DS-221: Inferential Statistics and Applied Probability

Project Report

Section - C

Faculty – CS

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Introduction:

The Grading System application was developed to provide an automated and flexible solution for calculating and assigning grades based on both absolute and relative grading schemes. It simplifies the grading process by integrating file handling, data visualization, and user interactivity, ensuring efficiency and accuracy. By leveraging Python's robust libraries, the system offers a user-friendly interface and powerful computational capabilities, making it a versatile tool for educators. This report delves into the methodology, algorithms, and results of the application, highlighting its effectiveness and potential for further enhancement.

Methodology:

The development of the Grading System application followed a structured and iterative methodology to ensure clarity, flexibility, and accuracy. The process was designed to address the needs of educators for automated grading while maintaining transparency and user control over the grading criteria. Below are the key steps involved in the methodology:

1. **File Upload and Validation**:
    - The system allows users to upload an Excel file containing student scores. A validation step ensures the file contains the required columns: Quizzes, Assignments, Midterm, Finals, and Project.
    - If the file structure is invalid, the system provides clear error messages to guide the user in correcting the input.
2. **Input Weightages and Total Marks**:
    - Users are prompted to input the weightages (as percentages) for each component (e.g., Quizzes, Assignments).
    - The system validates that the total weightages sum to 100%.
    - Users also input the total marks for each component to standardize the scoring calculations.
3. **Grading Scheme Selection**:
    - Users choose between two grading schemes:
        - **Absolute Grading**: Grades are assigned based on fixed percentage thresholds.
        - **Relative Grading**: Grades are assigned based on the statistical distribution of scores (mean and standard deviation).
4. **Grade Calculation**:
    - The system computes the final score for each student by applying the user-defined weightages to the normalized component scores.
    - For absolute grading, predefined or user-specified boundaries determine the

grades.

- For relative grading, grades are calculated based on statistical measures, with options for post-adjustment using custom standard deviation multipliers.

5. **Visualization**:
   - The system generates bar charts to display the frequency of grades, providing an intuitive overview of grade distributions.
   - For relative grading, a bell curve visualization highlights the statistical spread of scores, including the mean and standard deviations.
6. **Results Export**:
   - The final processed dataset, including calculated scores and assigned grades, can be exported to CSV or Excel format for further use.
   - The system ensures that the saved file retains all essential data, including the original inputs and computed outputs.

This methodology ensures that the grading process is transparent, adaptable to different grading styles, and provides meaningful insights through visualization.

Algorithms used:

- File Handling and File Requirements:

1. Prompt the user to upload an Excel file using a file dialog.
2. Validate the file by checking for the presence of required columns: Quizzes, Assignments, Midterm, Finals, and Project.
3. If any required column is missing, display an error message and terminate the process.
4. Load the file into a Pandas DataFrame for further processing.
5. Ensure the data is clean and numeric, handling missing or invalid entries gracefully.

- Final Score Calculation:

1. Prompt the user to input weightages for each component (e.g., Quizzes, Assignments) as percentages.
   - Validate that the total weightages sum to 100%.
2. Prompt the user to input the total marks for each component.
3. Normalize the marks for each component by dividing the student's score by the total marks for that component.
4. Multiply the normalized score by the corresponding weightage to compute the weighted contribution of each component.

5. Sum the weighted contributions to calculate the final score for each student by scaling the data according to relative weightage

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- Absolute Grading (HEC Guidelines):

1. Define grade boundaries based on HEC guidelines, e.g., 90% = A, 80%-89% = A-, etc.
2. For each student's final score, compare the score against the predefined boundaries.
3. Assign the highest grade for which the student's score meets or exceeds the threshold.
4. Store the assigned grade in the dataset.

- Absolute Grading (Post Adjustment):

1. Allow the user to input custom grade boundaries for each grade (e.g., A, B, C).
2. Validate the input to ensure it forms a valid grading structure (e.g., descending order of percentages).
3. For each student's final score, compare the score against the adjusted boundaries.
4. Assign the highest grade for which the student's score meets or exceeds the threshold.
5. Store the adjusted grades in the dataset.

- Relative Grading (HEC Guidelines):

1. Calculate the mean and standard deviation of the final scores.
2. Define grade boundaries based on standard deviations from the mean according to HEC Guidelines.
3. For each student's final score, compare the score against these boundaries.
4. Assign the grade corresponding to the range in which the score falls.
5. Store the grades in the dataset.

