technische universität dortmund

SCHÜCHTERMANN-KLINIK BAD ROTHENFELDE

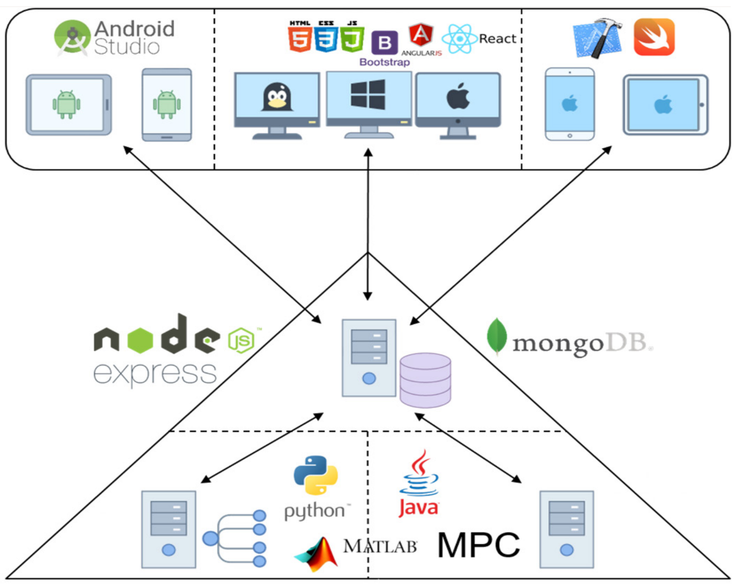
Development of a computer-aided dosage and telemonitoring system for patients under oral anticoagulation therapy

Motivation

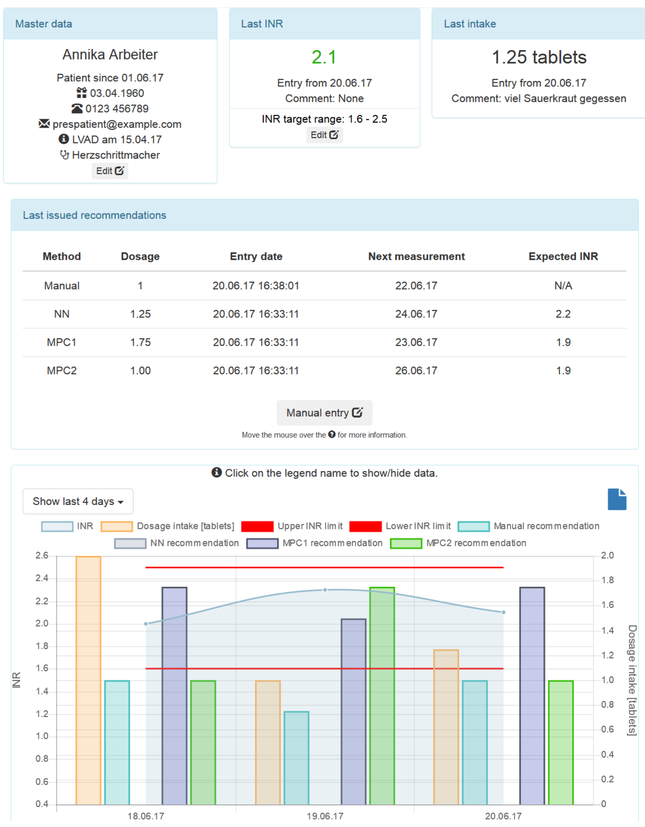
Goal Improve the treatment of patients in self management who require anticoagulation medications.

Solution Develop a system that:

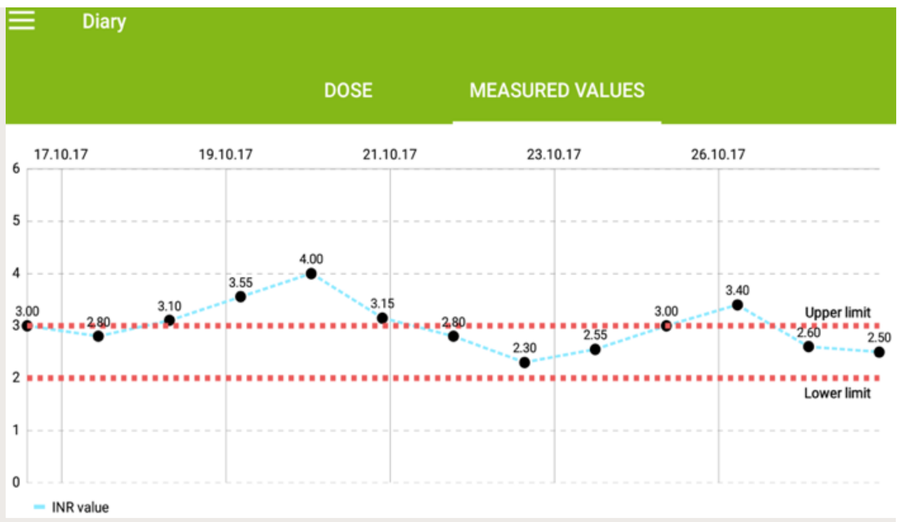
1. Works as a digital diary for INR self management
2. Automatically communicates the INR-specific values to the physician for documentation and control
3. Creates an individually calculated medication recommendation for the patient based on personal health parameters and therapy relevant data records



Application



App The Application works as a digital diary for all the individual and medical relevant data records of the patient. It also offers possibilities to communicate with the physician. Measured INR-values and prior dosage intakes can be reviewed in a graphical or tabular view as well as new dosage recommendations.



