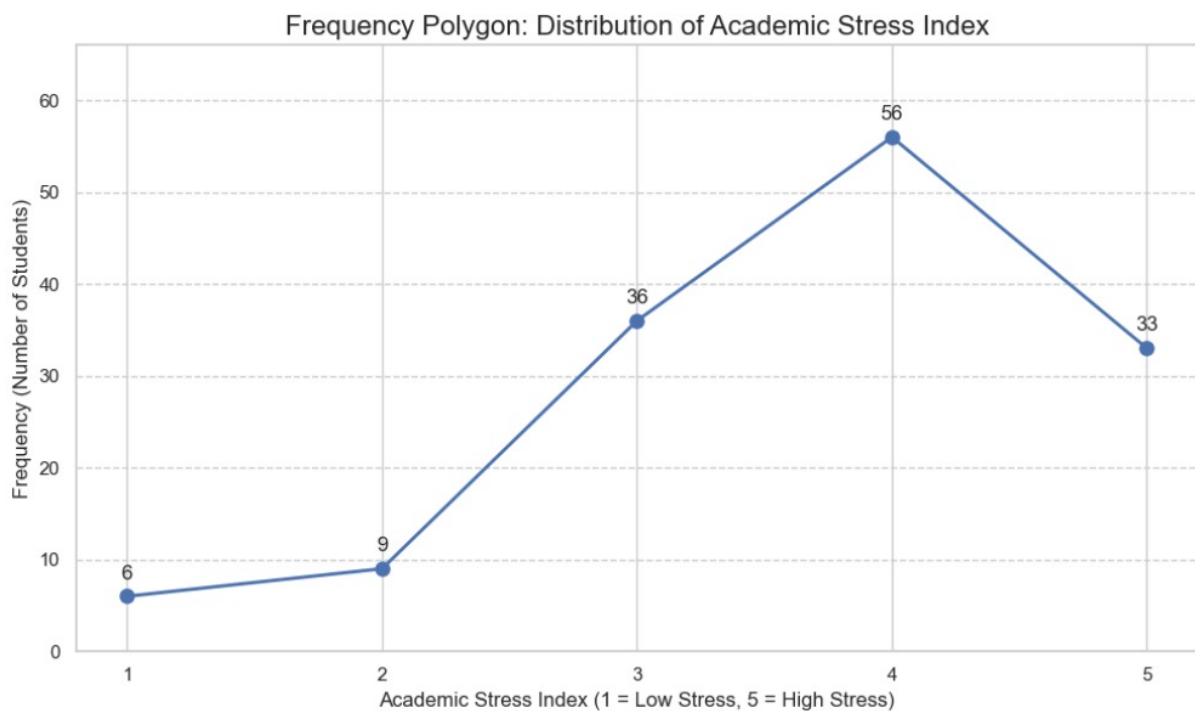


Figure 16: Frequency Polygon

3.3 Ogive Chart (Cumulative Frequency Graph)

```
1 plt.figure(figsize=(10, 6))
2 plt.plot(freq_table['Stress Index'], freq_table['Cumulative Frequency (cf)'],
3         marker='o',
4         linestyle='--',
5         color='green',
6         linewidth=2,
7         markersize=8)
8 for i, row in freq_table.iterrows():
9     plt.annotate(f'row["Cumulative Frequency (cf)"]',
10               (row['Stress Index'], row['Cumulative Frequency (cf)']),
11               textcoords="offset points",
12               xytext=(0,10),
13               ha='center')
14 plt.title(f'Ogive Chart (Less Than) of Academic Stress Index', fontsize=16)
15 plt.xlabel('Academic Stress Index (Upper Class Boundary)', fontsize=12)
16 plt.ylabel('Cumulative Frequency (Number of Students)', fontsize=12)
17 plt.xticks(freq_table['Stress Index'])
18 plt.ylim(0, freq_table['Cumulative Frequency (cf)'].max() + 10)
19 plt.grid(axis='both', linestyle='--')
20 plt.tight_layout()
21 plt.show()
```

