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Interpretation of geospatial data using explainable machine learning methods

Abstract

Machine learning has undoubtedly become widespread in various scientific disciplines, including Earth and environmental sciences, revolutionizing the way of analyzing and interpreting geospatial data. These advances have enabled the development of complex black-box models for tasks such as land cover classification, flood risk zone prediction and route optimization. However, the expansion of these models has introduced new challenges related to the transparency of their operation and the interpretability of the results.

The presented dissertation examines the usefulness of explainable machine learning methods for interpreting geospatial data, answering the question of whether these methods can support the process of interpreting factors leading to a result. The objective of the thesis was achieved through three research experiments involving the application of:

1) regression analysis for estimating the surface temperature of lakes in Poland based on thermal satellite imagery and in-situ measurements of water temperature;
2) supervised classification for automatic mapping of geomorphological forms based on the Digital Geomorphological Map of Poland and geomorphometric variables;
3) unsupervised classification for determining and interpreting land surface types based on geomorphometric variables.

Based on the obtained results, the applied explainability methods were found to be useful for interpreting the operation of black-box models in the context of analyzing spatial data used for regression and classification. They allowed for a better understanding of the decisions made by the models and revealing the relationships between the explanatory variables and the model output. These methods indicated not only which features were significant, but more importantly, how they affected the prediction result. Consequently, the transparency of the modeling process has increased, which is crucial to further improving models and building confidence, and helps make more informed decisions.

Keywords: geospatial data, machine learning, explainability, black-box model