

## SOFTWARE METAPAPER

# AvoPlot: An extensible scientific plotting tool based on matplotlib

Nial Peters<sup>1</sup>

<sup>1</sup> Geography Department, Cambridge University, Cambridge, United Kingdom

AvoPlot is a simple-to-use graphical plotting program written in Python and making extensive use of the matplotlib plotting library. It can be found at <http://code.google.com/p/avoplot/>. In addition to providing a user-friendly interface to the powerful capabilities of the matplotlib library, it also offers users the possibility of extending its functionality by creating plug-ins. These can import specific types of data into the interface and also provide new tools for manipulating them. In this respect, AvoPlot is a convenient platform for researchers to build their own data analysis tools on top of, as well as being a useful standalone program.

**Keywords:** plotting; data visualisation

**Funding Statement:** Much of the initial development was conducted whilst on fieldwork supported by the Royal Geographical Society (with IBG) with a Geographical Fieldwork Grant, and support from Antofagasta plc via the University of Cambridge Centre for Latin American Studies.

## (1) Overview

### Introduction

The software was originally created as a real-time visualisation program for monitoring sulphur dioxide emissions from volcanoes. However, with several different projects under way in our research group, all requiring a different set of data manipulation tools but similar user interfaces, it soon became clear that a more generic solution would be extremely useful; AvoPlot was designed to fill this role.

Essentially, AvoPlot aims to achieve two things:

- To provide a simple and intuitive graphical user interface for the matplotlib plotting library, with tools for importing common data formats.
- To provide an extensible platform that researchers can easily customise to suit their specific data visualisation and analysis requirements.

Although there are numerous open-source plotting programs already available, none (that the author is aware of) provide the same functionality as AvoPlot. Spreadsheet programs such as OpenOffice Calc [1] and Gnumeric [2] cannot load arbitrary data types, and also lack good data navigation tools (panning, zooming etc.) for their plots. The plot viewer built into matplotlib [3], provides good data navigation tools, but has very few graphical facilities for editing plot parameters. The Veusz [4] program incorporates most of the features of AvoPlot. It has a

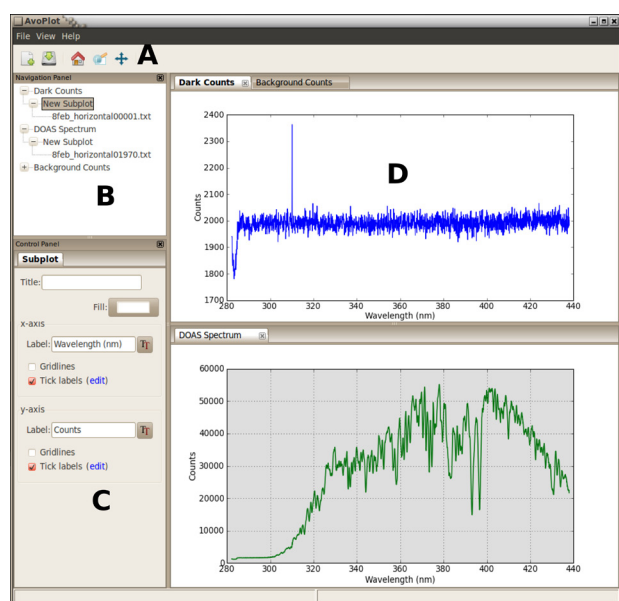
comprehensive graphical interface for creating and editing plots, as well as providing a plug-in interface to allow users to load arbitrary data types and define new analysis functions. However, Veusz implements its own plotting backend which is unlikely to be as familiar to developers as matplotlib and has a smaller community providing support. Furthermore, the scope for writing complex plug-ins is far more limited than in AvoPlot, which allows developers the freedom to use any wxPython [5] constructs when writing their plug-in interfaces.

At the time of writing, AvoPlot is still at an early stage of development. However, it is already being used as a visualisation and analysis tool by several members of the Cambridge Volcanology Group [6] and the Mount Erebus Volcano Observatory [7]. Plug-ins for working with differential optical absorption spectroscopy (DOAS) data and Fourier transform infrared (FTIR) spectra are currently under development and will be published in due course.

### Implementation/architecture

AvoPlot is written in pure Python [8]. Graphical interface elements are implemented using wxPython and plots are created and displayed using matplotlib and its wx-agg backend.

The software consists of two major components; the user interface (UI) and the plug-in system. The UI provides a generic graphical interface to much of matplotlib's functionality, allowing users to change plot parameters (such as line styles, colours etc.) without needing to write any code.



**Fig. 1:** Screen-shot of the AvoPlot user interface showing its main components: **a)** Toolbar providing the “standard” matplotlib pan, zoom and save controls; **b)** Navigation panel allowing selection of different plots, axes and data series; **c)** Control panel providing controls for editing plot properties such as axis titles, line styles etc. Any tools provided by the plug-in for the currently selected plot are also displayed here under a different tab; **d)** Tabbed plot window with a variable number of panes allowing multiple plots to be viewed simultaneously.

It also allows users to interact with any plug-ins that have been installed. An overview of the UI is shown in **Figure 1**.

