Representation and Handling of Event Based on Geographic Object Set

† Masakazu IKEZAKI, † Toyohide WATANABE and ‡ Taketoshi USHIAMA

† Department of Systems and Social Informatics, Graduate School of Information Science, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, 464-8603, Japan
‡ Faculty of Design, Kyushu University, 9-1 Shiobaru 4-chome, Minami-ku, Fukuoka, 815-0032, Japan

ABSTRACT

Recently, a lot of researches on geographic information models for event handling are proposed. However, these models are application oriented model. Namely, they are not suitable for handling broad spreading geographic information. In this paper, we propose a new data model for geographic information system. In our model, event information and geographic information are represented independently, and they are associated dynamically according to the viewpoint of users for an event.

1. INTRODUCTION

Recently, Geographic Information Systems (GISs) are used in various fields such as city administration, economics, etc., and take important roles as the fundamental infrastructures. In traditional systems, only representing and managing the version history of geographic objects or geographic fields' attributes are focused on. However, information of circumstances or situations behind these geographic changes, which have not been represented in traditional GIS, are so important in variety of GIS applications such as geographic analyses, spatio-temporal data mining and so on. In this paper, we address representation of such circumstances or situations which are called as events.

There are some researches on representation of situations in which geographic information changes. One of them is introduced here. In [1], Yuan et al. analyzed physical phenomena such as storms. In their research, events are treated as aggregations of some related geographic processes, and have the starting time and ending time. A geographic process is represented by sequential data measured from the real world. However, in Yuans' model, an event was inflexible representation, since the translation from geographic processes into an event needed the knowledge of specialist. Therefore, Yuans' model can be said that it is static representation.

In this paper, we propose a new framework representing various aspects of an event. This paper is organized as follows. In Section 2, we show a brief framework and in Section 3, provide a formal definition of our model. Finally, in Section 4 we state the conclusion of this paper and the future work.

2. REPRESENTATION OF EVENT

We discuss a representation model of events in order to extract event features dynamically according to viewpoints of GIS users. The event feature is regarded as one aspect of the event, and the event has various aspects. The focusing geographic change in an event is different according to the viewpoints of users. For example of a typhoon event, some people focuses on the amounts of rainfall in the typhoon, while another people focuses on the damages by the typhoon. In our model, these various aspects of an event must be represented and handled.

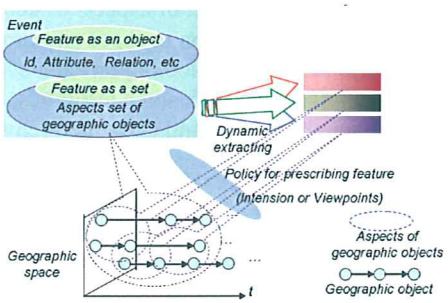

Figure 1 Conceptual Structure of our model

In this paper, the geographic space is defined as a set of geographic objects such as buildings, rivers, etc. A geographic object has the lifespan and changes over time. An event represents a situation in space and time. Therefore, we treat an event as a set of geographic objects whose positions are included in the occurrence regions of the event, based on the definition of the space. In our representation, geographic object involved in an event is managed as an "aspect" of the geographic object. In other words, an aspect of a geographic object indicates a condition of the geographic object when it is involved in the event. The event features are aggregated from corresponding aspects set directly. By using our representation of an event, it is possible to provide users with event features reflecting the viewpoint for an event dynamically (Figure 1).

3. FORMAL DESCRIPTION

3.1 DATA MODEL

Geographic Object A geographic object is an object with the shape and the lifespan such as a building, a road, and so on. Properties of a geographic object can change during the lifespan. The values of the properties are managed with the valid time. A geographic object o is described as follows.

$$o=(id_o, t_s, t_e, ATTR)$$

$$ATTR=\{AT_1, \ldots, AT_n\}$$

$$AT_i=\{(val_0, t_0, t_1), \ldots, (val_{n-1}, t_{n-1}, t_n)\}, t_0=t_s \wedge t_n=t_e$$

Here, id_o is the identifier of o. t_s and t_e represent the onset time and the termination time, respectively. $ATTR$ is the attribute value set. Each AT_i is an attribute values with the valid time.

