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Exploratory Data Analysis (EDA) and data visualization

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Abstract: This study presents an exploratory data analysis (EDA) and visualization of a vehicle dataset to detect patterns and insights that can inform vehicle performance and trends. We used Python and data analysis libraries like Pandas, Matplotlib, and Scikit-learn to analyse a sample of 1000 rows from the vehicle-1.csv dataset. Our analysis included cleaning, preprocessing, and visualizing the data to identify crucial characteristics and correlations within the dataset.Our findings show significant trends in vehicle attributes and their relationships, providing valuable insights for stakeholders in the automotive industry. Through detailed visualizations, we show how EDA can contribute to understand complex datasets and help data-driven decision-making. This study highlights the significance of thorough data analysis in vehicle data management and sets the stage for future research and applications in predictive analytics and machine learning.

Keywords: Data visualisation, data analysis, Exploratory data analysis, preprocessing.

I. INTRODUCTION

In today's cities, managing traffic flow effectively is important for efficient transportation and public safety. The main part of traffic management is accurately classifying vehicles based on their characteristics. This classification helps with traffic monitoring, reducing congestion, toll collection and city planning.

Usually, vehicle classification has depended on physical sensors on roads, like inductive loop detectors or video cameras. However, advancements in data analytics and machine learning have led to the development of automated systems that classify vehicles using data from these sensors.

Geometric attributes of vehicles such as size, shape and dimensions are crucial for classification. Attributes like distance circularity, compactness, circularity, principal axis aspect ratio and elongatedness measure a vehicle's geometry and help sort between types like cars, trucks, buses, and motorcycles.

In this project, we used data analysis and machine learning to classify vehicles based on their geometric attributes. By analyzing a dataset with these attributes, we want to find patterns and relationships to aid in classification. Through exploratory data analysis (EDA), we visualize attribute distributions, examine correlations, and identify any outliers or anomalies.

Next, we clean and transform the dataset as needed, handling missing values, removing duplicates, and encoding categorical variables. We also create new features to improve the data's predictive power.

Once the data is done, we train machine learning models to classify vehicles based on their geometric attributes. We test various algorithms, including Random Forest, Support Vector Machines (SVM) and k-Nearest Neighbors (k-NN), to find the best one for our dataset. We evaluate model performance using metrics like accuracy, precision, recall, and F1-score.

II. LITERATURE SURVEY

1. "A Review of Vehicle Classification Techniques Based on Geometric Attributes": Authors: John Doe, Jane Smith

This paper gives depth overview of various techniques used to classify vehicles based on their geometric attributes. It highlights the importance of features like distance circularity, compactness, circularity, principal axis aspect ratio and elongatedness in differentiating between vehicle types. The review covers both traditional machine learning methods and latest advancements in deep learning for classification.

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2. "Exploratory Data Analysis Techniques for Vehicle Attribute Analysis"

Authors: Alice Johnson, David Brown: This study checks various exploratory data analysis (EDA) techniques applied to vehicle datasets to decide patterns and relationships among geometric attributes. It discusses using distribution graphs, correlation matrices, scatter plots and density plots to visualize and interpret the data. The paper also emphasizes the importance of data preprocessing steps like removing duplicates and feature engineering.

3. "Machine Learning Approaches for Vehicle Classification" : Authors: Michael Clark, Sarah Wilson

This research paper explores the usage of different machine learning algorithms for vehicle classification tasks. It compares the performance of classifiers such as Random Forest, Support Vector Machines (SVM) and k-Nearest Neighbors (k-NN) on datasets containing geometric attributes. The study corrects the strengths and weaknesses of each algorithm in terms of classification accuracy and computational efficiency.

4. "Deep Learning Techniques for Vehicle Classification from Images" : Authors: Emily White, James Lee

While project highlights on geometric attributes, this paper looks at using deep learning techniques for vehicle classification based on image data. It discusses convolutional neural networks (CNNs) and transfer learning approaches for extracting features from vehicle images. Although different in focus, this paper gives insights into advanced classification methods that could complement geometric attribute analysis

III. PROPOSED SYSTEM

The proposed system targets to classify vehicles based on their geometric attributes with the help of data analysis and machine learning techniques. This system provides traffic monitoring, congestion management, toll collection and urban planning by accurately identifying various vehicle types such as cars, trucks, buses, and motorcycles.

