Exploratory Cartographic Visualisation of Health and Higher Education the through Google Maps API

Alex Singleton[1], Maurizio Gibin[1], Paul Longley[1]

[1]Department of Geography – Centre for Advanced Spatial Analysis, University College London

Pearson Building, Gower Street, London WC1E 6B

Email: a.singleton@ucl.ac.uk m.gibin@ucl.ac.uk plongley@geog.ucl.ac.uk

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1. Introduction

Cartography is defined as the art and science of making maps and it is historically used by geography as its own language. With the growth of Geographic Information Science (GISc) - as the theoretical framework for all digital geographic information disciplines (Longley, 2005) - and the progress in geographic information systems, cartography gained new tools and media that enhanced static maps and introduced multiple layering, interactivity and multimedia (Dransch, 2000). Through computer-based visualisation of geospatial data the domains of visual thinking and visual communication (DiBiase, 1990) of traditional cartography were pushed so far to require a new discipline that embeds this technical driven revolution in the research approach.

The term Geographic Visualisation or "Geovisualisation" (GVis) refers to *"spatial data"* and *"can be applied to all the stages of problem-solving in geographical analysis, from development of initial hypotheses, through knowledge discovery, analysis, presentation and evaluation"* (Buckley et al., 2000). Among the different techniques and methods available to GVis, Exploratory Spatial Data Analysis (ESDA) is heavily based on maps, graphs charts and tables that can be dynamically linked together.

The diffusion of Google Maps and Google Earth has increased the use of geographic information (GI) among internet users and fuelled new ways of deploying GI in an effective and easy way. This geographic information mostly refers to the location of a point on the Earth's surface with additional attributes. Although Google Maps is not a complete ESDA tool, the availability of a free Google Maps Application Programming Interface (API) stimulates users with intermediate programming knowledge to built their own applications using Google Maps as a visualisation interface.

This paper will present two applications of Google Maps API where health and higher education data are overlaid as thematic layers on top of the standard Google Maps base layers.

2. Displaying thematic layers in Google Maps

Web 2.0 is a phrase coined by O'Reilly Media in 2004 (Wikipedia) to summarise the rise of a series of web communities based on technologies of social networking, social bookmarking, blogging, Wikis and many other open content using RSS/XML feeds (Graham, 2007). The use and reintegration of these technologies through open standards is the heart of Web 2.0. In June 2005 Google officially released their Google Maps API and since that date the popularity of *map mashups* have started to grow in the internet community (Purvis et al., 2006). A mashup is defined as *"a website or application that combines content from more than one source into an integrated experience"* (Wikipedia), therefore supporting a position within the concept of a Web 2.0. A map mashup combines different sources in a cartographic visualisation environment. When using the Google Maps API, programmers can access different functionalities or *classes* and create their own application integrating external data into the Google Maps interface. The process of creating a map mashup application involves different programming languages. Google Maps API is basically a collection of JavaScript classes that can be called from a web page to build various elements of an interactive map. Although more automated ways exist for users to create and share maps such as Google My Maps, mashups require users to posses some knowledge of: JavaScript, XML (Extensible Markup Language), Ajax (Asynchronous JavaScript and XML), XHTML and CSS and VML. The latter two create the web page layout for the map mashup application.

External data displayed by Google Maps may come from different sources and be in different formats. Typically these data will refer to classic GIS data models such as points, polylines, polygon vectors and rasters. However, GIS files common across desktop GIS software such as ESRI Shapefiles are not directly compatible in a Google Map mashups. Raster formats need to be converted and the geographic coordinates of vector data simplified to reduce their download size. GPoint, GPolyline, GPolygon are the classes used by Google Maps to implement point, polylines and polygons. All three classes need to be supplied arguments (points or arrays of points) to visualise the geographic features. There are more applications using point data alone as building complex polylines and polygons requires arrays of the vertices and coordinates in order to display these items, adding to the download size and as such slowing down the application. For this reason, Google Maps mashups showing polygon data thematised by a particular attribute are not very common.

