SuperMap Objects Java 6R Technology Document ——Data Model

SuperMap Software Co., Ltd.

Beijing · China

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Summary

The data model is an abstract description of the real world, which can create a virtual world in computers. In the models, the map displaying, query, editing and analyzing could be carried out.

SuperMap GIS supports a wide range of data models, and creatively brings up four data model integrations as follows:

Raster Data and Vector Data Aggregation

In previous GIS software, the vector data and raster data were stored separately to manage and display, as they have different formats. The design idea of the SuperMap GIS products is to integrate them by employing compound document technology and database technology, storing both vector and raster data in one datasource. Hence, to manage, display, and analyse the data of GIS will be easily.

Object Oriented Data and Topology Oriented Data Aggregation

The spatial data was stored as "nodes-arc-surface" format which is topology oriented data structure in old GIS software. With the development of object oriented idea, the spatial data was stored as object oriented data structure later; however, the topology information was lost at the same time. SuperMap GIS has created a datasource to store points, lines, surfaces, text data models that are object oriented and the network data model that is topology oriented together; meanwhile, the transfer between them could be achieved according to practical necessity.

GIS and CAD Aggregation

Traditionally, the displaying style was decided by the style of layer or thematic layer. Each layer data was a single object type, for instance, a line layer had only line objects, and the surface layer contained only region objects, and so on. There were no parametric type spatial objects, for instance arcs, rounded rectangles. However, in CAD, for drawing convenient, there are loads of parametric geometry objects, and in each layer, various data types could be stored together. In conclusion, traditional GIS is good at spatial analysing and calculating, while CAD performs wonderful in drawing and storing economically, which improves the drawing precise degree in large-scale geography map. SuperMap GIS combines both advantages of the two software, creating a datasource which is capable to store single object such as data model of points, lines, regions, or text, as well as multiple geometry objects in a composite data model (including parametric objects). Moreover, each object is able to carry individual display style. The composite data model in SuperMap GIS can access to the DXF/DWG files of AutoCAD, DGN file of MicroStation directly. This access approach not only can keep the original properties and styles of the data, but also add more

customize attributes, providing a modern GIS to replace the simple CAD software.

Additionally, the concept of GeoCompound (Compound Object) is created to combine various geometry objects as well as other GeoCompound. As a result, the management and drawing of various complicated objects would be possible. The Cell of the MicroStation and the Block of AutoCAD could also be fully supported.

Aggregation of Various Storage Mediums

In traditional GIS software, the spatial data was stored as files. With the development of database technology, more medium and big scale GIS projects had been employed spatial database. In last two years, the server terminals became popular, meanwhile, SOA, network server, including WFS, WMS and WCS are increasingly popular. However, in SuperMap GIS the data that is from different sources, including file data, database data and web data could be managed and edited together. As a result, there are various data types in the map of SuperMap which are stored in one workspace.

Data Models Supported by the SuperMap Objects Java is illustrated in the following diagram:

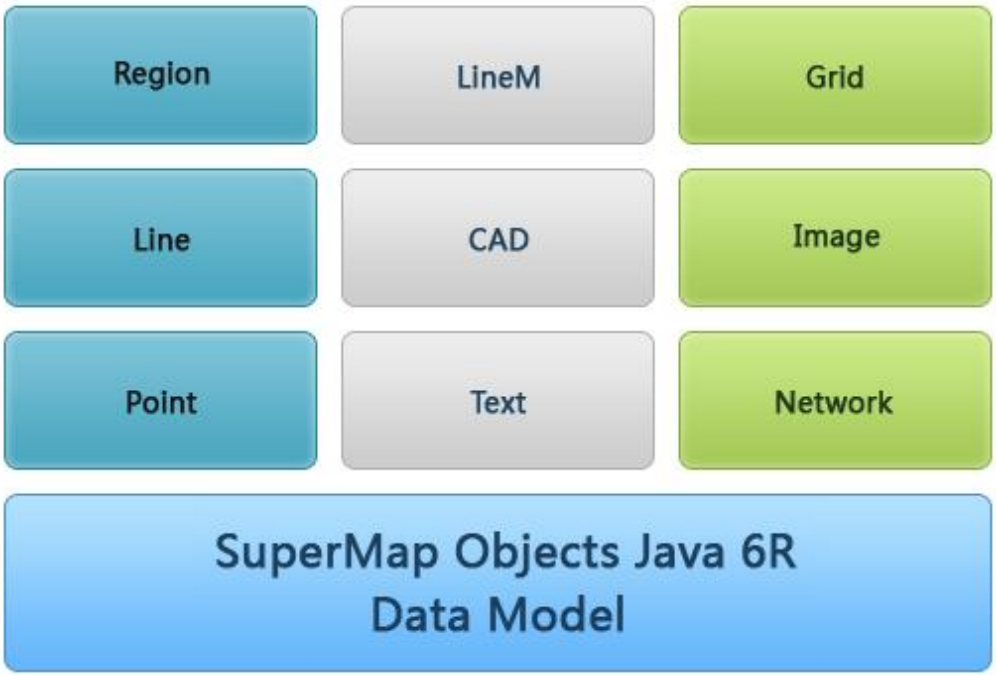


Diagram 1 Data Models Supported by the SuperMap Objects Java

Usually, people have to apply a suitable data model to describe a realistic phenomenon. Take the river as an example: it is well known that river has been playing a very important role in the development of human society. People make use of the river as the transport route, and also as the

boundary of administration areas. Moreover, many animals take the rivers as their habitat place, or as the border of their habitat area. In GIS, rivers will be displayed by different models according to specific scenes.

