

Empirical Evaluation of Open Source QGIS with Contemporary Proprietary GIS Systems - A Study

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Abstract - The GIS code sector has developed quickly over the last decade of decades. Open source GIS applications square measure unit gaining relevant market shares in business, academia, and public administration. The target of this study is to spotlight benefits and drawbacks of the utilization of proprietary and free/open-source code for applications involving geospatial knowledge. Open source code is that sort of code that may be freely used, changed, and shared by anyone. Generally, the open source code is formed by many folks, and distributed below licenses that go with the Open Source Definition. There are presently many open source GIS code solutions that obligatory themselves in GIS environments and gained ground against proprietary GIS branded solutions. The aim of this article is to spotlight the characteristics of the 2 classes of code - Open source and Proprietary GIS Systems, like simple implementation and smart usability, analytical and show capability and practicality of open source GIS solutions like QGIS and a few benefits of mistreatment them.

Keywords— GIS, QIS, Open-Source Software (OSS), Proprietary GIS Systems, QGIS Plugins, Spatial Data.

1. INTRODUCTION

In normal life, we have a tendency to need to have availed offerings like door-step pizza pie shipping, emergency clinical services, real-time flight facts, and chase and transport of shipments on time. Most companies like rapid-food chains, banks, hospitals, and therefore the aviation commercial enterprise, use Geographic records machine (GIS) and one of a kind computerized systems to deliver time professional offerings to their customers. Groups use GIS as a decision-

guide-machine. For instance, banks will use GIS to research the population density all through a kingdom and determine if to put in new computerized teller machines (ATM) in particular regions, to increase their customer base. The intention of GIS is to automatize the method of capturing, storing, editing, updating, analyzing, and showing each form of geographic expertise. GIS eases the method of manually grouping geographic knowledge and its conversion to digital type. This tends to scale back the amount of errors locomotion in throughout the manual method [1].

The extensive adoption of the web and therefore the World-Wide internet (WWW) as a method of understanding alternate has had a profound have effect on all components of the knowledge Technology (IT) community due to the fact the specialized domain of Geographical Information Systems (GIS) no but others. Some ambitions are realized: intranets, as an example, have induced the shift in paradigm from the monolithic computer approach to employer level, client-server based totally often GIS [2].

The position of GIS in facilitating decision-making approaches might also be a key issue conducive to its modern popularity; the aggregate of any relevant knowledge sources will solely add charge to the know-how yielded via GIS analysis [3].

2. GIS SYSTEMS

Software (SW) is shortly outlined because the feasible code that controls laptop behaviour and operations. The term is employed, however, to explain a large vary of programming languages, applications, procedures and everyone connected documentation resources.

2.1 Open-source software (OSS)

It is a PC code with its source code made available partner degreed authorized with an open-source permit inside which the copyright holder gives the rights to survey, alteration and disperse the PC code for complimentary to anybody and for any reason. Open-source PC code is amazingly normally created in an exceedingly open, agreeable way. Open-source PC code is that the most extraordinary case of open-source advancement and rarely contrasted with (in fact characterized) client produced content or (legitimately characterized) open-content developments.

As indicated by the FSF, programming can be marked as free programming if the related permit conditions satisfy the 'Free Software Definition', which awards four flexibilities [4]:

- 1) The flexibility to run the program for any reason.
- 2) The flexibility to check how the program functions and adjust it to your necessities.
- 3) The opportunity to redistribute the product.
- 4) The opportunity to support the program, and to release your improvements to people in general, all together that the aggregate group edges.

