Design and Implementation of Spatial Variation Analysis System

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Abstract: - The advantages of traditional integrated GIS are integrate each component of GIS and form independent complete system, for example ArcGIS and MapGIS, but the system is complex, huge, difficult to install, leads to high cost and difficulty in integrate with other applications or system and so on. Component GIS that meet various professional needs not only can carry on reorganization freely and nimbly between each module, but also has a visualization interface and easy-to-use standard interfaces. Spatial variation research mainly has traditional statistics analysis and geostatistics. The advantage of geostatistics is not only consider the value of the sample size, but also pay attention to sample space position and its distance, that make up for the defect of traditional statistics analysis that ignore spatial position. Geostatistics has not been integrated with GIS is a severe flaw of GIS. So, we develop a light-duty Spatial Variation Analysis System use VS 2005 in the support of ArcGIS Engine combined present needs. The article introduces the system's design ideas, the major function modules, the development and implementing; and use HeBei province Handan County soil data to do system test. The result shows that the system has a good operation efficiency and accuracy to meet the general spatial variation analysis need.

Key-Words: - Spatial gridding methods; Geostatistics; Spatial variation analysis; Components development; ArcGIS Engine

1 Introduction
Spatial variation study has traditional statistics and geostatistics. Geostatistics is a new branch of statistics also known as geological statistics, the French well-known statistician G. Matheron propose it first through substantial theoretical research. Geostatistics could not integrate with GIS analysis model well long time. New version of the current commercial GIS include statistical analysis module, because of the high cost, complex installation, too large memory space and other factors, its application is limited. ArcGIS Engine (referred to as AE) is the bridge between Geostatistics and GIS, making the complex geostatistics to achieve well. Therefore, we use C # develop the system to meet the need of the spatial variation job.

2 System Development Environment and Development Model
2.1 AE Technology
Major international commercial component GIS software are ArcObjects, MapObjects, ArcGIS Engine that all of them are developed by ESRI. Compared with the ArcObjects, MapObjects has less interface but provides common GIS functions, even the dynamic characteristics of GPS, and its structure is rational, and easy to understand, but it is only meet the user who need result inquiry, searching, graphical display and easy Edit functions only. ArcObjects owns more than 1800 components, is the most powerful, most components, has the most complex structure. AE is a independent components package based on ArcObjects, through reintegration and expansion, it do not bundled with ArcGIS Desktop, provides running version and development version, suitable for advanced development.

2.2 . NET Integrated Development Environment
Visual C # . NET is created based on the powerful C ++ tradition language. C # is a powerful, intuitionistic, object-oriented programming language, which not only allows C ++ and Java developers familiar with it right away, but also provides important improvements, includes a unified type system, to maximize the developer-controlled "non - security " code as well as most developers easier to understand powerful new language structure. . NET provides a convenient, fast, friendly, powerful toolbox, improve the efficiency of system development greatly.
2.3 Integrated Secondary Development

Independent development is much more difficult, simple secondary development is limited by the programming language that GIS tools supplied, and the effect is not good enough, so, integrated secondary development that combine GIS and today's visual programming language become the mainstream approach of the GIS applications development. It can take full advantage of management and analysis spatial data of GIS tools, but also can make use of highly efficient and convenient programming advantages of other visual language, not only can improve the development efficiency of application system greatly, and has a better appearance, more powerful database functionality, reliability, easy to transplant, easy to maintain.

3 System Design and Implementation

3.1 System Design

Overall goal is to build a all-purpose spatial variation analysis system, its design follow following principles: user-friendly, prototype model, advanced and practicality, openness and scalability. System design methods is from the next and the next modular and structured.

3.2 System Function

(1) Data management. Realize the basic functions of GIS systems, include open files, add data, save as, zoom in and zoom out, pan, full extent and other functions of maps elements, delete layer, query corresponding attribute data of the spatial data, set to initialize display layers, quit applications, select point data symbols;

(2) Data analysis. System can use the five interpolation function (Krige, IDW, Spline, Trend, Variogram) carry interpolation analysis to the loaded point data, generate a surface and then make a further prediction and evaluation value analysis.

(3) Set parameters. System can select interpolation function, select characteristics field, set the output raster image pixel size and other functions.

(4) The production of thematic maps. System can carry general rendering or classificatory rendering to the results, classify and render the gray shading shows results, enhanced visual effects, so that the results of interpolation to get a better clarity, and easy to analysis. Users can only carry general rendering according to actual demand rather than classification, also can set the number of classification level to carry classificatory rendering.

3.2 System implementation

Visual ActiveX Control of AE provides data management capabilities. First of all add ToolBarControl, through the Item attribute to add the basic required functions of the system, such as load geographic layers, zoom in, zoom out, pan, full extent and so on. Add ToccControl, MapControl, and set the buddy attribute of ToolBarControl and ToccControl, that it bundled with MapControl, user clicks on the view or drag the map can change the display scope of the map. System runs connect spatial database when load data, we develop three classes include connect attribute data of the corresponding spatial data, delete the current layer and symbols selector, user can achieve the operation through the main program invoke the corresponding class.

The core of the system is data analysis module, that is IRasterAnalysisEnvironment interface definitional five methods (Krige, IDW, Spline, Trend, Variogram), the user can run the drop-down box to select the appropriate method in accordance with actual situation. Every method has its parameter. The five methods share the first parameter, its meaning is put IFeatureClassDescriptor type definitional variable that pfdc forced into Geodatabase type, its provide the characteristics field of the current activity layer; the second parameter is different optional meanings of each method. The production of thematic maps provide general color rendering and classificatory rendering function, so that the analysis results is more clear. General rendering achieves by IRasterLayer, IRasterStretchColorRampRenderer, IRasterRenderer, IAlgorithmicColorRamp interfaces; classification rendering achieves by IRasterLayer, IRasterClassifyColorRampRenderer, IAlgorithmicColorRamp, IRasterRenderer, IFillSymbol interfaces, and user can select the classification number through the drop-down box. Method’s core is setting the colorRamp attribute of IRasterStretchColorRampRenderer or IRasterClassifyColorRampRenderer then assigned it to the renderer attribute of current layer (IRasterLayer) to achieve rendering.

4 System Application

System integrates five methods used for spatial variation analysis, covers the classical theory algorithms of geostatistics, the software is easy to operation, user-friendly, results intuitive, has good usability. We analyze the soil nutrient data of Hebei Handan use Trend interpolation analysis (Figure 1), characterized field is Total_K. We can see the entire
Handan total soil K content from the chart, the maximum value is 31.0628, the minimum value is 11.1926, extreme difference is 19.8702. The center region has the highest K content, the lowest is in the Northeast, the general trend is reducing from west to east. Compare to the integrated GIS spatial variation analysis module, the results of the analysis show that the system redundancy small, fast, reaching the same results, and simple operation, easy to understand and installation.

5 Conclusion
Spatial variation analysis system considers the user's needs, uses GIS, computer technology, programming design, can analyze the spatial variation characteristic of regional variables quickly, conveniently and accurately, can meet the need of current research and analysis of spatial variation, can be used in soil science, meteorology, ecology, geology, hydrology and environmental resources all field that exist "Spatial Variation", and provides help management, fertilizer, and so on for agricultural production. Future development work is to increase graphics output and other functions.

References: