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Producing Linked Open Dataset from Bibliographic Data with Integration of External Data Sources for Academic Libraries

Biswajit Saha
The University of Burdwan, biswajit@knu.ac.in

Dr. Rajesh Das
The University of Burdwan, rajeshdas99@gmail.com

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Biswajit Saha
PhD Research Scholar, Department of Library & Information Science, The University of Burdwan, Burdwan, West Bengal, India, PIN-713104. Email: biswajit@knu.ac.in

and

Dr. Rajesh Das
Assistant Professor, Department of Library and Information Science, The University of Burdwan, Burdwan, West Bengal, India, PIN-713104

Abstract

This paper has focused on transformation of bibliographic data to linked open data (LOD) as RDF(Resource Description Framework) triple model with integration of external resources. Library & Information centres and knowledge centres deal with various types of databases like bibliographic databases, full text databases, archival databases, statistical databases, CD/DVD ROM databases and more. Presently, web technology changes storing, processing, and disseminating services rapidly. The semantic web technology is an advance technology of web platform which provides structured data on web for describing and retrieving by the organization or institutions. It may provide more information from other external resources to the users. The main objective of this paper is transformation of library bibliographic data, based on MARC21, to RDF triple format as LOD with enrichment of external LOD dataset. External resources like OpenLibrary, VIAF, Wikidata, DBpedia, GeoNames etc. We have proposed a Workflow model (Figure-1) to visualize details steps, activities, components for transforming bibliographic data to LOD dataset. The methodology of this work includes the various methods and steps for conducting such research work. Here we have used an open source tool OpenRefine (version 3.2), formally it is known as GoogleRefine. The OpenRefine tool is used for managing and organizing the messy data with different attribute like row-column manipulation, reconciliation manipulation, different format manipulation like XML, JSON, N-Triple, RDF etc. The OpenRefine tool has played the various roles for the research work such as insertion of URI column, link generation, reconciliation data for external sources, conversion of source format to RDF format etc. After conversion of whole bibliographic data into RDF triple format as considerable LOD dataset. At the production page we may find a RDF file of bibliographic data. This LOD dataset may further be used by the organizations or institutions for their advanced bibliographic service.

Key Words: *Linked open data, RDF, Bibliographic data, OpenRefine, MARC-21, URI.*

1. Introduction

Cataloguing is the method of creating and maintaining bibliographic and authority records of a library holdings such as books, serials, databases, images, videos, cartographic materials, sound records, computer files etc. The catalogue is of two types card and electronics (OPAC) (Ahmad, 2014).

The main purpose of bibliographic records is to describe a document uniquely with sufficient detail, to identify it distinctively among other documents and specify where the record can be located within a file of other bibliographic records. Bibliographic record is a conceptual whole that includes all the bibliographic information about a resource together in one place, like a catalogue card or a MARC record. (Clerk, 2014). A bibliographic record contains the data elements necessary to help users for identifying and retrieving that resource, as well as additional supporting information, presented in a formalized bibliographic format. There are many types of bibliographic formats such as MARC, ISBD, AACR, FRBR (Rajaram, 2013) etc. At present, the users are looking for information in advance level with more detailed on a document. But, OPAC search or discovery search can't meet this demand. It is only possible if we provide the advanced level service such as semantic we technology based service.

2. Literature Review

During our research work, the review of literature part has been done to integrate the other related research works and related projects. A lot of literatures have been searched and studied to find out the similarities, gaps, problems and prospects on this research area. In the semantic web domain, other than library and information science professionals, professionals with the science and engineering background are very much involved in this research area, such as developers of computer applications, data science professionals and many more. We have studied GoogleScholars(http://scholar.google.com), DOAJ(http://www.doaj.org), Scopus(http://www.scopus.com), Web of Science (https://mjl.clarivate.com/), LISA(https://proquest.libguides.com/lisa) and other online resources during the process of literature review. Some of literatures are very much closed to our works which will be discussed in the next sections of this review.

Kumar, Marjit and Biswas (2013) have conducted a research work regarding MARC21, Bibliographic Data and Linked Data in the web platform. Their work mainly had focussed on conversion of MARC21 bibliographic data to linked data as well as provided the advanced web services. Actually, they have studied bibliographic data in MARC21 format. MARC21 is a format to use in machine readable catalogue in automated library environment. It is used to describe bibliographic data, authority data and holding data. Here the authors conducted their work with MARC21 bibliographic data. They selected some important MARC21 tags and converted to RDF model and linked data. Actually, linked data is an RDF model which has three parts i.e. subject, predicate and object. The authors simply converted the MARC21 bibliographic tags with values to RDF formats as linked data with integration of RDF schema and vocabulary. The RDF schema is used to describe the properties and vocabularies that are used to establish the relationship of objects and properties. The authors had used MARC Ontology vocabularies, dublin core terms and RDA (Resource Description and Access) vocabularies (Chandel & Prasad, 2013).

