

Research context and motivation

- In the last decade, **Deep Learning** revolutionized artificial intelligence in almost all its fields of application. Indeed, it allowed to reach impressive results in both **perception** (computer vision, natural language processing) and **decision making** (reinforcement learning, navigation). This drastic change was aided by a huge boost in **computing capabilities**, and by the development of hardware specifically dedicated to massive data processing.
- However, **robotic systems** usually lack the computational power typically dedicated to deep learning algorithms due to **cost**, **dimensions**, and power **consumption**. Also, critical applications like autonomous navigation must give particular attention to **latency**, as the slightest delay could cause severe damages to the robot and its surroundings. Due to these challenges, network **optimization** and **edge AI** have become of enormous interest in the last few years, as embedding powerful models closer to sensors and actuators is the key for the future of intelligent robotics.
- For this reason, my research focuses on the development of deep learning models to obtain **intelligent sensors** for robot perception, control and decision making. Particular attention is given to key aspects of real-world applications like **generalization** and **robustness**. Moreover, the **constraints** imposed by the application field in terms of latency, power consumption and weight are always taken into account.

Addressed research questions/problems

- Real-time perception** for robotic applications → Computer Vision, Time Series
- Network optimization** techniques → Quantization, Pruning, Knowledge Distillation
- Robustness** to out-of-distribution data → Domain Generalization, Sim-to-Real Adaptation

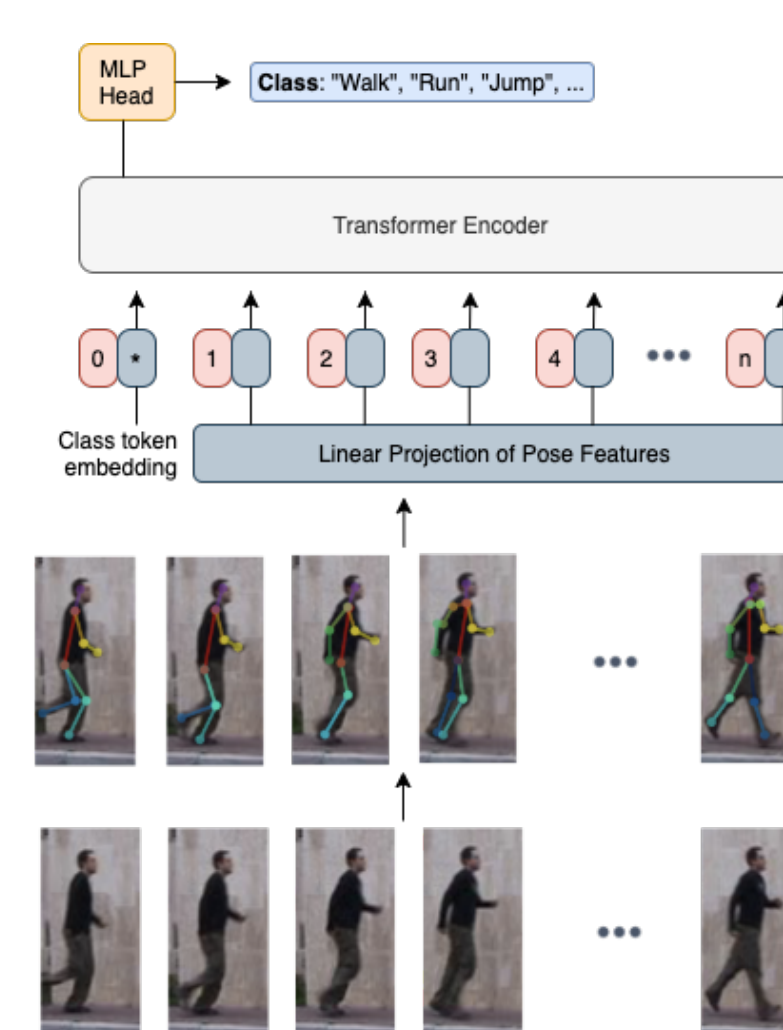
Novel contributions

- A lightweight model for precise Ultra-Wideband **range error correction** for robot **indoor localization** in non-line-of-sight conditions, deployed on a **microcontroller**.
- A **real-time transformer** model for **human action recognition**
- A **domain generalization benchmark** for different kind of deep learning **backbones** (architecture + training methodology) on popular DG datasets
- A Soft Actor-Critic **Deep Reinforcement Learning** environment for Position-agnostic **Navigation** in vineyards
- A model to generate global paths for **autonomous navigation** in crops by generating row **waypoints** from aerial or **satellite** binary occupancy grids.
- A **real-time** single image **super resolution** model trained as a generative adversarial network (**GAN**) and optimized using **knowledge distillation**.

