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Introduction to OzGIS

The OzGIS system is designed for ANALYSIS of spatial attribute data, and for the display of other types of spatial data such as environmental data .

A common application is the display of Census data. Visual inspection of choropleth maps is the intuitive way to interpret the spatial features of data. An analyst needs to be able to rapidly display and manipulate maps to aid his understanding. OzGIS was designed to enable maps to be changed within
seconds so the analyst does not lose his train of thought.

OzGIS enables the analyst not just to display a map, but to generate the map that best shows the features of the attribute data. A hardcopy map can be generated as the final operation as a record or for dissemination.

OzGIS aims to accept basic data files and to provide most of the facilities required for the analysis and display of data, mainly as maps. The analyst has to be able to rapidly use the facilities, so OzGIS provides an interactive user interface. The user interacts via menus , dialog boxes and buttons

There are three WINDOWS programs:

WOZGIS is the main program for preparation, display and analysis of map data.
WOZMAP is for outputting maps to files.
VECTOR is for outputting metafiles to printers and plotters.

Easy to use systems are usually trivial systems, and the enormous number of options within OzGIS means that it takes some time to understand everything.
However, maps can be produced quite simply by using only a small number of options and by using the system defaults. It is suggested that you use the simple Census mapping option first to become familiar with the system.

READ the manual!!!!!!!!!!!!!!

The manual tries to lead readers through the main options first and for the most common applications first. Working through the manual and generating the maps as explained will soon provide the knowledge to enable the rest of the system to be used.

OzGIS was originally developed as a research project within the CSIRO Division of Computing Research. The project started in 1979 using special hardware developed for the DIDS system in Washington DC.

Demonstration

A demonstration is supplied with the OzGIS system, which displays a series of saved maps along with comments.

You should look at it first as it gives an overview of the capabilities of OzGIS.

The demonstration is started by clicking the item in the OzGIS programs group.

The Clever Company

OzGIS is developed by The Clever Company, a Canberra based software company offering consulting and contract programming services in the areas of:

. C and FORTRAN programming
. Spatial databases
. Scientific applications
. Graphics
. UNIX workstation, minicomputer and PC environments

Simple Census-type mapping

A much simpler set of options are provided by the SIMPLE MAPPING version of OzGIS.

These options are suitable for basic mapping of Census type data and are recommended for use while learning to use the system as there are two or three menus and about twenty menu options while the full version has over a hundred menus and a few hundred menu options.

The best way to understand OzGIS is to try it. As a first example look at the files for Australia Statistical Divisions.

There are two files, one for the geographic map data and the other holding the related attribute data:

Run the simple version of OzGIS by clicking the icon.

Select MAPPING from the tool bar.

choose the option to "DISPLAY A NEW MAP".

give the attribute file name as OZ (actually the file is oz.att but the file extensions are fixed)

When asked for the geographic file name click the USER button. A list of the available files will appear. Double click on OZ.GEO. (you could have typed the name as OZ).

The data are now processed and the map is displayed,.

You now have a default map with legend and distribution diagram. The legend has the numbers of zones in each class on the left and the class value ranges to the right of the coloured boxes.

The map colours are defined in the default device file.

Now investigate some of the options:

Choose the option to display the next sequential attribute

Select the option to select by number. Type 0 to get a list. Type in a number to select an attribute.

Select the option to change the number of classes.

change the number of classes to 10.

Select the option to change the quantisation method. Another menu will appear. These options are very important as they enable the map to show the data in a way relevant to the purpose of the analysis.

Choose QUANTILES and set the number of classes to 10 (deciles).

Choose the option to display statistics.

Choose an option to interrogate the map. This will enable the current values for the displayed zones to be listed. A cursor will appear on the screen which indicates the bottom left position. Place it using the mouse (left button to select) and holding down the button use the box cursor to select the other corner. All zones are listed where the minimum bounding rectangle (MBR) intersects the selected window.

etc

Continue investigating options

Several other example files are available which you can display by selecting the NEW MAP option. They are in geographic / attribute file pairs

Geographic	Attribute	
OZ	OZ	Australia
FEA	FEA	Far East Asia
LOWE	LOWE1	Lowe electorate
WASHTRAC	WASHTRAC	Washington (not evaluation system)
AFRICA	AFRICA	

Specifying files

Every type of file is uniquely identified in the OzGIS system. This means that the same name can be used for different types of files.

e.g. the attribute and geographics example files for australia are both called "OZ".

This is accomplished by the use of different extensions, so the two Australian files are OZ.ATT and OZ.GEO

However, you seldom use the extensions to the file names; the system adds them automatically. The exceptions are data INPUT data files and parameter files as they often come from external sources e.g. they cannot be changed on CD-ROM.

