

# CWSPI'25



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## 17<sup>th</sup> Cyprus Workshop on Signal Processing and Informatics

### FINAL PROGRAM AND BOOK OF ABSTRACTS

Venue: CYENS Centre of Excellence,  
Lellou Demetriades, Plateia Dimarchou 1, Nicosia 1016

Directions via Google Maps: <https://maps.app.goo.gl/rSNqQ8sFAVy1VHyt6>

Connect online via Microsoft teams at the following link:

[https://teams.microsoft.com/l/meetup-join/19%3ameeting\\_Y2FmMjE3MzctZjFiNi00ODRmLTkzZGUtOTk4YzcxM2ZkOTZm%40thread.v2/0?context=%7b%22Tid%22%3a%228dd1e6b4-8dac-408e-8d8d-6753e9800530%22%2c%22Oid%22%3a%22623bf02a-7889-4842-b0fe-4bfddf34d536%22%7d](https://teams.microsoft.com/l/meetup-join/19%3ameeting_Y2FmMjE3MzctZjFiNi00ODRmLTkzZGUtOTk4YzcxM2ZkOTZm%40thread.v2/0?context=%7b%22Tid%22%3a%228dd1e6b4-8dac-408e-8d8d-6753e9800530%22%2c%22Oid%22%3a%22623bf02a-7889-4842-b0fe-4bfddf34d536%22%7d)

Meeting ID: 392 978 574 026 7

Passcode: Ju92Bh2t

13:50-19:00, July 17<sup>th</sup>, 2025

## Organized and Sponsored



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## 17<sup>th</sup> Cyprus Workshop on Signal Processing and Informatics (CWSPI) - 2025

### **Preface:**

Following the successful one-day workshop hosted over the past 16 years, we would like to cordially invite you to participate in the upcoming 17<sup>th</sup> Cyprus Workshop on Signal Processing and Informatics (CWSPI 2025).

The overall objective of CWSPI 2025 is to disseminate new research findings in the areas of signal processing, image processing, analysis and informatics. Over the years, CWSPI has grown to become the primary forum of Cyprus' graduate students to present their latest research endeavors. Moreover, this one-day workshop hosts presentations by faculty and industry researchers serving a key mission of CWSPI, towards establishing strong industry – academia and multi – university collaborations. The workshop is strongly supported by the CYENS and KIOS centers of excellence, constituting an ideal event for sharing new knowledge while building effective research networks.

We would like to express our sincere thanks to IEEE Cyprus Section, the IEEE Engineering in Medicine Biology and Signal Processing Societies (EMBS & SPS) Cyprus Chapters, the IEEE CIS Cyprus Chapter and the IET Cyprus Network for their support and sponsorship.

The papers will be presented either in physical presence (PP) or via Teams link (ZL).

Wishing you a fruitful and joyful event.

*Andreas Panayides, Constantinos S. Pattichis,  
Efthymoulos Kyriacou, Christos Loizou,  
Andreas Spanias, Marios S. Pattichis*  
July 2025

### **Topics:**

- Digital signal and image processing
- Interactive Media, Virtual Reality and Augmented Reality Systems and Applications
- Speech, and audio, processing
- Intelligent and Cognitive systems
- Machine Learning and Deep Learning
- Generative AI in signal and image processing
- Sensor networks and signal analysis
- Biomedical signal, image, and video analysis
- Wireless communications and signal processing
- FPGAS in signal, image and video processing.

Workshop Organizing Committee	
<b>Chair</b>	A. S. Panayides, CYENS Centre of Excellence, Cyprus
<b>Co-Chairs</b>	E. Kyriacou, Cyprus University of Technology, Cyprus C. S. Pattichis, University of Cyprus & CYENS, Cyprus
<b>Program Chair</b>	A. Spanias, Arizona State University, USA
<b>Program Co-Chair</b>	M.S. Pattichis, University of New Mexico, USA
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<b>Local Arrangements</b>	C. S. Pattichis, University of Cyprus & CYENS, Cyprus
<b>Publications</b>	C. P. Loizou, Cyprus University of Technology, Cyprus
<b>Liaison/Publicity</b>	C. S. Pattichis, University of Cyprus & CYENS, Cyprus
<b>Webmaster</b>	3ahealth, Nicosia, Cyprus

#### Venue

CYENS Centre of Excellence,  
Lellou Demetriades, Plateia Dimarchou 1, Nicosia 1016

#### More info

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**Webpage:** <https://cwspi.3ahealth.com/>

