Free and Open Source Software for Geospatial (FOSS4G) Conference Proceedings

Volume 13 *Nottingham, UK* Article 1

2013

FOSS4G 2013 Full Conference Proceedings (papers)

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A New Zealand case study

Open Source, Open Standards, Open Data

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Abstract

The National Institute for Water and Atmospheric Research (NIWA) is New Zealand's leading agency providing freshwater, ocean, climate, atmosphere and fisheries related research. Open Source software is widely used internally, both infrastructurally and in desktop systems.

In 2011, the New Zealand Government passed "The Declaration on Open and Transparent Government". This requires central government agencies to make taxpayer funded information freely available to the public, and encourages regional and local government, as well as agencies such as NIWA to comply. NIWA works closely with central and regional government, utilities, NGO's and primary industry, making information discovery and delivery using common and open standards critical.

NIWA is using Open Source applications to meet these open data discovery and delivery requirements. Open Geospatial Consortium (OGC) standards compliance ensures interoperability. Standards adopted to date include SFS (Postgis), CSW (Geonetwork), WMS/WFS (Mapserver, Geoserver, Openlayers, Quantum GIS, Quantum Map) and SOS (52°N, Quantum Map). Some proprietary applications are also used. These are also OGC compliant and fit within NIWA's OGC based architecture. This paper describes the role that open source software and open standards play in NIWA's strategies and architecture for environmental information management, discovery and delivery and gives implementation examples.

Keywords: environmental data, interoperability, NIWA, OGC, open data, open source, OSGEO, web services.

Introduction

This paper presents several examples of using Open Source GIS related tools to manage and deliver environmental data captured by a variety of research programmes undertaken by the National Institute for Water and Atmospheric Research in New Zealand (NIWA, http://www.niwa.co.nz).

The systems are fully compliant with open industry standards developed by the Open Geospatial Consortium (OGC) which are the basis of New Zealand government standards for spatial data interoperability (NZGO, 2011), to comply with the recommendations of the New Zealand Government's 2011 Declaration on Open and Transparent Government:

"To support this declaration, the government asserts that the data and information it holds on behalf of the public must be open, trusted and authoritative, well managed, readily available, without charge where possible, and reusable, both legally and technically. Personal and classified data and information must be protected.

Public service and non-public service departments are directed and State Services agencies encouraged to commit to the release of high value public data for re-use in accordance with the declaration and principles."

NIWA has therefore a responsibility to ensure the publicly funded environmental data it holds, as well as the results of research and analyses on these data, are made readily available. This is being done primarily using Open Source tools to implement data (and metadata) discovery and delivery capabilities for NIWA held data.

NIWA's environmental information needs.

NIWA needs integrated and interoperable systems to manage its various and heterogeneous environmental data and information holdings, and to provide search and access facilities to enable discovery and delivery, both internally, within its various science centres, and externally, for clients, collaborators, other agencies and the public.

NIWA's internal requirements

NIWA is New Zealand's leading environmental science provider in the aquatic, climate, atmospheric and fisheries domains. As a New Zealand Crown Research Institute (CRI), NIWA operates as a commercial business, although the New Zealand government is the only shareholder. Internally, NIWA is divided into science centres, each focused on one of NIWA's environmental science domains. Given the highly inter-related nature of physical, chemical and

Spatial Data Infrastructure of the Plurinational State of Bolivia

A free and democratic SDI

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Abstract

The Vice Presidency of the State, with the help of the GeoBolivia project, is building the Spatial Data Infrastructure of the Plurinational State of Bolivia (IDE-EPB by its Spanish initials). The first phase of the project has already been completed. It consisted in implementing an infrastructure and a geoportal that nowadays gives access to the reference geographic information of Bolivia, through WMS, WFS, WCS and CSW services. The project is currently in its second phase dedicated to decentralizing the structure of IDE-EPB and promoting its use throughout the Bolivian State.

The whole platform uses free software and open standards. As a complement, an on-line training module was developed to undertake the transfer of the knowledge the project generated. The main software components used in the SDI are: gvSIG, QGis, uDig as GIS desktop clients; PostGreSQL and PostGIS as geographic database management system; geOrchestra as a framework containing the GeoServer map server, the GeoNetwork catalog server and the OpenLayers and Mapfish GIS webclient; MapServer as a map server for generating OpenStreetMap tiles; Debian as operating system; Apache and Tomcat as web servers.

Keywords: SDI, Bolivia, GIS, free software, catalog, gvSIG, QGIS, uDig, geOrchestra, OpenLayers, Mapfish, GeoNetwork, MapServer, GeoServer, OGC, WFS, WMS, WCS, CSW, WMC.

