SALES AND INVENTORY OPTIMIZATION

DATASET SELECTION: DATASET NUMBER 2

DAWIZARD - TEAM 14

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INTRODUCTION

CHALLENGES

Key issues that retail businesses are currently facing related to sales and storage management

MINIMUM VIABLE PRODUCT

Brief introduction of the Minimum Viable Product (MVP)

OBJECTIVES

Objectives that the MVP aims to achieve or its role and purpose in assisting business owners

CHALLENGES

INACCURATE PREDICTABILITY

Inaccurate sales forecasts can cause problems like surplus inventory or shortages, raising costs and lowering efficiency.

INVENTORY MANAGEMENT

High storage costs and markdown risks accompany excessive inventory, while shortages can lead to missed sales and longer customer wait times.

DIVERSE SALES CHANNELS

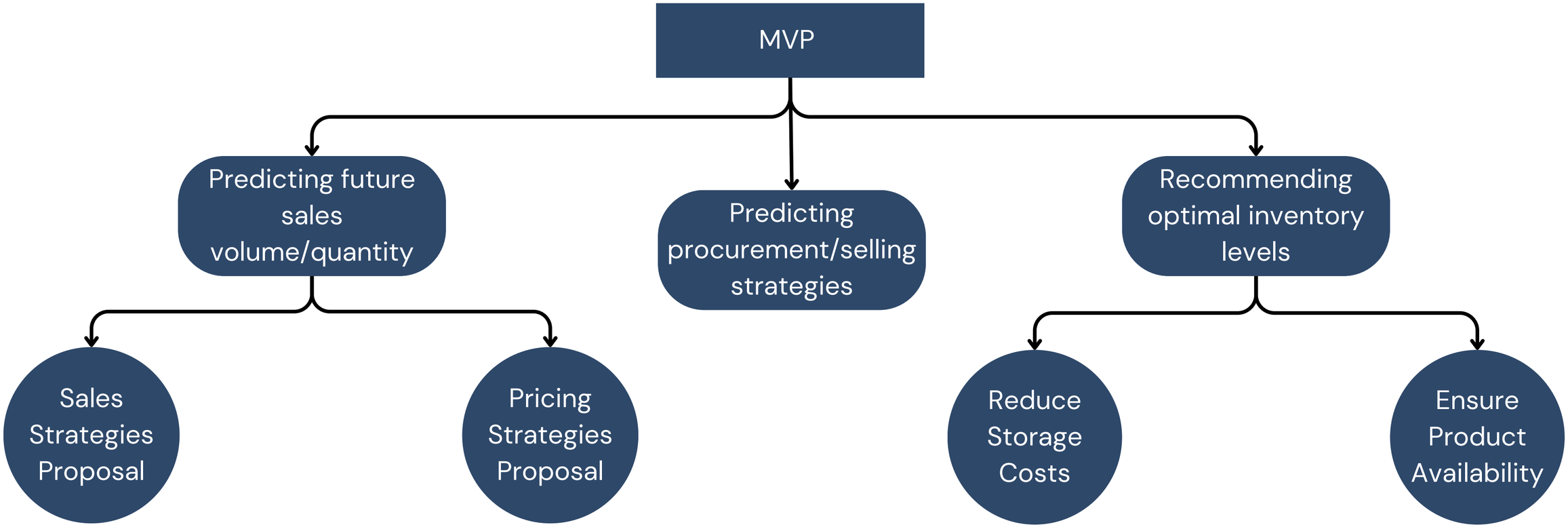
Diverse sales channels, like physical stores, e-commerce, and social media, create challenges in integrating and managing inventory, potentially causing missed business opportunities.

NON-ADAPTIVE SALES/PRICING STRATEGIES

Static pricing may miss market changes, impacting profitability and sales opportunities.

MINIMUM VIABLE PRODUCT (MVP)

Can Artificial Intelligence open up new capabilities to transform the supply chain and storage management by allowing real-time tracking of demand and inventory?



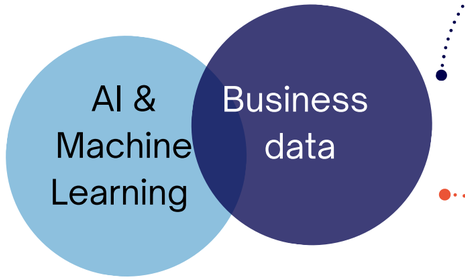
OBJECTIVES

OPTIMAL INVENTORY LEVELS

Recommend the optimal level of product storage

FUTURE SALES VOLUME

Make predictions related to sales in terms of monetary value



FUTURE SALES QUANTITY

Make predictions related to sales in terms of quantity

PROPOSE SELLING STRATEGIES

Put forward selling strategies in order to maximize profit

PROBLEM STATEMENT

ADDRESSING CHALLENGES

PAIN POINTS

CHALLENGES THE SYSTEM AIMS TO ADDRESS

01

Innaccurate predictability

The MVP focuses on developing an advanced prediction model, utilizing machine learning and artificial intelligence to process large datasets

02

Inflexible inventory

The goal is to optimize inventory levels, reduce storage costs, and ensure flexibility in inventory management

03

Lach of flexibility in procurement

The system aims to identify market segments and provide personalized sales strategies for different customer groups.

