EMERALD

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Issue #8

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MDSS validated by nuclear medicine experts for accuracy and reliability.

Welcome to the eighth edition of the EMERALD newsletter.

Dear readers,

As we share the final edition of the EMERALD newsletter, we reflect on the progress made from December 2024 to April 2025. This issue highlights our latest advancements, research contributions, and key milestones. While this marks the conclusion of our newsletter series, the impact of EMERALD continues. We encourage you to explore our published research and stay engaged with the ongoing developments in AI-driven healthcare innovation.

Enjoy,

The EMERALD Team

Progress catch-up

Since December 2024, the EMERALD project has made significant progress in advancing explainable AI for medical diagnostics. We are proud to announce that EMERALD won Second Place in the Silver Award for AI & Data Solutions at the AI & Data Awards 2025, recognizing our commitment to innovation and transparency. The Medical Decision Support System (MDSS) has been successfully validated by experts and is now fully integrated with a dedicated database, enabling real-time data management and streamlined diagnostics for CAD and NSCLC. Additionally, we have presented our latest research on the MDSS at conferences, showcasing its capabilities and clinical applications.

Validation of MDSS with Nuclear Experts at the University of Patras (Link: Access the EMERALD website and navigate to the 'MDSS' tab)

Prof. Elpiniki Papageorgiou, Principal Investigator of the EMERALD project, along with Assoc. Prof. Nikolaos Papandrianos and Postdoctoral Researcher Dr. Ioannis Apostolopoulos, and Theodosis Theodosiou visited the University of Patras to collaborate with nuclear medicine specialists Dr. Dimitrios Apostolopoulos and Dr. Nikolaos Papathanasiou.

The team conducted an extensive validation of the MDSS using diverse real-world cases of CAD and NSCLC, incorporating clinical, imaging, and multimodal data. The validation aimed to assess the accuracy, reliability, and interpretability of the system in diagnosing complex medical conditions. By leveraging advanced AI-driven methodologies, the MDSS showcased its potential to enhance clinical decision-making with transparent and explainable predictions. The findings confirmed the system's robustness and applicability in real-world medical settings, solidifying its role as an innovative tool in nuclear medicine diagnostics.

Based on the clinician feedback, the MDSS developed by EMERALD provides:

- ✓ **Easy to Use:** Nuclear experts found the system user-friendly and easy to navigate.
- ✓ **Trusted and Recommended:** 85% of clinicians said they would recommend the system to others, showing strong trust in its results.
- ✓ **Clear Explanations:** The system provided meaningful and clinically relevant explanations that were easy to understand and interpret within a medical context.
- ✓ **Helpful Design and Visuals:** The interface looked clean and was easy to understand.
- ✓ **Understanding Features:** Clinicians found the results used in the predictions to be appropriate and meaningful, enhancing their trust in the model's clinical applicability.
- ✓ **Suggestions for the Future:** Ideas included shorter explanations, simpler visual aids, and quick training guides to help new users get started.

Silver Award in AI & Data Solutions at the AI & Data Awards 2025

Dr. Papageorgiou, Principal Investigator of the EMERALD project, and founder of ACTA Lab **attended the AI & Data Awards 2025** ceremony that took place on Thursday, February 27, 2025, at Technopolis City of Athens, under the auspices of the Ministry of Digital Governance, with the support of the National Documentation Centre (EKT) and powered by UBITECH. Dr. Papageorgiou won the **Silver Award** for the **EMERALD** project at **the AI & Data Awards 2025** in the category **AI & Data Solutions - Best Machine Learning Solution**.

Organized for the first time by Boussias Events, the event was dedicated to Innovation and Excellence, bringing together industry leaders, innovative professionals, and pioneers in Artificial Intelligence and Data Science.

This distinction recognizes the lab's dedication to advancing artificial intelligence and data science, reinforcing its role in developing innovative and impactful AI solutions. The awarded solution, EMERALD, integrates advanced Machine Learning and XAI techniques to improve diagnostic accuracy and support clinical decision-making in healthcare. **By ensuring transparency and reliability**, the solution enhances the scientific, social, and commercial applicability of AI technologies.

This award is a significant achievement for both ACTA Lab and the University of Thessaly, **as it was the only academic laboratory recognized among leading industry players and AI professionals in Greece**. The team remains committed to driving innovation in AI and delivering solutions that bridge research excellence with real-world applications.

