

# Project Topic B: Patient Scheduling Problem

## Problem Solving and Search in AI: Programming Exercises

March 5, 2025

This is one of two problems you can choose for the programming exercises. You can choose the same problem for both exercises, or work on a different problem for each exercise. If you have any questions, you can ask in the TUWEL forum.

## 1 Problem Definition

Recent developments in healthcare scheduling move towards the integration of different optimization problems. To accelerate research in this direction, the Integrated Healthcare Timetabling Competition 2024 (IHTC 2024) recently took place. It combines Patient-to-Room Assignment (PRA), Nurse-to-Patient Assignment (NPA), and Surgical Case Planning (SCP). The problem definition can be found on the competition web page (PDF).

While the full integrated problem is out of scope for this lecture, this assignment deals with a subset of the competition: The Patient-to-Room Assignment (PRA) and a part of Surgical Case Planning (SCP). Nurse assignments are not considered, neither are assignments to operating theatres. The corresponding constraints and parts of the instances can be ignored. This also includes the separation of days into different shifts. Therefore, the following decisions remain for each patient:

- If the patient is not mandatory, choose whether to schedule them or not
- For each scheduled patient, choose the admission day (= surgery day)
- For each scheduled patient, choose the room for their stay

The following constraints from the full problem are relevant:

- H1 No gender mix in any room
- H2 Compatible rooms assigned to each patient
- H7 Room capacity must be respected
- H3 No overtime for surgeons (surgeons are fixed for each patient)
- H5 All mandatory patients must be scheduled
- H6 Admission day must be in the range of surgery release day to due day (due days are only given for mandatory patients)
- S1 Minimize the mix of age groups
- S7 Minimize the admission delay
- S8 Schedule as many optional patients as possible

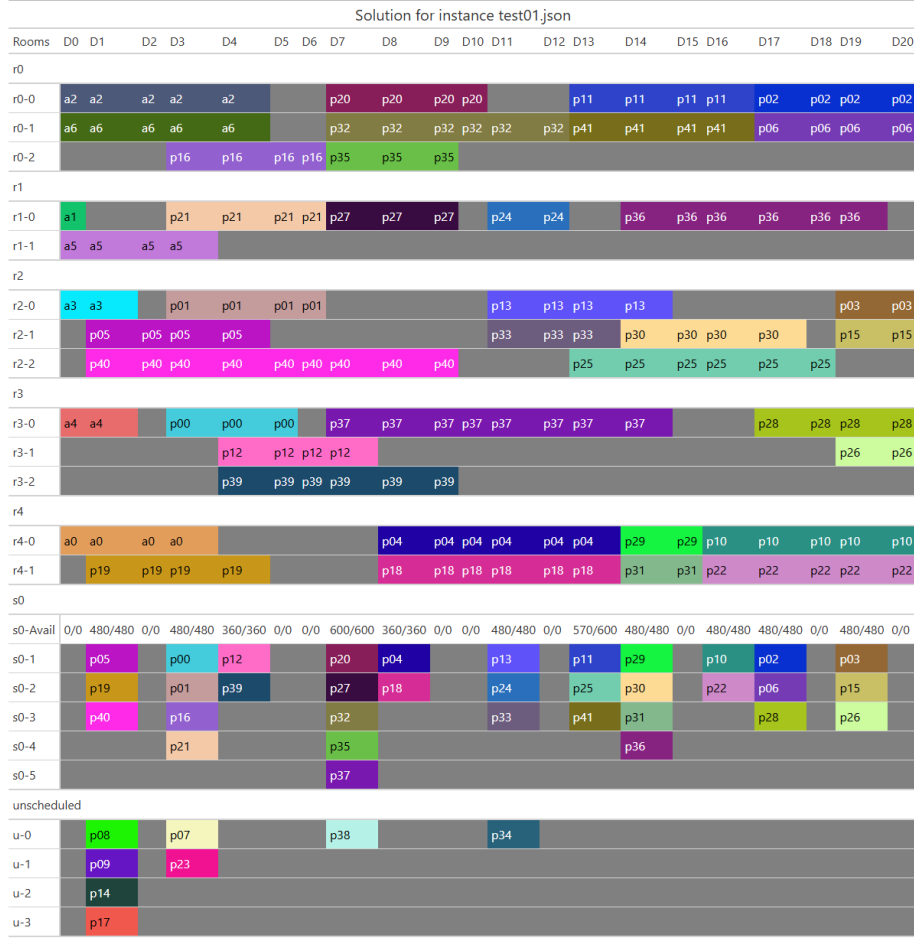


Figure 1: Visualization of relevant solution parts for test instance 1

A solution is feasible if all six hard constraints are fulfilled. The three soft constraints are combined by weights given for each instance and minimized. For details about the constraints refer to the competition document.

Figure 1 shows the visualization of a solution to the test instance 1. Each patient occupies a bed in one of the five rooms for a given amount of days. Additionally, each patient requires time of the corresponding surgeon (only *s0* in this instance). Used and available surgeon time is shown as well. Unscheduled patients are shown on their release day at the bottom.

## 2 Benchmark Instances

The competition provides a set of 5 test instances with solutions, and a set of 30 competition instances.

All instances and solutions are written in JSON. A validator is also provided on the web page. We also provide a compiled version (.exe) in TUWEL. Note that the validator will report constraint violations for nurse assignments and

operating theatre assignments that you can ignore.

Additionally we provide Python classes to read and write instances and solutions, as well as to visualize solutions (method `print_table`). You are free to use these, but you don't have to.

The competition setting was to use up to 4 threads for up to 600 seconds to obtain solutions. For comparison, you are recommended to also evaluate your method in this setting, but feel free to use other evaluation settings if you want.