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Analysis of customer churn prediction using machine learning and deep learning algorithms

A Mahalekshmi

Research scholar, RaniAnna Government College for women, Tirunelveli, Tamilnadu, India

Corresponding author email: mahaas2104@gmail.com

G Heren Chellam

Assistan Professor of Rani Anna Government College for Women, Tirunelveli, Tamilnadu, India

Email: herenchellam@gmail.com

Abstract---The telecommunication industry need a customer churn prediction due to many competitors. The companies also lack of churn prediction to retain the customer. This problem not only affect the growth of the business but also affect the revenues. To retain the existing customer is very crucial task for the company. A rapid increasing in technology, the various machine learning and deep learning are tools are developed which can be used by telecoms companies to monitor the churn behaviour of customers. In this study, a brief idea on the customer churn problem on various machine learning techniques such as XGBoost, Gradient Boost, AdaBoost, ANN, Logistic Regression and Random Forest are analysed. Also the various deep learning techniques such as Convolutional Neural Network, stacked auto encoders to predict the customer churn problem are analysed by comparing the models in terms of accuracy.

Keywords---Churn prediction, Telecommunication, Machine Learning, Deep Learning.

Introduction

Customer churn is focus of the industries has been shifted to retaining the customer than acquiring the new customer. In CRM churn management is very important because it is already proved that the art of identifying the valuable customers, who are churn from a company and take a necessary steps to retain them. The telecommunication industry has got tough competition between the various service providers. So, they keep introducing new attractive offers every day, making the customers switch from one competing mobile service provider to

another. The fact that the customers to search of better services at a lower cost so that they are switch between the operators at any time.

The telecom companies facing the customer churn problem frequently because they are not able to predict the customers who are going to churn on a time. Churn prediction is important in telecommunication industry to retain their valuable customers and strengthen their customer relationship management by making the effective churn prediction model is required to identify the customers to leave the services at right time.

Customer churn is recognized as an important issue in telecommunication industry due to the direct affect on their revenues. So, the telecommunication industries focus on reducing customer churn and identifying suitable techniques for doing so. The company faced the customer churn prediction try to acquire new customers that become 5 to 6 times expensive than retaining the existing customers. The reason for customer churn due to higher cost low quality, low features and etc. To reduce customer churn the telecom industry has introduced a new offer like internet services, free calls to retain the customers.

Machine Learning is the most widely used and fastest growing subset of Artificial Intelligence. Machine Learning techniques are mathematical techniques that adopt and evolve based on the given data and process to produce the pre determined outcomes. Machine Learning uses various task were the programming algorithm with high performance was difficult. Mainly there are two categories of Machine Learning algorithms, such as, Supervised and Unsupervised Machine Learning. In supervised Machine Learning algorithm, its training data are already labelled or structured, on the other hand, the unsupervised Machine Learning algorithm work with unstructured data, that is, the data has not already been classified or labelled. Table 1 list the Machine Learning techniques have been used for churn prediction in telecom industry.

In Deep Learning a computer models learns to perform the classification tasks directly from text, images or sound. Deep Learning machines works better than Machine Learning techniques. Deep Learning gives better accuracy than the other techniques for large data. Deep Learning techniques are trained by using large sets of labelled data and Neural Network that learn features directly from the data without the need for manual feature extraction. Machine Learning uses a variety of techniques and models based on the given data. Deep Learning requires a large amount of labelled data. Table 1 list the Deep Learning techniques have been used for churn prediction in telecom industry

In general, there are many machine learning and deep learning techniques were used to predict the customer churn with better accuracy. This study, compares the churn prediction using machine learning techniques namely, XGBoost, Gradient Boost, AdaBoost, ANN, Logistic Regression and Random Forest and deep learning techniques namely, CNN, stacked auto encoders.

Literature Review

Lopamudra Hota et al., [3] explores how various machine learning techniques can be used to predict customer churn via models such as XGBoost, Gradient Boost, AdaBoost, ANN, Logistic Regression and Random Forest and also compare the effectiveness of the models in term of accuracy. The dataset used from the IBM Telecom's Kaggle Dataset and the set consists of 7043 instances of 21 attributes. The future work proposed to achieve better result with the same techniques for various other datasets form telecom industry. The proposed analysis found that ANN, XGBoost models were out perform the other models in terms of precision for modelling and testing.

