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Churn rate prediction in Telecommunication systems

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Abstract*: *The broad view of chum rate measures the amount of individuals or items comes out of a collective group over a predefined time period. Many challenges linked with the churn rates in the telecom industry rise in increasing competition with the elimination of switching costs. The customer loyalty over the telecom industry exists along with the service provider struggling to offer improved services with the lower cost. Many author reviews depends on the churn rate prediction in the field of telecommunication sector discussed with the paper. The paper talk about an idea related with an application of churn rate for the technical review.

Keyword* :*Churn rate, prediction techniques, telecommunication sector, machine learning algorithm, customer probability .

I. INTRODUCTION

The percentage of subscribes in the chum rate for a service, which discontinue the subscription for a service in a particular time period. The time period for a company to extend their clients and growth of the number of new barter can beat its associate rate. Main associate amount is an important application for the blast and corpuscle buzz casework industry. The geography area such as more companies need for computing the customers and make it comfortable for the people to transfer from one to another service provider. The competition grows the pressure from competition and the government need improvements in retention rates for the profitable customers may have an increase urgently with the telecom service providers.

The most critical problems in the customer chum management are the prediction of customer churn. The three main characteristics of telecom data set are (1) Calculation of chum rate is small when the ratio of the numbers of customers in active to the large number of lost customer. The imbalance is the problem occurred may lower the learning performance and also the big challenges for many algorithms like machine learning algorithms. The model prediction for the customer chum discusses with predicting the customer probability using socio – economical information, behavioral and historical activity. A great benefit for the tool to subscribe based companies, which allows them to aerate the aftereffect with assimilation campaigns. The data mining and apparatus acquirements communities helps in studying the problem of chum predictive modeling. The problem tackled with the help of classification algorithm in different patterns of both the churners and non-churners. The accepted accompaniment of the art allocation algorithm charge not aligned with bartering goals, with the models lags in acceptance of absolute financial cost and benefits throughout the training phase and evaluation phase. [2]. Client maintenance is urgent in an assortment of organizations as obtaining new clients is regularly more exorbitant than keeping the present ones. As a result, beat forecast has pulled in incredible consideration from both the business and scholastic universes. Customary endeavors in the money related area chiefly center around space explicit factors, for example, item possession or administration use total, in any case, without considering dynamic personal conduct standards of clients' monetary exchanges [3].

The high ante of Churn the assiduous action of bulge arrival and takeoff influence rating systems for distributed (P2P) networks. Specifically, short companion lifetimes mean notorieties are regularly created from few exchanges, and therefore are not many hard. To understand this relationship, this note presents a diagnostic model which decides the ideal exchange rate and the normal time to actualize a solid notoriety, beneath both exponential and Pareto lifetime disseminations [4]. In writing, factual and information mining methods have been utilized to make the forecast models." Classifications apparatuses are frequently used to display and anticipate client agitate. A portion of the procedures usually used to accomplish this are neural networks, Decision tree (DT), accidental forests, support vector machines (SVM) and logistic corruption [5].

II. OBJECTIVE OF THE STUDY

- Reviewing the pertinent examinations about churn investigation on media communications industry displayed over the most recent five years, especially over the most recent two years, and acquainting these up-with date thinks about in the writing.
- Determining the information mining techniques every now and again utilized in agitate usage.
- Shedding a light on techniques that can be utilized in further investigations. The following session talked about writing overview for churn forecast.

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III. LITERATURE SURVEY

A. Churn prediction using data mining techniques

Farshid Abdi et al.,2018 [6] proposed a model named as Customer Behaviour Mining Frame work on the basis of data mining techniques for telecom company.

The frame work considered the pattern for customer behavior's and predicts the path may work in future. The clustering technique used to implement the portfolio analysis and earlier customers grouped based on the socio-demographic features with the help of k-means algorithm.

B.Mathematical Model

Vincent Wing-Hei Luk et al., 2013 [7] proposed a new protocol named as Redundancy Reduced Account for absolute time N-to-N accumulation communication. The proposed agreement may achieve an actual abundant cartage with the lower akin amount than the accepted push- based account protocols. The anticipated advance cull account protocols charge the aforementioned anticipation for acknowledged supply has evaluated the college achievement in arrangement accretion with abate delays. We actuate a, algebraic archetypal for ciphering the case non-conveyance likelihood and the cartage amount from overhead, and appearance the accepted accurateness of the archetypal by simulation.

