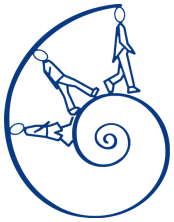

III Congresso Brasileiro de Jovens Pesquisadores
em Matemática Pura, Aplicada e Estatística

Curitiba, December 12-14, 2018

Session: New trends in Inverse Problems

Organized by Fabio Margotti (Universidade Federal de Santa Catarina)
Louise Reips (Universidade Federal de Santa Catarina)
and Vinicius Albani (Universidade Federal de Santa Catarina)

Schedule

Wednesday, December 12

9:00 - 9:30	Opening
9:30 - 10:30	Plenary talk 1
10:30 - 11:00	Coffee break
12:00 - 13:30	Lunch
13:30 - 14:30	Plenary talk 2
16:40 - 17:10	Coffee break
17:10 - 18:40	Round table

Thursday, December 13

9:00 - 10:00	Plenary talk 3
10:00 - 10:30	Coffee break
12:00 - 13:30	Lunch
13:30 - 14:30	Plenary talk 4
16:40 - 17:10	Coffee break
20:00 - 0:00	Social dinner

Friday, December 14

9:00 - 10:00	Plenary talk 5
10:00 - 10:30	Coffee break
10:30 - 11:00	Adriano De Cezaro (UFRGS) *A level set regularization method for parameter identification problems with piecewise constant solutions*
11:00 - 11:30	Gujji Murali Mohan Reddy (USP) *An efficient adaptive boundary algorithm to reconstruct Neumann boundary data in the MFS for the inverse Stefan problem*
11:30 - 12:00	Vinicius Viana Luiz Albani (UFSC) *A Splitting Strategy for the Calibration of Jump-Diffusion Models*
12:00 - 13:30	Lunch
13:30 - 14:30	Plenary talk 6
14:40 - 15:10	Xu Yang (UFAL) *The Calibration of Stochastic-Local Volatility Models: An Inverse Problem Perspective*
15:10 - 15:40	Roseane Alves de Souza Albani (UFSC) *Source Identification in Air Pollutant Modeling*
15:40 - 16:10	Wagner Barbosa Muniz (UFSC) *Qualitative inversions from ultrasound data through fast non-iterative schemes*
16:10 - 16:40	Fabio Margotti (UFSC) *Inexact Newton regularization combined with gradient methods in Banach spaces*
16:40 - 17:10	Coffee break
17:10 - 18:40	Assembly

Abstracts

1. *Speaker:* **Adriano De Cezaro**
Affiliation: Universidade Federal do Rio Grande
Title: ***A level set regularization method for parameter identification problems with piecewise constant solutions***

We propose and analyse a regularization method for parameter identification problems modeled by ill-posed nonlinear operator equations, where the parameter to be identified is a piecewise constant function taking known values. A piecewise constant level set approach is used to represent the unknown parameter, and a corresponding Tikhonov functional is defined on an appropriated space of level set functions. Additionally, a suitable constraint is enforced, resulting that minimizers of our Tikhonov functional belong to the set of piecewise constant level set functions. In other words, the original parameter identification problem is rewritten in the form of a constrained optimization problem, which is solved using an augmented Lagrangian method. We prove existence of zero duality gaps and existence of generalized Lagrangian multipliers. Moreover, we extend the analysis in "De Cezaro et. al. Inverse Problems, 2013", proving convergence and stability of the proposed parameter identification method. A primal-dual algorithm is proposed to compute approximate solutions of the original inverse problem, and its convergence is proved. Numerical examples are presented: this algorithm is applied to a 2D diffuse optical tomography problem. The numerical results are compared with the ones in "Agnelli et. al. ESAIM - COCV, 2017" demonstrating the effectiveness of this primal-dual algorithm.

2. *Speaker:* **Gujji Murali Mohan Reddy**
Affiliation: ICMC-USP
Title: ***An efficient adaptive boundary algorithm to reconstruct Neumann boundary data in the MFS for the inverse Stefan problem***

In this exposition, a simple practical adaptive algorithm is presented for efficient and accurate reconstruction of Neumann boundary data in the inverse Stefan problem, which is a highly nontrivial task. Primarily, this algorithm detects the satisfactory location of the source points from the boundary in reconstructing the boundary data in the inverse Stefan problem efficiently. To deal with the ill-conditioning of the matrix generated by the MFS, we use Tikhonov regularization and the algorithm is designed in such a way that the optimal regularization parameter is detected automatically without any use of traditional methods like the discrepancy principle, the L-curve criterion or the generalized cross-validation (GCV) technique. Furthermore, this algorithm can be thought of as an alternative to the concept of Beck's future temperatures for obtaining stable and accurate fluxes, but without it being necessary to specify data on any future time interval. The effects of accuracy and measurement error (random noise) is studied on both optimal location and number of source points. The effectiveness of the proposed algorithm is shown through several test problems.

