

Software Salary Prediction

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Abstract

This project presents a machine learning–based web application designed to predict software professionals’ salaries based on various factors such as experience, education, role, and location. The system integrates trained ML models (Linear Regression and Random Forest) with a Flask backend and a user-friendly frontend interface. The application helps companies and individuals estimate fair salary ranges using data-driven predictions, promoting transparency and better decision-making in the software job market.

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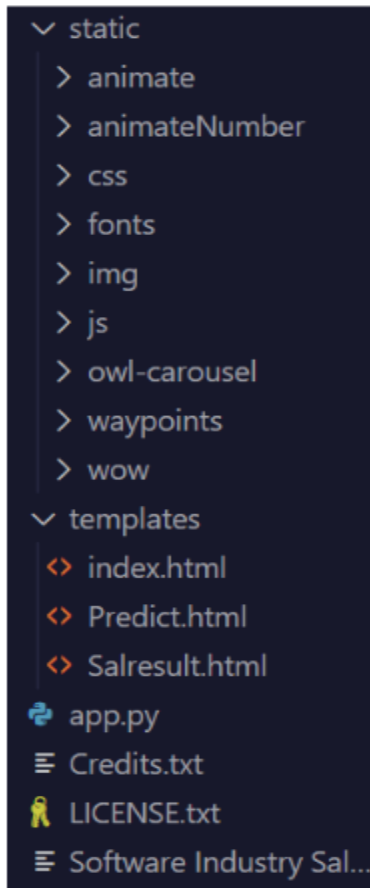
1. Introduction

The software industry is evolving rapidly, driven by innovation and global digital transformation. Salaries in this field vary based on factors such as technical skills, experience, education, company reputation, and job location. Traditional salary estimation methods often rely on subjective opinions and limited market data, leading to inconsistencies and inequalities.

This project aims to leverage machine learning techniques to predict software professionals' salaries with higher accuracy. By analyzing historical salary datasets, the system learns complex relationships between input features and salary outcomes. The developed web application enables real-time, data-driven salary predictions, making it a valuable tool for job seekers, HR departments, and organizations to make informed and transparent compensation decisions.

2. Objectives

- **Develop an Intelligent ML Model:** Design and train machine learning models capable of accurately predicting salaries using factors such as experience, education, job title, and company location.
- **Build a Real-Time Web Application:** Integrate the trained model with a Flask-based web interface to deliver instant salary predictions to users.
- **Compare Model Performance:** Evaluate and compare Linear Regression and Random Forest models to identify the most efficient and accurate algorithm for salary prediction.
- **Provide Salary Insights:** Enable users to explore patterns and trends in salary data across different roles and locations.
- **Enhance Decision-Making:** Help companies and employees make informed financial and career decisions through transparent salary estimation.
- Project structure:



3. Problem Statement & Proposed Solution

Problem Statement:

Determining fair and competitive salaries in the software industry is a complex challenge due to various influencing factors. Manual estimation methods often result in biases, outdated benchmarks, and inconsistent compensation structures. Job seekers and employers struggle to understand the true market value for specific roles.

Proposed Solution:

This project introduces a machine learning-driven salary prediction web application that minimizes human bias by using real data for prediction. The system enables users to input job details, including experience, education, and job role, and instantly receive a predicted

salary estimate. The integration of Flask with trained ML models ensures smooth interaction between the frontend and backend, delivering accurate, real-time results.

4. System Scenarios & Use Cases

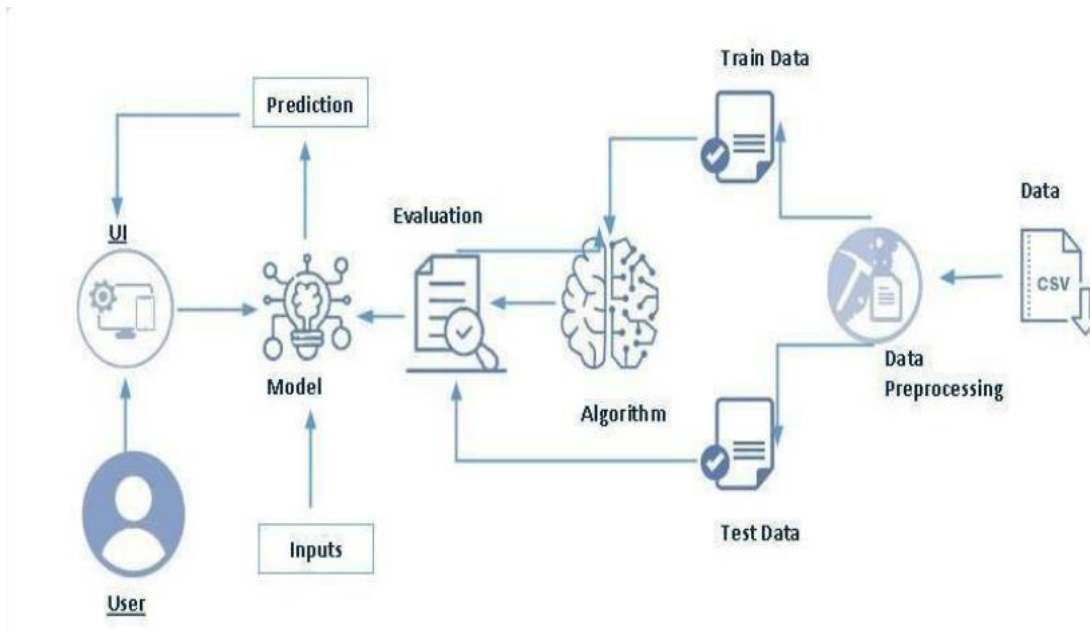
- **For Job Seekers:** Helps candidates evaluate expected salaries for their roles and locations before applying, enabling better negotiation and career decisions.
- **For Employers:** Assists in offering competitive, data-backed salaries that align with market standards, improving hiring fairness and employee satisfaction.
- **For HR Analysts:** Provides analytical insights into salary trends, helping HR departments maintain salary equity and optimize compensation strategies.
- **For Students and Researchers:** Offers a learning model to understand how machine learning can be applied to HR analytics and salary estimation.

