Title: Investigation and study on reinforcement learning for optimizing well path

Problem Statement: due to so many complex and interacted drilling variables and design constraints, wellbore trajectory optimal design is very demanding. In drilling engineering, well path optimization plays an important role, that could be based on the minimization of the total length of wellbore, minimization of drilling cost, improvement of cuttings transport efficiency, and increase of drilling speed. When different optimization algorithms (genetic algorithm, particle swarm optimization etc.) are applied, they give some probable solutions. Considering this complex optimization problem, our attempt is to introduce AI techniques and algorithms for optimization. Deep reinforcement learning is able to solve a wide range of complex decision-making tasks that are previously unsolvable/challenging problems. For this study, we aim to investigate reinforcement learning algorithm for optimizing 2D and 3D well path to see if the solution will be acceptable or reasonable or it performs better or worse than other existing optimization algorithms (genetic algorithm, particle swarm algorithm, etc.)

Solution

Reinforcement learning (**RL**) is an area of machine learning concerned with how intelligent agents ought to take actions in an environment in order to maximize the notion of cumulative reward. This neural network learning method helps you to learn how to attain a complex objective or maximize a specific dimension over many steps.

There are two important learning models in reinforcement learning:

- Markov Decision Process
- Q learning

Q learning is a value-based method of supplying information to inform which action an agent should take.

Grid World

Grid World, a two-dimensional plane , is one of the easiest and simplest environments to test reinforcement learning algorithm.
In this environment, agents can only move up, down, left, right in the grid, and there are traps in some tiles.The agent starts at the fixed start position and when it arrives at the goal or trap, episode ends.

Path Finding

Path Finding is a technique used in Q learning to find the shortest path between two points in. It ensures that planning is done in less time and in optimized way to finish the task.

The program

The program is written in Gridworld with 11x11 grid. Close to real world scenario, underground there might be some hard rock and soft rock that are hard for a driller to penetrate. Considering this, the program has some hard and soft obstacles to imitate real-world. Start and end points are generated randomly, and reward is set to 10000. Once the driller reaches the end, it gets the reward and program closes. The program is trained 10000 times to find optimal path from point A to B. It updates the QTable every time it changes its position. Visualization is done using OpenCV library and simulated plot is created.

Components

1. 11x11 grid
2. Hard Obstacles marked as pink
3. Soft obstacles marked as purple
4. start and end points are generated random

The squares are identified by the coordinate (x,y) where x is the column and y is the row to which the square belongs. Each square can be empty or have an Obstacle or have an Object. The position of the Obstacles can be changed using config.

Algorithms

The program uses Q learning algorithm.

Output

Program gives an output generated by OpenCV library. The output is a window of the grid and simulation of the path taken.