In visualisation section the authors have shown simple HTML (Hyper Text Markup Language) representation () of bibliographic data with properties and values. Lastly, the authors have concluded that their main approach is transforming the MARC21 format of bibliographic data into linked data. They have shown the methods for generation of built-in mapping between RDF and MARC21 data. They have also produced RDF data set which is to access in different models (Kumar et al.,2010).

Alemu and et al. (2012) have written a paper on linked data for library. They have focused on the benefits of RDF based data model in library. The main purpose of their work is to make a conceptual shift from document centric to data centric metadata. They have focused how it is possible to convert a library model i.e. RDA in to FRBR (Functional Requirements of Bibliographic Records) model which is based on linked data principles. Their objective is also transformation of MARC21 records to RDF data without distracting library metadata operation (Alemu et at., 2012)

Schilling (2017) had conducted a research work on transformation of library metadata into linked library data. He also discussed that how MARC record is to be transformed with specific RDF schema and vocabulary into linked dataset. He discussed about the different library metadata and detailed knowledge on resource description framework. Linked data is nothing but an advanced structured data with semantic web technology (Schilling, 2017)

In 2010, Bowen conducted a research work on transforming library metadata to linked data by using the eXtensible catalog (XC) support system Web technology. eXtensible Catalog is not only support linked data services but also be used as discovery search interface. He also analysed the MARC21 tags and mapping between RDF terms and MARC21 tags. He used RDA vocabularies, eXtensible catalog ontology and Dublin Core terms metadata. He concluded that systematic web technology is not an easy task to integrate with library system (Bowen, 2010).

The four works, narrated above, are closely related to our works because all of them have worked on transformation of library data into Linked Data. The basic ideas and activities of their works are same as our research works. Each and every work has followed different methodology and tools, but nobody has explained the feasibility of methodology. In our research work, we have proposed a new work flow for transforming library records into linked data.

3. Statement of problem

At present, academic libraries, libraries of research institutes and other educational institutes provide their bibliographic information through web OPAC (Online Public Access Catalogue) search. Academic libraries and libraries of other educational institutes are not only including their bibliographic data of resources but also contain several databases such as their Institutional Repositories, own electronic resource management systems and literature debases. Now, they are transforming or integrating all this bibliographic information with simple OPAC and Discovery search. Discovery search facilitates single search box/window for searching multiple databases simultaneously and retrieve information into a useful form according to users' need. Presently, library professional and researchers are doing research on library Discovery service to add more features and make it more user-friendly. But, most of academic and other libraries are not providing their library services in Semantic level. The user can retrieve very limited information from searching the OPAC and library Discovery service. They only can get the information which are available in the particular library's databases they (user) are searching.

Let us take an example, suppose a user puts a search query in the search box about a book of his interest by providing the name of the author. He/she would get the bibliographic information of the book/s written by that particular author but, he/she will not get the other

bibliographic information of that author which are not in the databases of that particular library. If the user would like to know more about the author like about his (author's) personal life, family history, date of birth, other activities, and relations with other persons in the related fields etc., the user would not retrieve the information from the database of the particular library. Because they are not providing any external sources of the author. This is the advance facility of the library OPAC, library Discovery Service that provides more information about the particular search to the user, and this can be achieved with the help of LOD. But, the main problem of such kind of academic libraries is that they are not providing any Linked open data (LOD) services with their existing services. LOD management and service helps for the advancement of a library service.

The concept of LOD is formed of semantic web technology. To implement LOD, the library should go with the RDF model and RDF based metadata schema. It would be a very advance kind of service if the academic and other related libraries convert their existing library services to semantic technology-based services with the integration of LOD services. The LOD plays several roles which are as follows:

1. A library can provide their bibliographic and authority data to linked open dataset.
2. A library can conceive other external LOD datasets with enrichment of their existing library dataset.

From the above discussion we may draw the following research questions:

1. Is it possible to convert /transform all existing bibliographic data of a academic libraries in to the LOD set in RDF model?
2. Can we provide the RDF based metadata schema (Ontology, Namespace) in the line of conversion of RDF model ?
3. Is it possible the conversion of bibliographic data into LOD set with enrichment of other external LOD dataset by using an automatic or semi-automatic method ?
4. Is it possible the conversion can be made in different RDF format (like Turtle, RDF-XML, JSON LD etc.) and human readable format ?

