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# ANNO – a powerful tool for solving set of non-linear equations

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ANNO is an acronym for Artificial Neural Network Optimization. ANNO is algorithm and software code for efficient solution of many geophysical inverse problems represented by a set of non-linear equations.

Standard way how to solve a set of non-linear equations may be split into three steps: (i) transforming all equations into a "residual form", in which all RHS's should be zero, (ii) compiling all these residuals into a norm, (iii) minimizing this norm. Instead of this, ANNO performs approximate but direct inversion. Let forward problem is represented by mapping the model space **m** into the data space **d**: $\mathbf{d} = \boldsymbol{F}(\mathbf{m})$. Mapping function $\boldsymbol{F}$ is frequently complex and non-linear. In many practical cases, it may be even non-analytical and may be evaluated only numerically. Exact inverse problem, $\mathbf{m} = \boldsymbol{G}(\mathbf{d})$, $\boldsymbol{F} = \boldsymbol{G}^{-1}$, therefore does not exist in an analytical form neither. ANNO overcomes this problem by using an artificial neural network for approximation of the function $\boldsymbol{G}$ mapping **d** to **m**. There are numerous artificial neural networks available for approximating functions, but ANNO is using Radial Basis Functions Network only up to now.

Basically, ANNO is working simultaneously with a population of candidate solutions. In this aspect it shares some features of algorithms using evolution principles (genetic algorithm, differential evolution, evolution strategy etc.). Relations between model and data spaces known from the current population are used for setting up the neural network, which predicts new model best satisfying measured data.

The main advantage of ANNO is the ability to solve both simple and complex problems very efficiently with low number of evaluations of the forward problem. It is therefore suitable for inversion of time-consuming tasks.

The properties of ANNO are demonstrated on synthetic and real examples corresponding to seismic moment tensor inversion. While original moment tensor inversion based on true amplitudes is a simple linear problem, we solved also modified version based on inverting P/S amplitude ratios, which is again non-linear.