A Survey on E-Commerce Recommendation Systems Using Artificial Intelligence and Current Trends for Personalization to Improve Customer Experience

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Abstract— In E-commerce, the recommendation system plays a very crucial role which is a significant part of the E-shopping or electronic shopping that engages with the users and enhances their shopping experience. In today's world, where people are gradually shifting to online shopping, it is very much essential to personalize the recommender system according to their preferences. The study examines how E-commerce recommendation systems powered by Artificial Intelligence (AI) are revolutionizing the online shopping experience by exploring various personalization trends, and investigating how these systems enhance customer experience within the e-commerce domain. Lastly, the survey analyses the strengths and limitations of existing AI techniques, highlighting areas for future research and aims to provide a comprehensive overview of AI's role in shaping personalized recommendations and improving customer satisfaction in the evolving world of e-commerce.

Keywords— E-commerce; Recommendation Systems; Artificial Intelligence; Personalization; Customer Experience; Customer Satisfaction

I. INTRODUCTION

In today's world, E-commerce is incredibly popular and one of the fastest growing retail sectors. Unlike traditional shopping, the E-shopping offers the users a wide range of diversity, flexibility, convenience and especially the liberty to explore their preferences from a huge range of collections. However, the system comes with complexities too - understanding the exact users' need and providing the suitable preferences for seamless shopping experience.

The exponential growth of e-commerce has intensified competition, demanding a focus on Customer Experience (CX) differentiation. Artificial intelligence (AI) has become a game-changer in this arena, particularly through the development of intelligent recommendation systems. These systems leverage user data and product attributes to provide personalized suggestions, aiming to streamline the discovery process, enhance customer satisfaction, and ultimately drive sales.

This study offers a comprehensive examination of AI-powered recommendation systems in the e-commerce domain by delving into the core functionalities of these systems, exploring how they utilize AI to personalize product recommendations for individual users. Further, this survey investigates the impact of personalization on Customer Experience (CX), considering factors like reduced decision fatigue and increased purchase likelihood. Finally, the current study evaluates the strengths and limitations of the current AI techniques employed in recommendation systems and aims to provide a valuable information about the transformative role AI plays in shaping personalized recommendations and fostering a more engaging and satisfying online shopping experience for customers in the e-commerce platform.

II. RELATED WORK

E-commerce recommendation system is a hot topic, with numerous recent surveys exploring the latest approaches. This section aims to provide some of the recent surveys in this area.

Dr. Gaurav Jangra et al [1] in the conference paper titled "Role of Artificial Intelligence in Online Shopping and its Impact on Consumer purchasing behaviour and Decision" proposes the need for Artificial Intelligence (AI) in the field of ecommerce domain to understand customer needs and behaviors, leading to personalized product and service offerings. In this survey, they have conducted research on the impact of consumer behaviour by conducting a study of 200 respondents from Haryana state, showing a significant association between AI tools (like voice and visual search, chatbots, etc.) and consumer buying behaviour, including trust, attitude, and perceived risk and have analyzed their purchasing patterns, such as preferred payment methods, frequency of online shopping, and electronic gadgets used for shopping to gain insights related to their shopping behaviour. Also, this study provides demographic insights into the respondents' profiles, including gender, age, marital status, education, occupation, and income, highlighting their shopping

habits and preferences. Following which, it has used chi-square analysis to measure the association between various demographic profile and various purchasing pattern or habits. This study has used different statistical methods like ANOVA (Analysis of Variance) and linear regression to determine the impact of Artificial Intelligence on customer purchasing decisions. The study conducted on Haryana's rural and urban population about the online shopping using AI was resulted with maximum benefits and stated it will influence the customer purchasing behaviour and assist them in selecting or purchasing products that meet their personalized needs. The study has been concluded by stating that no significant effect of artificial intelligence on customer purchasing decisions has been rejected.

