Samsung Innovation Campus
GSSSIETW, Mysore

Project Title: Employee Salary Data Cleaning and Aggregation for HR Insights

Description: The project **"Employee Salary Data Cleaning and Aggregation for HR Insights"** focuses on converting raw salary data into reliable and structured information for HR use. It involves cleaning missing and inconsistent values, standardizing records, and aggregating data such as average salary and departmental distribution. Visualizations like charts and graphs are used to highlight trends and patterns. This project supports HR teams in making data-driven decisions for workforce and compensation planning.

Submitted By:

Vijayalakshmi R

5th semester

AI & DS Department

E-mail: vijayaravi17lakshmi@gmail.com

Table of the content:

Problem Statement: The HR department of a company maintains employee records, including salaries, departments, and job titles. However, the dataset contains duplicates, missing values, and inconsistent data formats.

The goal is to clean the employee dataset using Pandas, perform aggregation to extract useful HR insights, and export the results for reporting

Project Objectives

- **Data Cleaning**: Automated removal of duplicates and standardization of employee records
- **Data Enrichment**: Calculate derived metrics like years of service
- **Analysis**: Generate department and job title performance summaries
- **Visualization**: Interactive dashboard for HR insights and reporting

- **Export Capabilities**: CSV export functionality for further analysis

Features :

📈 Key Performance Indicators

- Total Employees: Current employee count with filtering
- Average Salary: Mean salary across selected filters
- Total Salary Cost: Sum of all salaries
- Average Years of Service: Mean employee tenure

Interactive Filters

- Department Filter: Dropdown to select specific department or view all
- Real-time Updates: All metrics and charts update automatically

Visualizations

1. **Salary Distribution Histogram**
   - Shows salary range distribution
   - Identifies salary clusters and outliers
   - Updates based on department filter
2. **Department Salary Comparison**
   - Bar chart comparing average salaries by department
   - Helps identify compensation disparities
   - Visual department performance comparison
3. **Salary vs Experience Scatter Plot**
   - Relationship between tenure and compensation
   - Color-coded by department
   - Identifies salary progression patterns

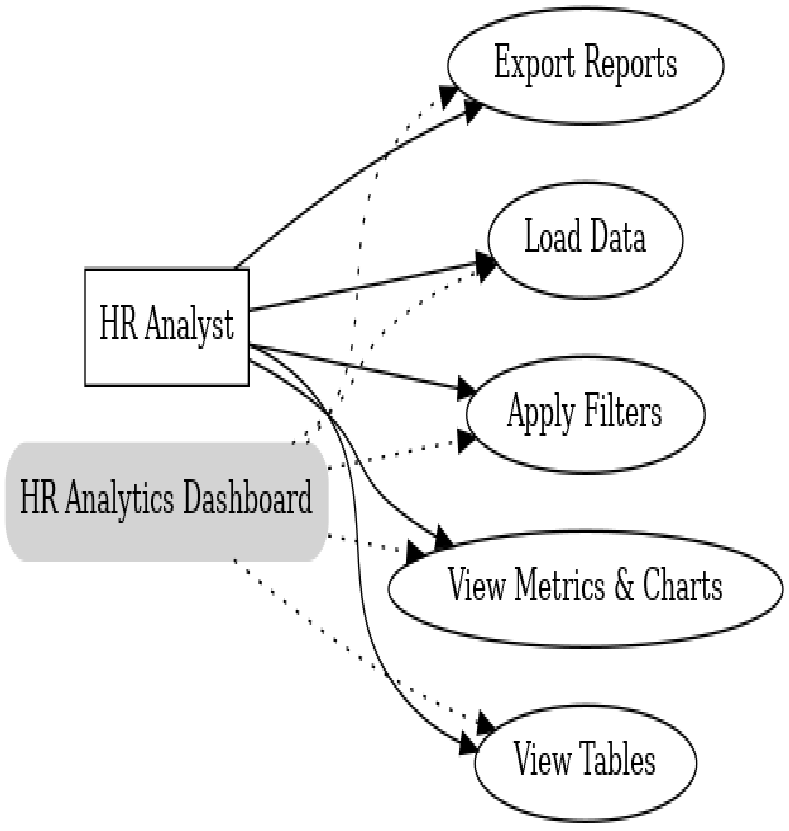
☐ Export Functionality

4. CSV Downloads: Export any table or filtered dataset
5. Custom File Names: Descriptive export file naming
6. Real-time Data: Always exports current filter state

