Schema Visualisation using a Metadata Approach for GIS

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Extended Abstract

A major requirement for using a GIS effectively is the ability to visualise the geographic datasets that are available for manipulation and analysis. Such geographic datasets may have been obtained from various sources and provided in the form of map data files in vector or raster formats. In general, a map file would represent a specific area in space and in the case of digitised vector data will contain information on a particular class of features in space, e.g. roads, rivers, land-use, etc.

To be able to use the map files effectively, the user will need some means of identifying their contents. In particular the type of data, the spatial extent or location of the data in space, as well as other meta-data such as, the scale of the map and date the data has been acquired. In addition, to be able to manipulate the information contained in more than one map, it is important to view how the maps are related in space, e.g. whether they are overlapping partially or wholly.

In traditional databases, a schema or a data model is the means of representing the objects, their properties and their relationships in the database. GIS are often characterised as being data rich but schema poor. In particular, it is often not possible to pre-determine, calculate and store the possible relationships between geographic objects on maps and between maps in the database. A common way of achieving the above visualisation is to have some external means of identifying the map files and relating them such as, e.g., coding the file names and relating them to national grid tiles. However, this solution may be satisfactory in the case of very specialised and expert use of the GIS. In more general cases, the above solution may not be satisfactory nor logical for ordinary or casual users of a GIS. The same argument is true for large geographic databases and geographic digital libraries, where visual browsing of the stored data sets is an essential pre-requisite to the appropriate selection and use of the data.

In this paper, the construction and visualisation of the schema of a geographic database is suggested as a tool to support the effective use of the contained data sets in a GIS or in other types of large geographic databases. The schema is automatically extracted by utilising metadata of the represented data sets. In particular, geographic extent of the maps or data sets, the theme or set of characteristic geographic features represented, the scale and accuracy of representation as well as other attributes including, the data provider and time of data capture are used. Indeed, the metadata utilised are ISO19115 (model for geographical metadata) compliant.

A prototype system has been built using Java to simulate a 3D visualisation interface that offers the browsing of the database through three main avenues, namely, selection by theme, selection by scale, and selection by (spatial) object type, i.e. whether points, lines or areas.
In particular users of the system are able to visualise, query and select data sets from the database, using the following variables.

- **Map theme**: information relating to specific geographical themes, such as roads or rivers is known as a thematic map; maps may have multiple themes.

- **Geometry of map features:** Three primary types of spatial data types are used to represent geographical features/themes namely, points, lines and polygons, as well as raster or gird data for image files.

- **Map Scale and level of detail**: Spatial analysis is usually carried out with data sets of matching scales and level of detail. Hence, it is logical to provide a view to the user based on the scale and/or level of detail of the data sets and associated features. For example, it will not be possible to determine whether a road crosses the boundaries of a particular city, if the only representation held of the city in the database is a point.

- **Map Extent:** It is useful to view the relationships not only of specific features on maps and in datasets but also the relationships between the maps and data sets themselves. Visualising the extent of overlap or otherwise of data sets and their relative location in space gives immediate valuable information of whether and how do features interact in those maps, and hence may provide a useful guide to the queries to be posed to the data sets.

- **Data provider:** The specialist map provider, for example, Ordnance Survey.

- **Date of capture:** The date the map information was captured by the map provider.

- **Accuracy:** Positional accuracy associated with the data sets.

The datasets are represented by their minimum bounding rectangles (MBR). Relationships between maps are realised through the relationships of their MBRs, e.g. to indicate whether maps are coincident, overlapping or disjoint. The interface is transparent, where data variables can be usually accessed from any of the three main views. For example, the scale of the data sets can be viewed by clicking on the required data set in the view by theme view. Logical restriction of views are intended to guide the user to an informed selection of data sets to utilise in further geo-analysis and computation. A comparison of the developed prototype with the interface of the ArcView GIS is given and a usability evaluation of the interface is provided. A snapshot of the developed interface is shown in figure 1.

