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The role of Artificial Intelligence (AI) in making accurate stock decisions in E-commerce industry

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ABSTRACT

With accumulation and proliferation of large data, it is highly necessary to make some meaningful sense out of the data. Here is where Artificial Intelligence (AI) tools and algorithms play a major role. AI is highly expertise in handling the customer data and forecasting the purchase behavior of customers. This has brought out the biggest level of automation in the e-commerce industry. AI provide notification when a company has to re-order stock and assist in creating manufacturing schedule as per the variation in demand during the particular period of time accurately. The autonomous and data-driven supply chain has optimized logistics, manufacturing, warehousing and the last mile delivery. E-commerce giant like Amazon use leads to time and forecasting techniques to critically plan inventory orders. Machine learning system (MLS), a subset of AI solves the cognitive problems associated with human intelligence and helps to optimize logistic speed and quality. This paper discusses AI-based inventory management tools which are being utilized in the e-commerce industry. AI provides customers an enriched experience which helps to maximize profits.

Keywords: Artificial intelligence, E-commerce, Forecasting, Inventory management

1. INTRODUCTION

E-commerce involves buying and selling goods on the internet platform. Besides transaction of money, the movement of goods has to happen in timely fashion. Here comes the need of supply chain. The supply chain is a critical aspect of e-commerce which has to be secure, uninterrupted and quick. E-commerce is a highly competitive weapon for logistic industry [1]. Nowadays e-commerce firms are fighting for higher market share by developing and identifying unique delivery and selling strategies. When the supply chain is efficient, cash utilization can be enhanced. Inventory, a dynamic figure is one of the most valuable assets of a company irrespective of its small scale or large scale or whether its brick and motor or online stores. It has to be assured that goods are sold on time or else large inventory cause risk of damage or spoilage. Inventory Management is an important function that determines the efficiency of supply chain and also impacts the financial condition of the balance sheet. Optimum inventory should be maintained by all organization so that under inventory can be eliminated which disrupt the financial figures. Careful evaluation of internal and external factors through better planning can improve the status of inventory. Inventory planners review and monitor the inventory continuously and interface with procurement, production and finance departments. It's stated that logistics is the backbone of e-commerce operations [2].

Advantages of successful e-commerce inventory management:

- Optimize the resources in the warehouse.
- The quick response about the variation in demand
- Helps to easily calculate the inventory required for each item.
- Momentarily access to quantities sold/shipped, quantities in stock.
- Analyze the reports on inventory and sales data.

2. OBJECTIVE

The major objectives of the research work are to study on:

- The influence of AI on e-commerce sector in managing and forecasting the inventory accurately.
- The basic e-commerce models and the inventory strategies adopted by online retailers.
- Machine learning Techniques and AI tools utilized by one of the online retail giant, Amazon.

3. LITERATURE REVIEW

Inventory costs are easy to identify and reduce the supply chain problems. Simple inventory models can identify the cost savings from, for example, information is shared with supply chain partners **Lee & Nahmias (1993)**, but for is applied into supply chains for greater efficiency.

Logistics and SCM

Logistics include controlling, planning and implementing effective storage of flow of goods and services and satisfy the customer requests from the point of origin to the final point of consumption [3]. This includes internal and external environment, outbound and inbound, the return of goods and order fulfillment [4].

Logistics and E-Commerce

E-logistics provide end to end fulfillment and automates the complete logistic process and enhance complete SCM services to whole players of logistic process. Logistics are completely automated by e-logistic which provide complete supply chain visibility and could be a part of e-commerce enterprise [5].

On another hand, [6] E-SCM collaborates the Business-to-Business (B2B), technology process and enhance speed and customer satisfaction. This involves the role of IT to improve operational efficiency in supply chain activities like planning, procurement, control, and coordination.

4. THE INFLUENCE OF AI ON E-COMMERCE SECTOR IN MANAGING AND FORECASTING THE INVENTORY ACCURATELY

Inventory research and development in pricing strategy are activities which are time-consuming and requires data scientist. Artificial Intelligence (AI) and machine learning can tackle these daily tasks and can generate highly automated process. For example, AI instantly generates the purchase order for the goods which is in greater demand in the market. This notifies the sellers which products run out of stock on a real-time basis. Useful automated reports can be built in regards to the change in demand in the market. Hence less time is consumed for estimating the stock. Using machine learning algorithm and natural language processing, AI chat box helps to automate better conversation with buyers. The role of IT in SCM has become crucial wherein the cost is reduced and response to supply chain has also increased [7-9]. The trend of globalization has increased the business competency and has to be managed centrally [10]. Recently SCM technology has been highly effective where the information is reliable and easily accessible [11].

