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International Conference on Intelligent Systems and Computational Methods

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2025

INTERNATIONAL CONFERENCE ON INTELLIGENT SYSTEMS AND COMPUTATIONAL METHODS (ICISCM)-I

ABOUT THE CONFERENCE

Step into the future of intelligent technologies at the International Conference on Intelligent Systems and Computational Methods (ICISCM). This premier global event unites researchers, academicians, industry experts, and students to explore innovative ideas, emerging trends, and practical applications in intelligent systems and computational techniques. ICISCM serves as a dynamic platform for presenting cutting-edge research, exchanging knowledge, and fostering collaborations that drive advancements in automation, machine learning, optimization, and real-world problem solving through computational intelligence.

SCOPE OF CONFERENCE

Join us at the International Conference on Intelligent Systems and Computational Methods (ICISCM) — a premier forum that brings together a global community of researchers, academicians, industry professionals, and students to delve into the latest developments in intelligent technologies and computational strategies. This event is designed to foster impactful collaborations, encourage innovative thinking, and highlight pioneering research that addresses theoretical foundations and real-world applications across areas such as machine learning, optimization, data analytics, automated decision-making, and complex system modeling.

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DESIGNING INTERPRETABLE DEEP LEARNING MODELS FOR CLINICAL DECISION SUPPORT SYSTEMS

Abdul Ro'uf, Agus Harjoko, Dr. Agfianto Eko Putra.
University of North Sumatra. Indonesia.
abdul123@gmail.com, harjokoagus@gmail.com and ekoputra1998@gmail.com

ABSTRACT

The integration of deep learning in clinical decision support systems (CDSS) holds transformative potential in modern healthcare, particularly in diagnosis, risk assessment, and treatment planning. However, the opacity of deep learning models remains a barrier to clinical adoption, as healthcare professionals require transparent and explainable outputs to ensure trust and accountability. This paper presents a framework for designing interpretable deep learning models tailored specifically for clinical contexts. By incorporating attention mechanisms, layer-wise relevance propagation, and model-agnostic interpretation techniques such as SHAP and LIME, the proposed system enhances both the transparency and the diagnostic accuracy of clinical recommendations. The approach is evaluated on multiple healthcare datasets, including electronic health records and medical imaging, to assess its generalizability across data types. Experimental results demonstrate that the interpretable models achieve performance levels comparable to or exceeding black-box models while providing clear insights into the reasoning behind each prediction. Furthermore, usability testing with clinicians reveals improved user confidence and greater willingness to rely on model outputs when explanations are provided alongside predictions. The study also emphasizes the importance of contextualizing interpretability methods within clinical workflows, ensuring that explanations align with medical reasoning processes. This research contributes a scalable and clinically relevant methodology for embedding interpretability into deep learning architectures, thereby supporting safe, effective, and ethical use of AI in healthcare environments.

Keywords: deep learning, interpretability, clinical decision support, explainable AI, healthcare analytics

Paper ID: ICISCM'25-253

INTEGRATING HUMAN-CENTERED EXPLANATIONS IN AI MODELS FOR FINANCIAL RISK ASSESSMENT

Sri Harsha Grandhi*, Dinesh Kumar Reddy Basani, Raj Kumar Gudivaka, Rajya Lakshmi Gudivaka, Basava Ramanjaneyulu Gudivaka

Intel, Folsom, California, USA CGI,Vancouver, British Columbia, Canada
Infosys,Raleigh, North Carolina,USA
Wipro, Hyderabad,Telangana,India,
Raas Infotek,Newark, Delaware,USA
sriharshagrandhi@ieee.org,dineshkumarreddybasan@ieee.org, rajkumargudivaka@ieee.org,
lakshmigudivaka@ieee.org, basavagudivaka@ieee.org

ABSTRACT

As artificial intelligence continues to influence financial risk assessment, the demand for models that not only perform accurately but also provide transparent and understandable explanations has become increasingly critical. This paper proposes a framework for integrating human-centered explanations into AI models used for financial risk assessment, ensuring that stakeholders, including analysts, regulators, and clients, can comprehend, validate, and trust the system's outputs. The methodology combines advanced predictive modeling techniques such as gradient boosting and neural networks with post-hoc explainability tools like SHAP (Shapley Additive Explanations) and counterfactual reasoning. The design process incorporates user feedback from financial professionals to ensure that the generated explanations align with domain-specific expectations and decision-making practices. A comprehensive evaluation is conducted using real-world datasets from the banking and insurance sectors to measure both predictive accuracy and explanation quality. Results indicate that human-centered explanations significantly improve user trust and model adoption without compromising performance. Additionally, scenario-based testing reveals that explanations tailored to the end user's perspective enhance interpretability across varying levels of financial literacy. The study underscores the importance of aligning AI behavior with human reasoning, particularly in high-stakes financial environments where interpretability is essential for regulatory compliance and ethical accountability. By bridging technical explainability with practical relevance, this work advances the development of AI systems that are not only powerful but also responsible and user-aware.

Keywords: explainable AI, financial risk, human-centered design, model transparency, user trust

Paper ID: ICISCM'25-105

APPLICATION OF ANT COLONY OPTIMIZATION FOR STRUCTURAL LAYOUT OPTIMIZATION IN CIVIL ENGINEERING

Rochman Achwan, Suraya Abdulwahab Afiff and Meily Badriati.
Airlangga University.
rochmanachwan@outlook.com, surayaabdul@outlook.com and meilybadriati009@gmail.com

ABSTRACT

Optimizing structural layouts in civil engineering is a complex task involving numerous design variables and constraints related to material use, load distribution, stability, and cost efficiency. Traditional optimization methods often struggle with the nonlinear, multi-objective nature of these problems. This paper explores the application of Ant Colony Optimization (ACO), a bio-inspired metaheuristic algorithm, to efficiently solve structural layout optimization challenges in civil engineering. ACO simulates the foraging behavior of ants to find optimal paths and is particularly suited to navigating large, discrete solution spaces. The proposed methodology involves encoding structural design variables into a form suitable for ant traversal and applying ACO to minimize structural weight while maintaining safety and performance standards. Several case studies are conducted, including truss layout optimization and frame structure design, with comparisons drawn against conventional optimization approaches such as genetic algorithms and gradient-based methods. Results show that ACO not only converges to high-quality solutions with fewer iterations but also demonstrates robustness in handling complex constraint interactions. Furthermore, the adaptability of ACO to varying design scenarios highlights its potential as a reliable tool for civil engineers seeking efficient, automated layout solutions. The paper concludes with a discussion on the practical integration of ACO into design workflows, emphasizing its computational efficiency, flexibility, and potential for hybridization with other intelligent techniques in future applications.

Keywords: ant colony optimization, structural layout, civil engineering, metaheuristic algorithms, design optimization

Paper ID: ICISCM'25-001

ENHANCING MECHANICAL COMPONENT DESIGN USING HYBRID GENETIC AND PARTICLE SWARM ALGORITHMS

Abdul Khairul Rizki Purba, Maviskasari pintoko kalanjati and Vidi Vianney Tanggo.
Lambung Mangkurat University.
Khairulrizkipurba012@gmail.com, maviskasaripintoko@gmail.com and vidivianney@gmail.com

ABSTRACT

The design of mechanical components often involves navigating complex, multidimensional design spaces where conflicting objectives such as strength, weight, manufacturability, and cost must be simultaneously addressed. Traditional optimization methods are often limited in their ability to explore such landscapes effectively. This study presents a hybrid optimization approach that integrates Genetic Algorithms (GA) and Particle Swarm Optimization (PSO) to enhance the design process of mechanical components. The hybrid model leverages the global search capabilities of GA and the fast convergence characteristics of PSO, resulting in a more balanced and efficient optimization strategy. The proposed framework is applied to the design of structural components such as brackets and connecting rods, which require high performance under load constraints. Design variables include geometric parameters, material properties, and stress distribution limits. Comparative analyses with standalone GA and PSO models demonstrate that the hybrid algorithm achieves superior solutions in terms of convergence speed, diversity, and objective function value. Additionally, sensitivity analysis reveals the robustness of the model against varying design requirements and boundary conditions. The integration of the hybrid algorithm into a computer-aided design environment further illustrates its practical applicability and ease of use for engineering professionals. This research contributes to the field by offering a scalable, flexible, and high-performance optimization strategy for mechanical design problems in industrial and academic contexts.

Keywords: genetic algorithm, particle swarm optimization, hybrid model, mechanical design, evolutionary computation

Paper ID: ICISCM'25-299

DISTRIBUTED FREQUENT PATTERN MINING USING MAPREDUCE FRAMEWORK FOR LARGE-SCALE RETAIL DATA

Dr. Sunita Bharatwal, Dr. Suresh Kumar Malik and Prof. Nitin Bansal.
Kurukshetra University. India.
Sunitabharatwal134@gmail.com, sureshmalik@edu.com and nitinbansal04@gmail.com

ABSTRACT

Frequent pattern mining plays a crucial role in discovering meaningful associations and correlations among items in large-scale retail datasets. However, traditional data mining techniques face significant scalability issues when applied to massive volumes of transactional data generated by modern retail systems. This paper proposes a distributed approach for frequent pattern mining using the MapReduce framework to efficiently process and analyze large-scale retail data. The methodology involves the parallel implementation of the FP-Growth algorithm, optimized for the MapReduce paradigm to ensure balanced workload distribution and reduced computation time. Large transactional datasets are partitioned across multiple nodes in a distributed computing environment, where local frequent patterns are mined in parallel and then aggregated to form global patterns. The proposed solution is evaluated using synthetic and real-world retail datasets, demonstrating substantial improvements in execution time and scalability when compared to traditional single-node implementations. Experimental results indicate that the system maintains high accuracy in pattern detection while significantly reducing runtime, particularly for datasets exceeding hundreds of gigabytes in size. Moreover, the approach exhibits robust fault tolerance and adaptability to growing data volumes, making it suitable for deployment in cloud-based retail analytics platforms. The research highlights the effectiveness of combining classical data mining algorithms with modern distributed computing techniques to meet the demands of big data environments in the retail sector.

Keywords: frequent pattern mining, MapReduce, retail analytics, distributed computing, big data

Paper ID: ICISCM'25-164

A SCALABLE CLUSTERING APPROACH FOR HIGH-DIMENSIONAL BIG DATA USING ADAPTIVE DENSITY TECHNIQUES

Krishna Chandra Bhattacharya, Amlan Das Gupta and and Hirendranath Mukherjee.