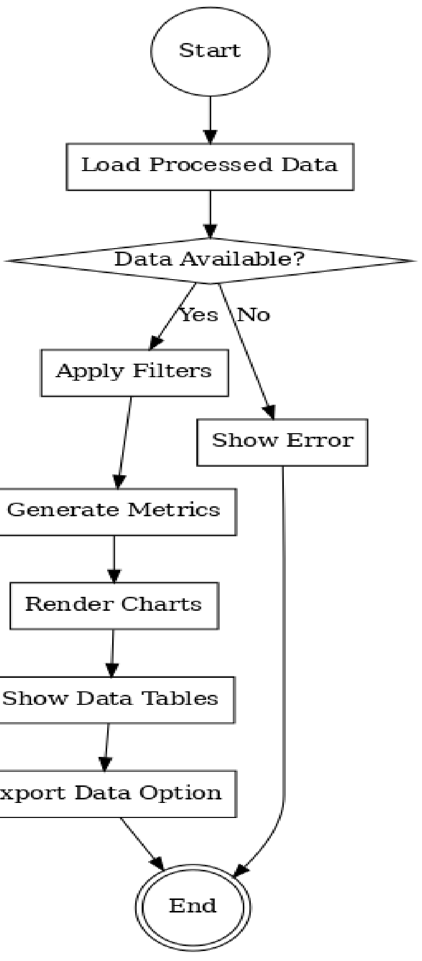
☐ Export Functionality

- CSV Downloads: Export any table or filtered dataset
- Custom File Names: Descriptive export file naming
- Real-time Data: Always exports current filter state

UML Diagram:



Use case diagram



Activity diagram

Structure of the project:

```
SIC_EmployeeInsights/
|
├── flask_app/
|    ├── app.py              # Main Flask application
|    |
|    ├── static/             # CSS, JS, images
|    |    ├── css/
|    |    |    └── style.css
|    |    ├── js/
|    |    |    └── script.js
|    |    └── images/
|    |
|    ├── templates/          # HTML templates
|    |    ├── index.html
|    |    ├── dashboard.html
|    |    └── error.html
|    |
|    ├── data/               # Dataset folder
|    |    └── employees.csv
|    |
|    ├── utils/              # Helper functions
|    |    ├── data_cleaning.py
|    |    └── data_analysis.py
|    |
|    └── __init__.py         # Makes flask_app a package
|
├── requirements.txt         # Python dependencies
├── README.md                # Project documentation
└── venv/                    # Virtual environment (optional, not uploaded to GitHub)
```

Detailed Explanation:

□ Technical Stack

Core Technologies

- **Python 3.7+**: Main programming language
- **Pandas**: Data manipulation and analysis
- **Streamlit**: Interactive web dashboard framework
- **Matplotlib**: Data visualization
- **NumPy**: Numerical computing

Development Environment

- **VS Code**: Primary IDE
- **Command Line**: Script execution and package management
- **Git**: Version control

□ Installation & Setup

Prerequisites

- Python 3.13
- pip (Python package installer)

Step 1: Install Required Packages

pip install pandas streamlit matplotlib numpy seaborn

Step 2: Project Setup

1. Create project directory: D:\learning\gsss_sic\mini_project

2. Place your employees.csv file in the project directory
3. Copy all Python scripts to the project directory
4. Input Data Format

The system expects a CSV file named `employees.csv` with the following structure:

