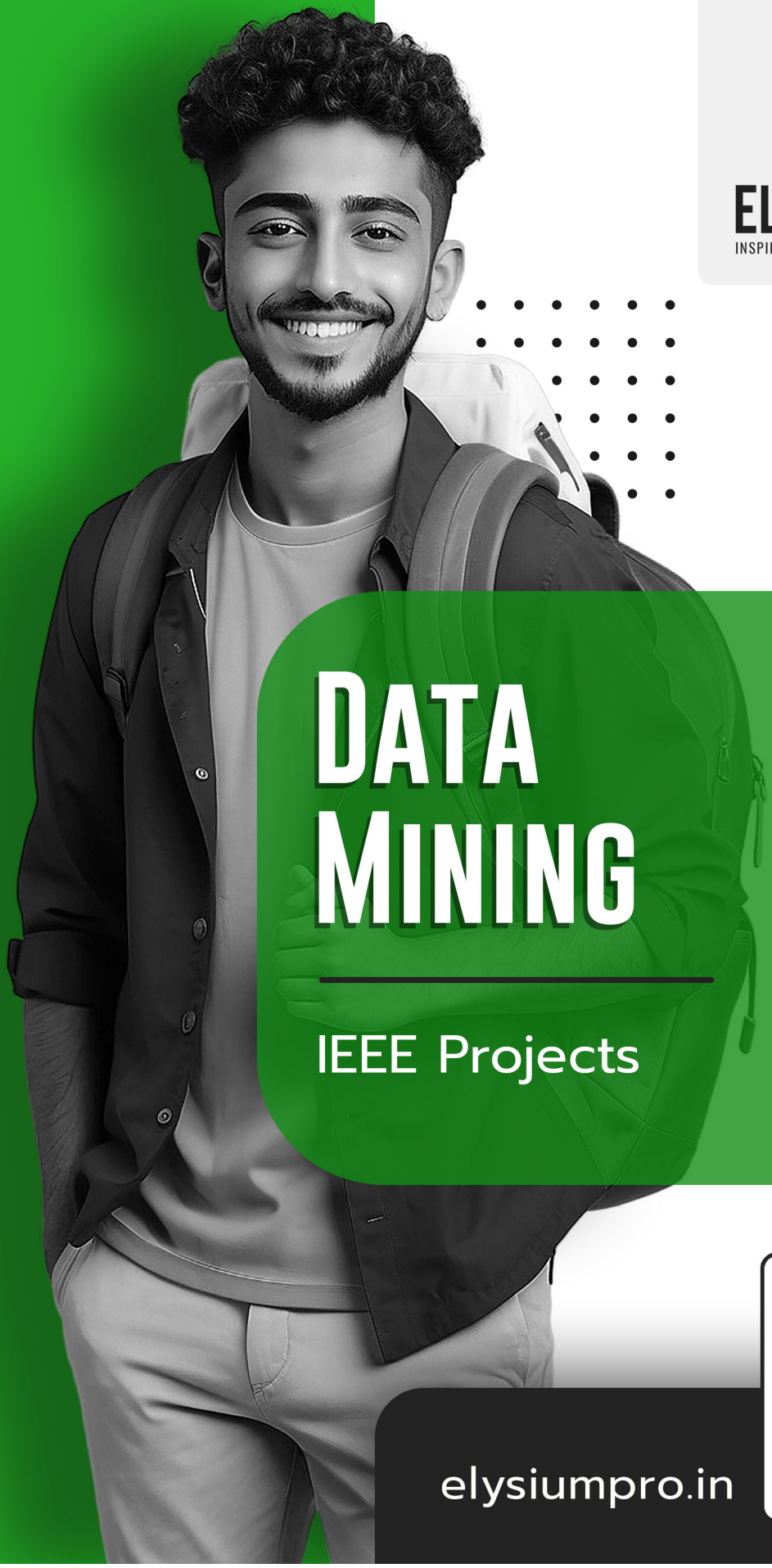
Titles & Abstract

2024- 2025



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EPRO-DM-001

MEL: Efficient Multi-Task Evolutionary Learning for High-Dimensional Feature Selection

Choosing the right features (feature selection) is important in machine learning, especially for complex data (high-dimensional). Biomedical datasets: ALL_AML, Leukemia, Lymphoma, Myeloma, and Prostate. This model compares different methods for picking features in medical datasets. They test traditional methods (ACO, PSO, BA, DE, SA) and a new method called MEL. MEL uses a multi-tasking approach to learn from multiple problems at once. They test these methods on five high-dimensional medical datasets. They analyze how well each method performs (accuracy, features chosen, time). Overall, MEL outperforms the traditional methods on most datasets. This suggests MEL is better suited for complex data and finding key features. The study also offers insights into the strengths and weaknesses of each method. This helps researchers choose the best feature selection method for their specific problem.

EPRO-DM-002

A Hybrid Air Quality Prediction Model Based on Empirical Mode Decomposition language

Air pollution is a severe environmental problem in urban areas. Accurate air quality prediction can help governments and individuals make proper decisions to cope with potential air pollution.
As a classic time series forecasting model, the AutoRegressive Integrated Moving Average (ARIMA) has been widely adopted in air quality prediction. However, because of the volatility of air quality
and the lack of additional context information, i.e., the spatial relationships among monitor stations, traditional ARIMA models suffer from unstable prediction performance. Though some deep networks
can achieve higher accuracy, a mass of training data, heavy computing, and time cost are required. In this paper, we propose a hybrid model to simultaneously predict seven air pollution indicators from
multiple monitoring stations. The proposed model consists of three components:
(1) an extended ARIMA to predict matrix series of multiple air quality indicators from several adjacent monitoring stations;
(2) the Empirical Mode Decomposition (EMD) to decompose the air quality time series data into multiple smooth sub-series; and (3) the truncated Singular Value Decomposition (SVD) to compress and

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EPRO-DM-003

E-Commerce Fraud Detection Based on Machine Learning Techniques: Systematic Literature Review

The e-commerce industry's rapid growth, accelerated by the COVID-19 pandemic, has led to an alarming increase in digital fraud and associated losses. To establish a healthy e-commerce ecosystem, robust cyber security and anti-fraud measures are crucial. However, research on fraud detection systems has struggled to keep pace due to limited real-world datasets. Advances in artificial intelligence, Machine Learning and cloud computing have revitalized research and applications in this domain. While ML and data mining techniques are popular in fraud detection, specific reviews focusing on their application in e-commerce platforms like eBay and Facebook are lacking depth. Existing reviews provide broad overviews but fail to grasp the intricacies of ML algorithms in the e-commerce context . So for identifying the intrusion we have designed the different machine learning algorithms such as KNN,LR. The experimental results shows that the accuracy algorithms. In this process, E-Commerce Fraud Detection was taken from dataset repository.

EPRO-DM-004

Gender-Based Analysis of User Reactions to Facebook Posts

This study explores ship object detection using Convolutional Neural Networks (CNN), YOLOv5, and YOLOv8, evaluating their performance based on accuracy, error rate, and execution time. CNNs, known for their robust image processing capabilities, provide a foundational approach but often suffer from longer execution times due to their complex architecture. YOLOv5, an advanced real-time object detection model, balances accuracy and speed, offering a streamlined approach with significant improvements in execution time and error reduction compared to traditional CNNs. The latest iteration, YOLOv8, further refines these capabilities, enhancing accuracy and reducing error rates through improved network structures and optimization techniques.

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EPRO-DM-005

Predicting Energy Consumption Using Stacked LSTM Snapshot Ensemble

Accurate forecasting of energy consumption is essential for efficient resource allocation, grid management, and sustainable energy planning. A novel approach leveraging Stacked Long Short-Term Memory (LSTM) networks combined with the Snapshot Ensemble technique is proposed for energy consumption prediction. The Stacked LSTM architecture enables capturing complex temporal dependencies in energy consumption data, while the Snapshot Ensemble technique enhances the model's generalization capabilities and robustness. The methodology involves training multiple Stacked LSTM models with varying initializations and snapshots of the training process. By ensembling predictions from these diverse models, improved accuracy and reliability in energy consumption forecasting are achieved. Experiments conducted on real-world energy consumption datasets evaluate the performance of the approach against baseline models and state-of-the-art techniques. The results demonstrate that the Stacked LSTM Snapshot Ensemble method outperforms existing approaches in terms of prediction accuracy, especially in handling non-linear and dynamic

EPRO-DM-006

A Cost-Sensitive Machine Learning Model With Multitask Learning For Intrusion Detection In Iot

A problem with machine learning (ML) techniques for detecting intrusions in the Internet of Things (IoT) is that they are ineffective in the detection of low frequency intrusions. In addition, as ML models are trained using specific attack categories, they cannot recognize unknown attacks. This article integrates strategies of cost sensitive learning and multitask learning into a hybrid ML model to address these two challenges. The hybrid model consists of an autoencoder for feature extraction and a support vector machine (SVM) for detecting intrusions. In the cost-sensitive learning phase for the class imbalance problem, the hinge loss layer is enhanced to make a classifier strong against low-distributed intrusions. Moreover, to detect unknown attacks, we formulate the SVM as a multitask problem. Experiments on the UNSW-NB15 and BoT-IoT datasets demonstrate the superiority of our model in terms of recall, precision, and F1-score averagely 92.2%, 96.2%, and 94.3%, respectively, over other approaches.