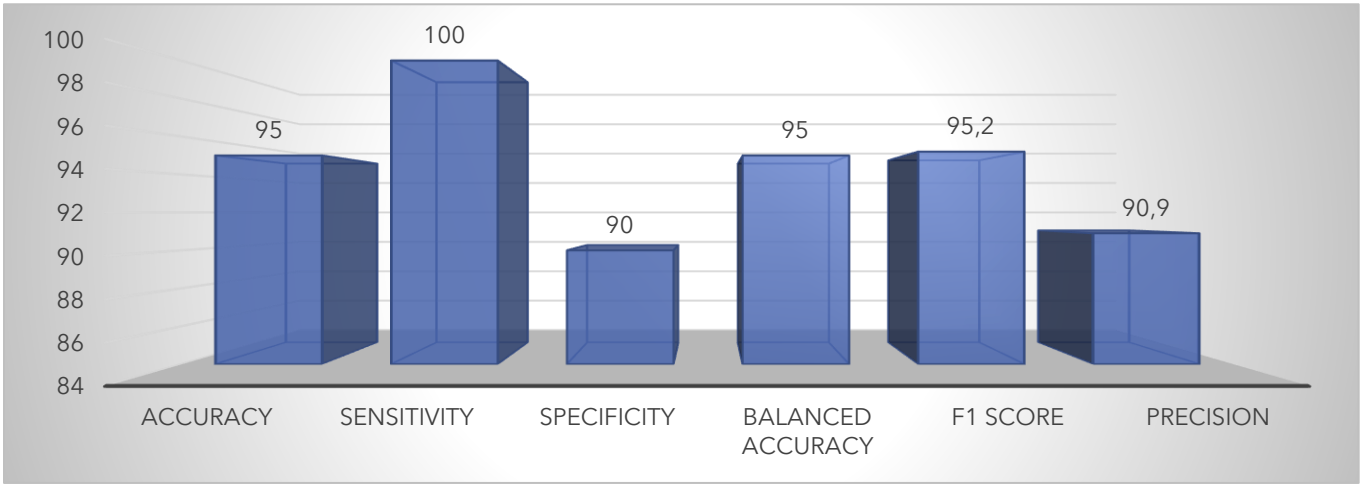
The Director of ACTA Lab, who founded the first Artificial Intelligence laboratory at the School of Technology at the University of Thessaly nearly two years ago, stated:

*"**I am particularly delighted with this significant distinction, which showcases the potential of academic research to provide substantial solutions for society and the market. This award is the culmination of our team's collective effort and gives us the momentum to continue researching, creating, and innovating.**"*

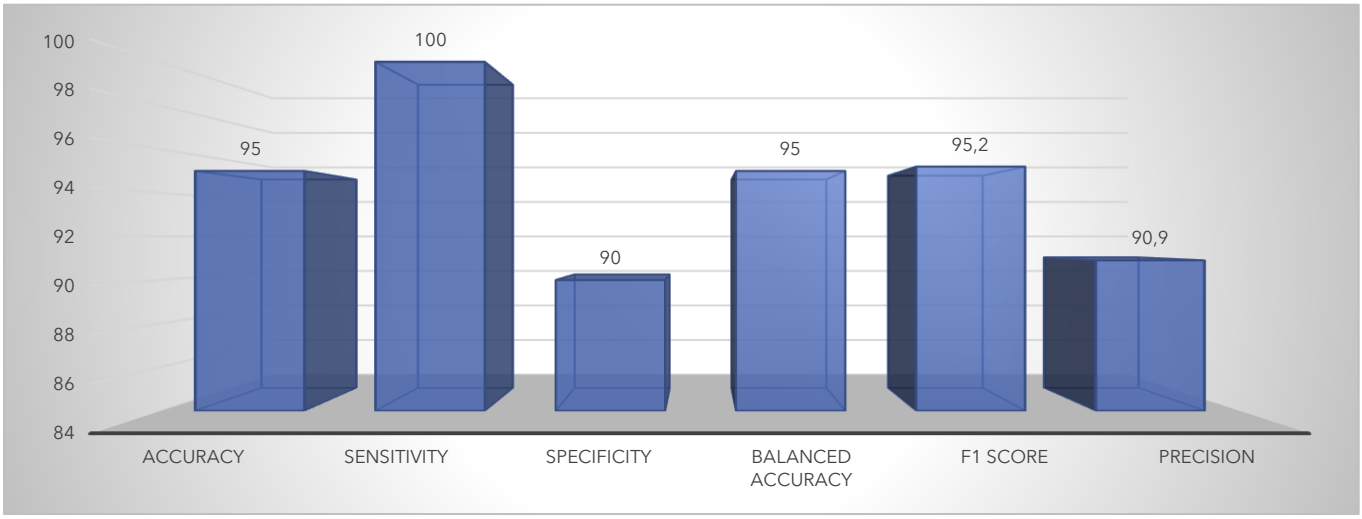
Validation of models with an External testing set

The trained models were validated through the EMERALD MDSS using external datasets, each comprising 20 new cases for both CAD and NSCLC multimodal diagnosis. This evaluation confirmed the MDSS's ability to generalize to unseen clinical scenarios, integrating both imaging and clinical data for accurate AI-assisted predictions. The system demonstrated strong performance across both case studies, reinforcing its potential as a trustworthy diagnostic support tool in real-world medical settings.