The only time you have to worry about extensions is when handling files external to OzGIS e.g. backing up.

One important point is that external data files usually have names with extensions ".DAT" before they can be imported into the system.

A standard interface is used to give file names. You usually just type in the name (without extension) e.g. "PHRED". If the file is in another directory you can put that on the front e.g. "\MYDATA\PHRED". Similarly, files can be on other devices e.g.
"A:PHRED" to read off a floppy.

The \OZGIS directory is used to hold "system" files. These can be selected by typing "*" on the front of the file name. e.g. "*C16SV4" is the same as typing "\OZGIS\C16SV4". System files include device files, marker files and font files supplied with the system. You can of course put any files you use a lot into the OZGIS directory too.

The file name interface has two other options. If you give the file name as "L" (or "l"), a list of all that type of file in the current directory. More commonly you click USER to list and select your files or SYSTEM to list the files in \OZGIS.

You can also give the file name as"E" (or "e"), which exits from the procedure back to the previous menu. More commonly you click the QUIT button.

Giving the file name as "H" or clicking the help button gives a message about selecting files.

File types

The OzGIS system process several types of files.

Some of the files can be entered into OzGIS as data. All of the files have internal formats, which are generated as part of the user interaction.

Data files usually come from Census bureaux, map data suppliers or your corporate database, and are entered as Ascii files in a variety of formats.

The file types will become obvious with use of the system.

External data files must be entered into OzGIS explicitly. This operation permits OzGIS to generate internal representations of the data for efficient processing and to check the data.

The following kinds of files must be entered into OzGIS:

- marker files
- device files
- presentation files

Certain files must be prepared explicitly within OzGIS under user direction. These files are:

- saved display files
- catchment files
- hardcopy files for VECTOR or other systems

Some files can be prepared externally or internally. These are:

- geographic files
- name files
- combine files

OzGIS distinguishes the various types of files, so that users can interrogate the current set of files of a specified type (from the Files menu)

Data files are ascii format files that are to be read into the system (with OzEnter) and converted into one of the standard file types. Data files must have names with extensions ".dat" e.g. FRED.DAT, A:USA.DAT

Geographic files describe geographic (map) data in terms of graphic elements - zones, polygons, line networks, line segments and points. The data can be drawn in geographic regions, or overlayed on displayed maps.

The files are generated by digitising base maps. This is a time-consuming soul-destroying task. Fortunately digitised map data are available for many commonly used maps e.g. states, postcodes, Census districts. Where special zones are required, they can often be defined in terms of Census districts and the map boundaries obtained by amalgamating the digitised Census boundary data (dropping internal lines). This has the additional advantage that Census data can also be extracted for the amalgamated zones and used for comparisons with the user's own attribute data.

Attribute files contain the values of attributes (variates, statistics, variables) referenced to zone, line or site names. Each file may contain a number of attributes for a fixed set of names.

Attribute files are processed to assign a class number to zones (colour) or lines (line type) or sites (symbol sizes) in a displayed map.

Attribute data files are usually generated via a standard database, spreadsheet or modelling system or by a user's own programs.

Names files contain a list of zones, lines or sites that defines a geographic region of interest. The files may be used to subset geographic data. It may also be used to restrict the set of attributes to be quantised for a map, or alternatively the set of zones lines or sites to be displayed on a map.

Combine files - define new items in terms of zones. A file may define new zones in terms of amalgamated base map zones or the influence of surrounding zones on a site.

The file contains a list of names of the new zones or sites defined.

For each new item there is a list of the base map zones it is defined by and a list of weights. New zones are defined by complete base map zones so the weights have value 1.0 e.g. Sales Territories. Site Catchments are used to retrieve data from underlying map zones so the weights give the proportions of the zones (range 0-1).

Marker files - define simple shapes as single polygons for display as markers.

The data are simply the (X,Y) points that are used to draw the polygons. The points are in the range -0.5 to +0.5 so the polygon can be easily scaled and displayed centred at a location.

Saved Display files contain the data to regenerate a complete display. These files should be stored by the user upon completion of a display for later recall e.g. for later regeneration on plotters etc. Subsequent manipulation of the display is possible after recall.

Saved display files are the common level of storage and retrieval of maps. A user may build up a set of commonly displayed maps with all the desired features that can be displayed and modified rapidly. Saved display files are also used for presentations.

Presentation files contain references to a number of Saved Display files. The files are used to present a set of displays quickly, usually for demonstration purposes.

Device files - define the graphic devices and their capabilities. Each device is a GKS workstation. Several files may exist for each device giving different values for the graphic primitive attributes (line type, text, colours, patterns etc.). In particular, each file contains sets of fill colours or patterns for single and bivariate maps.

Catchment files - contain definitions of sites, boundaries of catchments around sites, and catchment weights. Catchment files are interactively generated with reference to a base map.