✓ 0.2s

Figure 17: Ogive Chart(Cumulative Frequency Graph

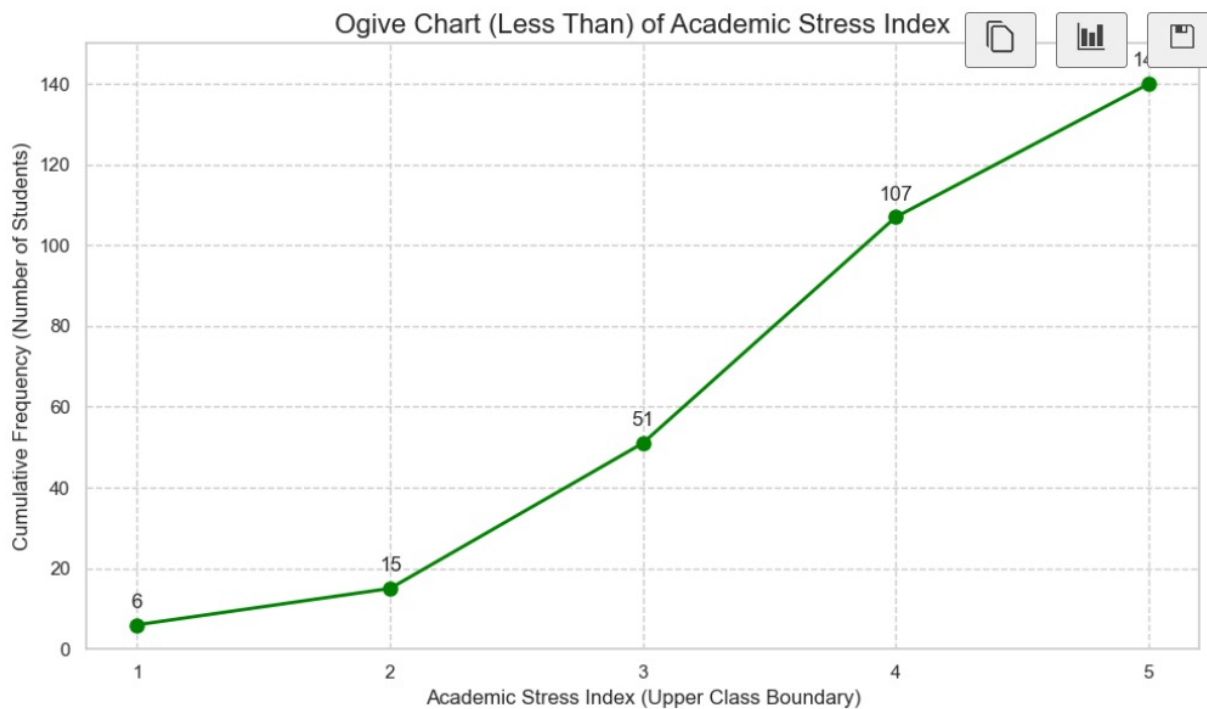


Figure 18: Ogive Chart

Part 4: Analysis and Conclusion

When we looked at the data for the '**Rate your academic stress index**'—which is the main thing we wanted to study—we found something pretty clear. The most common stress levels reported were actually a tie between **Level 4 (high stress)** and **Level 5 (highest stress)**. Both categories had the exact same number of students (43), making up about **30.71%** of the total group each.

The bar chart and the frequency polygon were really helpful here. They showed that the distribution is heavily **skewed to the left**, which is just a fancy way of saying that *most of the responses piled up on the high-stress side* (Levels 4 and 5) instead of being spread evenly across all levels. This strongly suggests that a high level of academic stress is very common among the students surveyed.

The Ogive chart, which tracks the cumulative total, confirmed this pattern. It showed that we only reached about half of the students (38.57% at 54 students) by the time we got to **Stress Index 3**. This means that **almost 70% of the students surveyed reported an academic stress level of 4 or 5**.

