

Usability Assessment of Data Analysis and Visualization Tools: A Heuristic Evaluation

Samar Swaid¹; Mnsa Maat¹; Hari Krishnan², Devarshi Ghoshal², Lavanya Ramakrishnan²
¹Philander Smith College, ²Lawrence Berkeley National Lab

Introduction

The growth in scientific data volumes has resulted in development of data analyses and visualization to allow information processing and scientific understanding. Data analyses and visualization tools are critical to next-generation scientific discoveries. However, potentially useful tools often go unused or have steep learning curves due to issues related to usability. The goal of this work is to provide a usability assessment of a number of data analysis and visualization tools through a heuristic evaluation. This project is conducted in the context of the DOE funded project - Usable Data Abstraction for Next-Generation Scientific Workflows (UDA). This study focuses on data analyses and visualization tools in the context of scientific workflows (e.g., climate).

Research Purpose

The purpose of this project is two-fold:

1. Develop heuristic rules to be used to evaluate the usability of data analyses and visualization tools
2. Identify usability issues in data analysis and visualization tools

Research Methodology

According to Nielsen, a “heuristic evaluation involves having a small set of evaluators examine the interface and judge its compliance with recognized usability principles” [5]. In this study two climate visualization applications, Jupyter [1,2] and UV-CDAT [3,12] are selected to conduct usability inspection following the process suggested by Nielsen [4]. Heuristics rules applied for this study include the ones developed by Nielsen [4] and two more rules suggested to fit the context of visualization applications of customizability and sense-of-community. Customizability rule refers to the extent the application supports customized experience and sense-of-community rule refers to the extent the application cultivate community-of-practice among its users [7, 8, 9,10, 11].

Selected Usability Issues

Heuristic Rule [Supporting Reference]	Jupyter	UV-CDAT
Visibility of System Status[4]	Visibility of pathname of running Notebook is not demonstrated (Severity: 2)	Some redo transactions take longer than expected with no note to user of the current status of system (Severity: 2)
User Control [4]	User has no mechanism to manage files and folders of Notebooks (Severity: 2)	Visualization properties dialog window can be closed but not enlarged (Severity: 1)
Recognition [4]	Imported libraries are not shown for user while coding (Severity: 2)	When user to delete a variable that is used to derive another variable, error message is unclear (Severity: 2)
Customizability [7,8,9]	No mechanism to enable user to customize the cell thematic look (Severity: 1); User is not provided with mechanisms to customize dashboard theme (Severity: 1)	No features to customize look of GUI and widgets (Severity 2);
Sense-of-Community [7,8,9,10,11]	User can save work and generate python scripts, but can not share work with others live (Severity 2)	User can share their work outside application (Severity 2)