Column	Data Type	Description	Example
EmpID	String	Unique employee identifier	E001, E002
Name	String	Employee full name	Alice Wong
Department	String	Department name	HR, IT, Finance, Sales
JobTitle	String	Employee job title	HR Manager, Software Engineer
Salary	Integer	Annual salary in dollars	60000, 75000
JoiningDate	Date	Employee joining date	2019-03-15

Code Explanation:

Step 1: Data Loading & Inspection

File: step1_load_inspect.py

Purpose: Initial data exploration and quality assessment

Operations:

- Load CSV data into pandas DataFrame
- Display dataset information (info(), head(), describe())
- Identify data types, missing values, and basic statistics

Output**:** Console display of dataset overview

Step 2: Data Cleaning & Standardization

File: step2_clean_standardize.py

Purpose: Clean and standardize raw data

Operations:

- Remove exact duplicate rows
- Handle duplicate Employee IDs (keep first occurrence)
- Fill missing salary values with median
- Replace missing job titles with "Unknown"
- Standardize department names (HR, IT, Finance, Sales)
- Standardize job title variations

Output: cleaned_employees.csv

Step 3: Data Enrichment

File: step3_add_derived_column.py

Purpose: Add calculated columns for enhanced analysis

Operations:

- Convert JoiningDate to datetime format
- Calculate Years of Service based on current date
- Handle date parsing errors gracefully

Output: employees_enriched.csv

Step 4: Department Analysis

File: step4_group_by_department.py

Purpose: Generate department-wise performance metrics

Operations:

- Group employees by department
- Calculate average salary per department
- Calculate total salary expenditure per department
- Count employees per department

Output: dept_summary.csv

Step 5: Top Performers by Department

File: step5_highest_paid_per_department.py

Purpose: Identify highest-paid employee in each department

Operations:

- Find maximum salary employee per department
- Extract detailed employee information
- Sort results by department

Output: highest_paid.csv

Step 6: Job Title Analysis

File: step6_group_by_jobtitle.py

Purpose: Analyze salary patterns by job title

Operations:

- Group employees by job title
- Calculate average salary per job title
- Calculate total salary cost per job title
- Count employees per job title

Output: job_summary.csv

Step 7: Automated Pipeline Execution

File: step7_all_exports.py

Purpose: Execute entire data processing pipeline

Operations:

- Run steps 2-6 sequentially
- Handle execution errors
- Provide pipeline status updates

