

## **Inverse Problems Network Meeting 3**

Thursday, 26<sup>th</sup> April 2018 - Friday, 27<sup>th</sup> April 2018

Centre for Inverse Problems, UCL

### **Abstract of Talk**

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## **MACHINE LEARNING FOR INVERSE PROBLEMS**

Peter Maass

University of Bremen

The classical approach to inverse problems starts with an analytical description  $F : X \rightarrow Y$  of the forward operator in some function spaces  $X, Y$ . The field of inverse problems addresses the task of approximating an unknown  $x^*$  from noisy data  $y^\delta \sim F(x^*)$  with the further complication that  $F^{-1}$  or any type of generalized inverse is unbounded. The mathematical analysis stays within this framework and provides a regularization theory for optimal analytical convergence rates, stability estimates and convergence of numerical schemes.

This model driven approach has at least two shortcomings. First of all, the mathematical model is never complete. Extending the model might be challenging due to an only partial understanding of the underlying physical or technical setting. Secondly, most applications will have inputs which do not cover the full space  $X$  but stem from an unknown subset or obey an unknown stochastic distribution. E.g. there is no satisfactory mathematical model, which characterizes tomographic images or other image classes amongst all  $L_2$ -functions.

Machine learning offers several approaches for amending such analytical models by a data driven approach. Based on sets of training data either a specific problem adapted operator update is constructed and an established inversion process is used for regularizing the updated operator or the inverse problems is addressed by a machine learning method directly. We present an overview on machine learning approaches for inverse problems. We include some first numerical experiments on how to apply deep learning concepts to inverse problems and we finish by showing some first applications of data driven model updates for magnetic particle imaging (MPI).