Eunjo Lee et al., 2015[8] proposed an agitate prediction technique for streamlining benefit consisting of two fundamental advances: 1) choosing prediction target, 2) tuning limit of the model. In web based recreations, the dissemination of a's client lifetime worth is exceptionally one-sided that a couple of clients add to a large portion of the deals, and the vast majority of the churners are no-paying users. Thusly, it is cost-effective to concentrate on beat prediction to steadfast clients who have adequate advantages. The structure incorporates prescient modeling just as the related essential works, for example, stir definition and assurance of anticipation targets and plays out a cost-advantage assay of the anticipation model. To the best of our information, this is the arch appraise that has advised about speaking systems apropos accepted account in the online bold field.

C.Network Gradient Topology

Håkan Terelius et al., 2018 [9] proposed the system topology combination in a peer-to-peer align framework, area the cold of the framework is to addition live- alive performance. The broadcast framework builds an bend bury topology, declared by a directed chart, area every hub angular appear neighbors absolute college account qualities to such an admeasurement that means of accretion utilities appear in the arrangement topology. The abruptness cartography has a abode with the chic of babble produced bury networks that are formed from an aberrant bury align through agreement breaking application a alternative work. The hubs are apparent with their alone account value, and the edges from the allusive acquaintance sets are appeared. In the abruptness topology, means of accretion utilities rise.

D.Using Big data

Carlo Stingl et al., 2018[10] proposed industry part of the endeavors together with open big abstracts (geographic data, online-content, amusing media abstracts and authoritative statistical data) to analyze and ahead the electricity appliance of such. Our beeline corruption analysis demonstrates that advice on the budgetary branches of the enterprises, basal area of buildings, amount of aperture hours and amusing media abstracts can acknowledge up to 19% of about-face in electricity consumption.

Hyoung-Goo Kang et al., 2014 [11] broke down features four ways to deal with M&A assessment that vary with mixes of vulnerability and debate: work area valuation dependent on financial analysis, ability configuration utilizing situation arranging and objective setting strategies, issue records that identify clashing objectives, and narrating techniques that endeavor to verbalize compelling rationales for a bargain. Evaluate potential to grow the purchaser's remote system business by moving from being a versatile virtual system administrator (MVNO) to a mobile organize administrator (MVO) player. Create and examine turnaround opportunities with respect to the objective: How to cut losses, how to lessen beat rate, and where to discover collaborations.

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E.Data Mining a Strategic Tool for Mining Telecom System

Balasubramanian et al., 2014 [12] KDD (Knowledge Discovery in Databases) is characterized as the "non-atomic action of acquainted legitimate, novel, conceivably accessible and at endure barefaced examples of in data". The affair of our barter manages the detached admired ambition capricious and our absolute point is to advertise every adherent as,, potentially churner‟ or "conceivably non churner", so the KDD plan for our problem is characterized to be the arrangement issue.

F.Regression Method

Li Jiang et al.,2018 [13] yearly institutional possession data from firms crosswise over 40 countries, we locate that outside institutional proprietorship is adversely connected with excess stock return co movement.

Our outcomes are

progressively articulated when remote institutional financial specialists start from precedent-based law nations and hold a huge value stake in contributed firms; and when the put firms are situated in common law nations.

In general, the proof recommends that remote institutional financial specialists from nations with hard investor assurance assume a significant enlightening job in alleviating overabundance stock return co-development around the globe.

Xue Zeng et al,2008[14] proposed the data irregularity issue leaving in this field, traditional looks into consistently redistribute tests as indicated by misclassification cost. Be that as it may, exiting looks into around there neither gave out the quantitative assuming of the misclassification amount nor set up a brought calm action for redistributing tests. To yield affliction of these issues, a different accurate acceptation of misclassification amount for this area is set up by demography telecom industry budgetary apparatus into anticipation and a redistribute arrangement abased on this amount is fatigued out. The about analysis after-effects authenticate that, this action has finer bigger the carefulness of telecom activity anticipation and establishes a academic framework for added abstruse analysis on the misclassification amount of this field.

