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| id | Cite | Abstract |
|  | @article{Xu2021TelecomCP,  title={Telecom Churn Prediction System Based on Ensemble Learning Using Feature Grouping},  author={Tianpei Xu and Ying Ma and Kang-ryeol Kim},  journal={Applied Sciences},  year={2021},  url={https://api.semanticscholar.org/CorpusID:236344316}  } | [Telecom Churn Prediction System Based on Ensemble Learning Using Feature Grouping](https://www.semanticscholar.org/paper/Telecom-Churn-Prediction-System-Based-on-Ensemble-Xu-Ma/e3adf0c881a19896c96ef1e5c519ac9d62634a81)  In recent years, the telecom market has been very competitive. The cost of retaining existing telecom customers is lower than attracting new customers. It is necessary for a telecom company to understand customer churn through customer relationship management (CRM). Therefore, CRM analyzers are required to predict which customers will churn. This study proposes a customer-churn prediction system that uses an ensemble-learning technique consisting of stacking models and soft voting. Xgboost, Logistic regression, Decision tree, and Naïve Bayes machine-learning algorithms are selected to build a stacking model with two levels, and the three outputs of the second level are used for soft voting. Feature construction of the churn dataset includes equidistant grouping of customer behavior features to expand the space of features and discover latent information from the churn dataset. The original and new churn datasets are analyzed in the stacking ensemble model with four evaluation metrics. The experimental results show that the proposed customer churn predictions have accuracies of 96.12% and 98.09% for the original and new churn datasets, respectively. These results are better than state-of-the-art churn recognition systems |
|  | @article{Sudharsan2022ASR,  title={A Swish RNN based customer churn prediction for the telecom industry with a novel feature selection strategy},  author={R. Sudharsan and E. N. Ganesh},  journal={Connection Science},  year={2022},  volume={34},  pages={1855 - 1876},  url={https://api.semanticscholar.org/CorpusID:249940935}  } | [A Swish RNN based customer churn prediction for the telecom industry with a novel feature selection strategy](https://www.semanticscholar.org/paper/A-Swish-RNN-based-customer-churn-prediction-for-the-Sudharsan-Ganesh/8ff66c211fb73058224dd7f9634c5749c14f26a3)  Owing to saturated markets, fierce competition, dynamic criteria, along with introduction of new attractive offers, the considerable issue of customer churn was faced by the telecommunication industry. Thus, an efficient Churn Prediction (CP) model is required for monitoring customer churn. Therefore, this work proposes a novel framework to predict customer churn through a deep learning model namely Swish Recurrent Neural Network (S-RNN). Finally, SRNN is adapted to classify the Churn Customer (CC) and a normal customer. If the result is a churn customer, network utilisation history is analysed for retention process. Whereas, the number of churn customers based on the area network usage is not recognised in this frameworkOwing to saturated markets, fierce competition, dynamic criteria, along with introduction of new attractive offers, the considerable issue of customer churn was faced by the telecommunication industry. Thus, an efficient Churn Prediction (CP) model is required for monitoring customer churn. Therefore, this work proposes a novel framework to predict customer churn through a deep learning model namely Swish Recurrent Neural Network (S-RNN). Finally, S-RNN is adapted to classify the Churn Customer (CC) and a normal customer. If the result is a churn customer, network utilisation history is analysed for retention process. |
|  | @article{Zhang2022ADA,  title={A Data-Driven Approach to Improve Customer Churn Prediction Based on Telecom Customer Segmentation},  author={Tianyuan Zhang and S{\'e}rgio Moro and Ricardo F. Ramos},  journal={Future Internet},  year={2022},  volume={14},  pages={94},  url={https://api.semanticscholar.org/CorpusID:247532720}  } | [A Data-Driven Approach to Improve Customer Churn Prediction Based on Telecom Customer Segmentation](https://www.semanticscholar.org/paper/A-Data-Driven-Approach-to-Improve-Customer-Churn-on-Zhang-Moro/b9480825c593c84f9287cf983e3f1671e72e344e)  Numerous valuable clients can be lost to competitors in the telecommunication industry, leading to profit loss. Thus, understanding the reasons for client churn is vital for telecommunication companies. This study aimed to develop a churn prediction model to predict telecom client churn through customer segmentation. Data were collected from three major Chinese telecom companies, and Fisher discriminant equations and logistic regression analysis were used to build a telecom customer churn prediction model. According to the results, it can be concluded that the telecom customer churn model constructed by regression analysis had higher prediction accuracy (93.94%) and better results. This study will help telecom companies efficiently predict the possibility of and take targeted measures to avoid customer churn, thereby increasing their profits. |
|  | @article{Zayed2022AnII,  title={An Investigation into the Effect of Knowledge Management on Employee Retention in the Telecom Sector},  author={Nurul Mohammad Zayed and Friday Ogbu Edeh and Khan Mohammad Anwarul Islam and Vitalii Nitsenko and Tetiana Dubovyk and Hanna Doroshuk},  journal={Administrative Sciences},  year={2022},  url={https://api.semanticscholar.org/CorpusID:253010011}  } | [An Investigation into the Effect of Knowledge Management on Employee Retention in the Telecom Sector](https://www.semanticscholar.org/paper/An-Investigation-into-the-Effect-of-Knowledge-on-in-Zayed-Edeh/ad9a891f266a7640a99c356a9c4522e90827c7aa)  Employees in the telecom sector are knowledge workers and, thus, managers, HR professionals, and policymakers in the industry need to retain them through knowledge management policies. It is against this premise that this study investigated the effect of knowledge management on employee retention in the telecom sector. Research design employed in this study is a cross-sectional survey with an accessible population of thirty telecom companies in the southeastern region of Nigeria using a simple random sampling technique. The sample size was determined with the Krejcie and Morgan sample size determination table. A questionnaire was used as an instrument for data collection. Respondents’ profiles were analysed with frequency distribution while the formulated hypotheses were analysed with linear regression. The study found that knowledge management dimensions have a significant effect on the measures of employee retention. The study concludes that knowledge management measured in terms of knowledge acquisition, knowledge storage, and knowledge sharing predicted employee retention that is measured by supervisor support, coworkers support, and flexible working arrangements. One of the implications of this study is that managers of telecom companies should liaise with their board of directors to make funds available that would be used to train employees to acquire relevant knowledge that is needed in the telecom industry. |
