Bed-Capacity Forecasting For Hospitals

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Forecasts for improved clinical planning

Do you want to make a real impact in the field of healthcare?
We invite you to seize the opportunity to become an integral part of an innovative healthcare project in collaboration with the Ernst von Bergmann (EVB) hospital, policlinic, and MvZ.
As we've all come to realize during the COVID-19 pandemic, early warnings regarding the emergence of new infection waves are crucial for the well-being of the entire population, with a special emphasis on hospital capacity planning. We want to prevent unnecessary shutdowns of clinical operations and treatment delays, as well as avoiding the overload of hospital resources. We aim for improvement of clinical processes by using state of the art machine learning methods to predict future patient load, addressing the following problem. The hospital don't know how many patient to schedule for a give day. Too few patients mean, that more people could be helped, too many patients means work overload for medical staff and reduced treatment quality. Ideally the number of vacant beds should be zero for any day.

Working topics

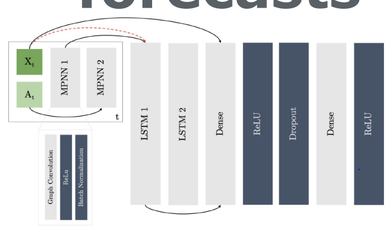
The main goal of the project is the generation of forecast of the number of operable and occupied hospital beds. The vacant bed can be calculated from this formula:

Vacant beds = **operable beds** – (**staying patients** + (**emergency admissions** + **planned admissions**) – **discharges**)

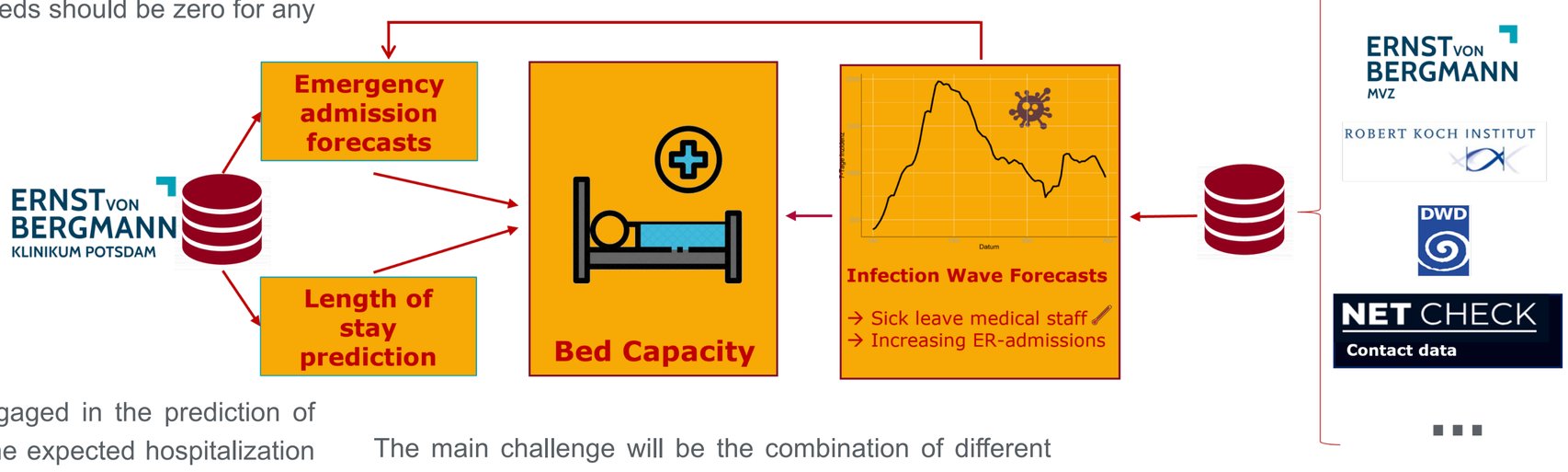
Red: target parameters we want to predict as accurate as possible
Blue: influenceable parameter

Depending on your preferences, the focus can be on one of these five tasks:

Infection wave forecasts



You will develop a Germany-wide predictive model for respiratory diseases using data from public sources, RKI data, hospital records, and demographic data. Providing insights into prediction uncertainties is important. This forecast will be used as input for the sick leave forecast and the emergency admission forecast.



In this project you will be engaged in the prediction of infection waves, forecasting the expected hospitalization rates, estimating patient lengths of stay, and projecting medical staff sick leave. These efforts collectively contribute to a comprehensive bed capacity forecast.

The main challenge will be the combination of different data to an 'infection-index' and the adapting of an existing GNN-model for COVID-19 forecasts to respiratory diseases in general. Therefore you will use public health data from RKI, weather data, contact-data, ICD10-codes from medical practices and social-demographic data.

Emergency Admission Prediction

You will use historical data and results from the infection prediction, along with external factors like weather (heat stress, ice related accidents) and holidays, to predict emergency department admissions.

Vacant beds = operable beds – (staying patients + (**emergency admissions** + planned admissions) – discharges)

Length of Stay Prediction

Using clinical data (diagnoses, vital parameters, lab results …) you will employ methods like Random Forest and Decision Trees to forecast patient lengths of stay. Additional research questions, like probabilities of re-admission or ER-transfer could also be worked on depending on interest.

Vacant beds = operable beds – (**staying patients** + (emergency admissions + planned admissions) – **discharges**)

Visualization and Integration

Communicating the results: an easy-to-understand visual representation and easily accessible integration into the hospital's workflow and systems will determine the success of the project. Only if this is solved will our predictions become an integral part of hospital planning and patient care will benefit.

Sick Leave Prediction

Hospitals suffer from high absence rates and predictions of the sick leave will enable the hospital to plan according to their resources. This forecast tackles the 'operable beds' variable.

Vacant beds = **operable beds** – (staying patients + (emergency admissions + planned admissions) – discharges)

First, a historical analysis of the correlation between circulating waves of infection and medical staff sick leave is performed. Subsequently, various machine learning methods can be used to obtain accurate predictions.

Your challenge

How to integrate different real-world data to meaningful forecasts?

In this project you have to deal with often non-ideal real-world data and their typical limitations. You will face problems coming with the usage of health data in Germany and consider privacy and ethical questions. In order to understand how the data is generated and where the integration of the predictions will bring the most benefit, interviews with and visits of various medical and nursing staff can be part of the project.
On the data analysis side, you will deal with the following questions:

- How can we integrate and harmonize diverse data?
- Which statistical and machine learning methodologies are the most suitable for different questions?
- How can we visualize and integrate the results into clinical processes?

Your skill set

You should bring strong programming skills in Python, familiarity with SQL, Linux and command line interface.
Knowledge of scikit-learn is recommended
Experience in data science, statistical analysis, and/or machine learning techniques is essential.
A genuine interest in conducting research, including the review and writing of scientific publications, is highly desirable.
A good knowledge of German is a prerequisite for this project, as many of our project partners' staff members may not have a strong command of English.
As we will be analyzing patient data, it may be required for project participation that project participants sign non-disclosure agreement and/or student research assistant contracts with the hospital to ensure compliance with data protection standards.

Further Reading:

Information

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Maximum of 6 students