

IMPROVING DISSEMINATION OF HUMAN KNOWLEDGE BY EXPORTING DATA FROM RESEARCH INFORMATION SYSTEMS

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Abstract:

The paper describes the three methods for exporting scientific research outputs data from the research information system of the University of Novi Sad (the CRIS UNS system). The data can be exported by the OAI-PMH protocol, SRU protocol and XML-based protocol defined for the specific needs of exchanging data between information systems in Serbia. Exporting scientific research outputs from the CRIS UNS system by these protocols improves dissemination of scientific research results published by researchers from the University of Novi Sad. Dissemination of human knowledge included into these scientific research results improves further development of knowledge based societies.

Keywords: knowledge based society, dissemination of scientific research results, OAI-PMH, SRU

1. INTRODUCTION

CRIS (*Current Research Information System*) based on CERIF data model (*Common European Research Information Format*) is meant for processing all relevant entities of research domain. The CRIS systems support entities that contain data about researchers, projects, scientific conferences, institutions, published results, etc. In the last couple of years, the most scientific institutions already have or are in the process of implementation of the CRIS systems and these systems already contain significant amount of data about scientific activity stored in the semantically rich model.

Metadata about published scientific-research results can be stored in a CRIS system database using the semantically rich CERIF data model. However, metadata about scientific-research results can be also visible via other Internet based applications such as library information systems, institutional repositories, digital libraries, information systems of publishing activity (Springer - <http://www.springer.com/>, Emerald - <http://www.emeraldinsight.com/>), etc. Systems that provide the most data are citation databases such as Web of Science, Scopus, Google Scholar, etc. The importance of scientific-research results visibility for further development of science is discussed in the manuscripts (Lawrence, 2001; Harnard and Brody, 2004; Antelman, 2004, Anderson et al., 2001, Kurtz et al. 2005a; Kurtz et al. 2005b; Kurtz et al. 2005c; Eysenbach, 2005). On one hand, metadata about scientific-research results can be separately entered in all those Internet based systems by researchers or by librarians. This is hard and error-prone job. On the other hand, metadata about scientific-research results can be entered in one system and exported to other systems. This approach contributing to:

- Avoiding duplicated inputs on the two platforms,
- Increasing metadata quality, reliability and reusability.

This paper describes the possible approaches and formats of exporting scientific research results data from CRIS that is developed at the University of Novi Sad (CRIS UNS). The second section provides the short history of the CRIS UNS system development together with its most important features. After that, the three protocols for obtaining data from CRIS UNS are described. The conclusion of the paper provides the discussion on benefits of export data from CRIS UNS system for further development of knowledge based society.

2. CRIS UNS

The system CRIS UNS has been developed for the needs of the University of Novi Sad according to the recommendations of non-profit organisation euroCRIS (www.eurocris.org). The implementation of the system started 2009 and it is publically available at www.cris.uns.ac.rs. Two main requirements for the specification and implementation of the system were the compliance with the international standards in the field of representing scientific-research data on one side and fulfilling the specific local requirements defined by the University and Republic of Serbia within which the University was established.

In order to increase the availability of scientific results we analysed the systems that contains published scientific results (Ivanović, 2011a; Ivanović, 2013). Paper (Ivanović et al., 2011a) proposes the data model compatible with CERIF and MARC 21 library format. In this data model, the part of CERIF data model related to research results is mapped to MARC 21 format. MARC 21 format is a standard for representing bibliographic data. It can be shown that MARC 21 format supports all metadata proposed by Dublin Core and EDT-MS format (Ivanović et al., 2012a).

The previously mentioned CERIF-compatible data model was the basis for developing the information system of scientific-research activity for the needs of University of Novi Sad (Ivanović et al., 2010; Milosavljević et al., 2010). The automatic extraction of metadata from published scientific papers for the needs of CRIS UNS is described in (Kovačević et al., 2011). The component for reporting developed within CRIS UNS is described in (Dimić Surla & Ivanović, 2012). Exchanging data with other systems is the subject of the paper (Ivanović, 2011). CRIS UNS ontologies are the subjects of the papers (Ivanović et al. 2012d; Dimić Surla et al., 2012).