**Facebook** <https://www.facebook.com/cwspi.cyprus>

## Technical Program

TIME	SESSIONS
13:50	<b>Introductions</b>
13:55-14:00	<b>Welcome</b> <i>Andreas Spanias &amp; Andreas Panayides</i> <i>Arizona State University, USA &amp; CYENS Centre of Excellence</i>
	<b>SESSION 1: PLENARY TALKS</b>  <b>Chair: <i>Andreas Spanias, Arizona State University, USA</i></b>
14:00-14:45	<b>Dynamic Early-Exit Convolutional Neural Networks for Edge Vision: Do only <i>what</i> and <i>when</i> you need!</b> Theocharis Theocharides Associate Professor and Department Chair, Department of Electrical and Computer Engineering and KIOS Research and Innovation Center of Excellence, University of Cyprus
14:45-15:00	<b>A Fulbright US Scholar Project on Research and Workforce Development in AI for Solar Energy Applications</b> Andreas Spanias, Professor and SenSIP Center Director Arizona State University, USA
	<b>SESSION 2: Deep Neural Networks Modelling and Video Coding</b>  <b>Chair: <i>Andreas S. Panayides, CYENS Centre of Excellence</i></b>
15:00-15:10	<b>Investigation of Early Exit in Convolutional Channel-Wise Competitive Learning</b> Stanimira Georgieva <sup>1</sup> , Andreas Papachristodoulou <sup>1</sup> , Christos Kyrkou <sup>1</sup> , Theocharis Theocharidis <sup>1,2</sup> <sup>1</sup> KIOS Research and Innovation Center of Excellence <sup>2</sup> Department of Mathematics and Statistics/ Computer Science / Electrical & Computer Engineering, University of Cyprus, Nicosia, Cyprus
15:10-15:20	<b>Effective Loss Weighting under Class Imbalance</b> Antonis Savva <sup>1</sup> , Christos Kyrkou <sup>1</sup> , and Theocharis Theocharides <sup>1,2</sup> <sup>1</sup> KIOS Research and Innovation Center of Excellence <sup>2</sup> Department of Electrical and Computer Engineering, University of Cyprus
15:20-15:30	<b>Towards Adversarial Purification via Distilled and Finetuned Denoising Diffusion Implicit Models</b> Mehmet Demirel <sup>1</sup> , Christos Kyrkou <sup>1</sup> <sup>1</sup> KIOS Research and Innovation Center of Excellence, University of Cyprus, Nicosia, Cyprus
15:30-15:40	<b>Benchmarking Video Codecs on 4K Content Using Subjective and Objective Quality Metrics</b> Ioanna Valiandi <sup>1</sup> , Moatasim Mahmoud <sup>2,3</sup> , Stamatia Rizou <sup>2</sup> , Andreas S. Panayides <sup>1</sup> <sup>1</sup> Videomics group, CYENS Centre of Excellence, Nicosia, Cyprus <sup>2</sup> R&D Department, Singular Logic, Athens, Greece <sup>3</sup> School of Electrical and Computer Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece
15:40-16:10	<b>COFFEE BREAK</b>

	<p><b>SESSION 3: Biomedical Imaging</b></p> <p><b>Chair: Costas Pitris</b>, Department of Electrical and Computer Engineering and KIOS Research and Innovation Center of Excellence, University of Cyprus</p>
16:10-16:20	<p><b>Blueprint for a National Secure Processing Environment in Cyprus Aligned with EHDS Regulation Requirements</b></p> <p>Maria Papaioannou<sup>1</sup>, Nikoletta Prentza<sup>1</sup>, Ioannis Konstantinou<sup>1</sup>, Ioannis Rodosthenous<sup>1</sup>, Constantinos Pattichis<sup>1</sup>, Christos N. Schizas<sup>1</sup>  <sup>1</sup>University of Cyprus</p>
16:20-16:30	<p><b>An Augmented Mirror System for Real-Time Musculoskeletal Biofeedback in Musicians: A Randomized Controlled Evaluation</b></p> <p>Christos Ioannou<sup>1</sup>, Fotos Frangoudes<sup>1</sup>, Tania Karina Garcia Vite<sup>1</sup>, Marios Avraamides<sup>2</sup>, Evangelia Athanasiou<sup>1</sup>, Christina Pari<sup>1</sup>, Ali Najim<sup>1</sup>, Gulsu Tecer<sup>1</sup>  <sup>1</sup>CYENS Centre of Excellence, Nicosia, Cyprus  <sup>2</sup>University of Cyprus</p>
16:30-16:40	<p><b>FlyQTA: A Convolutional Neural Network for the Assessment of <i>Drosophila</i> Intestinal Tissue Chronological Age Using Confocal Images – Preliminary Findings</b></p> <p>Euripides Soteriou<sup>1</sup>, Maria Michail<sup>1</sup>, Andria Nicolaou<sup>2</sup>, Constantinos S. Pattichis<sup>2</sup>, Chrysoula Pitsouli<sup>1</sup>  <sup>1</sup>Department of Biological Sciences, University of Cyprus  <sup>2</sup>Department of Computer Science, University of Cyprus</p>
16:40-16:50	<p><b>Deep Learning-Based Classification of Colon Polyps for Colorectal Cancer (CRC) Detection Using Feature-Enhanced <i>Ex Vivo</i> Optical Coherence Tomography (OCT) Images</b></p> <p>Christos Photiou<sup>1</sup>, Andrew Thrapp<sup>2</sup>, Guillermo Tearney<sup>2</sup> and Costas Pitris<sup>1</sup>  <sup>1</sup>KIOS Research and Innovation Center of Excellence, University of Cyprus, Nicosia, Cyprus  <sup>2</sup>Harvard Medical School, Massachusetts General Hospital, Wellman Center for Photomedicine, USA, Boston</p>
16:50-17:00	<p><b>Endometrial Abnormality Detection Using Deep Learning on Hysteroscopic ROIs</b></p> <p>Andreas Anastasiou<sup>1</sup>  <sup>1</sup>University of Cyprus</p>
17:00-17:10	<p><b>Personalized Medicine via AI-based Precision Tracheostomy</b></p> <p>Evropi Toulkeridou<sup>1</sup>, Panagiota Kosmidou<sup>2</sup>, Kristis Vevis<sup>2</sup>, Zinonas Antoniou<sup>3</sup>, Loizos Kallinos<sup>3</sup>, Ioanna Valiandi<sup>1</sup>, Andreas Panayides<sup>1, 3</sup>  <sup>1</sup>Videomics FRG, CYENS Center of Excellence, Nicosia, Cyprus  <sup>2</sup>German Oncology Center (GOC), Limassol, Cyprus  <sup>3</sup>3aHealth, R&amp;D Department, Nicosia, Cyprus</p>
17:10-17:20	<p><b>Disk harmonic map of head CT scans for skull fracture visualization</b></p> <p>Nicolas Hadjittoouli<sup>1</sup>, Costas Pitris<sup>1</sup>  <sup>1</sup>KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus</p>
17:20-17:30	<p><b>Assessing Breast Cancer Invasiveness and Grade using Subtraction of Temporally Sequential Mammograms and Machine Learning</b></p> <p>Kosmia Loizidou<sup>1</sup>, Eleni Orphanidou Vlachou<sup>2</sup>, Anneza Yiallourou<sup>3</sup>, Christos Nikolaou<sup>4</sup>, and Costas Pitris<sup>1</sup>  <sup>1</sup>KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus  <sup>2</sup>EIMC Clinic Strovolos, Cyprus  <sup>3</sup>Medical School University of Cyprus, Breast Unit Nicosia General Hospital, State Health Services Organization, Cyprus  <sup>4</sup>Limassol General Hospital, Cyprus</p>
17:30-17:40	<p><b>Critical Outcomes Prediction in the Emergency Department</b></p>

