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Faculté des Mathématiques et de l'Informatique

LI@M
Laboratory of Informatics and its Applications of M'sila

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THE 2ND INTERNATIONAL WORKSHOP ON
MACHINE LEARNING AND DEEP LEARNING

WMLDL
2025

# ABSTRACT BOOK

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## About WMLDL'25

The 2nd International Workshop on Machine Learning and Deep Learning (WMLDL 2025) is organized by the Laboratory of Informatics and its Applications of M'sila (LIAM), Faculty of Mathematics and Computer Science, and the Artificial Intelligence House of the University Mohamed Boudiaf of M'sila on November 25, 2025, in M'sila, Algeria. After its first edition organized in 2023, WMLDL continues to be a scientific event that provides an excellent international forum for sharing knowledge and results in theory, methodology and applications of Machine Learning and Deep Learning. The Workshop seeks significant contributions to all major fields of both Machine Learning and Deep Learning encompassing both theoretical and practical aspects. The workshop aims to provide a platform for senior researchers, research scholars, and practitioners from both academia and industry to meet and share their research results and experiences on all topics within the ML and DL fields.

Topics of the Workshop include, but are not limited to:

- Fundamentals of Machine Learning and Deep Learning
- Machine Learning Algorithms, Models, and Systems
- Machine Learning Platforms, Technology, and Tools
- Artificial Neural Networks, Architectures and Models
- Machine Learning and Deep Learning Environments (Python, Tensorflow, Keras…)
- Machine Learning and deep learning Applications

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# Cross-Dataset Evaluation of Feature-Based and Deep Learning Models for Crowd Anomaly Detection

*Nesrine Rachedi [*1], Kamel Eddine Heraguemi [2], Ikram Senoussaoui [3] and Toufik Azib [3]*

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## Abstract

Anomaly detection in crowds is a critical task for public safety in smart cities. In this paper, we conduct a comparative study of traditional and Deep Learning (DL)-based methods for crowd anomaly detection, focusing on heterogeneous, multi-sensor datasets. We evaluate Gaussian Mixture Models (GMM), Histogram of Oriented Gradients (HOG) + Support Vector Machine (SVM), simple Convolutional Neural Network (CNN), ResNet50, Autoencoder (AE), and Vision Transformer (ViT) across the UCSD Ped1 dataset and the recent Multi-Scenario Anomaly Detection (MSAD) dataset that integrates multiple sensors, highlighting the challenges and opportunities of heterogeneous data. In addition, we investigate the impact of I3D feature extraction, comparing model performance with and without I3D features on the UCSD Ped1 dataset. DL models, particularly ResNet50, consistently outperform traditional techniques, achieving up to 98% accuracy. Beyond providing a benchmark, this study explores how to leverage the diversity of data sources, demonstrating the potential of multi-modal and multi-sensor approaches and motivating further research into integrating temporal and cross-modal information.

**Keywords:** Crowd anomaly detection, CNN, Transformers, traditional techniques, MSAD, UCSD Ped1, Cross-Dataset.

# A Graph-Based Hybrid Clustering Approach for Detecting Complex Structures

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## Abstract

Clustering is essential for identifying patterns in data by grouping similar points. However, many advanced algorithms face challenges when dealing with clusters of varying shapes and sizes. In this paper, we propose a KNN-FN hybrid algorithm combines the strengths of K-Nearest Neighbors (KNN) and the Fast Newman (FN) community detection algorithm to enhance clustering performance. KNN is used to construct a graph that captures local neighborhood structures by connecting each data point to its nearest neighbors, while the FN algorithm applies modularity maximization to detect well-defined clusters within the graph. This hybrid approach improves clustering, particularly in complex datasets with irregular shapes and varying densities, The KNN-FN hybrid algorithm efficiently detects clusters in large-scale data, making it suitable for real-world applications.

**Keywords:** Clustering, Hybrid, K-nearest neighbor, Fast Newman.

# Behavior-Aware Learning Style Classification Using Multilayer Neural Architectures

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## Abstract

Learning style modeling plays a critical role in the development of intelligent tutoring systems and adaptive educational platforms. This paper presents a supervised deep learning approach to automatically predict students' learning styles, based on the VARK model (Visual, Auditory, Reading/Writing, Kinesthetic), using implicit behavioral data collected from an open e-learning environment. The proposed model is a Multilayer Perceptron (MLP) architecture trained on interaction logs extracted from the Open University Learning Analytics Dataset (OULAD). Key features include modality-specific engagement metrics, interaction frequency, activity distribution over time, and participation in different resource types. By eliminating the need for self-reported questionnaires, the model offers a scalable and non-intrusive alternative for learner profiling. Experimental results show high classification performance, with 95% accuracy, a macro-averaged AUC-ROC of 0.97, and an average F1-score exceeding 0.90 across all VARK categories. These results confirm the model's capacity to capture cognitive preferences from real usage patterns. The study also introduces a behavioral satisfaction metric (Style Utility Score), further validating the alignment between predicted styles and learners' engagement behaviors. This research contributes to advancing data-driven personalization in education, offering a robust framework for real-time, adaptive learner modeling through deep neural architectures.

**Keywords:** VARK model, e-learning systems, adaptive learning, deep learning, learning style prediction.

# Automatic Speech Recognition for the Amazigh Language Using Whisper

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## Abstract

This paper evaluates the feasibility of adapting large multilingual speech recognition models for low-resource languages, focusing on the Amazigh language. The primary research objective is to establish a performance baseline and identify key challenges when fine-tuning OpenAI's Whisper model on a newly compiled Amazigh language corpus. A dataset of 100,000 audio recordings, primarily covering Kabyle dialects, was collected, preprocessed, and used for fine-tuning the Whisper model. The system achieved a Word Error Rate (WER) of 10%. This result, while high, demonstrates the viability of the approach while highlighting the significant difficulties posed by Amazigh's rich morphology, dialectal diversity, and data scarcity. We present our methodology, error analysis results, and avenues for future performance improvement, including data augmentation and the integration of domain-specific language models.

**Keywords:** Amazigh, Kabyle, Whisper, Automatic Speech Recognition, WER, Low-resource language.

# Machine Learning for Drug Discovery: A Case Study on Classifying Ligand Activity for the 5-HT$_2$C Receptor

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## Abstract

We built a machine learning pipeline to forecast small molecules as active or inactive against a specific drug target from experimental bioactivity data. The ligands were downloaded from the Binding DB database with reported IC$_{50}$ values and labeled according to the levels of potency. Each molecule was projected as a Morgan fingerprint from the SMILES string, and seven supervised models—Logistic Regression, Random Forest, Gradient Boosting, Support Vector Machines, Decision Tree, K-Nearest Neighbors, and Naive Bayes—were trained for binary classification tasks. Model performances were evaluated in terms of accuracy, precision, recall, F1-score, ROC-AUC curves, and confusion matrices. Support Vector Machine achieved the best overall performance, with an accuracy of 85.4%, precision of 88.3%, recall of 94.3%, and an F1-score of 91.2%. The target studied was the 5-hydroxytryptamine receptor 2C (5-HT$_2$C), a G protein-coupled receptor for which there has been reported central mood, appetite, and neurological disorder association. Our results indicate that classical ML algorithms are a lightweight and interpretable alternative to deep learning as an early-stage virtual screening approach in drug discovery.

**Keywords:** 5-HT2C receptor, drug discovery, machine learning, Binding DB, Classification.

# Facial Emotion Recognition Using Deep Learning Approach

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## Abstract

This study attempted the classification of facial emotions into seven categories with a deep learning approach using Convolutional Neural Networks: The classification task is performed on facial expressions with the Extended Cohn-Kanade (CK+) dataset. The Preprocessing of the images incorporated grayscale conversion, resizing, and image data augmentation. The proposed model has been attested to perform with significant accuracy both during training and testing. An interface featuring a simple application design was also created to allow testing both in real-time and on static images. Future work will focus on recognizing under hard circumstances, arising from multimodality.

**Keywords**: Facial Emotion Recognition, Deep Learning, CNN, CK+ Dataset, Human-Computer Interaction.

# Speech Emotion Recognition Using Deep Learning Models

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## Abstract

This paper concerns the SER system using deep learning to classify emotions from vocalizations. We designed and implemented a CNN trained by a hybrid dataset combining RAVDESS, SAVEE, CASIA and IEMOCAP. In essence, MFCCs were extracted to capture salient audio features, and the data were further augmented with noise injections, pitch shifts, and time-stretching. The model could classify seven emotions, namely anger, disgust, fear, happiness, sadness, surprise, and neutral, with a classification accuracy of over 96%. The results thus prove CNN-based models to be effective for addressing the complexity and variation of human emotional expressions in speech.