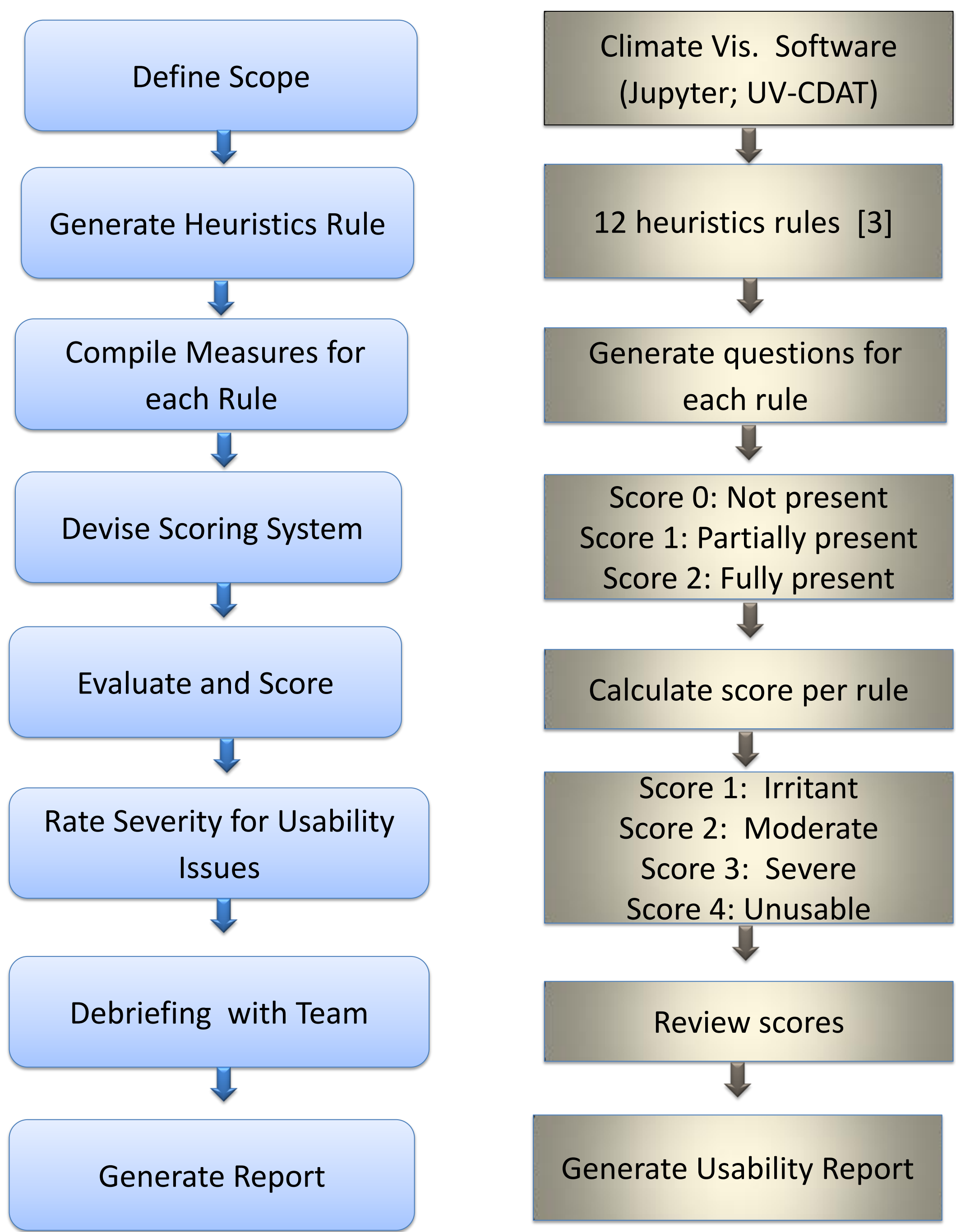


Figure. Heuristics Evaluation Process

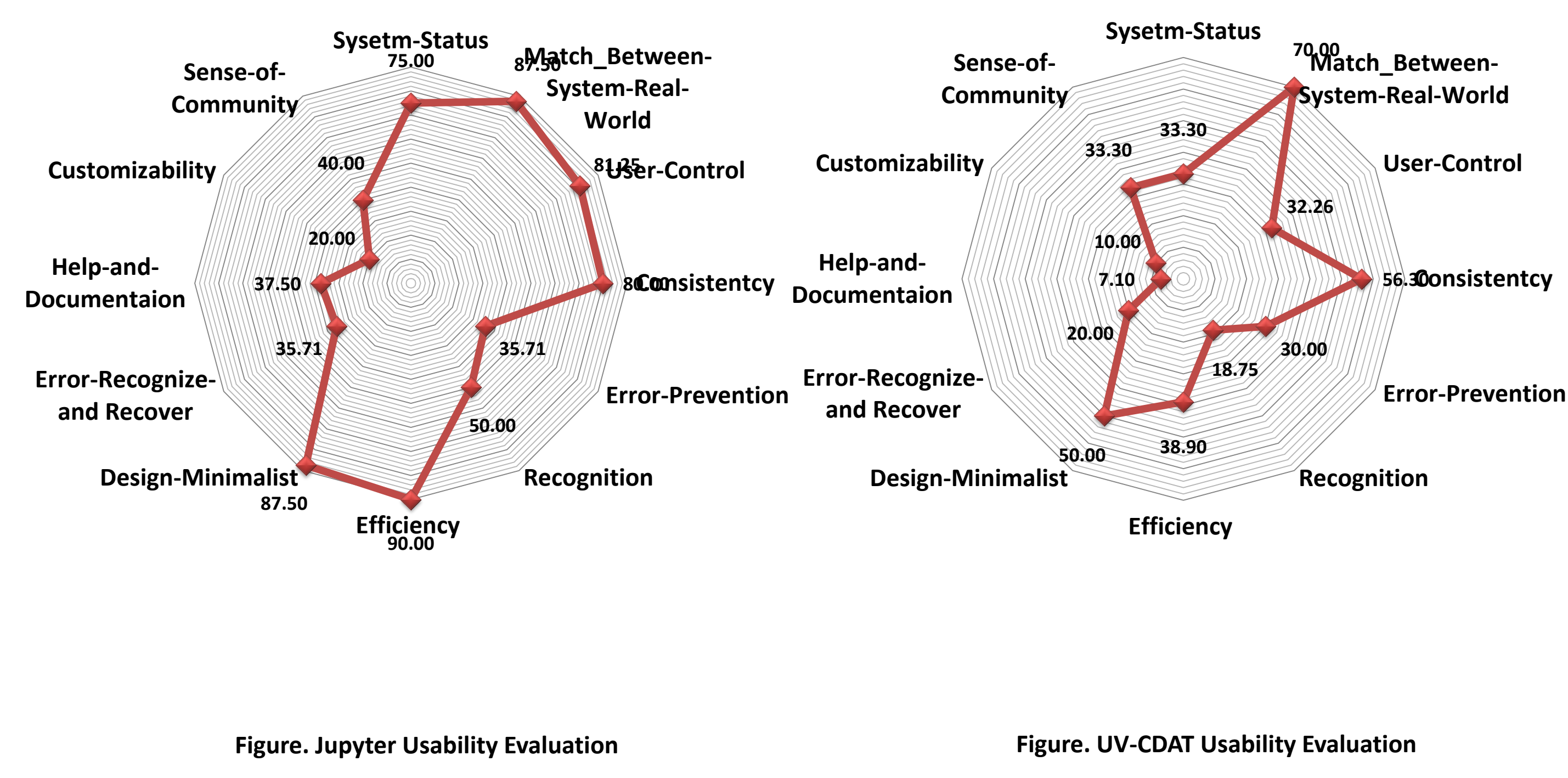


Figure. Jupyter Usability Evaluation

Figure. UV-CDAT Usability Evaluation

Results

Heuristics evaluation indicates that Jupyter application lacks appropriate documentation mechanisms that support user scripting. Although the GUI components are well designed, some inconsistencies were found. Jupyter provides the user the ability to download different libraries and modules; however, user lacks features to track modules downloaded and libraries in use. We also found Jupyter has functions that support sharing work among