DDI-RDF Discovery Vocabulary

A vocabulary for publishing metadata about data sets (research and survey data) into the Web of Linked Data

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This document is also available in this non-normative format: PDF

Abstract

This specification defines the DDI-RDF Discovery Vocabulary (Disco), an RDF Schema vocabulary that enables discovery of research and survey data on the Web. It is based on DDI (Data Documentation Initiative) XML formats.

Status of This Document

The DDI-RDF Discovery Vocabulary is a draft specification of the DDI Alliance.

This specification is produced by the subgroup on Disco (chair Joachim Wackerow) of the RDF Vocabularies Working Group, a working group at the DDI Alliance.

Resources:

- Webpage at DDI Alliance
- Google Group
- Issue tracker
- GitHub repository

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§ 1. Table of Figures

§ 2. Introduction

The namespace for all terms in this ontology is: http://rdf-vocabulary.ddialliance.org/discovery#".

Normative formats of the DDI-RDF Discovery Vocabulary specification are

- this HTML specification, and
- the Turtle file.

There is also a non-canonical RDF/XML version of the Turtle file.

Open issues are discussed on the issue tracker: open issues.

A detailed overview of the Disco vocabulary is available as LODE view or a web view using the web application Web-based Visualization of Ontologies.

For a detailed explanation of DDI terms please refer to section 2.

§ 2.1 Scope and Purpose

This specification is designed to support the discovery of microdata sets and related metadata using RDF technologies in the Web of Linked Data. Many archives and other organizations have large amounts of data, sometimes publically available, but often confidential in nature, requiring applications for access. Many such organizations use the Data Documentation Initiative standard, which is a proven and highly detailed XML metadata format for describing rectangular data sets of this type. This vocabulary makes use of the DDI specification to create a simplified version of this model for the discovery of data files.

The data holdings of data archives are often collected by researchers, and only afterwards disseminated by archives. Other data-producing organizations such as research centers and statistical agencies are also increasingly interested in the DDI standards for documenting their own microdata. In general terms, most DDI metadata describes data sets for the social, behavioural, and economic sciences. This data is fairly consistent in format, consisting of rectangular data files with columns containing variables for a set of cases, contained in the rows. It is often collected by survey, although in some cases may come from administrative sources, sensors, or registers.

This vocabulary is intended not only for use by the research data community, but also by any others needing an RDF vocabulary for describing this type of rectangular data. This vocabulary will provide a useful model for describing some of the data sets now being published by open government initiatives, by providing a rich metadata structure for them. While the data sets may be available (typically as CSV files) the metadata which accompanies them is not necessarily coherent, making the discovery of these data sets difficult. This vocabulary would help to overcome this difficulty by allowing for the creation of standard queries to programmatically identify data sets, whether made available by government or held within a data archive.

Disco could be used to discover datasets by searching for specific questions, topics, and geographical coverage. Depending on the complexity of the search respectively of the data portal, parts of Disco could be used, the complete Disco, or Disco together with related vocabularies. The document [Scenarios] by Vompras, Gregory, Bosch, Capadisli, and Wackerow describes typical use cases for the applicability of the DDI-RDF Discovery vocabulary. In the Section Use Cases and Example Queries of the Appendix additional discovery use cases are illustrated by several SPARQL queries.

Statistical domain experts (core members of the DDI Alliance Technical Implementation Committee, representatives of national statistical institutes, national data archives) and Linked Open Data community members have selected the DDI elements which are seen as most important to solve problems associated with use cases in the area of data discovery. Section 2 gives an overview of the conceptual model. More detailed descriptions of all the properties are given in the specification and two conference papers [Linked-Statistical-Data] [DDI-RDF-Discovery-Vocabulary]. Disco is intended to provide means to describe microdata by essential metadata for the discovery purpose. Existing DDI-XML instances can be transformed into this RDF format and therefore exposed as Linked Data. The vice-versa process is not intended, as we have defined Disco components and reused components of other RDF vocabularies which make only sense in the Linked Data field.

§ 2.2 About DDI

The Data Documentation Initiative standards are produced and maintained by a member-based consortium of global scope, the DDI Alliance. Housed currently at the Interuniversity Consortium for Political and Social Research (ICPSR) at the University of Michigan, there are currently more than 30 member institutions. The standards have been under development for more than ten years, and are in widespread use among data archives and libraries, producers of research data, secure data centers, and statistical agencies.

There are two major versions of DDI (both serialied in XML format): the “Codebook” version, which allows for holding general information about a study, along with its data dictionary; and the “Lifecycle” version of DDI, which allows for the description of more complex multi-wave studies, throughout the data lifecycle, from study conception through data collection and processing.

This vocabulary contains a selection of the major types of metadata defined by these two versions in a highly simplified form, for the purposes of discovery. The XML Codebook and Lifecycle versions of DDI are very broad: these standards contain hundreds of metadata elements, providing enough information to programmatically work with the data files for such functions as the automatic creation of databases, and transformations between statistical packages. DDI in both versions is generally used to describe data found in ASCII files, whether positional files with fixed-width fields or files using a delimited format such as CSV.