Introduction

The Spatial Data Infrastructure (SDI) of the Plurinational State of Bolivia IDE-EPB, created through the GeoBolivia project, aims at providing useful geographic information (GI) to institutions and citizen. The SDI provides relevant, harmonized, and high quality GI, allowing to support the formulation, evaluation, implementation and monitoring of practical policies, with a direct or indirect impact on the territory. Additionally the SDI brings support in terms of education and research.

The GeoBolivia project is responsible of organizing the cooperation with and between all the institutions involved in the field of GI in Bolivia. Indeed, the contribution of public and private institutions and professionals is crucial for strengthening and improving the data.

With respect to these main objectives, the specific goals of the first phase of the GeoBolivia project were to build a server infrastructure, publish GI using open standards[1] and develop a web portal for consultation, as a pioneer and main node of the SDI (Nebert, 2004).

Regarding the selection of technology, the GeoBolivia project opted for the use of free software and OGC standards, ensuring its sustainability and promoting the democratization of access to information. On one side, this decision was based on the conviction that democracy depends on an informed citizenry with a wide access to public information, allowing them to fully participate in public life, collaborate in determining priorities for public spending and fight against corruption through demand accountability (Neuman, 2002). On the other side, the selection of free software was based on the fact that open source geographic software has reached yet a mature technological level that allows to use them exclusively. The use of free software is also endorsed by Article 77 of the new Bolivian General Telecommunications Law that states: "The Executive, Legislative, Judicial and Electoral bodies at all levels shall promote and prioritize the use of free software and open standards, within the framework of sovereignty and national security".

Project Development

Main SDI framework

Initially, various technological options for imple-

[1] The only exception to the rule of open standards is the use of ISO 19139 profile for metadata (see http://www.opengeospatial.org/ogc/faq/openness/#2 for definition of an "open standard"). It has been decided the benefits in terms of interoperability of using this *de facto* standard justify the exception.

GIS for All: Exploring the Barriers and Opportunities for Underexploited GIS Applications

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Abstract

Geographical Information Systems have been existed since the early 1960s, but evidence suggests that adoption of GIS technologies still remains relatively low in many sectors. We will explore both the barriers that affect the utilisation of GIS and opportunities to overcome these barriers. As part of this exploration we performed a literature review, collected responses from quantitative questionnaire survey and interviewed a range of technical and domain experts. Having analysed and collated the results of these studies we have identified ways forward for future research and development to facilitate wider spread adoption and exploitation of GIS applications. Our discussion focuses on the importance of open-source GIS software, open data and cloud computing as key mediators for breaking the barriers and promoting the wider appropriation of GIS based solutions.

Keywords: GIS barriers, GIS opportunities, Open-Source GIS, Open Data, OpenStreetMap, Cloud Computing.

1. Introduction

The development of Geographical Information Systems (GIS) began in the early 1960s and rapidly advanced since the late 1980s. Over the past 50 years, GIS technology has been increasingly introduced to a wide range of sectors. In addition to planning agencies and local governments, many other sectors have been involved, such as social science, transportation, earth science, military, agriculture, environmental protection, etc. The integration of GIS technology in traditional geospatial tasks provides a number of optimal solutions for individuals/groups, e.g. policy developers, decision-makers, managers, researchers, and allows the performance of existing tasks cheaper, faster and more completely (Elangovan 2006).

The multidisciplinary nature of GIS technology means that the diffusion, appropriation and use of GIS technologies are distributed in a variety of subject domains, was and is often regarded as a new technology or approach on traditional task with specific disciplines. This characteristic means that the adoption of GIS technologies have not yet fully delivered its potential or adequately addressed the need of GIS users in many domains (Ventura 1995, Nedovic-Budic 1999). Early studies have mentioned that most users adopt GIS technology in relatively simple applications but rarely use it for sophisticated tasks (Nedovic-Budic 1998). More specifically, these studies indicated that the expectation of GIS technology in the areas of geospatial analysis and decision-making was particularly high but the penetration is relatively low. The task demands were either not achieved at all or not achieved as expected due to barriers and factors that hinder the utilisation of GIS.

Some researchers have investigated the direct or indirect barriers which affect the adoption rate of GIS from early stages (Ventura 1995, Nedovic-Budic 1999, Esnard 2007, Akingbade et al. 2009). This previous work has identified the existing barriers found for effective use of GIS and classified them into two board groups(Brown 1996, Brown & Brudney 1998, Esnard 2007, Yap et al. 2008, Asligui Gocmen & Venturac 2012) ;

- **Organisational barriers**: generally referred to department factors, such as lack of staff (e.g. constraints by size of the team or funding), lack of purpose or mission to promote GIS application and lack of collaborators and networking.
- **Technical barriers:** including lack of context, insufficient software and tools, lack of reliable data and lack of technical knowledge.

In addition, another difficulty is the fast paced updating and development of GIS technology. Empirical knowledge is still scarce on the changing barriers accompanied with rapid advances of GIS technology, as well as potential solutions to justify the possibility for problem-solving.

