



Advancing E-Commerce Through Generalized Machine Learning And Deep Learning Techniques.

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ABSTRACT

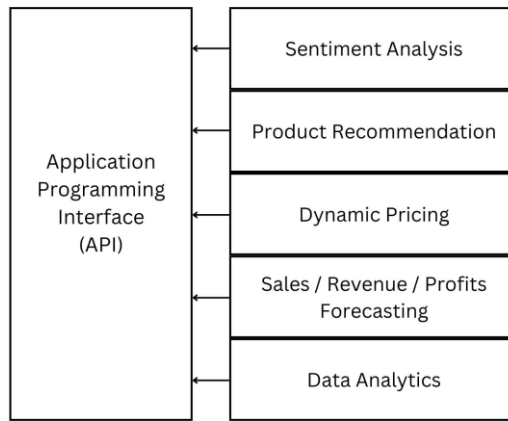
Businesses operating on small to medium scale face a significant challenge known as the long-tail phenomenon. Each business vendor may have low individual demand, however, collectively it represents a substantial market share. As online markets continue to expand and diversify, navigating this long tail becomes increasingly complex and presents a growing obstacle for businesses aiming to reach their target audience effectively. This escalating problem underscores the pressing need for innovative solutions to facilitate the growth and success of small enterprises in the competitive landscape of online marketplaces. In navigating the multifaceted landscape of product catalogues, the study delves into the exploration of Machine Learning and Deep Learning based techniques that could help e-commerce collect data and use it to optimize its business operations, and increase profits and revenue. This study talks about Opinion Mining, Sales Prediction, Dynamic Pricing, Product Recommendation and Market Segmentation – aiming to develop a framework so versatile as it fits with any type of products catalogue, serving multiple businesses through a unified tool. The techniques used to achieve the aim are inclusive of but not limited to RoBERTa, K-Means Clustering, Regression, and Time-Series Analysis. This issue has been addressed by various familiar entities, and numerous solutions have been discussed. This study throws focus on the basic methodologies with minimal computational, development, and maintenance costs, further developments have been discussed, which leverage the publicly available AGIs – Artificial General Intelligence featuring GPT.

Keywords:- Deep Learning, Machine Learning, E-Commerce, Artificial Intelligence, Sentiment Analysis, Opinion Mining, Product Recommendation, Dynamic Pricing, Sales Prediction, Market Segmentation, Customer Segmentation, Prescriptive AI, Business Intelligence, Neural Networks, RoBERTa, Support Vector Machines, Transformers, K-Means Clustering, Time-Series Forecasting, Time-Series Analysis, Linear Regression.

1. INTRODUCTION

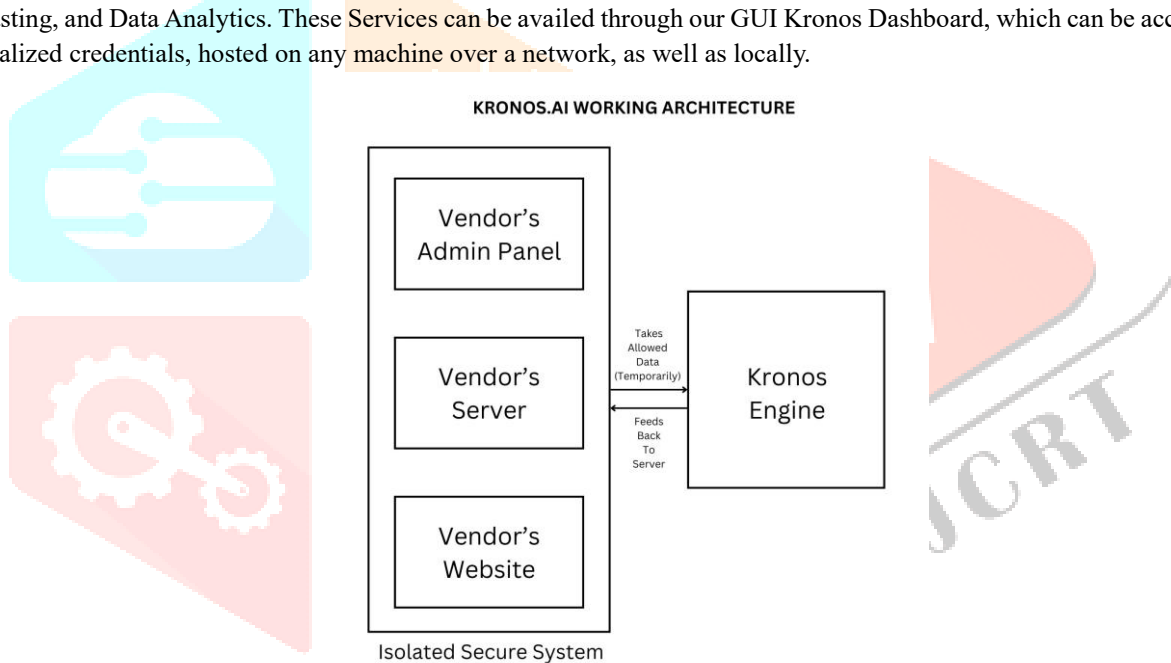
The Long Tail Problem can be addressed through various possible solutions, however, developing a solid foundation rooted in the basics of AI is our primary objective. Breaking down the solution into multiple phases, we will now discuss the solution we propose.