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EPRO-DM-007

Pretrained_Quantum-Inspired_Deep_Neural_Network_for_Natural_Language_Processing

A pretrained quantum inspired deep neural network is proposed in this work, whichis constructed based on quantum theory for carrying out strongperformance and great interpretability in related NLP fields.Concretely, a quantum-inspired pretrained feature embedding(QPFE) method is first developed to model superposition statesfor words to embed more textual features. Then, a QPFE-ERNIEmodel isdesigned by merging the semantic features learned fromthe prevalent pretrained model ERNIE, which is verified with twoNLP downstream tasks: 1) sentiment classificationandwordsensedisambiguation(WSD). In addition, schematic quantumcircuit diagrams are provided, which has potential impetus forthe future realization of quantum NLP with quantum device.

Finally, the experiment results demonstrate QPFE-ERNIE is significantly better for sentiment classification than gated recurrentunit (GRU), BiLSTM, and TextCNN on Using Sentiment Analysis Dataset in all metricsand achieves better results than ERNIE in accuracy, F1-score,and precision is calculated .

EPRO-DM-008

A Novel Recommendation Algorithm Integrates Resource Allocation and Resource Transfer in Weighted Bipartite Network

Grid-based recommendation algorithms traditionally view users and items as abstract nodes, relying on selection relationships between these entities to make recommendations. However, this approach often overlooks valuable information, leading to less accurate recommendations. Our paper proposes enhancements to the standard substance diffusion algorithm by incorporating the influence of user ratings on recommended items, introducing a moderating factor, and optimizing the initial resource allocation vector and resource transfer matrix within the recommendation framework.The proposed algorithm improves recommendation accuracy by taking into account the user's rating behavior, thereby refining the diffusion process. A moderating factor is introduced to adjust the impact of individual user ratings on the recommendation results, ensuring that high and low ratings are appropriately weighted. Additionally, the optimization of the initial resource allocation vector and resource transfer matrix ensures a more efficient and effective distribution of recommendation resources.To quantify user satisfaction with the recommendation results, an average ranking score evaluation index is introduced. This metric provides a more nuanced assessment of recommendation quality compared to traditional metrics.Experiments conducted on the MovieLens training dataset demonstrate that the proposed

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EPRO-DM-009

Leveraging_Gametic_Heredity_in_Oversampling_Techniques_to_Handle_Class_Imbalance_for_Efficient_Cyberthreat_Detection_in_IIoT

Machine learning techniques have garnered interest insecurity applications due to their rapid processing capabilities
and real-time predictions. However, imbalanced data distributionis a prevalent issue in IIoT environments, adversely affecting MLbased attack detection systems. In this work, we present a novelgameticheredity-based oversampling technique for addressingimbalanced data challenges in cybersecurity applications, specifically targeting IIoT systems. The proposed model enhancesdiversityin the minority classes by generating unique syntheticminority samples, creating diverse synthetic data while restricting instances to the minority class region. The proposed modeloutperforms complex and conventional methods in terms ofprecision, recall & F-Score while mitigating over-generalizationby evenly distributing newly generated samples within minorityclass boundaries and regions. To validate the proposed model andverify its efficacy in identifying cyber threats, we used the UNSWNB15 dataset. Simulation results demonstrate that the proposedmodel efficiently detects attacks with high performance comparedto state-of-the-art techniques. Our research contributes to developing robust & efficient machine learning models for enhancing
the security of IIoT systems while handling class imbalanceissues.

EPRO-DM-010

Classification of Tolerances in Permanent Magnet Synchronous Machines With Machine Learning

Faults in electrical machines are mostly detected by analyzing direct measurements. However, an early detection can be difficult with this measurement evaluation. With the knowledge of the most important tolerances, that influence the output performance of the machine and the significant frequency orders, a method to classify the machine's quality at the End of Line (EoL) test bench and for condition monitoring is studied. With a transient drive simulation stochastically distributed tolerances are simulated, the associated frequency orders analyzed and compared to test bench measurement results. Machine Learning (ML) is applied on the simulation data and evaluated for an EoL test procedure as well as eccentricity classification where a large portion of the test cases is correctly classified. If the ML models are applied on the measurement data the results are classified slightly too high, but the gradation of the machines remains equal compared to the measurement analysis.

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EPRO-DM-011

A Cost-Sensitive Machine Learning Model With Multitask Learning for Intrusion Detection in IoT

A problem with machine learning (ML) techniques for detecting intrusions in the Internet of Things (IoT) is that they are ineffective in the detection of low-frequency intrusions. In addition, as ML models are trained using specific attack categories, they cannot recognize unknown attacks. This article integrates strategies of cost-sensitive learning and multitask learning into a hybrid ML model to address these two challenges. The hybrid model consists of an autoencoder for feature extraction and a support vector machine (SVM) for detecting intrusions. In the cost-sensitive learning phase for the class imbalance problem, the hinge loss layer is enhanced to make a classifier strong against low-distributed intrusions. Moreover, to detect unknown attacks, we formulate the SVM as a multitask problem. Experiments on the UNSW-NB15 and BoT-IoT datasets demonstrate the superiority of our model in terms of recall, precision, and F1-score averagely 92.2%, 96.2%, and 94.3%, respectively, over other approaches.

EPRO-DM-012

An IoMT-Based Incremental Learning Framework With a Novel Feature Selection Algorithm for Intelligent Diagnosis in Smart

Several recent research papers in the Internet of Medical Things (IoMT) domain employ machine learning techniques to detect data patterns and trends, identify anomalies, predict and prevent adverse events, and develop personalized patient treatment plans. Despite the potential of machine learning techniques in IoMT to revolutionize healthcare, several challenges remain.The conventional machine learning models in the IoMT domain are static in that they were trained on some datasets and are being used for real-time inferencing data. This approach does not consider the patient's recent health-related data. In the conventional machine learning models paradigm, the models must be re-trained again, even to incorporate a few sets of additional samples. Also, since the training of the conventional machine learning models generally happens on cloud platforms, there are also risks to security and privacy. Addressing these several issues, we propose an edge-based incremental learning framework with a novel feature selection algorithm for intelligent diagnosis of patients. classification and anomaly detection are 9X and 16X faster than their corresponding best-performing batch learning-based models.

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EPRO-DM-013

Exploring Classification of Topological Priors With Machine Learning for Feature Extraction

In many scientific endeavors, increasingly abstract representations of data allow for new interpretive methodologies and conceptualization of phenomena. For example, moving from raw imaged pixels to segmented and reconstructed objects allows researchers new insights and means to direct their studies toward relevant areas. Thus, the development of new and improved methods for segmentation remains an active area of research. With advances in machine learning and neural networks, scientists have been focused on employing deep neural networks such as U-Net to obtain pixel-level segmentations, namely, defining associations between pixels and corresponding/referent objects and gathering those objects afterward. Topological analysis, such as the use of the Morse-Smale complex to encode regions of uniform gradient flow behavior, offers an alternative approach: first, create geometric priors, and then apply machine learning to classify. This approach is empirically motivated since phenomena of interest often appear as subsets of topological priors in many applications. Using topological elements not only reduces the learning space but also introduces the ability to use learnable geometries and connectivity to aid the classification of the segmentation target.

EPRO-DM-014

Multilayer Perceptron Neural Network Approach to Classifying Learning Modalities Under the New Normal

Because of community quarantines and lockdowns during COVID–19 times, the Philippine's Department of Education (DepEd) implemented blended learning (BL) [both online and offline distance learning modalities (LM)] among basic educational institutions in the hope of continuing learners' learning experiences amidst the pandemic. Learners' LM are classified through the use of an Algorithm for Learning Delivery Modality as recommended by DepEd. Based on initial investigation, mismatches in learners' LM were, however, observed, resulting in learners' massive shifting from one LM to another in the middle of the school year. In this study, we introduced an approach to classifying learner's LM using machine learning (ML) techniques. We compared the effectiveness of five ML classifiers, namely the random forest (RF), multilayer perceptron neural network (MLP NN), K-nearest neighbor (KNN), support vector machine (SVM), and Naïve Bayes (NB). Learner's enrolment and survey form (LESF) data from the repository of a local private high school in the Philippines is used in model formulation. We also compared three existing feature selection (FS) algorithms (recursive feature elimination (RFE), Boruta algorithm (BA), and ReliefF)–integrated into the five ML classifiers as data feature reduction techniques.

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EPRO-DM-015

A Novel Recommendation Algorithm Integrates Resource Allocation and Resource Transfer in Weighted Bipartite Network

Grid-based recommendation algorithms view users and items as abstract nodes, and the information utilised by the algorithm is hidden in the selection relationships between users and items. Although these relationships can be easily handled, much useful information is overlooked, resulting in a less accurate recommendation algorithm. The aim of this paper is to propose improvements on the standard substance diffusion algorithm, taking into account the influence of the user's rating on the recommended item, adding a moderating factor, and optimising the initial resource allocation vector and resource transfer matrix in the recommendation algorithm. An average ranking score evaluation index is introduced to quantify user satisfaction with the recommendation results. Experiments are conducted on the MovieLens training dataset, and the experimental results show that the proposed algorithm outperforms classical collaborative filtering systems and network structure based recommendation systems in terms of recommendation accuracy and hit rate.