|  | @article{Habibniya2022ImpactOC,  title={Impact of Capital Structure on Profitability: Panel Data Evidence of the Telecom Industry in the United States},  author={Houshang Habibniya and Suzan Dsouza and Mustafa Raza Rabbani and Nishad Nawaz and Rezart Demiraj},  journal={Risks},  year={2022},  url={https://api.semanticscholar.org/CorpusID:251329619}  } | [Impact of Capital Structure on Profitability: Panel Data Evidence of the Telecom Industry in the United States](https://www.semanticscholar.org/paper/Impact-of-Capital-Structure-on-Profitability%3A-Panel-Habibniya-Dsouza/cba5dc476b6f9280359642847df66af0528e1d8c)  Debt finance, when considered a source of finance, always leads to financial risk; however, it is also considered a source of increased profitability in the normal business scenario. It has always been challenging to find the correct debt equity combination. In the discussed sample of the telecom industry in the USA, an abnormally high total liability-to-total assets ratio was observed. Thus, it is inclined to investigate the capital structure (CapSt) effect on firms’ profitability. By taking annual data of the telecom industry from 2012 to 2020 in the USA, unbalanced cross-sectional data (panel data) comprising 421 firm-year observations for 72 firms were studied using pooled panel regression, univariate analysis, correlation, and descriptive statistics models. We decided to test the impact of CapSt (Total Liabilities to Total Assets (TLsTAs) and Total Equity to Total Assets (TETAs)) on the profitability (Return on Assets (ROA) and Return on Equity (ROE)) of firms in the telecommunication industry in the USA. The results reveal that the ratio of TLsTAs has a significant impact on ROA, and TETAs has a significant impact on ROA. However, TLsTAs and TETAs have no impact on ROE. |
|  | @inproceedings{Xu2022EarlyWO,  title={Early Warning of Telecom Customer Churn Based on Multialgorithm Model Optimization},  author={Jingxiu Xu and Xueguang Li and Zhonglin He and Jinge Zhou},  booktitle={Frontiers in Energy Research},  year={2022},  url={https://api.semanticscholar.org/CorpusID:250276108}  } | [Early Warning of Telecom Customer Churn Based on Multialgorithm Model Optimization](https://www.semanticscholar.org/paper/Early-Warning-of-Telecom-Customer-Churn-Based-on-Xu-Li/5208ccc2240e9cb351261da6d7b747dee4596e38)  This work aims to build a variety of algorithm models for target optimization and use them to predict whether telecom companies will lose customers, respond to the early warning of customer churn, and then implement active retention measures. Data characteristics affect the final loss prediction effect. In this study, the weight contribution rate of each characteristic variable is obtained by calculating the evidence weight and then the characteristic variable information value so as to optimize the prediction accuracy of the algorithm model. Through calculation, we noted the weight contribution rate of five characteristic variables to be the highest. Including total day charge, total day minutes customer service calls, international plan, and number of voicemail messages, linear regression, decision tree, Bayesian, artificial neural network, and support vector machine are used to predict customer churn on the customer dataset published by telecom companies. The experimental results are used to test the performance of the algorithm mode |
|  | @article{Aftan2023UsingTA,  title={Using the AraBERT Model for Customer Satisfaction Classification of Telecom Sectors in Saudi Arabia},  author={Sulaiman Aftan and Habib Shah},  journal={Brain Sciences},  year={2023},  volume={13},  url={https://api.semanticscholar.org/CorpusID:255964486}  } | [Using the AraBERT Model for Customer Satisfaction Classification of Telecom Sectors in Saudi Arabia](https://www.semanticscholar.org/paper/Using-the-AraBERT-Model-for-Customer-Satisfaction-Aftan-Shah/720574165a68bd6296fcad998d0157cd67ae12c7)  Customer satisfaction and loyalty are essential for every business. Feedback prediction and social media classification are crucial and play a key role in accurately identifying customer satisfaction. This paper presents sentiment analysis-based customer feedback prediction based on Twitter Arabic datasets of telecommunications companies in Saudi Arabia. The human brain, which contains billions of neurons, provides feedback based on the current and past experience provided by the services and other related stakeholders. Artificial Intelligent (AI) based methods, parallel to human brain processing methods such as Deep Learning (DL) algorithms, are famous for classifying and analyzing such datasets. Comparing the Arabic Dataset to English, it is pretty challenging for typical methods to outperform in the classification or prediction tasks. Therefore, the Arabic Bidirectional Encoder Representations from Transformers (AraBERT) model was used and analyzed with various parameters such as activation functions and topologies and simulated customer satisfaction prediction takes using Arabic Twitter datasets. The prediction results were compared with two famous DL algorithms: Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN). Results show that these methods have been successfully applied and obtained highly accurate classification results. AraBERT achieved the best prediction accuracy among the three ML methods, especially with Mobily and STC datasets. |
|  | @article{Peng2022ResearchOT,  title={Research on Telecom Customer Churn Prediction Based on GA-XGBoost and SHAP},  author={Ke Peng and Yan Peng},  journal={Journal of Computer and Communications},  year={2022},  url={https://api.semanticscholar.org/CorpusID:254090028}  } | [Research on Telecom Customer Churn Prediction Based on GA-XGBoost and SHAP](https://www.semanticscholar.org/paper/Research-on-Telecom-Customer-Churn-Prediction-Based-Peng-Peng/91336ffd3b4efc4cb479e779a75c5c1df5af4bf3)  To address the prominent problems faced by customer churn in telecom enterprise management, a telecom customer churn prediction model integrating GA-XGBoost and SHAP is proposed. By using the ADASYN algorithm for data processing on the unbalanced sample set; based on the GA-XGBoost model, the XGBoost algorithm is used to construct the telecom customer churn prediction model, and the hyperparameters of the model are optimized by using the genetic algorithm. The experimental results show that compared with traditional machine learning methods such as GBDT, decision tree, KNN and single XGBoost model, the improved XGBoost model has better performance in recall, F1 value and AUC value; the GA-XGBoost model is integrated with SHAP framework to analyze and explain the important features affecting telecom customer churn, which is more in line with the telecom industry to predict customer the actual situation of churn. |
|  | @article{Nalluri2022RiskAF,  title={Risk assessment for sustainability on telecom supply chain: A hybrid fuzzy approach},  author={Venkateswarlu Nalluri and Longchao Chen},  journal={Uncertain Supply Chain Management},  year={2022},  url={https://api.semanticscholar.org/CorpusID:246617152}  } | [Risk assessment for sustainability on telecom supply chain: A hybrid fuzzy approach](https://www.semanticscholar.org/paper/Risk-assessment-for-sustainability-on-telecom-A-Nalluri-Chen/1aeb0b6399f34978e03b113ecfdace991bb6e115)  Telecom supply chain (TSC) research has determined several risk sources can happen for sustainable supply chain management (SSCM) due to their ambiguous nature. However, investigation of these risks is relatively sparse and has primarily been independent with less combinatory research, despite their interrelationships and causality. The present study aims to address that gap by an extant literature review and analysis of relationships among risk factors using a combination of fuzzy approaches. A mixed approach was used, including empirical data from private and government firms in a developing telecom sector. This research finding confirmed that economical dimension risk is major for SSCM in the TSC. In developing countries, it could help telecom service providers in determining which risk factors are critical and those that are crucially significant. As a result, they will be able to more effectively develop strategies focussing on the most affecting risk dimension for SSCM. This is the first study using a hybrid fuzzy approach that analysed interrelationships of risk factors for SSCM. Further, it gives a comprehensive view of risk assessment in the risk management context in the supply chain. |