The aim of this paper is to gather information from the literature, as well as questionnaire re-

Web–based Participatory GIS with data collection on the field – A prototype architecture

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Abstract

The rise of Web 2.0 and the current, unprecedented diffusion of mobile devices have laid new foundations for the development of PGIS (Participatory GIS). This study evaluates the possibility of exploiting FOSS (Free and Open Source Software) tools to build up a PGIS prototype providing Web publication of user field-collected data. Besides increasing public awareness and collaboration, user-generated content should also enlarge the knowledge of specific phenomena up to the local level. A prototype architecture was designed and tested in relation to a simple, planning-related case study, i.e., the report of road pavement damages. Open Data Kit suite was used to gather georeferenced multimedia data using mobile device sensors (e.g., the GPS) and to store them into a PostgreSQL database with PostGIS spatial extension. Data was then Web-published using GeoServer. Web access was finally enabled from both traditional desktop-computers and mobile platforms through ad hoc OpenLayers and Leaflet client-side solutions. The architecture provided support for FOSS applicability within the typical PGIS-related tasks, from field survey to data storage, management and dissemination on the Internet. This bottom-up communication paradigm, which exploits real-time, freely available user contributions, can become a potentially precious tool for making decision-processes more democratic, faster and ultimately better.

Keywords: WebGIS, GeoWeb, Web Mapping, FOSS, Mobile, PGIS.

Introduction

The dissemination and sharing of geospatial information on the Web has recently known a tremendous impulse. After the rise of Web 2.0 (O'Reilly 2005), Internet communication paradigm evolved from the traditionally top-down, centrist approach (typical of Web 1.0) to a collaborative, bi-directional model, where users are no longer pure consumers but can also interactively create and share contents (Rinner et al. 2008). The Open Geospatial Consortium (OGC) standards for Web mapping interoperability (Peng & Tsou 2003), together with the non-stop development driven by AJAX (Asynchronous JavaScript and XML) technology, spread this revolution to the field of geographic applications known as Geospatial Web. As a consequence, the terms GeoWeb 2.0 (Maguire 2007) and Web Mapping 2.0 (Haklay et al. 2008) were coined in order to identify the new era of dynamic, interactive tools allowing user participation in managing spatial data. Other concepts introduced after the dawn of GeoWeb 2.0 were neogeography (Turner 2006), i.e., the creation of customized maps through mash-ups of multiple data sources, and VGI (Volunteered Geographic Information), i.e., the idea of humans behaving like sensors able to register geospatial contents. A final, remarkable boost to this new era of Web mapping was given by the tremendous spread of mobile devices, provided with sensors (e.g., cameras and GPS receivers) able to collect georeferenced data and a network connection to immediately publish it on the Web.

The paradigm of Participatory GIS (PGIS) or Public Participation GIS (PPGIS), born in the mid-1990s to define the use of GIS as a tool for promoting citizens' intervention in decision-making processes, found an incredibly fruitful ground in the developments of GeoWeb 2.0. The focus of literature research on PGIS, which is generally related to planning disciplines (Sieber 2006), has therefore dramatically changed in the last two decades. First studies addressed the social and critical role of PGIS (Elwood 2006), paying little attention on the GIS technical aspects. Almost all these applications were desktop-based (e.g., Oliveira et al. 1999) or even paper-based (e.g., Brown & Reed 2000) and simply consisted in getting the public informed about the results of some GIS analysis. Technological developments of Web 2.0 allowed the use of proprietary APIs (Application Programming Interfaces), especially the Google one, for creating interactive Internet applications where users could enter and share customized information

Taarifa

Improving Public Service Provision in the Developing World Through a Crowd-sourced Location Based Reporting Application

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Abstract

Public service provision in the developing world is challenged by a lack of coherence and consistency in the amount of resources local authorities have in their endowment. Especially where non-planned urban settlements (e.g. slums) are present, the frequent and constant change of the urban environment poses big challenges to the effective delivery of services. In this paper we report on our experiences with Taarifa: a location-based application built through community development that allows community reporting and managing of local issues.

Keywords: Location-based application, community development, crowd-sourcing.

Introduction

The availability of geographic data in the developing world is improving with the advent of community mapping projects like Map Kibera [1, 2] and through organisations like Humanitarian Open Street Map Team (H.O.T). Previously a large barrier for NGOs, governments and business in providing services in developing world, the lack of governmental and non-governmental data is becoming an issue of the past and with this barrier rapidly dissolving further questions are arising, such as: now we have the data, what do we do next?

The Taarifa project aims to address this question, with respect to the monitoring of public service provision. Taarifa as a software platform allows for the community reporting of problems, from health to waste issues, through a mobile phone interface using SMS or a HTML5 client. Once reports are collected they are entered into a workflow allowing those in charge of providing services to monitor, triage and act upon reports.

