Information and Networking Event
Horizon Europe 2023-2024 Calls
Co-Funded by the Government of India
(DST)

HORIZON-CL4-2024-HUMAN-03-02: Explainable and Robust AI
24 May 2024

- **Explainable Machine Learning based on Causality, Similarity and Perceptual Features**
- Dimitris Iakovidis, Professor
- University of Thessaly
- Greece
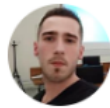- diakovidis@uth.gr, dimitris.iakovidis@ieee.org, Tel. +30 6932 252591
- https://www.uth.gr
- https://is-innovation.eu (team)

Meet our Team

Prof. Dimitris K. Iakovidis [cv]
Intelligent signal processing & medical decision support systems

Faculty - Internal

Prof. Konstantinos Delibasis [cv]
Medical informatics & image analysis

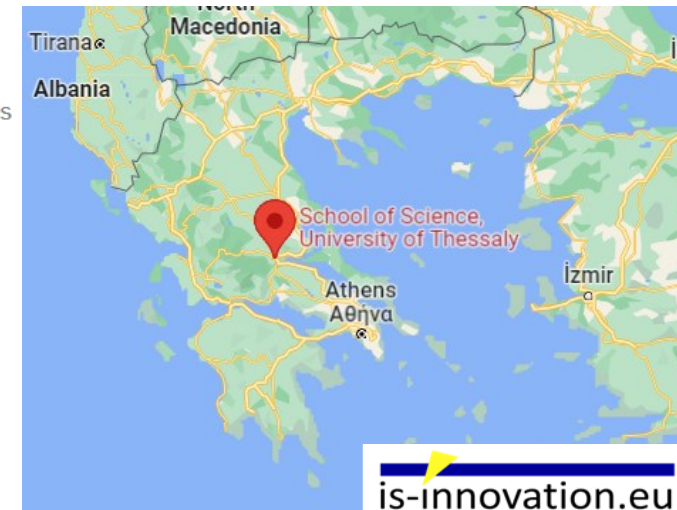**Prof. Michalis A. Savelonas** [cv]
Expert systems & pattern recognition

Prof. Panagiotis Vartholomeos [cv]
Robotics

Supporting Personnel

Ms. Penny Athanasiou
Project administration

Senior researchers

Dr. Dimitris Diamantis [cv]
Deep learning

Mr. George Dimas [cv]
Computer vision & visual measurements

Dr. Panagiotis Kalozoumis [cv]
In silico modeling, finite element analysis & simulation

Dr. Dimitra-Christina Koutsiou [cv]
Color imaging & physics-inspired algorithms

Dr. Argyris Stasinakis [cv]
Optical communications

Dr. Michalis Vasilakakis [cv]
Data analysis for information extraction

Doctoral Researchers

Ms. Eirini Cholopoulou [cv]
Interpretable machine learning & computational modeling

Ms. Panagiota Gatoula [cv]
Machine learning & multimodal data processing

Ms. Georgia Sovatzidi [cv]
Evolutionary algorithms & bio-inspired optimization

Mr. George Triantafyllou [cv]
Computational modeling of complex systems using machine learning

School of Science, University of Thessaly

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Facts about our Laboratory

- Belongs to the Department of Computer Science & Biomedical Informatics of the University of Thessaly, ranked among the top 5% of Universities in EU

- > 400 publications, 2 patents pending

- [10 recently published papers](#) on explainable machine learning (2022-2024):
  - Novel **generic inherently interpretable** systems that can render current machine learning systems interpretable
  - **Uncertainty tolerant** using **linguistic data interpretations** based on fuzzy logic
  - Explanations **based on causality, similarity and perceptual features**
  - Suitable for both **structured** (tabular) and **unstructured data**, including signals and images.