Output: All CSV files generated automatically

Step 8: Dashboard Visualization

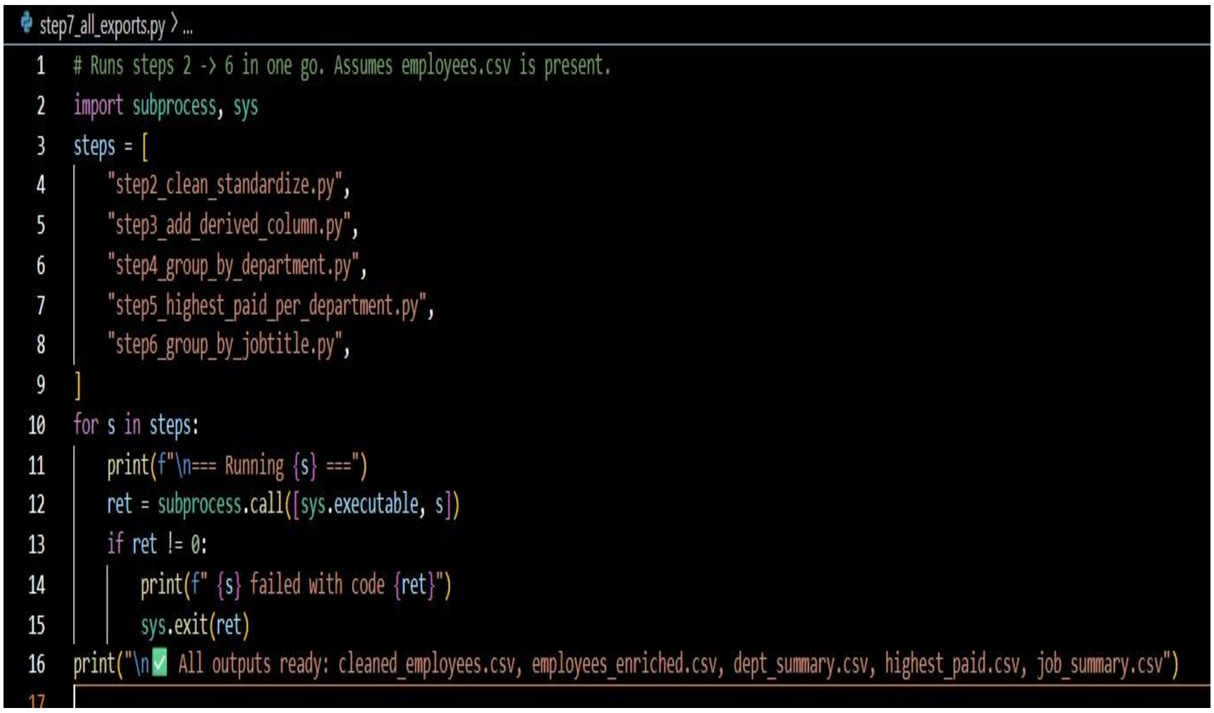
File: dashboard.py
Purpose: Provide an interactive dashboard for HR to view aggregated salary insights and anomalies
Operations:

- Load processed datasets (payroll_enriched.csv, dept_summary.csv, anomalies.csv)
- Display KPI metrics (total payroll, avg salary, median salary, headcount)
- Visualize charts:
  • Salary distribution (histogram)
  • Average salary by department (bar chart)
  • Headcount by department (bar chart)
- Allow export of filtered views (CSV)

Output:

Interactive dashboard tables, and downloadable reports for HR managers

Code all_exports.py:



```
step7_all_exports.py > ...
# Runs steps 2 -> 6 in one go. Assumes employees.csv is present.
import subprocess, sys
steps = [
    "step2_clean_standardize.py",
    "step3_add_derived_column.py",
    "step4_group_by_department.py",
    "step5_highest_paid_per_department.py",
    "step6_group_by_jobtitle.py",
]
for s in steps:
    print(f"\n=== Running {s} ===")
    ret = subprocess.call([sys.executable, s])
    if ret != 0:
        print(f" {s} failed with code {ret}")
        sys.exit(ret)
print("\n✅ All outputs ready: cleaned_employees.csv, employees_enriched.csv, dept_summary.csv, highest_paid.csv, job_summary.csv")
```

Output and Explanation:

Output of step7_all_exports.py:

Explanation:

Step 2 cleans and standardizes raw employee data into a consistent format with basic employee information like ID, name, department, job title, salary, and joining date.

Step 3 adds a calculated "Years of Service" column to the cleaned data, showing how long each employee has been with the company.

Step 4 groups employees by department and creates summary statistics showing average salary, total salary costs, and employee count for each department.

