

Cadcorp Introductory Paper II

Functionality within Geographic Information Systems (GIS)



Keywords: computer, data, digital, geographic information systems (GIS), geographic information (GI), mapping, software.

Cadcorp Introductory Paper I discussed some of the basic tenets of GIS and Geographic Information (GI). This brief paper is intended to outline some of the core functions which GIS have. Obviously this is not an exhaustive study but the reader should be able to get a feel for what GIS can do and they would like GIS to do.

GIS as a tool

In simple terms GIS is a collection of tools to perform certain tasks. It is important to identify which tasks need to be performed GIS which offer 'high end' functionality, will allow the user the opportunity to perform operations which go beyond the simple display or printing of spatial data. In broad terms, a fully functional system will allow each of the following data tasks to be undertaken;

- Capture and Editing
- Manipulation and Analysis
- Visualisation
- Dissemination/ Export

Many GIS systems offer a subset of these capabilities but very few offer all of the functions in one application. Also, some systems concentrate on specific elements, e.g. a package may not have any editing capabilities but may be a good visualisation tool.

The following sections discuss each of the above topics in terms of what GIS could do. A reference section is provided which points to specific subject texts.

Data Capture and Editing

Data capture is a fundamental requirement of GIS. Data capture may simply be the importing of data e.g. opening a file. In the wider sense though, data capture can include the use of peripheral hardware such as digitisers, scanners, or links to textual or database records. GIS can also allow users the opportunity to create their own data from scratch or to incorporate or augment external data such as aerial photographs, satellite images, points, lines, polygons and so on. Some systems may however only allow vector or raster data to be incorporated or may at least favour one over the other.

Example: A Planning Department in a local Council office would like to find out about the number of Council houses which are suffering from heat loss. They decide to commission an airborne thermal image survey, where an aircraft flies over the area in question. This is data then has to be processed and captured into the GIS. This will allow the images to be fitted to the places they relate (geo-coding). Because this data has been captured the survey images will relate to other data such as Ordnance Survey Address-Point or Landline building outlines. This will allow the Housing Department the opportunity to find the highest emitters and develop a works programme.

One step beyond data capture is data editing. Editing functions allow users to duplicate data and/ or modify it for a given purpose. Data editing may be necessary when features in the real world are demolished or built. A new road may need to be added onto a 'Street' layer within a GIS. Modification may be at a micro or macro scale, in that only a small amount of data may be altered or a whole overlay may be deleted from a disk.

Example: The staff in the Council Department may want to edit some of their survey data to incorporate a more recent thermal image survey. Having found new areas of heat loss they may want to draw new building outlines to show where the properties are which still suffer from heat loss.

GIS normally have links to Relational Databases (RDBMS) such as Oracle or Access. These links allow data to be brought in from existing digital sources although the data will still need to be **geo-coded** or related to its physical location. e.g. a series of records in an oracle table may have several fields and two fields with an x and y coordinate pair (25 High Road, Anytown, Anycounty, 567900,

230930). These values can be used to place the record at this co-ordinate value within a reference system such as the National Grid.

Data Manipulation and Analysis

Whilst data capture and data editing allow basic information or geometry to be altered, data **manipulation** and **analysis** is where core GIS analysis takes place. By manipulating data calculations can be performed such as the length of a road, the size of a conservation zone, the distance between two towns and so on. A manipulation may also include the selection of certain records from a dataset or layer. This may utilise SQL (structured or standard query language) or may involve spatial operations. SQL allows users to interrogate data by using a specific generic syntax. An example may be, `SELECT*FROM buildings WHERE AREA < 2000`, this would select all records from a layer called buildings with an area less than 2000m². More complex **analysis** would include calculating answers to multi-criteria problems such as finding the optimum location for a new supermarket taken into account the size of the sites available and the number of customers with access to transport within a given time/ distance.

There are obviously differences between raster and vector analyses. A raster package may concentrate on image analysis or a vector package may concentrate its capabilities on topological or network analysis.

Example: After receiving data from the survey team, the Housing Department discovers it has only got enough resources to insulate 50% of the properties which are suffering from heat loss. However, Social Services agree to fund part of the program where the residents are pensioners. The GIS is used to analyse which are the highest emitters (using GIS analysis they can query the values from the survey). The electoral roll and Social Services register is then used to select from these properties those which are inhabited by pensioners. This is a multi-criteria analysis. Analytical GIS excel in producing informed, data driven solutions to real world problems.

Data Visualisation

Perhaps the most poignant use of GIS is in the production of visual representation of geo-spatial data. Whilst certain analytical calculations produce answers to problems, many people are struck by the graphical element which is central to many GIS. These images (akin to traditional maps) can communicate complex information in a variety of ways. It should not be forgotten that these images are alternate representations of data. Many techniques can be used to portray information to the viewer. Points can be used to show locations, symbols can be placed to differentiate between facilities, shading and annotation can be employed to show variations and so on. The following example illustrates two ways of representing the same data. Both images show the total population over 70 years of age for each Ward in Kent (1991). These techniques are called graduated symbol and thematic shading.