- Relative Grading (Post Adjustment):

1. Allow the user to specify a custom standard deviation multiplier.
2. Recalculate grade boundaries using the adjusted standard deviation multiplier
3. For each student's final score, compare the score against the adjusted boundaries.
4. Assign the grade corresponding to the range in which the score falls.
5. Store the adjusted grades in the dataset.

- <u>Visualization:</u>

1. **Grade Distribution**:
    - Count the frequency of each grade.
    - Plot a bar chart with grades on the x-axis and frequencies on the y-axis.
2. **Bell Curve (for Relative Grading)**:
    - Generate a normal distribution curve using the mean and standard deviation of the scores.
    - Plot the curve with key markers highlighted.

- <u>Save Results:</u>

1. Prompt the user to select a save location and file format (CSV or Excel).
2. Prepare the dataset for export by including all original columns and the calculated grades.
3. Export the dataset:
    - For CSV: Use Pandas to_csv() method.
    - For Excel: Use Pandas to_excel() method with the OpenPyXL engine.
4. Confirm successful saving with a success message or display an error message if saving fails.

Results and Conclusion:

<u>Results:</u>

The Grading System application successfully processed the dataset, demonstrating its flexibility and accuracy in handling both absolute and relative grading schemes. The following results were observed:

1. Absolute Grading:
    - Grades were assigned based on predefined HEC guidelines, resulting in a balanced distribution across different grade categories.
    - Post-adjustment grading allowed for custom boundaries, enabling teachers to tailor grading standards to specific needs.

2. Relative Grading:
    - Pre-adjustment grading effectively utilized the statistical distribution of scores, with grade boundaries dynamically calculated using mean and standard deviation.
    - Post-adjustment grading allowed further refinement through custom standard deviation multipliers, reflecting user-defined grading preferences.
    - The bell curve visualization provided a clear depiction of score distribution, showcasing the natural spread and clustering of grades.
3. Visualization:
    - Bar charts illustrated the frequency of grades, offering a comprehensive view of overall performance.
    - The bell curve highlighted key statistical markers, aiding in understanding the relative grading process.
4. Exported Results:
    - The final dataset, including calculated final scores and assigned grades, was successfully exported in user-specified formats (CSV or Excel). This ensures easy integration with other tools or record-keeping systems.

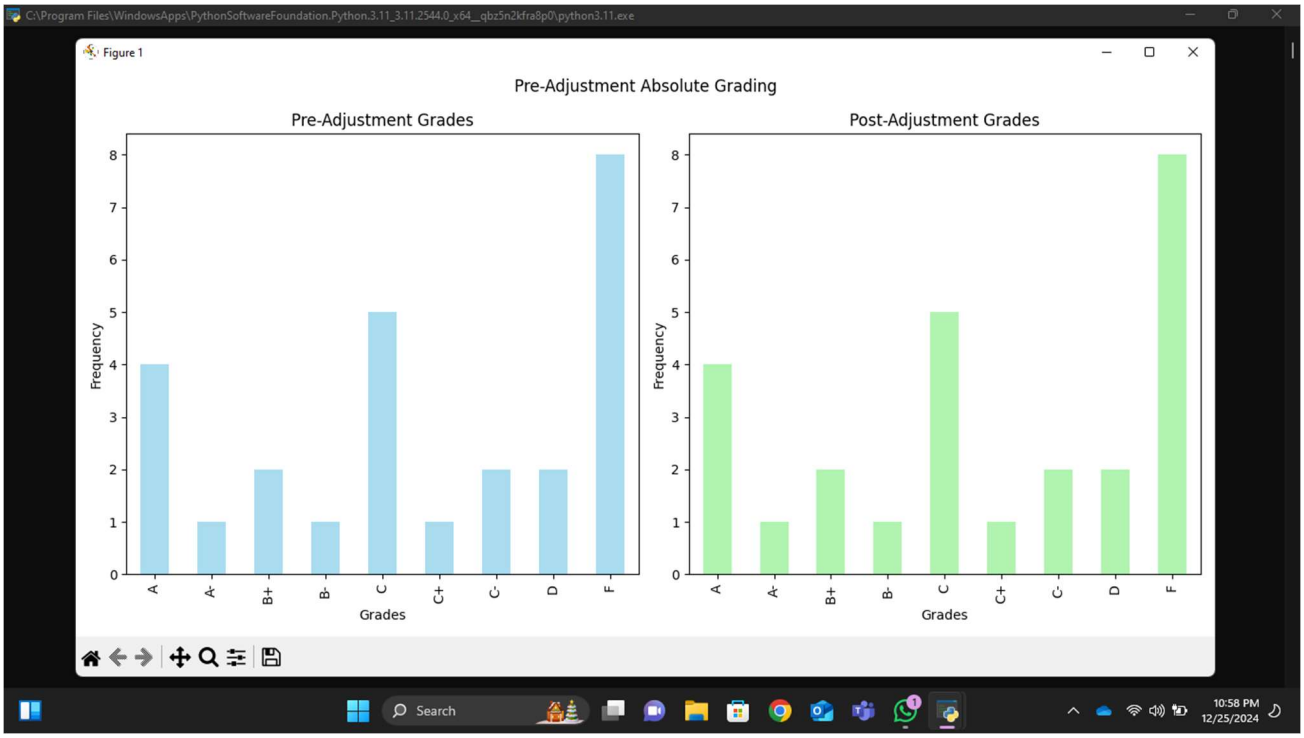
Conclusion:

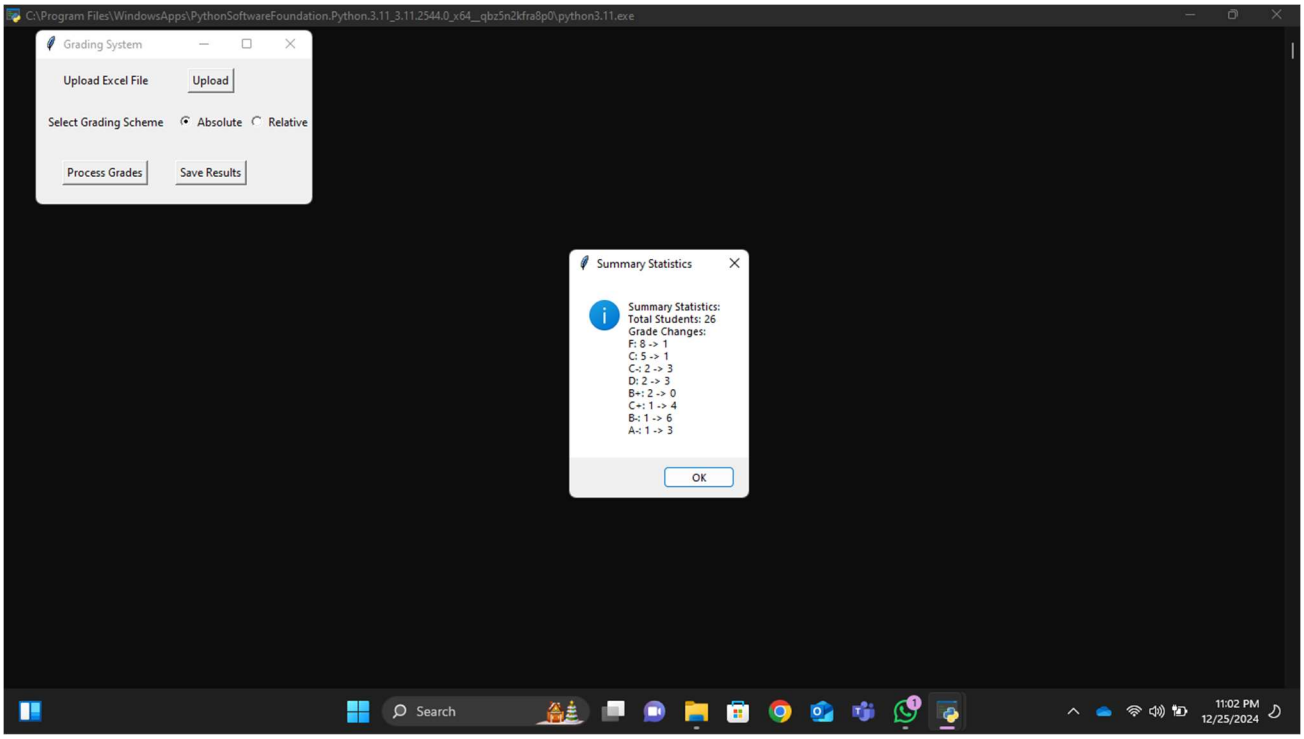
The Grading System application proved to be a robust and user-friendly tool for automating the grading process. Its key strengths include:

- Support for both absolute and relative grading schemes, with customization options for teachers.
- Insightful visualizations that enhance understanding of grade distributions and statistical trends.
- Reliable file handling and export capabilities for seamless data management.

