Project Summary

Batch details	BLR OCTOBER 2022
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Domain of Project	Supply chain management
Proposed project title	Back Order Prediction
Group Number	Group 4
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PROJECT DETAILS

OVERVIEW

Backorder prediction is a process of estimating the likelihood of a stockout or a backorder, i.e., when the inventory is depleted and the customer is unable to receive their order. Backorder prediction helps businesses to avoid stockouts and improve customer satisfaction by ensuring that products are always in stock.

Backorder prediction is usually performed by analyzing historical sales data, inventory levels, and other relevant factors. Machine learning algorithms, such as neural networks and decision trees, can be used to predict the probability of a backorder. These algorithms use historical data to identify patterns and trends in demand, and then make predictions based on those patterns.

The accuracy of backorder prediction depends on the quality and quantity of data available. Some of the factors that can affect the accuracy of the predictions include the number of products being sold, the variability in demand, the lead time to replenish inventory, and the seasonality of sales.

Backorder prediction can be useful for a variety of businesses, including retailers, manufacturers, and wholesalers. By accurately predicting demand, businesses can optimize their inventory levels, reduce the risk of stockouts, and improve customer satisfaction.

BUSINESS PROBLEM STATEMENT:

Business Problem Understanding: The primary business problem that Back Order Prediction seeks to address is the issue of stockouts, where a business runs out of stock of a particular product. Classify the products whether they would go into Backorder(Yes or No) based on the historical data from inventory, supply chain and sales. This can result in lost sales, reduced customer satisfaction, and decreased revenue. Back Order Prediction aims to predict when a product may go out of stock and the estimated duration until it is restocked, allowing businesses to take proactive steps to avoid stockouts and optimize their inventory levels.

Business Objective: The primary business objective of Back Order Prediction is to improve inventory management and avoid stockouts. The following are the specific business objectives that Back Order Prediction seeks to achieve:

1. Increase sales revenue: By avoiding stockouts, businesses can ensure that they have sufficient stock to meet customer demand, which can lead to increased sales and revenue.
2. Improve customer satisfaction: By accurately predicting stock levels, businesses can ensure that they have the products customers need in stock. This can lead to improved customer satisfaction and loyalty.
3. Optimize inventory management: Back Order Prediction can help businesses optimize their inventory levels, reducing the risk of overstocking or understocking.
4. Improve supply chain management: By identifying suppliers with long lead times or other issues that impact product availability, Back Order Prediction can help businesses improve their supply chain management.
5. Reduce costs: By optimizing inventory levels, businesses can reduce storage and carrying costs associated with excess inventory. Additionally, avoiding stockouts can reduce the costs associated with lost sales and customer dissatisfaction.

Overall, the business objective of Back Order Prediction is to improve inventory management, increase sales revenue, and improve customer satisfaction by accurately predicting stock levels and avoiding stockouts.

Approach: The approach to build a Back Order Prediction model typically involves the following steps:

1. Data collection: Gather historical data on product demand, inventory levels, supplier lead times, and other factors that can impact stock levels.

2. Data preprocessing: Clean and preprocess the data to remove outliers, missing values, and other errors. Aggregate the data into a format suitable for training machine learning models.

3. Feature engineering: Create new features or transform existing ones that can improve the accuracy of the model. For example, features such as product category, price, promotions, and seasonality may be included to help predict stock levels.

4. Model selection: Select an appropriate machine learning algorithm for the Back Order Prediction task. Commonly used algorithms include linear regression, decision trees, and neural networks.

5. Model training: Train the selected machine learning model on the preprocessed data, using techniques such as cross-validation to optimize model parameters.

6. Model evaluation: Evaluate the trained model's accuracy and performance using metrics such as mean squared error, root mean squared error, and R-squared.

7. Model deployment: Deploy the trained model in a production environment to make predictions on new data. Integrate the model with inventory management systems to provide real-time insights and recommendations.

8. Model monitoring and updating: Monitor the model's performance over time and retrain or update the model as needed to ensure its accuracy and effectiveness.

Overall, the approach to Back Order Prediction involves a combination of data processing, feature engineering, machine learning, and integration with inventory management systems to provide real-time insights and recommendations to businesses.