EPRO-DM-016

Vaccine Hesitancy Hotspots in Africa: An Insight From Geotagged Twitter Posts

Many social media users express concerns about vaccines and their side effects on Twitter. These concerns lead to a compromise of confidence which brings about vaccine hesitancy. In Africa, vaccine hesitancy is a major challenge faced by health policymakers in the fight against COVID-19. Given that most tweets are geotagged, clustering them according to their sentiments could help identify locations that may likely experience vaccine hesitancy for health policy and planning. In this study, we collected 70000 geotagged vaccine-related tweets in nine African countries, from December 2020 to February 2022. The tweets were classified into three sentiment classes—positive, negative, and neutral. The quality of the classification outputs was achieved using Naíve Bayes (NB), logistic regression (LR), support vector machines (SVMs), decision tree (DT), and K-nearest neighbor (KNN) machine learning classifiers. The LR achieved the highest accuracy of 71% with an average area under the curve of 85%. The point-based location technique was used to calculate the hotspots based on the locations of the classified tweets. Locations with green, red, and gray backgrounds on the map signify a hotspot for positive, negative, and neutral sentiments. The outcome of this research shows that discussions on social media can be analyzed to identify hotspots during a disease outbreak, which could inform health policy in planning and management of vaccine hesitancy in Africa.

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EPRO-DM-017

Forecasting Gender in Open Education Competencies: A Machine Learning Approach

This article aims to study the performance of machine learning models in forecasting gender based on the students' open education competency perception. Data were collected from a convenience sample of 326 students from 26 countries using the eOpen instrument. The analysis comprises 1) a study of the students' perceptions of knowledge, skills, and attitudes or values related to open education and its subcompetencies from a 30-item questionnaire using machine learning models to forecast participants' gender, 2) validation of performance through cross-validation methods, 3) statistical analysis to find significant differences between machine learning models, and 4) an analysis from explainable machine learning models to find relevant features to forecast gender. The results confirm our hypothesis that the performance of machine learning models can effectively forecast gender based on the student's perceptions of knowledge, skills, and attitudes or values related to open education competency.

EPRO-DM-018

A Multi-perspective Fraud Detection Method for Multi-Participant E-commerce Transactions

Detection and prevention of fraudulent transactions in e-commerce platforms have always been the focus of transaction security systems. However, due to the concealment of e-commerce, it is not easy to capture attackers solely based on the historic order information. Many works try to develop technologies to prevent frauds, which have not considered the dynamic behaviors of users from multiple perspectives. This leads to an inefficient detection of fraudulent behaviors. To this end, this article proposes a novel fraud detection method that integrates machine learning and process mining models to monitor real-time user behaviors. First, we establish a process model concerning the business-to-customer (B2C) e-commerce platform, by incorporating the detection of user behaviors. Second, a method for analyzing abnormalities that can extract important features from event logs is presented. Then, we feed the extracted features to a support vector machine (SVM)-based classification model that can detect fraud behaviors. We demonstrate the effectiveness of our method in capturing dynamic fraudulent behaviors in e-commerce systems through the experiments.

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EPRO-DM-019

FRHIDS: Federated Learning Recommender Hybrid Intrusion Detection System Model in Software-Defined Networking for

In the past few years, numerous methods of attack against recommendation systems have been developed. Cellphones, smart devices, and self-driving cars are instances of distributed IoT consumer devices that generate massive amounts of data on a daily basis and pose security threats to the cloud server. Due to the higher exchange of data, the challenges in this domain lead to increased security issues. Therefore, intrusion detection systems are important for the security and privacy of IoT consumer devices and hence to the cloud server. Due to the prediction, classification of attacks and recommendation of malware devices, the accuracy of machine learning and deep learning approaches for research in security for IoT consumer devices has gained tremendous popularity. Federated learning (FL), is a privacy-preserving decentralized learning technique that does not transport data but instead trains the model locally before sending the parameters to a cloud server, which helps in ensuring the security of data. However, communication channels can still be attacked by hackers, so blocking malicious data is a major requirement for the cloud server.

EPRO-DM-020

Attention-Based Hybrid Deep Learning Model for EEG Emotion Recognition

Emotion recognition based on electroencephalography (EEG) has received much attention in recent years, and there is more and more research on emotion recognition utilizing deep learning. It is difficult to extract more discriminative features for emotion recognition. To solve this problem, an attention-based hybrid deep learning model is proposed for EEG emotion recognition. The proposed approach extracts the critical feature information and achieves an excellent classification effect. To begin, the differential entropy features of EEG data are extracted and organized according to electrodeposition. Then, the convolutional encoder is used to encode the EEG signal and extract the spatial features, and the band attention mechanism is introduced to assign adaptive weights to different bands. Finally, a long short-term memory network is utilized to extract temporal features, and a time attention mechanism is used to obtain critical temporal information. The performance of the proposed model is analyzed on benchmark emotion databases such as DEAP and SEED for the classification task. The experimental results in terms of accuracy are 85.86% and 84.27% on DEAP datasets and 92.47% on SEED datasets. The experimental analysis shows that the proposed model can effectively recognize emotions and has a good classification performance.

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EPRO-DM-021

SAFER-STUDENT for Safe Deep Semi-Supervised Learning With Unseen-Class Unlabeled Data

Deep semi-supervised learning (SSL) methods aim to utilize abundant unlabeled data to improve the seen-class classification. However, in the open-world scenario, collected unlabeled data tend to contain unseen-class data, which would degrade the generalization to seen-class classification. Formally, we define the problem as safe deep semi-supervised learning with unseen-class unlabeled data. One intuitive solution is removing these unseen-class instances after detecting them during the SSL process. Nevertheless, the performance of unseen-class identification is limited by the lack of suitable score function, the uncalibrated model, and the small number of labeled data. To this end, we propose a safe SSL method called SAFE R -STUDENT from the teacher-student view. First, to enhance the ability of teacher model to identify seen and unseen classes, we propose a general scoring framework called D iscrepancy with R aw (DR). Second, based on unseen-class data mined by teacher model from unlabeled data, we calibrate student model by newly proposed U nseen-class E nergy-bounded C alibration (UEC) loss.

EPRO-DM-022

Extensible Machine Learning for Encrypted Network Traffic Application Labeling via Uncertainty Quantification

With the increasing prevalence of encrypted network traffic, cybersecurity analysts have been turning to machine learning (ML) techniques to elucidate the traffic on their networks. However, ML models can become stale as new traffic emerges that is outside of the distribution of the training set. In order to reliably adapt in this dynamic environment, ML models must additionally provide contextualized uncertainty quantification to their predictions, which has received little attention in the cybersecurity domain. Uncertainty quantification is necessary both to signal when the model is uncertain about which class to choose in its label assignment and when the traffic is not likely to belong to any pretrained classes. We present a new public dataset of network traffic that includes labeled virtual-private-network-encrypted network traffic generated by ten applications and corresponding to five application categories. We also present an ML framework that is designed to rapidly train with modest data requirements and provide both calibrated predictive probabilities and an interpretable “out-of-distribution” (OOD) score to flag novel traffic samples. We describe calibrating OOD scores using p -values of the relative Mahalanobis distance. We demonstrate that our framework achieves an F1-score of 0.98 on our dataset and that it can extend to an enterprise network by testing the model: 1) on data from similar applications

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EPRO-DM-023

Hybrid Models for Knowledge Tracing: A Systematic Literature Review

Knowledge tracing is a well-known problem in AI for education, consisting of monitoring how the knowledge state of students changes during the learning process and accurately predicting their performance in future exercises. In recent years, many advances have been made thanks to various machine learning and deep learning techniques. Despite their satisfactory performances, they have some pitfalls, e.g., modeling one skill at a time, ignoring the relationships between different skills, or inconsistency for the predictions, i.e., sudden spikes and falls across time steps. For this reason, hybrid machine-learning techniques have also been explored. With this systematic literature review, we aim to illustrate the state of the art in this field. Specifically, we want to identify the potential and the frontiers in integrating prior knowledge sources in the traditional machine learning pipeline as a supplement to the normally considered data. We applied a qualitative analysis to distill a taxonomy with the following three dimensions: knowledge source, knowledge representation, and knowledge integration. Exploiting this taxonomy, we also conducted a quantitative analysis to detect the most common approaches.