Jadavpur University, West Bengal.

krishnachandra@outlook.com, amlandasgupta@gmail.com and hirendranath1899@gmail.com

ABSTRACT

Clustering high-dimensional big data presents unique challenges due to the curse of dimensionality, data sparsity, and scalability constraints. Traditional clustering methods such as k-means and DBSCAN often struggle to maintain accuracy and efficiency in such environments. This study introduces a novel, scalable clustering approach that leverages adaptive density estimation to identify clusters in high-dimensional datasets effectively. The proposed method dynamically adjusts density thresholds based on local data distribution, allowing it to adapt to varying data densities and uncover meaningful patterns across different scales. To handle massive data volumes, the algorithm is designed to operate within distributed computing frameworks, enabling parallel execution and efficient memory utilization. The approach is validated using benchmark high-dimensional datasets and synthetic big data simulations, with comparative analysis against existing clustering algorithms. Results demonstrate superior clustering accuracy, robustness to noise, and significantly reduced computational time, particularly as dimensionality and dataset size increase. Additionally, the model effectively identifies non-spherical and arbitrarily shaped clusters that traditional methods fail to capture. A case study on real-world e-commerce user behavior data illustrates the practical utility of the approach in deriving actionable insights from complex, high-volume data. The research offers a promising solution for clustering applications in domains such as cybersecurity, bioinformatics, and market segmentation, where scalability and adaptability are critical for uncovering hidden structures in data.

Keywords: clustering, high-dimensional data, big data, adaptive density, scalable algorithms

Paper ID: ICISCM'25-117

AUTOMATED DETECTION OF PULMONARY DISEASES FROM CHEST X-RAYS USING CONVOLUTIONAL NEURAL NETWORKS

Dr. Wan Mohd Asyraf Wan Mahmood, Assoc. Prof. Dr. Shafinaz Shahir and Dr. Zarita Zakaria.
University of Malaysia Kelantan. Malaysia.
Mohdasyr26@gmailcom, shahir_shafina34@gmail.com and zaritazakaria10@gmail.com

ABSTRACT

The accurate and timely detection of pulmonary diseases is essential for effective clinical intervention, especially in resource-constrained environments where expert radiological assessment may be limited. This study presents a deep learning-based framework utilizing Convolutional Neural Networks (CNNs) for the automated detection of various pulmonary conditions from chest X-ray images. The proposed system is trained and validated using publicly available datasets that include labeled images for conditions such as pneumonia, tuberculosis, and COVID-19. The CNN architecture is optimized through a series of experiments involving hyperparameter tuning, data augmentation, and transfer learning using pretrained models like ResNet and DenseNet. Performance metrics, including accuracy, sensitivity, specificity, and area under the ROC curve (AUC), are evaluated to assess model effectiveness across different disease classes. Results show that the model achieves high diagnostic accuracy and consistent generalization across multiple test sets, outperforming conventional image analysis methods. The system also incorporates visualization techniques such as Grad-CAM to highlight relevant regions in the X-rays, providing interpretability to support clinical decision-making. The study emphasizes the potential of AI-driven diagnostic tools in supporting radiologists and improving early disease detection, particularly in high-volume clinical settings. This research demonstrates how CNNs can be effectively employed to automate radiographic analysis, offering a scalable solution for enhancing diagnostic workflows and reducing human error in pulmonary disease screening.

Keywords: convolutional neural networks, pulmonary disease, chest X-rays, medical imaging, automated diagnosis

Paper ID: ICISCM’25-098

HYBRID DEEP LEARNING FRAMEWORK FOR BRAIN TUMOR CLASSIFICATION IN MRI SCANS

Dr. Linda Burnett, Professor John-Paul Chalykoff and Dr. Walter Chan.

Capilano University. Canada.

lindaburnett@outlook.com, chalykoff12@outlook.com and walterchan@outlook.com

ABSTRACT

Accurate classification of brain tumors from magnetic resonance imaging (MRI) scans is vital for effective diagnosis, treatment planning, and patient prognosis. This paper presents a hybrid deep learning framework designed to improve classification performance by integrating convolutional neural networks (CNNs) with recurrent neural networks (RNNs), specifically long short-term memory (LSTM) layers. The proposed architecture captures both spatial and contextual dependencies in MRI sequences, enabling enhanced feature extraction and temporal modeling. Initially, CNN layers are employed to extract detailed spatial features from each scan slice, followed by LSTM layers that process the sequential information across slices to improve tumor localization and classification. The model is trained and evaluated on benchmark brain tumor datasets comprising glioma, meningioma, and pituitary tumor categories. Results demonstrate that the hybrid architecture significantly outperforms standalone CNN and RNN models in terms of classification accuracy, sensitivity, and specificity. Data augmentation and transfer learning are applied to address limited training data and ensure better generalization. Furthermore, Grad-CAM visualization is used to provide interpretable outputs, aiding radiologists in understanding the model’s focus areas. Comparative analysis against existing state-of-the-art models highlights the framework’s robustness and efficiency, with a lower false positive rate and improved clinical reliability. This research supports the development of AI-assisted diagnostic systems in neuroimaging and emphasizes the importance of combining spatial and temporal learning mechanisms for precise medical image classification.

Keywords: brain tumor, MRI classification, deep learning, CNN-LSTM hybrid, medical image analysis

Paper ID: ICISCM'25-203

PRIVACY-PRESERVING FEDERATED LEARNING FOR HEALTHCARE DATA COLLABORATION ACROSS HOSPITALS

Pieter Abbeel, Cathryn Carson and Alan Shabel.
University of California, Los Angeles.
Abbeelpieter87@gmail.com, carsoncathryn@gmail.com and alanshabel31@gmail.com

ABSTRACT

Data-driven models hold immense potential in transforming healthcare, but the sensitive nature of patient information and regulatory constraints often hinder the sharing of clinical data across institutions. This paper presents a privacy-preserving federated learning framework tailored for collaborative healthcare model training across hospitals without exchanging raw patient data. The proposed approach allows each participating institution to train local models on their respective datasets while only sharing encrypted model updates with a central server. To enhance security, techniques such as differential privacy and secure aggregation are incorporated to prevent information leakage during the communication process. The system is evaluated using multiple hospital datasets involving tasks such as disease classification and readmission prediction. Results indicate that the federated model achieves accuracy comparable to traditional centralized approaches while preserving data privacy and complying with medical data regulations. Additionally, the model demonstrates strong performance in heterogeneous data settings, where patient populations and clinical practices vary across hospitals. A detailed analysis of communication overhead, convergence time, and privacy-utility tradeoffs provides insights into real-world deployment feasibility. The study also explores clinician involvement in validating model outcomes and ensuring interpretability. This research highlights the viability of federated learning as a secure, collaborative solution for leveraging distributed healthcare data, offering a path forward for AI adoption in multi-institutional clinical environments without compromising patient confidentiality.

Keywords: federated learning, healthcare data, privacy preservation, hospital collaboration, secure AI systems

Paper ID: ICISCM'25-015

OPTIMIZING COMMUNICATION EFFICIENCY IN FEDERATED LEARNING FOR FINANCIAL FRAUD DETECTION

Osman Bin Bakar, Azlina Binti Abd Rahman and Md Zahangir Alam.

Sultan Zainal Abidin University.

Binbakar1998@gmail.com. bintiabdrahman@gmail.com and zahaginalam@edu.uk

ABSTRACT

Federated learning offers a promising framework for collaborative model training across decentralized institutions without compromising data privacy, making it especially valuable in sensitive domains such as financial fraud detection. However, frequent and voluminous communication between client nodes and the central server poses a significant challenge to efficiency and scalability. This paper presents a novel optimization strategy to enhance communication efficiency in federated learning while maintaining high fraud detection accuracy. The proposed approach combines update sparsification, adaptive client selection, and model compression techniques to reduce bandwidth consumption and synchronization delays. Experiments are conducted using real-world transaction datasets sourced from multiple financial institutions, simulating heterogeneous data distributions and varying client participation rates. Results demonstrate a substantial reduction in communication overhead, with negligible impact on the convergence rate or detection performance. Furthermore, dynamic adjustment mechanisms are introduced to tailor communication frequency based on network conditions and model update significance, enabling robust operation in constrained environments. Comparative evaluations with baseline federated algorithms such as FedAvg and FedProx highlight the superiority of the optimized framework in balancing accuracy and communication cost. The study also includes an analysis of computational load on client devices to ensure practical deployment feasibility. By addressing the dual needs of privacy and efficiency, this research contributes a scalable federated learning solution for real-time fraud detection in the financial sector, facilitating secure and responsive model development across distributed infrastructures.

Keywords: federated learning, fraud detection, communication efficiency, model compression, financial AI

Paper ID: ICISCM'25-246

ADAPTIVE FUZZY LOGIC CONTROLLER FOR REAL-TIME NAVIGATION IN AUTONOMOUS VEHICLES

Sharon Roseman, Lincoln Addison and Kathleen Gordon.
McMaster University. Canada.
Rosemansharon23@yahoo.com, addisonlincoln@yahoo.com and gordonkathleen1910@yahoo.com

ABSTRACT

Real-time navigation in autonomous vehicles demands precise control under dynamic and uncertain environmental conditions. Conventional control algorithms often struggle to maintain performance in complex driving scenarios due to their limited adaptability. This paper proposes an adaptive fuzzy logic controller (AFLC) designed to enhance real-time decision-making and path-following capabilities in autonomous vehicle systems. The controller integrates a fuzzy inference system with an online parameter tuning mechanism, enabling it to adjust membership functions and rule weights dynamically based on real-time sensory feedback. The adaptability ensures robust performance across diverse operating conditions, including varying road surfaces, traffic densities, and obstacle proximities. Simulation and hardware-in-the-loop testing are conducted using a high-fidelity vehicle dynamics model and real-time sensory inputs such as LiDAR and GPS. The AFLC is benchmarked against traditional PID and static fuzzy controllers across metrics including path accuracy, response time, and stability under disturbance. Results indicate that the proposed controller significantly reduces tracking error and improves responsiveness, particularly in environments with unpredictable obstacles or changing surface conditions. Moreover, the system demonstrates resilience against sensor noise and delayed feedback, ensuring safe operation in practical scenarios. This study highlights the viability of adaptive fuzzy systems as a lightweight and interpretable alternative to black-box models for real-time vehicular control. The approach offers a scalable, transparent, and efficient solution for enhancing the autonomy and safety of next-generation intelligent transportation systems.

Keywords: fuzzy logic, autonomous vehicles, real-time control, adaptive systems, vehicle navigation

Paper ID: ICISCM'25-013

INTEGRATION OF FUZZY INFERENCE SYSTEMS IN DECISION-MAKING FOR UNMANNED AERIAL SYSTEMS

Amanaullah Ahmadi, Saifullah Mansoori and Zubair Hassan Zada.