**Keywords:** Speech Emotion Recognition, Deep Learning, CNN, MFCC, Data Augmentation, Audio Classification.

# Enhanced Virtual Trial Rooms for Excellent E-Shopping Experience

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## Abstract

EnVTR (Enhanced Virtual Trial Room) initiates a Clothes Trial Room as a service framework to enhance the online shopping (E-shopping) environment. The framework enables the seamless fitting of clothes into the virtual Trial room, according to the 3D model's Body Measurements. Customers can vigorously engage in trying different clothes and get to know how it will look on them. What size would fit them best? It gives the diligent experience that enhances and upgrades the E-Shopping Experience by trying a variety of clothes within this integrated platform. This system also offers styling suggestions with the help of AI according to the clothes, as well as permits tried clothes links, which is a faster way to buy clothes. Through this innovative approach, customers have a real-time experience of trying clothes, from home, knowing the perfect standard size they fit into, and also get fashion and styling-related pieces of advice from AI, which can enhance their Online shopping experience. The project emphasizes the potential of virtual Trial Rooms to bridge the gap between online shopping and real-world product interaction by enabling customers to visualize and try products virtually and know the standard fit size before purchasing in a dynamic Online Shopping Industry.

**Keywords:** Virtual Trial Room, Augmented Reality (AR), Artificial Intelligence (AI), Pose Estimation, Homograph Transformation, 3D Garment Simulation, Deep Learning, Size Prediction, Real-Time try-on.

# Bridging Tradition and Technology: A Dual-Model Architecture for Automated Recognition of Tulunadu's Cultural Scenes and Artifacts

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## Abstract

Tulunadu, a culturally rich coastal region of Karnataka, India, is celebrated for its dynamic intangible heritage. This includes traditional performing arts and ritualistic practices like Yakshagana, Bhootha Aradhane, Pilivesha, and Nagamandala. A major hurdle in documenting, digitally preserving, and academically studying these ancient traditions is their fundamental characteristics: they are orally transmitted and inherently temporary. Our research presents a novel AI framework that combines two prominent deep learning architectures to address the complexities of analyzing cultural images. The framework utilizes MobileNetV2, a lightweight convolutional neural network, for the automatic classification of cultural practices from visual data. The YOLOv8 architecture is utilized for the precise detection and spatial localization of traditional artifacts and costume components. Our methodology is built on a custom, meticulously annotated dataset of 7,122 hand-collected images. This dataset covers five classes—the four main cultural forms of Tulunadu plus a general "Other" category—and includes detailed annotations for classification, with a subset of images also specifically annotated for object detection. Our experimental findings showcase impressive performance. The MobileNetV2 model achieved a classification accuracy of over 96.58%, demonstrating its ability to accurately differentiate various cultural practices. Concurrently, YOLOv8 exhibited strong object detection capabilities with a mean Average Precision (mAP) at an intersection over union (IoU) threshold of 0.5 reaching 89.04%. This model precisely identified specific artifacts such as the Bannada Kirita, Bhuja Keerthi, Paara, Ani, Bolli Mudi, Dakka, Pingara, and Pili da Moga. The combined framework offers a scalable, automated solution for preserving cultural heritage, with the entire pipeline achieving an 80.70% success rate. This supports digital preservation and academic research while maintaining the integrity of Tulunadu's traditions.

**Keywords:** MobileNetV2, YOLOv8, Tulunadu culture, cultural heritage, deep learning, object detection, intangible heritage.

# Automated Skin Disease Detection Using DenseNet Deep Learning Architecture

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## Abstract

Skin disorders are among the most prevalent health issues globally, occurring in millions of individuals of all ages. Timely detection and precise diagnosis are important to avoid complications and enhance patient outcomes. Conventional clinical diagnosis tends to depend upon dermatologists' specialist skills, which can be constrained by subjectivity, case load, and accessibility. With the quick progress of deep learning, convolutional neural networks (CNNs) have been developed as strong tools for automated analysis of medical images. This work introduces a project on skin disease classification based on deep learning with three advanced CNN models: DenseNet, ResNet, and VGG. Experimental assessment was conducted on a dermatology image data set, and performance was verified with accuracy, precision, recall, F1-score, and confusion matrices. The results show the great promise of DenseNet in providing secure and scalable skin disease categorization. The work adds to the field of Artificial Intelligence in Dermatology with the introduction of a framework that can be used in real-world healthcare systems to aid dermatologists and enhance patient treatment.