Irfan Ullah et al., [8] the proposed churn prediction model is evaluated using metrics, such as accuracy, precision, recall, f-measured receiving operating characteristics area and the churn prediction model produced better churn classification using the customer profiling using K-means clustering and RF algorithm. There are two dataset are used. The first dataset is obtained from South Asia GSM telecom service provider which contains 64,107 instances with 29 features. The second dataset is available in churn – bigml dataset. The future work investigate eager learning and lazy learning approaches for better churn prediction.

Alrence Santiago Halibas et al., [9] the proposed study implemented exploratory data analysis and feature engineering in a public domain Telecoms dataset and applied seven classification techniques namely, Naïve Bayes, Logistic Regression, Generalized Linear Model, Deep Learning, Random Forest, Decision Tree, and Gradient Boosted Trees. The proposed study revealed that all classifiers have achieved more than 70% of accuracy and also examined the use of oversampling the minority class. This study recommends GBT algorithm of choice for churn prediction.

Hemalata Jain et al., [10] proposed two machine learning techniques for predicting customer churn such as Logistic Regression and Logit Boost. The experiment was carried out by WEKA machine learning tool. The database used from an American Company named Orange. The datasets contains 3333 instances has 20 attributes. The experiment reveals that there was not much difference in results of both techniques. Logistic Regression had an accuracy of 85.2384%, where as Logit Boost had an accuracy of 85.1785%. The future work focus on a real and big database.

Praveen Lalwani et al., [2] proposed the prediction process using the most popular predicting models, namely, Logistic Regression, Naïve Bayes, Support Vector Machine, Random Forest, Decision Tree, etc. on train set and also in boosting. The experiment results shows that AdaBoost and XGBoost classifier gives maximum accuracy of 81.71% and 80.80%.

Abdelrahim Kasem Ahmad et al., [11] proposed Decision Tree, Random Forest, Gradient Boosted Tree and Extreme Gradient Boosting algorithms for churn prediction in telecommunication industries. A large data set provided by SyriaTel telecom company. The 70% of dataset used for training and the 30% of dataset

for testing. The experiments results that the value of AUC (Area Under Curve) in SyriaTel reached 93.301%. To enhance the results of in churn prediction telecom companies by the use of social network analysis features.

Uzain Ahmed et al., [12] presents a solution to the internet problems of churn prediction, using the concept of Transfer Learning(TL) and Ensemble – based Meta – classification. The dataset used from the two standard telecom companies, namely, orange and cell2cell. The proposed TL – DeepE makes use of multiple CNN architectures and GP – AdaBoost ensemble as meta – classifier are evaluated to obtain the churn predictions. The experiment results that TL – DeepE gave a churn prediction accuracy of 75.4% and AUC value is 0.83 on Orange Dataset and it gave a churn prediction accuracy of 68.2% and AUC value is 0.74 on cell2cell Dataset.

Nurul Izzati Mohammad et al., [13] proposed to identify the factors that influence customer churn and develop an effective churn prediction model as well as provide best analysis of data visualization results. The dataset from kaggle open data website. There are three machine learning classifiers such as Logistic Regression, ANN and Random Forest are used. The experiments results with high accuracy of 85% . The Logistic Regression classifier shows the best results. J Pamina et al., [14] proposed to predict the customer churn using the machine learning techniques like, KNN, Random Forest and XGBoost. IBM Watson dataset used for this analysis. The comparison study gave XGBoost classifier perform well out of the other classifiers namely KNN, Random Forest. The experiment results that fibre optic customers have a higher influence of churn because of its higher monthly charges.

V Kavitha et al., [4] proposed to predict the customer churn using the machine learning techniques, namely, Decision Tree, Random Forest, XGBoost. Dataset is used form Kaggle. The proposed work for churn prediction shows that Random Forest technique gave better accuracy among the other methods.

Samah Wael Fujio et al., [1] proposed Deep –BP- ANN deep learning technique used for customer churn prediction. IBM Telco and Cell2Cell data sets are used for this analysis. The Deep – BP – ANN model outperforms they existing deep learning techniques with great accuracy that uses holdout or 10 – fold CV for the same datasets. In future, the prior stopping technique use to achieve the higher accuracy with the help of 10 – fold cross validation as achieved with the hold – out evaluation method.

