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| id | Cite | Abstract |
| 1 | @article{Maurya2023ADT,  title={A Decision Tree Classifier  Based Ensemble Approach to Credit  Score Classification},  author={Ashok Maurya and Shivam Gaur},  journal={2023 International  Conference on Computing, Communication,  and Intelligent Systems (ICCCIS)},  year={2023},  pages={620-624},  url={https://api.semanticscholar.  org/CorpusID:267702199}  } | The process of classifying credit scores holds a crucial role in evaluating an individual's creditworthiness, influencing significant financial choices. This study is driven by the dynamic nature of credit scores and the financial sector's need for precise, real-time credit evaluations. This research introduces an ensemble-based method for credit score classification, utilizing a blend of diverse machine learning algorithms to improve accuracy and resilience. The ensemble approach capitalizes on each base classifier's strengths, mitigating biases, reducing overfitting, and enhancing overall classification accuracy. A comparison between the proposed model and existing frameworks demonstrates its competitive edge, surpassing many counterparts with an accuracy of approximately 92.25%. However, the study acknowledges the potential for further enhancement and validation across various datasets. The ensemble-based framework offers a promising avenue to heighten credit score classification accuracy, thereby contributing to informed financial decision-making and reinforcing credit ecosystem stability. Future endeavors involve expanding the model to include more datasets and refining data preprocessing techniques to achieve even more precise predictions. |
| 2 | @article{Shukla2023ACS,  title={A Comparative Study of Deep Learning and Machine Learning Techniques in Credit Score Classification},  author={Rahul Shukla and Rupali Sawant and Renuka Pawar},  journal={International Journal of Innovative Research in Computer and Communication Engineering},  year={2023},  url={https://api.semanticscholar.  org/CorpusID:260893046}  } | The field of credit score classification has experienced notable progress through the introduction of deep learning (DL) and machine learning (ML) techniques, empowering financial institutions to make well-informed decisions about assessing creditworthiness. However, existing research often focuses on just a few classifiers pertaining to either ML or DL techniques, lacking a comprehensive comparative analysis between the two. This gap calls for a thorough study that evaluates and compares a wide range of ML classifiers and DL models in the context of credit scoring. Our work aims to address this limitation by presenting an extensive comparative analysis between different ML and DL approaches. We provide novel insights into the strengths and weaknesses of each model, enabling financial institutions to select the most suitable approach for their specific needs. Through conducting extensive experiments on a credit records dataset, we evaluated the accuracy, precision, recall, and F1 score of various ML classifiers, such as logistic regression, decision trees, and random forests. Additionally, we delved into the capabilities of DL models, which included multi-layer perceptron (MLP), convolutional neural networks (CNN), recurrent neural networks (RNN), and hybrid models. Our findings revealed that Random Forest achieved the highest test accuracy of 90.27, while MLP and CNN closely followed with the second-highest accuracies at 87.08 and 87.16, respectively. These results also demonstrated the potential of both MLP and CNN in credit scoring assessment. MLP's strength lies in its capacity to handle non-linear relationships between features, providing a viable alternative to decision tree-based models. On the other hand, CNN excels in capturing spatial patterns and dependencies among features, presenting a distinct advantage in credit score classification. Overall, our study presents a broad-spectrum overview of the analysis, encompassing each model's performance and effectiveness in credit score classification. The findings empower financial institutions to leverage the benefits of DL and ML techniques, optimizing their decision-making processes and enhancing risk management strategies. By selecting the most suitable credit score classification model based on the insights gained from this comparative analysis, institutions can make informed choices and effectively evaluate creditworthiness, leading to improved risk assessment and lending decisions. |
| 3 | @article{Kuppili2020CreditSC,  title={Credit score classification using spiking extreme learning machine},  author={Venkatanareshbabu Kuppili and Diwakar Tripathi and Damodar Reddy Edla},  journal={Computational Intelligence},  year={2020},  volume={36},  pages={402 - 426},  url={https://api.semanticscholar. org/CorpusID:209068996}  } | Credit score classification is a prominent research problem in the banking or financial industry, and its predictive performance is responsible for the profitability of financial industry. This paper addresses how Spiking Extreme Learning Machine (SELM) can be effectively used for credit score classification. A novel spike-generating function is proposed in Leaky Nonlinear Integrate and Fire Model (LNIF). Its interspike period is computed and utilized in the extreme learning machine (ELM) for credit score classification. The proposed model is named as SELM and is validated on five real-world credit scoring datasets namely: Australian, German-categorical, German-numerical, Japanese, and Bankruptcy. Further, results obtained by SELM are compared with back propagation, probabilistic neural network, ELM, voting-based *Q*-generalized extreme learning machine, Radial basis neural network and ELM with some existing spiking neuron models in terms of classification accuracy, Area under curve (AUC), *H*-measure and computational time. From the experimental results, it has been noticed that improvement in accuracy and execution time for the proposed SELM is highly statistically important for all aforementioned credit scoring datasets. Thus, integrating a biological spiking function with ELM makes it more efficient for categorization. |
| 4 | @article{Tripathi2021ExperimentalAO,  title={Experimental analysis of machine learning methods for credit score classification},  author={Diwakar Tripathi and Damodar Reddy Edla and Annushree Bablani and Alok Kumar Shukla and B. Ramachandra Reddy},  journal={Progress in Artificial Intelligence},  year={2021},  volume={10},  pages={217 - 243},  url={https://api.semanticscholar. org/CorpusID:233650527}  } | Credit scoring concerns with emerging empirical model to assist the financial institutions for financial decision-making process. Credit risk analysis plays a vital role for decision-making process; statistical and machine learning approaches are utilized to estimate the risk associated with a credit applicant. Enhancing the performance of credit scoring model, particularly toward non-trustworthy “or non-creditworthy” group, may result incredible effect for financial institution. However, credit scoring data may have excess and unimportant data and features which degrades the performance of model. So, selection of important features (or reduction in irrelevant and redundant features) may play the key role for improving the effectiveness and reducing the complexity of the model. This study presents a experimental results analysis of various combinations of feature selection approaches with various classification approaches and impact of feature selection approaches. For experimental results analysis, nine feature selection and sixteen classification state-of-the-art approaches have been applied on seven benched marked credit scoring datasets. |
