Creating Migration Networks based on Archaeological Data using Least-Cost-Path Analysis

Max Brockmann
brockmann@math.uni-koeln.de

Lena Perlberg
lperlber@smail.uni-koeln.de

Department of Mathematics and Computer Science, Division of Mathematics
University of Cologne

Abstract

We investigate how to identify possible migration routes of humans in the past, represented as networks. Human's presence spanned large parts of Europe in the time periods from the Upper Paleolithic to the Neolithic. We model major migratory events using migration corridors between a map of human presence sites derived from archaeological data. The question of creating migration networks arises is the context of the interdisciplinary research project HESCOR[1] at the University of Cologne.

We use data provided by archaeologists([KH],[M]). These datasets form the basis for human presence. Each archaeological site serves as a guaranteed marker of human presence and thus represents a node in the network. Additionally to the location of the sites, the data includes information on materials found. This provides valuable insights into cultural aspects, which are used in the creation of connections between the nodes.

We use the distance between nodes of the network as the primary factor of possible connectivity. In essence, we propose a model of connectivity in which the probability of connection increases as the distance between nodes decreases. Cultural information is incorporated by utilizing data on shared material presence from archaeological findings. If specific materials are only produced in one area, but are found throughout Europe, these must have been transported by humans. This indicates a higher probability of connection between two locations and is therefore included in the stochastic decision rule.

We base our distance calculation on the concept of effective distance. We argue that an effective distance approach best mimics migration corridors, as humans would have had to base their migration decisions on a relation of distance to effort required. To calculate the effective distance, we determine a least-cost path using Dijkstra's algorithm applied to an elevation raster using topographic data ([ETOPO]). We allow king's movement (as in chess) between raster cells and calculate the movement costs with a modified Tobler's hiking function from [KS], which maps slope to walking speed. This least-cost path is calculated for each pair of nodes. Subsequently, probability-based decision-making process is applied. After implementing all concepts, we can generate graphs that describe a network of possible human migration routes in the past.

We present current results of migration networks for different time periods and analyse the effects of including material data provided by archaeologists.

References

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[1] HESCOR: Human & Earth System Coupled Research, https://hescor.uni-koeln.de

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