Sabina-Cristiana Necula et al [2] in their paper titled "AI-Driven Recommendations: A Systematic Review of the State of the Art in E-Commerce" has aimed to investigate the extent to which the artificial intelligence is utilized in the recommender system for e-commerce and as well explained about other technologies in conjunction with AI to enhance the consumer experience throughout the e-commerce process. This study has explored various AI methods like machine learning, deep learning, and predictive modelling used in e-commerce recommender systems and highlights the integration with technologies like blockchain and virtual reality. The study has also discussed the impact of AI-based recommender systems on sales and the competitive landscape of e-commerce and reviewed the evolving nature of users who prioritize privacy and require trust-building efforts from sellers. The study concluded that most AI-based techniques employed in recommender systems are machine learning, deep learning, augmented reality and virtual assistance and criticized that the effectiveness of AI-based recommendations may vary depending on the specific application, user profiles and recommendation contexts. The study has kept forth a strong point that they did not have enough evidence to determine the drawbacks of AI-based recommendation and it will only pave a way for future enhancement and it is a technique that is very much efficient in the world of ecommerce.

Jinting Shi et al [3] in their conference paper titled "E-Commerce Products Personalized Recommendation Based on Deep Learning" paper proposes a personalized recommendation model for e-commerce products using BERT-Bi-LSTM, aiming to improve recommendation accuracy. This study combines the BERT model for feature extraction with Bi-LSTM for learning contextual semantic information, resulting in more accurate product recommendations. The study has compared the experimental results of various benchmark models like BERT-SVM model, BERT-RNN model and BERT-LSTM model and used RMSE (Root Mean Square Error) to measure the differences between values predicted by different models. Thus, the study examined the experimental results of all the models and concluded that the BERT-Bi-LSTM model achieved the lowest RMSE value of 0.82 compared to other benchmark models, indicating the highest recommendation accuracy. This study provides a proof of utilizing deep learning techniques in AI-based recommendations for efficient results.

III. AI-POWERED PERSONALIZATION

A. AI Powered Recommendation Systems

The AI-powered recommendation systems in the ecommerce which uses AI algorithms and machine learning techniques [2] that depends on huge amount of data in order to suggest or recommend a product to customers. The major difference between the traditional and AI recommendation system is that, the traditional recommendation system operates based on predefined instructions and relies on rule-based approaches, often limited to handle vast amount of data and lacks the ability to learn from different scenarios whereas the AI recommendation systems has the capability to adapt to new situations and provide flexibility in generating dynamic and personalized results. These recommendation systems utilize the advanced AI algorithms to analyze customer behaviour, preferences and historical data to provide personalized product suggestions.

The benefits of AI recommendation systems include enhancing customer experience through personalization – where it expands the options for customers through making personalized suggestions, meeting customer experience expectations, delivering only the relevant contents, reducing customer frustrations and enabling smooth experience across multiple channels.

B. Techniques used in AI Powered Recommendation Systems

The AI recommendation system works by collecting data which includes implicit data, explicit data and behaviour data of users that are generally stored in its knowledge base, analysing the data to get valuable insights and providing suggestions or recommendations that are most aligned to the users' preferences. AI-powered recommendations rely on a combination of machine learning algorithms and data analysis techniques. Some of the techniques that are commonly used [5] in AI recommendation systems are mentioned.
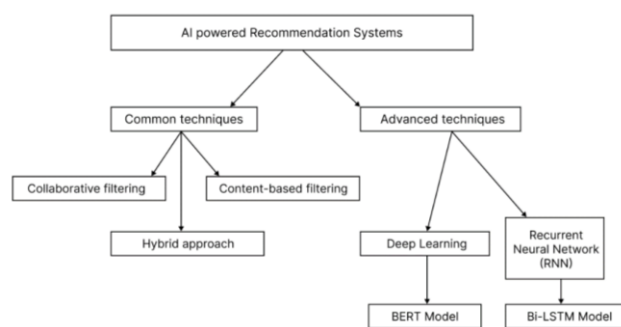

Fig.1 Representation and classification of AI-powered recommendation system

1) Collaborative filtering: The Collaborative filtering technique [6] identifies users with similar purchase history or browsing behaviour. By analysing these similarities, the system recommends products that these similar users have enjoyed. For instance, if a user frequently purchases athletic wear, the system might recommend other popular athletic apparel brands or products frequently bought by customers with similar profiles.

2) Content-based filtering: The Content-based filtering approach focuses on the characteristics of products [5] a user has previously interacted with. By analyzing product attributes

like brand, category, color, or material, the system recommends items with similar features. For an instance, if a user shows interest in a specific brand of derby shoes, the system might recommend other derby shoes from the same brand or shoes with similar specifications.

