USING JAVA TOPOLOGY SUITE FOR REAL-TIME DATA GENERALISATION AND INTEGRATION

Mikael Johansson and Lars Harrie
National Land Survey of Sweden
SE-801 82 Gävle
micke.j@goteborg.utfors.se, lars.harrie@lantm.lth.se

KEY WORDS: Generalisation, Integration, Algorithm, Data structure, JAVA, GML

Introduction

The amount of cartographic data distributed on the Internet is still increasing. Today, most of the data are raster data, but the emerging XML-standards will make it easier to distribute vector data on the Internet. One of the main advantages with vector data is that it is easier to integrate and generalise them than raster data. However, this requires a suitable technical environment to perform the data-integration and generalisation.

During the last years some prototype systems for distributing vector data on the Internet have been developed. Many of these systems are based on the two XML-standards *Geographic Markup Language* (GML; OGC, 2002) and *Scaleable Vector Graphics* (SVG; W3C, 2002). These two standards are complementary: GML is used for storing and distributing geographic data and SVG is used for presenting data. In many current prototype applications the cartographic data is stored in a database; when a map request is performed to the database a GML-file is created. The GML-file is then translated into an SVG-file (in e.g. an XSLT-transformation). In this step it is also possible to perform some generalisation transformations (Lehto and Kilpeläinen, 2000, 2001a, 2001b). The project described in this paper also follows this workflow. The new thing is the use of *Java Topology Suite* (JTS; Vivid Solutions, 2002; see Figure 1). The purpose of this step is to have a powerful and flexible environment to perform the data-integration and generalisation.

Java Topology Suite is a class library in Java. JTS was chosen as environment for generalisation and data-integration mainly due to following reasons. Like GML, JTS conforms to the *Simple Features Specification for SQL* (OGC, 2002) and it contains robust implementations of the most fundamental spatial algorithms (in 2D). Furthermore, JTS is an open source and free to use and modify in research.

Our project concentrates on following tasks:
1) Write a Java-based routine that reads GML-files and creates objects in geometry classes (defined in Java Topology Suite) plus write another routine that translates the data in the other direction.
2) Implement some data-integration and generalisation algorithms, using the spatial operations in Java Topology Suite when applicable.
3) Perform case studies using data from National Land Survey of Sweden. These studies will concentrate on real-time applications on a small-display (about 8x10 cm).

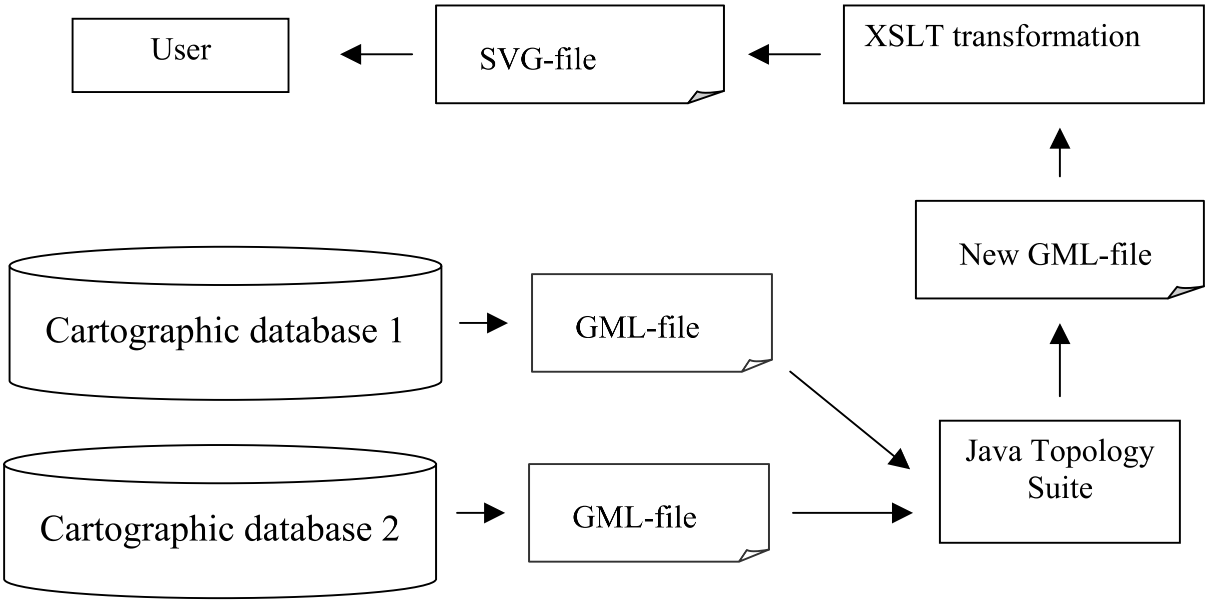

Figure 1: A schematic view of distributing cartographic vector data from a database to a user.

