Chapter 20
Towards the Integration of Trajectory Information Sources for Semantic Conflicts Detection Purpose:
A Trajectory Ontology Based Approach

Marwa Manaa
ISG, Université de Tunis, Tunisia

Akaichi Jalel
ISG, Université de Tunis, Tunisia

ABSTRACT

The advance of remote sensors and positioning technologies is leading to the eruption of disparate mobility data. For a long while, location sensing devices became released. As a result, different structures of mobility data sources may reveal the details of instantaneous behaviors performed by mobile entities. Collected mobility information forms the need of behavior modeling to understanding behaviors from cognitive and analytics perspectives. Each designer may use a different formalism and representation by using either "conceptual modeling" or "ontology". The phenomenon of adopting ontologies by organizations creates a new type of data called semantic data handled by semantic databases. The diversity of these formalisms highly increases the structural and semantic heterogeneities and consequently increases the complexity of integration tasks. In this chapter, authors propose a semantic and scalable approach that unifies formalisms and representations by the means of ontologies. This approach is supported by a case study.

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INTRODUCTION

The fast-paced advance of remote sensors and positioning technologies is leading to the eruption of disparate mobility data. Trajectory information may reveal the details of instantaneous behaviors performed by mobile entities associated to various applications including military (Perry, 2008), biology (Wannous et al., 2013; Sakouhi et al., 2014), bird migration (Spaccapietra et al., 2008), traffic management (Yan et al., 2014), health care (Akaichi & Manaa, 2014), etc. Collected mobility data forms the need of behavior modeling to understanding entities behaviors and activities from cognitive and analytics perspectives.

In the first generation of applications supporting trajectory information, mobility data collection concerns mainly a single location sensing device. Due to the existence of a single device, the identification of conflict trajectory information is an easy step which is realized quickly. For a long while, location sensing devices started to be released. As a result, designers may use different modeling techniques for trajectory information sources design i.e., "conceptual modeling" or "ontology" for the design of trajectory information sources. Classical conceptual modeling techniques present a conceptualization of a universe of discourse through a set of classes defined by properties. Conceptual modeling is based on spatio-temporal and moving object database structures. Besides, ontologies cover a universe of discourse through a set of concepts and properties. The phenomenon of adopting ontologies by organizations creates a new type of data called semantic data. Recent advances in DBMS technology handle ontologies and semantic data in *semantic databases.* Alongside, due to the autonomy of designers, various trajectory representations can be defined. A very popular, although old, representation has been investigated by the geographic information science community called "*Geospatial Lifeline*", mainly based on periods of time during which entity occupies space (Thériault et al., 2002). Instead, the database community has stored and manipulated these data in Spatio-Temporal Databases (STDB) and Moving Object Databases (MOD) by the definition of "*spatio-temporal data types*" inter alia, *moving point, moving line* and *moving region data types* (Güting & Schneider, 2005; Xu & Güting, 2013). Until recently, ontology-building and logics attracted researches aimed at supporting trajectory based applications with new models bearing further semantic information about moving object behavior and/or activity (Yan et al., 2008; Yan & Chakraborty, 2014 ; Wannous et al., 2013). In this case, to identify conflicting trajectories, designers seem to find the "*best*" and "*consensual*" knowledge, according to the experts needs in the field through sharing a point of view. Consequently, the semantics of each used concept became unambiguous.

In the meantime, note that the nature of trajectory sources has been evolved, where new formalisms were launched: *semi-formal sources* including *conceptual formalisms* like STUML STER (Tryfona et al., 2003), PERCEPTORY (Brodeur et al., 2000) MADS (Spaccapietra et al., 2008) and *formal sources* including *ontological formalisms* like RDF (Wannous et al., 2013), DAML (Horrocks, 2002), PLIB (Pierra, 2008), OWL (Tryfona & Pfoser, 2001; Baglioni et al., 2008). In addition to the structural heterogeneity, semantic heterogeneity involves different representations of trajectories like *raw, structured, semantic, region of interest*, and *space–time path*. The diversity of these formalisms and representations highly increases the structural and semantic heterogeneities and consequently increases the complexity of integration tasks. Therefore, structural and semantic heterogeneities generate several scenarios relevant to trajectories conceptual phase: "N-representations- 1-formalism", "1-representation- M-formalisms", "N-representation- M-formalisms", where N and M represent respectively the number of used representations and formalisms.

Modeling mobility data involves the consideration of structural and semantic heterogeneities. Consequently, the design methodology might evolve and should be generic. To do so, the conceptual model