3) Hybrid approach: Many recommendation engines combine collaborative filtering and content-based filtering for a more comprehensive recommendation strategy [5]. This hybrid approach supports the strengths of both techniques, providing more relevant and diverse suggestions to users [16].

The study also includes some of the advanced techniques in AI recommendations.

4) Deep learning: The deep learning technique [8] is a powerful subset of machine learning which excels at analyzing complex data formats like images and text reviews. By incorporating deep learning algorithms, recommendation engines can gain a deeper understanding of user preferences by analyzing the visual content of products a user has viewed or the sentiment expressed in their reviews [7]. This technique generally uses network architecture and optimization algorithms to train huge amount of data which can be helpful in improving accuracy and personalization by learning automatically pattern and representation. There are several deep learning techniques that are associated in recommendation, this study has explained the working of BERT (Bidirectional Encoder Representations from Transformers) model in detail.

a) BERT model: BERT (Bidirectional Encoder Representations from Transformers) primarily known for its work in Natural Language Processing (NLP). In recommendation systems, BERT [3] can be used to create embedding also known as vector representations for users and items. For users, the embedding could be based on their interaction history, search queries and reviews. Similarly, for items, embedding could be derived from description, titles or metadata. BERT can process and extract the features from text data associated with users and items. Then the model can process the extracted features which can be fed into the machine learning model to generate recommendations. In the feedback loop, the results of the process are subjected back to system which helps to fine tune the model, making it more personalize and accurate over time. In the fig.2, E_i is embedding input, T_i is resultant output and Trm is Transformer network.
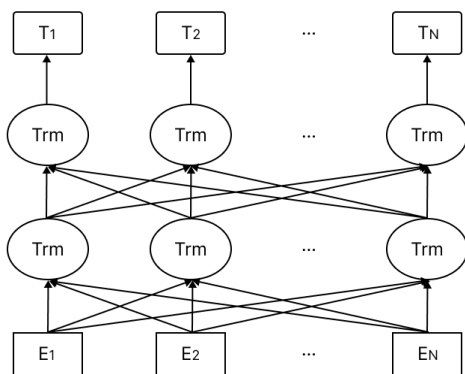
5) Recurrent Neural Network (RNNs): The RNN algorithm is efficient in handling sequential data. In the context of e-commerce recommendations, [10] RNNs can analyze a user's browsing history or purchase sequence, recommending products based on the user's recent interactions. For an instance, if a user starts browsing laptops and then moves on to look at backpacks, an RNN-powered system might recommend laptop bags or other accessories typically purchased alongside laptops. The study has explained one of the RNN algorithms used in recommendation, namely Bi-LSTM (Bidirectional Long Short-Term Memory) model in detail.

a) Bi-LSTM model: Bi-LSTM (Bidirectional Long Short-Term Memory) model leverage sequential and temporal user behaviour data to generate more accurate and relevant recommendations [3]. This model can recognize patterns in user behaviour over time, which is important for predicting future actions. This model collects the user-item interaction data such as view, click and purchase which are organized as sequences. Following which, the model extracts the features from the sequence data, both the immediate context of each action and its relation to past and future actions as these are essential to understand user's behaviour. Subsequently, the model sequences bidirectionally to learn complex user preferences and behaviour patterns. The learned patterns and preferences are then used to predict future user actions or preferences. The model is continuously trained and updated with new user interaction data and learns from the feedback loop. In the fig.3, X_i is input sequences, O_i is output patterns, h_L represents state value of forward LSTM layer and h_R represents state value of backward LSTM layer.
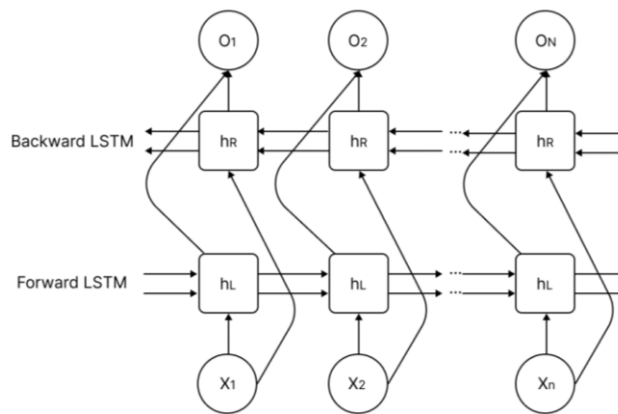

Fig. 3 Representation of Bi-LSTM model

C. Utilization of AI for Personalization

As the Artificial Intelligence (AI) plays a vital role in recommendation systems, the following study examines how to utilise AI for personalization and certain methods that could be taken into consideration.