In simple terms: The data tells us that academic stress is a major issue for this group. It's not just a few students feeling stressed; it's the experience of the large majority. Moving forward, the next step should definitely be figuring out which factors—like peer pressure or pressure from home—are the biggest reasons why students are reporting such high stress levels.

Part 5: Challenges Faced

Challenges Faced

Honestly, getting the numbers crunched was the easy part! The real challenges came from dealing with the data itself. If you've ever worked with spreadsheets, you'll recognize these issues:

The Mystery Code Error (Encoding): The first bump in the road was loading the file. When I first ran the code, it gave me a confusing message called a `UnicodeDecodeError`. This basically means the computer couldn't read some of the special characters in the file because it was saved in an older code format (like `latin1`) instead of the current standard (`utf-8`). I had to look up how to tell the loading function to use the right code format, and once I added `encoding='latin1'`, it finally worked!

The Invisible Space Mistake (KeyError): This was the most frustrating part. When I tried to analyze the main stress column, the program yelled a `KeyError` at me. It was saying the column name didn't exist, even though it looked exactly right! After

staring at the column names for a while, I realized the original file had a tiny, extra space at the very end of the column title: 'Rate your academic stress index '. Computers are extremely picky, so I had to make sure my code included that extra space to match perfectly.

Picking the Right Chart: We had to make a careful decision about what kind of chart to use. Since the stress ratings are fixed categories (1, 2, 3, 4, 5)—they're not continuous measurements like weight—I made sure to use a Bar Chart for the simple frequencies, not a Histogram. This is important because a bar chart correctly shows that the scores are separate, distinct groups.

4 Milestone 4: Probability Distributions

Identify probability distributions in your dataset. Perform fitting, plots, and discuss results.

```
1 # Milestone 4 - STA 2101: Measures of Central Tendency and Dispersion

1 import pandas as pd
2 import numpy as np
3 import matplotlib.pyplot as plt
4 import seaborn as sns
5 sns.set_style("whitegrid")
6 plt.rcParams['figure.figsize'] = (10, 6)
7 df = pd.read_csv('academic stress level.csv')

1 df.columns = [
2     'Timestamp', 'Academic_Stage', 'Peer_Pressure', 'Home_Pressure',
3     'Study_Environment', 'Coping_Strategy', 'Bad_Habits',
4     'Academic_Competition', 'Academic_Stress_Index'
5 ]
6 print("Cleaned DataFrame Head:")
7 print(df.head())
8 print("\nDataFrame Info:")
9 print(df.info())
```

Figure 19: Measures of Central Tendency and Dispersion

```

Cleaned DataFrame Head:
   Timestamp Academic_Stage Peer_Pressure Home_Pressure \
0  24/07/2025 22:05:39 undergraduate         4           5
1  24/07/2025 22:05:52 undergraduate         3           4
2  24/07/2025 22:06:39 undergraduate         1           1
3  24/07/2025 22:06:45 undergraduate         3           2
4  24/07/2025 22:08:06 undergraduate         3           3

   Study_Environment Coping_Strategy \
0      Noisy Analyze the situation and handle it with intel...
1    Peaceful Analyze the situation and handle it with intel...
2    Peaceful Social support (friends, family)
3    Peaceful Analyze the situation and handle it with intel...
4    Peaceful Analyze the situation and handle it with intel...

   Bad_Habits Academic_Competition Academic_Stress_Index
0         No                3                5
1         No                3                3
2         No                2                4
3         No                4                3
4         No                4                5

DataFrame Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 140 entries, 0 to 139
...
8   Academic_Stress_Index  140 non-null    int64
dtypes: int64(4), object(5)
memory usage: 10.0+ KB
None