- 5 Recently funded HORIZON EUROPE projects (2022-2024)
  - SEARCH: Synthetic Health Data Governance Hub; IHI; 2025-2028; €15.266.705 (accepted)
  - INTELLI-INGEST: Intelligent Ingestible Devices; MSCE-DN; 2025-2028; €3.610.022 (accepted)
  - SOFTREACH: Minimally-Invasive Soft-Robot-Assisted Deep-Brain Localized Therapeutics Delivery for Neurological Disorders; PATHFINDER; 2023-2026; €2.915.065
  - HS4U: Healthy Ship 4 U; 2022-2025; €6.514.729
  - ENDORSE: Safe, Efficient and Integrated Indoor Robotic Fleet for Logistic Applications in Healthcare and Commercial Spaces; MSCA-RISE; 2018-2022; €1.122.400

Facts about our Laboratory

- A petascale cloud computing platform >200.000 GPU cores for efficient experimentation on deep learning

- In-house cloud computing services for real time data acquisition from external sensors and streaming

- Robotic arm, drones for case studies

- 3D printers for rapid prototyping

- Virtual Reality–VR & Mixed Reality–MR

- Computational modelling software

- High quality portable EEG platform

- Portable and static eye-trackers

- Various cameras

- Modern premises for ~30 researchers

- High-end workstations
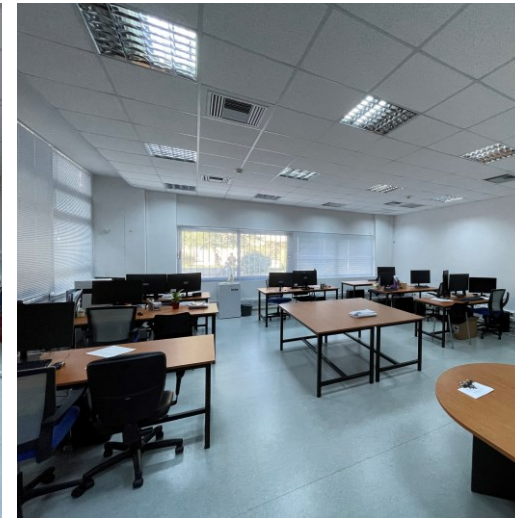
Perceptually Interpretable
Image Classification & Segmentation
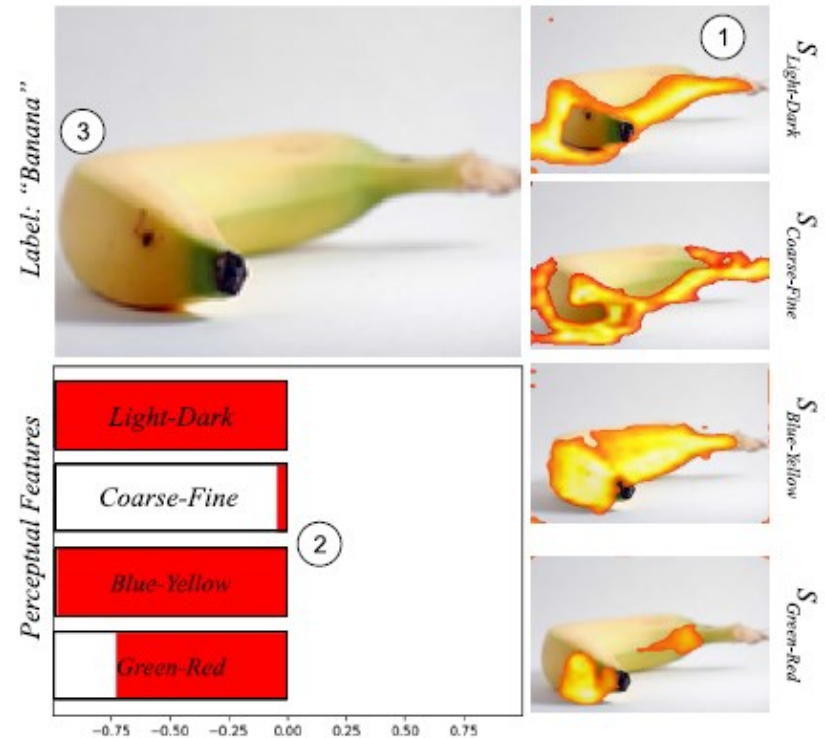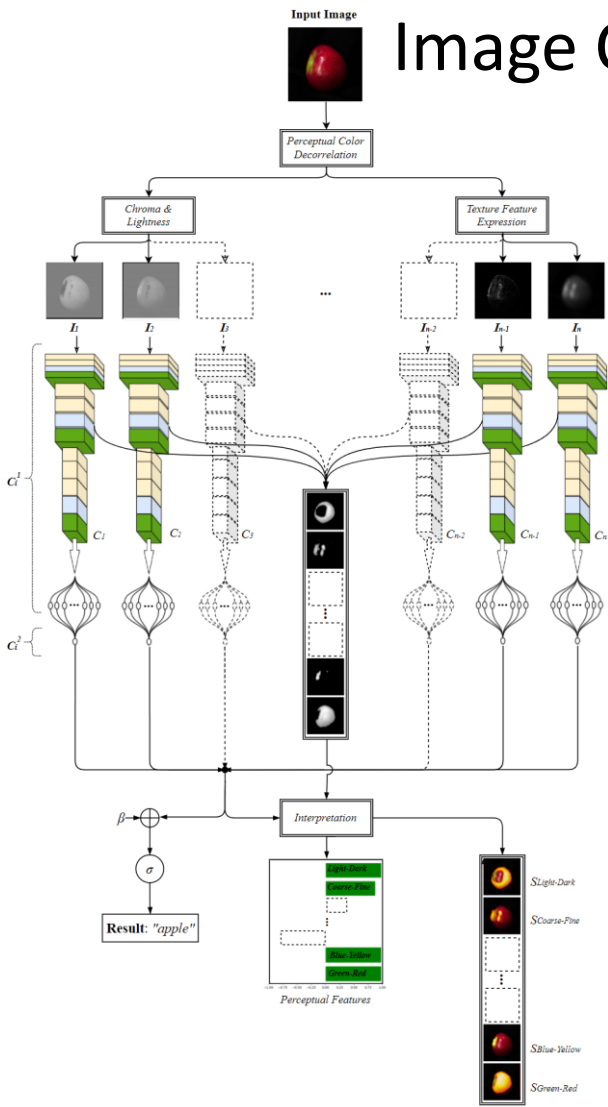
Example:

