IEEE 2025-26 PROJECT LIST	
Embedded	
CODE	TITLE AND ABSTRACT
26-ANSP-EM-001	**An Innovative Smart Irrigation Using Embedded and Regression-Based Machine Learning Technologies for Improving Water Security and Sustainability** Global agriculture is facing major challenges such as food security, sustainable water management, and the preservation of natural resources. Water scarcity, exacerbated by climate change, requires adopting more efficient agricultural practices. Traditional irrigation systems, often imprecise, contribute to water wastage. The use of embedded systems and machine learning offers a solution for optimizing irrigation according to local conditions and actual crop needs while contributing to food security and environmental sustainability. This study proposes an innovative approach to irrigation management, integrating real-time data and predictive models to improve irrigation efficiency. This study proposes an irrigation system based on embedded systems, using sensors and algorithms to collect and analyze data in order to optimize water management. The system adjusts irrigation levels according to specific crop needs, thus contributing to more sustainable water management. Using ML algorithms like linear regression algorithms to model the relationships between environmental factors and crop water requirements, enabling accurate prediction of required irrigation levels based on data collected by sensors. The use of embedded systems such as the ESP32, combined with temperature, humidity, and water level sensors, has enabled the development of an autonomous and efficient system for collecting data in real-time and processing it for decision-making. The proposed model has an MAE of 0.8434, an RMSE of 0.8434, and a coefficient (R2 Score) of 0.4044, offering soil moisture prediction accuracy. Furthermore, the training time of our model is 0.00253 seconds, while the prediction time is 0.00117 seconds. These results show not only the performance of the proposed model in terms of accuracy but also its computational efficiency, outperforming some of the studies mentioned. The results of the study show a significant reduction in water consumption, with a marked improvement in water resource management. Discussions reveal that the integration of embedded systems with machine learning algorithms can not only improve irrigation efficiency but also contribute to the sustainability of agriculture by enabling more accurate and adaptive management of water resources. This paper represents an important step towards improving food security and sustainable water management, particularly in regions facing increasing climatic challenges.
26-ANSP-EM-002	**Automated Targeted Sectioning of Resin-Embedded Hard Tissue Specimen Using Micro-Computed Tomography in Combination With Laser Microtomy** Objective: Histological analysis of hard tis- sue specimens is widely used in clinical practice and pre- clinical research, but it remains a labor-intensive and destructive process. In particular, resin-embedded tissues present challenges due to the inability to target regions of interest (ROI), as internal structures are not visible externally. This work proposes a guided sectioning work- flow that enables precise targeting of concealed ROIs using a multimodal approach. Methods: By combining microCT imaging with an automated cutting system, and laser microtomy, precise targeted sectioning was achieved. MicroCT imaging enables visualization of internal struc- tures,

	guiding the automated cutting system for precise sectioning. Laser microtomy then allows thin tissue sections to be prepared while preserving diagnostic features. Result: Comparing the automated workflow to the conventional cutting-grinding technique showed that the new method improved accuracy by a factor of 7 and reduced material loss by half and processing time by 75%. Validation was performed by comparing the histological sections within silico target planes generated from the microCT scans, showing precise alignment between the targeted regions and the prepared sections. Conclusion: We demonstrate that the proposed approach significantly reduces tissue loss and offers a more efficient workflow compared to traditional methods. Additionally, microCT-based targeting enables accurate correlation between histological findings and 3D pathological structures. Significance: The auto- mated guided sectioning workflow provides valuable in- sights into tissue pathology, enhancing clinical diagnostics and preclinical research. It also facilitates the generation of multimodal datasets, which can be used in future machine learning applications.