User interface

You control OzGIS by responding to menus, questions and commands presented on the PC screen.

OzGIS Menus

Main menus appear as pull-down menus on the toolbar. Lower level menus appear as pop-up menus.

The system contains about 140 menus. As you select options you move to different locations in the menu network.

Selecting major options (e.g. a new map) causes a different main menu to appear on the menu bar. You have to click the return icon on the toolbar to go back to the top (start) menu.

At lower menu levels popup menus appear. Clicking outside the menus causes them to disappear, holding down the left button pops them up again.

Question Dialog Boxes

Questions are asked by OzGIS when data are required for an operation. The user must supply the data by entering appropriate responses in a dialog box.

The format of questions consists of the question, a possible range of values in brackets (if appropriate), a default value in parentheses (if appropriate) and terminated by a question mark. The range of values and default values indicate the form of the expected answer. An example is:

- request to replace an existing file:
  DO YOU WANT TO REPLACE THE FILE [Y,N]?

The user must respond by clicking on YES or NO.

The following single character responses provide assistance when answering some questions:

"H": presents a "help" or informative message about the required response.

"E": returns to the previous menu without further action.

Errors in responses are trapped and result in help messages being printed. The user is asked the question again.

Command Dialog Boxes

Commands are issued by OzGIS when an operation has to be performed by the user. When the operation is completed, control returns to the appropriate menu.

The format for commands consists of a directive, a possible range of values in brackets (if appropriate), a default value in the input field (if appropriate), terminated by a colon. For example::

- to provide the number of classes:
  TYPE NUMBER OF CLASSES [1-6] (4):

The number of classes must be in the range 1 to 6, and if the user simply presses the "Enter" key a default value of 4 will be selected.

The following single character responses provide assistance when responding to commands:

"L": provides a list of data items that can be selected.

"H": presents a help or informative message about the desired operation.

"E": returns to the previous menu without further action.

Errors in responses are trapped and cause a help message to be displayed and the command to be repeated.

Toolbar Icons

Map drawing is a slow process so maps are not automatically redrawn after an option is selected. You click the toolbar "draw" icon.

To return to the top menu click the "return" icon.

Graphic interaction

Graphic interaction in OzGIS involves the use of the mouse to control the cursors on the monitor. Use the left mouse button to select.

The user is directed to operate the mouse etc by the appearance of the cursor on the monitor and by an appropriate command on the screen. The extent of the command depends on the current level of user communication, which can be set from the Files menu.

There are several types of cursors:

. a pointer to select a position of object
. a box to select a region. The bottom left corner is selected and then the other.
. a fixed size box to select text positions
. a cursor for selecting a circle (centre first followed by a point on the circumference.

Output files

Every program generates printout on a file OZGIS.OUT.

This includes:

Reports
Error messages
Debug output

After a spatial query the list of slected items is written to the file QUERY.OUT

The windows graphics interface outputs error messages to a file WINDOWS.OUT

Map types

Several types of maps and diagrams can be displayed by the OzGIS program.

The type required has to be selected from the MAP pulldown menu, which looks like:

Display zones for an attribute file
Display lines for an attribute file
Display sites for an attribute file
Display bivariate zones for two attribute files
Display bivariate lines for two attribute files
Display bivariate sites for two attribute files
Display zones and lines for two attribute files
Display zones and sites for two attribute files
Display geographic files (no attributes)
Display attribute files (diagrams)
Display a saved-display file

Attribute maps

The appearance of the map depends on the attribute values.

There are one or two streams of attribute processing for the types of maps available for zone, line and site attribute data:

- zones map
- lines map
- sites map
- two zone streams i.e. bivariate maps
- two line streams
- two site streams
- zones and lines
- zones and sites

The type of map is selected before display and cannot be changed except by returning to this main menu.

Zone (polygon) data is coloured .

Site data can be displayed in several ways:

. as sized symbols, where additional files of points can be display in one of 4 symbols and colours
. as first symbol using class colours
. as contour map
. as contour map and class coloured symbols
. as first symbol using the 4 symbol colours

Line data can be displayed in several ways:

. as line patterns, where additional files of line can be display in one of 4 line types and colours
. using class colours
. using the 4 line colours

Geographic Maps

These display map data without attribute data but optionally subset by feature codes.

Attribute maps

Attribute data can be displayed as histograms and scatter diagrams.

Example zones and attributes map

The most common application is the display of data such as Census data as coloured polygons. Here the processes necessary to display such data are described.

You will probably have a file of attribute data (such as population Census data) and a file of digitised boundary data for mapping: We will look at data for Australia.

Run OzGIS in the \demo directory.

