**PRODUCT DEMAND PREDICTION USING MACHINE LEARNING**

**PHASE 1-Problem Definition and Design Thinking**

**SUBMITTED BY**

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**INTRODUCTION:**

**Product demand prediction is a crucial aspect of supply chain management and business planning. It involves forecasting the future demand for a specific product or group of products. This prediction is based on historical sales data, market trends, economic indicators, and other relevant factors. By accurately estimating future demand, businesses can optimize inventory management, production schedules, and distribution, ensuring they meet customer needs while minimizing excess or insufficient stock. Advanced techniques like data analytics, machine learning, and artificial intelligence are often employed to improve the accuracy of demand predictions, helping businesses make informed decisions and remain competitive in their respective markets.**

**PROBLEM STATEMENT:**

**The problem statement for product demand prediction can be framed as follows:**

**"In a dynamic and competitive market, our company faces the challenge of accurately forecasting the demand for our products. The lack of precise demand prediction results in frequent stockouts or excessive inventory, leading to increased costs and customer dissatisfaction. We need a robust demand prediction system that leverages historical sales data, market factors, and other relevant information to provide accurate forecasts, enabling us to optimize inventory management, production planning, and distribution. The goal is to ensure that we meet customer demand while minimizing carrying costs and operational inefficiencies."**

**This problem statement sets the stage for addressing the critical issue of product demand prediction and highlights the need for a solution to enhance inventory and supply chain management.**

**Product demand prediction using machine learning involves leveraging algorithms and data-driven approaches to forecast the future demand for a product. Here's an explanation of how it works:**

**1. \*\*Data Collection\*\*: The first step is to gather historical data related to the product's sales, such as past sales volumes, pricing, promotions, and any external factors that might influence demand, like seasonality or economic indicators.**

**2. \*\*Data Preprocessing\*\*: Data may need cleaning and preprocessing, including handling missing values, outliers, and normalizing data, to make it suitable for machine learning models.**

**3. \*\*Feature Engineering\*\*: Relevant features (variables) are selected or created. For instance, you might create features like day of the week, time of year, or competitor pricing data to help the model understand patterns in demand.**

**4. \*\*Splitting the Data\*\*: The data is typically divided into training, validation, and test sets. The training data is used to train the machine learning model, the validation data helps tune hyperparameters and assess model performance, and the test data is used to evaluate the final model.**

**5. \*\*Model Selection\*\*: Various machine learning models can be applied to predict demand. Common choices include linear regression, decision trees, random forests, and more advanced models like neural networks.**

**6. \*\*Training the Model\*\*: The selected model is trained on the training data. During training, the model learns the relationships between the features and the product's demand.**

**7. \*\*Model Evaluation\*\*: The model's performance is evaluated using the validation dataset. Metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), or Root Mean Squared Error (RMSE) are used to assess the accuracy of predictions.**

**8. \*\*Hyperparameter Tuning\*\*: Hyperparameters of the machine learning model are fine-tuned to optimize its performance. Techniques like cross-validation may be employed to find the best hyperparameters.**

**9. \*\*Testing the Model\*\*: Once the model performs well on the validation data, it is tested on the separate test dataset to ensure it generalizes effectively to unseen data.**

**10. \*\*Deployment and Monitoring\*\*: If the model passes the test phase, it can be deployed into a real-time environment where it can make predictions about future demand. Regular monitoring and retraining are often necessary to adapt to changing market conditions.**

**11. \*\*Continuous Improvement\*\*: As new data becomes available, the model can be continuously updated and refined to improve its predictive accuracy.**

**Machine learning models can adapt to changing market dynamics, making them valuable tools for product demand prediction. They can capture complex patterns and relationships in the data, helping businesses optimize inventory, production, and distribution while meeting customer demands more effectively.**

**CONCLUSION:**

**In conclusion, product demand prediction using machine learning is a powerful tool for businesses to optimize their operations and meet customer needs efficiently. By leveraging historical data, feature engineering, and advanced algorithms, machine learning models can accurately forecast future demand for products.**

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