

# The 21st IEEE International Conference on Machine Learning and Applications (IEEE ICMLA 2022)

## Keynote talk: **Exemplar-based Deep Learning**

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Machine Learning (ML) and Artificial Intelligence (AI) justifiably attracted the attention and interest not only of the wider scientific community and industry, but also society and policy makers. However, even the most powerful (in terms of accuracy) algorithms, such as deep learning (DL) algorithms, can give a wrong output, which may be fatal. Due to the cumbersome and opaque model used by DL, some authors started to talk about a dystopian “black box” society. Despite the success in this area, the way computers learn is still principally different from the way people acquire new knowledge, recognise objects and make decisions. People do not need a huge amount of annotated data. They learn by example, using similarities to previously acquired exemplars, not by using parametric analytical models. Current ML approaches are focused primarily on accuracy and overlook explainability, the semantic meaning of the internal model representation, reasoning and its link with the problem domain. They also overlook the efforts to collect and label training data and rely on assumptions about the data distribution that are often not satisfied. The ability to detect the unseen and unexpected, and start learning this new class/es in real time with no or very little supervision, is critically important and is something that no currently existing classifier can offer. The challenge is to fill this gap between high level of accuracy and the semantically meaningful solutions. The most efficient algorithms that have fuelled interest towards ML and AI recently are also computationally very hungry – they require specific hardware accelerators such as GPU, and huge amounts of labelled data and time. They produce parameterised models with hundreds of millions of parameters, which are also impossible to interpret or be manipulated by a human. Once trained, such models are inflexible to new knowledge. They cannot dynamically evolve their internal structure to start recognising new classes. They are good only for what they were originally trained for. They also lack robustness, formal guarantees about their behaviour and explanatory and normative transparency. This makes problematic use of such algorithms in high stake complex problems such as aviation, health, bailing from jail, etc. where the clear rationale for a particular decision is very important and the errors are very costly. All these challenges and identified gaps require a dramatic paradigm shift and a radical new approach. In this talk the speaker will present such a new approach towards the next generation of computationally lean ML and AI algorithms that can learn in real-time using normal CPUs on computers, laptops, smartphones or even be implemented on chip that will change dramatically the way these new technologies are being applied. It is explainable-by-design. It focuses on addressing the open research challenge of developing highly efficient, accurate ML algorithms and AI models that are transparent, interpretable, explainable and fair by design. Such systems are able to self-learn lifelong, and continuously improve without the need for complete re-training, can start learning from few training data samples, explore the data space, detect and learn from unseen data patterns, collaborate with humans or algorithms seamlessly.

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