PAIN POINTS INEFFCIENCIES

Data Sprawl and Complexity

Organizations face the problem regarding data in terms of increasing volume and complexity, making it challenging to manage storage quantity efficiently

Inefficient Storage Utilization

Due to poor data organization, ineffective data tiering, and a lack of visibility into storage usage patterns, storage resources are underutilized

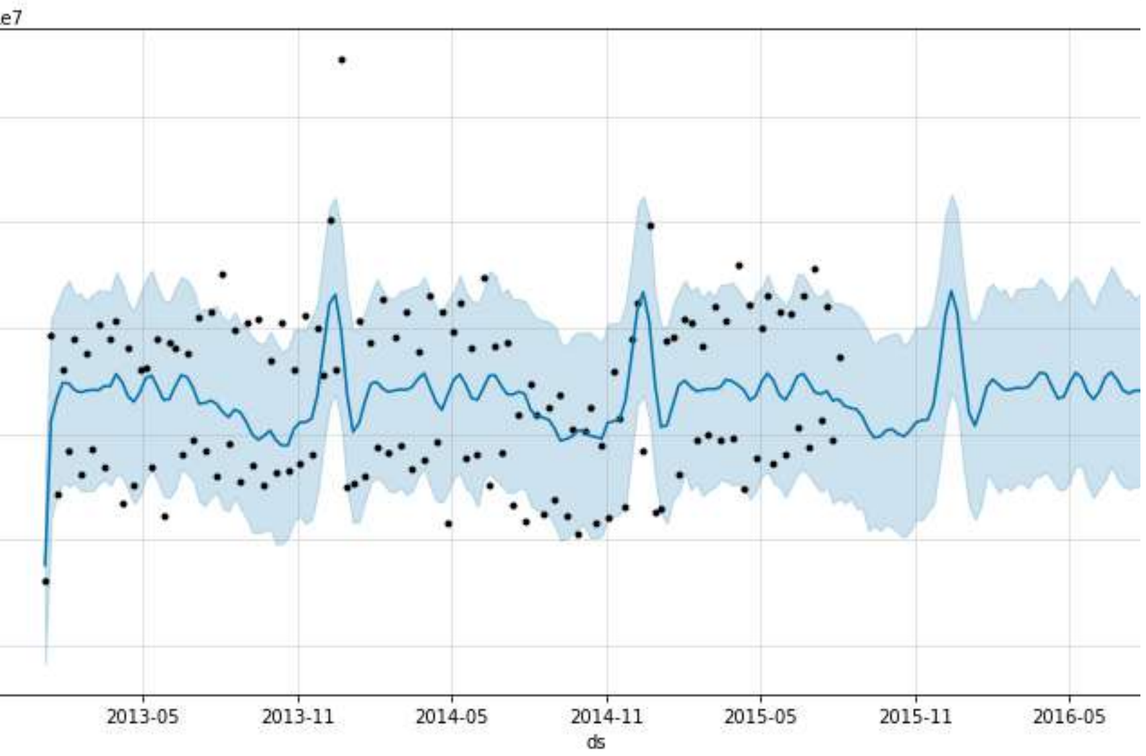
Data Silos and Lack of Integration

Data is often siloed in different storage systems and formats, making it difficult to access, analyze, and utilize for decision-making

Predictive Analytics for Storage Needs

Organizations struggle to accurately forecast future storage requirements, leading to over-supplying or under-supplying of storage resources.

SOLUTION OVERVIEW



AI-POWERED PREDICTIVE MODELS

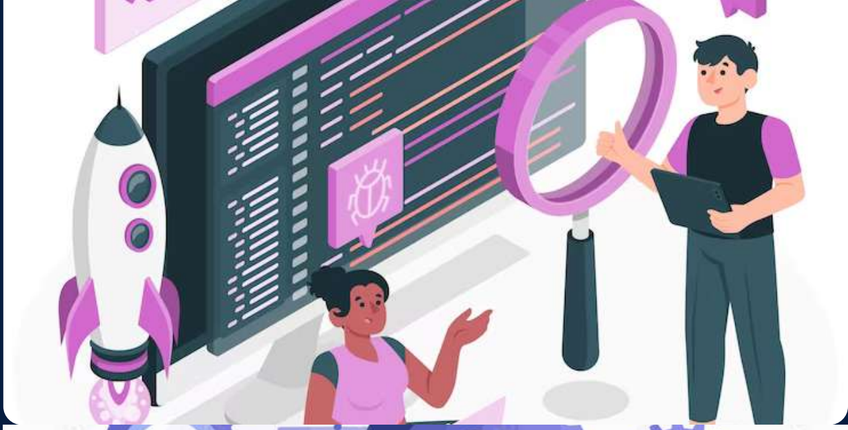
Utilizing time series forecasting to scrutinize past sales data, uncovering seasonal patterns, market trends, and external influences.

