Project Report:

Rainfall Prediction System for Agricultural Risk Assessment.

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1. Project Overview:

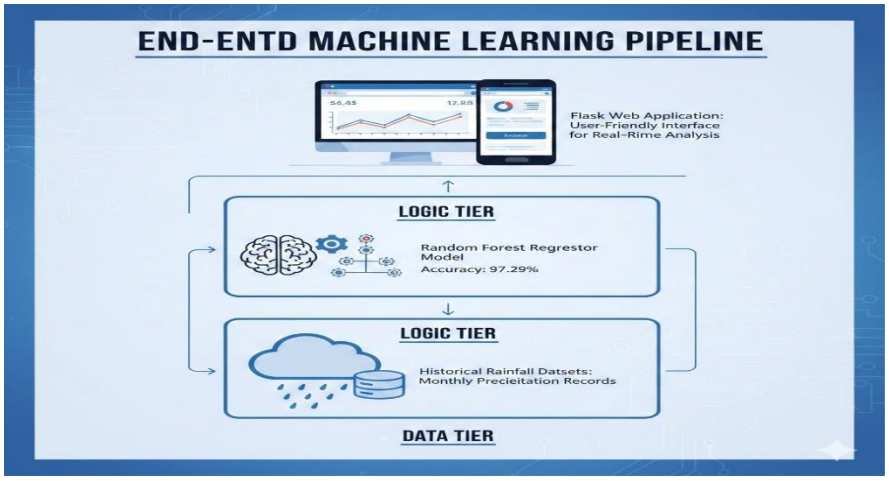
Project Description:

The Exploratory Analysis and Prediction of Rainfall in India is a critical initiative aimed at supporting the country's agricultural sector. By forecasting annual precipitation based on monthly historical data, this system helps farmers and financial institutions evaluate risks and plan for irrigation or crop selection more effectively.

Technical Architecture:

The project is built on an end-to-end Machine Learning pipeline:

- Data Tier: Historical rainfall datasets containing monthly precipitation records.
- Logic Tier: A Random Forest Regressor model, selected for its high precision in regression tasks, achieving an accuracy of 97.29%.
- Presentation Tier: A Flask web application that provides a user-friendly interface for real-time analysis.



2. Project Strategy:

Prior Knowledge:

To execute this project, knowledge in the following domains was applied :

- **Supervised Learning**: Specifically, regression techniques for continuous numerical prediction .
- **Ensemble Methods**: Utilizing Random Forest to handle complex, non-linear weather data.
- **Web Frameworks**: Understanding Flask routing and HTML template rendering.

Project Objectives:

- **Regression Analysis**: Identifying and classifying the rainfall prediction problem as a regression task.
- **Data Preprocessing**: Implementing data cleaning and feature scaling using Standard Scaler.
- **Visualization**: Gaining insights through univariate and bivariate data analysis.
- **Web Application**: Developing a functional application using the Flask framework.

Project Flow:

1. **User Input**: The user interacts with the UI to enter 12 monthly rainfall values .
2. **Analysis**: The backend scales the input and passes it through the trained Random Forest model.
3. **Output**: The annual prediction and success/warning alerts are displayed on the UI.

3. Implementation & Structure:

Project Folder Setup:

The folder structure is organized according to Flask standards to ensure proper file routing :

- **Rainfall Project/** (Main Directory)
    - **app.py**: The Flask server script.
    - **Rainfall.csv**: The raw training dataset.
    - **Models/** (Subfolder)
        - Rainfall. Pkl : The trained predictive model.
        - scale. pkl : The saved scaler object.
    - **Templates/** (Subfolder)

- index.html: The input form.
- chance.html: High rainfall result page.
- nochance.html: Low rainfall warning page.

