Geographic Information Standardization and Potential Applications in Tourism

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1. Introduction

Geographic information standards are the set of standards established for sharing geographic information, which refers to any information regarding phenomena on the earth. ISO/TC 211 began standardization activities in 1994, and has created the ISO 19100 series of standards. The author was directly involved in this standardization work for ten years starting in 1995, and since then has been a member of the Japanese domestic committee to ISO/TC 211, and also a leader of several working groups established under the domestic committee to create corresponding JIS standards. This article begins by giving an overview of geographic information standards. It then describes knowledge systems for geographic information technology, which provide background for these standards. It then proposes a tourism data infrastructure, which applies these standards to the field of tourism.

2. Geographic information standards

In this section, we discuss what geographic information standards are, how they are used, and more specifically, how they are studied and used in Japan.

2.1 Geographic information standards and their application

Geographic information standards provide a framework for creating geographic information specifications and systems that use them. The goal of this standardization activity is to enable specification of geographic information management, including definition and description; tools; services; data acquisition, analysis, search, and representation; and transmission of data among different users, systems and locations.

For example, in 2007 the European Union (EU) enacted a directive called the Infrastructure for spatial information in Europe (INSPIRE) and participating EU countries are each creating their own domestic laws for geographic information standards in conformance with this directive. It is establishing a geographic spatial data infrastructure that will enable sharing of geographic data. Today, most countries in the EU region publish spatial data conforming to this directive. The International Hydrographic Organization (IHO) has also established profiles for the ISO/TC 211 standards (S57, S100, etc.), and many countries are using product standards based on them to create global electronic navigation charts. The Open Geospatial Consortium (OGC), an NGO, is also leading the creation of many international specifications. For example, OGC has submitted a standard proposal called Geography Markup Language (GML) to ISO/TC 211, and has published specifications based on it, including City GML, for describing 3D city models and Indoor GML for describing indoor models. OGC has also published the “14-083r2 Moving Features Encoding Part I: XML Core,” specification for describing the motion of objects such as people and vehicles within XML documents, based on the ISO standard for describing moving features. The project leader for this specification was Professor Ryosuke Shibasaki from The University of Tokyo.

2.2 Geographic information standards study systems

As of March 2017, there are more than 51 standards for geographic information. There are 39 voting member countries participating in creating standards, and a further 28 countries with observer status. Collaborating organizations include 25 within the ISO, 35 other international agencies, and two others. Japan has participated as a voting member since TC 211 was established in 1994. Deliberation within Japan is done under the Association of Precise Survey and Applied Technology (APA).

In Japan, a geographic information JIS standardization committee was formed under the domestic committee, to translate ISO standards as needed and to work on the JIS X 7100 Japanese industrial standards. To promote these standards, the Geospatial Information Authority of Japan (GSI) has established the Japan Profile for Geospatial Information Standard (JPGIS) for terrestrial geographic information, specifications are being created based on it for geographic information provided by government and other public agencies, and the Japan Hydrographic Association (JHA) is providing electronic navigation charts according to IHO specifications (S57, S100, etc.), which conform to geographic information standards. The Japan Institute for Promotion of Digital Economy and Community (JIPDEC) is also working to create geographic information standards in Japan, and has already created the Geographic information Place Identifier (PI) architecture, standardized as ISO 19155:2012.

3. Geographic information technology knowledge systems

Here we discuss geographic information technology, which provides background for geographic information standards, and then give an overview of related systems and the knowledge domains which are their constituents.

3.1 What is geographic information technology?

The Harmonized Model Maintenance Group (HMMG) was created within ISO/TC 211 to check the consistency and ensure compatibility between standards systems. As such, creating a mapping between the knowledge underlying different sets of standards should make it possible to derive knowledge systems required to process geographic information related to these standards. Here, we refer to this collected knowledge as Geographic Information Technology (GIT).