IINVENTORY OPTIMIZATION

Determining optimal purchase timings, recommended product selections, and the ideal quantities to procure.

HIGHLIGHTS

SALES FORECAST
AND INVENTORY OPTIMIZATION SOLUTION



A HOLISTIC VIEW

The AI - MVP solution delivers a holistic view of inventory management by incorporating diverse data sources and variables. This holistic perspective enables businesses to make informed decisions that align with overarching business goals.

END- TO- END SOLUTION

This solution isn't merely a tool for predicting future inventory needs; it offers actionable recommendations and decision support systems. It suggests optimal reorder points, restocking strategies, or supply chain adjustments

METHODOLOGIES

EDA AND PREPROCESSING

EDA obtains a high-level understanding of the dataset by doing some basic statistics, cleaning data, handling missing data and data visualization to explore the pattern of dataset.

ARIMA MODEL

ARIMA models are chosen for sales forecasting due to their ability to capture temporal dependencies, handle trends and seasonality, adapt to different data structures, and serve as a strong foundational model in time series analysis.

DECISION TREE

Involves leveraging business capabilities to make decisions regarding inventory levels, restocking, and supply chain management based on various factors.

EXPLORATORY DATA ANALYSIS

DATA CLEANING

- Handling missing/duplicates values
- Handling outliers
- Encoding Categorical Variables

DESCRIPTIVE STATISTICS

- Measures of central tendency (mean, mode,..)
- Dispersion or variability (variance, standard deviation, range,...)
- Distribution, Skewness and Kurtosis

DATA VISUALIZATION

Extracting meaningful insights from data, aiding in decision-making processes

MULTIVARIATE ANALYSIS

Exploring relationships, patterns, and dependencies among multiple variables

- Multivariate Regression
- Principal Component Analysis (PCA)
- Cluster Analysis

FEATURE ENGINEERING

Selecting, creating, or modifying features to enhance the predictive power of the machine learning algorithm

SALES FORECASTING

ARIMA MODEL

The first step is underlying patterns, trends, and seasonality within the dataset.

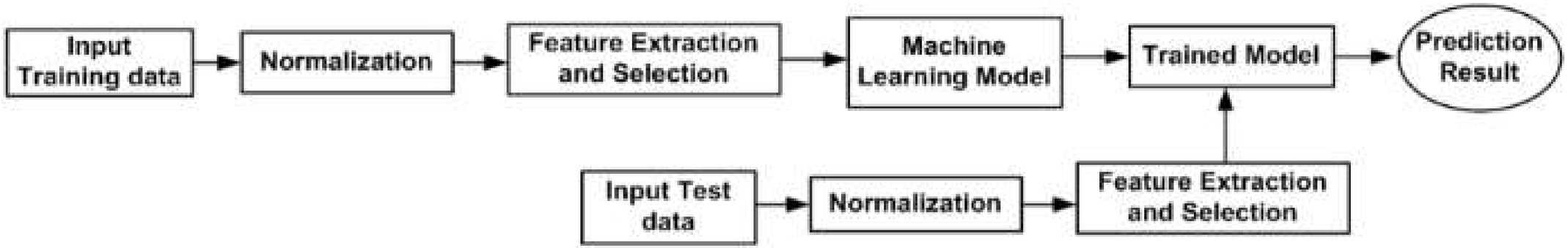


Figure 2: Proposed forecasting sales model using machine learning method

Layers:

- p: the order of the autoregressive component
- d: the degree of differencing
- q: the order of the moving average component

Key Components:

- Autoregressive (AR) Component
- Integrated (I) Component
- Moving Average (MA) Component

Data collection

Analysis/ Modelling

Forecasting/ Future Strategy

Sales data from (31/01/2022 - 31/07/2023)