It is difficult to claim that there is a single agreed conceptual model for describing research data in the social, behavioural, and economic sciences—there is a wide range of models and terms. However, the issues faced in this area have been the subject of discussion within the DDI community for many years, and the DDI model represents the best consensus which exists today. As such, it gives us a good basis for creating a vocabulary which will be recognizable to researchers familiar with this type of data.

§ 2.3 Relationship to Data Cube, DCAT and XKOS

The Discovery Vocabulary (Disco) is aligned to several other metadata vocabularies used in the RDF community. Disco is designed to be used in conjunction with other vocaularies.

The Data Catalog Vocabulary (DCAT) is a W3C standard for describing catalogs of datasets, and we map to it in two places: Our `LogicalDataSet` is a subclass of DCAT's Dataset, and our `DataFile` is a subclass of DCAT's Distribution. DCAT makes few assumptions about the kind of datasets being described, and focuses on general metadata about the datasets (mostly using Dublin Core), and on different ways of distributing and accessing the dataset, including availability of the dataset in multiple formats. Combining terms from both DCAT and the Discovery Vocabulary can be useful for a number of reasons:

- Describing collections (catalogs) of research datasets (DCAT)
- Providing additional information about physical aspects (file size, file formats) of research data files (DCAT)
- Providing information about the data collection that produced the datasets in a data catalog (Disco)
- Providing information about the logical structure (variables, concepts, etc.) of tabular datasets in a data catalog (Disco)

DCAT is richer for the description of collections and catalogue. Disco supports richer descriptions of groups of datasets or individual datasets. In this spec, some of our examples are partially based on DCAT (and we will indicate when this is the case).

The Data Cube vocabulary is a W3C standard for representing data cubes, that is, multidimensional aggregate data. Data cubes are often generated by tabulating or aggregating record-level datasets. For example, if an observation in a census data cube indicates the population of a certain age group in a certain region is 12345, then this fact was obtained by aggregating that number of individual records from a record-level (or "microdata") dataset. The Discovery Vocabulary contains a property "aggregation" (pointing from a Disco data set to a Data Cube dataset) that indicates that a Cube dataset was derived by tabulating a record-level dataset.

Data Cube provides for the description of the structure of such cubes, but also for the representation of the cube data itself, that is, the observations that make up the cube dataset. This is not the case for the Discovery Vocabulary, which only describes the structure of a dataset, but is not concerned with representing the actual data in it. The actual data is assumed to sit in a data file (e.g., a CSV file, or in a proprietary statistics package file format) that is not represented in RDF.

The interplay of Data Cube and Disco needs further exploration regarding the relationship of aggregate data, aggregation methods, and the underlying microdata. The goal would be to drill down to the related microdata based on a search resulting in aggregate data. On the one hand aggregate data are often easily available and gives a quick overview. On the other hand microdata enable more detailed analyses.

The use of formal statistical classifications is very common in research data sets—these are treated in our vocabulary as SKOS concepts, but in some cases those working with formal statistical classifications may desire more expressive capability than SKOS provides. To support such users, the DDI Alliance also publishes XKOS, a vocabulary which extends SKOS to allow for a more complete description of such classifications. While the use of XKOS is not required by this vocabulary, the two are designed to work in complementary fashion.

More details on the relationship to Data Cube, DCAT and XKOS as well as to other vocabularies are provided in