Current status

The current status of the project is that we have written a translation program from for GML file, based on a free parser (Xerces) from Apache (2002). The cartographic data is then stored in a Java environment called JGML (Java GML; the enclosed pdf-document describes JGML in a UML-model). JGML is a Java implementation of the GML specifications that uses the class libraries from JTS.

A Java Viewer is also developed (see Figure 2). The viewer will only be used for development work.

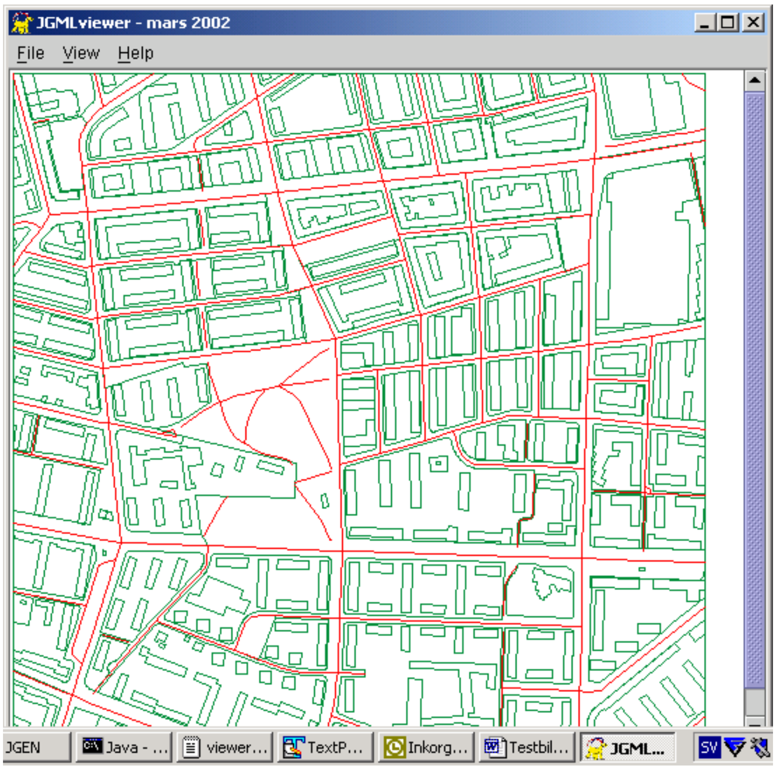

Figure 2: Data from the City of Malmö, Sweden, shown in the JGML viewer.
© The local municipalities in Skåne and National Land Survey of Sweden, 2002.

Future plans
The starting point for the generalisation and integration part (task 2) will be one or a few realistic scenarios around user cases where real-time generalisation and data-integration are needed to create a map with dynamic content. We are currently working in the modelling stage with this problem. An extension of the UML model is made and will implemented in Java during the summer. Among others, this extension adds a spatial data structure based on constrained Delaunay triangulation (Shewchuk, 1996).

In the near future the project will concentrate on implementing known algorithms. Examples of routines we would like to implement are variable-scale presentations (Harrie et al., 2002), least squares methods for graphic generalisation (Harrie and Sarjakoski, 2002; Sester, 2000), building generalisation (Regnauld, 1996) and possibly some methods from the Agent project (Lamy et al., 1999).

If we take a longer time perspective our aim is also to develop some new methods. Of special interest are, perhaps, methods for real-time data integration. One such example is adding route-data to a map; a major issue here is that the route data should not hide important map data.

