

# Characteristic of Spatial Data and the Design of Data Model

Tiejun CUI

(Institute for Surveying and Mapping of PLA Information Engineering University, Zhengzhou 450052)

**Abstract** In this paper, the integration of spatial data, its characteristic for analyse, its spatial location and attribute relation are discussed in detail. The problem, division of spatial relation caused by delamination management of map element is settled successfully. Also, this paper brings forward the way to connect spatial relation of multi maps and give the spatial data model based on spatial relation of map data.

**Key words** Spatial data, Spatial relation, Spatial data model, Spatial data database

## 1 Introduction

If you want to design the spatial data model, you should know the spatial relation of all kinds of things in realistic world, such as plants and farmlands beside the road, residential area connecting with the road, and etc. We get the information from maps by thinking of images. With the development of computer on graphics and data disposal, scholars of graphics begin to ponder how to use this technique to manage and reflect the distributing, combination, relation of nature and society phenomenal and their space-time development and movement. This gradually forms a new subject --geographic information system(GIS). The core of GIS is to study how to describe scientifically and factually and simulate geography entity or phenomena, its interrelation and distributing character in computer storage medium. Primeval system only abstract all geographic elements into points, edges and faces, and this can not satisfy practical needs. We must do more to study their spatial relation to develop the prospect of application. Spatial relation is to describe and express the interrelation of spatial objects with special location, attribution and configuration by special data model. We must translate spatial relation into data structure that is suited for computer if we want to describe map information in digital form and make the system have a special function for spatial inquiry and analysis. Spatial data model is the expression of geographical data and its logical relation in geographical data database system and it is a deeper data description in computer data disposal. Spatial data model is not only the basis of organizing, storing, managing all kinds of spatial data efficiently but also the basis of transmission, exchanging, application of the spatial data. It describes the movement of the system and the information flow in abstract form. Each entity's geographic database is defined by a corresponding Spatial data model. From all above, we can see that the spatial relation of map data is the basis of devising, building map database and for spatial inquiry and decision-making. In all, we must improve the capability of the GIS spatial analysis to resolve the description and expression of the spatial relations.

## 2.Characteristic of spatial data

### 2.1 Contradiction to disperse and aggregate spatial data

We must disperse and abstract the continuous geographic entity and their interrelation, express map elements and their interrelation in discrete data in order to identify and dispose geographic elements. Geographic character of a single location or phenomenon is showed in point .A point may has actual senses such as bench mark ,well ,road intersection, residential area in small scale map ,and it can also has no actual sense. A point element can be defined with double coordinates ,having no length or area.Isolated point is a point without edge element to connect with. Junction is a point with two or more edge elements to connect with .Hanging point has only one edge element to connect with,and it is a especial junction. Geometric character of linear object is drawn up by a chain connected by edges ,so ,a chain can be seen as the collection of points .In some special circumstance ,given some known coordinates, we can establish a function to approach linear object(curve smooth) .Face element is a closed figure,and its borderline encircles a region with the same type.Thereby ,geometric character of a faced object is approached by edges,that is to say, the entity is formed with a closed coordinates.

We take spatial goal as our object to manage, store and dispose if we don't take spatial relation into our account .For example ,without considering crossed road, we take roads with the same character and attribute as one object . A faced geographic element is thought as a entity with a single closed polygon .The excellence of this data model is that it keeps the integrality of a geographic element, data structure is simple,and it is convenient to devise and realize a software system. The shortcoming of this model is that the common edge of faced elements is stored for two times .This make the common edge not in one location ,and can not manage the spatial relation of the faced elements. Using this repeated stored manners, it is hard to analyse geographic circumstance.In order to overcome these shortcomings,people bring forward topological relations according to the principle of topology,noting and expressing geographic location and phenomenon with Nodes,Edges and Faces,which are three basic spatial characteristic types .Let's take road for example, we disperse road with same character and attribute into lines end to end, establishing the relation of roads and road junctions.That is to say,we establish the relation of roads with different attribute,and may carry out the road's network analysis. Area features are formed by a group of edges end by end. The term "polygon" roots in this, and it means "a figure with many lines" .It may be a simple single connected area, or a complex polygon formed by some embedded simple polygons such as administrative area ,woodland ,and other kind of area features in map. Whereas this kind of model makes the integral line object dispersed into lines with same attribute , and destroy the integral attribute. This not only adds the burden to manage map data, but also increase the expense to acquire data. What's more , this model falls short with habit and request of map cartography when we export figure. For instance ,boundary segmentation breaks the integral line . For user's demanding ,we usually re-collect the dispersed data having same attribute to compose a complex feature .This make data structure complex , realizing system difficultly ,and adds the complexity to manipulate map elements. There by , most commercial GIS software have no definition and manipulation of complex features . So , it is a difficult problem to dispose spatial data's dispersal and aggregate , integrality , analytical character.

