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Machine-Learning-Based Robust Optimization of Brine Extraction Well Placement in CCS Projects Using Fast Marching Method

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In carbon sequestration projects, ensuring the safe management of reservoir pressure is essential for long-term security. The injection of CO2 can lead to pressure build-up, risking safety issues like caprock damage, induced seismicity, and potential leaks. While brine extraction offers a practical solution to mitigate those safety issues, it is crucial to optimize the location of the brine extraction well, especially in heterogeneous reservoirs.

Optimizing the brine extraction well location is computationally expensive, requiring numerous simulation runs to identify the most effective configuration. To perform robust optimization, which employs multiple reservoir models representing reservoir uncertainties, the computational complexity further increases.

In this study, we propose a machine-learning-based surrogate model that accurately predicts the effectiveness of the input well location with low computational cost. The proposed model incorporates the fast-marching method (FMM) to calculate the hydraulic connectivity and convolutional neural network (CNN) to extract the features of the connectivity map and predict the net present value (NPV). NPV is used as an objective function that represents the effectiveness of a brine extraction well. We applied this model to a CO2 injection site in the Pohang basin, Korea. Our model showed strong predictive performance, significantly reducing the computational costs by utilizing only 5% of the total location candidates.

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