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Comparative Study Between Advanced Machine Learning and Deep Learning Approaches combined in an Advanced Hybrid Framework for Estimating Thermal Hydraulic Performance in Heat Exchangers

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Paper Type: Abstract

Abstract – The thermal-hydraulic performance parameters in the heat exchangers are important for energy-efficient design and operation. This research presents a new hybrid framework that combines advanced machine learning (ML) and deep learning (DL) techniques to predict Nusselt number (Nu), friction factor (f), and performance (P) from advanced heat exchanger parameters. The dataset comprises five diverse scenarios, specified for the Reynolds number Re and the basic parameters of the exchanger plate geometry (radii a, b, and hyperbolic tangent function). This study employs ML models like Gradient Boosting Machines (GBM), Extreme Gradient Boosting (XGBoost), and Support Vector Regression (SVR); and it utilizes DL models viz. Long Short-Term Memory (LSTM) and Transformer Architecture, unlike most studies. A comparison of Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), coefficient of determination (R^2) of models is done for their accuracy measurement. The results show that Transformer model (RMSE values of 0.032 for Nu, 0.0048 for f, and 0.51 for P) is better than traditional ML methods (RMSE values of 0.45 for Nu, 0.065 for f, and 0.98 for P) at capturing complex nonlinear relationships. Results provide valuable recommendations for the selection of models to predict heat exchanger performance parameters for improved efficiency and design.

Keywords – Advanced Plate Heat Exchanger, Prediction, Machine Learning, Deep Learning.

Hybrid Chaotic Attention Mechanism for 2D Image Classification in Noisy Environments

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Paper Type: Abstract

Abstract **–**In this study, the hybrid Chaotic Attention Mechanism (HCAM), a new method peoposed to increase the robustness of convolutional neural networks (CNNs) for 2D image classification in noisy environment. The main idea of this method is to integrate low dimensional chaotic maps into CNNs' layers, that include logistic and tent maps. By adjusting weights during training dynamically, these maps help the model to focus more on key image regions while filtering out unnecessary or noisy features. HCAM uses the adaptive and deterministic unpredictability of chaos, which offer a way to enhance feature selection and improve performance, and this is making it unlike the traditional methods. This design improves generalization and classification accuracy, especially in challenging environments such as image noise or occlusion, according to the results in the initial tests. Future work will include full implementation and evaluation using datasets like CIFAR-10 and Fashion-MNIST. This method could lead to new inspired regularization models for deep learning.

Keywords – Chaotic maps, convolutional neural networks, image classification, noise robustness, dynamic regularization

Quantum ARQ Protocols for Ultra Reliable Low Latency Communications

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Paper Type: Abstract

Abstract – Methods that develop error control are required in order to meet the growing needs for Ultra Reliable Low Latency Communication (URLLC) in the next generation of wireless networks. An Automatic Repeat reQuest (ARQ) model is suggested in this study. It makes use of the quantum error correction ideas like entanglement and superposition. It provides a new method for dealing with retransmission and redundancy processes that are essential to conventional communication networks. Redundancy is used by means of multipath entangled packet encoding and scheduling superposition based retransmission in order to enhance reliability while simultaneously lowering latency in the suggested method. The main difference between this model and the earlier ones is that it uses quantum logic to add statistical redundancy without actually using real quantum infrastructure for retransmission. The system is completely developed in a traditional setting, and it will serve as a model for future implementations that are made to meet URLLC's strict standards for stability. This research uses ideas from quantum communication theory in a new way to address the performance needs of important communication system, which introduces an original method to the protocol design of ARQ.

Keywords – Quantum Communication, Automatic Repeat reQuest, URLLC, Quantum Error Correction, Superposition, Entanglement, Low Latency Protocols

Log-Based Malware Detection: A Smart Dynamic Security Mechanism via Machine Learning

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Paper Type: Abstract

Abstract –Windows Event Logs hold remarkable and underutilized potential for malware detection in today's rapidly evolving threat landscape. This study demonstrates their value by introducing a dynamic, smart security mechanism built to identify and classify malicious software with high fidelity across diverse computing environments. By executing both benign and harmful applications in isolated sandbox settings, we systematically capture and analyze granular event logs, exposing critical behavioral markers of illicit activity. Using a suite of advanced machine learning algorithms; including gradient boosting, random forest, neural networks and simple deep learning techniques. On thousands of labeled samples, we extract, engineer, and correlate key log-based indicators that reliably separate malware from normal processes. During training, feature engineering and selection further enhance classification robustness, leading to detection accuracies surpassing 95%. Additionally, environment-specific log attributes influence classifier performance, underscoring the need for multi-scenario experimentation to counter sophisticated evasion methods. By centering the detection pipeline on Windows Event Logs, we significantly enhance real-time threat identification, offering a scalable, smart dynamic security framework for enterprise and personal systems. These outcomes further emphasize proactive event monitoring as a strategic approach to harness the full potential of Windows Event Logs for mitigating emerging zero-day vulnerabilities.