Taarifa is currently unique in this field from its initial design, inception and deployment. It was originally conceived at the Random Hacks of Kindness (RHOK) London Water Hackathon. A Hackathon is an organised meeting of developers who team up to code on a specific topic or to address a specific problem. Hackathon are very popular in the developers community. Both private and public organisations often set up hackathons to get some fresh hands working on certain issues they are facing. During the RHOK hackathon a group of core developers 'hacked' a solution in 48 hours. After continued development and design Taarifa was first deployed in cooperation with the Ugandan Ministry of Local Government in March 2012, followed by a deployment with the Zimbabwean Government in April 2012 facilitated by the World Bank.

In this paper we present a narrative and case study of the Taarifa project from its inception, design, refinement and deployment. We also discuss the future directions Taarifa might take both as a community software project and as an organisation. The global aim is to facilitate a discussion on how crowd-sourced geospatial data and open source platforms can combine to improve public and private service delivery in developing nations.

Related Work

Most related work considering the emergent phenomena of crisis mapping are case studies of specific crises, the Haiti Earthquake [3], terrorist attacks [4], methodologies for crisis situation triage [5]. Though, in context not all methodologies of crisis relief are wholly focused on external response as [6] demonstrates. These instances of citizens generating reports fall under the banner of crowdsourcing. Here [7] specifically looks at providing situational awareness; how a visual 'group map' of all the reports is useful as errors can be made. The crowd sourcing of information has inherent dangers of trusting the information supplied, as [8] demonstrates with respect to potential crisis situations.

Currently there are two themes missing from the literature; A study of how the reports are being used to aid decisions and an understanding of areas in a constant state of crisis. These areas, like slums and informal developments do not have an event like an earthquake or a tsunami to illustrate the plight. This is combined by [9] review of the Map Kibera project.

Almost anecdotal evidence [10, 11] exists to how the crowd sourced data is used, but nothing to the

OSM–GB

Using Open Source Geospatial Tools to Create OSM Web Services for Great Britain

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Abstract

A use case of integrating a variety of open-source geospatial tools is presented in this paper to process and openly redeliver open data in open standards. Through a software engineering approach, we have focused on the potential usability of OpenStreetMap in authoritative and professional contexts in Great Britain. Our system comprises open source components from OSGeo projects, the Open Street Map (OSM) community and proprietary components. We present how the open data flows among those components and is delivered to the Web with open standards. Apart from the cost issues, utilizing the open-source tools has offered some distinct advantages compared to the proprietary alternatives, if any was available. At the same time, some technical limitations of utilizing current open-source tools are described. Finally a case study is shown for the usability of the developed solution.

Keywords: OpenStreetMap, open source, open data, open standards.

Introduction

Since its inception in 2004, OpenStreetMap (OSM) has become the main free source of digital maps made by the crowd. Although OSM is rapidly growing in both contents and contributors, the belief that it is made by amateurs is perceived to limit trust in the value of this free data source within the traditional GIS community. The quality aspects of OSM have been investigated by different researchers and with different tools (Girres and Touya 2010; Haklay 2010; Zielstra and Zipf 2010; Mooney and Corcoran 2011). We contend that to encourage uptake of data, not only must the OSM community produce better maps but the authoritative and professional use cases of OSM shall be facilitated.

Because of the volunteer nature of the community, many open-source geospatial tools have been developed around OSM in the recent years, ranging from data handling and data analysis to cartography and presentation. There are a number of core open-source tools that are used by the OSM developers, e.g. Mapnik (Pavlenko 2011) for rendering, while some other open-source tools have been developed for users and contributors e. g. JOSM (JOSM 2012) and the OSM plug-in for Quantum GIS (QuantumGIS n.d.).

Although those open-source tools generally fit the purposes of core OSM users and contributors, they may not necessarily fit for the purposes of professional map consumers, authoritative users and national agencies. If OSM is not effectively usable by this group, the gap between professional and amateur map producers/consumers may never be filled and a sense of trust in OSM may never happen among those users. On the other hand, if OSM can be used effectively by authorities, there will be a big chance that those users become active contributors, leading to even more usability and reliability.

Having observed this research gap, this paper presents a system with a strong reliance on open source geospatial components that can fit the British authoritative user's requirements. The solution is developed within the framework of a project called OSM–GB (OSMGB 2012).

In the rest of this paper, a software engineering approach is taken to analyze the specific requirements of authoritative users in Britain. Based on those requirements, the conceptual and detailed designs of our system are presented. The solution developed also benefits from open standards and open data initiatives as will be explained later.

Users' Requirements

In the Great Britain context, the following requirements were collected from authoritative users in the first stages of the project, particularly through steering group meetings and direct contacts. The requirements are a combination of general and GB-specific functionalities, as will be explained in this section.