TOPIC SURVEY IN BRIEF

Problem understanding: The problem of backorder prediction is to accurately predict the likelihood of a product going on backorder in the future. Backorders occur when a customer places an order for a product that is out of stock, and the business is unable to fulfill the order immediately. This can result in lost sales, dissatisfied customers, and decreased revenue.By understanding the problem of backorder prediction and developing an accurate prediction model, businesses can improve their inventory management, reduce the rate of backorders, and increase customer satisfaction.

Current solution to the problem: There are several current solutions to the problem of backorder prediction. Some of the commonly used solutions are:

1. Rule-based systems: Rule-based systems involve setting up a set of rules that help identify potential backorder situations. This can include rules around lead time, stock levels, and supplier performance. If any of these rules are triggered, the system will alert the business to take action.
2. Statistical forecasting: Statistical forecasting involves using statistical methods to forecast the future demand for a product. This can help businesses anticipate potential backorder situations and take action to prevent them.
3. Machine learning algorithms: Machine learning algorithms involve training a model on historical data and using it to make predictions about the future. This can be more accurate than rule-based systems or statistical forecasting, as the model can identify complex patterns and correlations that may not be apparent to humans.
4. Demand planning software: Demand planning software helps businesses manage their inventory and anticipate future demand for their products. This can include features such as inventory optimization, demand forecasting, and supplier performance tracking.

Overall, the current solutions to the problem of backorder prediction are focused on improving the accuracy and speed of predicting potential backorder situations, and providing businesses with the tools they need to take action to prevent them. By leveraging these solutions, businesses can reduce the rate of backorders, improve customer satisfaction, and increase revenue.

Proposed solution to the problem: A proposed solution to the problem of backorder prediction is to use a machine learning model that can accurately predict the likelihood of a product going on backorder. The following steps can be taken to implement this solution:

1. Data collection: Collect data on historical orders, inventory levels, lead times, supplier performance, and other relevant factors.
2. Data preprocessing: Clean the data, handle missing values, and perform feature engineering to extract relevant features that can be used by the machine learning model.
3. Model selection: Select an appropriate machine learning algorithm that can handle the specific requirements of the backorder prediction problem, such as imbalanced data or seasonality.
4. Model training: Train the machine learning model on the preprocessed data using appropriate training techniques such as cross-validation.
5. Model evaluation: Evaluate the performance of the model using appropriate evaluation metrics such as accuracy, recall, precision, and F1 score.
6. Model deployment: Deploy the trained model in a production environment and integrate it with existing business processes and systems.
7. Model monitoring and updating: Continuously monitor the model's performance and update it as new data becomes available or as business requirements change.

By using a machine learning model to predict potential backorder situations, businesses can take proactive measures to prevent them, such as ordering more inventory, adjusting production schedules, or finding alternative suppliers. This can improve inventory management, reduce the rate of backorders, and increase customer satisfaction.

DATA DESCRIPTION

In the dataset we are provided with 23 columns(Features) of data.

- Sku(Stock Keeping unit) : The product id — Unique for each row so can be ignored
- National_inv : The present inventory level of the product
- Lead_time : Transit time of the product
- In_transit_qty : The amount of product in transit
- Forecast_3_month , Forecast_6_month , Forecast_9_month : Forecast of the sales of the product for coming 3 , 6 and 9 months respectively
- Sales_1_month , sales_3_month ,sales_6_month , sales_9_month : Actual sales of the product in last 1 , 3 ,6 and 9 months respectively
- Min_bank : Minimum amount of stock recommended
- Potential_issue : Any problem identified in the product/part
- Pieces_past_due: Amount of parts of the product overdue if any
- Perf_6_month_avg , perf_12_month_avg : Product performance over past 6 and 12 months respectively
- Local_bo_qty : Amount of stock overdue
- Deck_risk , oe_constraint, ppap_risk, stop_auto_buy, rev_stop : Different Flags (Yes or No) set for the product
- Went_on_backorder : Product went on backorder(Target variable)

CRITICAL ASSESSMENT OF TOPIC SURVEY

What key gaps are you trying to solve ?

