Master theses projects, group Serra

Master thesis: AI-assisted detector design
This project investigates how modern machine learning methods can support the design and optimization of particle detectors. The work focuses on comparing two approaches: large language models used as generative and planning tools, and reinforcement learning agents trained to propose and refine detector configurations. The student will study how these models explore design spaces, handle trade-offs between performance metrics and constraints, and adapt to new physics targets. The project involves implementing and evaluating different architectures in Python, training deep neural networks, and carrying out simulated experiments. Familiarity with high-energy physics setups is helpful but not required; the emphasis is on rigorous analysis of the strengths and limitations of each AI method. The goal is to understand when and how these tools can meaningfully accelerate detector R&D rather than simply replicating standard optimization methods.

Master thesis: operational research with deep neural networks
This project lies at the intersection of physics-style modeling, optimization theory, and industrial operations. The student will explore how deep neural networks can improve decision-making in problems such as scheduling, resource allocation, supply-chain prediction, or logistics optimization. Depending on timing , candidate's interests and availability, the project may include collaboration with local industry partners, where real data and operational constraints can be tested. The work involves formulating the problem in an operational-research framework, implementing neural models that interact with classical optimization algorithms, and evaluating the gains and failure modes of learning-based strategies. Python proficiency and a solid understanding of modern deep learning are essential. The aim is to determine when neural approaches genuinely outperform conventional OR methods, and to characterize the regimes where they break down or require hybrid solutions.

Bachelor theses

Just pass by and ask