Screenshots of the results and visualizations are provided below for reference.

Sample Output:

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Grading System
Upload Excel File
Upload
Select Grading Scheme
Absolute
Relative
Process Grades
Save Results
Summary Statistics
Summary Statistics:
Total Students: 26
Grade Changes:
F: 8 -> 1
C: 5 -> 1
C-: 2 -> 3
D: 2 -> 3
B+: 2 -> 0
C+: 1 -> 4
B-: 1 -> 6
A-: 1 -> 3
OK
Search
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Figure 1
Pre-Adjustment Relative Gr ading
Pre-Adjustment Grades
Post-Adjustment Grades
Frequency
Grades
A-
B
B+
B-
C
C+
C-
F
Search
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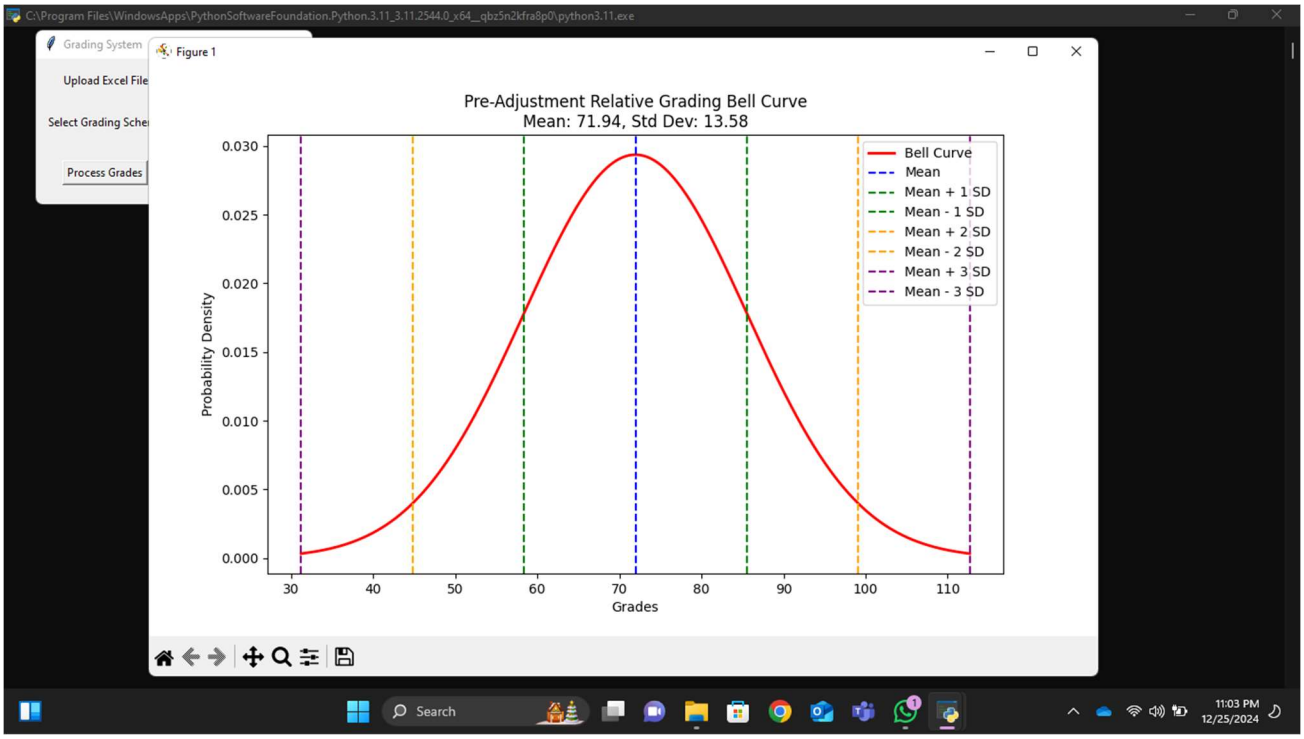
12/25/2024