It is however noticeable that gathering the users' requirements is done within the open-source/open-data contexts and implications, i. e. the users are generally willing to use the free software, data and standards as opposed to the licensed products (for many reasons including the known cost and updatedness issues) but they are looking for the best possible solution that fits their specific purposes. Oth-

Using Free and Open Source GIS to Automatically Create Standards-Based Spatial Metadata in Academia

First Investigations

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Abstract

The importance of understanding the quality of data used in any GIS operation has increased significantly as a result of the advent of Free and Open Source (FOSS) tools and Open Data, which in turn have encouraged non-specialists to make use of GIS. Metadata (data about data) traditionally provides a description of this quality information and permits data curation, but it is frequently deemed as complex to create and maintain. Additionally, it is generally stored separately from the data, leading to issues where updates to the data are not reflected in the metadata and to users not being aware that metadata exists. This paper describes an approach to address these issues in an academic context – tightly coupling data and metadata and automating elements of standards-based metadata creation and automating keyword generation and language detection. We describe research into the potential of the FOSS packages Quantum GIS and PostGIS to support this form of metadata generation and maintenance.

Keywords: Keyword1, keyword2.

1 Introduction

Advances in positioning, web mapping, mobile communications, Web 2.0 and Volunteered Geographic Information (VGI) (Goodchild 2007), along with the emergence of the Open Data movement, have led to increasing availability of spatial data (Budhathoki et al. 2008), with much of this data available free of charge (Coleman et al. 2009). The availability of free Geographical Information Systems (GIS) software (e.g. Google Earth, ArcGIS Explorer, Quantum GIS) encourages nonspecialist users to make use of GIS tools and data.

In academia, this increase in available data and software, along with the requirement to curate the data, is coupled with a reduction in GIS expertise of the end user of such tools. Given this, having information to allow end-users to understand, manage and integrate the heterogeneous data they are using, and identify any limitations, becomes more important (Deng & Di 2009, Haklay & Weber 2008).

Traditionally, among GIS professionals, metadata ('data describing the data') has been created to curate data (Sboui et al. 2009). It details how data was derived, why it was captured, at what scale and how it has been processed, covering issues related to topological correctness, semantic, temporal and positional accuracy (Goodchild 2002, Longley et al. 2011, Van Oort 2005, Burrough 1994). It provides a formal description of the data quality (Kim 1999), allows for data reuse (Craglia et al. 2008) and avoids data duplication. Good metadata increases trust (Craglia et al. 2008) and helps increase the credibility of a dataset (Coleman et al. 2009). In general, therefore, "the purpose of metadata is to facilitate the interpretation of data" (Sboui et al., 2009).

However, metadata is complex to create (Poore & Wolf 2010, Manso-Callejo et al. 2009, Batcheller 2008, Craglia et al. 2008) and is usually created by a dedicated team of professionals (Mathes 2004 in (Kalantari et al. 2010)). "Many view its generation as monotonous and time-consuming" (Batcheller 2008, p. 388). Standards are producer-centric (Goodchild 2007, Devillers et al. 2005) and quality may be variable (Rajabifard et al. 2009). Metadata production is often left to the end of a project, which results in metadata that is barely useful and often contains errors (West & Hess 2002). The current approach to data curation -where metadata is decoupled from the data it describes -further complicates this situation. Decoupled metadata may not be updated when data changes, and its existence is easily ignored by users.

This paper presents preliminary work on an approach to overcome these issues in the context of academic research and data curation. Using Free and Open Source (FOSS) GIS products -Quantum GIS 1.8.0 and PostGreSQL 9.2 with Post-GIS 2.0 (to maximize potential uptake amongst academics without

Gestural Interaction with Spatiotemporal Linked Open Data

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Abstract

Exploring complex spatiotemporal data can be very challenging for non-experts. Recently, gestural interaction has emerged as a promising option, which has been successfully applied to various domains, including simple map control. In this paper, we investigate whether gestures can be used to enable non-experts to explore and understand complex spatiotemporal phenomena. In this case study we made use of large amounts of Linked Open Data about the deforestation of the Brazilian Amazon Rainforest and related ecological, economical and social factors. The results of our study indicate that people of all ages can easily learn gestures and successfully use them to explore the visualized and aggregated spatiotemporal data about the Brazilian Amazon Rainforest.

Keywords: Gestural interaction, spatiotemporal phenomena, Linked Open Data.

1 Introduction

In recent years, gestural interaction has been successfully used to enable untrained users to control different types of applications. Some operations arguably map naturally to certain types of gestures. Examples of this are pointing at an item to select it or moving a body part to trigger a similar motion of the screen content. These properties of gesture control are typically used to facilitate access to simple data such as photographs, media or basic maps. Given this, our hypothesis is that gestural interaction is equally well suited to enable the exploration of more complex (linked) spatiotemporal data. The goal is thus to create methods for communicating results of the field of Geographic Information Science to the public, for example in an exhibition, in a science museum or science center, where large surfaces are important for better visibility.

