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Using different intelligent methods in Orange software to estimate the deformation modulus of rock mass

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Abstract

The deformation modulus indicates the degree of deformability of the rock mass in response to any loading and unloading, and it is important because it plays a role in the design of most underground structures. Estimation of this parameter on site is usually done with the help of two tests of plate loading and dilatometer, which is associated with spending a lot of money and time. In addition, due to the presence of discontinuities and cracks in the rock mass, laboratory tests on core samples also face errors. Today, to define a relationship between a parameter and its dependent parameters and to build a model to estimate or predict the chosen parameter, a variety of computational intelligence methods are used, and of course, they also provide favorable results. The purpose of this research is to use these types of algorithms in order to create an efficient model for predicting the deformation modulus on a database. In this regard, the performance of three models created by artificial neural network, K-nearest neighbor and random forest methods have been evaluated with the Orange software. The results showed that the artificial neural network model has the best performance and accuracy with RMSE=0.116 and MAE=0.094. Also, the sensitivity analysis of the input parameters shows that the RMSE system is considered as an important and effective parameter.

Keywords: *Rock mass, deformation modulus, artificial neural network, sensitivity analysis, Orange software.*

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Extended Abstract:

1. Introduction

In order to estimate the value of the deformation modulus parameter, in-situ tests such as plate loading and dilatometer, laboratory tests and empirical relations can be used. Most of the time, implementing and conducting in-situ tests are time-consuming and costly, and providing the real conditions that prevailed on the sample in the field is not possible in the laboratory, or hypothetical and unrealistic results are extracted. For this reason, researchers throughout history have invented many empirical relationships based on classification indices, such as Q, RMR, GSI, RQD to calculate the modulus of deformation of isotropic rock mass. These types of relationships, due to the presence of complex structures in different data sets, have lost their accuracy and efficiency compared to modern artificial intelligence methods. Different methods of artificial intelligence in various fields solve prediction and estimation problems with optimal performance and very high accuracy. Many researches have been done in this direction.

2. Materials and methods

In the field of computational intelligence, all kinds of algorithms with different approaches have been developed every day. Here, three of them are used, i.e. artificial neural network, k-nearest neighbor and random forest methods. These methods are used for prediction in regression and classification problems. In this research, their help has been taken to solve the regression problem. In addition, orange data mining software is also used. This software has suitable capabilities for modeling, statistical analysis and data preprocessing and is very interactive and has high graphic capabilities. Modeling is done on a database including 60 samples with four input parameters of rock mass raiting system RMR, uniaxial compressive strength UCS, depth D and elasticity modulus Ei and output parameter of deformation modulus.

3. Results and discussion

In this research, with the help of Orange software, models were created by three computational intelligence methods: artificial neural network model, k-nearest neighbor and random forest, and they were verified to predict the deformation modulus. The created models generally have good results and can be used in predicting the deformation modulus instead of the methods of in-situ tests, laboratory tests and empirical relations. Validation and evaluation of the models showed that the artificial neural network model performed better with RMSE=0.116 and MAE=0.094, and the random forest model showed a weaker performance than the other two models. The sensitivity analysis of the input parameters with the help of RReliefF and Univariate Regression showed that the two parameters RMR and uniaxial compressive strength are more effective in the process of estimating the value of the deformation modulus and also the elasticity modulus is the least effective in this case.

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