users, however, it still lacks a number of features to support sense-of-community rule and controlling privacy and accessibility settings. UV-CDAT is found to be difficult to use when it comes to customizing the GUI components, share work with others and track the visibility of the system. It was also found that users are not provided with documentation, neither with mechanisms to improve customizability and sense-of-community.

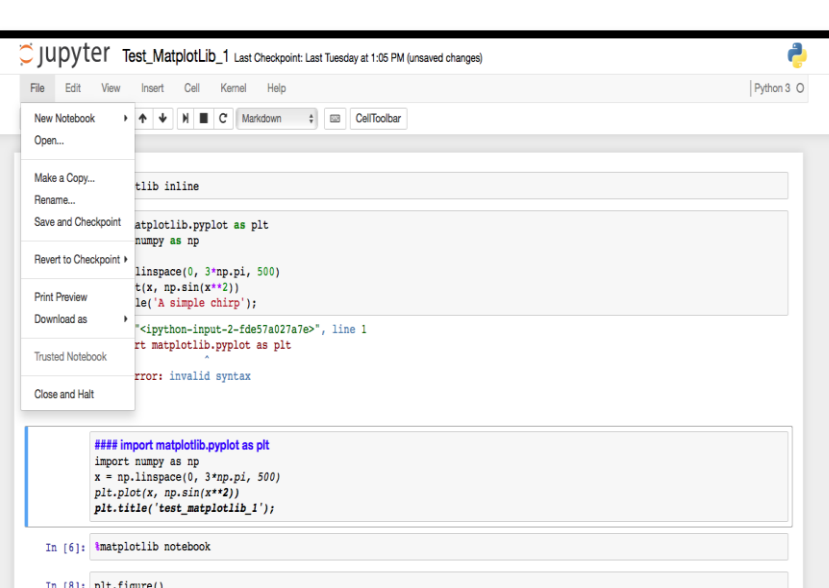


Figure. Usability issue related to file and folders management of Jupyter




Figure. Usability issue related to explanatory notes for unique features of Jupyter's interface