Dunya University of Afghanistan (DUA).

amanaullahahmadi@gmail.com, saifullahmansoori@gmail.com and hassanzada1601@gmail.com

ABSTRACT

Unmanned Aerial Systems (UAS) are increasingly employed in complex operational environments that require rapid, context-aware decision-making under uncertainty. Traditional control and decision-making algorithms often lack the flexibility to handle imprecise or incomplete data, leading to suboptimal or unsafe actions in dynamic scenarios. This paper presents a framework for integrating Fuzzy Inference Systems (FIS) into the decision-making architecture of UAS to improve autonomy, adaptability, and safety. The proposed system models pilot-like reasoning through a rule-based structure that interprets sensor inputs and environmental variables to generate control decisions in real time. Inputs include flight altitude, proximity to obstacles, battery levels, and mission urgency, while outputs govern navigation, altitude correction, and avoidance strategies. A Mamdani-type fuzzy system is implemented and optimized using expert knowledge and simulation data. The integrated framework is tested in a simulated environment featuring variable terrain, weather conditions, and dynamic obstacles. Performance metrics such as mission completion rate, collision avoidance success, and decision response time are compared against conventional deterministic controllers. Results demonstrate that the FIS-based decision-making system outperforms baseline models, particularly in ambiguous or rapidly evolving scenarios. The findings confirm that fuzzy logic enhances UAS decision-making by enabling smooth transitions between states and human-like reasoning under uncertainty. This work underscores the potential of FIS as a transparent, lightweight, and effective component for intelligent aerial autonomy.

Keywords: fuzzy inference system, unmanned aerial systems, autonomous decision-making, intelligent control, aerial robotics

Paper ID: ICISCM'25-189

URBAN TRAFFIC FLOW PREDICTION USING SPATIOTEMPORAL DATA AND MACHINE LEARNING MODELS

Dr. Chiging Yamang, Likha Rinchin and Dr. Kaling Moyong.
Apex Professional University. Arunachal Pradesh.
Chigingyamang@yahoo.com, rinchinlikha@yahoo.com and kalingmoyong@yahoo.com

ABSTRACT

Accurate prediction of urban traffic flow is essential for improving transportation efficiency, reducing congestion, and supporting intelligent traffic management systems. Traditional traffic forecasting methods often struggle with the nonlinear and dynamic nature of urban mobility patterns. This study presents a machine learning-based framework for urban traffic flow prediction that integrates spatiotemporal data from multiple sources, including historical traffic counts, GPS trajectories, road network topology, and real-time sensor data. The framework evaluates the performance of several machine learning models, such as random forests, gradient boosting, and long short-term memory (LSTM) networks, to capture both spatial dependencies across road segments and temporal variations in traffic volume. Feature engineering techniques are applied to extract relevant traffic indicators, including average speed, vehicle density, and peak hour trends, while geospatial encoding accounts for the hierarchical structure of road networks. Experimental analysis is conducted on traffic datasets from major metropolitan areas, with results indicating that LSTM models outperform others in capturing complex temporal dependencies and delivering higher prediction accuracy. The framework also supports short-term forecasting for specific time windows, enabling real-time traffic response mechanisms. The study highlights the significance of combining spatial and temporal data for predictive accuracy and demonstrates how machine learning can be scaled for smart city applications. The findings support the development of responsive, data-driven urban transportation systems that enhance commuter experience and infrastructure planning.

Keywords: traffic prediction, spatiotemporal data, machine learning, urban mobility, LSTM model

Paper ID: ICISCM’25-204

ENERGY CONSUMPTION FORECASTING IN SMART GRIDS THROUGH PREDICTIVE ANALYTICS AND IOT INTEGRATION

Sian Davies Edwards, Eleanor Molly Smith and Carolyn De Vishlin.

Aichi Medical University. Japan.

Edwards2820@gmail.com, mollysmith@gmail.com and devishlin23@gmail.com

ABSTRACT

Accurate forecasting of energy consumption is a critical component of efficient smart grid management, enabling better demand-side planning, resource allocation, and grid stability. This paper presents a comprehensive approach to energy consumption forecasting by integrating predictive analytics techniques with Internet of Things (IoT) data streams in a smart grid environment. The proposed framework leverages time-series forecasting models such as ARIMA, Prophet, and Long Short-Term Memory (LSTM) neural networks, trained on real-time and historical consumption data collected from IoT-enabled smart meters and distributed sensors. The integration of IoT devices ensures high granularity and timeliness of energy data, while advanced machine learning models are used to capture consumption patterns, seasonality, and external influences such as weather conditions and occupancy levels. A layered system architecture is designed to process, analyze, and visualize energy trends, offering actionable insights to utility providers and end-users. Experimental validation is conducted using data from residential and commercial buildings, demonstrating high forecasting accuracy and robust performance across different consumption profiles. The research highlights the value of combining IoT with intelligent analytics to create an adaptive and scalable energy management system. Moreover, the proposed method supports real-time decision-making and contributes to energy efficiency initiatives by enabling predictive load balancing, peak demand reduction, and cost optimization in smart grid infrastructures. The findings promote a data-driven approach to sustainable energy governance.

Keywords: energy forecasting, smart grids, IoT integration, predictive analytics, time-series modeling

Paper ID: ICISCM’25-076

SEMANTIC SEGMENTATION USING DEEP NEURAL NETWORKS FOR SCENE INTERPRETATION IN OFF-ROAD ROBOTICS

AKAGI Kazushige, EBARA Yasuhito and OHNO Tomoko.
Nagoya City University.
Kazushige2345@yahoo.com, yasuhitopebara@yahoo.com and ohnotomoko@yahoo.com

ABSTRACT

Scene interpretation in off-road robotics presents significant challenges due to unstructured terrain, variable lighting, and environmental complexity. This paper proposes a deep learning-based semantic segmentation framework tailored to enhance scene understanding for autonomous navigation in off-road environments. The approach employs a fully convolutional neural network (FCN) architecture augmented with encoder-decoder modules and skip connections to accurately classify each pixel into semantic categories such as vegetation, ground, rocks, water, and obstacles. To improve generalization across diverse terrains, a dataset composed of annotated off-road scenes under varying weather and terrain conditions is constructed, and data augmentation techniques are applied. Pretrained backbone networks such as ResNet and MobileNet are fine-tuned to accelerate convergence and boost segmentation accuracy. Experimental evaluations are conducted on benchmark and custom datasets, demonstrating that the proposed model achieves high intersection-over-union (IoU) scores across critical object classes, with robust performance in low-visibility conditions. The output of the segmentation model is integrated with a navigation stack to enable real-time path planning and terrain assessment for unmanned ground vehicles. The system also incorporates a confidence estimation module to handle uncertain predictions and inform safety decisions. Results from real-world field trials show that the proposed approach enhances environmental awareness and operational reliability, enabling more autonomous and resilient robotic systems in off-road applications such as agriculture, search and rescue, and defense.

Keywords: semantic segmentation, off-road robotics, scene interpretation, deep learning, autonomous navigation

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MULTI-MODAL SCENE ANALYSIS FOR AUTONOMOUS NAVIGATION IN COMPLEX OUTDOOR ENVIRONMENTS

Jad Abdallah, Nibal R. Chamoun and Hani Dimassi.

New York University Shanghai.

Jadabdallah90@outlook.com, chamounnubak@outlook.com and hanidimassi@outlook.com

ABSTRACT

Autonomous navigation in complex outdoor environments requires robust perception systems capable of understanding diverse, dynamic, and unstructured surroundings. This paper presents a multi-modal scene analysis framework that integrates visual, LiDAR, and thermal data to enhance environmental understanding and navigation reliability in outdoor settings. The proposed system fuses complementary data modalities using a deep learning architecture that leverages convolutional and attention-based fusion layers to extract and integrate spatial and semantic features across sensors. Visual data provides rich texture and color information, LiDAR offers precise depth and shape measurements, and thermal imaging contributes additional contrast in low-light or occluded scenarios. The fusion network is trained on a composite dataset comprising urban, forested, and off-road terrains, with diverse conditions such as varying illumination, weather, and cluttered environments. Experimental results demonstrate improved object detection, terrain classification, and obstacle recognition accuracy compared to unimodal systems. The multi-modal output is used to generate real-time semantic maps and safe path predictions, integrated into a navigation stack for autonomous ground vehicles. Performance metrics, including classification accuracy, inference speed, and robustness under sensor degradation, are evaluated. Results from real-world field deployments confirm the system's ability to navigate safely and adaptively through heterogeneous environments. This study highlights the importance of sensor diversity and deep fusion in advancing reliable autonomous navigation and establishes a scalable approach for future intelligent robotic platforms.

Keywords: multi-modal perception, autonomous navigation, scene analysis, sensor fusion, deep learning

Paper ID: ICISCM'25-127

ADAPTIVE POLICY LEARNING FOR AUTONOMOUS AGENTS IN NON-STATIONARY ENVIRONMENTS

Tatsuhei Morozumi, Hirano Takayuki and Niki Ryu.

Toyohashi University of Technology.

Tatsuheimorozumi0409@gmail.com, hiranptakayuki@gmail.com and nikiryu1997@gmail.com

ABSTRACT

Autonomous agents operating in real-world settings often encounter non-stationary environments, where dynamics, goals, or reward structures evolve over time. Traditional reinforcement learning approaches, which assume fixed environments, struggle to maintain optimal performance in such changing conditions. This paper introduces an adaptive policy learning framework that enables agents to detect, respond to, and learn from environmental shifts during deployment. The proposed method combines meta-learning and continual learning strategies with policy gradient reinforcement learning to create agents capable of online adaptation. An environment change detection mechanism is integrated using statistical divergence metrics and performance feedback, allowing the agent to trigger adaptation routines only when significant shifts are identified. To prevent catastrophic forgetting of previously learned knowledge, experience replay and regularization techniques are employed. Experimental validation is conducted across a series of benchmark tasks, including dynamic grid worlds, variable-goal navigation, and adversarial pursuit-evasion scenarios, simulating real-world non-stationarity. Results show that agents using adaptive policy learning maintain higher cumulative rewards, exhibit faster recovery after environmental changes, and generalize better across unseen variations compared to baseline reinforcement learning models. The study also explores policy reuse and transfer mechanisms to accelerate adaptation across task families. This research demonstrates the importance of flexibility in learning architectures and offers a scalable approach for developing autonomous agents that remain competent and resilient in unpredictable and evolving operational contexts.

