Abstract

In this thesis some applications of Genetic Algorithms to geophysical inverse problems are discussed. Genetic Algorithms have been employed as inversion strategy because of their ability to globally optimise highly nonlinear problems with limited amount of a priori information. In this way they promise to overcome one of the main disadvantage in the use of tradition local optimisation methods to geophysical problem, i.e., the need of detailed a priori information in order to avoid been trapped in local minima. Also, they are able to simultaneously reconstruct a large number of solutions in problems characterised by high degree of ambiguity. Again, traditional inversion methods that search the solution space for a single minimum are not suitable for such problems because a single solution can hardly be representative of the ambiguity domain.

The main drawbacks in the use of global optimisation techniques, i.e., their poor performance in large dimensional spaces and the large computation effort required, have been tackled by the use of a pseudo subspace method, whereby the complexity and dimensionality of the problem under analysis is progressively increased during the inversion. The inclusion of such method sensibly enhanced Genetic Algorithms performance both in terms of quality and efficiency, allowing to obtain satisfactory results in large solution with reasonable computation effort.

The algorithm here presented does not contain problem specific operators about the problem to be solved and proved to be very versatile. It has been successfully applied to a set of different geophysical problems, including seismic refraction tomography, inversion of magnetic and gravity data, both in 2-D and 3-D. For each experiment the ability of the algorithm to cope with the mathematical implications of the problem has been evaluated on synthetic data and its potentiality on real applications tested on different sets of field data. Also, the potentiality of the simultaneous inversion of gravity and magnetic data, as well as of seismic and gravity data, has been explored on synthetic examples.

Although further research is needed to apply such technique routinely in geophysical exploration, the method can already at this stage be considered as a useful tool for a fast and preliminary analysis of geophysical data in order to indicate where and how to direct further geological/geophysical survey.

As a part of the seismic application an original method to pick seismic

first arrival has also been implemented and is included in the document. The method works by analysis the variation in fractal dimension along seismic traces and proved to be more robust than traditional methods in situation of low signal-to-noise ratio.