Public service for searching CRIS UNS database of scientific-research results is based on CQL profile for CRIS systems (Penca et al., 2012) and is available at www.cris.uns.ac.rs/search.jsf.

Papers (Ivanović et. al., 2011b, Ivanović et. al., 2012b) propose the extension of the CERIF data model for evaluation of published scientific-research results. The extension is created using the semantic layer of the CERIF model that allows classifications of entities and its relationships by various classification schemas. The model for evaluation was verified on the evaluation rules proposed by the Rule books for evaluation and quantitative expression of scientific-research results of the researchers of the University of Novi Sad (Surla et al., 2012). Public service for evaluation of scientific results published in journals developed within the CRIS UNS system is available at www.cris.uns.ac.rs/evaluation/evaluationStrucnoVeceTT.jsf and described in the paper (Nikolić et al., 2012).

CRIS UNS system also supports the repository of dissertations that is integrated with the ETD-MS-compatible repositories as described in the paper (Ivanović et al., 2012c). Migration of data from the former dissertation repository DIGLIB UNS was described in the paper (Ivanović & Surla, 2012). Public service for searching repository of dissertations defended at the University of Novi Sad is available at: www.cris.uns.ac.rs/searchDissertations.jsf.

The CRIS UNS contains significant amount of data about scientific-research activity at the University of Novi Sad including:

- Over 3000 researchers
- 14 faculties that belong to the University of Novi Sad
- Over 20000 published results, 3500 of which are PhD dissertations
- Over 7000 scientific conferences
- etc.

To sum up, CRIS UNS has significant amount of scientific-research data that can exported to various Internet based applications in the ways that are described in the following sections ending by the discussion of importance of dissemination of scientific research results data for further development of knowledge based societies.

3. OAI-PMH

The Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH - www.openarchives.org/OAI/openarchivesprotocol.html) is a client-server protocol that enables the data exchange between the systems that implement it. There are two classes of participants in OAI-PMH communication and these are: **Data Provider – server side of the protocol** that provides data from its repository and **Service Provider – client side of the protocol** that retrieves data. OAI-PMH request is specified as HTTP GET or POST request. There are six types of requests defined by OAI-PMH protocol:

- *Identify* – *Data Provider* sends information about repository name, protocol version, the address of the contact person and similar.
- *ListMetadataFormats* – is used for obtaining information about available metadata formats. All repositories are obliged to support Dublin Core format, but can support other metadata formats: MARC 21, oams, EDT-MS.
- *ListSets* – every repository can create logical sets that can be hierarchically organised and contain metadata. The request provides the information about all defined sets.
- *ListIdentifiers* – besides the metadata in specific format, every record contains the header with the record identifier, date of record creation/modification.
- *ListRecords* – is used for retrieving records in certain format from the repository. It can be defined if the required records belong to specific logical set or all record regardless of the logical sets should be included in the response. Moreover, in the request we can define the retrieving of the records that are created in specific time period.
- *GetRecord* – is used for retrieving the single record by assigning the parameter that uniquely identifies the record along with the desired format of the record.

OAI-PMH response is in XML format that is wrapped in HTTP response. HTTP response contains the header which specifies the content-type as *text/xml*, followed by the body that contains the XML document created by the schema available at: www.openarchives.org/OAI/2.0/OAI-PMH.xsd. For *ListRecords* and *GetRecord* requests the responses contains records from the repository in Dublin

Core, but other formats can also be supported: MARC 21, EDT-MS, etc. By introducing new metadata formats the repositories increase their interoperability.

For developing subsystem of CRIS UNS for exporting data we used the OAICat library (www.oclc.org/research/activities/oaicat.html) that is primarily meant for collecting metadata about theses and dissertation in OAI-PMH protocol for NDLTD networks. OAICat provides open access and includes collection of abstractions that enable adjustments and customization for different data sources. For example, OAICat is customized and included in *DSpace* distribution. According to the data from the UIUC OAI-PMH registry (<http://oai.grainger.uiuc.edu/registry/ListToolkits.asp>), OAICat is used in significant number of well-known OAI-PMH repositories.