Total quantity

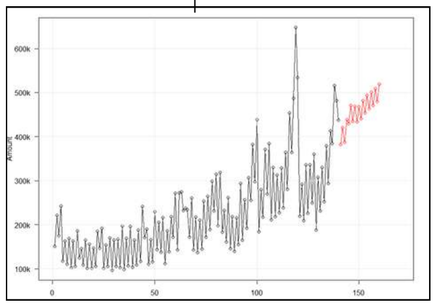
Net price

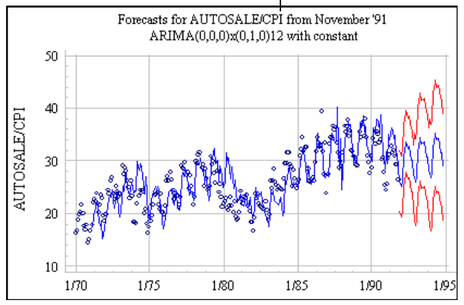
Product group

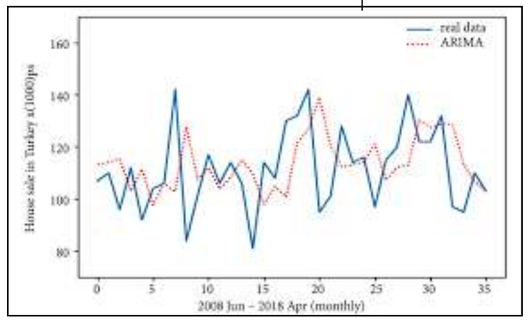
Total quantity

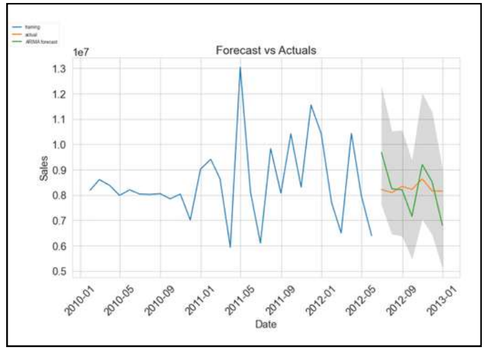
Total revenue

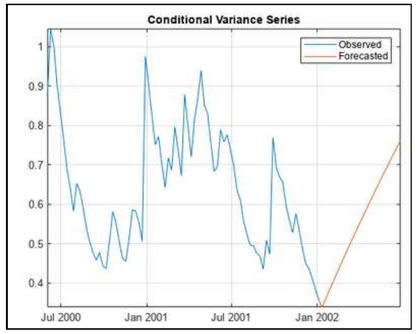
ARIMA

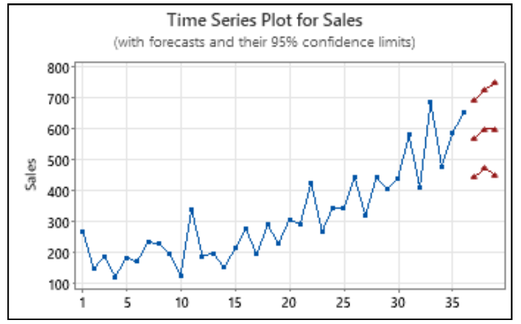








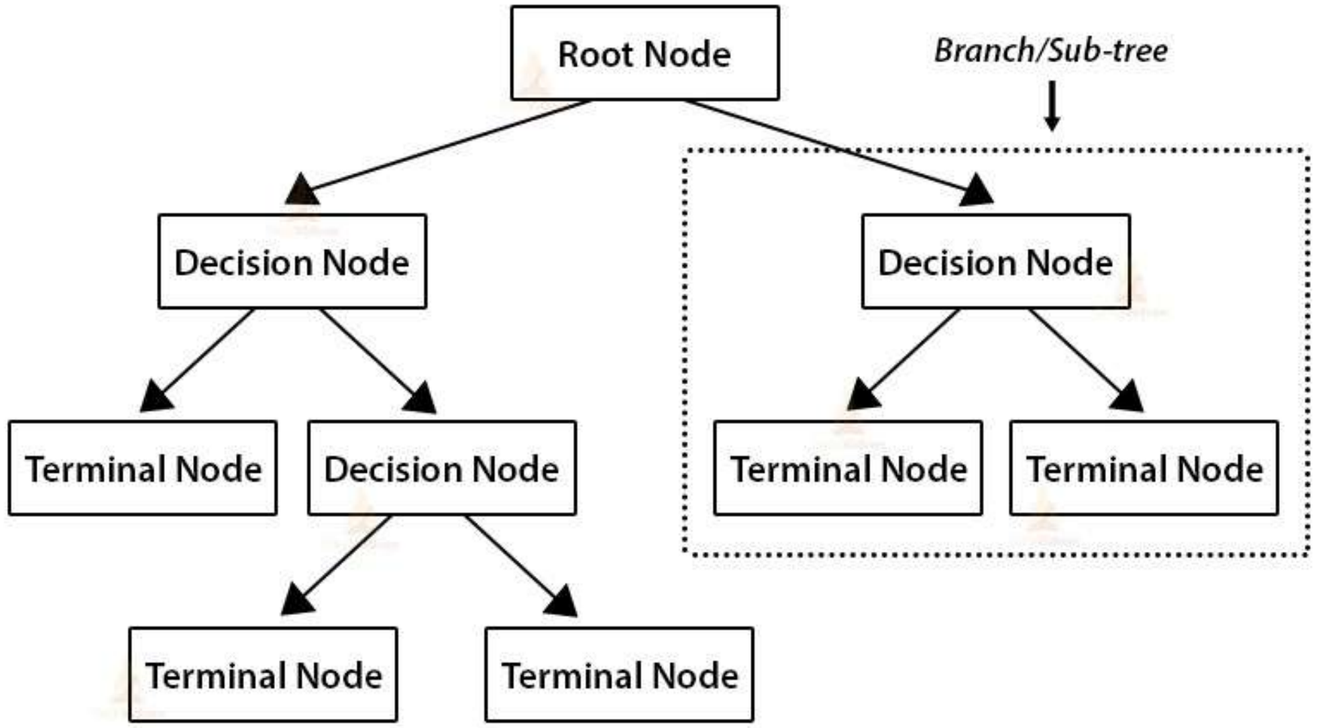




DECISION TREE

INVENTORY OPTIMIZATION

*Inventory management system based on **Decision Tree model** that recommends optimal inventory for each product and location based on historical sales data, sales timing, and demand forecasts. It is also worth noting that the attributes' data passed into the tree **MUST** be categorized into groups.*



Layers:

- Top layer: the root node
- Internal layer: internal nodes
- Bottom layer: leaf nodes

Key Components:

- Learning module
- Prediction module

DETERMINE THE ROOT/ CHILD NODES

- Use Information gain, Gini impurity, or Entropy method to evaluate the importance of attributes and calculate the impurity measure for each feature or feature-value combination

$$\text{Entropy} = -\sum_{i}^{n} log_2(P_i$$

$$Gini = 1 - \sum_{i=1}^{C} (p_i)^2$$

- Select the feature that minimizes the impurity or maximizes the information gain

$$Gain(S, A) = Entropy(S) - \sum_{v \in Values(A)} \frac{|S_v|}{|S|} Entropy(S_v)$$

CALCULATE THE SAFETY STOCK LEVELS

The recommended up-to and safety stock levels

The safety stock level is a critical component in inventory management that helps to ensure sufficient stock availability to meet unexpected increases in demand or delays in supply

Cycle Stock = Inventory Level - Safety Stock

Stock in Transit = Mean value for product's demand * Review Period

Safety Stock = Up to level of stock - Mean demand during replenishment cycle

Mean demand during replenishment cycle = (Review period - Lead time) * Mean value of demand

