How to Pick a GIS

Getting Started With GIS
Chapter 9

9 How to Pick a 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

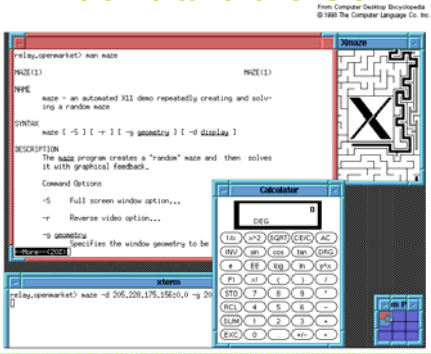
GIS in the 1980s

- 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

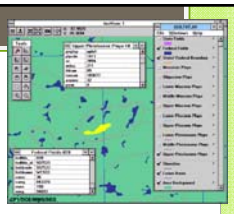
GIS in the 90s

- 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

X windows and the GUI



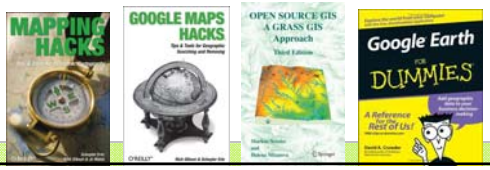
GIS in the 2000s



- 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

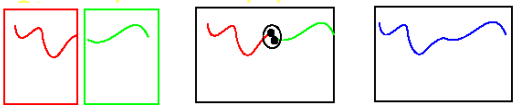


Figure 8.1 Steps in mosaicing. Left: Two maps show one feature, but there is a gap. Center: Map edge is merged; nodes are snapped to "zip" feature. Right: Mosaiced map with continuous feature and dissolved map edge.

FIGURE 8.2: Steps in the dissolve operation. Left: Two maps show one feature, split across an edge. Attribute and graphic database have three records for type "B". Right: After dissolve, edge lines are removed and the three type "B" records are amalgamated.

Rubber sheeting

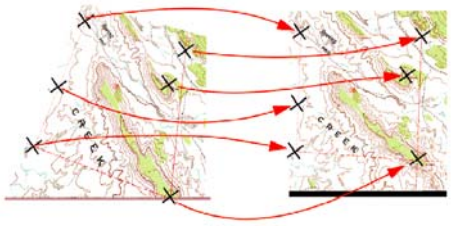


FIGURE 8.5: The rubber sheeting method. A map with unknown geometry (say an air photo taken or scanned map) can be distorted so that its geometry matches that of another map. Pairs of points must be available both on the image and on the map showing the same place or feature location, called control points. Within the GIS, rubber sheeting warps the geometry statistically into that of the map, so that the two geometries match.

Line generalization

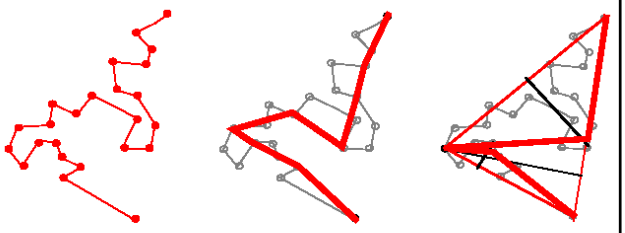


Figure 8.4 *Line generalization* alternatives. The line (left) can be resampled by retaining every *n*th point (center), or by repeatedly selecting the most distant point from a line between end nodes (right) and redividing the line until a minimum distance is reached, the Douglas–Peucker method.

Storage functions

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

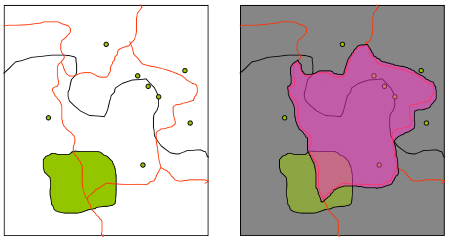
Compression

- 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

Cookie cutting



Data retrieval functions

- locating
- selecting by attributes
- buffering
- map overlay
- map algebra

Map algebra

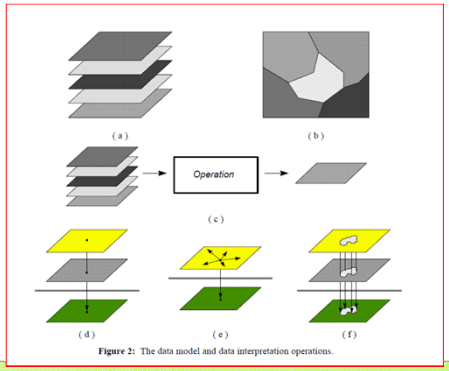
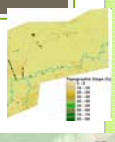
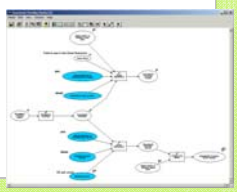


Figure 2: The data model and data interpretation operations.