|  | @inproceedings{Bharambe2022CHURNPI,  title={“CHURN PREDICTION IN TELECOM INDUSTRY”},  author={Yashraj Bharambe and Pranav Karanjawane and Pranav Manikrao Deshmukh and Diptesh Chaudhari},  year={2022},  url={https://api.semanticscholar.org/CorpusID:253525555}  } | [“CHURN PREDICTION IN TELECOM INDUSTRY”](https://www.semanticscholar.org/paper/%E2%80%9CCHURN-PREDICTION-IN-TELECOM-INDUSTRY%E2%80%9D-Bharambe-Karanjawane/9566fc90d0a013572dd7569ec4b95bc6a90fc7e5)  Customers are the base for any business success and that is why firms become aware of the significance of acquiring satisfaction of customers. Customer churn is an essential issue and it is regarded as one of the most essential concerns among firms because of increasing rivalry among firms, increased significance of marketing strategies and customers conscious behaviour in present years. Organizations must develop different strategies to resolve the churn issues relying on the service they offer. Customer churn practise is essential in competitive and rapidly developing telecom sector. The process of migrating from one service provider to another telecom services provider occurs due to good services or rates or due to various advantages which the rivalry firm provides customers when signing up, Due to the greater cost related with acquiring new customers the prediction of customer churn has developed as an indispensable part of planning process and strategic decision making in telecom sector. |
|  | @article{CidLpez2022DECISIONMAKINGMF,  title={DECISION-MAKING MODEL FOR DESIGNING TELECOM PRODUCTS/SERVICES BASED ON CUSTOMER PREFERENCES AND NON-PREFERENCES},  author={Andr{\'e}s Cid-L{\'o}pez and Miguel J. Hornos and Ram{\'o}n Alberto Carrasco and Enrique Enrique Herrera-Viedma},  journal={Technological and Economic Development of Economy},  year={2022},  url={https://api.semanticscholar.org/CorpusID:253209442}  } | [DECISION-MAKING MODEL FOR DESIGNING TELECOM PRODUCTS/SERVICES BASED ON CUSTOMER PREFERENCES AND NON-PREFERENCES](https://www.semanticscholar.org/paper/DECISION-MAKING-MODEL-FOR-DESIGNING-TELECOM-BASED-Cid-L%C3%B3pez-Hornos/21a2a5e316cb36297dc4db870437a9860f32b87b)  The design of the packages of products/services to be offered by a telecom company to its clients is a complex decision-making process that must consider different criteria to achieve both customer satisfaction and optimization of the company’s resources. In this process, Intuitionistic Fuzzy Sets (IFSs) can be used to manage uncertainty and better represent both preferences and non-preferences expressed by people who value each proposed alternative. We present a novel approach to design/develop new products/services that combines the Lean Six Sigma methodology with IFSs. Its main contribution comes from considering both preferences and nonpreferences expressed by real clients, whereas existing proposals only consider their preferences. By also considering their non-preferences, it provides an additional capacity to manage the high uncertainty in the selection of the commercial plan that best suits each client’s needs. Thus, client satisfaction is increased while improving the company’s corporate image, which will lead to customer loyalty and increased revenue. To validate the presented proposal, it has been applied to a real case study of the telecom sector, in which 2135 users have participated. The results obtained have been analysed and compared with those obtained with a model that does not consider the non-preferences expressed by users |
|  | @article{Fraihat2022AnEE,  title={An efficient enhanced k-means clustering algorithm for best offer prediction in telecom},  author={Malak Fraihat and Salam Fraihat and Mohammed Awad and Mouhammd Alkasassbeh},  journal={International Journal of Electrical and Computer Engineering (IJECE)},  year={2022},  url={https://api.semanticscholar.org/CorpusID:247468477}  } | [An efficient enhanced k-means clustering algorithm for best offer prediction in telecom](https://www.semanticscholar.org/paper/An-efficient-enhanced-k-means-clustering-algorithm-Fraihat-Fraihat/1932069bd2b5ab05f77b64a8ccad62bebaa904e8)  Telecom companies usually offer several rate plans or bundles to satisfy the customers’ different needs. Finding and recommending the best offer that perfectly matches the customer’s needs is crucial in maintaining customer loyalty and the company’s revenue in the long run. This paper presents an effective method of detecting a group of customers who have the potential to upgrade their telecom package. The used data is an actual dataset extracted from call detail records (CDRs) of a telecom operator. The method utilizes an enhanced k-means clustering model based on customer profiling. The results show that the proposed k-means-based clustering algorithm more effectively identifies potential customers willing to upgrade to a higher tier package compared to the traditional k-means algorithm. Our results showed that our proposed clustering model accuracy was over 90%, while the traditional k-means accuracy was under 70% |
|  | @article{Akter2022CraftingEE,  title={Crafting employee engagement through talent management practices in telecom sector},  author={Habiba Akter and Waqas Ahmed and Ilham Sentosa and Sheikh Muhamad Hizam},  journal={SA Journal of Human Resource Management},  year={2022},  url={https://api.semanticscholar.org/CorpusID:246605293}  } | [Crafting employee engagement through talent management practices in telecom sector](https://www.semanticscholar.org/paper/Crafting-employee-engagement-through-talent-in-Akter-Ahmed/99eac1fe2bf521b5ff08701b4585e2c22a7999df)  Orientation: Solving the dearth of skilled employees and maintaining the engagement policy are key concerns of the Malaysian telecom sector. Therefore, talent management practices have created a mainstream process for telecom employers to be proactively involved in talent engagement. Research purpose: This study aimed to elucidate the vital talent management practices towards employee engagement in telecom sector, incorporating psychological empowerment as a mediator. Motivation for the study: Studies linking talent management with career development, rewards and recognition, training and development, are still not established in terms of employee engagement in the context of Malaysian telecom sector. Research design, approach and method: An online survey was conducted through the purposive sampling technique to collect data from telecom firms in Malaysia. The survey resulted in 242 responses, which were analysed through Partial Least Squares – Structural Equation Modelling (PLS-SEM) and PLS-Predict. In PLS-SEM, data were evaluated for hypothesis testing. After hypothesis result was obtained, the PLS-SEM model was assessed for its predictive validity through PLS-Predict. Main findings: The results explored that talent management factors positively and significantly predicted employee engagement through psychological empowerment, except training and development. The PLS-Predict resulted a higher value of predictive power for our model. Practical/managerial implications: This study may lead to practical applications to support human resource management practitioners towards comprehending the impact of talent management practices, either directly or indirectly, in engaging the right talent. Contribution/value-add: This study will fill the untapped area of improving employee engagement by adding psychological empowerment as a mediator between employee engagement and talent management practices. |