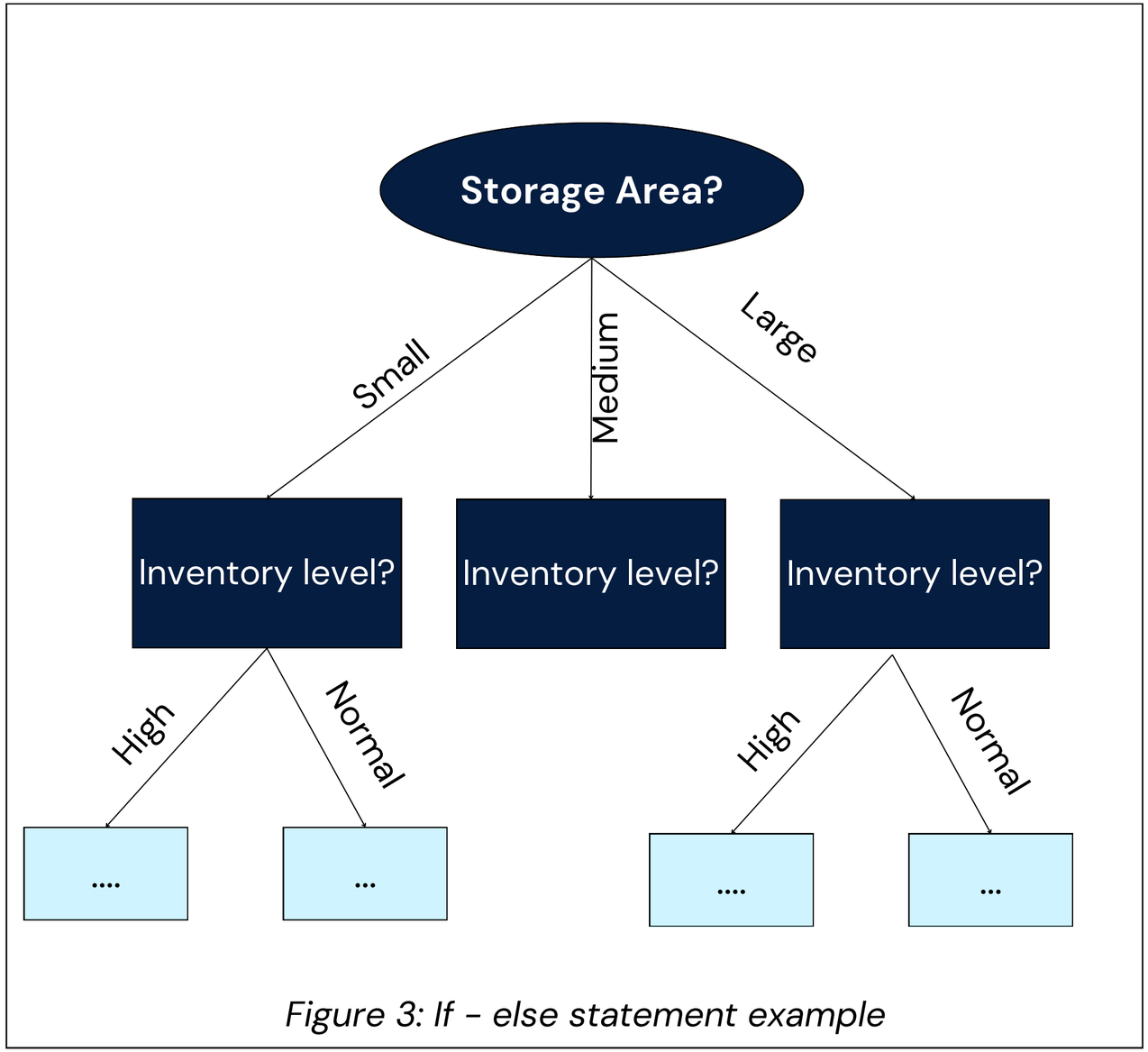


Figure 3: If – else statement example

DEVELOP SERIES OF RULES

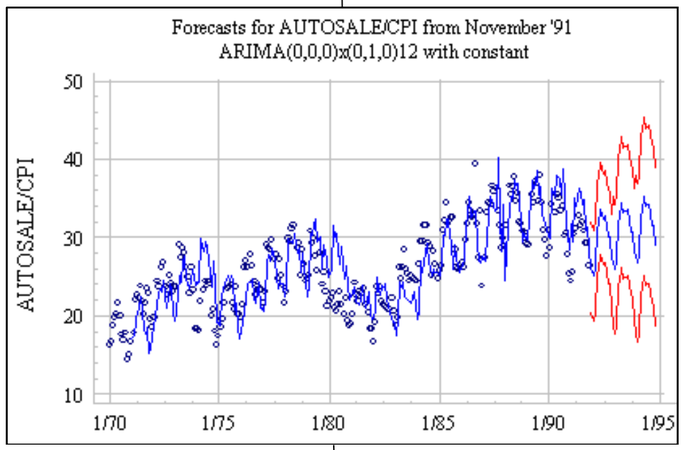
- Translate each path from the root to a leaf into an if-else statement or a rule
- Each rule should comprise a sequence of conditions based on features leading to a specific outcome or decision
- Combine similar or overlapping rules to avoid redundancy

MODEL OVERVIEW

Sales data from (31/01/2022 - 31/07/2023)

Total quantity | Net price | Product group | Total quantity | Total revenue

ARIMA

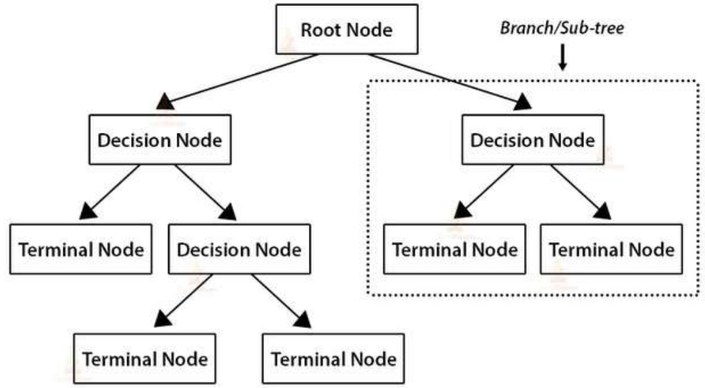


Sales forecast

Quantity forecast | Product group | Net price

Inventory Data | Sales forecast | Storage area | ...

Decision Tree



Recommendation

Suitable Storage Quantity Range

CORE FUNCTIONALITY

- AI-Driven Decision Support
- Performance Evaluation and Monitoring

AI-DRIVEN DECISION SUPPORT

AUTOMATED RECOMMENDATIONS

Providing automated suggestions or recommendations for inventory levels, restocking strategies, or supply chain adjustments based on forecasted sales and inventory data.

VISUALIZATION AND REPORTING

Dashboard or reporting interface to visualize sales forecasts, inventory status, and key performance metrics.

