SedImporter: A Tool and an Extensible Framework for Constructing Interoperable Spectral Energy Distribution Data Files

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Abstract. The SedImporter enables the seamless analysis and exploration of photometric and spectroscopic data by allowing users to combine their own data files with archival data extracted from VAO services and convert that data into the standard IVOA Spectral Energy Distribution (SED) Data Model format. It was developed as a stand alone module in support of Iris, the Virtual Astronomical Observatory's Spectral Energy Distribution Analysis Tool. The SedImporter is designed to be flexible enough to serve a wide range of specific use cases through its various components. The Graphical User Interface allows users to build standard multi-segment spectro-photometric SEDs from local and remote files. It supports files conforming to IVOA standards and provides a mechanism for mapping non-compliant files stored in the most common file formats. It also allows users to fetch SEDs served from the NASA Extragalactic Database SED service. The tool is interoperable with Iris and other VO enabled tools through SAMP, the Simple Applications Messaging Protocol. Much photometric and spectroscopic data is stored by single users and large collaborations using custom formats: the SedImporter provides a dedicated Software Development Kit which allows third party developers to extend the SedImporter supported file formats, allowing the users to build a library of dynamically loaded plug-ins. The Command Line Interface provides flexibility in how users can apply the SedImporter functionality. For example, one could generate a script which applies a custom conversion to a large set of files.

1. Introduction

The International Virtual Observatory Alliance[1] (IVOA) defines standards and protocols to promote interoperability in astronomical datasets, services and applications. However, legacy datasets or user defined data files can be stored in custom, non interoperable formats. It is important, thus, to allow users to employ these datasets in the interoperable workflows of Virtual Observatory (VO) enabled applications and services.

While providing the users with a tool which allows conversion of data from custom to standard formats, SedImporter also allows basic construction of SED files by stringing together spectro-photometric segments from different sources, like the NASA

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[1]http://www.ivoa.net
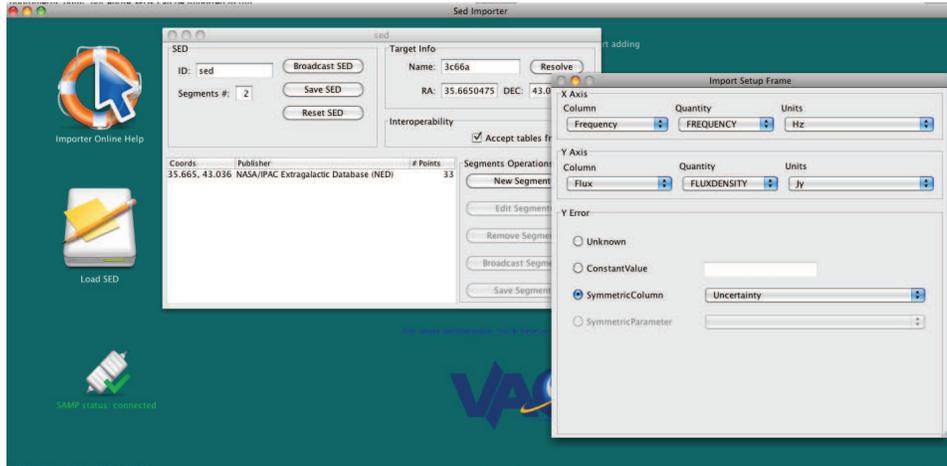
Figure 1.   The SedImporter desktop with an SED window and an importing window partially resized to fit in the figure.

Extragalactic Database[2] (NED). A segment can be a spectrum or a photometric point, and entire SEDs can be imported in full as well.

Also, since *custom* is a broad concept, one of our main concerns was to allow developers to add new formats: therefore we designed SedImporter to be extensible and to allow the development of plug-ins that can be loaded at runtime.

SedImporter was developed in the Virtual Astronomical Observatory[3] (VAO) framework and is distributed in bundle with the VAO SED Tool, Iris[4] (Doe et al. 2012) with an Apache License v2.0.[5]

2.   The Graphical User Interface

SedImporter can be launched in the GUI mode for interactive creation of SEDs. The GUI enables the users to:

- Create new SEDs and add segments to them from different sources:

    - local filesystem (see section 2.2)
    - remote URL (see section 2.2)
    - NED (see section 2.3)

- Create an SED from a Setup File (see section 4)

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[2]`http://ned.ipac.caltech.edu/`. The NASA/IPAC Extragalactic Database (NED) is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

[3]`http://www.usvao.org`

[4]`http://cxc.cfa.harvard.edu/iris`

[5]`http://www.apache.org/licenses/LICENSE-2.0.html`

- Install/uninstall third party Plug-ins (see section 5)

- Launch Iris, the VAO SED Tool (Doe et al. 2012)

- Browse the online documentation

- Set the SedImporter SAMP policy[6] (see section 3)

2.1. The SED Window

Users can manage any number of different SEDs using the SED window. The windows can be maximized and iconified in a self contained desktop (Fig. 1). From the SED window it is possible to add, edit or remove segments for the current SED; some of these operations can be performed on a subset of segments selected by the user.