**Keywords:** Detection of skin disease, Deep learning, DenseNet, ResNet, VGG, Convolutional Neural Networks, Medical image analysis.

# Deep Learning Architectures for Predictive Drug Screening: Advances in Neural Networks and AI-Driven Drug Discovery

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## Abstract

Accurate prediction of therapeutic activity from molecular structures is a cornerstone of modern drug discovery. Traditional screening methods remain costly and time-consuming, driving a shift toward artificial intelligence (AI) and machine learning (ML) frameworks. This study investigates the application of artificial neural networks (ANNs) for predicting analgesic activity in a dataset of 532 compounds described by 227 molecular descriptors. To enhance prediction reliability, a stepwise feature elimination strategy was applied, reducing dimensionality and mitigating overfitting. The ANN architecture was optimized through iterative training, regularization, and generalization criteria, achieving a correlation coefficient of 95.9% and a prediction error of only 0.433%. These results demonstrate the capacity of ANNs to model nonlinear and complex chemical–biological relationships more effectively than traditional statistical methods. Beyond a case study in analgesics, this framework provides a scalable template for applying deep learning architectures to broader pharmacological targets. By bridging cheminformatics with advanced AI modeling, this work underscores the growing role of deep learning in accelerating drug discovery pipelines, reducing attrition rates, and supporting rational therapeutic design.

**Keywords:** Artificial neural networks; Machine learning; Drug discovery.

# Explainable AI for Heart Failure Diagnosis Using ECG and PPG: A Review of Methods, Challenges and Clinical Assurance

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## Abstract

Objective: The systematic review investigates the utilization of Explainable Artificial Intelligence (XAI) in electrocardiogram (ECG) and photoplethysmography (PPG)-based diagnosis systems for heart failure. It aims to evaluate the present state of development, identify the lack of multimodal (ECG+PPG) explainable models, and unveil significant research gaps that are limiting clinical adoption and trust.

Methods: A systematic review following PRISMA 2020 was conducted on the main databases (PubMed, IEEE Xplore, ScienceDirect, Google Scholar) for research articles between the years 2018 and 2025. Of 4,680 records retrieved, 14 were eligible. Research works were compared in terms of data modality (ECG, PPG, or multimodal), type of AI model, and XAI approach used (e.g., SHAP, LIME, Grad-CAM).

Results: Results indicate that although deep learning models obtain high diagnostic accuracy (typically over 94%), XAI is still infrequently applied—especially in multimodal ECG+PPG systems. Where applied, techniques like Grad-CAM and LIME enhance interpretability primarily for ECG-based models, yet the explanations provided are devoid of clinical context. Furthermore, clinician involvement and the use of standardized evaluation metrics are generally lacking, and the computational overhead of XAI restricts its real-time or wearable application.

Conclusion: Cutting-edge research demonstrates a clear performance-explainability gap with no practical, real-world multimodal XAI application achieved to date. Future research needs to endeavor to achieve clinically approved, computationally lightweight XAI approaches unifying ECG and PPG for interpretable, reliable, and real-time heart failure diagnosis.

**Keywords:** Explainable AI (XAI), Heart Failure, Cardiovascular Diseases, ECG, PPG, Multimodal Learning, Clinical Trust, Interpretability.

# A Survey on Generative Models for RNA Design

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## Abstract

Ribonucleic acid RNA plays an important role in biological processes. Therefore, its rational design is a major challenge in computational biology. Recent developments in deep learning have proposed generative models that can produce new RNA molecules with novelty and functional potential. This paper provides a review of recent models in RNA design. It starts with a background on RNA and the main categories of generative modeling. Then, existing studies are classified into four categories: sequence-based models, structure-based models, joint sequence–structure models, and function-oriented models. For each category, representative studies are summarized and compared in terms of architectures, datasets used, evaluation metrics, and reported results. The comparison highlights the contributions and distinct strengths of each approach. It also notes several limitations, such as limited data, modest structural validity, and limited functional improvement. Finally, the study discusses future directions, including incorporating RNA features and expanding and diversifying datasets. It also recommends improving multi-objective design through experimental feedback techniques. Overall, generative modeling appears to be a growing paradigm that could accelerate discoveries and therapeutics based on RNA and synthetic biology.

