**Problem Domain**

The problem domain selected for this project is Marketing.

**The Selected Problem**

The selected problem is prediction of customer purchase behavior on whether the customer will purchase based on their demographic and behavioral data to understand customer inclinations and preferences better which contributes to designing more effective marketing strategies

**Part A - Application Area Review**

Customer is one of the most important assets and the foundation of any successful business. With the proliferation of data, businesses have access to a wealth of information about the customers (Chaubey et al., 2023). The data growth due to advancement of technology has made traditional statistical methods inadequate for marketers to process vast data volumes. The ability of AI to quickly and effectively analyze extensive datasets enable businesses to extract invaluable insights, facilitating the development of targeted strategies that strongly resonate with customers (Fu, Li and Chen, 2023). Observably, a growing trend of artificial intelligence exists in the marketing domain (Labib, 2024). Experts worldwide are trying to figure out the best fit AI solutions for their marketing functions (Verma et al., 2021). Various applications of AI within this domain can be evaluated as follows.

Integration of AI with Customer Relationship Management (CRM) helped organizations such as Zoho, SugarCRM, and Salesforce to improve the management of their customers, specifically by analyzing the vast amount of data data to understand the preferences of potential customers, that drive better business results (Chatterjee et al., 2019).

Chatterjee et al. (2019) describes price optimization as another application of AI. Price and price promotions are important drivers of sales (Guha et al., 2018). AI plays an important role in predicting what price to charge, and whether price promotions should be offered (Shankar, 2018). For example, with use of its AI system Kanetix helps Canadian customers find deals on car insurance by allowing prospective buyers to compare and evaluate policies and rates offered by more than 50 providers.

Chui et al. (2018) describes the potential of analyzing non-numeric data with AI which improves understanding of customer preferences and customer service, primarily using speech and image recognition capabilities achieved with deep learning neural networks. For example, Conversica’s virtual AI assistant, named Angie, sends outbound emails to up to 30,000 leads per month, then interprets the most promising leads from the responses to human salesperson. In a pilot test with a company called Century Link, Angie appropriately interpreted more than 95% of emails received, resulting in a 20-fold return on its investments (Power, 2017).

Robots built using AI are used in a business environments, with the aim is to assign repetitive and predictive tasks to robots which augments human capabilities and allows the (human) associates to focus on more complex customer service requests (Avalos, 2018). Some such instances are, at Café X, a robot barista can serve up to 120 coffees per hour (Hochman, 2018). Another example, the Lowebot at Lowe’s Home Improvement stores (Hullinger, 2016) assists customers by scanning or a voice input of the desired product of a customer, checking availability and navigating to the location of the product. Walmart partnered with Bossa Nova Robotics to deploy robots in its stores to scan shelves. Nguyen and Sidorova (2018) states customer experience can be improved through AI-driven chatbots with Natural Language Processing (NLP).

Another important research area is e-commerce. In this context, Kachamas et al. (2019) proposed an analytic tool with Naïve Bayes classification model which achieved an accuracy of more than 86% for online vendors to predict the behavior of patrons. To find loyal customers from online customers, Charanasomboon and Viyanon (2019) presented a solution for repeat buyer prediction. The Random Forest regressor, with the help of leave-one-offer performed the best. Recently, in a study by Hung and Van Trang (2020) on the purchase decisions of customers. Decision tree, multilayer perception, naive Bayes, radial basis function (RBF), and SVM were used from which decision tree outperformed the other methods, achieving an accuracy of 91.67%. Studies on customer purchase intentions have shown significant progress with the use of clickstream data. The MBT-POP model, which incorporates multi-behavioral trendiness and product popularity, has achieved an impressive F1 score of 0.9031 (Rana et al., 2024). This model exemplifies the utility of integrating behavioral data to refine prediction accuracy in customer purchase behaviors. Machine learning models such as Logistic Regression (LR) and Naive Bayes (NB) have been effectively utilized to predict customer churn in the banking sector. Findings indicate that the Naive Bayes model surpasses Logistic Regression in predictive accuracy (Wen, Lin and Liu, 2023). This demonstrates the continued relevance of traditional machine learning models in specific domains like banking.

The integration of RFID technology with machine learning models effectively analyzes customer behavior in physical stores. Using the received signal strength (RSS) data from RFID tags, time-domain features were extracted and used for classification which demonstrated high accuracy, precision, recall, and F1-score, providing valuable insights for product placement and customer recommendations (Alfian et al., 2023).

