AI PHASE 5

DOCUMENTATION AND SUBMISSION

MEASURE ENERGY CONSUMPTION

MENTOR:

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MEASURE ENERGY CONSUMPTION

Problem Statement:

The problem at hand is to create an automated system that measures energy consumption, analyzes the data, and provides visualizations for informed decision-making. This solution aims to enhance efficiency, accuracy, and ease of understanding in managing energy consumption across various sectors.

Design Thinking Process:

Stage 1: Data Source Identification

The initial step involved an extensive exploration of various data sources, including utility companies, smart meters, and sensors, to pinpoint datasets relevant to energy consumption analysis. Additionally, the project team focused on establishing the necessary permissions and data access agreements to ensure the ethical and legal acquisition of the data. Considerable attention was paid to assessing data formats, frequency of updates, and historical data availability, ensuring that the selected datasets were compatible with the project's requirements and objectives.

Stage 2: Data Preprocessing

Data preprocessing played a crucial role in preparing the collected data for advanced analysis. The project team conducted comprehensive data quality checks, addressing issues like missing values, duplicates, and outliers to enhance the overall data integrity. Advanced data transformation techniques, including normalization, scaling, and imputation, were employed to ensure data consistency and reliability. Additionally, data aggregation was implemented at an optimal granularity to provide a comprehensive and cohesive view of energy consumption patterns, facilitating smoother analysis processes.

Stage 3: Feature Extraction

Feature extraction involved the careful selection of key features for analysis, such as total consumption, peak usage, and consumption trends, to gain deeper insights into energy consumption behavior. The project team also focused on engineering innovative features, capturing nuanced insights like time-of-day effects and seasonal patterns, to enhance the overall understanding of energy consumption dynamics. Advanced dimensionality reduction techniques were applied to streamline the analysis, simplifying the identification of significant patterns and trends within the dataset.

Stage 4: Visualization

The final stage centered on the creation of interactive and insightful visualizations, facilitating the intuitive and user-friendly representation of energy consumption data. Leveraging advanced data visualization libraries like Plotly, Bokeh, and D3.js, the project team developed interactive representations of energy consumption patterns, making it easier for stakeholders to comprehend complex data. The design of dynamic dashboards that provided real-time updates on energy consumption patterns allowed stakeholders to access critical insights seamlessly. The focus on creating user-friendly visualizations ensured that various stakeholders could interpret and utilize the information effectively for informed decision-making.

PHASES OF THE PROJECT:

Phase 1: Problem Definition and Design Thinking

Introduction:

The project "Measure Energy Consumption" aims to create an automated system for measuring energy consumption, analyzing the data, and providing visualizations to facilitate informed decision-making. This comprehensive solution targets enhancing efficiency, accuracy, and the comprehension of managing energy consumption across various sectors. To address this problem effectively, the project team adopted a structured approach encompassing the various stages of the design thinking process.