In a city water network research, the river is taken as one of the elements comprise city water network, which will be displayed as a Network data model. Each line has a range of properties including length, direction, and capacity. By using the facilities network analysis, the headwaters of a river, the common headwaters and lower reaches of several rivers, pollution sources can be located easily.

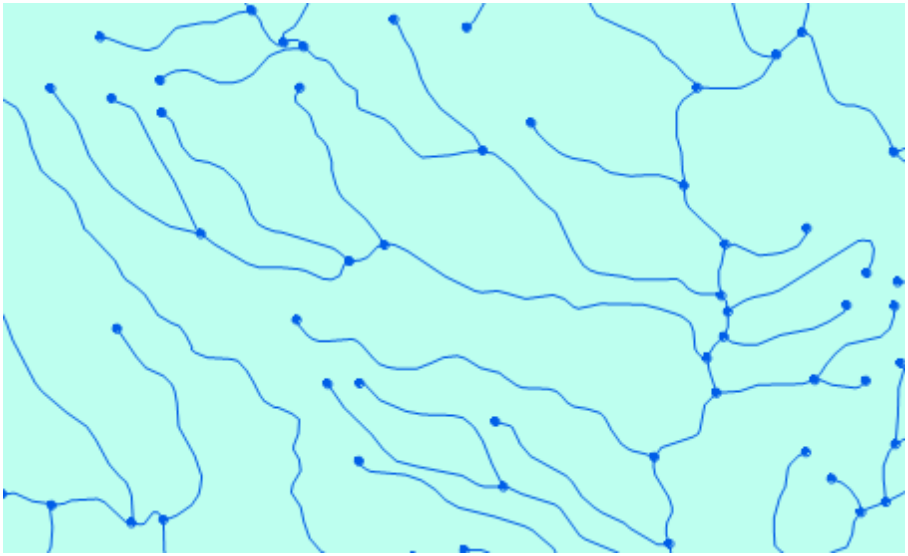


Diagram 2 Rivers are Taken as Lines in Water Network

In the analysis that the length and flow direction of rivers is the only consideration, rather than the square measure or width, the rivers will be displayed as lines. For instance, a section of the Yellow River is taken as the administrative boundary of Shanxi (falling-raising tone) and Shanxi (even tone) in diagram three.

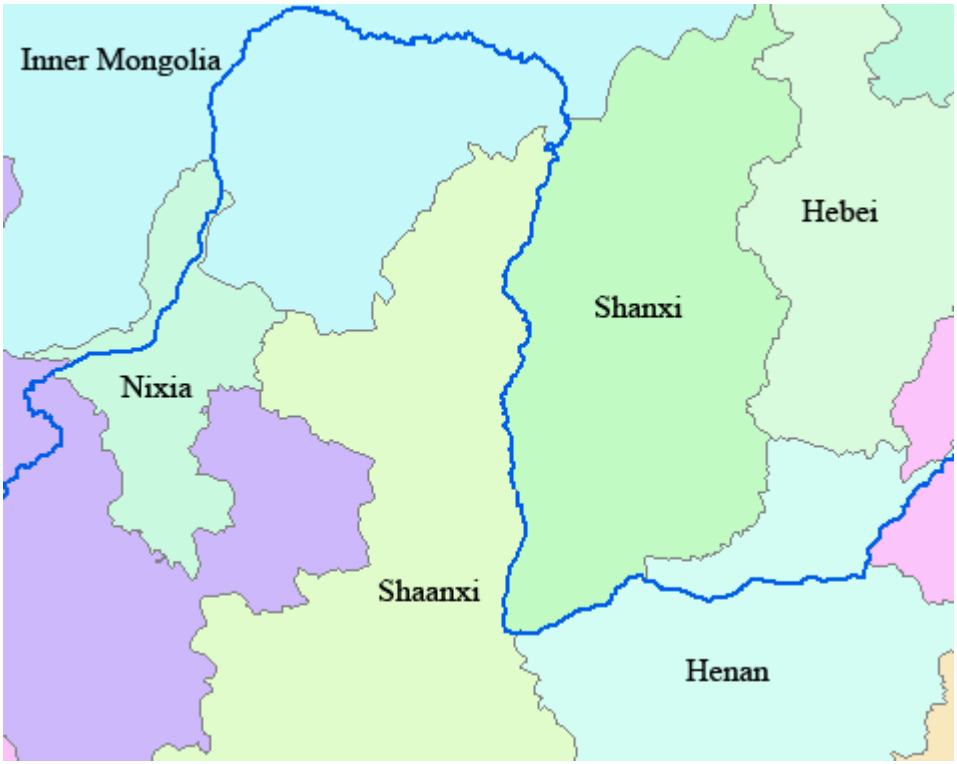


Diagram 3 Rivers are Taken as Administrative Borders

In the large-scale map, rivers are displayed as regions, with attributes of width, depth, and flow capacity. For instance, the width of the river should be considered in the research of building bridge; while the square measure is the important aspect to be considered in the research of building island in the middle of the river.

