8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

GENETIC ALGORITHMS IN TSUNAMI STUDIES

Ahmad ALA AMJADI
Ph.D. Candidate, IIEES, Tehran, Iran
alaamjadi@iiees.ac.ir
Mohammad MOKHTARI
Associate Professor, IIEES, Tehran, Iran
mokhtari@iiees.ac.ir

Keywords: Real-value genetic algorithm, Tsunami, Spike response database

ABSTRACT

Genetic Algorithms (GA) can solve unknown parameters of a problem by examining a small percent of all possible answers. Applying GA on an unknown tsunami study may require several thousand to millions of numerical modelings. Numerical modeling of tsunamis consists of time-consuming (high cost) processes which are dependent on the resolution of the mesh grid and the configuration of the modeling computer. Therefore, the application of GA for finding an unknown Initial Water Displacement (IWD) was not an option and considered non-applicable due to its severely high costs. In this study, we have presented a different approach which enables the application of GA on tsunami studies. A Spike Response Database was created in the most possible area of the presence of a tsunami-genetic source. Once the database was created, the effect of any IWD was evaluated in a fraction of a second which minimized the computational cost of the numerical modeling and made GA applicable for tsunami studies. A real-value GA was applied in a sea-like medium with six arbitrary stations, to solve a pre-defined problem. The results obtained is very close to the actual test parameters of the problem. This indicates success in the application of GA on numerical modeling of tsunamis. The result of this study can further be extended for application on other numerical schemes and other adaptive algorithms in tsunami studies.

INTRODUCTION

Genetic algorithms were introduced by John Holland in 1960 based on the concept of Darwin's theory of evolution, the idea which is presented in nature. His student, David E. Goldberg, afterward extended GA in 1989 (Goldberg and Holland, 1988; Sadeghi et al., 2014) and GA became applicable in various complicated studies. GA finds the solution by examining a very small portion of all possible solutions. By the aid of GA, many problems which were considered unsolvable due to the high amount of computation became applicable. If the GA parameters are carefully adjusted, there would be hope that the best individual in the final population is the solution to the problem. Since GA works with a population of individuals, the GA solution procedure for detecting an IWD of a tsunami may require a number of computations in the order of several hundred thousand to millions depending to the size of GA chromosomes. Therefore, the application of GA for finding an unknown IWD's was not an option and considered non-applicable due to its severely high costs prior to this study.

In this study, we link GA with numerical modeling in tsunami studies to find an unknown IWD. We represent the Spike Response Database (SRD) method as a required tool for applying an adaptive algorithm in tsunami studies. Once SRD is created in for a modeling domain, the computation cost of tsunami modeling is severely reduced to some milliseconds. This new approach provides the room for applying any adaptive algorithms such as GA in tsunami studies. In this study a Target Initial Water Displacement is assigned and GA has successfully found the parameters of it (see Figure 1).

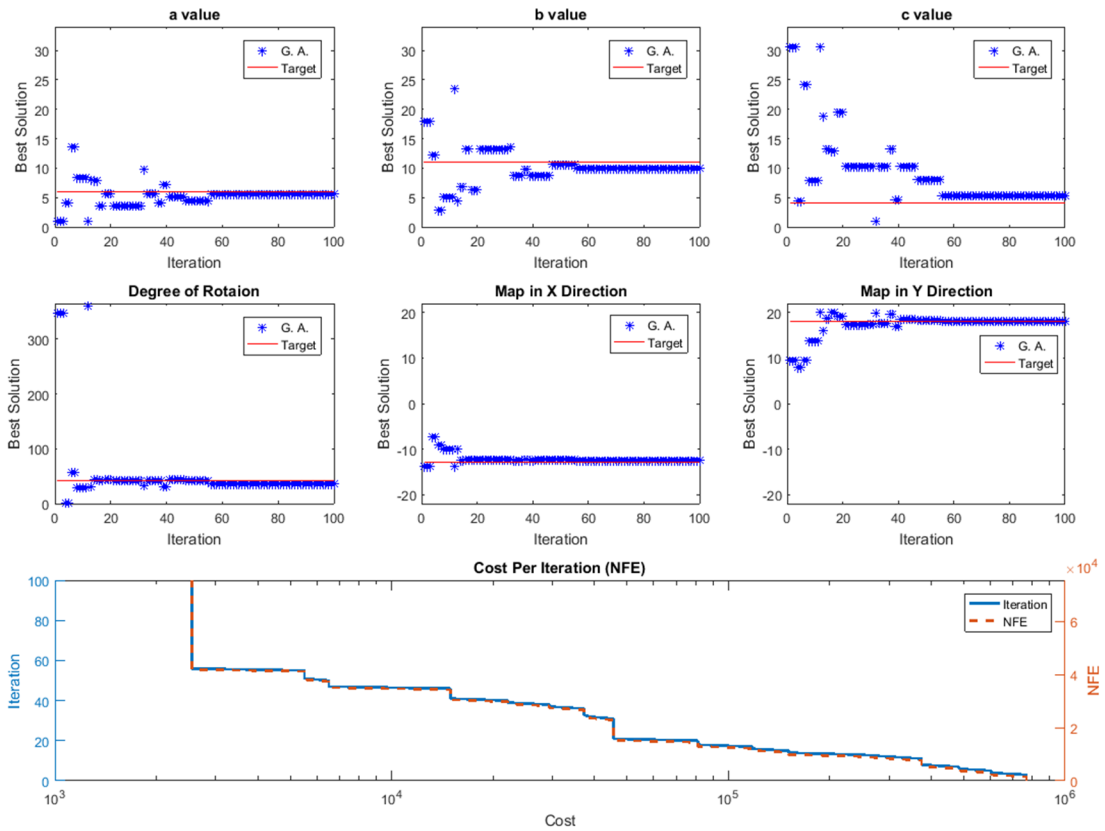

Figure 1. The Evolution strategy of the GA parameters for our Target model parameters. The top row includes the scaling parameters. The middle row includes the rotation and mapping parameters. The last bottom row shows the cost in each iteration or NFE (Number of Function Evaluation). The NFE represent the number of CFD process that had to be executed if the SRD was not defined. The red line in top and middle subfigures show the target parameter value for our experiment. The blue asterisks are the best GA solution for each iteration. Although the exact value is not achieved in all six parameters, the parameters have got very close to the exact solution. End of the GA program was defined by 100 iterations by the user.

CONCLUSIONS

In this study, we have connected genetic algorithms with tsunami modeling to find an unknown target initial water displacement. The SRD method enabled the possibility to reduce the computation cost of a costly CFD procedure to some milliseconds. This enhancement has allowed the usage of Genetic Algorithms on a regular PC in this study. The real-value GA used in this study was successful in determining the target IWD parameters and achieved very close similarity with the target records and target IWD.

REFERENCES

Goldberg, D.E. and J.H. Holland (1988). Genetic algorithms and machine learning. *Machine Learning*, *3*(2), 95-99.

Sadeghi, J., Sadeghi, S., and Akhavan Niaki, S.T. (2014). Optimizing a hybrid vendor-managed inventory and transportation problem with fuzzy demand: an improved particle swarm optimization algorithm. *Information Sciences*, *272*, 126-144.