**17<sup>th</sup> Cyprus Workshop on Signal Processing and Informatics (CWSPI) - 2025**

	Waqar Aziz <sup>1</sup> <sup>1</sup> Department of Computer Science and Biomedical Engineering Research Centre, University of Cyprus
<b>17:40-17:50</b>	<b>Explainable AI-Driven Sepsis Diagnosis 12Hrs Ahead</b> Charithea Stylianides <sup>1</sup> , Andria Nikolaou <sup>1</sup> , Nikos Ioannides <sup>2</sup> , Lakis Palazis <sup>2</sup> , Anna Vavlitou <sup>2</sup> , Constantinos S. Pattichis <sup>1</sup> , Andreas S. Panayides <sup>1</sup> <sup>1</sup> CYENS CoE, Cyprus <sup>2</sup> State Health Services Organization, Cyprus
	<b>SESSION 4: 2025 NSF REU Quantum Computing Projects at the ASU SenSIP Center</b>  <b>Chair: C. S. Pattichis</b> , University of Cyprus & CYENS, Cyprus
<b>17:50-18:00</b>	Nine Short Elevator Pitch Presentations by students from ASU, Carnegie Mellon, Cornell, Georgia Tech, Lafayette Colleg, Princeton, UIUC, and Yale  Coordinator: A. Spanias, ASU SenSIP Center
	<b>Closing Remarks</b>

## Abstracts

### SESSION 1: PLENARY TALK

#### **Dynamic Early-Exit Convolutional Neural Networks for Edge Vision: Do only *what* and *when* you need!**

Theocharis Theocharides

Associate Professor and Department Chair Department of Electrical and Computer Engineering  
KIOS Research and Innovation Center of Excellence, University of Cyprus

#### **Abstract**

While computer vision has seen unparalleled growth over recent years, mainly due to advancements in deep convolutional neural networks, deploying such models on edge devices such as tiny autonomous unmanned aerial and terrestrial vehicles has been challenging, due to constraints involving power and energy, computational resources and memory footprint, and application performance requirements. Applications in safety-critical missions such as search and rescue operations and emergency management, elevate these challenges, as they also impose performance constraints, in addition to visual constraints associated with the inference due to occlusions, changing environmental parameters, and dynamic operational and situational context. Current practice involves performing training of the CNNs in a way that generalizes to all these constraints and optimizing the model to target an embedded processing device, custom accelerator or an embedded multi-processor platform. While methods such as pruning (structured and unstructured) and quantization have achieved various levels of success in compressing and optimizing deep CNNs for embedded devices, they remain subject to the computational boundaries imposed by the host platforms.

Leveraging from the benefits of adaptive inference in dynamic deep CNNs, in this talk I will present our recent work in dynamic deep convolutional neural networks targeting low power embedded computer vision applications. In particular, Dynamic Deep Convolutional Neural Networks (DNNs) offer significant resource savings over static CNNs in edge computer vision by adapting their computation based on input complexity. Unlike static models that process every input with a fixed depth and width, dynamic DNNs selectively activate layers, channels, or early exits, reducing unnecessary computation and memory access. This conditional execution leads to lower energy consumption, faster inference, and improved efficiency—making dynamic architectures ideal for real-time, resource-constrained edge applications.

#### **Short Bio**

Prof. Theocharis (Theo) Theocharides is an Associate Professor and the Department Chair, at the Department of Electrical and Computer Engineering, at the University of Cyprus and the Director of Research of the KIOS Research and Innovation Centre of Excellence. He is a senior member of the IEEE and the IEEE Computer Society, a member of the ACM, and a member of the HiPEAC Network of Excellence. He is an Associate Editor for ACM's Computing Surveys, ACM's Transactions on Emerging Technologies for Computing Systems (JETC), IEEE Transactions on Computer Aided Design of Integrated Circuits and Systems (TCAD) and the IEEE Design and Test magazine. He also serves on several Organizational and Technical Program Committee boards of various IEEE/ACM Conferences, most recently being the Technical Programme Committee Chair of the 2025 edition of the Design, Automation and Test in Europe (DATE), the largest conference in Electronic Design and Automation of Integrated Circuits and Embedded Systems.

His present work focuses on development of embedded machine learning algorithms (tinyML) and applications, embedded computer vision, and edge AI algorithms for autonomous unmanned aerial and terrestrial vehicles.