Keywords – Windows Event Logs, malware detection, dynamic smart security, sandbox environments, machine learning

Prediction of Wind Speed Using Tree-Based Ensemble Algorithms: CatBoost, HistGBM, and XGBoost

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Paper Type: Abstract

Abstract – In this study, three advanced tree-based machine learning models (XGBoost, HistGradientBoosting (HistGBM), and CatBoost) are compared for predicting wind speed (V (m/s)) in an urban area. A dataset covering four years is used to train the models, and their performance is evaluated, especially on the test data. The root mean square error (RMSE), mean absolute percentage error (MAPE), coefficient of determination (R^2), and P-value are used to evaluate the model's performance. XGBoost is the best amongst all the models with respect to RMSE, MAPE, and R^2 values, which are measured at 0.0416, 0.0089, and 0.9993, respectively. Next, we can have the second best as CatBoost with very successful results, having RMSE of 0.0843 and an R^2 value of 0.9972. The third model, with an RMSE of 0.1174, has an R^2 value of 0.9946. When the p-values are considered, then all estimates of the models is found to be statistically significant. The results indicate that the ensemble type modeling algorithms have very active performance for the time-series problems like estimations of V (m/s). Hence, the XGBoost method is found to be the most efficient and trustworthy for the V (m/s) estimation applications.

Keywords – Wind Speed Prediction, Tree-Based Ensemble Learning, XGBoost, CatBoost, Time Series Forecasting

Signal Verification with Multi Modal Language Model

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Paper Type: Abstract

Abstract – Immediate recognition of potential threats and rapid response to these threats are of critical importance in ensuring the safety of life and property. In this study, an Artificial Intelligence (AI) system has been presented for real-time threat detection in security camera feeds and aimed to increase situational awareness and response times in security monitoring by focusing on the identification of objects such as weapons and masks to alert users. The proposed approach uses a scalable microservices architecture based on FastAPI, Redis, Celery that supports efficient parallel processing. The core analysis is based on multi-modal InternVL2-8B model running on Nvidia 3090 GPU, triggered by motion detection events. The encrypted images have been processed within the targeted response time of less than 5 seconds. The experimental analysis performed using 15 images and 4 different prompts with a blind evaluation method revealed that prompt engineering has a decisive impact on performance; the best-performing prompt achieved 80% success rate versus 46.7% compared to the one with the lowest. These evaluations show that the integration of AI models such as InternVL2 with microservices framework provides an effective security solution; however, it shows that performance is dependent on prompts quality that are tailored to specific tasks.

Keywords –Real Time Threat Detection, Microservice Architecture, InternVL2-8B, Prompt Engineering, Computer Vision

Real Estate Price Estimation with AI: A Hybrid Approach Combining Clustering and Machine Learning

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Paper Type: Abstract

Abstract – Accurate price prediction in the real estate market is important for buyers, sellers, and investors. This study evaluates the performance of various machine learning models including AdaBoost, Gradient Boosting, k-Nearest Neighbors (kNN), Artificial Neural Networks, and Support Vector Machines (SVM) to predict house prices in Gaziantep, Turkey. Parameters such as number of rooms, square meters, building age, floor level, and neighborhood are taken as datasets from a real estate website. A hybrid study is conducted to improve the model performance by clustering analysis using the Simple K-Means algorithm in WEKA application and categorizing the data into groups according to the parameters. The clustered data served as input for Orange 3. Model performance is evaluated using metrics such as Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and R^2. The results show that AdaBoost consistently achieves the highest accuracy and reliability, followed by Gradient Boosting, which demonstrates strong generalization capabilities. While kNN provided moderate performance, Neural Networks and SVM performed poorly, showing high error measures and poor adaptability.