4. Objectives

In general point of view, the objectives of the research work is providing a LOD set of the existing library bibliographic data with enrichment of external data sources.

The specific objectives of this research work are:

1. To produce/convert/transform the existing library bibliographic data into LOD set (RDF triple formats/ human readable format).
2. To provide RDF based metadata schema for the library bibliographic data (schema.org, vivo, Bibo, FOAF etc.) for conversion.
3. To provide LOD from library bibliographic data with enrichment of external data sources (like DBpedia, Geonames, Wikidata, Open library, VIAF etc.)
4. To produce LOD set in RDF model with different format (RDF XML, N-Triple.)

5. Methodology

The methodology contains the detailed steps and methods of the research work to produce linked open data (LOD) set with integration of external data sources. The conceptual framework has been designed to understand the full research work in a single diagram (Figure-1).

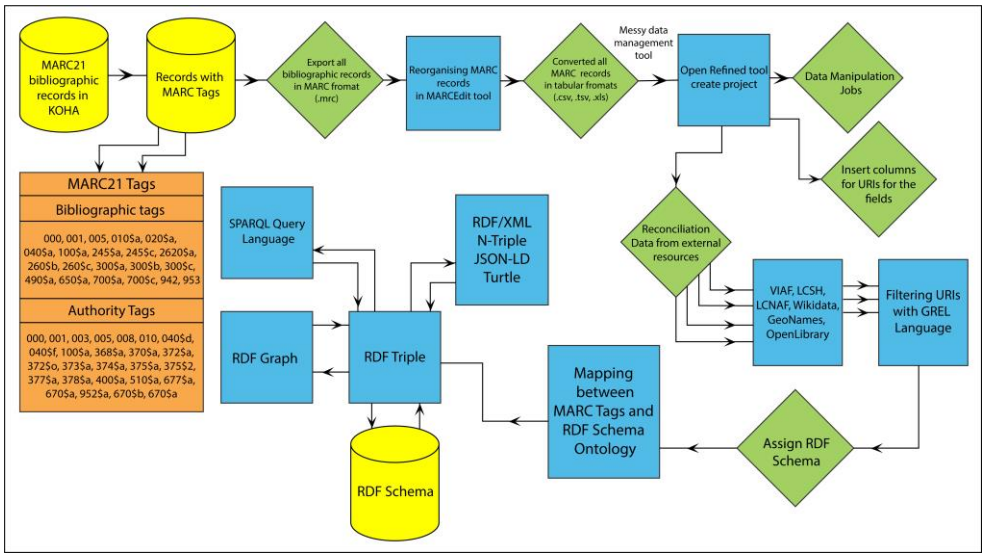

Figure-1: Workflow of producing LOD dataset from bibliographic data

The detailed methodology includes the following steps:

Step 1: Experimental Data

The research work is a practical experience in the Central Library of KNU (https://www.knu.ac.in/). To perform the search work more than thousand bibliographic data have been imported in MARC21 format from the existing Library Management Software KOHA. Before Transforming as LOD data set we need an existing dataset in the suitable format (Format should be tabular, XLS, XML, CSV, MARC, or any RDMS supported format) (Mishra, 2002).

At present all standard Libraries like Academic Library, Public Library, Special Library maintain their database in such a LMS (Kamble, Raj & Sangeeta, 2012) which generally support MARC format. At present, all over the world KOHA is mostly supported all Library standards such as MARC, Z39.50, ISO2709, etc. The research work has shown the experience with MARC21 format because most of the Libraries are using MARC21 standard for describing, indexing, visualising of bibliographic database.

Step 2: Selection of open source tool for managing and transforming of bibliographic data:

In this research work, we have used the open source tool OpenRefine (https://openrefine.org/). OpenRefine is a tool software for handling messy data, clearing data, transfer data from one format to another and extending data with web services and external data. It is formerly known as Google Refine. In this research work, the OpenRefine tool includes the activities regarding to manage bibliographic data set with several sub-

activities like URI column insertion, Link generation, reconciliation data, conversion from one format to another format etc. The beauty of this tool is it allow semi-automatic reconciliation from external data source and integration as URI as well as Literal with being transformed to LOD set.

