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Free and Open Source Software's for Geographic Information System (GIS)

JAGDISH CHAND
Department of Geography
Govt. PG College, Nahan, HP
India

Abstract:

Open source may be viewed by many as a revolutionary phenomenon that is capable of providing the software industry with an alternative and competitive way of doing business. Research done so far has tackled the history and business aspects of the open source phenomena, and only few have researched its technical aspects. The results of the research provide an insight on how different categories of people view open source, and demonstrate that lack of awareness about open source concepts and its competencies may be a major reason behind the poor adoption of open source solutions. The results of the comparative analysis also demonstrate that Map Server is technically equivalent to its commercial counter parts. A new open source sharing platform has emerged from the joint initiatives of the educationist, researchers and software developers. Present paper throws light on the contemporary development of this open source technology in field of geographic information system (GIS). An effort has been made to review the main components of open source technology at desktop and web based platforms, while the significance of open source technologies has been also discussed.

Key words: Open source; GIS; Map Server; Educationist; Open source technology.

Introduction

The development of free and open source software has

experienced a boost over the last few years. The variety of Free and Open Source Software (FOSS) that can be found on desktop computers ranges from word processors (e.g. OpenOffice.org), web browsers (e.g. Mozilla Firefox) to drawing (e.g. Inkscape) and scientific applications (e.g. R Project). In the GIS domain, the widespread use of FOSS is apparent as well. This rise in popularity of free GIS tools can be measured using four indicators. The first indicator is the number of projects started in the last couple of years. For instance, in last two years 20 entries have been added to the list of software projects on the website FreeGIS.org (containing now 330 entries). As a second indicator, there is increasing financial support by governmental organizations for the foundation of FOSS GIS projects. The listing of desktop GIS projects provided below shows that governmental funding supports at least 4 out of 10 projects. The third indicator is the download rates of free desktop GIS software. SAGA GIS for instance experienced an average increase of downloads in its documentation section between 2005 and 2008 from 700 to 1300 per month. Finally, a fourth indicator is an increasing number of use cases of open source GIS software such as PostGIS for the geospatial database (Ramsey, 2007a).

Along with this trend towards the application of open source software goes the number of research publications that mentions the use of open source software tools and libraries. Furthermore, software and algorithms developed in research projects are increasingly being published under open source licenses. As such, it is important to note that the free and open source software movement that postulates the freedoms of use and modification for software is not restricted to software only. Rather one regards free software as the foundation of a learning society where we share our knowledge in a way that others can build upon (FSF 2008a). Hence, this movement also includes the free availability of data that forms a basis for our knowledge. Certain initiatives that focus especially on the free

availability of geodata do exist. Probably the best-known project is the OpenStreetMap Project. This movement of free software and data is further facilitated by (online) platforms such as Sourceforge.org, which provide an environment for software development, Eduforge.org, which aims to foster the sharing of ideas, research outcomes, and open content for education, as well as the Open Knowledge Foundation (okfn.org) and ScienceCommons.org, which both provide strategies and tools to develop, protect, and share open (i.e. free) knowledge (Badard and Braun 2003, Mitasova and Neteler 2004, Pebesma 2004, Burghardt et al. 2005, Buliung and Remmel 2008).

As previously mentioned, the amount of new GIS software projects being started is noticeably increasing. It is aim with this article to provide an overview on more than fifteen FOSS GIS projects, which develop and maintain different desktop GIS. However, this is not the first topic of an overview on GIS related FOSS tools. The potential of open source software for implementing spatial data infrastructures (SDIs) reviewed by earlier many scholars. The open-source software provides great potential to make available components for SDI implementations that are affordable by resources poor organizations and add that many building blocks for SDIs are already available. An annual overview on open source GIS projects, remarks that existing (FOS GIS) products are now entering a phase of rapid refinement and enhancement (Reid and Martin 2001 and Ramsey 2007b).

An introduction and a structured overview into the multitude of different FOS desktop GIS projects are missing, which additionally discusses issues of the application of FOSS in GIScience research and education. A necessary requirement for such a review will be to clarify the terms related to open source and free software first. Therefore, outline is provided that what is meant by 'free software', briefly explain two common software licenses, and address three common misconceptions. Afterwards, they introduce the world of FOSS

GIS in terms of organizations and software groups. The following section then provides an overview of major free desktop GIS projects and will outline possible evaluation criteria (Wagner 2006).

