Edinburgh, Scotland
EURONOISE 2009
October 26-28

Open source software for the acoustician

Mikael Ögren[a]
VTI - the Swedish Road and Transport Research Institute, Gothenburg, Sweden

ABSTRACT

Open source software is rapidly growing compared to traditionally licensed software. This paper describes the basics of open source development of software, which is relevant both for commercial and free software distribution, and gives a compact demonstration of a few programs useful in the field of acoustics. These cover a few different areas such as operating systems (Linux), math related tools (Octave and Maxima), audio processing (Audacity and Nyquist) and GIS (QGIS).

1. INTRODUCTION

Open source software is essentially software where the source code is publicly available. A more elaborate definition is available from the *Open Source Initative*[1] and the *Free Software Foundation*[2]. This could be compared to making the technical drawings and specifications available for an ordinary product such as a car. It is important to note that open source software is not necessarily free of charge and that companies that work with open source are essentially no different from those working with traditional license models, they are not adopting open source for ideological reasons or as a charity to their customers. Indeed, software vendors working with open source solutions are among the fastest growing companies[3], and open source software is used in mission critical roles by many large companies such as Google and Amazon.com.

The main advantages of open source software development is that the developer can use the growing pool of other open source applications as an inspiration or simply to reuse code from and that anyone can make improvements to the code. The main drawback is that it is more difficult for the software developer to make money than with the traditional licenses, but not impossible. The successful open source company MySQL estimate that they have approximately 1000 non-paying software users for each paying customer. Still they thrive, and out-compete many companies that use traditional licensing.

The benefits for the users of opens source software is mainly the increased freedom of choice and increased competition between vendors associated with the availability of the source code. The users can more easily migrate their data and applications to other softwares or vendors since all information about formats and so on can be found in the source code. In a way this is an effect similar to standardization, since it is impossible to hide information about the inner workings of the system like data formats. Another benefit is shared development and support; since the software is free anyone can get a copy and help out with whatever the user needs. Using an expensive and closed system the user is limited to the official support channel of the vendor.

[a] Email address. mikael.ogren@vti.se

The topic of this paper is open source software useful for the acoustician, and very briefly describes the open source operating system Linux in section 2. In section 3 a few examples of software for audio analysis and sound creation and manipulation is given, and in section 4 more general tools for math and science are presented. Finally in section 5 some tools for GIS are presented.

2. THE OPERATING SYSTEM LINUX

The operating system itself is perhaps not central for the typical acoustician, but I will discuss Linux[4] here for two reasons. The first is that Linux has an outstanding support for open source software. All software packages mentioned in this paper are accessible from the main Linux distributions via their respective package management software. Installing for example Audacity is then as simple as typing the name to search for it, select it, and pressing install. Any dependencies are automatically handled by the package manager. Most software described in this paper is also available for Windows XP and OS X (Macintosh), but here the installation procedures differ and dependencies on other packages may require manual installation and tweaking.

The second reason is that Linux is becoming more and more accepted in the scientific community. As an example there is a Linux distribution called *Scientific Linux*[5] which is backed by many organisations such as CERN and Fermilab. It is packed with software for the scientist such as FEM solvers, CFD systems, mathematical and statistical software and so on. There is also a special initiative aimed at making the Linux kernel (the core of the operative system) better optimized for audio processing (and focusing on low latency). The best known end user system using this approach is Ubuntu Studio[6], which is easy to install and use and is full of software for audio applications.

Even if installing Linux is not a complex task and Linux lives quite happily alongside Windows on your hard drive, you may prefer to use your familiar Windows environment. Still most software discussed below are usable, at least if you have Windows XP, and support for Windows Vista is getting better all the time.

3. AUDIO SOFTWARE

Audacity[7] is an excellent software for creating, manipulating and analyzing audio files. There are a lot of similar software around, but what makes Audacity stand out for the acoustician is the ability to write plug-ins using the lisp variant Nyquist[8]. Nyquist is a lisp dialect for audio processing and includes functions for FFT analysis, filtering, waveform synthesis and much more. Other important strengths of Audacity is the many supported audio formats and the ability to work with different sampling rates and bit depths in many formats. An example of using Audacity to perform spectrum analysis is given in Figure 1.