5. Technical Architecture

The system architecture is divided into multiple layers:

1. **Data Layer:** Contains datasets with attributes like experience, education, role, and location.
2. **Processing Layer:** Handles data preprocessing, including missing value treatment, feature encoding, and normalization.
3. **Model Training Layer:** Employs ML algorithms such as Linear Regression and Random Forest to train predictive models.
4. **Application Layer:** Built with Flask, this layer provides APIs to communicate between the trained models and the frontend interface.
5. **User Interface Layer:** A web-based frontend built using HTML, CSS, and JavaScript that enables user interaction for input and result display.

This modular design ensures scalability, reliability, and easy maintenance.



6. Methodology

Dataset:

The dataset includes information such as years of experience, education level, company size, job location, and primary skills, with corresponding salary labels.

Data Preprocessing:

- Handling missing values and outliers.
- One-hot encoding categorical variables.
- Standardizing numeric features like years of experience.
- Splitting data into training and testing sets.

Model Training:

- Algorithms used: Random Forest Regressor, Linear Regression, and XGBoost.
- Model trained using Python and Scikit-learn in Jupyter Notebook.

Model Persistence:

The trained model is saved as model.pkl using joblib for deployment.

Evaluation:

Metrics such as Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and R^2 Score are used to assess performance.

7. Implementation

The implementation involves both backend and frontend development:

- **Backend (Flask):** The Flask framework connects the frontend with the ML model. It handles user requests, processes inputs, runs the model, and returns predicted salaries.
- **Model Integration:** The trained Random Forest model was serialized using pickle and loaded during Flask runtime for efficient predictions.
- **Frontend Design:** HTML and CSS were used to design an intuitive interface for data entry. JavaScript was used for dynamic updates and smooth interaction.

The project includes the following structure:

- app.py – Flask backend
- model/salary_model.ipynb – Jupyter Notebook for training
- model/model.pkl – Trained ML model file
- templates/ – HTML templates
- static/ – CSS and JavaScript files

8. Results

The trained Random Forest model achieved:

RMSE: 0.12 (log-scaled)

MAE: 4200 INR

R^2 Score: 0.87

The Flask app successfully predicts salaries in real-time. Screenshots demonstrate smooth user interaction, accurate predictions, and responsive design. The system provides meaningful salary ranges and insights based on entered attributes.

The Linear Regression and Random Forest models were successfully trained and evaluated. Random Forest provided better accuracy and lower error values, making

it the final model integrated into the web app. The web application delivers predictions effectively and enhances user understanding of salary trends.

9. Conclusion

The Software Salary Prediction project showcases how machine learning can analyze professional and demographic data to produce useful insights. The integration of AI/ML with web technologies demonstrates real-world applicability and helps bridge the gap between technical skills and compensation analysis.

This project demonstrates how machine learning can be used to estimate software professionals' salaries accurately. By combining Linear Regression and Random Forest models within a Flask-based web app, the project offers a functional, interactive, and scalable salary prediction system.

10. Future Scope

- Include more detailed features like skill sets, company size, and job level.
- Incorporate additional features like job role, company rating, and skill proficiency.
- Use larger and more diverse datasets for improved accuracy.
- Deploy the application on cloud platforms for public access.
- Implement visualization dashboards to display salary trends.