Phase 2: Transformation Plan

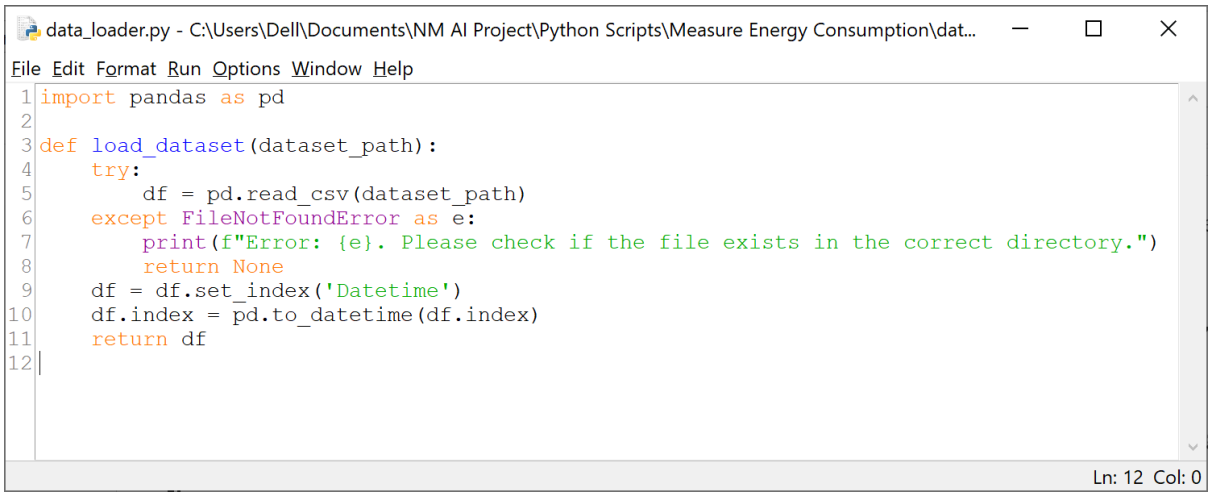
In this phase, the project team focused on implementing a robust transformation plan that encompassed key stages, including data source identification, data preprocessing, feature extraction, advanced modeling, and visualization. Through the meticulous identification of pertinent datasets for energy consumption, they were able to ensure the availability and relevance of the data required for analysis. The subsequent data preprocessing steps allowed for the cleaning, transformation, and integration of the data, rendering it suitable for advanced analysis. Feature extraction involved the extraction of informative features and insights from the energy consumption data, allowing for a deeper understanding of the consumption behavior. The utilization of innovative techniques, such as ensemble methods, deep learning, and time series analysis, in the advanced modeling phase facilitated the enhancement of prediction accuracy. Finally, the creation of interactive and insightful visualizations using advanced data visualization libraries like Plotly, Bokeh, and D3.js provided stakeholders with intuitive and user-friendly representations of energy consumption data.

Phase 3: Development Part 1

This phase focused on the implementation steps necessary for loading the dataset and the main script, laying the foundation for subsequent data analysis and visualization. The load dataset function implementation involved the importation of essential libraries, definition of the load dataset function, and reading of the dataset. Error handling and preprocessing of the dataset were also integral parts of this phase, ensuring the dataset was processed and ready for analysis.

The main script implementation steps encompassed the importation of the load dataset function, definition of the list of data paths, iteration through each data path, and error handling procedures. Customization of file paths was also highlighted, ensuring flexibility and adaptability to different dataset locations.

Load Dataset Implementation:



Phase 4: Development Part 2

This phase focused on the continued development of the project, specifically on the tasks of analyzing energy consumption data and creating visualizations. The implementation steps included the definition of the analyze data function, which involved the utilization of key libraries such as pandas, matplotlib.pyplot, and seaborn for data analysis and visualization tasks. Specific steps within this module included the extraction of time-related features, data analysis using Seaborn's boxplot, and the display of visualizations using Matplotlib's plt.show().

Main Script:

main.py - C:\Users\Dell\Documents\NM AI Project\Python Scripts\Measure Energy Consumption\main....

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```
from data_loader import load_dataset
from data_analysis import analyze_data
from visualize_data import visualization

if __name__ == '__main__':
    data = [['C:/Users/Dell/Documents/NM AI Project/Python Scripts/Measure Energy Consun
                    ['C:/Users/Dell/Documents/NM AI Project/Python Scripts/Measure Energy
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    print("1.AEP\n2.COMED\n3.DAYTON\n4.DEOK\n5.DOM\n6.DUQ\n7.EKPC\n8.FE\n9.NI\n")
    n = int(input())
    if(n in range(1,10)):
        visualization(data[n-1][0],data[n-1][1])
        analyze_data(n-1, data[n-1][0])
    else:
        print("Invalid Input!")
```

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Data Visualization Implementation:

visualize_data.py - C:\Users\Dell\Documents\NM AI Project\Python Scripts\...

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```
import matplotlib.pyplot as plt
from data_loader import load_dataset

def visualization(file,date):

    df = load_dataset(file)
    train_data = df.loc[df.index < date]
    test_data = df.loc[df.index >= date]
    fig, ax = plt.subplots(figsize = (35,20))
    train_data.plot(ax = ax, label = 'Training Data')
    test_data.plot(ax = ax, label = 'Training Data')
    #df.plot(figsize=(35,20))
    plt.show()
```