4. Full Source Code:

Milestone 1: Data Loading, Cleaning and Visualisation (Jupyter Notebook)

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# Load the file
df = pd.read_csv('Rainfall.csv')

# Success Check
print("Data Loaded Successfully!")
df.head()
```

```
Data Loaded Successfully!
```

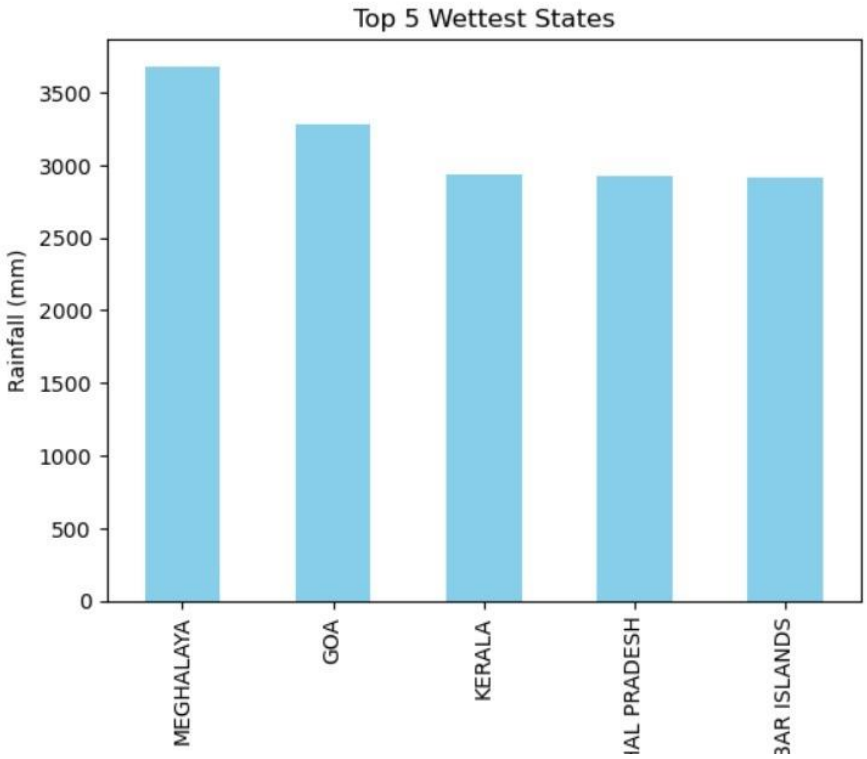
[1]:

	STATE_UT_NAME	DISTRICT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	ANDAMAN And NICOBAR ISLANDS	NICOBAR	107.3	57.9	65.2	117.0	358.5	295.5	285.0	271.9	354.8	326.0	315.2	250.9
1	ANDAMAN And NICOBAR ISLANDS	SOUTH ANDAMAN	43.7	26.0	18.6	90.5	374.4	457.2	421.3	423.1	455.6	301.2	275.8	128.3
2	ANDAMAN And NICOBAR ISLANDS	N & M ANDAMAN	32.7	15.9	8.6	53.4	343.6	503.3	465.4	460.9	454.8	276.1	198.6	100.0
3	ARUNACHAL PRADESH	LOHIT	42.2	80.8	176.4	358.5	306.4	447.0	660.1	427.8	313.6	167.1	34.1	29.8
4	ARUNACHAL PRADESH	EAST SIANG	33.3	79.5	105.9	216.5	323.0	738.3	990.9	711.2	568.0	206.9	29.5	31.7

[2]:
```
# 1. Remove hidden spaces from column names
df.columns = df.columns.str.strip()

# 2. Fill missing values with 0
df.fillna(0, inplace=True)

# 3. Clean names inside the data
df['STATE_UT_NAME'] = df['STATE_UT_NAME'].str.strip()
df['DISTRICT'] = df['DISTRICT'].str.strip()

print("Data Cleaning Complete. Ready for Analysis!")
```

```
Data Cleaning Complete. Ready for Analysis!
```

[3]:
```
# Show top 5 states by annual rainfall
state_avg = df.groupby('STATE_UT_NAME')['ANNUAL'].mean().sort_values(ascending=False).head(5)
state_avg.plot(kind='bar', color='skyblue')
plt.title('Top 5 Wettest States')
plt.ylabel('Rainfall (mm)')
plt.show()
```



Milestone 2: Model Training & Scaling (Jupyter)

[4]:
```
from sklearn.model_selection import train_test_split

# 1. Define your Features (X) and Target (y)
# X = The 12 months used to predict
# y = The Annual total we want to find
X = df[['JAN', 'FEB', 'MAR', 'APR', 'MAY', 'JUN', 'JUL', 'AUG', 'SEP', 'OCT', 'NOV', 'DEC']]
y = df['ANNUAL']

# 2. Split the data
# test_size=0.2 means 20% is for testing and 80% is for training
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

print("Data successfully divided!")
print(f"Training rows: {len(X_train)}")
print(f"Testing rows: {len(X_test)}")
```

