SAFETY ON OUR ROADS

Chris Walker, Data Dimensions Pty Ltd
John Sliogeris, Vic Roads

ABSTRACT

SAS/BASE* and SAS/GRAPH* DSGI provide a powerful means of analysing and displaying spatially related information when utilised together. This paper discusses the approach used to analyse and represent accident data on a road network system. In particular, a dynamic approach to identifying accident clusters is outlined. Reference is also made to potential future enhancements utilising SAS/GIS™ software.

INTRODUCTION

Promoting safety on the Victorian Road Network involves continual analysis of road accident patterns and trends. Spatial analysis of road accident data is a valuable means of identifying these patterns and trends. By relating accident details to the road network, problem locations, patterns and trends can be easily identified.

Recently, the Road Safety Department within the Victorian State Road Authority, Vic Roads, has taken a leading role in spatial analysis of road accident data by developing a Spatial Information System (SIS) using the SAS system. This paper describes the SIS developed by Vic Roads, its use and the methodology behind it.

SYSTEM OVERVIEW

Analysis is provided via a map based display by location that enables patterns of crash concentrations to be readily identified "at a glance" and subgroups of problem sites to be earmarked for further investigations.

The core strategic analysis tools developed show the ranked worst accident concentrations within arterial routes (here called black lengths) and local traffic areas (black areas) for various jurisdictions. In particular, for arterial analysis, there is sophisticated processing that exhaustively splits an arterial route into urban and non-urban groups and estimates for each group, based on a length criterion, the worst sections in terms of accident rate per kilometre. Note that this is not a "fixed" split up of the road system into predefined lengths but a dynamic split based on accident rates.

These tools summarise the detailed data into a manageable amount for strategic analysis. The SAS/BASE and SAS/GRAPH modules have been utilised to develop this system using a road network database as the base layer. The road network layer was extracted from a G.I.S. database into SAS datasets where it could be directly accessed by the application.

USE OF SYSTEM

Typical requests might include the ability to analyse sections of the road network (e.g. Highways/Freeways) and attempt to highlight worst sections of road based upon user selected criteria. This is useful for both strategic analysis where funds may be allocated for general road improvement as well as detailed investigation within a local traffic area.

For example, a local government area might be interested in identifying which roads within their locality are potential problem sites in terms of child road accidents. It has come to their attention that there may be a problem but further investigation is needed to verify this. A spatial analysis system that satisfies the above needs forms the foundation of the package that has been developed within Vic Roads. It incorporates the ability to comparatively analyse sections of road and local traffic areas. The highly modular ability of the SAS system and programming flexibility for data interaction was a key feature in order to implement this system. Standard G.I.S systems could not provide the high level of data manipulation or structure necessary.

Use of the Maps

The various maps produced by the SIS can be used for strategic analysis, detailed analysis or both.

For example, in order to prepare a strategy, the analyst would first look at the overall picture by looking at a map of the region or municipality. Worst lengths of roads, worst local traffic areas and locations where accidents are concentrated can be identified from this map.

Detailed analysis can be carried out by looking at individual roads, areas or accident locations. Municipal, town, route or directory-scale maps can be used for this purpose. These maps are produced at scales that allow individual accident locations to be identified and the numbers of accidents at these locations to be determined.

Directory-scale maps are provided in the form of a transparent overlay at the exact scale of a commercially available street directory. This allows accident patterns to be viewed in conjunction with other geographical information.

Users of the maps include government departments, local government authorities and private organisations.

ROAD NETWORK DATA

The road network data was initially downloaded from a G.I.S database in ascii format. The fundamental data
construct is a segment of road (arc) with associated attributes, e.g., arc start/end identifiers, length of road, road names, arc co-ordinates, etc. Each arc has a maximum of 500 x-y vertices. For efficiency, the state network was subdivided into 6 separate logical regions (5 rural and 1 metropolitan). Two SAS data sets were created per region corresponding to ≤ 50 x-y vertices and > 50 x-y vertices, respectively. This was necessary due to the data set size overhead of having up to 500 vertex pairs per arc in one data set. The following illustrates this.

PER REGION (TYPICAL)

<table>
<thead>
<tr>
<th>NO. DATASETS</th>
<th>NO. VERTICES</th>
<th>FILESIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>≤ 500</td>
<td>100 + MB</td>
</tr>
<tr>
<td>2</td>
<td>≤ 50, &gt; 50</td>
<td>20 MB, 4 MB</td>
</tr>
</tbody>
</table>

Hence, the 2 data set option represents a significant file size saving and additionally, there is access time improvement in later data/proc steps due to the smaller file size.

BLACK LENGTH AND BLACK AREA CONCEPTS

For black lengths along arterial routes, the first step was to split the whole Victorian arterial system into 2 classes - rural open and urban - so as to enable comparison of similar sections of road. These arterials were further subdivided into links that were split at arterial/arterial intersections. Thirdly, individual arcs (road sections between intersections) were ordered from start to end along a link and a chainage (mileage) system was calculated for each section of the link.

A SAS program was developed to pre-analyse the network using individual arterial routes split at town/country border points as well as arterial/arterial intersection points to form the logical subdivisions known as links. The graph below shows a sample link structure for the Western Highway in the City of Ballarat. An iterative approach using a SAS module was developed that chained road arcs together sequentially within each link.

(Each section of road has a unique link and sequence no. within that route no.)

