Customer Churn Prediction using Deep Learning

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ABSTRACT **-** The issue of customers ending their association with a business, known as customer churn, poses a substantial challenge to businesses in a variety of industries. Because it's usually less expensive to keep current clients than to get new ones, churn prediction is an essential component of business strategy. In order to create predictive models for customer attrition, we investigate in this study the use of historical customer data, including demographics, transaction history, customer interactions, and usage habits. Data preparation, feature engineering, model selection, and evaluation are the steps in our methodology. We talk about how crucial feature engineering and selection are to producing useful input features for predictive models. To create precise churn prediction models, major machine learning methods including Random Forest, Gradient Boosting and Neural Networks are used. Metrics are part of the model performance review process. The evaluation of model performance includes metrics such as precision, F1-score, accuracy, ROC-AUC, and recall offering a comprehensive view of predictive capabilities.

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Keywords - Churn, Customer, Demographics, Data preprocessing, Feature engineering, Model selection, Evaluation, Feature selection, Input features

I INTRODUCTION

In today's fiercely competitive landscape, customer churn remains a pivotal concern for industries reliant on subscription-based services, particularly in the domains of telecommunications and banking. The cost-effectiveness of retaining existing clientele over acquiring new customers has propelled businesses to invest heavily in predictive models aimed at pre-empting customer attrition. This survey paper delves into the extensive body of research surrounding customer churn prediction, focusing on its application in the dynamic realms of telecommunications and banking sectors. The telecommunications sector, driven by rapid technological innovations, has witnessed a surge in the adoption of triple play services across European markets. However, this unprecedented growth has been paralleled by escalating pressure on providers to deliver seamless voice, data, and video services. Customer churn, defined as the migration of subscribers to competitor services, poses a significant threat to industry profitability, necessitating the establishment of effective churn prediction models. Existing churn prediction models have grappled with a multitude of challenges, including the oversight of temporal customer behaviour, disregard for class rarity, and the inability to conclusively identify underlying churn causes. To address these limitations, various machine learning algorithms have been employed, providing a robust foundation for enhancing customer retention strategies. The banking sector, likewise, confronts the imperative of accurately forecasting customer churn to optimize resource allocation. This study delves into a comparative analysis of classification models, encompassing Logistic Regression, KNN , Decision Tree Classifier, Voting Classifier, Stochastic Gradient Descent, Naive Bayes, SVM and Random Forest. The aim is to discern the most suitable model for predicting churn, thereby

curtailing resource wastage.Customer relationship management (CRM) assumes paramount importance in customer retention efforts, making accurate churn prediction an indispensable tool for marketers. This survey underscores the spectrum of supervised machine learning classifiers, including Neural Networks, Random Forests, and SVM. Additionally, it spotlights a novel approach leveraging deep learning through RNN models equipped with LSTM units to discern patterns in customer data. The authors present an innovative deep learning framework for customer churn prediction in the telecommunications sector, harnessing the power of RNN with LSTM units. This model showcases exceptional accuracy in churn prediction, validated through metrics such as F1-score, AUC, Maximum Profit measure, and Expected Maximum Profit measure on real-world telecommunications datasets. By synthesizing a wealth of research findings, this survey paper offers a comprehensive overview of the evolving landscape of customer churn prediction models. The convergence of technological advancements and analytical methodologies in this domain presents an invaluable resource for industry stakeholders seeking to fortify their customer retention strategies in an increasingly competitive market and.

II RELATED WORK

(Agarwal et al., 2022) customer churn, or the progressive drop in repeat business, is a major worry for organizations, particularly in the banking industry. Early switcher detection supports proactive retention initiatives. In order to predict the possibility of customer churn, this article uses machine learning, specifically Logistic Regression (LR) and Naive Bayes (NB), along with information about the client's age, geography, credit history, and balance. NB is revealed to be the best model. The paper promotes enhanced churn prediction methodologies, highlighting the combination of methods, such as LGBM-Classifiers and boosting procedures, for improved accuracy and performance. These developments show promise for future churn computation, offering priceless support for customer retention initiatives which helps the customers in the nearby future.