Advanced machine learning techniques such as Random Forest, Decision Tree, K-Nearest Neighbors, Neural Networks, and Support Vector Machine have significantly enhanced the understanding of customer purchase patterns in e-commerce, customer purchase behavior, customer experience, streamline inventory management, and optimize marketing strategies, as validated by recent research (Kumar et al., 2023). In the context of online grocery shopping, machine learning models such as Artificial Neural Networks (ANN), Decision Trees (DT), Recurrent Neural Networks (RNN), and Naive Bayes (NB) have shown significant promise. These models estimate the kind and timing of client transactions with high accuracy rates. For instance, ANNs identified intricate patterns with an accuracy of 97.6%, while Decision Trees achieved precision and accuracy rates of 97.3% and 97.8%, respectively (Chaudhary et al., 2024). These insights enable businesses to better understand customer behavior and optimize target marketing efforts.

Analyzing e-commerce customer reviews through multi-label classification provides in-depth insights into customer opinions beyond simple sentiment analysis. Techniques such as Term Frequency-Inverse Document Frequency (TF-IDF), Word2Vec, GloVe, and Bidirectional Encoder Representations from Transformers (BERT) have been employed to extract meaningful features from text. Using algorithms like Binary Relevance, Random Forest, and XGBoost, researchers have achieved high accuracy in classifying multi-label customer reviews, highlighting the diverse opinions customers hold about products (Agarwal et al., 2022).

Lastly, one of the most important research area is using AI for customer purchase behavior prediction.

In the comparative study by Chaubey et al. (2022), different machine learning algorithms were evaluated for customer purchasing behavior prediction. The hybrid classifier using the ensemble stacking method with KNN and SGD demonstrated the best accuracy of 92.42%. Leveraging KNN minimized the errors introduced by SGD. Cardoso (2012) applied logical discriminant analysis for the same problem, achieving maximum accuracy achieved was 90.9% with a two-level and 90.0% with five-level decision tree. Vafeiadis et al. (2015) used ANN, SVM, decision tree, naïve Bayes, and logistic regression algorithms, along with their boosted versions, to predict customer churn. Among these, the best classifier was the boosted SVM (SVM-POLY with Adaboost), with an accuracy of 97%.

Recent advancements in customer behavior prediction have demonstrated the effectiveness of multi-objective evolutionary algorithms (MOEAs). By leveraging techniques such as Word2Vec for feature extraction and boosted ant colony optimization (BACO) for feature selection, the MOEA approach significantly enhances prediction accuracy and efficiency compared to traditional machine learning methods (Krishnamoorthy et al., 2023). This innovative approach highlights the growing trend of combining advanced algorithms and feature engineering techniques to improve predictive models. Federated learning utilizes differential privacy, and homomorphic encryption has emerged as a promising technique for predicting customer behavior while preserving data privacy which is important in today’s data-driven world (Thabet, Messaadia and Kumar, 2023).

In conclusion, Artificial Intelligence is widely applied in the marketing domain and continuous advancements are evident in applications in various areas in marketing.

**References**

Agarwal, V. et al. (2022). Customer - churn prediction using machine learning. 2022 2nd International Conference on Technological Advancements in Computational Sciences (ICTACS), 893–899. Available from https://doi.org/10.1109/ictacs56270.2022.9988187.

Alfian, G. et al. (2023). Customer shopping behavior analysis using RFID and machine learning models. Information, 14 (10), 551. Available from https://doi.org/10.3390/info14100551.

Avalos, G. (2018). Walmart tests shelf-scanning robots in Bay Area. The Mercury News. Available from https://www.mercurynews.com/2018/03/20/walmart-tests-shelf-scanning-robots-bay-area/.

Cardoso, M.G.M.S. (2012). LOGICAL DISCRIMINANT MODELS. WORLD SCIENTIFIC eBooks. 223–253. Available from https://doi.org/10.1142/9789814407724\_0008.

Charanasomboon, T. and Viyanon, W. (2019). A Comparative Study of Repeat Buyer Prediction. In Proceedings of the 2019 2nd International Conference on Information Science and Systems., 306–310. Available from https://doi.org/10.1145/3322645.3322681.

Chatterjee, S. et al. (2019). Are CRM systems ready for AI integration? The Bottom Line Managing Library Finances, 32 (2), 144–157. Available from https://doi.org/10.1108/bl-02-2019-0069.

Chaubey, G. et al. (2022). Customer purchasing behavior prediction using machine learning classification techniques. Journal of Ambient Intelligence and Humanized Computing, 14 (12), 16133–16157. Available from https://doi.org/10.1007/s12652-022-03837-6.

Chaubey, G. et al. (2023). Customer purchasing behavior prediction using machine learning classification techniques. Available from http://dx.doi.org/10.1007/s12652-022-03837-6.

Chaudhary, R. et al. (2024). Artificial Intelligence-Based Digital Marketing for Discovering Shopping Possibilities and Enhancing Customer Experience. IEEE, 413–417. Available from https://doi.org/10.1109/icdt61202.2024.10489412.

