9 How to Pick a GIS

9.1 The Evolution of GIS Software
9.2 GIS and Operating Systems
9.3 GIS Software Capabilities
9.4 GIS Software and Data Structures
9.5 Choosing the Best GIS

Choosing the GIS
- A first GIS analyst decision is often “Which GIS?”
- GIS users need to be aware of different GIS software products during system selection and beyond
- OpenGIS (OGC) standards have led to a new generation of choices for software
- Informed choice is the best way to select the best GIS

Functionality
- What functions must a GIS perform?
- What functions can it perform?
- What software has what functions?
- First management step is often to make a requirements matrix: needs vs. capabilities
- Then can rank or score systems and select highest, or exclude
A functional definition of GIS

- A GIS is often defined not for what it is but for what it can do
- If the GIS does not match the requirements for a problem, no GIS solution will be forthcoming
- A GIS may have overcapacity (function creep)
- User contributions often fill unmet needs

For example: Hawth’s Tools and Fragstats

GIS as a toolbox...

- How did functions develop over time?
- What are the differences among software packages?
- What are any given package’s strengths and weaknesses?
- What other factors come into play, cost, training, maintenance, robustness, etc.

GIS software in 1979

- A historical GIS “snapshot” was the IGC survey conducted in 1979
- In the 1979 survey, most GISs were sets of loosely linked FORTRAN programs performing spatial operations
- Computer mapping programs had evolved GIS functionality
- Many competing operating systems
GIS in the 1980s
- Spreadsheet was ported to the microcomputer, allowing “active” data
- Relational DBMS evolved as the leading means for database management
- Single integrated user interface
- Degree of device independence
- Led to the first true GIS software

GIS in the 90s
- Used graphical user interfaces and the desktop/WIMP model
- Unix workstations integrated GIS with the X-windows GUI
- GISs began to use the OS GUI instead of their own
- PCs integrated GIS with the variants of Windows and other OSs

GIS in the 2000s
- Mobile systems
- Web-based extensions
- Distributed systems and data
- Most software now object-oriented
- New competition: OpenSource GIS
- Web services
- Location-based services
Trends still under way
- Open Source development tools now ubiquitous, e.g. geotools libraries
- GoogleEarth, Bing Maps, etc.
- Mash-up solutions
- Many solutions using scripts and utilities, not programs

The “critical six” functional capabilities
- data capture
- storage
- management
- retrieval
- analysis
- display

Data capture functions
- digitizing
- scanning
- mosaicing
- editing
- generalization
- topological cleaning

Figure 8.1 Steps in mosaicing. Left: Two maps show one feature, but there is a gap. Center: Map edge is merged, nodes are snapped to “map” feature. Right: Mosaic map with continuous feature and dissolved map edge.
Rubber sheeting

![Image: Rubber sheeting method]

Figure 8.3: Rubber sheeting method. A map with line and geometry for an air photo taken or scanned can be distorted so that its geometry matches that of another map. This is performed for both on the image and on the map showing the same place or feature location, called control points. When the OGR rubber sheeting maps the geometry minimally in that of the maps so that the two geometries match.

Line generalization

![Image: Line generalization alternatives]

Figure 8.4: Line generalization alternatives. The line (left) can be resampled by taking every nth point (center), or by repeatedly selecting the most distant point from a line between end nodes (right) and subdividing the line until a minimum distance is reached, the Douglas-Peucker method.

Storage functions

- compression
- metadata handling
- control via macros or languages
- format support

Compression

- By data structure
  - quad trees
  - run length encoding
  - image pyramids
- By data format
  - compressed TIF
  - jpeg
- By physical compression
  - digit handling
Data management functions
- physical model support
- DBMS
- address matching
- masking
- cookie cutting

Data retrieval functions
- locating
- selecting by attributes
- buffering
- map overlay
- map algebra

Cookie cutting

Map algebra
Data analysis functions
- Interpolation
- Optimal path selection
- Geometric tests
- Slope calculation
- Line-of-sight
- Workflow support

Interpolation

Data display functions
- Desktop mapping
- Interactive modification of cartographic elements
- Graphic file export
- Support for new map types
- Support for press quality