What does Free Software and Open Source Software mean?

A couple of terms, such as proprietary, free and General Public License (GPL), are often used with respect to open source software. It is to see that the terms free software and open sources software seems to cover different domains despite their large overlap. The opposite domain of free and open source is the domain of proprietary software. The domain of the latter encloses terms such as closed software and shareware. The existence of the three different domains of free, open source and proprietary software requires that at least two of these domains are clearly defined, while the third domain covers those software that is excluded from the others. Such a definition has been setup for free software by the Free Software Foundation (FSF, www.fsf.org) and for open source software by the Open Source Initiative. According to the FSF, software can be labelled as free software if the associated license conditions fulfill the Free Software Definition (Smith, 2008), which grants four freedoms:

1. The freedom to run the program, for any purpose.
2. The freedom to study how the program works, and adapt it to your needs.
3. The freedom to redistribute copies so you can help your neighbour.
4. The freedom to improve the program, and to release your improvements to the public, so that the whole community benefits.

Free and open source software's available from different web sites for geographic information system.

CommonGIS **Fraunhofer Institute, Germany**
Type: GIS **http://www.commongis.com**
Java based GIS package with strong thematic mapping and exploratory data analysis facilities (this is the successor to the Descartes software). New facilities include movement analysis, a range of ESDA and decision support facilities and L.O.G.I.S - a "Library of Optimization Algorithms for Geographical Information Systems" used in the new Districting add-on.

Fragstats **University of Mass., USA**
Type: Landscape analysis
http://www.umass.edu/landeco/research/fragstats/fragstats.html
Analysis of ecological raster data. Spatial pattern analysis for categorical maps. V3 is a raster-only program, whereas V2 has support for ArcInfo vector files (coverages).

GDAL
Type: GIS tools
http://www.gdal.org/
Geospatial Data Abstraction Library (GDAL/OGR) is a cross platform C++ translator library for raster and vector geospatial data formats that is released under an X/MIT style Open Source license by the Open Source Geospatial Foundation. As a library, it presents a single abstract data model to the calling application for all supported formats. It also comes with a variety of useful command line utilities for data translation and processing. GDAL supports over 50 raster formats, and OGR over 20 vector formats.

GeoDa Spatial Analysis Laboratory, Univ of Conneticut, USA
Type: Exploratory data analysis
http://geodacenter.asu.edu/software
Exploratory spatial data analysis, vector (L Anselin). GeoDa is

the latest incarnation of a collection of software tools designed to implement techniques for exploratory spatial data analysis (ESDA) on lattice data. It is intended to provide a user friendly and graphical interface to methods of descriptive spatial data analysis, such as global and local (LISA) autocorrelation statistics and indicators of spatial outliers, plus some more advanced regression analysis facilities.

GMT School of Earth Science and technology, Univ of Hawai'I, Manoa
Type: GIS tools
http://gmt.soest.hawaii.edu/
GMT (Generic Mapping Tools) is an open source collection of around 60 tools for manipulating geographic and Cartesian data sets (including filtering, trend fitting, gridding, projecting, etc.) and producing Encapsulated PostScript File (EPS) illustrations ranging from simple x-y plots via contour maps to artificially illuminated surfaces and 3-D perspective views. It is designed as a command line driven suite of programs for Unix environments.

GRASS **Open source**
Type: GIS
http://grass.itc.it/
Geographic Resources Analysis Support System. Open source GIS with both raster and vector support. Geographic Resources Analysis Support System, commonly referred to as GRASS, is a Geographic Information System (GIS) used for geospatial data management and analysis, image processing, graphics/maps production, spatial modeling, and visualization. GRASS is currently used in academic and commercial settings around the world, as well as by many governmental agencies and environmental consulting companies.

GVSIG **Generalitat Velenciana, Spain**

Type: GIS

http://www.gvsig.org

gvSIG is a desktop tool designed to manage geographic information. It is characterized by a user-friendly interface that can easily access the most common raster and vector formats. In a single view, it includes local files as well as remote data through SDI standards, geographic databases, etc. Multiple language support - its interface is in Spanish, Valencian, English, Basque, Gallego, Czech, Chinese, French, German, Italian, Romanian, Polish and Portuguese.