Gesture control is a promising approach to enable interaction with large surfaces in particular since it can improve ease of learning and help overcome reachability issues [15] and due to its high level of learnability [7, 23]. While previous work has shown this for basic spatial operations (panning, zooming, re-arranging objects), it is not clear whether gestural control can work equally well when interacting with spatiotemporal data.

Interfacing research on Human-Computer Interaction with recent Linked Open Data and visualisation techniques for complex spatiotemporal data is a contribution towards Linked Open Science [14] to support transparency and openness of science via facilitating the exploration of scientific observations. Clearly, Linked Open Science needs Linked Open Data (LOD)[8] to allow for publishing of very different kinds of data on the web, and to interconnect them together and to space and time. Additionally Linked Open Science needs Open Source Software, to make its results reproducable and freely available.

In this paper we present and evaluate an application based on open source technologies enabling the exploration of Linked Spatiotemporal Data integrated into an exhibit. We present a set of gestures that visitors to a science fair can use to explore large amounts of linked data related to deforestation on large screens and we also report on results from an initial survey. In the following, we first briefly describe the background before presenting the prototype system, the linked open spatiotemporal datasets [13], their visualizations and the gestures we have implemented. We then describe the survey we conducted and summarise the results we obtained. The penultimate section discusses possible implications of our findings on the design of similar systems. The paper closes by summarising the main contributions and giving a brief outlook on future work.

2 Related Work

There is a broad range of previous work investigating the use of different types of gestures (e.g. arm-, body-, or headgestures) to facilitate interaction with various types of systems (e. g. desktop computers, mobile phones or public displays). The recent intro-

[8] http://linkeddata.org

AEGIS

A state-of-the art component based spatio-temporal framework for education and research

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Abstract

In past years, geoinformation has gained a significant role in information technology due to the spread of GPS localization, navigation systems and the publication of geographical data via Internet. The inclusion of semantic information and temporal alteration has also become increasingly important in GIS. The overwhelming amount of spatial and spatio-temporal data resulted in increased research effort on processing algorithms and efficient data management solutions.

This article presents the AEGIS framework, a currently developed spatio-temporal data management system at the Eötvös Loránd University, Faculty of Informatics (ELTE IK). This framework will serve as the future platform of GIS education and research at ELTE IK. It aims to introduce a data model for the uniform representation of raster and vector data with temporal references; to enable efficient data management using specialized indexing; and to support internal revision control management of editing operations. The framework offers a data processing engine that automatically transforms operations for distributed execution using GPGPUs, allows fast operations even with large datasets and high scalability with regard to new methods.

To demonstrate the usage of the system two prototype applications – segment-based image classification and agent-based traffic simulation – are also presented.

Keywords: Geospatial Information Systems, spatio-temporal data, indexing data structures, GPU based data processing, revision controls of data, remotely sensed image classification, agent based traffic simulation.

1 Introduction

Geographical information systems (GIS) have undergone a spectacular development in the past years. Beside traditional areas of GIS applications a rapid development has taken place in the world of navigation systems as well. Google Maps and NASA World Wind, together with their Application Programming Interface (API), are common tools in the global handling of spatial data. The world of open source software has also evolved a lot. There is a rising need for professionals whose practice cover both information technology and geography. This paradigm shift has to be taken into account both by professionals and by academic people.

At the Eötvös Loránd University, Faculty of Informatics (ELTE IK) the informal association, called Creative University GIS Workshop (TEAM) deals with several related research topics, e.g. Intelligent Raster image Interpretation System (IRIS), University Digital Map Library (EDIT), Virtual Globes Museum (VGM) and segment-based analysis of remote sensing images. An important collaboration takes place both in education and research with the Institute of Geodesy, Cartography and Remote Sensing (FÖMI). This governmental institution is responsible for the research, development and application of remote sensing in Hungary, mainly in the areas of agriculture and environmental protection.

Based upon the experience gained with research and education, the plan of a standalone geographic framework, called AEGIS has been outlined. It is designed for broad functionality, efficiency, and allowing students to skip the learning curve and concentrate on their main tasks in lab projects and thesis works without the need of building up auxiliary functionality from scratch. The system is based on standards of the Open Geospatial Consortium (OGC – http://www.opengeospatial.org), and is not intended to be a competitor of current industrial GIS solutions or GIS toolkits such as GeoTools (http://www.geotools.org), but rather to be a prototype and sandbox for experimental research and education.