26-ANSP-EM-003	**Design and Research of Network Edge Device Security Monitoring System Based on Embedded System and Bi-LSTM** With the popularization of smart devices and networked devices, edge device security issues have become increasingly prominent. Traditional security monitoring systems often rely on centralized data processing mode, which is difficult to meet the current real-time analysis requirements of massive data. In order to solve this problem, this paper designs a network edge device security monitoring system based on the fusion of embedded system and bidirectional long-short-term memory network. By deploying the Bi-LSTM model through the embedded processor, the system can detect the abnor- mal behavior of edge devices in real time, thereby improving the response speed and accuracy of security monitoring. This paper conducts experimental analysis on the actual network traffic data set, collects security data from different types of edge devices, covering device types including smart routers, IoT sensors, etc., and processes more than 100GB of network traffic data in total. The experimental results show that the detection accuracy of the Bi-LSTM model in network attack behavior reaches 96.8%, which is about 4.2% and 5.5% higher than the traditional random forest and support vector machine models respectively. In addition, the real-time analysis of the system shows that the average processing latency of the embedded system is less than 200 ms, which meets the low latency requirement in edge computing environment.
26-ANSP-EM-004	**Dimension-Specific Margins and Element-Wise Gradient Scaling for Enhanced Matryoshka Speaker Embedding** Speaker embeddings trained with Matryoshka Representation Learning (MRL) provide embeddings of various dimensions with minimal overhead, adapting to different computational and storage constraints. Compared to single-dimensional models, MRL-based models show improved speaker verification performance in lower dimensions, but there is some degradation in higher dimensions. Analyzing learned embeddings, we observe an imbalance in the element-wise magnitudes of speaker embeddings trained with MRL. Specifically, the higher-dimensional elements exhibit extremely small values, which could reduce their contribution to cosine similarity and degrade speaker verification performance. To address this imbalance and improve performance consistency across all dimensions, we propose two methods: dimension-specific margins and element-wise gradient scaling. Dimension-specific margins stabilize training by adjusting the margin for each dimension to mitigate instability caused by excessively high values for given dimensions. Element-wise gradient scaling mitigates imbalance by scaling gradients propagated to each element, considering differences in embedding dimensionality and the number of loss functions

	influencing each element. Evaluation on the VoxCeleb benchmark shows that the proposed methods, when applied to MRL, improve speaker verification performance in higher-dimensional embeddings while maintaining performance in lower-dimensional embeddings. Additionally, an analysis of the element-wise magnitudes of learned embeddings visually demonstrates that element-wise gradient scaling effectively mitigates the magnitude imbalance.
26-ANSP-EM-005	**Enhanced Vector Quantization for Embedded Machine Learning: A Post-Training Approach With Incremental Clustering** TinyML enables the deployment of Machine Learning (ML) models on resource-constrained devices, addressing a growing need for efficient, low-power AI solutions. However, significant challenges remain due to strict memory, processing, and energy limitations. This study introduces a novel method to optimize Post-Training Quantization (PTQ), a widely used technique for reducing model size, by integrating Vector Quantization (VQ) with incremental clustering. While VQ is a technique that reduces model size by grouping similar parameters, incremental clustering, implemented via the AutoCloud K-Fixed algorithm, preserves accuracy during compression. This combined approach was validated on an automotive dataset predicting CO2 emissions from vehicle sensor measurements such as mass air flow, intake pressure, temperature, and speed. The model was quantized and deployed on Macchina A0 hardware, demonstrating over 90% compression with negligible accuracy loss. Results show improved performance and deployment efficiency, showcasing the potential of this combined technique for real-world embedded applications.
26-ANSP-EM-006	**Enhancing Reliability in Embedded Systems Hardware: A Literature Survey** Embedded Systems are used in extreme conditions, often for long lifespans; as such, ensuring hardware reliability is essential. Additionally, the applications of embedded systems can be safety-critical or costly in the event of a failure. Applications and environments such as these demand high reliability. This literature survey explores the challenges of achieving hardware reliability in embedded systems. It examines critical works using different methodologies and viewpoints to summarize hardware reliability comprehensively. The paper discusses the main failure modes identified in embedded systems hardware, evaluates various mitigation strategies, and identifies emerging trends influencing the future of embedded system design. By critically analyzing existing literature, this survey is a resource for future research efforts focused on growing the reliability of embedded systems. Finally, this paper outlines the motivation and first methods for a systems-level approach to embedded systems reliability.
