

Straubing, June 21, 2022

Master's Thesis Topic

The Stochastic Patient-to-Bed Assignment Problem

Patients who are admitted to a hospital as inpatients must be assigned a bed while respecting certain constraints. For instance, gender-mixed rooms are usually to be avoided and it is desirable to assign patients of similar age to a room since this has been shown to increase patient satisfaction. Transfers of a patient to a different room during their stay are possible but should be minimized in order to reduce work for the nurses and stress for the patients. The resulting patient-to-bed assignment problem is a well-studied problem in the literature (cf. [2, 1]). Part of the literature assumes that the admission and discharge dates of patients are deterministic and known at the start of the planning period [2]. Another part of the literature takes uncertainty of patient arrivals and length of stay (LOS) into account via a rolling horizon approach that solves a series of deterministic problems over the course of the planning period [1, 3].

The goal of the master's thesis is to go beyond the rolling horizon approach by formulating the patient-to-bed assignment problem with stochastic arrivals and lengths of stay of patients using Markov decision processes (MDPs). Based on real data from a German hospital, stochastic length of stay (but deterministic patient arrivals) will first be considered by using an explicit historical distribution for each patient category (specialty or DRG), where the time step is one day. The patient arrivals on each day are still completely known at the start of the planning period (including all patient characteristics except for LOS). In the second step, only distributional data of patient arrivals per day is assumed (joint or independent distributions providing specialty, age, gender, and LOS).

The specific tasks to be performed include:

- Generate explicit distributions and test instances from the real data set.
- Set up an automated instance generator.
- Formulate an MDP for the case with stochastic length of stay.
- Formulate an MDP for the case where both length of stay and patient arrivals are stochastic.

The thesis will be supervised by the Chair of Supply and Value Chain Management (Prof. Dr. Alexander Hübner). If you are interested, please send an email to alexander.huebner@tum.de.

References

- [1] Sara Ceschia and Andrea Schaerf, *Modeling and solving the dynamic patient admission scheduling problem under uncertainty*, Artificial Intelligence in Medicine **56** (2012), no. 3, 199–205.
- [2] Peter Demeester, Wouter Souffriau, Patrick De Causmaecker, and Greet Vanden Berghe, *A hybrid tabu search algorithm for automatically assigning patients to beds*, Artificial Intelligence in Medicine **48** (2010), no. 1, 61–70.
- [3] Fabian Schäfer, Manuel Walther, Alexander Hübner, and Heinrich Kuhn, *Operational patient-bed assignment problem in large hospital settings including overflow and uncertainty management*, Flexible Services and Manufacturing Journal **31** (2019), no. 4, 1012–1041.