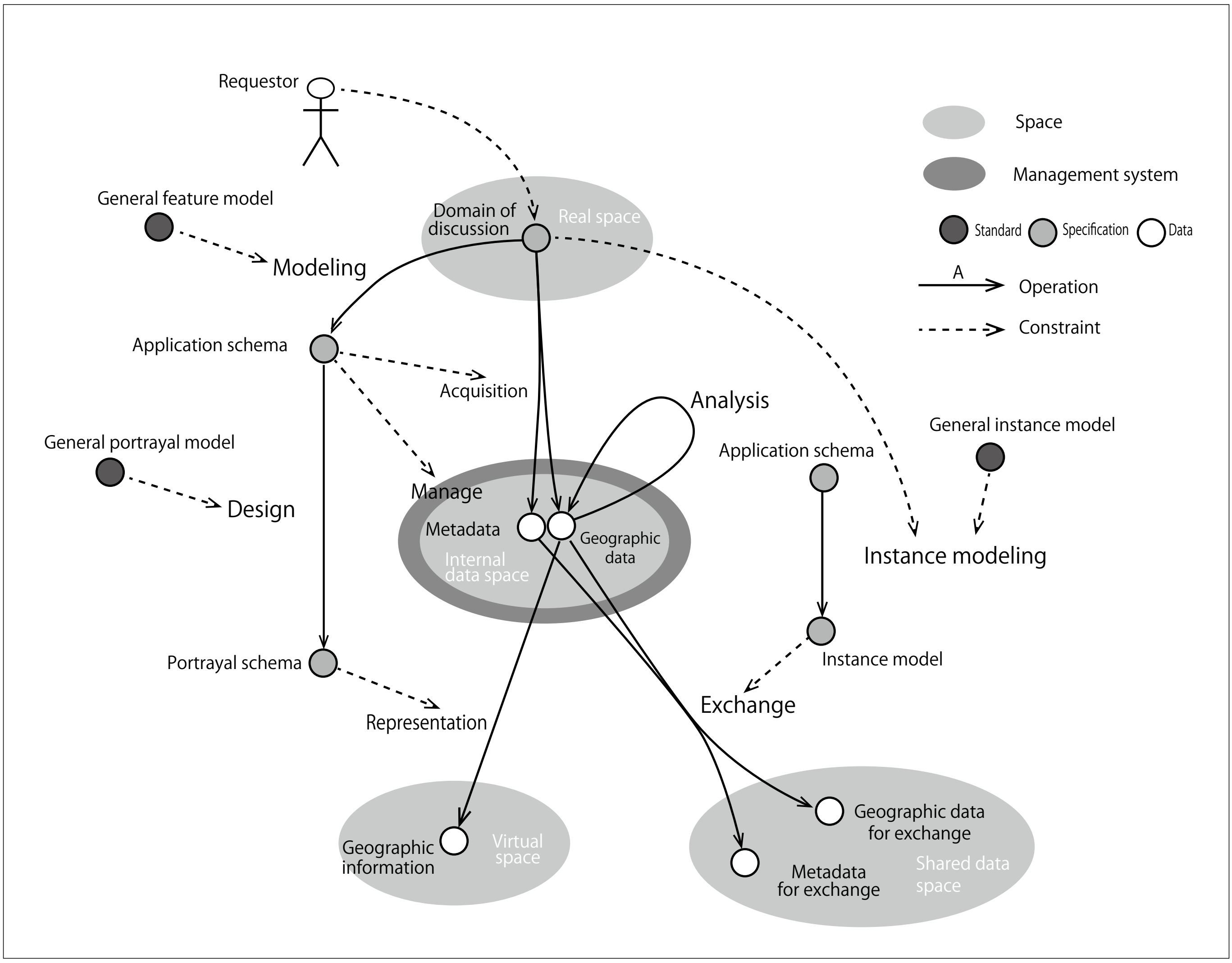
According to the Oxford English Dictionary, "knowledge" is defined as, "facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject."

According to this definition, there are two types of knowledge, namely facts or information, and skills. These are generally called propositional and procedural knowledge respectively. Most provisions in a standard have the form "In order to A, follow a." For example, expressions such as "To encode a location in physical space, use the point as a geometric primitive," so such provisions are called propositional knowledge. On the other hand, skills required to behave according to the provisions include ability to develop and operate information systems conforming to the provisions. Both are collections of knowledge for use in society, and can be considered to be elements of GIT.

3.2 Geographic information technology knowledge systems

Information processing can be regarded as basically sequences converting input data to other data. Such sequences can be expressed as directed graphs, with nodes representing data and the knowledge required to convert it, and arcs connecting them. These directed graphs comprise systems of propositional and procedural knowledge. From this perspective, the GIT Body of knowledge, including geographic information standards, can be illustrated as shown in Figure 1. This is based on the following declaration, appearing in the scope of the geographic information

Figure 1: Knowledge systems of geographic information technology conforming to geographic information standards



standard, “The geographic information standard regulates the management, acquisition, processing, analysis, search, representation and transmission of geographic data, including its definition and description.” If we consider the definition and description of geographic data as “modeling”, processing and analysis as “spatial analysis”, and search and transmission as “exchange”, we can say the geographic information standards are based on the knowledge domains of modeling, acquisition, management, spatial analysis, exchange, and representation. These domain categories are also used as the framework for the GIS&T Body of Knowledge published by the University Consortium for Geographic Information Science (UCGIS) in the United States. As such, the geographic information technology knowledge underlying the standards can be organized by matching the knowledge domains of each of the standards. Below, we discuss the main standards and the technical knowledge underlying them for each of the knowledge domains.

3.3 Modeling

Modeling is the activity of examining objects and phenomena of interest occurring in the real world (the domain of discourse) and summarizing them in a conceptual model. To do so requires a meta-model to express the structure of the conceptual model. Within the geographic information standards, this is called the General Feature Model (GFM) and its structure is specified in ISO 19109-Rules for application schema (JIS X 7109). The conceptual models output as a result of modeling use a schema formulated for a specific field of application, so they are called application schema. City GML, mentioned earlier, is one such application schema. To understand modeling requires knowledge of a schema language for describing the model. The Unified Modeling Language (UML) is used in the geographic information standards. Knowledge of the application domain is also required in order to create an application schema.