### **A Fulbright US Scholar Project on Research and Workforce Development in AI for Solar Energy Applications**

Andreas Spanias,  
Professor and SenSIP Center Director  
Arizona State University

#### **Abstract**

This CWSPI presentation highlights a Fulbright-supported research and workforce development initiative on classical and quantum machine learning (QML) for solar energy applications. Originating at Arizona State University's SenSIP Center, the program launched ML projects in solar energy, imaging, and audio signal processing, while hosting five NSF-sponsored efforts to train students and faculty. In 2024, workforce development and research in energy systems expanded internationally through a Fulbright U.S. Scholar grant, fostering collaboration with universities in the Balkans. The program combined research, student training, and outreach through seminars at regional universities. Recent efforts also introduced QML simulations and tutorials aimed at building local capacity. This seminar presents insights and outcomes from the Fulbright experience, emphasizing the role of ML and QML in advancing solar energy solutions and supporting workforce development through international research engagement.

#### **Short Bio**

Andreas Spanias (FIEEE) is Professor in the School of Electrical, Computer, and Energy Engineering at Arizona State University (ASU). He is also the director of the Sensor Signal and Information Processing (SenSIP) center and the founder of the SenSIP industry consortium (also an NSF I/UCRC site). His research interests are in the areas of adaptive signal processing, speech processing, machine learning, quantum AI simulations and sensor systems. He and his student team developed the computer simulation software Java-DSP and its award-winning iPhone/iPad and Android versions. He is author of two textbooks: Audio Processing and Coding by Wiley and DSP; An Interactive Approach (2nd Ed.). He contributed to more than 350 papers, 10 monographs, 26 US patents and 10 provisional patents. He served as Associate Editor of the IEEE Transactions on Signal Processing and as General Co-chair of IEEE ICASSP-99. He also served as the IEEE Signal Processing Vice-President for Conferences. Andreas Spanias is co-recipient of the 2002 IEEE Donald G. Fink paper prize award and was elected Fellow of the IEEE in 2003. He served as Distinguished Lecturer for the IEEE Signal processing society in 2004. He is a series editor for the Morgan and Claypool lecture series (now under Springer) on algorithms and software. He is heading four NSF workforce development programs on machine learning and quantum AI. He received recently the 2018 IEEE Phoenix Chapter award with citation: "For significant innovations and patents in signal processing for sensor systems." He also received the 2018 IEEE Region 6 Educator Award (across 12 states) with citation: "For outstanding research and education contributions in signal processing." He is co-author on the 2024 SPIE Defense and Commercial sensing best student paper award. He was elected as Senior Member of the National Academy of Inventors (NAI). He was recently selected for the prestigious Fulbright US Research Scholar award with support for collaborative research activities in Spring 2025 at the Ss. Cyril and Methodius University (UKIM) FEEIT.

## SESSION 2: Deep Neural Networks Modelling and Video Coding

### Investigation of Early Exit in Convolutional Channel-Wise Competitive Learning

Stanimira Georgieva<sup>1</sup>, Andreas Papachristodoulou<sup>1</sup>, Christos Kyrkou<sup>1</sup>, Theocharis Theocharidis<sup>1,2</sup>

<sup>1</sup>KIOS Research and Innovation Center of Excellence

<sup>2</sup>Department of Mathematics and Statistics/ Computer Science / Electrical & Computer Engineering, University of Cyprus, Nicosia, Cyprus

#### Abstract

Optimizing computational efficiency in deep learning remains a key challenge. Early Exit (EE) strategies in Convolutional Channel-Wise Competitive Learning offer a promising approach to reduce inference time and parameter count while preserving test accuracy. Using a pretrained model, we utilize intermediate classifiers, which are activated under a specific condition, during inference. Therefore, each convolutional neural network layer functions as a standalone classifier. The results of this experiment showed that the estimation of the threshold for each layer is pivotal for deciding whether to EE or not. More particularly, without the implementation of EE, we have total accuracy, parameters and time: 80.73%, 4409400, 1.753s, respectively. Nevertheless, with EE and a stable threshold value of 0.2 for all layers, the outputs are 80.47%, 2431579, 1.42s. These findings suggest the need for a dynamic threshold estimation algorithm and a more systematic framework for EE deployment. However, the model's sensitivity to small input perturbations—adversarial attacks—remains an unresolved issue. Addressing this vulnerability through uncertainty estimation using Monte Carlo Dropout constitutes the next phase of our research.

### Effective Loss Weighting under Class Imbalance

Antonios Savva<sup>1</sup>, Christos Kyrkou<sup>1</sup>, and Theocharis Theocharides<sup>1,2</sup>

<sup>1</sup>KIOS Research and Innovation Center of Excellence

<sup>2</sup>Department of Electrical and Computer Engineering, University of Cyprus

#### Abstract

This work examines loss weighting strategies for handling class imbalance in 3D semantic segmentation and 2D image classification tasks. It focuses on three methods: inverse logarithm weighting, inverse power weighting, and a complementary frequency-based approach that considers inter-class relationships. Experiments on the DALES dataset (3D) and modified versions of CIFAR10 with class imbalance (2D) show that these methods are broadly applicable and perform effectively. The inverse logarithm method leads to improvements of up to 13.44% in mean IoU for 3D semantic segmentation and up to 39% in classification accuracy for 2D tasks under high imbalance. Analysis using confusion matrices shows that standard methods often result in majority classes being misclassified as minority classes, which reduces precision. In contrast, the proposed methods maintain majority class accuracy and improve recognition of minority classes.

Initial results from other 3D datasets, including aerial, mobile laser, and indoor data, support the general applicability of the methods.

In addition, new imbalanced CIFAR10 versions that reflect class distributions from 3D datasets show that common benchmarks do not perform well under more realistic imbalance scenarios. Ongoing work is investigating whether data distribution characteristics can inform the selection of the most suitable weighting scheme.

