EMERALD

October 2023
Issue #4

The latest news, views, and announcements - Issue #4

Welcome to the fourth edition of the EMERALD newsletter.

Dear readers,

We're excited to share key updates from July 2023 to October 2023. Stay informed with the latest developments and achievements.

Enjoy,

The EMERALD Team

INSIDE

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Applied Sciences Journals
The Emerald team performed two presentations in IISA 2023

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Eusflat representation
DeepFCM development as a multimodal model for CAD.

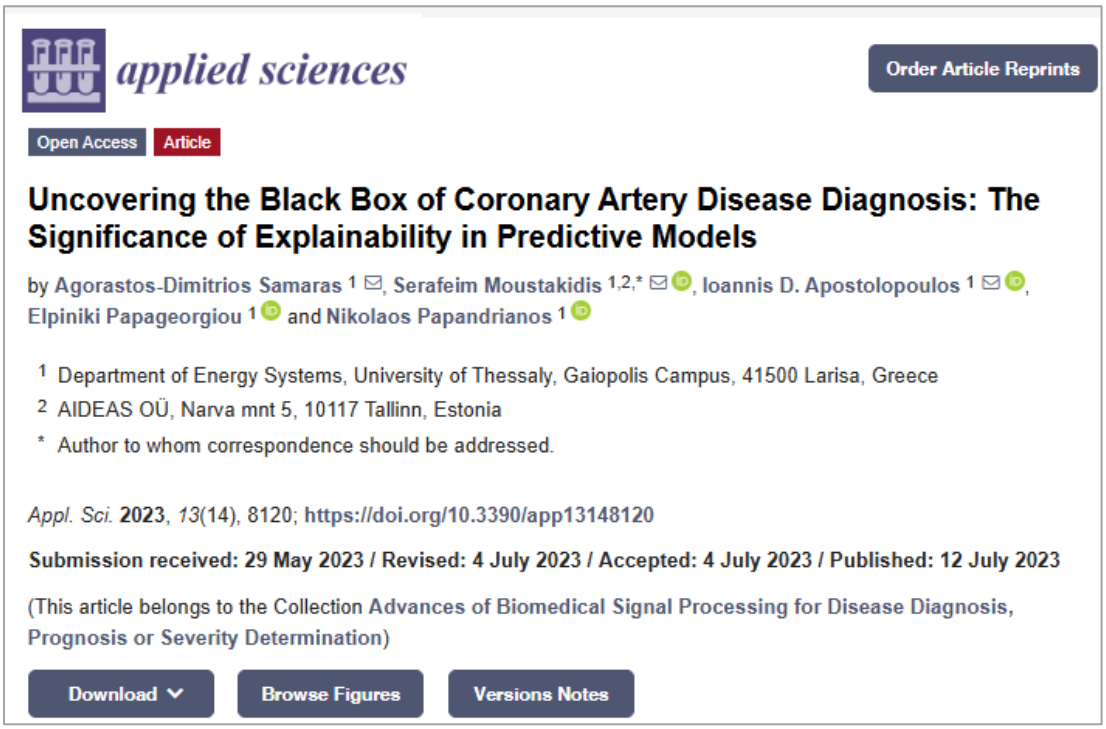
Progress catch-up

Our recent studies continue to push the boundaries of AI-driven diagnostics, emphasizing explainability and clinical integration.

Recent research within the EMERALD project explores the integration of explainable AI and multimodal learning to enhance medical diagnostics. Studies in Applied Sciences highlight techniques (SHAP) that improve model interpretability and decision support, reinforcing the role of feature selection and attention-based architectures in predictive accuracy. At EUSFLAT 2023, we introduced DeepFCM, a framework that bridges symbolic reasoning and deep learning, demonstrating the potential of hybrid AI in clinical assessments. These advancements reflect EMERALD's ongoing pursuit of trustworthy, data-driven methodologies, aiming to refine diagnostic transparency and decision-making processes in healthcare.