§ 3. Overview

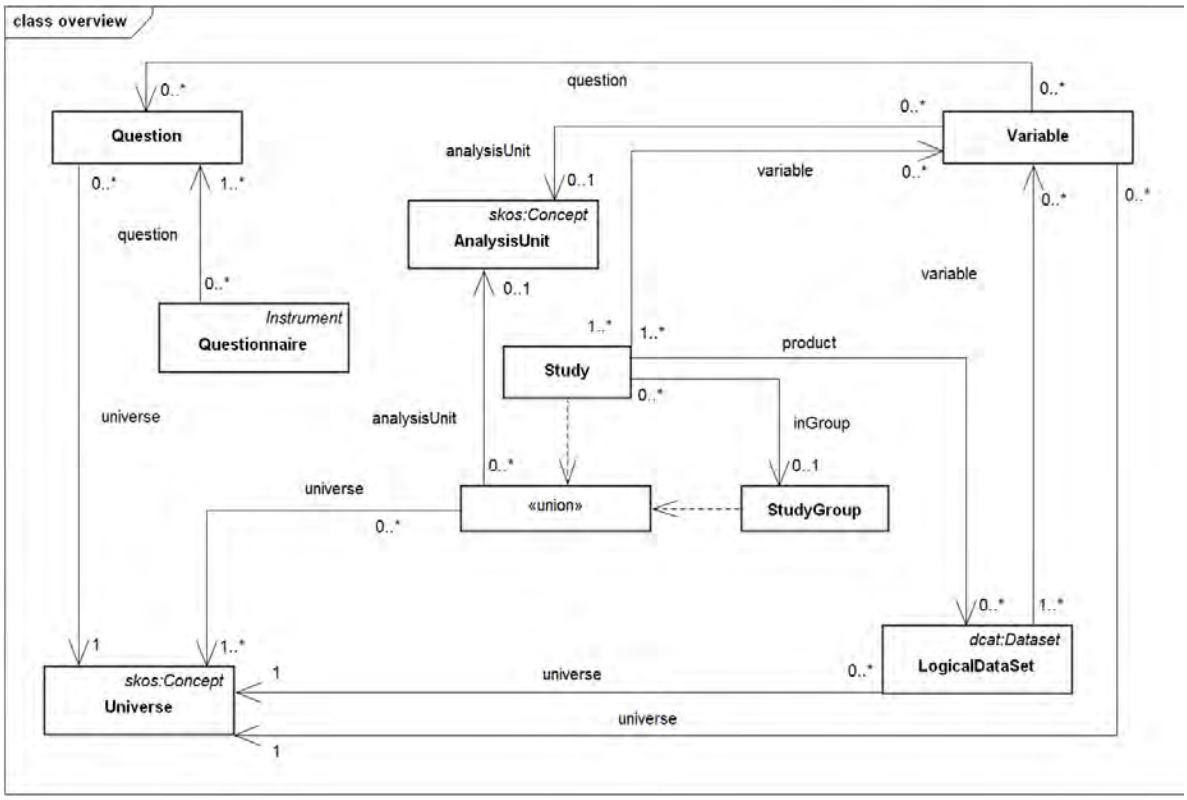


Figure 1 Vocabulary Overview

To understand the DDI Discovery Vocabulary, there are a few central classes, which can serve as entry points. The first of these is the `Study` class. A **`Study`** in our model represents the process by which a data set was generated or collected. Literal properties include information about the funding, organizational affiliation, abstract, title, version, and other such high-level information. In some cases, where data collection is cyclic or on-going, data sets may be released as a **`StudyGroup`**, where each cycle or "wave" of the data collection activity produces one or more data sets. This is typical for longitudinal studies, panel studies, and other types of "series" (to use the DDI term). In this case, a number of `Study` objects would be collected into a single `StudyGroup`.

Data sets have two representations in our model: a logical representation, which describes the contents of the data set, and a physical representation, which is a distributed file holding that data. It is possible to format data files in many different ways, even if the logical content is the same. In our model the **`LogicalDataSet`** represents the content of the file (its organization into a set of variables (`Variable`)). The `LogicalDataSet` is an extension of the `dcat:DataSet` class. Physical, distributed files are represented by the class **`DataFile`** (not depicted in the diagram), which is itself an extension of the `dcat:Distribution`.

When it comes to understanding the contents of the data set, this is done using the **`Variable`** class. Variables (`Variable`) provide a definition of the column in a rectangular data file, and can associate it with a particular Concept, and a **`Question`** (the `Question` in the **`Questionnaire`** which was used to collect the data). Variables (`Variable`) are related to a representation of some form, which may be a set of codes and categories (a "codelist") or may be one of other normal data types (dateTime, numeric, textual, etc.) Codes and Categories are represented using SKOS concepts and concept schemes.

Data is collected about a specific phenomenon, typically involving some target population, and focusing on the analysis of a particular type of subject. These are respectively represented by the **`Universe`** class and the **`AnalysisUnit`** class. If, for example, the adult population of Finland is being studied, the `AnalysisUnit` would be individuals or persons and the **`Universe`** would be the adult population of Finland. Bosch, Cyganiak, Wackerow, and Zapilko give a detailed overview of the DDI-RDF Discovery Vocabulary in a full paper written for the Dublin Core conference [Linked-Statistical-Data].

§ 4. Real-life Example

We have a sample of a survey which has been documented using DDI XML—the 1980 Argentine National

Population and Housing Census. We are using for this example the version disseminated by IPUMS, which provides internationally harmonized census data, to make it more useful for cross-border research. Thus, this data set is produced by two organizations: The Argentine National Institute of Statistics and Censuses, and the Minnesota Population Center hosted in the University of Minnesota.

To give some idea of what is contained in the metadata set, we will use some screen shots from OpenMetadata Survey Catalog, a portal which indexes the DDI files to facilitate searching, and reflects the contents in a fashion which is easy to view. Follow this link for the information about this DDI file at the OpenMetadata Survey Catalog.

