EMERALD

June 2024
Issue #6

INSIDE

The latest news, views, and announcements - Issue #6

Welcome to the sixth edition of the EMERALD newsletter.

Dear readers,

We are pleased to announce the release of the sixth edition of the EMERALD newsletter. This issue covers significant developments from February 2024 to June 2024. We aim to keep you informed about noteworthy events and updates during this period.

Enjoy,

The EMERALD Team

Progress catch-up

Since February 2024, the EMERALD project has made important strides in both outreach and development. We showcased our work at JOIST Innovation Park, where the Principal Investigator was invited to speak on the integration of Artificial Intelligence in Energy and Environment. Alongside this, we advanced the Medical Decision Support System (MDSS) and published new research articles focused on the diagnosis of Hyperparathyroidism and Non-Small Cell Lung Cancer (NSCLC) using AI-based methods.

In this edition of the EMERALD newsletter, we highlight recent advances in both scientific research and the development of our Medical Decision Support System (MDSS). A key milestone during this period was the implementation of the NSCLC clinical, imaging, and multimodal forms, reinforcing our commitment to building a transparent, interpretable, and practical AI platform to assist clinicians in real-world diagnostic scenarios.

EMERALD team attending Innovent Forum 2024

Presentation of the EMERALD project

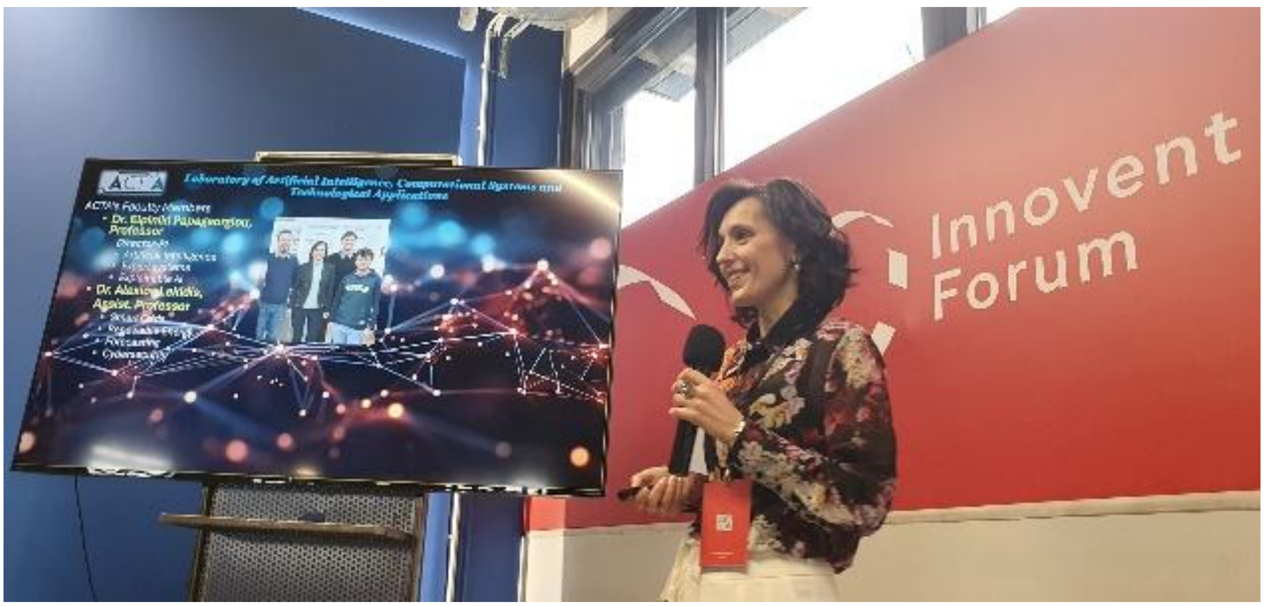
EMERALD was presented at the Innovent Forum Science & Technology Event held at JOIST on February 9 and 10, 2024. The event was co-organized by the University of Thessaly, with support from the Ministry of Digital Governance and the Ministry of Development. Members of the scientific team engaged a large audience of visitors and students, providing insights into the methodologies and applications of artificial intelligence in medical diagnosis and decision-making.