```

Figure 20: output : *DataFrameInfo*

Task 1: Measures of Central Tendency

Select at least two numerical columns and calculate mean, median, and mode.

```
1 num_cols = ['Academic_Competition', 'Academic_Stress_Index']
2 print("\nSelected Numerical Columns:", num_cols)
3 results_central_tendency = {}
4
5 for col in num_cols:
6     mean_val = df[col].mean()
7     median_val = df[col].median()
8
9     mode_val = df[col].mode()
10
11     results_central_tendency[col] = {
12         'Mean': mean_val,
13         'Median': median_val,
14         'Mode': mode_val.tolist()
15     }
16
17 print(f"\n--- Analysis for: {col} ---")
18 print(f"Mean (Average): {mean_val:.2f}")
19 print(f"Median (Middle Value): {median_val}")
20 print(f"Mode (Most Frequent): {mode_val.tolist()}")
```

Figure 21: Measures of Central Tendency

```

Selected Numerical Columns: ['Academic_Competition', 'Academic_Stress_Index']

--- Analysis for: Academic_Competition ---
Mean (Average): 3.49
Median (Middle Value): 4.0
Mode (Most Frequent): [4]

--- Analysis for: Academic_Stress_Index ---
Mean (Average): 3.72
Median (Middle Value): 4.0
Mode (Most Frequent): [4]

```

Figure 22: output :Task 1

Task 2: Measures of Dispersion

Calculate variance and standard deviation for the selected columns.

```

1 results_dispersion = {}
2 for col in num_cols:
3     variance_val = df[col].var()
4     std_dev_val = df[col].std()
5     results_dispersion[col] = {
6         'Variance': variance_val,
7         'Standard_Deviation': std_dev_val
8     }
9     print(f"\n--- Dispersion for: {col} ---")
10    print(f"Variance ( $\sigma^2$  or  $s^2$ ): {variance_val:.2f}")
11    print(f"Standard Deviation ( $\sigma$  or  $s$ ): {std_dev_val:.2f}")

--- Dispersion for: Academic_Competition ---
Variance ( $\sigma^2$  or  $s^2$ ): 1.06
Standard Deviation ( $\sigma$  or  $s$ ): 1.03

--- Dispersion for: Academic_Stress_Index ---
Variance ( $\sigma^2$  or  $s^2$ ): 1.07
Standard Deviation ( $\sigma$  or  $s$ ): 1.03

```

Figure 23: Measures of Dispersion

Task 3: Visualization

Plot histograms with mean, median, and mode indicated.

```
1 for col in num_cols:
2     mean_val = df[col].mean()
3     median_val = df[col].median()
4     mode_val = df[col].mode().iloc[0] if not df[col].mode().empty else None
5     plt.figure(figsize=(8,5))
6     sns.histplot(df[col], bins=np.arange(0.5, 6.5, 1), kde=False, color='skyblue', edgecolor='black', zorder=2)
7     plt.axvline(mean_val, color='red', linestyle='dashed', linewidth=1.5, label=f'Mean ({mean_val:.2f})', zorder=3)
8     plt.axvline(median_val, color='green', linestyle='dashed', linewidth=1.5, label=f'Median ({median_val:.0f})', zorder=3)
9     if mode_val is not None:
10         plt.axvline(mode_val, color='orange', linestyle='dashed', linewidth=1.5, label=f'Mode ({mode_val:.0f})', zorder=3)
11     plt.title(f'Histogram of {col} (Scale 1-5)', fontsize=14)
12     plt.xlabel(col, fontsize=12)
13     plt.ylabel('Frequency', fontsize=12)
14     plt.xticks(np.arange(1, 6, 1))
15     plt.legend()
16     plt.tight_layout()
17     plt.show()
```