|  | @article{Bidnyk2022UltradenseIC,  title={Ultra-dense interferometric chain architecture for datacom and telecom applications},  author={Serge Bidnyk and Ksenia Yadav and Ashok Balakrishnan},  journal={EPJ Web of Conferences},  year={2022},  url={https://api.semanticscholar.org/CorpusID:252958332}  } | [Ultra-dense interferometric chain architecture for datacom and telecom applications](https://www.semanticscholar.org/paper/Ultra-dense-interferometric-chain-architecture-for-Bidnyk-Yadav/2b2fda1dd98651b2f697760bfd9955ebfc5cedf3)  Further increase in the density of integrated planar lightwave circuits (PLCs) depends on the introduction of compact guided-wave layout solutions. We describe a novel architecture for coiling multistage interferometric devices with densities reaching the theoretical limit. Our approach is validated by the design, fabrication, and deployment of state-of-the-art PLCs based on the proposed architecture for use in datacom and telecom applications. |
|  | @article{Edwine2022DetectingTR,  title={Detecting the Risk of Customer Churn in Telecom Sector: A Comparative Study},  author={Nabahirwa Edwine and Wenjuan Wang and Weiwei Song and Denis Ssebuggwawo},  journal={Mathematical Problems in Engineering},  year={2022},  url={https://api.semanticscholar.org/CorpusID:250657207}  } | [Detecting the Risk of Customer Churn in Telecom Sector: A Comparative Study](https://www.semanticscholar.org/paper/Detecting-the-Risk-of-Customer-Churn-in-Telecom-A-Edwine-Wang/538497ace61246fa8a376bb9824fbab35601150c)  Churn rate describes the rate at which customers abandon a product or service. Identifying churn-risk customers is essential for telecom sectors to retain old customers and maintain a higher competitive advantage. e purpose of this paper is to explore an effective method for detecting the risk of customer churn in telecom sectors through comparing the advanced machine learning methods and their optimization algorithms. Based on two different telecom datasets, Mutual Information classier was rstly utilized to select the most critical features relevant to customer churn. Next, the controlled-ratio undersampling strategy was employed to balance both minority and majority classes. Key hyperparameter optimization algorithms of Grid Search, Random Search, and Genetic Algorithms were then combined to t the three promising machine learning models-Random Forest, Support Vector Machines, and K-nearest neighbors into the customer churn prediction problem. Six evaluation metrics-Accuracy, Recall, Precision, AUC, F1-score and Mean Absolute Error, were last used to evaluate the performance of the proposed models. e experimental results have revealed that the RF algorithm optimized by Grid Search based on a low-ratio undersampling strategy (RF-GS-LR) outperformed other models in extracting hidden information and understanding future churning behaviors of customers on both datasets, with the maximum accuracy of 99% and 95% on the applied dataset 1-2 respectively |
|  | @article{Bariah2023UnderstandingTL,  title={Understanding Telecom Language Through Large Language Models},  author={Lina Bariah and Han Zou and Qiyang Zhao and Belkacem Mouhouche and Faouzi Bader and M{\'e}rouane Debbah},  journal={ArXiv},  year={2023},  volume={abs/2306.07933},  url={https://api.semanticscholar.org/CorpusID:259145106}  } | [Understanding Telecom Language Through Large Language Models](https://www.semanticscholar.org/paper/Understanding-Telecom-Language-Through-Large-Models-Bariah-Zou/6a3ed569d47b4ea08aca4f69ec7da5e8d87734b0)  The recent progress of artificial intelligence (AI) opens up new frontiers in the possibility of automating many tasks involved in Telecom networks design, implementation, and deployment. This has been further pushed forward with the evolution of generative artificial intelligence (AI), including the emergence of large language models (LLMs), which is believed to be the cornerstone toward realizing self-governed, interactive AI agents. Motivated by this, in this paper, we aim to adapt the paradigm of LLMs to the Telecom domain. In particular, we fine-tune several LLMs including BERT, distilled BERT, RoBERTa and GPT-2, to the Telecom domain languages, and demonstrate a use case for identifying the 3rd Generation Part- nership Project (3GPP) standard working groups. We consider training the selected models on 3GPP technical documents (Tdoc) pertinent to years 2009-2019 and predict the Tdoc categories in years 2020-2023. The results demonstrate that fine-tuning BERT and RoBERTa model achieves 84.6% accuracy, while GPT- 2 model achieves 83% in identifying 3GPP working groups. The distilled BERT model with around 50% less parameters achieves similar performance as others. This corroborates that fine-tuning pretrained LLM can effectively identify the categories of Telecom language. The developed framework shows a stepping stone towards realizing intent-driven and self-evolving wireless networks from Telecom languages, and paves the way for the implementation of generative AI in the Telecom domain. Index Terms—Generative AI, Large Language Models, Pre- trained Transformer, Telecom Language, 3GPP |
|  | @article{Maatouk2023LargeLM,  title={Large Language Models for Telecom: Forthcoming Impact on the Industry},  author={Ali Maatouk and Nicola Piovesan and Fadhel Ayed and Antonio De Domenico and M{\'e}rouane Debbah},  journal={ArXiv},  year={2023},  volume={abs/2308.06013},  url={https://api.semanticscholar.org/CorpusID:260865838}  } | [Large Language Models for Telecom: Forthcoming Impact on the Industry](https://www.semanticscholar.org/paper/Large-Language-Models-for-Telecom%3A-Forthcoming-on-Maatouk-Piovesan/124899d681a9b761832a95bd465a45ebe9ddbb09)  Large Language Models (LLMs) have emerged as a transformative force, revolutionizing numerous fields well beyond the conventional domain of Natural Language Processing (NLP) and garnering unprecedented attention. As LLM technology continues to progress, the telecom industry is facing the prospect of its potential impact on its landscape. To elucidate these implications, we delve into the inner workings of LLMs, providing insights into their current capabilities and limitations. We also examine the use cases that can be readily implemented in the telecom industry, streamlining numerous tasks that currently hinder operational efficiency and demand significant manpower and engineering expertise. Furthermore, we uncover essential research directions that deal with the distinctive challenges of utilizing the LLMs within the telecom domain. Addressing these challenges represents a significant stride towards fully harnessing the potential of LLMs and unlocking their capabilities to th e fullest extent within the telecom domain |
|  | @inproceedings{Xu2022EarlyWO,  title={Early Warning of Telecom Customer Churn Based on Multialgorithm Model Optimization},  author={Jingxiu Xu and Xueguang Li and Zhonglin He and Jinge Zhou},  booktitle={Frontiers in Energy Research},  year={2022},  url={https://api.semanticscholar.org/CorpusID:250276108}  } | [Early Warning of Telecom Customer Churn Based on Multialgorithm Model Optimization](https://www.semanticscholar.org/paper/Early-Warning-of-Telecom-Customer-Churn-Based-on-Xu-Li/5208ccc2240e9cb351261da6d7b747dee4596e38)  Background: China telecom is the largest integrated information service provider in China, its business volume all over the world. It is interesting to note that China Unicom and other telecom companies have carried out similar businesses one after another. How to prevent the loss of existing customers in the fierce competition is an important issue for telecom companies to think about. Methods: This work aims to build a variety of algorithm models for target optimization and use them to predict whether telecom companies will lose customers, respond to the early warning of customer churn, and then implement active retention measures. Data characteristics affect the final loss prediction effect. In this study, the weight contribution rate of each characteristic variable is obtained by calculating the evidence weight and then the characteristic variable information value so as to optimize the prediction accuracy of the algorithm model. Through calculation, we noted the weight contribution rate of five characteristic variables to be the highest. Including total day charge, total day minutes customer service calls, international plan, and number of voicemail messages, linear regression, decision tree, Bayesian, artificial neural network, and support vector machine are used to predict customer churn on the customer dataset published by telecom companies. The experimental results are used to test the performance of the algorithm model. Results: It is found that the characteristic variables calculated after optimization are put into multialgorithm models to predict the churn of telecom customers. Finally, it is found that it is better for the optimized characteristic variables to use the decision tree algorithm model to predict the loss of telecom customers |