ILWIS **ITC**

Type: GIS

http://www.itc.nl/ilwis

The Integrated Land and Water Information System (ILWIS) is a PC-based GIS & Remote Sensing software, developed by ITC up to its last release (version 3.3) in 2005. ILWIS comprises a complete package of image processing, spatial analysis and digital mapping. It is easy to learn and use; it has full on-line help, extensive tutorials for direct use in courses and 25 case studies of various disciplines.

Landfrag **Univ of Conneticut**

Type: Landscape analysis

http://placeways.com/products/landfragtool.php

The Landscape Fragmentation tool is designed to be used in ESRI's ArcGIS 9.2 geographic information system (GIS) software and allows users to analyze fragmentation using their own raster land cover information. The forest fragmentation model uses the land cover data from Connecticut's Changing Landscape to characterize the degree to which our forests have become carved up by developed landscapes, especially roads.

MapGuide
Type: GIS
http://mapguide.osgeo.org/
MapGuide Open Source is a web-based platform that enables users to quickly develop and deploy web mapping applications and geospatial web services. MapGuide features an interactive viewer that includes support for feature selection, property inspection, map tips, and operations such as buffer, select within, and measure. MapGuide includes an XML database for managing content, and supports most popular geospatial file formats, databases, and standards.

OSSIM Open Source
Type: Image handling
http://www.ossim.org/
Open Source Software Image Map (OSSIM) is a high performance engine for remote sensing, image processing, geographical information systems and photogrammetry.

PostGIS Refractions research,
Victoria, BC, Canada
Type: GIS
http://postgis.refractions.net/
PostGIS adds support for geographic objects to the PostgreSQL object-relational database. In effect, PostGIS spatially enables the PostgreSQL server, allowing it to be used as a backend spatial database for geographic information systems (GIS).

QGIS
Type: GIS
http://www.qgis.org/
Quantum GIS (QGIS) is a user friendly Open Source Geographic Information System (GIS) that runs on Linux, Unix, Mac OSX, and Windows. QGIS supports vector, raster, and database formats.

SAGA Abteilung für Physische Geographie Geographisches Institut Göttingen, Germany
Type: GIS
http://www.saga-gis.org/
Open source GIS designed with geosciences in mind, especially terrain and hydrographic analysis. Powerful raster analysis and programmability.

Virtual Terrain Project VTP
Type: Visualisation (2D and 3D)
http://vterrain.org
3-D Terrain Modelling/Virtual Reality software. The goal of VTP is to foster the creation of tools for easily constructing any part of the real world in interactive, 3D digital form.

Conclusion

The FOSS geospatial software world has recently seen a lot of activity. For instance, a formal organization has been founded, a related conference series is on the way to establishing itself, and new software projects have been started. One aim of this article was to present an overview on organizational structures in the open source community, and to closely examine those projects that develop desktop GIS software. To further the understanding of the open source software development the outcome of article to introduced important terms and discussed advantages and disadvantages of FOSS for the general user. The second conclusion that can be drawn is that most of the projects have a slightly different application and platform focus. Furthermore, with the exception OrbisGIS, all presented projects have reached a mature stage and the software offers a multitude of functionalities. As the analysis reveals, some of the FOSS software listed, such as GRASS GIS and gvSIG, can provide more functionality than proprietary low-end GIS products, such as ESRI's ArcView.

In the discussion section the study explicitly argued for the use of open source practices and software in research. The study could highlight that the principles of free software conform to one fundamental research principle of experiments must be reproducible. That is, if the source code is given, then everybody is able to learn from the source code and directly improve upon the algorithms and models without running into the danger of misinterpretation. In contrast, GIScientists have developed and implemented methods for the handling of spatio-temporal data types and methods for 3D/4D geo-visualization and analysis in free and open source software. Hence, if aim is to test and develop new models and the emerging theories in-time, rely (more or less) on open principles and software that allowed to adapt the software to research needs, and on software that is not focused on the end-user. Thus, free software supports the scientific development by facilitating learning, testing of hypothesis, amelioration and comparing of models and algorithms, and the spreading of valuable or even ground-breaking results.

BIBLIOGRAPHY:

Ames, D. P., Michaelis, C. and Dunsford, T. 2007. "Introducing the MapWindow GIS project." *OSGeo Journal* 2 Available from http://www.osgeo.org/journal [Accessed 17 April 2008].

