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Project Work

Bachelor of Artificial Intelligence and Data

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1 Motivation

When patients undergo cardiac surgery, a serious number of risk scores will follow. The most widely used tools for estimating complication rates are EuroSCORE II and STS risk score. However, these risk scores come with shortcomings, as they lack precision in estimating the risk for the individual patient, and they are mostly designed to predict mortality but not morbidity. Therefore, this project investigates the possibilities of using Artificial Intelligence (AI) to create stronger prediction models. Ultimately, if these AI models, in opposition to the existing ones, can be trained to detect complications in patients earlier, as this will help prevent mortality when undergoing surgeries. It is known that yearly, out of 1800 patients who undergo cardiac surgery at Rigshospitalet in Copenhagen. A crucial amount of these individuals will experience complications post surgery, keeping them hospitalized longer, and sometimes their health becomes fatal. The investigation done in this project is, therefore, highly important, as this new found knowledge can serve as guidance for doctors and patients deciding on the surgery.

2 State of the art

This section describes existing academic theory on the EuroSCORE II model based on the belonging EuroSCORE II article¹. The goal of this article was to update the European System for Cardiac Operative Risk Evaluation (EuroSCORE) risk model from the year 1995, which is mentioned as the first EuroSCORE model. Here, the newer EuroSCORE II model from 2012 was trained based on existing EuroSCORE risk factors as well as additional factors. When training this model, the data was split into a subset for training a logistic regression model and a subset for testing the model. The article concludes that EuroSCORE II was superior, as it is better calibrated while preserving powerful discrimination. From this model, it was also deduced that cardiac surgical mortality has been significantly reduced in the last 15 years despite including older and sicker patients.

3 Research questions

The main focus is to assess the risk of organ failure following cardiac surgery, which is especially to investigate the risk of mortality after 30 to 90 days post-surgery. To research that there are three following questions:

- To what extent is a Machine Learning (ML) model able to outperform the EuroSCORE II, in predicting the mortality of a cardiac surgery patient, and is it more practical?
- Is there a correlation between different groups and the outcome of the surgery, so the complex ML model can decide if a patient should undergo cardiac surgery?

¹<https://www.euroscore.org/index.php?fid=201>

- How well can ML models predict post-operative complications, like organ failure, so the patient would not stay in the ICU?

4 Data description



The data which is used in this project, is collected from 8000 patients, over five years, undergoing cardiac surgery at Rigshospitalet. The Cardiac patient data journey has a Preoperative section as; "sex, age, ECG, medical- and surgical history ect.", Perioperative as; "blood pressure, heart rate, pressure, ect.", ICU as; "blood pressure, heart rate, dialysis, ect.", Ward as; "blood pressure, heart rate, medication"1. The above data is described in a sampling rate in the Table 1 1, at a surgery ($T = 0$)2.

Variables	Preoperative	Perioperative	Postoperative	High Frequency
Medical history	✓	X	X	X
Surgical history	✓	X	X	X
Echocardiography	✓	✓	✓	X
Pulmonary function	✓	X	X	X
Coronary angiography	✓	X	X	X
Monitors	✓	✓	X	✓
Charts	✓	✓	X	✓
Medication	✓	✓	X	✓
Biochemistry	✓	✓	✓	✓
Ventilator	X	✓	✓	✓
Extracorporeal circulation	X	✓	✓	✓
Age	✓	X	X	X

Table 1: Sampling rate

Furthermore, is there already made a logistic regression (EuroSCORE II) on the data, which would be used to compare the more complex machine model we will make.

There will be a restriction on the data, for the reason that the data we use is under the GPR-rules, so the data can only be used on one computer to make the machine learning models.

References

- [1] PhD studerende Theis Itenov MD PhD Lars Grønlykke MD PhD Chaoqun Zheng, MD.
Cardiac surgery prediction modelling, pages 3, 4. 2024.

