**AAI-501 – Final Project Proposal**

Team Number: Team AI 6

Team Leader/Representative: Sebin Thankachan

Full Names of Team Members:

1. Sebin Thankachan

2. Kesavan Rangaswamy

3. Sowrab R Iyengar

Title of Your Project: AI-powered inventory management and forecasting for Retail

**1. Brief Discussion of the Problem and Algorithms/Systems to Investigate**

The problem of inventory management in retail is crucial, as poor forecasting can lead to either stockouts or excessive inventory, both of which harm profitability. Traditional inventory systems often rely on historical averages, which lack adaptability to demand fluctuations, seasonal trends, and unexpected events. AI-powered solutions can overcome these limitations by leveraging historical data, real-time updates, and advanced algorithms to accurately forecast demand and optimize inventory levels.

For this project, we plan to investigate time series forecasting models, such as *ARIMA*, *Prophet*, and deep learning-based approaches like *Long Short-Term Memory (LSTM)* and *Transformer models*, as well as *Reinforcement Learning* for dynamic inventory management. The system will integrate demand forecasting with automated inventory management, making real-time recommendations for restocking, markdowns, or strategic promotions.

**2. Identification of Specific Related Course Topics**

The project aligns with several course topics, including:

* **Time Series Forecasting**: Analyzing patterns in retail demand data to predict future trends.
* **Classification**: Classifying demand patterns based on product, season, or demographic information.
* **Deep Learning**: Using LSTM and Transformer models to capture complex time dependencies and seasonality.
* **Reinforcement Learning**: For adaptive decision-making in inventory management.
* **Optimization Techniques**: To balance cost, demand, and stock levels.

**3. Expected Behaviors of the System**

The AI-powered inventory management system is expected to:

* Forecast demand accurately across different products, accounting for trends, seasonality, and external factors.
* Automatically adjust inventory levels by suggesting orders, redistributions, or markdowns.
* React to real-time data, such as sudden increases in demand or supply chain delays, by adjusting forecasts and inventory strategies.
* Minimize costs associated with overstock or stockouts, improving overall inventory turnover rates.

The algorithms are intended to handle issues such as high variance in demand, seasonality, new product introductions, and supply chain disruptions.

**4. Issues to Focus On**

Key issues to focus on include:

* **Data Quality and Quantity**: Ensuring enough high-quality data for training reliable models, especially for new products or low-availability items.
* **Model Interpretability**: Balancing accuracy with interpretability, especially for stakeholder buy-in and practical implementation.
* **Scalability**: Ensuring that the model can handle the scale of data typical in retail, across numerous product lines and stores.
* **Real-time Data Integration**: Developing pipelines for integrating real-time data and updating forecasts.
* **Ethical and Economic Implications**: Ensuring that decisions made by the AI system align with ethical considerations, especially concerning workforce impact and waste reduction.

**5. Core References**

Here are a few key papers and resources that will inform this project:

1. **Seeger, M. W., et al.** "Bayesian forecasting of demand spikes in retail: A Bayesian Structural Time Series approach." *International Journal of Forecasting*.
2. **Huang, X., et al.** "A hybrid model for sales forecasting: Integrating LSTM with Prophet and ARIMA." *Procedia Computer Science*.
3. **Mnih, V., et al.** "Human-level control through deep reinforcement learning." *Nature*, 2015. (For reinforcement learning-based dynamic inventory adjustments).
4. **Brown, R. G.** "Smoothing, Forecasting, and Prediction of Discrete Time Series." *Dover Publications*.
5. **Zhou, Z., et al.** "Deep reinforcement learning for inventory management in supply chains." *IEEE Access*.

**6. A list of EQUAL contributions that each team member will make to the Final Team Project.**

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| --- | --- | --- |
| Team Member 1 – Sebin Thankachan | Team Member 2 – Kesavan Rangaswamy | Team Member 3 – Sowrab R Iyengar |
| List of contributions  Identifying datasets apt for the  project  Contributed to the code base | List of contributions  Identified what kind of  analysis to perform on the  dataset  Contributed to the code base | List of contributions  Helped with setting up Git  repo and working on the  converting the analysis to a  code base. |