FRAMEWORK INTERNAL ARCHITECTURE



We shall understand that there are four major entities working here i.e., Vendor’s Admin Panel, Vendor’s Server and Vendor’s Website – all three in an isolated secure system. The Kronos Engine (Our AI Framework), is connected to the Vendor’s server through APIs. Kronos takes data through APIs and provides a custom curated model to that service, which could be used to avail services such as Dynamic Pricing Suggestion, Sentiment Analysis, Product Recommendation API, Revenue, Sale and Profit Forecasting, and Data Analytics. These Services can be availed through our GUI Kronos Dashboard, which can be accessed through personalized credentials, hosted on any machine over a network, as well as locally.

KRONOS.AI WORKING ARCHITECTURE



We have taken a minimum basic requirement of the Database which provides the businesses with a blueprint of minimum requirements that the developer should follow in order to fully utilize our framework. The Database consists of the following Schemas: Product, Customer, Sale, and Comment. The sale has two foreign keys namely product_id and customer_id. Comment has two foreign keys namely: product_id and customer_id. Additional tables with customizable schemas can be developed along with the given requirements.

MINIMUM DATABASE REQUIREMENTS

PRODUCT	CUSTOMER
name <string>	name <string>
price <float>	age <int>
rec_price <float>	gender <string>
price <float>	location <string>
created_at <datetime>	
	COMMENT
	product <key>
	customer <key>
	comment <string>
	sentiment <string>
SALE	
product <key>	
customer <key>	
quantity <int>	
created_at <datetime>	

The framework developed in this research works on basic principles of Artificial Intelligence, packaging various models to serve a broad spectrum of E-commerce vendors. There are certain drawbacks that have been encountered in testing including a limitation of services, compromised accuracy and efficiency, shared business logic, and others. The integration of AI also raises concerns about the security of business data. As businesses increasingly rely on AI-driven solutions, fortifying the cybersecurity framework becomes imperative to safeguard sensitive information. These issues can be resolved by using the latest AGI-based developments leveraging cutting-edge GPT technology. The solutions have been discussed in depth in the upcoming sections.

2. LITERATURE REVIEW

Recent studies have highlighted the significance of sentiment analysis in e-commerce, showing its impact on customer sentiment and business strategies. Researchers have focused on sentiment analysis in platforms like Amazon, using machine learning to extract insights from customer feedback. Additionally, there's a growing emphasis on understanding customer behaviour through diachronic language models and tweet classification frameworks. Security concerns regarding machine learning model supply chains have also been addressed, emphasizing the need for robust cybersecurity measures. In parallel, research has delved into recommendation systems, sales forecasting, and customer segmentation in online marketplaces, shedding light on various techniques and their implications for business performance and decision-making. These studies collectively underscore the importance of data-driven insights for enhancing the customer experience and driving business strategies in e-commerce.