(Agrawal et al., 2018) In Customer churn, or when a group of customers stop using a company's services, has an effect on a company's profitability and stability, hence it is important to foresee it. Deep Learning stands out because it can find important features in complicated, unstructured datasets like those from the telecom industry. Analyzing the major factors significantly determining churn rates is necessary for understanding and predicting churn. The study uses deep learning to predict churn with an accuracy of 80.03%, showing characteristics that are important for client retention efforts. This study enables businesses to focus on important factors for customer retention, reducing losses to rivals.

(Ahmad et al., 2019) this project presents the essential issue of customer turnover is addressed in this study, particularly in the telecom industry where it has a direct impact on revenues. A churn prediction model is created using machine learning techniques on a big data platform along with cutting-edge feature engineering and selection approaches. The area under the curve (AUC) score for the model is an amazing 93.3%. Notably, adding Social Network Analysis (SNA) elements improves performance even more, increasing AUC from 84% to 93.3%. The model surpasses the XGBOOST method for classification when tested on a sizable dataset from the telecom firm SyriaTel. This study is helpful in guiding profitability and reducing customer churn for telecom firms like SyriaTel.

(Ahmed et al., 2017) the Customer turnover, a crucial component of the telecom industry, frequently results from discontent or better deals from rivals. Churn prediction and prevention are crucial, driving businesses to use various data mining and machine learning techniques. Customized products and effective retention techniques are required due to the intense competition. Hybrid methods are the most accurate, however existing techniques such as meta-heuristics and machine learning show effective churn prediction. This study highlights not just precise churn prediction but also examines churn causes and method shortcomings, laying the groundwork for possible hybrid model development in subsequent studies.

(Amol Chole et al., 2023) In Large businesses, especially those in the telecom sector, face a substantial difficulty as a result of customer turnover, necessitating the development of reliable prediction techniques. By creating a churn prediction model using machine learning and deep learning techniques on a sizable dataset derived from GitHub, this study makes a contribution. The model performed better than expected when tested using algorithms including Random Forest, SVM, KNN, and CNN. The Random Forest approach produced an accuracy of 83.11%. In order to improve churn prediction, future research will concentrate on fine-tuning hyperparameters and investigating various machine learning techniques for feature selection and resampling data.

(Anvita Gupta et al., 2022) predicting customer churn is crucial for banks to proactively engage with at-risk customers and prevent attrition. Early intervention alone can reduce churn by 11%. Utilizing past customer data through machine learning and data science techniques offers a solution. This study compares various churn prediction models used by financial organisations., ultimately advocating for a hybrid approach. Results indicate that this hybrid method outperforms existing models and voting classifiers, showcasing its superior accuracy. This underscores the importance of feature impact assessment and dataset clustering for tailored prediction. Future work may involve further sub-clustering and employing additional classification algorithms for enhanced accuracy and outlier mitigation.

(Bhatnagar et al., 2019) customer churn is a challenge for businesses because of fierce competition and a wide range of telecommunication services. Potential churners must be early identified for retention strategies to succeed and be profitable. Churn categorization encompasses both voluntary and involuntary churn, with an emphasis on anticipating purposeful churn. This forecast, a task for supervised classification, aids companies in retaining customers and lowering customer acquisition expenses. Machine learning classifiers like Logistic Regression, Support Vector Machine and Decision Tree are frequently employed in churn prediction models. This paper evaluates the state-of-the-art in churn prediction research, highlighting issues and suggesting future research directions while providing sage advice for young researchers.

(Bhuse et al., 2020) delivers that the customers have many options in today's competitive market, making client turnover a critical concern for banks. In order to retain engagement, this article uses machine learning approaches to forecast client attrition in the banking industry. The study examines consumer behaviour by classifying data using KNN, SVM, Decision Tree, and Random Forest classifiers, as well as feature selection techniques. Following oversampling, experimental results on a Kaggle churn modelling dataset favoured the Random Forest model, displaying improved accuracy. The study stresses the significance of early-stage churn prediction in the banking industry and offers insights for larger-scale applications while using a very small, unbalanced dataset.

(Bin et al., 2007) customer attrition prediction is essential for profitability in the cutthroat Chinese telecom market. Even with insufficient customer data, it's crucial to improve attrition models. The paper recommends decision tree-based experimentation for efficient churn prediction. The churn model's recall rate, precision rate, and F-measure increased as a result of changing the sub-periods of training data, misclassification costs, and sample techniques. With the use of this technique, China Telecom can successfully predict and control customer churn, increasing customer retention in a cutthroat industry. To further improve prediction churn models in related scenarios, future research could investigate alternative data mining techniques.

