**LITERATURE SURVEY:**

**1. TITLE: Heterogeneous Ensemble for Default Prediction of Peer-to-Peer Lending in China.**

**AUTHOR: WEI LI, SHUAI DING , YI CHEN, AND SHANLIN YANG**

**YEAR: 2018**

**PAPER EXPLANATION:**

As a novel financing method, peer-to-peer (P2P) lending has drawn extensive attention as it Provides those financers who cannot participate in the traditional financial market with funds. In P2P lending Marketplaces, one of the crucial challenges that P2P online lending platforms are facing is to accurately Predict the default risk of each loan by tapping into default prediction models, thus effectively helping P2P Lending companies avoid credit risks. That traditional credit risk prediction models fail to meet the demand of P2P lending companies for default risk prediction, which is because of the uneven distribution of credit data Samples in the P2P lending marketplaces (i.e., the default sampled data are scarce). In this paper, we designed a multi-round ensemble learning model based on heterogeneous ensemble frameworks to predict default Risk. In this model, an extreme gradient boosting (XGBoost) is initially used for ensemble learning, and Data from a famous P2P online lending marketplace in China were used in a test. The results of the experiment Indicate that this model can effectively increase the predictive accuracy compared with traditional machine Learning models and ensemble learning models.

**2. TITLE: Application of Instance-Based Entropy Fuzzy Support Vector Machine in Peer-To-Peer Lending Investment Decision**

**AUTHOR: POONGJIN CHO1 , WOOJIN CHANG1, AND JAE WOOK SONG 2.**

**YEAR: 2019**

**PAPER EXPLANATION:**

Loan status prediction is an effective tool for investment decisions in peer-to-peer (P2P) lending Market. In P2P lending market, most borrowers fulfill the repayment plan; however, some of them fail to pay back their loans. Therefore, an imbalanced classification method can be utilized to discriminate such default borrowers. In this context, the aim of this paper is to propose an investment decision model in P2P lending market which consists of fully paid loans classified via the instance-based entropy fuzzy support vector machine (IEFSVM). IEFSVM is a modified version of the existing entropy fuzzy support vector machine (EFSVM) in terms of an instance-based scheme. Then, We also provide a multiple regression model to generate an investment portfolio based on non-default loans that are predicted to yield high returns. Throughout the experiment, the empirical results reveal that IEFSVM outperforms not only EFSVM but also the six other state-of-the-art classifiers including the cost-sensitive adaptive boosting, cost-sensitive random forest, Easy Ensemble, random under sampling boosting, weighted extreme learning machine, and cost-sensitive extreme gradient boosting in terms of loan status classification

**3. TITLE: Credit Evaluation Ensemble Model with Self-Contained Shunt.**

**AUTHOR: Wenyu Qiu, Siwen Li, Yumeng Cao, Hua Li.**

**YEAR: 2019**

**PAPER EXPLANATION:**

In the actual loan scenario, the proportion of “good” and “bad” samples is usually extremely imbalanced. Therefore, this paper constructs an ensemble model with a pre-judging mechanism for the imbalanced datasets of small enterprise. It can learn the structure of data set independently and adjust the structure spontaneously through the “data shunt”, which can improve the efficiency of model, simplify the complexity of model and optimize the indicators to achieve the goal of reducing bank operating costs and bad debt rates.(1)Supervised data splitter: In this paper, we select the density-based outlier test algorithm Local Outlier Factor (LOF) as the main algorithm of the shunt and the raw data will be reduced and clustered by Principal Component Analysis (PCA) and K-Means++ clustering algorithm, and the outlier test pipeline will be constructed for each cluster data. (2)Construction of the two-channel model: It has been verified that the “strict channel” has the best performance when using the bagging model as the main model based on eXtreme Gradient boosting (XGBoost), and the “loose channel” has the best performance when using the Gradient Boosting Decision Tree (GBDT) single model.