Why is this recognized as a banana and not as an apple?

- It has a bright yellow body
- It has a green hue on its top and bottom
- Its texture resembles to that of the banana

G. Dimas, E. Cholopoulou, and D.K. Iakovidis, "E Pluribus Unum Interpretable Convolutional Neural Networks," Scientific Reports, vol. 13, 11421, 2023
G. Dimas, P.G. Kalozoumis, P. Vartholomeos, D. K. Iakovidis, "ArachNet: Interpretable Sub-Arachnoid Space Segmentation using an Additive Convolutional Neural Network," in Proc. International Symposium on Biomedical Imaging (ISBI), 2024
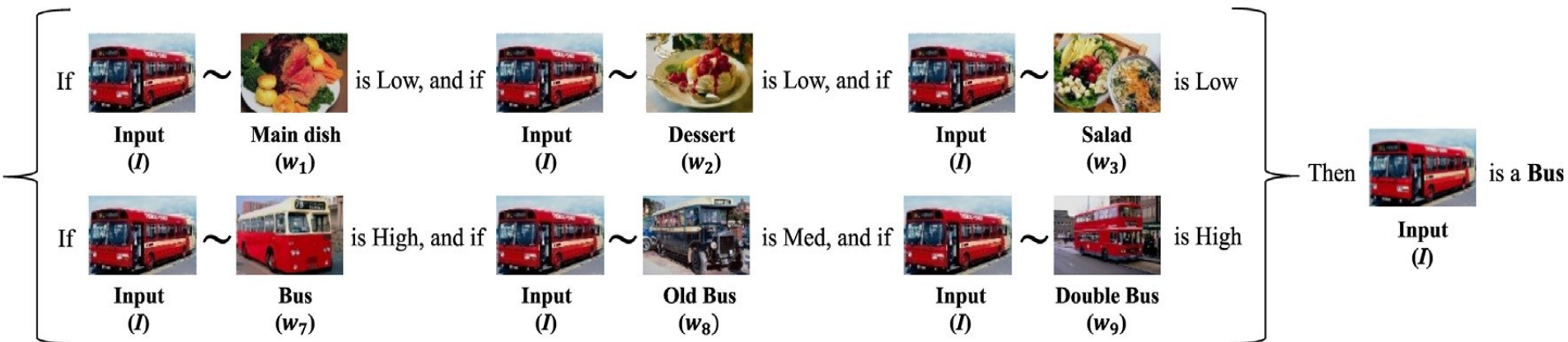
Interpretable Data Classification based on Fuzzy Similarity Phrases (FSPs)

