

COMPUTER AND CONTROL ENGINEERING

PNRR - Cloud continuum machine learning

Funded By	HUB NODES: NORD OVEST DIGITALE E SOSTENIBILE SOCIETA' CONSORTILE A RESPONSABILITA' LIMITATA [P.iva/CF:12714360018] MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019] Centro Interdipartimentale SmartData@PoliTO
Supervisor	APILETTI DANIELE - daniele.apiletti@polito.it
Contact	MALNATI GIOVANNI - giovanni.malnati@polito.it
Context of the research activity	<p>As the demand for novel distributed machine learning models operating at the edge continues to grow, so does the call for cloud continuum frameworks and technologies that combine edge and fog computing to support machine learning.</p> <p>In this broad context, the candidate will explore innovative solutions achieved by combining the benefits of edge-based machine learning models with the cloud continuum scenario, in a wide range of application contexts ranging from sustainable manufacturing to smart cities and watersheds, from healthcare to smart manufacturing, smart grids, and the Internet of Energy.</p> <p>PNRR M4C2, Investimento 1.5 - Avviso n. 3277 del 30/12/2021 - ECS00000036 Nord Ovest Digitale E Sostenibile (NODES) - CUP E13B22000020001</p>
	<p>This research aims to define new methods for improving machine learning applications in cloud computing contexts. Compared to traditional machine learning models that are trained in the cloud and can leverage virtually unlimited storage and computational resources offered by scalable data centers, the goal of the research is to investigate limitations, experimentally evaluate, and improve the state of the art in machine learning models based on distributed and federated learning techniques.</p> <p>Applications that are delay sensitive or generate large amounts of distributed time series data can benefit from the proposed paradigm: The computational power provided by devices at the edge and by intermediate nodes between the edge and the central cloud (fog computing) can be used to provide cloud continuum machine learning models.</p> <p>Innovative cloud continuum machine learning solutions will be applied using</p>

Objectives

existing cloud-to-edge frameworks, while also following current EU research directions that aim to create alternatives to established hyperscalers by building an EU-based sovereign edge platform (e.g., SovereignEdge.eu, EUCloudEdgeIoT.eu, FluidOS, etc.).

The proposed research can be useful in many scenarios: Time Series Data Modeling and Energy Management at different scales, from watersheds (e.g., PNRR project NODES) to smart cities, from large buildings to complex vehicles (e.g., airplanes and cruise ships), from smart manufacturing to distributed sensors in healthcare, in smart power grids, and IoT networks where devices have limited resources and are very sensitive to environmental conditions, data speed, network connectivity, and power consumption.

To this end, several research topics will be addressed, such as:

- ¿ Edge AI and machine learning for next generation computing systems.
- ¿ Benefits and challenges of cloud and edge computing through comparative experimental analysis of state-of-the-art applications and real-world scenarios.
- ¿ Lightweight AI models with better efficiency for devices with limited computational and energy resources.
- ¿ Distributed and decentralized learning techniques in network monitoring and orchestration techniques.
- ¿ Mitigation and prevention of security breaches in Edge ML, using AI monitoring tools.

Skills and competencies for the development of the activity

- Knowledge of the basic computer science concepts.
- Knowledge of the main cloud computing topic.
- Programming skills in C-family languages and Python language
- Undergraduate experience with data mining and machine learning techniques
- Knowledge of English, both written and spoken.
- Capability of presenting the results of the work, both written (scientific writing and slide presentations) and oral.
- Entrepreneurship, autonomous working, goal oriented.
- Flexibility and curiosity for different activities, from programming to teaching to presenting to writing.
- Capability of guiding undergraduate students for thesis projects.