



Optimization of nonlinear geological structure mapping using hybrid neuro-genetic techniques

T. Ganesan^{a,*}, P. Vasant^b, I. Elamvazuthi^c

^a Mechanical Engineering Department, University Technology Petronas, Malaysia

^b Fundamental and Applied Sciences Department, University Technology Petronas, Malaysia

^c Electrical & Electronic Engineering Department, University Technology Petronas, Malaysia

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ABSTRACT

A fairly reasonable result was obtained for nonlinear engineering problems using the optimization techniques such as neural network, genetic algorithms, and fuzzy logic independently in the past. Increasingly, hybrid techniques are being used to solve the nonlinear problems to obtain a better output. This paper discusses the use of neuro-genetic hybrid technique to optimize the geological structure mapping which is known as seismic survey. It involves minimization of objective function subject to the requirement of geophysical and operational constraints. In this work, the optimization was initially performed using genetic programming, and followed by hybrid neuro-genetic programming approaches. Comparative studies and analysis were then carried out on the optimized results. The results indicate that the hybrid neuro-genetic hybrid technique produced better results compared to the stand-alone genetic programming method.

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1. Introduction

Seismic surveying [1] is one of the vital technologies for geophysical prospecting since the 1940's [2]. In recent times, more sophisticated survey designs and data processing techniques have led to more complex field acquisition operations. Most survey designs today are in three-dimensions (3-D) with source and receiver points that are distributed geometrically on a region on the surface of the earth. The design of the distribution of the source and receiver arrangement is dependent on the requirements of the survey. The optimization models for operations planning in 3-D land seismic surveys have been formulated and solved previously in Morice et al. [3]. The optimization of an orthogonal split-spread survey design to minimize cost (objective function) subject to both geophysical and operational constraints was carried out successfully in [3], using the 'Microsoft Excel Nonlinear Optimization Solver'.

In this work, the optimization of an orthogonal split-spread survey design outlined in Morice et al. [3] was carried out using a pure genetic programming (GP) and a hybrid neuro-genetic programming (Neuro-GP) approach. The optimized results are then compared against each other and against the results obtained in Morice et al. [3]. The nature of this problem is nonlinear and it involves 16 constraints and 33 variables.

Genetic programming (GP), developed by Koza [4], is the most general form of the machine learning paradigm. This technique enables computers to solve problems without being explicitly programmed using Holland's genetic algorithms (GA), [5] to automatically generate computer programs (automatic programming). GP applies GA to a 'population' of programs encoded as tree-structures (symbolic expression). The symbolic expressions are then used to generate phenotypes

* Corresponding author.

E-mail address: tim.ganesan@gmail.com (T. Ganesan).