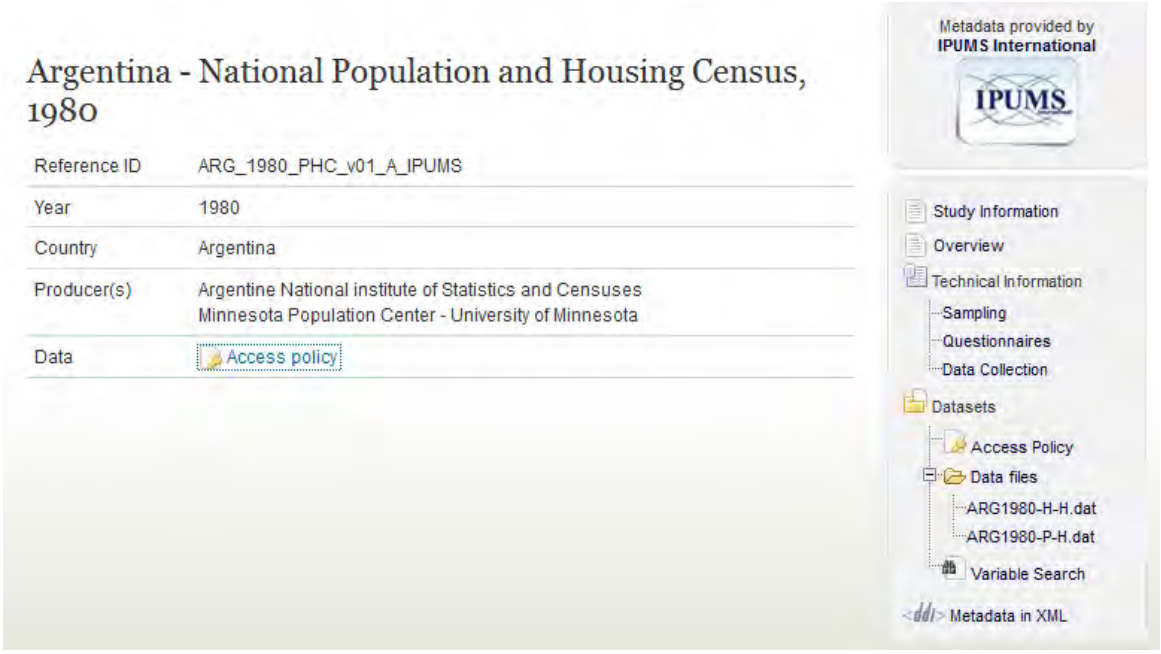


Figure 2 Overview

Figure 2 shows us the overview page for this study, giving us some basic information - title, identifier for the study, data producers, year, country, and a link to the access policies. If we look at the right-hand panel, we see an outline of the metadata contents of the file, including information about the questionnaire used, sampling methodology, and data collection activities, as well as the two data files which contains detailed information about its variables.

Not all of this information is useful in a data discovery scenario—sampling and data collection methodologies are not typically indexed for searches. Information about the questionnaire is, as is detailed information about the variables contained in the files. We will look more closely at the metadata of primary interest for our discovery scenario.

Using RDF and the DDI Discovery Vocabulary, the study can also be described in triples: an instance of type of `Study` is given the title and the identifier; also, the two data producers are linked and further described. The year and country are described in the form of a temporal and spatial coverage of the study. Also, the topics of the study are represented. The study instance further contains an abstract. Since a study is a versionable object in DDI, we attach a version to it. A study is further described using additional information which is described in the following Example 1.

EXAMPLE 1

```
# We will use the namespace 'ddi' in all of our examples.

ddi:Study_1 a disco:Study;
    dcterms:title "National Population and Housing Census, 1980"@en;
    dcterms:identifier "ARG_1980_PHC_v01_A_IPUMS";
    dcterms:creator [
        rdfs:label "Minnesota Population Center"@en;
        skos:notation "MPC";
        org:memberOf [
            rdfs:label "University of Minnesota"@en;
        ];
    ];
    dcterms:creator [
```

```
        rdfs:label "Argentine National institute of Statistics and Censuses"@en;
    ]
        dcterms:temporal [
                a dcterms:PeriodOfTime ;
                disco:startDate "1980-10-22"^^xsd:date;
                disco:endDate "1980-10-22"^^xsd:date;
                rdfs:comment "The interviews take place on the expected census day. In
                              some areas the enumeration took place the following day because of
                              access problems due to heavy rains.";
    ];
    dcterms:spatial [
      # This is the DC-strictly compatible way to do it
      a dcterms:Location;
      rdfs:label "Argentina, national coverage"@en;
    ];
    # Only a subset of subjects mentioned in the original file
    dcterms:subject [
                skos:definition "Technical Variables -- HOUSEHOLD"@en ;
    ] ;
    dcterms:subject [
                skos:definition "Group Quarters Variables -- HOUSEHOLD"@en ;
    ] ;
        dcterms:abstract "IPUMS-International is an effort to inventory, preserve,
                          harmonize, and disseminate census microdata from around the world. The
                          project has collected the world's largest archive of publicly available
                          census samples. The data are coded and documented consistently across
                          countries and over time to facilitate comparative research. IPUMS-
                          International makes these data available to qualified researchers free
                          of charge through a web dissemination system. The IPUMS project is a
                          collaboration of the Minnesota Population Center, National Statistical
                          Offices, and international data archives. Major funding is provided by
                          the U.S. National Science Foundation and the Demographic and Behavioral
                          Sciences Branch of the National Institute of Child Health and Human
                          Development. Additional support is provided by the University of
                          Minnesota Office of the Vice President for Research, the Minnesota
                          Population Center, and Sun Microsystems.";

    owl:versionInfo "Version 1.0. This version contains selected variables from
                     the original census microdata plus harmonized variables from the IPUMS
                     International data base."@en;

    disco:universe ddi:Universe_1;
    disco:instrument ddi:Questionnaire_1;
    disco:product ddi:Dataset_1;

    disco:analysisUnit ddi:AnalysisUnit_1;
    disco:kindOfData ddi:KindOfData_1;

    # stdyInfo/notes currently not represented.
    disco:variable ddi:AR80A401, ddi:AR80A402, ddi:AR80A404, ddi:AR80A407, ddi:AR80A411.
```

While the sampling methodology may not be of great interest for those searching for data, one field within this section is: the “universe”, that is, the population being studied. Figure 3 gives us an example of this information.