Chui, M. et al. (2018). Notes from the AI frontier: Applications and value of deep learning. McKinsey & Company. Available from https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-applications-and-value-of-deep-learning.

Deniz, E. and Bülbül, S.Ç. (2024). Predicting customer purchase behavior using machine learning models. Information Technology in Economics and Business. Available from https://doi.org/10.69882/adba.iteb.2024071.

Fu, L., Li, J. and Chen, Y. (2023). An innovative decision making method for air quality monitoring based on big data-assisted artificial intelligence technique. Journal of Innovation & Knowledge, 8 (2), 100294. Available from https://doi.org/10.1016/j.jik.2022.100294.

Guha, A. et al. (2018). Reframing the Discount as a Comparison against the Sale Price: Does it Make the Discount More Attractive? Journal of Marketing Research, 55 (3), 339–351. Available from https://doi.org/10.1509/jmr.16.0599.

Hochman, D. (2018). This $25,000 robotic arm wants to put your Starbucks barista out of business. CNBC. Available from https://www.cnbc.com/2018/05/08/this-25000-robot-wants-to-put-your-starbucks-barista-out-of-business.html.

Hullinger, J. (2016). What the Lowe’s robot will do for you – and the future of retail. Available from http://campfire-capital.com/retail-innovation/sales-channel-innovation/what-the-lowes-robot-will-do-for-you-and-the-future-of-retail/ [Accessed 11 February 2019]

Hung, Q., DO and Van Trang, T. (2020). An approach based on machine learning techniques for forecasting Vietnamese consumers’ purchase behavior. Decision Science Letters, 313–322. Available from https://doi.org/10.5267/j.dsl.2020.5.004.

Kachamas, P. et al. (2019). Application of Artificial Intelligent in the Prediction of Consumer Behavior from Facebook Posts Analysis. International Journal of Machine Learning and Computing, 9 (1), 91–97. Available from https://doi.org/10.18178/ijmlc.2019.9.1.770.

Krishnamoorthy, R. et al. (2023). Multi Objective Evaluator Model Development for Analyze the Customer Behavior. Available from https://doi.org/10.1109/aece59614.2023.10428189.

Kumar, M.M. et al. (2023). Driving E-commerce Success with Advanced Machine Learning: Customer Purchase Pattern Insights. IEEE, 1196–1203. Available from https://doi.org/10.1109/icscna58489.2023.10370205.

Labib, E. (no date). Artificial intelligence in marketing: exploring current and future trends. Cogent OA. Available from http://dx.doi.org/10.1080/23311975.2024.2348728.

Nguyen, Q.N. and Sidorova, A. (2018). Understanding user interactions with a chatbot: a self-determination theory approach. Available from https://www.semanticscholar.org/paper/Understanding-user-interactions-with-a-chatbot%3A-a-Nguyen-Sidorova/cd1193c8c1a3feb4bad42aee91d50690217cc01b.

Power, B. (2017). How AI is streamlining marketing and sales. Harvard Business Review. Available from https://hbr.org/2017/06/how-ai-is-streamlining-marketing-and-sales.

Rabie El Kharoua. (2024). 🛍️ Predict Customer Purchase Behavior Dataset [Data set]. Kaggle. https://doi.org/10.34740/KAGGLE/DSV/8725150

Rana, N.M.N.U. et al. (2024). Revolutionizing Banking Decision-Making: A deep learning approach to predicting customer behavior. Journal of Business and Management Studies, 6 (3), 21–27. Available from https://doi.org/10.32996/jbms.2024.6.3.3.

Shankar, V. (2018). How Artificial Intelligence (AI) is Reshaping Retailing. Journal of Retailing, 94 (4), vi–xi. Available from https://doi.org/10.1016/s0022-4359(18)30076-9.

Thabet, M., Messaadia, M. and Kumar, M. (2023). Distributed machine learning for predicting customer behavior while preserving privacy. 2022 International Conference on Decision Aid Sciences and Applications (DASA), 613–617. Available from https://doi.org/10.1109/dasa59624.2023.10286716.

Vafeiadis, T. et al. (2015). A comparison of machine learning techniques for customer churn prediction. Simulation Modelling Practice and Theory, 55, 1–9. Available from https://doi.org/10.1016/j.simpat.2015.03.003.

Verma, S. et al. (2021). Artificial intelligence in marketing: Systematic review and future research direction. 1 (1), 100002. Available from https://doi.org/10.1016/J.JJIMEI.2020.100002.

Wen, Z., Lin, W. and Liu, H. (2023). Machine-Learning-Based approach for anonymous online customer purchase intentions using clickstream data. Systems, 11 (5), 255. Available from https://doi.org/10.3390/systems11050255**.**