In the current retail market, inventory management is a major challenge which is now tackled easily by AI algorithms. Managing stock was every retailer's nightmare. Overstocking requires to meet extra rental, inventory cost. In the current constantly fluctuating market, AI technology can design models of predictive analytics. For example, AI can identify the key factors affecting the velocity of the orders. E-commerce companies use this predictive AI analytics and algorithms to improve productivity and resource utilization at warehouses. Predictive maintenance for conveyors and trucks rationalize distribution cost and warehousing. These AI tools help logistic provider to simplify distribution network, aggregate customer demand and manage the inventory. AI and big data create a hyper-efficient logistic system in the smart ecosystem. AI gathers data through IoT and remote sensing. Sensors are embedded into products and vehicles which provide insight into the recipient of goods, origin, and destination. AI algorithms and data-driven methods can leverage the cost of last mile delivery. Continuous use of big data and AI pushes logistics to evolve in more- eco-friendly way.

Amazon Go

Amazon Go is a cashier-free store, which has the combination of machine learning, computer vision, and cameras. Just walk out technology keep track of what shoppers pick back from shelves and with what customers leave the store in the virtual cart. Customers are charged for their purchase and final recipient is sent to their smartphone. Automation plays a major role in the evolution of warehouse operations. In 2012, Amazon acquired Kira systems Inc, warehouse robot manufactures.

5. THE BASIC E-COMMERCE MODELS AND THE INVENTORY STRATEGIES ADOPTED BY ONLINE RETAILERS

5.1 E-commerce models

- **Marketplace Model**

Marketplace stands for the zero inventory. This organization creates a platform for the dealer to frame their own display products, send orders and maintain stock in a store. The platform facilitator charges certain commission on the orders from the online merchant. Few classic examples are Amazon, Flipkart, and Snapdeal.

- **Inventory model**

Buyers choose a product from the company's online shopping platform where this company takes care of the process from the start to product purchase. In this e-commerce, the organization maintains its own distribution center to the stock inventory and dispatches order to customer doorstep.

- **Hybrid Model**

Due to current FDI flaws in India, recently Amazon and Flipkart are shifted towards the hybrid model. Hybrid e-commerce model is a mix of inventory and marketplace model. This marketplace includes many fulfillment services like FBA (Fulfillment by Amazon), Snapdeal Plus, Flipkart Advantage. Here the seller has the choice of either self-fulfillment or marketplace fulfillment. This model created bigger hype in sale in the e-commerce sector.

6. SIX INVENTORY STRATEGIES

1. Hybrid Warehousing

It is a combination of self-warehousing and third-party stocking, but the organization should decide which products have to be kept in its warehouse and in the warehouse of its suppliers. Small products like books, electronic gadgets can be kept in its own warehouse, while heavy products (durables) are usually delivered from the supplier's location. This method helps to moderate the supply costs.

2. Outsource e-commerce fulfillment

In e-commerce retail, outsourcing is one of the successful methods of inventory management. On outsourcing, the inventory, complete fulfillment process is handed over to the third party vendor.

3. Cross-Platform Tracking

Inventory activities across all multiple sales channel have to be centralized. This is one of the efficient Inventory management Strategy to identify which sales channel requires stock on a real-time basis.

4. FIFO (First In First Out)

This is one of the best method adopted by online retailers to manage their inventory in case of selling the outdated goods. Packing design and product models have to be optimized regularly or else the stock will remain on the shelves unsold.