2.2 Proprietary Software

The term proprietary originates from the Latin word *proprietas* that implies property. Restrictive programming framework is workstation programming framework charged underneath the selective legitimate privileges of the copyright holder. Exclusive programming framework is produced by somebody or firm United Nations organization has privileges of abuse existing or growing new apparatuses to shape new programming framework. An exclusive

programming framework designer offers or gives his creation underneath some solid conditions that should be taken after to keep away from any lawful issues. All in all, these solid conditions include use abuse programming framework with a bought permit, inside the permissible limits, no alteration permitted, no any re-circulations and no figuring out to connected. The most personality of restrictive programming framework is that its ASCII content record is regularly unbroken mystery from outside world. In this way, the inward structure of restrictive programming framework isn't uncovered. The limitations on exclusive programming framework are typically required through a record known as EULA (End-client permit understandings) to that clients are surmised to concur before abuse the product framework. It works rather like an agreement of utilization conditions between the client and seller. In the event a client is discovered enjoyed exercises bringing about the breaking of copyright conditions, the trade specialist has the right to force legitimate activities against the abusing individual.

3. MAIN FEATURES OF OSS (OPEN SOURCE SOFTWARE)

The first characteristic is that this type of code is free and might be changed by the user teams and developers. The most component that distinguishes these product from the proprietary code or software is free license that specify legal rights of users to use, study, change, modify, distribute and improve source codes. This questionable free license ensures all users access to the source code.

In 1976 invoice GATES wrote the "Open Letter to Hobbyists" in which he criticizes copyright infringements of the hobbyist community as they could motive restrains of builders to make investments within the introduction of satisfactory software program [5]. years earlier than, in 1974 the country wide commission on New Technological Use of Copyrighted Works CONTU became hooked up in the united states of America with the task to evaluate the public safety of software program. According to their advice, the computer software Copyright Act which allowed for costs for violations of copyright, turned into handed in

1980 by way of Congress. Those ideas had been followed in different nations. Within the European Union a guideline for software copyright changed into brought in 1991 through the European commission. It accompanied America American concept and classified laptop packages as “works of literature” and accordingly protected their copyright for nearly 50 years. In OSS improvement members are often no longer based totally inside the equal geographical place. This calls for wonderful operating mechanisms in which supply code need to be shared with several customers [6]. In 2010 a survey become carried out in 2.300 groups in 15 international locations which showed that extra than 25% of the surveyed firms develop PCSS as well as OSS [7]. There are more and more establishments that organize and promote OSS and OS information codecs. Inside the region of geospatial software, the Open source Geospatial foundation (OSGeo) may be named.

In the last years had been formed an excellent range of open source GIS code solutions. There are unit roaring comes like QGIS (QuantumGIS), PostGIS, Grass UN agency have concerned each GIS developers and users. There are unit necessary organizations as FOSS4G (Free and Open source code for Geospatial) and OSGEO (The Open Source Geospatial Foundation) that aim to develop and promote these kinds of code [8].

3.1 QGIS (Open Source GIS Software)

QGIS (already alluded to as Quantum GIS) is an open source GIS. It exists for the operational frameworks Windows, Mac OS X, Linux, BSD and humanoid (beta). QGIS bundle is created by the programing dialect C++ and in this manner the modules of the open source venture Qt Project [9] that could be a cross-stage application and program system. The "Q" in QGIS pinpoint with the one from Qt Project. Before the two.0 unharness in Gregorian date-book month tenth, 2013, the program was alluded to as Quantum GIS besides as QGIS and is exclusively known as QGIS from that point forward. QGIS is offered in forty-two dialects. QGIS comprises of 4 parts, QGIS Desktop, QGIS Server QGIS Browser/Mobile, and QGIS Web Client. QGIS Desktop is that the likened to ArcGIS for Desktop

since it gives GIS capacities to altering, survey, information creation, and examination.

As QGIS is open source, the occasion technique is amazingly very surprising thereto of exclusive GIS framework ArcGIS. QGIS venture was begun in 2002 by the Alaskan specialist purpose of passage SHERMAN who was longing for a quick geographic learning watcher that keeps running on Linux and backings numerous information groups. As a few consequences of his unsuccessful inquiry he set to start his own GIS venture. In June 2002 QGIS was precisely register as a task of the Open Source Geospatial Foundation (OSGeo), a non-benefit association with the mean to help the agreeable refinement of open source geospatial bundle, and advance its boundless utilize [10]. The outline on the QGIS committers by the venture's author SHERMAN demonstrates an ascent in engineers that crests in 2008, delineates in figure 1. From that point forward the amount of most recent committers is contracting that demonstrates that the center advancement group is extremely steady.