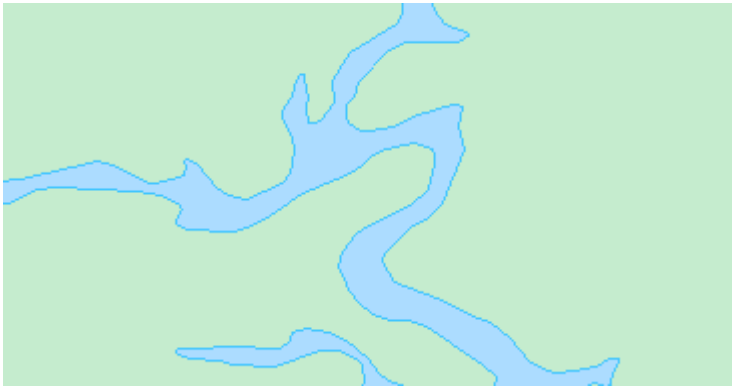


Diagram 4 Rivers are Taken as Regions in Water Network

It seems that, as simple as a river requires several data models to be displayed in different research subjects. Hence, it could be concluded that there is no such a data model that is suitable in every circumstance. The choice of a data model should come after the consideration of explicit application scene as well as the problem that need to be solved. In a word, it is must be a suitable model that correctly represents the world in each situation.

We are going to introduce the data models supported by SuperMap Objects Java in the following paragraphs.

2

Data Model of Points

Point data model (Point): zero dimension. It is stored as a pair of coordinates (X, Y), with its attributes. Point data models are used to describe very small elements, which are not qualify to be the line or region.

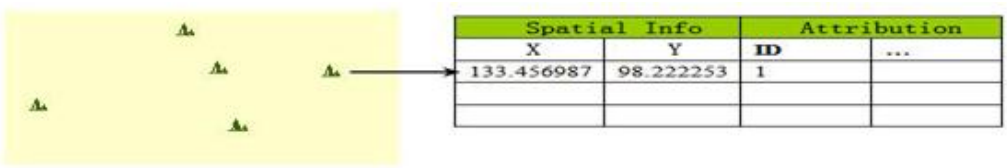


Diagram 5 Point Data Model and Its Physical Storage

Any object has size and shape character. Point data model represents the location information of an object, rather than its size or shape. For instance, the location of the Himalayas is a point on a World Map. There is a wide range of symbols provided by the SuperMap Objects Java to represent points with different meaning.

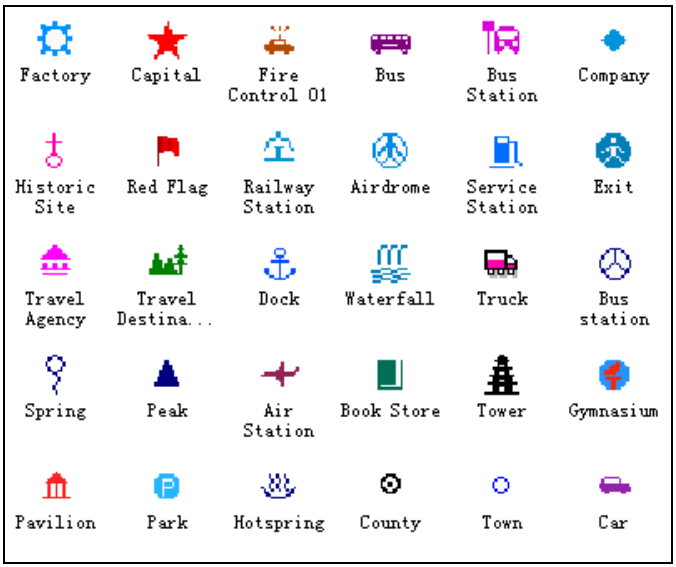


Diagram 6 Point Symbols and their representation

3

Data Model of Lines

Line data model (Line): one dimension. It is stored as a group of ordered pairs of coordinates (X, Y), with their attributes. There is line complicated object. The shape of the line could be straight lines, ploylines, circles, ellipses, and rotary line. The circles, ellipses, and arcs will be stored as ploylines. It is used to represent the 2D geographic element that is not wide enough to be a region. When the flow direction of a geography element is the only required feature, the line data model is the best choice. For instance, the rivers used as administrative borders, and the city road used in small-scale map.

The difference between simple geometries and complicated geometries: a single object is usually considered as simple geometry; while the complicated object is composed by several single objects or the result of their spatial operations. For instance, when we consider the Yellow River as integrity, it is only several lines that are necessary to represent it; however, when its branches and main streams should be displayed, the complicated object should be used to illustrate the whole system of the Yellow River.

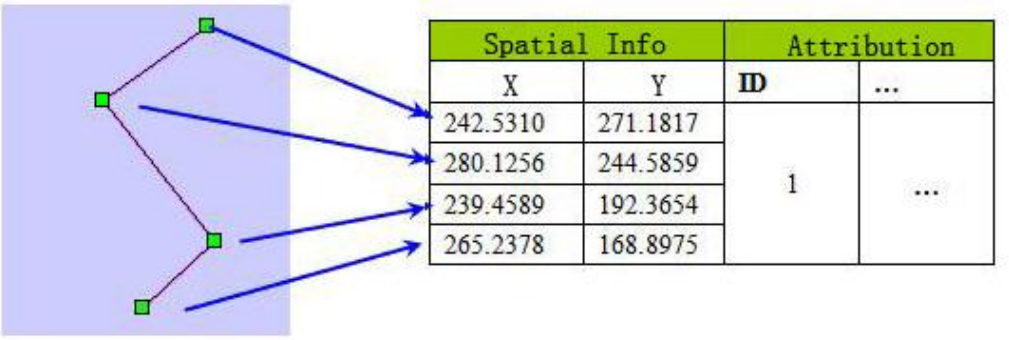
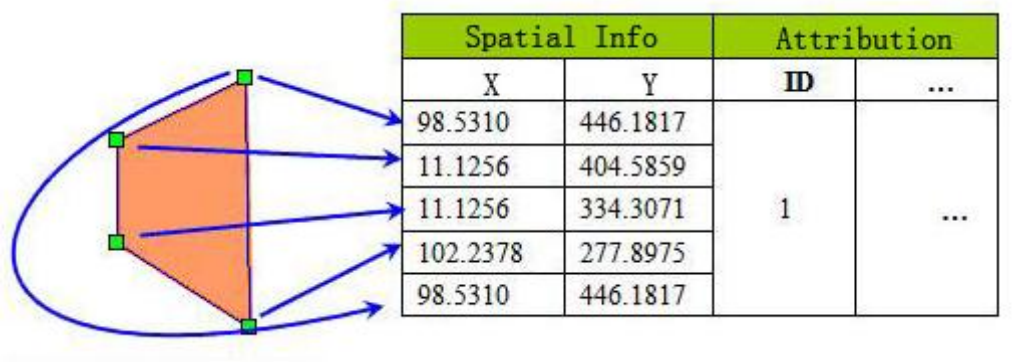