G.Support Vector Machine

Machine Learning et al., 2016 [15] proposed a help vector approach depends on the kernel and that is one noteworthy restriction. A subsequent confinement is that of speed and size in training and testing. Another issue is that the SVMs can be horribly moderate in test phase, despite the fact that they have a decent general execution. SVMs - from a reasonable point of see - have a few disadvantages. Another significant unsolved pragmatic inquiry is the selection of the bit capacity parameters. Another disadvantage of SVMs is the high algorithmic multifaceted nature and huge memory prerequisites of the required quadratic programming in huge scale assignments.

H.Data Analytics

Freddie Mathews Kau et al., 2017 [16] proposed a prescient models can assist organization with identifying clients that are bound to agitate, this will assist the organizations with planning heretofore and put in safeguard measures. The examination applies logistic relapse and choice trees utilizing R bundle for data investigation to foresee the churn.

I.Data mining methods

Susan Lomax et al., 2017 [17] exhibited a two contextual investigations that use choice tree learning techniques to create models for foreseeing beat for a product organization. The first contextual investigation intends to foresee stir for associations which at present have a continuous project, to decide whether associations are probably going to proceed with different ventures. While the second contextual investigation shows an increasingly customary model, where the point is to foresee organizations liable to stop being a supporter of an administration. The contextual investigations incorporate presentation of the exactness of the models utilizing a standard approach just as comparing the outputs with what occurred by and by.

J.Social Network Analytics

María Óskarsdóttir proposed et al 2017[18] factually assess the impact of social classifiers and aggregate deduction techniques on the prescient intensity of social learners, just as the presentation of models where social students are consolidated with customary strategies for foreseeing client agitate in the media transmission industry. At long last we explore the impact of system development on model execution; our findings suggest that the meaning of edges and loads in the system has a impact on the consequences of the prescient models.

K.Data Mining using Revolution Analytics Tool

Manpreet Kaur et al., 2015 [19] proposed a Churn Factor is utilized in numerous capacities to depict the different territories or situations where churners can be recognized. The paper is considering agitate factor in record to delineate different examples for churners. R is a powerful measurable programming device which can speak to the dataset graphically with respect to various parameters and it additionally utilizes various bundles accessible.

Shreya Monani et al., 2016 [20] talked about the client maintenance procedures in a telecommunication industry. The objective of this examination is to apply different investigation techniques alongside data mining procedures to anticipate client residency and churn designs by utilizing data from a telecommunications organization. These strategies include survival examination or beat investigation.

L.Neural Networks Based Churn Prediction

Kiran Dahiya et al., 2015 [21] proposed a churn prediction model aides the client relationship management to hold the clients who are likely to stop. In ongoing epochs, various group and managed classifiers and data mining techniques are utilized to model the beat prediction in telecom.

M.Data mining techniques and logistic regression

Ecaterina Oana Slăvescu et al., 2012 [22] proposed a Predictive Model utilizing Logistic Regression procedure and assess its effectiveness when contrasted with the arbitrary determination. In the future, we will concentrate on broadening our investigation by integrating added business contemplations and mining models so as to change the beat models or overhaul advertising exercises for the telecom business.

Daniel A. Asamoah et al., 2016[23] talked about

1. The stir exercises prompted a general diminishing in the client center base which brought about diminished by and large income.
2. As agitating happened, long-term and faithful clients were lost. New clients generally began with fundamental administrations. Extra administrations, which make more income, set aside some effort to be embraced by these clients, bringing about moderate development of organization income.

G.M. Apurva Sree et al., 2019[24] proposed Support Vector Machine SVM is the managed learning model that investigations the given data utilized with the end goal of arrangement and relapse approach, predominantly here the data sets from the beat prediction are broke down with the absolute reliance between the data sets for the stirred data .SVM has an impact by posting the data sets for figuring the grouping and relapse examination.

Irregular woods calculation is executed over here by utilizing the various degree of the choice trees and these choice trees are here developed between the various variables of the stir prediction like: Telecom suppliers, Internet administration, Call rates, Messaging administrations, and so on and the mode and the medians are determined then consistency of the data sets are set up and the data sets are determined and the relapse rates are very entrenched here. The subtleties of various data examination calculations are broke down and the precision esteems are given here.

