📊Project Documentation: Smart Traffic Safety Intelligence for Dubai using AI & ML

🔗1. Project Overview

This project aims to solve the growing problem of traffic congestion and accidents in Dubai using data analytics, machine learning, and geospatial intelligence. It combines historical accident data and GPS-based traffic logs to predict accident severity, identify high-risk areas, and recommend safety improvements.

🔗2. Technologies Used

- **Python Libraries**: Pandas, NumPy, Seaborn, Scikit-learn, Matplotlib, Folium
- **ML Algorithms**: Random Forest Classifier, KMeans Clustering
- **Visualization Tools**: Seaborn, Matplotlib, Folium
- **Data**: `accidents_dubai.csv`, `traffic_data_dubai.csv` (simulated datasets)

🔗3. Step-by-Step Implementation

① Importing Required Libraries

Used for data manipulation, visualization, ML modeling, and geospatial mapping.

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import folium
from folium.plugins import HeatMap
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report, confusion_matrix
```

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② Loading the Datasets

Read accident and traffic data files into pandas DataFrames.

```
df_acc = pd.read_csv('accidents_dubai.csv')
df_traffic = pd.read_csv('traffic_data_dubai.csv')
```

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③ Data Exploration & Cleaning

Inspected structure, null values, and formatted columns such as date/time, hour, and categorical values.

```
df_acc.info()
df_traffic.info()
df_acc.isnull().sum()
df_traffic.isnull().sum()
```

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④ Exploratory Data Analysis (EDA)

- Plotted accident severity distribution
- Analyzed hourly accident frequency
- Used heatmaps to visualize accident locations in Dubai

```
sns.countplot(data=df_acc, x='severity')
sns.histplot(df_acc['hour'], bins=24)
```

```
map = folium.Map(location=[25.276987, 55.296249], zoom_start=11)
heat_data = [[row['lat'], row['lon']] for index, row in df_acc.iterrows()]
HeatMap(heat_data).add_to(map)
map
```

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⑤ Feature Engineering

Converted categorical features to numerical using Label Encoding.

```
le = LabelEncoder()
df_acc['road_type_encoded'] = le.fit_transform(df_acc['road_type'])
df_acc['weather_encoded'] = le.fit_transform(df_acc['weather'])
df_acc['severity_encoded'] = le.fit_transform(df_acc['severity'])
```

Selected features and target for ML model:

```
X = df_acc[['hour', 'day_of_week', 'road_type_encoded', 'weather_encoded']]
y = df_acc['severity_encoded']
```

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⑥ Train-Test Split

Split data for training and testing ML model.

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,
random_state=42)
```

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⑦ Model Training

Trained a Random Forest Classifier to predict accident severity.

```
model = RandomForestClassifier(n_estimators=100, random_state=42)
model.fit(X_train, y_train)
y_pred = model.predict(X_test)
```

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⑧ Evaluation

Used confusion matrix and classification report to evaluate model performance.

```
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred))
```

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⑨ Feature Importance Analysis

Visualized the impact of each feature on prediction.

```
feat_imp = pd.Series(model.feature_importances_, index=X.columns)
feat_imp.sort_values().plot(kind='barh')
```

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⑩ Clustering for High-Risk Zone Detection

Applied KMeans clustering to locate accident-prone areas.

```
from sklearn.cluster import KMeans
coords = df_acc[['lat', 'lon']]
df_acc['cluster'] = KMeans(n_clusters=5, random_state=42).fit_predict(coords)
sns.scatterplot(data=df_acc, x='lon', y='lat', hue='cluster')
```

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❶ Business Insights (Markdown)

- High-risk areas were identified using clustering
- Severity prediction accuracy was \~80%
- Most severe accidents occurred during evening hours and bad weather

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❷ Real-World Applications (Next Steps)

- Integrate with Google Maps API for real-time route and traffic prediction
- Apply YOLOv5 on CCTV frames to detect real-time safety violations
- Build a Streamlit dashboard for live monitoring and alerts

🔗Conclusion

This project combines the power of machine learning and geospatial AI to detect, predict, and explain traffic accidents in Dubai. The model can support smart city infrastructure by improving emergency response, optimizing traffic control, and guiding public safety policies in the UAE.