Geometric Algorithms in GIS

GIS Visualization Software

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GIS Software for Visualization

- ArcView
- GEO/SQL
- Digital Atmosphere
- AutoDesk
- Visual_Data
- GeoMedia
- GeoExpress
- CAVE?
Visualization in GIS deals with displaying information regarding geographical data. Challenges include accuracy, integrity, and visibility. Commercial and specialty software and programming tools exist that focus on visualizing geographical information in specific areas of GIS.
General Challenges in GIS Visualization

- Moving from photos/data to digital images
- Displaying diverse information in a consistent manner
- Manipulating data easily
- Creating databases of GIS information
- Processing spatial queries easily
Example: Geological Information

- Visualization of geological information includes minerals, precious metals, oil and gas deposits, etc.

Courtesy of: http://www.nrcan.gc.ca/gsc/calgary/labs/geologic1_e.html
ArcView and Geology
Programming Tools

- ArcView is an interactive software that can be tailored to users' needs.
- It provides a host of built-in tools for geological information visualization.
- It allows for the creation of application specific scripts and macros.
- It also allows for the creation and linking of spatial databases to information visualization.
ArcView as part of ArcGIS
Software: ArcGIS Extensions

- **Extensions**
  - Useable by ArcView, ArcEditor, ArcInfo
  - **3D Analyst**
    - ArcScene for real-time interactive 3D scenes
    - 3D modeling tools for visualizing, analyzing surface data from multiple viewpoints
    - Surface queries
    - ArcTIN tools
  - **Spatial Analyst**
    - Advanced cell-based raster modeling and analysis
    - Raster to vector analysis, accumulated travel cost calculations
    - ArcGrid calculator for grid functions
Graphics: ArcView (3D Analyst)
Query: ArcView

- Generate queries in QueryManager using SQL query language
- ArcIMS allows client-server queries over web
- Automatic extraction of query results into Microsoft Excel
- TIN based model
Database: ArcView
Software: Geo/SQL

- Calgary-based company
- Provides solutions to simple and complex GIS and mapping problems
- Based on spatial technology
- Supports ESRI data formats
Points
- Representation: (x, y, z) single-coordinate triplet
- Symbols (held in libraries) [name, angle of rotation, size]
- Translated from AutoCAD block inserts

Lines
- Representation: points or geometric arc (center point, radius, start-end angles)
- Line of variable width, series of symbols forming a pattern

Polygons
- Representation: like a line, but end point = starting point
- Solid colours, hatch patterns, boundary lines, centroid symbols
- May contain islands (nested polygons)

Backgrounds / Wallpaper
- Rich display that are spatially related to the data, but cannot be edited
- No negative impact on display
Database: Attributes

- All spatial objects may be described by spatial and non-spatial properties (attributes)
- Example: Heart attack database in Calgary
  - Regions with many attributes, tables and columns
- Geo/SQL: SQL databases used for backend storage:
  - Attributes correspond to Column Names in the SQL tables
Database: Geo/SQL

- Supports connections to multiple databases by storing them as part of the data source definition of all themes.

- DB Interface (DBI) manages communication with SQL DB’s using run-time loadable drivers (no multi-user editing).
Database: Geo/SQL

- Spatial SQL Database:
  - Alternative is available in Geo/SQL
  - All spatial and non-spatial data stored in a single DB
  - Since spatial data requires expensive search algorithms, indexes and referential integrity checks, the representation is procedural and complex
Databases: Geo-Coding

- Supported by both Geo/SQL & ArcView
- Automatically assigns spatial properties to objects through attributes (using a common field)
- Resulting spatial objects are known as derived objects
- Point Geo-Coding, Line Geo-Coding
Databases: Geo-Coding

Point Geo-Coding

Line Geo-Coding
Climate Information

- Used extensively by weather forecasters, these systems attempt to model climate patterns, such as air currents, precipitation, temperature, and dew point information.

- Courtesy of: http://www.ocs.orst.edu/prism/prism_new.html
Challenges in Climate Visualization

- Dynamic updates from databases
- Representation of many aspects of climate over the same area
- Extrapolation of weather conditions over time
- Tracking weather changes over time
Climate Visualization Programs

- For the most part, climate visualization software uses static maps that represent climate information.
- Climate and weather maps are usually locally for geographical regions.
- Digital Atmosphere 2000 is an example of Climate Visualization Software.
Digital Atmosphere 2000
Digital Atmosphere 2000

Features

- The program allows to import practically any map in a format accepted by the World Meteorological Organization
- It allows to create scripts and run simulations over time of weather patterns
- It allows to transmit digital satellite photos.
- It provides ways to view all types of climate information.
DA2000 – Digital Satellite Photos
Residential Information

- Focuses on visualizing man-made structures, such as roads, city blocks, etc.
- Used in a variety of areas such as urban development, residential planning, and GPS Navigation.

Courtesy of: http://ca.maps.yahoo.com/
Challenges in Residential Visualization

- Focus (coarse vs. fine grain)
- Information Representation
- Intelligent Navigation (GPS)
- Intelligent Search (Databases)
- Traffic Planning
Residential Visualization Programs

- Most commercial applications simply provide maps for residential development.
- One of the leading companies that deals with residential information is Autodesk.
- The Autodesk Map software package is run on an AutoCAD base.
- The main advantage of AutoDesk Map is its ability to incorporate satellite photos and directly manipulate them.
AutoDesk Map 2002
AutoDesk Map 2002 Features

- Easy creation of spatial databases.
- Direct manipulation of maps, aerial, and satellite photos.
- Automatic coordinate geometry information extracted from maps.
- Ability to add spatial information (polygons) and convert polygons/polylines into polyobjects for export into spatial databases.
- Basic Algorithms: shortest-path, network tracing, and polygon overlay.
Visual_Data

- Supplementary Software for “Data Visualization in Geo Sciences,” J. Carr
- This is a Visual Basic program that presents a large suite of tools for data analysis and digital image processing
- Includes multivariate analysis, geostatistical simulation and digital image analysis tools
GeoMedia Viewer

- GeoMedia Viewer is an easy to use, free GIS software application for desktop viewing and distribution of geospatial data.
- It converts any type of data to uniform representation for viewing, analyzing and displaying.
- It also provides a full suite of powerful analysis tools, including attribute and spatial query, buffer zones, spatial overlays, and thematics.
Geo Express

- GeoExpress View has been designed so that you can make quick and efficient use of remotely sensed data.
- It is a robust stand-alone application employing wavelet image compression technology that significantly speeds up zooming and panning operations. This makes loading, viewing and moving around image data quick and easy.
CAVE Visualization

Terrain model – a CAVE Perspective @ the University of Illinois – Urbana, Champagne
Future of GIS Visualization

- The future of GIS Visualization will ultimately be based on new paradigms of visualization.
- Current traditional models work on bringing the 3D to the 2D.
- Future visualization will work on allowing spatial information to be visualized and analyzed in 3D.
- Trend toward integration, interoperability and interactive software development.