11. Appendix

Project Structure:

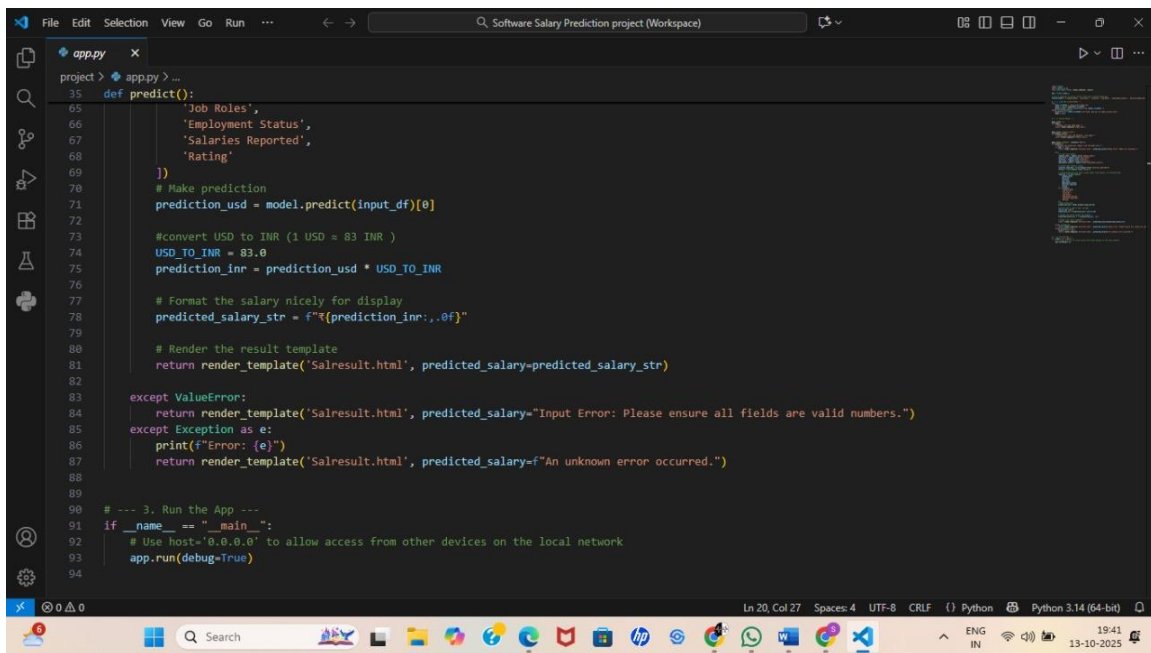
- app.py – Flask backend
- model/salary_model.ipynb – Model training notebook
- model/model.pkl – Trained ML model
- templates/ – HTML templates
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Demonstration

This section provides visual evidence of the developed project, including source code snippets and the web application interface

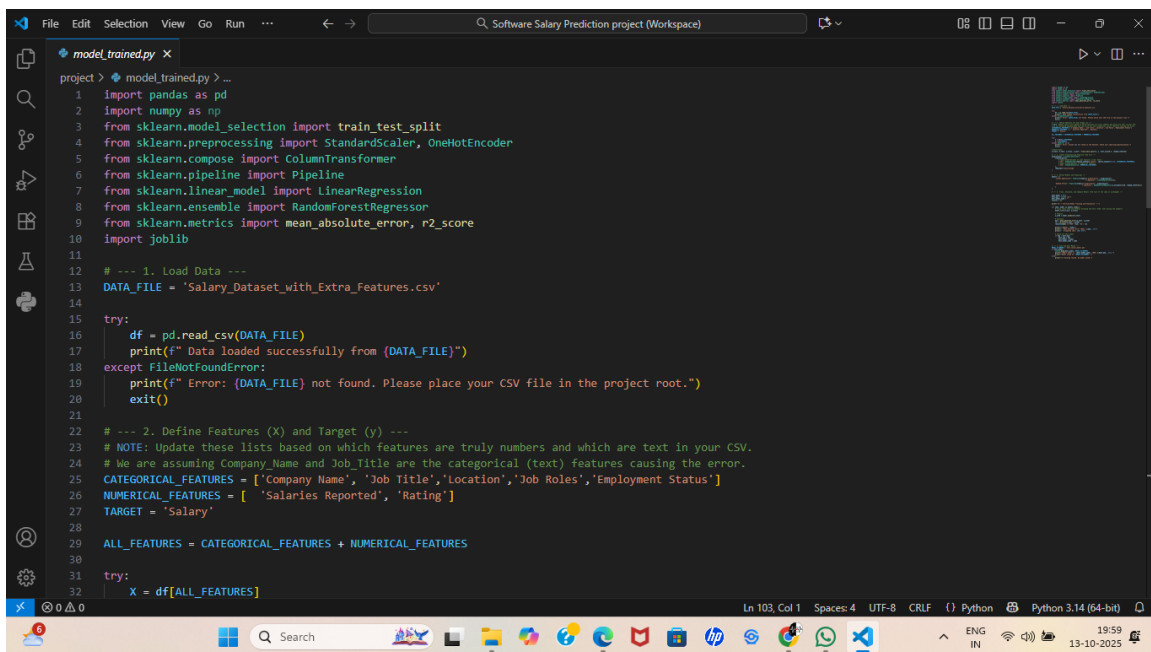
Figure 1: Screenshot of app.py (Flask backend code).


```
File Edit Selection View Go Run ... Software Salary Prediction project (Workspace)
app.py
project > app.py > ...
1 import joblib
2 import pandas as pd
3 from flask import Flask, render_template, request
4
5 app = Flask(__name__)
6
7 # List of features to ensure correct order when creating DataFrame
8 FEATURE_ORDER = ['Company_Name', 'Job_Title', 'Location', 'Job_Roles', 'Employment_Status', 'Salaries_Reported', 'Rating']
9
10 # --- 1. Load the Trained Model ---
11 try:
12     MODEL_FILENAME = 'best_salary_model.pkl'
13     model = joblib.load(MODEL_FILENAME)
14     print(f"Model loaded successfully from {MODEL_FILENAME}.")
15 except FileNotFoundError:
16     print(f"Error: {MODEL_FILENAME} not found. Did you run model_trainer.py?")
17     model = None
18
19
20 # --- 2. Define Routes ---
21
22 @app.route('/')
23 def home():
24     """Renders the main Home page."""
25     return render_template('index.html')
26
27
28 @app.route('/predict_form')
29 def predict_form():
30     """Renders the 'FILL THE DETAILS!' form page."""
31     return render_template('Predict.html')
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```
project > app.py > ...
35 def predict():
65     'Job Roles',
66     'Employment Status',
67     'Salaries Reported',
68     'Rating'
69 ])
70 # Make prediction
71 prediction_usd = model.predict(input_df)[0]
72
73 #convert USD to INR (1 USD = 83 INR )
74 USD_TO_INR = 83.0
75 prediction_inr = prediction_usd * USD_TO_INR
76
77 # Format the salary nicely for display
78 predicted_salary_str = f"₹{prediction_inr:,.0f}"
79
80 # Render the result template
81 return render_template("Salresult.html", predicted_salary=predicted_salary_str)
82
83 except ValueError:
84     return render_template("Salresult.html", predicted_salary="Input Error: Please ensure all fields are valid numbers.")
85 except Exception as e:
86     print(f"Error: {e}")
87     return render_template("Salresult.html", predicted_salary=f"An unknown error occurred.")
88
89
90 # --- 3. Run the App ---
91 if __name__ == "__main__":
92     # Use host='0.0.0.0' to allow access from other devices on the local network
93     app.run(debug=True)
94
```