26-ANSP-EM-007	**From Bag-of-Words to Transformers: A Comparative Study for Text Classification in Healthcare Discussions in Social Media** One notable paradigm shift in Natural Language Processing has been the introduction of Transformers, revolutionizing language modeling as Convolutional Neural Networks did for Computer Vision. The power of Transformers, along with many other innovative features, also lies in the integration of word embedding techniques, traditionally used to represent words in a text and to build classification systems directly. This study delves into the comparison of text representation techniques for classifying users who generate medical topic posts on Facebook discussion groups. Short and noisy social media texts in Italian pose challenges for user categorization. The study employs two datasets, one for word embedding model estimation and another comprising discussions from users. The main objective is to achieve optimal user categorization through different pre-processing

	and embedding techniques, aiming at high generalization performance despite class imbalance. The paper has a dual purpose, i.e., to build an effective classifier, ensuring accurate information dissemination in medical discussions and combating fake news, and to explore also the representational capabilities of various LLMs, especially concerning BERT, Mistral and GPT-4. The latter is investigated using the in-context learning approach. Finally, data visualization tools are used to evaluate the semantic embeddings with respect to the achieved performance. This investigation, focusing on classification performance, compares the classic BERT and several hybrid ver- sions (i.e., employing different training strategies and approximate Support Vector Machines in the classification layer) against LLMs and several Bag-of-Words based embedding (notably, one of the earliest approaches in text classification). This research offers in- sights into the latest developments in language modeling, advancing in the field of text representation and its practical application for user classification within medical discussions.
26-ANSP-EM-008	**Generalized Score Comparison-Based Learning Objective for Deep Speaker Embedding** In state-of-the-art speaker verification systems, speaker embeddings are trained to be closer to the target speaker prototype, which is either obtained from the other speech samples or constructed with trainable parameters. This can be considered a classification task since the network is trying to learn the features that are most relevant to the corresponding speaker from the input speech. Although classification-based learning demonstrates the ability to extract speaker-related information, it does not guarantee optimal speaker verification performance. In this paper, we propose a score comparison-based learning objective, which guides the training framework to be more consistent with the verification task, enforcing the embedding space to have lower intra-class variance compared to inter-class variance in terms of similarity scores. Furthermore, we propose a generalized loss function for score comparison-based learning, encompassing many conventional training losses and regularization techniques. The proposed technique is compared with the conventional methods using the VoxCeleb, VOiCES, CN-Celeb, and Common Voice datasets. Experimental results demonstrate that the proposed method can boost the performance and make the system more robust to over-fitting in speaker verification tasks.
26-ANSP-EM-009	**High-Level Reconfigurable Embedded System Design Based on Heterogeneous Models of Computation** One of the main challenges of embedded system design lies in the natural heterogeneity of these systems. We can say that embedded systems are electronic systems designed and programmed to tackle a specific application. Each application has its requirements, although embedded systems often combine many domain-specific subsystems. Considering this context, the design of embedded systems can be extremely challenging, including system modeling, simulation, formal verification, and the synthesis to a correct implementation. To manage the complexity of such systems, the design should start at higher levels of abstraction, based on formal models, without considering the low-level characteristics of the underlying software or hardware. These high-level formal meta-models, named models of computation (MoC), define a set of rules that dictate how computation should be performed and how they should communicate with each other, along with other information such as the notion of time. In this paper, we present as the main contribution a set of rules and interfaces that enable the proper mixing of different MoC domains in a framework for complex embedded system design, thus allowing a heterogeneous system composition at a high abstraction level, including the synchronous reactive, synchronous dataflow, and scenario-aware dataflow MoCs. We model both part of an avionic system and a reconfigurable RISC-V processor using these MoCs and the

	proposed interfaces as a case study showing the applicability brought by our proposal.