```
Data successfully divided!
Training rows: 512
Testing rows: 129
```

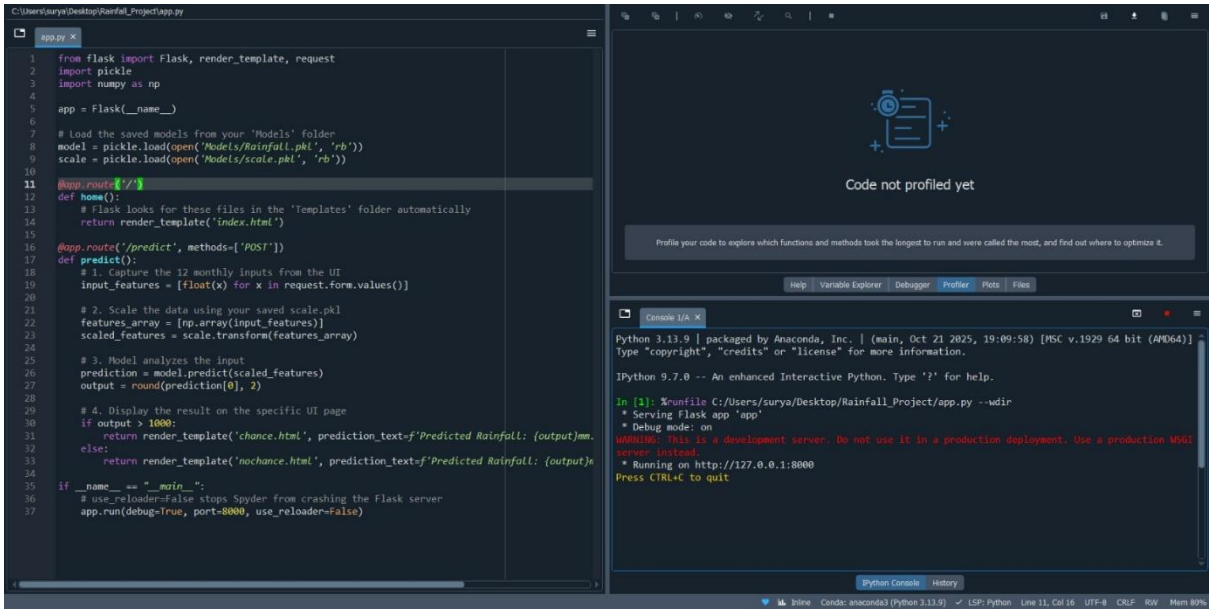
[9]:
```python
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import r2_score

# 1. Initializing the model
model = RandomForestRegressor(n_estimators=100, random_state=42)

# 2. Training the model (Learning from X_train_scaled)
model.fit(X_train_scaled, y_train)

# 3. Evaluation of Model (Testing on X_test_scaled)
y_pred = model.predict(X_test_scaled)
accuracy = r2_score(y_test, y_pred)

# 4. Save the Model as Rainfall.pkl
pickle.dump(model, open('Models/Rainfall.pkl', 'wb'))

print(f"Model Training Complete! Accuracy: {accuracy*100:.2f}%")
print("Rainfall.pkl saved in models folder.")
```

```
Model Training Complete! Accuracy: 97.29%
Rainfall.pkl saved in models folder.
```

[7]:
```python
from sklearn.preprocessing import StandardScaler
import pickle