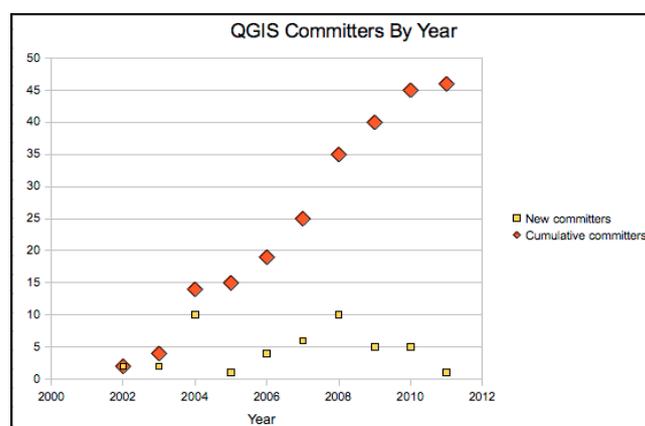


Fig. 1: QGIS Committers 2002-2011, Source: SHERMAN

The above graphical figure incorporates all committers including designers/developers, documentation essayists, and interpreters. Also, it doesn't cover the entire range of individuals who have contributed code and fixes that were connected by venture engineers. There square measure engaged with the care and bolstering of QGIS than the forty-six spoke to on the chart.

3.2 Personal Preference and Parameters of QGIS

QGIS joins a module outline that allows the including of most recent alternatives. QGIS establishment can favour modules so inside control is secured. On the authority QGIS modules net gateway designers will understand a stock of all steady and exploratory QGIS modules further as a manual for making their own particular modules.

Concerning standard trait common sense inside the class reasonableness, restrictive GIS bundle ArcGIS doesn't win inside the performed examination as they were picked so they might be performed by each program, yet for the arrangement of instruments it will. ArcGIS gives a considerable measure of development and vector calculations 'out-of-the-container' which may exclusively be implemented with python programming in QGIS. In any case, the investigation of cartographical common sense after some time has demonstrated that QGIS is making up for lost time rapidly that is reflected inside the demonstrated certainty that a substitution QGIS form is free concerning each fourth month. The precision of the conveyed comes about was practically identical. For capacity QGIS has the lead however as it utilizes the usefulness of the OS programs SAGA GIS, GRASS GIS, Orfeo instrument case OTB for photogrammetric, OSSIM for picture process and is perfect with the main information point program R conjointly inside the class consistence QGIS is better than ArcGIS in light of that it utilizes open gauges. Though ArcGIS underpins over a hundred data arranges that exclusively exemplify limited OGC data designs QGIS utilizes the open source interpretation library GDAL/ORG that backings more than two hundred vector and development organizes together with all regular net administrations. Conjointly for databases ArcGIS commonly utilizes the exclusive ESRI Personal File, and ArcSDE data though QGIS utilizes open source Spatialite databases and backings PostgreSQL/PostGIS.

For practicality QGIS holds bound endowments. Analysability and strength zone unit even on each program will be reached out with python scripting and the documents will be used in elective projects. Testability and changeableness yet zone unit won by QGIS in

view of its source code plainly realistic. As to standard trait moveable QGIS wins everything classes. Its parcel of convertible since it has numerous ties to elective bundle programs. It scores higher in introduce capacity due to it exists for all regular operational frameworks though ArcGIS exclusively keeps running on Windows. It rules in consistence in view of the work of open benchmarks. At last, QGIS joins a higher potential for commutability of elective projects since it keeps running on entirely unexpected operational frameworks and utilizations open benchmarks.