PERFORMANCE EVALUATION AND MONITORING

1

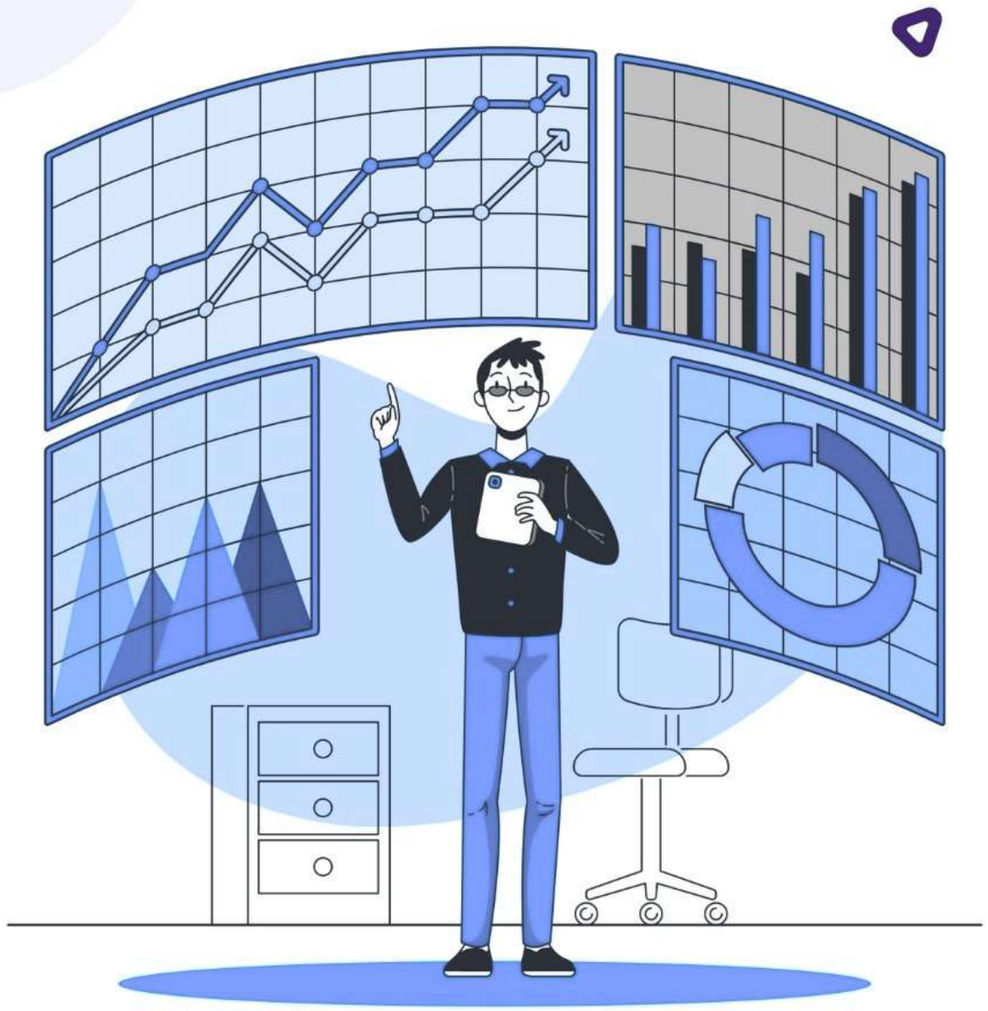
KPI TRACKING

Capability to monitor and track key performance indicators (KPIs) like forecast accuracy, fill rates, inventory turnover, and service levels.

2

FEEDBACK MECHANISM

Incorporating a feedback loop to gather input from actual sales and inventory outcomes for continuous improvement.



