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Spectrum and Bandpass Services for the Virtual Observatory

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Abstract. We present easy-to-use web applications and XML Web Services to search, plot and manage spectral energy distributions and filter profiles. We provide keyword search, advanced query forms and SQL interfaces to select spectra and band passes that may be retrieved in a variety of formats including XML, VOTable and ASCII. All SDSS DR1 spectra had been loaded into a database as well as the entire 2dF catalog that adds up to half million SEDs but registered users can upload their own data making it available for the rest of the community and are free to modify or delete them at any time. Scientific services allow to build rest-frame composite spectra out of selected spectra. The filter profile database has a growing collection of photometric filters and the same search interfaces. Using the spectrum and filter profile core services, we plan to build higher level services to help astronomers create color-color diagrams, simulated catalogs and to estimate distances to extragalactic objects.

1. Introduction

The Virtual Observatory (VO) is an Internet based system to federate the large astrophysical archives without centralization by defining communication standards to allow astronomers and astrophysicists to access data in an easy manner from different sources and incorporate them into their scientific applications (Szalay & Gray 2001).

The VO Community has already built several data services containing and publishing photometric data and images. We present Web Services that publish spectral energy distributions[1] (SEDs) in the wavelength range which should have been organized in a VO compliant way.

[1] http://www.voservices.net/wave/

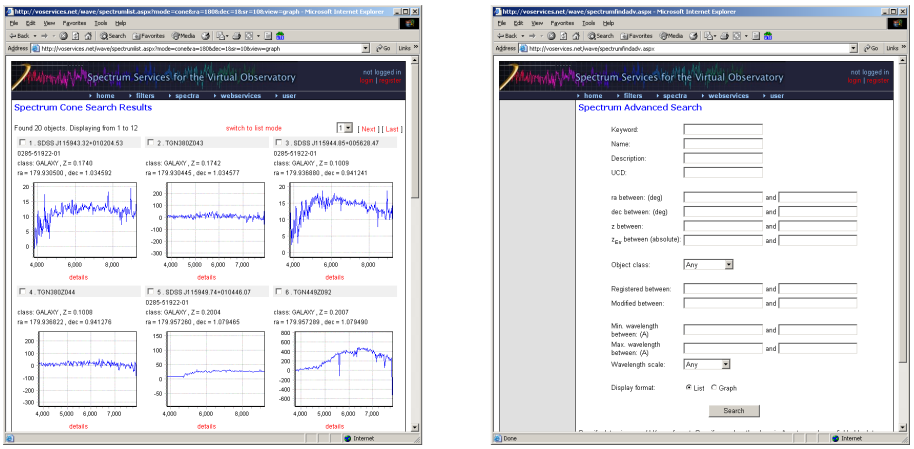

Figure 1. Screenshots from the website at http://voservice.net/wave. Left picture shows a resultset of a spectrum query, the right picture shows the advanced query form.

2. Virtual Observatory Services

2.1. Spectrum Services

The database contains SDSS DR1 and 2dFGRS spectra (almost half a million). Registered users can upload their own spectra. SDSS spectra are calibrated and can be used to calculate synthetic magnitude and color when convolved with filter curves. Search functions: keyword, redshift, ConeSearch, advanced, SQL. The ConeSearch uses Hierarchical Triangular Mesh indexing (Kunszt et al. 2001).

The library provides functions to resample, redshift and normalize spectra. Composite spectra generation with different templates for near galaxies and QSOs (median, average) and convolution with filter curves to calculate magnitude and color are also available. A graphical module is built for visualizing SEDs on graphs and to plot color–color diagrams.

2.2. Bandpass Services

The database contains the band passes of the main astronomical instruments used in large scale surveys. Users can upload their own filter profiles and search for keyword and advanced criteria. Native SQL search is also available.

Functions are provided to resample and normalize filter curves. Convolution with spectra (magnitude, color calculation) and visualization on graph are also available.

