

Some Considerations to Improve the General Feature Model and General Portrayal Model in Gittok

Morishige Ota

Kokusai Kogyo Co., Ltd., morishige_ota@kk-grp.jp

Abstract: The general feature model (GFM) and the general portrayal model (GPM) are defined in the geospatial information technology learning assistance tool called gittok. This paper introduces five proposals to integrate different types of features and associations in the GFM and GPM: 1) the extensional-schematization procedure enables to formulate application schemata by specifying its extension, that is, every object that falls under the screening guideline; 2) nongeographic feature type may be included in the application schema; 3) feature association type can be geographic or nongeographic in a similar way as feature type; 4) nongeographic features and/or associations can be represented as a one-dimensional map or list; 5) representation by the copy of the portrayal declaration associating with a super feature type to avoid duplication should be possible. These proposals will expand the discipline of geospatial information technology (GIT).

Keywords: geospatial schematization, geographic information standard, geospatial information technology

1. Introduction

According to the geographic information standards provided by ISO/TC 211, we should create an application schema before acquisition and interchange of geospatial objects and/or development of geospatial applications. Already application schemata and data product specifications from many different application domains have been provided for spatial data infrastructures and geospatial applications (EU, 2007; Murakami, 2008; Gröger *et al.*, 2012; Ishimaru, 2014).

To create useful schemata, we should understand the rules for application schema and portrayal schema, and we should consider how to improve them to reply wider requirements. For example, when predicting the future of a city, we should design an application schema including nongeographic objects such as demographics and industrial statistics as well as geographic features such as land and urban facilities. Usually, most of these data are updated independently in different time intervals. Therefore, some nongeographic feature should not be attributes of geographic features and should be maintained independently from other features. However, they should be included in one application schema as long as they are associated with each other. Internet searches yielded few discussions and proposals on metamodels for the integrated schemata involving nongeographic features and their representation.

In this paper, we will consider five issues shown below for the improvements of the general feature model (GFM) and the general portrayal model (GPM) to integrate different types of features and associations.

- Extensional-schematization procedure

- Nongeographic feature type
- Feature association as a real-world phenomenon
- Representation of features and associations
- Representation through super feature type

The GFM includes rules for formal definitions of feature types and association types, and their properties such as attributes and operations (ISO/TC 211, 2005). The GPM is a metamodel that enables instantiations of portrayal schemata as rules for the representation of map faces (Ota, 2017b). In other words, the GFM is a metamodel of the deep structure (a model for geospatial objects) and GPM is a metamodel of the surface structure (a model for geospatial representation), as originally proposed by Moellering and Nyerges (Moellering, 1980; Nyerges, 1991).

2. Extensional-schematization

2.1 Broad agreement on feature definition

Geographic feature types should be defined clearly. For example, “building” is defined as “a structure with a roof and walls, such as a house or factory” (Oxford English Dictionary). However,

“The British Ordnance Survey once defined a mountain as having 1,000 feet of elevation and less was a hill, but the distinction was abandoned sometime in the 1920's. There was even a movie with this as its theme in the late 1990's - The Englishman That Went Up a Hill and Down a Mountain. The U.S. Board on Geographic Names once stated that the difference between a hill and a mountain in the U.S. was 1,000 feet of local relief, but even this was abandoned in the early 1970's. Broad agreement on such questions is essentially impossible, which is why there are no official feature classification standards.”

[<https://www.usgs.gov/faqs/what-difference-between-mountain-hill-and-peak-lake-and-pond-or-river-and-creek> (accessed 2018-11-27)]

In Japan, there is an imaginary mountain appearing on a map provided by the Geospatial Information Authority of Japan (GSI). It is Hiyori-yama (Mt. Hiyori) at Sendai City in the north-east part of Japan. According to Wikipedia [[https://ja.wikipedia.org/wiki/日和山_\(仙台市\)](https://ja.wikipedia.org/wiki/日和山_(仙台市)) (accessed December 2018)], this mountain (original height, 6m) was constructed for weather observation by fishermen approximately 1909 and was destroyed by the tsunami caused by the Great East Japan Earthquake in 2011. However, in 2014 the GSI certified the existence of the Mt. Hiyori, with a height of 3m above the sea level, as the lowest mountain in Japan today. This mountain exists in the real world as an imaginary object until and unless it is reconstructed.