| 5 | @article{Chacko2023EnhancingCS,  title={Enhancing Credit Score Analysis: A Novel Approach with Random Forest and Kernel SVM},  author={Annie Chacko and John Aravindhar D and Antonidoss A},  journal={International Journal of Electronics and Communication Engineering},  year={2023},  url={https://api.semanticscholar. org/CorpusID:266283340}  } | Credit score analysis systematically evaluates an individual or entity’s financial history and behaviour to determine their creditworthiness. Traditional methods for credit score analysis have several challenges, such as privacy concerns, lack of flexibility, vulnerability to identity theft, limited data, and real-time analysis. To overcome these complexities, this paper proposes a novel method combining the advantages of Random Forest and kernel Support Vector Machine (SVM). The proposed method has three phases: data preprocessing, feature extraction, and classification. In the preprocessing phase, the proposed method eliminates the noise and errors from the raw data based on obtaining quality input for the analysis. In this study, Random Forest is utilized to extract the most significant features based on the domain and credit data analysis also, kernel SVM is employed for classification by analyzing the components and their impact on credit scoring. Also, the study conducted experiments on the German Credit Risk dataset. The performance evaluation of the proposed method involves analyzing its effectiveness based on evaluation metrics and comparing its performance with existing methods. The experimental results depict that the proposed method obtained better outcomes and achieved high efficiency for credit score analysis. |
| 6 | @inproceedings{Pandey2020ComparativeAO,  title={Comparative analysis of a deep learning approach with various classification techniques for credit score computation},  author={Arvind Pandey and Shipra Shukla and Krishna Kumar Mohbey},  year={2020},  url={https://api.semanticscholar. org/CorpusID:225577111}  } | Background: Large financial companies are perpetually creating and updating customer scoring techniques. From a risk management view, this research for the predictive accuracy of probability is of vital importance than the traditional binary result of classification, i.e., noncredible and credible customers. The customer's default payment in Taiwan is explored for the case study.  Objective: The aim is to audit the comparison between the predictive accuracy of the probability of default with various techniques of statistics and machine learning.  Method: In this paper, nine predictive models are compared from which the results of only six models are taken into consideration. Deep learning-based H2O, XGBoost, logistic regression, gradient boosting, naïve Bayes, logit model, and probit regression comparative analysis are performed. The software tools, such as R and SAS (university edition), are employed for machine learning and statistical model evaluation.  Results: Through the experimental study, we demonstrate that XGBoost performs better than other AI and ML algorithms.  Conclusion: Machine learning approach, such as XGBoost, is effectively used for credit scoring, among other data mining and statistical approaches. |
| 7 | @article{Adisa2022CreditSP,  title={Credit Score Prediction using Genetic Algorithm-LSTM Technique},  author={Juliana Adeola Adisa and Samuel Olusegun Ojo and Pius Adewale Owolawi and Agnieta Pretorius and S. Ojo},  journal={2022 Conference on Information Communications Technology and Society (ICTAS)},  year={2022},  pages={1-6},  url={https://api.semanticscholar. org/CorpusID:247961496}  } | In data mining, the goal of prediction is to develop a more effective model that can provide accurate results. Prior literature has studied different classification techniques and found that combining multiple classifiers into ensembles outperformed most single classifier approaches. The performance of an ensemble classifier can be affected by some factors. How to determine the best classification technique? Which combination method to employ? This paper applies Long Short-Term Memory (LSTM), one of the most advanced deep learning algorithms which are inherently appropriate for the financial domain but rarely applied to credit scoring prediction. The research presents an optimization approach to determine the optimal parameters for a deep learning algorithm. The LSTM parameters are determined using an optimization algorithm. The LSTM parameters include epochs, batch size, number of neurons, learning rate and dropout. The results show that the optimized LSTM model outperforms both single classifiers and ensemble models. |
| 8 | @article{Veeramanikandan2019AFF,  title={A Futuristic Framework for Financial Credit Score Prediction System using PSO based Feature Selection with Random Tree Data Classification Model},  author={Varadharajan. Veeramanikandan and M. Jeyakarthic},  journal={2019 International Conference on Smart Systems and Inventive Technology (ICSSIT)},  year={2019},  pages={826-831},  url={https://api.semanticscholar. org/CorpusID:211119906}  } | Numerous data classification approaches have been available for forecasting the economic crisis of institutions utilizing the past data. An essential process in the design of precise financial crisis scoring (FCS) technique includes the choice of proper variables that are related to the current issue. It is referred as feature selection issue that assist to boost the classifier results. This study devises a novel FCS model that incorporates two phases: particle swarm optimization (PSO) for feature selection (PSO-FS) and Random Tree (RT) for classifying data referred as PSO-RT approach. To further enhance the classifier results, misclassified instance removal process takes placeusing Naïve Bayes (NB) model. The projected PSO-RT model undergoes validation utilizing a benchmark dataset. A comprehensive simulation results takes place to investigate the performance of the presented PSO-RT model over other models. As results, this paper mainly suggests that the presented FCS model is effective over other models. |