Select the MAP pulldown menu.
Select the option to DISPLAY ZONES FOR AN ATTRIBUTE FILE

Give the name of the attribute file as OZ

Give the name of the geographic files as OZ

The map will appear. The legend describes the way the zones have been assigned to classes and the histogram shows the way the data are distributed.

Example bivariate zones map

Bivariate maps display zones coloured for two attributes. Two attribute files are specified (they can be the same).

A two dimensional colour sequence should be used by selecting a bivariate device file.

Use the File menu to specify a new device file. Use one of the bivariate ones e.g. *C256BV1.

Select the bivariate zones option from the MAP pulldown menu.

Give attribute files as LOWE1 and LOWE2 and geographic file as LOWE.

Note the form of the legend; the primary attribute (first file, top description) is the vertical part of the legend.

Example zones and sites map

From the MAP pulldown on the top menu, select the zones & sites option and the option to display sites data as sized symbols.

Use the LOWE1 and LOWE2 attribute files, and the LOWE zones geographic file.

Give the sites geographic file as LOWE-S1.

Next choose the define regions option and the option to change quantised data and then the option to display more quantised sites.

Give the next sites geographic files as LOWE-S2.

Use symbol number 2 (number one is already used).

You will have a coloured zones map with different sized symbols. This type of map is for applications such as deciding where to put shopping centres, where different symbols can be used for e.g. existing centres, centres owned by different retail chains and proposed new centres.

Example geographic map

Maps can be displayed that show geographic data without attribute data i.e. polygons, lines, names at points and symbols at points.

Where the data are preclassified, feature codes can be used to subset the files for display.

For example, display some of the Hawaii DLG files. These files came from the USGS, and after some cleaning up, were entered as DLG-3 data and the polygons formed using the zone building option.

From the MAP pulldown in the top menu select the option to display geographic maps.

Select the option to display polygons and use file HAWDLGWB, which is the outlines of the islands. Use any polygon number, give some text for the legend (e.g. "Islands") and use the no boundaries default.

Select the option to display polygons for feature codes. Use file HAWDLGABwhich is administrative boundaries. The file has feature codes in the range 900103 to 900108. Give the range as 900103 to 900103 and use polygon number say 4.Repeat for another feature code range and polygon number.

The administrative boundaries go outside the island coastlines so you may want to redraw the island outlines by overlaying line segments for file HAWDLGWB.

Select the option to overlay line segments for feature codes. Use file HAWDLGRD which is roads.The file has feature codes in the range 2905001 to 2905041.Select a subset e.g. 2905000 to 2905020. Give the legend text as "roads".

Select the option to overlay line segments. Use file HAWDLGST which is streams. Give the legend text as "streams".

Select the option to display names at sites. Give the file HAWDLGWB.The polygon names will be displayed (the area numbers from the DLG file). Usually a points file would be used that has the actual names.

Select the option to add text, type in a title e.g. "HAWAII", and position it at the top of the map.

Note that if you regenerate the map the polygons are drawn first, and then line segments, symbols and finally names. Click the draw icon to see. Within each type they are displayed in the order specified.If a mistake is made overlays can be removed.

Example attributes map (diagrams)

Distributions, sorted values and quantisation results can be displayed as full screen diagrams for one or two attribute files. Scatter diagrams can be displayed for two files.

From the MAP pulldown in the top menu choose the "display attribute file" option and then the "distribution for two attribute files" option.

Use LOWE1 and LOWE2 attribute files.

Next choose "features",

followed by "add statistics" and "display mean & std. deviation".

You can change attributes and quantisation in the usual ways. Click the draw icon to see changes.

Map appearance

Device files control the appearance of maps:

. polygon colours and type of fill
. text colours, sizes and fonts
. line colours and styles
. sequences of class colours or hatch patterns
. menu and message colours

Experience showed that it is better to have fixed sets of definitions rather than allow the user to specify the display parameters.

The best way to understand device files is to look at the contents:

From the Files pulldown at the top menu select the option to CHANGE DEVICE FILE

Give the file as *WINSV

Select the option to DISPLAY DEVICE CHARACTERISTICS

You will now get a display that shows the text types (sizes and colours), line (types and colours) and the various polygon fills as rectangles.

Of particular interest are the class colours. The bottom set is a sequence of 121 colours which is designed to give the appearance of increasing attribute values. In this device file for a 16 colour board the colours are in blocks, but for 256 colour boards all the colours will be different (and can be used for "continuous colour" maps). The set of colours above are a 7 x 7 set for bivariate maps. They actually map onto the same set as for single variate maps, so if bivariate maps are to be produced different device files should be used.

Now choose a bivarite device file and display that. Use file WINBV. The bivariate sequence will show a progression of colour in each dimension.