Step 3: Mapping of MARC21 data to RDF terms/Metadata schema

LOD is nothing but RDF triple model. Before describing any data, it needs to assign metadata or software or structured information of the data. It is generally nothing but attributes or columns of a general database e.g. MySQL, Oracle, etc (Barve & Dahibhate, 2012). In web platform it must follow the metadata before the describing the content. Accordingly, to generate a LOD dataset it must assign a metadata schema that is RDF metadata schema. RDF metadata schema are of various types for the different domains. In a RDF dataset, the data are describe with RDF based metadata schema. Sometimes, the RDF metadata schema is known as namespace/terms/ontology. The Ontology (Mehra & Kumar, 2011) describes the data along with its relationships. However, our research work has used multiple RDF based schema and ontology (describes in the Table-1). Our research has concentrated to library bibliographic data and it would be followed with bibliographic RDF metadata Schema. There are a lot of bibliographic RDF metadata Schema like Schema.org vivo ontology and more. The Schema.org is used for different works like creative work, book, movie, music recording, recipe, TV service, person, organisation, place, product, health and medical, etc. We used the metadata Schema Schema.org for producing the LOD dataset for our research work. It is a comprehensive metadata that include all concepts of a mark record. After selection of the RDF metadata Schema i.e. Schema.org we performed the mapping between the MARC21 data and Schema.org (https://schema.org/) .

Fields	MARC21 tags	RDF terms/ ontology /schema
Title	245$a, 245$b	schema:Book rdf:about schema:title dc:title owl:sameAs rdf:resource → Title Literral Title URI
Personal names (author / editor / creator / contributor etc)	100$a, 700$a	foaf:Person foaf:name schema:author dc:creator owl:sameAs → Author Literal Author URI
Place	260$a, 264$a	schema:place dc:place rdf:resource owl:sameAs → Place Literal Place URI
Publisher	260$b, 264$b	schema:publisher dc:publisher rdf:resource owl:sameAs → Publisher Literal Publisher URI

Year	260$c, 264$c	schema:year dc:date	Year Literal

Table-1: Mapping between MARC21 tags and RDF terms / ontology / schema

Step 4: Integration with external data sources

The main objectives of LOD is to provide more information from different sources to the group of people. Our research is not only concentrated on producing the LOD dataset but also integration of external sources with the LOD dataset. Our bibliographic dataset contains the fields like bibliography number, title, author, place, publisher, year and subject. We have integrated the external data sources with the fields of title, author, place and subject. We have a URI of our existing dataset i.e. the URI/ URL from our web OPAC. Firstly, we have integrated the web OPAC URI /URL with the title field. Then we have integrated with the URI of OpenLibrary (http://https://openlibrary.org) with title, the URI of VIAF (http://viaf.org/) with author, the URI of LC-NAF with author, the URI of Wikidata with place, the URI of LCSH with subject. In the figure 2, we can see that a column named Title_URI (OpenLibrary) has been inserted between the column Title and OPAC_URL. The URI values of the column Title_ URI (OpenLibrary) have been reconciliated from OpenLibrary and filtered by GREL (Google Refine Expression Language) in the OpenRefine tool. In the same way the field Author_URI (VIAF) and Author_URI (LCNAF) have been inserted after the column Author (In figure 3). The values of the column Author_URI (VIAF) and Author_URI(LCNAF) have been reconciliated from VIAF and Library of Congress respectively. These columns are basically linked column of the subject and object. The GREL is basically using for link generation.

Figure-2: Generated the link column of the tile

Figure-3: Generated the link column of the author

In the figure 4 we can see how columns of bibliographic data are mapped with RDF terms/ontology/namespace. The figure shows that the title is the subject of RDF triple and it is described by multiple RDF metadata elements like “schema: title” and “owl: same As”. In the same way other column like author, place, publisher, publication year have been described with multiple RDF metadata schema.