- **CAD Multimodal diagnosis with DeepFCM-PSO**



- **NSCLC Multimodal diagnosis with CatBoost**

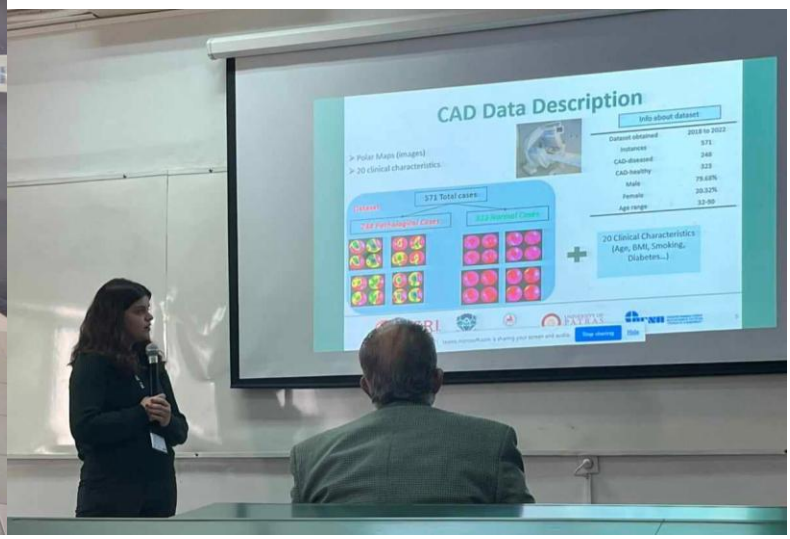


New Article in EXPLAINABILITY 2024

DOI: link, Date: 17 November 2024

Our team published a paper titled "A Medical Decision Support System for Explainable Multimodal Detection of Non-Small Cell Lung Cancer Using Clinical and PET Data" at the First International Conference on Systems Explainability EXPLAINABILITY 2024. In this study, DeepFCM was developed for diagnosing NSCLC with PET images and clinical data. Two learning techniques, Particle Swarm Optimization (PSO) and Genetic Algorithm (GA), were applied. The RGB-CNN, trained on PET images, provided CNN predictions that, together with clinical data, served as inputs for the multimodal DeepFCM model. The results showed that the RGB-CNN on image data achieved an accuracy of 83.12%±6.43%. DeepFCM-PSO outperformed with an accuracy of 88.14%±3.8%, while DeepFCM-GA achieved 87.08%±5.96% in accuracy. These findings underscore the effectiveness of combining multimodal data for enhanced diagnostic accuracy. Explainable AI techniques, including Gradient-weighted Class Activation Mapping (Grad-CAM) for the interpretation of CNN predictions and Natural Language Generation (NLG) with the incorporation of GPT-4, were utilized. Grad-CAM accurately identified the location of the Solitary Pulmonary Nodule (SPN) in PET images, while GPT-4 translated DeepFCM's results into human-readable explanations. In NLG, a structured prompt was created, detailing DeepFCM's interconnections among input-output concepts, the CNN and DeepFCM predictions, and the instance-specific values, which GPT-4 used to justify the diagnostic outcomes. All these techniques and methodologies were integrated into an MDSS that encompasses all trained models for clinical, imaging, and multimodal data for NSCLC and CAD diagnosis. Check the full article here.