There is a set of files for 16 colour displays, *C16SV1 to *C16SV9 for single variate maps, and *C16BV1 to *C16BV3 for bivariate maps under DOS and the two files WINSV and WINBV under WINDOWS.

There is also a set of files *C256SV1 to *C256SV9 and *C256BV1 to *C256BV3 for 256 colour boards under DOS or for **general use under WINDOWS**.

You will usually use the **256 colour** sets. Try displaying one of these. The colour sequence will now be complete.

Other device files are also available, primarily for display on printers and plotters, but these can also be used on the display; try them!

*HATCHSV1 is for display of hatched single variate maps and *HATCHBV1 for bivariate maps. The *CSIM* files are for colour simulation on plotters.

You should now display a few of the single variate device files *C256SV?
and decide on one that you will use as the **default** file.

When you have decided on the default file, exit from OzGIS and:

```
cd \ozgis
copy C256SV6.DEV DEFAULT.DEV
```
(using the file you have chosen)

Importing data

Most data are entered into OzGIS as external data files. Examples are Census data and Census digitised boundaries. These files come from Census Bureaux, Mapping agencies, data supply companies or your own data-base systems. Some data can be prepared or modified with word processors or spreadsheets.

Choose the Import option from the Files pulldown menu.

Data files usually have names that finish with the extension DAT. e.g. LONDON.DAT, A:SALES.DAT, however a full file name can be specified.

Often data files will need further processing by the OzData program before used for mapping e.g. attribute data may need manipulating by arithmetic expressions geographic line segments may need thinning and forming into polygons.

The system comes with many of the system files already entered e.g. device files. The data files are also provided.

OzGIS can import data in many formats. These are descibed in the manual. Sample data files are provided for every format. These are often called DEMO*.DAT

Example

You will often have a file of attribute data (such as population Census data) and a file of digitised boundary data for mapping:

We will look at data for Far East Asia. There are two data files:

FEA-G.DAT are the digitised boundary data, and FEA-A.DAT are the attribute data

Choose Import from the Files pulldown.

1. select the option to enter standard format geographic files give the input data file as fea-g give the output geographic file as fea (or the default if you like)

2. select the option to enter an attribute file give the input data file as fea-a give the output attribute file as fea (or the default if you like)

Preparing data

The raw data are imported using the option in the files menu.. However, the data often need further processing. Also, some data needed within the system cannot be specified as data files and need to be prepared.

These facilities are provided by the Prepare pulldown menu.

Attribute Files

A new attribute file can be generated from an attribute file and a combine file. The combine file defines new zones (or site catchments) in terms of the names referenced by the attribute file.

Attributes can also be derived from existing attributes by applying arithmetic operations to the attribute values.

Attributes are identified by the character # followed by a number, indicating the sequential position of the attribute on the input file (e.g. #10 represents the tenth attribute). An example of an expression to form a composite attribute is:

(#1+#2)/2 > 0 < 1000

This creates a new attribute whose values are half the sum of the values from the first and second attributes on the input file. Any valid arithmetic expression is acceptable. The output values are limited to the given range.

Functions available are:-

LOG10 : common logarithm
SQRT : square root
ABS : absolute value EXP : exponential
SIN : sine
COS : cosine

Pi is referred to as PI.

Operators are:

\+ addition
\- subtraction
* multiplication
/ division
\> greater than or equal to
< less than or equal to

Expressions are evaluated left to right and have a limit of 70 characters. Parentheses should be used to ensure there are no ambiguities.

The user must give a 30 character attribute description and 10 character units description for each new attribute that is generated.

Geographic Files

Geographic files can be subset (windowed) on the basis of a list of required display items

(zones, sites, lines).
- items in a names file
- items in an attribute file
- items within a window selected with the cursor from a displayed file

The line segments can be simplified to reduce the number of points that have to be processed. This is used to speed up display where the resolution of the digitised data are higher that that needed for display terminals.

Line segments that form polygons can be joined together into long segments. Where many short segments are used this process, in conjunction with simplification, can sustantially reduce the disk storage required and speed processing.

The zones in a geographic file can be amalgamated according to a combine file to generate a new geographic file. The new file contains the new zones. The same combine file can be used to generate attribute data for the same new zones.

Names Files

Names files give lists of items (zones, sites,lines) that are to be processed. These lists can be generated from other types of files. These options are particularly useful when the names files are to be modified.

Building polygons

The process takes line segments and joins the ends together to form polygons. The names of the zones on each side of the segments are used to derive the zone names.

Line segments can also be formed into complex lines.

Complex polygons are handled. Zones can be made up of many polygons, both disjoint polygons and polygons within polygons. The display order of the polygons are calculated so e.g islands within lakes within zones all appear.

Projections

You can process a geographic file to form a new geographic file converting either from (Longitude,Latitude) to a projection or in the reverse direction. Hence conversion from one projection to another has to take place in two steps.