|  | @article{Ni2022AVF,  title={A Victim-Based Framework for Telecom Fraud Analysis: A Bayesian Network Model},  author={Peifeng Ni and Wei Yu},  journal={Computational Intelligence and Neuroscience},  year={2022},  volume={2022},  url={https://api.semanticscholar.org/CorpusID:252034291}  } | [A Victim-Based Framework for Telecom Fraud Analysis: A Bayesian Network Model](https://www.semanticscholar.org/paper/A-Victim-Based-Framework-for-Telecom-Fraud-A-Model-Ni-Yu/a90ed0ea6203b12bd9085d31676218719aee71c4)  The increasingly rampant telecom network fraud crime will cause serious harm to people’s property safety. The way to reduce telecom fraud has shifted from passive combat to active prevention. This paper proposes a victim analysis and prediction method based on Bayesian network (BN), which models victims from age, gender, occupation, marriage, knowledge level, etc. We describe the fraud process in terms of whether to report to the police, property loss, and realizing the reasoning of the whole process of telecom fraud. This paper uses expert experience to obtain a Bayesian network structure. 533 real telecom fraud cases are used to learn Bayesian network parameters. The model is capable of quantifying uncertainty and dealing with nonlinear complex re- lationships among multiple factors, analyzing the factors most sensitive to property damage. According to the characteristics of victims, we conduct situational reasoning in the Bayesian network to evaluate property damage and alarm situations in different scenarios and provide decision support for police and community prevention and control. The experimental results show that male staff in government agencies are the most vulnerable to shopping fraud and women in schools are the most vulnerable to phishing and virus fraud and have the greatest property loss after being deceived; victim characteristics have very limited influence on whether to report to the police |
|  | @article{Mahmood2022TelecomCP,  title={Telecom Churn Prediction based on Deep Learning Approach},  author={Israa Nafea Mahmood and Hasanen S. Abdullah},  journal={Iraqi Journal of Science},  year={2022},  url={https://api.semanticscholar.org/CorpusID:252788715}  } | [Telecom Churn Prediction based on Deep Learning Approach](https://www.semanticscholar.org/paper/Telecom-Churn-Prediction-based-on-Deep-Learning-Mahmood-Abdullah/ec1bdae0f0470df700e512747c0623d533c3d8f3)  The transition of customers from one telecom operator to another has a direct impact on the company's growth and revenue. Traditional classification algorithms fail to predict churn effectively. This research introduces a deep learning model for predicting customers planning to leave to another operator. The model works on a high-dimensional large-scale data set. The performance of the model was measured against other classification algorithms, such as Gaussian NB, Random Forrest, and Decision Tree in predicting churn. The evaluation was performed based on accuracy, precision, recall, F-measure, Area Under Curve (AUC), and Receiver Operating Characteristic (ROC) Curve. The proposed deep learning model performs better than other prediction models and achieves a high accuracy rate of 91%. Furthermore, it was noticed that the deep learning model outperforms a small size Neural Network for the customer churn prediction. |
|  | @article{Zhou2023EarlyWO,  title={Early warning of telecom enterprise customer churn based on ensemble learning},  author={Yancong Zhou and Wenyue Chen and Xiaochen Sun and Dandan Yang},  journal={PLOS ONE},  year={2023},  volume={18},  url={https://api.semanticscholar.org/CorpusID:263902791}  } | [Early warning of telecom enterprise customer churn based on ensemble learning](https://www.semanticscholar.org/paper/Early-warning-of-telecom-enterprise-customer-churn-Zhou-Chen/2fa34f42b5823c9ccb761a4100066644d9bcacd5)  Analyzing customers’ characteristics and giving the early warning of customer churn based on machine learning algorithms, can help enterprises provide targeted marketing strategies and personalized services, and save a lot of operating costs. Data cleaning, oversampling, data standardization and other preprocessing operations are done on 900,000 telecom cus- tomer personal characteristics and historical behavior data set based on Python language. Appropriate model parameters were selected to build BPNN (Back Propagation Neural Net- work). Random Forest (RF) and Adaboost, the two classic ensemble learning models were introduced, and the Adaboost dual-ensemble learning model with RF as the base learner was put forward. The four models and the other four classical machine learning models- decision tree, naive Bayes, K-Nearest Neighbor (KNN), Support Vector Machine (SVM) were utilized respectively to analyze the customer churn data. The results show that the four models have better performance in terms of recall rate, precision rate, F1 score and other indicators, and the RF-Adaboost dual-ensemble model has the best performance. Among them, the recall rates of BPNN, RF, Adaboost and RF-Adaboost dual-ensemble model on positive samples are respectively 79%, 90%, 89%,93%, the precision rates are 97%, 99%, 98%, 99%, and the F1 scores are 87%, 95%, 94%, 96%. The RF-Adaboost dual-ensemble model has the best performance, and the three indicators are 10%, 1%, and 6% higher than the reference. The prediction results of customer churn provide strong data support for tele- com companies to adopt appropriate retention strategies for pre-churn customers and reduce customer churn |
|  | @article{Khan2023PrivacyPreservingBT,  title={Privacy-Preserving Based Technique for Customer Churn Prediction in Telecom Industry},  author={Gul Zaman Khan and Ikram Ulhaq and Ihsan Adil and Sajad Ulhaq and Inam Ullah},  journal={VFAST Transactions on Software Engineering},  year={2023},  url={https://api.semanticscholar.org/CorpusID:267025008}  } | [Privacy-Preserving Based Technique for Customer Churn Prediction in Telecom Industry](https://www.semanticscholar.org/paper/Privacy-Preserving-Based-Technique-for-Customer-in-Khan-Ulhaq/8acf5b303fa41175623aa15c240994240fd9b6c6)  In recent years, customer churn has been one of the most prominent topics, especially in the telecom industry. The telecommunications industry is producing massive amounts of data every minute. Thus, the telecom industry is seeking more ways to analyze and predict their potential and churn customers. According to telecom analysis, acquiring a new customer is costlier than keeping a current one. To lessen customer churn, it is compulsory for industries to detect an increase in customer churn factors. The number of service suppliers is increasing daily, especially in the telecom industry. Phishing attacks and fraud are crucial points in customer churn. The aim of this study is to predict customer churn with predictive churn models for retention campaigns to satisfy the business requirement of profit maximization. The proposed research used the BAT-ANN classification model with the BigML dataset to predict customer churn in the telecom industry. The proposed model achieved 89.2% accuracy. |