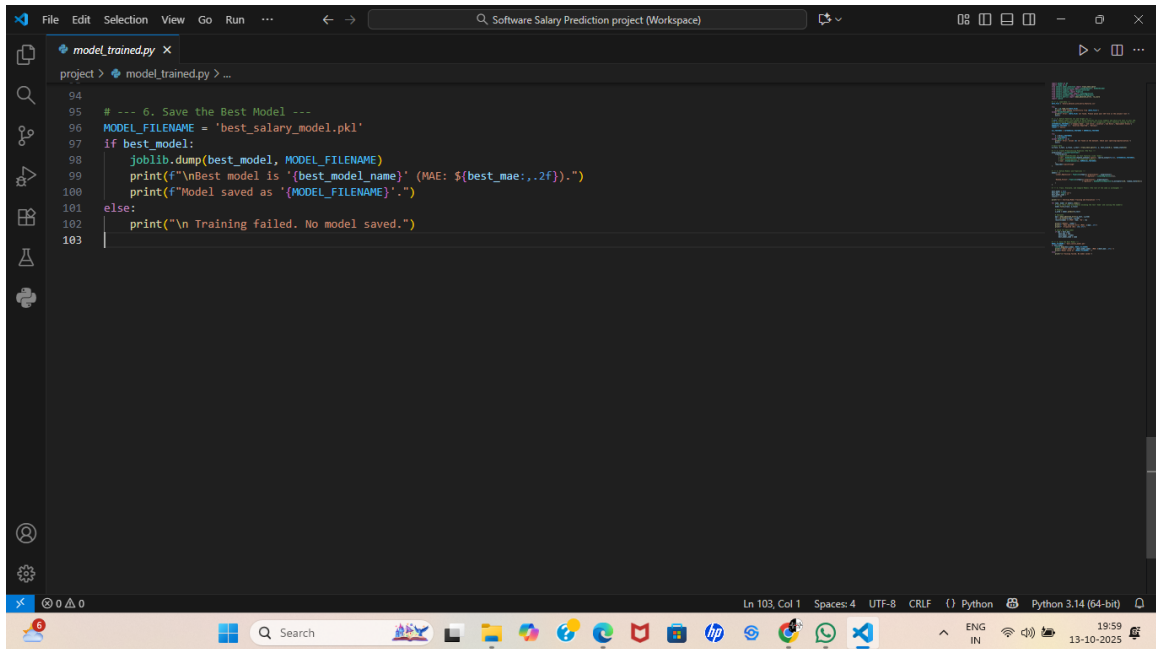
Figure 2: Screenshots of model_train.py(model training)



```
project > model_train.py > ...
1 import pandas as pd
2 import numpy as np
3 from sklearn.model_selection import train_test_split
4 from sklearn.preprocessing import StandardScaler, OneHotEncoder
5 from sklearn.compose import ColumnTransformer
6 from sklearn.pipeline import Pipeline
7 from sklearn.linear_model import LinearRegression
8 from sklearn.ensemble import RandomForestRegressor
9 from sklearn.metrics import mean_absolute_error, r2_score
10 import joblib
11
12 # --- 1. Load Data ---
13 DATA_FILE = 'Salary_Dataset_with_Extra_Features.csv'
14
15 try:
16     df = pd.read_csv(DATA_FILE)
17     print(f"Data loaded successfully from {DATA_FILE}")
18 except FileNotFoundError:
19     print(f"Error: {DATA_FILE} not found. Please place your CSV file in the project root.")
20     exit()
21
22 # --- 2. Define Features (X) and Target (y) ---
23 # NOTE: Update these lists based on which features are truly numbers and which are text in your CSV.
24 # We are assuming Company Name and Job Title are the categorical (text) features causing the error.
25 CATEGORICAL_FEATURES = ['Company Name', 'Job Title', 'Location', 'Job Roles', 'Employment Status']
26 NUMERICAL_FEATURES = ['Salaries Reported', 'Rating']
27 TARGET = 'Salary'
28
29 ALL_FEATURES = CATEGORICAL_FEATURES + NUMERICAL_FEATURES
30
31 try:
32     X = df[ALL_FEATURES]
```