Keywords: reinforcement learning, adaptive policy, non-stationary environments, autonomous agents, continual learning

Paper ID: ICISCM'25-110

DEEP REINFORCEMENT LEARNING FOR REAL-TIME DECISION MAKING IN DYNAMIC TRAFFIC SYSTEMS

Janelle Adsit, Marianne Ahokas and Marcos Hernandez.

California State University Channel Islands.

janelle1982@gmail.com, ahokas009@gmail.com, and hernandez2820@gmail.com

ABSTRACT

Managing dynamic traffic systems in real time requires intelligent control strategies that can adapt to fluctuating traffic conditions, varying driver behavior, and unforeseen disruptions. Traditional rule-based and model-driven traffic control methods often lack the flexibility and scalability needed for such complex, non-linear environments. This paper presents a deep reinforcement learning (DRL) framework designed to optimize real-time decision making in dynamic traffic systems. The proposed approach models intersections and traffic networks as Markov Decision Processes (MDPs), where an agent learns optimal control policies through interactions with the environment. A deep Q-network (DQN) and a Proximal Policy Optimization (PPO) algorithm are implemented to train the agent to minimize traffic congestion, reduce vehicle wait times, and improve overall traffic throughput. The system is trained and validated on both simulated traffic environments and real-world traffic datasets, incorporating vehicle flow, signal timing, pedestrian presence, and accident conditions. Results demonstrate significant improvements in metrics such as average travel time and intersection efficiency compared to conventional fixed-timing and adaptive signal control strategies. The model also shows strong generalization capabilities across various traffic volumes and network layouts. In addition, the framework supports multi-agent coordination to handle large-scale traffic systems involving multiple intersections. This study demonstrates the potential of DRL to enable intelligent, data-driven traffic control systems that enhance urban mobility, reduce emissions, and support the development of smart cities.

Keywords: deep reinforcement learning, traffic systems, real-time decision making, intelligent transportation, adaptive control

Paper ID: ICISCM'25-161

GENETIC ALGORITHM-BASED OPTIMIZATION FOR MULTI-OBJECTIVE JOB SHOP SCHEDULING

Nidhi Agrawal, Ryan Allen and Wendy Baesler.
Western Washington University.
nidhiagzarwal@gmail.com, allenryan26@gmail.com and baselerdr@gmail.com

ABSTRACT

Job shop scheduling is a classical optimization problem widely encountered in manufacturing and production systems, where multiple jobs with specific operations must be processed on distinct machines with constraints on order and timing. Solving this problem efficiently becomes even more challenging when considering multiple conflicting objectives such as minimizing makespan, reducing machine idle time, and balancing workload. This paper presents a genetic algorithm (GA)-based optimization framework designed to address the multi-objective nature of job shop scheduling problems (JSSP). The proposed method employs a Pareto-based evolutionary strategy to explore trade-offs among objectives and generate a diverse set of optimal schedules. Chromosome encoding is carefully structured to represent operation sequences across machines, while genetic operators such as crossover, mutation, and elitism are adapted to maintain feasibility and promote convergence. A non-dominated sorting mechanism ranks candidate solutions, and a crowding distance metric is used to preserve diversity within the solution space. Experimental evaluation is conducted on standard benchmark instances and extended to real-world shop-floor scenarios with dynamic job arrivals and machine breakdowns. Results demonstrate that the GA-based approach effectively identifies high-quality scheduling solutions that outperform traditional heuristic methods in both solution quality and computational efficiency. The study also includes an analysis of convergence behaviour, scalability, and robustness under varying problem sizes. This work contributes a flexible and adaptive tool for real-time production planning and resource optimization in smart manufacturing environments.

Keywords: genetic algorithm, job shop scheduling, multi-objective optimization, evolutionary

Paper ID: ICISCM'25-071

HYBRID EVOLUTIONARY STRATEGIES FOR DYNAMIC TASK SCHEDULING IN CLOUD COMPUTING ENVIRONMENTS

Aoshima, Karube and Padrón-Hernández.

Tokyo Gakugei University.

Aoshima916@gmail.com, karubeies@gmail.com and hernandezpadron@gmail.com

ABSTRACT

Efficient task scheduling in cloud computing environments is critical for optimizing resource utilization, minimizing execution time, and maintaining quality of service in the presence of dynamic workloads. Traditional static scheduling algorithms often fail to adapt to the unpredictable nature of cloud environments, where resource availability and task requirements frequently change. This paper proposes a hybrid evolutionary strategy that combines the strengths of Genetic Algorithms (GA) and Particle Swarm Optimization (PSO) to address dynamic task scheduling in heterogeneous cloud infrastructures. The hybrid model leverages GA's exploration capability and PSO's fast convergence to balance global and local search performance. Task-resource mappings are encoded as chromosomes, and a fitness function is designed to consider execution time, load balancing, energy consumption, and deadline adherence. The algorithm dynamically updates scheduling decisions in response to real-time fluctuations in task arrivals and virtual machine statuses. Experimental validation is performed using both synthetic workloads and real-world cloud traces on a simulated cloud environment. Comparative analysis with standalone GA, PSO, and traditional heuristic methods shows that the hybrid approach consistently outperforms others in terms of throughput, response time, and makespan. The results highlight the proposed strategy's adaptability, scalability, and robustness under varying workload intensities. This study demonstrates the potential of hybrid evolutionary methods as a practical and intelligent solution for real-time task scheduling in cloud computing platforms, paving the way for more responsive and efficient cloud resource management.

Keywords: cloud computing, task scheduling, hybrid algorithms, evolutionary strategies, dynamic environments

Paper IDL: ICISCM'25-123

AUTOMATING DATA CLEANING AND TRANSFORMATION USING AI-DRIVEN WRANGLING PIPELINES

Prof. Dr. Mohammad Saleh, Prof. Dr. Isti Fadah, and Prof. Dr. Dominikus Rato.
Tadulako University.
salehmohammad@gmail.com, fadahisti@gmail.com and dominikrato22@yahoo.com

ABSTRACT

The rapid growth of data-driven applications has intensified the need for efficient and accurate data preprocessing, especially in domains where data quality directly impacts analytical and predictive performance. This paper presents an AI-driven approach to automate data wrangling tasks, specifically focusing on data cleaning and transformation processes. The proposed framework utilizes a combination of machine learning models, pattern recognition techniques, and rule-based heuristics to identify anomalies, impute missing values, detect schema inconsistencies, and perform intelligent type transformations. A modular wrangling pipeline is designed to adaptively process diverse datasets by analyzing metadata and content characteristics in real time. The system employs reinforcement learning to optimize transformation sequences, while natural language processing techniques enable semantic type inference and entity resolution. Comparative experiments are conducted on structured datasets from healthcare, finance, and e-commerce domains to evaluate performance in terms of accuracy, scalability, and processing speed. Results demonstrate that the AI-driven pipeline significantly reduces manual intervention while maintaining high data fidelity, outperforming traditional ETL tools in both efficiency and flexibility. The framework also supports user-in-the-loop interaction, allowing domain experts to validate and refine transformations through an intuitive interface. This work highlights the transformative potential of artificial intelligence in simplifying complex data preparation workflows and enabling faster deployment of data-centric solutions. The findings suggest strong applicability for AI-driven wrangling pipelines in enterprise data engineering, automated analytics, and real-time data integration platforms.

Keywords: data wrangling, data cleaning, AI automation, data transformation, machine learning

Paper ID: ICISCM'25-217

INTELLIGENT SCHEMA MAPPING AND ANOMALY DETECTION FOR SCALABLE DATA PREPARATION

Mr. Rohit Verma, Dr. Vandana Bhadani and Dr. Nagendra Kumar Sharma.

Pakistan Institute of Engineering and Applied Sciences.

Rohitverma08@yahoo.com, vandanabhadani@gmail.com and nagendrasharma@edu.pk

ABSTRACT

Scalable data preparation is a critical prerequisite for effective data analytics and machine learning pipelines, particularly in large-scale enterprise environments where heterogeneous data sources, inconsistent schemas, and latent anomalies are common. This paper proposes an intelligent framework for automating schema mapping and anomaly detection to streamline the data preparation process. The system leverages ontology-based reasoning, machine learning models, and statistical profiling to semantically align schemas from diverse sources. For schema mapping, the approach integrates deep embedding techniques with supervised learning to identify structural and semantic correspondences across datasets. Simultaneously, the anomaly detection module uses unsupervised learning algorithms such as isolation forests and autoencoders to uncover data irregularities, including outliers, duplications, and schema violations. A scalable architecture is implemented to support distributed execution on large datasets, using parallelized processing and adaptive indexing. The framework also includes a feedback mechanism that refines mappings and detection rules based on user interaction, enhancing accuracy over time. Evaluations conducted on multi-domain datasets demonstrate improved mapping precision and recall, as well as high anomaly detection rates compared to conventional rule-based systems. The proposed solution significantly reduces the time and effort required for manual data alignment and cleansing, making it well-suited for dynamic data integration scenarios. This work contributes to the growing field of intelligent data engineering and offers a practical toolset for organizations aiming to operationalize data-driven decision-making at scale.

Keywords: schema mapping, anomaly detection, data preparation, machine learning, data integration

Paper ID: ICISCM'25-111

COMPARATIVE PERFORMANCE ANALYSIS OF YOLO AND FASTER-RCNN FOR REAL-TIME OBJECT DETECTION

Dr. Muhammad Shakeel, Samina Saghir and Amina Tabassum.
Shifa Tameer-e-Millat University.
shakeelmuhammad@yahoo.com, saminasaghir@yahoo.com and tabassumamina12@gmail.com

ABSTRACT

Real-time object detection plays a crucial role in numerous computer vision applications, including autonomous driving, surveillance, and robotics. This paper presents a comprehensive comparative analysis of two widely used deep learning-based object detection algorithms: You Only Look Once (YOLO) and Faster Region-based Convolutional Neural Network (Faster-RCNN). The study evaluates both models in terms of detection accuracy, inference speed, model complexity, and resource utilization. YOLO, known for its speed and efficiency, performs detection in a single pass through the neural network, making it suitable for real-time applications. In contrast, Faster-RCNN adopts a two-stage approach, offering higher localization accuracy but at the cost of increased computational overhead. The models are trained and tested on benchmark datasets including PASCAL VOC and MS COCO, with metrics such as mean Average Precision (mAP), frames per second (FPS), precision, and recall used for evaluation. Results show that while Faster-RCNN outperforms YOLO in precision and detection accuracy for small objects, YOLO demonstrates superior performance in terms of speed and suitability for resource-constrained environments. The analysis also considers the trade-offs between model complexity and deployment feasibility in real-time systems. This work provides actionable insights for researchers and engineers in selecting appropriate object detection models based on application-specific requirements. The findings support the integration of real-time vision systems in domains requiring both speed and reliability.

