GeoS4S Module Geovisualization

Vozenilek, V. and Vondrakova, A.
Palacky University Olomouc, Olomouc, Czech Republic
E-mail: vit.vozenilek@upol.cz, alena.vondrakova@upol.cz

Abstract
Any geospatial study involves geovisualization as either input information sources or output information presentations. The term Geovisualization consists of cartographic concepts of coding and encoding of spatial information. It involves GIS-related topics of data management, data processing and principles of data visualization, mainly concerning Bertin's principles of graphic variables. The efficient practicing in GIS-based geovisualization includes interface design, interactivity, generalization, and publishing. The paper summarizes the learning objectives, lesson content, learning activities and evaluation scheme for the Geovisualization module.

1. Introduction

Visualization is the process of conveying information by some means that we can see. Its purpose is to convert the seemingly random into a form that can be quickly understood. Geovisualization is short for geographic visualization. It is a branch or discipline within visualization that deals solely with displaying information that has a geospatial component to it. A geospatial component is geographic or positioning information. The map as a representational metaphor and main display mode is now a key to a whole raft of new interactive visualizations of scientific data. The switch from a static screen presentation to one where the viewer is able to control key aspects of the map display directly underpins the rapid development of spatial technologies including GIS, multimedia atlases, and 3D virtual scenes.

1.1 Module Description

Any geospatial study involves geovisualization as either input information sources or output information presentations. The Geovisualization module consists of two main blocks: (i) visualization concepts of coding and encoding of spatial information and (ii) practical practicing in geovisualization products. The course starts with GIS-related topics of data management, data processing and principles of data visualization, mainly concerning Bertin's principles of graphic variables. Students learn to think about geovisualization design and content compilation. Many illustrations and geovisualization examples will be used for studying various ways of visual representations and visual concepts. Practical skill will be taught by the most applicable techniques of geovisualization. The concepts of coding and encoding of spatial information via geovisualization products will include the following topics: map projections, image design, symbolizing, methods of thematic cartography, typography, user issues and visual analysis. The efficient practicing in GIS-based geovisualization includes interface design, interactivity, generalization, and publishing.

This module focuses the dual purpose of geovisualization as a tool for visual communication and spatial thinking. Students will learn how to use geovisualization to understand their data, and how to use visualization to create powerful and effective communication with the user.

1.2 Learning Outcomes

After the course implementation students should be able to:
- plan, prepare and conduct all phases of geovisualization production,
- manage geodata for geovisualization products,
- create symbols, select colors, and place labeling,
- publish and disseminate the compiled products,
- understand the user needs and the effective visual communication.

2. Module Structure

2.1 Module Overview

The Geovisualization module consists of 15 lessons, while each lesson is implemented with slides, accompanying notes, required or optional reading assignments, practice exercises, individual assignments, and self-assessment quizzes. The overall student effort is estimated at 150 to 170 hours, and the module is intended to provide credit equivalent to 6 ECTS. The module materials are designed to be used in either a traditional classroom setting or for online self-study. The computer with specific software is required for the implementation of the practical exercises.

2.2 Summary of Lesson Content

The lesson content is following:

- *Lesson 1: Introduction into geovisualization* – course introduction; geovisualization products; digital spatial data infrastructures;
- *Lesson 2: Concept of geovisualization I* – purposes of geovisualization (explanation, synthesis, presentation, analysis); elements of the coordinate system and map projections;
- *Lesson 3: Concept of geovisualization II* – principles of symbolization; visual variables;
- *Lesson 4: Static maps* – principles of color; typography and design; thematic mapping methods;
- *Lesson 5: Web mapping* – graphic user interface; map elements; publishing – tools;
- *Lesson 6: Geovisualization on Mobile Devices* – wireless communication; map design for mobile devices; local based services;
- *Lesson 7: Geovisual Analytics* – spatial thinking & map use; representing space and time;
- *Lesson 8: Multimedia in geovisualization* – sounds; pictures; videos;
- *Lesson 9: 3D visualization* – modeling for 3D visualization; 3D graphics; 3D printing;
- *Lesson 10: Animations* – animate view; animate layer; animate scene properties; animate through time;
- *Lesson 11: Time Mapping* – Space-Time-Cube; dynamic maps;
- *Lesson 12: Fly-Throughs* – defining fly-throughs; options setting;
- *Lesson 13: Virtual reality* – virtual environments; virtual globes;
- *Lesson 14: Modern trends in geovisualization* – Big data; real-time visualization; augmented reality;
- *Lesson 15: Related issues* – related principles and rules of visual communication; open data, licenses and copyright issues; data sources, geodata interoperability.