**Keywords**: RNA design, generative models, deep learning, co-design, therapeutics, synthetic biology.

# Deep Learning and Explainable AI for Plant Disease Detection: A Comprehensive Survey

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## Abstract

Plant diseases pose a significant threat to agricultural productivity and food security worldwide, particularly in developing regions. Traditional methods for detecting plant leaf diseases are often limited by time, cost, and the need for expert input, motivating the integration of deep learning and artificial intelligence (AI) to develop automated, accurate, and scalable diagnostic solutions for plant diseases. This survey provides a comprehensive review of recent advancements in deep learning-based approaches for plant leaf disease detection, with a particular focus on the integration of Explainable AI (XAI) techniques. This study analyzed state-of-the-art models, including CNNs, transfer learning architectures (e.g., VGG, ResNet, and EfficientNet), and ensemble frameworks, and evaluated their performance across diverse datasets. Furthermore, it investigates the growing application of XAI methods, such as Grad-CAM, LIME, SHAP, and saliency maps, which enhance model interpretability and promote user trust among end users, such as farmers and agronomists. By systematically reviewing the literature from 2023 to 2025, this study identifies key challenges, such as dataset limitations, overfitting, computational complexity, and generalization issues, and proposes future research directions, including hybrid models, multimodal data fusion, and edge device deployment. This study emphasizes that coupling deep learning with XAI is essential not only for achieving high diagnostic performance but also for ensuring transparent, trustworthy, and sustainable smart agricultural systems.

**Keywords:** Plant leaf disease detection, explainable AI, deep learning.

# Self-Supervised Transfer Learning for Arabizi Sentiment Analysis

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## Abstract

Arabizi, the Latin-script representation of Arabic dialects, poses major challenges for natural language processing due to its informal nature, inconsistent spelling, and limited availability of labeled resources. These challenges are particularly acute for underrepresented dialects such as Algerian. In this paper, we propose a self-supervised transfer learning framework that adapts pretrained Arabizi language models to the Algerian dialect. Our approach leverages masked language modeling and contrastive learning objectives to refine representations and improve robustness to dialectal variation. The adapted encoder is integrated into a hybrid deep learning architecture and fine-tuned for sentiment analysis. Experimental results show that our framework outperforms traditional baselines and generalizes better than models relying solely on Modern Standard Arabic embeddings.

**Keywords:** Self-Supervised Learning, Arabizi, Sentiment Analysis, Low-Resource Languages.

# Creation of a Dataset and Development of a Speech Recognition System for the Amazigh Language (Kabyle)

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## Abstract

The Amazigh language, particularly its Kabyle variant, is a cornerstone of North African cultural heritage, characterized by a rich oral tradition. However, its underrepresentation in digital resources threatens its long-term sustainability in the digital age. This work presents a comprehensive approach to the preservation and promotion of Kabyle through speech recognition. We detail the creation of a structured and diverse speech corpus, specifically collected for this task. Subsequently, we present the development of a phoneme recognition system based on a Bidirectional Long Short-Term Memory (BLSTM) neural network architecture. The model, trained on our custom corpus, achieved outstanding accuracy in transcribing voice recordings, demonstrating excellent adaptability to a wide variety of speakers and recording conditions. This research represents a significant step forward for the documentation of minority languages and paves the way for new applications in language preservation.

**Keywords:** Amazigh Language, Kabyle, Speech Recognition, BLSTM, Linguistic Corpus, Low Resource Languages, Signal Processing.

# Multimodal Fusion and Artificial Intelligence for Personality Trait Assessment in Recruitment Processes: Application to Sensitive Environments

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## Abstract

Recruitment in High-Risk Environments (Police, Military, Aviation, Nuclear, etc.): Beyond technical skills, psychological evaluation of the individual is essential. This paper proposes a new approach to personality-trait estimation that uses multimodal data- text, voice, and visual signals- within the OCEAN psychometric model. The system analyzes the meaning of the interview transcripts for coherence of discourse and other visual and audio signals to create an overall multimodal representation of the personality. The framework supports transparency and traceability so as to avoid end-to-end learning and thus control possible biases. Through real interview data, we see communicative stability under pressure and personality traits are related. This can help us achieve better recruitment for high-risk positions. This method is an alternative to psychometric tests and helps in recruitment decisions in sensitive situations.