(Celik et al., 2019) minimizing expenses is essential in today's fiercely competitive environment. Research shows that keeping existing customers costs ten times less than recruiting new ones, highlighting the importance of customer churn monitoring. In the context of customer churn analysis, this paper examines a number of machine learning methods, including ANN, decision tree, SVM, naive bayes, knn, and XG Boost. Machine learning algorithms are considered to be trustworthy

substitutes for time-related event estimates, such as customer turnover, even though deep learning approaches exhibit greater performance in complex circumstances. While deep learning approaches excel in complex structures, the Cox regression model efficiently analyses independent variables influencing temporal variables and risk groups. Deep learning techniques are expected to continue to progress and produce even higher success rates over time.

(Fujo et al., 2022) this study addresses the pressing issue of customer churn in the telecom industry by implementing a Deep-BP-ANN model, bolstered by feature selection methods and overfitting prevention techniques. The model outperforms traditional ML techniques like KNN, Logistic Regression, XG Boost, and Naïve Bayes on real datasets (IBM Telco and Cell2cell) with an accuracy exceeding 88%. Lasso regression proves pivotal for feature selection, particularly in datasets with numerous attributes. The ROS technique effectively balances the datasets, and activity regularization aids in mitigating overfitting. Fine-tuning parameters, such as neuron count and epoch number, significantly enhance performance.

(Gaur et al., 2018) says that in Churn research, which makes use of data mining, forecasts client attrition, which is essential in today's cutthroat marketplaces. Predicting customer loss improves marketing, customer loyalty, and communication, which has an effect on profitability. To efficiently retain customers, businesses, particularly telecom providers, concentrate on identifying customer churn factors. Gradient Boosting emerges as the most efficient, followed by Logistic Regression and Random Forest, with SVM performing somewhat less well. These machine learning models include Logistic Regression, SVM, Random Forest, and Gradient Boosted Tree.

(Hu et al., 2018) client churn prediction uses a variety of machine learning classifiers and is essential for client retention and current CRM. Time series customer data analysis is now possible because to recent advancements in data technology, improving accuracy. A pRNN model with LSTM units and product operations has been proposed, and it exhibits great accuracy in predicting churn in the telecom industry. The article covers potential future research topics and emphasizes the importance of recurrent neural networks in processing sequential input. To validate findings and investigate long-term prediction views, additional diversified real-world datasets are required.

(Ismail et al., 2015) the customer management is essential in the telecommunications sector to prevent churn. The large expenses involved with adopting it across the whole customer base can be avoided with targeted retention initiatives for likely churn clients. Utilizing historical churn data and predictive factors, churn management focuses on prediction. While long-term success is assured by keeping existing clients, traditional marketing places greater emphasis on obtaining new ones. With a prediction accuracy of 91.28%, Multilayer Perceptron Artificial Neural Network outperforms conventional statistical models in predicting customer attrition. These information should be used in customer retention initiatives to effectively lower churn rates.

(Karvana et al., 2019) the customer attrition in banking may be accurately predicted by data mining. Recall rates are highly influenced by sample size and inter-class comparisons, favoring a 50:50 data ratio with a 70% recall. Each class has roughly 7,975 samples out of approximately 15,949 data samples. The 50:50 SVM sampling model is the most effective one, which identifies important characteristics like vintage, EDC transaction volume and amount, average balance, and age and generates a large profit of 456 billion. This is consistent with the research, which highlights SVM's accuracy while highlighting Logistic Regression's ability to reduce losses.

(Kumar, P et al., 2023) distributed denial-of-service (DDoS) attacks pose a significant threat to the confidentiality and integrity of computer networks, disrupting web traffic to target servers and impeding authorized user access to services. Detection of DDoS attacks can be challenging, requiring robust mitigation strategies due to the diverse methods used to flood networks or servers.

These assaults leverage resource limitations, impacting the functionality of the targeted organization's website infrastructure. Analyzing the most recent datasets is crucial for identifying and understanding the evolving landscape of DDoS attacks, assessing their varied techniques, and evaluating their efficacy. Clients accessing network services are consistently exposed to this pervasive and severe threat, necessitating ongoing vigilance and proactive security measures.