1) Contextual recommendations: AI can take into account of the current context like time of day, weather, season, festivals and upcoming holidays to suggest relevant products. As, the system gathers information and providing contextual suggestions will be very engaging to user and improve their shopping experience. For instance, an e-commerce platform might recommend raincoats or umbrellas during a rainy season.

Fig. 2 Representation of BERT model

2) Real-time recommendations: By analysing a user's current browsing behaviour or search queries, AI can dynamically recommend products in real-time. This approach personalizes the shopping experience based on the user's immediate needs and interests.

3) Next-basket recommendations: AI can be used to identify complementary products that users are likely to purchase alongside the item they are currently viewing. This technique helps the users to discover new items they might be interested in and increases the average order value for the platform.

4) Personalized search results: AI can tailor the search results based on a user's past searches and purchase history. This ensures that users see products most relevant to their individual needs, saving them time and effort in their search for desired items.

D. Impact of Personalization on Customer Experience

A novel approach to customer experience personalization is emerging through the utilization of AI-powered recommendation systems, significantly impacting business practices. AI is helping businesses see beyond the surface and cater to the unique desires of each customer. These systems are very much helpful for users by providing an environment where they have the flexibility to explore their choices, improving users' engagement, and enhancing positive Customer Experience (CX). Additionally, these systems also help in business perspective by boosting sales, providing suggestions that actually users like which will lead to healthy customer-vendor relationship and increased revenues. There are several impacts of personalization on customer experience that are stated.

1) Enhanced Conversion Rates: Tailoring the shopping experience increases sales by guiding customers directly to what they need, resulting in a lower bounce rate on personalized homepages. By presenting relevant content, language, currency, and shipping costs based on the shopper's location, the user will improve the likelihood of completing a purchase.

2) Elevated Customer Loyalty: Effective loyalty programs go beyond generic rewards by offering personalized incentives tailored to customers' preferences. Rewarding loyal behaviour, such as frequent purchases or successful referrals, strengthens engagement and retention. Aligning rewards with specific product interests or purchase frequencies enhances the program's effectiveness.

3) Improved Customer Experience: Streamlining product choices through curated recommendations and targeted promotions alleviates decision fatigue, preventing potential customers from leaving due to overwhelming options. A user-friendly interface that allows for content filtering and personalized suggestions accommodates diverse customer demographics [4] and preferences.

The success of e-commerce hinges on a customer's ability to discover and purchase desired products. Personalization strategies play a crucial role in achieving this by tailoring recommendations to individual needs. This is supported by the 2021 State of Personalization Report [22] by Twilio Segment, which found that Over half (56%) of consumers say they will become repeat buyers after a personalized experience, a 7% increase year-over-year (Twilio Segment,

2021). Increased conversions signify a positive impact on customer experience. Personalization helps users discover relevant products faster, reducing frustration caused by irrelevant suggestions. This leads to a more efficient shopping journey and ultimately, greater customer satisfaction. By facilitating successful purchases, personalization demonstrates its effectiveness in enhancing the overall customer experience in e-commerce.
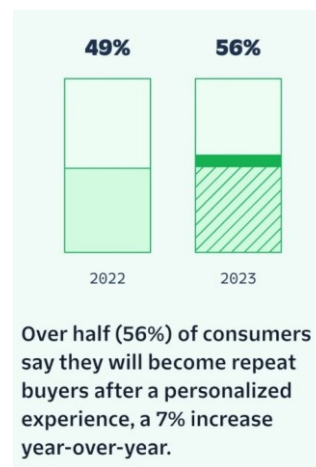

Fig.4 Pictorial representation of impact of personalization provided by Twilio Segment 2021