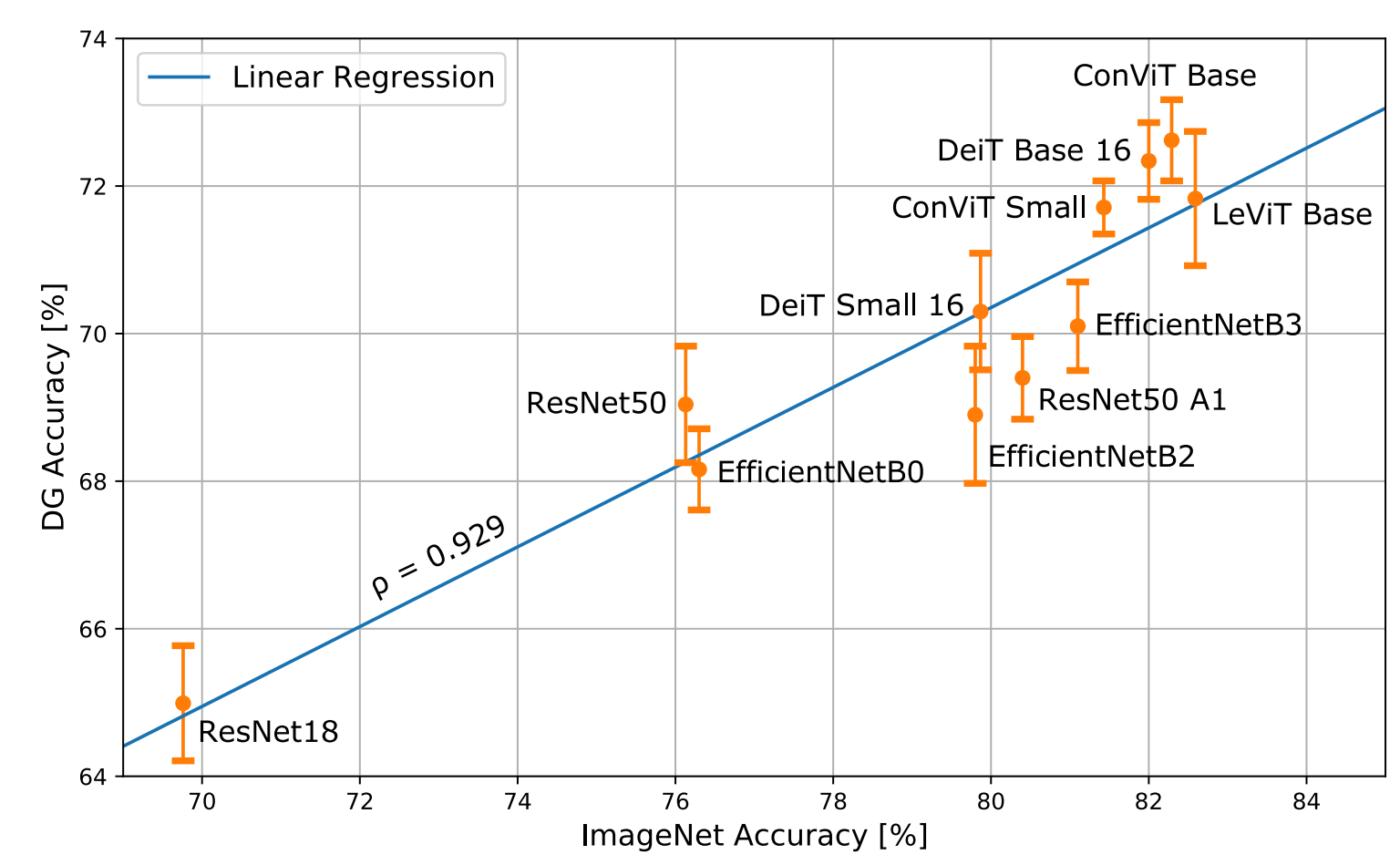
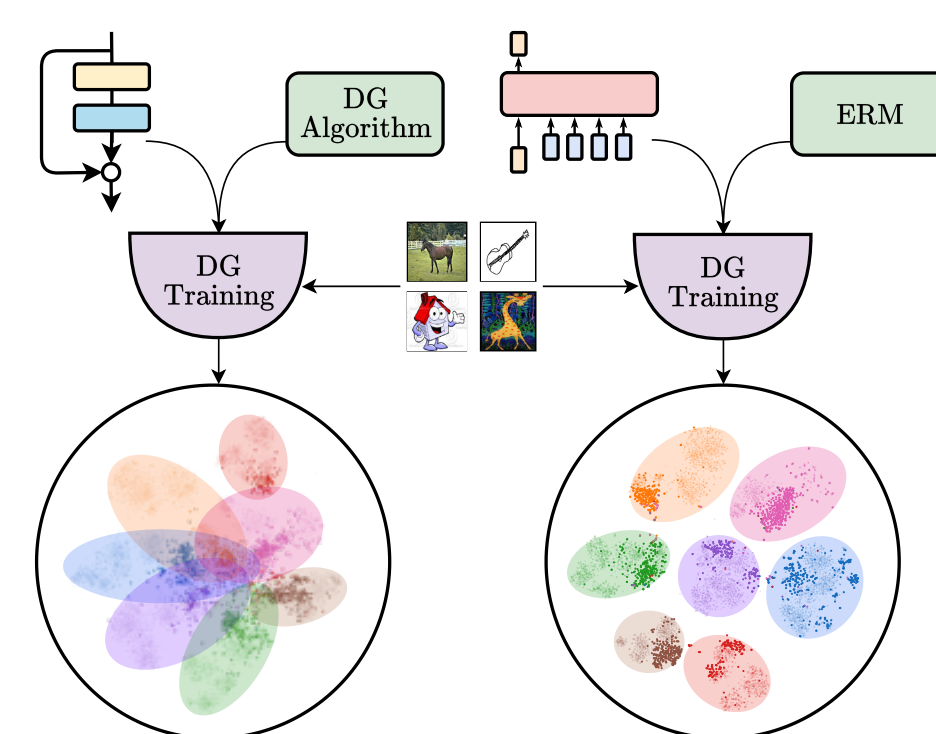