EPRO-DM-024

Multi-Branch Mutual-Distillation Transformer for EEG-Based Seizure Subtype Classification

Cross-subject electroencephalogram (EEG) based seizure subtype classification is very important in precise epilepsy diagnostics. Deep learning is a promising solution, due to its ability to automatically extract latent patterns. However, it usually requires a large amount of training data, which may not always be available in clinical practice. This paper proposes Multi-Branch Mutual-Distillation (MBMD) Transformer for cross-subject EEG-based seizure subtype classification, which can be effectively trained from small labeled data. MBMD Transformer replaces all even-numbered encoder blocks of the vanilla Vision Transformer by our designed multi-branch encoder blocks. A mutual-distillation strategy is proposed to transfer knowledge between the raw EEG data and its wavelets of different frequency bands. Experiments on two public EEG datasets demonstrated that our proposed MBMD Transformer outperformed several traditional machine learning and state-of-the-art deep learning approaches. To our knowledge, this is the first work on knowledge distillation for EEG-based seizure subtype classification.

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EPRO-DM-025

A Novel CNN-BiLSTM Ensemble Model With Attention Mechanism for Sit-to-Stand Phase Identification Using Wearable Inertial Sensors

Sit-to-stand transition phase identification is vital in the control of a wearable exoskeleton robot for assisting patients to stand stably. In this study, we aim to propose a method for segmenting and identifying the sit-to-stand phase using two inertial sensors. First, we defined the sit-to-stand transition into five phases, namely, the initial sitting phase, the flexion momentum phase, the momentum transfer phase, the extension phase, and the stable standing phase based on the preprocessed acceleration and angular velocity data. We then employed a threshold method to recognize the initial sitting and the stable standing phases. Finally, we designed a novel CNN-BiLSTM-Attention algorithm to identify the three transition phases, namely, the flexion momentum phase, the momentum transfer phase, and the extension phase. Fifteen subjects were recruited to perform sit-to-stand transition experiments under a specific paradigm. A combination of the acceleration and angular velocity data features for the sit-to-stand transition phase identification were validated for the model performance improvements. The integration of the CNN, Bi-LSTM, and Attention modules demonstrated the reasonableness of the proposed algorithms.

EPRO-DM-026

An_Introduction_to_Adversarially_Robust_Deep_Learning

The widespread success of deep learning in solving machine learning problems has fueled its adoption in many fields, from speech recognition to drug discovery and medical imaging. However, deep learning systems are extremely fragile: imperceptibly small modifications to their input data can cause the models to produce erroneous output. It is very easy to generate such adversarial perturbations even for state-of-the-art models, yet immunization against them has proven exceptionally challenging. Despite over a decade of research on this problem, our solutions are still far from satisfactory and many open problems remain. In this work, we survey some of the most important contributions in the field of adversarial robustness. We pay particular attention to the reasons why past attempts at improving robustness have been insufficient, and we identify several promising areas for future research.

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EPRO-DM-027

Deep_Learning_for_Electromyographic_Lower-Limb_Motion_Signal_Classification_Using_Residual_Learning

Electromyographic (EMG) signals have gained popularity for controlling prostheses and exoskeletons, particularly in the field of upper limbs for stroke patients. However, there is a lack of research in the lower limb area, and standardized open-source datasets of lower limb EMG signals, especially recording data of Asian race features, are scarce. Additionally, deep learning algorithms are rarely used for human motion intention recognition based on EMG, especially in the lower limb area. In response to these gaps, we present an open-source benchmark dataset of lower limb EMG with Asian race characteristics and large data volume, the JJ dataset, which includes approximately 13,350 clean EMG segments of 10 gait phases from 15 people. This is the first dataset of its kind to include the nine main muscles of human gait when walking. We used the processed time-domain signal as input and adjusted ResNet-18 as the classification tool. Our research explores and compares multiple key issues in this area, including the comparison of sliding time window method and other preprocessing methods, comparison of time-domain and frequency-domain signal processing effects, cross-subject motion recognition accuracy, and the possibility of using thigh and calf muscles in amputees.

EPRO-DM-028

DiffMDD_A_Diffusion-Based_Deep_Learning_Framework_for_MDD_Diagnosis_Using_EEG

Major Depression Disorder (MDD) is a common yet destructive mental disorder that affects millions of people worldwide. Making early and accurate diagnosis of it is very meaningful. Recently, EEG, a non-invasive technique of recording spontaneous electrical activity of brains, has been widely used for MDD diagnosis. However, there are still some challenges in data quality and data size of EEG: (1) A large amount of noise is inevitable during EEG collection, making it difficult to extract discriminative features from raw EEG; (2) It is difficult to recruit a large number of subjects to collect sufficient and diverse data for model training. Both of the challenges cause the overfitting problem, especially for deep learning methods. In this paper, we propose DiffMDD, a diffusion-based deep learning framework for MDD diagnosis using EEG. Specifically, we extract more noise-irrelevant features to improve the model's robustness by designing the Forward Diffusion Noisy Training Module. Then we increase the size and diversity of data to help the model learn more generalized features by designing the Reverse Diffusion Data Augmentation Module.

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EPRO-DM-029

From_Clustering_to_Cluster_Explanations_via_Neural_Networks

A recent trend in machine learning has been to enrich learned models with the ability to explain their own predictions. The emerging field of explainable AI (XAI) has so far mainly focused on supervised learning, in particular, deep neural network classifiers. In many practical problems, however, the label information is not given and the goal is instead to discover the underlying structure of the data, for example, its clusters. While powerful methods exist for extracting the cluster structure in data, they typically do not answer the question why a certain data point has been assigned to a given cluster. We propose a new framework that can, for the first time, explain cluster assignments in terms of input features in an efficient and reliable manner. It is based on the novel insight that clustering models can be rewritten as neural networks—or "neuralized." Cluster predictions of the obtained networks can then be quickly and accurately attributed to the input features. Several showcases demonstrate the ability of our method to assess the quality of learned clusters and to extract novel insights from the analyzed data and representations.

EPRO-DM-030

Learning_Random_Access_Schemes_for_Massive_Machine-Type_Communication_With_MARL

This paper investigates various multi-agent reinforcement learning (MARL) techniques for designing grant-free random access (RA) schemes suitable for low-complexity, low-power battery-operated devices in massive machine-type communication (mMTC). Previous studies on RA with MARL have shown limitations in terms of scalability and suitability for mMTC. To address scalability and practicality of the proposed methods, we examine the impact of excluding agent identification in the observation vector of each agent on network performance. We employ value decomposition networks (VDN) and QMIX algorithms with parameter sharing (PS) and compare their policies with the deep recurrent Q-network (DRQN). Our simulation results demonstrate that the MARL-based RA schemes can achieve a better throughput-fairness trade-off between agents without having to condition on the agent identifiers. We also present a correlated traffic model, which is more descriptive of mMTC scenarios, and show that the proposed algorithm can easily adapt to traffic non-stationarities. Moreover, the robustness of the proposed method in terms of scalability is also shown through simulations.

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EPRO-DM-031

Machine-to-Machine_Transfer_Function_in_Deep_Learning-Based_Quantitative_Ultrasound

A Transfer Function approach was recently demonstrated to mitigate data mismatches at the acquisition level for a single ultrasound scanner in deep learning (DL) based quantitative ultrasound (QUS). As a natural progression, we further investigate the transfer function approach and introduce a Machine-to-Machine (M2M) Transfer Function, which possesses the ability to mitigate data mismatches at a machine level, i.e., mismatches between two scanners over the same frequency band. This ability opens the door to unprecedented opportunities for reducing DL model development costs, enabling the combination of data from multiple sources or scanners, or facilitating the transfer of DL models between machines with ease. We tested the proposed method utilizing a SonixOne machine and a Verasonics machine. In the experiments, we used a L9-4 array and conducted two types of acquisitions to obtain calibration data: stable and free-hand, using two different calibration phantoms. Without the proposed calibration method, the mean classification accuracy when applying a model on data acquired from one system to data acquired from another system was approximately 50%, and the mean AUC was about 0.40. With the proposed method, mean accuracy increased to approximately 90%, and the AUC rose to the 0.99.

EPRO-DM-032

Otago_Exercises_Monitoring_for_Older_Adults_by_a_Single_IMU_and_Hierarchical_Machine_Learning_Models

Otago Exercise Program (OEP) is a rehabilitation program for older adults to improve frailty, sarcopenia, and balance. Accurate monitoring of patient involvement in OEP is challenging, as self-reports (diaries) are often unreliable. The development of wearable sensors and their use in Human Activity Recognition (HAR) systems has lead to a revolution in healthcare. However, the use of such HAR systems for OEP still shows limited performance.