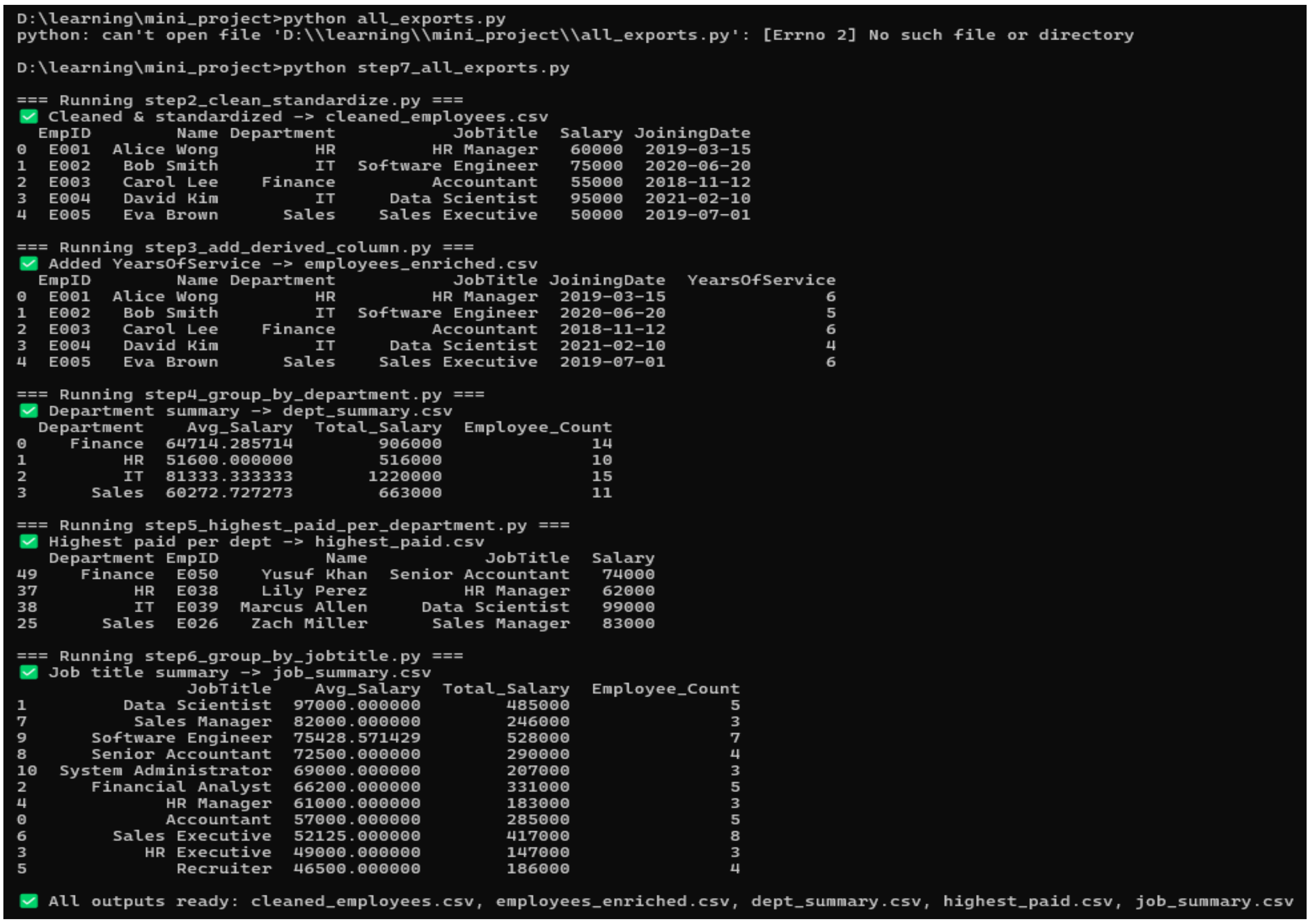
Step 5 identifies the highest-paid employee in each department, revealing top earners like Marcus Allen (IT Data Scientist) at $99,000.

Step 6 analyzes data by job title across all departments, showing salary ranges and employee counts for each position type.

he Finance department has the highest average salary, while IT has the most employees with 15 staff members.