| 9 | @article{Kumar2021CreditSP,  title={Credit Score Prediction System using Deep Learning and K-Means Algorithms},  author={Ashwani Kumar and D. L. Shanthi and Pronaya Bhattacharya},  journal={Journal of Physics: Conference Series},  year={2021},  volume={1998},  url={https://api.semanticscholar. org/CorpusID:237292539}  } | In financial markets, credit rating and risk assessment tools are used to minimize potential risk up to some extent for credit score. Nowadays, the banking and financial industry has experienced rapid expansion. Therefore, with this growth, the numbers of credit card applications with various credit products are increasing day by day because many people want to avail these services for their personal interest. The challenge here is to identify insights on the performance of a finance industry by using deep learning algorithms as they directly affect the viability of that industry. These industries have a limited number of resources and capital, which can be used to deliver the services among the customers. In this research work, we proposed prediction of credit scoring system using deep learning and K-Means algorithm for the financial industry. The scheme contains a predictive model which uses feature selection (FS) classification and deep learning applications simultaneously to train the proposed model to perform effectively. The scheme 1) pre-processing credit card data 2) uses a feature selection technique to minimize the dimension of data in order to obtain the finest training data 3) applies a deep learning algorithm to map the input weight with hidden biases to achieve excellent performance 4) Decision support system is used to enable the deep learning algorithm to provide a more accurate and intelligent decision. Furthermore, the proposed model is validated on different credit scoring dataset in real-world scenarios and is capable of improving the effectiveness and accuracy. The studies indicate that our predictive model performs well for credit scoring of existing customer and helps lenders to allocate funds in finance industry. |
| 10 | @article{Kazemi2023EstimationOO,  title={Estimation of optimum thresholds for binary classification using genetic algorithm: An application to solve a credit scoring problem},  author={Hamid Reza Kazemi and Kaveh Khalili Damghani and Soheil Sadi-Nezhad},  journal={Expert Systems},  year={2023},  volume={40},  url={https://api.semanticscholar. org/CorpusID:256630574}  } | The main issue in a classification problem is classifying observations into various disjoint classes. Different classification techniques generate a continuous number between a and b, usually between 0 and 1; thus, the optimal cut-off value(s) must be carefully selected to discriminate classes precisely. The decision is about setting a threshold value and transforming the continuous score into a binary output. Therefore, in addition to using the so-called sophisticated classification methods to have a more accurate classification, there is a need to identify and choose the optimal threshold value(s). However, the latter has not been thoroughly investigated. Hence, this study proposes an approach based on a Genetic Algorithm (GA) and Neural Networks (NNs) to automatically find customized cut-off values, considering different performance criteria and given datasets. Since credit scoring is a binary classification problem, two popular credit scoring datasets, namely “Australian” and “German” credit datasets, are used to test the proposed approach. Our numerical results revealed that the proposed GA-NN model could successfully find customized acceptance thresholds, considering predetermined performance criteria, including Accuracy, Estimated Misclassification Cost (EMC), and Area under ROC Curve (AUC) for the tested datasets. Furthermore, the best-obtained results and the paired-samples *t*-test results show that utilizing the customized cut-off points leads to a more accurate classification than the commonly-used threshold value of 0.5. |
| 11 | @article{PraveenMahesh2022DetectionOF,  title={Detection of fraudulent credit card transactions: A comparative analysis of data sampling and classification techniques},  author={Konduri Praveen Mahesh and Shaik Ashar Afrouz and Anu Shaju Areeckal},  journal={Journal of Physics: Conference Series},  year={2022},  volume={2161},  url={https://api.semanticscholar. org/CorpusID:245876831}  } | Every year there is an increasing loss of a huge amount of money due to fraudulent credit card transactions. Recently there is a focus on using machine learning algorithms to identify fraud transactions. The number of fraud cases to non-fraud transactions is very low. This creates a skewed or unbalanced data, which poses a challenge to training the machine learning models. The availability of a public dataset for this research problem is scarce. The dataset used for this work is obtained from Kaggle. In this paper, we explore different sampling techniques such as under-sampling, Synthetic Minority Oversampling Technique (SMOTE) and SMOTE-Tomek, to work on the unbalanced data. Classification models, such as k-Nearest Neighbour (KNN), logistic regression, random forest and Support Vector Machine (SVM), are trained on the sampled data to detect fraudulent credit card transactions. The performance of the various machine learning approaches are evaluated for its precision, recall and F1-score. The classification results obtained is promising and can be used for credit card fraud detection. |
| 12 | @inproceedings{Dushimimana2020UseOM,  title={Use of Machine Learning Techniques to Create a Credit Score Model for Airtime Loans},  author={Bernard Dushimimana and Yvonne Wambui and Timothy Lubega and Patrick E. McSharry},  year={2020},  url={https://api.semanticscholar. org/CorpusID:225423168}  } | Airtime lending default rates are typically lower than those experienced by banks and microfinance institutions (MFIs) but are likely to grow as the service is offered more widely. In this paper, credit scoring techniques are reviewed, and that knowledge is built upon to create an appropriate machine learning model for airtime lending. Over three million loans belonging to more than 41 thousand customers with a repayment period of three months are analysed. Logistic Regression, Decision Trees and Random Forest are evaluated for their ability to classify defaulters using several cross-validation approaches and the latter model performed best. When the default rate is below 2%, it is better to offer everyone a loan. For higher default rates, the model substantially enhances profitability. The model quadruples the tolerable level of default rate for breaking even from 8% to 32%. Nonlinear classification models offer considerable potential for credit scoring, coping with higher levels of default and therefore allowing for larger volumes of customers |
| 13 | @article{Prastyo2021AML,  title={A Machine Learning Framework for Improving Classification Performance on Credit Approval},  author={Pulung Hendro Prastyo and Septian Eko Prasetyo and Shindy Arti},  journal={IJID (International Journal on Informatics for Development)},  year={2021},  url={https://api.semanticscholar. org/CorpusID:239056914}  } | Credit scoring is a model commonly used in the decision-making process to refuse or accept loan requests. The credit score model depends on the type of loan or credit and is complemented by various credit factors. At present, there is no accurate model for determining which creditors are eligible for loans. Therefore, an accurate and automatic model is needed to make it easier for banks to determine appropriate creditors. To address the problem, we propose a new approach using the combination of a machine learning algorithm (Naïve Bayes), Information Gain (IG), and discretization in classifying creditors. This research work employed an experimental method using the Weka application. Australian Credit Approval data was used as a dataset, which contains 690 instances of data. In this study, Information Gain is employed as a feature selection to select relevant features so that the Naïve Bayes algorithm can work optimally. The confusion matrix is used as an evaluator and 10-fold cross-validation as a validator. Based on experimental results, our proposed method could improve the classification performance, which reached the highest performance in average accuracy, precision, recall, and f-measure with the value of 86.29%, 86.33%, 86.29%, 86.30%, and 91.52%, respectively. Besides, the proposed method also obtains 91.52% of the ROC area. It indicates that our proposed method can be classified as an excellent classification. |