# Initialize the Scaler
scaler = StandardScaler()

# Fit and Transform the training data
X_train_scaled = scaler.fit_transform(X_train)

# Transform the testing data (using the same rules)
X_test_scaled = scaler.transform(X_test)

# Save the scaler as scale.pkl in your models folder
pickle.dump(scaler, open('models/scale.pkl', 'wb'))

print("Feature Scaling complete and scale.pkl saved!")
```

```
Feature Scaling complete and scale.pkl saved!
```

Milestone 3: Flask Deployment (app.py)

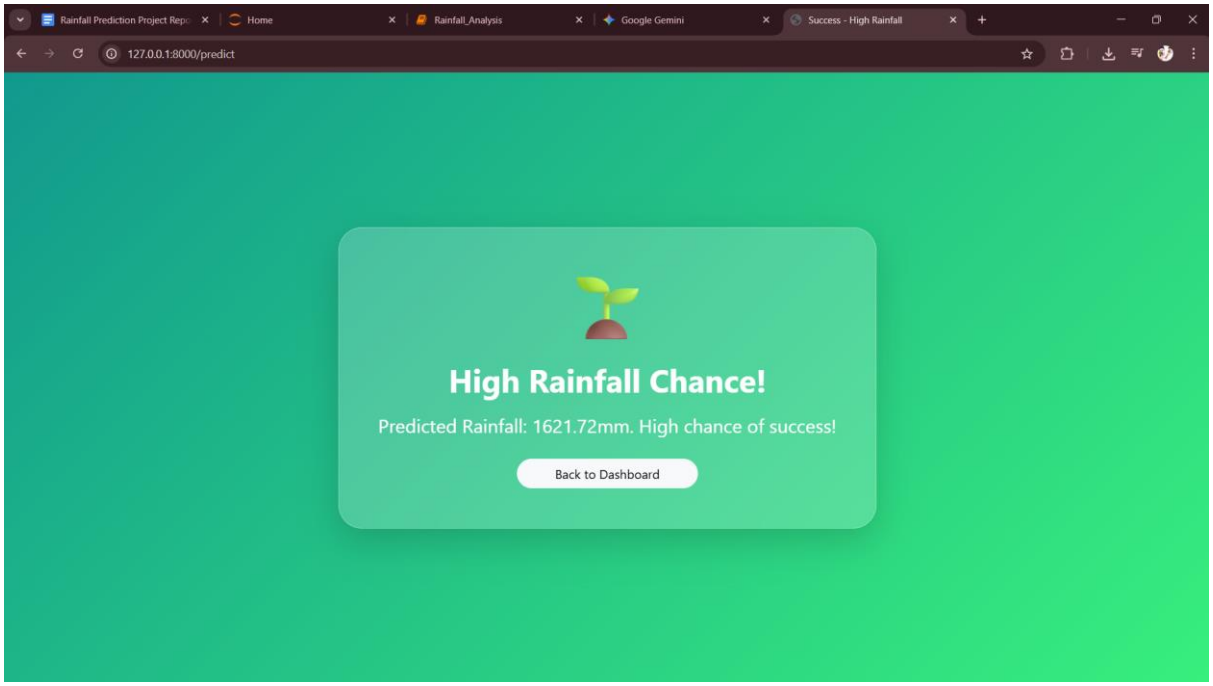


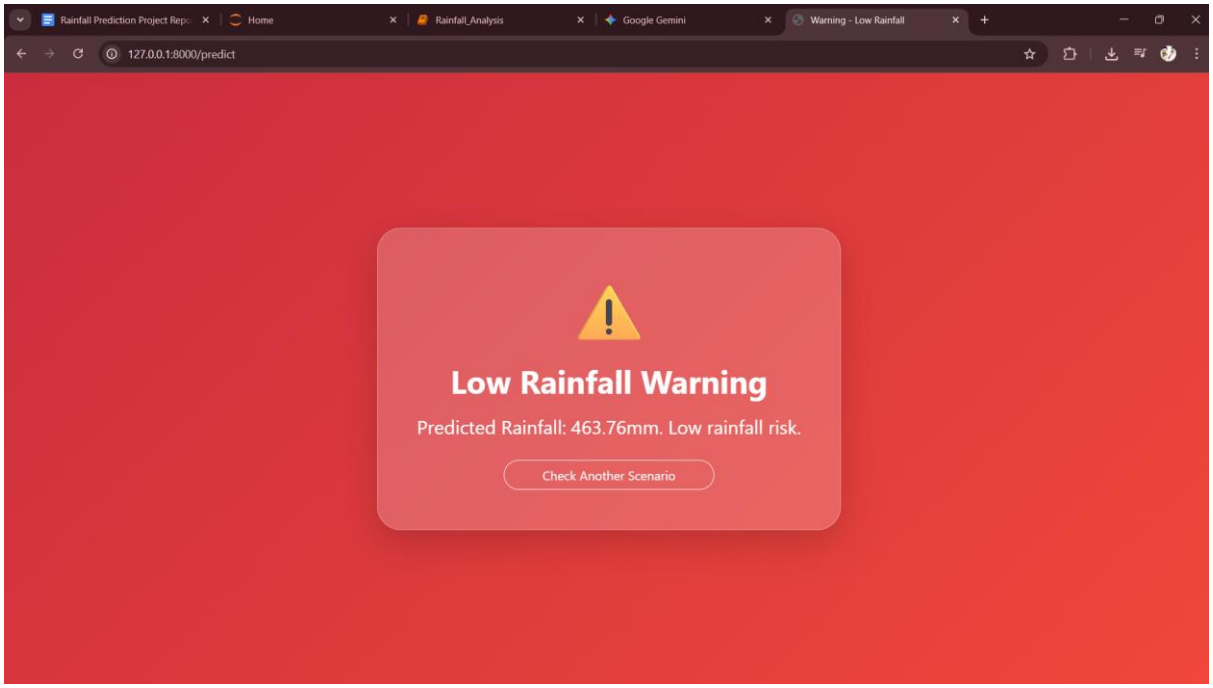
Milestone 4: UI Development (index.html, chance.html, nochance.html)