5. Real-time Inventory Information

Information on real-time inventory is the backbone of an efficient inventory management system. The sales data has to be updated periodically. Real-time inventory information can be shared with customers in "In stock" section in the website

6. Drop Shipping

Here e-commerce maintains a good relationship with the supplier, who maintains inventory and items to be purchased as soon as the order is placed. This help to effectively share information between the merchant and supplier regarding real-time inventory, order, and invoices

7. MACHINE LEARNING TECHNIQUES

E-commerce merchants analyze the data to anticipate the seismic shifts in the purchase behavior of the customer. The machine learning and data analysis enable the retailers to have the clear insight on the sales information and trends from various sources like social media, retail sites, and blogs. Machine learning is of the best technology adopted for forecasting the inventory. By applying the concept of machine learning to inventory forecasting, companies understand the products that are likely to sell for a month/year. Based on computational learning and pattern recognition theories in AI, machine learning utilizes these algorithms to make accurate predictions. Machine learning computes the variety of data where the programming and designing are done with least error and of high accuracy.

The application of machine learning in e-commerce includes sentimental analysis, wallet share estimation, fraud detection, query expansion, churn prediction, inventory management, channel optimization, market basket analysis and few others too. To reach the demand accurately retailers should foresee demand accurately using predictive analytics. AI technology designs these analytical models which identify the key factors responsible for the change in demand for different products at the different time period. Now retailers can predict their inventory needs in the highly volatile market with the high level of accuracy. The product demand of e-commerce often suffers from bullwhip effect, so machine learning techniques like the neural network, recurrent neural network and support vector machine (SVM) play a major role in demand forecasting.

Today logistic experts, big retailers have adopted machine learning forecasting to analyze the demand forecasting accurately and to personalize customer engagement much better the traditional forecasting techniques. ML algorithm is accurate, powerful and self-corrective in forecasting the demand when compared with traditional techniques like moving average, multiple, linear regression, trend and other time series forecasting appreciated. Dynamic regression and cloud computing are the catalysts for successful "Machine Learning Forecasting". Traditional time series forecasting approach can use only few demand factors, while ML forecasting integrates cloud computing, big data, learning algorithm to assess huge data using many fundamental demand factors at once.

ANN (Artificial Neural Network) models one of the main methods adopted by Machine learning algorithms. ANN is a mathematical model which analyzes and compare data beyond human abilities. This helps to optimize inventory level and improvise the inventory management. The basic components of ANN are a neuron, learning rules, and interconnection. This model is being designed for the production of multi-stage, multi-product and multi-location with constraints in capacity and products like transit time, processing time and arrival order and so on.

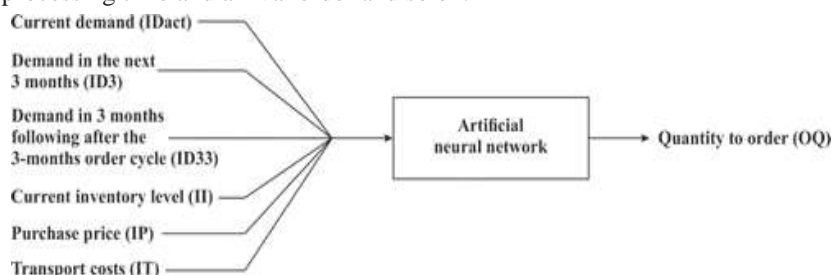


Fig. 1: Neural network input and output diagram

For example, output quantity ordered is modified to ensure the optimal behavior of the stock. The above ANN model is considered as an example to brief about its functioning. Here is an example, the model is designed to find the optimal no. of goods to be ordered in future to optimize the current quantity of goods in future. ANN model is more effective than the basic EOQ

model as EOQ model will not function with the variable demand within a year. ANN can easily detect the highly complicated non-linear relationship between a dependent and independent variable and helps to predict the future demand for stock with high accuracy rate.

Amazon is successful in winning the heart of its customers by accurately analyzing the big data regarding what customers buy, what do they search for and what they actually need from the store. Amazon had increased the revenue by at least 20% by personalizing information and recommending to the customers. Amazon classifies the customers in two ways – a) Amazon buying customer b) Sellers in Amazon marketplace.

7.1 Amazon Machine Learning Algorithm

Amazon Machine Learning (ML), highly robust cloud-based services that have simplified the work of developers with the machine learning technology. Visualization tools and wizards clearly guide in framing ML nodes without learning about the complex algorithms. Once the model is realized, Amazon ML determines the predictive factors for the application.