The plug-in system is intended to give developers a simple way both to import their specific data into the UI, and to provide tools for manipulating them. Details of how to write plug-ins are given in the AvoPlot documentation which can be found in the “doc” folder of the source distribution, or online as part of the software archive. Furthermore, example plug-ins can be found in the “examples” folder of the source distribution.

AvoPlot comes with a simple file import plug-in which will be installed automatically. Currently, this can only load text files containing columns of numerical data. However, it will be extended in future releases to support other file types such as CSV, Excel spreadsheets etc. Sample data for creating a plot with this plug-in are provided in the “spectrum\_data.txt” file of the “examples” folder of the source distribution and step-by-step instructions for its use can be found in the AvoPlot documentation.

### Quality control

Functional testing has been carried out on both Linux and Microsoft Windows (XP and 7) using Python 2.7. AvoPlot behaved as expected in both cases.

### Support

Support is provided for users through an email list. There is a separate email list for developers which aims to provide support for people writing plug-ins. Both lists can be found at the code repository site.

## Availability

### Operating system

The software has been successfully tested on Linux (Ubuntu and OpenSUSE), Microsoft Windows (XP and 7) and MacOSX. There is no reason why AvoPlot cannot be installed on any system that can run Python.

### Programming language

Python ( $\geq 2.6$ , currently untested on 3.x)

### Additional system requirements

N/A

### Dependencies

- wxPython ( $\geq 2.8.10$ )
- Numpy ( $\geq 1.4$ )
- matplotlib ( $\geq 1.0.1$ )
- python-magic ( $\geq 0.4.3$ ) – optional, but recommended.

### List of contributors

- Nial Peters – coding, testing.
- Yves Mousallam – artwork.
- Kayla Iacovino – testing.

### Archive

#### Name

figshare

#### Persistent identifier

<http://dx.doi.org/10.6084/m9.figshare.757683>

#### License

GNU General Public License version 3

#### Publisher

Nial Peters

#### Date published

27/07/2013

#### Code repository

##### Name

Google Code

##### Identifier

<http://code.google.com/p/avoplot/>

#### License

GNU General Public License version 3

#### Date published

10/03/2013

#### Language

English

### (3) Reuse potential

As a standalone program, AvoPlot provides an easy to use, generic plotting tool capable of producing publication-quality figures. Although the current feature set is relatively limited, future development will focus on exposing more of matplotlib's functionality through AvoPlot's UI. This will give users access to matplotlib's extensive capabilities without requiring them to write Python scripts. In this respect, the program has a high reuse potential "as is" for a wide spectrum of end-users regardless of coding experience.

However, the main reuse potential for AvoPlot comes from its plug-in based architecture. With just a few lines of relatively simple code, researchers can write a plug-in that will plot their specific data set (which may be in a format difficult to import with mainstream plotting programs) in the AvoPlot UI. They can then take advantage of a feature-rich plot editing environment to customise their plot without having to edit or run scripts. Furthermore, AvoPlot plug-ins are distributed using Python's distutils system [9], making it simple for other researchers (who may have no programming experience) to install plug-ins written by their peers.

In addition to data import, AvoPlot plug-ins also allow researchers to easily integrate their own data manipulation and analysis tools into the AvoPlot UI, enabling them to create a graphical data processing software without having to write extensive UI code of their own. The aim is to encourage researchers to make the analysis tools which they create user-friendly and accessible for others, who may not be programmers.

### Acknowledgements

The author wishes to thank his supervisor Prof. Clive Oppenheimer for his support of the project.

### References

1. Apache OpenOffice Calc. Available at <http://www.openoffice.org/product/calc.html> [Last accessed 19 July 2013]
2. GNOME Office / Gnumeric - Welcome to Gnumeric!. Available at <https://projects.gnome.org/gnumeric/> [Last accessed 19 July 2013]
3. **Hunter, J D** 2007 Matplotlib: A 2D graphics environment. *Computing in Science & Engineering*, 9(3): 90–95. DOI: <http://dx.doi.org/10.1109/MCSE.2007.55>
4. Veusz - A Scientific Plotting Package. Available at <http://home.gna.org/veusz/> [Last accessed 19 July 2013]
5. **Dunn, R** 2003 *wxpython: wxwindows for python*. Available at <http://www.wxpython.org>
6. CVG – Cambridge Volcanology Group | Undertaking pioneering research into the processes, monitoring, and impacts of volcanism. Available at <http://www.volcano.group.cam.ac.uk/> [Last accessed 18 July 2013]
7. MEVO | Mount Erebus Volcano Observatory. Available at <http://erebus.nmt.edu/> [Last accessed 18 July 2013]
8. Python. Python Software Foundation. Available at [www.python.org/](http://www.python.org/)
9. Distributing Python Modules – Python v2.7.5 documentation. Available at <http://docs.python.org/2/distutils/> [Last accessed 21 July 2013]

**How to cite this article:** Peters, N 2014 AvoPlot: An extensible scientific plotting tool based on matplotlib. *Journal of Open Research Software*, 2(1): e1, DOI: <http://dx.doi.org/10.5334/jors.ai>

**Published:** 10 February 2014

**Copyright:** © 2014 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution 3.0 Unported License (CC-BY 3.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See <http://creativecommons.org/licenses/by/3.0/>.