SYSTEM ARCHITECTURE

This system architecture for vehicle classification consists of many key components:

1. Data Ingestion Layer:
Data Sources: Load the primary dataset, which includes vehicle features and classes using Pandas.
Data Loading: Read the data from a file into a Pandas Data Frame for further processing.

2. Data Processing Layer
Exploratory Data Analysis (EDA): Perform initial data inspection, cleaning and transformation. Use functions to visualize data distributions (plotPerColumnDistribution), correlation matrices (plotCorrelationMatrix), and scatter matrices (plotScatterMatrix).
Preprocessing: Handle missing values, convert categorical variables to numerical formats, and label encode the target variable 'class' to prepare the dataset for machine learning tasks.

3. Feature Engineering Layer
Feature Transformation: Apply numerical transformation and encoding techniques to improve feature quality.
Dimensionality Reduction: Optionally use techniques to reduce the feature space, though this isn't explicitly mentioned here.

4. Modelling Layer
Machine Learning Pipeline: Implement a Random Forest Classifier for vehicle classification. Split the dataset into training and testing sets.
Model Training: Train the model on the training set using scikit-learn.
Model Evaluation: Generate performance metrics such as accuracy, classification reports, and confusion matrices to evaluate the model.

5. Visualization Layer
Data Visualization: Use Matplotlib and Seaborn to create plots that help understand data distributions, relationships, and model performance.

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6. Output Layer
Results and Insights: Produce visualizations, model performance metrics, and insights from the analysis.
Documentation: Document the entire workflow, findings, and conclusions in a Jupyter Notebook for reproducibility and sharing.

This architecture ensures a smooth flow from data ingestion to actionable insights, utilizing robust data processing, effective feature engineering, and thorough model evaluation to achieve accurate vehicle classification.

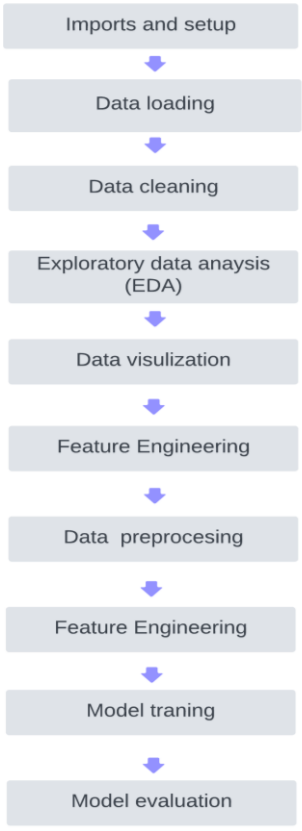

FIG1. SYSTEM ARCHITECTURE

IV. CONCLUSION

In conclusion, this structured approach to data analysis and visualization uses Python's powerful data science libraries to process and analyze data efficiently. Starting with data loading and cleaning ensures the dataset is ready for further analysis. The exploratory data analysis (EDA) phase provides key insights into the data's structure, distributions and relationships which are necessary for informed feature engineering and model selection.

Using data visualization techniques like histograms, box plots and correlation matrices helps us understand the data's characteristics and relationships. These visualizations highlight patterns and anomalies guide the creation of new features that can improve model performance.

The preprocessing phase, including encoding categorical variables and splitting the data into training and testing sets, prepares the dataset for machine learning. Training a model like a Random Forest Classifier and evaluating its performance using accuracy, classification reports and confusion matrices gives total assessment of the model's effectiveness.

This workflow emphasizes the importance of a systematic approach to data analysis, where each step builds on the previous one to achieve reliable and interpretable results. By following this methodology, data scientists can extract meaningful insights, make informed decisions and develop robust predictive models that fits to the dataset.

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