Keywords: object detection, YOLO, Faster-RCNN, real-time systems, deep learning

Paper ID: ICISCM'25-156

ENHANCING OBJECT DETECTION ACCURACY IN COMPLEX SCENES USING HYBRID YOLO AND FASTER-RCNN MODELS

Mohammed Alharbi, Abdullah M. Al-Shaalan and Ibrahim Elshafiey.

Princess Nourah Bint Abdul Rahman University.

alharbi1981@gmail.com, shaalan@edu.pk and elshafieyinrahim@gmail.com

ABSTRACT

Object detection in complex and cluttered scenes remains a significant challenge due to varying object scales, occlusions, illumination conditions, and background noise. This paper proposes a hybrid deep learning framework that combines the strengths of YOLO (You Only Look Once) and Faster-RCNN (Region-based Convolutional Neural Network) to enhance detection accuracy in such environments. The architecture integrates YOLO's rapid inference capabilities with Faster-RCNN's superior precision by leveraging a parallel detection strategy followed by result fusion. YOLO is first employed to generate initial region proposals and coarse object localization, which are then refined using the more precise region proposal network and classifier of Faster-RCNN. The output from both models is processed through a confidence-weighted ensemble mechanism that consolidates overlapping detections and filters false positives. Experiments are conducted on challenging benchmark datasets, including MS COCO and Open Images, focusing on scenes with dense object distributions and dynamic backgrounds. The hybrid model demonstrates improved mean Average Precision (mAP) and recall compared to standalone implementations of YOLO and Faster-RCNN, particularly in detecting small or partially occluded objects. Moreover, the proposed system achieves near real-time performance with acceptable computational overhead, making it viable for deployment in surveillance, autonomous navigation, and smart city monitoring applications. This research highlights the potential of model fusion strategies in achieving both speed and accuracy in object detection tasks, especially in visually complex scenarios.

Keywords: object detection, hybrid model, YOLO, Faster-RCNN, complex scenes

Paper ID: ICISCM'25-200

DESIGNING INTELLIGENT DECISION SUPPORT SYSTEMS FOR EMERGENCY RESPONSE MANAGEMENT

Dr Vijaykumar, Dr SachinGudage and Dr Syeda Asma Surayya.
BENGALURU DR.B.R. AMBEDKAR SCHOOL OF
ECONOMICS UNIVERSITY.
vijayakumar@gmail.com, sachingudage12@gmail.com and asmasuryya@edu.uk

ABSTRACT

Effective emergency response management demands rapid, accurate decision-making under conditions of uncertainty, time pressure, and information overload. This paper presents a framework for designing intelligent decision support systems (IDSS) tailored to the needs of emergency response operations. The proposed system architecture integrates real-time data from heterogeneous sources such as sensor networks, weather feeds, social media, and geospatial platforms to enable comprehensive situational awareness. A combination of machine learning models, rule-based reasoning, and predictive analytics is employed to assess risk levels, forecast incident evolution, and suggest prioritized response actions. The IDSS supports multi-agency coordination by offering a shared interface that visualizes alerts, resource availability, evacuation routes, and ongoing developments through dynamic dashboards and geospatial mapping tools. Case studies simulated on disaster scenarios, including urban flooding, industrial accidents, and wildfire outbreaks, demonstrate the system's capability to reduce response time, improve decision accuracy, and optimize resource allocation. The framework also incorporates adaptive learning mechanisms to refine recommendations based on post-event evaluations and responder feedback. Evaluation metrics such as decision latency, user satisfaction, and action effectiveness are used to validate system performance. The results indicate that the IDSS enhances operational agility and decision support quality in rapidly evolving crisis conditions. This study offers a scalable and modular approach to building intelligent systems that strengthen disaster preparedness and response efficiency in smart governance and public safety domains.

Keywords: emergency response, decision support system, real-time analytics, disaster management, intelligent systems

Paper ID: ICISCM’25-003

AI-POWERED DECISION FRAMEWORK FOR STRATEGIC PLANNING IN SMART MANUFACTURING

Salwa Hussein A. Elramly, Nagda Helmy Elmeniawy and Ahmed Hisham Eissa Morshed.

Alexandria University, Egypt.

salwahusseina@gmail.com, elmeniawy34@gmail.com and eissamorhsed@gmail.com

ABSTRACT

Strategic planning in smart manufacturing environments requires the integration of vast, complex, and dynamic datasets to support informed and agile decision-making. This paper proposes an AI-powered decision framework designed to enhance strategic planning by synthesizing data from industrial operations, supply chains, market trends, and workforce dynamics. The framework employs a multi-layered architecture that combines machine learning, predictive analytics, and optimization algorithms to generate actionable insights across various planning horizons. A knowledge-driven decision engine leverages historical and real-time data to simulate production scenarios, assess risk factors, and recommend adaptive strategies aligned with performance goals such as cost reduction, process efficiency, and sustainability. Reinforcement learning is applied to continuously refine planning decisions in response to changing internal and external variables. The framework also incorporates explainable AI components to ensure transparency and interpretability of recommendations, supporting managerial trust and informed intervention. Validation is performed using real-world datasets from smart factories in the automotive and electronics sectors, with results showing improvements in planning accuracy, responsiveness to disruptions, and overall operational efficiency. Additionally, the system supports collaborative decision-making by presenting visualized forecasts and multi-objective trade-off analyses to stakeholders. This research demonstrates how AI can be systematically embedded into the strategic planning layer of smart manufacturing systems to drive agility, competitiveness, and resilience in Industry 4.0 environments.

Keywords: smart manufacturing, strategic planning, decision framework, artificial intelligence, Industry 4.0

Paper ID: ICISCM'25-076

INTEGRATING NEURAL NETWORKS WITH SYMBOLIC REASONING FOR EXPLAINABLE AI SYSTEMS

Prof. Enrico Quagliarini, Prof. Franco Chiaraluce and Prof. Michele Germani.
University of Aosta Valley. Italy.
enricoquagliarini@outlook.com, francochiraluce@outlook.com and germanimichele@outlook.com

ABSTRACT

The lack of interpretability in deep learning models remains a critical barrier to the adoption of artificial intelligence in high-stakes domains where transparency and trust are essential. This paper presents a hybrid framework that integrates neural networks with symbolic reasoning to develop explainable AI (XAI) systems capable of both high-performance prediction and human-understandable reasoning. The approach leverages the pattern recognition power of deep neural networks for data-driven learning and combines it with symbolic logic-based systems that enable structured inference and rule extraction. Through this integration, the system is able to generate accurate predictions while simultaneously offering transparent justifications, traceable decision paths, and contextual explanations. The architecture includes an encoder-decoder neural component that interfaces with a symbolic reasoning engine to translate latent representations into symbolic forms. The reasoning module applies predefined or learned logical rules to derive conclusions that align with domain-specific knowledge. Experimental validation is conducted across multiple use cases, including medical diagnosis, fraud detection, and legal document analysis, where explainability is a regulatory and operational requirement. Results demonstrate that the hybrid model achieves comparable or superior performance to standalone neural networks while offering interpretable outputs that improve user trust and decision accountability. This work contributes to the growing field of neuro-symbolic AI by showing how the complementary strengths of connectionist and symbolic methods can be effectively fused to meet the demands of transparent and responsible AI systems.

Keywords: explainable AI, neural networks, symbolic reasoning, hybrid models, interpretable systems

Paper ID: ICISCM'25-187

A HYBRID NEURAL-SYMBOLIC APPROACH FOR KNOWLEDGE REPRESENTATION AND LOGICAL INFERENCE

Prof. Galal Zaki Said, Prof. Saad Mohamed Saad Atta and Prof. Wafaa Ahmed Hammad.
Beni-Suef University. Egypt.
Zakisaidprof@yahoo.com, saadmohamedatta@yahoo.com and wafaahammad@yahoo.com

ABSTRACT

Knowledge representation and logical inference are foundational challenges in artificial intelligence, requiring systems that can efficiently handle both sub-symbolic data patterns and symbolic reasoning processes. This paper proposes a hybrid neural-symbolic framework that combines the learning capabilities of neural networks with the expressiveness and interpretability of symbolic logic for enhanced knowledge representation and inference. The approach utilizes deep neural architectures to encode complex data features into distributed representations, which are then integrated with a symbolic reasoning engine capable of performing logical deductions and rule-based inference. This fusion allows the system to leverage the robustness and adaptability of neural models alongside the clarity and rigor of symbolic logic. The framework supports dynamic knowledge updates and can infer new facts from existing information through logical rules while maintaining tolerance to noise and uncertainty in data inputs. Experimental evaluation on benchmark reasoning datasets and real-world knowledge graphs demonstrates that the hybrid model achieves improved inference accuracy and computational efficiency compared to purely neural or symbolic approaches. Additionally, the system provides interpretable reasoning chains that enhance explainability and user trust. The proposed method advances the development of intelligent systems capable of complex cognitive tasks such as question answering, automated theorem proving, and semantic understanding. This research underscores the potential of neural-symbolic integration as a promising direction for building AI systems that combine data-driven learning with logic-based reasoning.

Keywords: neural-symbolic, knowledge representation, logical inference, hybrid AI, interpretable reasoning.

Paper ID: ICISCM'25-031

SCALABLE FRAMEWORK FOR REAL-TIME DATA STREAM PROCESSING IN SMART CITY APPLICATIONS

Luca Benini, Alberto Bolognetti and Giacomo Ciamician.
University of Bergamo. Italy.
Lucabenini12@gmail.com, albertobolognetti@gmail.com and ciamocian1982@gmail.com

ABSTRACT

The proliferation of sensors and IoT devices in smart cities generates vast volumes of continuous data streams that require efficient real-time processing for timely decision-making and service optimization. This paper presents a scalable framework designed to handle high-velocity data streams in smart city applications such as traffic monitoring, environmental sensing, and public safety. The proposed architecture integrates distributed stream processing engines with adaptive load balancing and fault-tolerant mechanisms to ensure reliability and scalability under varying data rates and network conditions. Key components include real-time data ingestion, preprocessing modules for filtering and aggregation, and analytics engines powered by machine learning algorithms for anomaly detection and predictive insights. The framework supports heterogeneous data formats and sources, enabling seamless integration across diverse urban infrastructures. A case study implementation demonstrates the framework's effectiveness in processing real-time traffic sensor data to optimize signal timings and reduce congestion. Performance evaluations on both simulated and real-world datasets highlight its ability to maintain low latency, high throughput, and resource efficiency at scale. Additionally, the system's modular design facilitates easy extension and customization for various smart city use cases. This research contributes to the advancement of intelligent urban management by providing a robust and scalable solution for continuous data stream processing, ultimately enhancing the responsiveness and sustainability of smart city services.