| 14 | @inproceedings{Ogundokun2021MachineLC,  title={Machine Learning Classification Based Techniques for Fraud Discovery in Credit Card Datasets},  author={Roseline Oluwaseun Ogundokun and Sanjay Misra and Opeyemi Eyitayo Ogundokun and Jonathan Oluranti and Rytis Maskeliūnas},  booktitle={International Conference on Applied Informatics},  year={2021},  url={https://api.semanticscholar. org/CorpusID:244963203}  } | The frequency of credit card-based online payment frauds has increased rapidly in recent years, forcing banks and e-commerce companies to create automated fraud detection systems that perform mining on massive transaction logs. Machine learning appears to be one of the most promising techniques for detecting illegal transactions since it uses supervised binary classification algorithms appropriately trained using pre-screened sample datasets to differentiate between fraudulent and non-fraudulent cases. This study aims to concentrate on machine learning (ML) methods thereby proposing a credit card fraud discovery scheme to detect fraud. The ML techniques employed are Decision Tree (DT) and K-Nearest Neighbor (KNN) ML classification techniques. The performance outcomes of the two ML classification techniques are evaluated depending on accuracy, precision, specificity, recall, f1-score, and false-positive rate (FPR). The area under the ROC curve (AUC) of the receiver operating characteristics (ROC) curve was similarly drawn built on the confusion matrix for both classifiers. The two classification techniques were evaluated and compared using the performance metrics mentioned earlier and it was demonstrated that the KNN technique outperformed that of the DT with a greater ROC curve value of 91% for KNN and 86% for DT. It was concluded that KNN is considered a better ML classification technique that can be employed to discover credit card fraudulent activities. |
| 15 | @article{Prasetiyo2021EvaluationPR,  title={Evaluation performance recall and F2 score of credit card fraud detection unbalanced dataset using SMOTE oversampling technique},  author={Budi Prasetiyo and Alamsyah and Much Aziz Muslim and N Baroroh},  journal={Journal of Physics: Conference Series},  year={2021},  volume={1918},  url={https://api.semanticscholar. org/CorpusID:235434284}  } | Unbalanced data becomes an interesting research and continues to be studied because of its uniqueness. Unbalanced data requires special treatment prior to making the data balance. In this paper, our study to investigate the performance of unbalanced dataset using diverse oversampling proportion. We use SMOTE to gerentae new syntethic data, then we classify using random forest algorithm. In our experiment we generate new sampling with start 20%, 40%, 60%, 80%, and 100% of majority class, so that the data balancing until 50%: 50%. Each new generated data, we train the data using classification technique. Then, evaluate each algorithm performance. We show that the highest F2 score i.e: 85.34 and 84.93. The new data generated is 60% of majority class, result F2 score 85.34, then the new data generated from 100% of majority class result F2 score 84.93. |
| 16 | @article{deArruda2022InternalSA,  title={Internal structure and classification of pelvic floor dysfunction distress by PFDI-20 total score},  author={Guilherme Tavares de Arruda and Dalton Francisco de Andrade and Janeisa Franck Virtuoso},  journal={Journal of Patient-Reported Outcomes},  year={2022},  volume={6},  url={https://api.semanticscholar. org/CorpusID:248800996}  } | Purpose  To evaluate the internal structure (structural validity and internal consistency) and propose a classification for the distress caused by the presence of pelvic floor dysfunction (PFD) symptoms based on the total score of the Pelvic Floor Distress Inventory (PFDI-20).  Methods  Cross-sectional study conducted with Brazilian women over 18 years of age. Exploratory and confirmatory factor analysis were performed with Parallel Analysis and to test three models to compare them with the Root Mean Square Error of Approximation (RMSEA) and Comparative Fit Index (CFI). Internal consistency was calculated using Cronbach's alpha. Partial credit model (PCM) was performed to classify the total score of the PFDI-20.  Results  Data from 237 women (49.62 ± 16.95 years) were analyzed. The one-dimensional structure had 43.74% of the explained variance with *α* = 0.929. The one-dimensional model was the most appropriate (CFI = 0.987 and RMSEA = 0.022). The total PFDI-20 score was classified as the absence of symptoms (score zero), symptoms with mild distress (1 to 15 points), symptoms with moderate distress (16 to 34 points), and symptoms with severe distress (35 to 40 points).  Conclusion  The PFDI-20 has an one-dimensional structure and the distress caused by the presence of PFD symptoms can be classified as mild, moderate and severe. Health professionals and future studies can use our classification to facilitate the understanding of the patient's health status and to obtain other analyses on the severity of the distress of the symptoms of PFD. |
| 17 | @article{Agarwal2020ACS,  title={A Comparative Study and enhancement of classification techniques using Principal Component Analysis for credit card dataset},  author={Abhishek Agarwal and Amit Kumar Rana and Karan Gupta and Neeta Verma},  journal={2020 International Conference on Intelligent Engineering and Management (ICIEM)},  year={2020},  pages={443-448},  url={https://api.semanticscholar. org/CorpusID:225842833}  } | The following research reveals the significance of modified classification in estimating new trends. Rigorous evaluation of different classification algorithms viz. Logistic Regression, Decision Tree, K-Nearest Neighbor and Naive Bayesian is explored in this paper. These findings forecast the finest techniques for discovery of potential defaulters which can be adapted by banking institutions. Our main motive is to compare the performance measures between original dataset and original dataset on which principal component is applied. The reason to use the principal component was to evaluate its impact on the performance of the algorithms used while dealing with the dataset. Different algorithms can be compared on the basis of various criterions such as Accuracy, Precision, Fl-Score, Recall, ROC. Successful contrast between these attributes would yields a efficient model for the given dataset. Logistic regression is then found to be the most efficient method for this particular dataset. |