Diagram 7 Line Data Model and Its Physical Storage

4

Data Model of Regions

Region Data Model (Region): two dimensions. It is stored as a group of ordered coordinates pairs (X, Y), with their attributes, and the last point's coordinates should be the same with the first one's. Region data model represents a closed geography element which has certain square measure. For instance, the administrative provinces are usually displayed as region; the rivers in a big-scale map sometimes have to be represented by regions.



Spatial Info		Attribution	
X	Y	ID	...
98.5310	446.1817	1	...
11.1256	404.5859		
11.1256	334.3071		
102.2378	277.8975		
98.5310	446.1817		

Diagram 8 Region Data Model and Its Physical Storage

Region data model provides regional complicated object which is frequently used in describing the geographic elements correctly. For instance, Shanghai city consists of four regions, which are Shanghai downtown, Chongming Island, Changxing Island, Hengsha Island. Since these four parts are integrity, the complicated object, rather than the simple object, can display the whole city.

5

Data Model of Text

Text: Its information is divided into two parts to be stored. The first part is the coordinates of the upper-left point of the smallest external rectangle, with its attribute; secondly, the text information, including content, font, size, height, width, bold, rotation degree, colour, transparent setting, fixed-size etc., will be stored as diagram nine shows. It should be illustrated that transparent setting means making the selected text to be transparent; otherwise, the chosen setting color will be displayed. The default setting colour is transparent. Fixed-size means the text is not going to change with its layer's zoom in either zoom out, for instance, place names that have no relationship with scales. If the text is about the map's information, it ought to zoom with the layer. The height limitation of fixed-size text is 255. If your setting is bigger than that, the system will take is as 255 by default.

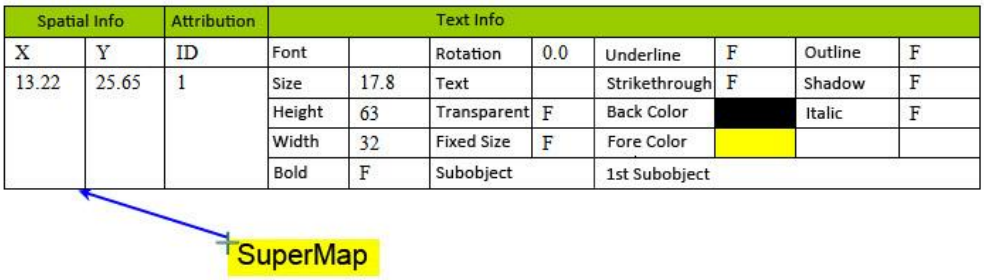
In many popular GIS software, the text annotation usually applies label thematic maps. Besides the popular one, SuperMap also provides an approach that labeling objects by the text data model. We will introduce you the differences between the text data model and label thematic maps in the bellow paragraphs.

The position of a label in the label thematic map could be changed by settled principles. With the zoom in and zoom out of the map, the label will be displayed by flow visualization and automatic avoidance. However, the position of a text data model could be settled and adjusted manually,

Label thematic map content is added from property fields, while the text in the text data model is added or edited on the layer directly.

The label style of the label thematic map is designed by rules, which are able to provide label segmentation thematic map by setting. The text data model permits every data model has individual style given manually.

In a summary, the label thematic map is flexible and easily to adjust; while the text data module is an ideal choice whenever a fixed position, independent display style and other data importing are required. In SuperMap GIS, there is selection to store the label thematic map "saving as text data module". Therefore, you may create the label thematic map first, and then save it as text data model, finally make adjustments to the particular text according to specific requirements.



Spatial Info		Attribution	Text Info							
X	Y	ID	Font		Rotation	0.0	Underline	F	Outline	F
13.22	25.65	1	Size	17.8	Text		Strikethrough	F	Shadow	F
			Height	63	Transparent	F	Back Color		Italic	F
			Width	32	Fixed Size	F	Fore Color			
			Bold	F	Subobject		1st Subobject			

Diagram 9 Text Data Model and Its Physical Storage

6

Data Model of GeoCompound

GeoCompound data model (CAD): a data model that can store multiply types of geometry objects. Please see the diagram ten. At beginning, many GIS projects employed the CAD software (for instance AutoCAD, MicroStation and so on) to produce maps; therefore, there are a lot CAD data available. CAD drawing is simple and usually small size and was the main contributor to digitize maps in the early GIS development period. However, CAD data is not convenient to expand properties; neither has analysis functions in GIS. Hence, the development of GIS requires the GIS software that is powerful than CAD software. At this stage, it is necessary to import CAD data into the GIS environment, and to access the CAD data from GIS software directly. For all of the stated to be possible, SuperMap GIS designed GeoComponent data model, which is used to store and manage the spatial data that is similar with CAD data structure and functions. Through GeoCompound data model of the SuperMap GIS, you are allowed to directly access the DXF/DWG files of AutoCAD, and DGN file of MicroStation, with their original property and style, creating custom properties easily.

