Drilling sequence optimization for subsurface exploration using reinforcement learning and data-driven modeling.

Karthik Menon, M.S.E.E.R

The University of Texas at Austin, 2024

Abstract

In subsurface resource extraction projects such as oil and gas, mining, and geothermal energy, drilling an exploration well to confirm the existence of resources or make leasing and project expansion decisions is vital, yet costly and time-consuming. Optimizing drilling decisions is essential from an economic and environmental standpoint to reduce project costs and prevent drilling unnecessary wells. This optimization procedure is often formulated as a sequential decision problem. It has been conventionally undertaken by using dynamic programming techniques, which are computationally expensive. This thesis aims to showcase the performance of reinforcement learning models in solving the sequential drilling problem and provide a more realistic method to model uncertainty through geological models. A unified framework for uncertainty modeling using stochastic simulation has been combined with a Q-learning-based reinforcement learning model, which has been utilized to solve the decision problem, and its performance has been compared with dynamic programming for various cases. It was discovered that the reinforcement learning model could converge to a near-optimal policy and identify it much faster than dynamic programming for problems where the number of wells to be drilled was more than nine. A comparison study of the effect of approximations in the joint probability distribution on the drilling policy in the case of dynamic programming and reinforcement learning methods has also been showcased.

Eric Bickel (Co-supervisor) ____________________

Michael Pyrcz (Co-supervisor) ____________________