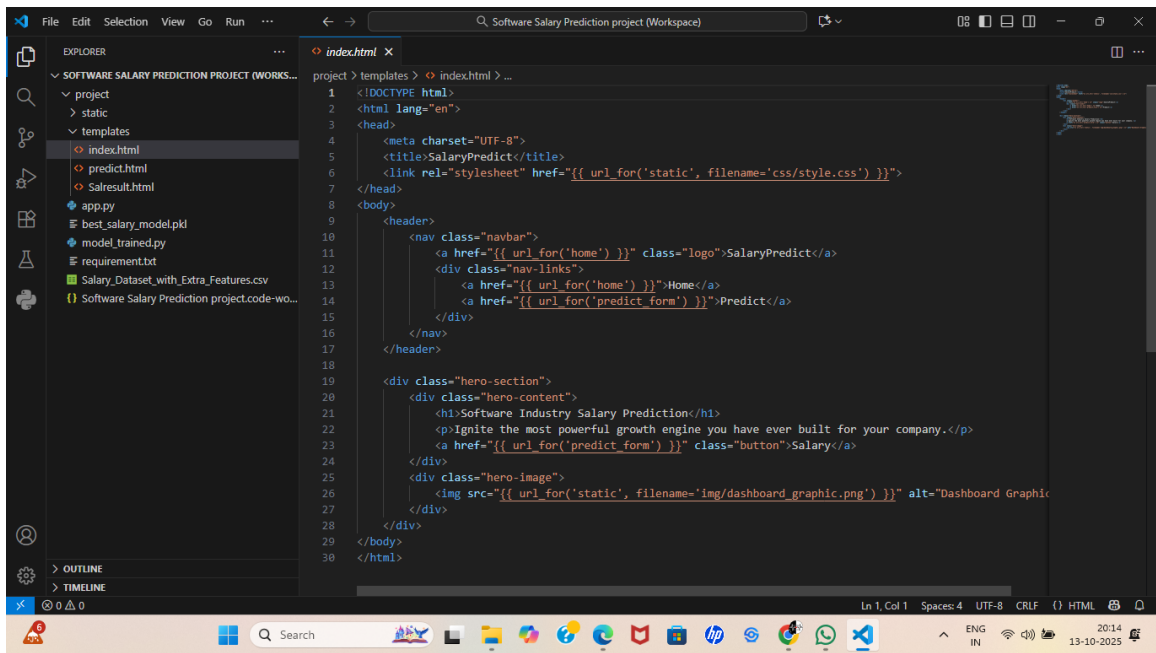
```
File Edit Selection View Go Run ... Software Salary Prediction project (Workspace)
model_trained.py X
project > model_trained.py > ...
32 A = df[['SALE_PRICE']]
33 y = df[TARGET]
34 except KeyError as e:
35     print(f"Error: Column {e} not found in the dataset. Check your spelling/capitalization.")
36     exit()
37
38 # Split data
39 X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
40
41 # --- 3. Create Preprocessing Pipeline (The Fix) ---
42 preprocessor = ColumnTransformer(
43     transformers=[
44         # Apply OneHotEncoder to text features (like 'Xome')
45         ('cat', OneHotEncoder(handle_unknown='ignore', sparse_output=False), CATEGORICAL_FEATURES),
46         # Apply StandardScaler to numerical features
47         ('num', StandardScaler(), NUMERICAL_FEATURES)
48     ],
49     remainder='passthrough'
50 )
51
52 # --- 4. Define Models and Pipelines ---
53 models = {
54     'Linear_Regression': Pipeline(steps=[('preprocessor', preprocessor),
55                                         ('regressor', LinearRegression())]),
56     'Random_Forest': Pipeline(steps=[('preprocessor', preprocessor),
57                                     ('regressor', RandomForestRegressor(n_estimators=10, random_state=42))])
58 }
59
60 # --- 5. Train, Evaluate, and Compare Models (The rest of the code is unchanged) ---
61
62
63
```

```
File Edit Selection View Go Run ... Software Salary Prediction project (Workspace)
model_trained.py X
project > model_trained.py > ...
65 best_model = None
66 best_mae = float('inf')
67 best_model_name = ""
68 results = {}
69
70 print("\n--- Starting Model Training and Evaluation ---")
71
72 for name, model in models.items():
73     # Train (This step now handles encoding the text 'Xome' and scaling the numbers)
74     model.fit(X_train, y_train)
75
76     # Predict
77     y_pred = model.predict(X_test)
78
79     # Evaluate
80     mae = mean_absolute_error(y_test, y_pred)
81     r2 = r2_score(y_test, y_pred)
82     results[name] = {'MAE': mae, 'R2': r2}
83
84     print(f"\nModel: {name}")
85     print(f" Mean Absolute Error (MAE): ${mae:.2f}")
86     print(f" R-squared (R2): {r2:.4f}")
87
88     # Check for best model
89     if mae < best_mae:
90         best_mae = mae
91         best_model = model
92         best_model_name = name
93
94 # --- 6. Save the Best Model ---
95 MODEL_FILENAME = 'best_salary_model.pkl'
96
```



```
94
95 # --- 6. Save the Best Model ---
96 MODEL_FILENAME = 'best_salary_model.pkl'
97 if best_model:
98     joblib.dump(best_model, MODEL_FILENAME)
99     print(f"\nBest model is '{best_model_name}' (MAE: ${best_mae:,.2f}).")
100     print(f"Model saved as '{MODEL_FILENAME}'.")
101 else:
102     print("\n Training failed. No model saved.")
103
```