Often projections will not be of concern, as map data will be used as supplied. However, if data comes from several sources in different projections the files may have to be converted to a common coordinate system.

You will have to have a basic knowledge of the projection you want to use e.g. that AMG is UTM with the Australian Spheroid and a false origin (500000,10000000).

The parameters of the projection are stored in the geographic file. When the data are first entered the projection is usually set to 'undefined', unless it is known e.g. Census boundary data are usually set to geographic (lat/long units degrees).

The first operation is often to define the projection of a new geographic file and store the parameters in the file header.

Several projections and spheroids are available.

Spatial operations

Spatial operations enable a new geographic file to be generated that is the result of spatial operations such as union and intersection between the spatial objects in two input geographic files.

The operations take place between the objects in two input geographic files, with the resultant objects being output to a new geographic file.

The following operations are supported:

. Intersection of points with polygons

For example, extract all sightings (points) of the wedgetail eagle within vegetation type 100 (polygons)

For example extract all retail sites within competitor's store catchments (polygons).

This is a point-in-polygon operation i.e. the points in one file that lie inside any of the polygons in the second file are selected.

. Intersection of lines with polygons

For example, select all roads that are within the franchise area. (then match addresses)

This is a crossing operation i.e. the parts of any lines that cross (are inside of) the polygons in the other file are output.

. Intersection of polygons with polygons

For example, Extract polygons that have soil types (feature codes) 500 to 600 and forest trees feature codes 77 to 88

For example, Extract Census districts within the digitised areas covered by all hospitals.

The polygons that are the overlapped parts of any pairs of polygons from the two files are output (an AND operation)

. Union of polygons with polygons.

For example, Extract polygons that have soil types 500 to 600 or forest trees feature codes 77 to 88

Pairs of polygons from the two input files that overlap are merged to form new polygons. Those that do not overlay are output as is.

Quantisation (classification)

Attributes are usually presented to OzGIS as values which have to be quantized into a number of classes for display.

A maximum of 10 classes can appear in single variate zone displays and 9 classes (a maximum of 3 per variate) in a bivariate display. A maximum of 4 classes is available for lines and 4 classes for sites.

The quantisation process is the most important aid for the analyst in understanding the features of the attribute data. The quantisation method and parameters should be chosen logically according to the purpose of analysing the data.

The aim is to display the map that best shows the spatial features and distribution of the data.

Note that the best maps usually have a small number of classes; manipulate the map to show the data according to requirements. This contrasts with the production of atlases, where large numbers of colours are used as the purpose to which the map will be put is not known.

There are other options to change the list of zones to which quantisation is applied and to change the range of values over which the method operates.

Quantisation Methods

The following methods for quantization are available for determining the class intervals:

(a) Equivalence Classes: numbers are assigned to the attribute values (possibly with integer round-off). The attribute values should lie in the range of the maximum number of classes permitted but they will be scaled for the selected number of classes.

This method enables the quantisation to be carried out on another system and the resulting class numbers entered instead of attribute values. A common use is for mapping discrete data e.g. political parties on election maps.

(b) Quantiles: intervals are computed by assigning the same number of zones to each class.

This method has often been used to generate choropleth maps, e.g. deciles. The effect of equal numbers of zones is maps that have approximate equal areas of each class colour. Such maps are pretty. Unfortunately quantiles tend to obscure the distribution of the attribute data.

(c) Equal Value Intervals: intervals are computed from equal increments over the range of attribute values.

The default quantisation method selected when a map is first generated is equal value intervals. The advantage of this method is that the number of zones assigned to each class indicate the distribution of the data. It is **recommended** for general purpose maps and for initial investigations of attribute data.

(d) Refined Equal Value Intervals: intervals are computed from equal increments over the attribute value range, modified by a "round-off" procedure (e.g. an increment of 10.12 would become 10.00).

Maps for publications usually have 'nice' values in the legend.

(e) 121 Equal Value Intervals: 121 intervals are computed from equal increments over the range of attribute values. Only 8 classes are displayed in the legend, but the colours are assigned over the 121 quantized values to give a "continuous colour" appearance. This option is only available with standard zone maps.

(f) Interactive Selection of Class Intervals: intervals are selected by the user by placing crosshairs on a displayed histogram.

(g) Mean and Standard Deviation: intervals are determined by dividing the range of attribute values at the mean value and at specified offsets from the mean that are multiples of the standard deviation of the data. The number of classes must be even.

This method has particular application for attribute data from random populations where the data are expected to have a normal distribution and hence statistical theorems govern percentages of population within the classes.

(h) Nested Means: intervals are determined by iterative division of the range of attribute values at the mean value of the subdivision. The number of classes must be 2, 4 or 8.