Professor Elpiniki Papageorgiou, together with Nikolaos Papandrianos and Alexios Lekidis, presented the project's results and highlighted the ongoing research activities of the EMERALD team. Their presentation was delivered to the Deputy Minister of Development, Mr. Maximos Senetakis, and the Rector of the University of Thessaly, Mr. Charalambos Billinis, showcasing the team's commitment to advancing AI applications in healthcare and fostering academic excellence.

Present in the photo: Agapi Vasileiadou, Elpiniki Papageorgiou, Konstantinos Papageorgiou, Theodoros Tziolas, Anna Feleki, Nikolaos Xafoulos, Nikolaos Papandrianos, Serafeim Moustakidis

Presentation in Innovent Forum 2024, JOIST, Larissa, Greece

At the Innovent Forum, Prof. Elpiniki Papageorgiou, Principal Investigator of the EMERALD project, was an invited speaker in a panel discussion on Energy and Environment. She highlighted the role of Artificial Intelligence (AI) in addressing environmental challenges, emphasizing how AI-driven solutions can optimize resource management, enhance sustainability, and support decision-making in various sectors. During her presentation, she introduced the Artificial Intelligence, Computational Methods, and Technological Applications (ACTA) Lab, showcasing its latest advancements in AI methodologies, machine learning, and explainable AI (XAI) for medical and industrial applications. The event provided an excellent platform for fostering collaboration between academia and industry in developing cutting-edge AI solutions. Check the ACTA Lab website.



New Article in Applied Sciences

DOI: https://doi.org/10.3390/app14052171, Date: 29 February 2024

applied sciences

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Open Access Article

Explainable Classification of Patients with Primary Hyperparathyroidism Using Highly Imbalanced Clinical Data Derived from Imaging and Biochemical Procedures

by Agorastos-Dimitrios Samaras [1], Maria Tsimara [2], Sofia Voidila [2], Nikolaos Papandrianos [1], Petros Zampakis [2], Serafeim Moustakidis [1,3], Elpiniki Papageorgiou [1,*] and Christina Kalogeropoulou [2]

[1] Department of Energy Systems, University of Thessaly, Gaiopolis Campus, 41500 Larisa, Greece
[2] Department of Radiology, University of Patras, 26504 Patras, Greece
[3] AIDEAS OÜ, 10117 Tallinn, Estonia
[*] Author to whom correspondence should be addressed.

Appl. Sci. **2024**, *14*(5), 2171; https://doi.org/10.3390/app14052171

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Our team published a study named "Explainable Classification of Patients with Primary Hyperparathyroidism Using Highly Imbalanced Clinical Data Derived from Imaging and Biochemical Procedures" in the Journal of Applied Sciences. Primary hyperthyroidism (PHPT) is a common endocrine disorder characterized by hypercalcemia and elevated parathyroid hormone (PTH) levels. The aim of this work was the development of a Computer-aided classification model relying on clinical data to classify PHPT instances and, at the same time, offer explainability for the classification process. The dataset utilized in the study was imbalanced and included biometric and clinical data from 134 patients. Oversampling was employed to handle the imbalance and increase prediction robustness. Various ML models were applied where LightGBM outperformed with an accuracy of 86.9% for adenoma and 81.5% for multi gland disease. Regarding explainability techniques, Shapley additive explanations (SHAP) analysis and Cohen's effect sizes were utilized to highlight the most impactful factors that influence the final prediction. Click HERE.

New Pre-print Article in SSRN

DOI: https://dx.doi.org/10.2139/ssrn.4824618, Date: 17 May 2024

Explainable Yolov8 Model for Solitary Pulmonary Nodules Classification Using Positron Emission Tomography and Computed Tomography Scans

