MACHINE LEARNING APPLICATIONS IN HUMAN LANDSCAPE PALAEOECOLOGY

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Sensible applications of predictive modelling can profoundly enlighten the nature of prehistoric settlement distributional rules. This is especially useful for cultural heritage management, prediction of new archaeological sites and research of human-environment systems. Yet, current studies in the field are mostly of local scale and lack time-depth perspective. Thus, the global context needed for the interpretations is often missing. In addition, the field is still in the search for “the optimal” computational approach. To tackle these problems, we performed a predictive settlement modelling study in south-east Baltic, Lithuania. This study was of regional scale and had time-series study design. The settlement data used was obtained from archaeological-site dataset PROLIGIS, while regional explanatory variables (21 in total) were derived by GIS from various sources (DEM, geological, hydrological map and etc.). We analysed the data using a set of machine learning and statistical methods with thorough testing procedures. Random forest, for instance, was used for variable importance estimation, PCA – for the reduction of number of variables, k-means clustering – for classification of regional environment, Generalized Additive Models – for model performance estimation and creation of predictive landscapes. The problematic nature of archaeological and spatial data was approached by using dummy variables (simulated as random fields on the basis of original variables) for null hypothesis tests, as well as by performing repeated stratified cross-validation and parallel analyses that treated only settlements with specific (period-confined) dating. Thus, this strategy allowed us to quantitatively formalize and track changes in prehistoric human regional settlement behaviour from times of Palaeolithic to Iron Ages.

The results revealed that regions of higher settlement probability at all times were generally confined within one regional landscape type, characterized by rougher landscape, denser hydrography and more diverse soils. They also revealed that changes in Lithuanian settlement regional niche are best described by two stability periods (Stone Age and Metal Age), separated by a marked shift at Neolithic-Bronze Age boundary. Regions of Stone Age settlements were defined by amount of water, distance to flint mines and to the sea, landscape roughness, ratio of sand to moraine loam area and LS-factor. Whereas, regions of Metal Age settlements were defined by amount of water, landscape roughness, distance to the sea, slope steepness and elevation above channel network. Small scale, gradual and period-specific variations were also observed within these period groups. We argue that the observed grand settlement reorganization event may be associated with immigration of steppe people to the Baltics, 4.2 ka. climatic event and spread of agricultural practices. Other results showed continuously increasing complexity of regional settlement strategies in terms of 1) predictive landscape surface roughening, 2) decreasing performance of predictive models, 3) increasing spatial randomness and regional environment diversity of settlement locations. The results of this study, therefore, provides the preliminary, but essential global context for further, more detailed studies in the area and serves for hypotheses generation.
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