Inderpreet Singh et al.,2017[25]proposed a (Recency-Frequency-Monetary) RFM examination direct the association to break down the client esteem on premise of which association can foresee which clients are probably going to react just as that won't react to their offer. Every client is assessed on premise of recency, recurrence and money related an incentive in RFM examination. In straightforward words, RFM is strategy of advertising examination which is utilized to inspect which clients are best ones by analyzing how ongoing client has made buy (Recency), how much regularly they buy (Frequency) and the amount the person burns through (Monetary). It depends on market law that ―80% of business originates from 20% of your clients.

Yiqing Huang et al., 2015 [26] exhibited that telecom enormous data make beat prediction a lot simpler through 3V's points of view. For all intents and purposes, the revive rate of potential churners has been extraordinarily improved around half, accomplishing a major business esteem. For quite a long time of framework building, telecom data have low irregularities and clamors, with the goal that Veracity is a characteristic property of telecom data. In this sense, this examination in this way covers 5V qualities of telco enormous data: Volume, Variety, Velocity, Veracity and Value, with regards to agitate prediction and maintenance frameworks.

N.Telecom Industry analysis using machine learning processes:

Adnan Amin et al., 2015[27] discretization is a action of accumulating the quality's abstracts based on the bent cuts and the amaranthine factors, alteration over into detached attributes. There may exists such concealed article which can't coordinate with the guidelines or it can increment computational cost that hinder the AI procedure, so cut and discretization techniques are utilized so as to get high caliber of characterization.

O.Telecom Industry analysis using Social Network Analysis

Abdelrahim Kasem Ahmad et al., 2019[28] built up a model in this work utilizes machine learning procedures on huge data stage and manufactures another method for highlights' engineering and choice. So as to gauge the presentation of the model, the Area beneath Curve (AUC) accepted admeasurement is embraced, and the AUC account got is 93.3%. Another assumption charge is to advance applicant amusing arrangement in the anticipation model by extricating Amusing Network Analysis (SNA) highlights.

Ammar A. Q et al., 2017[29] presents a Meta heuristic based exhausted anticipation adjustment that performs exhausted anticipation on immense telecom data. An alloyed blazon of Firefly algorithm is activated as the classifier. It has been acclaimed that the action concentrated basic of the Firefly adding is the assay square, area anniversary firefly is compared with anniversary added firefly to admit the one with the a lot of alarming ablaze force. This basic is supplanted by Simulated Annealing and the adjustment action is conveyed out. The activities are concluded if a agreed greatest ages (maxgen) accept been appear to, or if the framework does not move to a above acknowledgment for a predefined amount of iterations. Criteria of the primary sort is generally set in a creation domain, while the second type is set during improvement to recognize the time intricacy. This procedure is carried out for every one of the test data. Cross approval is at long last performed to recognize the accuracy of the classifier.

Samaher Al_Janabi et al., 2019[30] proposed framework comprises of three fundamental pashas: First Phase: A apperception of the organization's data, which comprised of two capital parts, included abstracts on a agnate alignment as far as amount of employees, amount of customers, incomes and costs, and applicant accompanying data. The proposed model, it includes architecture affirmation archetypal utilizing bigger abruptness advocacy apparatus by supplant the centermost of it is (Decision Tree) by (hereditary calculation). We advance axiological admeasurement of affirmation blooper to appraise the endure model, these measures absorb admiration matrix: Accuracy (AC), analysis or 18-carat absolute amount (TP), carefulness (P), F-measure (considers both carefulness and review) and Fb and 10-crease cantankerous approval.

P.Telecom Industry analysis using Unsupervised Discretization Technique

Tan Yi Fei et al 2017 [31] proposed two examinations with the execution of data handling methods utilizing K-Means and Equal-Width Discretization (EWD) combined with Naïve Bayes are performed alone to advance a alternation of techniques to admit acceptable activity exercises.

Irfan Ullah et al., 2019[32] proposed model initially groups beat clients data utilizing classification algorithms in which the Random Forest (RF) adding performed able-bodied with 88.63% accurately abiding instances.

Making able aliment arrange is a capital assignment of the CRM to apprehend churners. After classification, the proposed archetypal bits the agitating client's abstracts by classifying the activity barter in groups utilizing cosine accurateness to accord agglomeration based aliment offers.

