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ANNIT - An Efficient Inversion Algorithm based on Prediction Principles

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Solution of inverse problems represents meaningful job in geophysics. The amount of data is continuously increasing, methods of modeling are being improved and the computer facilities are also advancing great technical progress. Therefore the development of new and efficient algorithms and computer codes for both forward and inverse modeling is still up to date. ANNIT is contributing to this stream since it is a tool for efficient solution of a set of non-linear equations.

Typical geophysical problems are based on parametric approach. The system is characterized by a vector of parameters p, the response of the system is characterized by a vector of data d. The forward problem is usually represented by unique mapping F(p)=d. The inverse problem is much more complex and the inverse mapping p=G(d) is available in an analytical or closed form only exceptionally and generally it may not exist at all. Technically, both forward and inverse mapping F and G are sets of non-linear equations. ANNIT solves such situation as follows: (i) joint subspaces {pD, pM} of original data and model spaces D, M, resp. are searched for, within which the forward mapping F is sufficiently smooth that the inverse mapping G does exist, (ii) numerical approximation of G in subspaces {pD, pM} is found, (iii) candidate solution is predicted by using this numerical approximation.

ANNIT is working in an iterative way in cycles. The subspaces {pD, pM} are searched for by generating suitable populations of individuals (models) covering data and model spaces. The approximation of the inverse mapping is made by using three methods: (a) linear regression, (b) Radial Basis Function Network technique, (c) linear prediction (also known as “Kriging”). The ANNIT algorithm has built in also an archive of already evaluated models. Archive models are re-used in a suitable way and thus the number of forward evaluations is minimized.

ANNIT is now implemented both in MATLAB and SCILAB. Numerical tests show good performance of the algorithm. Both versions and documentation are available on Internet and anybody can download them. The goal of this presentation is to offer the algorithm and computer codes for anybody interested in the solution to inverse problems.