|  | @article{Singanamalla2022TelechainBT,  title={Telechain: Bridging Telecom Policy and Blockchain Practice},  author={Sudheesh Singanamalla and Apurv Mehra and Nishanth Chandran and Himanshi Lohchab and Seshanuradha Chava and Asit Kadayan and Sunil Bajpai and Kurtis Heimerl and Richard J. Anderson and Satya Lokam},  journal={ACM SIGCAS/SIGCHI Conference on Computing and Sustainable Societies (COMPASS)},  year={2022},  url={https://api.semanticscholar.org/CorpusID:249062837}  } | [Telechain: Bridging Telecom Policy and Blockchain Practice](https://www.semanticscholar.org/paper/Telechain%3A-Bridging-Telecom-Policy-and-Blockchain-Singanamalla-Mehra/0d2e90e4adee44a8c0baad4e8197d77499888b44)  The use of blockchain in regulatory ecosystems is a promising approach to address challenges of compliance among mutually un- trusted entities. In this work, we consider applications of blockchain technologies in telecom regulations. In particular, we address grow- ing concerns around Unsolicited Commercial Communication (UCC aka. spam) sent through text messages (SMS) and phone calls in In- dia. Despite several regulatory measures taken to curb the menace of spam it continues to be a nuisance to subscribers while posing challenges to telecom operators and regulators alike. In this paper, we present a consortium blockchain based ar- chitecture to address the problem of UCC in India. Our solution improves subscriber experiences, improves the efficiency of regula- tory processes while also positively impacting all stakeholders in the telecom ecosystem. Unlike previous approaches to the problem of UCC, which are all ex-post, our approach to adherence to the regulations is ex-ante. The proposal described in this paper is a primary contributor to the revision of regulations concerning UCC and spam by the Telecom Regulatory Authority of India (TRAI). The new regulations published in July 2018 were first of a kind in the world and amended the 2010 Telecom Commercial Communication Customer Preference Regulation (TCCCPR), through mandating the use of a blockchain/distributed ledgers in addressing the UCC prob- lem. In this paper, we provide a holistic account of of the projects’ evolution from (1) its design and strategy, to (2) regulatory and policy action, (3) country wide implementation and deployment, and (4) evaluation and impact of the work. While the scope of the work presented in this paper is in the context of the UCC prob- lem in India, we believe that the approach can be generalized to adopt blockchain based solutions to improve regulatory processes in other contexts and countries. We hope this account will serve as a useful case study for the stakeholders of the telecommunications ecosystem and regulators, and motivate countries across the world facing similar challenges to consider the viability of the technology, be convinced to establish it, continue efforts at addressing active research challenges, and scale the technology from our experiences |
|  | @article{Zhang2022AKG,  title={A Knowledge Graph Completion Method for Telecom Metadata Based on the Spherical Coordinate System},  author={Kaicheng Zhang and Han Wang and Mingchuan Yang and Xinchi Li and Xiaoqing Xia and Zhixia Guo},  journal={IEEE Access},  year={2022},  volume={10},  pages={122670-122678},  url={https://api.semanticscholar.org/CorpusID:253697618}  } | [A Knowledge Graph Completion Method for Telecom Metadata Based on the Spherical Coordinate System](https://www.semanticscholar.org/paper/A-Knowledge-Graph-Completion-Method-for-Telecom-on-Zhang-Wang/e117f01878a67f9a3a0ab87ca6dcad291cdc5469)  In the telecommunications field, the problem of data island is caused by the separation and isolation of data. They are distributed in different systems including the business support system (BSS), management support system (MSS), and operation support system (OSS). The common idea is to use global ID mapping to break data barriers. However, using the direct global ID mapping of raw data has the problems of large data scale and the inability to guarantee privacy and security. With this in mind, constructing and completing a metadata knowledge graph to fabric the data is a feasible approach. Considering the particularity of the telecom metadata knowledge graph and the need for hierarchical distinction in business and semantic abstraction, we propose a deep learning method and framework based on the spherical coordinate system. It can be extended to a poly-spherical coordinate system and add a pre-training process composed of word2vec and a clusterer. Experimental results show that our method achieves state-of-the-art |
|  | @article{Simakovic2022BigDataPF,  title={Big-Data Platform for Performance Monitoring of Telecom-Service-Provider Networks},  author={Milan Simakovic and Zoran {\vC}i{\vc}a and Dejan Draji{\'c}},  journal={Electronics},  year={2022},  url={https://api.semanticscholar.org/CorpusID:250652723}  } | [Big-Data Platform for Performance Monitoring of Telecom-Service-Provider Networks](https://www.semanticscholar.org/paper/Big-Data-Platform-for-Performance-Monitoring-of-Simakovic-%C4%8Ci%C4%8Da/aedd805e7ce7ec115d0adf420af9303c210b39d8)  Large telecom-service-provider networks are typically based on complex communications infrastructures comprising millions of network devices. The performance monitoring of such net- works is a very demanding and challenging task. A large amount of data is collected and processed during performance monitoring to obtain information that gives insights into the current network per- formance. Using the obtained information, providers can efficiently detect, locate, and troubleshoot weak spots in the network and improve the overall network performance. Furthermore, the extracted information can be used for planning future network expansions and to support the determination of business-strategy decisions. However, traditional methods for processing and storing data are not applicable because of the enormous amount of collected data. Thus, big-data technologies must be used. In this paper, a big-data platform for the performance monitoring of telecom-service-provider networks is proposed. The proposed platform is capable of collecting, storing, and processing data from millions of devices. Typical challenges and problems in the development and deployment process of the platform, as well as the solutions to overcome them, are presented. The proposed platform is adjusted to HFC (Hybrid Fiber-Coaxial) network and currently operates in the real HFC network, comprising millions of users and devices. |
|  | @article{Wei2023InternalFI,  title={Internal Factors Influencing Vulnerability to Telecom Fraud},  author={Zizhao Wei},  journal={Advances in Economics, Management and Political Sciences},  year={2023},  url={https://api.semanticscholar.org/CorpusID:259598895}  } | [Internal Factors Influencing Vulnerability to Telecom Fraud](https://www.semanticscholar.org/paper/Internal-Factors-Influencing-Vulnerability-to-Fraud-Wei/f1d21a5df7cb27f22657ebde005dfedb912c2539)  With the popularity of the Internet and electronic devices, the rateoftelecommunication fraud is getting higher and higher. Most of the current researchfocuseson the prediction of telecom fraud through machine learning. This study, on the other hand,focuses on the people who have been defrauded and finds out how people's internal factors—"cognitive flexibility", "critical thinking", "material desires" and social attributesinfluence "vulnerability to Telecom Fraud", trying to find out which mental characteristicsmake people more vulnerable to telecom fraud. This study uses SPSS 25.0 softwarefor dataanalysis and draws results and conclusions through the methods of questionnaire surveyandhypothesis testing. It discovers both cognitive flexibility and critical thinking are negativelycorrelated with vulnerability to telecom fraud, meaning that people with more cognitiveflexibility and critical thinking were less likely to be telecom scammed. It alsofindsthatpeople with higher disposable income are also more vulnerable to wire scams. Finally, thisstudy discusses the discovered insights and put forward constructive suggestionsforscholars and related departments. |