Alfaro, A.A.A. and Rico, G.C. 2003. "gvSIG: Open source solutions in spatial technologies." In *Proceedings of GISPLANET 2005,* Estoril, Spain, Available from http:// www.gvsig.gva.es/fileadmin/conselleria/images/Documen tacion/articulos/GIS_PLAN ET_2005_gvSIG.pdf [Accessed 17 April 2008].

Antonello, A. and Francheschi, S. 2007. "JGrass and uDig, chronicles of a lovestory." In *Proceedings of FOSS4G*

2007, Lausanne, Switzerland. Available from http://www.foss4g2007.org/presentations/view.php?abstract_id=147 [Accessed 30 July 2008].

Badard, T. and Braun, A. 2003. "Oxygene: An open framework for the deployment of geographic web services." In *Proceedings of the 21st International Cartographic Conference,* Durban, South Africa, CD-ROM.

Buliung, R.N. and Remmel, T.K. 2008. "Open source, spatial analysis, and activity-travel behaviour research: capabilities of the space package." *Journal of Geographical Systems,* in press.

Burghardt, D., Neun, M. and Weibel, R. 2005. "Generalization services on the web – classification and an initial prototype implementation." *Cartography and Geographic Information Science* 32: 257-268.

Butler, H. 2005. "A guide to the python universe for ESRI users." *ArcUser* 2: 34-37. Available from: http://www.esri.com/news/arcuser/0405/files/python.pdf [Accessed 17 April 2008].

Clinton, B. 1993. "Coordinating geographic data acquisition and access: The national spatial data infrastructure. Executive Order 12906." *Federal Register* 59, No. 71. Available from: http://www.archives.gov/federal-register/executive-orders/pdf/12906.pdf [Accessed 17 April 2008].

Cook, J. 2008. "Dear ESRI, it's not me, it's you [online]." *Computing, GIS and Archaeology in the UK.* Available from: http://www.archaeogeek.com/blog/2008/03/12/dear-esri-its- not-me-its-you/ [Accessed 17 April 2008].

Conrad, O. 2007. "SAGA – System für Automatisierte Geowissenschaftliche Analysen." Presentation held at *FOSSGIS 2007,* Berlin, Germany, 14. March 2007. Available from: http://www.fossgis.de/wiki/images/e/eb/Oconrad_fossgis2007_saga.pdf [Accessed 17 April 2008].

Daues, J. 2006. "The open-source software development paradigm: Nothing new to scientific research." In *Proceedings of iEMSs 2006,* Burlington, VT, USA. Available from: http://www.iemss.org/iemss2006/papers/w13/Daues.pdf [Accessed 17 April 2008].

Edwardes, A., Burdhardt, D., Bobzien, M., Harrie, L., Reichenbacher, T., Sester, M. and Weibe, R. 2003. "Map generalisation technology: addressing the need for a common research platform." In *Proceedings of the 21st International Cartographic Conference,* Durban, South Africa, CD-ROM.

Fee, J. 2008. "The Closing Q&A [online]." *James Fee GIS Blog*. Available from: http://www.spatiallyadjusted.com/2008/03/21/the-closing-qa/#comments [Accessed 17 April 2008].

GVSIG. 2006. "gvSIG project : Open Source SDI client." Presentation held at Joint Research Centre, Milano, Italy. 30 Nov. 2006. Available from: http://www.gvsig.gva.es/ fileadmin/conselleria/images/Documentacion/ponencias/ Presentacion_JRC_Milan_20 06.pdf [Accessed 17 April 2008].

Hugentobler, M. 2008. "Quantum GIS." In *Encyclopedia of GIS*, edited by S. Shekhar and H. Xiong. Springer-Verlag, 171–188.

Jolma, A., Ames, D.P., Horning, N., Neteler, M., Racicot, A. and Sutton, T. 2006. "Free and open source geospatial tools for environmental modelling and management." In *Proceedings of iEMSs 2006,* Burlington, VT, USA. Available from:http://www.iemss.org/iemss2006/papers/w13/pp.pdf [Accessed 22 April 2008].