(Kumar, P. et al., 2023) delves into the pressing issue of increasing energy consumption within cloud server farms, highlighting their substantial contribution to environmental pollution resulting from heightened power usage. This study accentuates the complexities associated with mitigating power consumption while upholding agreements concerning service quality. To address this challenge, the paper proposes a solution centered on optimizing resource allocation. This involves a strategic approach that limits the operation of dynamic servers, thereby aiming to curtail energy usage while simultaneously meeting the demands of clients and ensuring efficient task performance. To validate the efficacy of their proposed algorithms, the researchers leverage Cloud Sim, a simulation tool, utilizing real-world data obtained from a significant pool of over 1000 Planet Lab virtual machines. The study underscores the pivotal role played by server farms in this evolving technological landscape, emphasizing the critical need to strike a balance between energy conservation and maintaining high-quality service provision.

(Maw et al., 2019) the companies have a problem from customer churn, which is a result of severe competition and a variety of telecommunication services. For retention initiatives to be successful and profitable, potential churners must be identified quickly. With an emphasis on foreseeing intentional churn, churn categorization includes both voluntary and involuntary churn. This forecast, a supervised categorization task, helps businesses keep clients and cut acquisition costs. In churn prediction models, machine learning classifiers like Support Vector Machine, Logistic Regression, and Decision Trees are widely used. This paper examines current churn prediction research, noting problems and potential areas for future research while offering insightful advice for up-and-coming scientists. The research, though, is time-bound and concentrates on churn that is instigated by the consumer.

(Rahman et al., 2020) the customers have many options in today's competitive market, making client turnover a critical concern for banks. In order to retain engagement, this article uses machine learning approaches to forecast client attrition in the banking industry. The study examines consumer behaviour by classifying data using KNN, SVM, Decision Tree, and Random Forest classifiers, as well as feature selection techniques. Following oversampling, experimental results on a Kaggle churn modelling dataset favoured the Random Forest model, displaying improved accuracy. The study stresses the significance of early-stage churn prediction in the banking industry and offers insights for larger-scale applications while using a very small, unbalanced dataset. The results also show how important oversampling is for resolving data imbalances, especially when applied to SVM classifiers.

(Sudharsan et al., 2022) in the cutthroat and fast-paced telecom sector, client turnover is a significant problem that needs to be addressed. S-RN0N is a unique framework for precise churn prediction. The model divides clients into churners and non-churners, and if churn is anticipated, it prompts further study for retention tactics. Data collection, preprocessing, filtering, grouping, feature engineering, and classification are all included in the suggested methodology. The S-RNN model performs admirably in experimental analysis, attaining outstanding metrics like 98.27% sensitivity, 92.31% specificity, and 95.99% accuracy. The suggested method also performs better in terms of resilience and reliability than current methods.

(Zhang et al., 2022) the telecom companies face a pressing challenge with client churn, impacting profits in a saturated global market. Although attracting new clients is expensive, keeping the ones you already have is more cost-effective. Predicting

and preventing customer churn has become a top priority for telecom companies. This study introduces discriminant and logistic regression models using customer segmentation data from major Chinese telecom firms. The findings empower managers to accurately predict customer behaviour, enhance retention strategies, and optimize budgets.

(Zhao et al., 2008) the customer loyalty has a bigger impact on bank profits than things like growth and market share. client churn lowers sales and new client acquisition. Data mining provides for accurate churn prediction and customized marketing tactics. With excellent accuracy and practical considerations, a support vector machine (SVM) model beat other classifiers in predicting bank customer attrition. SVM is a reliable method for churn prediction because of its straightforward classification surface, good generalization, and fitting accuracy.

III METHODOLOGY

1. Logistic Regression: Whenever the dependent variable is binary, logistic regression regression analysis is useful (binary). At the nominal, ordinal, interval, or ratio levels, data can be described and the relationship about one dependent binary variable and one or maybe more independent variables can be demonstrated using logistic regression. Logistic regression is used to determine the probability ratio of a group of explanatory factors. The response variable is binomial, but other than that, the process is comparable to multiple linear regressions. The outcome is how each variable affects the overall rate of the pertinent occurrence.

2. Linear Discriminant Analysis: Using linear discriminant analysis is one way to lower dimensionality. It serves as an initial step in applications involving pattern recognition and machine learning. To minimize energy and dimension costs and address the curse of dimensionality, Linear Discriminant Analysis (LDA) strategically places functions into a lower-dimensional space within a broader context. By compressing the feature space intelligently, LDA enhances model generalization and facilitates more effective analysis of high-dimensional data.