Keywords: real-time processing, data streams, smart cities, scalable framework, IoT analytics

Paper ID: ICISCM'25-208

ADAPTIVE EVENT DETECTION IN HIGH-VELOCITY DATA STREAMS USING ONLINE LEARNING ALGORITHMS

Dr A Jaiyeola, Dr RF Chidzonga and Dr J Mukuna.

Durban University of Technology. South Africa.

Jaiyeola45@outlook.com, chidzonga@outlook.com and muknaj98@outlook.com

ABSTRACT

High-velocity data streams generated by modern sensing and communication systems present significant challenges for timely and accurate event detection. Traditional batch processing methods are inadequate for real-time responsiveness and adaptability in dynamic environments where data distributions may evolve rapidly. This paper proposes an adaptive event detection framework that leverages online learning algorithms to continuously update predictive models and maintain high detection accuracy in streaming scenarios. The approach utilizes incremental classifiers capable of learning from new data instances in real time while forgetting outdated patterns, thereby addressing concept drift and changing data characteristics. Feature extraction and selection modules are designed to operate efficiently under strict latency constraints, ensuring that relevant information is captured without overwhelming computational resources. The framework incorporates a feedback loop enabling self-tuning of model parameters based on detection performance metrics, facilitating robustness to noise and anomalies. Experiments conducted on synthetic and real-world datasets from network traffic monitoring and sensor networks demonstrate the effectiveness of the proposed system in achieving superior detection rates and lower false alarm rates compared to static and traditional methods. The results highlight the potential of online adaptive learning to enhance event detection in environments with evolving data streams, such as cybersecurity, smart manufacturing, and intelligent transportation systems. This work provides a scalable and flexible solution for real-time analytics in high-velocity streaming data contexts.

Keywords: event detection, online learning, data streams, adaptive algorithms, concept drift

Paper ID: ICISCM'25-101

DEEP LEARNING-BASED REAL-TIME HUMAN ACTIVITY RECOGNITION FOR INTELLIGENT SURVEILLANCE SYSTEMS

Dr. Michele Rossouw, Attwell B. Gogotya and Dr Robert Badenberg.
St Augustine College of South Africa.
michelerossouw@gmail.com, gogtyaattwell@gmail.com and badenbergrobert@gmail.com

ABSTRACT

Human activity recognition in real-time is a critical component of intelligent surveillance systems aimed at enhancing security, public safety, and behavioral analytics. This paper presents a deep learning-based framework for accurate and efficient human activity recognition in complex and dynamic environments. The proposed system leverages convolutional neural networks (CNNs) combined with recurrent neural networks (RNNs) to effectively capture spatial features and temporal dependencies from video streams. The model is designed to process live video input from multiple camera sources, performing activity classification with low latency suitable for real-time applications. A comprehensive preprocessing pipeline, including background subtraction, pose estimation, and data augmentation, improves robustness against varying illumination, occlusion, and viewpoint changes. Experimental validation is conducted using benchmark surveillance datasets such as UCF Crime and HMDB51, achieving high accuracy in detecting activities ranging from normal behaviors to suspicious or anomalous events. The framework also incorporates an adaptive thresholding mechanism to reduce false alarms and supports incremental learning to adapt to new activity patterns over time. Performance evaluation highlights the system's ability to maintain real-time inference speeds on edge computing devices without compromising detection precision. This research demonstrates the potential of integrating deep learning techniques into intelligent surveillance for proactive monitoring and threat detection, contributing to safer urban environments and smarter security infrastructures.

Keywords: human activity recognition, deep learning, real-time surveillance, convolutional neural networks, recurrent neural networks

Paper ID: ICISCM'25-287

ANOMALY DETECTION IN PUBLIC SPACES USING CONTEXT-AWARE VIDEO ANALYTICS FRAMEWORK

María del Mar Royuela García, María Natividad Blanco Bueno and Daniel Martín Vega.

University of Alicante. Spain.

royuelagarcia@outlook.com, mariablancobueno12@outlook.com and martindaniel1119@outlook.com

ABSTRACT

Detecting anomalies in public spaces is essential for enhancing security, preventing crimes, and ensuring public safety. This paper presents a context-aware video analytics framework designed to identify unusual activities and behaviors in real-time surveillance footage. The proposed system integrates computer vision techniques with contextual information such as time, location, crowd density, and environmental conditions to improve anomaly detection accuracy and reduce false alarms. The framework employs a combination of deep learning models, including convolutional neural networks for feature extraction and long short-term memory networks for capturing temporal dependencies in video sequences. Additionally, it incorporates a context modeling module that dynamically adjusts detection thresholds based on situational factors and historical patterns. Extensive experiments conducted on publicly available datasets and real-world surveillance videos demonstrate the effectiveness of the framework in detecting diverse anomalies such as loitering, sudden crowd dispersal, and unauthorized access. Results indicate significant improvements in precision and recall over traditional video anomaly detection methods that lack contextual awareness. The system's scalable architecture supports deployment in smart city environments with multiple camera feeds and heterogeneous data sources. This research advances the state of the art in intelligent video surveillance by combining deep learning with context-sensitive analysis, offering a robust solution for proactive security monitoring and emergency response in public spaces.

Keywords: anomaly detection, video analytics, public safety, context-aware systems, deep learning

Paper ID: ICISCM'25-010

IMPROVING IMAGE CLASSIFICATION ACCURACY ON LIMITED DATA USING TRANSFER LEARNING WITH PRETRAINED CNNS

Eleni Moushi, Vasiliki Gkretsi and Panoraia Siafaka.
University of Design, Innovation, and Technology. Spain.
Moushieleni23@gmail.com, vasilikigkretsi@gmail.com, siafakapanoraria0907@gmail.com

ABSTRACT

Image classification tasks often suffer from limited labeled data, which hinders the training of deep learning models due to overfitting and poor generalization. This paper investigates the use of transfer learning techniques, leveraging pretrained convolutional neural networks (CNNs) to improve classification accuracy on small datasets. The study evaluates several popular CNN architectures, such as VGG, ResNet, and EfficientNet, pretrained on large-scale datasets like ImageNet, and fine-tuned on target datasets with limited samples. A systematic comparison of feature extraction and fine-tuning strategies is conducted to identify optimal approaches for different data scarcity scenarios. Additionally, data augmentation methods are integrated to enhance model robustness and reduce overfitting risks. Experimental results on benchmark small-scale image classification datasets demonstrate that transfer learning significantly boosts performance compared to training CNNs from scratch. Fine-tuning deeper layers yields higher accuracy but requires careful hyperparameter tuning to prevent catastrophic forgetting. The paper also discusses computational efficiency and training time trade-offs inherent in various transfer learning schemes. The findings highlight that pretrained CNNs can effectively transfer learned representations to new tasks with minimal labeled data, enabling practical deployment in resource-constrained environments such as medical imaging, remote sensing, and industrial inspection. This research contributes to the development of scalable and accurate image classification solutions where data availability is limited.

Keywords: image classification, transfer learning, pretrained CNNs, limited data, fine-tuning

Paper ID: ICISCM'25-177

DOMAIN ADAPTATION TECHNIQUES IN TRANSFER LEARNING FOR LOW-RESOURCE NATURAL LANGUAGE PROCESSING TASKS

Ahmed Ali, Mootaz Allam, and Ahmed Gamal.

New Giza University. Egypt.

Aliahmed1987@yahoo.com, allammootz@yahoo.com and ahmedgamal06@yahoo.com

ABSTRACT

Natural Language Processing (NLP) tasks often face significant challenges when applied to low-resource domains due to limited annotated data and domain-specific linguistic variations. Transfer learning with domain adaptation techniques has emerged as an effective strategy to overcome these constraints by leveraging knowledge from high-resource source domains to improve performance in low-resource target domains. This paper systematically reviews and evaluates various domain adaptation methods applied within transfer learning frameworks for NLP tasks such as sentiment analysis, named entity recognition, and machine translation. Techniques discussed include instance weighting, feature alignment, adversarial training, and representation learning that minimize domain discrepancies. The study further explores fine-tuning pre-trained language models like BERT and GPT on target domain data with domain-specific regularization and multi-task learning approaches. Experimental results on benchmark datasets demonstrate that domain adaptation significantly enhances model generalization and robustness, particularly in scenarios with scarce labeled data. Moreover, hybrid methods combining supervised and unsupervised adaptation yield superior performance by effectively exploiting unlabeled target domain corpora. The paper also highlights challenges such as negative transfer, computational overhead, and domain shift measurement, providing insights for future research directions. This work contributes to advancing transfer learning methodologies that enable more accurate and scalable NLP applications in low-resource settings, facilitating broader language technology adoption.

Keywords: domain adaptation, transfer learning, low-resource NLP, pre-trained models, domain shift

Paper ID: ICISCM'25-300

DESIGN OF SELF-ADAPTIVE CONTROL SYSTEMS USING FUZZY LOGIC AND EVOLUTIONARY ALGORITHMS

Min Hyung Kang, Sangseok Bae and Cheul Rhee.
Baekseok Arts University.
hyungmin@gmail.com, baesangseok@edu.com and Cheulrhee23@gmail.com

ABSTRACT

The design of self-adaptive control systems is critical for managing complex, nonlinear, and uncertain environments where fixed-parameter controllers often fail to maintain optimal performance. This paper proposes an integrated approach that combines fuzzy logic with evolutionary algorithms to develop robust self-adaptive control systems capable of real-time adjustment and improved decision-making. Fuzzy logic provides a flexible framework to model system uncertainties and approximate reasoning, enabling smooth handling of imprecise inputs and dynamic conditions. Evolutionary algorithms such as genetic algorithms and particle swarm optimization are employed to optimize the fuzzy controller parameters automatically, facilitating the adaptation process without requiring precise mathematical models. The proposed system continuously monitors control performance metrics and environmental feedback to update membership functions and rule bases dynamically, ensuring sustained adaptability and stability. Simulation studies conducted on benchmark nonlinear control problems, including robotic arm trajectory tracking and temperature regulation, demonstrate that the hybrid approach achieves superior accuracy, faster convergence, and enhanced robustness compared to conventional control methods. Additionally, the evolutionary optimization process reduces manual tuning efforts and enables the control system to adapt efficiently to changing operational contexts. This research highlights the synergy between fuzzy logic and evolutionary computation for designing intelligent control systems that can autonomously adjust to complex, time-varying environments, making them suitable for applications in industrial automation, robotics, and smart infrastructure management.