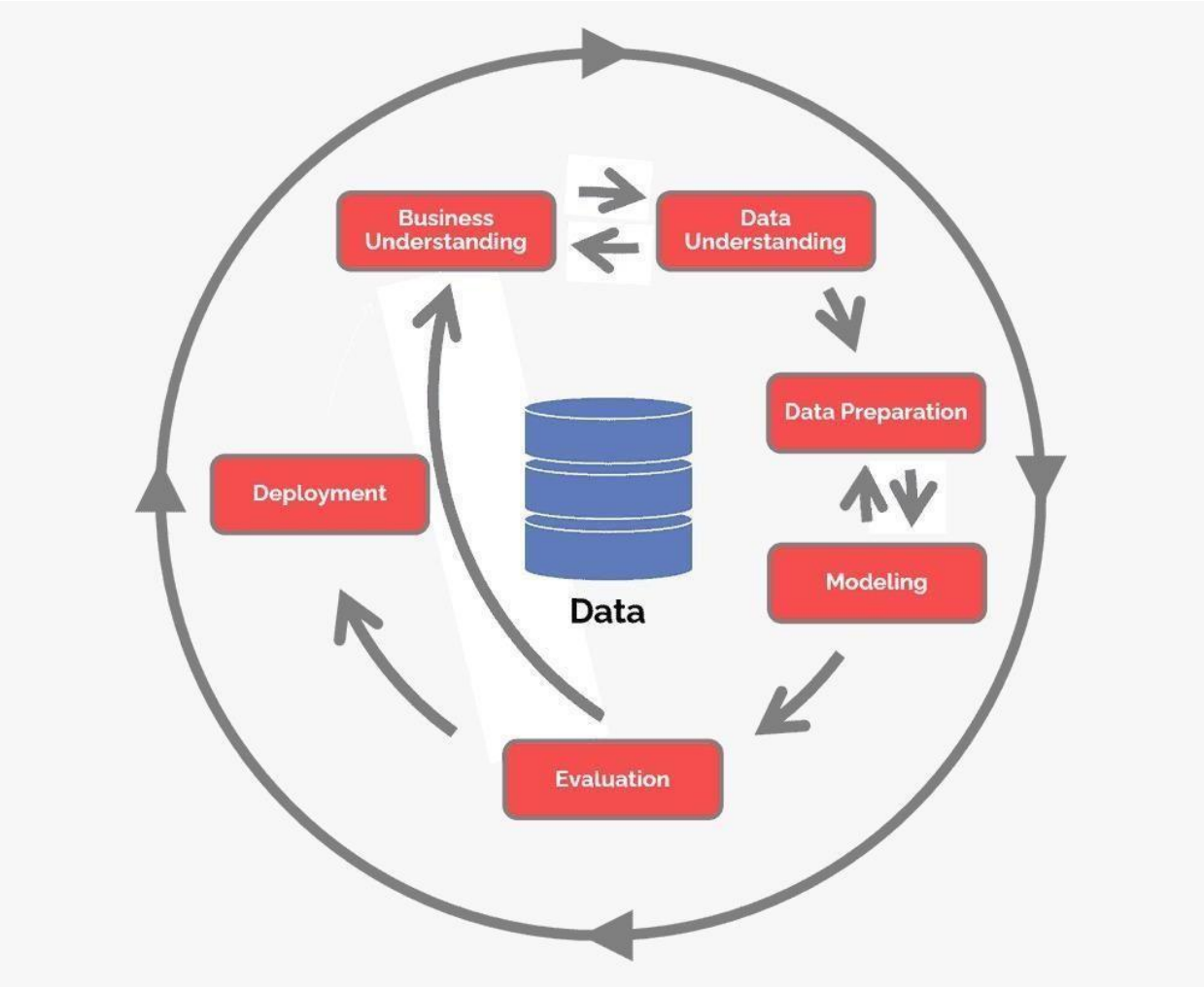
One of the key gaps in backorder prediction is data quality. Accurate and comprehensive data is essential to make accurate predictions. However, businesses may struggle to gather and maintain good quality data due to factors such as data fragmentation, missing data, or data errors. As a result, there may be gaps in the data that can affect the accuracy of backorder predictions.

Another key gap in backorder prediction is the lack of expertise and resources. Developing and maintaining a backorder prediction system can be complex and time-consuming. It requires expertise in machine learning, data science, and logistics. Small or medium-sized businesses may not have the resources or the knowledge to develop and implement a robust backorder prediction system.