These examples express the difficulty of finding broad agreement on feature type definitions by intentional schematization, which we define as conceptual modelling by directing the mind towards an object. However, agreement may be possible if the number of the decisionmakers involved in the schematization is relatively small. In fact, many of domain-specific schemata are designed and maintained by the intentional-schematization method today.

2.2 Extensional-schematization procedure

We may define geographic feature type by the extensional-schematization procedure (Figure 2). An extensional schematization means that we formulate the feature types included in the schema by specifying its extension, that is, every object that falls within the minimum guideline. We include an object that follows the tentative simple guideline made just for initial object screening. The guideline is intended to identify the commonality across different human understandings about a particular feature type. For example, “a raised area of land” would be a commonality of different understandings about a mountain. The first form of feature type is defined in accordance with the analysis of the object first added as a feature instance, but the application schema and/or the guideline may be changed as new objects are added (Figure 2). This is the extensional-schematization procedure. The difference from intentional-schematization is that the new type of object is not rejected in principle as long as it follows the guideline for screening. For example, if the candidate object is a low mountain beside of a hill that is higher, it is important to accept the fact that people living nearby commonly recognize it as a mountain. We should discuss whether to improve the properties of the feature type or to amend the guideline for screening. If we can agree that the height of mountain is independent from its classification, we should add the note “the height of a mountain does not affect its classification” in the guideline for the “Mountain” feature type. In addition, if there is an objection to that note, it also should be recorded in the guideline for future discussion.



Figure 1. Mt. Hiyori.

- (a) Air photograph taken in 1980s. Inside of the white circle is Mt. Hiyori.
- (b) Ortho-photograph taken just after the Great East Japan Earthquake in March 2011.
- (c) Mt. Hiyori in the GSI Map on the web.

All images were obtained from the GSI web map service [<https://maps.gsi.go.jp/#17/38.255373/141.011834/&base=std&ls=std&disp=1&lcd=gazo3&vs=c1j0h0k0l0u0t0z0r0s0f1&d=vl>] (accessed December 2018).

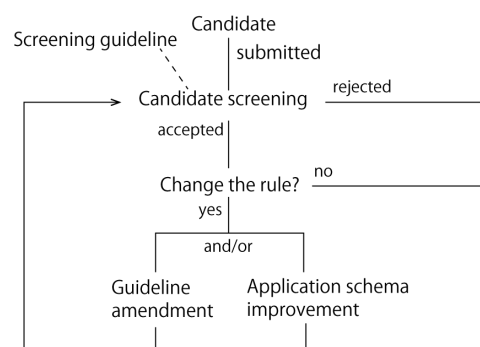


Figure 2. Extensional-schematization procedure

2.3 Temporal general feature model

The mechanism to maintain the extensional-schematization procedure should have at least three functions (Figure 2): judgement regarding acceptance of a candidate as a new object; consideration of whether to change the application schema, and consideration of whether to amend the screening guideline. To realize this process, application schema need to be in compliance with the temporal general feature model (TGFM). The TGFM is a GFM that enables application schema components to be valid only for a specified duration (Ota, 2017a). When the guideline for the feature type is changed, the new feature type will stack up on the old type in the application schema. The appropriate type can be selected in accordance with the time point that the user indicates. The user will be able to get objects that are valid at that time point as each object associates with its type definition.

3. Nongeographic feature type

As long as a feature is an abstraction of real world phenomena, it is a geographic feature in accordance with the definition of feature type provided by ISO 19101-1 (ISO/TC 211, 2014). However, this standard also states the following.

“Nongeographic features are also of interest in ISO geographic information standards. Such features may be included in the application schema with no spatial characteristics.”

There are two types of geographic features (Ota and Plews, 2015; Ota, 2017b). One is a physical feature and the other is a virtual feature. A physical feature is something that has a shape existing in the real world such as the Eiffel Tower in Paris. A virtual feature is generally a something that is intangible but is considered to exist in the real world. The two features can be distinguished by proxy attribute, which

is a special attribute that authorizes the representation method of a feature. A geographic feature is physical if the proxy attribute is geometrical, and it is virtual if the proxy attribute is not geometrical. For example, university, company, and academic association are virtual features. The Japan Cartographers Association has no geometric shape, but it exists in Japan. In such a case, the proxy attribute may be the name of the organization.