**Keywords:** class imbalance, loss weighting, point cloud, inverse logarithm, long-tail distribution.

## **Towards Adversarial Purification via Distilled and Finetuned Denoising Diffusion Implicit Models**

Mehmet Demirel<sup>1</sup>, Christos Kyrkou<sup>1</sup>

<sup>1</sup>KIOS Research and Innovation Center of Excellence, University of Cyprus, Nicosia, Cyprus

### **Abstract**

Deep Neural Networks (DNNs) on edge devices are highly susceptible to adversarial attacks, creating significant security vulnerabilities in essential applications. While Diffusion Model-based Adversarial Purification (DM-AP) offers a strong defense, its high computational cost from iterative denoising makes it unsuitable for on-device protection.

We introduce an efficient adversarial purification framework utilizing Denoising Diffusion Implicit Models (DDIMs), which drastically reduces the sampling steps needed for purification. We boost efficiency further by using knowledge distillation to derive a compact student model from a larger, pre-trained DDIM. This student model is then finetuned to maintain both generative quality and robustness. Our extensive experiments on diverse image datasets, from small (CIFAR-10) to larger (CelebA-HQ), show that our DDIM-based method achieves comparable or even superior robustness against various adversarial attacks compared to current state-of-the-art DM-AP techniques. Our approach delivers substantial inference speedups over existing methods. Moreover, our distilled and finetuned variant reduces model size and computational demands, making robust, diffusion-based adversarial purification practical for edge devices and enabling on-device defense for pre-existing classifiers.

**Keywords:** Adversarial Learning, Diffusion Models, Edge AI

## Benchmarking Video Codecs on 4K Content Using Subjective and Objective Quality Metrics

Ioanna Valiandi<sup>1</sup>, Moatasim Mahmoud<sup>2,3</sup>, Stamatia Rizou<sup>2</sup>, Andreas S. Panayides<sup>1</sup>

<sup>1</sup>Videomics group, CYENS Centre of Excellence, Nicosia, Cyprus

<sup>2</sup>R&D Department, Singular Logic, Athens, Greece

<sup>3</sup>School of Electrical and Computer Engineering, Aristotle University of Thessaloniki,  
Thessaloniki, Greece

### Abstract

A Subjective Video Quality Assessment (VQA) experiment was conducted to evaluate the performance of advanced video encoding standards when displayed on a large UHD video wall measuring 30 m<sup>2</sup>. The comparative analysis covers four video codecs including Advanced Video Coding (AVC/H.264), High-Efficiency Video Coding (HEVC/H.265), Versatile Video Coding (VVC/H.266) and AOMedia Video 1 (AV1). In contrast to prior work, we performed a subjective VQA study to measure the perceived quality of 4K videos displayed on a large-scale video wall. Five UHD video sequences with diverse content were encoded at multiple quality levels and 27 participants rated the perceptual quality using the Degradation Category Rating (DCR) method. This study also assesses how well several widely used full-reference objective VQA metrics correlate with the obtained subjective mean opinion scores (MOS). Their correlation was analyzed using Pearson, Spearman, Kendall, RMSE and MAE measures. The findings reveal that Versatile Video Coding (VVC/H.266) consistently delivers superior perceptual quality compared to the other codecs, achieving the best rate-distortion performance both subjectively and objectively. The subjective findings align with both the objective assessment results and existing research. Among the objective metrics evaluated, VMAF-4K demonstrated the strongest correlation with the subjective ratings across codecs. These results highlight VVC's advantage for efficient 4K video streaming and underscore the importance of combining subjective and objective evaluations for comprehensive codec benchmarking.

**Keywords:** Video Quality Assessment (VQA), Video Compression, Subjective Study, UHD (4K)

### SESSION 3: Biomedical Imaging

#### **Blueprint for a National Secure Processing Environment in Cyprus Aligned with EHDS Regulation Requirements**

Maria Papaioannou<sup>1</sup>, Nikoleta Prentza<sup>1</sup>, Ioannis Konstantinou<sup>1</sup>,  
Ioannis Rodosthenous<sup>1</sup>, Constantinos Pattichis<sup>1</sup>, Christos N. Schizas<sup>1</sup>

<sup>1</sup>University of Cyprus

#### **Abstract:**

Cyprus currently lacks any infrastructure supporting the secondary use of health data. To address this gap, Cyprus is implementing the CY-EHDS-2nd, a direct EU-funded project aimed at developing five core modules aligned with the European Health Data Space (EHDS). As part of this project, the country's first national Secure Processing Environment (SPE) will be implemented. In this paper, we present the design and architecture of this Cypriot SPE, explicitly tailored to meet the requirements outlined in the EHDS Regulation (EU) 2025/327. The National eHealth Authority (NeHA), acting as the sole designated Health Data Access Body (HDAB) of Cyprus, operates the proposed two-tier SPE architecture. This includes an Internal SPE, where authorised HDAB personnel securely prepare health datasets and an External SPE, which allows authorised users to perform controlled analyses under strict technical and organisational safeguards. Key features such as role-based access control, data minimisation and strict non-exfiltration measures have been embedded in the SPE architecture to protect personal privacy and ensure regulatory compliance. Furthermore, the SPE closely integrates with the national Data Access Application Management system (DAAMs) to streamline processes and enhance data governance. Given that Cyprus does not currently have legal provisions supporting such infrastructure, this architectural blueprint also highlights necessary future amendments to national law to facilitate effective governance of the SPE. This paper thus demonstrates a practical approach for a Member State without existing infrastructure to develop a critical HDAB digital business capability, ensuring adaptability to upcoming TEHDAS2 technical specifications and EHDS2 implementing acts.

