University of Messina, Italy
Department of Mathematical and Computer Sciences,
Physical Sciences and Earth Sciences

Subject: Internship Proposal

ID	PTI_EN_Finocchio Giovanni_27/06/2026 18.55.21
Data	27/06/2026 18.55.21

Project Supervisor

Surname	Finocchio
Name	Giovanni
Department	MIFT
Laboratory	Petaspin
E-mail	gfinocchio@unime.it
Phone number	3286264205

Project Co-Supervisor

Surname	
Name	
Job Position	
Department	

Laboratory	
E-mail	
Phone number	

Project details

Title	Advanced AI and Heuristic Approaches for the Quadratic Assignment Problem

Detailed description: The Quadratic Assignment Problem (QAP) is a fundamental combinatorial optimization problem in operations research, widely applied in facility layout, logistics, circuit design, and data clustering. It involves assigning a set of facilities to a set of locations to minimize the total cost, which is determined by the flow between facilities and the distance between locations. Because QAP is strongly NP-hard, exact algorithms are computationally infeasible for large-scale instances, making the development of efficient heuristic and metaheuristic approaches a critical research challenge. Recently, novel computing paradigms, including Artificial Intelligence (e.g., Deep Reinforcement Learning, Graph Neural Networks) and physics-inspired hardware like Ising Machines, have shown significant potential in tackling complex NP-hard problems. This project aims to explore the scientific and technical potential of advanced AI methods and alternative computing formulations applied to the QAP. The internship has an exploratory and research-oriented nature, with a particular focus on developing hybrid solvers, evaluating AI-driven heuristics, and formulating the QAP as a Quadratic Unconstrained Binary Optimization (QUBO) / Ising model to assess its suitability for next-generation probabilistic computing architectures. |
2. Internship Objectives.
The main objective of this internship is to support the development, implementation, and evaluation of advanced computational methods for approximating solutions to large-scale Quadratic Assignment Problem instances. The work may include one or more of the following activities:
(i) Literature review on exact, metaheuristic, and AI-driven methods for combinatorial optimization and QAP, including recent advancements in Graph Neural Networks and Ising model formulations.
(ii) Mathematical modeling of the QAP and its mapping to alternative computational frameworks (e.g., QUBO / Ising model).

(iii) Implementation of baseline metaheuristics (e.g., Simulated Annealing, Tabu Search, Genetic Algorithms) and advanced AI-based models using Python. (iv) Experimental design and benchmarking of the proposed algorithms on standard QAPLIB instances, evaluating metrics such as solution quality, computational time, and scalability. (v) Comparative evaluation of methods in terms of robustness, generalization, and potential relevance for real-world industrial applications. (vi) Preparation of visual summaries, tables, and concise technical documentation of the obtained results. (vii) Participation in discussions with academic supervisors to refine methodology and support interpretation of findings.

Duration (month – max 12)	4
Duration (hours)	150
Open positions	1

Internship Skills

Technical requirements: knowledge of Ising machines	
Other skills	