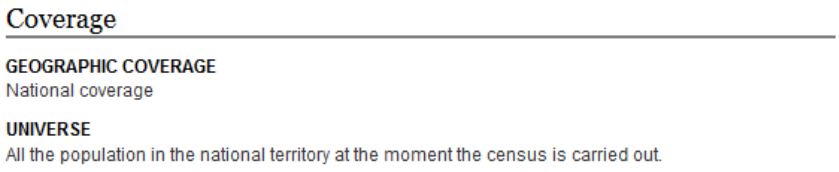


Figure 3 Coverage and Universe

Thus, the study refers to a specific universe.

EXAMPLE 2

```
ddi:Universe_1 a disco:Universe;
    skos:definition "All the population in the national territory at the moment the census is carried out."@en .
```

Using a type of instrument - a questionnaire -, the study produced a dataset. The dataset has access rights. The dataset has a concrete data file (physical representation or distributed file) populated by certain variables.

EXAMPLE 3

```
ddi:Dataset_1 a disco:LogicalDataSet;
    disco:instrument ddi:Questionnaire_1;
    dcterms:accessRights ddi:AccessRights_1;
    disco:dataFile ddi:Datafile_1;
    disco:variable ddi:AR80A401, ddi:AR80A402, ddi:AR80A404, ddi:AR80A407, ddi:AR80A411.

ddi:AccessRights_1 a dctermsRightsStatement;
  dcterms:description "IPUMS-International distributes
        integrated microdata of individuals and households only by agreement ...
        designed to extend this record.";
    rdfs:seeAlso <http://microdata.worldbank.org/index.php/catalog/442/accesspolicy>.
```

Figure 4 shows us the information about access policies, which typically is of interest to those searching for data.

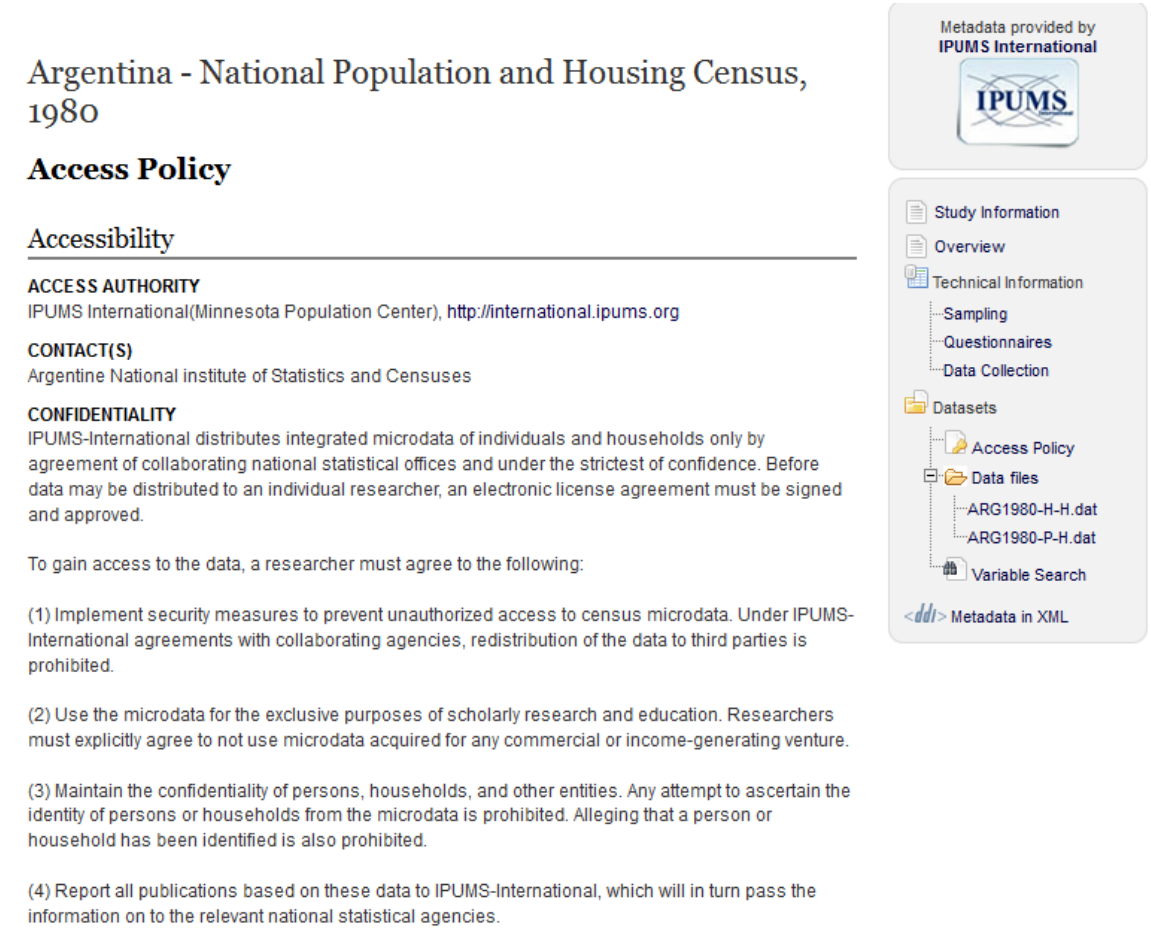


Figure 4 Access Policy

The Unit of Analysis and Kind of Data further describe the study.