7.2 Types of ML node include:

i. Binary Classification Model

A binary outcome is predicted from the binary classification problems under ML nodes. Here Amazon ML utilizes the standard learning algorithm, which is known as “logistic regression”.

ii. Multiclass Classification Model

Here ML nodes are designed for multiclass classification problems which allow predicting for the multiple classes (predict one outcome out of more than two customers). Here Amazon ML utilizes the standard learning algorithm, which is known as “Multinomial logistic regression”.

iii. Regression Model

Here ML model predicts the numerical value for regression. Here Amazon ML utilizes the standard learning algorithm, which is known as “Linear regression”.

Two mechanisms involved in generating prediction – When there are large no. of observation and all the prediction should happen at the same time in single stretch then asynchronous **prediction/ batch prediction** is used. The process uses an input data and generates the output prediction in.csv file stored in S3 bucket. The maximum size of the data source that Amazon ML can handle is 1TB. If the data is greater than 1TB, the job will fail and Amazon will return an error code. To avoid this state, data has to be divided into multiple batches.

Synchronous real-time prediction can be utilized in case of low predictions. Single serialized input is accepted as JSON string for real-time prediction API. API can be invoked multiple times to obtain the synchronous prediction.

7.3 Amazon machine learning process

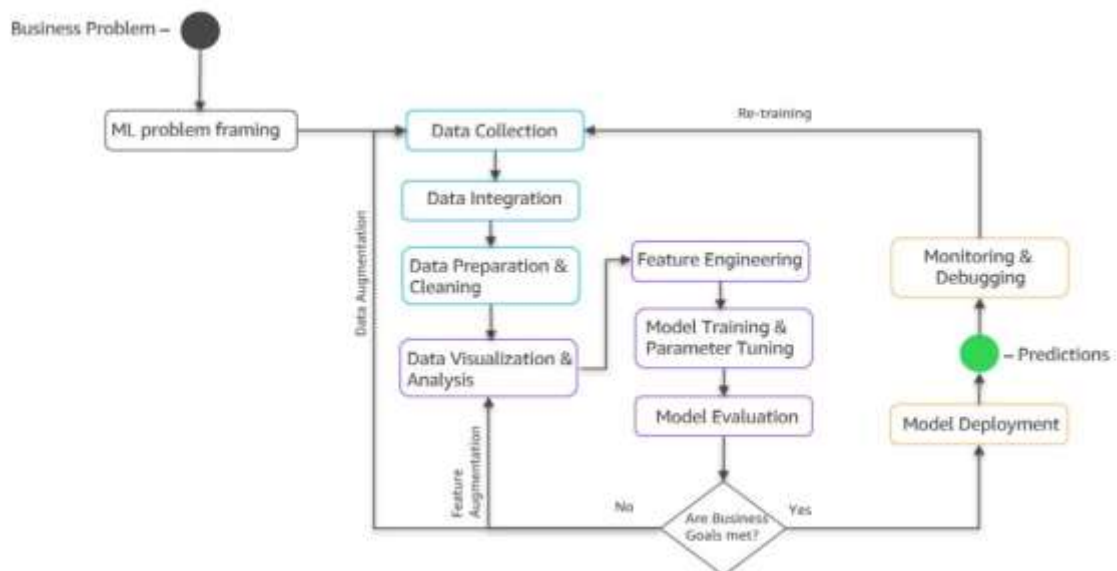


Fig. 2: Machine Learning Process

Initially, with good domain knowledge, right problems have to be framed. Data platform has to be built with Amazon S3. For model training, manage the notebook environment and the training clusters together. Determine the data connector and distribute the large data set of ML algorithm to various /multiple machines. Before model deployment, set up the model influence cluster and manage the APIs. Performance tracking and model visionary are completed in the last stage. Finally, new model version is automated.

7.4 Amazon Elastic Map Reduce (EMR)

Amazon extended the use of big data using the cloud for data collection, data sharing, and data storage and data collaboration. Amazon Elastic Map Reduce assists the retailers to efficiently manage and utilize the Analytics platform built on Hadoop Network. EMR is a cloud solution that supplies the horsepower as well as on-demand infrastructure to solve the issues regarding

trends and the large volume of data. Amazon EMR completely utilizes Amazon S3 (Single, storage, service) to store the results of analysis and also hosts the data for processing. Amazon EMR is similar to Hadoop and can analyze the huge data set. Map Reduce splits the data into smaller fragments which are distributed to the body that comprises the whole cluster. Total flow is executed in such a way that Hadoop components are divided into the master, core, and the task cluster.