IV. LIMIITATIONS IN THE EXISTING WORK

The traditional recommendation system has limited functionality to vast amount of data. Unlike the human sales associate, the system cannot adapt to changing requirements and it is unable to produce efficient results when it comes to users' dynamic preferences. This drawback can be addressed with AI recommendation system which has the ability to provide personalization for users. The current AI techniques in recommendation systems possess several strengths that contribute to their effectiveness in providing personalized and accurate recommendations. These techniques, such as collaborative filtering, matrix factorization, and deep learning, excel in handling vast and complex datasets, allowing them to capture intricate patterns and relationships in user behavior. By leveraging machine learning algorithms, recommendation systems can continuously learn and adapt to evolving user preferences, leading to improved recommendation quality over time. Additionally, AI techniques enable recommendation systems [25] to incorporate various data sources, including user interactions, demographic information, and contextual data, resulting in more holistic and context-aware recommendations. Furthermore, advancements in deep learning enable recommendation systems to learn high-level representations of users and items, facilitating more nuanced understanding and prediction of user preferences. Overall, the strength of current AI techniques lies in their ability to provide highly personalized, adaptive, and contextually relevant recommendations, thereby enhancing user experience and engagement in diverse application domains such as e-commerce, content streaming, and social media platforms. However, the system may have some restrictions like limited ability to handle unstructured data, providing creative

solutions and dependency on human input to function. These are some of the valuable insights that can be a considered for the scope for future advancements.

V. CONCLUSION

AI-powered recommendations are the future of building deeper connections with customers. This study gives a comprehensive overview on AI based recommendation systems and how they work to enhance the customer experience. The notable advancements made in the AI-powered recommendation systems are explored. It is well evident that the world is functioning to improve the current working of recommendation system by integrating with Artificial Intelligence (AI) to bring a greater impact in the field on E-commerce. However, to improve user satisfaction and enhance business sectors to next level, considering factors like novelty, integrity and diversity are very much essential.

REFERENCES

[1] Dr. Gaurav Jangra, Monika Jangra, "Role of Artificial Intelligence in Online Shopping and its Impact on Consumer purchasing behaviour and Decision." in 2022 Second International Conference on Computer Science, Engineering and Applications (ICCSEA) | 978-1-6654-5834-4/22/$31.00 ©2022 IEEE | DOI: 10.1109/ICCSEA54677.2022.9936374.

[2] Sabina-Cristiana Necula, Vasile-Daniel Păvăloaia, "AI-Driven Recommendations: A Systematic Review of the State of the Art in E-Commerce". Appl. Sci. 2023, 13, 5531. https://doi.org/10.3390/app13095531.

[3] Jinting Shi, "E-Commerce Products Personalized Recommendation Based on Deep Learning" 2022 6th Asian Conference on Artificial Intelligence Technology (ACAIT) | 978-1-6654-5311-0/22/$31.00 ©2022 IEEE | DOI: 10.1109/ACAIT56212.2022.10137959

[4] Ch. Sai Vamsee, D. Rakesh, I. Prathyusha, B. Dinesh, Ch. Bharathi, "Demographic and Psychographic Customer Segmentation for Ecommerce Applications." 2023 2nd International Conference on Applied Artificial Intelligence and Computing (ICAAIC) | 978-1-6654-5630-2/23/$31.00©2023IEEE|DOI: 10.1109/ICAAIC56838.2023.10140861.

[5] Janisa Gosbel Pereira, Shubha Tiwari, Sheetal Ajoy, "A Survey on Filtering Techniques for Recommendation System" In 2020 IEEE International Symposium on Sustainable Energy, Signal Processing and Cyber Security (iSSSC) | 978-1-7281-8880-5/20/$3 978-1-7281-8880-5/20/$31.00©2020IEEE1.00©2020IEEE | DOI: 10.1109/iSSSC50941.2020.9358819.

[6] R. Prabakaran, J. Pradeepkandhasamy, M. Arun, "A Survey on Recommendation Systems using Collaborative Filtering Techniques", In 2023 5th International Conference on Smart Systems and Inventive Technology (ICSSIT) | 978-1-6654-7467-2/23/$31.00 ©2023 IEEE | DOI: 10.1109/ICSSIT55814.2023.10060889.

[7] Yarasu Madhavi Latha, B. Srinivasa Rao, "Product recommendation using enhanced convolutional neural network for e-commerce platform" in under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2023 https://doi.org/10.1007/s10586-023-04053-3(0123456789().,-volV)(0123456789().,-volV).

[8] Caiwen L, Iskandar Ishak, Iskandar Ishak, Maslina Zolkepli1, Fatimah Sidi, Caili Li, "Deep Learning-Based Recommendation System: Systematic Review and Classification" Digital Object Identifier 10.1109/ACCESS.2023.3323353.