Keywords: self-adaptive control, fuzzy logic, evolutionary algorithms, optimization, intelligent systems

Paper ID: ICISCM'25-268

COMPUTATIONAL INTELLIGENCE APPROACHES FOR DYNAMIC RECONFIGURATION IN AUTONOMOUS SYSTEMS

Jerry Bergsma, Sheila Boehning and Paige Bokach.

Ajou University.

bergsmajerry@outlook.com, sheilaboehning56@outlook.com and paigebokach@outlook.com

ABSTRACT

Dynamic reconfiguration in autonomous systems is essential for maintaining operational efficiency, robustness, and adaptability in uncertain and evolving environments. This paper explores computational intelligence techniques to enable real-time dynamic reconfiguration of autonomous agents, allowing them to modify their behavior, structure, or control strategies in response to internal changes or external stimuli. The proposed framework integrates neural networks, fuzzy logic, and evolutionary algorithms to model complex system dynamics and optimize reconfiguration decisions. Neural networks facilitate pattern recognition and prediction of system states, while fuzzy logic handles uncertainty and imprecise information during decision-making. Evolutionary algorithms provide adaptive optimization capabilities to identify optimal reconfiguration strategies under varying constraints and objectives. The framework supports modular architectures that can seamlessly switch or adjust components, ensuring continuous functionality even under faults or environmental disturbances. Case studies involving autonomous robotics and unmanned aerial vehicles demonstrate the effectiveness of the approach in enhancing system resilience, mission success rates, and energy efficiency. Performance evaluations reveal that computational intelligence-driven reconfiguration outperforms static and rule-based methods by offering higher adaptability and faster response times. This research contributes to advancing autonomous system design by providing a scalable, intelligent, and flexible solution for dynamic reconfiguration, which is critical for applications in defense, industrial automation, and smart transportation systems.

Keywords: computational intelligence, dynamic reconfiguration, autonomous systems, neural networks, evolutionary algorithms

Paper ID: ICISCM'25-040

KNOWLEDGE GRAPH CONSTRUCTION AND REASONING FOR SEMANTIC DATA INTEGRATION

Jung hoon Koo, Jaeryang Yoon and Sang-Jo Kan.
Korea Maritime University.
junghoonkoo@edu.com, yoonjaeyang0102@edu.com and Sangkanjo@edu.com

ABSTRACT

Semantic data integration is a critical challenge in managing heterogeneous and distributed data sources across various domains. Knowledge graphs have emerged as a powerful tool to represent and unify diverse data by capturing entities, relationships, and contextual semantics in a structured form. This paper presents a comprehensive framework for constructing knowledge graphs and performing reasoning to facilitate effective semantic data integration. The proposed methodology includes automated extraction of entities and relationships from unstructured and semi-structured data, ontology alignment to harmonize different schemas, and graph embedding techniques to enrich semantic representations. Reasoning mechanisms based on rule inference and description logic enable the discovery of implicit knowledge, consistency checking, and support complex queries across integrated datasets. The framework addresses challenges related to data heterogeneity, incompleteness, and scalability through modular components and efficient algorithms. Experimental validation is conducted on real-world datasets from healthcare and finance domains, demonstrating improved data interoperability, query accuracy, and knowledge discovery compared to traditional integration approaches. The results confirm that combining knowledge graph construction with advanced reasoning techniques significantly enhances the ability to integrate and analyze semantically rich data, enabling more informed decision-making and facilitating intelligent applications such as recommendation systems, semantic search, and automated reasoning. This work contributes to advancing semantic data integration by providing a scalable and interpretable solution based on knowledge graphs.

Keywords: knowledge graphs, semantic data integration, ontology alignment, reasoning, graph embedding

Paper ID: ICISCM'25-137

GRAPH NEURAL NETWORKS FOR INFERENCE AND PREDICTION IN COMPLEX DATA RELATIONSHIPS

Martina Absinta, Alfonso Fasano and Chiara Arienti.
IULM University of Milan.
absinramartina@epk.com, alfonosfasano@epk.com and chiaraarienti23@epf.com

ABSTRACT

Graph Neural Networks (GNNs) have emerged as powerful tools for modeling complex relational data by combining graph theory with deep learning to capture dependencies among entities in non-Euclidean domains. This paper investigates the application of GNNs for inference and prediction tasks involving complex data relationships found in social networks, biological systems, recommendation engines, and knowledge graphs. The proposed approach leverages message passing mechanisms to iteratively aggregate and transform node and edge features, enabling the model to learn rich representations that encode both local and global graph structure. We explore various GNN architectures, including Graph Convolutional Networks, Graph Attention Networks, and GraphSAGE, to evaluate their effectiveness in tasks such as node classification, link prediction, and graph-level prediction. The framework integrates domain-specific feature engineering with end-to-end training to enhance model generalization and interpretability. Extensive experiments on benchmark datasets demonstrate that GNN-based models outperform traditional machine learning techniques and shallow graph embedding methods in terms of accuracy, scalability, and robustness to noisy or incomplete data. Furthermore, the paper discusses challenges related to over-smoothing, computational complexity, and dynamic graph handling, proposing potential solutions to address these issues. The research highlights the versatility and strength of GNNs as a unifying framework for learning from complex relational data, paving the way for advances in numerous intelligent systems applications.

Keywords: graph neural networks, inference, prediction, complex data, relational learning

Paper ID: ICISCM'25-220

MULTI-VIEW STEREO TECHNIQUES FOR ACCURATE 3D RECONSTRUCTION IN DYNAMIC ENVIRONMENTS

Annamaria Agnes, Francesca Anastasi and Luigi Apuzzo.
University of International Studies of Rome.
Annamariaagnes@org.com, anastasifrancesca1214@org.com, apuzzoluigi88@org.com

ABSTRACT

Accurate 3D reconstruction in dynamic environments remains a challenging problem due to scene complexity, object movement, and varying lighting conditions. This paper presents an advanced multi-view stereo (MVS) framework designed to enhance the precision and robustness of 3D reconstruction from multiple camera viewpoints in dynamic settings. The proposed technique integrates real-time depth estimation, feature matching, and temporal coherence mechanisms to effectively handle occlusions, motion blur, and changing scene geometry. A novel adaptive view selection strategy is introduced to prioritize camera perspectives that contribute the most informative data for reconstruction, thereby improving accuracy while reducing computational overhead. Additionally, motion segmentation algorithms are incorporated to separate dynamic objects from static backgrounds, enabling targeted reconstruction and minimizing artifacts caused by moving elements. Extensive experiments using synthetic and real-world datasets demonstrate the framework's superior performance in reconstructing detailed 3D models of scenes with multiple moving objects compared to traditional MVS approaches. The method achieves high spatial resolution and temporal consistency, supporting applications in augmented reality, robotics, and smart surveillance. The system's modular design facilitates integration with existing computer vision pipelines, making it scalable and adaptable to diverse use cases. This research advances the state-of-the-art in multi-view stereo reconstruction by providing a practical and effective solution for dynamic environments, where real-time accuracy and robustness are critical.

Keywords: multi-view stereo, 3D reconstruction, dynamic environments, motion segmentation, depth estimation

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DEEP LEARNING-BASED 3D SCENE RECONSTRUCTION FROM MONOCULAR AND MULTI-CAMERA INPUTS

Sumit Agarwal, Cristian Badarinza and Poorya Kabir.

Singapore Management University.

Sumitagrwal12@outlook.com, badarinza@outlook.com and kabirpoorya1009@poutlook.com

ABSTRACT

Accurate 3D scene reconstruction plays a vital role in numerous applications such as autonomous navigation, virtual reality, and digital content creation. This paper presents a deep learning-based framework for 3D reconstruction that effectively handles both monocular and multi-camera inputs, enabling flexibility across various deployment scenarios. Traditional geometry-based approaches struggle with depth ambiguity and occlusions in monocular settings, while multi-camera systems often demand extensive calibration and synchronization. The proposed framework leverages convolutional neural networks and attention mechanisms to infer dense depth maps and geometric structures directly from image data. For monocular inputs, the model employs supervised and self-supervised training paradigms to estimate depth and generate coherent 3D representations. For multi-view inputs, a view aggregation module fuses spatial cues from different perspectives, improving depth accuracy and surface completeness. A multi-scale refinement strategy is integrated to enhance fine-grained geometric details and reduce reconstruction noise. The system is evaluated on standard datasets such as KITTI and ScanNet, achieving competitive performance compared to state-of-the-art reconstruction methods. Moreover, the approach demonstrates strong generalization across indoor and outdoor scenes, as well as scalability to real-time applications with appropriate hardware acceleration. This research contributes to bridging the gap between monocular and multi-camera reconstruction through a unified deep learning model that balances accuracy, adaptability, and computational efficiency for diverse 3D scene understanding tasks.

Keywords: 3D reconstruction, deep learning, monocular input, multi-camera, depth estimation

Paper ID: ICISCM'25-148

LIGHTWEIGHT CONVOLUTIONAL NEURAL NETWORK ARCHITECTURES FOR REAL-TIME IMAGE CLASSIFICATION

Professor Mark Ogden, Mrs Kaye Mazzoleni and Prof. Sarina Claassens.
The University of Newcastle. Australia.
ogdenmark@23.org.com, mazzoleni@org.com, and sarinaclaassens@org.com

ABSTRACT

Real-time image classification is a critical task in many edge and mobile computing applications, including autonomous vehicles, surveillance systems, and wearable devices. Traditional convolutional neural network (CNN) architectures, while highly accurate, often involve substantial computational complexity and memory consumption, making them unsuitable for real-time deployment on resource-constrained platforms. This paper investigates lightweight CNN architectures that strike a balance between model accuracy and computational efficiency for real-time image classification. We evaluate and compare several state-of-the-art lightweight models such as MobileNet, ShuffleNet, and EfficientNet-Lite, focusing on their architecture design, parameter count, floating-point operations (FLOPs), and inference latency. Furthermore, we propose a modified architecture that incorporates depthwise separable convolutions, channel pruning, and knowledge distillation to reduce model size without significant loss in classification accuracy. Extensive experiments are conducted on benchmark datasets, including CIFAR-10 and ImageNet-100, demonstrating that the proposed lightweight architecture achieves real-time performance with minimal accuracy degradation. The model is benchmarked on edge devices such as Raspberry Pi and Jetson Nano, achieving inference speeds suitable for practical applications. Additionally, optimization techniques, including quantization and tensor decomposition, are discussed to further enhance runtime efficiency. This research contributes to the development of deployable CNN solutions for real-time classification tasks, offering a framework that ensures fast, accurate, and energy-efficient inference in constrained environments.