**Keywords:** Big Five (OCEAN), multimodal fusion, personality trait estimation, high-risk recruitment, psychometric testing, communicative stability, transparency.

# CNN-Based Satellite Imagery Framework for Wildfire Detection and Spread Prediction

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## Abstract

Wildfires are some of the maximum unfavorable natural failures, inflicting massive ecological, social, and financial harm global. With climate alternate contributing to their elevated frequency and intensity, early detection and correct unfold prediction have turn out to be important for effective disaster control. This takes a look at provides a satellite tv for pc-primarily based wildfire detection and prediction framework the use of deep learning techniques. A Convolutional Neural Network (CNN) version turned into educated on a massive-scale dataset of satellite tv for pc imagery, comprising over 40,000 photographs classified into wildfire and non-wildfire classes. The dataset turned into preprocessed through normalization, segmentation, and augmentation to enhance feature illustration and generalization. The proposed CNN finished a textbf97% accuracy at the take a look at dataset, with precision, remember, and F1-ratings constantly above zero.96 for each class, outperforming current processes. Unlike traditional hotspot detection systems, the model leverages multi-sensor satellite facts and is designed to support real-time monitoring. Experimental outcomes highlight the model's robustness and reliability for automatic wildfire detection, at the same time as its scalability shows capacity deployment for real-time disaster response. Future extensions include integrating weather variables together with wind pace, temperature, and humidity to permit wildfire unfold forecasting, as well as lightweight deployment on edge gadgets for area-degree programs.

**Keywords:** Wildfire detection, satellite imagery, deep learning, convolutional neural network (CNN), disaster management, spread prediction, real-time monitoring, edge deployment.

# A Hybrid ResNet50-PCA-SVM Model for Accurate Palmprint Recognition

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## Abstract

Biometric authentication has demonstrated effectiveness in accurately verifying an individual's identity. Specifically, palmprint-based biometric systems have gained growing interest in recent years because of their high security, feasibility, and user acceptance. Conventional palmprint recognition approaches involve extracting palmprint features prior to classification, which can influence the recognition performance. In this study, we propose a hybrid model combining deep learning and traditional machine learning techniques for palmprint identification. Features are first extracted using a pre-trained ResNet50 model, then reduced via Principal Component Analysis (PCA), and finally classified using a Support Vector Machine (SVM) with a linear kernel. The experiments are conducted on publicly available contactless datasets, namely Tongji and BMPD, under different data split ratios. Performance is evaluated using accuracy, precision, recall, F1-score, and ROC-AUC analysis. The experimental results show that the proposed approach achieves an accuracy exceeding 99.3% across all tests, with an AUC of 1.00, demonstrating the effectiveness of combining CNN-based feature extraction with classical machine learning techniques for palmprint recognition.

**Keywords:** Palmprint Recognition, ResNet50, Principal Component Analysis, Support Vector Machine, Deep Learning, Feature Extraction.

# Dynamic Spammer Detection using deep learning with temporal graph embeddings

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## Abstract

Spammers in online social networks continuously adapt their strategies, making detection a challenging and dynamic task. While traditional machine learning models and static deep learning approaches such as CNNs achieve good performance, they often fail to capture the temporal evolution of user behavior and network interactions. In this paper, we propose a novel deep learning framework for dynamic spammer detection that combines Principal Component Analysis (PCA) for feature reduction, Convolutional Neural Networks (CNNs) for local content feature extraction, and Temporal Graph Embeddings (TGEs) to capture evolving interaction patterns over time. Unlike prior static models, our approach explicitly models the dynamics of user behavior and relational changes in the social graph. Experiments conducted on benchmark Twitter datasets demonstrate that our hybrid PCA–CNN–TGE model significantly outperforms classical baselines (ANN, CNN, SVM) and static hybrid models, achieving an F1-score of 94 %. The results highlight the importance of temporal graph learning for robust and adaptive spammer detection in social networks.