3. Hands-on Sessions

The module consists of many interactive activities to develop student's practical skills. Some of these activities are part of the module evaluation scheme, but there are also some voluntary tasks. The practical realization of exercises does not assume any prior knowledge of specific software; nevertheless the knowledge of any GIS software is beneficial.

4. Teaching and Learning System

The learning and teaching is conducted by student-centred e-learning approaches. The knowledge from the previous e-learning activities was used for the proper system of distance learning (Vavra et al., 2010; Pechanec et al., 2013). The detail presentation with further readings, tutorials and manuals are provided for each lesson. Individual assignments are related to student specialization.

- Exercise 1: Web Map (Lesson 5)
- Exercise 2: Mobile applications (Lesson 6)
- Exercise 3: Story Maps (Lesson 8)
- Exercise 4: Terrain Visualization (Lesson 9)
- Exercise 5: V-Analytics (Lesson 11)
- Exercise 6: Time-series Map (Lesson 11)

5. Evaluation System

An evaluation will be based on the required practical activities. All students will both evaluate existing geovisualization products and compile their own. After assessment the students will receive the prepared examples of correct solution. Assignments and quiz evaluations include:

- Assignment 1 – 20 pts
  Application on graphic variables for map symbology (Lesson 3)
- Assignment 2 – 15 pts
  Compilation of static map (Lesson 4)
- Assignment 3 – 15 pts
  Visual Analytics (Lesson 7)
- Assignment 4 – 15 pts
  Map Animation (Lesson 10)
- Assignment 5 – 15 pts
  Virtual Reality in GIScience (Lesson 13)
- Quiz 1 – 10 pts (Lesson 12)

6. Additional Notes

The presented module content is based on the latest development in geovisualization. Each lesson contains links and references to expert publications and contributions in GIScience. Selected papers are included as mandatory reading. Practical exercises are also focusing on user issues in geovisualization (Vondráková and Voženílek, 2016). For better understanding of geovisualization, the widely acclaimed books, such as The Power of Maps (Wood, 1992), How Maps Work (MacEachren, 2004), Thematic Cartography and Geovisualization (Slocum et al., 2009), and Cartography: visualization of spatial data (Kraak and Ormeling, 2013), are recommended.

Acknowledgements

References and bibliography

Kraak, M. J. and Ormeling, F. J., 2013, Cartography: Visualization of Spatial Data. London: Routledge. 216. ISBN 9781317903116

MacEachren, A. M., 2004, How Maps Work: Representation, Visualization, and Design. New York: Guilford Press. 513. ISBN 978-1572300408

Pechanec, V., Vávra, A., Voženílek, V., Tolasz, R., Jílková, J., Němcová, Z., Šeflová, J., Holtanová, E., Vondráková, A. and Jurek. M., 2010, Education Project About Climate for Multi-User eLearning Courses. In: Escudeiro P. (Ed) *Proceedings of the 9th European Conference on e-Learning.* Reading, Academic Publishing Limited. ISBN: 978-1-906638-83-2. 454–462.

Slocum, T. A., McMaster, R. B., Kessler, F. C. and Howard, H. H., 2008, *Thematic Cartography and Geovisualization.* 3rd Edition. Upper Saddle River, New Jersey: Prentice Hall. 624. ISBN 9781292055442

Vávra, A., Vondráková, A., Pechanec, V. and Voženílek, V., 2010, *Multi-user e-Learning Courses For Climate and Climate Changes.* Information and Communication Technology in Education. Proceedings. Ostrava: University of Ostrava, 70. ISBN 978-80-7368-775-5

Vondráková, A. and Voženílek, V., 2016, *User Issues in Geovisualization.* In: 16th Multidisciplinary Scientific Conference SGEM 2016. Vol. III, 599–606 .

Wood, D., 1992, *The power of maps.* New York: Guilford Press. 248. ISBN 978-0898624939