Keywords – House Price Prediction, Machine Learning, AdaBoost, Gradient Boosting, Clustering, Orange 3, Real Estate Analytics, Predictive Modeling

Ensemble Learning for Predicting AI Content Domination in Global Digital Media Sectors (2020–2025)

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Paper Type: Abstract

Abstract – The rapid advancement of artificial intelligence (AI) technology since 2020 has significantly transformed the global digital media landscape, where AI-generated content—such as text, images, and videos—is increasingly dominating various platforms, including digital advertising, news portals, entertainment, and social media. This trend has created an urgent need to understand and accurately predict the extent of AI content domination to support strategic decision-making in the media industry and inform public policy development. This study aims to develop a predictive model using an ensemble learning approach to identify patterns and projections of AI content domination across global digital media sectors from 2020 to 2025. The methodology integrates multiple machine learning algorithms, including Random Forest, Gradient Boosting, and Voting Classifier, trained on historical datasets consisting of AI adoption statistics, media consumption trends, and user behavior across different regions and sectors. Data preprocessing involves cleaning, normalization, feature selection based on correlation analysis, and time-series modeling using ensemble stacking techniques to enhance model generalization. Model performance is evaluated using a confusion matrix with four key metrics: accuracy, precision, recall, and F1-score, to ensure comprehensive and practical classification performance. The expected outcome of this research is the development of a robust and adaptive predictive model capable of projecting AI content dominance across diverse media sectors and geographical areas. These findings are anticipated to serve as a strategic foundation for media industry stakeholders, regulators, academics, and policymakers in responding to the evolving digital media ecosystem increasingly shaped by AI technologies.

Keywords –AI Content, Ensemble Learning, Predictive Modeling, Machine Learning, Media Domination

Face Mesh Özelliklerine Dayalı Derin Öğrenme ile Dikkat-DuyguYorgunluk Tespiti

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Paper Type: Abstract

Özet – Bu çalışma, bireylerin anlık dikkat düzeyi, duygu durumu ve yorgunluk seviyesini entegre bir şekilde analiz eden yapay zeka tabanlı bir sistem geliştirmeyi amaçlamaktadır. Python diliyle geliştirilen sistemde, yüz ifadeleri ve göz hareketleri MediaPipe, DeepFace ve OpenCV gibi kütüphanelerle analiz edilerek; yorgunluk, dikkat ve duygu durumuna dair ölçümler elde edilmiştir. Kullanıcı dostu bir arayüz PyQt5 ile tasarlanmış, böylelikle tüm analizlerin arka planda gerçek zamanlı olarak gerçekleştirilmesi sağlanmıştır.

Yorgunluk tespiti için EAR(Eye Aspect Ratio), MAR (Mouth Aspect Ratio), MOE (Mouth Opening Extent), PERCLOS (Percentage of Eye Closure) ve Blink Rate (göz kırpma oranı) gibi metrikler, LSTM tabanlı bir modelle analiz edilmiştir. Dikkat seviyesi, dijitalleştirilmiş D2 Dikkat Testi üzerinden göz takibiyle ölçülmüş ve geleneksel testle yüksek korelasyon göstermiştir. Böylelikle literatürde yaygın olarak kullanılan D2 Dikkat Testi'nin göz takip teknolojileriyle dijital ortama aktarılmasının mümkün olduğu gösterilmiştir. Bu yönüyle, dikkat testlerinin dijitalleşmesine öncülük eden ilk uygulamalardan biri olma özelliği taşımaktadır. Duygu analizi ise CNN ve K-Means kümeleme yöntemleriyle gerçekleştirilmiş, ve duygu sınıfının yanında duygu yoğunluğunun da belirlenebilmesi sağlanmıştır.

Gerçekleştirilen deneylerde sistemin yorgunluk tespitinde %94, duygu analizinde %88 doğruluk oranı yakaladığı ve dikkat ölçümünde güvenilir sonuçlar verdiği görülmüştür. Çalışma, geleneksel tek yönlü analizlerin ötesine geçerek, entegre ve gerçek zamanlı bir analiz imkanı sunmakta ve dikkat testlerinin otomasyonu konusunda literatüre katkı sağlamaktadır.