Generic functions
Functional capabilities are by-products of data structure

- Raster systems work best in forestry, photogrammetry, remote sensing, terrain analysis, and hydrology
- Vector systems work best for land parcels, census data, precise positional data, and networks

Vector

- Precision intact
- Used when individual coordinates are important
- More concise spatial description
- Assumes feature model of landscape
- Easy to transform data e.g. map projections

Raster

- Better for field data
- Used by most imaging systems
- Can be compressed
- Easy to display and analyze
- Many common formats
- However, most systems now use both
- Raster layer often backdrop-onscreen editing

Commercial GIS

<table>
<thead>
<tr>
<th>Software</th>
<th>About</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcView</td>
<td>Map, TOPObase, MapGuide, and other products that integrate with ArcGIS tools.</td>
<td><a href="http://www.esri.com">www.esri.com</a></td>
</tr>
<tr>
<td>Environment Systems</td>
<td>Intergraph, Intergraph Professional, CoordAge, WebMap, and other products for industry sectors, as well as photogrammetry.</td>
<td><a href="http://www.intergraph.com">www.intergraph.com</a></td>
</tr>
<tr>
<td>ERDAS</td>
<td>Intergraph's software integrates GIS, photogrammetry, and remote sensing.</td>
<td><a href="http://www.erdas.com">www.erdas.com</a></td>
</tr>
<tr>
<td>ENVI</td>
<td>ArcView, ArcGIS, ArcSDE, ArcGIS, ArcView, and ArcGIS server.</td>
<td><a href="http://www.envi.com">www.envi.com</a></td>
</tr>
<tr>
<td>ENVI</td>
<td>ArcView/ENVI, Image analysis, exploitation, and hyperspectral analysis.</td>
<td><a href="http://www.esri.com">www.esri.com</a></td>
</tr>
<tr>
<td>MapInfo</td>
<td>Interfa horse, includes: MapInfo Professional and MapInfo Server. Integrates GIS software, data and services.</td>
<td><a href="http://www.mapinfo.com">www.mapinfo.com</a></td>
</tr>
<tr>
<td>MapInfo</td>
<td>Preeminent GIS software package.</td>
<td><a href="http://www.mapinfo.com">www.mapinfo.com</a></td>
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Commercial GIS (ctd.)

TatukGIS. Gdynia, Poland.

MapGIS: Wuhan University, China

SuperMap: Chinese Academy of Sciences
The Big Eight

- Form the bulk of operational GIS in professional and educational environments
- Have changed only slightly over time
- All use version update
- There are some significant differences between these “big eight” systems

ArcGIS
ESRI
Redlands, CA
Market leader
PC and workstation
remarkable functionality
many formats supported

ArcPad
Mobile GIS
Designed for GPS and PDA
Developer package
Uses Windows CE
AutoCAD MAP

- Windows all versions
- SQL DBF Access
- Extension to AutoCAD
- Menu-based
- Massive installed base
- Added grid, projection & topology support
- DB links good.
- 3D links good

GRASS (QGIS)

- First UNIX GIS
- Developed by Army Corps of Engineers
- UNIX functionality
- Many unique functions
- Free until recently
- Many data sets
- Baylor University now supports

IDRISI

- Developed at Clark University, Worcester MA
- Original in PASCAL, with open code
- Development uses a specialty
- Windows/DOS
- Spatial analysis/stats /modeling extensions

Maptitude

- Caliper Corporation
- Consultancy
- TRANSCAD and GIS+
- Many network solutions
- Windows
- Import/Export
- Address matching
GeoMedia
- CAD software with GIS
- extensions
- Intergraph Corp, Huntsville AL
- Uses Windows NT
- Many parcel applications
- Web extensions, server tools etc.

MapInfo
- Based in Troy, NY
- Mapping functions
- Uses Visual Basic
- Many applications
- Favored for 911, field

Manifold GIS

Open Source GIS
- Basis in standards: OGC critical, but others e.g. GeoVRML, X3D, X11, GML
- Includes code level tools, scripts, libraries, and utilities
- Clearinghouses for information: e.g. opensource.org
- Support fora, wikis, lists, etc
- Whole GIS systems e.g. GRASS, QGIS, MapWindow
- Whole web-based support systems e.g. MapServer
What is Open Source?