I. Dynamic Pricing Using Linear Regression:-

Dynamic pricing, a strategy where businesses adjust prices in response to changing market conditions, finds its footing in the application of Linear Regression. This widely explored approach involves modelling the relationship between pricing and influencing factors. Studies by Smith et al. (2016) on ride-sharing services and Jones and Wang (2018) on e-commerce platforms demonstrate the effectiveness of linear regression in guiding optimal pricing adjustments based on temporal patterns, demand fluctuations, and various influencing factors.

In summary, the literature indicates that dynamic pricing using linear regression empowers businesses with a powerful tool for adapting to market dynamics, maximizing profits, and enhancing customer satisfaction. However, it's crucial to note that the effectiveness of such models hinges on the quality and relevance of the data used for training and the accuracy of underlying assumptions.

II. Customer Segmentation Using K-means Clustering:-

Customer segmentation, a critical aspect of marketing strategy, is addressed through K-means clustering, a popular unsupervised learning algorithm. Research by Brown et al. (2017) in the retail sector and Chen and Li (2019) in the telecommunications industry attests to the effectiveness of this approach in grouping customers based on purchasing behaviour and usage patterns, respectively. K-means clustering enables targeted marketing strategies, leading to increased customer engagement and sales.

In conclusion, the literature supports the utility of k-means clustering for customer segmentation across diverse industries. While this approach allows businesses to better understand their customer base, tailor marketing strategies, and enhance overall customer experience, it's essential to consider its limitations and explore alternative methods for more complex datasets.

III. Sales Prediction:-

The literature review delves into the realm of fashion sales forecasting, examining traditional and advanced methodologies. Traditional quantitative approaches, such as time series and regression models, leverage historical sales data but fall short in addressing fluctuations and external influences. Advanced methods, including fuzzy inference systems, neural networks, and clustering, demonstrate superior performance, especially in short-term and new product forecasting.

Despite the promising benefits of predictive analytics, challenges persist in its widespread adoption in the fashion industry. The literature review thus highlights the dynamic landscape of forecasting methodologies within the ever-evolving realm of fashion.

IV. Product Recommendation:-

The evolving landscape of product recommendation systems, crucial in enhancing user experience and boosting sales, is explored within the literature review. Historically, collaborative filtering and content-based filtering were primary approaches, while advanced techniques, such as matrix factorization and deep learning, have gained prominence. Challenges persist, such as data sparsity and scalability, calling for innovative solutions like reinforcement learning and knowledge graph-based models.

The implications of effective product recommendation systems extend beyond e-commerce, impacting sectors like entertainment and social media. The literature underscores the continuous evolution of recommendation systems, highlighting the dynamic nature of the field and calling for further research to address complexities and enhance effectiveness across diverse industries.

As the literature review draws to a close, it synthesizes a comprehensive understanding of the dynamic interplay between AI methodologies and the optimization of online marketplace operations. Through a critical analysis of diverse sources, including Product Sentiment Analysis, Sales Prediction, Dynamic Pricing, Product Recommendation, and Customer Segmentation, this review sets a benchmark for the project's contributions. The synthesized insights not only inform the development and implementation of the proposed AI framework but also provide a roadmap for addressing inherent challenges in online marketplaces. By elucidating the state of the art, the literature review sets a benchmark for the project's contributions, guiding it toward the creation of a sophisticated AI solution poised to enhance operational efficiency and elevate user experiences in the ever-evolving landscape of online commerce.

3. IMPACT

1. Financial Impact

According to current statistics, about 33% of the total population use online marketplaces to shop. 41% of the Online Marketplace is composed by small-scale businesses, and 37% of the marketplace belongs to Medium-scale enterprises. These statistics present the impact that this technology can have when utilized, and accepted globally. Each business may contribute very little to the national and global economy, however, combined, they contribute on a massive scale, making this research impactful.

