THE DESIGN OF CARTOGRAPHIC SYMBOL SYSTEM WITHOUT DEPENDENCY ON GIS PLATFORM

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Abstract
Symbols are the main forms to illustrate graphical elements in mapping. Thus, the design of symbol library directly affects the quality of digitalized map and geographic information acquisition efficiency using geographical information system (GIS) software. Generally GIS software manages symbol library as different separate files. There exist various disparities between different GIS software, each of which possesses its own cartographic features and the corresponding symbols system. Consequently, it is commonly difficult to achieve cross-system symbol sharing for different GIS software. Considering the current development of symbol library design, we propose a scheme for the realization of symbol sharing between different GIS software so as to meet the commonality need for different users with different GIS software expertness. The scheme mainly consists of two parts - unified management of symbol library in universal database software and separate storage of graphic symbols and their related properties in different files. Another contribution of this proposal is the independent development of symbol library that could be detached from the development of GIS software.

Key words: *cartographic symbol; cross system; graphic and attribute stored separately; symbol sharing*

INTRODUCTION

Map is a kind of symbol model about spatial information. Cartographic symbol is a professional language to express the information and content of map. It has a huge ability for expressing map not only in spatial position, size, quantity and quality of real thing, but also in the connection, relationship and general characteristics of the specific things. The function of cartographic symbol designing is an important part in cartographic system or geographic information system.

In the reality world, geospatial features have many types and ways to express. In order to express the features in the map perfectly, a complete cartographic symbol system is needed. In GIS, software has a symbol editor model to draw, edit, store and manage the symbol. In addition, software has an independent symbol system, such as CorelDraw, AutoCAD, ArcGIS, Arc/Info, MapInfo, and MapGIS. The normal way to store common cartographic symbol is using the software's symbol library. Moreover, users could make a personal symbol library to create custom symbols and store them in the personal symbol library.

In making and managing symbols, software has several advantages and shortages. For example, CoreDraw software uses the CSL file to manage the symbol library and has an obvious advantage in drawing. The drawing effect is good while other software couldn't maintain. MapGIS software provides basic symbol library which is open to users. The users can modify the symbol in the system library and create personal symbol library named " Slib file " . ArcGIS software has powerful function in creating and managing symbol. It provides many types symbol library. Users can create new symbols and save them in the personal symbol library named " Style file ".

Software has several problems in common use of symbols. First of all, because software bind with their symbol library, it is hard for users to use one symbol library in other GIS software. Secondly, due to the lack of unified standard of symbol library's storage format, sharing the symbols in different GIS system platforms is difficult. Additionally, the foreign GIS software cannot consider the symbol demand in China.

Therefore, it is necessary for us to design a symbol library which is independent to any GIS system. Creating standard symbol is also required. Consequently, we would easily share the symbol in different platforms and satisfy the demand of users.

THE STRUCTURE FEATURE OF CARTOGRAPHIC SYMBOL

Symbol is a kind of abstract expression about subject, process or attribute of things. Symbols can represent size, position, quantity, quality and distribution of things. Different symbols can reflect the relationships and general characteristics in the whole area.

Symbol has graphic and attribute feature. Symbol's graphic feature is the basic and the important element. It has direct effect in map showing result. Symbol's size, color, angle and other attributes can express scale and quantity of geographic things and phenomenon. For a specific graphic symbol, modifying its color, size, angle, offset and other attributes can constitute different symbols. For example, snow mountain contour line symbol is represented by the blue solid line. The line width with $0.1mm$ or $0.2mm$ represents intermediate contour or index contour. That is to say, for two symbols which have same graphic feature, the width is changed and the symbol representation is changed as well.

Symbols can be classified according to their geometrical characteristics into point symbols, line symbols and polygon symbols.

Point symbol on the map is an anchor point, representing an independent position and discrete space phenomenon. Point symbols fail to scale the sign of change. Graphic symbols are fixed, with defined anchor points and direction. Meanwhile, graphic symbols are regular, generally constituted by the geometry, such as lines, polylines, arcs, polygons. These basic graphic elements are called symbols of elements. Point symbols are composed of point elements superposition.

Line symbol is a line on the map. Things are expressed by linear symbols with equal relative length or line features. Line symbol is a semi-scale change according to the sign. There is a tangible or intangible positioning line, which can be seen as a number of lines superimposed on the symbol (straight, dotted line, dashed line, etc.).Line symbol consists of point elements and line elements.

Polygon symbol on the map is a diagram spot, showing a continuous spatial phenomenon, like having a continuous distribution of natural resources, urban range. Polygon symbol is in accordance with the scale to indicate the spatial distribution of the change of sign. There is a tangible or intangible contour. Fill pattern is generally filled by color, line or point symbol. Polygon symbol consists of point elements, line elements and polygon elements.

THE DESIGN OF CARTOGRAPHIC SYMBOL DATABASE

Spatial information and symbol information store in different ways in cartographic software. Generally in computer professional cartographic software, spatial information and symbol information store in the same layer. The layer has the same symbol, which exists as an incidental attribute layer. GIS software saves the symbol information in the basic symbol library, and the corresponding relation between the spatial data and the symbol is stored in the project file.