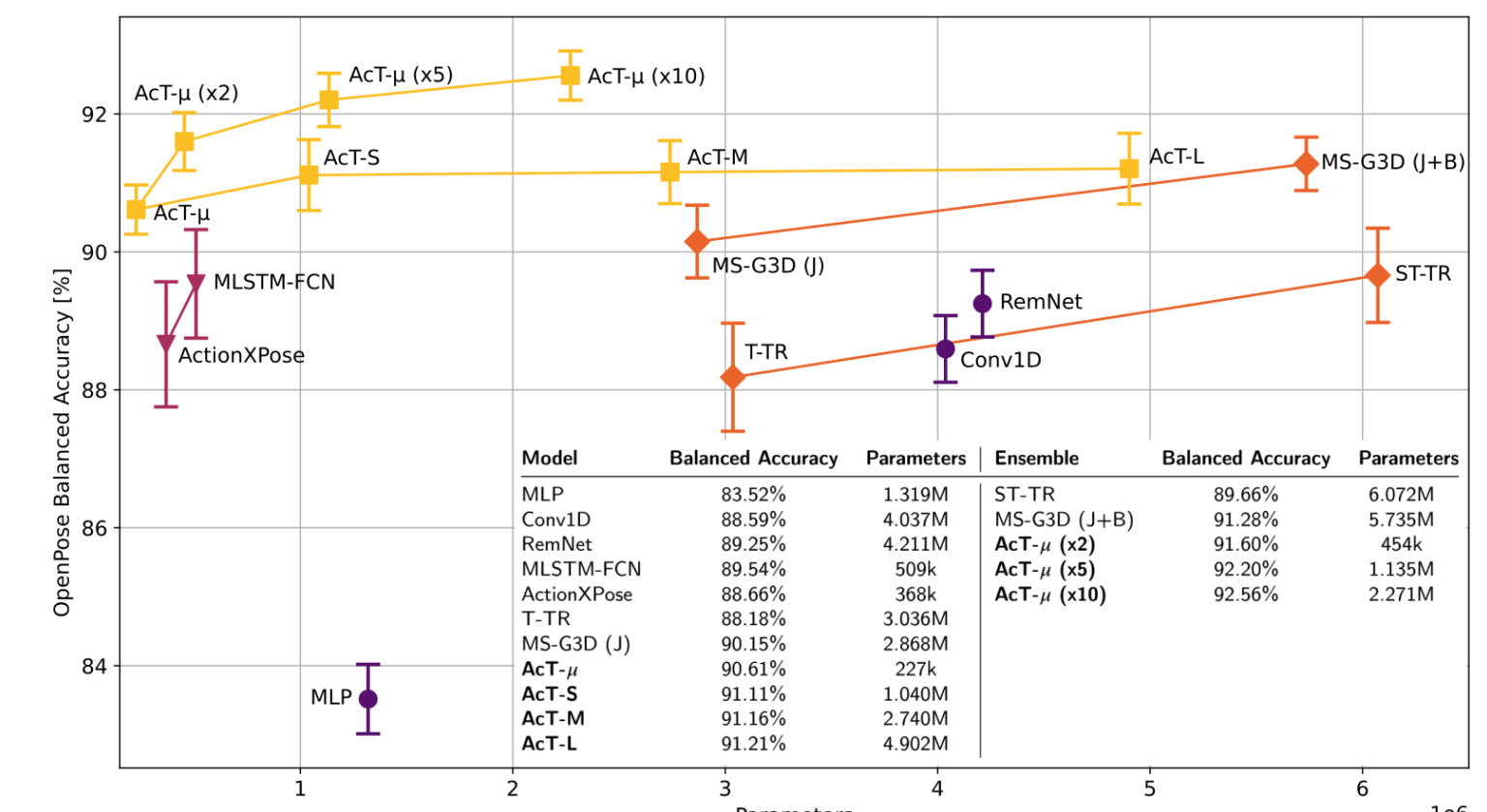
Submitted and published works