- Receives any data as input
- It automatically extracts rules from data in the form of linguistically expressible phrases
- Easier interpretable because it produces fewer rules than SoA methods
- Uncertainty-aware and noise tolerant
- Tolerant to missing values

Example: Why is this input image is recognized as a bus?
- Because of the extracted rules expressed as FSPs which look like these:

If Input (I) ~ Main dish (w_1) is Low, and if Input (I) ~ Dessert (w_2) is Low, and if Input (I) ~ Salad (w_3) is Low

If Input (I) ~ Bus (w_7) is High, and if Input (I) ~ Old Bus (w_8) is Med, and if Input (I) ~ Double Bus (w_9) is High

Then Input (I) is a Bus

Interpretable Data Classification based on Causal Fuzzy Graphs

- Extracts a vocabulary of semantically-relevant concepts
- Automatically extracts causal relations between these concepts and creates a fuzzy cognitive map (FCM) graph
- Classifies data after reasoning performed based on that graph
- Uncertainty-aware and noise tolerant

Example: Why is this input image classified as an elephant?

- Because parts of the elephant exhibit low/medium/high similarity with the parts of the training images forming the vocabulary
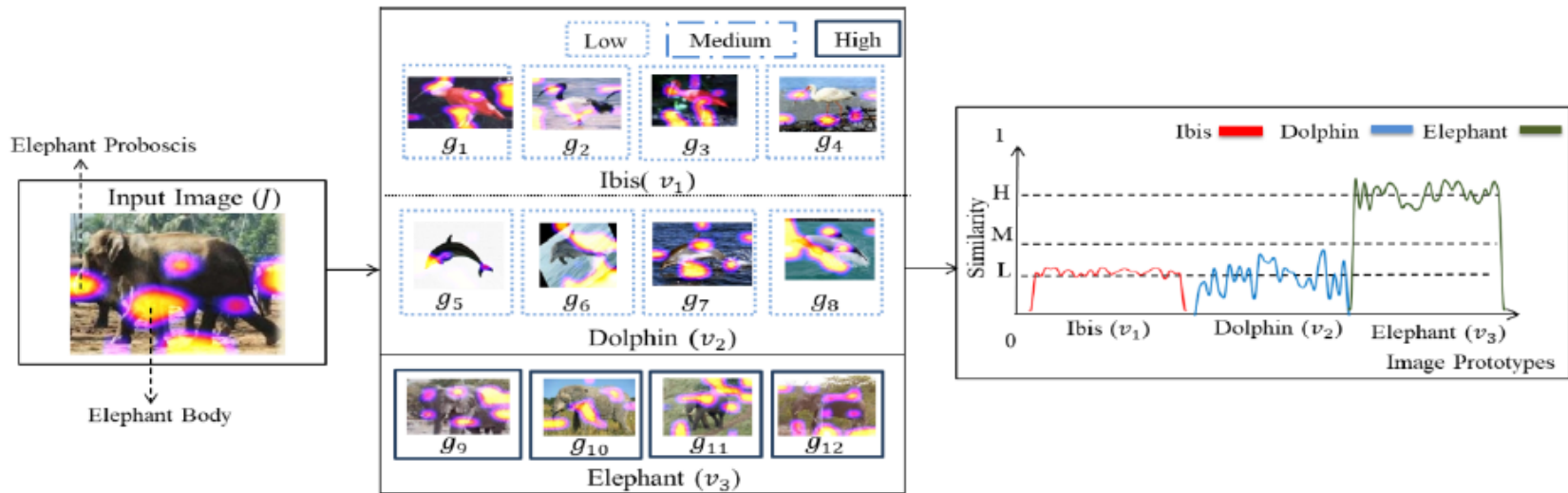
Unique Experience & Contributions in a Consortium

- State-of-the-art explainable machine learning methods and novel ideas for progressing beyond the state-of-the-art

- Develop links and enhance interaction between relevant on-going EU projects during the project implementation

- Access to a network of industrial partners and hospitals

- The generality of our methods enables applicability on almost any case study

- Experience from previous projects on case studies that include (but not limited to):

    - Biomedical applications

    - Robotics

    - Cultural heritage

- Scientific dissemination (usually > 15 paper publications per project)

- >10 years experience from proposal evaluations

Thank you

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    (please use both)

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