(i) Natural Breaks: intervals are determined by iterative division at the largest difference between attribute values. The number of attribute values between differences is user-specified. Hence class intervals occur at "jumps" in the data.

(j) Specification of Class Intervals: interval values (for a specified number of classes) are typed in by the user.

Hence data within certain value ranges can be isolated. Suitable class intervals for hard-copy maps can be selected.

(k) Specification of Numbers Per Class: intervals are determined by user-specification of the number of zones or sites in each class The numbers need only be given for some of the classes; the remaining zones or sites will be distributed over the remaining classes during each quantization.

An analyst can isolate data at the extremes of the attribute distribution by using this method.

(l) Class Number Percentiles: intervals are determined from user-specified values giving the percentages of the number of zones within each class.

(m) Class Range Percentiles: intervals are determined from user-specified values giving the percentage of the total range of attribute values in each class.

(n) Current Class Intervals: the intervals (and number of classes) are used to quantize subsequent attributes.

Hence a series of maps can be produced with the same legend which enables attributes to be compared.

(o) Current Numbers: the number of zones or sites per class (and number of classes) are used to determine the intervals for subsequent attributes.

Quantisation Ranges

The range of values over which the quantization is applied can be restricted in all methods. The following options are available for limiting the range:

- the extremes of all values (default)
- user-specified limits (the user enters the low and high values)
- refined values (i.e., automatically rounded to "nice" values)
- limits fixed at current values for subsequent quantisations

Zones with values outside these limits are assigned the "excluded zone" value and colour, lines and sites are not displayed.

For example a standard legend for percentage data with value ranges 0,25,50,75 and 100 could be generated by choosing extremes to be 0 and 100 and fixing them, and by using 4 equal value classes.

Quantisation Lists

Each of the attribute processing streams has an associated list that holds the names of the items being quantised i.e. zones or lines or sites. There is one list for a single stream, one zones list for bivariate maps, and
for two streams there is a list of zones and a list of lines or sites.

Each list selects the items that are to be quantised from the corresponding attribute file. When a map is generated the lists are set to all the names if the attribute files (common names in the case of bivariate maps).

Zone lists can be reset to:

- all zones in current attribute file (single variate)
- all zones common to two attribute files (bivariate)
- the displayed zones
- zones in a names file

Zone lists can also be modified by adding or deleting zone names by typing in a name or selecting the zone with the cursor

Site lists and line lists can be modified by giving the names.

Hence the quantisation can take place for a set of items that is independent of the displayed, zone lines and sites (although it is illogical for none to be the same). It is common for the quantisation to be carried out over a larger geographic area than that being displayed. Sometimes zones are removed because the attribute data are doubtful e.g. Census districts with a low population.

Changing attribute files does not change the items whose values are quantized.

Map regions

Geographic files can be displayed in user-defined parts of the screen.

A map region is established when a geographic file is displayed. The region is defined by the geographic window (or subset) and the part of the screen it is displayed on.

A geographic window defaults to the total area of the geographic file. Files are subset as a data preparation process or selected with the mouse.

A viewport is selected by positioning the cursor on the monitor with the mouse (i.e. it is a rectangular part of the screen).

Map regions enable complex map layouts to be generated. Maps often have only one region, typically zones from one geographic file displayed on the default viewpoint on the monitor. Multiple regions, each with defined window and viewport provide many possibilities e.g. subsets of a main map can be added as new regions at high magnification e.g. extreme parts of a map can be chopped off and added on as new regions in a corner e.g. several files for different parts of a country could be displayed as separate map regions.

It is possible to overlay data from geographic files onto a map region. More than one set of zones from a geographic file can be displayed in a region but the zones being displayed will overwrite any underlying zones.

Geographic files are automatically windowed, scaled and clipped for display on map regions.

When multiple files are displayed on a region, the precedure order is quantised zones, lines, sites, line overlays, markers and finally text at points.

Multiple regions can be defined anywhere on the map display area of the monitor. However, if regions overlap the display procedure is established by the order of display. Therefore the user should consider the order of display carefully in multiple region presentations.

Geographic files can be displayed in any order, and regions can be defined and changed as desired. Many of these operations destroy the data on the display so the draw icon has o be clicked to redraw the map.

Hard-copy maps

Printing

Maps can be printed from the Files pulldown menu. A device file with a white background(e.g. *WINSV) would normally be used.

OzMap

Maps can also be prepared and output as Saved display files. The saved display files are then read into the OzMap program and output on the desired device or file. Attributes and quantisation can be changed in the usual way to produce a series of maps.

Hardcopy map production is limited by the capabilities of the SCIPLOT package. SciPlot produces many graphic file types:

The Postscript file is an ASCII file that may be edited or sent directly to any Postscript printer.

