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AI for Efficient Geothermal Exploration and Utilization

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Abstract : Artificial intelligence (AI) is a powerful tool in the geothermal energy sector, aiding in both exploration and utilization. Identifying promising geothermal sites can be challenging due to limited surface indicators and the need for expensive drilling to confirm subsurface resources. Geothermal reservoirs can be located deep underground and exhibit complex geological structures, making traditional exploration methods time-consuming and imprecise. AI algorithms can analyze vast datasets of geological, geophysical, and remote sensing data, including satellite imagery, seismic surveys, geochemistry, geology, etc. Machine learning algorithms can identify subtle patterns and relationships within this data, potentially revealing hidden geothermal potential in areas previously overlooked. To address these challenges, a SIML (Science-Informed Machine Learning) technology has been developed. SIML methods are different from traditional ML techniques. In both cases, the ML models are trained to predict the spatial distribution of an output (e.g., pressure, temperature, heat flux) based on a series of inputs (e.g., permeability, porosity, etc.). The traditional ML (a) relies on deep and wide neural networks (NNs) based on simple algebraic mappings to represent complex processes. In contrast, the SIML neurons incorporate complex mappings (including constitutive relationships and physics/chemistry models). This results in ML models that have a physical meaning and satisfy physics laws and constraints. The prototype of the developed software, called GeoTGO, is accessible through the cloud. Our software prototype demonstrates how different data sources can be made available for processing, executed demonstrative SIML analyses, and presents the results in a table and graphic form.

Keywords : science-informed machine learning, artificial inteligence, exploration, utilization, hidden geothermal
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