In the process of the symbol rendering in cartographic software, the general method is to divide the sub-types. For example, in the expression of the "city" symbol, city could be divided into capital, provincial capital, county level, administrative village level, according to this symbol's attribute. Some cities are not the provincial capital, but enjoy the provincial capital level of economic management authority. So when dividing the sub type, the object requires a separate symbol, not simply in accordance with provincial or prefecture level symbol matching. This need is difficult to achieve by only dividing sub-types in the cartographic software.

Therefore, considering this problem, object-oriented symbol idea which means a space object corresponding to a symbol is proposed. The idea means using one object matches and modifies one symbol, and changes the traditional thought of classes-oriented or subclasses. The method is to use the property to save the symbol information and spatial information.

GIS data is divided to graphic property and attribute property. Graphic property is the most direct and most fundamental aspect in any mapping visualization, whereas the attribute property assigns and controls the size, color, tissue or angle of the symbol to denote the scale and feature of specific geographic object or phenomenon. For different cartographic geographic objects that share a common property, they can serve as different symbols with modification of the attribute properties for the same graphics. For example, thinking about property of pipeline, we could describe it from its name, throughput, transmission speed, nature and other aspects. These features could be classified into name, variety and characteristic. Based on the foregoing, in order to achieve the object-oriented symbol, we need to expand the property fields and add symbolic attributes expression.

The structure of this proposed cartographic symbol system will be organized in a spatial database manner. The information of any symbol, whether point, line or area will have two parts, its graphic appearance and its own attribute. In many cases, the attribute of symbol, rather than the entire symbol itself, will vary according to the corresponding geographical information it represent. The structure of this symbol database will be designed in the following way. First, all symbols will be categorised based on their own geometry type. Then for a certain symbol, the graphic information and attribute will be store separately. Furthermore, three index tables will be established, one for the graphic information, one for the attribute information, and one for the symbol information. In the last symbol index table, in addition to normal details it may encompass, an extra field named "SymbolCode (SC)" will be created so as to set up the linkage among all three index table. This SC would be designed as an eight digit CHAR type variable, in which the first four-digit would denote the ID number in graphic index table and the last four-digit represents the ID number in attribute index table. Thus, the SC variable will be deemed as a retrieval pointer in the other two tables, the graphics and the attribute, and after the successful retrieval, a complete symbol with specific denotation will be eventually constructed. Take the road design for example. There are national road, state/provincial road, city road, town road and county road. Traditionally, they are stored using different line symbols in different GIS platforms. Nevertheless, if we adopt the library system mentioned above, only one graphic information will be required to be stored. The variation of different line symbols can be signified using different attribute information. Moreover, would an extra road with specific function need to be created in the GIS platform, we only need to append a specific attribute in the attribute index table and update the symbol index table for the realization of the mapping visualization of this specific road.

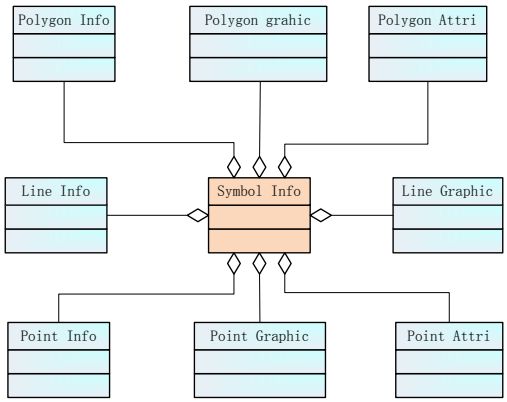

Figure 1. Symbol Storage Structure

When designing the table structure of the symbol database, the fields would be designed as Blob type. The graphic and attribute information would be stored as BLOB type in the symbol database. For instance, polygon symbol consists of point, line and polygon elements. When storing a polygon symbol in the database, the three types of elements would be gotten and compressed into BLOB information, and then stored in the corresponding fields in polygon graphic table. In addition, the attribute information would be stored in polygon attribute table.

There exist several advantages of our proposed cartographic symbol system. One is the effective management and the easy maintenance for the graphic and attributes information due to their functional and structural separation. Another edge for this database-based system is the prominent reduction in the storage redundancy and thus an expected boost in the efficiency during the production of any geophysical products. Last but not the least, a successful launching and execution of this symbol system would undoubtedly pave a path for the realization of universally adopted database that would eventually promote cross-system symbol sharing among different GIS software.

CONCLUSION

This article studies the cartographic symbol system, analyses different types of design and management in GIS software platform, and summaries the drawbacks. We suggest that proposing as database to manage cartographic symbols and using graphic and attribute separated storage style would make the structure of symbol system more reasonable and reduce the redundancy of data. Meanwhile, the universal problem of symbol system would be solved. The next step is to study and design reasonable data access interface and apply it in different GIS platforms.

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