26-ANSP-EM-010	**Innovative Tailored Semantic Embedding and Machine Learning for Precise Prediction of Drug-Drug Interaction Seriousness** This study explores applying advanced machine-learning strategies, particularly improved semantic vectors, to predict the severity of drug-drug interactions (DDIs), a crucial element in pharmacovigilance. Based on the Adverse Event Reporting System (FAERS), our study aims to analyze the combination of advanced embedding techniques with state-of-the-art machine learning (ML) algorithms to identify and quantify DDI severity. The CatBoost Classifier is the center of our analysis, as it has emerged as the most effective model in the examined trials. We improved the performance by increasing the BioWordVec Indication Substance embedding specificity, a new creation constructed through transfer learning method- ologies employed on the BioWordVec model. This approach employs not only the names of the drugs but also the indications for the drugs and the active substances, forming a highly semantic network capable of capturing multiple relations between drugs. Applying BioWordVec Indication Substance embedding combined with the CatBoost Classifier, especially using the contact-vectors method, provided the best F1 score of 73. 32% and an ROC AUC score of 84%. The results imply that this method effectively models and predicts severe consequences of DDIs using deep learning that comprehensively covers pharmacological and clinical aspects. Based on our results, we suggest incorporating semantic embedding and ML into the pharmacovigilance processes to improve the predictive potential of DDI evaluations. Thus, by enhancing the body of knowledge related to the analytical methods of assessing drug interactions, the present study substantially enhances the quality of clinical decision-making and patient protection. The novel embedding marks a significant step forward in the methodology, providing a more solid tool for the fine-grained dissection of the complexities needed in modern medicine, where multiple drug therapies are now the norm.
26-ANSP-EM-011	**Knowledge Graph-Driven Approach in Aspect-Based Sentiment Analysis: Exploring the Impact of Embedding Techniques** Despite the high performance of the existing embedding approaches for Aspect-Based Sentiment Analysis (ABSA), such as Word2Vec and GloVe, they still have several limitations, mainly in contextual understanding and relational insights of natural language, especially in complex and long sentences. This paper presents a novel approach that enhances ABSA by integrating knowledge graphs into a transformer model, where the graphs are automatically built from raw text without requiring external resources, making the system adaptable and fully data-driven. Our approach allows a better understanding of context and relationships between entities, by combining of the contextual understanding of BERT with the relational insights provided by Node2Vec, a graph-based embedding technique. In this paper, we benchmark our hybrid embedding technique with the existing state-of-the-art embedding techniques. Specifically, we compare traditional embeddings, such as Word2Vec and GloVe, against BERT for textual input, while also exploring Word2Vec and Node2Vec for graph-based embeddings. Our experiments demonstrate that combining BERT's deep contextual embeddings with the structural insights of Node2Vec leads to promising improvements in sentiment classification performance. Our model achieved 98% accuracy on SemEval2015 Restaurant dataset. These results demonstrate that integrating both contextual and relational information significantly enhances the performance of ABSA models, thereby

	making them more effective at capturing nuanced sentiment relationships. The proposed model's modular design also allows flexible integration of alternative embeddings or graph configurations, making it suitable for broader sentiment analysis applications beyond the benchmark datasets.