Article in Applied Sciences

DOI: https://doi.org/10.3390/app13148120, Date: 12 July 2023



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Open Access Article

Uncovering the Black Box of Coronary Artery Disease Diagnosis: The Significance of Explainability in Predictive Models

by Agorastos-Dimitrios Samaras [1], Serafeim Moustakidis [1,2,*], Ioannis D. Apostolopoulos [1], Elpiniki Papageorgiou [1] and Nikolaos Papandrianos [1]

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Appl. Sci. **2023**, *13*(14), 8120; https://doi.org/10.3390/app13148120

Submission received: 29 May 2023 / Revised: 4 July 2023 / Accepted: 4 July 2023 / Published: 12 July 2023

(This article belongs to the Collection Advances of Biomedical Signal Processing for Disease Diagnosis, Prognosis or Severity Determination)

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Our team published a study named "Uncovering the Black Box of Coronary Artery Disease Diagnosis: The Significance of Explainability in Predictive Models" in Journal Appl. Sci. 2023, 13(14), 8120

The study evaluated various ML models for the classification of coronary artery disease (CAD) by leveraging biometric and clinical data from 571 patients. Among the evaluated models, CatBoost demonstrated the best performance, particularly after implementing feature selection. With feature selection, the model's performance showed notable improvements: Sensitivity increased from 67.80% (±8.60) to 74.63% (±7.49). Specificity improved from 80.20% (±5.36) to 82.05% (±6.74). Accuracy rose from 74.78% (±3.93) to 78.82% (±4.02), surpassing the human expert's accuracy of 78.81%. F1-score improved from 69.83% (±5.53) to 75.32% (±4.97). To enhance model interpretability, SHapley Additive exPlanations (SHAP) analysis was employed to identify the most influential predictors. The results highlighted that previous CAD conditions, diabetes, and gender were the most significant factors influencing the model's predictions. Additionally, exercise levels and age played a crucial role, with less physically active individuals and those aged 40–50 years exhibiting a higher likelihood of developing CAD. By combining high-performing machine learning with explainable AI (XAI) techniques, this study not only improved diagnostic accuracy but also provided greater transparency in model decision-making, bridging the gap between AI-driven predictions and clinical applicability. Check the full article here.

Article in Springer

DOI: https://link.springer.com/chapter/10.1007/978-3-031-39965-7_2, Date: 21 August 2023

Presentation on September 4-8, 2023, in Palma, Spain

Professor Elpiniki Papageorgiou, Principal Investigator of the EMERALD project, attended the 13th Conference of the European Society for Fuzzy Logic and Technology (EUSFLAT 2023), where she presented her article.


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A Fuzzy Cognitive Map Learning Approach for Coronary Artery Disease Diagnosis in Nuclear Medicine

Conference paper | First Online: 21 August 2023

pp 14–25 | Cite this conference paper

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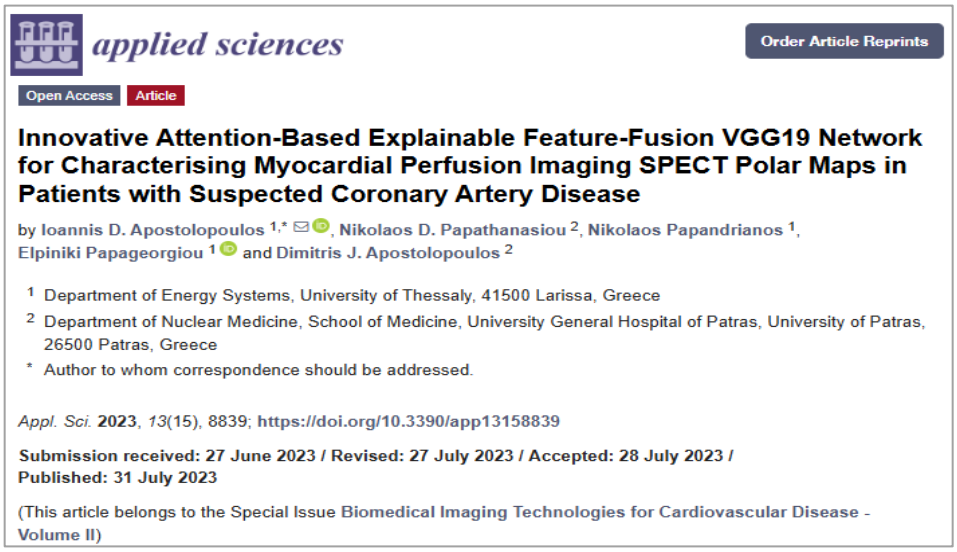
Anna Feleki, Ioannis D. Apostolopoulos, Konstantinos Papageorgiou, Elpiniki I. Papageorgiou, Dimitris J. Apostolopoulos & Nikolaos I. Papandrianos