The objective of this study is to build an unobtrusive and accurate system to monitor OEP for older adults. Data was collected from 18 older adults wearing a single waistmounted InertialMeasurement Unit (IMU). Two datasets were recorded, one in a laboratory setting, and one at the homes of the patients. A hierarchical system is proposed with two stages: 1) using a deep learning model to recognize whether the patients are performing OEP or activities of daily life (ADLs) using a 10-minute sliding window; 2) based on stage 1, using a 6-second sliding window to recognize the OEP sub-classes. Results showed that in stage 1, OEP

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EPRO-DM-033

Physics-Informed_Deep_Learning_for_Muscle_Force_Prediction_With_Unlabeled_sEMG_Signals

Computational biomechanical analysis plays a pivotal role in understanding and improving human movements and physical functions. Although physics-based modeling methods can interpret the dynamic interaction between the neural drive to muscle dynamics and joint kinematics, they suffer from high computational latency. In recent years, data-driven methods have emerged as a promising alternative due to their fast execution speed, but label information is still required during training, which is not easy to acquire in practice. To tackle these issues, this paper presents a novel physics-informed deep learning method to predict muscle forces without any label information during model training. In addition, the proposed method could also identify personalized muscle-tendon parameters. To achieve this, the Hill muscle model-based forward dynamics is embedded into the deep neural network as the additional loss to further regulate the behavior of the deep neural network. Experimental validations on the wrist joint from six healthy subjects are performed, and a fully connected neural network (FNN) is selected to implement the proposed method. The predicted results of muscle forces show comparable or even lower root mean square error (RMSE) and higher coefficient of determination compared with baseline methods, which have to use the labeled

EPRO-DM-034

Semi-Supervised_Learning_for_Multi-Label_Cardiovascular_Diseases_Prediction_A_Multi-Dataset_Study

Electrocardiography (ECG) is a non-invasive tool for predicting cardiovascular diseases (CVDs). Current ECG-based diagnosis systems show promising performance owing to the rapid development of deep learning techniques. However, the label scarcity problem, the co-occurrence of multiple CVDs and the poor performance on unseen datasets greatly hinder the widespread application of deep learning-based models. Addressing them in a unified framework remains a significant challenge. To this end, we propose a multi-label semi-supervised model (ECGMatch) to recognize multiple CVDs simultaneously with limited supervision. In the ECGMatch, an ECGAugment module is developed for weak and strong ECG data augmentation, which generates diverse samples for model training. Subsequently, a hyperparameter-efficient framework with neighbor agreement modeling and knowledge distillation is designed for pseudo-label generation and refinement, which mitigates the label scarcity problem. Finally, a label correlation alignment module is proposed to capture the co-occurrence

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EPRO-DM-035

Stealthy_Adversarial_Attacks_on_Machine_Learning-Based_Classifiers_of_Wireless_Signals

Machine learning (ML) has been successfully applied to classification tasks in many domains, including computer vision, cybersecurity, and communications. Although highly accurate classifiers have been developed, research shows that these classifiers are, in general, vulnerable to adversarial machine learning (AML) attacks. In one type of AML attack, the adversary trains a surrogate classifier (called the attacker's classifier) to produce intelligently crafted low-power "perturbations" that degrade the accuracy of the targeted (defender's) classifier. In this paper, we focus on radio frequency (RF) signal classifiers, and study their vulnerabilities to AML attacks. Specifically, we consider several exemplary protocol and modulation classifiers, designed using convolutional neural networks (CNNs) and recurrent neural networks (RNNs). We first show the high accuracy of such classifiers under random noise (AWGN). We then study their performance under three types of low-power AML perturbations (FGSM, PGD, and DeepFool), considering different amounts of information at the attacker. On one extreme (so-called "white-box" attack), the attacker has complete knowledge of the defender's classifier and its training data.

EPRO-DM-036

Targeted-BEHRT_Deep_Learning_for_Observational_Causal_Inference_on_Longitudinal_Electronic_Health_Records

Observational causal inference is useful for decision-making in medicine when randomized clinical trials (RCTs) are infeasible or nongeneralizable. However, traditional approaches do not always deliver unconfounded causal conclusions in practice. The rise of "doubly robust" nonparametric tools coupled with the growth of deep learning for capturing rich representations of multimodal data offers a unique opportunity to develop and test such models for causal inference on comprehensive electronic health records (EHRs). In this article, we investigate causal modeling of an RCT-established causal association: the effect of classes of antihypertensive on incident cancer risk. We develop a transformer-based model, targeted bidirectional EHR transformer (T-BEHRT) coupled with doubly robust estimation to estimate average risk ratio (RR). We compare our model to benchmark statistical and deep learning models for causal inference in multiple experiments on semi-synthetic derivations of our dataset with various types and intensities of confounding. In order to further test the reliability of our approach, we test our model on situations of limited data. We find that our model provides more accurate estimates of relative risk [least sum absolute error (SAE) from ground truth] compared with benchmark estimations.

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EPRO-DM-037

Test_Input_Prioritization_for_Machine_Learning_Classifiers

Machine learning has achieved remarkable success across diverse domains. Nevertheless, concerns about interpretability in black-box models, especially within Deep Neural Networks (DNNs), have become pronounced in safety-critical fields like healthcare and finance. Classical machine learning (ML) classifiers, known for their higher interpretability, are preferred in these domains. Similar to DNNs, classical ML classifiers can exhibit bugs that could lead to severe consequences in practice. Test input prioritization has emerged as a promising approach to ensure the quality of an ML system, which prioritizes potentially misclassified tests so that such tests can be identified earlier with limited manual labeling costs. However, when applying to classical ML classifiers, existing DNN test prioritization methods are constrained from three perspectives: 1) Coverage-based methods are inefficient and time-consuming; 2) Mutation-based methods cannot be adapted to classical ML models due to mismatched model mutation rules; 3) Confidence-based methods are restricted to a single dimension when applying to binary ML classifiers, solely depending on the model's prediction probability for one class.

EPRO-DM-038

Unleashing_the_Potential_of_Knowledge_Distillation_for_IoT_Traffic_Classification

The Internet of Things (IoT) has revolutionized our lives by generating large amounts of data, however, the data needs to be collected, processed, and analyzed in real-time. Network Traffic Classification (NTC) in IoT is a crucial step for optimizing network performance, enhancing security, and improving user experience. Different methods are introduced for NTC, but recently Machine Learning solutions have received high attention in this field, however, Traditional Machine Learning (ML) methods struggle with the complexity and heterogeneity of IoT traffic, as well as the limited resources of IoT devices. Deep learning shows promise but is computationally intensive for resource-constrained IoT devices. Knowledge distillation is a solution to help ML by compressing complex models into smaller ones suitable for IoT devices. In this paper, we examine the use of knowledge distillation for IoT traffic classification. Through experiments, we show that the student model achieves a balance between accuracy and efficiency. It exhibits similar accuracy to the larger teacher model while maintaining a smaller size. This makes it a suitable alternative for resource-constrained scenarios like mobile or IoT traffic classification.

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EPRO-DM-039

A Weighted Stacking Ensemble Model With Sampling for Fake Reviews Detection

Customers use reviews as a primary source of information to judge a product or service. Positive reviews help boost companies' reputations, increasing their revenue by attracting new clients, and increasing the purchasing order size. On the other hand, negative reviews significantly reduce sales, which might be the case due to competitive advantage. Organizations can use fake (i.e., misleading or fraudulent) reviews to generate fast profits by deceiving customers into buying their products. Recently, various methods to assess the legitimacy of reviews have been introduced using advances in machine learning. However, existing methods fall short of achieving highly accurate detection results for unbalanced classes. We aimed to create a spam review identification model using ensemble-based learning while balancing classes using sampling techniques. This article proposes a weighted stacking ensemble model with sampling (WSEM-S) for efficient fake reviews detection. We used n -gram models to effectively model language data for feature retrieval.

EPRO-DM-040

An Explainable and Resilient Intrusion Detection System for Industry 5.0

Industry 5.0 is a emerging transformative model that aims to develop a hyperconnected, automated, and data-driven industrial ecosystem. This digital transformation will boost productivity and efficiency throughout the production process but will be more prone to new sophisticated cyber-attacks. Deep learning-based Intrusion Detection Systems (IDS) have the potential to recognize intrusions with high accuracy. However, these models are complex and are treated as a black box by developers and security analysts due to the inability to interpret the decisions made by these models. Motivated by the challenges, this paper presents an explainable and resilient IDS for Industry 5.0. The proposed IDS is designed by combining bidirectional long short-term memory networks (BiLSTM), a bidirectional-gated recurrent unit (Bi-GRU), fully connected layers and a softmax classifier to enhance the intrusion detection process in Industry 5.0. We employ the SHapley Additive exPlanations (SHAP) mechanism to interpret and understand the features that contributed the most in the decision of the proposed cyber-resilient IDS. The evaluation of the proposed model using the explainability can ensure that the model is working as expected. The experimental results based on the CICDDoS2019 dataset confirms the superiority of the proposed IDS over some recent approaches.

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EPRO-DM-041

Resource-Constraint Deep Forest based Intrusion Detection Method in Internet of Things for Consumer Electronic

Consumer Electronics (CEs) are smart devices using IoT for connectivity. They're susceptible to attacks like DoS, DDoS, and web attacks, impairing functions and enabling remote hijacking. Attackers can exploit CEs to target other systems, like vehicles. Malicious code can propagate through networks or CEs, causing vehicle failures. Existing ML/DL based IDS have high classification accuracy and robustness in traditional internet environments, but they are overly complex for performance improvement, which hinders their deployment in edge small computing environments. Furthermore, the comparison experiments of these intrusion detection algorithms with other algorithms are not sufficiently comprehensive to evaluate their performance in small computing environments. Therefore, balancing "detection performance and resource consumption" is a key issue in CE network detection. To address this issue, this paper proposes a hybrid feature selection model based on chi-square test and information gain combined Ig-Chi, which effectively reduces the feature dimensionality and improves the classification accuracy of classifiers for high-dimensional data sets. Additionally, layered intrusion detection is employed to perform intrusion detection on the data after feature selection.