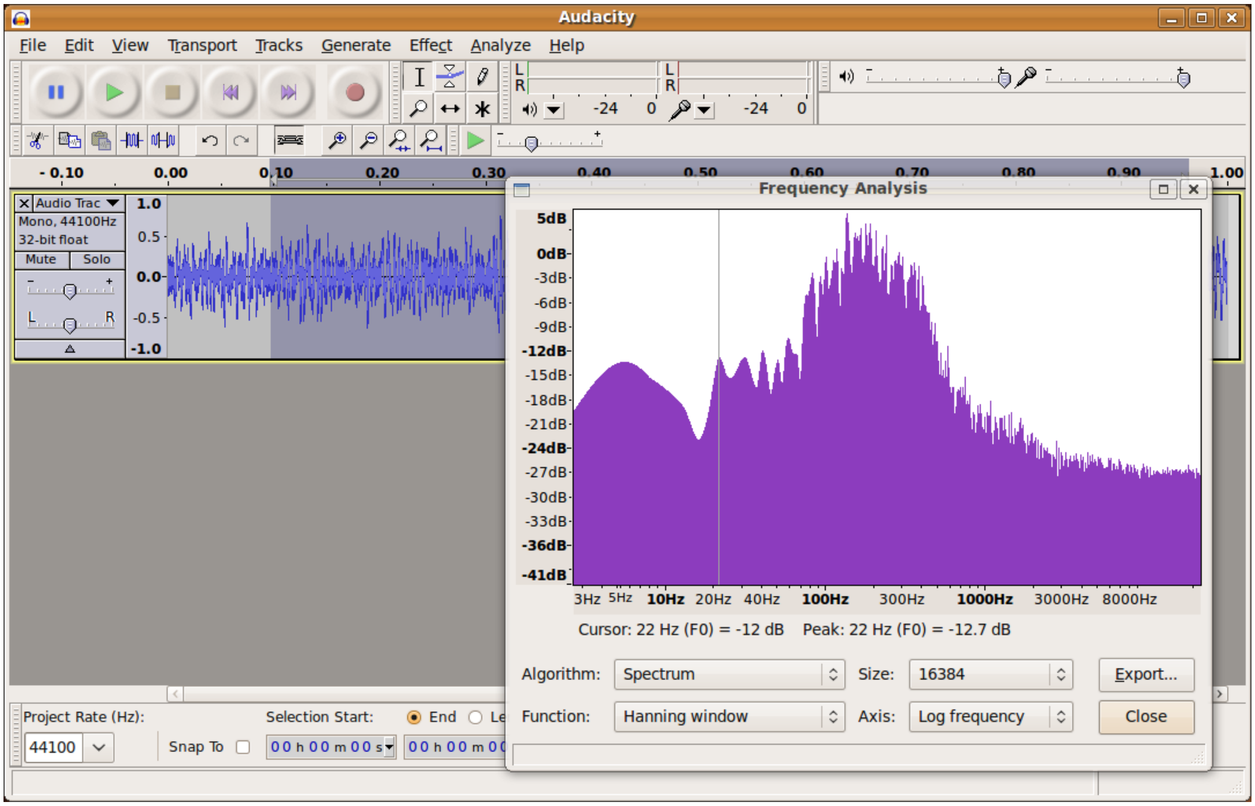

Figure 1: Using Audacity to perform spectrum analysis. Note that you can export the spectrum for use in other applications.

4. MATH / SCIENCE SOFTWARE

I often stumble across mathematical formulas during my research, and having a good computer algebra system at hand is a great tool. One such system that is open source is Maxima[9], which supports all of the manipulations I typically use; from integration and derivation of expressions to plotting a function over a certain interval.

Another fantastic tool is Octave[10], a high-level numerical programming language centered around numerical matrix and vector analysis. The closely related cousin Matlab is perhaps more familiar. In fact, many M-files written for Matlab works perfectly running under Octave, but not all. Octave is easy to use and perfect for generating high quality plots and graphics for academic publication. For audio analysis there are many functions for filtering and signal processing. The graphical capacity of Octave can be extended even further by installing Otcaviz[11], which makes it easy to generate 3-D graphical output. Figure 2 shows a typical screen running Octave, a text editor for writing an M-file and the graphical output from Octaviz of the calculations performed.