Grading System
Upload Excel File
Select Grading Scheme
Process Grades
Figure 1
Pre-Adjustment Relative Grading Bell Curve
Mean: 71.94, Std Dev: 13.58
Probability Density
Grades
Bell Curve
Mean
Mean + 1 SD
Mean - 1 SD
Mean + 2 SD
Mean - 2 SD
Mean + 3 SD
Mean - 3 SD
Search
11:03 PM
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Grading System
Figure 1
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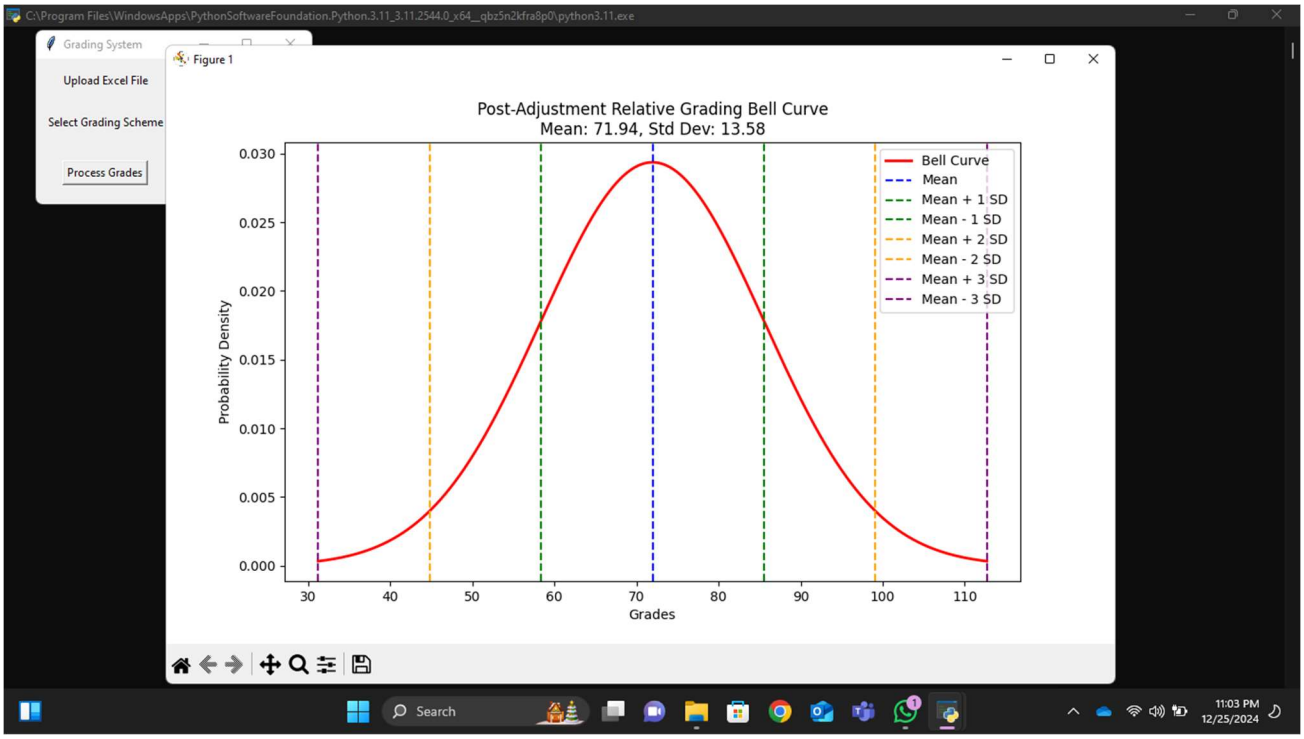
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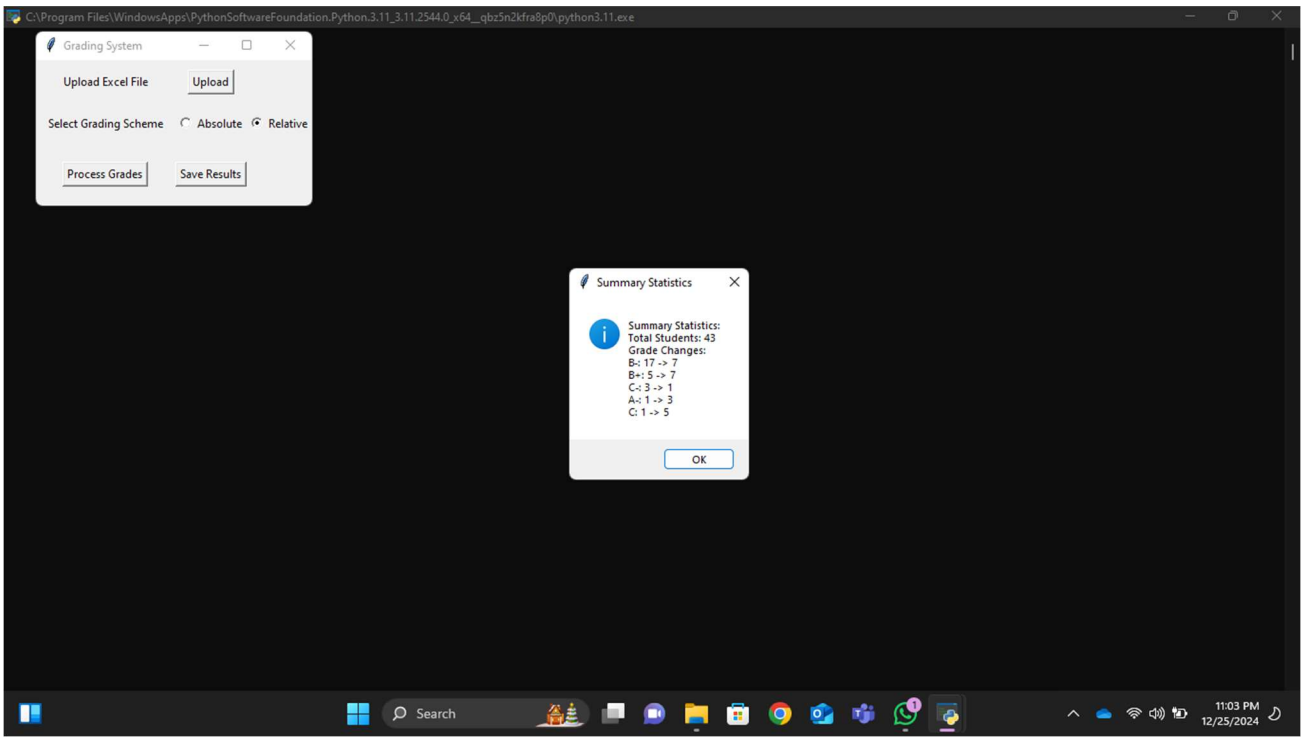
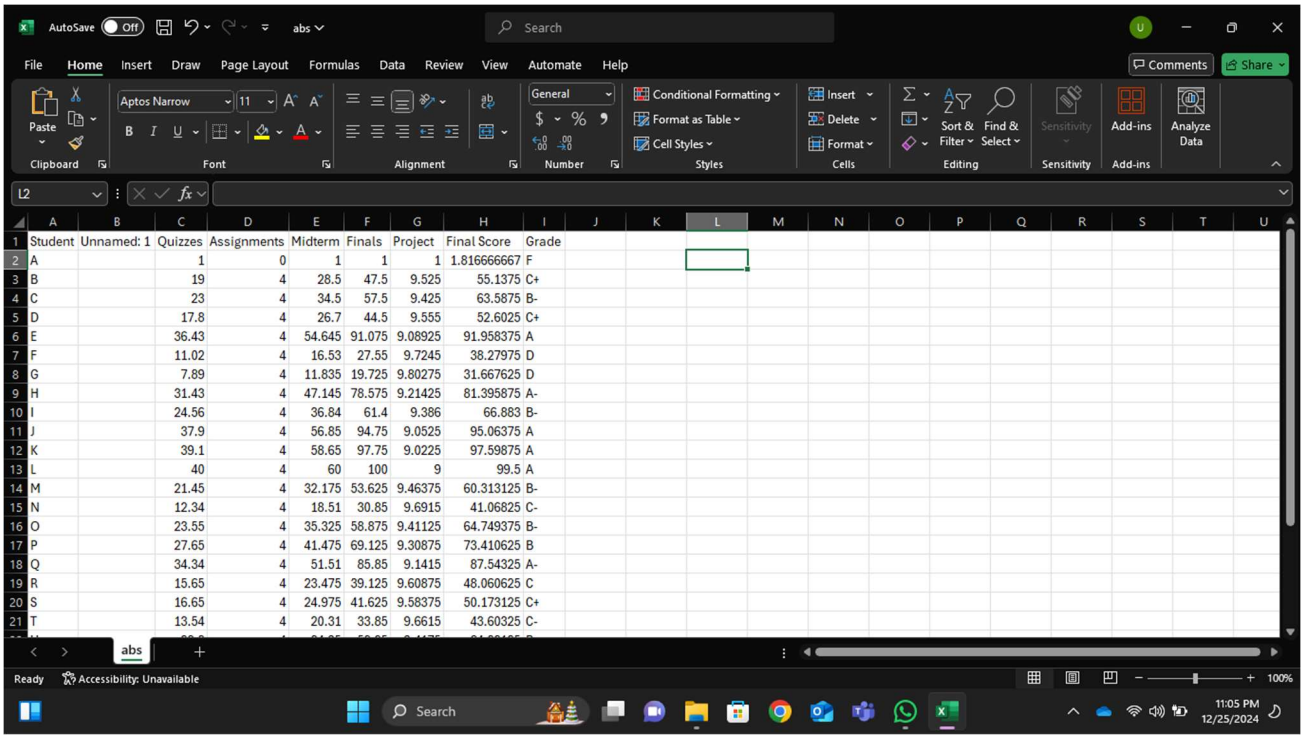
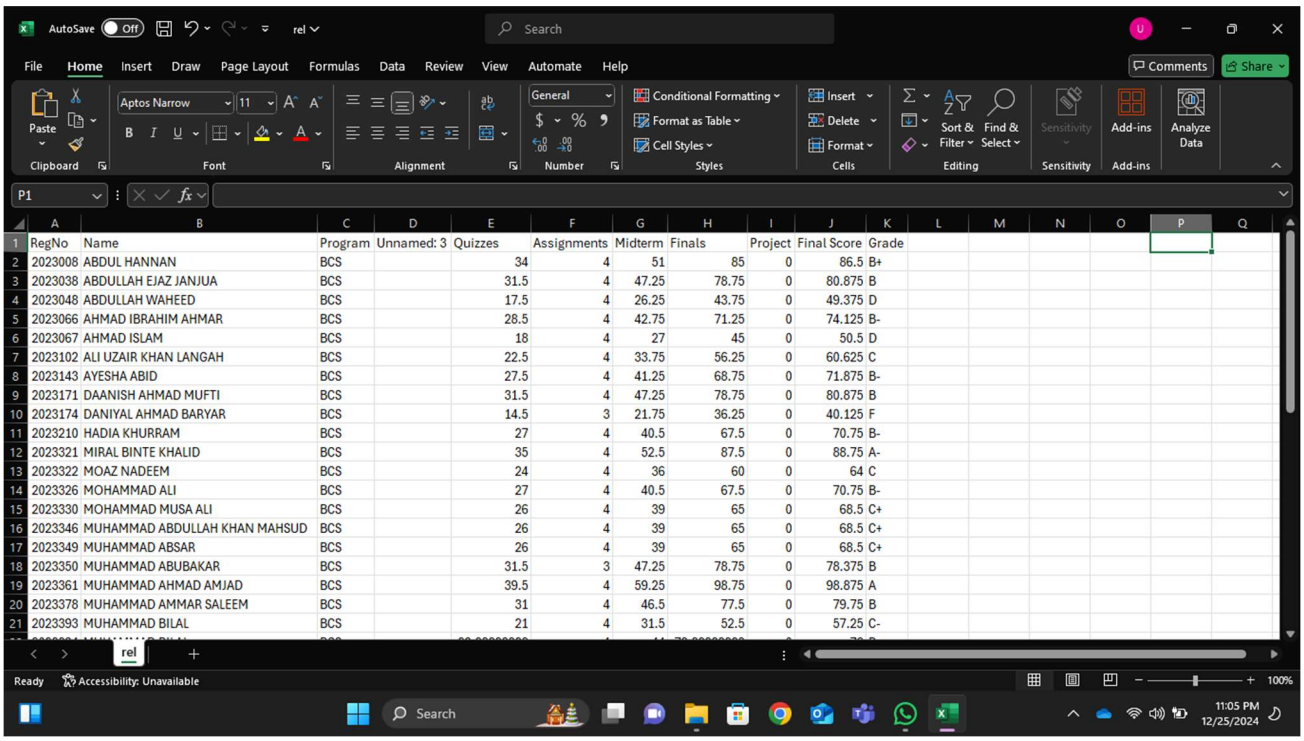

