

MATHEMATICAL SCIENCES

PNRR/NODES - Development of novel numerical methods and complexity reduction techniques based on Machine Learning for addressing highly complex problems

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019] Centro Interdipartimentale SmartData@PoliTO
Supervisor	BERRONE STEFANO - stefano.berrone@polito.it
Contact	PIERACCINI SANDRA - sandra.pieraccini@polito.it SCIALO' STEFANO - stefano.scialo@polito.it
Context of the research activity	Development of numerical methods and complexity reduction techniques based on Machine Learning for problems characterized by significant geometric, phenomenological, or dimensional complexity. Particular attention will be given to numerical methods and programming techniques for HPC architectures. Progetto finanziato nell'ambito del PNRR (PNRR M4C2, Investimento 1.5 - Avviso n. 3277 del 30/12/2021 - ECS00000036 Nord Ovest Digitale E Sostenibile (NODES) - CUP E13B22000020001)
Objectives	The development of numerical methods and complexity reduction techniques based on Machine Learning addresses problems with significant geometric, phenomenological, or dimensional complexity. These problems often arise in fields such as computational physics, engineering simulations, and large-scale geological problems, where traditional methods may struggle to provide efficient and accurate solutions due to the high computational costs and intricate nature of the problems. In this context, Machine Learning offers powerful tools for identifying patterns and making predictions, which can be leveraged to enhance numerical methods or speed up Uncertainty Quantification methods. Furthermore, special attention is given to the implementation of these methods on High-Performance Computing (HPC) architectures. HPC systems provide the necessary computational power to handle the intensive demands of large-scale simulations and data processing tasks. Developing efficient numerical methods and programming techniques tailored for HPC

architectures is crucial for maximizing performance and scalability. This involves optimizing algorithms to exploit parallelism, minimize communication overhead, and efficiently manage memory resources.

**Skills and
competencies
for the
development of
the activity**

A strong background in numerical analysis, computational linear algebra, and C++ programming is essential for tackling complex computational problems efficiently.

Proficiency in C++ programming is crucial due to its performance efficiency and control over system resources, making it ideal for developing high-performance numerical algorithms.

Basic knowledge of machine learning is highly advantageous, as it allows for the integration of modern data-driven approaches into traditional numerical methods. Additionally, proficiency in Python is beneficial due to its widespread use in the scientific community.