Georges D. Olle et al., 2014[33] Proposed an admixture acquirements archetypal to ahead exhausted in mobile telecommunication systems. Tests were completed utilizing WEKA a Machine Acquirements device; alongside a 18-carat dataset from an Asian able ambassador to evaluate the achievement of the model.

The outcomes demonstrate that the new half and half model is more exact than single techniques.

Jelena Mamčenko and Jamil Gasimov et al., 2014[34] proposed strategy is fit for identifying potential churners at the agreement level for a particular prediction time span.

In addition, the proposed strategy fuses the multi-classifier class-combiner approach to address the challenge of an exceedingly slanted class dissemination among churners and non-churners.

Kamya Eria1and Booma Poolan Marikannan et al., 2018[35] proposed Support Vector Machines, Naïve Bayes, Decision Trees and Neural Networks are the about activated CCP techniques. Highlight determination is the for the most part utilized data readiness strategy pursued by Normalization and Noise evacuation. Under inspecting is the for the most part favored system for handling telecom abstracts chic askew characteristics. Imbalanced, astronomic and top dimensional datasets are the key difficulties in telecom beat prediction. The affair of huge telecom datasets is handled by appliance of new astronomic abstracts innovations, for example, Hadoop, Hbase and NoSQL (Not only Structured Query Language) about their accession is still at a low rate.

Table I: Techniques analysed in Churn rate Prediction.

Sl.No.	Churn rate Prediction techniques in telecommunication systems
1.	Data mining techniques
2.	Mathematical Models
3.	Network Gradient topology
4.	Bigdata
5.	Linear regression model
6.	Data analysis
7.	Neural Network
8.	Social Network Analysis
9.	Unsupervised Learning Techniques

The table 1 demonstrates the various kinds of methods utilized in the agitate rate prediction in media transmission frameworks. Here the strategies, for example, data mining and machine learning methods utilized habitually and gives better outcome and execution well for the Churn rate Prediction.

IV. CONCLUSION

This paper goes for auditing the ongoing writing in the region of telecom and customer agitate prediction for the most part with two points of view, for example method being connected to telecom agitates anticipation and the administration year. Likewise the point is to advance the advisers to accretion ability into the advancing patterns here, which will advise them in award the accessible purposes abaft the activity and appropriately abbreviating them and causing the telecom sector to lessen their money related misfortune. The various systems adapted in the stir rate prediction are recorded beneath. The AI and data mining methods are performing better. It ought to be seen that, the audit does not include all the research around there, however the outcomes are just based on the papers studied by the creators.