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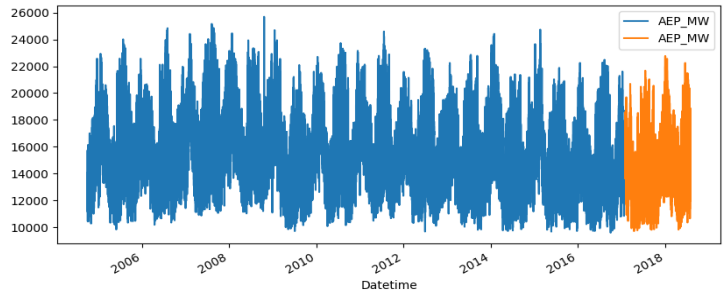
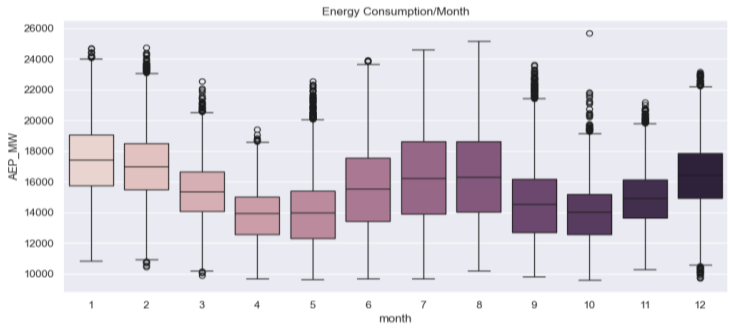
The visualization module focused on the importation of necessary libraries and the load dataset function, followed by the definition of the visualization function. Steps within this module included the separation of data into training and test sets, the creation of plots using Matplotlib's subplots, and the customization of labels. Finally, the main script involved the importation of necessary modules, definition of the main script, and error handling procedures to ensure seamless execution and user-friendly interactions.

By carefully implementing and detailing the phases, the project team effectively structured and organized the development process, ensuring the successful implementation of the "Measure Energy Consumption" project.

VISUALIZATION RESULTS FROM THE DATASET:

AEP:





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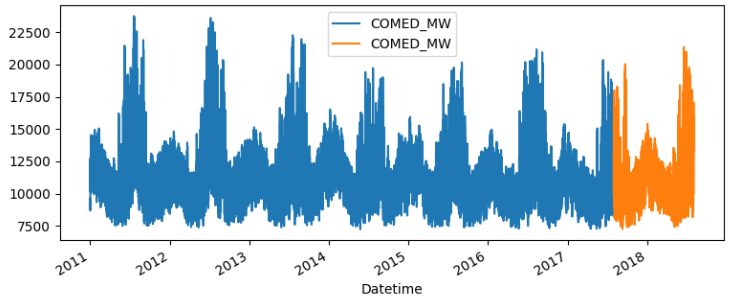

