New methodological approaches for cross-scale integration of environmental remotely sensed data with spatio-temporal movement data

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Abstract:

Geographic Information Science has been concerned mostly with the spatial representation of static phenomena. However, environmental and social processes have an implicit temporal dimension as well and its meaning for each spatial coordinate requires to be better understood (Hägerstrand 1970).

The space-time bond is the forefront of GIScience, highlighted recently by novel developments for movement related studies. Such developments have arisen due to the mismatch between the increase in data availability, provided by the advances in locational technologies (Demšar et al. 2015), and the ongoing challenges of analysing and visualising space and time simultaneously.

The current literature on movement research has focused on two main applications: 1) wildlife movement ecology and 2) human mobility. In each of these fields, scientists aim to develop methods capable of extracting meaningful information from movement data in order to integrate movement trajectories with related environmental data to better understand the contextual factors influencing observed movement (Gschwend & Laube 2014). Context-aware movement analysis will enable inference on how the moving object is interacting with its surroundings (Demšar et al. 2015), a crucial connection, since movement behaviour is inherently linked to the state of environment in which it occurs.

In order to integrate context into movement research, new spatial analysis and visualisation techniques are required. Such methods will support the integration of large trajectories datasets with environmental data from other sources such as remotely sensed imagery and meteorological data. The context-aware movement analysis will enable a deeper understanding of movement related questions that are currently unresolved due to the absence of adequate tools to analyse space, time and contextual attributes simultaneously.

In this project, we are exploring data on human movement generated as part of the GEOCROWD project (Sila-Nowicka et al., 2014). These data consist of the personal movement trajectories of 91 volunteers from the town of Dunfermline, in the Kingdom of Fife, UK. We use the Met Office Rain Radar Data from the NIMROD system for United Kingdom and meteorological station data (temperature, wind speed and humidity) for Braemar, Eskdalemuir, Leuchars and Glasgow to provide contextual information on environmental conditions.

As the first step to contextualise these trajectories, the meteorological data are interpolated using the Thiessen polygons and the Thermal Sensation Index is calculated. Second, a cellular arrangement in space and time will be developed to enable integration of data sources with varied spatial and temporal resolutions. Following data integration, cluster analysis is applied to the contextualized trajectory data in order to identify relationships between weather and human movement patterns.

Subsequently, space-time prisms (Miller 1991) are calculated, using a moving window in time, to quantify all the movement possibilities between a known start and end point, i.e., the so-called area of movement capability; this will allow us to verify how weather constrains human movement capability. In addition, the moving window will allow us to verify how granularity affects the correspondence between real trajectories and space time prisms.

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