**4. TITLE: A Novel Noise-Adapted Two-Layer Ensemble model for Credit Scoring Based on Backflow Learning.**

**AUTHOR**: SHUANG WEI1, DONGQI YANG 2, WENYU ZHANG 2, AND SHUAI ZHANG 2.

**YEAR**: 2019

**PAPER EXPLANATION:**

Recently, the machine learning method and artificial intelligence algorithm have become increasingly important in classification problems, such as credit scoring. Building an ensemble learning model that has been proven to be typically more accurate and robust than individual classifiers, it is an important information management task of commercial banks and loan lenders. In this paper, a novel noise-adapted two-layer ensemble model for credit scoring based on backflow learning is proposed, in which five widely used base classifiers, i.e., extreme gradient boosting, gradient boosting decision tree, support vector machine, random forest, and linear discriminant analysis, are integrated. A final predictive result is obtained by fusing the prediction of all base classifiers through two-layer ensemble modeling. In addition, considering that noise data are a major problem that aggravates the accuracy of a predictive model, a new noise adaption approach based on the isolation forest algorithm is proposed to address noise data. It first calculates the outlier score of each data point to detect the noise data that are subsequently boosted in the training set to form the noise-adapted training set. Three credit datasets from the UCI machine learning repository are tested to compare the performance of the proposed model with those of other benchmark models. The experimental results prove that our proposed model outperforms other models by demonstrating satisfactory improvement in various performance measures.

**5. TITLE: The Value of Collaboration in Convex Machine learning with Differential Privacy.**

**AUTHOR: Nan Wu, Farhad Farokhi, David Smith, and Mohamed Ali Kaafar.**

**YEAR: 2020**

**PAPER EXPLANATION:**

In this paper, we apply machine learning to distributed private data owned by multiple data owners, entities with access to non-overlapping training datasets. We use noisy, differentially-private gradients to minimize the fitness cost of the machine learning model using stochastic gradient descent. We quantify the quality of the trained model, using the fitness cost, as a function of privacy budget and size of the distributed datasets to capture the trade-off between privacy and utility in machine learning. This way, we can predict the outcome of collaboration among privacy-aware data owners prior to executing potentially computationally-expensive machine learning algorithms. Particularly, we show that the difference between the fitness of the trained machine learning model using differentially-private gradient queries and the fitness of the trained machine model in the absence of any privacy concerns is inversely proportional to the size of the training datasets squared and the privacy budget squared. We successfully validate the performance prediction with the actual performance of the proposed privacy-aware learning algorithms, applied to: financial datasets for determining interest rates of loans using regression; and detecting credit card frauds using support vector machines.

**6. TITLE: Building up Explainability in Multi-layer Perceptrons for Credit Risk Modeling.**

**AUTHOR: Rudrani Sharma and Christoph Schommer , Nicolas Vivarelli .**

**YEAR: 2020**

**PAPER EXPLANATION:**

Granting loans is one of the major concerns of financial institutions due to the risks of default borrowers. Default prediction by the neural networks is a popular technique for credit risk modeling. Neural networks generally offer the accurate predictions that help banks to prevent financial losses and grow their business by approving more creditworthy borrowers. Although neural networks are capable of capturing the complex, non-linear relationships between a large number of features and output, these models act as black boxes. This is a graduation project paper that is focused on loan default risk prediction by multi-layer perceptron neural network and building up explainability to some degree in the trained neural networks through sensitivity analysis. The architecture of a multi-layer perceptron neural network with the best result is used to help the credit-risk manager in explaining why an applicant is a defaulter or non-defaulter. The prediction of a trained multi-layer perceptron neural network is explained by mapping input features and target variables directly using a model-agnostic explanation as well as a model- specific explanation. Lastly, a comparison is performed between two explanation methods.

**7. TITLE: An Investigation of Credit Card Default Prediction in the Imbalanced Datasets.**

**AUTHOR: TALHA MAHBOOB ALAM 1, KAMRAN SHAUKAT 2, 7IBRAHIM A. HAMEED 3, (Senior Member, IEEE), SUHUAI LULUO, MUHAMMAD UMER SARWAR4, SHAKIR SHABBIR1, JIAMING LI5 , AND MATLOOB KHUSHI 6.**