The difference between a virtual feature and a nongeographic feature is that the virtual feature exists in the real world, but a nongeographic feature is considered not to relate to the real world. They also differ in terms of the space to which they belong. That is, nongeographic features exist in the imaginary space that we share, while imaginary space such as a repository on a cloud server is a space in which the feature is identified by URI, which thus can be the proxy attribute. Therefore, the responsible party for schematization should distinguish geographic (physical and virtual) and nongeographic feature types in the application schema. Figure 3 is a diagram of the main proposed improvement to GFM for distinguishing the feature is geographic or not. The attribute “isGeographic” is assigned Boolean values the indicate whether or not the feature is geographic, and “proxyName” under “FeatureType” is the name of the proxy attribute.

4. Feature association as real world phenomenon

Feature association is a relationship that links instances of one feature type with instances of the same or a different feature type (ISO/TC 211, 2005). Geometrical association such as boundary or coboundary relationship is different from the feature association. It is described as topological relationship of the spatial schema (ISO/TC 211, 2003). Feature association is a semantic association described in the application schema. As long as feature association is a phenomenon in the real world, it should have attributes and

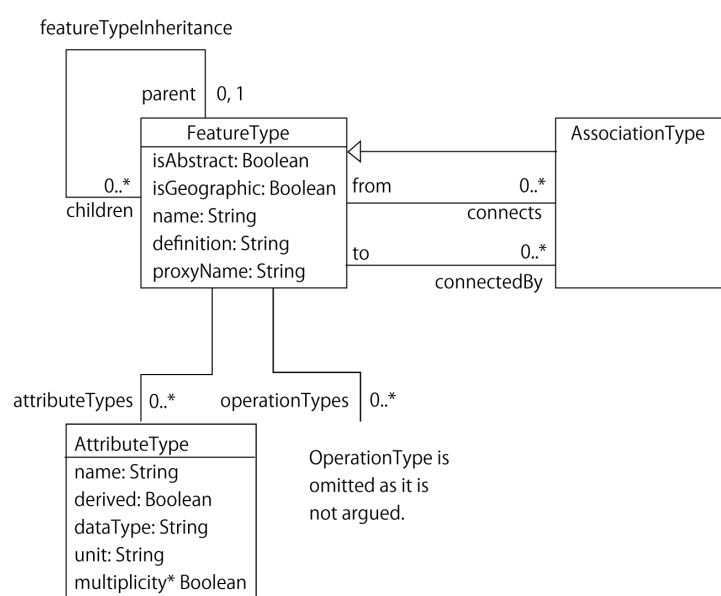


Figure 3. Central part of the General Feature Model improvement to distinguish feature type by “isGeographic.”

operations. Additionally, association has inherent properties about a connection between feature types.

Usually, feature association is intangible. For example, even if a house is located along the river, there is nothing to show “located along” in the real world. However, we can draw a line symbol to connect two features on a map. Such a line connects reference points representing the two features. Each reference point may be the centre of a feature or the point nearest the partner. The shortest path connecting the departure location and the destination is also imaginary, but it can be an attribute of the association between the two. The feature-association line and shortest path can be both geometric attributes for visualizing association, which means that both associations can be physical. On the other hand, the association between a campus and a university is difficult to visualize by a symbol on a map as university is a virtual feature. Therefore, association is physical or virtual in a similar fashion as that feature type is physical or virtual.

We also may consider that there is nongeographic association in a similar fashion as nongeographic feature. If one or both sides of an association are nongeographic features, the association is considered to be nongeographic.

Figure 3 illustrates the main part of our proposed GFM given these considerations. We can define the feature type as it is abstract or concrete, and as geographic or nongeographic. A feature type may inherit properties of its

“parent” feature type, and may connect to and be connected by other feature types through the “AssociationType,” which is a subtype of “FeatureType” that has inherent connections between “from” and “to” feature types.