Aspect of Geographic Object We introduce an aspect that is a part of a geographic object. It indicates a condition of a geographic object in one time interval during which the geographic object is involved in the event. In other words, it provides a view for the geographic object. Assumed that a time interval is (t_{st}, t_{et}), an aspect a_s of $o=(id_o, t_s, t_e, ATTR)$ is represented as follows.

$$a_s=(id_{as}, id_o, t_{st}, t_{et}, ATTR_{as}), t_s<t_{st} \wedge t_{et}<t_e$$

id_{as} is the identifier of a_s. t_{st} and t_{et} represent a focusing time interval in the lifespan of o. a_s can exist in the lifespan of o. $ATTR_{as}$ is inherited attributes from o, and it can be referred during the focusing time interval (t_{st}, t_{et}).

Event An event consists of a set of aspects of geographic objects and represents a situation in space and time. In addition, it is also important to look upon each event as an object [2]. Namely, an event has some attributes, its lifespan, relationships to another event, and class hierarchy. An event ev is represented as follows.

$$ev=(id_{ev}, AS, attr_{ev}, t_s, t_e)$$

Here, id_{ev} is the identifier of ev. $attr_{ev}$ is the invariable attribute values of ev during the lifespan. AS is an aspects set of geographic objects involved in ev. t_s and t_e is the onset time and the termination time of ev.

3.2 DATA HANDLING

In our model, the data handling for an event is performed by specifying behaviors of aspects. The behavior of an aspect is defined as state transitions of the aspect. For example, if the $strength$ attribute of some buildings change from $normal$ to $destructed$, then these buildings have same destructing behavior. By specifying such geographic objects' behaviors, extraction of focusing geographic changes in an event from participant geographic object set represented aspect set can be performed. The patterns of behavior can be described as follows.

$$bpt=(classname, state+)$$

$$state=(atname, cond)$$

Here, $classname$ is a name of geographic object class, and $state$ represents the state of a geographic object. The signature "+" means temporal iteration more than once. $state$ is represented as a tuple of an attribute name $atname$ and its condition $cond$. For example of destruction of buildings, assumed that the class name of buldings is $Build$ and the attribute name representing strength of buldings is $strength$, the behavioral pattern bpt_1 is described as $bpt_1=(Build, <st_1, st_2>)$, $st_1=(strength, 6<val<10)$, $st_2=(strength, 1<val<5)$. Here, notation "<",">" represents ordered list on the time axis and val represents value of attribute $strength$. In this example, we treat the changes from a state that strength value is in 6 to 10 to a state that strength value is in 1 to 5 as "destructing" behavior.

A function $extract$ for extracting a focusing aspects set expected by users is introduced.

$$extract: Event, BehavioralPattern \rightarrow \{Aspect\}$$

$$extract(ev, bpt)=\{as \mid obj \text{ behaves like } bpt \text{ in } ev\}$$

The calculation of an event feature can be performed by applying statistical operation such as $COUNT$, $AVERAGE$, MAX, etc. to the extracted aspects set.

For example, the retrieval of the earthquake events in which more than 100 buildings destructed is described in select-from-where style as follows.

$$select\ ev\ from\ Earthquakes$$

$$where\ COUNT(extract(ev, bpt_1)) > 100$$

Here, $Earthquakes$ represents the set of earthquake events.

5. CONCLUSION

In this paper, we proposed a representation model of events in order to represent event features dynamically. In our model, an event is represented as both a set and an object. As a set, an event is represented as an aspect set of involving geographic objects. The event feature reflecting users' intension is extracted from this aspect set directly by using statistical operations. In the future work, we must consider spatio-temporal relations between events topologically for more flexible retrieval. Moreover, we have to develop a data structure for efficient management of events and its elements. The visualization method for multiple events is also needed.

6. REFERENCE

[1] Yuan, M., "Representing Complex Geographic Phenomena in GIS", Cartography and Geographic Information Science **28** pp. 83–96, 2001.

[2] Ikezaki, M., Mukai, N., Watanabe, T.and Ushiama, T. "Event-Based Specification for Controlling Spatio-temporal Changes of Geographic Situation", In: International Special Workshop on Databases for Next Generation Researchers, Japan, 1249, 2005.