**Keywords:** Secure Processing Environment (SPE), EHDS Regulation, Secondary use of health data, Health Data Access Body (HDAB), Cyprus

## **An Augmented Mirror System for Real-Time Musculoskeletal Biofeedback in Musicians: A Randomized Controlled Evaluation**

Christos Ioannou<sup>1</sup>, Fotos Frangoudes<sup>1</sup>, Tania Karina Garcia Vite<sup>1</sup>, Marios Avraamides<sup>2</sup>,  
Evangelia Athanasiou<sup>1</sup>, Christina Pari<sup>1</sup>, Ali Najim<sup>1</sup>, Gulsu Tecer<sup>1</sup>

<sup>1</sup>CYENS Centre of Excellence, Nicosia, Cyprus

<sup>2</sup>University of Cyprus

### **Abstract**

Playing-Related Musculoskeletal Disorders (PRMDs) are prevalent among musicians, stemming from repetitive motor activities and sustained non-ergonomic postures. Traditional methods for posture correction, such as mirror use, offer limited visual feedback and fail to inform about muscular activity or asymmetries. This study presents the development and evaluation of an innovative biofeedback system functioning as an augmented mirror, integrating wireless motion capture and surface electromyography (sEMG) to provide real-time visual muscular and postural feedback. In a randomized controlled trial, 20 healthy professional musicians were assigned to either a biofeedback group or a mirror control group. Both groups performed a series of musical exercises, pre- and post-intervention, while motion and EMG data were recorded. Usability and user experience were assessed using standardized instruments (UEQ, SUS) and thematic interviews. Results showed a significant improvement in pelvic alignment over time for both groups, though no group-specific effects were found for muscle activity. The biofeedback system was rated as highly usable and effective, with qualitative feedback highlighting its real-time feedback capabilities, usability for training and teaching, and recommendations for future enhancements. These findings suggest that the augmented mirror system is a promising tool for musculoskeletal training and injury prevention in musicians.

**Keywords:** Biofeedback, Musculoskeletal Disorders, Motion Capture, Electromyography, Musicians' Health

## **FlyQTA: A Convolutional Neural Network for the Assessment of *Drosophila* Intestinal Tissue Chronological Age Using Confocal Images – Preliminary Findings**

Euripides Soteriou<sup>1</sup>, Maria Michail<sup>1</sup>, Andria Nicolaou<sup>2</sup>, Constantinos S. Pattichis<sup>2</sup>, Chrysoula Pitsouli<sup>1</sup>

<sup>1</sup>Department of Biological Sciences, University of Cyprus

<sup>2</sup>Department of Computer Science, University of Cyprus

### **Abstract**

Aging is a significant risk factor for many diseases, including inflammatory, cardiovascular, neurodegenerative conditions, and cancer. The United Nations predicts a dramatic increase in the population aged 65 and older, reaching approximately 1.5 billion by 2050 and posing both humanitarian and economic challenges. Accelerated aging, independent of chronological age, can result from environmental toxins, consumables, and certain drugs. Moreover, lifestyle and medical interventions can potentially delay aging. This study proposes the use of the fruit fly *Drosophila melanogaster* as an in vivo model to investigate aging, given that around 77% of human disease-

causing genes have fly homologues and several age-related diseases have been modelled in this organism. Adult fly midguts are dissected and immunostained for intestinal stem cells, nuclei and cellular junctions before imaging with a confocal microscope. The images are acquired after implementing an image-acquisition protocol at different timepoints and, then, are normalized. A convolutional neural network (CNN) is implemented to assess *Drosophila* intestinal tissue chronological age using the normalized images. The findings indicate that the CNN model can classify the midgut images based on the tissue state determined by the chronological age. Future work will evaluate the effectiveness of potential age-accelerant (gerontogens) and anti-aging treatments on young and old *Drosophila* midguts, respectively.

*Keywords: Aging; Classification; Confocal Microscopy; Drosophila Midgut.*

### **Deep Learning-Based Classification of Colon Polyps for Colorectal Cancer (CRC) Detection Using Feature-Enhanced *Ex Vivo* Optical Coherence Tomography (OCT) Images**

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#### **Abstract**

Colorectal cancer (CRC) is a leading cause of cancer deaths, with thousands of new cases each year worldwide. CRCs mainly develop from dysplastic polyps, which gradually progress into malignancies. Population-based screening with colonoscopy is a crucial cancer prevention strategy, potentially decreasing CRC mortality by up to 57%. Despite its effectiveness, colonoscopy can be improved. Recent efforts to enhance colonoscopic efficiency tried to reduce the procedure time and cost by leaving diminutive polyps (<5 mm) in place. However, such a strategy introduces additional risks since it implies leaving 80% of the, now-resected, polyps in place. Thus, technological advancements are needed to minimize the risk from unresected polyps. OCT can aid in detecting and classifying colon polyps, but its application in colon imaging lags behind other clinical uses due to its dependence on images of tissue microstructure without any biochemical information, necessary, to distinguish early signs of cancer. This study proposes a novel approach to overcome limitations in interpreting OCT images for CRC screening. *Ex vivo* OCT images of colon polyps were used to extract features that remain unused and indicate sub-resolution and biochemical tissue changes, such as scatterer size and group velocity dispersion. Along with the intensity images, feature images were created and used for deep learning (DL) classification with late fusion to distinguish benign (normal and hyperplastic) from malignant (adenoma and SSA) polyps. The novel DL method resulted in 88.3 % correct classification rate per image.

**Keywords:** Optical coherence tomography (OCT), image processing, colorectal cancer, polyps, feature extraction, biomarkers, Deep Learning, Machine learning.