EPRO-DM-042

Micro-Expression Recognition Based on Nodal Efficiency in the EEG Functional Networks

Micro-expression recognition based on ima- ges has made some progress, yet limitations persist. For instance, image-based recognition of micro-expressions is affected by factors such as ambient light, changes in head posture, and facial occlusion. The high temporal resolution of electroencephalogram (EEG) technology can record brain activity associated with micro-expressions and identify them objectively from a neurophysiological standpoint. Accordingly, this study introduces a novel method for recognizing micro-expressions using node efficiency features of brain networks derived from EEG signals. We designed a real-time Supervision and Emotional Expression Suppression (SEES) experimental paradigm to collect video and EEG data reflecting micro- and macro-expression states from 70 participants experiencing positive emotions. By constructing functional brain networks based on graph theory, we analyzed the network efficiencies at both macro- and micro-levels. The participants exhibited lower connection density, global efficiency, and nodal efficiency in the alpha, beta, and gamma networks during micro-expressions compared to macro-expressions.were selected.

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EPRO-DM-043

High Precision Traffic Flow Reconstruction via Hybrid Method

Traffic management and sustainable mobility are the central topics for intelligent transportation systems (ITS). By means of modern technologies, it is possible to collect real-time traffic flow data to extract useful information to monitor and control vehicular traffic. On the other hand, costs to obtain this piece of information are high. It requires either direct measures in the network road by installing large number of sensors (more precise data) or acquiring data from international providers supplying data coming from onboard units, mobile app, navigators, etc. In current paper, this problem has been addressed providing a solution granting traffic flow data in each road segment of the whole network by reconstructing the computation by means of data from few scattered traffic sensors in fixed positions of the road network. The proposed approach combines the solution of nonlinear Partial Differential Equations (PDEs) with machine learning for improving the state-of-the-art solutions of PDE. The result has been a higher precision with respect to PDE-based solutions, and a strongly reduced execution time. Several different machine learning models have been compared for such a purpose, demonstrating the general viability of the hybrid architecture proposed.

EPRO-DM-044

Time-series Failure Prediction on Small Datasets Using Machine Learning

Condition-based maintenance is a decision-making strategy using condition monitoring information to optimize the availability of operational plants. In this context, machine learning techniques are useful and have been used in predicting the remaining useful life (RUL) of equipment to ensure the overall safety and reliability of the system through maintenance policies and, consequently, reducing costs arising from the failure. These databases are not large which is tricky for data-driven models. In this study, we consider five different databases containing the failure times from distinct real-world equipment. Here, four different regression algorithms were compared for RUL prediction, namely: Support Vector Regression (SVR), Decision Tree (DT), Multilayer Perceptron (MLP) and K-Nearest Neighbors (KNN). Furthermore, aiming to improve the data quality, the Empirical Mode Decomposition (EMD) was used, which is responsible for pre-processing the input data used on the predictive modeling. We optimize the models hyperparameters using grid-search cross-validation algorithm and the performance of each model is compared using the normalized root mean squared error (NRMSE).

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EPRO-DM-045

Application of Quantum Recurrent Neural Network in Low-Resource Language Text Classification

Text sentiment analysis is an important task in natural language processing and has always been a hot research topic. However, in low-resource regions such as South Asia, where languages like Bengali are widely used, the research interest is relatively low compared to high-resource regions due to limited computational resources, flexible word order, and high inflectional nature of the language. With the development of quantum technology, quantum machine learning models leverage the superposition property of qubits to enhance model expressiveness and achieve faster computation compared to classical systems. To promote the development of quantum machine learning in low-resource language domains, we propose a quantum–classical hybrid architecture. This architecture utilizes a pretrained multilingual bidirectional encoder representations from transformer (BERT) model to obtain vector representations of words and combines the proposed batch upload quantum recurrent neural network (BUQRNN) and parameter nonshared batch upload quantum recurrent neural network (PN-BUQRNN) as feature extraction models for sentiment analysis in Bengali.

EPRO-DM-046

Self-Supervised Learning-Based General Laboratory Progress Pretrained Model for Cardiovascular Event Detection

Leveraging patient data through machine learning techniques in disease care offers a multitude of substantial benefits. Nonetheless, the inherent nature of patient data poses several challenges. Prevalent cases amass substantial longitudinal data owing to their patient volume and consistent followups, however, longitudinal laboratory data are renowned for their irregularity, temporality, absenteeism, and sparsity; In contrast, recruitment for rare or specific cases is often constrained due to their limited patient size and episodic observations. This study employed self-supervised learning (SSL) to pretrain a generalized laboratory progress (GLP) model that captures the overall progression of six common laboratory markers in prevalent cardiovascular cases, with the intention of transferring this knowledge to aid in the detection of specific cardiovascular event. Methods and procedures: GLP implemented a two-stage training approach, leveraging the information embedded within interpolated data and amplify the performance of SSL. After GLP pretraining, it is transferred for target vessel revascularization (TVR) detection. Resultstranscending the limitations of data availability.

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EPRO-DM-047

Deep Ensemble Learning With Pruning for DDoS Attack Detection in IoT Networks

The upsurge of Internet of Things (IoT) devices has increased their vulnerability to Distributed Denial of Service (DDoS) attacks. DDoS attacks have evolved into complex multi-vector threats that high-volume and low-volume attack strategies, posing challenges for detection using traditional methods. These challenges highlight the importance of reliable detection and prevention measures. This paper introduces a novel Deep Ensemble learning with Pruning (DEEPShield) system, to efficiently detect both high- and low-volume DDoS attacks in resource-constrained environments. The DEEPShield system uses ensemble learning by integrating a Convolutional Neural Network (CNN) and a Long Short-Term Memory (LSTM) network with a network traffic analysis system. This system analyzes and preprocesses network traffic while being data-agnostic, resulting in high detection accuracy. In addition, the DEEPShield system applies unit pruning to refine ensemble models, optimizing them for deployment on edge devices while maintaining a balance between accuracy and computational efficiency. To address the lack of a detailed dataset for high- and low-volume DDoS attacks, this paper also introduces a dataset named HL-IoT, which includes both attack types.

EPRO-DM-048

Classifying Routine Clinical Electroencephalograms With Multivariate Iterative Filtering and Convolutional Neural Networks

Electroencephalogram (EEG) is widely used in basic and clinical neuroscience to explore neural states in various populations, and classifying these EEG recordings is a fundamental challenge. While machine learning shows promising results in classifying long multivariate time series, optimal prediction models and feature extraction methods for EEG classification remain elusive. Our study addressed the problem of EEG classification under the framework of brain age prediction, applying a deep learning model on EEG time series. We hypothesized that decomposing EEG signals into oscillatory modes would yield more accurate age predictions than using raw or canonically frequency-filtered EEG. Specifically, we employed multivariate intrinsic mode functions (MIMFs), an empirical mode decomposition (EMD) variant based on multivariate iterative filtering (MIF), with a convolutional neural network (CNN) model.

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EPRO-DM-049

Exploring COVID-19 Trends in Mexico During the Winter Season with Explainable Artificial Intelligence (XAI)

COVID-19 has become the most significant pandemic in recent years. Today, Mexico has recorded millions of infections and deaths since the pandemic started. Around the world, machine learning methods have been used to understand, predict or develop strategies to manage the virus and the pandemic. Although algorithms provide good results, it is necessary to understand why a model makes specific predictions with a particular data set. To explain this question, we apply Explainable Artificial Intelligence (XAI) in this paper. With this, it is possible to understand the characteristics that influence the model decisions when denoting between deaths and survivors. As a case of study, the positive cases detected during the winter season of 2020-2021 and 2021-2022 were considered. In this season, respiratory diseases increased considerably, and in the study period, they influenced the increase in positive cases and the spread of COVID-19. Preliminary results suggest that age is essential when using a Random Forest model. Preliminary results suggest that age is essential when determining the prognosis of a patient infected by COVID-19 in winter seasons.

EPRO-DM-050

Classifying Routine Clinical Electroencephalograms With Multivariate Iterative Filtering and Convolutional Neural Networks

Contribution: This study incorporates competition-based learning (CBL) into machine learning courses. By engaging students in innovative problem-solving challenges within information competitions, revealing that students' participation in online problem-solving competitions can improve their information technology, and showcase competitions can enhance their competition ability. Background: The CBL model seamlessly integrates project-based learning and competition, placing a strong emphasis on both collective learning and outcomes. This approach cultivates motivation among team members, driving them to enhance their learning and translate knowledge into practical experience. Research Questions: The objective is to examine the disparities in the development of theoretical knowledge, information technology, AI practical ability, and competition ability among students participating in online problem-solving competitions and showcase competitions, and discusses the potential moderating effect of competition type on the relationships between variables in the hypothetical model. Methodology: The study involved 74 students enrolled in machine learning course at a university.