26-ANSP-EM-012	**Multi-Modal Deep Embedded Clustering (MM-DEC): A Novel Framework for Mineral Detection Using Hyperspectral Imagery** Identification of minerals through remote sensing imagery plays an important role in mineral exploration, especially when ground truth data or field work is not accessible. Hyperspectral imaging, which collects information from hundreds of narrow spectral bands, is a powerful tool that provides intricate surface information, but presents challenges due to its high-dimensionality and the complex structure of the data. To this end, we propose Multi-Modal Deep Embedded Clustering (MM-DEC) approach, an innovative unsu- pervised learning framework that integrates Convolutional Autoencoders(CAEs), Variational Autoencoders (VAEs), and Gray Level Co-occurrence Matrix (GLCM) based texture extraction that is able to exploit the spatial, spectral, and texture features of mineral in consideration We demonstrate the MM-DEC potential to identify hematite prospects in the mineralized Kiriburu area of Jharkhand, India using EO-1 Hyperion hyperspectral data. Preprocessing pipeline includes denoising using Machine Learning(ML) and statistical techniques, followed by major land cover classification based on spectral indices including Normalized Difference Vegetation Index (NDVI); Normalized Difference Water Index (NDWI) and Normalized Difference Soil Index (NDSI). By using the widely applied Pixel Purity Index (PPI), pure spectral pixels are extracted for refining and providing a high-confidence target point of hematite detection. Evaluation metrics based on cluster quality such as Silhouette Score, and Davies-Bouldin Index (DBI), show that MM-DEC is a competent model, as it is able to produce relatively compact and well-defined clusters as compared to conventional clustering methods. We achieved a similarity score of 98.69% in reference to the hematite spectral signatures. With accurate cluster labels, geographical coordinates, and spectral similarity scores, our method establishes a precedent in mineral extraction and resource planning based on remote sensing advancements.

26-ANSP-EM-013	**Navigating the Challenges and Opportunities of Securing Internet of Autonomous Vehicles With Lightweight Authentication** The Internet of Things (IoT) can be defined as the network of physical objects, or ‘‘things,’’ embedded with sensors and software for processing and exchanging data with other devices and ecosystems using the Internet as a medium. With its rapid growth over the past decade, it has permeated several application domains, including intelligent vehicular systems. The Internet of Autonomous Vehicles (IoAV) is a subset of IoT that envisions dynamic autonomous driving without human intervention. The dynamic nature of the environment in which autonomous vehicles operate introduces significant challenges, such as real-time communication and security vulnerabilities. These challenges cannot be directly addressed by standard cybersecurity solutions designed primarily for static IoT environments. In this work, we outline the various vulnerabilities of the IoAV systems, and we delve into the critical importance of adopting lightweight security protocols. These protocols are crucial to ensure robust protection while at the same time not jeopardizing the performance of the IoAV system. We also highlight the

	fast lightweight security protocols implemented on heterogeneous embedded, low-power, high-performance computing platforms as a viable solution to address these challenges.
26-ANSP-EM-014	**Research on Encryption Algorithm and Embedded System Optimization Strategy Based on IoT Security** In the face of increasingly complex IoT environments and increasing data volumes, existing encryption algorithms still need to be further optimized in terms of the balance between efficiency and security. For embedded systems, their hardware resources are limited, and the current optimization strategies still have shortcomings in improving system performance, reducing power consumption and enhancing system stability. In this study, the optimization strategy of encryption algorithm and embedded system based on IoT security is studied. Designed for lightweight encryption algorithms and deployed in embedded systems, it aims to balance the security and performance of IoT devices and provide users with a seamless and reliable service experience. In this study, three encryption algorithms, AES-Light, SPECK and SIMON, were selected and compared on ARM Cortex-M series microcontrollers. Experiments show that the SPECK algorithm leads with its excellent encryp- tion and decryption rate, which is 15% faster than AES-Light, while the power consumption of SIMON is reduced by 20%. Based on this, preferred encryption schemes suitable for different IoT scenarios are established. In addition, in order to overcome the limitation of fixed encryption settings in a dynamic network environment, this project proposes an adaptive encryption strength adjustment strategy. By monitoring the risk level of the equipment in real-time and automatically optimizing the encryption parameters, the security guarantee is improved by 30% in high-risk situations while avoiding unnecessary computing overhead in low-risk scenarios, improving the overall efficiency by more than 15%, and significantly enhancing the intelligence and adaptability of IoT systems.
