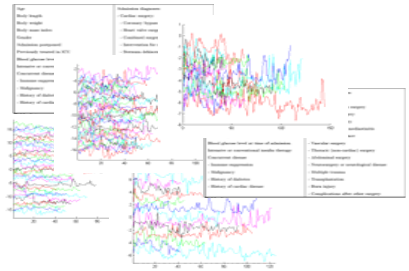
Gaussian Processes for Prediction in Intensive Care

Fabián Güiza
Jan Ramon
Hendrik Blockeel

KATHOLIEKE UNIVERSITEIT
LEUVEN

Introduction – Intensive Care

I.C.U. Patient



Patient Information

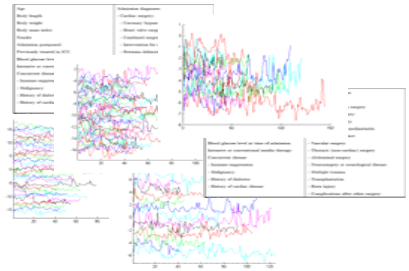
Intensivist

A physician analyses the data to foresee a change in the patient's condition and to administer an appropriate treatment

Treatments

Introduction – Intensive Care

I.C.U. Patient



Patient Information

Intensivist

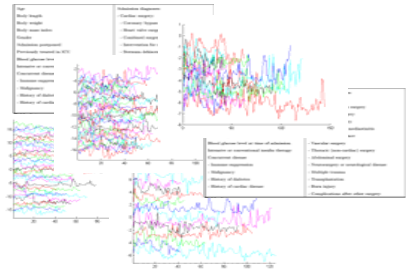
A physician analyses the data to foresee a change in the patient's condition and to administer an appropriate treatment

It is crucial to detect clinical problems early enough so that treatments can be applied in time

Treatments

Introduction – Intensive Care

I.C.U. Patient



Patient Information

Intensivist

Treatments

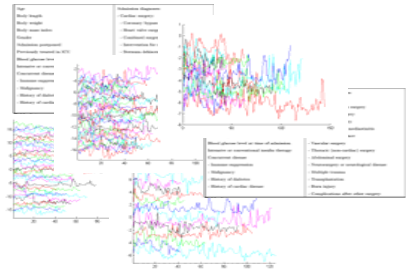
A physician analyses the data to foresee a change in the patient's condition and to administer an appropriate treatment

It is crucial to detect clinical problems early enough so that treatments can be applied in time

Of all the available data the physician makes a selection of only a few variables for prediction

Application – Intensive Care

I.C.U. Patient



Patient Information

Intensivist

MODELS

Treatments

Models deal with the large amount of data and make predictions (with a confidence value) of the patient's future state

Application – Intensive Care

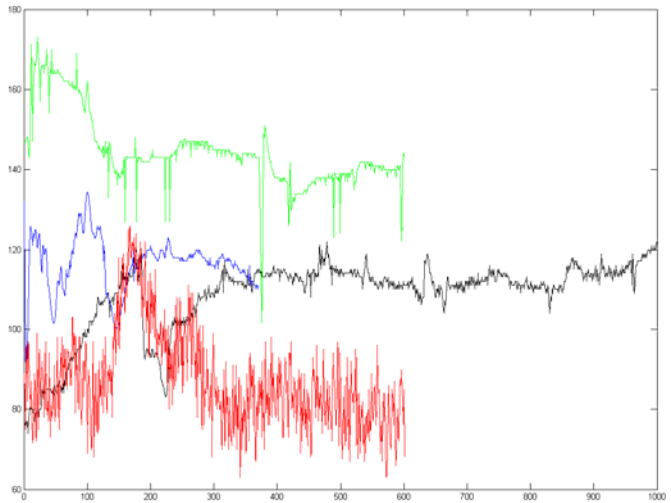
Develop models to predict the future values of variables that are considered interesting by the physicians to determine the future state of the patient