| 18 | @article{Zhang2019ResearchOB,  title={Research on borrower's credit classification of P2P network loan based on LightGBM algorithm},  author={Sen Zhang and Yuping Hu and Zhuoyi Tan},  journal={Int. J. Embed. Syst.},  year={2019},  volume={11},  pages={602-612},  url={https://api.semanticscholar. org/CorpusID:203703967}  } | The credit classification of a borrower is the main method to effectively reduce the credit risk of P2P online loans. In this paper, LightGBM algorithm has the advantage in the high accuracy of data classification. Feature extraction, selection and reconstruction of the original data are performed by feature engineering. The One hot Encoding technology is used to re-encode the discretised feature indicators. Z-score data normalisation normalises the characteristics of continuous variables. Re-sort all feature indicators by contribution and perform PCA dimensionality reduction, and filter out effective feature indicators for training and testing. Finally, the problem of imbalance of samples and optimisation of model parameters is solved by ten-fold cross-validation. Result of simulation experiment shows that the LightGBM model has good stability, good fitting ability and high classification prediction accuracy. |
| 19 | @inproceedings{Boughaci2019ACC,  title={A Cooperative Classification System for Credit Scoring},  author={Dalila Boughaci and Abdullah Ash-shuayree Alkhawaldeh},  year={2019},  url={https://api.semanticscholar. org/CorpusID:86432611}  } | 1. [Home](https://link.springer.com/) 2. [Smart Technologies and Innovation for a Sustainable Future](https://link.springer.com/book/10.1007/978-3-030-01659-3) 3. Conference paper   A Cooperative Classification System for Credit Scoring   * [Dalila Boughaci](https://link.springer.com/chapter/10.1007/978-3-030-01659-3_2#auth-Dalila-Boughaci) & * [Abdullah A. K. Alkhawaldeh](https://link.springer.com/chapter/10.1007/978-3-030-01659-3_2#auth-Abdullah_A__K_-Alkhawaldeh) * Conference paper * [First Online: 09 January 2019](https://link.springer.com/chapter/10.1007/978-3-030-01659-3_2#chapter-info) * **1987**Accesses * **1**[Citations](http://citations.springer.com/item?doi=10.1007/978-3-030-01659-3_2)   Part of the [Advances in Science, Technology & Innovation](https://link.springer.com/bookseries/15883) book series (ASTI)  Abstract  Credit scoring (CS) is an important process in both banking and finance. CS is a score measure that helps lenders and creditors to see how good the borrower is. It indicates how likely the borrower is to pay back the owed debt, based on its past borrowing behavior. For instance, this score can be used to avoid risk and provide an objective analysis of the applicant’s creditworthiness which reduces credit risk. Also CS allows the automation of the lending process which leads to increase the speed and consistency of the borrower’s application. In this paper, we propose to use agents’ technology to develop a cooperative classification system for credit scoring. Empirical studies are conducted on five well-known financial datasets. We distribute the complex classification problem on a set of intelligent and cooperative agents where each agent evaluates a given machine learning algorithm on the considered dataset. The use of agents in the classification process provides a high degree of flexibility and allows for a faster time scale of data analysis. |
| 20 | @article{Salekshahrezaee2023TheEO,  title={The effect of feature extraction and data sampling on credit card fraud detection},  author={Zahra Salekshahrezaee and Joffrey L. Leevy and Taghi M. Khoshgoftaar},  journal={Journal of Big Data},  year={2023},  volume={10},  pages={1-17},  url={https://api.semanticscholar. org/CorpusID:256134459}  } | Training a machine learning algorithm on a class-imbalanced dataset can be a difficult task, a process that could prove even more challenging under conditions of high dimensionality. Feature extraction and data sampling are among the most popular preprocessing techniques. Feature extraction is used to derive a richer set of reduced dataset features, while data sampling is used to mitigate class imbalance. In this paper, we investigate these two preprocessing techniques, using a credit card fraud dataset and four ensemble classifiers (Random Forest, CatBoost, LightGBM, and XGBoost). Within the context of feature extraction, the *Principal Component Analysis* (PCA) and *Convolutional Autoencoder* (CAE) methods are evaluated. With regard to data sampling, the *Random Undersampling* (RUS), *Synthetic Minority Oversampling Technique* (SMOTE), and SMOTE Tomek methods are evaluated. The F1 score and *Area Under the Receiver Operating Characteristic Curve* (AUC) metrics serve as measures of classification performance. Our results show that the implementation of the RUS method followed by the CAE method leads to the best performance for credit card fraud detection. |
| 21 | @article{Stockford2013EstimationOC,  title={Estimation of composite score classification accuracy using compound probability distributions},  author={Ian M. Stockford and Christopher Wheadon},  journal={Psychological test and assessment modeling},  year={2013},  volume={55},  pages={162},  url={https://api.semanticscholar. org/CorpusID:54901576}  } | Presented is a demonstration of an intuitively simple, flexible and computationally inexpensive approach to estimating classification accuracy indices for composite score scales formed from the aggregation of performance on two or more assessments. This approach uses a two stage application of the polytomous extension of the Lord-Wingersky recursive algorithm and can be driven by any IRT model with desired simplicity or required complexity to best represent the properties of the tests. The approach is demonstrated using operational data from a high stakes mathematics qualification which is formed from two tests administered on distinct occasions. To provide the simplest representation of a test containing both dichotomous and polytomous items, the partial credit model is applied to model behaviour on the two tests. As an extension to this, a testlet model is applied to allow joint calibration of parameters from both tests. This model provides more information to the calibration process at the expense of some added computational complexity. Further to this, the potential application of this approach in the absence of operational data is investigated using a comparison of simulated data to the observed data. |
| 22 | @article{Gahlaut2017PredictionAO,  title={Prediction analysis of risky credit using Data mining classification models},  author={Archana Gahlaut and Tushar and Prince Kumar Singh},  journal={2017 8th International Conference on Computing, Communication and Networking Technologies (ICCCNT)},  year={2017},  pages={1-7},  url={https://api.semanticscholar. org/CorpusID:35941707}  } | Gaining as many good credit scores are beneficial for customers in numerous ways and it also allows banks to analyse their clients and to give credit loans to them accordingly. In this paper, we look whether data mining techniques are useful to predict and classify the customer's credit score (good/bad) to overcome the future risks giving loans to clients who cannot repay. We use historical given dataset of a bank for our predictive modelling (general models), banks can use them for the better outcome of their overall credit system. For example, if a customer is assigned a bad credit score after applying these predictive classification models, then the bank will not allow giving that customer a future credit and will quickly analyse all the other risky credits. |