26-ANSP-EM-015	**Research on Optimization of Large-Scale Heterogeneous Combat Network Based on Graph Embedding** In the era of information warfare, the combat system-of-systems consists of interconnected entities that can be abstracted as heterogeneous combat network (HCN). Developing HCNs with exceptional performance is crucial to building effective combat system-of-systems. Currently, large-scale research on HCN suffers from significant time costs and poor convergence results. To address these problems, a graph embedding-based Heterogeneous Combat Network Optimization Framework (HCNOF) is proposed, which optimizes HCN features and reduces time overhead. In this paper, we design crossover operators and mutation operators for HCNs to iteratively search for the optimal HCN. Additionally, we developed a heterogeneous graph embedding method for HCNs to transform the high-dimensional HCN representation matrix into a low-dimensional embedding matrix. Finally, we designed experiments to optimize the functional robustness of HCN, verifying the effectiveness of HCNOF. The results demonstrate that, in the graph embedding task, the *MAP* value of HCNOF is higher than several conventional graph embedding methods, indicating better preservation of network structure. In the optimization task, HCNOF demonstrates superior performance, particularly in terms of convergence speed, which is a measure of optimization efficiency. It has shown a 17.23% improvement in this aspect compared to HCNOF0 and a 6.89% enhancement when compared to the GE-SU-EANet algorithm, underscoring its advantages in both optimization performance and cost reduction. Overall, our research findings motivate the establishment of stronger combat systems and provide an innovative approach for large-scale HCN optimization.

26-ANSP-EM-016	**Restage:Relation Structure-Aware Hierarchical Heterogeneous Graph Embedding** Heterogeneous graphs contain multiple types of entities and relations, which are capable of modeling complex interactions. Embedding on heterogeneous graphs has become an essential tool for analyzing and understanding such graphs. Although these meticulously designed methods make progress, they are limited by model design and computational resources, making it difficult to scale to large-scale heterogeneous graph data and hindering the application and promotion of these methods. In this paper, we propose Restage, a relation structure-aware hierarchical heterogeneous graph embedding framework. Under this framework, embedding only a smaller-scale graph with existing graph representation learning methods is sufficient to obtain node representations on the original heterogeneous graph. We consider two types of relation structures in heterogeneous graphs: interaction relations and affiliation relations. Firstly, we design a relation structure- aware coarsening method to successively coarsen the original graph to the top-level layer, resulting in a smaller-scale graph. Secondly, we allow any unsupervised representation learning methods to obtain node embeddings on the top-level graph. Finally, we design a relation structure-aware refinement method to successively refine the node embeddings from the top-level graph back to the original graph, obtaining node embeddings on the original graph. Experimental results on three public heterogeneous graph datasets demonstrate the enhanced scalability of representation learning methods by the proposed Restage. On another large-scale graph, the speed of existing representation learning methods is increased by up to eighteen times at most.
26-ANSP-EM-017	**ReTMiC: Reliability-Aware Thermal Management in Multicore Mixed-Criticality Embedded Systems** As the number of cores in multicore platforms increases, temperature constraints may prevent powering all cores simultaneously at maximum voltage and frequency level. Thermal hot spots and unbalanced temperatures between the processing cores may degrade the reliability. This paper introduces a reliability-aware thermal management scheduling (ReTMiC) method for mixed-criticality embedded systems. In this regard, ReTMiC meets Thermal Design Power as the chip-level power constraint at design time. In order to balance the temperature of the processing cores, our proposed method determines balancing points on each frame of the scheduling, and at run time, our proposed lightweight online re-mapping technique is activated at each determined balancing point for balancing the temperature of the processing cores. The online mechanism exploits the proposed temperature-aware factor to reduce the system's temperature based on the current temperature of processing cores and the behavior of their corresponding running tasks. Our experimental results show that the ReTMiC method achieves up to 12.8◦C reduction in the chip temperature and 3.5◦C reduction in spatial thermal variation in comparison to the state-of-the-art techniques while keeping the system reliability at a required level.