3.4 Data acquisition

Data acquisition is the activity of observing something and creating geographic data according to an application schema. There are many ways to acquire data, such as GPS positioning, indoor positioning, photogrammetric measurements, and remote sensing. Standards directly related to data acquisition include those related to spatial reference (ISO 19111, ISO19112) and those related to data quality (ISO 19113, ISO 19114). Underlying these standards is geodetic knowledge and knowledge of statistics and error theory. Knowledge of the actual techniques used to collect the data is also necessary.

3.5 Data management

Data management is the activity of systematically storing the acquired data and providing it to users as needed. Management information technology is not necessarily specific to geographic information, but among the geographic information standards there is a metadata standard, ISO 19115-Metadata (JIS X 7115) for describing geographic information. Data search mechanisms for indexing geographic metadata are variously called geographic information clearing house, geolibrary, or geographic data catalog. Geographic extents are also used to search this data, so services displaying background maps are needed so that the location of these domains can be seen at a glance. In Japan, the Geospatial Information Authority provides its GSI Maps, which is this type of service, and there are also non-governmental organizations providing services, such as Google Maps and Open Street Map, and geographic knowledge is required to implement these services.

3.6 Data analysis

Data analysis is the process of taking input geographic data and converting it to information that is meaningful for users. This is generally called “processing”, but the word processing is also used for modeling and data management, so we use “analysis” here to distinguish from these other activities. There are no geographic information standards for specifying analysis algorithms. For example, among application schema, even though the expression “shortest path” appears, specific analysis methods are implemented by the system developers. In fact, the standard notation for showing analysis as an operation within a class in a UML class diagram is an Application Programming Interface (API), according to the general object model. As such, knowledge for selecting and developing algorithms according to the requirements shown in an application schema is part of geographic information technology.

3.7 Data exchange

Data exchange is the service of sending managed geographic data to clients. A server encodes geographic data in some intermediate format according to an instance model, which is the interface, and the client decodes and uses it. In the geographic information standards, geographic data conforming to an application schema is exchanged in the form of Extensible Markup Language (XML) documents. ISO 19136-Geography markup language (GML)(JIS X 7136) has been standardized as a meta-model conforming to the general object model, to encode these XML documents, so that geographic data can be exchanged in that form. Thus, to understand this knowledge domain requires an understanding of XML, but there are also many other data formats such as JSON (ECMA 404), CSV, Shape and DXF, so knowledge is also required to convert between these formats.

3.8 Geographic information expression

Expressing geographic information is the process of taking geographic data as input and expressing it in a form that has value for the user (mapping, conversion to speech or documents, etc.). One standard for visualizing geographic data using maps is

ISO 19117:2012-Portrayal. This standard gives a general model for depicting functions and symbols, for converting geographic features into symbols to be displayed on a map (such a place-name labels). Design for expression is the process of creating a portrayal schema for the geographic information being created, according to this standard. Note that today, expression of geographic information is not limited to ordinary maps, but includes diverse means of expression such as statistical maps, interactive maps that can be searched for local attributes after specifying a location, walk-through videos, and 3D maps. As such, a more comprehensive initiative is needed to organize this knowledge and standardize these sorts of expression.

4. Potential for applications in tourism

Tourism is not the specialty of the author, so there may already be a similar service, but we propose a potential application below. There is a need for both competitiveness and collaboration in tourism information services. As an example, services for introducing and selecting tourism-related facilities would be expected to have different content depending on the nature of the site, but if information such as business hours was different, it would cause confusion for users. On the other hand, it is difficult for a touristic facility to know all of the sites that provide information about it, so when the business hours are changed, it is difficult to ensure that changes are made comprehensively on all sites. This suggests that some of this basic data that needs to be common, such as location, could be managed centrally by an intermediate organization, facilities could register their own data there, and information services could reference and provide that information to travelers or other entities that need it.

If this sort of tourism data infrastructure is to be built, it would be preferable to provide the data and APIs for manipulating it according to an international standard and in a common international format. This would enable the data infrastructure to be opened to services around the world, and not just domestically.

As shown more concretely in Figure 2, a database for the tourism data infrastructure would need to be studied, selecting data items appropriate for the common platform. The results would be shared with stakeholders, defining the scope of discussion, and agreements reached on aspects such as application schema and metadata describing data providers. Based on the agreements, data would be acquired, the database system would be developed, and the formats and service APIs for the data being provided would be published. Providers of the data registered in the tourism data infrastructure could freely update their own data, and service providers could reference the shared data and use it in providing their own services. Considering issues like the digital divide and multi-lingual data, data registration agency services would also be needed. This would enable travelers to receive personalized information services, based on data free of inconsistencies, and better services could be provided through collaboration with tourism-related agencies such as police, fire prevention, traffic management, and mapping facilities.

Figure 2: Proposed Tourism data platform organization