Individual Patient Characteristics

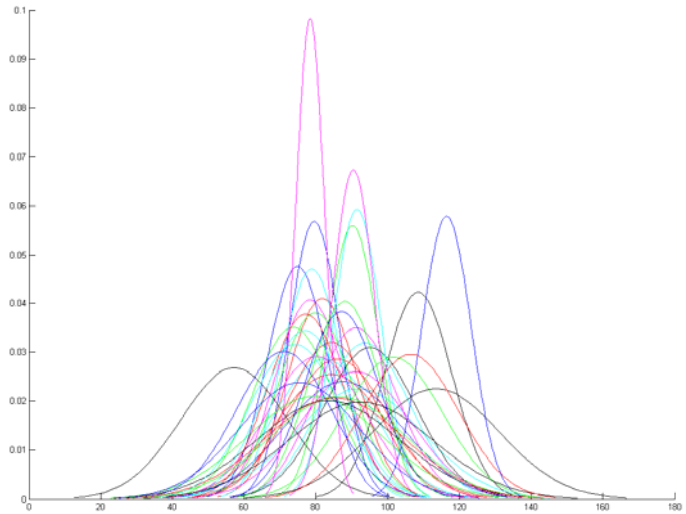
- Remain constant for a given patient during I.C.U. stay
- Different amongst individual patients
- Define ‘normal’ or ‘typical’ state of a patient
- Deviations from typical value is important information for prediction
- Unknown upon admission to ICU but can be estimated from measurements

Application – Intensive Care

Individual Patient Characteristics



Heart Rates for different patients



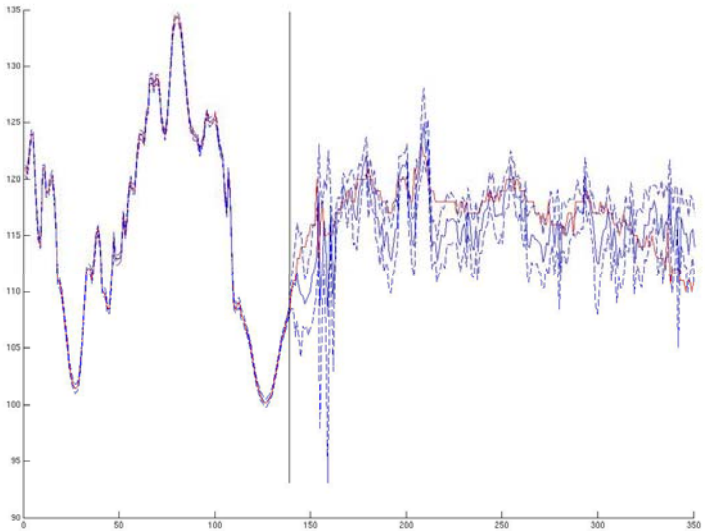
Normal distributions of
HR for different patients

Methods – Gaussian Processes

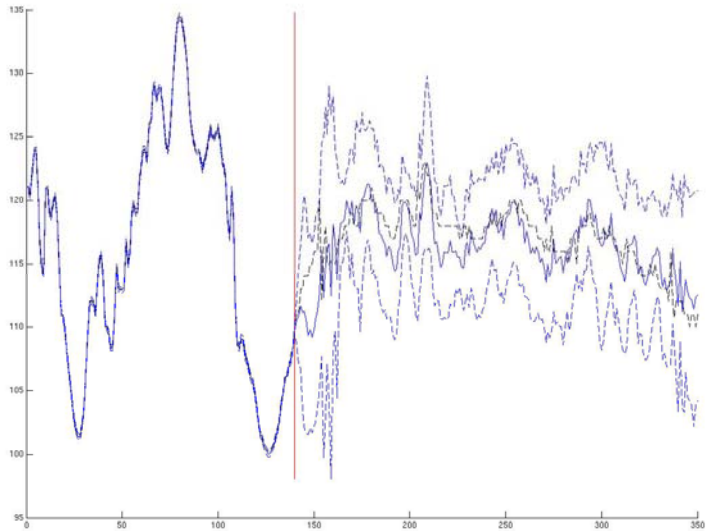
- GPs for regression have been used to model and forecast real dynamic systems, because of their flexibility and high predictive performances
- Allow for multi-dimensional inputs
- Assign a confidence value to predictions
- Predictions can be made with noisy (uncertain) inputs, such that the uncertainty propagates to the confidence of the predicted value.
    - Allows for the direct use of the estimated individual patient characteristics
    - Predictions can not be over-confident since they are used for critical decision making processes on the physician's part

Methods – Gaussian Processes

First Experiments



Prediction without IPC
MSE = 4.97



Prediction with IPC
MSE = 2.27

Future Work and Challenges

- Define (learn) and select a set of Individual Patient Characteristics that are relevant for the prediction tasks
- Verify that models are not over-confident and real values are within predicted variances
- Determine appropriate time-scales for the different variables according to the predictive task
- Make use of sparse methods and aggregation to deal with the large amount of data available
- Preprocessing to deal with the specific type of noise for the application

Thank You