PERFORMANCE METRICS

01 FINANCIAL METRICS

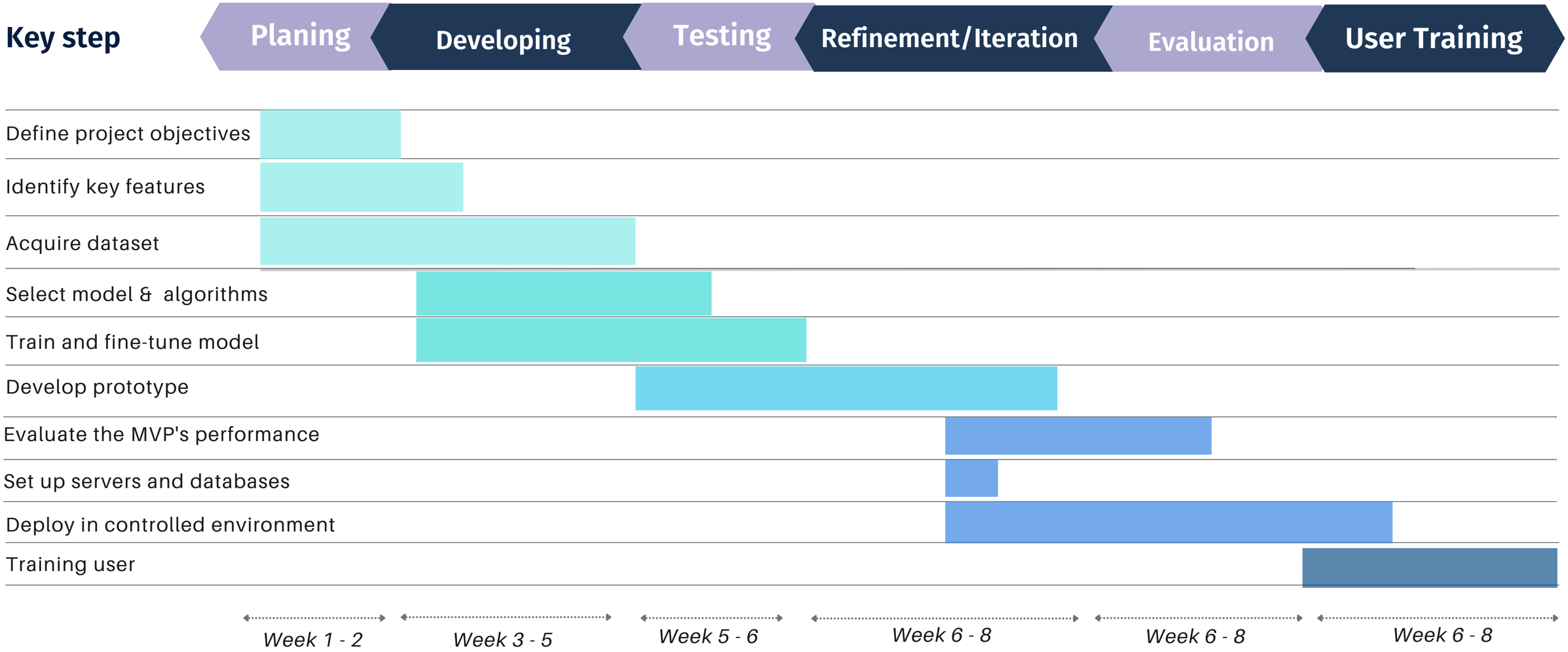
02 TECHNOLOGICAL METRICS

03 OPTIMIZATION METRICS

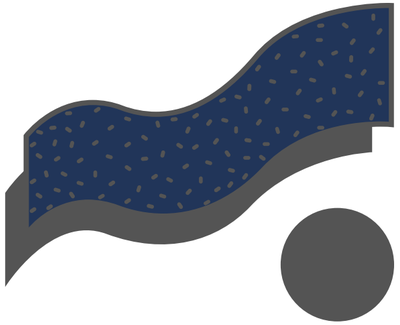
PERFORMANCE METRICS

	Indicator	Meaning
Financial improvement	• Reduce inventory cost • Increase profits	Provide insights into how the solution contributes to financial improvement
Technological improvement	• ARIMA: MAE, MSE and RMSE • Decision Tree: MAPE, R^2 or R-squared, Accuracy, Precision, Recall	Evaluate the model's effectiveness in making predictions
Optimization improvement	• Stock products reasonably • Decide which products to stock to gain the most profit • Choose which products should be sold at different periods	Provides insights into how the solution contributes to optimization improvement

DEPLOYMENT PLAN



LIMITATIONS AND CONSTRAINTS OF THE MVP

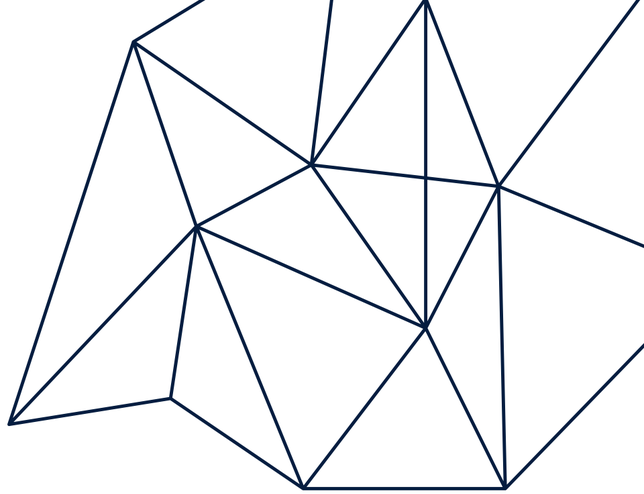


A sufficient amount of data (at least 3 years) is required to predict the most accurate results.

Unpredictable fluctuations (sudden events, major changes without previous trends) cannot be predicted.

The results of the forecast generated from the MVP are only valid at the time of use.

POTENTIAL FUTURE ENHANCEMENTS



Real-Time Forecasting

Implement real-time demand sensing capabilities by integrating live data streams, IoT sensors, or external factors

Scalability and Cloud Deployment

Implement real-time demand sensing capabilities by integrating live data streams, IoT sensors, or external factors

Integration with ERP and E-commerce Platforms

Implement real-time demand sensing capabilities by integrating live data streams, IoT sensors, or external factors

THANK YOU

THANK YOU

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