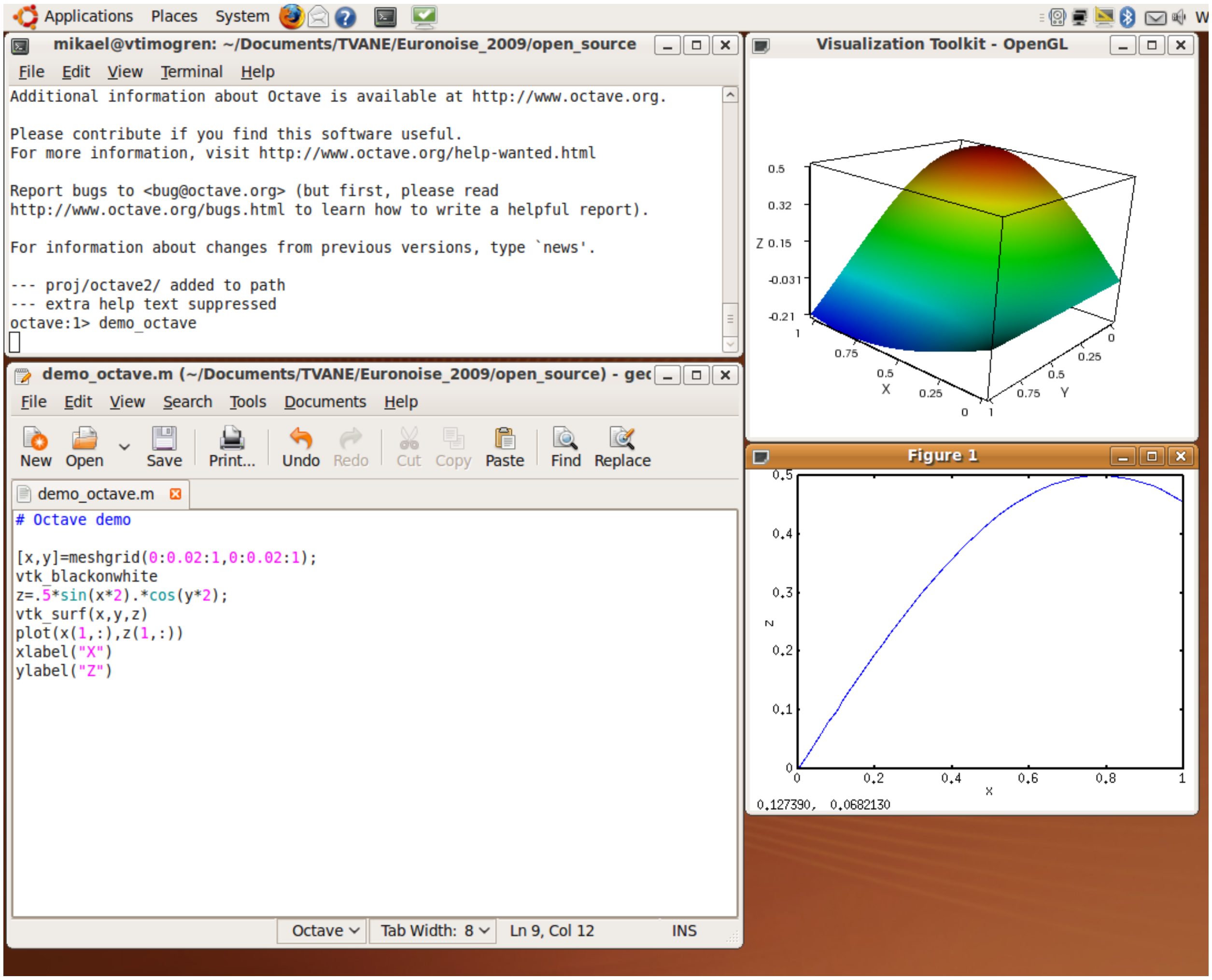

Figure 2: Numerical analysis using Octave and Octaviz.

5. GEOGRAPHIC INFORMATION SYSTEM SOFTWARE (GIS)

GIS tools are becoming increasingly important for the acoustician. Extracting data from digital maps and coupling calculation of sound levels with geographical data are two examples of common tasks. There are a great number of formats in which GIS data can be stored, but fortunately many of them are standardized or open in the meaning that the owner of the format has published specifications on how the data can be extracted or stored. But some are proprietary and closed with no option except to use the software that created the data to access it.

A great resource is the *Geospatial Data Abstraction Library*[12] provided by the the *Open Source Geospatial Foundation*[13]. The library is intended to be used from other programs, and one such example is the open source Quatum GIS[14] (QGIS). QGIS can import many vector and raster based formats, and uses an intuitive graphical user interface for many GIS operations. It can also be extended with small programs called plug-ins. This is excellent for research purposes where essentially any kind of analysis is possible if the user is familiar with one of the many supported programming languages (C++, Python, ...). Figure 3 shows QGIS in action working with noise maps.