C:\Program Files\WindowsApps\PythonSoftwareFoundation.Python.3.11_3.11.2544.0_x64__qbz5n2kfra8p0\python3.11.exe
Grading System
Upload Excel File
Upload
Select Grading Scheme
Absolute
Relative
Process Grades
Save Results
Summary Statistics
Summary Statistics:
Total Students: 43
Grade Changes:
B-: 17 -> 7
B+: 5 -> 7
C-: 3 -> 1
A-: 1 -> 3
C: 1 -> 5
OK
Search
11:03 PM
12/25/2024



Student	Unnamed: 1	Quizzes	Assignments	Midterm	Finals	Project	Final Score	Grade
A		1	0	1	1	1	1.816666667	F
B		19	4	28.5	47.5	9.525	55.1375	C+
C		23	4	34.5	57.5	9.425	63.5875	B-
D		17.8	4	26.7	44.5	9.555	52.6025	C+
E		36.43	4	54.645	91.075	9.08925	91.958375	A
F		11.02	4	16.53	27.55	9.7245	38.27975	D
G		7.89	4	11.835	19.725	9.80275	31.667625	D
H		31.43	4	47.145	78.575	9.21425	81.395875	A-
I		24.56	4	36.84	61.4	9.386	66.883	B-
J		37.9	4	56.85	94.75	9.0525	95.06375	A
K		39.1	4	58.65	97.75	9.0225	97.59875	A
L		40	4	60	100	9	99.5	A
M		21.45	4	32.175	53.625	9.46375	60.313125	B-
N		12.34	4	18.51	30.85	9.6915	41.06825	C-
O		23.55	4	35.325	58.875	9.41125	64.749375	B-
P		27.65	4	41.475	69.125	9.30875	73.410625	B
Q		34.34	4	51.51	85.85	9.1415	87.54325	A-
R		15.65	4	23.475	39.125	9.60875	48.060625	C
S		16.65	4	24.975	41.625	9.58375	50.173125	C+
T		13.54	4	20.31	33.85	9.6615	43.60325	C-