## Endometrial Abnormality Detection Using Deep Learning on Hysteroscopic ROIs

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### Abstract

Accurate detection of endometrial abnormalities in hysteroscopic images is crucial for early diagnosis. This study evaluates a custom Convolutional Neural Network (CNN) and a fine-tuned DeiT transformer for binary classification of regions of interest (ROIs) in hysteroscopic imaging. Both models were trained on CPU hardware and assessed for diagnostic accuracy and feasibility. The results highlight the potential of deep learning, including transformer-based architectures, in supporting computer-aided diagnosis (CAD) for endometrial pathology.

## Personalized Medicine via AI-based Precision Tracheostomy

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### Abstract

Accurate multi-organ segmentation in the head, neck, chest, and abdomen is critical for diagnosis, surgical planning, and radiation therapy. In tracheostomy procedures, however, segmentation and measurement of the trachea are still predominantly performed manually using 3D-CT data, which is time-consuming and subject to variability. Artificial intelligence (AI), however, offers a powerful solution for medical image segmentation, enabling enhanced diagnostic accuracy and efficiency. In particular, deep learning methods—leveraging data-driven feature extraction and end-to-end training—have consistently outperformed traditional segmentation techniques. This study focuses on developing an AI-assisted tool capable of trachea segmentation with accuracy comparable to that of experienced clinicians. Our goal is to integrate such tools into clinical workflows to support decision-making, especially in complex or ambiguous cases. As a first step, we trained and evaluated two deep learning models—U-Net and SegVol—on the OSIC Pulmonary Fibrosis Progression dataset for automated trachea segmentation. Both models achieved segmentation accuracies exceeding 85%, with SegVol demonstrating superior performance. These preliminary results highlight the potential for further improvement, particularly with access to more diverse and comprehensive datasets.

## Disk harmonic map of head CT scans for skull fracture visualization

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## Abstract

**Background:** Skull fractures affecting the base and facial regions pose significant challenges in diagnosis and treatment within cranial trauma management. The complex structure of the skull, especially at its base, requires careful consideration due to potential impacts on neurological function and patient outcomes.

**Method:** This study introduces a novel approach of disk harmonic map, to improve diagnostic accuracy and time efficiency for skull fractures, particularly in challenging areas of the base of the skull. The method maps the shape of the skull to the topological shape of unit disk, by applying disk harmonic mapping to CT volumetric data. The effectiveness of the technique was evaluated using the CQ500 dataset, with qualitative assessments performed to estimate its impact on fracture visibility and detection.

**Results:** The mapping technique results in fractures consistently appearing perpendicular to the bone's surface, making them more visible and realistic while preserving skull anatomy. This approach offers enhanced visibility of fractures, especially subtle basilar fractures, increasing the likelihood of detection, while it enables slice-by-slice examination of the bone. Qualitative evaluation demonstrated promising advancements in skull fracture diagnostics, particularly in complex regions of the skull base and facial bones.

**Conclusion:** Disk harmonic map presents a valuable addition to conventional diagnostic methods for skull fractures, while taking account the shape of the skull. By providing a supplementary perspective for radiologists and emergency staff, this innovative approach has the potential to improve the accuracy and efficiency of skull fracture diagnostics, particularly in challenging cases involving the skull base and facial regions.

**Keywords:** Computer-Aided Diagnoses, Computed Tomography, Image Processing, Medical Imaging, Skull Fracture.

## Assessing Breast Cancer Invasiveness and Grade using Subtraction of Temporally Sequential Mammograms and Machine Learning

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## Abstract

Despite significant advancements, Breast Cancer (BC) remains a leading cause of morbidity and mortality among women worldwide. The management of BC, as well as the patient prognosis, depends on the tumor invasiveness and grade. Definitive classification of both is provided by biopsy and histopathology. However, this process is both invasive and increases delays in the diagnosis. In this study, an algorithm is developed for the automatic detection and sub-typing of BC type as *in situ* vs. invasive and tumor grading as grade 2 vs. grade 3 from mammographic images and other patient data. Subtraction of temporally sequential digital mammograms and feature-based Machine Learning (ML) were combined to achieve this goal. The methodology involves two main steps: (1) detection of Regions of Interest (ROIs) and (2) classification of the ROIs. The algorithm was developed using a new dataset of 164 images, with precise annotations. Ninety-six image features and 12 epidemiological and medical history features were collected. Eight feature selection algorithms and 10 classifiers were evaluated for identifying the best models. The algorithm achieved

91.2% accuracy and 0.91 AUC for *in situ* vs. invasive classification, and 92.8% accuracy and 0.92 AUC for tumor grading. These are the first such results reported in the literature. By reducing the reliance on biopsies, the algorithm provides a faster, non-invasive, and accurate tool for the subtyping of BC. When translated to clinical practice, it has the potential to enhance diagnostic efficiency, improve patient outcomes, and lower BC-related mortality rates.

**Keywords:** Breast cancer, Computer-Aided Diagnosis (CAD), Temporal subtraction, Machine learning

## Critical Outcomes Prediction in the Emergency Department

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### Abstract

Rapid identification of patients at risk of critical outcomes—such as inpatient mortality or ICU admission within 12 hours—is essential in emergency departments (EDs). This study developed and evaluated interpretable machine learning models using Gradient Boosting (GB) and Logistic Regression (LR), based on 13 initial triage variables from the MIMIC-IV-ED database. GB achieved slightly superior performance compared to LR (Accuracy: 78.21% vs. 77.27%; AUROC: 0.887 vs. 0.863; AUPRC: 0.445 vs. 0.370). To enhance interpretability, the Te2Rules method was applied to extract clinically meaningful rules from the GB model. Additionally, a Rule Coverage Index (RCI) was introduced to categorize rules into high, medium, and low coverage levels, further supporting clinical applicability. The study demonstrates a balanced approach between predictive performance and model transparency, enabling early identification of critically ill patients in the ED.

