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Data Fusion from Diverse Resources for Optical Identification of Radio Sources.

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Abstract. Optical identification of the SS sample of the RC radio source catalogue was impossible without the use of additional astronomical resources. The volume of information for each source grew from the 100 bytes for each RC-catalogue row up to 10MB including radio and optical observations, information from catalogues and surveys, data processing results and files for Internet publication. Such work pushes us to find a solution for integration of heterogeneous data and realization of the discovery procedure. The experience gained in this project has allowed formalization of a procedure for distant radio galaxy discovery in the subject mediator context.

1. Introduction

The BIG TRIO (Goss et al. 1992, 1994) project to investigate distant radio galaxies was carried out at the Special Astrophysical Observatory of RAS. The list of objects for research consisted of radio sources from the deep survey of the sky strip observed with RATAN-600 (Parijskij et al. 1991, 1992). 104 radio galaxies were selected from the 1145 objects in the RC catalogue. The candidates were selected by radio source parameters including steep spectra and FRII morphology (Parijskij et al. 1996). Most of the RC catalogue radio sources have flux densities between 5 and 50 mJy. 10% of sources have a steep spectrum ($\alpha \geq 0.9$) and 70% have double radio structure. VLA observational data (NRAO, USA) were used in making more precise radio coordinates. Data from the MIT-GB (Griffith et al. 1991), the FIRST (Becker et al. 1995) and the NVSS (Condon et al. 1998) surveys were also used for obtaining additional information about the structure of the radio sources. The candidates are identified with galaxies with magnitudes up to 24-25 in R band using observations from the 6-m telescope of SAO RAS. The fields were tied to secondary astrometry standards defined by the DSS-II survey and USNO-A2 catalogue for optical identification of radio sources (Verkhodanov et al. 2000). Overlaying of optical and radio images was done for 75 sources. The results of optical identification of radio sources are published in the web archive of the information system "Evolution of radio galaxies"[1].

[1] `http://sed.sao.ru/rc_archive.html`

2. Information Resources

The data and resources used in this work are listed below:

1. The initial information is observational data. Observations were carried out by RATAN-600, the 6-m and VLA telescopes with the following data volumes: RATAN-600 - 100MB; the 6-m telescope - 4000MB; VLA - 500MB. The data are from observation data archives SAO RAS, VLA (NRAO, USA); observation files are in the FITS format;
2. Information from astronomical web resources dealing with data processing (digital surveys and catalogues: DSS-I, DSS-II, FIRST, NVSS, USNO-A2.0);
3. Data processing results. About 2600 files (40 files per object) were prepared for the web archive. A 2-5 arcmin sky area was processed per source. The information volume per source increases from 100 bytes (the RC catalogue row) up to 10MB for all the necessary data for the processing;
4. Astronomical software: MIDAS (ESO, Germany), GAIA (Starlink, UK), WCSTools (SAO, USA);
5. Web resources: the European Southern Observatory[2], Centre de Donnes astronomiques de Strasbourg[3], the Harvard-Smithsonian Center for Astrophysics[4], the National Radio Astronomy Observatory[5], the U.S. Naval Observatory[6], the Starlink Project[7].

3. Data Integration

In this work we have assembled a collection of information for each object in our sample, integrating data from a diverse range of resources. This collection is being utilized by a collaborative team for research into the nature of radio sources. Organizing and providing access to such a collection is a non trivial problem. There are sites, where actualization of heterogeneous data is at a high level, for example the Oracle company[8]. It would be desirable to use such a DBMS warehouse to organize our data collection, where web publication and access to the information are implemented. Designs for such a data warehouse are diverse. The basic task for such warehouse design is addition of new types of data.

The implementation of Web access to our heterogeneous archive data (radio and optical) for source identification, and for obtaining information about the processing of the observations, has also been an exercise of integrating archives

[2]`http://www.eso.org`

[3]`http://cdsweb.u-strasbg.fr`

[4]`http://cfa-www.harvard.edu`

[5]`http://www.nrao.edu`

[6]`http://ad.usno.navy.mil`

[7]`http://star-www.rl.ac.uk`

[8]`http://www.oracle.com`

and addition of new formats. We find it necessary to have semantic representation of the data content (meta data definition) and to use this as the basis for integrating data of different formats. Recognizing the need for such services, we have developed an interface to observational data archives as a means to federate these archives. A prototype is available at interface[9] for access by date to heterogeneous local observation archives. For other request types (by coordinates, tools etc.) a table with the mappings of observation parameter keywords to the relevant table columns and their UCDs (Derriere et al., 2003) is provided. Furthermore we plan to implement access services to the observation data according to IVOA specifications and formats (SIA specification 2002; Williams et al. 2002).

4. Discovery Distant Radio Galaxies by a Subject Mediator

The procedure of compiling a radio source sample from the catalogues is well enough completed. The resulting collection is an essential resource for research into the properties of early galaxies. The collection includes spectra, luminosity functions, morphology, starburst history, and clustering, all of which are necessary for checking theories of galaxy formation.

The appearance of new deep radio surveys enables compilation of samples with optimized selection criteria for detecting large numbers of radio galaxies with $z \geq 3$, and for research of more precisely defined classes of objects. On the basis of our experience of the optical identification of RC-sources we have formalized a procedure for discovery of distant galaxies. We have defined the necessary information resources, selection criteria and procedures, and the astronomical software required. For sampling the necessary information from heterogeneous digital collections the application of the technology of the intellectual mediators is provided. The subject mediator supports representation and access to the information. The conceptual scheme of the mediator defines the interface for interaction with the user during problem solving. The mediator allows decisions to be made on how to integrate diverse information at a semantic level. At the level of the mediator it is possible to present and simulate the different information (metadata, images, programs and processes). For association of diverse data models a special approach involving mapping of different data models and meta information to a canonical model will be utilized with the help of a few steps to specify the data model.

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[9] `http://www.sao.ru/oasis/fetch`

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[10]`http://cdsweb.u-strasbg.fr/doc/VOTable`

[11]`http://www.us-vo.org/news/simspec.html`