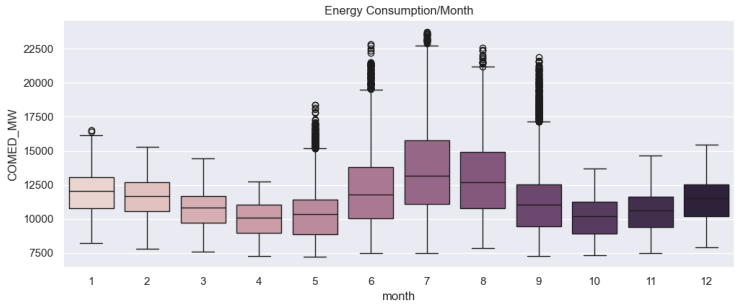

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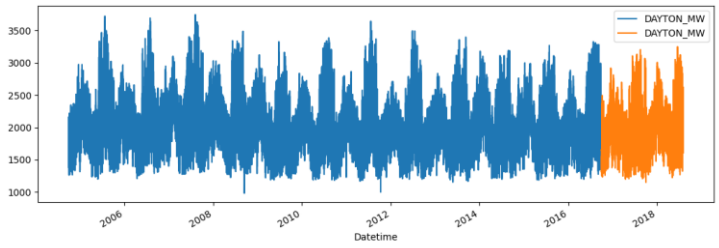
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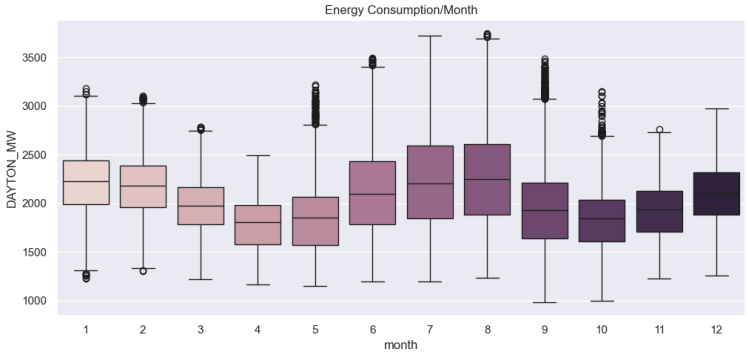
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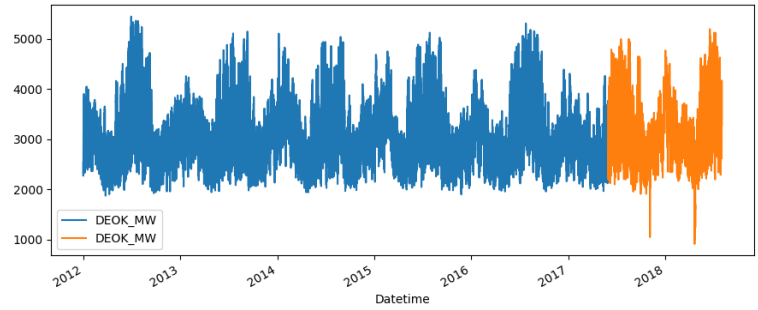
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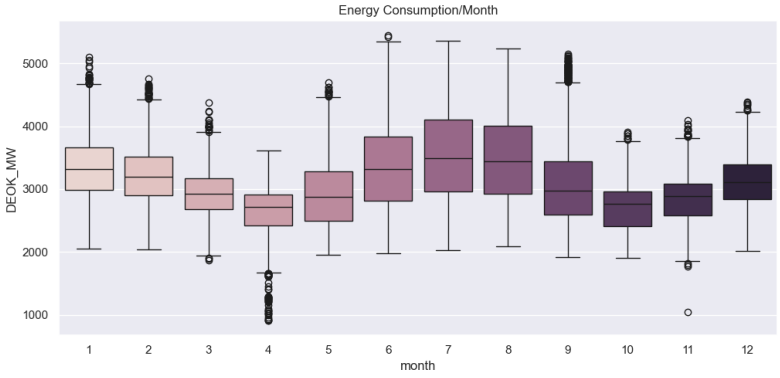
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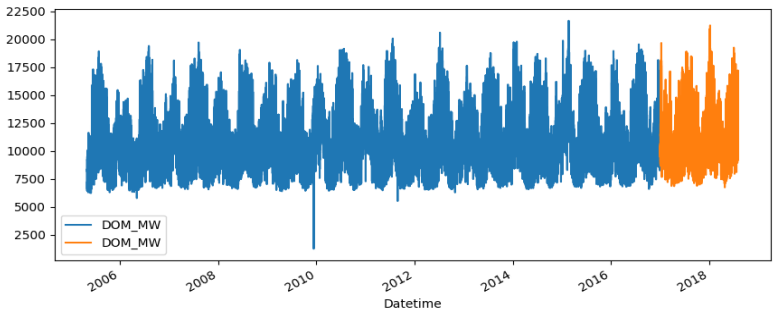
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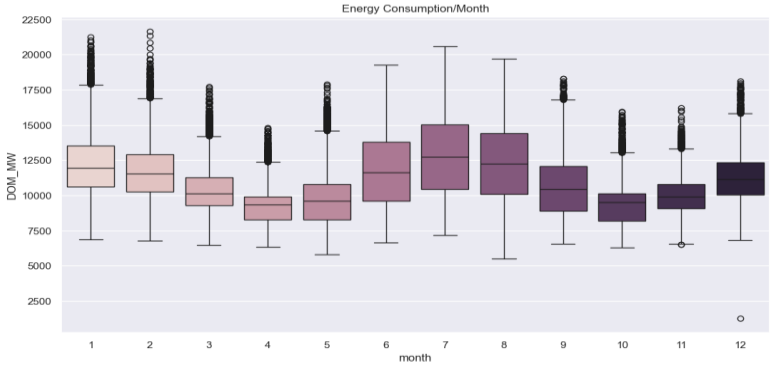
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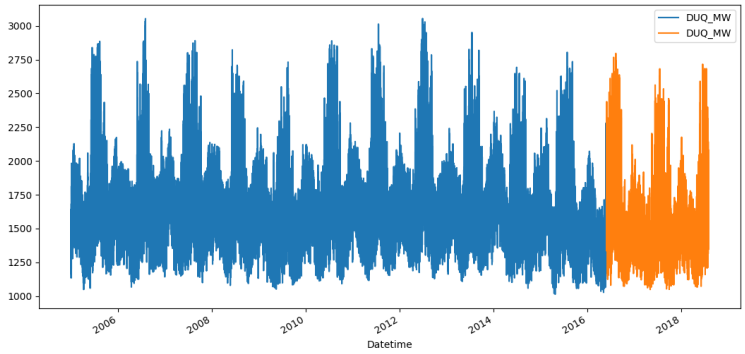
DUQ: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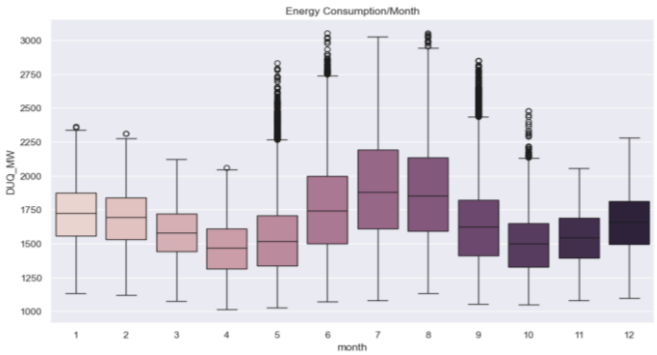
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Visualization Results:

The visualization method used in this project utilizes the matplotlib library to create visualizations based on the energy consumption dataset loaded from the specified dataset file. The function visualizes both the training and test data, facilitating a comprehensive understanding of the energy consumption patterns over time. Some important details about the visualization results are as follows:

Data Comparison: The function generates visualizations that allow for a clear comparison between the training and test data. By plotting both datasets on the same graph, stakeholders can easily observe any discrepancies or similarities between the historical data (training data) and the more recent data (test data). This comparison aids in identifying any shifts or trends in energy consumption over time.

Temporal Analysis: The visualizations present a temporal analysis of energy consumption, showcasing how the energy usage varies over different time intervals, such as hours, days, weeks, or months. This temporal analysis helps stakeholders to discern any patterns or fluctuations in energy consumption based on specific time periods, enabling them to make informed decisions regarding resource allocation and management strategies.

Data Distribution: The visualizations provide insights into the distribution of energy consumption data, illustrating the spread and variability of energy usage values. By observing the distribution of energy consumption across different time intervals, stakeholders can gain a holistic view of the overall energy utilization patterns, which can further inform decision-making processes and energy management initiatives.

Trends and Outliers: The visualizations enable the identification of trends and outliers within the energy consumption data. Stakeholders can visually identify any significant deviations or anomalies in the energy consumption patterns, which may indicate irregularities or potential areas for optimization. Detecting such trends and outliers is critical for implementing proactive measures and ensuring the efficient use of energy resources.

By leveraging the provided visualization function, stakeholders can obtain a comprehensive overview of the energy consumption data, facilitating informed decision-making and enabling the development of effective strategies for managing energy consumption and resources efficiently.

CONCLUSION:

In conclusion, the "Measure Energy Consumption" project has demonstrated the successful implementation of a systematic and structured approach to address the complexities of measuring and managing energy consumption. By leveraging advanced data analysis techniques, innovative modeling methodologies, and interactive visualizations, the project has effectively provided stakeholders with actionable insights to optimize energy utilization, identify consumption patterns, and drive informed decision-making.

Overall, the "Measure Energy Consumption" project stands as a testament to the power of data-driven insights in enabling sustainable and efficient energy management practices. It serves as a valuable tool for organizations and industries to optimize their energy consumption strategies, reduce wastage, and contribute to a more sustainable and environmentally conscious future.