5 Appendix

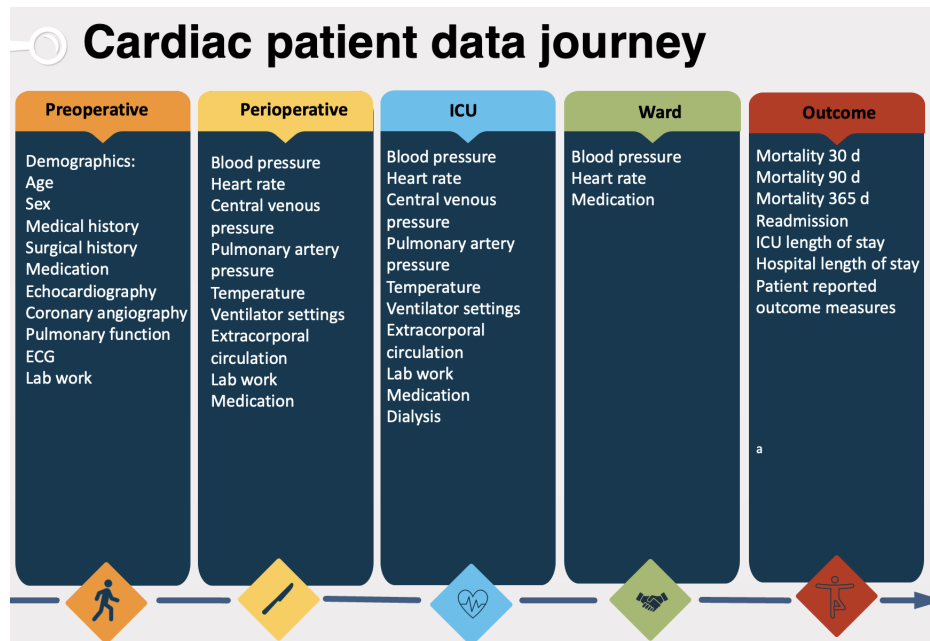


Figure 1: Cardiac patient data journey[1]

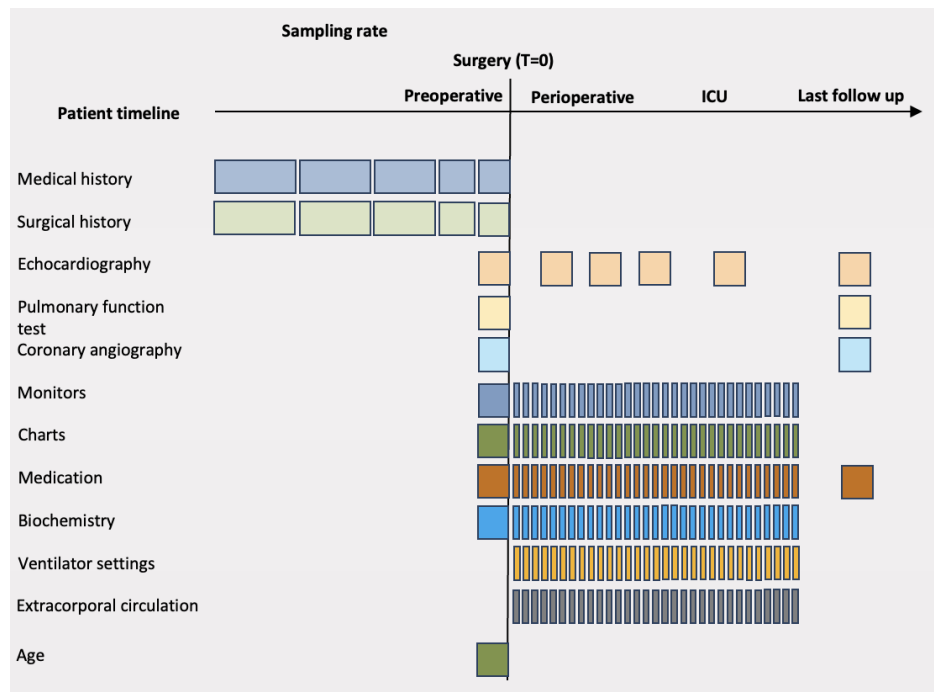


Figure 2: Sampling rate[1]