Scientific Area	Computer Science
Topic title	**Hybrid quantum-inspired optimization to solve home health care nurse allocation, routing, and scheduling problems**
Main host institution	University of Haute-Alsace, IRIMAS Research Institute
Supervisor/institution	Pr. Lhassane IDOUMGHAR, IRIMAS Institute, University of Haute-Alsace
Co-Supervisor/institution	Pr. Amirhossein Gandomi - University of Technology Sydney: https://profiles.uts.edu.au/Amirhossein.Gandomi
Mentor[1]/institution	Pr. Abdelhafid Abouaissa, IRIMAS Institute, University of Haute-Alsace
Secondment institution	

Topic description

The organization of home health care (HHC) presents growing operational complexity due to demographic aging and increasing demand for long-term care. Key decisions such as nurse-to-patient assignment, scheduling of visits, and routing must be managed under various time, capacity, and service continuity constraints. These challenges result in large-scale combinatorial optimization problems, whose integrated resolution is computationally intractable with exact methods under realistic conditions [1]. This project aims to address these challenges by developing time-efficient optimization strategies adapted to the operational context of HHC systems.

Given the scale and complexity of the problem, metaheuristics represent a practical alternative to exact methods [2]. However, their computational burden may still pose limitations in time-sensitive situations, such as when rapid rescheduling is required due to cancellations or unforeseen disruptions [3]. To improve efficiency, the project investigates the design of quantum-inspired metaheuristics, which incorporate concepts such as qubit-inspired representations, probabilistic modeling, and parallel search dynamics to enhance the performance of classical search processes [4,5]. These approaches aim to accelerate convergence and improve search robustness in high-dimensional and dynamic settings [5]. To further enhance solution quality and reduce computational cost, learning-based techniques such as surrogate modeling will be integrated into the metaheuristic design [3,6].

References:

[1] Shavarani, S. M., Golabi, M., & Vizvari, B. (2019). Assignment of medical staff to operating rooms in disaster preparedness: A novel stochastic approach. IEEE Transactions on Engineering Management, 67(3).

[2] Boussaïd, I., Lepagnot, J., & Siarry, P. (2013). A survey on optimization metaheuristics. Information sciences, 237.

[3] Sulaman, M., Golabi, M., Essaid, M., Lepagnot, J., Brévilliers, M., & Idoumghar, L. (2024). Surrogate-assisted metaheuristics for the facility location problem with distributed demands on network edges. *Computers & Industrial Engineering,* 188.

[4] Dahi, Z. A., & Alba, E. (2022). Metaheuristics on quantum computers: Inspiration, simulation and real execution. Future Generation Computer Systems, 130.

[5] Pooja, & Sood, S. K. (2024). Scientometric analysis of quantum-inspired metaheuristic algorithms. Artificial Intelligence Review, 57(2).

[6] Azerine, A., Golabi, M., Oulamara, A., & Idoumghar, L. (2024). Enhancing Electric Vehicle Charging Schedules: A Surrogate-Assisted Approach. In Proceedings of the Genetic and Evolutionary Computation Conference Companion.

[1] Mentor: The primary role of the mentors will be to identify and facilitate specific training objectives, advise on any problems faced by the DC, including career matters with an external perspective and provide mediation in the case of disputes.

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Recommended applicant's profile

- Master's degree in Computer Science, Applied Mathematics, or a related field (e.g., Operations Research, Data Science, or Engineering with a strong quantitative focus).
- Solid programming skills and experience in algorithm implementation.
- Background in optimization techniques, particularly metaheuristics.
- Familiarity with artificial intelligence and machine learning methods.
- Interest in quantum-inspired algorithms; prior exposure to basic concepts in quantum computing is welcome.

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