Web-App The web application is used by medical professionals and administrators to manage all aspects about the patients and the platform. In the doctor's view the assigned patient's accumulated data can be reviewed and therapy decisions can be tweaked. Automatic dosage calculations and patient's recent comments can be examined. Alarms help to focus the user's attention on critical entries. It is designed to work on all modern internet browsers, whether on a desktop or mobile environment.

AI

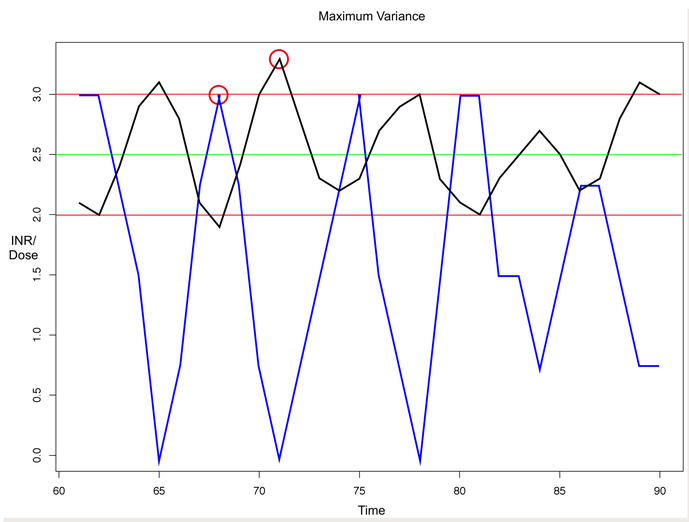
Artificial Neural Networks provide a great opportunity to extract complex patterns in big data. We used this as a method of choice to approach dosage prediction for oral anti-coagulation therapy.

1. Patients Vital-History is divided into chunks of N successive days containing the INR and dosage values plus patient specific information
2. Together with the next INR value and dosage as the label this chunks form the training data
3. Our network is designed as a multi-layer feed-forward network with 2*N+3 input neurons and two output neurons. As training algorithm we used the gradient descent based algorithm of back propagation

MPC originates from control system theory and extends regular control systems with a model to predict the behavior of the system and to choose the optimal inputs.

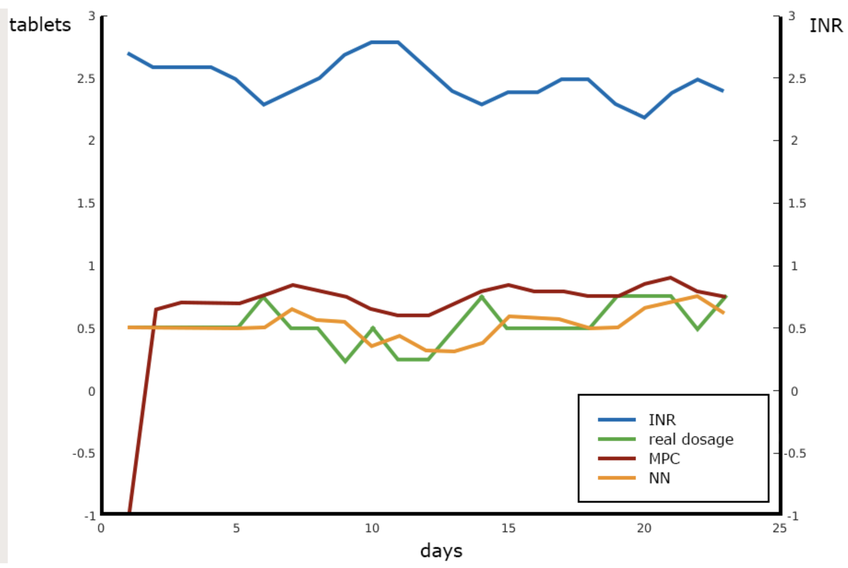
1. Use internal model to describe dosage-INR-relationship
2. Infer current state from patients drug history and INR measurements
3. Optimize dosage using model by minimizing difference between calculated INR and center of therapeutic range

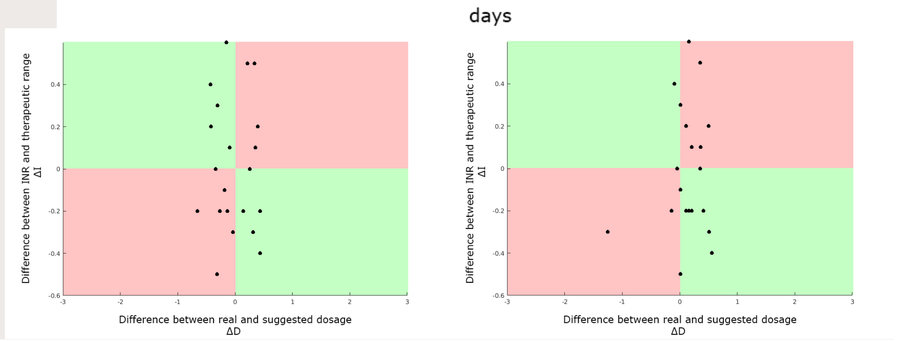
Results



Evaluation To evaluate the recommendation models we looked at 30 day blocks of measurements and moved a window of 7 days along these blocks. When evaluating the dosage, we take the difference between this and the corresponding recommendation. We then look at the INR offset by a span of 2 days and compare this to the center of the therapeutic range. With this difference we can assume if the dosage was too high or too low. The models have between 50% and 60% recommendations that meet the described criteria.

Furthermore, the recommendation models were compared with actual dosages. Since these dosages – which were chosen by the patients themselves – are not necessarily optimal, a recommendation close to the actual dosage does not indicate a good recommendation.





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