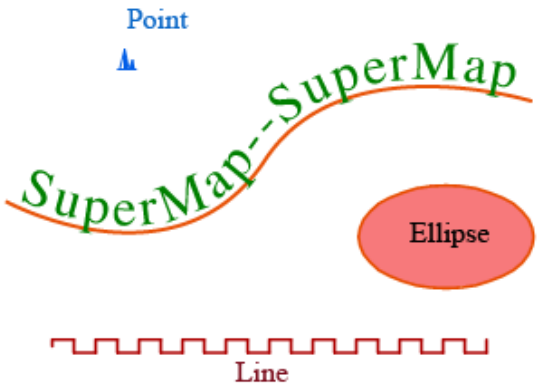
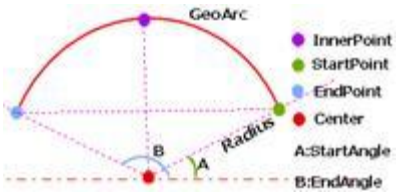
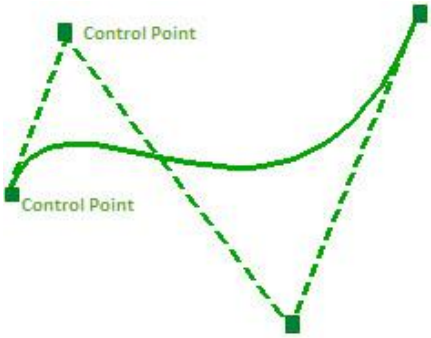
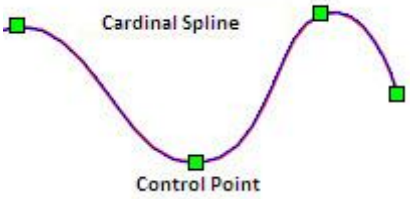
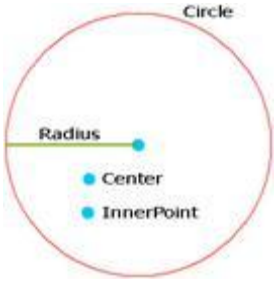


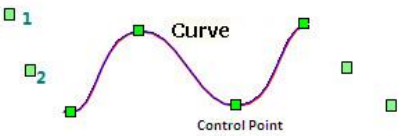
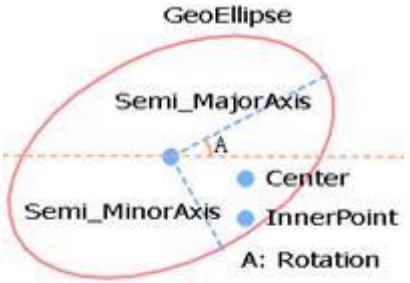
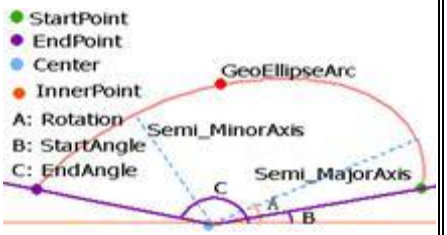
Diagram 10 GeoCompound Data Model Contains Multiple Data Types and Style

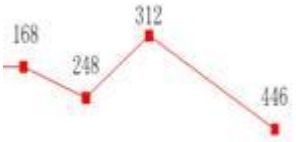
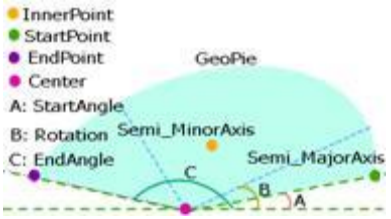
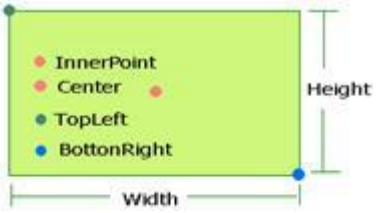
Geocompound data model can contain geometry objects of points, lines, regions, and text, all of which are able to have individual style. Currently, CAD supports many objects including arcs,

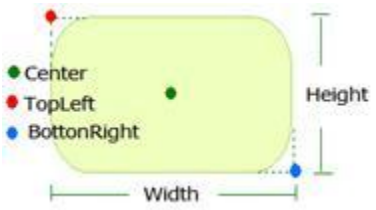
B-splines, cardinal splines, circles, compounds, curve splines, ellipses, ellipse arcs, lines, routings, multiple-points, sectors, points, rectangles, rounded rectangles, regions, and text.

Table 1 Object Types

OBJECT TYPES	OBJECT NAMES	PARAMETRIC OR NOT	OBJECT FIGURES
GeoArc	Arc Object	Y	
GeoBSpline	B-spline Object (The first and final control points on the spline which is created by fitting of the middle control points.)	Y	
GeoCardinal	Cardinal Spline Object (All the control points are on the spline which is created by fitting of the middle control points.)	Y	
GeoCircle	Circle object	Y	

OBJECT TYPES	OBJECT NAMES	PARAMETRIC OR NOT	OBJECT FIGURES
GeoCompound	GeoCompound object	N	
GeoCurve	Spline object (The two control points of a spline's initial point as well as its two control points of the endpoint make the direction of the whole spline. Besides the four control points, other points are on the line, which is created by fitting of other control points.)	Y	
GeoEllipse	Ellipse object	Y	
GeoEllipticArc	Ellipse arc object	Y	

OBJECT TYPES	OBJECT NAMES	PARAMETRIC OR NOT	OBJECT FIGURES
GeoLine	Line object	N	
GeoLineM	Routing object	N	
GeoMultiPoint	Multiple points object	N	
GeoPie	Sector object	Y	
GeoPoint	Point object	N	
GEORECT	**RECTANGLE OBJECT**	**N**	

OBJECT TYPES	OBJECT NAMES	PARAMETRIC OR NOT	OBJECT FIGURES
GeoRoundRect	Rounded rectangle object	Y	
GeoRegion	Region object	N	
GeoText	Text object	N	text

The differences between GeoCompound data model and single data model (points, lines, regions data models):

There are multiple data types could be stored in the GeoCompound data model, for instance, points, lines, regions, and text and so on. In the simple data model, only one data type is legal. For instance, only point data can be found in the point data model.