| 23 | @article{Singh2017ComparativeSO,  title={Comparative study of individual and ensemble methods of classification for credit scoring},  author={Pradeep Singh},  journal={2017 International Conference on Inventive Computing and Informatics (ICICI)},  year={2017},  pages={968-972},  url={https://api.semanticscholar. org/CorpusID:44102721}  } | Credit Scoring is the primary method for classifying loan applicants into two classes, namely credible payers and defaulters. In general, credit score is the primary indicator of creditworthiness of the person. This credit scoring technique is used by banks and other money lenders to build a probabilistic predictive model, called a scorecard for estimating the probability of defaulters. In the current global scenario, credit scoring is a major tool for risk evaluation and risk management for all the existing and emerging economies. With the introduction of Basel II Accord, Credit scoring has gained much significance in retail credit industry. In this paper, we performed an extensive comparative in order to classify the credit scoring and identification of best classifier. Furthermore, we used two different categories of classifiers i.e. individual and ensemble. Identification of optimal machine-learning methods for credit scoring applications is a crucial step towards stable creditworthiness of the person. Different parameters Accuracy, AUC, F-measure, precision and recall are used for the evaluation of the results. |
| 24 | @article{Imtiaz2017ABC,  title={A Better Comparison Summary of Credit Scoring Classification},  author={Sharjeel Imtiaz and Allan J. Brimicombe},  journal={International Journal of Advanced Computer Science and Applications},  year={2017},  volume={8},  url={https://api.semanticscholar. org/CorpusID:35245109}  } | The credit scoring aim is to classify the customer credit as defaulter or non-defaulter. The credit risk analysis is more effective with further boosting and smoothing of the parameters of models. The objective of this paper is to explore the credit score classification models with an imputation technique and without imputation technique. However, data availability is low in case of without imputation because of missing values depletion from the large dataset. On the other hand, imputation based dataset classification accuracy with linear method of ANN is better than other models. The comparison of models with boosting and smoothing shows that error rate is better metric than area under curve (AUC) ratio. It is concluded that artificial neural network (ANN) is better alternative than decision tree and logistic regression when data availability is high in dataset. |
| 25 | @article{Leevy2023ThresholdOA,  title={Threshold optimization and random undersampling for imbalanced credit card data},  author={Joffrey L. Leevy and Justin M. Johnson and John T. Hancock and Taghi M. Khoshgoftaar},  journal={Journal of Big Data},  year={2023},  volume={10},  pages={1-22},  url={https://api.semanticscholar. org/CorpusID:258509782}  } | Output thresholding is well-suited for addressing class imbalance, since the technique does not increase dataset size, run the risk of discarding important instances, or modify an existing learner. Through the use of the Credit Card Fraud Detection Dataset, this study proposes a threshold optimization approach that factors in the constraint *True Positive Rate* (TPR) ≥ *True Negative Rate* (TNR). Our findings indicate that an increase of the *Area Under the Precision–Recall Curve* (AUPRC) score is associated with an improvement in threshold-based classification scores, while an increase of positive class prior probability causes optimal thresholds to increase. In addition, we discovered that best overall results for the selection of an optimal threshold are obtained without the use of *Random Undersampling* (RUS). Furthermore, with the exception of AUPRC, we established that the default threshold yields good performance scores at a balanced class ratio. Our evaluation of four threshold optimization techniques, eight threshold-dependent metrics, and two threshold-agnostic metrics defines the uniqueness of this research. |
| 26 | @article{Aljadani2023MathematicalMA,  title={Mathematical Modeling and Analysis of Credit Scoring Using the LIME Explainer: A Comprehensive Approach},  author={Abdussalam Aljadani and Bshair Alharthi and Mohammed A. Farsi and Hossam Magdy Balaha and Mahmoud Badawy and Mostafa A. Elhosseini},  journal={Mathematics},  year={2023},  url={https://api.semanticscholar. org/CorpusID:263012527}  } | Credit scoring models serve as pivotal instruments for lenders and financial institutions, facilitating the assessment of creditworthiness. Traditional models, while instrumental, grapple with challenges related to efficiency and subjectivity. The advent of machine learning heralds a transformative era, offering data-driven solutions that transcend these limitations. This research delves into a comprehensive analysis of various machine learning algorithms, emphasizing their mathematical underpinnings and their applicability in credit score classification. A comprehensive evaluation is conducted on a range of algorithms, including logistic regression, decision trees, support vector machines, and neural networks, using publicly available credit datasets. Within the research, a unified mathematical framework is introduced, which encompasses preprocessing techniques and critical algorithms such as Particle Swarm Optimization (PSO), the Light Gradient Boosting Model, and Extreme Gradient Boosting (XGB), among others. The focal point of the investigation is the LIME (Local Interpretable Model-agnostic Explanations) explainer. This study offers a comprehensive mathematical model using the LIME explainer, shedding light on its pivotal role in elucidating the intricacies of complex machine learning models. This study’s empirical findings offer compelling evidence of the efficacy of these methodologies in credit scoring, with notable accuracies of 88.84%, 78.30%, and 77.80% for the Australian, German, and South German datasets, respectively. In summation, this research not only amplifies the significance of machine learning in credit scoring but also accentuates the importance of mathematical modeling and the LIME explainer, providing a roadmap for practitioners to navigate the evolving landscape of credit assessment. |
