Computational Inverse Problems

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Timetable: 20 hrs (see Class Schedule on https://phd.dei.unipd.it/course-catalogues/)

Course requirements:
- basic notions of linear algebra and, possibly, numerical linear algebra.
- the examples and homework will be in Python (the transition from Matlab to Python is effort-
less).

Examination and grading: Homework assignments and final test.

SSD: INF/01 Information Engineering

Aim: We study numerical methods that are of fundamental importance in computational in-
verse problems. Real application examples will be given for distributed parameter systems
in continuum mechanics. Computer implementation performance issues will be considered as
well.

Course contents:
- definition of inverse problems, basic examples and numerical difficulties.
- numerical methods for QR and SVD and their application to the square-root implementa-
tion in PCA, least-squares, model reduction and Kalman filtering; recursive least-squares;
  High Performance Computing (HPC) implementation of numerical linear algebra algo-
  rithms.
- regularization methods;
- underdetermined linear estimation problems and sparse recovery;
- numerical algorithms for nonlinear parameter estimation: nonlinear least-squares (Levenberg-
  Marquardt), back-propagation learning;
- underdetermined nonlinear estimation problems and deep learning;
- examples with distributed parameter systems in continuum mechanics: reconstruction of
  forcing terms and parameters estimation;

References:
1 F.Marcuzzi ”Computational Inverse Problems”, lecture notes (will be posted on the moo-
dle page of the course)
2 G. Strang, “Linear Algebra and Learning From Data”, Wellesley - Cambridge Press, 2019