Anurag Thantharate et al., [15] proposed deep slice model which will be used to make a decision and a select an appropriate network slice even if a network failure occurs. This demonstrate the benefits of deep slice for predicting the best network slice based on device key parameters. In future to improve this model with hand overs catching and predicting the future load and borrowing resources form other slices.

Sarangi Choudhari et al., [16] proposed customer churn prediction using Convolutional Neural Network (CNN). The experiments shows that CNN gave 10% more accuracy than the other Neural Networks. In the future, use Artificial

Intelligence techniques such as deep nets and fuzzy deep nets to improve the performance of the churn prediction algorithms and also to work on security of churn prediction by using the block chain based techniques for better system performance.

Mirjana Karanovic et al., [19] proposed CNN which was applied as a classifier on pre-processed one dimensional dataset of accuracy 98.85%. Dataset is used from orange telecom. The removal of machine values and redundant data are reduced by pre-processing with the help of Lasso and manual feature engineering. The future work focus on network complexity and feature selection.

Sunday A Amatare et al., [5] proposed Convolutional Neural Network model for predicting the behaviour of the churning customers. The two datasets used from the cellular companies from Nigeria, which contains 14000 data instance. The CNN models gave a great accuracy of 89%. In future an ensemble technique to improve the accuracy.

Nasebah Almufadi et al., [17] proposed CNN model for churn prediction. The datasets contains 100k instances got from mobile company dataset. The experiment results that the proposed model have 96% accuracy. Only one dataset used in this work for predicting customer churn. In future, a similar models with other datasets will be used. The proposed model could be used in the other sector.

Nadia Alboukaey et al., [6] proposed the deep learning models like. LSTM based model and CNN based model. The datasets are got from MTN operator in Syrian Arabic Republic. The experiment shows that LSTM based model out performs CNN based model. In this study, addresses the customer churn prediction based on the daily behaviour of the customer instead of the monthly based. The future work to extend the RFM based and LSTM based models by adding a dummy variable for customer churn prediction.

Atallah M AL – Shatnwai et al., [7] proposed one of the powerful machine learning techniques such as XGBoost with the oversampling methods for customer prediction in telecom industry. The dataset contains 5000 instances. The proposed studying uses the four common oversampling methods which are random oversampling, SMOTE, ADASYN and Borderline SMOTE. The experiments shows that the oversampling method improve the performance of XGBoost Tree for predicting the churn classes.

Shulin Cao et al., [18] proposed the deep learning techniques for customer churn. The dataset used from a telecom operator which contains 400,000 customer behaviour records. The stacked autoencoder network is used to extract features from the data and classify the customers using logistic regression.

Ruiqi Li et al., [20] proposed stacked auto encoder for feature extraction in churn prediction and also proposed a new hybrid feature extraction framework based on stacked auto – encoder and Fisher's ratio analysis. The dataset are used from Orange Telecom. The experiment results that the proposed method enhanced the performance of prediction models both on AUC and computing efficiency.

Analysis of Churn Prediction

Machine Learning Algorithm

Extreme Gradient Boosting (XGBoost) was improved version of the Gradient Boost algorithm and this algorithm is one of the machine learning techniques. This tools applied for regression and classification. A Random Forest method is the ensemble learning and supervised learning, both are used for classification and regression. AdaBoost is another ensemble classifier. A single algorithm is combined with the AdaBoost classifier gives good accuracy of score. ANN can also appropriate for handling large datasets and more complex Machine Learning Problems, namely, image classification, speech recognition or video recommendation. Logistic regression is the machine learning algorithm. This is the simplest machine learning algorithms applied for classification problems like, churn prediction, fraud detection, spam detection and so on. Gradient Boosting is one of the machine learning algorithm. This method is used for classification and regression, to remember that use weak learner only.