The Encapsulated Postscript file (EPS) and the Computer Graphics Metafile (CGM), an ANSI standard format file, are files that should not be edited for they contain binary information.EPS and CGM files can be imported directly into wordprocessors or other graphical products.

The HP pen plotter file (HPGL) is an ASCII file that can be edited or imported into wordprocessors or other graphical products.

The WordPerfect file (WPG) is a binary file in WordPerfect's internal graphics format.WPG files are directly importable into the WordPerfect wordprocessor.

The SciPlot Graphics file is a file in SciPlot's own internal format and is used solely as input to the VECTOR program.This file is a binary file in very compact format.It contains the stream of vectors which represent the figures, characters, etc. generated during the execution of the application program. VECTOR processes this graphic file and arranges raw vectors in a direction of paper motion order before display on dot matrix printers and laserjet printers.

For Apple LaserWriters, HP pen plotters, and other graphics devices that support avector drawing commands directly, ordering is not required and VECTOR immediately displays the vectors.

Device files

Several device files are provided to control the appearence of maps on output devices. These device files can also be used with OzGIS.

You have to use device files that use hatching for polygon fill. The configuration section explains the files available. Generally you need to use hatching device files that have the same resolution as that used in OzGIS or aspects and character sizes may not be suitable.

HATCHSV1 - provides polygon display using hatching.
HATCHBV1 - hatching for bivariate maps.
CSIMSV* and CSIMBV* - a series of device files that use the red, green and blue plotter pens (or screen colours) to simulate the colour sequences; look at them on the screen first to decide which ones to try.

The hatching device files can of course be modified to define other hatching patterns.

VECTOR Program

This program enables metafiles produced in the OzMap program to be output to a variety of devices and files with such options as rotation and scaling.

VECTOR's function is to provide a utility to register SciPlot's output on plotting devices (dot matrix and laserjet printers) which cannot be supported directly without requiring significant system resources.VECTOR also provides interactive preview of graphics files on the screen or bath processing at some other time.

Summary

. Maps are prepared with OzGIS and output as saved display files
. The saved display files are then read into OzMap
. As output is to vector devices, hatching or colour simulation device files are used
. The output file type must be chosen
. The draw icon on the toolbar is clicked to actually write the map to file
. Attributes etc can be changed for multiple maps
. The vector program is used to output meta-files to devices

Territory definition

Usually territories are to be developed from base zones according to some criterion; e.g. Sales territories should all have similar sales potential; e.g. School districts should have similar numbers of children.

The operations are as follows.

A base map is displayed: Usually this will be a standard geographic file (e.g. Melbourne postcodes). Basic OzGIS facilities are used to subset files if non-standard regions are required.

Specification of territories: Each territory has a unique 10 character name. Zones are assigned off the screen with the cursor. Zones can be moved between territories and deleted. Territories can be defined or deleted at any time.

Specification of a base-map attribute file: Territory attributes are continually calculated by adding the values for the base zones in each territory. The derived values are quantised (usually sequential colour 121 class method), the territories coloured, and a legend and histogram of sorted values displayed.

Zones can be shuffled according to the displayed territories attribute values to meet the assignment criteria while watching the legend and histogram.

When territory assignment is complete, the definition is output as a combine file.

OzGIS provides a facility for amalgamating attribute data for a combine file.

The combine file can be used to amalgamate the base map geographic file zones to produce a new geographic file, where the new zones are the territories.

The new geographic file and attribute data can be mapped by OzGIS in the standard way.

Territory assignment can be iterated by displaying the base map as before, but using the combine file to set the initial territory definition. Similarly, if a basic territory assignment is know, it can be input as a combine data file and used to start the process.

Site catchment definition

A common requirement is to know the demographics of an area surrounding a site.

For example, a shopping centre manager would like to know how many customers of a particular type should be attracted to the centre.

The basic source of demographic data is usually Census data. The aim of the site catchment software is to determine weights to be applied to Census districts around a site so values can be accumulated.

As it is expected that the attraction to a site will fall away with distance, the procedure is to define a set of contours around each site.

For example, it may be decided that 95% of people living within 10KM of a hospital will go there in am emergency, 50% within 20KM outside that, and 10% within 30KM.

The contours are defined interactively on the screen, and their shape will reflect other influences such as barriers and competition.

After the catchment contours have been defined they can be overlayed on the underlying Census boundaries to find which Census districts lie within each contour.

The Census districts, the proportion within the contours and the contour levels are used to produce a list of districts and their weights for each site. The lists are output as a combine file which can be used to amalgamate Census data for mapping.

The site names and locations are output as a geographic file that can be used with the attribute file to map the sites.

Geographic files containing the contour lines and other site definition graphics can also be produced for use as an overlay on maps.