|  | @article{Lin2023AnomalyIM,  title={Anomaly Identification Model for Telecom Users Based on Machine Learning Model Fusion},  author={Jianhong Lin and Peng Wang and Chunming Wu},  journal={J. Comput. Inf. Technol.},  year={2023},  volume={30},  pages={35-50},  url={https://api.semanticscholar.org/CorpusID:257778800}  } | [Anomaly Identification Model for Telecom Users Based on Machine Learning Model Fusion](https://www.semanticscholar.org/paper/Anomaly-Identification-Model-for-Telecom-Users-on-Lin-Wang/f1f64b566f490d68c15c40a20feeb9d89b0f2129)  With the development of economic globalization and modern information and communication technology, the situation of communication fraud is becoming more and more serious. How to identify fraudulent calls accurately and effectively has become an urgent task in current telecommunications operations. Affected by the sample set and the current state of the art, the current machine learning methods used to identify the imbalanced distribution dataset of positive and negative samples have low recognition accuracy. Therefore, in this paper, we propose a new hybrid model solution that uses feature construction, feature selection and imbalanced classes handling. A stacking model fusion algorithm composed of a two-layer stacking framework with several state-of-the-art machine learning classifiers is adopted. The results show that the risk user identification model based on mobile network communication behavior established by our stacking model fusion algorithm can accurately predict the category labels of telecom users and improve the risk of telecom users. The generalization performance of the identification is high, which provides a certain reference for the telecommunications industry to identify risk users based on mobile network communication behaviors. |
|  | @article{Mogare2023TELECOMCP,  title={TELECOM CHURN PREDICTION USING MACHINE LEARNING ALGORITHM},  author={Pallavi Mogare and Vaishnavi Kadam and Mohini Pawar and Gayatri Kadam},  journal={International Research Journal of Modernization in Engineering Technology and Science},  year={2023},  url={https://api.semanticscholar.org/CorpusID:259591391}  } | [TELECOM CHURN PREDICTION USING MACHINE LEARNING ALGORITHM](https://www.semanticscholar.org/paper/TELECOM-CHURN-PREDICTION-USING-MACHINE-LEARNING-Mogare-Kadam/0b0cec56e7a24bc983d03a067fdc2f14f029b7f1)  Customers always play vital role in increasing profit and revenue of every organization; hence, to gain customer satisfaction it is important for the organizational managers to maintain one efficient customer relationship management system by selecting the target customers and maintaining effective relationship with them. In current days, the customers are getting more attracted towards the quality of service (QoS) provided by the organizations. However, the current era is evidencing higher competition in providing technologically advanced QoS to the customers. Nevertheless, efficient customer relationship management systems can be advantageous for the organization for gaining more customers, maintaining customer relationships and improve customer retention by adding more profit to the organizational business. Furthermore, the machine learning models such as support vector machine algorithms can add more value to the customer retention strategies. |
|  | @article{Kunal2023ANES,  title={AN EXPLORATORY STUDY ON THE COMPONENTS OF AI IMPACTING CUSTOMER RETENTION IN TELECOM INDUSTRY},  author={DR. Kishore Kunal and DR. K. R. Ramprakash and Dr. C. Joe Arun},  journal={Russian Law Journal},  year={2023},  url={https://api.semanticscholar.org/CorpusID:259767211}  } | [AN EXPLORATORY STUDY ON THE COMPONENTS OF AI IMPACTING CUSTOMER RETENTION IN TELECOM INDUSTRY](https://www.semanticscholar.org/paper/AN-EXPLORATORY-STUDY-ON-THE-COMPONENTS-OF-AI-IN-Kunal-Ramprakash/736cac49b028fdb186806e2587d7c9cd5c2e55f6)  Consumer behavior in the mobile industry, particularly consumer behaviors, has become a prominent marketing research topic. Every consumer has distinct life experiences that influence their shopping decisions. Age, employment, lifestyle, personality, and self-concept are social and personal elements that can affect a buyer's final selection. Based on tests performed on data collected, several outcomes were discovered. In this research, the participants were chosen using the technique described, and their data were analyzed using descriptive and inferential statistics. The Chi-Square test was used to investigate the relationship between companies and their usage of optimal service techniques. According to the study's findings, AI-powered solutions may aid organizations in encouraging customers to take action at each stage of the user life cycle. |
|  | @article{Wang2022CountermeasureOT,  title={Countermeasure of Telecom Network Fraud Investigation Based on Big Data},  author={Tianyu Wang and Bo Yang},  journal={Scientific Programming},  year={2022},  url={https://api.semanticscholar.org/CorpusID:249114780}  } | [Countermeasure of Telecom Network Fraud Investigation Based on Big Data](https://www.semanticscholar.org/paper/Countermeasure-of-Telecom-Network-Fraud-Based-on-Wang-Yang/822a92cfd5074f28a7a7c9bcbc6ec5271e4ef7eb)  With the diversication of information data in the information age of big data and the integration of network technology and the development of dierent industries, criminals who carry out telecommunication fraud are also using the technical loopholes existing in the process of integration of big data with dierent industries as an opportunity to commit crimes. is paper studies the investigation process and countermeasures of telecom network fraud through big data technology. is paper rst introduces the characteristics of big data, analyzes the challenge of personal information security under the background of big data, warns people to protect their personal information in the era of big data, puts forward the clustering algorithm based on big data, introduces the concrete steps based on big data clustering algorithm, and then puts forward the specic steps of big data clustering algorithm. e current situation of telecom network fraud is analyzed, and the telecommunication network fraud is clustered based on big data. e experimental results show that, based on the clustering analysis of telecommunication network fraud based on big data, it is found that through the information age of big data, as long as big data are used rationally, it can eectively suppress telecommunications fraud and reduce it by 80%. |

# **I) Giới thiệu bài toán**

Ngành viễn thông là một lĩnh vực quan trọng trong nền kinh tế toàn cầu, chịu trách nhiệm về việc truyền tải thông tin và giao tiếp giữa con người trên khắp thế giới. Ngành viễn thông bao gồm một loạt các dịch vụ và công nghệ liên quan đến việc truyền tải, lưu trữ, xử lý và tiêu thụ thông tin. Các lĩnh vực chính trong ngành này bao gồm truyền thông di động, internet, truyền hình, điện thoại cố định và nhiều hơn nữa. Ngành viễn thông có sự phát triển mạnh mẽ trên toàn cầu và bao gồm các doanh nghiệp lớn như nhà mạng di động, nhà cung cấp dịch vụ internet, công ty truyền hình và các nhà sản xuất thiết bị viễn thông. Phạm vi của ngành này rất rộng lớn, từ việc cung cấp dịch vụ di động cho người dùng cá nhân đến việc cung cấp giải pháp viễn thông doanh nghiệp cho các công ty lớn.