Table 1
Performance of Machine learning Algorithms used for churn prediction in telecom industry

Authors	Classifiers/Techniques used in churn prediction	Results
Lopamudra Hota et al.,	XGBoost, Gradient Boost, AdaBoost, ANN, Logistic Regression and Random Forest	ANN, XGBoost models were outperform the other models in terms of accuracy.
Irfan Ullah et al.,	Random Forest and K-means clustering	Random Forest J48 produced better F-measure result.
Alrence Santiago Halibas et al.,	Navie Bayes, Generalized Linear Model, Logistic Regression, Deep Learning, Decision Tree, Random Forest and Gradient Boosted Trees.	All classifiers have achieved more than 70% of accuracy. The GBT outperformed the other classifiers.
Hemlata Jain et al.,	Logistic regression and Logit Boost	Both techniques are outperformed. Logistic regression had an accuracy 85.2385%, Logit Boost hand an accuracy 85.1785

Praveen Lalwani et al.,	Logistic regression, Naïve Bayes, Support Vector Machine, Random Forest, Decision Tree, Extra Tree, XGBoost, CatBoost and AdaBoost	AdaBoost, XGBoost classifiers gives maximum accuracy with AUC score of 84%
Abdelrahim Kasem Ahmad et al.,	Decision Tree, Random Forest, Gradient Boosted Tree and XGBoost	XGBoost achieved the best results with AUC value of 93.01%
Uzain Ahmed et al.,	AdaBoost and Deep CNN	The experiments are conducted using CNN as base classifiers and GP-AdaBoost as a meta classifier and the prediction accuracy are 75.4% and 68.2% on Orange and Cell2Cell datasets respectively.
Nurul Izzati Mohammad et al.,	Logistic Regression, ANN and Random Forest	All the classifiers produces a results with an accuracy over 85%. But the LR outperforms compared to ANN and RF.
J Pamina et al.,	KNN, Random Forest and XGBoost	XGBoost classifier outperforms compared to KNN and RF classifiers with an accuracy 0.798 and F-Score 0.582
V Kavitha et al.,	Decision Tree, Random Forest and XGBoost	RF produced better results and better accuracy
Atallah M AL-Shatnwai et al.,	XGBoost and Gradient Boost Tree	The experiments implemented with over sampling methods. The performance of GBT gives best result with F-measure value around 84%

Deep Learning Algorithms

CNN is a specific type of Artificial Neural Network for supervised learning algorithm to analyse the data. CNN method used various area, like, image and pattern recognition, natural language processing and video analysis. Convolutional Neural Network was applied to data classification process. It is also classified one dimensional data. Stacked auto encoders is unsupervised deep learning method and it is formed by stacking multiple auto encoders together which includes one input layer, one hidden layer and one output layer.

Table 2
Performance of Deep Learning Algorithms used for churn prediction in telecom industry

Authors	Classifiers/Techniques used in churn prediction	Results
Shulic Cao et al.,	Logistic Regression and stack auto encoder(SAE)	For extract features the used stacked auto encoder network and logistic regression to classify the customers
Nadia Albaukaey et al.,	LSTM based model and CNN based model	LSTM based model outperforms significantly the CNN based model.
Samah Wael Fujo et al.,	ANN, backpropogation and Lasso regression	The Deep – BP – ANN model results outperforms the other methods
Sarangi choudhai et al.,	Neural network and CNN	CNN outperforms the other type of churn prediction by at least 10% as far as precision
Sunday A Amatare et al.,	CNN and Multi – layer Perceptron (MLP)	CNN implemented python programming language and gives accuracy of 88.22%
Anurag Thantharate et al.,	Deep Learning Neural Network	DLNN implemented to develop Deep Slice
Mirjana Karanovic et al.,	Convolutional Neural Network	The preprocessing phase of the experiment using Lasso and manual feature engineering processed one dimensional dataset CNN was applied and accuracy of 98.85%
Nasebah Almufadi et al.,	Convolutional Neural Network and Recurrent Neural Network	One dimensional CNN model detect the best result with an accuracy 96%
Ruiqi Li et al.,	Feature Extraction and Stacked auto encoder	The feature extraction are done with PCA, Fisher's ration, SAE and HSAE

Conclusion

In the competitive field telecom industry, churn prediction is an important issue of the customer Relation Management to the retain the customers. The company offers to the respective group of churn prediction customers. In this paper, we present a survey on customer churn issue using Machine Learning techniques such as XGBoost, Gradient Boost, AdaBoost, ANN, Logistic Regression and Random Forest and also the Deep Learning techniques such as Convolutional

Neural Network, stacked auto encoders. From this study are observed that Deep Learning gives better results and works with speed and accuracy.

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