3. *Speaker:* **Vinicius Viana Luiz Albani**

Affiliation: UFSC
Title: ***A Splitting Strategy for the Calibration of Jump-Diffusion Models***

We present a detailed analysis and implementation of a splitting strategy to identify simultaneously the local-volatility surface and the jump-size distribution from quoted European prices. The underlying model consists of a jump-diffusion driven asset with time and price dependent volatility. Our approach uses a forward Dupire-type partial-integro-differential equations for the option prices to produce a parameter-to-solution map. The ill-posed inverse problem for such map is then solved by means of a Tikhonov-type convex regularization. The proofs of convergence and stability of the algorithm are provided together with numerical examples that substantiate the robustness of the method both for synthetic and real data.

4. *Speaker:* **Xu Yang**
Affiliation: Universidade Federal de Alagoas
Title: ***The Calibration of Stochastic-Local Volatility Models: An Inverse Problem Perspective***

We tackle the calibration of the so-called Stochastic-Local Volatility (SLV) model. This is the class of financial models that combines the local volatility and stochastic volatility features and has been subject of the attention by many researchers and practitioners recently. More precisely, given a calibrated local volatility surface and a choice of stochastic volatility parameters, we calibrate the corresponding leverage function. Our approach makes use of regularization techniques from inverse-problem theory, respecting the integrity of the data and thus avoiding data interpolation. The result is a stable and resilient algorithm which is resilient to instabilities in the regions of low probability density of the spot price and of the instantaneous variance. We substantiate our claims with numerical experiments using synthetic and real data. This is a joint work with Dr. Yuri F. Saporito and Dr. Jorge P. Zubelli.

5. *Speaker:* **Roseane Alves de Souza Albani**
Affiliation: UFSC
Title: ***Source Identification in Air Pollutant Modeling***

We consider the source identification problem in air pollution modeling, where a stabilized finite elements formulation is used to solve the corresponding advection-diffusion equation. We examine several atmospheric conditions through parametric models based on the Monin-Obukov similarity theory. To solve the source identification problem, we compare different techniques from Tikhonov-type regularization, in order deal with noise in the data and modeling uncertainty. Numerical experiments using real data are also provided.

6. *Speaker:* **Wagner Barbosa Muniz**

Affiliation: Universidade Federal de Santa Catarina
Title: ***Qualitative inversions from ultrasound data through fast non-iterative schemes***

Within the mathematical inverse scattering theory community, the so-called qualitative imaging methods have been continuously investigated during the last twenty years. Their applications range from static and quasi-static to high-frequency inverse scattering problems, and consist in imaging the support of the contrast without quantifying it. In particular, sampling-like algorithms – specific versions of the qualitative methods – have shown to be rather robust and fast for various acoustic and electromagnetic imaging problems. We will present different formulations of these qualitative schemes when applied to ultrasound imaging, assuming the availability of fixed-frequency multistatic scattering data and under the rather natural assumption that some information on the background is known a priori. In ultrasound imaging, algorithms based on Born linearization, distorted Born or Rytov approximations, still play their role but may not be viable in some situations as they impose non-realistic constraints on the contrast strength and size. On the other hand, nonlinear optimization schemes may quickly become too expensive as they need to evaluate many forward solvers, and this cost may be truly prohibitive for 3D imaging applications. Contrasting with these observations, qualitative sampling-like algorithms do not use approximations such as Born and take fully into account the multiple/nonlinear scattering aspect of the ultrasound problem. They also have the nice features of not needing any forward solver, and having completely parallelizable implementation, which results in a rather fast imaging scheme. We will report on the performance, drawbacks and robustness of these algorithms with synthetic data, and show a few examples with real experimental multistatic data in ultrasound imaging.

7. *Speaker:* **Fabio Margotti**
Affiliation: Universidade Federal de Santa Catarina
Title: ***Inexact Newton regularization combined with gradient methods in Banach spaces***

Inexact Newton methods have proven to be a powerful class of iterative methods for solving nonlinear ill-posed problems in Hilbert spaces. In order to realize such a method, one must linearize the original equation around the current iterate and then apply a regularization technique to solve the resulting linear system. We propose the adaptation of some classical gradient-type regularization methods for solving the linear systems in a relatively general Banach space setting.