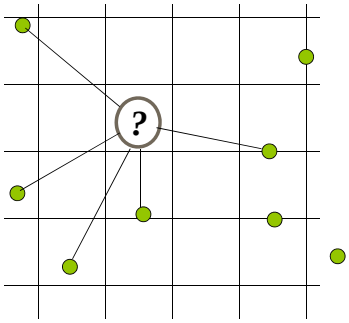
Data analysis functions





- Interpolation
- Optimal path selection
- Geometric tests
- Slope calculation
- Line-of-sight
- Workflow support

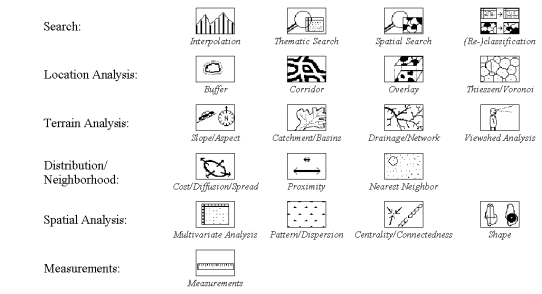
Interpolation



Data display functions

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

Generic functions? (Jochen Albrecht)



Basic Operation Type	Task	Tasks	Tasks	Tasks
Ingest data	Across formats	Convert	Reproject	
Measurement	Location	Distance/angle	Length/area	
Search	Interpolation	Thematic search	Spatial Search	(Re-)Classification
Location analysis	Buffer	Corridor	Overlay	Thiessen/Voronoi
Terrain Analysis	Slope/Aspect	Catchments	Drainage/Networks	Viewshed
Distribution/Neighborhood	Cost/Diffusion/Spread	Proximity	Nearest Neighbor	
Spatial Analysis	Multivariate	Pattern/Dispersion	Centrality/Connectedness	Shape
Display maps	Map types	Data types		

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

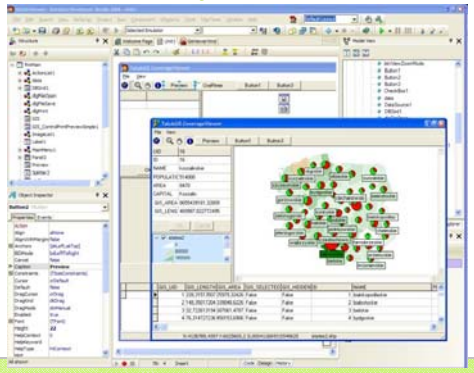
Commercial GIS

Software	About	Information
Autodesk	Map 3D, Topobase, MapGuide and other products that interface with its AutoCAD CAD package.	usa.autodesk.com/
Bentley Systems	Products include Bentley Map, Bentley PowerMap, and other products that interface with its MicroStation software.	www.bentley.com/en-US/
Intergraph	GeoMedia, GeoMedia Professional, GeoMedia WebMap, and add-on products for industry sectors, as well as photogramme-try.	www.intergraph.com/
ERDAS	Leica Geosystems subunit encompassing GIS, Photogramme-try, and Remote Sensing. Main software is Imagine.	www.erdas.com
ESRI	ArcView 3.x, ArcGIS, ArcSDE, ArcIMS, ArcWeb services, and ArcServer.	www.esri.com
ENVI	From ITT. Image analysis, exploitation, and hyperspectral analysis.	www.itt.com.
MapInfo	From Pitney Bowes. Includes MapInfo Professional and MapXtreme. Integrates GIS software, data and services.	www.mapinfo.com
Manifold	Full capability GIS software package.	www.manifold.net

Commercial GIS (ctd.)

Smallworld	Developed in Cambridge, England; now owned by General Electric and used primarily for public utilities.	http://www.gepower.com/prod_serv/products/gis_software/en/smallworld4.htm
Cadcorp	Cadcorp SIS (desktop), GeognoSIS (web), mSIS (mobile), and developer kits.	www.cadcorp.com
Caliper	Maptitude, TransCAD, and TransModeler. Develops GIS and the only GIS for transportation.	www.caliper.com
GeoConcept	GeoMap 3D,Topobase, GC Standard, GC eterprise, Sales & Marketing, routing, Geo optimization, Geo Server and other products.	www.geoconcept.com/en
IDRISI	Taiga GIS product developed by Clark Labs.	www.idrisi.com
TatukGIS	TatukGIS Developer Kernel (SDK), GIS Internet Server, GIS Editor, and free GIS Viewer software products.	www.tatukgis.com
SuperGeo	SuperGIS Desktop, SuperPad Suite, SuperWebGIS, SuperGIS Engine, SuperGIS Mobile Engineg, SuperGIS Image Server, SuperGIS Server, and other desktop extensions.	www.supergeotek.com

TatukGIS. Gdynia, Poland.