3. K-Nearest Neighbours Classifier: Through using nearest neighbours as an illustration of a question and those neighbours to determine the query's class, the Nearest Neighbour Classifier carries out classification. This categorization approach is highly intriguing because present data centres do not solve common run-time efficiency issues.

4. Support Vector Machines: Regression is another name for support vector machines (SVMs), which are supervised learning methods for classification. In order to maximise predicted accuracy and avoid overfitting the training set, Support Vector Machines (SVM) employ regression modelling and classifiers that are already part of machine learning theory. Typically, SVMs are conceptualised as systems that employ functions inside a high-dimensional feature space, and are trained by a statistical learning strategy based on optimisation theory.

5. Random Forest: Eighty percent of the dataset is used for training with one hundred estimators, meaning that one hundred trees are built and the average of the predictions is then calculated. For every decision tree, the maximum depth is assumed to be 10. Using this method, significant traits are ranked and forecast according to decision tree voting. Thus, Random Forest provides us with excellent accuracy.

6. XG Boost: One of the classifiers is the Python implementation of the XGBoost package. Extreme Gradient Boosting, or XGBoost for short, is a boosting and gradient descent hybrid. A supervised ensemble learning approach called "boosting" operates by allocating distinct weights to the training data distribution for every iteration. To determine the ideal split, the XGBoost algorithm employs the exact greedy algorithm. The XGBoost classifier excels in prediction models due to its superior cache optimization, enhancing computational efficiency. However, its iterative nature results in longer training times compared to some other methods and algorithms.

IV PROPOSED SYSTEM

Proposed System for Customer Churn Prediction: In this project paper, we propose the development of an advanced customer churn prediction system that leverages cutting-edge machine learning and deep learning techniques to help businesses proactively identify and retain at-risk customers. The system will involve the collection and preprocessing of historical customer data, including demographic information, transaction history, and customer interactions. Feature engineering and selection will be employed to extract relevant information, and a diverse set of machine learning algorithms, such as logistic regression, decision trees, neural networks, and Convolution Neural Networks will be implemented to model customer churn behaviour..This system aims to help organizations reduce customer attrition, enhance customer loyalty, and ultimately improve their bottom line. To enhance the accuracy of the models we fine tune this with different hyperparameters and increase the overall accuracy of these models.

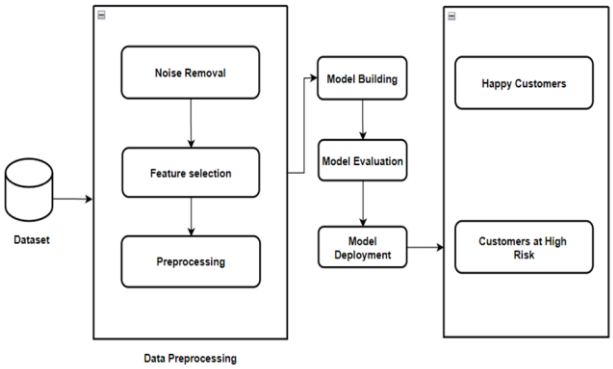

Figure 1.1 Architecture Diagram

V CONCLUSION

This study highlights the application of deep learning techniques in predicting client retention, emphasizing their effectiveness in capturing intricate customer behaviour patterns. The telecom sector, in particular, stands to benefit significantly from this approach. By harnessing the power of deep neural networks, telecom companies can analyse extensive customer data to proactively address churn-causing factors. This predictive strategy enables the implementation of targeted retention initiatives, such as personalized offers and engagement programs, ultimately leading to reduced churn rates and heightened customer satisfaction. It is crucial to note that successful implementation of deep learning models requires high-quality data and ongoing refinement. As the telecom industry evolves, adopting deep learning for churn prediction will be imperative for maintaining competitiveness and securing customer loyalty. To overcome churn, a multifaceted strategy to overcome churn. This entails enhancing customer support, tailoring communications, putting loyalty plans into place, examining data trends, and applying predictive algorithms to spot at-risk clients early. Reducing churn also involves competitive pricing, personnel training, targeted retention marketing, communication, customer feedback, and retention campaigns. By combining these strategies, businesses can increase profitability, strengthen customer loyalty, and gain competitive advantages in the fast-paced market of today.

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