Near-Optimal Sequential Correlation Sequences using Q-Learning and Shortest-Path Trees

Héctor Corzo-Pola

March 2023

The alignment in sequential well log correlations depends on the order in which the logs are correlated, since errors add up as we progress along correlation sequences. For large number of wells, it is computationally unfeasible to find the best correlation sequence with an exhaustive search. I present two methods that address this issue.

The first one is based on exploring only a subset of all the possible correlation sequences. It is based on using Q-Learning agents to find optimal correlation sequences and using dynamic time warping for shift estimation. I test three different implementations of Q-Learning agents on synthetic data and on well logs from the Teapot Dome dataset. The results favor using a sequence-state based agent with a reward mechanism based on measuring the flatness of the logs after alignment.

The second method treats the problem of finding optimal correlation sequences as a traveling salesman problem in which we minimize a distance function used as a proxy for the sequence flatness. It is based on following correlation sequences computed by Dijkstra's shortest path method and using local similarity scans for shift estimation. It starts by computing the shortest path from a source well to every other well in the field. Then, it uses local similarity scans to sequentially flatten the well-logs along the obtained paths. A test on the Teapot Dome dataset shows that this method can outperform simple sequential correlation without having to evaluate multiple correlation sequences.

Approved: ______________________________

Sergey Fomel, Ph.D.
Supervisor