03:30 pm

Session 5.04. - Poster Pitch

Room:
R10 Studio

Topic:
5.04. Applying Machine Learning and Big Data to Understand Complex Hydrogeologic Systems

Form of presentation:
Poster

Duration:
15 Minutes

106384: Applying LSTM Neural Network To Predict Water Levels in Injection Wells

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Proper operation of injection wells involves monitoring their performance over time. Specific capacity is a traditional method for monitoring the performance of injection wells in geothermal open-loop and standing column well systems. However, this method does not differentiate between the impact of temperature and clogging issues caused by suspended solids on injection well performance. This study proposes an alternative method that considers these factors to provide a more realistic representation of the injection well's performance. For this work, a long short-term memory (LSTM) neural network is developed to predict the water level in an injection well of an operating standing column well. The dataset required for training and hyperparameter optimization of the LSTM is constructed using a coupled multiphysics finite element numerical model. A total of 500 simulations were performed to investigate the water level response under various input temperatures, flow rates, and total suspended solids concentrations. The accuracy of the predictions was evaluated by comparing the predicted water level with an experimental dataset. The optimized neural network's predictions showed a small acceptable error. In the end, an efficient tool is developed for managing the maintenance of injection wells in geothermal systems.

106603: From lithological descriptions to geological models: a geostatistical learning approach

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Geological models form a crucial foundation for hydrogeological models, significantly influencing the spatial distribution of key hydraulic parameters such as permeability, transmissivity, and porosity. The conventional modeling workflow involves a hierarchical approach, simulating three levels: stratigraphical units, lithologies, and finally, properties. While lithological descriptions are often available in the data (boreholes), the same is not true for unit descriptions, leading to potential inconsistencies in the modeling process. This limitation not only hinders the delineation of unit boundaries but also under uses existing data, given that the information is present in an alternative form, lithological descriptions.
To address this challenge, a geostatistical learning approach is presented, which aims to predict stratigraphical units at boreholes where this information is absent, primarily leveraging lithological logs as inputs. Various standard machine learning algorithms have been compared and evaluated to identify the most effective one. The outputs of these algorithms are processed and utilized to simulate boreholes with consistent stratigraphy. Subsequently, these boreholes contribute to the construction of stochastic geological models, which are then compared to models generated without the inclusion of these supplementary boreholes.
This method proves instrumental in reducing uncertainty in specific locations and mitigating inconsistencies between units and lithologies. It not only enhances the accuracy of stratigraphical unit predictions but also maximizes the utilization of available data, contributing to more robust hydrogeological models.

109153: Sourcing of groundwater inflows into underground mining works based on statistical modelling and artificial neural networks – the "Čukaru Peki" Cu-Au mine case study

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Growing demand for raw materials is turning mining companies toward deeper ore bodies. Due to the increasing depth of mining operations, characterization of groundwater inrush is becoming more important for maintaining a mine safety and operation feasibility. A set of 179 baseline groundwater quality analyses covering 20 parameters (major ions and trace elements), sampled in the mine pre-production period, is used for developing predictive models for sourcing of groundwater inflows during the mine development. A Discriminant Analysis (DA) and supervised Artificial Neural Network (ANN) are used to predict the affiliation of groundwater samples to the three delineated principal hydrogeological units (andesite, "Bor" clastic and Miocene sediments). Data were transformed and standardized for the DA, while ANNs are trained with z-scored, 0-1 scaled, and raw data. A stepwise DA approach enabled delineation of seven predictors among groundwater physical-chemical parameters. For the ANNs, available analyses are divided into 153 training and 26 testing datasets. The ANNs are developed by acknowledging DA-derived seven predictor parameters, and with 15 or 20 input neurons or physical-chemical parameters. The nets architecture comprises one input layer with 7, 15, and 20 neurons, two hidden layers, and one output layer with three neurons referring to principal hydrogeological units. The cross-validation results revealed that 76.5% of groundwater samples were correctly classified by DA. With the ANN approach, 42-85 % of the training sample sets were correctly classified, depending on the input data configuration. Nets based on 7 and 20 input parameters with raw data gave the best results. The predictive ability of the models was further tested with the validation set composed of 11 mine water samples. In the studied case, the most successful in sourcing groundwater inflows were less complex ANN of seven parameters with raw data, followed by Discriminant Analysis approach.