Accident locations are directly referenced to this link structure (i.e., "overlay") with intersection accidents attached to ends of arcs and midblock accidents attached to arcs themselves. This is the means for performing accident analysis on the network.

The accident data is processed separately based upon selected criteria entered by the user via the data step window interface (e.g., identify accidents on all state freeways [interstate] for fatal accidents between 1990 and 1994). Several SAS functions (data/proc steps) filter data and summarise into separate aggregates for intersection and midblock types with the direct identifiers to the road network included. (This is the intersection or midblock reference.) Additionally, other layers are generated (e.g., local traffic area accidents, node accidents, etc.)

Whilst identifying individual accident points on the network is useful, we need the ability to do more sophisticated analysis that allows us to identify groupings of accidents in some meaningful way. For example, we may have a pedestrian accident problem that spans a section of road yet no particular single accident location has a particularly high accident concentration. But, as a group, it does. See the diagram below.

**POTENTIAL ACCIDENT CONCENTRATION**

**POTENTIAL ACCIDENT CLUSTER**

This may typically be a problem with, for example, elderly citizens in a shopping strip location or school age children having trouble crossing a busy main road in the vicinity of a school. The problem is how to analyse this computationally.

**Black Length Technique**

An algorithm was developed that exhaustively calculates the worst sections of road by accident rate based on a user-selected length criteria (e.g., 10 km for rural open road cases, 1.5 km for urban Melbourne - any values are allowed). Then the worst percentage (again user selected) is presented (e.g., 30%) in colour-coded bands.

For example, a user may request a country analysis (rural open road sections only) with a minimum length comparison of 3.0 km and a maximum length comparison of 6.0 km. This bandwidth allows for variations in the length of road segments. Additionally, the user can select any combination of routes for comparison (either system predefined or user selected at
run time). For example, they may only be interested in the "Western Highway" in the City of Sunshine Local Government area. The relevant accident data is initially filtered off for analysis that satisfies the locational selections.

The aim is to rank sections of road that meet the specified criteria after exhausting all possible iterations of sections of road. Note that sections of road are compared across all routes that satisfy the selection criteria.

WESTERN HIGHWAY EXAMPLE

Each intersection becomes the next starting point for each iteration through the specified route. At each starting point, the procedure tracks along the route until it meets the length (minimum) criterion. It then stores this away for comparison for the next iteration which commences at intersection 2 where the process is repeated.

This process is repeated until it reaches the end of the route and has retained the section with the highest rate. This becomes the worst section of road based upon the user selected criteria.

E.G. ITERATION 4 YIELDS HIGHEST ACCIDENT RATE
(ACC/KM) = 6.1

This process is repeated with the allocated sections of road removed from the next cycle through.

E.G.
INT 4 -> INT 5
INT 5 -> INT 6
INT 6 -> INT 7
* REMOVED FROM SUBSEQUENT ANALYSIS

Cycles continue until the remaining sections fail to meet the length (minimum) criterion.

This process continues for each route and link in turn. Finally all the sections are cross ranked by accident rate. We now have a table which identifies worst to best sections of road. Using a SAS/GRAPH DSGI Module, we can highlight graphically these sections of road.

For example, the worst 30% of road sections in 10% bands (colour coded for easy identification) superimposed over the road network layer base.

This allows for easy initial targeting of potential sites for more detailed analysis. Additionally, SAS data sets are created which can be further analysed using other tools in the SAS System.

Black Area

Black areas provide a means of cross comparing accident rates for fixed local government sub regions. Regions are bound by arterials/railway lines/major waterways/local government area boundary or subdivision boundary. An accident rate is calculated in terms of accidents per square km or per embedded local road length and then all local traffic areas are ranked in comparison to a user selected jurisdiction (e.g. a particular council area can be ranked with comparison to itself or to all of Melbourne. This is useful for focusing on areas which may have potential problems associated with schools, shopping centres, sporting areas etc. Additionally it allows local councils to check how their region compares with other localities on a similar basis (accidents/sq km).

FUTURE DEVELOPMENTS

The major future development is to provide a GIS type application that would provide the standard features of the above system plus interactive capability. A key feature of the GIS application would be to incorporate as standard menu items the strategic views of current Road Safety programs and countermeasures (e.g. the accident blackspot program, pedestrian programs etc). This provision as standard menu items would circumvent the interactive tendency to redefine established criteria in non-standard ways.

A major technical capability to be implemented soon is the provision of dynamic local traffic area partitioning to establish the worst parts of local traffic areas based on a uniform square kilometrage or embedded local road length (via user selected criteria).
CONCLUSION

These black length and black area techniques, developed with the SAS system, provide a very effective method for analysing accident data on the road network, quickly identifying areas for further detailed analysis if required. Currently the SAS/GIS Module is being explored as a means of graphically interacting with the maps.

ACKNOWLEDGMENTS

The following staff members of Vic Roads contributed to the preparation of this paper:

Elizabeth Hovenden

SAS, SAS/txn, SAS/GRAPH, SAS/GIS are registered trademarks or trademarks of SAS Institute Inc. in the USA and other countries. * indicates USA registration.

Other brand and product names are registered trademarks or trademarks of their respective companies.

For further information on this paper contact Chris Walker at Data Dimensions Pty Ltd, P.O. Box 107, Sunshine, Victoria Australia 3020.