Presentation of Article in PCI 2024 Conference

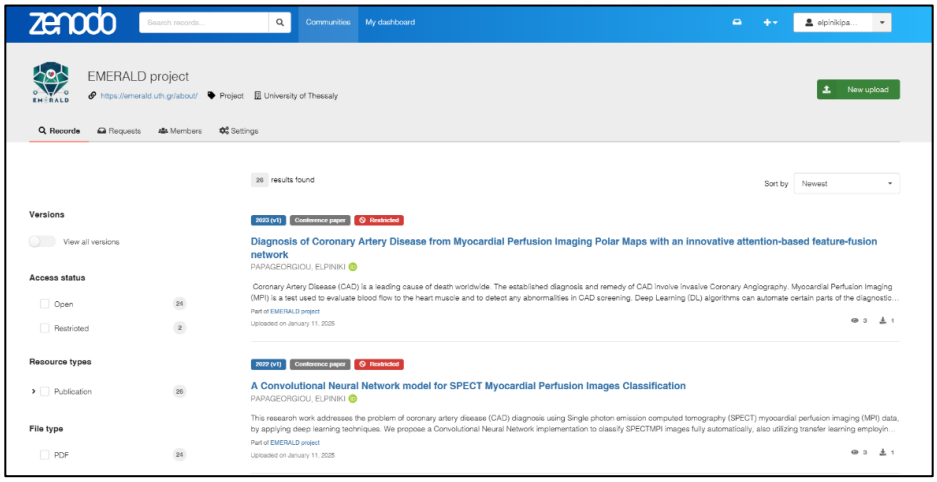


Anna Feleki, PhD Student of the University of Thessaly and Project Member of the EMERALD project, attended the 28th Pan-Hellenic Conference on Progress in Computing Informatics with International Participation, on 13-15 December 2024, in Athens, Greece.

The presented paper titled "Multimodal Diagnosis using Deep Fuzzy Cognitive Map with Extreme Learning Machine Integrated into a Medical Decision Support System for Coronary Artery Disease and Non-Small Cell Lung Cancer Detection" demonstrates DeepFCM, a multimodal approach that combines clinical variables and CNN predictions to provide a holistic diagnosis, that has been previously published by the EMERALD team. In this study, DeepFCM is advanced by integrating Extreme Learning Machine (ELM) into the learning process to calculate the interconnections between concepts. The research focuses on two diseases: Coronary Artery Disease (CAD), using Polar Maps to visualize blood perfusion, and Non-Small Cell Lung Cancer (NSCLC), using Computed Tomography (CT) images to detect Solitary Pulmonary Nodules (SPNs). For both cases, the clinical data include demographic information about the patient and disease-specific clinical variables. As explainability techniques, the interconnections among concepts are visualized, clearly demonstrating the influence of each factor on the final prediction. Gradient-weighted Class Activation Mapping (Grad-CAM) is applied to generate the heatmap image, which interprets the CNN's decision-making process by highlighting critical pathological regions in the provided medical images. Additionally, Natural Language Generation (NLG) with the GPT-4 API from OpenAI translates DeepFCM outputs into human-understandable narratives for nuclear physicians. The prompt provided to the GPT-API incorporates clinical values, original images, Grad-CAM heatmaps, DeepFCM weights, and CNN/DeepFCM predictions. A comparison has been conducted between DeepFCM-ELM and DeepFCM-GA, which incorporates a Genetic Algorithm in the DeepFCM training process. The results indicate that the DeepFCM-ELM model outperformed DeepFCM-GA, achieving 80.4% ± 4.97% accuracy for CAD diagnosis and 91.9% ± 3.07% accuracy for NSCLC diagnosis. By visualizing interconnections and generating clear narratives, DeepFCM improves transparency and enhances trust in diagnostic results, making it a reliable and interpretable medical decision support system.

Dissemination Activities

The EMERALD project is active on LinkedIn, Facebook, and Zenodo, sharing updates and research to engage with the community and promote AI-driven medical advancements.



1. **LinkedIn:**

   The EMERALD LinkedIn page has shown steady growth, reaching 180 followers, a 7.8% increase, and recording 435 post impressions, marking a remarkable 5,337.5% rise. Recently, the profile attracted 50 views and appeared in 24 LinkedIn searches, reflecting increased visibility.

2. **Facebook:**

   - The EMERALD Facebook page actively engaged 201 followers through more than 25 posts, including project updates, dissemination of research outcomes, and promotional material for events. The EMERALD Facebook page recorded 3,408 views, with 917 unique users reached, 404 content engagements, and a total of 7 followers. The page served as an interactive space, enhancing the project's visibility among broader, non-specialist audiences, facilitating community building, and maintaining transparency.

3. **Zenodo:**

   - The EMERALD Zenodo community has become a comprehensive repository for all project-related publications, datasets, and software. By project completion, 25 research outputs were made openly accessible and 2 were published under restricted access, supporting transparency, reproducibility, and wide dissemination within the global scientific community. These efforts led to over 121 downloads and 196 views of the research papers, significantly enhancing the visibility and impact of the project's findings.

4. **Website:**

   - The EMERALD website functioned as a central information hub, consistently updated with project milestones, publications, promotional materials, and news items. It has recently attracted 14 new users, and over the past 30 days, the site recorded a total of 18 active users, 6 of whom visited within the last 7 days. The website's audience spans multiple countries, including Greece (13 users), Austria, China, Spain, the United Kingdom, and the United States, indicating a growing international interest in the project.

Contact Us

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