MapGIS: Wuhan University, China

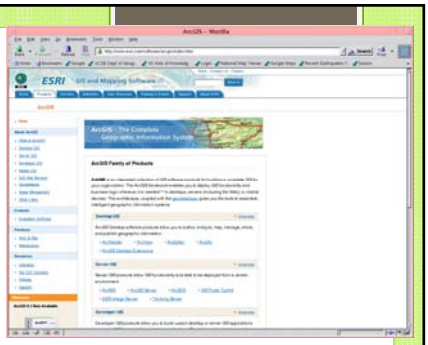
SuperMap: Chinese Academy of Sciences

StarGIS: Saudi Arabia

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

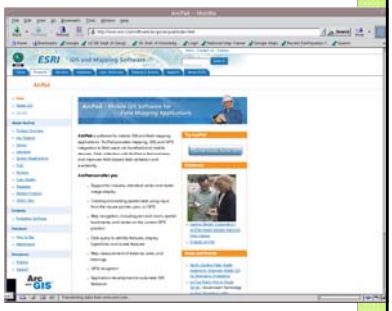
ArcGIS



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)

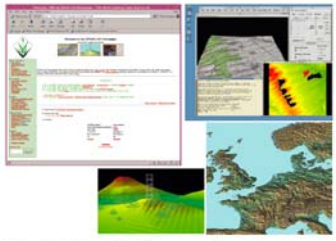
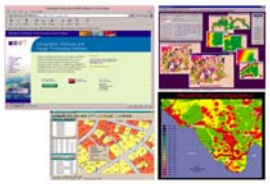


FIGURE 8.12: Left: The GRASS GIS Web page. (http://www3.baylor.edu/grass/index2.html) Right: The GRASS user interface: Bottom: Sample applications from the image gallery.

- 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

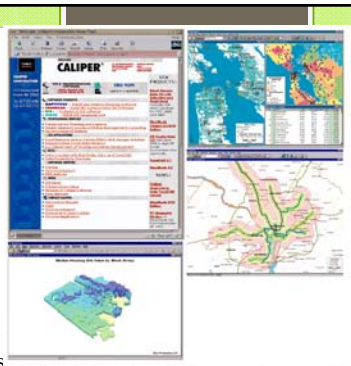


FIGURE 8.15: Upper left: The Caliper Corporation WWW home page at http://www.caliper.com. Right side: Sample applications and examples of the user interface. Bottom left: Example of a stepped statistical surface map generated by Maptitude. (Courtesy of Caliper Corp., Newton, MA. Used with Permission.)

- Caliper Corporation
- Consultancy
- TRANSCAD and GIS+
- Many network solutions
- Windows
- Import/Export
- Address matching

GeoMedia

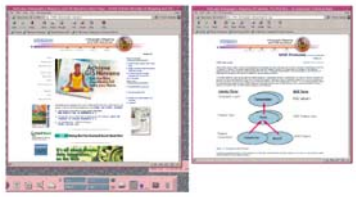


FIGURE 8.16: Left: The Intergraph home page at http://www.intergraph.com/gis. Right: Web page showing the basic data structure of Microstation MGE. (Courtesy of Intergraph Corp. Huntsville, AL. Used with permission.)

- 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

FIGURE 8.14: Left: The MapInfo home page at http://www.mapinfo.com. Right: MapInfo application, providing a mobile Internet search capability for restaurants using a cellular telephone. (Courtesy of MapInfo Corporation, Troy, NY. Used with permission.)

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 polices 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

  – Free Software Foundation, http://www.gnu.org/philosophy/categories.html

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 commandline 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