Individual segments, a subset of them or the entire SED can be either saved on the user's filesystem or broadcast to SAMP enabled applications (see section 3).

Each SED window has a Name Resolver widget that allows the user to resolve target object names to the coordinates that will be included in the final SED.

2.2. Importing a Local or Remote File

Files can be loaded from either the local filesystem or by providing a network location (HTTP and FTP protocols supported).

If a file is a compliant spectrum[7] it will be directly included in the SED using SEDLib[8]. If the file doesn't comply to the IVOA standards a new window allows the user to map the file's columns and parameters[9] to the Data Model attributes.

A specific mapping configuration can be saved to a file and the resulting file can be edited and used to import datasets in batch mode, from the command line (see section 4) or from the GUI.

2.3. Importing Data from NED

SedImporter includes a client for fetching NED files, which provides a multi-wavelength fusion of data for millions of objects. NED data are provided as standard[10] IVOA SEDs and are thus directly imported with no further input from the user.

2.4. Installing Plug-ins

In section 5 we describe the SedImporter Software Development Kit that allows advanced users and third party developers to create plug-ins that contain new file filters

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[6]Simple Application Messaging Protocol.

[7]The supported version of the IVOA Data Model is 1.03. The next Iris version will comply to the SpectralDM v2.0 and to the SEDDM v1.0, currently in the Working Draft stage.

[8]`http://cxc.cfa.harvard.edu/iris/sedlib`

[9]Some file formats, like FITS and VOTable, consist of an header and an actual table: any value in the header is considered a parameter, i.e. an attribute shared by all the records in the table. Other file formats do not allow headers to be present: in this case the parameters drop-down menu will be disabled.

[10]Since the SED Data Model is currently a Working Draft, there is no reference implementation and some interoperability issues may arise when using allegedly compliant files from other services.

not natively supported by the SedImporter itself. The GUI allows users to install and uninstall plug-ins, and to display the plug-in's file filters metadata. Plug-ins can be retrieved from the local filesystem or from a remote location (HTTP and FTP protocol supported).

3. Simple Application Messaging Protocol

SAMP is an IVOA standard protocol that allows desktop applications and web applications to exchange messages with each other, opening the door to multi-process and even multi-host seamless interoperability among applications and services. SedImporter supports SAMP for both input and output: users can *beam* a table from a SAMP-enabled application (e.g. Topcat, Aladin, other VAO applications); they can also *beam* an SED to an application listening to SED messages, like Iris, for analysis.

SedImporter starts a new SAMP hub if it does not find one already running, or if a running one is shut down. This behavior can be changed using the *Interop* menu.

4. The Command Line Interface

Interactively importing files is useful, but if users have many files with the same structure for different sources they might want to produce a batch process that converts the files on the fly, without interactive access to the SedImporter. For this reason SedImporter offers a command line interface that can be exploited for writing scripts that can be invoked from the command line.

This feature requires that the mapping configuration needed to import the dataset is stored in a Setup file. These files can be saved from the GUI in interactive mode and then edited by the user.

5. The Software Development Kit

The SedImporter Java archive can also be used as an API (Access Program Interface) in any Java program. This is the most basic feature of the SedImporter's Software Development Kit (SDK).

However, the SDK can also be exploited to create plug-ins that contain file filters not natively supported by SedImporter. For this purpose, third party developers can either implement the relevant interfaces or extend some of the abstract classes already defined in the Java archive. This approach is safe but a little more time consuming and verbose: a more flexible approach is to use Java annotations to annotate any Java class, so to provide SedImporter with the relevant plug-in metadata and business logic methods.

More information is available in the online documentation.

References

Doe, S., et al. 2012, in ADASS XXI, edited by P. Ballester, D. Egret, & N. P. F. Lorente, vol. 461 of ASP Conf. Ser., 893