The study developed DeepFCM a combination of Fuzzy Cognitive Maps (FCMs), which transformed the system variables into concepts in conjunction with Convolutional Neural Networks (CNN), which are capable of extracting patterns from images. FCMs transformed system variables into conceptual inputs, incorporating patient demographic information and CAD-related clinical data. Concurrently, CNNs were utilized to extract intricate patterns from Polar Map images, which provide detailed insights into blood perfusion. The CNN predictions for each image instance were integrated with the clinical data, resulting in a multimodal approach termed DeepFCM. This model effectively combined both clinical and imaging data for a comprehensive diagnosis. Expert knowledge was incorporated through fuzzy sets to initialize the interconnections among concepts, as provided by nuclear medicine specialists. Particle Swarm Optimization (PSO) was utilized for the calculation of interconnections among concepts. By leveraging the inherent capabilities of FCMs to generate interconnections, our model enhanced its credibility and adaptability for nuclear physicians in their diagnostic workflow. The proposed model attained an accuracy of 77.95%, with a standard deviation of 5.58%. Check the full article HERE.

Article in Applied Sciences

DOI: https://doi.org/10.3390/app13158839, Date: 31 July 2023



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Innovative Attention-Based Explainable Feature-Fusion VGG19 Network for Characterising Myocardial Perfusion Imaging SPECT Polar Maps in Patients with Suspected Coronary Artery Disease

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

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Appl. Sci. **2023**, *13*(15), 8839; https://doi.org/10.3390/app13158839

Submission received: 27 June 2023 / Revised: 27 July 2023 / Accepted: 28 July 2023 / Published: 31 July 2023

(This article belongs to the Special Issue Biomedical Imaging Technologies for Cardiovascular Disease - Volume II)

Our team published a study named "Innovative Attention-Based Explainable Feature-Fusion VGG19 Network for Characterising Myocardial Perfusion Imaging SPECT Polar Maps in Patients with Suspected Coronary Artery Disease" in Journal Appl. Sci. 2023, 13(15), 8839

The authors introduced an explainable deep learning framework for CAD classification using MPI SPECT Polar Map images, based on data from 486 patients. The proposed model, AFF-VGG19, incorporated attention-based feature fusion to enhance both classification accuracy and interpretability. The study demonstrated that AFF-VGG19 achieved a high agreement rate of 89.92% with medical experts and competitive diagnostic accuracy (0.789), comparable to human assessment. To improve explainability, the Grad-CAM++ algorithm was applied, generating 77 visual explanations across 100 selected samples, effectively highlighting the most significant Polar Map regions influencing the model's predictions. The results underscored the potential biases present in clinical diagnoses, emphasizing the importance of balanced datasets and the role of AI-driven decision support systems in enhancing diagnostic reliability and reducing subjectivity in medical assessments. Check the full article here.

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The research project was supported by the Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "2nd Call for H.F.R.I. Research Projects to support Faculty Members & Re-searchers" (Project Number: 3656).