

Improvement of software for analysis of visual meteor data

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In this paper, we present improvements made on our software for the analysis of visual meteor data. R package *MetFns* received major updates. Selection filters and algorithms for calculation of zenithal hourly rate and population index, as well as accompanying graphics, are corrected and their performance is improved. Web application *MetRApp* contains a completely remade user interface and some new features. Also, calculation performances are optimized.

1 Introduction

In this paper, we report about the improvements made to software for analysis of visual meteor data. The first version of our software was presented at the IMC 2014 in Giron (Veljkovic and Ivanovic, 2014). Currently, the software consists of R package of data and functions and a web application.

The R package *MetFns* enables users to select rate or magnitude data by different criteria, calculate and make graphs of the population index and the zenithal hourly rate. It is open source and free and it contains a detailed manual and examples. The web application *MetRApp* provides an easy-to-use interface to package *MetFns* and allows users to use its functions without any necessary knowledge of programming language R.

2 MetFns – new package version

The R package *MetFns* represents a collection of datasets containing visual meteor data and functions for data manipulation. There are three types of data: annual rate data, annual magnitude data and accompanying data which includes data frames with: the coordinates of the shower radiant throughout the year, a list of observed meteor showers, observers and observing sites. Datasets are retrieved from the IMO site¹. Two new datasets have been added to the existing data: a data frame with conversion from the average difference from the limiting magnitude to the population index and a data frame with error margins for the population index for a given number of meteors and value of the population index.

The user has a possibility to read annual rate or magnitude data directly from the IMO site using functions provided in the package. In addition to these functions, the package consists of functions that select (filter) data by one or more criteria and functions that perform some calculations and draw graphics from the data. Since the time of publishing the last package version, extensive testing of functions on visual meteor data has been performed. Errors have been corrected and the performance of the functions has been improved.

The following selection functions are currently provided: by shower code, by period of days or months, by IMO observer code, by observer's first and last name, by geographical coordinates of the observing site, by name of the observing site, by country, by solar longitudes, by correction factor(s) for field-of-view obstruction, by limiting magnitude(s), by radiant elevation(s) and by total correction factor. Also, there is a global filter function that combines previously mentioned filters performing various data selections. All listed filters existed in the previous version of the package, except the filter by period of days or months. It enables the user to select the data for an interval of days, in one or more months. It replaces two old filters by date and time.

The following data calculations can be performed using the functions available in the package:

- *calculation of solar longitude* with respect to the equinox of 2000.0 for a given year, month, day and time in hours (Steyaert, 1991).
- *calculation of calendar date and time* corresponding to the specified value of solar longitude and year.
- *calculation of the table and graphical representation of the summarized magnitude distribution* for a given magnitude dataset, specified meteor shower, period of days and time interval.
- *calculation and graphical representation of the population index of a meteor shower* for a given magnitude dataset, specified shower, period of days and bin size in degrees of solar longitude. This method is based on linear regression, i.e. it uses the method of least squares to calculate the population index. Also, probabilities of meteor perception are incorporated in magnitude distributions for each observing interval (Koschack and Rendtel, 1990).
- *calculation and graphical representation of the population index* for a given magnitude dataset, specified period of days, minimum and maximum bin size, and number of meteors. This method is based on the average distance from the limiting magnitude and it uses an adaptive-bin size algorithm. It tries to maintain a user-defined optimum meteor number per bin. For the case that not enough meteors

¹ <http://imo.net/data/visual>

are available, a maximum bin size is used (Arlt, 2003).

- *calculation of the zenithal hourly rate of a meteor shower* for a given rate dataset, specified shower, period of days, population index, minimum and maximum bin sizes, number of meteors. An adaptive-bin size algorithm is used. If the population index is not specified, it is calculated using the previously described function and then incorporated in the calculation of the ZHR.

The listed functions represent new package functions or optimized/improved functions. Package *MetFns* can be downloaded online².

In the future, we expect that an extensive survey of the literature, as well as the user's comments and suggestions will provide enough material for further improvement of the R package *MetFns*.

3 MetRApp – new application version

Initially *MetRApp* was a desktop application, written primarily in Java, which purpose was to enable the usage of the *MetFns* package's functions and data to people who are not familiar with the R programming language. Although it had the most necessary functionalities, this application was hard to install and maintain. The user interface (UI) was not very intuitive and it required some unnecessary settings to be made. However, the biggest technical problem was not the application itself, but the communication between Java's and R's runtimes which was very underdeveloped, with a lot of potential flaws and poor performance. It was concluded that *MetRApp* had to be remade in order to achieve its purpose.

The new version of *MetRApp* is a web application with a completely new UI and logic behind it. However, this version tends to keep the same idea about a data analysis process like previous version had. Also, the same as in previous version, this application's goal is to work closely with the functions from the R package. *MetRApp* is dependent on *MetFns* and since they could not be developed in parallel, *MetRApp* could be sometimes a version behind on *MetFns*. The current *MetRApp* uses version 1.0 of *MetFns*.

The new *MetRApp* is implemented using the new Shiny framework³ which allows incorporating all algorithms and models written in R in a fully-functional web application. Since all code of this application can be written in R, it avoids performance issues of the previous version and allows much easier maintenance. Although this framework is still very young and it may change dramatically over time, it is still the best available technology for implementing this kind of application.

The new *MetRApp* is currently online⁴. All information on how to use it is written on the 'About'-tab.

By default, the Shiny apps UI is responsive, so the new *MetRApp* is mobile-friendly. Although using this kind of UI is very easy, it is highly recommended that users first read the documentation of the *MetFns* package in order to understand how the R functions work⁵.

4 Improvements to come

There are a few very important improvements planned. Currently, data which is used in the *MetRApp* is contained in data sources provided by the *MetFns* package. Since the visual observation meteor database is being reconstructed, and a new application programming interface (API) is planned, *MetRApp* would be able to communicate directly to this main data source and provide a better and more customized analysis.

The new version of *MetFns* will, as discussed, bring some new functionalities, and those will also be implemented in future versions of *MetRApp*.

However, the most important idea is to make *MetRApp* a complete data analysis and reporting platform for visual observation data. This could include the exposed API for every functionality *MetRApp* has with more flexible pipelining processes of data analysis and a system for customizable reports. Also, since all necessary functionalities are already there, the dashboard with all interesting information and statistics from the new database could be implemented, allowing better insight into data.

5 Conclusions

New functions for the analysis of visual meteor data are provided in the R package *MetFns* to suit better the needs of its potential users. On the other hand, remaking *MetRApp* allows much easier usage of functions for the analysis of meteor data than the previous version, mainly because of a new user interface and a form of web application.

Further improvements of our software are planned in the future. We think that *MetRApp* will have an improved set of features once a complete data source of visual observation data is restructured and reorganized, and that performance will be even better. Final goal is a solid platform which will allow users to do a complete manipulation of visual observation data in one place – from querying to analysis and reporting.

References

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² <https://cran.r-project.org/web/packages/MetFns>

³ <http://shiny.rstudio.com>

⁴ <https://ivail.shinyapps.io/mettrapp-shiny>

⁵ <https://cran.r-project.org/web/packages/MetFns/MetFns.pdf>

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Kristina Veljković During her lecture (Photo by Axel Haas).