5. Representation of features and associations

A portrayal schema is a model for geographic information representation, and maps are representations in compliance with the portrayal schema. The schema consists of a set of feature- or association-portrayal units that combine types of feature or association and graphic modifiers for portraying features or associations on a map (Figure 4). The learning assistance tool “gittok” that Ota (2017b) developed can classify graphic modifiers into general modifiers for general-purpose maps, thematic modifiers for thematic maps such as a choropleth map, and information pages that represent multimedia attributes such as images, videos, sounds, websites, and texts.

Representation of a feature is affected by whether it is geographic or nongeographic. Geographic features can be visualized. Physical features can be represented on maps. Virtual feature and nongeographic feature cannot be represented on maps, as, in principle, they do not have geometric attributes with multidimensional coordinates. However, they have a unique identifier to distinguish from other features. It at least can be a value in nominal space. Accordingly, features with identifiers, whether geographic or nongeographic, can be arranged as a list.

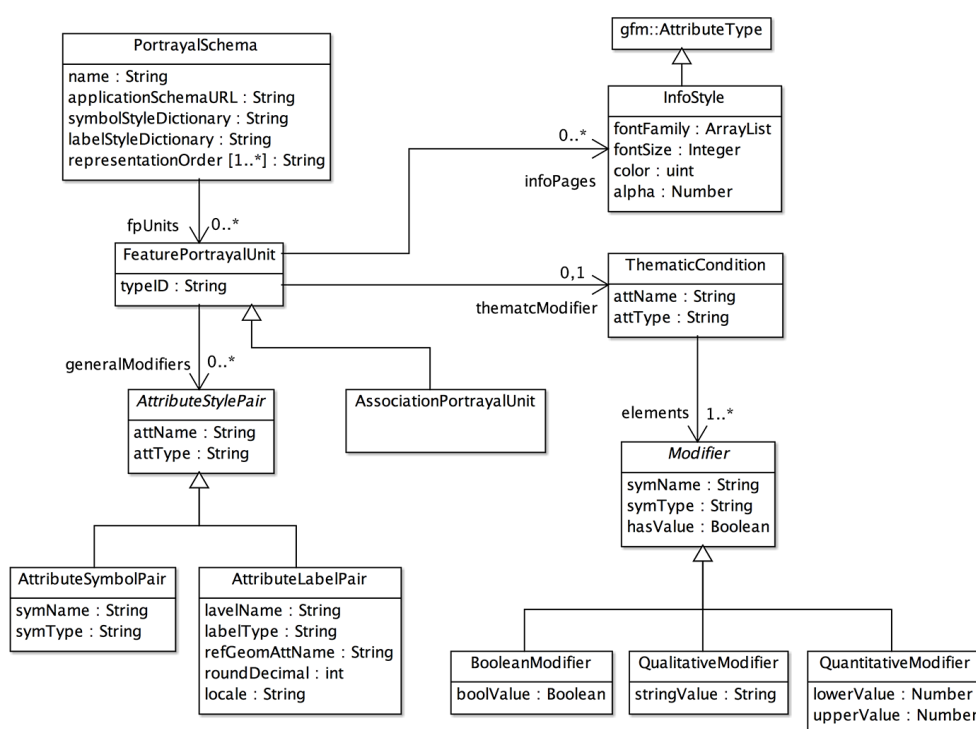
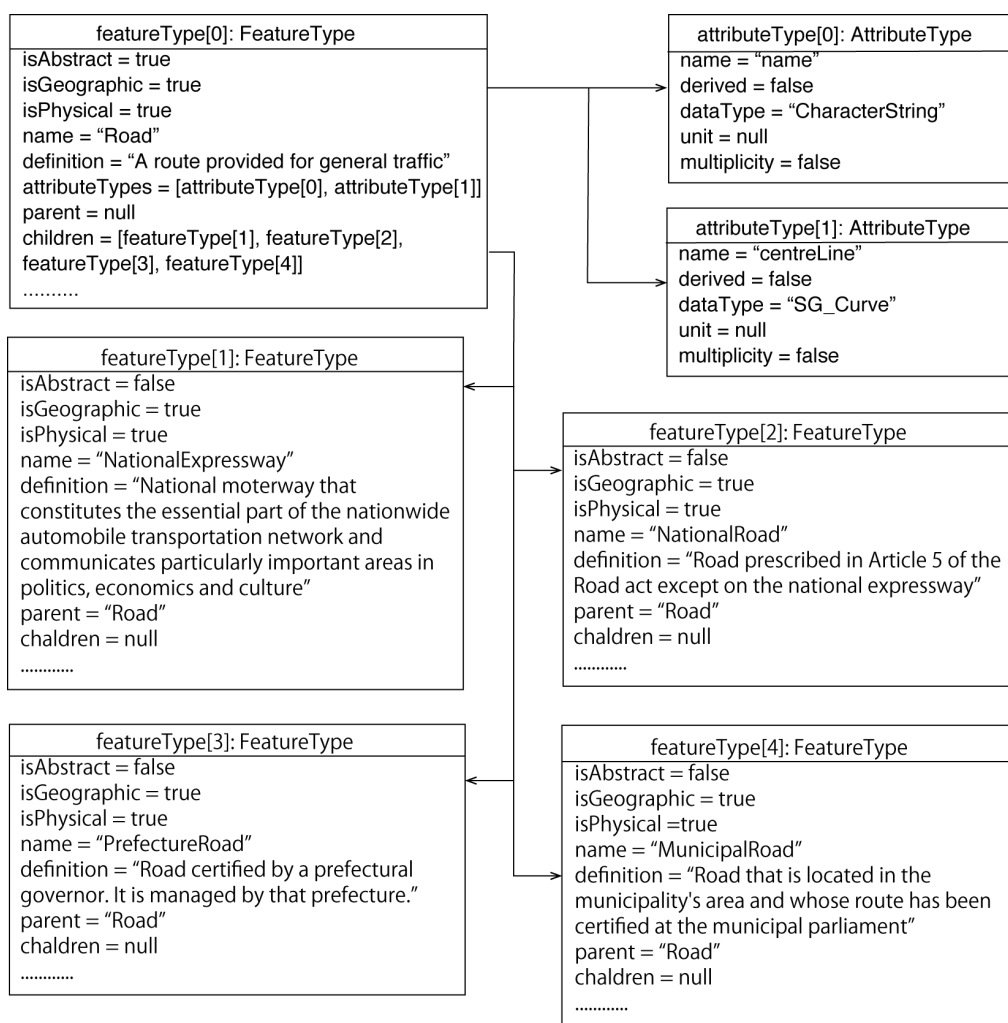
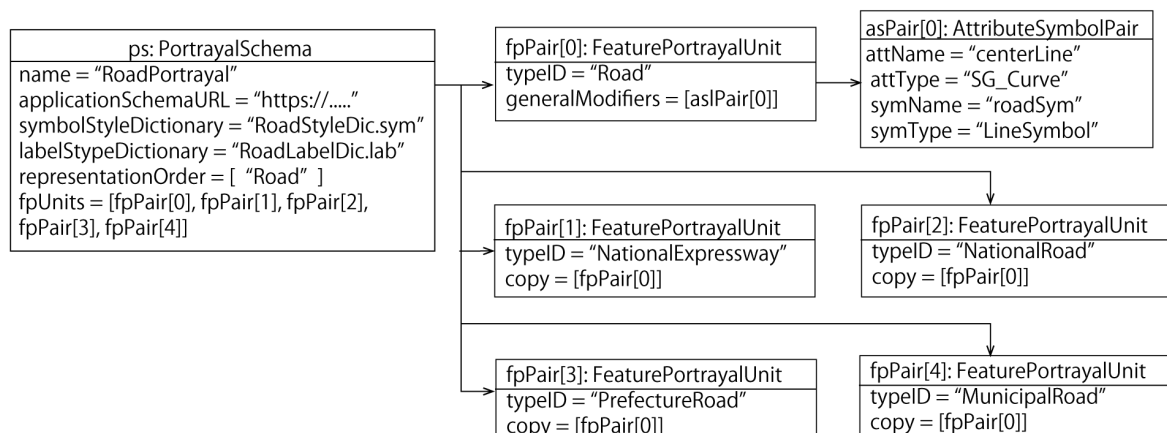


Figure 4. Gittok General Portrayal Model



(a) Application schema for “Road” represented as an object diagram in compliance with GFM. Prefix “SG_” in attributeType[1] means Spatial Geometry that is equivalent to “GM_” in the spatial schema defined in ISO 19107



(b) Portrayal schema to display “Road” as a line symbol “roadSym” represented as an object diagram in compliance with the improved GPM shown in Figure 6.