The choice of technique is important, very often images are produced from GIS which can confuse the viewer or intended audience. From both of these images (below) we can immediately tell **where** the higher concentrations of elderly people are although the second image will probably have greater impact to people who are used to dealing with the Ward Boundaries which are shade *i.e.* Council Officers, Members.

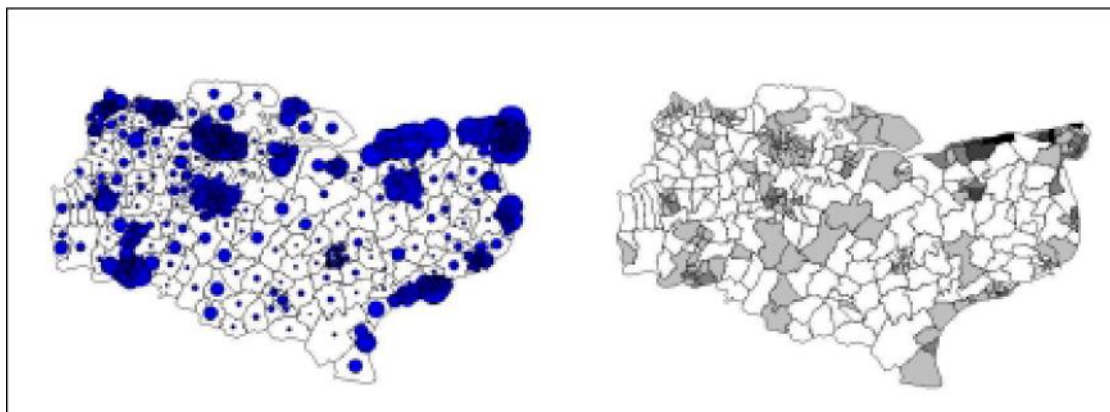


Figure 1a) Total Population of Kent over 70 years old (1991) – graduated symbols (larger circle = more population) 1b) thematic shading (darker = more population).

Some GIS offer advanced visualisation beyond two dimensions (2d). These range from 3d terrain models to the output of digital movie files or 'fly throughs'. The image below shows 3d and 2d scenes of part of South Wales viewed in Cadcorp Map Modeller v5.0. The upper window shows a digital elevation model (DEM) which is a moveable 3d 'landscape', the lower portion is the 2d representation of the same area. This approach to displaying data can also be applied to non-physical data such as surfaces of 'pollution' or demographic data.

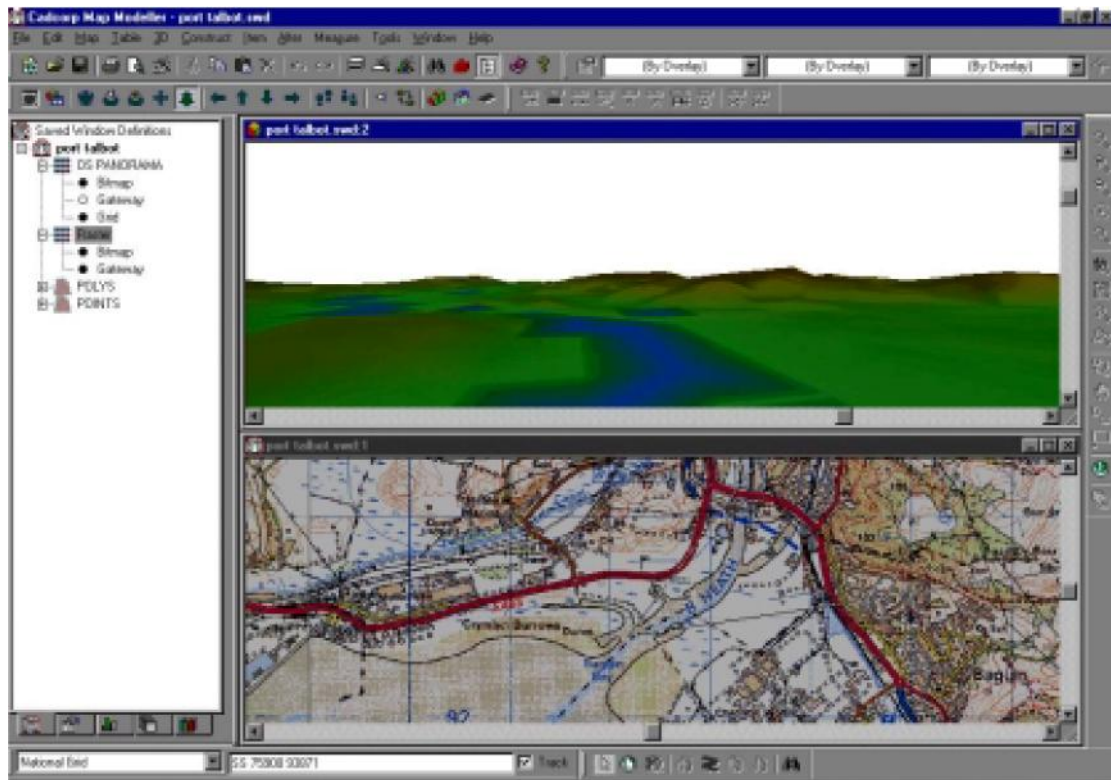


Figure 2) Screenshot of data visualisation in Cadcorp Map Modeller v5.0.