3. Implementation Details

3.1. Data representation and DB schema

We built a relational database of SEDs and implemented effective search algorithms as well as common spectrum and bandpass manipulation functions in

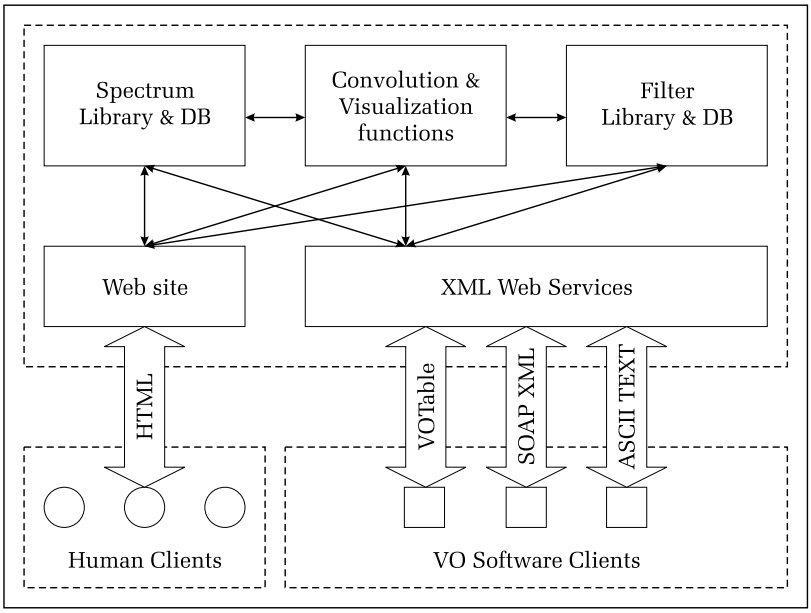

Figure 2. The structure of the server-side software layers.

the form of XML Web Services. Our implementation may be considered as a prototype of a VO standard of XML representation of astronomical data in the wavelength domain. Although we worked out this new data model and schema, our web service supports the overall Virtual Observatory standard VOTable format.

The schema was defined on the basis of SDSS spectra which today consists of 250 thousand SEDs, but we didn't want to limit the database to the SDSS and built an expandable database where users can register, modify or delete their own spectra and filter band passes.

3.2. Platform and tools

The server–side modules are implemented on Microsoft‘s .Net platform using the C# language. On the server-side different modules are communicating via native .Net calls, but all essential functions of the libraries are exported via the XML Web Services and can be called by any SOAP client. The web site also uses native .Net connection instead of SOAP calls to speed up displaying query results. Figure 2. shows the structure of the server–side software layers.

The database server is a dual Xeon processor PC running Windows 2000 and Microsoft SQL Server 2000. The size of the database is over 45GB, the response time of an advanced query is under 1 second.

3.3. Web interface

We designed an easy-to-use web interface for the services to provide human readable output to ordinary users.

All basic functions can be accessed from the web interface, spectacular graphs can be generated on-the-fly.

4. Sample Client

A downloadable sample client is written in C# using the .Net web service client and Windows Forms for the graphical interface. This tiny client doesn't contain any intelligence, that is all operations — like composite calculation or graph generation — are performed on the remote server and not on the local computer.

The downloadable source code demonstrates how to query the spectra database, retrieve spectra and send them to the graph generator function.

The sample client can be downloaded from the web site of the service, under the "downloads" menu.

5. Web addresses

You can access the web service on the Internet:
`http://voservices.net/wave`.

To access other Virtual Observatory Web Services visit
`http://voservices.org`.

To learn more about XML and Web Services visit
`http://msdn.microsoft.com/webservices/` or
`http://java.sun.com/webservices/`.

6. Summary and Future Works

The main goal of the system is that band passes of the astronomical instruments are also available in the database and the web service provides functions for calculating synthetic magnitudes, thus you can generate virtual photometric catalogs, which would be useful in instrument design for simulation or in photometric redshift calculations.

In the future the system is intended to be able to deal with data in the time domain, which is useful for super nova search. Additional services, such as on-the-fly synthetic spectrum generation based on several models are also under development.

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