Figure 3: Screenshot of Index.html, predict.html,result.html.



```
1 <!DOCTYPE html>
2 <html lang="en">
3 <head>
4 <meta charset="UTF-8">
5 <title>SalaryPredict</title>
6 <link rel="stylesheet" href="{{ url_for('static', filename='css/style.css') }}">
7 </head>
8 <body>
9 <header>
10 <nav class="navbar">
11 <a href="{{ url_for('home') }}" class="logo">SalaryPredict</a>
12 <div class="nav-links">
13 <a href="{{ url_for('home') }}">Home</a>
14 <a href="{{ url_for('predict_form') }}">Predict</a>
15 </div>
16 </nav>
17 </header>
18
19 <div class="hero-section">
20 <div class="hero-content">
21 <h1>Software Industry Salary Prediction</h1>
22 <p>Ignite the most powerful growth engine you have ever built for your company.</p>
23 <a href="{{ url_for('predict_form') }}" class="button">Salary</a>
24 </div>
25 <div class="hero-image">
26 
28 </div>
29 </body>
30 </html>
```

```
File Edit Selection View Go Run ...
SOFTWARE SALARY PREDICTIO...
project
static
templates
index.html
predict.html
Salresult.html
app.py
best_salary_model.pkl
model_trained.py
requirement.txt
Salary_Dataset_with_Extra_Features.csv
Software Salary Prediction project.code-wo...

predict.html X
project > templates > predict.html ...
1 <!DOCTYPE html>
2 <html lang="en">
3 <head>
4 <meta charset="UTF-8">
5 <title>Fill Details</title>
6 <link rel="stylesheet" href="{{ url_for('static', filename='css/style.css') }}">
7 </head>
8 <body>
9 <header>
10 <nav class="navbar">
11 <a href="{{ url_for('home') }}" class="logo">SalaryPredict</a>
12 <div class="nav-links">
13 <a href="{{ url_for('home') }}">Home</a>
14 </div>
15 </nav>
16 </header>
17
18 <div class="form-container-page">
19 <div class="form-image-left">
20 
22 </div>
23
24 <div class="form-content-right">
25 <h2>FILL THE DETAILS!</h2>
26 <form action="{{ url_for('predict') }}" method="post" class="prediction-form">
27
28 <div class="form-row">
29 <label for="company_name">Company Name :</label>
30 <input type="text" name="company_name" required>
31 </div>
32
```

```
File Edit Selection View Go Run ...
SOFTWARE SALARY PREDICTIO...
project
static
templates
index.html
predict.html
Salresult.html
app.py
best_salary_model.pkl
model_trained.py
requirement.txt
Salary_Dataset_with_Extra_Features.csv
Software Salary Prediction project.code-wo...

predict.html X
project > templates > predict.html ...
2 <html lang="en">
8 <body>
18 <div class="form-container-page">
24 <div class="form-content-right">
26 <form action="{{ url_for('predict') }}" method="post" class="prediction-form">
33
34 <div class="form-row">
35 <label for="job_title">Job Title :</label>
36 <input type="text" name="job_title" required>
37 </div>
38 <div class="form-row">
39 <label for="location">Location :</label>
40 <input type="text" name="location" required>
41 </div>
42
43 <div class="form-row">
44 <label for="job_roles">Job Roles :</label>
45 <input type="text" name="job_roles" required>
46 </div>
47
48 <div class="form-row">
49 <label for="employment_status">Employment Status :</label>
50 <input type="text" name="employment_status" required>
51 </div>
52
53 <div class="form-row">
54 <label for="salaries_reported">Salaries Reported (Count):</label>
55 <input type="number" step="1" name="salaries_reported" id="salaries_reported" value="1">
56 </div>
57
58 <div class="form-row">
59 <label for="rating">Rating (0.0-5.0):</label>
```