- Angarano, S.**, Salvetti, F., Martini, M., & Chiaberge, M. "Generative Adversarial Super-Resolution at the Edge with Knowledge Distillation". Submitted to Engineering Applications of Artificial Intelligence, 2022.
- Angarano, S.**, Martini, M., Salvetti, F., Mazzia, V., & Chiaberge, M. "Back-to-Bones: Rediscovering the Role of Backbones in Domain Generalization". Submitted to Pattern Recognition, 2022.
- Martini, M., Cerrato, S., Salvetti, F., **Angarano, S.**, & Chiaberge, M. "Position-Agnostic Autonomous Navigation in Vineyards with Deep Reinforcement Learning". Presented to Conference on Automation Science and Engineering, 2022.
- Salvetti, F., **Angarano, S.**, Martini, M., Cerrato, S., & Chiaberge, M. "Waypoint Generation in Row-based Crops with Deep Learning and Contrastive Clustering". Presented to European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases, 2022.
- Angarano, S.**, Salvetti, F., Mazzia, V., Fantin, G., Gandini, D., & Chiaberge, M. "Ultra-Low-Power Range Error Mitigation for Ultra-Wideband Precise Localization". Science and Information Conference (pp. 814-824). Springer, Cham, 2022.
- Mazzia, V., **Angarano, S.**, Salvetti, F., Angelini, F., & Chiaberge, M. "Action Transformer: A self-attention model for short-time pose-based human action recognition". Pattern Recognition, 124, 108487, 2022.
- Angarano, S.**, Mazzia, V., Salvetti, F., Fantin, G., & Chiaberge, M. "Robust ultra-wideband range error mitigation with deep learning at the edge". Engineering Applications of Artificial Intelligence, 102, 104278, 2022.