26-ANSP-EM-018	**SimE: A Knowledge Graph Embedding Model to Encode Self-Similar Structures Through Algebraic and Geometric Transformations** Knowledge Graphs (KGs), with their intricate hierarchies and semantic relationships, present unique challenges for graph representation learning, necessitating tailored approaches to effectively capture and encode their complex structures into useful numerical representations. The fractal-like nature of these graphs, where patterns repeat at various scales and complexities, requires specialized algorithms that can adapt and learn from the multi-level structures inherent in the data. This similarity to fractals

	requires methods that preserve the recursive detail of knowledge graphs while facilitating efficient learning and extraction of relational patterns. In this study, we explore the integration of similarity group with attention mechanisms to represent knowledge graphs in complex spaces. In our approach, SimE, we make use of the algebraic (bijection) and geometric (similarity) properties of the similarity transformations to enhance the representation of self-similar fractals in KGs. We empirically validate the capability of providing representations of bijections and similarities in benchmark KGs. We also conducted controlled experiments that captured one-to-one, one- to-many, and many-to-many relational patterns and studied the behavior of state-of-the-art models including the proposed SimE model. Because of the lack of benchmark fractal-like KG datasets, we created a set of fractal-like testbeds to assess the subgraph similarity learning ability of models. The observed results suggest that SimE captures the complex geometric structures of KGs whose statements satisfy these algebraic and geometric properties. In particular, SimE is competitive with state-of-the-art KG embedding models and is able to achieve high values of Hits@1. As a result, SimE is capable of effectively predicting correct links and ranking them with the highest ranks.

26-ANSP-EM-019	**Transformer-Based Amharic-to-English Machine Translation With Character Embedding and Combined Regularization Techniques** Amharic is the working language of Ethiopia and, owing to its Semitic characteristics, the language is known for its complex morphology. It is also an under-resourced language, presenting significant challenges for natural language processing tasks like machine translation. The primary challenges include the scarcity of parallel data, which increases the risk of overfitting and limits the model's ability to generalize effectively, and the complex morphology of Amharic, which further complicates learning patterns in translation tasks. This study proposes a Transformer-based Amharic-to-English neural machine translation model that leverages character-level embeddings and integrates advanced regularization techniques, including dropout, L1, L2, and Elastic Net. By focusing on character-level embeddings, the model captures the intricate morphological patterns of Amharic and effectively handles out-of-vocabulary words. Our model significantly improves upon the previous state-of-the-art results on the Amharic-to-English neural machine translation benchmark, achieving a BLEU score of 40.59, which is 7% higher than the previous state-of- the-art result. Among the regularization techniques tested, the integration of L2 regularization with dropout applied to the pointwise feed-forward network yielded the best translation performance. Additionally, the proposed model significantly reduces the parameter count from 75 million to just 5.4 million, demonstrating substantial computational efficiency while maintaining high accuracy. Extensive experiments demonstrated improvements in test accuracy, loss reduction, and translation fidelity compared to word-level embedding models. This research provides valuable insights into addressing the challenges of low-resource and morphologically complex languages, while also offering promising directions for future work, including the exploration of multilingual models, attention mechanism optimization, and the broader application of hybrid regularization techniques in the Transformer model architecture.
26-ANSP-EM-020	**Wafer Defect Classification Algorithm With Label Embedding Using Contrastive Learning** Effective disaster prediction is essential for disaster management and mitigation. This study addresses a multi-classification problem and proposes the Neural-XGBoost disaster prediction model (N- XGB), a hybrid model that combines neural networks

	(NN) for feature extraction with XGBoost for classification. The NN component extracts high-level features, while XGBoost uses gradient-boosted decision trees for accurate predictions, combining the strengths of deep learning and boosting techniques for improved accuracy. The N-XGB model achieves an accuracy of 94.8% and an average F1 score of 0.95 on a real-world dataset that includes wildfires, floods and earthquakes, significantly outperforming baseline models such as random forest, Support vector machine and logistic regression 85% accuracy. The balanced F1 scores for wildfires 0.96, floods 0.93, and earthquakes 0.96 demonstrate the model's robustness in multi-class classification. The Synthetic Minority Oversampling Technique (SMOTE) balances datasets and improves model efficiency and capability. The proposed N-XGB model provides a reliable and accurate solution for predicting disasters and contributes to improving preparedness, resource allocation and risk management strategies.