VISUALIZING DATA

Dolueg

A Measurement Network's Face

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Visualization is a major part of any scientific work, serving to communicate results in an inclusive way. Whether figures, plots, or graphs, they all play a central role in publications, teaching, and public outreach. Furthermore, visualization is one of the integral parts besides automatic tests of the data that help to ensure the quality of meteorological data from one or more weather stations of measurement networks. This last aspect, in particular, requires the automatic generation of figures and their dynamic presentation.

Our homepage, named “Dolueg” for “here, look” in German dialect/Swiss-German, allows researchers and the

public to view relevant and up-to-date data in an easy way that includes further information such as measurement height, device type, and other relevant metadata. Dolueg has proven its value for the detection of malfunctioning devices, showcasing interesting meteorological phenomena, and above all ensuring that the flow of data from our stations into the database can be easily checked and fixed, if need be. Because Dolueg is free, easy to use, and adjustable, it is especially suitable for measurement network operators, that is, when time series are constantly collected and are in need of visual quality control in addition to any automatic checks.

FIG. 1. (a) Example of Dolueg layout and (b)–(e) a few selected figures illustrating the different available types: (b) is a “windmap” type with the option “fullscreen” explicitly set (no coordinates). (continued)

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Dolueg example (c) is the default line plot that illustrates the air temperature at two stations (red, urban; green, rural) and the water temperature (blue) at a third one, and (d) is an "iso"(pleth) plot that depicts air temperature difference between a rural and an urban station (urban heat island effect). (continued)

Dolueg consists of two parts: a website created in PHP, a general purpose scripting language mainly used for web servers, and a selection of Python functions that generate a suite of plots. The Python pipeline produces figures frequently which are then dynamically (and in a mobile-friendly way) presented in categories according to the file name of the figure. The grouping reduces the time and effort required to add new figures. Each component can of course be used on its own as well.

The relevant code for these two components is freely available: the website framework (Fig. 1a) and PHP functions can be found at <https://github.com/spirrobo/dolueg2page>, and the Python code is hosted at <https://github.com/spirrobo/dolueg2figures>. Both repositories contain detailed instructions for setup and examples.

Several kinds of figures for time series data are available (Figs. 1b–e); wind roses for one or several stations

drawn over a map background, the default line plots, isopleth/contour graphs as time of day versus day of year, and mesh plots of measurement values at several heights. Each type can be further customized in terms of colors, titles, and more.

All figures are by default created as SVG (scalable vector graphics), making them precise, zoomable, usually small in size, and compatible with all common browsers, even without a web server. Figures can be downloaded and, if need be, edited in open-source or commercial vector graphics programs, and they can be directly inserted into documents. The choice of SVG as default makes our figures suitable for reports, lectures, and other applications.

System requirements and installing Dolueg

The requirements for Dolueg itself are fairly simple. Even a Raspberry Pi model B should be able to both create and

Dolueg example (e) represents a “mesh”-type plot of ceilometer backscatter including the required color bar.

display plots. Instead of a full web hosting solution, a local computer that runs PHP is also sufficient. The bottleneck for the creation of figures is usually reading the data from storage and thus mandates that enough RAM is available to hold the specified amount of data (e.g., a year of 1-min data).

To set up Dolueg, follow the instructions on the two GitHub repositories above. Each contains detailed instructions for the respective part of the setup (website and the figure pipeline). We further included examples for the creation of some default figures. These files will require minor changes to work with your specific data pipeline.

One adjustment must be done: the Python component of Dolueg requires a way to access data. Figure 2 gives an outline of our data pipeline, where box C represents Dolueg. It is likely that there are differences from our solution in implementation details from box A (measurement) to box B (storage). Regardless of the specific details of data (Excel files, SQL database, or other), when a Python function is available or can be written to get data and metainformation, Dolueg can be implemented and used like our use case (box D and E) and of course can be further extended (e.g., boxes 3, 4, and 5).

Two additional, minor adjustments are recommended but not required: adjusting the CSS (Cascading Style Sheets) files to fit your preferred color scheme in the web component and creating an API Key (Application Programming Interface) for Google Static Maps (if required). Without a valid key, the background of the wind rose/station maps will be from OpenStreetMap instead.

Any feedback, remarks, or requests are welcome and should be provided via the relevant repository to improve code at the source.

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FIG. 2. Depiction of the data flow of our measurement network. Primary flow of data is drawn in black, secondary/additional data in gray.

FOR FURTHER READING

Stauffer, R., G. J. Mayr, M. Dabernig, and A. Zeileis, 2015: Somewhere over the rainbow: How to make effective use of colors in meteorological visualizations. *Bull. Amer. Meteor. Soc.*, **96**, 203–216, <https://doi.org/10.1175/BAMS-D-13-00155.1>.