WOG Meeting on model selection

Turning images into value through statistical parameter estimation

Irish College, KU Leuven

11th of June 2018

Scientific program

9:30-10:00		**Welcome with coffee & tea**
10:00-11:00	Gerda Claeskens	Tutorial on model selection
11:00-11:30		**Coffee & tea**
11:30-12:30	Gerda Claeskens	Tutorial on model selection
12:30-14:00		**Lunch**
14:00-14:50	Uran Ferizi	Microstructure modelling for diffusion MRI
14:50-15:15	May Gade Pedersen	Asteroseismic modelling of massive stars in the context of both model selection and parameter determination
15:15-15:45		**Coffee & tea**
15:45-16:10	Annick De Backer	Model selection in quantitative atomic resolution electron microscopy
16:10-16:35	Piet Bladt	Accuracy and precision of parameter estimation in arterial spin labelling perfusion MRI
16:35-17:00		**Group discussion, wrap up & looking forward**
17:00-18:00		**Reception**

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Abstracts

Tutorial on model selection – Gerda Claeskens

The selection of a suitable model, including the selection of regression variables, is central to any good data analysis. In this short course we will learn about different criteria and methods for model selection, with a deeper understanding of where they originate, what they intend to optimize, and how they should be understood and used.

Microstructure modelling for diffusion MRI – Uran Ferizi

With an ever-increasing life expectancy, diseases such as dementia, prostate cancer, or osteoarthritis are increasingly on the rise – and (at least) one of them will most likely affect each of us. Their cause and development are little understood, so capturing the early signs of their onset and progression is very important to their prevention and treatment. For this, clinicians are increasingly dependent on the data from the microstructure of the tissue.

Diffusion MRI is a special kind of MRI that is particularly well suited to studying the microstructure of the tissue in a living human being. Its aim is to become a non-invasive substitute to histology. It measures the diffusion of water permeating through the biological structure, allowing us to study the integrity of the organ in fine detail. In order to construct a picture of the tissue, we have to interpret the signals from the scanner using a mathematical model. Ideally, the model would be unambiguously specific and sensitive to any physiological changes that a disease might cause.

At the moment, the most common model in clinical practice is the Diffusion Tensor. It is widely used in neurology, but it has recently made inroads into other specialities, such as musculo-skeletal diseases. Though this technique is useful, it is simple and crude; it fails to distinguish between many physiological changes in the tissue. A new class of biophysical models has started to be applied clinically, especially in neurodegenerative diseases.

My doctoral and postdoctoral work has involved comparing these (both existing and new) biophysical models of diffusion MRI signal. The model selection relied on the ability to describe both synthetic data and signal from the brain and knee cartilage acquired using clinical scanners in London, Boston and New York. My most recent work has involved comparing many Machine Learning models for predicting osteoporotic bone fractures.

Asteroseismic modelling of massive stars in the context of both model selection and parameter determination – May Gade Pedersen

Stars form the building blocks of galaxies and exoplanetary systems. Almost all studies in astronomy therefore dependent on the quality of stellar models. Asteroseismology, the study of starquakes, is a relatively new branch in astrophysics that allows to calibrate stellar models. In order to achieve this, we perform forward asteroseismic modelling of starquakes. Such quakes provide information on the stellar interior physics, which is not observable from direct measurements. In this talk we discuss the implementation of Mahalanobis distances into the forward seismic modelling scheme and its impact on the parameter estimation and model selection compared to the more simplistic chi^2 approach.

Model selection in quantitative atomic resolution electron microscopy – Annick De Backer

In order to fully understand the structure property relationship of materials, it is important to reliably quantify structure parameters such as the position of the atoms, the type of the atoms, and the number of atoms. The starting point of a quantitative analysis is the availability of a correct physics-based model depending on those structure parameters. This talk will highlight the model selection techniques, together with the possibilities and inherent limitations, used in the statistics-based methods for quantifying electron microscopy images.

Accuracy and precision of parameter estimation in arterial spin labelling perfusion MRI – Piet Bladt

The supply of blood to different parts of the brain, perfusion, is an important biomarker for detection and follow-up of many brain disorders. Arterial spin labeling is a non-invasive MRI modality that allows quantification of perfusion from a set of images, acquired at different time points during the dynamic inflow process of a magnetically labeled blood bolus. However, ASL images have a notoriously low SNR. Furthermore, throughout the years, a plethora of perfusion models of different levels of complexity have been introduced. Choosing a model and selecting the amount of parameters to be estimated, within the setting of a low SNR, is crucial in the interplay between the accuracy and the precision of the estimator.

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