OAICat library consist of four components *OAIHandler*, *Catalog*, *Factory* and *Crosswalk*. For the purpose of exporting data from CRIS UNS system the only thing that needed to be done is customization of the *Catalog* and *Factory* components of the OAICat library as well as customization of the parameters in the configuration file of the OAICat library. CRIS UNS supports exporting data in OAI-PMH protocol in the following formats: Dublin Core, MARC 21 and EDT-MS, with the plans of introducing export in CERIF format which is supported by the data model used in CRIS UNS. The basic URL for OAI-PMH protocol for CRIS UNS is <http://cris.uns.ac.rs/OAIHandler>. Data exported in this way can be downloaded by using existing and open-access web application OAI PMH *Validator & Data Extractor* (<http://validator.oaipmh.com/>) created by *Vangelis Banos* (<http://vbanos.gr/>), a PhD student from Greece.

The CRIS UNS system is a member of the DART-Europe network (www.dart-europe.eu/) and the OpenAIRE+ network (<https://beta.openaire.eu/>). Interoperability of nodes of these networks is implemented using the OAI-PMH protocol and the Dublin Core format.

4. SRU

SRU is a client-server protocol, successor to Z39.50 binary protocol, whose purpose is to simplify the Z39.50, but to save its main functionalities. SRU is based on the technologies that are widely available - XML, SOAP, HTTP, URI. It defines two methods of communication: usage of HTTP GET or HTTP POST methods and exchanging messages via SOAP.

SRU standard defines three services:

- *SearchRetrieve* – is meant for searching and retrieving data, starts with the *SearchRetrieveRequest* message sent by the client followed by the *SearchRetrieveResponse* message sent by the server. The data that client receives from the server are in the form of XML documents and client itself can specify the expected XML schema for the document by setting the *recordSchema* parameter in the request. There is the set of registered XML schemas accepted by the Library of Congress and every schema has the name and the unique URI identifier. For example, one of the accepted formats is Dublin Core and the name of the appropriate schema is *dc* with the URI identifier set to *info:srw/schema/1/dc-v1.1*. If the server is unable to send data in the requested format, it will return the appropriate error message.
- *Scan* – enables client to receive the set of values for a certain index by which the search is done or in some cases if server supports it, for every index value client can receive the number of matches that will be received in case the search of that index-value pair is performed. *Scan* service is commonly used together with the *SearchRetrieve* service in order to avoid unnecessary search and receiving excessive results set. The usual sequence of steps is that client calls the *Scan* service for the specific index first, receives the list of possible values for that index and then calls the *SearchRetrieve* service with the query in which one of the received values is specified.
- *Explain* – enables client to get the information about elements of standard that are supported by the server, because server does not need to implement all the details proposed by the standard.

The main characteristics of the SRU standard are:

- it allows definition of the services that enables search that is independent of internal data representation,
- enables search of the remote systems via the Internet,

- its query language (CQL) supports creation of very complex queries,
- allows that client side of the protocol can choose the format for the search results,
- uses modern information technologies (WSDL, SOAP, HTTP and XML)

We analyzed the systems that contain data about scientific-research activity and the possibility of choosing existing or creating new SRU profile that can be applied on CRIS systems. We analyzed the existing profiles and their context sets that can be used in searching data of scientific-research activity. The special emphasis of the analysis was placed on Bath 2.0 profile (<http://www.loc.gov/standards/sru/resources/bath-profile.html>) and Bib 1.0 profile (<http://www.loc.gov/standards/sru/resources/cql-bibliographic-profile.html>) because these two profiles contain indexes that relate to part of the data about scientific-research activity. Both profiles are based on Dublin Core context set. The analysis showed that given profiles and their specific context sets contain lots of different indexes mostly suitable for bibliographic data description, which led as to the conclusion that they cannot be used for description of all entities in CRIS systems. Apart from bibliographic data, the domain of the CRIS systems includes data about persons, institutions, events, projects, patents and products and hence the need of defining new profile and context set that will fully describe all relevant data from CRIS systems. For the purpose of implementing search of scientific-research data the new profile named CRIS was defined. The CRIS profile includes existing context sets of Dublin Core and CQL, as well as newly created CRIS context set (Penca et al., 2012). The implementation of the server side of the SRU protocol within CRIS UNS is in progress and is planned to be put into operation in the summer of this year. It is planned to enable search of CRIS UNS database via SRU protocol and retrieving data using Dublin Core and CRIS context set. In this way we will enable the export of scientific research results meeting the certain requirement expressed by a CQL query.

