Computational Inverse Problems: Bayes and Beyond

Workshop at the Technical University of Denmark, building 101, room S02

Wednesday, November 22, 2023, from 9:00–12:00

09:00-09:45 **Josselin Garnier,** *École Polytechnique, France*

Reduced order model approach for imaging with waves

Reduced order model approach for imaging with waves We consider the inverse problem for the scalar wave equation. Sensors probe the unknown medium to be imaged with a pulse and measure the backscattered waves. The objective is to estimate the velocity map from the array response matrix of the sensors. Under such circumstances, conventional Full Waveform Inversion (FWI) can be carried out by nonlinear least-squares data fitting. It turns out that the FWI misfit function is high-dimensional and non-convex, and it has many local minima. A novel approach to FWI based on a data-driven reduced order model (ROM) of the wave equation operator is introduced and it is shown that the minimization of ROM misfit function performs much better. The talk is based on a joint work with L. Borcea (Univ. Michigan), A. Mamonov (Univ. Houston), J. Zimmerling (Uppsala Univ.)

09:50-10:40 **Hanne Kekkonen,** *TU Delft, Netherlands*

Data based density selection for random tree Besov priors

Besov priors are well fitted for imaging since smooth functions with few local irregularities have a sparse representation in the wavelet basis which is encouraged by the prior. This edge preservation can be enhanced by introducing a new random variable T that takes values in the space of 'trees', and which is chosen so that the realisations have jumps only on a small set. The density of the tree, and so the size of the set of jumps, is controlled by a hyperparameter. In this talk I will show how this hyperparameter can be selected automatically based on the data.

10:40-11:00 **Coffee break**

11:00-11:50 **Tanja Tarvainen,** *University of Eastern Finland, Finland*

Utilising Monte Carlo method for light transport in the inverse problem of quantitative photoacoustic tomography

We study the inverse problem of quantitative photoacoustic tomography in a situation where the forward operator is stochastic. In the approach, Monte Carlo method for light transport, that is based on random sampling of photon propagation, is used to simulate light propagation in the imaged target. In the inverse problem, MAP estimates for absorption and scattering are computed, and the reliability of the estimates is evaluated. Now, due to the stochastic nature of the forward operator, also the search direction of the minimisation algorithm for solving the MAP estimates is stochastic.

Register (in particular for lunch) by email to Kim Knudsen kiknu@dtu.dk.

Kim Knudsen

Professor, PhD, Head of DTU Compute PhD School

Dir. 45 25 30 26, kiknu@dtu.dk