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Representation of Real-World Complexities: a paradigm shift

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Abstract:

Depiction of real world within Geo Information Systems presumes the world as some successive and static snapshots rather than a very dynamic system which is populated by various open-ended phenomena. Due to limitations inherited to traditional GIS, it is of utmost importance to develop a novel Spatio-Temporal Information System which is capable of collection and representation of historical states of the globe along with its dynamic aspects. In this study, the concept of "mapping" goes beyond the principle of mapping objects with distinct spatial, temporal and attributive identities as usual in object-oriented systems. The main goal of this work is to present a conceptual model for managing geo-knowledge. This effort handles real world dynamisms through representation of relationships amongst various objects with each other, objects with events, events with other events and their involving processes. It indeed uses an event centric system thinking approach which considers events as an information container of dynamic geo-historical phenomena to implicitly represent causal relationships in a Spatio-Temporal Information System. From this new perspective, objects in space and time are considered merely as information elements of events which are connected to other event elements through internal or external processes. The event here is defined and categorized as any kind of changes which apply on spatial and/or none-spatial characteristics of object(s); the happening which are bound to a location at a certain point of time or during a specific period of time

Historically, there are two distinguishable views on the objects and their relationships with their changes. The conventional object-oriented view, which is clearly reflected in ontologies that have been dominantly developed by western thoughts at the very least since the Aristotle time. In this object-change view, objects have a unique identifier which sustains and changes may happen to their both spatial and non-spatial features over time. The object-oriented view has been historically and intuitively practiced and has kept practicing since our ancestors developed their spatial awareness and started mapping their surroundings for the sake of survival very long time ago. In continuation to our ancestors, we still in the twenty first century map spatial features/objects around ourselves within our defined political boarders and make endless efforts to maintain them valid as long as possible. Indeed, we are typically attracted to consider the globe as some entirety of things. Explaining the world with objects and things is very normal for us, since our language and our technical tools are extremely object-oriented (Galton, 2005).

The second view which is called the process-oriented view, has consistently appeared in the history of philosophy; as far back as Heraclitus but also more recently by philosophers such as Bergson, James, and Whitehead (Galton and Mizoguchi, 2009; Rescher, 2008). In the object-centered view, matter and objects are considered prior to processes and events. The 'object-priority' view claims that essentially matter and objects are all that exists in the world. In another word, the existence of events and processes is entirely due to the distribution of matter and objects in time and space. In contradiction, the 'process-priority' view prioritizes processes and events to matter and objects. This view is also normally presented as an ontological claim that only processes and events exist in the world and objects and matter are constructed or emergent from other processes and events. It is important to note that, the properties of objects have to be interpreted with regard to space whereas properties of events should be interpreted with respect to time. By doing so, we can distinguish objects on one hand as 'spatial' entities with events on the other hand as 'temporal' entities (Galton and Mizoguchi, 2009).

Spatiotemporal ontologies have been studied by many scientists. However, there is a gap in considering event explicitly as an entity in geographic information systems. Most of the researches in this area were mainly focused on modeling events and the nature of relationships amongst them. Hence, temporal dimension was just added as an attribute for “spatial object” or as an integral part for a new entity which was called “spatiotemporal objects”.

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In addition, in such developments, semantic information has not been much taken into consideration. In order to bridge the gap and realize an Spatio-temporal Information System fully capable of focusing on an event-oriented perspective (Worboys, 2005; Worboys, and Hornsby, 2004; Peuquet, 1994; Peuquet and Duan, 1995). In this novel system, the events are happing, processes are running and the state are changing.

As already stated, in this study the concept of "mapping" goes beyond the principle of mapping an object as a conceptual geographic entity. Indeed, the change is the main concept that is modelled here and change units are the primary items for analysis and evaluation. In this approach, the spatial dimension is dominated by the temporal dimension, as the sequence of events in time is essential to be recorded. Hence, the primary units of analysis, and their dimensionalities in nature are essentially different, new methods are required to handle such relationships amongst spatial and temporal dimensions (objects and events). In this approach, the essential components for mapping dynamic phenomena are events as an identity container of objects, states and processes. A truly event-oriented approach enables us to move from simple snapshot queries to a much richer language which entails interaction of objects with events, event with other event and underlying process in relationship with events and objects. Therefore, the proposed mapping perspective here sees the world as a network of relationships and connections.

This new perspective integrates two aforementioned mapping principles; an event centric approaches that look at the phenomena wholistically while in its turn inherited the object-oriented perspective for mapping the object in reductionist way. In this new integrated model, objects belong to states while processes are running on them and making changes in their states (spatial and none-spatial) through the power of events as causal forces. In fact, the states and processes together create a new concept so called ‘dynamic snapshot’ at each moment. The snapshots contain both processes and objects, therefore they are no longer static but have an inherent dynamism which provides a solid foundation for understanding events which are happing over time.

We live in a world that more than ever before in the history of humankind, we realize our connections to each other as well as our vulnerabilities to all kinds of connections. Indeed, our lives is affected by myriads of various events, process and changes happening all over the globe. We also as a human race recognize that more than ever before for an efficient planning and managing of such complex interconnected world, understanding relationships among its different components and its reactive behavior is a vital. This study aims to mark to the point that analyzing these complex relations demands a spatio-temporal event-based model in which event plays a central role. The events are perhaps the most extensive information container for dynamic geo-historical phenomena. But we never can see them while they are happening, they are not tangible things like the objects around us. We always can identify them through the changes they are causing in our surroundings. Therefore, in order to explain any event well enough at any scale, we should take into account its causes and effects, its individual participants in roles, its place in space and time and its relationships to various other events. Indeed, representing enough large number of events along with all these dimensionalities enable us to analyze and discover underlying social natural historical processes of the globe and finally move towards realization of “spatial intelligent” where the acknowledgment of relationships between locational data is inevitable.

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