It is possible to set different style to the objects in the GeoCompound data model; however, all the objects in the simple dataset should share the same style with its located layer or get various style by setting thematic maps' property information.

Several objects in the GeoCompound dataset could compose to be one compound object. The attribute records of the compound object will be added to the end of the property table. The system fields will be assigned by the system; others will keep the smallest SMID value of the compound objects. The original objects and their attributes will be deleted. The compound object could be composed again with another compound object or simple object to become a new compound object. Compound objects are widely used in CAD mapping. For instance, we have to use a number of symbols which usually consist of points, lines, regions, and text in the garden plan design map. If we take the whole symbol as a single compound object, that would be more convenient for our mapping. For instance, the Disable Symbol contributed by a circle surface, a section of arc, several splines, as the below diagram shows. When all these elements are considered as an integrity, which is a compound object, the copy and paste of the symbol become a easy job.

Diagram 11 GeoCompound

The differences between the combination and mergers:

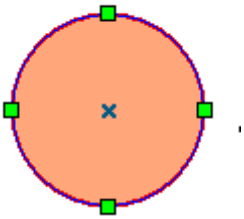
The merger is suitable to points, lines, regions, as well as compound data model; while the combination is only applied to compound data models.

For two region objects that have overlaps with each other, the merger can ignore their adjacent border lines as well as the overlap parts and produce a simple object; while the combination of the two objects does not mean to merge any part.

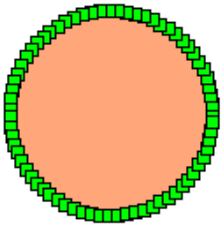
Only the objects which have the same types could be merged, while all the objects can be combined to become a compound object. As we stated, the compound object could go on to combine with other objects to be a new compound object.

The storage of ellipses and circles in compound dataset consists of centre coordinates x, y, and the radius length. However, the simple dataset stores a range of orderly coordinates of x, y, as Diagram 12 shows.

Parametric Storage



Coordinates of Point Storage



Spatial Info		Attribution	
Center		ID	…
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Y	88.542		
Radius			
24.739			

Spatial Info		Attribution	
X	Y	ID	…
229.551	414.925	1	…
229.421	417.795		
…	…		
229.044	409.209		
229.424	412.056		
229.551	414.925		

Diagram 12 Physical Storage Contrast

7

Data Model of Route (LineM)

Traffic departments usually investigate evens (traffic accident, speed limits) and facilities (bridges, crossroads) of the roads, rivers and pipelines in a line reference system. A line reference system produce distance from the known point (the route initial point, landmarks, or a crossroad) to the accident happen position. For instance, a traffic accident position contains street names and the distance to the landmark.

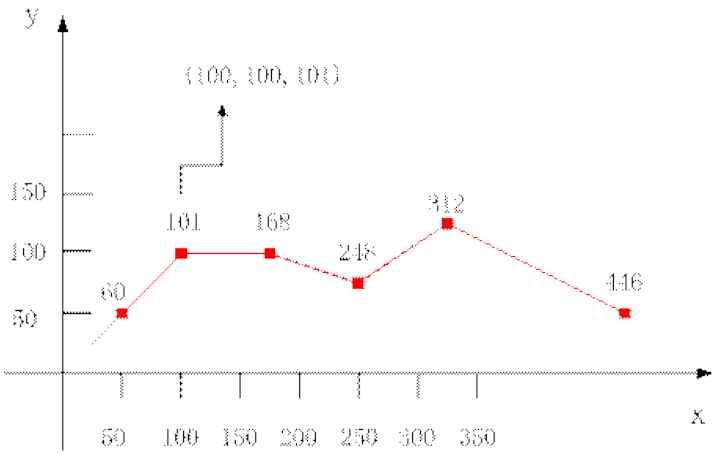
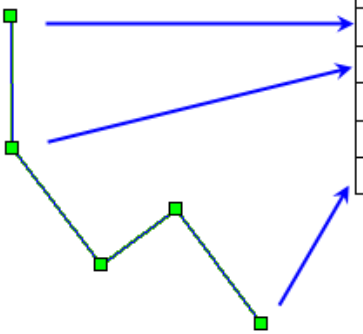


Diagram 13 Data Model of Route

Route data model (LineM): a range of orderly x, y coordinate pairs with attribute values and M value which are the distance property of the node (the distance to the known point), as the diagram thirteen shows. A LineM is a line data model with the value of M. The landmarks along the expressway are the most common LineM, which are used frequently by the officers to mark and manage the traffic, driving speeds limits, traffic accident positions and so on. LineM data model is able to locate dynamic road events by dynamic segments function, which means locating point-event position (accident place, bridges) or line-event position (speed limits, traffic and so on) by given conditions.



