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Armenian virtual observatory simple image access service

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ABSTRACT

The aim of the article is to introduce the data sharing service of the Armenian Virtual Observatory (ArVO) based on the Simple Image Access (SIA) Protocol of the International Virtual Observatory Alliance (IVOA).

Contents

1. Introduction

Data volumes generated in astronomy are very large and observations taken at a particular time are by definition unrepeatable and irreplaceable. The overall quality of telescopes and detectors is getting better year-by-year. It is expected that some of the surveys, which will be initiated over the next few years, will generate terabytes of data per day (Gudivada et al., 2015; Mickaelian et al., 2016b).

During recent years Byurakan Astrophysical Observatory (Murdin, 2000) astronomers have done a huge work to digitize the plates of past years. This First Byurakan Survey (FBS) data is the core of the ArVO database (Mickaelian et al., 2007). It includes Digitized First Byurakan Survey, the largest and the first systematic objective prism survey of the extragalactic sky. At the same time Byurakan Astrophysical Observatory telescopes continuously generate astronomical data. At the observatory five observational instruments are installed; the larger ones being 2.6 m Cassegrain telescope and 1 m Schmidt telescope. Storing, archiving, reducing, retrieving, analyzing, sharing and scientifically using these vast data are a formidable task. Virtual Observatories (VOs) seek to facilitate the mentioned task by using international standards and protocols.

2. Data access standards and protocols

A suite of IVOA (Quinn et al., 2004) protocols specifies basic access methods for different types of data resource, such as Simple Image Access (SIA) (Tody et al., 2009) for image archives, Simple Cone Search (Plante et al., 2008) for source catalogues, Simple Spectral Access (SSA) (Tody and Dolensky, 2004) for spectra, and several others. Only a few parameters can be involved in the data access requests (typically just RA, Dec, and search radius), and implementing these services is relatively easy. As a result all these protocols are called simple. IVOA provides Table Access Protocol (TAP) (Dowler, 2016), for more flexible access.

The Virtual Observatory (VO) is based around the two key concepts of Resources and Services (Brunner et al., 2001). "Resource" covers a wide variety of things, such as a database, a web page, a

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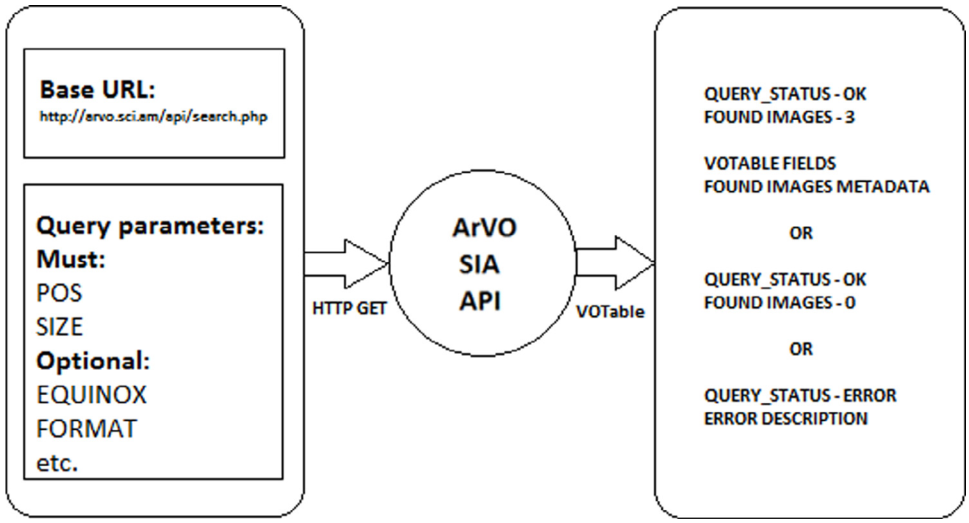

Fig. 1. Request/response process to ArVO SIA API.

storage element, and so on. All above mentioned things basically are uniquely addressable through the Internet. For example, a "data service" is a communication system that allows sending queries to a database resource and getting back data in return.

The service architecture has to follow some standard protocol, like the data access protocols described above. It also needs to publish service metadata that describes how it works, what it is and what it provides. Based on IVOA SIA protocol, a simple image search service for ArVO has been implemented. Its functionality is presented in detail in the next section.

3. ArVO SIA service

SIA protocol has 2 versions—SIA1.0 (Tody et al., 2009) and SIA2.0 (Dowler, 2015). In the first phase the implementation of ArVO SIA service was planned based on the SIA1.0 protocol. The extension of the service using the SIA2.0 is under construction. SIA provides capabilities for the discovery, description, access, and retrieval of multi-dimensional image datasets. It works using standard http get, and allows passing several standard query parameters. The output returned by an Image Query is a VOTable, an XML table format, returned with a MIME-type of text/xml. The purpose of the image query web method is to allow users to search for image data for a given region on the sky. Additional parameters may optionally be used to further refine the query. The size, scale, projection, and so forth of the ideal output image can be specified, and the service will return references to images, which most closely match what is requested. The request and response process is presented in Fig. 1.

A base URL for SIA request must be defined, to which web query parameters can be passed. The POS and the SIZE are mandatory parameters to be passed in get query. The POS is a position of the region of interest, expressed as the right ascension (RA) and declination (DEC) of the field center, in decimal degrees using the ICRS coordinate system. A comma should delimit the two values ($POS = 12.713, -21.1$).

The SIZE parameter presents the angular size of the region given in decimal degrees ($SIZE = 1$). Thus, having a base URL and passing POS and SIZE parameters will allow to construct a minimal and simple image access request.

For more complex requests it needs to use optional parameters, such as:

- NAXIS—the size of the output image in pixels. ArVO images size is predetermined and for given region of search can exist many images with different sizes. This parameter is used for returning the image whose size matches with provided NAXIS. The re-sampling mechanism of the output image size is under development.
- EQUINOX—epoch of the mean equator. EQUINOX is used for correcting the search coordinates, as ArVO data contains both B1950 and J2000 images.
- VERB—the desired level of information to be returned in the output table. Two levels of verbosity are implemented, 0 for minimal information for returned images, and 1 for regular number of columns with all available information.
- FORMAT—the desired format or formats of the images referenced by the output table, and so on. More information about optional parameters is available in SIA documentation (Tody et al., 2009).

The list of these parameters is regularly updated, and new functionalities are included in provided service. The returned table lists all the images available to the client that match the query constraints. It must contain a RESOURCE element, identified with the tag type = "results", containing a single TABLE element which contains the results of the query. The RESOURCE element contains an INFO with name = "QUERY_STATUS". Its value in case of success is OK and ERROR in case of any issue. It also includes all astronomical metadata of found images, their physical address URLs and so on. The result contains one record per image. Both calibrated and raw data can be returned. If calibrated data is not available, raw data will be returned. User can provide NAXIS parameter to get directly the raw data.

A simple web query example to ArVO SIA is http://arvo.sci.am/api/search.php?POS=322.3,3&SIZE=1. The base URL is http://arvo.sci.am/api/search.php, POS and SIZE query parameters are passed. The result of mentioned query is presented in Fig. 2.

SIA and other IVOA services of different VOs can be added in astronomical registries which allow discovering all published VO resources around the world. Thus, different astronomical resources become available in one place, and its data can be accessed by the same rules and request parameters. Each VO SIA service has a unique base URL, and a request with same parameters can be sent in parallel to all registered services. Hence, an astronomer will be able to get an entire part of universe observation results of different observatories in a single request.