Finally, there can be gaps in understanding the demand patterns and market trends. The demand for a product can change rapidly due to factors such as seasonality, trends, and external events. Businesses need to stay up-to-date with the latest trends and insights to accurately predict demand and avoid stockouts.

Overall, addressing these gaps in data quality, expertise, and market understanding can help businesses to improve their backorder prediction accuracy, optimize their inventory, and ultimately provide better customer satisfaction.

METHODOLOGY TO BE FOLLOWED



Predicting back orders can be a complex task and may require a combination of methods and techniques. Here are some steps you can follow to develop a methodology for back order prediction:

1. Data collection: The first step is to gather relevant data that can help you identify patterns and trends related to back orders. This may include historical sales data, customer orders, inventory levels, supplier performance, and other relevant data sources.

2. Data pre-processing: Once you have collected the data, you will need to clean, pre-process and transform it to make it ready for analysis. This may involve removing duplicates, filling in missing values, normalizing data, and transforming the data into a suitable format for analysis.
3. Feature selection: You will need to select the relevant features that are most predictive of back orders. This may involve using data exploration techniques, such as correlation analysis or principal component analysis, to identify the most important features.
4. Model selection: You will need to choose an appropriate model to predict back orders based on the selected features. This may involve using machine learning algorithms such as decision trees, random forests, or neural networks, or statistical models such as logistic regression.
5. Model training and evaluation: You will need to train the chosen model using historical data and evaluate its performance using various metrics such as accuracy, precision, recall, and F1-score. You may need to fine-tune the model parameters and test it on a validation set to ensure it performs well on new data.
6. Deployment and monitoring: Once the model is trained and tested, you can deploy it in a production environment to make real-time back order predictions. You should monitor the model's performance over time and update it as necessary to ensure its continued accuracy and relevance.

It's important to keep in mind that back order prediction is a complex task and may require iterative refinement of your methodology as you gain more insights and experience with the data.

Conclusion

Backorder prediction is an important task for businesses to accurately forecast and manage their inventory. By using historical data and machine learning models, it is possible to predict the likelihood of a product going on backorder and take proactive measures to prevent it from happening. This can include ordering more inventory, adjusting production schedules, or finding alternative suppliers.

However, it is important to continually evaluate and update the models to ensure their accuracy and effectiveness. Overall, backorder prediction can help businesses improve their efficiency and customer satisfaction by ensuring that products are available when and where they are needed.

REFERENCES

1. *De Santis, R. B., de Aguiar, E. P., and Goliatt, L. (2017). Predicting material backorders in inventory management using machine learning. IEEE Latin American Conference on Computational Intelligence (LA-CCI).1-6*
2. *Zhang, R. Q., Wu, Y. L., Fang, W. G., and Zhou, W. H. (2016). Inventory Model with Partial Backordering When Backordered Customers Delay Purchase after Stockout-Restoration. Mathematical Problems in Engineering, pp. 1– 16.*
3. *Hajek, P., and Abedin, M. Z. (2020). A Profit Function-Maximizing Inventory Backorder Prediction System using Big Data Analytics. IEEE Access, 1–1.*
4. *Abdul-Jalbar, Beatriz, José M. Gutiérrez, and Joaquín Sicilia. 2009. "A Two-echelon Inventory/distribution System with Power Demand Pattern and Backorders." International Journal of Production Economics 122 (2): 519–524. [Crossref], [Web of Science ®], [Google Scholar]*
5. *Bao, Lina, Zhiying Liu, Yimin Yu, and Wei Zhang. 2018. "On the Decomposition Property for a Dynamic Inventory Rationing Problem with Multiple Demand Classes and Backorder." European Journal of Operational Research 265 (1): 99–*
6. *Chaharsooghi, S. Kamal, Jafar Heydari, and S. Hessameddin Zegordi. 2008. "A Reinforcement Learning Model for Supply Chain Ordering Management: An Application to the Beer Game." Decision Support Systems 45 (4): 949–959. [Crossref], [Web of Science ®], [Google Scholar]*

NOTES FOR PROJECT TEAM:

Original owner of data	Chandana Reddy
Data set information	1687861 rows and 23 features
Link to web page	https://www.kaggle.com/datasets/chandanareddy12/back-order-prediction