Figure 5. Application schema for Road and portrayal schema to symbolize child types of Road

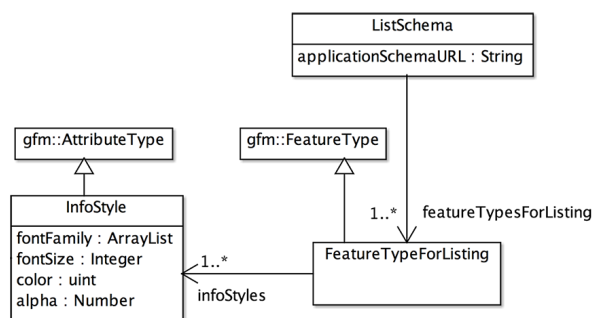


Figure 6. Gittok General List Model

A list can be a representation of virtual or nongeographic features sorted by value in nominal or one-dimensional metric space (Ota, 2017b). Accordingly, it is a one-dimensional map to visualize the real world. A list schema is designed to be in compliance with the general list model (GLM) (Figure 6). For representation by listing, feature type is associated with information style, which is a subtype of attribute type. It may be a multimedia attribute type used for image, video, audio, home-page URL, or text. The list contains hyperlinked URLs for those attributes. Attributes in “infoStyle” are used to represent text such as an address or a note to explain a feature. The actual form is a table that can be transformed into the HTML file with CSS, the CSV files, and various other formats or kinds of information.

6. Representation through super feature type

In the GPM (Figure 4), modifiers for representation are set for each basic feature type by using “FeaturePortrayalUnit.” However, it may be desirable to use other modifiers for a feature type.

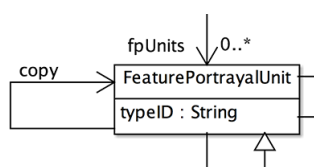


Figure 7. Improved part of the GPM (Figure 4) “FeaturePortrayalUnit” with self-association “copy” for reuse characteristics of another unit.

For example, the Japanese Road Act classifies roads into national expressway, national road, prefectural road, and municipal road. Therefore, these four subtypes inherit the characteristics of the “Road” feature type (Figure 5 (a)). If road subtypes must be shown by the same line symbol, we can use two methods to show them. The first method is to assign the same modifier to each subtype. Second, because all instances are roads, subtypes associate with modifiers of the “Road” type. As the parent type of “NationalRoad” is “Road”, it can be symbolized by “roadSym” by inheritance of “Road” (Figure 5 (b)). This is an object diagram in compliance with the improved GPM (Figure 4). Self-association with the role name “copy” cycling back to

the “FeaturePortrayalUnit” enables the association of another unit for reuse of its characteristics (Figure 7).

In Figure 5(b), each subtype may be visualized through “Road,” which has a relationship with the general modifier “asPair[0]:AttributeSymbolPair.” This modifier indicates that the geometric attribute “centreline” is symbolized by the line symbol “roadSym.” The merit of this method is that portrayal of four subtypes is possible by one declaration. And, if the portrayal rule changes, it is unnecessary to change the rules for four subtypes.

7. Conclusions

We have discussed the GFM for describing the deep structure of geographic objects and the GPM and the GLM for describing the surface structure for geographic representation. In the GFM, by classifying features and associations into concrete or abstract, geographic or nongeographic, characteristics of features and association can be more clearly defined. Additionally, to make it possible to express information according to the characteristics of the feature and its attributes, we introduced a method to describe the portrayal schema by applying the GPM and the list schema by applying the GLM. In addition, we proposed that extensional-schematization procedure is useful for defining feature types and that the TGFM can be used to maintain this procedure. We will improve gittok to attain a more precise data structure and to achieve unambiguous representation.

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