**Keywords:** Spam, Cybersecurity, CNN, Social Networks, Temporal Graph Embeddings, PCA.

# WakeUp AI – Fatigue Detection System

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## Abstract

Driver fatigue remains one of the most critical factors in preventable road deaths, yet conventional systems based on Convolutional Neural Networks (CNNs) often struggle to strike a vital balance between accuracy, speed, and practical usability under diverse conditions2. This paper introduces WakeUp AI, an intelligent fatigue detection system explicitly designed to bridge that gap. The core framework leverages the advanced feature extraction capabilities of a Vision Transformer (ViT), combined with an optimized Support Vector Machine (SVM) classifier, resulting in an outstanding 99.82% test accuracy on the CEW dataset. This hybrid ViT-SVM approach achieves superior feature discrimination while maintaining computational efficiency suitable for edge deployment. For real-time use, WakeUp AI integrates MediaPipe FaceMesh with a streamlined ViT model, achieving inference latency of < 100ms frame. Crucially, a continuous temporal logic module constantly monitors the driver's eye state, activating instant audio alerts only when fatigue patterns (such as prolonged eye closure duration) are robustly detected. Unlike conventional systems limited to simple, rigid thresholding, WakeUp AI intelligently adapts to diverse environments, making it exceptionally robust. By combining state-of-the-art deep learning with real-time responsiveness, WakeUp AI offers a scalable, high-performance solution for critical safety applications.

**Keywords:** Fatigue Detection, Vision Transformer, Media Pipe, SVM, Real-time Inference.

# Recent Advances in Fire Detection and Localization using AI and IoT: A Comprehensive Survey

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## Abstract

Detecting fires at an early stage is important to protect people, property, and the environment. Recent advances in artificial intelligence (AI), the Internet of Things (IoT), and edge computing have enabled faster and more intelligent solutions than traditional smoke- or heat-based detectors. This survey reviews recent state-of-the-art research and organizes it into three categories: (i) Vision-Based Systems, (ii) Sensor-Based & Fusion Systems, and (iii) AI IoT. In addition, we summarize fire-localization methods, highlight remaining gaps, and outline challenges and future directions. The objective is to give researchers and engineers an accurate guide to developing intelligent and dependable systems for fire detection.

**Keywords:** Fire Detection, IoT, Deep Learning, Edge AI, Sensor Fusion, Computer Vision, TinyML, Fire Localization, GIS.

# Semi-Supervised Medical Image Segmentation with Foundation Models: Recent Advances, Benchmarks, Challenges, and Perspectives

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## Abstract

Medical image segmentation has undergone a major transformation with the advent of foundational models, particularly the Segment Anything Model (SAM) and its medical modifications. Through our comprehensive review of research published between 2023 and 2025, we note that these developments have fundamentally reshaped traditional approaches to medical imaging. This paper summarizes recent advances in semi-supervised learning (SSL) approaches that incorporate baseline/foundation models for medical image segmentation. Our findings highlight that model reliability—with specific attention to uncertainty quantification and robust reliability assessment—should be fundamental to trustworthy clinical deployment, although it remains a major gap in current studies.

**Keywords:** Medical image segmentation, foundation models, SAM, semi-supervised learning, model calibration.

# A Systematic Review of Quantum Machine Learning: Taxonomy, Tools, and Future Horizon

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## Abstract

Quantum Machine Learning (QML) integrates quantum computing principles with data-driven learning to pioneer novel approaches for representation, optimization, and decision-making. This comprehensive review presents a structured overview of the QML landscape, categorizing methods by learning paradigm (supervised, unsupervised, and reinforcement), circuit architecture (variational, kernel-based, and quantum-native), and hybrid implementation strategies on noisy intermediate-scale quantum (NISQ) devices. It surveys recent algorithmic developments alongside evolving software and hardware ecosystems that enable experimentation and prototyping. The review also examines benchmark datasets and evaluation practices while addressing key challenges such as noise, scalability, and reproducibility. By synthesizing findings from current reviews and primary research, it identifies persistent gaps—including inconsistent benchmarking, limited interpretability, and the absence of resource-aware evaluations—and outlines pathways for developing robust, efficient, and explainable QML systems. This work provides researchers and practitioners with a coherent taxonomy, practical insights into available tools and frameworks, and a roadmap for transitioning from simulated experiments to real quantum deployments.

**Keywords:** Quantum Machine Learning; Taxonomy; Hybrid Quantum-Classical; Frameworks; Benchmarks; Reproducibility.