EXAMPLE 4

```
ddi:AnalysisUnit_1 a disco:AnalysisUnit ;
    skos:definition "Dwelling, quarter dwelling, census household, and population"@en .

ddi:KindOfData_1 a skos:Concept ;
        rdfs:label "Census/enumeration data [cen]"@en .
```

In some cases we may have a lot of information about the questionnaires used, and it is very common to search for data by the text of the question used to collect it. Sometimes there will be a PDF of a questionnaire, and sometimes question text may be linked to individual variables within a file. In this case, we have only a textual description of the set of forms used in the census (Figure 5).

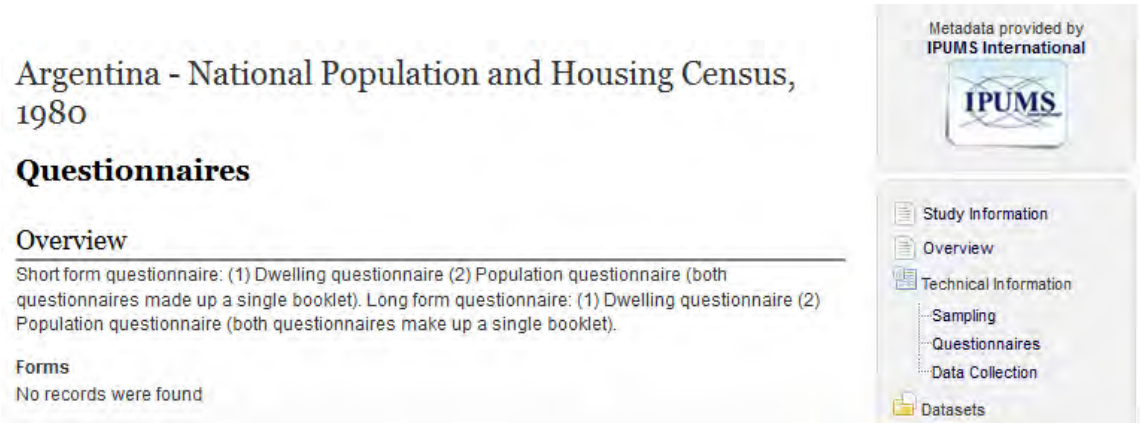


Figure 5 Questionnaires

The following example illustrates three questions. Each question does have a text.

EXAMPLE 5

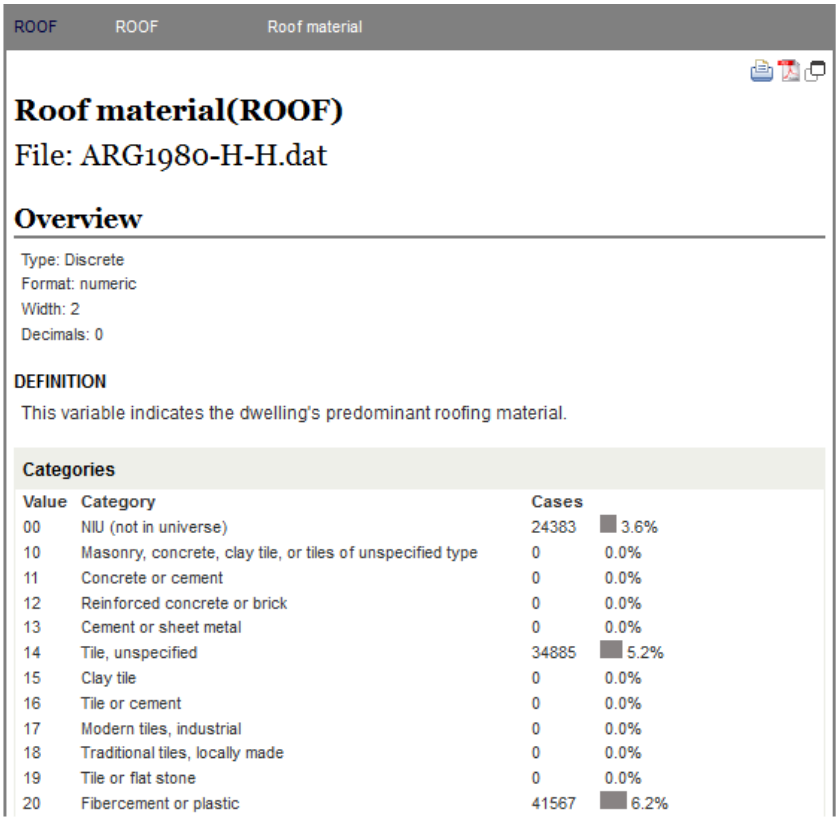
```
ddi:Questionnaire_1 a disco:Questionnaire;
    disco:question ddi:QuestionGender;
    disco:question ddi:QuestionAge;
    disco:question ddi:QuestionCitizenship.

ddi:QuestionGender a disco:Question;
    disco:questionText "2. Is the person a man or a woman? [] Man, [] Woman"@en.

ddi:QuestionAge a disco:Question;
    disco:questionText "3. What is his or her age? _ _ Mark the age in completed
                years at the date of the census for those younger than one year old mark
                00. For those younger than 10 years old, mark 01, 02, 03, etc. For those
                older than 99 years old, mark 99."@en.

ddi:QuestionCitizenship a disco:Question;
    disco:questionText "6. [Immigration status] Only for persons who have usual
                residence in Argentina and were born in another country. [Questions 6A
                and 6B asked only of persons born outside Argentina and who currently
                reside in Argentina.] B. Are you a naturalized citizen of Argentina?
                [] Yes [] No [] Unanswered"@en.
```

In Figure 6 we see the list of variables contained in the data file. For each of these we will also have a detailed view, showing the codes and categories used to encode the actual responses in the variables (Figure 7).