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EPRO-DM-051

Traffic Data-Empowered XGBoost-LSTM Framework for Infectious Disease Prediction

Large-scale infectious diseases pose a tremendous risk to humans, with global outbreaks of COVID-19 causing millions of deaths and trillions of dollars in economic losses. To minimize the damage caused by large-scale infectious diseases, it is necessary to develop infectious disease prediction models to provide assistance for prevention. In this paper, we propose an XGBoost-LSTM mixed framework that predicts the spread of infectious diseases in multiple cities and regions. According to big traffic data, it was found that population flow is closely related to the spread of infectious diseases. Clustering and dividing cities according to population flow can significantly improve prediction accuracy. Meanwhile, an XGBoost is used to predict the transmission trend based on the key features of infection. An LSTM is used to predict the transmission fluctuation based on infection-related multiple time series features. The mixed model combines transmission trends and fluctuations to predict infections accurately. The proposed method is evaluated on a dataset of highly pathogenic infectious disease transmission published by Baidu and compared with other advanced methods. The results show that the model has an excellent predictive effect and practical value for large-scale infectious disease prediction.

EPRO-DM-052

A deep multimodal fusion and multitasking trajectory prediction model for typhoon trajectory prediction to reduce flight scheduling

Natural events have had a significant impact on overall flight activity, and the aviation industry plays a vital role in helping society cope with the impact of these events. As one of the most impactful weather typhoon seasons appears and continues, airlines operating in threatened areas and passengers having travel plans during this time period will pay close attention to the development of tropical storms. This paper proposes a deep multimodal fusion and multitasking trajectory prediction model that can improve the reliability of typhoon trajectory prediction and reduce the quantity of flight scheduling cancellation. The deep multimodal fusion module is formed by deep fusion of the feature output by multiple submodal fusion modules, and the multitask generation module uses longitude and latitude as two related tasks for simultaneous prediction. With more dependable data accuracy, problems can be analysed rapidly and more efficiently, enabling better decision-making with a proactive versus reactive posture. When multiple modalities coexist, features can be extracted from them simultaneously to supplement each other's information.

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EPRO-DM-053

Achieving Multi-Time-Step Segment Routing via Traffic Prediction and Compressive Sensing Techniques

Traffic engineering (TE) is one of the most critical issues in networking, as it enables efficient and reliable network operations. With the advent of Machine Learning (ML) techniques, many ML-based TE methods have emerged in recent years, especially those employing Deep Neural Networks for future traffic prediction to enhance the performance of traditional approaches. However, current methods suffer from two major issues. Firstly, most prior works only solve the TE problem based on short-term traffic prediction, neglecting the network traffic dynamics over an extended time period. This oversight results in high network disturbance when numerous traffic flows need to be rerouted to adapt to traffic changes. Secondly, although traffic prediction models rely on historical traffic data to perform future prediction, ML-based TE studies often ignore the high overhead for network traffic monitoring. To address these issues, we propose a traffic prediction-based routing algorithm in which the routing rules can be applied to multiple time-steps without requiring changes, ultimately leading to reduced network disturbance. We employ the segment routing (SR) technique as the routing algorithm and formulate the multi-time-step segment routing method that incorporates future traffic prediction.

EPRO-DM-054

Long-Term Prediction of Sea Surface Temperature by Temporal Embedding Transformer With Attention Distilling and Partial Stacked Connection

Sea surface temperature (SST) is one of the most important parameters in the global ocean–atmosphere system, and its long-term changes will have a significant impact on global climate and ecosystems. Accurate prediction of SST, therefore, especially the improvement of long-term predictive skills is of great significance for fishery farming, marine ecological protection, and planning of maritime activities. Since the effective and precise description of the long-range dependence between input and output requires higher model prediction ability, it is an extremely challenging task to achieve accurate long-term prediction of SST. Inspired by the successful application of the transformer and its variants in natural language processing similar to time-series prediction, we introduce it to the SST prediction in the China Sea. The model Trans former with temporal embedding

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EPRO-DM-055

EMG-based Multi-User Hand Gesture Classification via Unsupervised Transfer Learning Using Unknown Calibration Gestures

The poor generalization performance and heavy training burden of the gesture classification model contribute as two main barriers that hinder the commercialization of sEMG-based human-machine interaction (HMI) systems. To overcome these challenges, eight unsupervised transfer learning (TL) algorithms developed on the basis of convolutional neural networks (CNNs) were explored and compared on a dataset consisting of 10 gestures from 35 subjects. The highest classification accuracy obtained by CORrelation Alignment (CORAL) reaches more than 90%, which is 10% higher than the methods without using TL. In addition, the proposed model outperforms 4 common traditional classifiers (KNN, LDA, SVM, and Random Forest) using the minimal calibration data (two repeated trials for each gesture). The results also demonstrate the model has a great transfer robustness/flexibility for cross-gesture and cross-day scenarios, with an accuracy of 87.94% achieved using calibration gestures that are different with model training, and an accuracy of 84.26% achieved using calibration data collected on a different day, respectively. As the outcomes confirm, the proposed CNN TL method provides a practical solution for freeing new users from the complicated acquisition paradigm in the calibration process before using sEMG-based HMI systems.

EPRO-DM-056

Indirect Estimation of Breathing Rate Using Wearable Devices

Wearable sensors can be exploited for the indirect estimation of physiological parameters, such as breathing rate (BR). Indeed, BR is a significative quantity for both general health status monitoring and diagnostic purposes; however, standard methods for its assessment are often uncomfortable and mainly used for punctual (or brief, anyway) measurements. This article aims to perform an uncertainty analysis of BR indirect estimation made starting from electrocardiographic signals gathered through wearable sensors, namely, a cardiac belt (Zephyr BioHarness 3.0) and a smartwatch (Samsung Galaxy Watch3). Three different estimation methods were employed, considering respiratory sinus arrhythmia (RSA), signal amplitude modulation (AM), and machine learning (ML)-based techniques. Finally, the Monte Carlo simulation method was exploited for the measurement uncertainty estimation, including both sensors (hardware) and algorithms (software) contributions in the measurement chain.

DATA MINING

EPRO-DM-057

Advances and Challenges in Meta-Learning: A Technical Review

Meta-learning empowers learning systems with the ability to acquire knowledge from multiple tasks, enabling faster adaptation and generalization to new tasks. This review provides a comprehensive technical overview of meta-learning, emphasizing its importance in real-world applications where data may be scarce or expensive to obtain. The article covers the state-of-the-art meta-learning approaches and explores the relationship between meta-learning and multi-task learning, transfer learning, domain adaptation and generalization, self-supervised learning, personalized federated learning, and continual learning. By highlighting the synergies between these topics and the field of meta-learning, the article demonstrates how advancements in one area can benefit the field as a whole, while avoiding unnecessary duplication of efforts. Additionally, the article delves into advanced meta-learning topics such as learning from complex multi-modal task distributions, unsupervised meta-learning, learning to efficiently adapt to data distribution shifts, and continual meta-learning. Lastly, the article highlights open problems and challenges for future research in the field. By synthesizing the latest research developments, this article provides a thorough understanding of meta-learning and its potential impact on various machine learning applications. We believe that this technical overview will contribute to the advancement of meta-learning and its practical implications in addressing real-world problems.

EPRO-DM-058

A Multi-Modal Classification Method for Early Diagnosis of Mild Cognitive Impairment and Alzheimer's Disease Using Three

Alzheimer's Disease (AD) accounts for the detection. Furthermore, we proposed a data augmentation method to enlarge the dataset, designed an extra ERPNet feature extract layer to extract multi-modal features and used domain-adversarial neural network to improve the performance of MCI diagnosis. We achieved an average accuracy of 88.81% for MCI diagnosis and 100% for AD diagnosis. The results of this paper suggest that our classification method can provide a feasible and affordable way to diagnose dementia majority of dementia, and Mild Cognitive Impairment (MCI) is the early stage of AD. Early and accurate diagnosis of dementia plays a vital role in more targeted treatments and effectively halting disease progression

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EPRO-DM-059

Digital Twinning of Cardiac Electrophysiology Models From the Surface ECG: A Geodesic Backpropagation Approach

The eikonal equation has become an indispensable tool for modeling cardiac electrical activation accurately and efficiently. In principle, by matching clinically recorded and eikonal-based electrocardiograms (ECGs), it is possible to build patient-specific models of cardiac electrophysiology in a purely non-invasive manner. Nonetheless, the fitting procedure remains a challenging task. The present study introduces a novel method, Geodesic-BP, to solve the inverse eikonal problem. Geodesic-BP is well-suited for GPU-accelerated machine learning frameworks, allowing us to optimize the parameters of the eikonal equation to reproduce a given ECG. We show that Geodesic-BP can reconstruct a simulated cardiac activation with high accuracy in a synthetic test case, even in the presence of modeling inaccuracies. Furthermore, we apply our algorithm to a publicly available dataset of a biventricular rabbit model, with promising results. Given the future shift towards personalized medicine, Geodesic-BP has the potential to help in future functionalizations of cardiac models meeting clinical time constraints while maintaining the physiological accuracy of state-of-the-art cardiac models.