Leduc, T., Gonzales-cortes, F. and Bocher, E. 2007. "OrbisGIS – a GIS for scientific simulation." Presentation held at

RMLL, Amiens, France, 12 June 2007. Available from http://2007.rmll.info//IMG/pdf/RMLL07Sc_OrbisGis_TLeduc.pdf [Accessed 17 April 2008].

Mitasova, H. and Neteler, M. 2004. "GRASS as an *open* source free software GIS: Accomplishments and perspectives." *Transactions in GIS* 8: 145-154.

Nebert, D.D. 2004. *Developing Spatial Data Infrastructures: The SDI Cookbook,* Version 2.0 (GSDI-Technical Working Group). Available from: http://www.gsdi.org/gsdicookbookindex.asp [Accessed: 17 April 2008]

Neun, M., Burghardt, D. and Weibel, R. 2008. "Web service approaches for providing enriched data structures to generalisation operators." *International Journal of Geographic Information Science* 22: 133-165.

OSGEO. 2006. *Open Source Geospatial Foundation Created to Strengthen Collaborative Development of Open Geospatial Technologies?* [online]. Available from: http://www.osgeo.org/content/news/news_archive/open_source_geospatial_foundation _initial_press_release.html.html [Accessed 29 July 2008].

Pebesma, E.J. 2004. "Multivariable geostatistics in S: the gstat package." *Computers and Geosciences* 30: 683-691.

Perens, P. 1999. "The Open Source Definition." In *Open Sources: Voices from the Open Source Revolution*, edited by C. Dibona, S. Ockman and M. Stone, 171–188. Cambridge, MA: O'Reilly. Available from: http://perens.com/Articles/OSD.html [Accessed 17 April 2008].

Ramsey, P. 2007a. *PostGIS Case Studies.* Presentation. Available from: http://www.refractions.net/expertise/whitepapers/postgis-case-studies/ [Accessed 17 April 2008].

Ramsey, P. 2007b. "The state of open source GIS." In *FOSS4G*

2007 Conference, Vancouver, BC, Canada, Available from: http://www.refractions.net/expertise/whitepapers/opensourcesurvey/survey-open-source-2007-12.pdf [Accessed 17 April 2008].

Ramsey, P. 2008. *Timmy's Telethon #5* [online]. Clever Elephant: smart people, smart maps. Available from: http://blog.cleverelephant.ca/2008/02/timmys-telethon-5.html [Accessed 17 April 2008].

Rauskolb, R. 1976. "Dr. Wangs' Palo Alto TINY BASIC." *Interface Age* 2: 92-108.

Regnauld, N. 2006. "Improving efficiency for developing automatic generalisation solutions." In *Proceedings of ISPRS Workshop: Multiple Representation and Interoperability of Spatial Data,* Hannover, Germany, IAPRS Vol. XXXVI, part 2/W40, pp. 1-5.

Reid, J. and Martin, F. 2001. "The open source movement and its potential in implementing Spatial Data Infrastructures." In *International Symposium on Spatial Data Infrastructure,* Melbourne, Australia, Available from: http://www.uow.edu.au/ jgreid/gis/sdi/corrected-paper-0.1.1.html [Accessed 17 April 2008].

Smith, B. 2008. "RE: Requirements when publishing a (research) article that uses/ modifies GPL software." [online] [Mail reference: gnu.org #357401 – licensing (at)fsf.org]

Stallman, P. 2007. "Why "Open Source" misses the point of Free Software." [online] *GNU Operating System*. Available from:http://www.gnu.org/philosophy/open-source-misses-the-point.html [Accessed 17 April 2008].

Weis, M. 2006. "Alternative GIS-Programme." Presentation held at Universität Hohenheim, Stuttgart, Germany, Available from: http://turbo.uni-hohenheim.de/wiki/images/ Alternative_gis.pdf [Accessed 17 April 2008].

Wagner, J.O. 2006. "Quo Vadis Desktop-GIS?" Presentation held at *Quo Vadis GIS workshop,* WhereGroup, 21 Dec. 2006, Bonn, Germany. Available from: http://www.wheregroup.com/files/DesktopGIS.pdf [Accessed 17 April 2008].

Westervelt, J. 2004. GRASS roots. In *Proceedings of the FOSS/GRASS User Conference,* Bangkok, Thailand. Available from: http://gisws.media.osaka-cu.ac.jp/grass04/viewpaper.php?id=53 [Accessed: 17 April 2008].