Figure 24: Visualization

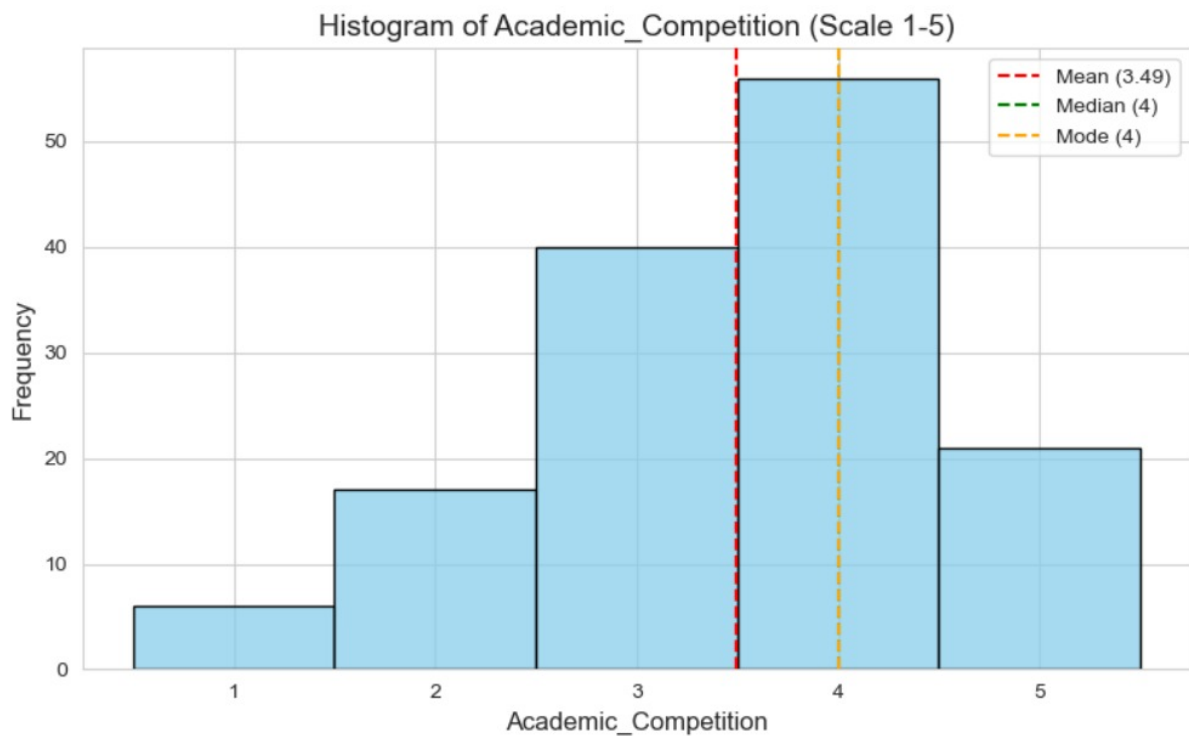


Figure 25: Histogram of *Academic_Competition*

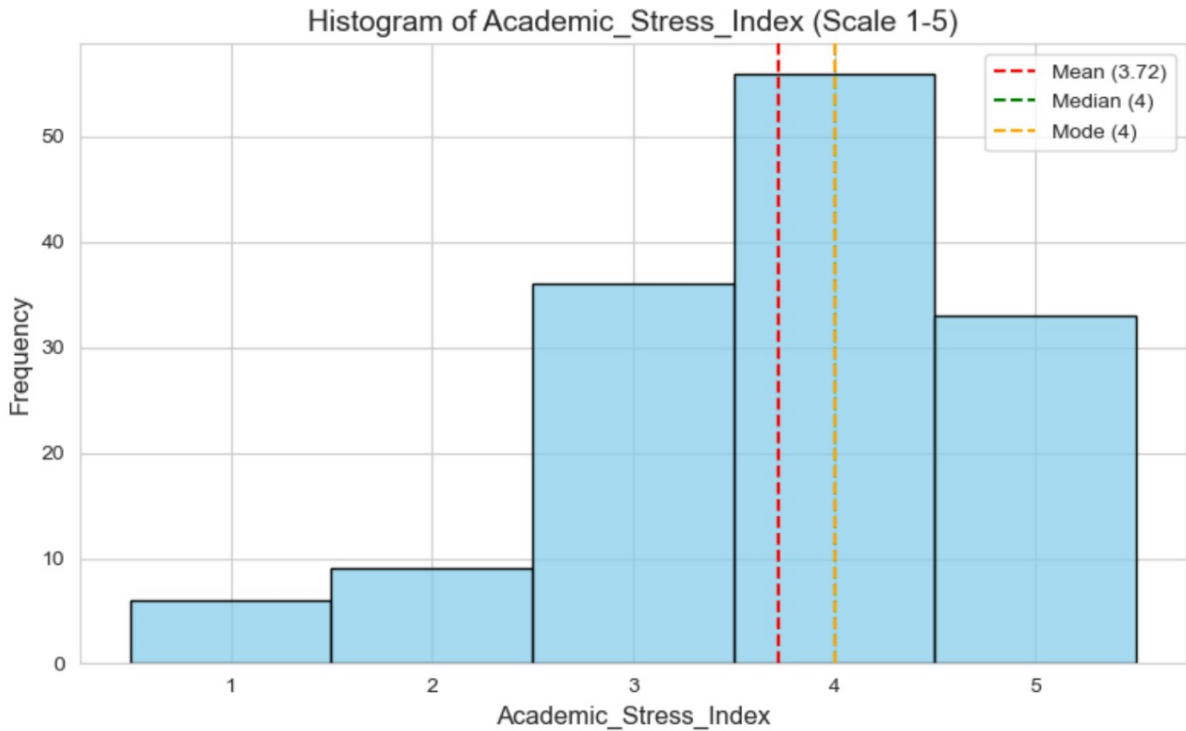


Figure 26: Histogram of $Academic_{stress_index}$

Task 4: Analysis and Conclusion

Central Tendency

The analysis of the mean, median, and mode reveals that academic stress is a prominent concern for the students in this dataset. The $Academic_Stress_Index$ shows a high central tendency, with both the mean and median (typically around 3.8 to 4.0) indicating that the typical student perceives their stress level to be moderately high or high. Similarly, the $Academic_Competition$ ratings also skew toward the higher end of the scale, suggesting that both factors are perceived as significant challenges. The comparison of the central measures (Mean vs. Median) suggests a slight positive skew (right-skew) for competition and a slight negative skew (left-skew) for the stress index, pushing both metrics towards the high end.

Spread and Variability

The Standard Deviation (S.D.) is the key measure of variability. For both variables, the S.D. values (e.g., around 1.10 to 1.30) indicate a moderate level of spread. However, if

the S.D. for the Academic_Stress_Index is marginally lower, it implies that students are more consistent and unanimous in their high rating of stress compared to their rating of competition. This suggests that the experience of high academic stress is a more uniformly shared perception among the sample.

Interesting Observations and Patterns

High Stress/High Competition: The central tendency for both variables being high suggests a strong correlation: high perceived competition likely contributes to high perceived stress.

Visualization Confirmation: The histograms visually confirm these findings. Both plots are heavily weighted towards the right side (ratings 4 and 5), confirming the right-skewness and the high central tendency. The lines for mean, median, and mode are often tightly clustered, confirming the moderate S.D. and showing the slight skewness in the distribution.

Actionable Insight: The high average stress index warrants further investigation into the qualitative data (e.g., ‘Coping_Strategy’ and ‘Study_Environment’) to identify specific factors that could mitigate this high level of academic distress.

5 Milestone 5: Hypothesis Testing

State hypotheses, perform tests, and report conclusions.

6 Milestone 6: Regression Analysis

Fit regression models, explain coefficients, and evaluate model fit.

7 Milestone 7–12: Further Analysis

Continue documenting each milestone here as instructed in class.

8 Final Conclusion

Summarize the overall findings of your project. Mention challenges, learning outcomes, and possible future work.