17 Pages • Posted: 17 May 2024

Agorastos-Dimitrios Samaras
affiliation not provided to SSRN

Nikolaos Papathanasiou
affiliation not provided to SSRN

Ioannis Apostolopoulos
affiliation not provided to SSRN

Dimitrios Apostolopoulos
affiliation not provided to SSRN

Elpiniki Papageorgiou
affiliation not provided to SSRN

Nikolaos Papandrianos
affiliation not provided to SSRN

Serafeim P. Moustakidis
affiliation not provided to SSRN

Our team published a preprint article with the title "Explainable Yolov8 Model for Solitary Pulmonary Nodules Classification Using Positron Emission Tomography and Computed Tomography Scans". In this study, Positron Emission Tomography (PET) and Computed Tomography (CT) scans were employed for the development of a classification tool to diagnose the early stages of Non-Small Cell Lung Cancer (NSCLC) in Solitary Pulmonary Nodules (SPN). The dataset included 456 patients. The YOLOv8 algorithm yielded a maximum accuracy of 92.3% for CT image sets and 89% for PET images. As a transparent and understandable classification mechanism, ablation heatmaps were employed in this study to interpret the model's decision-making process by emphasizing the pixels of interest regarding NSCLC diagnosis. Check it out HERE.

New Article in Diseases

DOI: https://doi.org/10.3390/diseases12060115, Date: 1 June 2024

diseases

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Open Access Article

Integrating Machine Learning in Clinical Practice for Characterizing the Malignancy of Solitary Pulmonary Nodules in PET/CT Screening

by Ioannis D. Apostolopoulos [1,*], Nikolaos D. Papathanasiou [2], Dimitris J. Apostolopoulos [2], Nikolaos Papandrianos [1] and Elpiniki I. Papageorgiou [1]

1 Department of Energy Systems, University of Thessaly, Gaiopolis Campus, 41500 Larisa, Greece

2 Department of Nuclear Medicine, University Hospital of Patras, 26504 Rio, Greece

* Author to whom correspondence should be addressed.

Diseases **2024**, *12*(6), 115; https://doi.org/10.3390/diseases12060115

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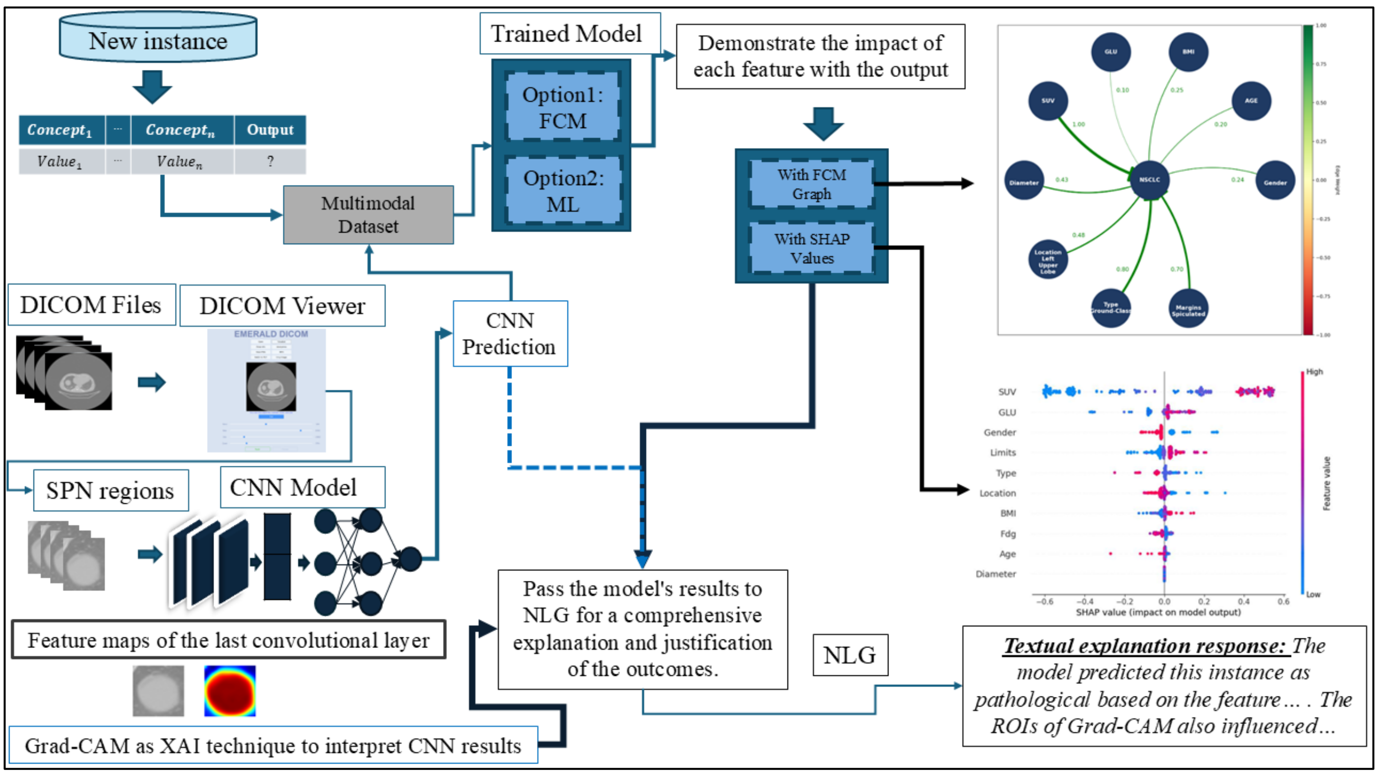
Our team published an article titled "Integrating Machine Learning in Clinical Practice for Characterizing the Malignancy of Solitary Pulmonary Nodules in PET/CT Screening" in the Journal "Diseases". This study investigated the integration of machine learning (ML) into clinical practice for diagnosing SPN malignancy, using data from the Department of Nuclear Medicine at the University Hospital of Patras, Greece. The analysis employed a comprehensive dataset comprising 456 SPN characteristics from CT scans, PET SUVmax scores, and biopsy-confirmed outcomes. Human experts initially provided independent malignancy assessments, which, when included in the ML training process, enhanced the model's diagnostic efficiency by approximately 3%. The ML model ultimately achieved a diagnostic accuracy of 95.39%, significantly outperforming human readers in complex and ambiguous cases. This highlights the synergistic potential of combining ML with human expertise and offers a more robust framework for clinical decision-making in SPN evaluation. The findings suggest that integrating expert knowledge into AI algorithms can significantly refine the diagnostic process, leading to more precise and reliable outcomes in the assessment of SPNs. Check the full article here.

