Modellering av berg- och grundvattennivåer med artificiell intelligens

Stefan Larsson (KTH) projektledare och geotekniker
Jennifer Wänseth (Tyréns) projektledare och bergtekniker
Emma Zäll (Tyréns) projektledare och beräkningsingenjör
Abbas Abbaszadeh Shahri (Tyréns & Johan Lundberg AB) expert AI och geofysik
Chunling Shan (Tyréns) geofysiker och dataanalytiker
Olof Friberg (Tyréns) BIM/GIS-specialist
Lars Marklund (Tyréns) Tekn Dr Hydrologi
Fredrik Johansson (KTH) bergmekaniker

BeFo projekt 415

Summary

Delineating and mapping the bedrock and overlaid deposits due to complex spatial patterns, associated uncertainties and sparse data is a vital difficult task in geo-engineering applications. Modern computing techniques such as artificial intelligence-based models (AIM) are appropriate alternative to overcome the deficiencies of previous methods. The objective of this study is to investigate the feasibility of AIM in prediction of 3D spatial distribution of subsurface bedrock in a large area in Stockholm, Sweden. The predictive artificial intelligence models were developed using 1968 processed soil-rock soundings comprising the geographical coordinates and ground surface elevation. The optimum topology was captured through the examining of wide variety of internal characteristics. The results from AI model was compared with traditional geostatistical interpolation method such as Ordinary Kriging. The comparison shows that the results/predictions from AI model has higher prediction accuracy than Ordinary Kriging method.

From the obtained prediction model, we also predicted the bedrock surface for a test area where the true bedrock surface was scanned after the excavation of overlaying soil. With this dataset it is possible to compare the predicted surface with the true scanned surface and thus estimate the AI model performance. A monte carlo method for deep learning was tested to estimate the uncertainties for the predicted bedrock levels and the accuracy of how much true bedrock levels are laying between the uncertainty intervals was estimated. The result is promising a few more methods for uncertainty analysis will be tested later on and the same method for mapping bedrock surface will be applied to groundwater data to map the groundwater surface.

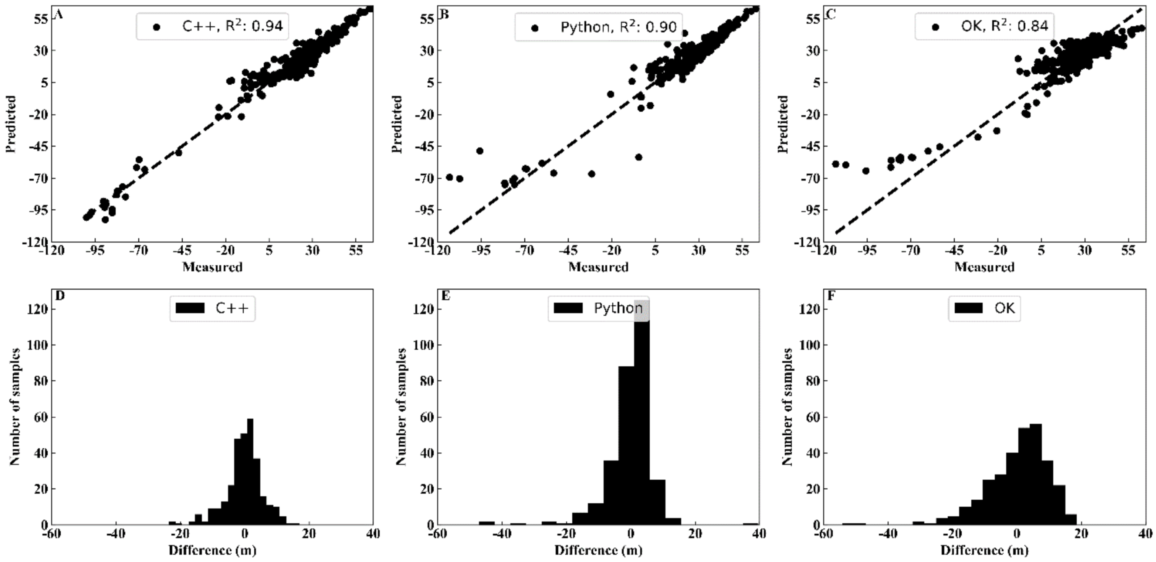

Figure 1. Comparing the differences of (A) predicted values using *C++* (B) *Python* and (C) *OK*. Residuals between measured and predicted data (D) *C++*, (E) *Python* and (F) OK.

Table 1. Results of statistical error criteria in evaluated model performance

Model	Performance criteria						Ranking of criteria							
	MAPE	***RMSE***	***IA***	***MAD***	R^2	***CR* domain**	***MAPE***	***RMSE***	***IA***	***MAD***	R^2	***CR***	**Total rank**	**Sort order**
C++	0.28	6.30	0.98	1.03	0.94	[-29,28]	3	3	3	3	3	3	18	1
Python	0.41	7.84	0.97	1.21	0.90	[-47,49]	2	2	2	2	2	1	11	2
OK	0.50	9.87	0.95	1.68	0.84	[-54,19]	1	1	1	1	1	2	7	3