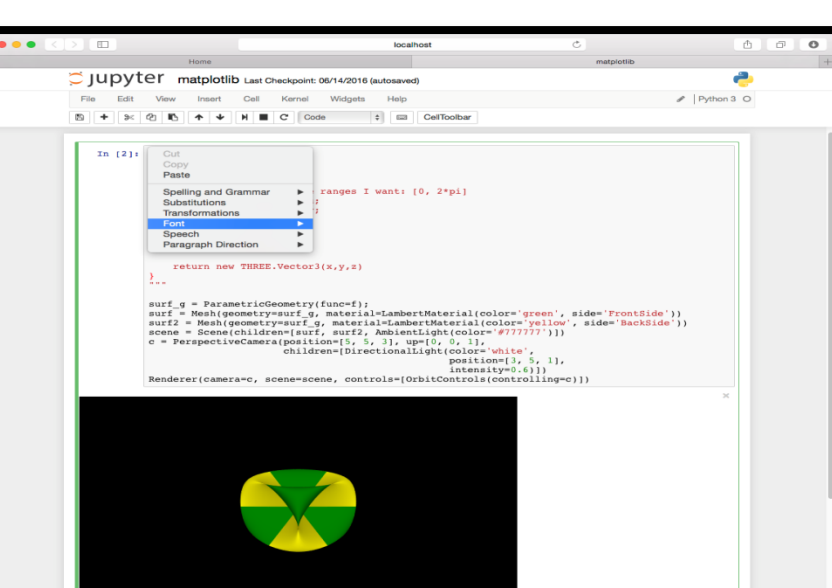


Figure. Usability issue related to user control over cells thematic look

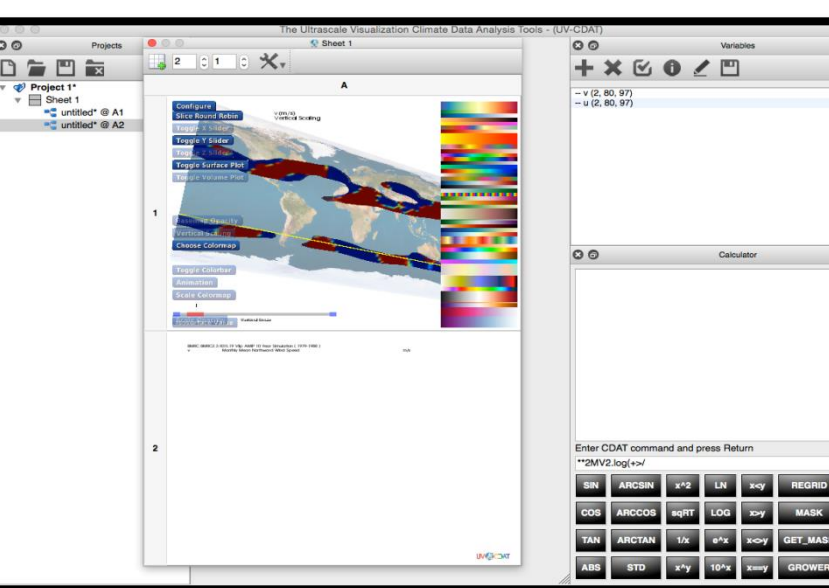


Figure. Usability issue with UVCDAT's configuration function of color-map

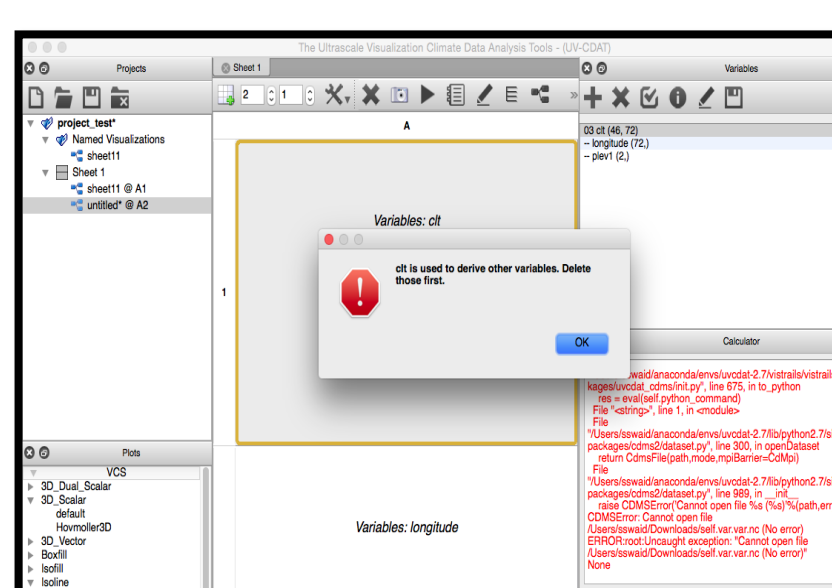


Figure. Usability issues related to error messages of UVCDAT when deleting variable used to derive another one