Variables

ID	NAME	LABEL	QUESTION
RECTYPE	RECTYPE	Record type	
CNTRY	CNTRY	Country	
YEAR	YEAR	Year	
SAMPLE	SAMPLE	IPUMS sample identifier	
SERIAL	SERIAL	Household serial number	
PERSONS	PERSONS	Number of person records in the household	
WTHH	WTHH	Household weight	
SUBSAMP	SUBSAMP	Subsample number	
GQ	GQ	Group quarters status	
UNREL	UNREL	Number of unrelated persons	
URBAN	URBAN	Urban-rural status	
REGIONW	REGIONW	Continent and region of country	

Figure 6 Variables List



ROOF ROOF Roof material

Roof material(ROOF)

File: ARG1980-H-H.dat

Overview

Type: Discrete
Format: numeric
Width: 2
Decimals: 0

DEFINITION

This variable indicates the dwelling's predominant roofing material.

Categories

Value	Category	Cases	
00	NIU (not in universe)	24383	3.6%
10	Masonry, concrete, clay tile, or tiles of unspecified type	0	0.0%
11	Concrete or cement	0	0.0%
12	Reinforced concrete or brick	0	0.0%
13	Cement or sheet metal	0	0.0%
14	Tile, unspecified	34885	5.2%
15	Clay tile	0	0.0%
16	Tile or cement	0	0.0%
17	Modern tiles, industrial	0	0.0%
18	Traditional tiles, locally made	0	0.0%
19	Tile or flat stone	0	0.0%
20	Fibercement or plastic	41567	6.2%

Figure 7 Variable Details

Any variable has a text and is based on a variable definition.

NOTE

Please note that the turtle example describes the variable labels from the screenshot above and references to the related represented variable and question.

EXAMPLE 6

```
ddi:AR80A401 a disco:Variable;
    dcterms:identifier "AR80A401";
    skos:prefLabel "Sex"@en, "Sexe"@fr;
    dcterms:description "This variable indicates the person's gender."@en;
    disco:basedOn ddi:SexVD;
    disco:question ddi:QuestionGender.

ddi:AR80A402 a disco:Variable;
    dcterms:identifier "AR80A402";
    dcterms:description "This variable indicates the person's age in years."@en;
    skos:prefLabel "Age"@en, "Âge"@fr.
    disco:basedOn ddi:AgeVD;
    disco:question ddi:QuestionAge.

ddi:AR80A407 a disco:Variable;
    dcterms:identifier "AR80A407";
    dcterms:description "This variable indicates whether or not the person is
                a naturalized citizen of Argentina."@en;
    skos:prefLabel "Citizenship"@en, "Citoyenneté"@fr;
    disco:basedOn ddi:CitizenshipVD;
    disco:question ddi:QuestionCitizenship.
```

Any variable definition has a representation defining the possible values of a variable. Also, a variable definition has its own universe (may be the same as the study or possibly narrower) and (DDI) concepts further describing the variable.

EXAMPLE 7

```
ddi:SexVD a disco:RepresentedVariable;
    disco:universe ddi:UniversePerson;
```

```
    disco:representation ddi:SexRepr;
    disco:concept ddi:IpumsC1;
    skos:prefLabel "Sex"@en, "Sexe"@fr;
    dcterms:description "Sex data element"@en.

ddi:SexRepr a skos:ConceptScheme, disco:Representation;
    skos:hasTopConcept ddi:SexM, ddi:SexF.

ddi:SexM a skos:Concept;
    skos:notation "1";
    skos:prefLabel "Male"@en, "Homme"@fr;
    skos:inScheme ddi:SexRepr.

ddi:SexF a skos:Concept;
    skos:notation "2";
    skos:prefLabel "Female"@en, "Femme"@fr;
    skos:inScheme ddi:SexRepr.

ddi:ageVD a disco:RepresentedVariable;
    disco:universe ddi:UniversePerson;
    disco:representation ddi:AgeRepr;
    disco:concept ddi:IpumsC1;
    skos:prefLabel "Age"@en, "Âge"@fr;
    dcterms:description "Age data element"@en.

ddi:AgeRepr a skos:ConceptScheme, disco:Representation;
    skos:hasTopConcept ddi:Age0, ddi:Age1, ddi:Age99.

ddi:Age0 a skos:Concept;
    skos:notation "0";
    skos:prefLabel "0";
    skos:inScheme ddi:AgeRepr.

ddi:Age1 a skos:Concept;
    skos:notation "1";
    skos:prefLabel "1";
    skos:inScheme ddi:AgeRepr.

# ...

ddi:Age99 a skos:Concept;
    skos:notation "99";
    skos:prefLabel "99";
    skos:inScheme ddi:AgeRepr.

ddi:CitizenshipVD a disco:RepresentedVariable;
    disco:universe ddi:UniverseNonArgentines;
    disco:representation ddi:CitizenshipRepr;
    disco:concept ddi:IpumsC2;
    skos:prefLabel "Citizenship"@en;
    dcterms:description "Citizenship data element"@en.

ddi:CitizenshipRepr a skos:ConceptScheme, disco:Representation;
    skos:hasTopConcept ddi:CYes, ddi:CNo, ddi:CUnknown, ddi:CNIU.

ddi:CYes a skos:Concept;
    skos:notation "1";
    skos:prefLabel "Yes";
    skos:inScheme ddi:CitizenshipRepr.

ddi:CNo a skos:Concept;
    skos:notation "2";
    skos:prefLabel "No";
    skos:inScheme ddi:CitizenshipRepr.

ddi:CUnknown a skos:Concept;
    skos:notation "8";
    skos:prefLabel "Unknown";
    skos:inScheme ddi:CitizenshipRepr.

ddi:CNIU a skos:Concept;
    skos:notation "9";
    skos:prefLabel "NIU (not in universe)";
    skos:inScheme ddi:CitizenshipRepr.
```

