

Computational Inverse Problems

Prof. Fabio Marcuzzi¹

¹ Dept. of Mathematics
University of Padova
Email: marcuzzi@math.unipd.it

Timetable: 16 hrs. (2 two-hours lectures per week): Classes on Monday and Wednesday, 10:30 - 12:30. First lecture on Monday February 23th, 2015. Room DEI/G, 3-rd oor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements:

1. basic notions of linear algebra and, possibly, numerical linear algebra.
2. the examples and homework will be in Python (the transition from Matlab to Python is effortless).

Examination and grading: Homework assignments and final test.

Aim: We study numerical methods that are of fundamental importance in computational inverse problems. Real application examples will be given for distributed parameter systems. Computer implementation performance issues will be considered also.

Course contents:

1. definition of inverse problems, basic examples and numerical difficulties.
2. numerical methods for QR and SVD and their application to the square-root implementation in PCA, least-squares, model reduction and Kalman filtering; recursive least-squares;
3. regularization methods;
4. numerical algorithms for nonlinear parameter estimation: Gauss-Newton, Levenberg-Marquardt, back-propagation (neural networks), adjoint model (VDA);
5. examples with distributed parameter systems;
6. HPC implementations and parallel implementations on GPUs;

References:

- [1] F.Marcuzzi "Analisi dei dati mediante modelli matematici",
<http://www.math.unipd.it/marcuzzi/MNAD.html>
- [2] CUDA programming guide, <http://docs.nvidia.com/cuda/index.html>