Master 2 Internship

From data to robust surgery schedules: learning the uncertainty of surgical duration and recovery-room stay

Project: ANR **SMART-SURGE**
Host lab: IBISC, Université Évry Paris-Saclay
Location: IBGBI building, 23 boulevard de France, 91000 Évry-Courcouronnes, France
Supervisors: Salma Makboul, Alexandru-Liviu Olteanu, and Marc Sevaux
Duration: 6 months, February 2027 – July 2027
Stipend: standard French internship allowance
Application deadline: November 15, 2026

Context

Operating rooms are among the most expensive and most constrained resources of a hospital. Scheduling elective surgery is difficult because the plan rarely unfolds as expected: an operation runs late, a patient stays longer than planned in the post-anesthesia care unit (PACU), an anesthesiologist is missing [1]. These events are linked. A delay in the operating room fills the PACU, which in turn can hold up the next patients.

SMART-SURGE is an ANR project that develops robust and distributionally robust optimization models for this problem [2–4], combined with machine learning, and validates them with a large public hospital in Essonne, France. Such models are only as good as their description of uncertainty. A robust schedule built on badly estimated durations is either too cautious, leaving operating rooms empty, or not cautious enough, leading to overtime and cancellations.

The aim of this internship is to learn this uncertainty from data and to measure what it changes in the schedules.

Work plan

The intern will first build a clean dataset from open perioperative sources and pseudonymized hospital real data (exploratory analysis, treatment of missing values and outliers, encoding of clinical variables), and convert the main tables into standard HL7 FHIR resources as a first step towards a reusable data pipeline. Predictive models will then be developed for two quantities: the duration of each operation and the length of stay in the PACU, from simple baselines to machine learning models, evaluated under realistic conditions.

The core of the internship is the quantification of uncertainty. Beyond point predictions, the intern will learn how far real durations may deviate from expected ones, and how this uncertainty varies across the surgical context. The learned uncertainty will finally be used in a surgery scheduling model under uncertainty [6], in order to assess its impact on schedule quality (overtime, idle time, PACU occupancy) compared with more classical assumptions.

The internship ends with a report and documentation of the data, models and results, to be built upon by the PhD student of the project.

What the intern will gain

The internship combines operations research and machine learning on a concrete healthcare problem. She/He will have a dedicated high-performance workstation, and will present the results at national and international conferences.

The intern will join the **SMART-SURGE** team as a member of the project, and the internship is a natural route towards the PhD funded by the project at **Université Paris-Saclay**.

Profile

- M2 student in operations research, data science, computer science or applied mathematics;
- good command of Julia/Python; some experience with a solver (Gurobi, CPLEX, or similar) is appreciated;
- solid basics in statistics, machine learning and linear/integer programming;
- interest in healthcare applications. Prior experience with medical data is not required.

How to apply

Applications are accepted **only** via the **SMART-SURGE internship form** (`https://lnkd.in/ex69_urj`), before **November 15, 2026**. Applications sent by email will not be considered.

References

[1] K.S. Shehadeh, R. Padman (2022). Stochastic optimization approaches for elective surgery scheduling with downstream capacity constraints: Models, challenges, and opportunities. *Computers & Operations Research*, 137, 105523.

[2] S. Makboul (2025). An efficient column-and-constraint generation algorithm for solving the adaptive robust elective surgery problem under uncertainties in surgery duration, length of stay, and emergency arrivals. *Annals of Operations Research.* **In Press**

[3] S. Makboul, A.L. Olteanu, M. Sevaux (2025). A multiobjective ε-constraint based approach for the robust master surgical schedule under multiple uncertainties. *European Journal of Operational Research*, 320, 682–698.

[4] J. Li, S. Zhao, S. Makboul, Z. Zhang, Y. Wang, M. Huang (2026). Distributionally robust master surgery scheduling with duration uncertainty and specialty parallelism. *Omega*, 138, 103417.

[5] K.S. Shehadeh, R. Padman (2021). A distributionally robust optimization approach for stochastic elective surgery scheduling with limited intensive care unit capacity. *European Journal of Operational Research*, 290(3), 901–913.

[6] D. Bertsimas, V. Gupta, N. Kallus (2018). Data-driven robust optimization. *Mathematical Programming*, 167(2), 235–292.

[7] O. Martinez, C. Martinez, C.A. Parra, S. Rugeles, D.R. Suarez (2021). Machine learning for surgical time prediction. *Computer Methods and Programs in Biomedicine*, 208, 106220.