4. COMMERCIAL GIS SOFTWARE

There are plenty of Proprietary GIS Software's available in the market. However, we are going to discuss some of them. Beneath is the list of some Proprietary structures:

1) AutoCAD

AutoCAD is a commercial computer-aided layout (CAD) and drafting software application, advanced and advertised with the aid of Autodesk. AutoCAD was first released in December 1982 as a computing device app walking on microcomputers with internal snap shots controllers. Earlier than AutoCAD turned into delivered, maximum commercial CAD packages ran on mainframe computers or minicomputers, with every CAD operator (consumer) running at a separate portraits terminal. For the reason that 2010, AutoCAD was launched as a mobile- and web app as nicely, advertised as AutoCAD 360. AutoCAD isn't just about drafting. AutoCAD Map 3D bridges the space between CAD and GIS. For the ones already the usage of Autodesk, this business GIS software program gives a familiar interface to manipulate spatial data and underlying asset facts. With its developing variety of equipment to choose from, you may additionally produce a few beautiful cartographic output. As the call suggests, AutoCAD Map 3D seamlessly renders spatial facts in three dimensions. Whether or not you're running in oil and gas, public utilities or the mining industry, 3-D mapping is a nice characteristic. AutoCAD is used across a huge range of industries, by using architects, task managers, engineers, photo designers, and many other professionals.

2) *AGISMap*

AGIS for domestic home windows is a mapping and smooth GIS package deal mainly designed to be clean to apply and dispensed as shareware through the world extensive web. AGIS is a user pleasant mapping and simple geographic records machine for Microsoft Windows 95, ninety eight, ME, NT, 2000 and XP. Maps and records can be provided by using the person inside the shape of textual content documents either created by means of different programs, or typed using a text editor. All control documents utilized by AGIS are ASCII text, so it is simpler to create such documents the usage of other systems. This system has enough manage dialogs built in to create and edit all manage data without requiring the consumer to understand the shape of these documents. Excessive high-quality map images may be copied to the clipboard and pasted into popular programs which includes Microsoft phrase, or shop at once to your hard disk as jpeg or bmp files.

3) *ArcGIS*

ArcGIS is a platform for groups to create, manipulate, proportion, and examine spatial facts. It consists of server additives, cell and computing device programs, and developer tools. This platform can be deployed on-premises or within the cloud (Amazon, Azure) with ArcGIS organization, or used through ArcGIS on line which is hosted and controlled with the aid of Esri. It's far a marketplace leader in commercial GIS software. The device affords an infrastructure for making maps and geographic facts to be had during a corporation, throughout a community, and brazenly at the net.

4) *Bentley Map*

Inside the Bentley global, their 2d and 3-D viewing provides a basis for top-notch visualization. Create, preserve, analyse, and proportion your geospatial, engineering, and commercial enterprise records in an effective, but acquainted MicroStation environment. With Bentley Map, you can get admission to, proportion, edit and analyse CAD, BIM and GIS statistics. Paintings with a bit of luck with engineering-fine GIS to supply pleasant maps and unify disparate 2nd/3-D statistics. Cast off disparate information and improve interoperability. It brings engineering

and geospatial data closer collectively through progressed interoperability with Esri record Geodatabase, Oracle 12c, CityGML, Bing Maps, and hybrid point cloud and vector workflow assist. Use a sturdy yet flexible software interface (API) for growing custom GIS packages. It will increase productivity and enhance selection making via giving discipline personnel rapid access from a pill with the Bentley Map mobile app.

5) *Cartographica*

It is designed for folks who need to work with geospatial statistics to create maps, examine statistics, convert among codecs, and find out new information about your facts and the sector wherein it exists. As such, we have emphasized easy importation, exploration, analysis, and output inside the layout of Cartographica is strong, but amusing to apply and easy to discover. It has a rich feature set of support for a huge wide variety of import and export formats, which include popular raster formats, manual editing and georeferencing, automated geocoding, integration with on line mapping.