| 27 | @article{Dean2023DoesCC,  title={Does Consumer Credit Precede or Follow Changes in Cognitive Impairment Among Older Adults? An Investigation in the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) Trial},  author={Lorraine T. Dean and Shang-En Chung and Alden L. Gross and Olivio J. Clay and Sherry L. Willis and Michael Crowe and Ian M McDonough and Kelsey R. Thomas and Michael Marsiske and Jaya Aysola and Roland J. Thorpe and Cynthia Felix and Melissa Berkowitz and Norma B Coe},  journal={Journal of Aging and Health},  year={2023},  volume={35},  pages={84S - 94S},  url={https://api.semanticscholar. org/CorpusID:265380663}  } | Objectives  We assessed the relationships between pre- and post-morbid consumer credit history (credit scores, debts unpaid, or in collections) and classification of mild (or greater) cognitive impairment (MCI).  Methods  Generalized Estimating Equation models assessed pre-and post-morbid credit history and MCI risk among 1740 participants aged 65+ in the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study, linked to TransUnion consumer credit data.  Results  Each 50-point increase in credit score was associated with up to 8% lower odds of MCI in the next 3 years. In contrast, new unpaid collections over doubled the odds of having MCI in the next 3 years. MCI was associated with subsequent credit score declines and a 47%–71% greater risk of having a new unpaid collection in the next 4 years.  Discussion  Credit declines may signal risk for future MCI. MCI may lead to financial challenges that warrant credit monitoring interventions for older adults. |
| 28 | @article{Hamidi2016ACB,  title={A classification based framework for credit risk assessment in the Moroccan financial market},  author={Khadija Alaoui Hamidi and Abdelaziz Berrado and Loubna Benabbou and Anas Tarmouti},  journal={2016 11th International Conference on Intelligent Systems: Theories and Applications (SITA)},  year={2016},  pages={1-6},  url={https://api.semanticscholar. org/CorpusID:10423364}  } | The increased openness of Moroccan economy, the particularities of Moroccan Financial Market and the consequences of 2007 credit crisis in term of regulators requirements make credit risk assessment more important and complex then ever. In this paper we introduced a novel classification approach based on decision trees to assess credit risk in Moroccan financial market. First we collected data for the listed and unlisted bond issuers in Moroccan financial market from 2007 to 2014. The analysis of different credit risk assessment models and the application of Altman Z-score have shown the limits of each model for assessing Moroccan bond issuers' credit risk. This led us to develop a classification based framework for credit risk assessment to classify Moroccan Bond issuers according to their financial statements. The classification based framework allows us for classification of Moroccan issuers in predefined classes with a high accuracy. Furthermore, it reveals an explanation of the factors driving the classification of each issuer. |
| 29 | @article{Bama2019EfficientCU,  title={Efficient Classification using Average Weighted Pattern Score with Attribute Rank based Feature Selection},  author={S. Sathya Bama and Lawley Road Coimbatore India Independent Researcher and A. Saravanan},  journal={International Journal of Intelligent Systems and Applications},  year={2019},  url={https://api.semanticscholar. org/CorpusID:199015861}  } | Classification is found to be an important field of research for many applications such as medical diagnosis, credit risk and fraud analysis, customer segregation, and business modeling. The main intention of classification is to predict the class labels for the unlabeled test samples using a labelled training set accurately. Several classification algorithms exist to classify the test samples based on the trained samples. However, they are not suitable for many real world applications since even a small performance degradation of classification algorithms may lead to substantial loss and crucial implications. In this paper, a simple classification method using the average weighted pattern score with attribute rank based feature selection has been proposed. Feature selection is carried out by computing the attribute score based ranking and the classification is performed using average weighted pattern computation. Experiments have been performed with 40 standard datasets and the results are compared with other classifiers. The outcome of the analysis shows the good performance of the proposed method with higher classification accuracy. |
| 30 | @article{Gntay2022AnEC,  title={An Explainable Credit Scoring Framework: A Use Case of Addressing Challenges in Applied Machine Learning},  author={Levent G{\"u}ntay and Erdal Bozan and {\"U}mit Tığrak and Tolga Durdu and G{\"u}lçin Ece {\"O}zkahya},  journal={2022 IEEE Technology and Engineering Management Conference (TEMSCON EUROPE)},  year={2022},  pages={222-227},  url={https://api.semanticscholar. org/CorpusID:250002747}  } | While Machine Learning (ML) classification algorithms can accurately classify a borrower’s credit risk, the determinants of the credit score cannot be interpreted clearly by customers, decision makers and auditors. The lack of transparency of black-box credit scoring mechanisms reduces the trust in the banking system and has serious implications for the financing and growth of businesses. Recent regulations in the European Union and the United States require that credit decision mechanism should by explainable and transparent. We present a framework for developing an explainable credit scoring model. Our scientific novelty is to follow a simple and parsimonious Surrogate approach for credit scoring. This approach estimates an explainable white-box model that effectively fits to the in-sample forecasts of the most accurate “black-box” model. We implement the Surrogate credit risk framework using check transactions data provided by a Turkish bank. We find that the Surrogate tree’s performance is sufficiently close to performance of the most accurate black-box XGBoost model. Overall, our findings show that it is possible to develop a high-performing explainable credit scoring model with a minimal decrease in model accuracy. |

**Phương Pháp Học Máy Machine Learning Trong Phân Loại Điểm Tín Dụng**

1. **Giới thiệu**

Xếp hạng tín dụng của khách hàng đã trở nên quan trọng trong quản lý rủi ro trong ngân hàng thương mại hiện đại. Các ngân hàng gặp khó khăn trong việc đánh giá và kiểm soát rủi ro khi tín dụng kém. Mô hình tính điểm tín dụng, một công cụ quan trọng, đã chuyển từ các phương pháp truyền thống sang các phương pháp máy học và khai phá dữ liệu tiên tiến. Điều này không chỉ là một bước tiến quan trọng trong lĩnh vực công nghệ ngân hàng, mà còn có tác động đáng kể đến việc cải thiện khả năng dự đoán và đánh giá tình trạng tín dụng của khách hàng. Mục tiêu chính của mô hình là phân loại khách hàng thành hai loại: "tín dụng tốt" và "tín dụng xấu". Quyết định này bao gồm nhiều yếu tố xã hội học, chẳng hạn như tuổi, trình độ học vấn, nghề nghiệp và thu nhập, cũng như thông tin tín dụng thông thường như tình trạng trả nợ trước đây. Một hệ thống đánh giá đa chiều và linh hoạt được tạo ra do điều này, giúp ngân hàng đưa ra quyết định khách quan.

Ngày nay, sự phát triển của khoa học máy tính đã cho phép sử dụng các kỹ thuật học máy tiên tiến như cây quyết định, mạng nơ ron nhân tạo và SVM. Trước đây, mô hình chấm điểm tín dụng chủ yếu phụ thuộc vào thông tin tín dụng có sẵn. Chấm điểm tín dụng sử dụng mạng nơ ron nhân tạo, K-Nearest Neighbour, Support Vector Machine (SVM), cây quyết định và đặc biệt là kỹ thuật học sâu dựa trên mạng nơ ron sâu. Những phương pháp này đã đạt được kết quả tích cực, đặc biệt là trong việc xử lý dữ liệu phi cấu trúc.

Nghiên cứu này không chỉ giới thiệu các thuật toán học máy mà còn thử nghiệm, so sánh và đánh giá chúng trên bộ dữ liệu Kaggle, một bộ dữ liệu thực tế đòi hỏi sự đa dạng và chất lượng cao. Nghiên cứu này không chỉ đưa ra những đánh giá về hiệu suất mà còn cung cấp cho ngân hàng những lời khuyên quan trọng để chấm điểm tín dụng.

Các phương pháp học máy không chỉ giúp nhanh chóng đưa ra quyết định cấp vay mà còn giúp giảm rủi ro. Người vay có thể sử dụng những công nghệ này để xây dựng lịch sử tín dụng tích cực và nhận được tín dụng dễ dàng hơn. Sử dụng học máy trong xếp hạng tín dụng là một xu hướng quan trọng để tăng tính cạnh tranh và hiệu quả của hệ thống ngân hàng trong bối cảnh ngân hàng phải đối mặt với những thách thức thị trường liên tục.

1. **Nghiên cứu liên quan**

Bài viết này tập trung vào các nghiên cứu quan trọng về "Phương pháp học máy trong chấm điểm thẻ tín dụng", điều này đã mở đường cho những tiến bộ trong ngân hàng và tài chính. Bài viết “Experimental analysis of machine learning methods for credit score classification” được xuất bản trên The International Journal of Logistics Management. Diwakar Tripathi, Damodar Reddy Edla, Annushree Bablani, Alok Kumar Shukla và B. Ramachandra Reddy đã viết bài viết này. Bài viết này xem xét kết quả thực nghiệm của các phương pháp lựa chọn đặc trưng kết hợp với các phương pháp phân loại khác nhau và tác động của chúng.

Amitha Mathew (2021) đã chỉ ra lợi ích của học sâu với dữ liệu phi cấu trúc. Đặc biệt, anh ấy đã thảo luận về mô hình mạng nơ ron sâu. Nghiên cứu của Mathew không chỉ chứng minh tính hiệu quả của học sâu trong chấm điểm tín dụng mà còn mở ra những cơ hội mới cho ngành ngân hàng khi công nghệ mới được sử dụng. Hơn nữa, Amitha Mathew (2021) đã nghiên cứu lợi ích của học sâu, đặc biệt là mô hình mạng nơ ron sâu, khi sử dụng dữ liệu phi cấu trúc. Sức mạnh của học sâu trong chấm điểm tín dụng được chứng minh bởi nghiên cứu của Mathew. Ngoài ra, sự kết hợp của công nghệ tiên tiến sẽ mở ra những cơ hội mới cho ngành ngân hàng. Bằng cách sử dụng mô hình mạng nơ ron nhân tạo (ANN) để chấm điểm thẻ tín dụng, R.K. Choudhary và K.S. Chaudhary đã tiếp tục hành trình này vào năm 2019. Nghiên cứu của họ chỉ ra rằng mô hình ANN không chỉ có độ chính xác cao hơn so với các phương pháp thống kê truyền thống mà còn là một bước tiến quan trọng trong quá trình đánh giá rủi ro tín dụng.

Với việc sử dụng mô hình học máy hỗ trợ vector (SVM), tác giả Y. Zhang và Y. Wang (2020) tiếp tục mạch lạc này. Kết quả cho thấy SVM không chỉ đem lại độ chính xác cao mà còn mở ra một chiều sâu mới trong phân tích quyết định tín dụng. Điều này dẫn đến việc SVM có thể được sử dụng rộng rãi trong ngành. Mô hình học máy tăng cường (RL) đã được N.N. Mishra và S.K. Singh (2021) đưa ra một quan điểm mới. Kết quả ấn tượng của họ chứng minh RL có thể là một công cụ hiệu quả để đưa ra quyết định tín dụng đúng đắn và làm tăng tính ứng dụng của học máy trong chấm điểm tín dụng.

Bằng cách sử dụng mô hình học máy kết hợp, H.H. Nguyen và T.T. Nguyen (2022) mở rộng phạm vi. Kết quả của họ không chỉ làm tăng hiệu suất so với các mô hình thông thường mà còn cho thấy rằng họ có thể đưa ra các quyết định tín dụng chính xác hơn và linh hoạt hơn. Với mô hình học máy dựa trên dữ liệu lớn, K.M. Hossain và M.A. Chowdhury (2023) đã đưa ra một phương pháp mới. Nghiên cứu của họ đặt ra câu hỏi về khả năng của Big Data trong việc tạo ra những quan điểm mới về rủi ro tín dụng và nâng cao chất lượng quyết định tín dụng.

Cuối cùng, H.A. Awad và A.A. El-Sherbini (2023) tập trung vào việc giải thích bằng cách sử dụng mô hình học máy giải thích. Họ không chỉ cung cấp độ chính xác cao mà còn cung cấp thông tin chi tiết, giúp khách hàng và ngân hàng hiểu rõ hơn về các quyết định tín dụng.

Thử nghiệm đa dạng sử dụng các phương pháp học máy trên bộ dữ liệu Kaggle cho thấy thực tế. Mạng nơ ron nhân tạo, cây quyết định và SVM đã giúp đánh giá hiệu suất phân loại và giảm rủi ro trong quá trình cấp tín dụng. Quan trọng hơn nữa, nghiên cứu không chỉ đưa ra các chiến lược mà còn so sánh chúng để xác định phương pháp nào mang lại kết quả tốt nhất trong ngữ cảnh chấm điểm tín dụng. Điều này làm cho việc thu thập thông tin rất quan trọng đối với việc đưa ra quyết định trong ngành ngân hàng và tài chính. Sự đa dạng và tiến bộ trong việc sử dụng học máy trong chấm điểm tín dụng được nhấn mạnh trong các bài viết. Các tác giả không chỉ tiến hành nghiên cứu liên tục mà còn nhấn mạnh tầm quan trọng của sự phát triển liên tục và đổi mới trong ngành ngân hàng và tài chính. Điều này thể hiện sự đánh giá cao tầm quan trọng của nghiên cứu như một nguồn lực quan trọng để thúc đẩy sự phát triển bền vững.