MDSS PROGRESS

(Link: Access the EMERALD website and navigate to the 'MDSS' tab)

The MDSS now supports multimodal diagnosis, allowing nuclear experts to perform NSCLC diagnosis based on clinical data, imaging data (CT/PET scans), and both. This flexibility enables the system to provide accurate predictions, whether clinical data or imaging data alone is used. By integrating both data types, the MDSS offers enhanced diagnostic support, ensuring a comprehensive approach to decision-making.

Diagnosis of NSCLC cases



The NSCLC Multimodal Form in the MDSS is designed to combine clinical data and imaging data for AI-driven diagnosis. Key features of the NSCLC form include:

- **Image Processing**: DICOM files from CT or PET scans are processed through an executable file, allowing users to crop the region of interest (SPN) and pass it to the MDSS for further analysis.
- **Insert Clinical Data**: Users can enter relevant clinical data, such as demographics, medical history, and other clinical parameters, along with the cropped image, to construct a multimodal dataset.
- **Select CNN Model**: For imaging-based prediction, nuclear experts can select between RGB-CNN–trained from scratch–or pre-trained models such as VGG-16 and VGG-19 to generate diagnostic outputs from the image.
- **Construction of the Multimodal Dataset**: The instance is automatically constructed by concatenating the clinical data with the CNN predictions derived from the selected model.

- **Select Model (FCM or ML)**: For multimodal prediction, the nuclear expert chooses between DeepFCM or Machine Learning (ML) models.
- **Perform Prediction**: Run the selected model to generate the multimodal prediction.
- **XAI Techniques to Analyze the Impact of Each Factor**: In DeepFCM, graphical visualizations illustrate how each factor influences the final diagnosis, while in ML models, SHAP plots highlight and rank the most impactful clinical features.
- **Grad-CAM as XAI Technique to Interpret CNN Prediction**: Grad-CAM, based on the feature maps from the last convolutional layer, highlights the most pathological regions of the image, showcasing the CNN's decision-making process.
- **Textual Explanation**: The NLG response provides a concise textual explanation, justifying the prediction made by DeepFCM through its learned interconnections or by the ML model via SHAP-derived feature importance. The explanation highlights the most influential characteristics to support clinical understanding.

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ΕΛ.Ι.Δ.Ε.Κ.
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