Intelligent Data Mining for Wormhole Reservoir Characterization

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Objective:
- Apply Data Mining techniques on wormhole reservoir datasets to discover the correlation, dependency, association and other relationships among reservoir properties.
- Design a Knowledge Base and a Fuzzy Expert System to predicate (1) high probability area of wormholes, and (2) wormhole growth on the basis of production and geological data.

Introduction
- High permeability channels, known as wormholes, can enhance oil production and it is essential to identify its potential area and growth.
- Currently none of the existing models are able to precisely explain and describe wormholes due to the complex variation of geological conditions.
- Raw data, implicitly containing the wormhole pattern, have been accumulated over years. The challenge is often to marshal and interpret the wormhole pattern from the overwhelming amount of raw data.
- Data mining is the technique to discover hidden patterns from large amount of the datasets. We propose to discover and represent these patterns in a knowledge base and develop a fuzzy expert system to provide prediction and analysis for wormhole reservoir characterization.

Task 1 — Literature Review
- A complementary literature review and background research will be conducted on: (1) wormhole modeling in cold production, (2) applying artificial intelligence in petroleum engineering

Task 2 — Data Collection and Data Cleaning
- We will collect the following data for the target reservoir: (1)Well Logs, (2)PVT data, (3)Reservoir Properties data, (4)Production data, (5)3-D or 4-D time lapse Seismic Data.
- Data cleaning will detect and correct the missing values, noise and inconsistencies.

Task 3 — Data Mining
- Feature Inputs Selection: Apply Fuzzy Ranking to identify a subset of critical variables from all the wormhole datasets for characterizing the wormhole pattern.
- Association Rule Mining: Apply association rule mining on the feature wormhole datasets with the target to discover the relationship between the feature variables to the wormhole pattern. A typical form of association rule is like:
  - If porosity is (16%, 20%) And Pressure is (3.3 Mpa, 3.5Mpa) And ....
  - Then wormhole happens with the probability of 63%.
- Pattern Recognition by ANN: Build Artificial Neural Network (ANN) to simulate the complex pattern between the feature variables and wormhole formation.

Task 4 — Fuzzy Expert System Development
- Build a Fuzzy expert system for predicitng high probability area of wormhole. Fuzzy Expert System simulates the reasoning process of human being includes three subsystems: Fuzzification, Knowledge Base and Defuzzification.

References