**Keywords:** Emergency department, Machine learning, Explainable AI

## Explainable AI-Driven Sepsis Diagnosis 12Hrs Ahead

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### Abstract

Sepsis remains a major cause of morbidity and mortality in Intensive Care Units (ICUs), where early intervention is critical in improving patient outcomes. In this study, we propose an explainable machine learning (ML) pipeline that leverages data from 45,148 patients in the Medical Information Mart for Intensive Care (MIMIC)-IV dataset. We develop an Extreme Gradient Boosting (XGB) model using 17 features to predict sepsis 12 hours in advance with Area Under the Curve (AUC) 91% and sensitivity 90%. We enhance interpretability using the TE2Rules explainability library, achieving an overall fidelity score of 93% with just 32 rules for a positive

prediction. Argumentation theory application raises sensitivity to 92%. The proposed system enables personalized decision making, and reduced mortality rates and healthcare costs.

**Introduction:** Sepsis is a critical condition with high mortality rates and healthcare costs in ICU settings, where early detection is vital for improving outcomes. Traditional diagnostic methods, including biomarkers and clinical scoring systems, are limited by lack of generalizability, delayed applicability, and absence of predictive capabilities. ML offers promising alternatives using Electronic Health Records [1]. Model transparency and ethical use of clinical data have driven the adoption of Explainable AI (XAI) to support trust and decision-making [2]. This study proposes a 12-hour-ahead ML-based sepsis prediction pipeline, analyzing the impact of observation window size, and integrating rule-based explainability and argumentation-based reasoning to enhance interpretability.

**Methodology:** This study uses MIMIC-IV v2.0 [3] data to identify sepsis onset in ICU patients based on Sepsis-3 criteria, selecting 14,623 sepsis cases and 58,558 controls (all adults), resulting in a final cohort of 73,181 patients. We converted ICD9 to ICD10 codes and handled outliers. We created 5 different cohorts according to 4-, 8-, 12-, 18-, and 24-hour observation windows to predict sepsis 12 hours ahead. For each cohort, we hourly-bin resampled, imputed missing values, and generated features like PO2/FIO2 ratio, Shock index, total Glasgow Comma Score (GCS), and statistics across windows. We split into train-test sets in a stratified 80:20 ratio and fitted RF, GBM, ADABOOST, and XGB on the most important features. We explored performance on balanced datasets, where we also fitted 1DCNN, LSTM, 1DCNN- LSTM, and TCN models. Finally, we used GBM within TE2Rules to extract rules and identified priorities by resolving dilemmas (argumentation) and compared metrics. Gorgias cloud provided application-level explanations.

**Results:** XGB achieved the best performance with AUC 0.91, sensitivity 90% and specificity 71%, using just 20 (17 distinct) features and a 12-hour observation window. Data used corresponded to the cohort of 45,148 subjects (36,118 for training, 9,030 for testing). Important features included NaCl 0.9% and dextrose 5% medications in the 1st hour, and GCS verbal response score in the last hour of observation. Cases accounted for about 2% of each split. Positive and negative class rule lists consisted of 32 and 41 rules, resp. The overall fidelity score was 93%. Argumentation corrected predictions and improved metrics by 2%.

Table I: XGB performance before and after argumentation.

	AUC	SEN	SPE
XGB (imbalanced)	0.91	0.90	0.71
XGB (balanced)	0.90	0.90	0.71
XGB+ARG	-	0.92	0.73

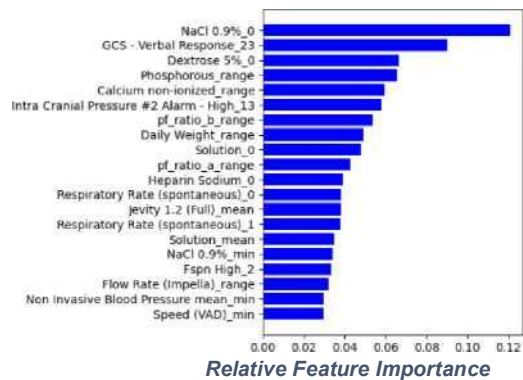


Figure 1: XGB feature importance ranking

**Conclusions:** The study predicts sepsis in ICU patients 12 hours in advance using 24 hours of data and just 17 distinct features, achieving an AUC 0.91 with XGB and outperforming existing models. XAI is proven promising, yielding 32 rules at 93% fidelity. Argumentation theory improves performance by 2%. Future work will explore new features, LLMs, external validation.

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**Keywords:** AI, explainable AI, ICU, sepsis prediction

#### **SESSION 4: 2025 NSF REU Quantum Computing Projects at the ASU SenSIP Center**

##### **Nine Short Elevator Pitch Presentations by students from ASU, Carnegie Mellon, Cornell, Georgia Tech, Lafayette Colleg, Princeton, UIUC, and Yale**

Coordinator: A. Spanias, ASU SenSIP Center

We provide here nine recorded elevator pitch presentations from the NSF Research Experience for Undergraduates (REU) students who spent the summer conducting research at the ASU SenSIP lab. Students from ASU, Carnegie Mellon, Cornell, Georgia Tech, Lafayette Colleg, Princeton, UIUC, and Yale performed research in areas including signal processing, machine learning and quantum AI applications. Projects included quantum-based methods for music source separation, MIDI generation, and image generation using quantum transformers. Two of the REU students explored quantum techniques in 3D vision and graphics, including positional encoding for neural radiance fields and enhanced 3D Gaussian splatting. Medical and security applications were also featured, with research on quantum pre-processing of MRIs for improved classification, quantum models for diagnosing dysarthria, and credit card fraud detection. One of the projects presented covers a mathematical analysis of Riemann gradient descent for optimization in quantum machine learning workflows.