## **2.2 Relation of geographic element's spatial location and attribute**

Attribute data is used to describe geographic elements, indicating what they are. The essential of it is to class and grade the geographic information ,and to express it .The geometric data and attribute data of spatial

object are not one-to-one. One spatial object's geometric data may have one more attribute data. For example, river and boundary may be in one position. More objects may use one attribute. For instance, a road may be divided into some lines. Establishing more-to-more relations of geometric data and attribute data of map data is a very complex task, and that can't be realized completely automatic. Therefore, most GIS change the more-to-more relation into one-to-one relation.

When we storage, manage and dispose spatial data, we must divide the spatial object into undivided unit—geometric element. Attribute data describes the geometric data in whole. That is to say, the whole geometric elements have the same attribute. In realistic world, some attribute data are not to describe the whole geometric element, but to describe some points or segments. Let's take road for example, the least curvature and the most gradient of the road are not to describe the whole road. People not only need to know the least curvature, but also need to know the location of it. So, attribute data should have attribute character and location.

### **2.3 The contradiction of delamination of geographic element and spatial relation**

Geographic space is a continuous and organic contact integer. For the sake of computer's management, disposal, analysis and inquiry, we storage and manage the map element classified by theme, and break the continuous geography space artificially. We adopt two methods for delaminate geographic element. One method is delaminating by logic, that is to say, we storage and manage data together, delaminating data by the code of the object, constructing topological relations of objects in one layer according to the needs of map data appliance. This data structure is very complex in management, and influence the time of manipulation and disposal when the volume of data is very large. Another method is delamination by physics, all the objects in one layer are put in one face, constructing the relation of objects by planar geometric arithmetic. Here "layer" is connecting with data model, and it is different from the notion—geographic element (resident, water system, vegetation etc.). We may put one kind of geographic element in one layer, or put two or more kind of geographic element in one layer. For instance, rivers and vegetation are put in different layers. If the river is the boundary of vegetation, the river must be stored in different layer. Thus, the consistence of the river data is destroyed, and because topological relations can only be construct in one layer, we can't construct the relation that the left of the river is vegetation. In order to make up the shortage, we describe the interrelation of different layers with "semantic relation". This spatial relation is hard to build automatically. We usually import data by man-machine conversation, or rebuild interrelation of different layers through congruence analysis operation.

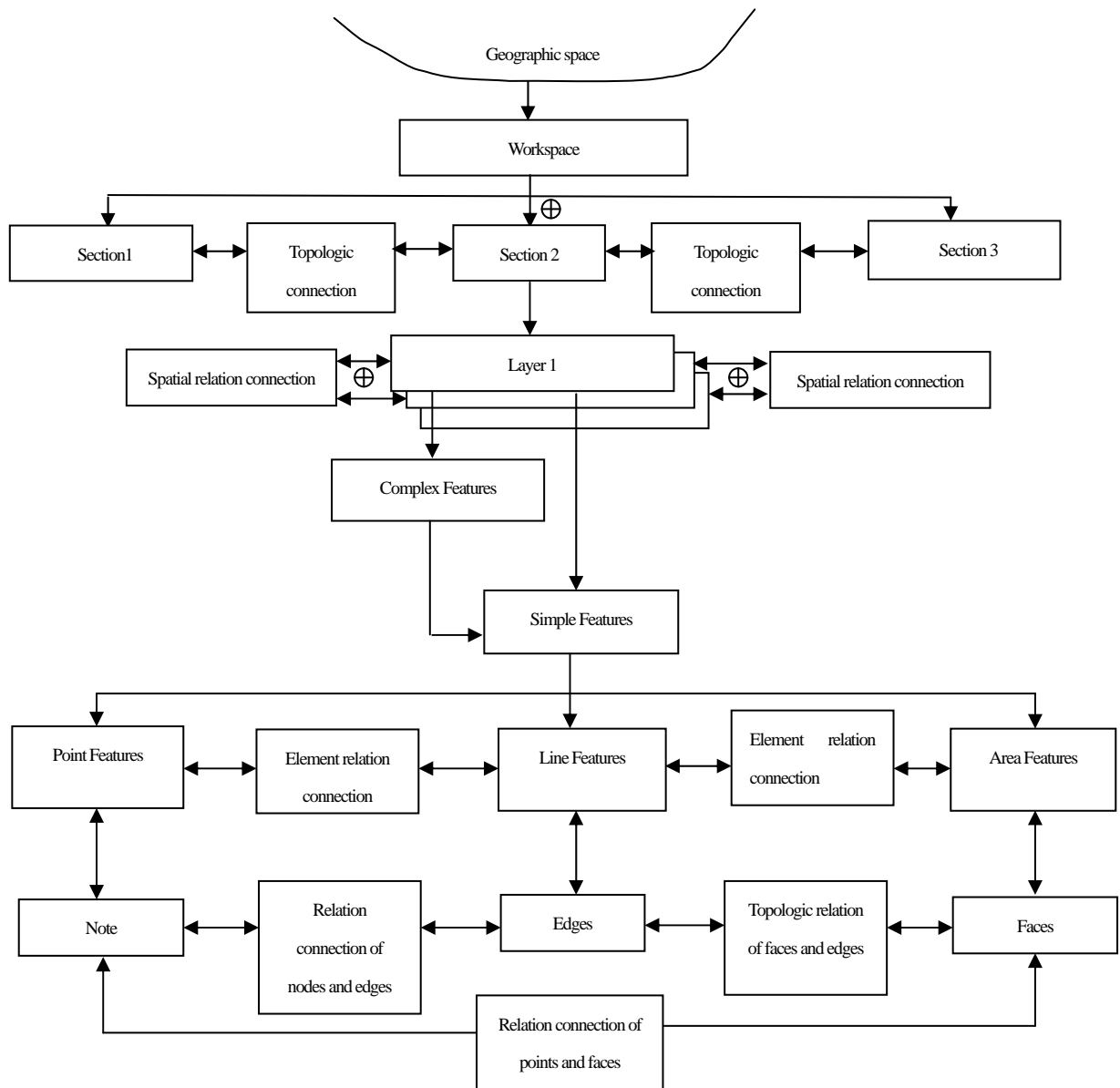
### **2.4 Topographic division of map data and spatial relation connection**