Spatial Info			Attribution	
X	Y	M	ID	...
116.68	358.94	0.00	1	
216.88	286.86	216.25		
355.12	286.86	381.63		
...	...	...		
489.82	374.63	630.53		

Diagram 14 LineM and Its Physical Storage

8

Data Model of Network

Net work data model (Network): storing the data with web topology relationship, containing network line datasets, network point datasets, and the spatial topology relationship between them. The line dataset is the first dataset, whose sub-set is point dataset.

Network Datasets

Line Dataset Point Dataset

Diagram 15 Line Data Model and Its Physical Storage

On the basis of network data model, governments and business organizations usually employ it to conduct route analysis, service zone analysis, locating nearest facilities, resource assignment, selecting location, analysis of adjacent points and accessing points.

9

Data Model of Grid

Grid data model (DatasetGrid): optical grating data model. Dividing a surface in equal rows and columns, each rectangle on the network surface is a pixel. DatasetGrid is a matrix of pixels. Each pixel represents a geography entity or geography phenomenon, such as elevation values, soil types, land use types, rock formation depth. Please refer to the diagram fifteen about the land use types image, the Diagram Seventeen is DEM diagram.

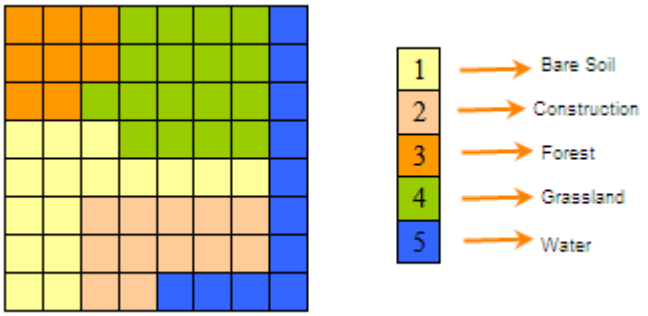


Diagram 16 Data Model of GRID

On the basis of DatasetGird, the operations focus on mathematic analyses and figures process, such as grid statistic, arithmetic operation. The most widely used grid analysis is spatial analysis on physical subject, for instance, grid analysis on the land surface, hydrological analysis on the land surface, obtaining the feature lines of terrain, building terrain surface module, as well as many analyses operations in science research.

Before the storage of DatasetGrid, it is usually recommended to conduct compression coding. Currently, the mainly compression coding is SGL (SuperMap DatasetGrid LZW). SGL is a compressed storage method defined by SuperMap, which is an improved LZW (Lempel_Zir_Welch) coding. This method not only compresses the repeated data, but also the none-repetition data. The current compression approach of DatasetGrid dataset and DEM dataset in SuperMap GIS is SGL, as it cause no data lost.

DEM: a displaying approach of a surface with fluctuate characters. DEM is a special DatasetGrid data model. Each web rectangle contains elevation value and is represented by standard colour, which is helpful to combine a tile DEM image.

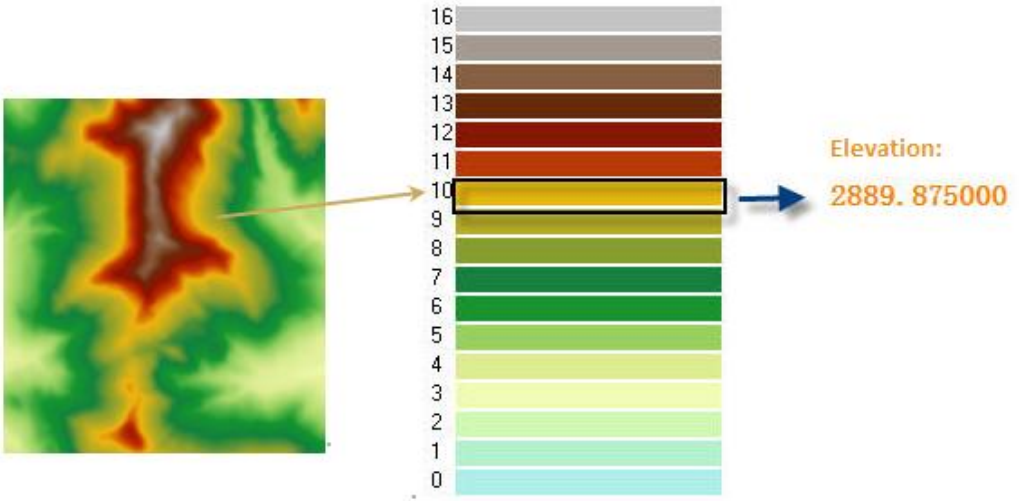
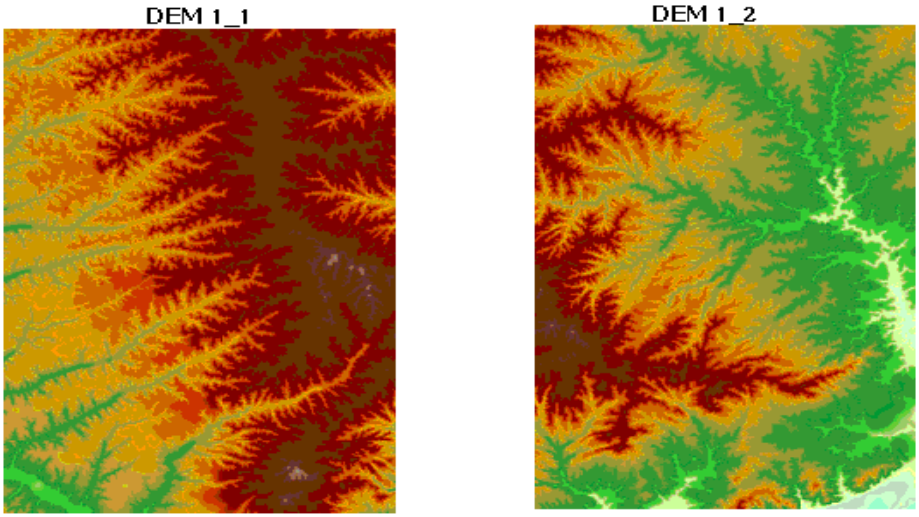


Diagram 17 Data Model of DEM

Diagram seventeen illustrates the tile DEM image combination procedure. There is no break between images either the colour.