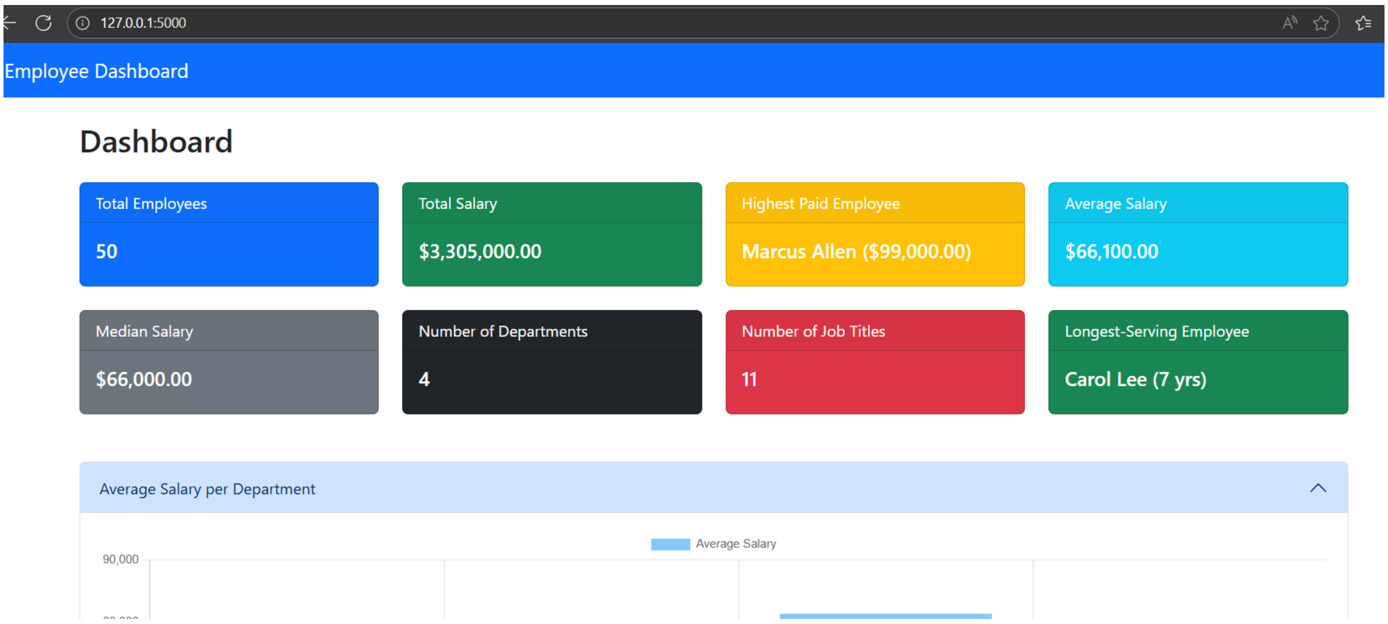
Data Scientists earn the highest average salary at $97,000, while Sales Executives are the most common job title with 8 employees.