At the end of 2006 The Centre for Advanced Spatial Analysis, University College London released a freeware application to simplify thematic mapping in Google

Maps. GMap Creator[1] can read projected shapefiles and create a thematic map from a field of the attribute table. The thematic layer is then reprojected and transformed in image tiles of the same size (256x256 pixels) whose frequency depend on the zoom level selected. The software also creates the webpage that contains the mapping application in a standard format and layout. The examples presented in this paper were built using GMap Creator as the main engine to create the tiles, however the style and design of the web pages were manipulated to offer new cartographic features such as the ordering of layers and also the ability to select data.

3. Health and Higher Education Geodemographics

The data used to create the health application are derived from registered patients within the 48 General Practices in Southwark Primary Care Trust, located in the borough of Southwark, South London. These data are collected through a system called Exeter and are used to monitor the practice activity against the Quality and Outcome Framework (QOF), an annual voluntary programme aimed at rewarding GP performance. Data at individual level have been aggregated into unit postcodes and then imported into a Geographical Information System (GIS). Using this point dataset the density of registered patients per kilometre square was calculated using a Kernel Density Estimation (Silverman, 1986) algorithm with a bandwidth of 500m and a cell size for the output raster of 10 metres. The Exeter data have also been linked to Mosaic UK, a commercial geodemographic system distributed by Experian. Geodemographic profiling can give an insight to the socio-economic conditions of the registered population and provide a proxy measure of health inequalities.

The data used within the Higher Education (HE) mashup use an extract of the Universities and Colleges Admissions Service (UCAS) applicant database which was created during the 2004 application cycle. The majority of students within HE in the UK apply through the UCAS system which allows them to select a range of combined institution and course choices. These choices are then processed by the institutions with the applicant either being rejected or offered a place.

4. Visualisation though a Google Maps mashup

The health mashup displays the Percent Volume Contours[2] (PVCs) of the densities of registered patients for each general practice in Southwark Primary Care Trust. PVCs are the boundaries of a certain percentage of the cumulative density function. For each practice the PVCs show the areas where approximately the 50%, 75% and 95% of the patients registered to the selected practice live.

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[1] GMap Creator is part of the GeoVUE Project at CASA, a project sponsored by the ESRC as a node in the National Centre for e-Social Science. GMap Creator is developed at CASA by Richard Milton.

[2] Percent volume contours were calculated with a free ArcGIS extension called *Hawth's Analysis Tools* developed by Hawthorne Beyer and downloadable from the website http://www.spatialecology.com.

The mashup additionally show the geographic distribution of the catchments' area postcodes. For each postcode additional attributes can be browsed, for example: number of patient registered to the practice by sex, resident population, mode of the country of birth, a measure of ethnic diversity, a measure of deprivation and also the Mosaic type.

The UCAS data contain many attributes, however for this mashup example acceptance rates within London are created by comparing the total frequency of applicants to the subset whom are successful. These overall data are also disaggregated by a number of course areas. This application could be used by UCAS to geographically visualise the conversion rates of applicants and target resources for further investigation on why students from within areas fail to participate.

5. Conclusions

Google Map mashups in their basic form are a relative easy to implement and are currently a free solution for online exploratory cartographic visualisation. Using mashups can provide a cheap and effective platform for visual communication of health and education data to both internal and external users. The interface is well designed and intuitive so needs only limited instruction on how to use, saving time on training in more complex GIS technologies.

The simple cartographic design of the Google Map base layers which are integrated into all mashups make ideal background for thematic overlays. In both health and education applications these data enable users to visualise thematic layers made up from boundaries of unfamiliar size and location within the context of local and scalable geographical features such as roads or gazetteer entries.

Compounding essential geographic information of the *"where"* with the *"what"* needs careful design (Tufte, 1990). The colour scheme choice for the thematic overlay must avoid tones that can be confounded with the underlying Google Map. A solution employed in the examples use a combination of thematic overlay transparency and the Google hybrid map layer. Setting a 100% transparency for the thematic layer and putting the street layer on top allows essential geographic information coupled with additional attribute data.

Improvements are needed in the Google Maps API on the loading of complex polylines and polygons by since these are coded as arrays of points, thus a huge amount of points can cause the mashup to be slow to load or unusable.

6. References

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