5. CRIS UNS XML-BASED PROTOCOL

For the specific needs of exchanging data with other systems in Serbia we defined and implemented client-server protocol that includes data about evaluation of scientific results according to the rules proposed by the Serbian Government. The protocol is based on XML and enables retrieving of data about researchers and published results. The protocol is used for exporting data from CRIS UNS to other institutional information systems of scientific activity that exist in Serbia. The protocol enables exporting of all published results for a single researcher or institution, or published results of a given type (for example: journal papers) of a researcher or institution. The response is given as an XML document created by the XML schema available at <http://cris.uns.ac.rs/interoperability/sema-cris.xsd>. The given XML schema entirely describes the semantics of the data structure. Namely, every record is defined by its ID number from CRIS UNS. In this way, we achieved that the exported data by this protocol can be imported in other systems without loss of information. For instance, all papers of the same researcher can be identified despite the difference in form of author's name or the same journal with the different names can be uniquely identified.

The server side of the protocol was implemented using Java Servlet technology within the CRIS UNS system and the main URL for retrieving data is <http://cris.uns.ac.rs/ReportsServlet/knr?reportType=resultsKnrXML>. The parameters that can be specified in the request are *researcherId*, *type*, *resultId*. The example of the request that gives all results for the researcher Bojana Dimić Surla is <http://cris.uns.ac.rs/ReportsServlet/knr?reportType=resultsKnrXML&researcherId=5514>. XML documents with data obtained by using this protocol can be downloaded in a web browser without implementation of the client side.

6. DISCUSSION & CONCLUSION

In this paper we described three different publically available services for retrieving data about scientific research results from the CRIS UNS system. Migration of data about scientific-research results from the CRIS UNS system to various Internet based systems is significant because it increases visibility of scientific-research results and avoids duplicated inputs on the two platforms. Increasing visibility of scientific-research results means improving dissemination of these results. These scientific research results contain human knowledge. Improving dissemination of human knowledge improves further development of knowledge based society. Also, the exported data

can be used as starting datasets for various researches connected to scientific-research activity at the University of Novi Sad, some of them are:

- The scientific-research productivity of the University of Novi Sad, distribution of the published results among faculties and researchers that belong to the University, finding the leader among faculties and researchers at the University. In case of retrieving datasets by the protocol described in the fifth section of this paper, the leaders among faculties and researchers can be determined not only by the production, but also by the evaluation of the published results according by the rules proposed by the Republic of Serbia's Government.
- Collaboration among departments, faculties and researchers of the University of Novi Sad, i.e. creation of graphs that illustrates the connection between departments, faculties and researchers.
Distribution of the published results among scientific areas, i.e. determining the areas that are most popular for the researchers at the University, in which areas the University has good and in which has the poor results.

Moreover, on the basis of these datasets and datasets obtained from databases of other institutions someone is able to compare the scientific productivity of the University of Novi Sad with some other scientific institutions. The most research on comparing scientific production of different countries are based on the datasets from various sources (Schubert et al, 1989; King, 2004; Glanzel et al, 2002; Hu and Rousseau, 2009) together with the research on development of science in certain institution, country or region (Fu and Ho, 2013; Moed et al, 1995; Glänzel et al., 1999). Moreover, there are research on collaborations between researchers, institutions or countries (Guan and Gao, 2008; Newman, 2001a; Newman, 2001b).

In addition to finish the implementation of the protocol described in the fourth section, in the next period we plan to implement the functionality of exporting data in various formats from the results obtained in user search through CRIS UNS web application (www.cris.uns.ac.rs/search.jsf). The same approach of retrieving data after database search can be found in citation databases such as Thomson Reuters Web of Science and Scopus.

We also started a research on influence of exporting data implementation on visibility and impact of scientific research results stored in CRIS UNS. This research is based on log mining. The CRIS UNS system logs the HTTP referer header field which contains the address of the webpage that linked to the resource being requested. By checking the referer, the CRIS UNS system can see where the request originated (from which Internet based application).

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