Anahtar Kelimeler – Yorgunluk Tespiti, Duygu Analizi, Otomatik Dikkat Ölçümü, Python, Derin Öğrenme, Bilgisayarlı Görü

Innovative Approaches to Formative Assessment Processes of Primary School Students with Artificial Intelligence

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Paper Type: Abstract

Abstract – One of the most striking aspects of the rapidly advancing digital transformation is undoubtedly artificial intelligence (AI) technologies. As AI becomes increasingly integrated into education, just as it has in many other domains, it brings about a reconfiguration of learning processes. Recognising the needs of learners born into the digital age and aligning educational practices accordingly is considered essential. Within this context, the present study aims to examine the impact of AI-supported formative assessment practices on the writing skills of year 4 primary school students. A convergent mixed-methods design was adopted, combining a quasi-experimental approach for quantitative data with a case study for the qualitative component. The study was conducted during the first term of the 2024–2025 academic year, involving 40 students enrolled in a state primary school in the Marmara Region of Türkiye.

In this study, students in the experimental group (n=20) received AI-supported formative feedback over a period of nine weeks, while those in the control group (n=20) received teacher feedback through conventional methods. Quantitative data were gathered using a Personal Information Form and Activity Evaluation Forms, which were used to assess spelling and punctuation errors. Qualitative data were collected through semi-structured interviews with the teacher who implemented the intervention and five participating students.

The findings indicate that the quantitative and qualitative results were complementary. Quantitative data revealed a statistically significant improvement in both groups in terms of spelling and punctuation accuracy, a result that was echoed in the qualitative theme of "awareness of writing conventions". Furthermore, students who actively engaged with AI tools made fewer errors and demonstrated higher performance. This finding was also reflected in the qualitative theme of "interaction with AI". Additional themes emerging from the qualitative data included "instructional ease and efficiency" and "learning attitudes and motivation". Moreover, the quantitative results showed that female students made fewer spelling and punctuation errors than their male counterparts. Overall, the findings suggest that AI-supported formative assessment may serve as an effective approach to improving students writing skills, particularly through its capacity to deliver individualised feedback and contribute to stronger academic outcomes.

Keywords – Artificial intelligence, Formative assessment, Technology integration, Writing skill, Primary school student

Akıllı Kent Bileşenlerinin Analitik Hiyerarşi Süreci İle Değerlendirilmesi

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Paper Type: Abstract

Özet **–** Kentler, sanayi devrimi sonrası istihdam olanaklarıyla zamanla cazibe merkezlerine dönüşmüştür. Ancak büyüyen kentlerle birlikte ekonomi, ulaşım, çevre, konut ve yönetişim gibi alanlarda yeni sorunlar ortaya çıkmıştır. Bu bağlamda akıllı kent; yenilikçi çözümler yaratma, bilgi ve iletişim teknolojilerini etkin kullanma becerisiyle tanımlanmaktadır. Literatürde yaygın kabul gören Giffinger modeline göre akıllı kentler altı temel bileşenden oluşmaktadır. Bu çalışmanın amacı, söz konusu bileşenlerin uzman görüşlerine dayalı olarak göreli önem derecelerinin belirlenmesi ve akıllı şehir planlamalarında hangi bileşenlerin öncelikli olması gerektiğine yönelik karar vericilere destek sağlamaktır. Araştırma kapsamında literatürde genel kabul gören altı akıllı kent bileşeni ile ilgili, farklı meslek gruplarından uzman görüşleri toplanmıştır. Elde edilen verilere AHP (Analitik Hiyerarşi Süreci) yöntemi uygulanmış; böylece akıllı şehir bileşenlerinin göreli önem düzeyleri hesaplanmıştır. Uzman görüşlerine dayanılarak gerçekleştirilen AHP metotuna göre, akıllı ulaşım %40,8 oranla göreli en yüksek öneme sahip akıllı kent bileşeni olmaktadır. Kalan beş bileşen sırası ile; akıllı insan , akıllı yaşam, akıllı yönetişim , akıllı ekonomi ve akıllı çevre olarak ölçülmüştür. Ortaya çıkan sonuçlar, akıllı kent inşasında önceliklerin saptanması ve bilimsel verilere göre planlanması açısından karar mercilerine yol gösterecektir. Yapılan bu çalışma, akıllı kenti oluşturan bileşenlerin hiyerarşik olarak saptanması bakımından bütüncül ve sistemli bir yaklaşım ortaya koyarak literatüre katkı sunmaktadır.

Anahtar Kelimeler – Analitik Hiyerarşi Süreci, Kent, Akıllı Kent, Akıllı Kent Bileşenleri Akıllı Sistemler