6) *Geomedia*

It's far a geographic information machine (GIS) utility for running with and undertaking evaluation on geographic records in addition to producing maps from that analysis. GeoMedia is used for: creating geographic information; coping with geospatial databases; becoming a member of enterprise facts, location intelligence and geographic records collectively; developing difficult and soft-copy maps; behaviour analysis in 'actual-time'; base platform for more than one applications, geographic statistics validation, and publishing geospatial records and reading mapped records. Geomedia has been the principle rival to ArcGIS for decades. It was evolved by way of Intergraph, now owned by means of Hexagon Geospatial.

7) *Manifold GIS System*

Manifold device is a GIS software package evolved by using Manifold software program confined that runs on Microsoft windows. It handles both vector and raster facts, consists of spatial SQL, an integrated internet Map Server (IMS), and other well-known GIS features. Manifold machine release eight.00 became the

first industrial product to encompass hugely parallel GPGPU functionality making use of NVIDIA GPUs, implemented within approximately 35 capabilities used within the raster transformation system. It has an energetic person network with a mailing listing and on-line boards. Manifold GIS is all approximately turning in international-class GIS commercial software. It's solid with a huge range of functions. Manifold GIS is a mixture of mapping, CAD, DBMS and picture processing.

8) *MapInfo professional*

MapInfo professional is a laptop geographic information device (GIS) software program product produced by way of Pitney Bowes software (previously MapInfo organization) and used for mapping and vicinity evaluation. MapInfo lets in customers to visualize, examine, edit, interpret, understand and output records to show relationships, styles, and traits. MapInfo lets in users to explore spatial statistics inside a dataset, represent features, and create maps. It has a clean cognizance on vicinity intelligence. It's smarter with labelling, legend and scale bars.

9) *Maptitude*

Maptitude is a mapping software program software created by Caliper organization that lets in customers to view, edit and combine maps. The software and generation are designed to facilitate the geographical visualization and analysis of either included information or custom outside statistics. It's far supposed for commercial enterprise users however competes at all degrees of the GIS market in many exclusive sectors. It encapsulates the center GIS functionality of the Caliper mapping software program suite of merchandise, and integrates with Microsoft workplace, information mapping from various sources along with Microsoft Excel, and consists of a proprietary simple-like programming language (Caliper Script) inside a development interface (GISDK) that lets in automation of the Maptitude environment. It has a few neat mapping outputs like three-D prism maps, scaled-symbol and bar chart maps.

10) *Ortelius*

Ortelius (named after the 16th-century cartographer, Abraham Ortelius). Ortelius is

outstanding cartography software program that meets the mapping desires of photograph designers, savvy public, historians, challenge managers, researchers. Ortelius is a "map instance" software program package that gives one more choice to the very limited mapping software program software options accessible for Macintosh customers. It introduces remarkable smart cartography equipment that speed-up the procedure of manual map making, plus a full photographs suite to assist your creativity. With a placing desire of colours, fills, strokes, and adornments we are able to assemble symbols and unlimited style combinations. It constructs expert styles, such as cased roads with hatches, dashes and dots, sample fills, and tapering strokes.

We have explored some of the details with our findings for Commercial GIS Software. Table 1 presents the details of Commercial GIS Software.

TABLE I
COMPARABLE VIEW OF DIFFERENT COMMERCIAL GIS SOFTWARE

GIS Software	Developed by	Used in application(s)	Development/ Language	Software License
AutoCAD (Dec 1982)	Auto desk	spatial data, cartographic maps	Windows , macOS, iOS, Android	Trialware
AGIS	AGIS Software	High quality map, 3D terrain	Windows	Commercial
ArcGIS (Dec 1999)	Esri	Viewing, Editing, Analysis, compiling geographic data	Windows	Proprietary commercial software
Bentley Map (Nov 2014)	Bentley	CAD capabilities, BIM, Analysis (Mobile App)	Windows	Proprietary software
Cartographic a (2005)	Clue Trust	Raster formats, georeferencing	Macintosh	Proprietary