Acknowledgements
This research is a part of the GiMoDig project, IST-2000-30090, which is funded from the European Union via the Information Society Technologies (IST) programme (GiMoDig, 2002). Thanks to Lassi Lehto (Finnish Geodetic Institute) for the idea of using JTS, to Lars-Håkan Bengtsson (National Land Survey of Sweden) for data transformations, and to Tiina Sarjakoski (Finnish Geodetic Institute) and Monica Sester (University of Hanover) for co-operation. Test data of Malmö, Sweden were kindly provided by the local municipalities in Skåne and National Land Survey of Sweden.

References
Apache, 2002. *Web site of Apache XML Project*, xml.apache.org (accessed 8 March 2002).

GiMoDig, 2002. *Geospatial info-mobility service by real-time data-integration and generalisation*, http://gimodig.fgi.fi/ (accessed 11 March 2002).

Harrie, L., and T. Sarjakoski, 2001. Simultaneous Graphic Generalization of Vector Data Sets. *GeoInformatica,* in print.

Harrie, L., L. T. Sarjakoski and L. Lehto, 2002. Variable-Scale Map For Small-display Cartography, *Proceedings of ISPRS*, Ottawa, Canada, in print

Lamy, S., A. Ruas, Y. Demazeau, M. Jackson, W. A. Mackaness, and R. Weibel, 1999. The Application of Agents in Automated Map Generalisation, *Proceedings of the 19th International Cartographic Conference*, Ottawa, pp. 1225-1234.

Lehto, L., and T. Kilpeläinen, 2000. Real-Time Generalization of Geodata in the Web. *International Archives of Photogrammetry and Remote Sensing*, Vol. XXXIII, Part B4, Amsterdam, pp. 559-566.

Lehto, L. and T. Kilpeläinen, 2001a. Real-time Generalisation of XML-encoded Spatial Data on the WEB. Kidner, D. B. and G. Higgs, eds., 2001, GIS Research in the UK, *Proceedings of the GIS*

Research UK, 9th Annual Conference GISRUK 2001, April 18th – 20th, University of Glamorgan, Wales, pp. 182–184.

Lehto, L. and T. Kilpeläinen, 2001b. Generalizing XML-encoded Spatial Data on the Web. *Proceedings of 20th International Cartographic Conference,* August 6–10, 2001, Beijing, China, Volume 4, pp. 2390–2396.

OGC, 2002. *OpenGIS*®, http://www.opengis.org (accessed 13 March 2002).

Regnauld, N., 1996. Recognition of Building Clusters for Generalization. *Proceedings of the 7th Spatial Data Handling Symposium*, Delft, the Netherlands, pp. 185-198.

Sester, M., 2000. Generalization Based on Least Squares Adjustment. *International Archives of Photogrammetry and Remote Sensing*, Vol. XXXIII, Part B4, Amsterdam, pp. 931-938.

Shewchuk, J. R., 1996. Triangle: Engineering a 2D Quality Mesh Generator and Delaunay Triangulator. In *First Workshop on Applied Computational Geometry,* Philadelphia, Pennsylvania, pp. 124-133.

Vivid Solutions, 2002. *Java Topology Suite*, http://www.vividsolutions.com/jts/jtshome.htm (accessed 13 March 2002).

W3C, 2002. *Scalable Vector Graphics (SVG)*, http://www.w3.org/Graphics/SVG/ (accessed 8 March 2002).

Biographies

Mikael Johansson completed the degree of Master of Science in Geodesy in 1991 at the Royal Institute of Technology (KTH) in Stockholm, Sweden. He worked as a cartographer at the National Land Survey of Sweden in Gävle between 1992 and 1998. His main responsibility was development of the production line for the small-scale maps. Since 1998 he has studied computer science at Gothenburg University. This project is part of his M Sc thesis in computer science.

Lars Harrie completed the degree of Master of Science in Geodesy in 1993 at the Royal Institute of Technology (KTH) in Stockholm, Sweden. He worked at the geodetic research and development department at the National Land Survey of Sweden in Gävle between 1994 and 1996. The main interest during this period was the national net of reference stations for GPS and the establishment of a new national geodetic reference system. Between 1996 and 2001 he was a PhD-student at Lund University. In 1998 he obtained the degree of Licentiate of Engineering with a work on propagating updates between cartographic data sets. He completed his PhD at Lund University in 2001. The main subject in the thesis was optimisation methods in cartographic generalisation. Since 2001 he work as a postdoctoral fellow at Lund University and as a researcher at the National Land Survey of Sweden.