**YEAR: 2020**

**PAPER EXPLANATION:**

Financial threats are displaying a trend about the credit risk of commercial banks as the incredible improvement in the financial industry has arisen. In this way, one of the biggest threats faces by commercial banks is the risk prediction of credit clients .In classification problems, an imbalanced dataset is also crucial to improve the performance of the model because most of the cases lied in one class, and only a few examples are in other categories. Traditional statistical approaches are not suitable to deal with imbalanced data. In this study, a model is developed for credit default prediction by employing various credit-related datasets. One-way Analysis of Variance is a hypothesis-testing technique, used to test the significance of the results. The split method is utilized to validate the results in which data has split into training and test sets. The results on imbalanced datasets show the accuracy of 66.9% on Taiwan clients credit dataset, 70.7% on South German clients credit dataset, and 65% on Belgium clients credit dataset. Conversely, the results using our proposed methods significantly improve the accuracy of 89% on Taiwan clients credit dataset, 84.6% on South German clients credit dataset, and 87.1% on Belgium clients credit dataset. The results show that the performance of classifiers is better on the balanced dataset as compared to the imbalanced dataset. It is also observed that the performance of data oversampling techniques are better than under sampling techniques. Overall, the Gradient Boosted Decision Tree method performs better than other traditional machine learning classifiers. The interpretable model is also deployed on the web to ease the different stakeholders. This model will help commercial banks, financial organizations, loan institutes, and other decision-makers to predict the loan defaulter earlier.

**8. TITLE: Explainability of Machine Learning Model for Bankruptcy Prediction.**

**AUTHOR: MIN SUE PARK 1, HWIJAE SON2, CHONGSEOK HYUN3, AND HYUNG JU HWANG 1,4.**

**YEAR: 2021**

**PAPER EXPLANATION:**

As the amount of data increases, it is more likely that the assumptions in the existing economic analysis model are unsatisfied or make it difficult to establish a new analysis model. Therefore, there has been increased demand for applying the machine learning methodology to bankruptcy prediction due to its high performance. By contrast, machine learning models usually operate as black-boxes but credit rating regulatory systems require the provisioning of appropriate information regarding credit rating standards. If machine learning models have sufficient by applying the Local Interpretable Model-Agnostic Explanations (LIME) algorithm, which measures the feature importance for each data point. To compare how the feature importance measured through LIME differs from that of models themselves, we first applied this algorithm to typical tree-based models that have ability to measure the feature importance of the models themselves. Moreover, we study the consistency of the feature importance through the model’s predicted bankruptcy probability, which suggests the possibility that observations of important features can be used as a basis for the fair treatment of loan eligibility requirements.

**9. TITLE: Predicting Default Risk on Peer-to-Peer Lending Imbalanced Datasets .**

**AUTHOR: YEN-RU CHEN1, JENQ-SHIOU LEU 1, SHENG-AN HUANG1, JUI-TANG WANG 1 AND JUN-ICHI TAKADA2.**

**YEAR: 2021**

**PAPER EXPLANATION:**

In the past few years, Peer-to-Peer lending (P2P lending) has grown rapidly in the world. The main idea of P2P lending is disintermediation and removing the intermediaries like banks. For a small business and some individuals without enough credit or credit history, P2P lending is a good way to apply for a loan. However, the fundamental problem of P2P lending is information asymmetry in this model, which may not correctly estimate the default risk of lending. Lenders only determine whether or not to fund the loan by the information provided by borrowers, causing P2P lending data to be imbalanced datasets which contain unequal fully paid and default loans. In our scenario, models without any adaptive methods would focus on learning the normal repayment. However, the characteristic of the minority class is critical in the loaning business. In this study, we utilize not only several machine learning schemes for predicting the default risk of P2P lending but also re-sampling and cost-sensitive mechanisms to process imbalanced datasets. Furthermore, we use the datasets from Lending Club to validate our proposed scheme. The experiment results show that our proposed scheme can effectively raise the prediction accuracy for default risk.

**10. TITLE: Model-Agnostic Counterfactual Explanations in Credit Scoring.**

**AUTHOR: XOLANI DASTILE 1, TURGAY CELIK 2,3,4, AND HANS VANDIERENDONCK 5.**

**YEAR: 2022**

**PAPER EXPLANATION:**

The past decade has shown a surge in the use and application of machine learning and deep learning models across various domains. One such domain is credit scoring, where applicants are scored to assess their creditworthiness for loan applications. It is essential to ensure that no biases or discriminations are incurred during the scoring process. Therefore, it is imperative to explain each prediction from the models during the scoring process to avoid the element of model bias and discrimination. Our study proposes a novel optimization formulation that generates sparse counterfactual explanations via a custom genetic algorithm to explain the black-box model’s predictions. We evaluated the efficacy of the proposed method on publicly available credit scoring datasets by comparing the counterfactual explanations generated by the proposed method with explanations from credit scoring experts. The proposed counterfactual explanation method does not only explain rejected loan applications but also can be used to explain approved loan applications.