Artificial Neural Network Prediction of Groundwater Remediation: Training Evolution and Optimization Benchmarking

L L Rogers (Earth Sciences Department, Lawrence Livermore National Laboratory, Livermore, CA 94551; 510-422-3538; rogers11@llnl.gov) (AGU Member 099231460)
V M Johnson (Environmental Protection Department, Lawrence Livermore National Laboratory, Livermore, CA 94551; 510-422-2005; vmjohnson@llnl.gov)

Artificial neural networks (ANNs) are being trained to predict the value of an objective function and/or constraint function of a groundwater remediation optimization at Lawrence Livermore National Laboratory (LLNL). The ANNs are trained on example results of 2-D numerical flow and transport models with spatially-variable transport parameters and multiple contaminant plumes. Once trained, the ANNs can predict the remediation success of an individual pumping configuration in a fraction of a second; then ANNs can stand in for a call to the flow and transport code which would require several hours to determine the success of an individual pumping configuration. Use of the ANNs enables rapid and efficient evaluation of objective and/or constraint functions in high dimensional combinatorial optimization algorithms. Also this approach enables processing the groundwater simulations in parallel and "recycling" or reusing the base of knowledge formed by these simulations.

The manifold computational efficiencies yielded by the ANNs allows more rapid optimization as well as numerical experiments (e.g. sensitivity studies designed to assess well interactions). Presented here are some of the training evolution issues of a 30 well remediation problem drawn from field data on the Volatile Organic Compound (VOC) plume under the LLNL square mile site and vicinity. In addition two optimization approaches, the multiple point search of the genetic algorithm and the single-point search of the simulated annealing algorithm, are linked to the ANNs and compared.

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1. 1995 IUGG Meeting
2. 009231460
3. (a) Leah L. Rogers
   LLNL
   POBox 808, L-206,
   Livermore, CA 94551

   (b) Tel: 510-422-3538

   (c) Fax: 510-422-3118

   (d) rogers11@llnl.gov
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