COMPARING GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION APPROACHES IN INVERSION OF SURFACE WAVE DATA

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One of the fields of studies with an effective role in engineering science progress is optimization approaches. In general, optimization algorithms can be divided into two categories: deterministic and stochastic algorithms. Deterministic algorithms follow a rigorous procedure and its path, values of both design variables, and functions are repeatable. On the other hand, stochastic algorithms which always have some randomness are of two types in general: heuristic and metaheuristic. Further development over heuristic algorithms is the so-called metaheuristic algorithms, which generally perform better than simple heuristics. In addition, all metaheuristic algorithms use the certain tradeoff of randomization and local search (Yang, 2010). Since most geophysical inverse problems are nonlinear and thus have non-linear misfit functions, the solution is quite often trapped to local minima during the application of local optimization methods. As a result, their success depends on the initial model for the true global-minimum solution. But global optimization algorithms include the ability of producing the solutions independent from the initial model in order to explore the model space in more details and, thus, find a better chance for the true global minimum solution (Sen and Stoffa, 1995; Soupios et al., 2011; Poormirzaee et al., 2014). In geophysical surveys, the application of metaheuristic techniques is quite new. Particle swarm optimaization (PSO) and Genetic algorithm(GA) are the global optimization methods that belong to metaheuristic searching algorithms. In the current study, the reability of PSO and GA algorithms in the inversion of surface wave data was investigated and then a comparison was made between the proposed inversion algorithms. In this study refraction microteremor (ReMi) (Louie, 2001) method was used as a passive surface wave data.

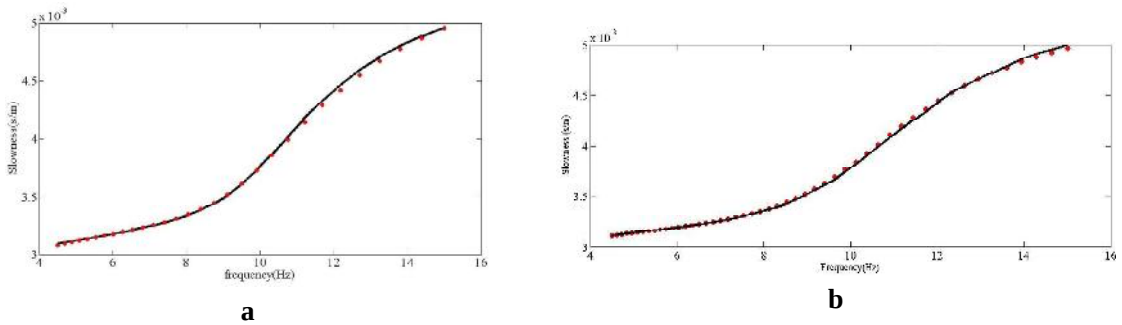

Figure 1. Model A (bold line) and mean estimated value (red points) by: a) PSO, b) GA

Table 1. Model A and search space for GA and PSO algorithms

layer	Vp(m/s)	Vs(m/s)	Poisson	H(m)	search space	
					Vs(m/s)	H(m)
1	400	200	0.45	8	100-300	4-12
2	600	400	0.25	half space	200- 600	-

Table 2. Obtained mean model by PSO and GA inversion algorithm

Parameters	True	Estimated by GA	Estimated by PSO
Model A			
Vs1(m/s)	200	196	199
Vs2(m/s)	400	395	408
H1(m)	8	7.8	7.9

First, PSO and GA code was developed in Matlab for the inversion of ReMi data and then the efficiency of the proposed algorithms was investigated by inversion of a synthetic data set, model A (Tables 1, 2 and Figure1). At the end, PSO and GA inversion algorithms were tested on a real ReMi data set which was collected for seismic hazard assesment in an area of Tabriz city in the northwest of Iran. The ReMi results were compared with the downhole data available around the studied area (Table 3). The finding in both synthetic and real dada sets proved that these algorithms were so suitable strategies for the inversion of surface waves. Also, comparison of two inversion algoriths showed that PSO algorithm, because of few parameters to adjust, is fast and easy to implement copared to GA. Another trait of the implemented PSO inversion code was its flexibility.

Table 3. Vs from ReMi and borehole (Percent Difference from Borehole in Parentheses)

Data	Vs(m/s) (top 4m)	Vs(m/s) (top 9m)	Vs(m/s) (top 13m)	Vs(m/s) (top 20m)
borehole	340	414	480	550
Experimental data (Inverted by PSO)	296 (-12)	383 (-7.4)	425 (-11)	491 (-10)

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