Students are offered step-by-step learning of standards, algorithms and solutions, easy to understand, documented source code, and well structured components that can be used for many types of GIS projects, including thesis works. Researchers may also find many possibilities in this flexible, yet stable environment to test results and compare them with existing solutions. Even the framework itself has several experimental features that are research topics, including multi-level spatio-temporal indexing solutions, revision control of spatial data and automated

A new GIS toolbox for integrating massive heterogeneous GIS data for land use change analysis

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Abstract

Agricultural land use in Germany and related impacts on the environment and the use of natural resources are key research topics at the Thünen-Institute of Rural Studies. As spatial context is essential for the analysis of causal connections, GIS data regarding all necessary information was gathered during different research projects and prepared for processing in a database. In particular, the Integrated Administration and Control System, which was available for certain project purposes for several Federal Laender and years, serves as a very detailed data source for agricultural land use. We use different Open Source GIS software like PostgreSQL/PostGIS, GRASS and QuantumGIS for geoprocessing, supplemented with the proprietary ESRI product ArcGIS. After introducing the used input data and the general processing approach, this paper presents a selection of geoprocessing routines for which Open Source GIS software was used. As an exemplary 'use case' for the conclusions from the consecutive statistical analysis, we summarize impacts of increased biogas production on agricultural land use change highlighting the trend in biogas maize cultivation and the conversion of permanent grassland to agricultural cropland.

Keywords: PostGIS, GRASS, geoprocessing, multiple data, Open Source, pre-processing of data, environmental impacts, biogas maize, permanent grassland, Germany.

1. Introduction

Agricultural land use and land use changes are related to environmental impacts like groundwater pollution, greenhouse gas emissions or loss of biodiversity (Schramek et al. 2012). These spark political efforts which result in legal acts (e.g. Nitrates Directive, FFH Directive). Agricultural subsidies or legal restrictions add to the driving forces influencing the usage of agricultural land, while land use must suit the natural conditions in order to optimize farm income.

The Thünen-Institute of Rural Studies analyzes land use change in agricultural areas of Germany focusing on environmental impacts and the effects of legal regulation with research projects like "Evaluation of the Common Agricultural Policy from a nature conservation point of view" (2008-2009) (see Nitsch et al. 2012) and "Analysis of land use change and development of methods for identification and quantification of measures for greenhouse gas abatement in the agricultural sector (parts I and II)" (2009-2013). A broad variety of GIS data is gathered in order to build a database for statistical analysis. The data contains official national and federal digital maps regarding land use, natural conditions and protected areas.

The central objective described in this article relates to the development of a GIS toolbox enabling the processing and analysis of massive and heterogeneous geodata useful for the statistical analysis of land use change patterns. The GIS toolbox subsumes all necessary processing steps for data preparation and for the integration of all input datasets into a combined dataset preserving relevant information on every site.

We base the development of the GIS toolbox on several conceptual considerations, whose applicabilities are to be proven as one result of the development process. Decisions with respect to the conceptual approach of the GIS toolbox include the choice of the main data format and the software environments as well as the definition of the necessary processing steps.

A conceptual precondition for the development of the GIS toolbox is the decision to chose a vector polygon approach as the main data format. This decision is motivated by the aim to preserve as much information as possible and necessary from the input data. Mostly all following conceptual decisions depend on this precondition. The related research challenges concern the feasibility of this approach within the given circumstances as well as the evaluation of its expandability and appropriateness. We are aware

Open Source in accessibility analyses

Modeling of street petrol station accessibility in Germany

by Stefan Neumeier

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Abstract

The paper relates two closely intertwined story lines. A socioeconomic one concentrating on street petrol station accessibility in Germany's rural areas and a geospatial one concentrating on the usability of the Open Street Map within rural studies. This is attributed to the fact that the paper builds on findings from applied research within rural studies and is intended to serve as a "practical experiences report" assessing the usability of open source GIS/-data in rural studies. Here we analysed the accessibility of street petrol stations as one core service of general interest important for the overall individual mobility of the population, especially in rural areas, based on an exemplary raster-based GIS accessibility analysis. This analysis builds upon an open source approach using PostgreSQL/PostGIS as well as the Dijkstra shortest path algorithm implemented in the Perl-module „Graph-0.94". Besides acquiring objective data on street petrol stations accessibility for policy advice, we were also interested in reviewing the usability of OpenStreetMap (OSM) data compared to commercial routing networks (ESM).

Altogether the findings suggest that in Germany, street petrol stations are for the majority of the population (ESM: 99.5%/ OSM: 99.4%) quite accessible. On average the distance to the next street petrol station amounts 5.4 km (ESM)/ 5.5 km (OSM). Regions with disadvantageous accessibility are predominantly sparsely populated.

The comparison of the accessibility values calculated based on ESM and OSM showed that great differences exist in a per cell comparison as well as on the community level, whereas aggregated average accessibility values for greater aggregates like counties proved to be comparable to each other. Against the background of OSM's lower level of completeness in rural areas an interesting but unexpected result is the fact that the accessibility values differ within urban as well as rural areas within the same range. Nevertheless, considering the identified shortcomings of the OSM, the data set still seems to show a lower performance than commercial data sets.