The pipeline generates 5 CSV files providing different analytical views of employee data for HR decision-making and compensation analysis.



```
D:\learning\mini_project>python all_exports.py
python: can't open file 'D:\\learning\\mini_project\\all_exports.py': [Errno 2] No such file or directory

D:\learning\mini_project>python step7_all_exports.py

=== Running step2_clean_standardize.py ===
✅ Cleaned & standardized -> cleaned_employees.csv
  EmpID        Name Department           JobTitle  Salary JoiningDate
0  E001  Alice Wong         HR         HR Manager   60000  2019-03-15
1  E002   Bob Smith         IT  Software Engineer   75000  2020-06-20
2  E003   Carol Lee    Finance         Accountant   55000  2018-11-12
3  E004    David Kim         IT     Data Scientist   95000  2021-02-10
4  E005   Eva Brown      Sales    Sales Executive   50000  2019-07-01

=== Running step3_add_derived_column.py ===
✅ Added YearsOfService -> employees_enriched.csv
  EmpID        Name Department           JobTitle JoiningDate  YearsOfService
0  E001  Alice Wong         HR         HR Manager  2019-03-15               6
1  E002   Bob Smith         IT  Software Engineer  2020-06-20               5
2  E003   Carol Lee    Finance         Accountant  2018-11-12               6
3  E004    David Kim         IT     Data Scientist  2021-02-10               4
4  E005   Eva Brown      Sales    Sales Executive  2019-07-01               6

=== Running step4_group_by_department.py ===
✅ Department summary -> dept_summary.csv
  Department    Avg_Salary  Total_Salary  Employee_Count
0    Finance  64714.285714        906000              14
1         HR  51600.000000        516000              10
2         IT  81333.333333       1220000              15
3      Sales  60272.727273        663000              11

=== Running step5_highest_paid_per_department.py ===
✅ Highest paid per dept -> highest_paid.csv
   Department EmpID          Name           JobTitle  Salary
49    Finance  E050    Yusuf Khan  Senior Accountant   74000
37         HR  E038    Lily Perez         HR Manager   62000
38         IT  E039  Marcus Allen     Data Scientist   99000
25      Sales  E026   Zach Miller      Sales Manager   83000

=== Running step6_group_by_jobtitle.py ===
✅ Job title summary -> job_summary.csv
                JobTitle    Avg_Salary  Total_Salary  Employee_Count
1         Data Scientist  97000.000000        485000               5
7          Sales Manager  82000.000000        246000               3
9      Software Engineer  75428.571429        528000               7
8      Senior Accountant  72500.000000        290000               4
10  System Administrator  69000.000000        207000               3
2      Financial Analyst  66200.000000        331000               5
4             HR Manager  61000.000000        183000               3
0             Accountant  57000.000000        285000               5
6        Sales Executive  52125.000000        417000               8
3           HR Executive  49000.000000        147000               3
5              Recruiter  46500.000000        186000               4

✅ All outputs ready: cleaned_employees.csv, employees_enriched.csv, dept_summary.csv, highest_paid.csv, job_summary.csv
```

Output of dashboard.py:



127.0.0.1:5000

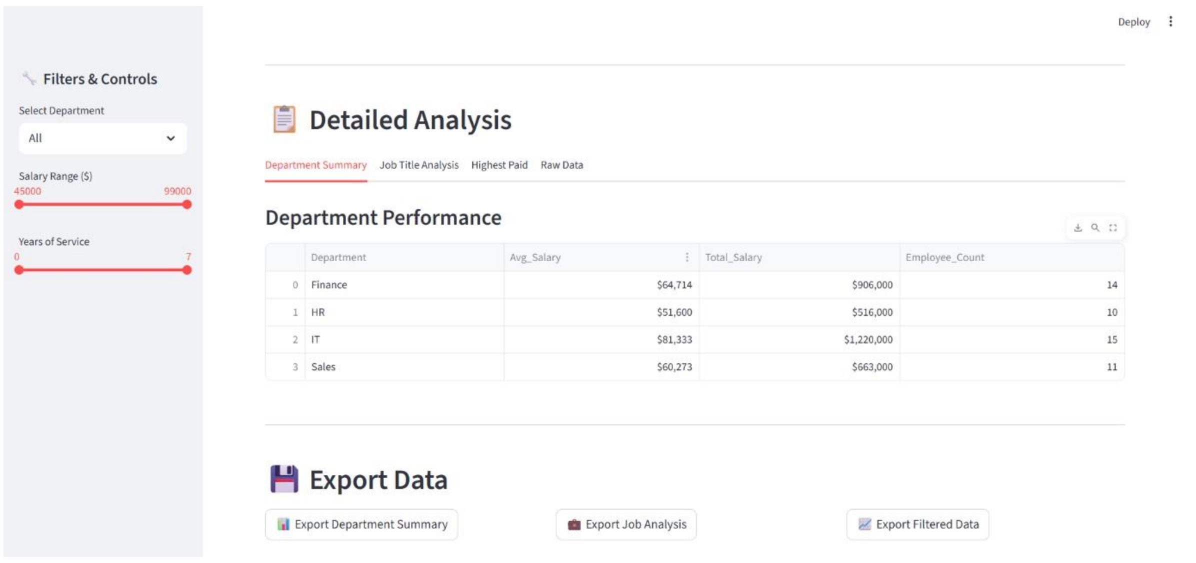
Employee Dashboard

Dashboard

Total Employees	Total Salary	Highest Paid Employee	Average Salary
50	$3,305,000.00	Marcus Allen ($99,000.00)	$66,100.00