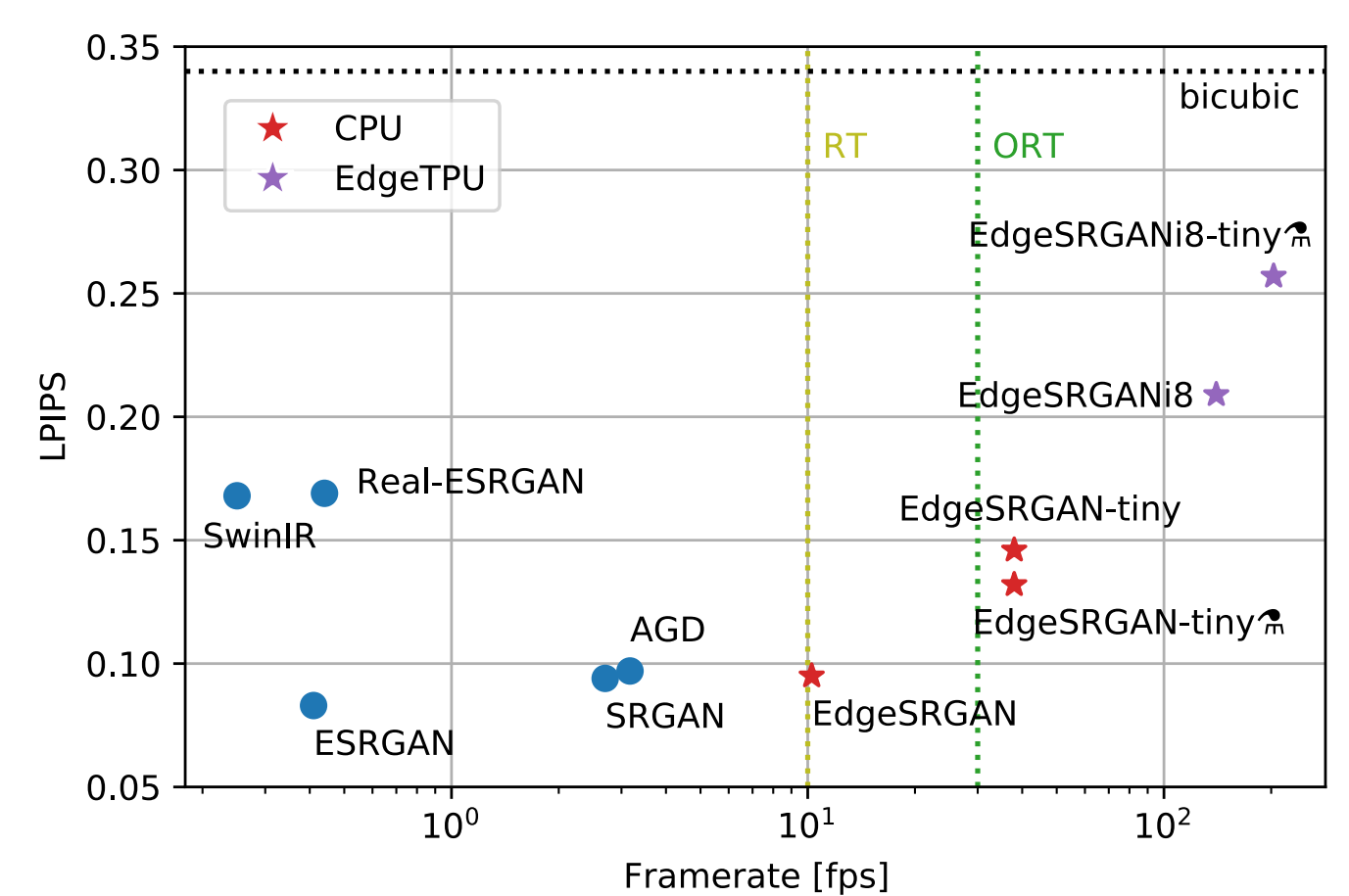
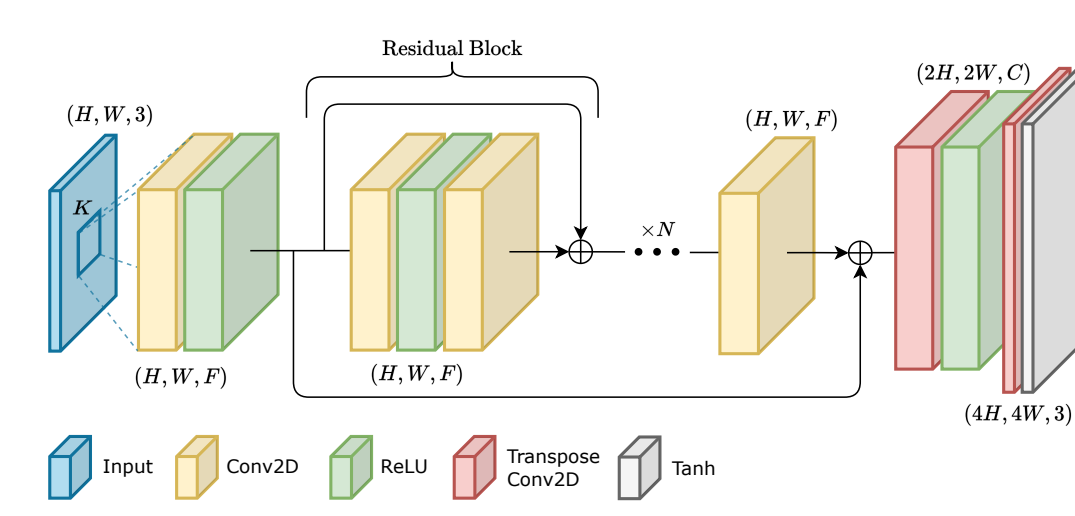
Adopted methodologies