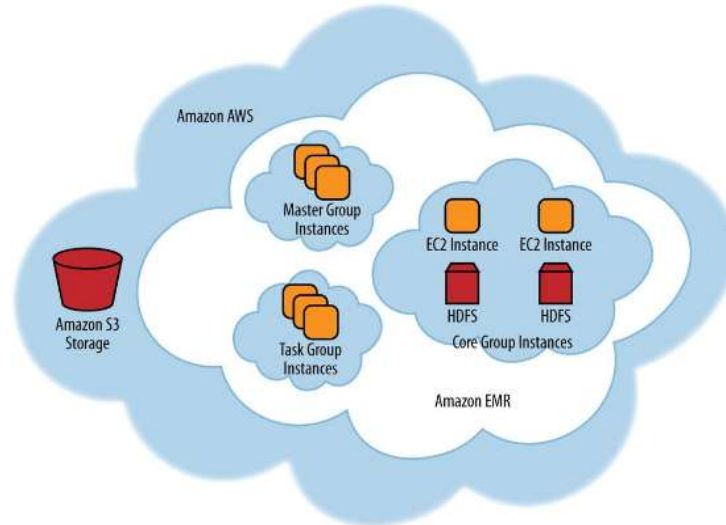


Fig. 3: The architecture of Amazon Elastic Map Reduce (EMR)

Master group instance: Master group manages the complete job flow and allocates the JARs, script to task and core instance. In case the master node is lost, the work will be delayed for the whole process relating to the core and task nodes. Master group collects the data from other instances and write to Amazon S3.

Core group instance: Map & Reduce portions are run by Core group instance members and store the intermediate data in HDFS (Hadoop Distributed File System) storage of Amazon EMR cluster. The loss of core node will finally result in the data loss and fail the job flow completely.

Task group instance: Task group is an optional instance and this does not have HDFS storage. So data is transferred to the nodes by the master instance to complete the work of Job flow. The failure of task node will lose the intermediate connection. Amazon S3 is used to store data sets and finally generated by Amazon EMR.

7.5 Amazon Inventory Management software tools include:

- **Sellics:** This tool does product research, review management and monitors the competitor's growth and products.
- **Forecasting:** This tool charts out the snapshots and monthly inventory and provides inventory automation. This gives a clear outlook on the ranking of sales.
- **Manage by Stats:** Based on real stats, web platform defines an important business for smart prediction and alerts.
- **Stitch Labs:** This tool provides complete inventory control, enhance transparency and accurate forecasting, multiple channel growth and high complex order fulfillment.
- **Restock Pro:** This works by converting the FBA data to better quality inventory utility. This tool helps to monitor the sale velocity, competitor listing, and expected management.
- **Ecomdash:** It features data syncing, free update, highly informative dashboard, inventory automation, multiple sales channels and provides an amazing support overall.
- **Seller Active:** Continuous re-pricing can be done without hidden fees. This provides clear visibility
- **Telemetrics:** This tool features inventory reports, review management, profitability analyzer etc.
- **Appath:** This is a cloud solution that enhances multi-warehousing, sync the inventory and drop shipping
- **Inventory Lab:** The key features include comprehensive reports are generated and products scouting on a real-time basis.

8. CONCLUSION

The e-commerce industry is gradually expanding their horizons with the use of AI, which predicts the consumer behavior and inventory required. The machine learning algorithms play a crucial role in analyzing the data regarding market campaigns and forecasting the inventory. These final reports help the managers to take the necessary action regarding the stock at various places across the channels. Cloud vendors from Google to IBM develop machine learning platforms to attract more workload regarding inventories. AML has reduced the complexities of traditional forecasting models and enhances the speed, accuracy of predicting models. This paper clearly illustrates inventory models, the machine learning process adopted by Amazon and the AI tools used by Amazon for inventory management. Machine learning algorithms have revolutionized the e-commerce sector with its high profile of accuracy and design. AI has enabled the organizations to track the customer activities regularly and enhance the profit levels.

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