Keywords: lightweight CNN, real-time classification, mobile computing, model compression, edge AI

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OPTIMIZING DEEP NEURAL NETWORKS FOR LOW-LATENCY INFERENCE IN EDGE COMPUTING ENVIRONMENTS

Dr. Pablo Barriga, Dr. Gunnar Kaßberg, Dr. Ana Beatriz Ribeiro.

University of Greifswald.

Pablobarriga@outlook.com, gunnarberg8712@outlook.com, and anaribeiro@outlook.com

ABSTRACT

The deployment of deep neural networks (DNNs) in edge computing environments poses significant challenges due to the constraints of limited computational resources, energy efficiency requirements, and the need for low-latency inference. This paper presents a comprehensive framework for optimizing DNNs to meet the stringent demands of real-time processing on edge devices. The approach integrates a combination of model compression techniques such as pruning, quantization, and knowledge distillation to reduce model complexity while preserving inference accuracy. Additionally, the use of neural architecture search (NAS) is explored to automatically design lightweight network structures tailored to specific hardware and task requirements. Runtime optimization strategies, including layer fusion, memory access reduction, and batch normalization folding, are implemented to minimize inference delay. Experimental evaluations are conducted on widely used models such as ResNet, MobileNet, and EfficientNet, deployed on platforms like Raspberry Pi and NVIDIA Jetson Nano. The results demonstrate significant improvements in inference speed, power consumption, and memory usage, with negligible impact on accuracy. The study also benchmarks the performance gains achieved through various optimization combinations, providing guidelines for selecting strategies based on application constraints. This research contributes to the advancement of practical deep learning deployment at the network edge by enabling responsive, resource-aware AI systems for applications such as smart surveillance, industrial automation, and autonomous systems.

Keywords: edge computing, deep neural networks, low-latency inference, model optimization, real-time AI

Paper ID: ICISCM'25-250

COOPERATIVE INTELLIGENT AGENTS FOR TASK ALLOCATION IN DISTRIBUTED CLOUD ENVIRONMENTS

Dr. Dinar Abdullin, Dr. Kaustuv Basu and Prof. Frank Bigiel.
Chemnitz University of Technology.
abdullindinar@yahoo.com, basukaustuv@yahoo.com and bigielfrank12@yahoo.com

ABSTRACT

Effective task allocation in distributed cloud environments is essential for optimizing resource utilization, minimizing response time, and ensuring service reliability. This paper proposes a cooperative multi-agent framework in which intelligent agents operate autonomously and collaboratively to allocate computational tasks across heterogeneous cloud resources. Each agent represents a cloud node equipped with decision-making capabilities driven by artificial intelligence, enabling it to evaluate local resource states and exchange information with peer agents. The system employs distributed negotiation and consensus-building strategies to achieve dynamic load balancing and fault tolerance without relying on centralized control. Reinforcement learning techniques are integrated within agents to enable adaptive decision-making based on real-time performance feedback, evolving network conditions, and task complexity. The proposed framework is evaluated under simulated cloud scenarios with varying workloads, latency constraints, and node availability. Results indicate that cooperative intelligent agents significantly improve task throughput, resource efficiency, and system scalability compared to traditional static and centralized allocation methods. Furthermore, the system demonstrates resilience in the face of node failures and fluctuating demand, maintaining consistent performance through agent-level adaptability. This research highlights the potential of decentralized, intelligent coordination mechanisms in complex cloud infrastructures, paving the way for next-generation autonomous cloud management systems that can self-organize, self-optimize, and scale on demand in distributed computing environments.

Keywords: intelligent agents, task allocation, distributed cloud, cooperative systems, reinforcement learning

Paper ID: ICISCM'25-079

DESIGN AND IMPLEMENTATION OF AUTONOMOUS AGENTS FOR LOAD BALANCING IN DISTRIBUTED SYSTEMS

Dr Julie Cross, Gianluca Andresani and Dr. Alessandro Stefano Ala.

Aberystwyth University.

Juliecross567@org.com, gianlucaandresani@org.com and stefanoala@org.com

ABSTRACT

Efficient load balancing in distributed systems is essential for maintaining high availability, minimizing latency, and optimizing resource utilization. This paper presents the design and implementation of autonomous software agents that perform decentralized load balancing across distributed computing environments. The proposed architecture enables each agent to operate independently while maintaining system-wide coordination through local interactions and decision-sharing mechanisms. These agents continuously monitor node workload, resource availability, and task queues, dynamically redistributing tasks to underutilized nodes to achieve balanced system performance. A combination of rule-based logic and reinforcement learning empowers the agents to adaptively refine their decision-making over time, learning optimal strategies for task migration and resource reallocation under diverse operating conditions. The implementation is tested in a simulated distributed network with heterogeneous nodes, where performance is evaluated based on response time, throughput, and fault tolerance. Results show that the autonomous agent-based approach significantly outperforms traditional static and centralized load balancing algorithms, particularly in environments with fluctuating workloads and partial node failures. Additionally, the system's scalability is demonstrated as the number of nodes and tasks increases, with agents maintaining effective load distribution with minimal communication overhead. This research contributes a scalable, adaptive solution to distributed system management, showing that autonomous agents can serve as intelligent load balancers capable of enhancing system robustness and performance without central coordination.

Keywords: autonomous agents, load balancing, distributed systems, adaptive algorithms, decentralized control

Paper ID: ICISCM'25-115

LONG SHORT-TERM MEMORY NETWORKS FOR ACCURATE MULTIVARIATE TIME SERIES FORECASTING

Sherin Hatem Khalil Abbas, Hassana Abdullahi and Teksin Kopanoglu.
Cranfield University.
Sherinhatem12@gmail.com, hassanaabdullahi@gmail.com, teksinkopanoglu0009@gmail.com

ABSTRACT

Accurate multivariate time series forecasting plays a vital role in decision-making processes across domains such as finance, energy, healthcare, and supply chain management. Traditional forecasting models often fail to capture complex temporal dependencies and nonlinear interactions among multiple variables. This paper investigates the application of Long Short-Term Memory (LSTM) networks, a variant of recurrent neural networks, for modeling and predicting multivariate time series data with high temporal dynamics. The proposed architecture includes stacked LSTM layers with attention mechanisms to selectively focus on relevant time steps and variables, enhancing the model's learning efficiency. Feature normalization and sequence padding techniques are employed to manage variable-length inputs and ensure stable training. The model is evaluated on benchmark datasets from diverse application domains, including electricity consumption, air quality monitoring, and stock price forecasting. Experimental results demonstrate that the LSTM-based framework significantly outperforms traditional statistical models such as ARIMA and VAR, as well as feedforward neural networks and standard recurrent networks, in terms of forecasting accuracy and robustness to missing or noisy data. Furthermore, the study explores the impact of hyperparameter tuning, window sizing, and multi-step forecasting on model performance. The findings highlight the capability of LSTM networks to model complex temporal relationships in multivariate contexts and their suitability for deployment in real-time predictive systems that require both precision and adaptability.

Keywords: LSTM networks, time series forecasting, multivariate prediction, temporal modeling, deep learning

Paper ID: ICISCM'25-206

TEMPORAL CONVOLUTIONAL NETWORKS FOR REAL-TIME FORECASTING IN ENERGY DEMAND PREDICTION

Aaron Coode, Dr Adetola Adekunle and Dr Alister Du Rose.

University of the Arts London.

coodeaaron.edu@org, adetolaadekunle.edu@org and alisterrose.edu@org

ABSTRACT

Accurate and real-time forecasting of energy demand is essential for ensuring efficient grid operation, reducing energy wastage, and supporting the integration of renewable sources. This paper presents the use of Temporal Convolutional Networks (TCNs) for energy demand forecasting, emphasizing their suitability for real-time applications due to their high parallelizability and long-range temporal modeling capabilities. Unlike recurrent models, TCNs leverage causal dilated convolutions and residual connections to capture both short-term fluctuations and long-term patterns in energy consumption data without suffering from vanishing gradients or sequential bottlenecks. The proposed TCN-based framework is trained and tested on real-world datasets consisting of hourly and daily energy consumption records from smart grids and utility providers. Data preprocessing includes normalization, windowing, and temporal feature extraction to enhance model performance. Comparative analysis with traditional models such as ARIMA and machine learning approaches, including LSTM and GRU, demonstrates that TCNs achieve superior prediction accuracy, faster inference time, and better scalability across varying data volumes. The system also supports multi-horizon forecasting, making it suitable for both operational and strategic energy planning. Implementation on edge-computing platforms further highlights the model's capacity for real-time deployment. This research confirms the effectiveness of TCNs as a robust and efficient solution for modern energy forecasting challenges, especially in dynamic and high-frequency environments.

Keywords: temporal convolutional networks, energy forecasting, real-time prediction, deep learning, smart grid

Paper ID: ICISCM’25-031

REAL-TIME FACIAL EXPRESSION RECOGNITION USING LIGHTWEIGHT DEEP LEARNING MODELS

Dr. Sudhir Pratap Singh, Dr. Chirayu Desai, PhD and Dr. Surya Ramachandran.
Gujarat Technological University.
pratapsingh@edu.gbu.in, chirayudesai@edu.in and ramachndrasurya12@edu.in

ABSTRACT

Facial expression recognition (FER) in real time is a key enabler for affective computing applications such as human–computer interaction, virtual assistants, and behavioral analysis. However, implementing FER on edge devices and mobile platforms presents significant challenges due to limitations in processing power, memory, and energy consumption. This paper presents a real-time FER system based on lightweight deep learning models optimized for deployment in constrained environments. The approach utilizes compact convolutional neural network architectures, including variants of MobileNet and ShuffleNet, which significantly reduce the number of parameters and floating-point operations without compromising accuracy. A hybrid training strategy combining transfer learning and data augmentation is adopted to improve generalization across diverse facial features and lighting conditions. The system is trained and evaluated on benchmark datasets such as FER-2013 and RAF-DB, showing high classification accuracy across basic emotion categories, including happiness, sadness, anger, and surprise. Real-time inference performance is benchmarked on Raspberry Pi and NVIDIA Jetson Nano, achieving stable frame rates and low latency suitable for live applications. The paper also explores model quantization and pruning techniques to further enhance runtime efficiency. Results demonstrate that the proposed lightweight models enable robust and responsive facial expression recognition in real-world scenarios, offering a practical solution for emotion-aware applications that demand low computational overhead and real-time responsiveness.

Keywords: facial expression recognition, real-time processing, lightweight CNN, emotion detection, deep learning