The screenshot shows the Visual Studio Code editor with the 'Software Salary Prediction project (Workspace)' open. The Explorer sidebar on the left shows the project structure, with 'predict.html' selected under the 'templates' folder. The main editor area displays the HTML code for 'predict.html'. The code includes a form with a text input for 'salaries_reported' and a rating input, both with appropriate attributes for form styling and validation. A 'Submit' button is also present. The status bar at the bottom indicates the current position is at line 1, column 1, with 4 spaces, in UTF-8 encoding, and the file is in HTML format.

```
project > templates > predict.html > ...
2 <html lang="en">
8 <body>
18 <div class="form-container-page">
24 <div class="form-content-right">
26 <form action="{{ url_for('predict') }}" method="post" class="prediction-form">
27 <input type="text" name="salaries_reported" value="{{ salaries_reported }}">
55 <div>
56 <input type="number" step="1" name="salaries_reported" id="salaries_reported" value="1"
57 </div>
58 <div class="form-row">
59 <label for="rating">Rating (0.0-5.0)</label>
60 <input type="number" step="0.01" name="rating" min="0" max="5" required>
61 </div>
62 <button type="submit" class="button-submit">Submit</button>
63 </form>
64 </div>
65 </div>
66 </body>
67 </html>
```

The screenshot shows the Visual Studio Code editor with the 'Software Salary Prediction project (Workspace)' open. The Explorer sidebar on the left shows the project structure, with 'Salresult.html' selected under the 'templates' folder. The main editor area displays the HTML code for 'Salresult.html'. The code includes a header with a navigation bar, a main content area with a predicted salary value and a dashboard graphic, and a footer. The code uses Jinja2 templating for dynamic content like the predicted salary and the dashboard graphic. The status bar at the bottom indicates the current position is at line 28, column 8, with 4 spaces, in UTF-8 encoding, and the file is in HTML format.

```
project > templates > Salresult.html > html
1 <!DOCTYPE html>
2 <html lang="en">
3 <head>
4 <meta charset="UTF-8">
5 <title>Prediction Result</title>
6 <link rel="stylesheet" href="{{ url_for('static', filename='css/style.css') }}">
7 </head>
8 <body>
9 <header>
10 <nav class="navbar">
11 <a href="{{ url_for('home') }}" class="logo">SalaryPredict</a>
12 <div class="nav-links">
13 <a href="{{ url_for('home') }}">Home</a>
14 </div>
15 </nav>
16 </header>
17 <div>
18 <div class="predicted-salary-value">
19 {{ predicted_salary }}
20 </div>
21 <div class="result-image">
22 
24 </div>
25 </body>
26 </html>
```