In traditional map graphics, people adopt topographic map division to resolve the contradiction that finite map paper can't describe infinite information of the surface of the earth. Similarly, in spatial database, in order to resolve the contradiction of infinite spatial information and finite computer resource, people adopt dividing topographic map to storage, manage and dispose information. In theory, non-topographic map database is the best. What is called non-topographic map database means the whole geographic object is continuous in database and in logic. It has uniform coordinates system, has no cranny, has no limitation of traditional topographic map division. The whole geographic region in database is an integer. This demands the database have a big storage space, a flexible database structure, a high efficient searching

function .Apparently ,it's economic ,efficient and easy to build some scale non- topographic map database in some small area countries . Our country has vast territory , and the data of the whole region are huge . It's difficult and uneconomical to build a physical continuous database . We build the database with some special scales ,and take data section as basic unit , then input and storage them separately .This device idea is certainly of no doubt . That demands spatial database matches the analog map . Jointing analog map is to resolve the question brought by map precision that the same point is in different location in borderline and one object has different attribute in different topographic map . Jointing spatial database not only needs to resolve the inevitably geometry differents and disaccord attributes in common boundary of two adjacent databases , but also needs to resolve the connection of space relation . The data should be stored and managed in block in physics , and be jointed without Sew in logic. Despite the same elements of different blocks are stored in diffrent pysics regions , the user still can quickly acquire the relations of various elements and possess integrated user's

### **3 Device of spatial data model**

People recognize the object and phenomena and their relations in a certain category ( relatiophic space ) , founding some geographic regions as the windows to recognize the geographic space , which is called workspace . Workspace is divided into some sections , those are the basic units . A section forms a data storage unit ,inputing , storing and managing separately . A section includes some geographic layers . Geometry objects in an element layer form a plane , establishing topology relation of the objects. Each element layer is comparatively independent in data organization and structure. Data updating ,inquiry ,analysis ,display take element layer as basic unit . Geographic element layers include some features , and features can be divided into simple features and complex features . Feature is a basic expression of geographic entity and phenomenon , including geometry character and attribute character. Geometry element and topologic relation express node ,edge ,face and their topology relation . Node ,edge ,face is the smallest undivided storage and management unit in geographic database ,describing the geographic entity's space location , space distribution and space relation . In geometry element ,we don't take geographic element's inherent meaning into account and our main purpose is to keep the geometric object's independence in operation and inquiry . In geography database , a geographic entity is composed of geometry element and attribute element . Simple feature denote point feature ,line feature and area feature ,describing the geographic means of the geometry element . Simple feature and geometry feature are not one-to-one relation , and attribute feature is added to geometry feature . Complex feature express the collection of simple feature and complex feature with the same character and attribute . In realistic world ,geographic space ,Section ,Layer and geographic object form a frame of geographic data model . (Figure 1) Each section builds its own topological relations . Through longitude and latitude or rectangle division ,we build adjacent relation of different sections .We joint the map timely when figure is shown . The relation of different layers is built through the “relation table” .



**4 Tag**

The geometry element, simple data model describe the complex relation of geographic elements or relation, space relation and complex relation in geographic elements. The same kind geographic elements have the same attributes to describe a set of geometry elements qualitatively and quantitatively. Topologic

Figure 1 Frame of spatial data model

relation of geographic element is very important in spatial relation . Composite relation emphasize assemble and united relation of geographic elements .Using the concept of workspace ,section and layer ,we can manage the geographic element's entity . User can conveniently and neatly choise different kind of geographic layers to organize and manage the data because that accord to the division of nature's hiberarchy and limiting the scope properly . However ,this model is a data model of geographic element that distributed in two dimensions ( $R^2$ ) .It is incapable when involving three dimensions ( $R^3$ ). The spatial data model of three dimensions is under study now.