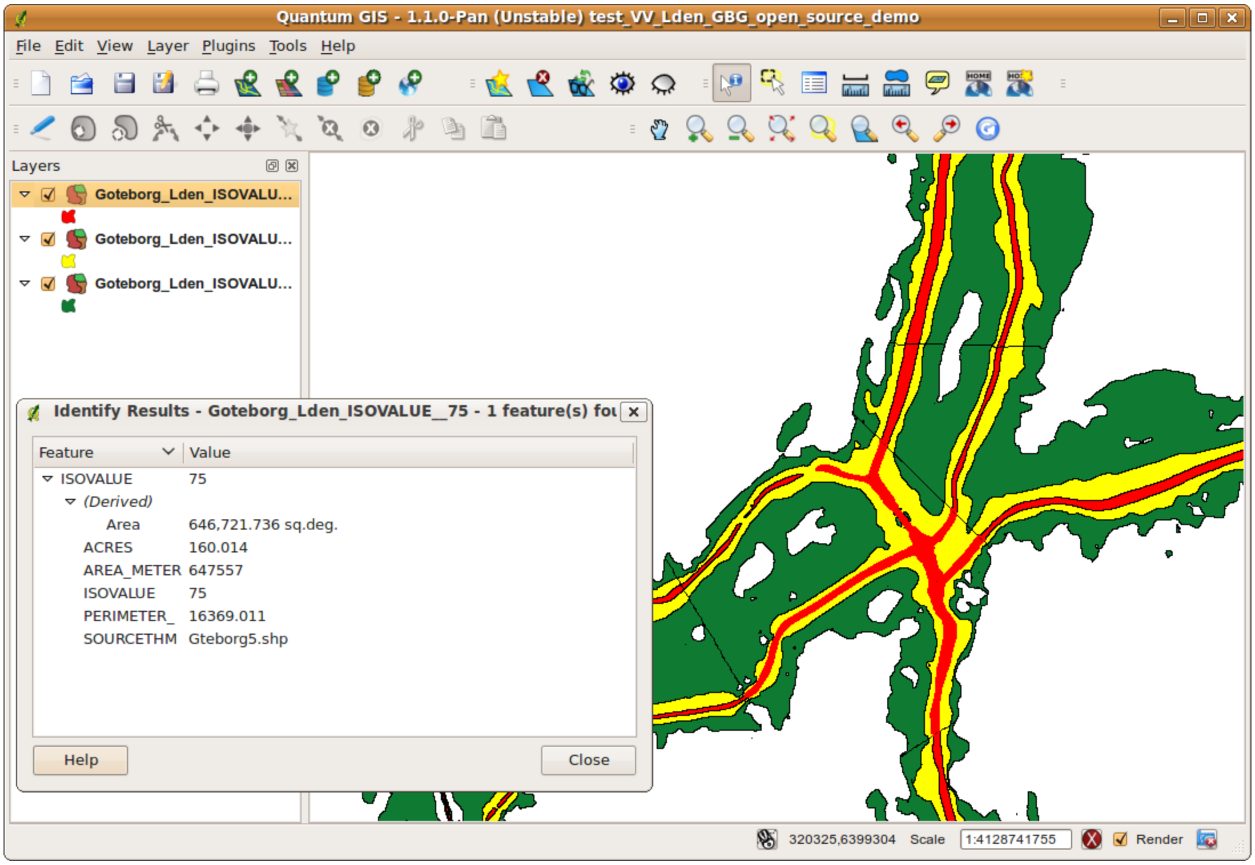

Figure 3: Using QGIS to access noise maps.

ACKNOWLEDGMENTS

Thanks to James B. Rawlings, John G. Ekerdt and John W. Eaton for writing and maintaining Octave, and releasing it using an open source license. Most of my research from 1998 and onwards have been based on this powerful and versatile numerical software.

REFERENCES

1. The Open Source Definition, http://opensource.org/docs/osd *
2. The Free Software Foundation, http://www.fsf.org/ *
3. Open-source companies log impressive growth in Q2 2009. Matt Asay, http://news.cnet.com/. Accessed 2009-07-10.
4. Linux definition at Wikipedia, http://en.wikipedia.org/wiki/Linux *
5. Scientific Linux, https://www.scientificlinux.org/ *
6. Ubuntu Studio, http://ubuntustudio.org/ *
7. Audacity sound editor, http://audacity.sourceforge.net/ *
8. Nyquist plug-ins for Audacity, http://audacity.sourceforge.net/help/nyquist *
9. Maxima computer algebra system, http://maxima.sourceforge.net/ *
10. Octave, http://www.gnu.org/software/octave/ *
11. Octaviz, visualization expansion for Octave, http://octaviz.sourceforge.net/ *
12. Geospatial Data Abstraction Library, http://www.gdal.org/ *
13. Open Source Geospatial Foundation, http://www.osgeo.org/ *
14. Quantum GIS, http://www.qgis.org/ *

* *accessed 2009-06-24*