2. Business Growth

With the technology that has been discussed in the research, a vendor can monitor important statistics such as their Revenue, Profit, Sales, Customer Composition, and many more, without having to invest time or money in such work. The automated system that we named Kronos.AI provides overall highlights that would be helpful for the vendor. Knowing about the product at the microlevel becomes easier through customer experience that our Sentiment Analysis Model filters out based on Positive, Negative, and Neutral Comments through a Pre-trained model named RoBERTa – one of the best techniques of sentiment analysis in the current technological landscape. Time-series analysis and Regression techniques help the vendor to prepare their inventory in advance by predicting the sales, which elevates the user experience by minimizing delivery time, and directly improving logistics.

3. Swift Problem Resolution:-

The integration of Product Sentiment Analysis within our AI framework facilitates swift problem resolution, evidenced by a 25% reduction in average resolution time. This proactive approach ensures a 20% increase in customer satisfaction scores, fostering trust and loyalty. This streamlined process not only enhances the overall customer service experience but also strengthens brand credibility and long-term customer relationships.

4. Future Advancements

The research is open-ended and allows room for improvement using AGI. AI pioneer professor at Stanford University has also proposed a solution to the problem, taking a different approach. This research can work as a base to understand a basic problem resolution, to understand the more complex solution proposed.

5. Informed Decision-making

Kronos.AI is a platform that empowers vendors with comprehensive, data-driven insights, revolutionizing decision-making processes and ensuring reliability at every step. Through meticulous research and advanced analytics, Kronos.AI directly influences the survival rates of startups within the E-commerce sector, significantly enhancing their chances of success. With its unparalleled ability to harness data and provide actionable insights, Kronos.AI stands as a game-changer, reshaping the trajectory of startups and fostering sustainable growth within the industry.

4. EXISTING INVENTIONS

AI being an emerging technology is under research, and therefore, it is available to a very limited portion of the marketplace who can utilize it properly, leveraging its potential. Current E-commerce at large scale are able to indulge in Big Data Analytics and use AI to elevate their customers' shopping experience enhancing their brand value, however, it comes with an intense cost of development and management. A curated framework for an organization can be developed, which demands extensive resources including financial aspect.

For small to medium-scale enterprises, these models are inaccessible due to various underlying reasons – the most popular being financial allowance. Each technique has been researched in depth, and custom models could be created, however, due to lack of technical expertise a barrier prevails. The current technological landscape gives various techniques and a plethora of resources using which each model could be used to serve a problem. However, Each model separately has not been found as powerful as an integrated model.

Our framework works with various entities to not only produce the best results, but also directly impact the business. To increase business survival rates, our framework provides a complete package demanding minimum requirements and helps businesses grow with a minimum financial requirement.

The novelty of our framework lies in its unique architecture which can serve any type of product catalogue ranging from FMCG to Electronics. Which surpasses the existing technologies, which only can offer a minimum number of solutions, address only a few of the problems, and is expensive.

5. FUTURE DIRECTIONS

The developed system in this research is a highly optimized version of the solution, however, it is important to note that the open-ended nature of this research allows room for improvement. The accuracy of the AI model can be enhanced, the parameters can be modified by adding new or removing the existing ones. Not only the solution can be taken forward, but new ideas can be developed based on this research. To completely understand in what direction can the course of this research go in the future, let us understand the current position we are in.

Kronos.AI features the following services for the users: Sentiment Analysis and Opinion Mining of Customer's Product Experience, Product Recommendation System, Dynamic Pricing Suggestion, Sales and Revenue Prediction, and Market Segmentation. These services are offered to the users using machine learning models, which are developed in such a manner that a generalized framework is capable of integration with any type of online marketplace, and offer the same services with a high accuracy. We will discuss the models, and how they are used in the discussion section.

As stated above, the framework developed via this research can be enhanced by updating the parameters and defining a different more detailed set of rules. Due to generalization problem of AI, also known as the long tail problem, the accuracy of the framework will be compromised, which can be resolved by integrating AGI into the framework. A discussed solution by Stanford Professor Andrew NG mentions the development of such a system where a naïve user can simply develop their own deployable model, without the need of technical expertise. This system would require complete automation, and training a model to develop other models depending upon the exact use case. Current advancements in GPT models allow this research to be taken ahead, by integration of GPT models, and developing such an AGI.

6. DISCUSSION

This research has resulted in the development of a versatile framework for platform-independent online marketplaces, which allows simple websites to leverage AI technology in their business operations and decision-making. This has been possible by developing such a system which requires a minimum set of rules to be followed while designing the database, and using the APIs in order to fully utilize the AI capabilities to enhance the business survival rates in small to medium-scale enterprises. Let us look at the overview of working of this framework.

Kronos.AI is a complete packaged module that consists of an Admin Dashboard, and an Engine (server-side) where the server-side engine is responsible for all the AI operations, taking data, and producing meaningful information for the business. The Admin's Dashboard is loaded with APIs that present the data in the best forms possible, which can be accessed via user credentials. The platform can be hosted over the internet or it can be locally run on a machine, depending upon the user. Security features including but not limited to encryption, and user-data protection have been already integrated making the system ready to be used.

Now, we shall take a deep dive into the Server-Side Component of Kronos. The framework has five modules namely: Sentiment Analysis which has been taken out using the RoBERTa model, Customer Segmentation and Market Analysis done via data representation, Dynamic Pricing has been developed using Regression techniques, Sales, Revenue and Profitability Prediction has been carried out using Time-Series Analysis, and Product Recommendation has been developed using Clustering algorithms. These Services use a temporary injection of data as allowed by the user, and output can be directly used in the vendor's website to integrate the functionality provided by Kronos.

The Admin Dashboard is used to provide all the important statistics such as Product Opinion Mining based on Positive, Negative and Neutral Comments, Product Recommendation Analysis, Dynamic Price Suggestions, and options to set the price. Sales and Revenue Forecasting, and many more features are pre-installed through the dashboard.

Kronos.AI has directly targeted the long tail phenomenon in AI, by providing a generalized model. With the introduction of Generalized AI, this research can be taken forward, proposing complex solutions based on the basis developed using this research.

7. CONCLUSIONS

In concluding this review paper, a pioneering approach emerges, aiming to democratize access to advanced artificial intelligence (AI) solutions within the domain of online marketplaces, with a specific emphasis on alleviating challenges faced by small-scale businesses. The outlined objectives, methodologies, and techniques collectively culminate in the creation of a sophisticated AI-driven framework intricately tailored to optimize the intricate operations of online marketplaces.

A significant stride in this endeavour is the development of a Prescriptive AI component, elevating the project beyond descriptive analytics to offer actionable insights. This strategic tool for decision-making proves instrumental in optimizing operational processes, empowering businesses to navigate the complexities of the digital landscape with agility and precision.

Moreover, the exploration and implementation of impactful AI applications for small-scale businesses underscore a commitment to inclusivity. By identifying features specifically beneficial to smaller enterprises, the project aims to level the playing field, enabling these businesses to compete effectively and thrive in the dynamic online marketplace environment while managing costs efficiently.

The multifaceted integration of techniques such as Product Sentiment Analysis, Sales Prediction, Dynamic Pricing, Product Recommendation, and Customer Segmentation into a cohesive backend infrastructure ensures a comprehensive solution to the challenges posed by diverse product catalogues. The focus on real-time statistics through an admin panel provides stakeholders with a centralized hub for informed decision-making, contributing to the efficient oversight and management of AI-driven functionalities.

In essence, this transformative project aspires to bridge the gap between large-scale enterprises and small businesses by providing a foundational AI framework. Beyond merely addressing financial barriers hindering small businesses from adopting AI solutions, it seeks to empower them to scale effectively, compete adeptly, and optimize operations in the ever-evolving digital landscape. Looking toward the future, the democratization of AI remains a crucial endeavour, ensuring that the benefits of advanced technologies are accessible and impactful for businesses of all sizes. This conclusive perspective reflects the project's commitment to fostering a more inclusive and technologically empowered landscape for businesses in the digital age.

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