Adaptive Robust Optimization for Integrated Facility Location and Staffing in Home Health Care Networks

Master's Research Internship (6 Months) in **Operations Research**

IBISC (Informatique, BIoinformatique, Systèmes Complexes)
Université Évry Paris-Saclay

Research Context and Objectives

The home health care industry is experiencing unprecedented growth globally, driven by aging populations and evolving healthcare delivery models. In France, the sector represents a strategic priority, with the number of elderly requiring home care services increasing significantly. The global home care market is projected to reach substantial growth by 2026 [12], while European countries are investing heavily in home healthcare infrastructure to reduce hospital burdens and improve patient quality of life. However, this growth is accompanied by severe workforce challenges [5, 6] that are particularly acute in France, where many regions struggle to meet demand. Analysis of real-world data from major European providers reveals that daily demand exhibits extreme variability with significant distributional ambiguity—multiple probability distributions fit historical patterns equally well and shift across time periods [13]. Home care agencies face three interconnected strategic challenges: (1) *where to locate service centers*, (2) *how many caregivers to hire* at each location, and (3) *how to allocate capacity* to different services as demand unfolds. Current optimization approaches treat these decisions in isolation or assume static environments where all decisions are made upfront without the ability to adapt to observed demand patterns [9, 11, 8, 7]. While robust optimization has demonstrated significant benefits for staffing problems [13] and facility location [1, 2], these approaches have largely focused on either single-stage decisions or treated location and staffing problems separately [10].

This internship therefore aims to develop a two-stage robust optimization framework using decomposition algorithms [3, 14] and carefully designed uncertainty sets [4] that coordinates strategic facility location decisions with tactical staffing and capacity allocation adjustments, balancing robustness guarantees with computational tractability for integrated location-staffing-allocation problems under uncertainty.

Expected Contributions

The research aims to deliver contributions appropriate for a master's level internship, including novel adaptive robust optimization formulations integrating location, staffing decisions under uncertainty.

PhD Extension Potential: Successful completion of this internship could lead to a PhD thesis at **Université Paris-Saclay**.

Required Skills and Evaluation Criteria

The candidate should be a final-year engineering or master's student (BAC+5) in **Operations Research**, **Applied Mathematics**, or **Computer Science**, with a strong focus on mathematical optimization and operations research techniques.

Essential Skills:

- Strong background in optimization (linear programming, integer programming)
- Proficiency in programming (Julia, Python, or C++)
- Understanding of probability and statistics
- Mathematical rigor and analytical thinking

Desirable Skills:

- Experience with optimization solvers (Hexaly, Gurobi, CPLEX, FICO...)
- Familiarity with stochastic optimization concepts
- Scientific writing and presentation skills in English
- Ability to read and synthesize research papers

Research Environment

The internship will be conducted within the **IBISC (Informatique, Bioinformatique, Systèmes Complexes EA 4526)** at **Université Évry Paris-Saclay**, benefiting from:

- Strong expertise in operations research and algorithmic
- Access to high-performance computing facilities and commercial optimization solvers
- Potential collaboration with French home care agencies providing real-world case studies
- International research network and collaborations with leading researchers in healthcare operations and optimization
- Regular research seminars and access to academic resources

Contact Information and Application Process

Supervisors:

- **Dr. Salma Makboul** (salma.makboul@univ-evry.fr)
- **Prof. Feng Chu** (feng.chu@univ-evry.fr)

Application Documents: **(Please send all documents to both supervisor)**

- Detailed Curriculum Vitae with academic background and relevant coursework
- Motivation Letter (1 page) explaining interest and relevant experience
- Academic Transcripts (Bachelor and Master levels)

- Contact information for two academic references
- Code samples or GitHub repository (if available)

Location: Bâtiment IBGBI – 2ème étage, 23 Boulevard de France- 91034 Évry, France
Duration: 6 months
Start Date: February 2026
Compensation: Internship stipend according to French regulations
Application Deadline: **Open until filled**

Note: *Applications must include all required documents to be considered. Only shortlisted candidates will be contacted for interviews.*

References

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[4] Bertsimas, D., Sim, M. (2004). The price of robustness. *Operations Research*, 52(1), 35–53.

[5] Deloitte (2021). Elder care crisis in Europe: Addressing the demographic challenge. Healthcare Report.

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[8] Makboul, S., Kharraja, S., Abbassi, A., and El Hilali Alaoui, A. (2024). A multiobjective approach for weekly Green Home Health Care routing and scheduling problem with care continuity and synchronized services. *Operations Research Perspectives*, 12:100302.

[9] Rodriguez, C., Garaix, T., Xie, X., and Augusto, V. (2015). Staff dimensioning in homecare services with uncertain demands. *International Journal of Production Research*, 53(24):7396–7410.

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[13] Wang, R., Shehadeh, K.S., Xie, X., and Li, L. (2023). Integrated home care staffing and capacity planning. *Computers & Operations Research*, 159:106348.

[14] Zeng, B. and Zhao, L. (2013). Solving two-stage robust optimization problems using column-and-constraint generation. *Operations Research Letters*, 41(5):457–461.