RegNo	Name	Program	Unnamed: 3	Quizzes	Assignments	Midterm	Finals	Project	Final Score	Grade
2023008	ABDUL HANNAN	BCS		34	4	51	85	0	86.5	B+
2023038	ABDULLAH EJAZ JANJUA	BCS		31.5	4	47.25	78.75	0	80.875	B
2023048	ABDULLAH WAHEED	BCS		17.5	4	26.25	43.75	0	49.375	D
2023066	AHMAD IBRAHIM AHMAR	BCS		28.5	4	42.75	71.25	0	74.125	B-
2023067	AHMAD ISLAM	BCS		18	4	27	45	0	50.5	D
2023102	ALI UZAIR KHAN LANGAH	BCS		22.5	4	33.75	56.25	0	60.625	C
2023143	AYESHA ABID	BCS		27.5	4	41.25	68.75	0	71.875	B-
2023171	DAANISH AHMAD MUFTI	BCS		31.5	4	47.25	78.75	0	80.875	B
2023174	DANIYAL AHMAD BARYAR	BCS		14.5	3	21.75	36.25	0	40.125	F
2023210	HADIA KHURRAM	BCS		27	4	40.5	67.5	0	70.75	B-
2023321	MIRAL BINTE KHALID	BCS		35	4	52.5	87.5	0	88.75	A-
2023322	MOAZ NADEEM	BCS		24	4	36	60	0	64	C
2023326	MOHAMMAD ALI	BCS		27	4	40.5	67.5	0	70.75	B-
2023330	MOHAMMAD MUSA ALI	BCS		26	4	39	65	0	68.5	C+
2023346	MUHAMMAD ABDULLAH KHAN MAHSUD	BCS		26	4	39	65	0	68.5	C+
2023349	MUHAMMAD ABSAR	BCS		26	4	39	65	0	68.5	C+
2023350	MUHAMMAD ABUBAKAR	BCS		31.5	3	47.25	78.75	0	78.375	B
2023361	MUHAMMAD AHMAD AMJAD	BCS		39.5	4	59.25	98.75	0	98.875	A
2023378	MUHAMMAD AMMAR SALEEM	BCS		31	4	46.5	77.5	0	79.75	B
2023393	MUHAMMAD BILAL	BCS		21	4	31.5	52.5	0	57.25	C-