Quantitative solutions for archaeological heritage management.

Experimenting and developing a new tool.

Project: Institute of Archaeological Science, University of Bern, Department of Earth Surface Dynamics, University of Lausanne
Advisors: Prof. Dr. Albert Hafner, Dr. Marj Tonini
PhD study: Maria Elena Castiello, MA

KEYWORDS: *PREDICTIVE MODELLING, ARCHAEOLOGY, MACHINE LEARNING*

Fig. 1 Predictive map projected with 3D buildings reconstruction of the city of Zurich. Green indicates low probability, red high probability.

Switzerland is still affected nowadays by the massive expansion of urban settlement areas and the still on-going development of transport infrastructures. These two phenomena occur mainly, but not exclusively, in agglomerations of urban centers. In these circumstances, the public authorities responsible for the management of archaeological heritage should be able to provide a balance between the inevitable growth of modern settlements and industrial areas and the protection and preservation of archaeological elements.

This interdisciplinary research project is an attempt to address this challenge. The archaeological risk assessment becomes of a crucial importance and prediction and modelling play a relevant role in this regard. For the heritage management services, predictive maps principally represent a tool that can help to asses where the highest probability to (re)-discover not yet unearthed archaeological evidences occurs. This process must take place before the start of any kind of working activities, allowing these services to target their investments more effectively. At the same time, it allows to assess the importance of external factors such as environmental and historical variables that may have influenced the position of archaeological sites.

The methodology applied mainly relies on GIS (Geographic Information System) and R (software for statistical processing), spatial statistics and Random Forest (RF), a machine learning algorithm based on decision trees.

Contextually, we provide a data-driven application for archaeological predictive modeling (APM). The study focuses on Swiss Cantons with diversified urban and rural landscapes where to develop our APM (Zurich, Aargau, Graubünden, Fribourg, Lausanne and Geneva). A dataset of observed archaeological sites in each canton, related to the Roman period, was considered and reclassified. The

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Link: www.iaw.unibe.ch

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model is created then with RF which is capable of learning from data and make predictions starting from the acquired knowledge through the modelling of the hidden relationships between a set of input (i.e. geo-environmental features prone to influence site locations) and output variables (i.e. the archeological sites).

As results, we will obtain: 1) a predictive map expressing the likelihood of archaeological site presence at different locations in the given landscape (Fig.1); 2) a ranking of geo-environmental features based on their goodness for the prediction of the archeological site occurrence.

While the in situ observation and the knowledge of the archaeologists provide a picture of past population dynamics, only more in-depth analyses, based on scientific methods, can offer the possibility of analyzing, with unknown spatial and temporal detail, the behavior of a population and the features of a specific simulated territory, as accurately as possible.

The outputs of this research, carried out in co-supervision with the department of Earth Surface Dynamics at University of Lausanne and the support of Swiss cantonal heritage departments, become important not only to verify the reliability of the data, but hence to produce a digital tool useful for the decision-making process related to urban planning. Solutions found in the selected cantons will serve as a general model and strengthen the implementation of a sustainable, preventive archeology in other regions, equally confronted with such problems.

Literature:

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