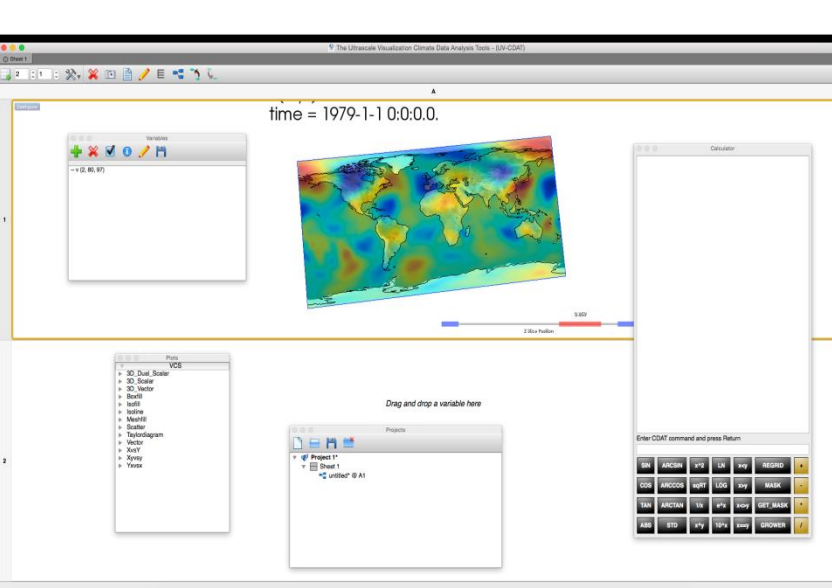


Figure. Usability issue with UVCDAT's GUI related to user control over the units

Conclusions

With increasing computing power, advanced climate systems are designed to support analyzing and presenting visualization and simulations. However, designing intuitive and meaningful visual representations in scientific workflows (e.g., climate) context faces the challenge of identifying usability criteria to bridge the gap between users and climate visualization systems. In this study we evaluate the usability of two climate visualization tools, Jupyter and UV-CDAT, using a set of heretics rules of Nielsen [4] and two more of customizability and sense-of-community[7,8,9,10,11]. We found that both tools suffer from a number of usability issues that call for improvements in areas related to strengthening system visibility, supporting user control and recognition, enabling customized experience and empowering cultivating community-of-practice among users. Moreover, we found the the proposed 12-hearestics rules proposed by the study are sufficient to conduct heuristics usability evaluation for similar software. Future research would focus on usability of other novel visualization tools such as Paraview and VisIt.

Contact

Samar Swaid, Ph. D.
Philander Smith College
sswaid@philander.edu

Acknowledgement

This work was funded by the Office of Science, Office of Advanced Scientific Computing Research (ASCR) of the U.S. Department of Energy under Contract Number DE-AC02-05CH11231.

References

[1] Jupyter: The Jupyter Notebook. Retrieved from http://jupyter-notebook-beginner-guide.readthedocs.io/en/latest/what_is_jupyter.html, on July 15, 2016

[2] Jupyter.org: Jupyter. Retrieved from: <http://jupyter.org>, on July 15, 2016.

[3] LLNL. n.d. UV-CDAT. Retrieved from: <http://uvcdat.llnl.gov/index.html>, on July 15, 2016

[4] Nielsen, J.1994. Heuristic evaluation. In Nielsen, J. and Mark, R.L. (Eds.) Usability Inspection Methods. New York: John Wiley & Sons

[5] Nielsen, J. n.d. How to Conduct a Heuristic Evaluation. Retrieved from: http://www.useit.com/papers/heuristic/heuristic_evaluation.html, on July 15, 2016.

[6] Rubin, J. 1994. Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests. New York: John Wiley & Sons

[7] Swaid, S., Blair, N., Martindale, G., Thornton, T. 2012. E-Service Quality of E-Science Platforms. Proceedings of XSEDE 2012, Chicago, IL, July 16-19, 2012.

[8] Swaid, S. 2014. A Novel Strategy to Improve STEM Education: The E-Science Approach. Encyclopedia of Education and Technology in Wang, V. 2014. The handbook of Research on Education and Technology in a Changing Society. IGI Global. Hershey, Pennsylvania

[9] Swaid, S., Walker, J., and Mortazavi, M. 2012. Creating a Cyberinfrastructure-Based Community of Practice". Academic Business World International Conference 2012, Nashville Tennessee, May 25-27, 2012

[10] Wenger, E. 2012. Communities of Practice: A Brief Introduction. Retrieved from: <http://wenger-trayner.com/wp-content/uploads/2012/01/06-Brief-introduction-to-communities-of-practice.pdf>, on July 15, 2016

[11] Wenger, Etienne. Communities of Practice, Cambridge University Press, 1998

[12] Santos, E., Wei, Y., Cook, B., Williams, D., Silva, C. 2012. V-CDAT: Analyzing Climate Datasets from a User's Perspective. Retrieved from: <http://homes.cs.washington.edu/~ipocom/pubs/uvcdatUser2013.pdf>, on June 27, 2016