

CUCKOO SEARCH ALGORITHM (CSA): BASED INVERSION FOR PETROPHYSICAL PROPERTY ESTIMATION OF WELL LOGS DATA

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A profound understanding of reservoir properties is essential for the optimal extraction of hydrocarbons, especially in both mature fields and new exploration areas. Traditional well-logging interpretation methods, which often rely on linear and sequential models, are adequate for homogeneous or previously studied reservoirs but can be inefficient in more complex subsurface environments. Advanced joint inversion techniques have demonstrated superior robustness in predicting petrophysical parameters by considering multiple datasets simultaneously. This study introduces the application of the Cuckoo Search Algorithm (CSA) to solve the well logging inverse problem. CSA, inspired by the breeding behavior of cuckoo birds, utilizes Lévy flights for its search strategy. This unique approach enables efficient exploration of the search space, allowing the algorithm to avoid local optima and achieve more accurate results compared to traditional optimization methods like Genetic Algorithms and Simulated Annealing. The algorithm was evaluated using both synthetic data models and actual borehole measurements. For synthetic models, including one-layer and four-layer configurations with added Gaussian noise, CSA accurately estimated petrophysical parameters such as porosity, volume of sand, and water saturation. The four-layer synthetic model results show a favorable fitting between calculated and actual data with stable convergence profiles, even when noise contamination was present. Field data from the Pannonian Basin in Hungary were also analyzed. The analysis revealed five distinct layers with varying shale content and porosity levels, accurately identifying hydrocarbon-bearing layers. The algorithm's ability to predict zone parameters, with the cementation exponent as an additional unknown, highlighted its robustness and adaptability. The CSA achieved an average relative data distance of 4.5%, demonstrating its efficacy in real-world applications. This study throws light on the potential of the Cuckoo Search Algorithm for enhancing the precision and efficiency of geophysical inversion processes. The findings suggest that CSA can significantly improve the accuracy of reservoir property estimation, offering a promising alternative to conventional well logging interpretation methods.