Geome dia (May 2015)	Inter graph , Hexa gon Geos patial	geographi c data, managing geospatial database	Windows	Propri etary
Manif old GIS System (2017)	Mani fold Soft ware Limit ed	vector and raster data, Spatial SQL	Windows	Propri etary
MapIn fo Profes sional (1986)	Pitne y Bowe s, MapI nfo Corp oratio n	location intelligen ce visualize, analyze, edit, interpret spatial data	Windows	Propri etary
Maptit ude (1995)	Calip er Corp oratio n	3D prism maps, scaled-symbol, bar Chart maps	Windows	Propri etary comm ercial softwa re
Orteli us (2008)	Map Diva	super smart cartograp hy	Macintos h	Propri etary

5. CONCLUSIONS

GIS is a basic apparatus for directing in vogue examination. Be that as it may, current exclusive bundle licenses, valuation and improvement models restrict access to more extensive group development and execution, especially in creating countries. To moderate these difficulties, we have a tendency to explore the work of Free and Open source (FOS) GIS bundle examination, and blessing this paper as an establishment for accomplishing this goal.

As of late, different open access programs have developed as reasonable contrasting options to expensive restrictive and modern item. Open source programming's square measure increasing quality, each have benefits and weaknesses

depending upon the applying choices they supply. Restrictive bundle includes a solid trade the registering time. Open source is rapidly picking up adequacy and hence it's a route forward for e-learning. A few world classification foundations have received Open source, however a few non-open GIS merchants and bundle organizations like ESRI, Microsoft, Google and Intergraph fight a critical part for GIS improvement inside the past, the Open source bundle Society has turned into a more grounded player as of late inside the GIS business.

The QGIS framework speaks to a flourishing case of the helpful advancement show. Clients square measure enlivened to exchange the basic code and analyze, assess, benchmark, alter, and improve all calculations and methodologies. Due to its lively client and advancement groups, we tend to imagine that QGIS can in any case be a general GIS with a constantly enhanced structure and intense help for local adjustment for particular wants, strikingly with importance ecological investigations. Since it's a standard framework, it ought to be upheld in fluctuated conditions beginning from instructional exercise frameworks to business and open organization use with their variable necessities.

Business GIS bundle is most useful once you need easy to understand bundle with keen specialized help, this can be especially important on the off chance that you plan on leading every one of your GIS exercises in-house and don't basically have bundle builds on representatives that may help you oversee potential bundle issues that may emerge. Open source GIS, on the contrary hand, is far less demanding to redo, scale and adjust to your current bundle frameworks. However, these alternatives return at an esteem - investigators working with these stages should have some mastery with GIS bundle as there's limited help.

The decision of open source or modern GIS mapping bundle relies upon your task, though mechanical GIS bundle is extra simple, and exceeds expectations inside the territories of spatial investigation, information control, and learning administration. Open source GIS bundle is more qualified for things amid which extra

flexibility and customization is required, albeit open source innovation is free, bind mind that you essentially can at present got the chance to put resources into GIS designers and examiners to encourage the innovation working appropriate for you.

ACKNOWLEDGMENT

In the name of Allah, the most Merciful, the most Gracious. All reward is due to Allah, we reward Him, are seeking His help with shelter and ask for His forgiveness. I am fairly grateful to Allah, for his monstrous steerage and assist to complete this research paper.

I'm thankful to all of these with whom I have had the satisfaction to work for the duration of this research. My exceptional buddy Faisal Mabool, Assistant professor at Govt. degree college, Beerwah, J&k has always been there to offer his fine assist and assist regardless of how unfavourable circumstances happened. I would like to thank my parents, whose love and steerage are with me in whatever I pursue. Lastly but not the least, I desire to thank my caring and supportive wife, Aayat, who provide endless inspiration.

I'm also immensely grateful to listeners, target market, scholars for their remarks on an in advance version of the manuscript, despite the fact that any errors are our personal and must no longer tarnish the reputations of these esteemed humans.

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