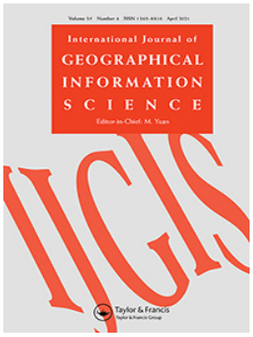

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# Multiple-aspect analysis of semantic trajectories(MASTER)

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EDITORIAL



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## 1. Preface

A plethora of applications and devices reporting their locations generate massive amounts of spatiotemporal data along with other useful information. These data can form trajectories with sequences of time-stamped locations; an arguably powerful representation model for unveiling patterns of life, of humans, objects or animals. The literature on the analysis of trajectories has recently taken a new twist, with the advent of big data that puts standard practices to the test. A subsequent concept of 'big trajectories' would refer not only to high volumes and rates but also to enriched sets of trajectory data, when mixed with potentially independent data sources of additional values. The result of this blend can lead to more comprehensive and semantically significant objects than trajectories of time-stamped locations. Such enriched sets of trajectories, referred to as 'semantic trajectories', combine multiple semantic aspects with the pure spatio-temporal facets (Dos Santos Mello *et al*. 2019) and promise novel solutions to inform policy making to application domains from transportation, security, health, tourism and environment. Big semantic trajectories, nevertheless, pose new challenges for the Geographical Information Science, database, machine learning and Artificial Intelligence communities to tackle, revolving around the complete semantic trajectory analysis lifecycle: fusion, modeling, storage, analysis.

After a previous survey in 2013 (Parent *et al*. 2013) and a following special issue in 2015 on semantic trajectories by Damiani and Renso (2015), research on the semantic trajectories flourished and new challenges and applications emerged. This Special Issue took origin from the community of the workshop MASTER2019 (Tserpes *et al*. 2020) that was held in conjunction with ECML/PKDD in 2019. The event emphasized the importance of this theme reaching out to broader communities and further fostering advances in this research area.

This special section reports three main advances of the state of the art: (1) searching semantically enriched trajectories; (2) anomaly detection in marine traffic and (3) extracting evolving clusters from trajectories graphs.

The problem of searching semantically enriched trajectories is addressed in Stop- and-move sequence expressions over semantic trajectories by Iraklis Varlamis, Yenier Torres Izquierdo, Garcıa Grettel Monteagudo, Marco Antonio Casanova, Luiz Andrè Paes Leme, Christos Sardianos, Konstantinos Tserpes, Livia Ruback. The idea of this paper is to propose a formal framework to use stop-and-move sequence expression as a query language for semantic trajectories. A concrete semantic trajectory model is proposed using the RDF (Resource Data Framework) formalism combined with SPARQL queries. A proof-of- concept experiment over a semantic trajectory dataset is constructed with user-generated content from Flickr combined with Wikipedia data showing the usefulness of the approach.

The issue of finding anomalies on vessels trajectories is addressed by paper A distributed framework for extracting maritime traffic patterns by Ioannis Kontopoulos, Iraklis Varlamis and Konstantinos Tserpes. This work focuses on the analysis of maritime trajectories to

detect anomalies like, for example, unexpected sailing behavior. Here, authors extend the DB-Scan clustering algorithm to extract shipping lanes. This is done by employing sparse historic trajectories captured by vessels equipped with Automatic Identification System (AIS). A peculiarity of this approach is that it implements distributed processing on Apache Spark in order to improve processing speed and scalability and is evaluated using real-world AIS data collected from terrestrial AIS receivers. The evaluation shows that the biggest part (i.e. more than 90%) of any future vessel trajectory falls within the extracted shipping lanes.

Advances on how to find evolving clusters from set of trajectories are addressed in paper Online discovery of co-movement patterns in mobility data by Andreas Tritsarolis, George-Stylianos Theodoropoulos and Yannis Theodoridis. This work proposes a new algorithm called *EvolvingClusters*, for identifying co-movement trajectory patterns trajectories based on graphs. This algorithm discovers different collective movement behaviours like flocks and convoys in a unified way thanks to an enriched graph representation of the movement. EvolvingCluster is evaluated using real-world and synthetic data-sets from multiple mobility domains demonstrating the effectiveness to profile semantically rich movement behaviour.

## 2. Towards mobility data science and mobility data ethics

With the increasing penetration of smart devices in daily life, the potential to produce extremely rich movement data is a foreseen scenario. The richer and complex the semantics is, the more challenging the representation and analysis task of such extremely rich datasets becomes. This calls for innovative methods that should consider in a holistic way all these semantic aspects of the movement data, considered as a whole. We are nowadays witnessing an increasing contamination of Artificial Intelligence methods for trajectory and mobility data and this goes exactly in the direction of being able to represent and analyse extremely complex data. The direction how to exploit the advances in Machine Learning and Artificial Intelligence methods for semantically rich movement data is a current and forthcoming line of research.

We hope this special section will stimulate new research ideas for a Mobility Data Science.

For the future, we see an increasing interest on the use of mobility data. The advent of the pandemic has created a new frame for movement data and a new perception on the collection and use of the mobility of people for good. This new perspective comes with the increasing needs for privacy, transparency, reliability and, more in general, for an ethics use of mobility data towards a Mobility Data Ethics.

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