Open Source Initiative
1. Free Redistribution
2. Source Code
3. Derived Works
4. Integrity of The Author's Source Code
5. No Discrimination Against Persons or Groups
6. No Discrimination Against Fields of Endeavor
7. Distribution of License
8. License Must Not Be Specific to a Product
9. License Must Not Restrict Other Software
10. License Must Be Technology-Neutral

OSI vs. FSF
- Open Source Initiative policies OpenSource
- Not exactly the same as freeware
- Some FSF licenses not accepted by OSI
- Nearly all free software is open source, and nearly all open source software is free

The nice thing about standards
- 39 Open Source License types
- 40 Types in Free Software Community
- Examples: Academic Free License, Common Public License, GNU General Public License, Zope Public License
- Other standards: e.g. Copyleft, Media Commons, Wiki, creative commons

Sample code libraries
- cgal.org: CGAL Open Source Project to provide easy access to efficient and reliable geometric algorithms in the form of a C++ library
- OGR: Simple features library, C++ open source library (and command line tools) providing R/W access to vector file formats
- GEOS: Geometry Engine - Open Source, C++ port of the Java Topology Suite (JTS)
- OpenCV: C++ Class library to support computer vision
Sample software tools

- **TARDEM**, A suite of programs for the Analysis of Digital Elevation Data
- **Merkaartor** is an OpenStreetMap editor distributed under the GNU General Public License
- **Worldwind**: browser tool for geospatial data

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**Open Source GIS**

- **QGIS**: Quantum GIS - QGIS is a user-friendly Open Source GIS that runs on Linux, Unix, Mac OS X, and Windows. [http://www.qgis.org/]
- **ILWIS**: Integrated Land and Water Information System. Integrates image, vector, and thematic data. [http://www.itc.nl/ilwis/]
- **Open Source GIS (Java, GML3)**: An Open Source GIS for water management. Supports modeling and simulation. [http://www.imagery.com/]
- **GeoServer**: Open source protocol and tools for serving GIS data over the Internet. [http://geoserver.org/display/GEOS/Welcome]
- **Open Source Web-based Mapping Server**: Enables users to quickly develop and deploy web mapping applications and geospatial web services. [http://mapguide.osgeo.org/]
- **MapServer**: Open source platform for developing web mapping applications that use a combination of rich client and web clients. [http://mapserver.org/]
- **PostGIS**: Spatial extender for PostgreSQL database, allowing geographic queries. [http://postgis.refractions.net/]
- **Spatialite**: Database extension for SQLite that supports spatial data. [http://spatialite.org/]
- **MySQL**: Spatial extension for MySQL database. [http://dev.mysql.com/doc/refman/5.0/en/spatial-extensions.html]

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**Not on list: DivaGIS**

For example: **uDig**
A variety of issues should be considered in system selection:

- cost
- upgrades
- LAN configuration support
- training needs
- ease of installation
- maintenance
- documentation and manuals
- help-line and vendor support
- means of making patches
- workforce

Tests show that:

- The same function, enacted in different systems give (slightly) different results!
- Errors can find their way into unquestioned final results unless tasks are carefully checked
- Workflows are the best way to repeat and check processes
- Most errors are made by people unfamiliar with functionality
Selecting a GIS can be a complex and confusing process.

- The intelligent GIS consumer should research, select, test, and question systems before purchase/installation
- Installation itself can be a challenge
- Match needs and requirements
- Be prepared to upgrade continuously

The needs matrix

<table>
<thead>
<tr>
<th>Requirement 1</th>
<th>Requirement 2</th>
<th>Requirement 3</th>
<th>Requirement 4</th>
<th>….</th>
<th>Requirement N</th>
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<tr>
<th>System 1</th>
<th>System 2</th>
<th>System 3</th>
<th>System 4 etc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes/No</td>
<td>Ranking</td>
<td>Score</td>
<td>Weighted Score</td>
</tr>
</tbody>
</table>

Coming next…..
GIS in Action