[9] Feng Y (2023) "Enhancing e-commerce recommendation systems through approach of buyer's self-construal: necessity, theoretical ground, synthesis of a six-step model, and research agenda." *Front. Artif. Intell.* 6:1167735. doi: 10.3389/frai.2023.1167735

[10] Naresh Nelaturi, Golagani Lavanya Devi, "A Product Recommendation Model Based on Recurrent Neural Network" Journal Européen des Systèmes Automatisés Vol. 52, No. 5, October, 2019, pp. 501-507 https://doi.org/10.18280/jesa.520509

[11] B Suvarna, Sivadi Balakrishna, "An Efficient Fashion Recommendation System using a Deep CNN Model" 2022 International Conference on Automation, Computing and Renewable Systems (ICACRS) | 978-1-6654-6084-2/22/$31.00 ©2022 IEEE | DOI: 10.1109/ICACRS55517.2022.10029063

[12] Xiangpo Li, "Research on the Application of Collaborative Filtering Algorithm in Mobile E-Commerce Recommendation System", IEEE Asia-Pacific Conference on Image Processing, Electronics and Computers (IPEC), October, 2021. DOI: 10.1109/IPEC51340.2021.9421092

[13] Bang Liu, Hanlin Zhang, Linglong Kong, and Di Niu, "Factorizing Historical User Actions for Next-Day Purchase Prediction", ACM Trans. Web, Volume 1, Article 1, January, 2021. https://doi.org/10.1145/3468227

[14] Orieb Abu Alghanam, Sumaya N. Al-Khatib, Mohammad O. Hiari, "Data Mining Model for Predicting Customer Purchase Behavior in e-Commerce Context – Journal Paper", International Journal of Advanced Computer Science and Applications (IJACSA), November,2022. DOI:10.14569/IJACSA.2022.0130249

[15] T. C. Pahadi, A. Verma and R. Ranjan, "Artificial Intelligence and its Influence on E-Commerce," 2022 International Conference on Applied Artificial Intelligence and Computing (ICAAIC), Salem, India, 2022, pp. 1-6, doi: 10.1109/ICAAIC53929.2022.9792783.

[16] W. Yue, Z. Wang, B. Tian, M. Pook and X. Liu, "A Hybrid Model- and Memory Based Collaborative Filtering Algorithm for Baseline Data Prediction of Friedreich's Ataxia Patients," in IEEE Transactions on Industrial Informatics, vol. 17, no. 2, pp. 1428-1437, Feb. 2021, doi: 10.1109/TII.2020.2984540.

[17] Khrais, L.T. "Role of Artificial Intelligence in Shaping Consumer Demand in E-Commerce." *Future Internet* 2020, *12*, 226. https://doi.org/10.3390/fi12120226

[18] Sungwoon Choi, Heonseok Ha, Uiwon Hwang, Chanju Kim, Jung-Woo Ha, and Sungroh Yoon, "Reinforcement Learning based Recommender System using Bi-clustering Technique." 2018. arXiv preprint arXiv:1801.05532 (2018)

[19] Bang Liu, Hanlin Zhang, Linglong Kong, and Di Niu, "Factorizing Historical User Actions for Next-Day Purchase Prediction", ACM Trans. Web, Volume 1, Article 1, January, 2021. https://doi.org/10.1145/3468227

[20] Vullam, Nagagopiraju & Vellela, Sai Srinivas & B., Venkateswara Reddy & Rao, M & Sk, Khader Basha & D., Roja, "Multi-Agent Personalized Recommendation System in E-Commerce based on User." (2023) 1194-1199. 10.1109/ICAAIC56838.2023.10140756.

[21] https://www.linkedin.com/pulse/how-ai-based-recommendation-systems-transforming-e-commerce-mori-w4h9f#:~:text=These%20recommendation%20engines%20utilize%20sophisticated,customers%20shop%20and%20businesses%20operate

[22] https://segment.com/state-of-personalization-report/#email-capture-form-wrapper

[23] https://learn.segment.com/state-of-personalization-2021/

[24] https://www.appier.com/en/blog/7-critical-challenges-of-recommendation-engines

[25] https://www.researchgate.net/figure/Strengths-and-weakness-of-recommendation-filtering-techniques_tbl3_353485380