Action Transformer: A self-attention model for pose-based human action recognition



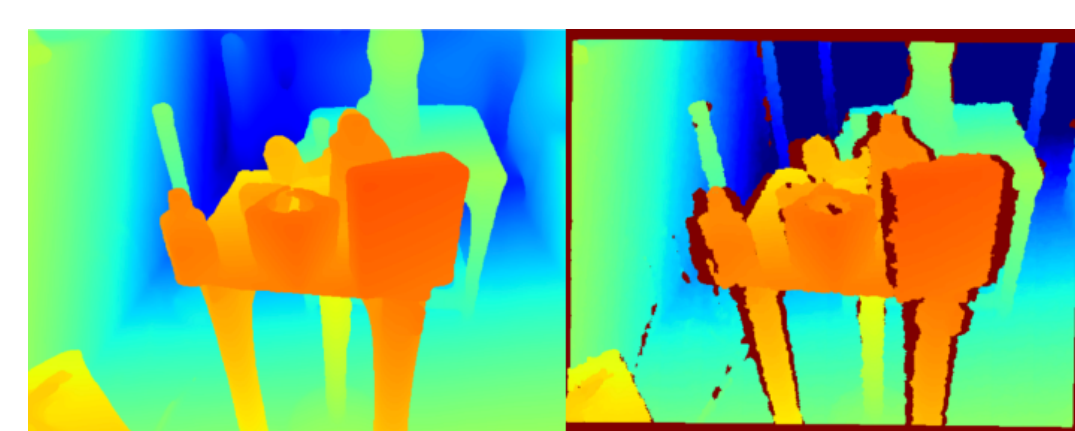
Back-to-Bones: Rediscovering the Role of Backbones in Domain Generalization



Generative Adversarial Super-Resolution at the Edge with Knowledge Distillation

Future work

- Sim2Real** generalization for depth images
- Continual self supervised** learning agent
- Knowledge distillation** using Sparse Neural Networks



List of attended classes

- 01UNXRV – Thinking out of the box (14/11/2021, 1 CFU)
- 01QTEIU – Data mining concepts and algorithms (03/02/2022, 4 CFU)
- 01UJUUIU – Human-Ai Interaction (09/02/2022, 4 CFU)
- 01TUFRV – All you need to know about research data management and open access publishing (12/04/2022, 3 CFU)
- 01QORRV – Writing Scientific Papers in English (05/05/2022, 3 CFU)
- 01UJBRV – Adversarial training of neural networks (06/06/2022, 3 CFU)
- 01DNMIU – Optimized execution of neural networks at the edge (05/09/2022, 5 CFU)