Discovering Spatio-temporal Nature of Phenomena from Linked Open Data Generated from SDI Spatial Resources, Using Formal Ontologies

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Abstract

Real world still remains in the permanent process of change. This causes, that each attempt of description of reality should reflex its dynamic nature. Even today, when information about reality is provided by computer systems (in the area of geographical sciences by GIS and SDI), description and interpretation of changes and time-related issues are difficult. Most data sets give us information only about states in chosen moments, so called “snapshots”.

Semantic data generated from Spatial Data Infrastructure (SDI) resources in form of Linked Open Data (LOD), can involve temporal information too. This could be done by using: annotated RDF (aRDF), temporal RDF graphs or named graphs. It is possible to involve temporal information directly in RDF structure, using appropriate vocabulary. But semantic data in most cases have a “snapshot” form too.

The Semantic foundation of LOD opens a possibility to enrich the stored information by referring it to more complex spatio-temporal structures, defining the nature of objects, describing their persistence or lability. This is done by making a distinction between persistent objects (endurants) and objects “happening” in time (perdurants, e.g. events and processes). It helps us to discover the nature of changes, which is not given by the LOD in an explicit way. Such role is played by formal ontologies like DOLCE, BFO or GFO. These ontologies give us ready to use structures describing the general nature and behavior of objects in spatio-temporal context.

The aim of this work is to present, how to use formal ontologies for discovering changes affecting particular objects and relationships between them. How to interpret recognized changes as events or how to gather them in coherent processes. A very important problem is to find cause-effect relations, including answers to the question of how processes affect the state of persistent objects.

Formal ontologies are used here as framework to build ontology formulating crucial spatio-temporal structures describing the behavior of entities. This ontology is mapped to a vocabulary describing the spatial LOD resources. Merging these resources in a common knowledge base enables the use of reasoning engines to infer new facts about objects provided by the LOD data: type of entities (persistent objects, events, processes), nature of such objects (dissective or cumulative objects) or pedigree (genidentity).

Presented example shows an application of such approach in spatial planning domain. The subject of analysis involve cadastral data, land cover as well data describing spatial development plans (zoning plans). Data in time series represent changes of cadastral division, state of land use and land cover, building distribution and planned land use, in each moment in history. Spatio-temporal structures deriving from formal ontologies help to find correlations between land use designation in zoning plan and actual development. Subsequently these development parameters affect population density. Such analysis could be used for finding patterns in processes of development change and its impact on pace of shaping of other spatial factors, necessary for future state forecasting.

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