Figure-4: Mapping between bibliographic column and RDF metadata schema

6. Evaluation

We have done evaluation on MARC21 bibliographic dataset. We have collected more than thousands MARC21 bibliographic data from the Central Library of Kazi Nazrul University. Some major columns have been selected for experimental research work. Our main objective has focused on production of Linked open dataset assigned with RDF metadata schema and with URI link generation from external resources. We, finally, got a LOD file in 2 formats- Turtle (Figure 5) and XML (Figure 6). From this figure we may find a triple format (subject, predicate, object) of the output dataset. In the output file we may find the used RDF metadata schema with their prefixes like schema, RDF, OWL, MADS, VIVO, FOAF, DC. Owl and RDFS have used for bringing relevancy among the subject, predicate and object.

```
@prefix schema: <http://schema.org/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix bibo: <http://purl.org/ontology/bibo/> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix dc: <http://purl.org/dc/elements/1.1/> .


<http://localhost/library/opac/biblio/1> a schema:Book, schema:creativeWork;
  schema:place "Bangalore", <http://wikidata.org/Q1355>;
  schema:publisher "Sarada Ranganathan Endowment for Library Science";
  schema:subject "Library science", <http://id.loc.gov/authorities/subjects/sh85076723>;
  schema:title "The five laws of library science", <http://localhost:8082/cgi-bin/koha/opac-
detail.pl?biblionumber=1>;
  schema:year "1988"^^<http://www.w3.org/2001/XMLSchema#int>;
  owl:sameAs <http://localhost:8082/cgi-bin/koha/opac-detail.pl?biblionumber=1>, <http://
openlibrary.org//works/OL356224W> .

<http://localhost/library/opac/biblio/Ranganathan%2C+S.+R.> a foaf:Person;
  schema:author "Ranganathan, S. R.";
  owl:SameAs <http://id.loc.gov/authorities/names/n85829498>;
  owl:sameAs <http://viaf.org/410715764325793859002> .

<http://localhost/library/opac/biblio/4> a schema:Book, schema:creativeWork;
  schema:place "London", <http://wikidata.org/Q84>;
  schema:publisher "Bingley";
  schema:subject "Colon classification", <http://id.loc.gov/authorities/subjects/sh85026797>;
  schema:title "An introduction to Colon Classification", <http://localhost:8082/cgi-bin/koha/opac-
detail.pl?biblionumber=4>;
  schema:year "1966."^^<http://www.w3.org/2001/XMLSchema#int>;
  owl:sameAs <http://localhost:8082/cgi-bin/koha/opac-detail.pl?biblionumber=4> .

<http://localhost/library/opac/biblio/Batty%2C+C.+D.> a foaf:Person;
  schema:author "Batty, C. D.";
  owl:SameAs <http://id.loc.gov/authorities/names/n50006343>;
  owl:sameAs <http://viaf.org/241145858094823021897> .
```

Figure-5:

Turtle format of the output LOD file

```
- <rdf:RDF>
  - <rdf:Description rdf:about="http://localhost/library/opac/biblio/1">
      <rdf:type rdf:resource="http://schema.org/creativeWork"/>
      <rdf:type rdf:resource="http://schema.org/Book"/>
      <schema:title>The five laws of library science</schema:title>
      <owl:sameAs rdf:resource="http://openlibrary.org//works/OL356224W"/>
      <owl:sameAs rdf:resource="http://localhost:8082/cgi-bin/koha/opac-detail.pl?biblionumber=1"/>
      <schema:place rdf:resource="http://wikidata.org/Q1355"/>
      <schema:place>Bangalore</schema:place>
      <schema:publisher>Sarada Ranganathan Endowment for Library Science</schema:publisher>
      <schema:year rdf:datatype="http://www.w3.org/2001/XMLSchema#int">1988</schema:year>
      <schema:subject>Library science</schema:subject>
      <schema:subject rdf:resource="http://id.loc.gov/authorities/subjects/sh85076723"/>
      <schema:title rdf:resource="http://localhost:8082/cgi-bin/koha/opac-detail.pl?biblionumber=1"/>
    </rdf:Description>
  - <rdf:Description rdf:about="http://localhost/library/opac/biblio/Ranganathan%2C+S.+R.">
      <rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
      <schema:author>Ranganathan, S. R.</schema:author>
      <owl:sameAs rdf:resource="http://viaf.org/410715764325793859002"/>
      <owl:SameAs rdf:resource="http://id.loc.gov/authorities/names/n85829498"/>
    </rdf:Description>
  - <rdf:Description rdf:about="http://localhost/library/opac/biblio/4">
```

Figure -6:XML format of the output LOD file

7. Conclusion:

The research work has been presented though this paper and we have faced a lot of problems and also have overcome them. Presently, the library users make advance queries and search for in-depth information about the bibliographic data, and only the LOD could solve these problems and meet the query of the user properly. Our research word made a linked open data set from bibliographic data with the generation of links from external data sources. As a result, we found RDF triple dataset in a single file (in Turtle, XML, JOSN LD formats etc.). The limitation of this research project is in visualization part. We have not shown proper visualization of the LOD dataset. Our next work will concentrate on visualization part. Even, the output LOD dataset may be consumed by the other organization or institutions. The LOD dataset can be accessed by SPARQL (SPARQL Protocol and RDF Query Language) end point interface (Michel and et. al., 2018) . However, it the easy and simple method for producing the LOD dataset from bibliographic dataset.

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