REFERENCES

1. Ottersten," A novel cost-sensitive framework for customer churn predictive modeling", Correa Bahnsen *et al. Decision Analytics* (2015) 2:5, DOI 10.1186/s40165-015-0014-6.
2. Abdelrahim Kasem Ahmad* , Assef Jafar and Kadan Aljoumaa," Customer churn prediction in telecom using machine learning in big data platform", Ahmad *et al. J Big Data (2019) 6:28* https://doi.org/10.1186/s40537-019-0191-6.
3 . Erdem Kaya1* , Xiaowen Dong2,3, Yoshihiko Suhara2,4, Selim Balcisoy1, Burcin Bozkaya1 and Alex "Sandy" Pentland2," Behavioral attributes and financial churn prediction", *EPJ Data Science* , https://doi.org/10.1140/epjds/s13688-018-0165-5 .
4. Marc S´anchez-Artigas, Pedro Garc´ıa-L´opez, *Member, IEEE,* and Blas Herrera," Exploring the Feasibility of Reputation Systems under Churn", IEEE COMMUNICATIONS LETTERS, VOL. 13, NO. 7, JULY 2009, Digital Object Identifier 10.1109/LCOMM.2009.090573.
5. Abbas Keramati1* , Hajar Ghaneei2 and Seyed Mohammad Mirmohammadi3," Developing a prediction model for customer churn from electronic banking services using data mining", Financial Innovation, DOI 10.1186/s40854-016-0029-6.
6. Ibrahim Mike Okumu1*, Edward Bbaale1 and Madina Mwagale Guloba2," and employment growth: evidence from manufacturing firms in Africa", Journal of Innovation and Entrepreneurship, https://doi.org/10.1186/s13731-019-0102-2.
7. Vincent Wing-Hei Luk*, Albert Kai-Sun Wong, Chin-Tau Lea and Robin Wentao Ouyang," RRG: redundancy reduced gossip protocol for real-time N-to-N dynamic group communication", Luk et al. Journal of Internet Services and Applications 2013, 4:14 doi: 10.1186/1869-0238-4-14.
8. Eunjo Lee, Boram Kim, Sungwook Kang, Byungsoo Kang, Yoonjae Jang, Huy Kang Kim, Member, IEEE," Profit Optimizing Churn Prediction for Long-term Loyal Customer in Online games", IEEE Transactions on Games, DOI 10.1109/TG.2018.2871215.
9. Håkan Terelius and Karl Henrik Johansson, *Fellow, IEEE,"* Peer-to-Peer Gradient Topologies in Networks with Churn", IEEE Transactions on Control of Network Systems, DOI 10.1109/TCNS.2018.2795704.
10. Carlo Stingl1, Konstantin Hopf1* and Thorsten Staake1,2," Explaining and predicting annual electricity demand of enterprises – a case study from Switzerland", Energy Informatics, https://doi.org/10.1186/s42162-018-0028-0.
11. Hyoung-Goo Kang1, Wonseok Woo2, Richard M. Burton3 and Will Mitchell4*," Constructing M&A valuation: how do merger evaluation methods differ as uncertainty and controversy vary", Journal for organizational design, DOI 10.1186/s41469-017-0025-y.
12. Dr. M.Balasubramanian *, M.Selvarani **," Churn Prediction In Mobile Telecom System Using Data Mining Techniques", International Journal of Scientific and Research Publications, Volume 4, Issue 4, April 2014 1 ISSN 2250-3153.
13. Li Jiang1*, Jeong-Bon Kim2 and Lei Pang3," Foreign institutional investors and stock return comovement", Frontiers of Business Research in China, https://doi.org/10.1186/s11782-018-0036-8.
14. Xue Zeng, Yue Wu, Yuan Tang," Definition Of Misclassification Cost & Redistribution Strategy Of Telecom Churn Analysis", 978-1-4244-3426-8/08/$25.00 ©2008 IEEE.
15. Avishkar Dalvi1, Bhushan Bhor2, Hiren Chauhan3, Prof. Prashant Sawant4," Churn Prediction Using Hadoop", International Research Journal of Engineering and Technology (IRJET), 2395 -0056.
16. Freddie Mathews Kau, Hlaudi Daniel Masethe and Craven Klaas Lepota, Member, *IAENG,"* Service Provider Churn Prediction for Telecoms Company using Data Analytics", Proceedings of the World Congress on Engineering and Computer Science 2017 Vol I WCECS 2017, October 25-27, 2017, San Francisco, USA, ISBN: 978-988-14047-5-6.
17. Susan Lomax," Case Studies in applying data mining for churn analysis", International Journal of Conceptual Structures and smart applications, volme 5, Issue 2. July- December 2017.
18. María Óskarsdóttira, Cristián Bravob, Wouter Verbekec, Carlos Sarrauted, Bart Baesensa,b, Jan Vanthienena," Social Network Analytics for Churn Prediction in Telco: Model Building, Evaluation and Network Architecture", Preprint submitted to Expert Systems with Applications May 9, 2017.
19. Manpreet Kaur, Dr. Prerna Mahajan," Churn Prediction in Telecom Industry Using R", International Journal of Engineering and Technical Research (IJETR), Volume-3, Issue-5, May 2015, ISSN: 2321-0869.
20. 1Shreya Monani, 2Shubham Gupta, 3Shubhangi Jain, 4Vidushi Mishra, 5Prof. Artika Singh," Survey on Prediction of Customer Churn Analysis in a Telecommunications Industry", International Journal for Research in Engineering Application & Management (IJREAM) ISSN: 2494-9150 Vol-02, Issue 07, Oct 2016.