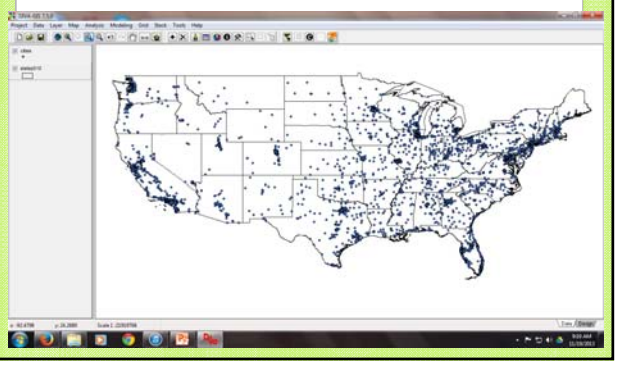
Sample software tools

- 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

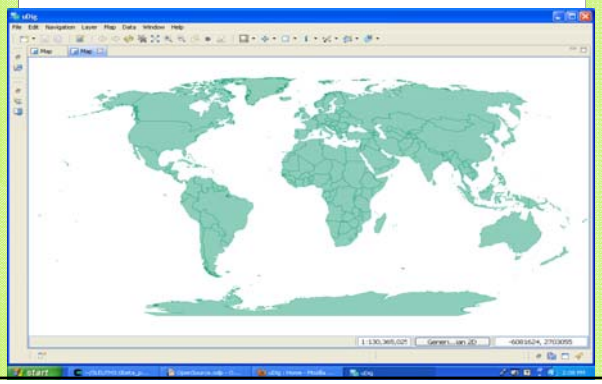
Open Source GIS

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/
MapWindow GIS	Free, open source GIS desktop application and programming component.	http://www.mapwindow.org/
ILWIS	Integrated Land and Water information System. Integrates image, vector and thematic data.	http://www.itc.nl/ilwis/
uDig	uDig is an open source desktop application framework, built with Eclipse Rich Client technology.	http://udig.refractions.net/
JUMP GIS / OpenJUMP–(O	Java Unified Mapping Platform. OpenJUMP, SkyJUMP, deeJUMP, and Kosmo emerged from JUMP.	http://www.jump-project.org/
Capaware rc1 0.1	General purpose virtual worlds 3D viewer. A free software project started in 2007 to promote the development of free sc	http://www.capaware.org/
Kalypso	An Open Source GIS (Java, GML3) that focuses on water management. Supports modeling and simulation.	http://www.ohloh.net/p/kalypso
TerraView	Desktop GIS that handles vector and raster data stored in a relational or geo-relational database, a frontend for TerraLib.	http://www.dpi.inpe.br/terraview/index.php
GeoServer	GeoServer is an open source software server written in Java that allows users to share and edit geospatial data. Design	http://geoserver.org/display/GEOS/Welcome
WebMap Server	Open source protocol and tools for serving GIS data over the Internet.	http://terraserver-usa.com/ogcwms.aspx
MapGuide Open Source	Web-based platform that enables users to quickly develop and deploy web mapping applications and geospatial web se	http://mapguide.osgeo.org/
MapServer	Web-based mapping server, developed by the University of Minnesota.	http://mapserver.org/
PostGIS	Spatial extensions for the open source PostgreSQL database, allowing geospatial queries.	http://postgis.refractions.net/
H2Spatial for	Spatial extension for an open source DBMS H2_(DBMS).	http://geosysin.iict.ch/irstv-trac/wiki/H2spatial/Download
SpatiaLite for SQLite	SpatiaLite extension enables SQLite to support spatial data in a way conformant to OpenGis specifications.	http://www.gaia-gis.it/spatialite-2.0/index.html
MySQL Spatial	MySQL spatial extensions following the specification of the Open Geospatial Consortium.	http://dev.mysql.com/doc/refman/5.0/en/spatial-extensions.html

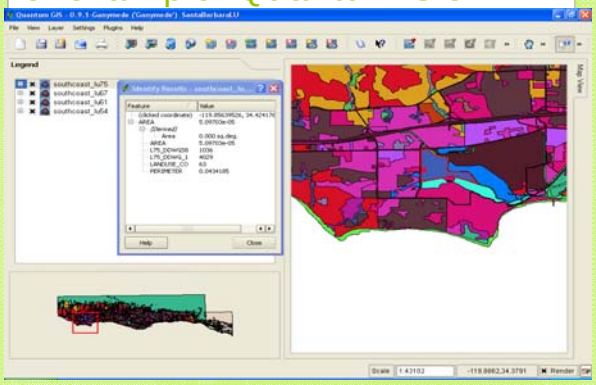
Not on list: DivaGIS



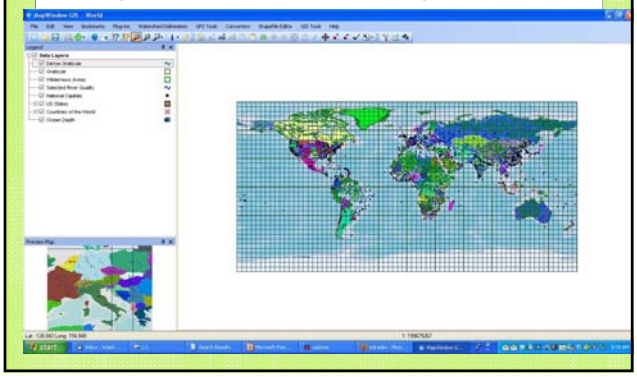
For example: uDig



For example: Quantum GIS



Open Source GIS: MapWindow



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

	System 1	System 2	System 3	System 4 etc
Requirement 1				
Requirement 2				
Requirement 3				
Requirement 4				
….				
Requirement N				

Yes/No
Ranking
Score
Weighted Score

Coming next…..

GIS in Action