EPRO-DM-060

Deep Learning for Radio Resource Allocation Under DoS Attack

In this paper, we focus on the problem of remote state estimation in wireless networked cyber-physical systems (CPS). Information from multiple sensors is transmitted to a central gateway over a wireless network with fewer channels than sensors. Channel and power allocation are performed jointly, in the presence of a denial of service (DoS) attack where one or more channels are jammed by an attacker transmitting spurious signals. The attack policy is unknown and the central gateway has the objective of minimizing state estimation error with maximum energy efficiency. The problem involves a combination of discrete and continuous action spaces. In addition, the state and action spaces have high dimensionality, and the channel states are not fully known to the defender. We propose an innovative model-free deep reinforcement learning (DRL) algorithm to address the problem. In addition, we develop a deep learning-based method with a novel deep neural network (DNN) structure for detecting changes in the attack policy post-training.

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EPRO-DM-061

Incremental Adversarial Learning for Polymorphic Attack Detection

AI-based Network Intrusion Detection Systems (NIDS) provide effective mechanisms for cybersecurity analysts to gain insights and thwart several network attacks. Although current IDS can identify known/typical attacks with high accuracy, current research shows that such systems perform poorly when facing atypical and dynamically changing (polymorphic) attacks. In this paper, we focus on improving detection capability of the IDS for atypical and polymorphic network attacks. Our system generates adversarial polymorphic attacks against the IDS to examine its performance and incrementally retrains it to strengthen its detection of new attacks, specifically for minority attack samples in the input data. The employed attack quality analysis ensures that the adversarial atypical/polymorphic attacks generated through our system resemble original network attacks. We showcase the high performance of the IDS that we have proposed by training it using the CICIDS2017 and CICIoT2023 benchmark datasets and evaluating its performance against several atypical/polymorphic attack flows. The results indicate that the proposed technique, through adaptive training, learns the pattern of dynamically changing atypical/polymorphic attacks, identifies such attacks with approximately 90% balanced accuracy for most of the cases, and surpasses various state-of-the-art detection and class balancing techniques.

EPRO-DM-062

Towards Real-time Network Intrusion Detection with Image-based Sequential Packets Representation

Machine learning (ML) and deep learning (DL) advancements have greatly enhanced anomaly detection of network intrusion detection systems (NIDS) by empowering them to analyze big data and extract patterns. ML/DL-based NIDS are trained using either flow-based or packet-based features. Flow-based NIDS are suitable for offline traffic analysis, while packet-based NIDS can analyze traffic and detect attacks in real-time. Current packet-based approaches analyze packets independently, overlooking the sequential nature of network communication. This results in biased models that exhibit increased false negatives and positives. Additionally, most literature-proposed packet-based NIDS capture only payload data, neglecting crucial information from packet headers. This oversight can impair the ability to identify header-level attacks, such as denial-of-service attacks.

DATA MINING

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EPRO-DM-063

Otago Exercises Monitoring for Older Adults by a Single IMU and Hierarchical Machine Learning Models

Otago Exercise Program (OEP) is a rehabilitation program for older adults to improve frailty, sarcopenia, and balance. Accurate monitoring of patient involvement in OEP is challenging, as self-reports (diaries) are often unreliable. The development of wearable sensors and their use in Human Activity Recognition (HAR) systems has lead to a revolution in healthcare. However, the use of such HAR systems for OEP still shows limited performance. The objective of this study is to build an unobtrusive and accurate system to monitor OEP for older adults. Data was collected from 18 older adults wearing a single waist-mounted Inertial Measurement Unit (IMU). Two datasets were recorded, one in a laboratory setting, and one at the homes of the patients. A hierarchical system is proposed with two stages: 1) using a deep learning model to recognize whether the patients are performing OEP or activities of daily life (ADLs) using a 10-minute sliding window; 2) based on stage 1, using a 6-second sliding window to recognize the OEP sub-classes. Results showed that in stage 1, OEP could be recognized with window-wise f1-scores over 0.95 and Intersection-over-Union (IoU) f1-scores over 0.85 for both datasets. In stage 2, for the home scenario, four activities could be recognized with f1-scores over 0.8: ankle plantarflexors, abdominal muscles, knee bends, and sit-to-stand.

EPRO-DM-064

Efficient Frequent Chronicle Mining Algorithms: Application to Sleep Disorder

Sequential pattern mining is a dynamic and thriving research field that aims to extract recurring sequences of events from complex datasets. Traditionally, focusing solely on the order of events often falls short of providing precise insights. Consequently, incorporating the temporal intervals between events has emerged as a vital necessity across various domains, e.g. medicine. Analyzing temporal event sequences within patients' clinical histories, drug prescriptions, and monitoring alarms exemplifies this critical need. This paper presents innovative and efficient methodologies for mining frequent chronicles from temporal data. The mined graphs offer a significantly more expressive representation than mere event sequences, capturing intricate details of a series of events in a factual manner. The experimental stage includes a series of analyses of diverse databases with distinct characteristics. The proposed approaches were also applied to real-world data comprising information about subjects suffering from sleep disorders. Alluring frequent complete event graphs were obtained on patients who were under the effect of sleep medication.

DATA MINING

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EPRO-DM-065

Flood Inundation Extraction and its Impact on Ground Subsidence Using Sentinel-1 Data: A Case Study of the "7.20" Rainstorm Event in Henan Province, China

On July 20, 2021, the northern Henan Province was hit by a historically rare, exceptionally heavy rainstorm ("7.20" Rainstorm Event), accompanied by severe urban flooding, flash floods, landslides, and other multiple disasters, resulting in significant casualties and property losses. On the other hand, the long-term overexploitation of groundwater since the last century has led to severe ground subsidence in the same area. We apply the intensity information of Sentinel-1 SAR images to extract the large-scale flood inundation area and their phase information to measure the ground deformation. Since heavy precipitations can recharge groundwater, the relationship between flood inundation, groundwater level change, and ground deformation is analyzed. The results show that the flood inundation areas are mainly distributed along the major rivers due to river overflowing, while heavy precipitation led to the rise of groundwater levels, and there was a significant amount of subsidence mitigation and surface uplift across the region due to the groundwater recovery. This study demonstrates the contribution of radar remote sensing to analyze the mechanism of groundwater recharge and subsidence mitigation benefited by rainstorm events and provides a technical reference to similar circumstances.

EPRO-DM-066

Sea Surface Signal Extraction for Photon-Counting LiDAR Data: A General Method by Dual-Signal Unmixing Parameters

The ice, cloud, and land elevation satellite-2 (ICESat-2) is the only satellite that produces photon-counting light detection and ranging data, and is equipped with the advanced topographic laser altimeter system. ICESat-2 provides sea surface height product; however, its approach of the product is unsuitable for areas with sub-surface signals. Conventional denoising methods applied to sea surface photon data of variable density involve the use of different empirical parameters. Considering the distribution of sea surface signal photons, we propose a general open-source method using a dual-signal unmixing parameter (DSUMP), which incorporates the Gaussian distribution of dual-signal peaks to determine the sea surface range. This method facilitates the direct extraction of sea surface photons under various observation conditions—day or night, strong or weak beams, and including or excluding seabed photons—without requiring any variable parameters. The elevation error by DSUMP within 0.1m accounts for more than 97%. The mean absolute error is within 0.01 m compared to sea surface photons obtained via manual extraction.

DATA MINING

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EPRO-DM-067

Enhancing Telemarketing Success Using Ensemble-Based Online Machine Learning

Telemarketing is a well-established marketing approach to offering products and services to prospective customers. The effectiveness of such an approach, however, is highly dependent on the selection of the appropriate consumer base, as reaching uninterested customers will induce annoyance and consume costly enterprise resources in vain while missing interested ones. The introduction of business intelligence and machine learning models can positively influence the decision-making process by predicting the potential customer base, and the existing literature in this direction shows promising results. However, the selection of influential features and the construction of effective learning models for improved performance remain a challenge. Furthermore, from the modelling perspective, the class imbalance nature of the training data, where samples with unsuccessful outcomes highly outnumber successful ones, further compounds the problem by creating biased and inaccurate models. Additionally, customer preferences are likely to change over time due to various reasons, and/or a fresh group of customers may be targeted for a new product or service, necessitating model retraining which is not addressed at all in existing works.

EPRO-DM-068

MAST: An Earthquake-Triggered Landslides Extraction Method Combining Morphological Analysis Edge Recognition With Swin-Transformer Deep Learning Model

Earthquake-triggered landslides (ETLs) are characterized by their extensive occurrences, having wide distributions. The conventional human–computer interaction extraction method is often time-consuming and labor-intensive, failing to meet the demands of disaster emergency response. There is a pressing need for a swift detection of ETLs. In this study, we introduce an ETLs extraction method (MAST) combining morphological analysis edge recognition with a Swin-Transformer (SWT) deep learning model, which is specifically designed for landslide extraction. The MAST model adopts a hierarchical construction approach akin to convolution neural networks, aiding in tasks such as target detection and semantic segmentation. To enhance the accuracy of landslide edge extraction, we incorporate an edge recognition algorithm based on the morphological analysis into the MAST model.

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