***Mô tả bài toán:***

Dữ liệu đầu vào: Bao gồm thông tin về các cuộc gọi điện thoại như số điện thoại gọi, số điện thoại nhận, thời gian gọi, địa điểm và các thông tin kỹ thuật khác như mức độ tín hiệu, loại cuộc gọi, và thông tin về gói cước.

* Mục tiêu:
* Phân tích hành vi của khách hàng: Dự đoán xu hướng gọi điện thoại, phân tích thói quen gọi và nhận cuộc gọi, xác định các mô hình gọi điện thoại phổ biến và không phổ biến.
* Đo lường hiệu suất mạng lưới: Theo dõi tỷ lệ gọi thất bại, thời gian kết nối trung bình, và sự phân phối của cuộc gọi theo vùng địa lý để phát hiện và giải quyết vấn đề kỹ thuật.
* Phát hiện gian lận và spam: Tìm kiếm các mô hình dự đoán và phát hiện các cuộc gọi lừa đảo hoặc gọi spam.
* Ý nghĩa và ứng dụng:
* Hiểu rõ hơn về hành vi và nhu cầu của khách hàng: Phân tích dữ liệu cuộc gọi có thể giúp nhà cung cấp dịch vụ viễn thông hiểu rõ hơn về thói quen gọi điện thoại của khách hàng, từ đó tạo ra các dịch vụ và gói cước phù hợp.
* Cải thiện chất lượng dịch vụ: Bằng cách theo dõi và đánh giá hiệu suất mạng lưới từ dữ liệu cuộc gọi, các nhà cung cấp có thể phát hiện và giải quyết các vấn đề kỹ thuật một cách nhanh chóng, tăng cường trải nghiệm người dùng.
* Bảo vệ an ninh mạng: Phân tích dữ liệu cuộc gọi có thể giúp phát hiện và ngăn chặn các cuộc gọi lừa đảo, spam và các hoạt động đe dọa bảo mật thông tin cá nhân của người dùng.
* Phạm vi dự án:
* Thu thập, tiền xử lý và khám phá dữ liệu cuộc gọi từ hệ thống viễn thông.
* Áp dụng các kỹ thuật xử lý dữ liệu lớn và học máy để phân tích và trích xuất insights từ dữ liệu.
* Xây dựng các mô hình dự đoán và phát hiện gian lận từ dữ liệu cuộc gọi.
* Tạo ra các báo cáo và đồ thị minh họa để trình bày kết quả phân tích và đánh giá hiệu suất mô hình.

Bài toán phân tích dữ liệu từ hệ thống viễn thông không chỉ giúp chúng ta hiểu rõ hơn về hành vi của khách hàng mà còn đóng vai trò quan trọng trong việc cải thiện dịch vụ và quản lý mạng lưới. Chúng ta hy vọng rằng việc áp dụng Apache Spark trong bài toán này sẽ mang lại những insights giá trị và đóng góp tích cực vào ngành viễn thông.

# **II) Nghiên cứu liên quan**

Có nhiều nghiên cứu liên quan đến ngành viễn thông (telecom) được thực hiện trên toàn cầu. Dưới đây là một số chủ đề và xu hướng nghiên cứu phổ biến trong lĩnh vực này:

1. **Công Nghệ 5G và Mạng Di Động Tiên Tiến:** Nghiên cứu về các công nghệ mới như 5G và tiến triển trong mạng di động nhằm tối ưu hóa hiệu suất mạng, tăng tốc độ truy cập và cải thiện trải nghiệm người dùng.
2. **Internet Vạn Vật (IoT):** Nghiên cứu về ứng dụng của IoT trong viễn thông, bao gồm cả mạng cảm biến không dây và các ứng dụng IoT trong công nghiệp, y tế, nông nghiệp và các lĩnh vực khác.
3. **An Toàn và Bảo Mật Mạng:** Nghiên cứu về các vấn đề liên quan đến an ninh mạng, bảo mật dữ liệu và phòng ngừa các mối đe dọa mạng như tấn công mạng, phần mềm độc hại và vi rút.
4. **Trí Tuệ Nhân Tạo (AI) trong Viễn Thông:** Nghiên cứu về ứng dụng của trí tuệ nhân tạo trong ngành viễn thông, bao gồm cả tự động hóa mạng, dự đoán nhu cầu và tối ưu hóa hệ thống.
5. **Phân Tích Dữ Liệu và Khai Thác Dữ Liệu:** Nghiên cứu về phương pháp và công nghệ phân tích dữ liệu để hiểu biết và tối ưu hóa hoạt động của mạng viễn thông, từ việc phân tích luồng dữ liệu đến dự đoán hành vi người dùng.
6. **Kinh Doanh và Chiến Lược Trong Ngành Viễn Thông:** Nghiên cứu về các chiến lược kinh doanh, tiếp thị và phân phối trong ngành viễn thông, bao gồm cả nghiên cứu về các mô hình kinh doanh mới và tương tác giữa các nhà cung cấp dịch vụ và khách hàng.
7. **Chính Sách và Quy Định:** Nghiên cứu về các chính sách và quy định về viễn thông, bao gồm cả vấn đề về sự quản lý tần số, quyền riêng tư và quản lý dữ liệu.