Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19927

Comparison of physical informed neural network and other machine learning methods for simulating heat transport in a nuclear waste disposal system

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This study evaluates the performance of five machine learning (ML) methods, namely, Physical Informed Neural Network (PINN), Convolutional Neural Network (CNN), Long Short-Term Memory (LSTM), Support Vector Regression (SVR), and Random Forest Regression (RFR), in simulating the heat transport process in a nuclear waste disposal system.The aim is to compare the performance of these models and determine which method provides the most accurate and computationally efficient simulation.

The evaluation metrics used in this study are the mean absolute error (MAE), mean squared error (MSE), and r-square. Experimental data obtained from the Full-scale Emplacement (FE) experiment, which is a large-scale experiment used to validate the performance of nuclear waste disposal systems [1]. The models are carried out with different ratios of the training-test dataset [2]. For the PINN model, the heat transport equation, initial and boundary conditions are considered.

We focus on the accuracy of the PINN model and other ML models. Then, comparison is done by considering the MAE, MSE and r-square values, respectively. In addition, the best method in simulating the heat transport process can be determined. The computational efficiency required of the PINN model as well as other ML models can be also obtained. This study demonstrates the potential of ML approaches, particularly the PINN model, in simulating complex thermal-hydraulic processes in nuclear waste disposal systems. The findings of this study can be used to improve the safety and effectiveness of nuclear waste disposal systems, as accurate and computationally efficient simulations can aid in the design of these systems.