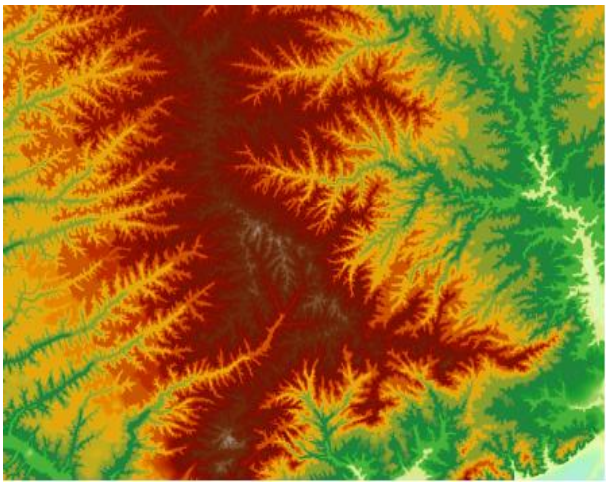


Diagram 18 splicing of Tile DEM

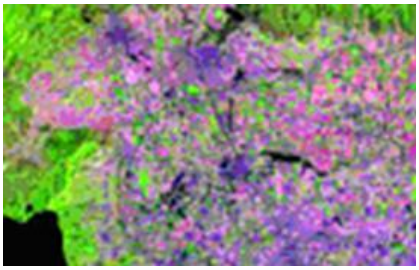
DEM is useful in many areas, no matter in civil or military areas. For instance, in the project of road designs, how to calculate the earthwork amount, choose road routes, and select address. While in military, it is employed in matching terrain for weapon precise shoot, displaying landscape for military activities and cross country analysis. In terrain relative subjects, it is widely used in comparing different terrain and statistic analysis, calculating slopes and aspects. Hence, the slop and shading map could be drawn. In analysis of other areas, calculating etching and stream flow, combining analysis with thematic data (soil for instance) to conduct combination analysis would produce many useful results. If the DEM data represents temperatures, population and groundwater level could be analyzed.

10

Data Model of Image

Image data model (Image): raster data obtained by photography system on the plane or satellite. Each pixels value is the reflectivity of light in certain wave band. The image of earth surface is able to analyze the land use, plant variation, mineral distribution, or climate conditions according to the cloud map of atmosphere.

According to the wave band, they are divided into single band image with various gray of black and white, and multiply band image with combined RGB pixels.



Satellite Remote Sensing Image

Aerial Photos

Diagram 19 The wave band image and the aerial photo

Aerial Photos is usually in big scale. We recommend you to compress it before importing into the SuperMap software. The compression will apply DCT (Discrete Cosine Transform) coding. DCT is a discrete cosine coding approach and popular in compressing images. DCT has a high compression rate, but there will be some information lost. However, image data is usually not employed in precise analysis, therefore, DCT is the ideal choice.

Image pyramid is useful to improve the browsing speed, which is an image set of grid dataset with reduced resolution. By re-sampling the images, a range of image layers with different resolution will be established. Each layer is stored separately, and has spatial index mechanism. Hence, the browsing speed will increase. Please see the diagram below. This is an image pyramid with four floors, which means four class resolutions. For an image with resolution 2a*2b (a>b), SuperMap will build a pyramid with (b-6) +1 floors.

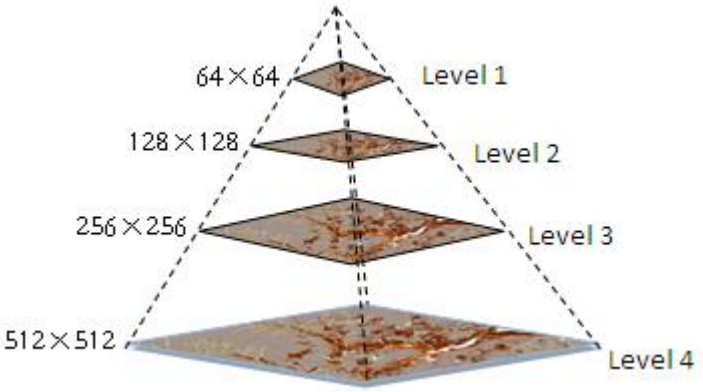


Diagram 20 The image pyramid

The image pyramid will be used to display the image data by the system whenever you browsing maps. The zoom move will lead to different floor of the pyramid to show the map. This would make the browsing procedure an enjoyment.

SuperMap provides a very latest image storage format: SIT, short for SuperMap Image Tower, which combines the image compression and pyramid technology. SIT are not only able to compress massive scale of data, but also improve the browsing speed.

SuperMap SIT used 64-bit code to support massive scale file, as large as 263 byte. This scale could merge all image data to one file. In practice, SIT is only restricted by the size of the hard disk or its segment system.

SuperMap SIT provides password protection function, permitting encryption to SIT file to raise the security of data.

SuperMap GIS also offers customize image plug-in (ImagePlugins), which supports directly access to BMP, JPG, TIF, SCI, RAW, SIT files. You may custom an image format according to the given head file, to open your image in SuperMap freely.