21. Kiran Dahiya, KanikaTalwar," Customer Churn Prediction in Telecommunication Industries using Data Mining Techniques- A Review", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 5, Issue 4, 2015 ISSN: 2277 128X .
22. Ecaterina Slavescu and Iulian Panait," Improving customer churn models as one of customer relationship management business solutions for the telecommunication industry", Academia de Studii Economice (Academy of Economic Studies), Hyperion University, "Ovidius" University Annals, Economic Sciences Series Volume XII, Issue 1 /2012.
23. Daniel A. Asamoah, Ramesh Sharda Pankush Kalgotra," *Teaching Case Who* Renews? Who Leaves? Identifying Customer Churn in a Telecom Company Using Big Data Techniques", Journal of Information Systems Education, Vol. 27(4) fall 2016.
24. G.M. Apurva Sree1, S. Ashika1, S. Karthi1, V. Sathesh1, M. Shankar1, J. Pamina2," CHURN PREDICTION IN TELECOM USING CLASSIFICATION ALGORITHMS", International Journal of Emerging Technology and Innovative Engineering Volume 5, Issue 2, February 2019 (ISSN: 2394 – 6598).
25. Inderpreet Singh a, Sukhpal Singh," Framework for Targeting High Value Customers and Potential Churn Customers in Telecom using Big Data Analytics", *I.J. Education and Management Engineering*, 2017, 1, 36-45 Published Online January 2017 in MECS (http://www.mecs-press.net) DOI: 10.5815/ijeme.2017.01.04.
26. Yiqing Huang1,2, Fangzhou Zhu1,2, Mingxuan Yuan3, Ke Deng4, Yanhua Li3, Bing Ni3,
Wenyuan Dai3, Qiang Yang3,5, Jia Zeng1,2,3," Telco Churn Prediction with Big Data", http://dx.doi.org/10.1145/2723372.2742794.
27. Adnan Amin1, Changez Khan1, Saeed Shehzad2, Imtiaz Ali1, Sajid Anwar1,*," Churn Prediction in Telecommunication Industry Using Rough Set Approach", DOI: 10.1007/978-3-319-10774-5_8.
28. Abdelrahim Kasem Ahmad*, Assef Jafar and Kadan Aljoumaa," Customer churn prediction in telecom using machine learning in big data platform", Ahmad *et al. J Big Data (2019) 6:28* https://doi.org/10.1186/s40537-019-0191-6.
29. Ammar A. Q. Ahmed ⇑, Maheswari D.," Churn prediction on huge telecom data using hybrid firefly based classification", Egyptian Informatics Journal, http://dx.doi.org/10.1016/j.eij.2017.02.002.
30. Samaher Al_Janabi(&) and Fatma Razaq," Intelligent Big Data Analysis to Design Smart Predictor for Customer Churn in Telecommunication Industry", © Springer Nature Switzerland AG 2019, https://doi.org/10.1007/978-3-030-12048-1_26.
31. Tan Yi Fei1, Lam Hai Shuan1, Lai Jie Yan1 Guo Xiaoning1, Soo Wooi King2," Prediction on Customer Churn in the Telecommunications Sector Using Discretization and Naïve Bayes Classifier", Int. J. Advance Soft Compu. Appl, Vol.9, No. 3, Nov 2017 ISSN 2074-8523.
32. Irfan Ullah1, Basit Raza1,*, Ahmad Kamran Malik1, Muhammad Imran1, Saif ul Islam2, Sung Won Kim3," A Churn Prediction Model using Random Forest: Analysis of Machine Learning Techniques for Churn Prediction and Factor Identification in Telecom Sector", IEEE Access, Citation information: DOI 10.1109/ACCESS.2019.2914999.
33. Georges D. Olle Olle and Shuqin Cai," A Hybrid Churn Prediction Model in Mobile Telecommunication Industry", *International Journal of e-Education, e-Business, e-Management and e-Learning, Vol. 4, No. 1, February 2014,* DOI: 10.7763/IJEEEE.2014.V4.302.
34. Jelena Mamčenko and Jamil Gasimov," Customer Churn Prediction in Mobile Operator Using Combined Model", DOI: 10.5220/0004896002330240.
35. Kamya Eria1and Booma Poolan Marikannan2," Systematic Review of Customer Churn Prediction in the Telecom", Journal of Applied Technology and Innovation (e-ISSN: 2600-7304) vol. 2, no. 1, (2018).

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