O9-7 SEPARATE AND JOINT INVERSION FOR THE ONE-DIMENSIONAL INTERPRETATION OF TEM AND VES DATA USING GENETIC ALGORITHMS, AS GLOBAL OPTIMIZATION METHOD

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Genetic algorithm (GA) is a global optimization method that is analogous to the process of the biological evolution. The separate and joint inversion using GA is performed for one dimensional (1D) earth structures. The inherent problems of equivalence and suppression in transient electromagnetic (TEM) and direct current (DC) resistivity methods are studied.

An initial population of models is selected in random in the GA algorithm that seeks to improve the fit between measured and calculated data. This is principally accomplished by the genetic process of coding, selection, crossover and mutation.

The discreetization of a group of model parameters is commonly done in any basic GA by using a binary coding scheme resulting an analog of chromosome. In the current search, I employed the simple binary coding scheme proposed by Holland (1975). In this scheme, each bit corresponds to a gene which can take a value of zero or unity. Each individual in the population is completely described by its bit string or chromosome. The modification of chromosome is carried out in the algorithm by selecting a new set of model parameters that produce better fit. This is analogous to the natural selection e. g. the survival of the particular model among all depends on these criteria. In GA, the search space of each model parameter can be independently defined and its resolution independently specified. Thus; the basic concept of coding the physical parameters using a binary representation limits the search space, defines the resolution of each parameter and limits the number of acceptable models. Once the fitness of each chromosome (individual model) has been calculated, GA processes are employed, the first of these processes is selection. Selection of an individual model for reproduction is based on its fitness value. Models with higher fitness values are more likely to get selected than models with lower fitness values. This is the analog of inheritance since the model giving less misfit value will often be selected for reproduction. In this work, tournament selection method was used.

The second relevant characteristic of evolution is that the changes applied to chromosomes and genotypes occur during reproduction and these alterations are facilitated through the relatively simple process of crossover and mutation. Reproduction generates offspring and crossover allows the structure of parent organism to be modified by the exchange and recombination of parts of each parent structure. The crossover process allows offspring to have combination of the parents characteristics and the offspring may also develop some different features, depending on how chromosome structures are recombined. Mutation is a random process which also provides the opportunity to introduce new characteristics unrelated to the parents, by changing some bits from unity to zeros or vice versa.

The modern trend in geophysical interpretation is to integrate various data sets to arrive at reliable subsurface information. However, even after combination of data sets, inherent ambiguities in the interpretation can remain. In this paper the individual and joint inversion of coincident loop TEM and Schlumberger DC data are performed to study GA optimization as a multi parameter search method and the applicability of separate and joint inversion of GA for TEM and DC data for 1D H,K,Q, and A type three layer models, both with and without noise.

Contrary to my expectations, in all four models, I found that the separate inversion of the DC and TEM data sets using GA yields better results than joint inversion of the both data sets. Success of joint inversion in classical inversion methods is depending on two factors; rank growth of the sensitivity matrix of the two data and growing of data/ parameters ratio. The second factor is considered secondary when compared with the first. GA has no sensitivity matrixes, and parameter producing process is totally independent and stochastic, this implies that joining two data sets will not be successful as it is the case in classical inversion methods.

It could also be concluded that any crossover, mutation or creep mutation possibilities can not be recommended to be used in joint inversion of both data sets. Because, any possibility of these GA operators which could be optimal for a set, may be non-optimal for the others.

These results are valid for most of the cases, but because of the stochastic process in parameters producing in GA, still one can see cases with different results. The noise contamination of the data does not effect the results.

In spite of the disadvantage of GA of being stochastic and time consuming, GA can perform a robust and global search for a wide set of parameters in a wide search space.