Digital Health – Connected Healthcare
Prof. Dr. Bert Arnrich
Master Project Winter 2020/21

In cooperation with the Surgical Department of the Charité, Universitätsmedizin Berlin.

# Preventive Maintenance for Patients

Detecting Critical Conditions and Complications Before They Occur

Unforeseen events make up for a substantial part in both our personal as well as our professional lives. The easiest way to deal with those problems is to address them after they occurred. However, nowadays we have access to large databases and tools, such as machine learning, to make use of data from the past to predict and address issues before they arise in the future.

In industry and transport, *preventive maintenance* is already used to avoid major outage of production pipelines, or to prevent critical infrastructure breakdowns, such as for bridges and aeroplanes. In medicine, although we have access to relational and time-series databases accurately describing the patients' history and state, this *preventive* approach is not widely used yet. Complications in the course of medical procedures may worsen patients' morbidity or even putting his or her life at risk, which motivates a more proactive strategy. Early detection of deteriorating patient condition is crucial to provide the best care possible and allow a quick recovery.

This is what you will address in this master's project, employing two case studies:

## Alarm Management in Intensive Care Units (ICU)

In intensive care units (ICUs), medical monitors trigger an alarm when physiological parameters exceed or fall below certain thresholds. For example, when the patient's heart rate goes below 60 bpm, an alarm will be triggered so medical staff is informed and can take action. The problem with this approach is, that there are so many alarms at an ICU, that the staff becomes fatigued and desensitised, hence not responding properly to every alarm.

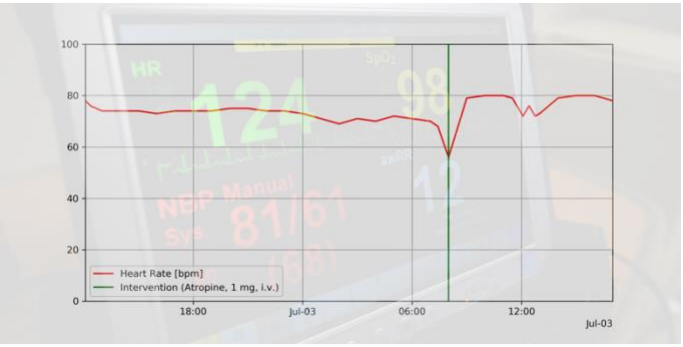


**Fig. 1:** As soon as the heart rate falls below 60 bpm, an alarm is triggered, and countermeasures are taken.

This project aims to predict alarms from trends in the physiological parameters. Thereby, alarms – which are supposed to indicate acutely critical conditions – can be replaced by scheduled tasks. Instead of triggering an alarm when the heart rate is already below 60 bpm, we can detect that the heart rate will probably fall below 60 bpm during the next hour and notify the medical staff to look after the patient when they have time. Thus, minimizing stress in staff and critical conditions in patients.

# Complications in Pancreatic Surgery

Within the field of abdominal surgery, pancreatic resections are particularly critical with postoperative mortality rates being as high as 10%. In fact, one out of four patients develops at least one major postoperative complication according to national and international studies. Hence, estimating and accurately stratifying a patient's individual risk prior to surgery – e.g. based on his or her comorbidities, laboratory parameters, etc. – might provide crucial support in the joint decision-making process between patients and their health care professionals. Moreover, the application of machine learning approaches using pre-, intra-, and postoperative parameters might allow us to predict major complications even before they actually occur in the postoperative setting.

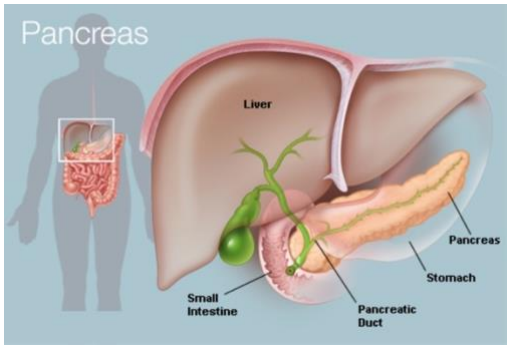


**Fig. 2:** Pancreas in context of the human body.[1]

To this end, we will analyse a wide set of real-world-clinical data derived from >500 cases of pancreatic resections as kindly provided by the Surgical Department of the Charité, Universitätsmedizin Berlin. The goal of this project is not only to test different ML-models as to their prediction capabilities but also to evaluate the effect of missing data on prediction accuracy, for example by ignoring post-operative data and only using pre- and intra-operative data.

# Requirements and Expectations

This is an interdisciplinary project at the intersection between computer science and medicine. Hence, a broad and diverse field of expertise is required. The following topics will be relevant for this project and we expect prior knowledge of or interest in:

- Processing large amounts of data
- Machine learning
- Time-series data
- Basic human physiology and pharmacology

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[1] Source: https://www.webmd.com/digestive-disorders/picture-of-the-pancreas#1