Obviously, not all GIS have such advanced visualisation capabilities, but most have at least a 2d 'map' style display of the underlying data.

Dissemination and Data Export

In practical terms any GIS system is only as good as the information it can provide to an end user. For instance, even if the most sophisticated analysis can be performed in a short time it is meaningless if the intended recipient cannot interpret the end results. In order to present information, GIS employ a variety of methods ranging from the printing out of a map image (with scale bar, north arrow and legend) to a spreadsheet style report of tabular information. Many systems allow the user to create a Layout, which can include charts, maps, tables, text and so on. The important point to bear in mind when creating this output is its fitness for purpose. The best outputs are those which use the right GIS tools rather than all of the available ones.

Other methods of data dissemination, include Internet GIS, where a server provides GIS images or query results over the Internet through a web browser such as Microsoft Internet Explorer or Netscape Navigator. The most common way of sharing data though is to save data to a disk, which can be accessed by more than one user of the same GIS (Client-server model). Unfortunately, a GIS will not necessarily open all formats of data. For instance, Vendor A's GIS may open Vendor B's data type but not Vendor C's. This is because some formats are proprietary or because a system is not designed to open other data. To counter this phenomenon, many GIS allow data to be **exported** or converted into a format which can be read by other systems. There are also many commercial packages which will **translate** data from one format to another. Cadcorp SIS v5.0 reads data in its native format and 'on the fly', this means that conversion doesn't have to take place to read and utilise data, this saves time especially when using Ordnance Survey data which, in other systems requires timely pre-processing.

More advanced discussion can be found in the following texts. Cadcorp offer training on all of the areas discussed and can be tailored to any user requirement.

Further Reading

Introductory Texts

- *Exploring Geographic Information Systems*
Nicholas Chrisman
Paperback - 314 pages (March 1996)
John Wiley and Sons (WIE); ISBN: 0471108421
- *Principles of Geographical Information Systems*
Peter A. Burrough, Rachael A. McDonnell
Paperback - 346 pages (February 1998)
Clarendon Press; ISBN: 0198233655

Reference

- *Geographical Information Systems*
Paul A. Longley (Editor), Michael Goodchild (Editor), David Maguire (Editor),
David W. Rhind (Editor)
Hardcover - 1296 pages (12 February, 1999)
John Wiley and Sons; ISBN: 0471321826

Data Capture and Editing

- *GIS Data Conversion : Strategies, Techniques, and Management*
Pat Hohl (Editor)
Paperback - 423 pages (November 1997)
Onword Press; ISBN: 1566901758

Data Manipulation and Analysis

- *Spatial Analysis and GIS*
A.S. Fotheringham (Editor), P. Rogerson (Editor)
Paperback - 296 pages (January 1994)
Taylor & Francis; ISBN: 0748401040
- *GIS for Business and Service Planning*
Paul Longley (Editor), Graham Clarke (Editor)
Paperback - 316 pages (January 1996)
John Wiley & Sons (Sd); ISBN: 0470235101

Data Visualisation

- *Mapping: Ways of Representing the World*
Daniel Dorling, David Fairbairn
Paperback - 190 pages (April 1997)
Addison Wesley Longman Higher Education; ISBN: 0582289726
- *How to Lie With Maps*
Mark Monmonier
Paperback (April 1996)
Univ of Chicago Pr (T); ISBN: 0226534219
- *Visualisation and GIS*
D. Unwin, H. Hearnshaw (Eds)
Hardback 243 pages (1994)
Wiley & Sons (London)
- *Cartography and GIS*
Association for Geographic Information Paperback (June 1997)
Association for Geographic Information; ISBN: 1874059039

Dissemination and Data Export

- *Geographical Information Systems and Computer Cartography*
Christopher B. Jones
Paperback - 272 pages (October 1996)
Addison Wesley Publishing Company; ISBN: 0582044391

- *GIS Online : Information Retrieval, Mapping, and the Internet*
Brandon Plewe
Paperback - 400 pages (August 1997)
Onword Press; ISBN: 1566901375

GIS Vendor

- Cadcorp is a leading developer of Geographic Information Systems (GIS). Based in Stevenage and London, the Cadcorp distribution and VAR network stretches worldwide.
<http://www.Cadcorp.com>