```
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Rainfall Predictor</title>
    <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.3.0/dist/css/bootstrap.min.css" rel="stylesheet">
    <style>
        body {
            background: linear-gradient(135deg, #1e3c72 0%, #2a5298 100%);
            min-height: 100vh;
            display: flex;
            align-items: center;
            justify-content: center;
            font-family: 'Segoe UI', Tahoma, Geneva, Verdana, sans-serif;
            color: white;
        }
        .prediction-card {
            background: rgba(255, 255, 255, 0.1);
            backdrop-filter: blur(10px);
            border-radius: 20px;
            padding: 40px;
            box-shadow: 0 15px 35px rgba(0,0,0,0.2);
            border: 1px solid rgba(255,255,255,0.1);
            max-width: 800px;
            width: 100%;
        }
        .form-control {
            background: rgba(255, 255, 255, 0.2);
            border: none;
            color: white;
            transition: all 0.3s;
        }
        .form-control:focus {
            background: rgba(255, 255, 255, 0.3);
            box-shadow: none;
            color: white;
```

```
<html>
<head>
    <title>Success - High Rainfall</title>
    <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.3.0/dist/css/bootstrap.min.css" rel="stylesheet">
    <style>
        body {
            background: linear-gradient(135deg, #11998e 0%, #38ef7d 100%);
            height: 100vh; display: flex; align-items: center; justify-content: center; color: white;
        }
        .result-box {
            background: rgba(255, 255, 255, 0.2);
            padding: 50px; border-radius: 30px; backdrop-filter: blur(15px);
            border: 1px solid rgba(255,255,255,0.3); text-align: center;
        }
    </style>
</head>
<body>
    <div class="result-box shadow-lg">
        <div class="display-1 mb-4">⏳</div>
        <h1 class="fw-bold mb-3">High Rainfall Chance!</h1>
        <p class="fs-4 mb-4">{{ prediction_text }}</p>
        <a href="/" class="btn btn-light rounded-pill px-5">Back to Dashboard</a>
    </div>
</body>
</html>
```

```
<html>
<head>
    <title>Warning - Low Rainfall</title>
    <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.3.0/dist/css/bootstrap.min.css" rel="stylesheet">
    <style>
        body {
            background: linear-gradient(135deg, #cb2d3e 0%, #ef473a 100%);
            height: 100vh; display: flex; align-items: center; justify-content: center; color: white;
        }
        .result-box {
            background: rgba(255, 255, 255, 0.2);
            padding: 50px; border-radius: 30px; backdrop-filter: blur(15px);
            border: 1px solid rgba(255,255,255,0.3); text-align: center;
        }
    </style>
</head>
<body>
    <div class="result-box shadow-lg">
        <div class="display-1 mb-4">⚠️</div>
        <h1 class="fw-bold mb-3">Low Rainfall Warning</h1>
        <p class="fs-4 mb-4">{{ prediction_text }}</p>
        <a href="/" class="btn btn-outline-light rounded-pill px-5">Check Another Scenario</a>
    </div>
</body>
</html>
```





7. Conclusion

The **Rainfall Prediction System** serves as a robust tool for agricultural decision-making. The updated codebase ensures that data is properly cleaned and scaled, leading to high-accuracy predictions. The successful deployment via Flask allows complex data science results to be accessible to users through a simple web interface, effectively meeting all core objectives of the internship.