Median Salary	Number of Departments	Number of Job Titles	Longest-Serving Employee
$66,000.00	4	11	Carol Lee (7 yrs)

Average Salary per Department



Select Department: All

Salary Range ($): 45000 – 99000

Years of Service: 0 – 7

Detailed Analysis

Department Summary | Job Title Analysis | Highest Paid | Raw Data

Department Performance

	Department	Avg_Salary	Total_Salary	Employee_Count
0	Finance	$64,714	$906,000	14
1	HR	$51,600	$516,000	10
2	IT	$81,333	$1,220,000	15
3	Sales	$60,273	$663,000	11

Export Data

Explanation:

This HR Analytics Dashboard represents the visual output of the employee data processing pipeline, transforming the raw CSV files into an interactive business intelligence interface.

Dashboard Overview The system displays comprehensive HR metrics with a total of 50 employees, an average salary of $66,100, total salary costs of $3.305 million, and an average tenure of 5.1 years across the organization.

Interactive Features The left sidebar provides filtering capabilities allowing users to select specific departments and adjust salary ranges ($45,000-$99,000) and years of service (1-7 years) to customize their analysis views.

Key Visualizations The first screen shows three primary charts: a salary distribution histogram revealing the spread of compensation across all employees, average salary comparisons by department showing IT leading at $81,333, and employee count distribution indicating IT as the largest department with 15 employees.

Advanced Analytics The second screen presents correlation analysis between salary and years of service by department, hiring timeline trends from 2018-2021 showing departmental growth patterns, and a top 10 highest-paid employees ranking with Marcus Allen leading at $99,000.

Detailed Data Tables The third screen provides tabular views of the processed data, including department performance metrics showing Finance with the highest average salary ($64,714) and total costs, alongside IT having the most employees and highest total salary expenditure ($1.22 million).

Export Functionality The dashboard includes data export options for Department Summary, Job Analysis, and Filtered Data, enabling users to download specific datasets for further analysis or reporting purposes.

This comprehensive dashboard effectively translates the backend data processing pipeline into actionable HR insights for strategic workforce management and compensation analysis.

□ Usage Instructions

Running the Data Pipeline

1. Single Step Execution:

```
python step1_load_inspect.py
python step2_clean_standardize.py
# continue with other steps
```

2. Complete Pipeline:

```
python step7_all_exports.py
```

Launching the Dashboard

1. Start the Dashboard:

```
streamlit run dashboard.py
```

2. Access the Application:
   - Open browser to http://localhost:8501
   - Dashboard loads automatically
3. Using the Dashboard:
   - Select filters from sidebar
   - Explore different visualizations
   - Navigate between data tables using tabs
   - Download data using export button

□ Troubleshooting Common Issues

The common issues you can face while running the files are listed here

Data Loading Errors:

Problem: FileNotFoundError: employees.csv not found
Solution: Ensure employees.csv is in the project directory

- Verify file name spelling and extension
- Check file permissions

Missing Dependencies

Problem: ModuleNotFoundError: No module named 'streamlit'
Solution: pip install streamlit pandas matplotlib numpy

Dashboard Import Errors

Problem: ImportError: DLL load failed

Solution: Use the simple dashboard version, Avoid plotly dependencies, Restart terminal

Empty Data Results

Problem: Dashboard shows no data

Solution:Run the complete data pipeline first,Verify CSV files are generated, Check data file paths

Bibliography

• Pandas Documentation: https://pandas.pydata.org/docs/
• NumPy Documentation: https://numpy.org/doc/
• Matplotlib Documentation:
https://matplotlib.org/stable/contents.html
• Plotly Python Graphing Library: https://plotly.com/python/
• Streamlit Documentation: https://docs.streamlit.io/
• Python Official Documentation: https://docs.python.org/3/