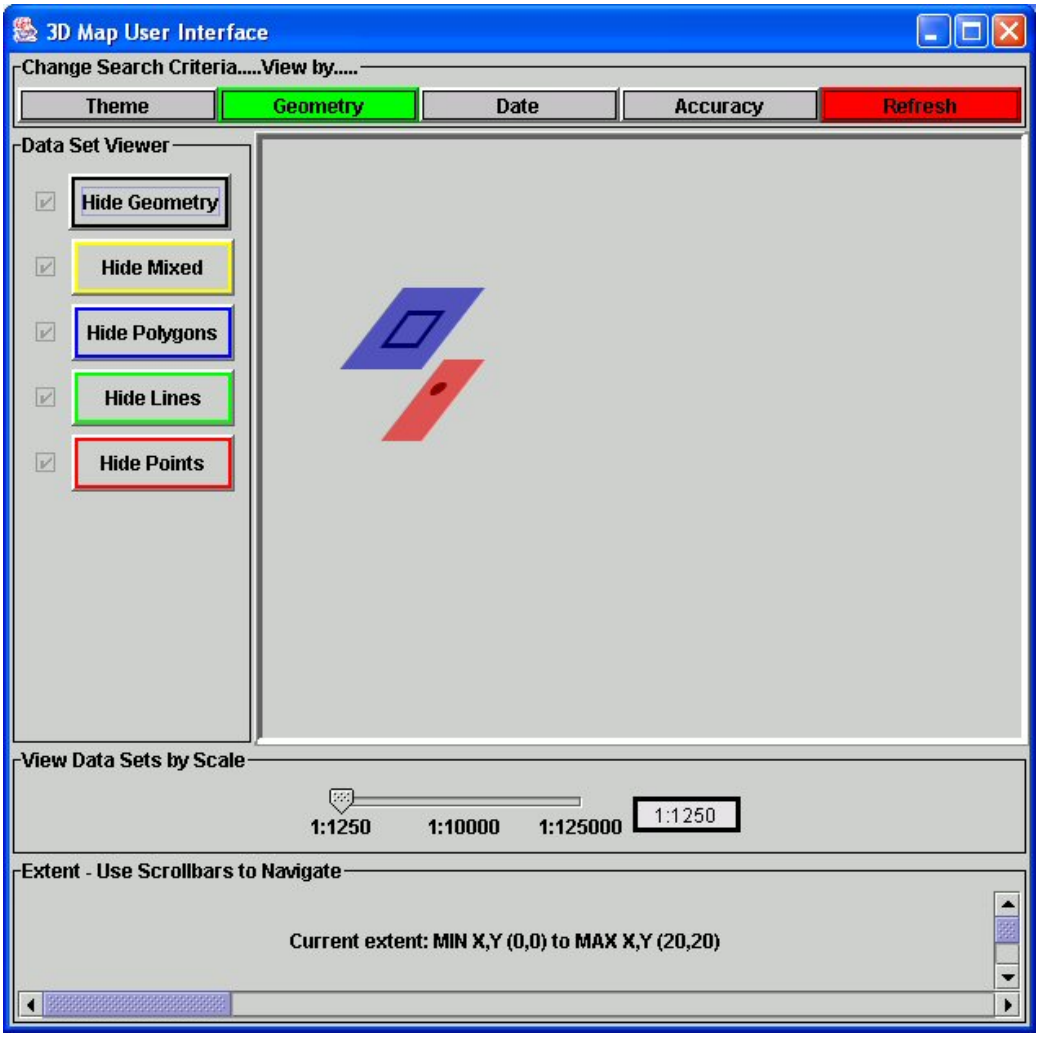

Figure 1. A snapshot of the prototype schema visualisation interface.

In this paper, it is argued that the usability of the geographic database or information system shall be enhanced by supporting the users in the following specific ways:

1) by allowing users to view the contents of the database and to make informed choices of the data sets to further utilise in analysis, viewing and manipulation,
2) by offering users informed feedback on selections, through guidance and restriction of choices to only those plausible for co-analysis and manipulation,
3) by offering an environment for interactive batch selection of data sets based on common characteristics, viz. by theme, scale, extent and geometric types, and,
4) by providing users with an interactive environment where customised visualisations of data sets based on meta-properties may be constructed and utilised homogeneously.

The paper gives an overview of related research and systems for visualising and browsing geographic databases. The design of the visualisation interface and the implemented prototype are described. A critical evaluation of the system and a comparison and evaluation of the interface with other GIS interfaces are provided.

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