Keywords: Petrol Station Accessibility, Shortest Path Analysis, OpenStreetMap.

1. Introduction

Amongst other factors, accessibility is one precondition for the economic, social and cultural development of regions (Hemetsberger & Ortner 2008). For example, good accessibility is one precondition for the participation of a region's resident in the economic prosperity of the centres; for participation in potential development opportunities, and the economic capacity of business locations (Hemetsberger & Ortner 2008, Platzer & Gmeinhart 2003). However, accessibility is not only important for location decisions and regional development but also for the individual life situation of the citizens. The quality of infrastructure accessibility also determines the regional infrastructure supply (BMVBS: Raumordnungsbericht 2011, p. 55). For the current discussion on ensuring the provision of services of general interest (SGI) for Germany's rural areas, held against the background of the demographic change and its potential consequences as well as the normative aim of providing comparable living conditions in all areas, up-to-date information about the accessibility of SGI is important in order to get an objective and realistic view on the current situation that can function as input for policy interventions (Schulz & Bröcker 2007). Accessibility information can also be utilized as input for catchment analyses, potential analyses and econometric analyses, for the building of regional typologies or for regional benchmarking. Objective methods of assessment and comparison are needed for this purpose. Data aggregated in statistical regions (supply indicators) strongly distort the situation as important intraregional disparities are levelled by the aggregation. Activity-based accessibility indicators like the accessibility of regional metropolitan areas mainly permit only indirect conclusions due to the accessibility of SGI (e.g., based on the level of centrality of the different places and their planned provision of infrastructure). Therefore more concrete data on the provision of SGI, is needed to enable scientists as well as politicians to get an idea of the true situation. The modelling of accessibility situations based on a raster-based ac-

Bytecode unification of geospatial computable models

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Abstract

Geospatial modelling revolves around the structures of data and the semantics of these structures. This is enough in simple cases, but becomes insufficient when the best structure and semantics is hard to find or the solution is too heterogeneous to fix and reuse. Field-based and objects-based geospatial models often share common GIS data structures interchangeably, but their all possible meanings are too many to define in an immutable manner. Less studied approach to geospatial modelling is using mutable structural properties and their semantic interpretation. This work shows that the functional aspect of geospatial models is just as important as the structural and semantic aspects. It also shows that semantic and even structural properties may change when functionality is integral part of the data model, and not exclusively separated at software implementation level. The paper uses this modelling paradigm to address the divide caused by field-based and object-based data models, and other challenges regarding synergy of geospatial systems that need to use both types of data models.

Keywords: field-based model, object-based model, computability, managed objects, geographic space, 3d, time, scale.

1 Introduction

The geospatial branch of information science (GISc) has a dual approach to representing the real world. Its duality is manifested by 1) discrete objects, which are identifiable, countable entities existing in otherwise empty geographic space, and by 2) continuous fields, which for every location in a given domain of geographic space have a value forming a field of certain quantity. The twofold nature of the object / field modelling is a concrete, classical problem that has been eluding specialists in GISc since 1980 (Goodchild, 2012). This work studies the comparative suitability of object-based and field-based representations for computable geospatial models. The goal is to provide a theoretical and engineering solution supporting both field- and object-based geospatial models in a uniform way. This is the scope depicted in Figure 1. The problem in principle is that the solution must provide a better modelling flexibility without hindering simplicity and applicability in practice. Due to these unmet requirements the solution to duality of fields and objects might also address number of other practical issues, such as dealing with heterogeneity of models across many application domains, design and management of complex geospatial models, or difficulties with handling and exchange of the models by various information systems.

Computability is essential for this work since computable geospatial modelling is the main subject, but it is also important in a much broader sense because computable models can do work that humans would have to do otherwise. The rest of this section provides a necessary introduction to the computability theory. This gives a basis to Section 2 where the method for geospatial modelling is formalized and the engineering design presented. Section 3 reports on implementation related topics and on the resulting technology.

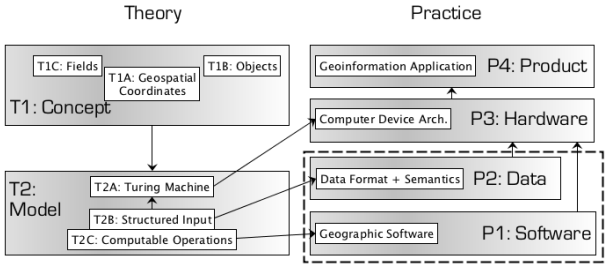

Figure 1: Computable geospatial modelling in context.

1.1 Computable models

This work deals with geospatial models that are *computable*. Computable in the sense that humans could also calculate the model manually. This means that the set of instructions followed to carry out a computation must be finite, that the computation carried is real - not imaginary (must be effective), and it must be possible to show how exactly the computation is performed (must be constructive). Exactly like in a program or a recipe.