Figure 4: Web application -Index page

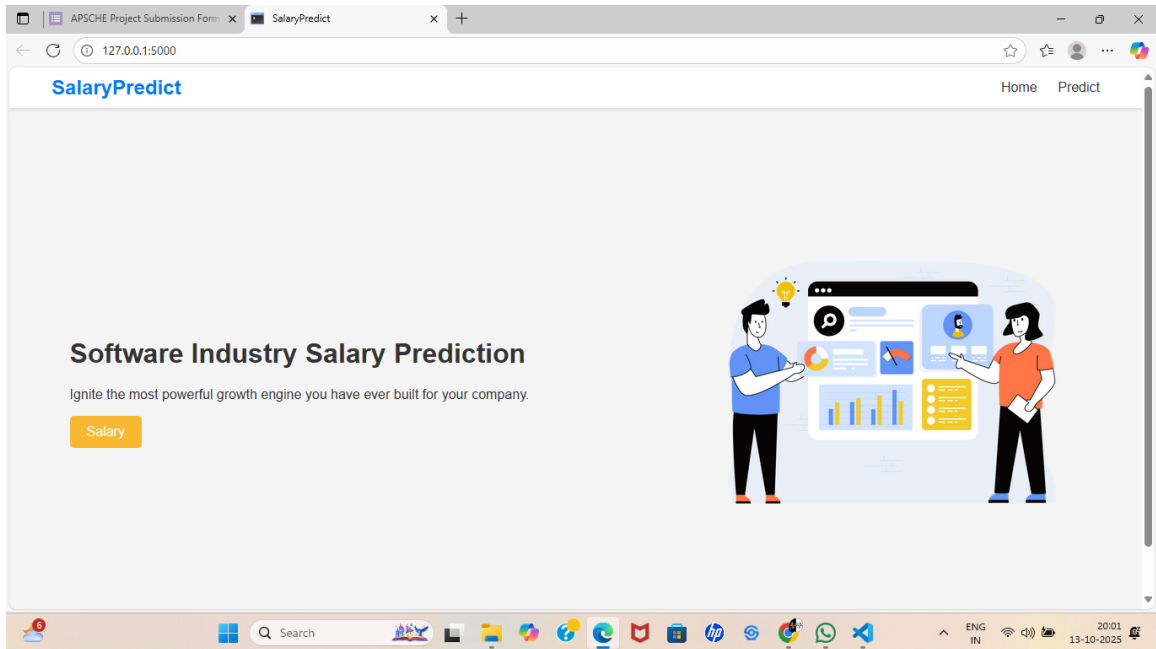
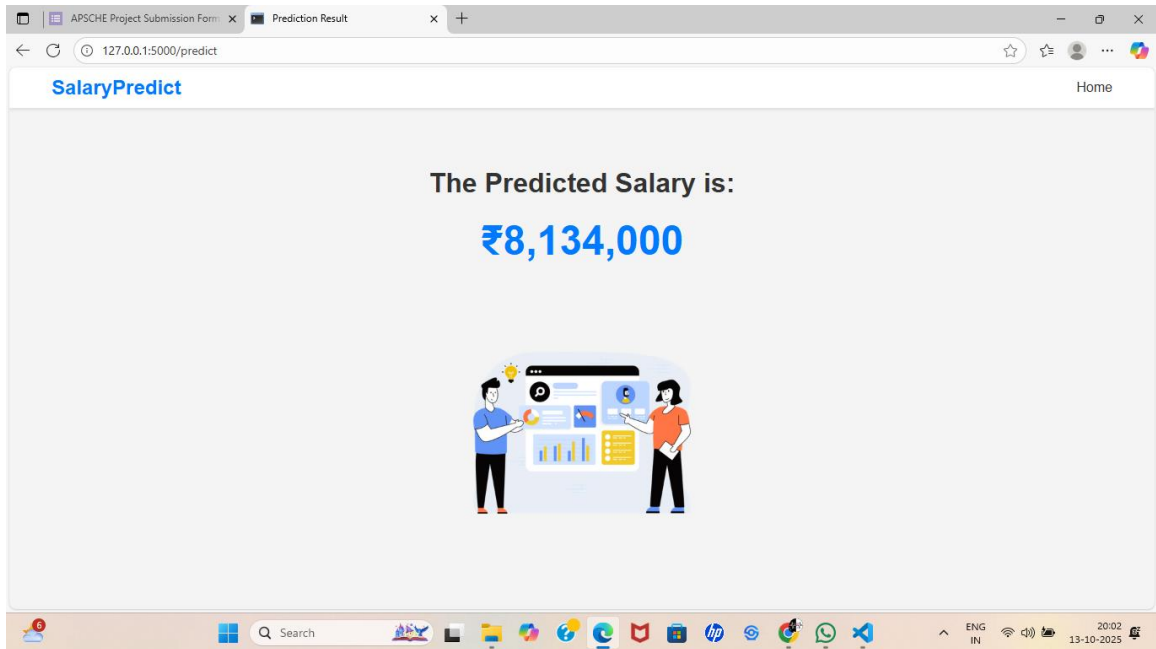


Figure 5: Web application- details page

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A screenshot of the 'Fill Details' page of the 'SalaryPredict' web application. The browser's address bar shows '127.0.0.1:5000/predict_form'. The page has a light gray background. At the top left is the 'SalaryPredict' logo. At the top right is a link for 'Home'. The main content area is divided into two sections. On the left is an illustration of four people (three women and one man) sitting around a table, engaged in a discussion. On the right is a form titled 'FILL THE DETAILS!' in bold black text. The form contains several input fields with pre-filled values: 'Company Name : google', 'Job Title : developer', 'Location : bangalore', 'Job Roles : andriod', 'Employment Status : intern', 'Salaries Reported (Count): 2', and 'Rating (0.0-5.0): 1.0'. Below the form is an orange button labeled 'Submit'. The Windows taskbar is visible at the bottom of the screen.

Figure 6: Web application- Result page.



12. References

- Flask documentation – <https://flask.palletsprojects.com/>
- Scikit-learn – <https://scikit-learn.org/>
- Python official documentation – <https://docs.python.org/3/>
- GitHub Repository - <https://github.com/kasadhanalakshmi/Software-salary-prediction>
- Demo Video - https://drive.google.com/file/d/1_KBOLCNdQi7tr5I-IM2pLotEnSbHrvxT/view?usp=sharing