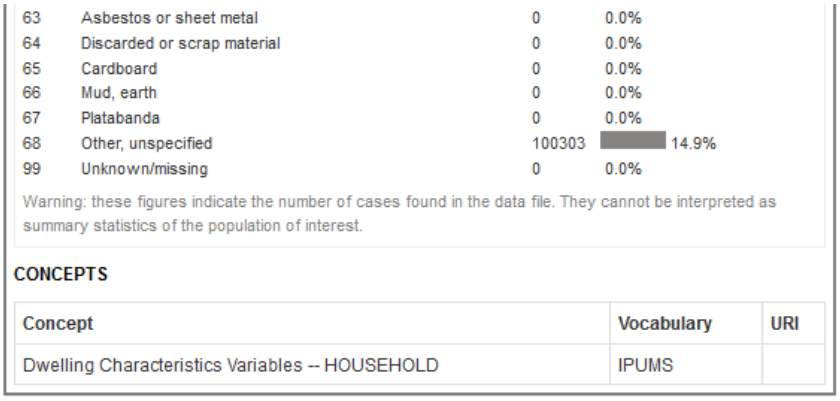
Any universe of a variable definition is a subset of the universe of the entire study. In our example, two questions

are addressing the universe of persons, the third question is addressing a specific subset of the universe of persons.

EXAMPLE 8

```
ddi:UniversePerson a disco:Universe;
    skos:definition "All persons."@en ;
    skos:narrower ddi:Universe_1.

ddi:UniverseNonArgentines a disco:Universe;
    skos:definition "Foreign-born persons who reside in Argentina."@en ;
    skos:narrower ddi:Universe_1;
    skos:narrower ddi:UniversePerson.
```

At the bottom of the screen showing the variable detail, we can see that the variable for roofing material is associated with a high-level concept, “Dwelling characteristics variables.” (Figure 8.)



63	Asbestos or sheet metal	0	0.0%
64	Discarded or scrap material	0	0.0%
65	Cardboard	0	0.0%
66	Mud, earth	0	0.0%
67	Platabanda	0	0.0%
68	Other, unspecified	100303	14.9%
99	Unknown/missing	0	0.0%

Warning: these figures indicate the number of cases found in the data file. They cannot be interpreted as summary statistics of the population of interest.

CONCEPTS

Concept	Vocabulary	URI
Dwelling Characteristics Variables -- HOUSEHOLD	IPUMS	

Figure 8 Concept-Variable Link

In Disco, DDI concepts can be hierarchically structured

EXAMPLE 9

```
ddi:IpumsCS a skos:ConceptScheme;
    skos:hasTopConcept ddi:IpumsC1.

ddi:IpumsC1 a skos:Concept;
    skos:prefLabel "Demographic Variables - PERSON"@en, "Variables démographiques - PERSONNE"@fr;
    skos:inScheme ddi:IpumsCS.

ddi:IpumsC2 a skos:Concept;
    skos:prefLabel "Nativity and Birthplace Variables -- PERSON"@en;
    skos:inScheme ddi:IpumsCS.
```

The variable within a data file can be described using category statistics. In the following example, absolute and relative frequencies of the variable categories are described. This variable represents the sex of the respondent. A variable is represented by a code list containing the code, the category statistics resource is pointing to.

EXAMPLE 10

```
ddi:CatStatistics_1 a disco:CategoryStatistics;
    disco:frequency 13314444;
    disco:percentage 49.97;
    disco:statisticsCategory ddi:SexM;
    disco:statisticsDataFile ddi:Datafile_1.

ddi:CatStatistics_2 a disco:CategoryStatistics;
    disco:frequency 1336270;
    disco:statisticsCategory ddi:SexF;
    disco:statisticsDataFile ddi:Datafile_1.
```

Next we find some general information about the data files produced by this study (Figure 9).

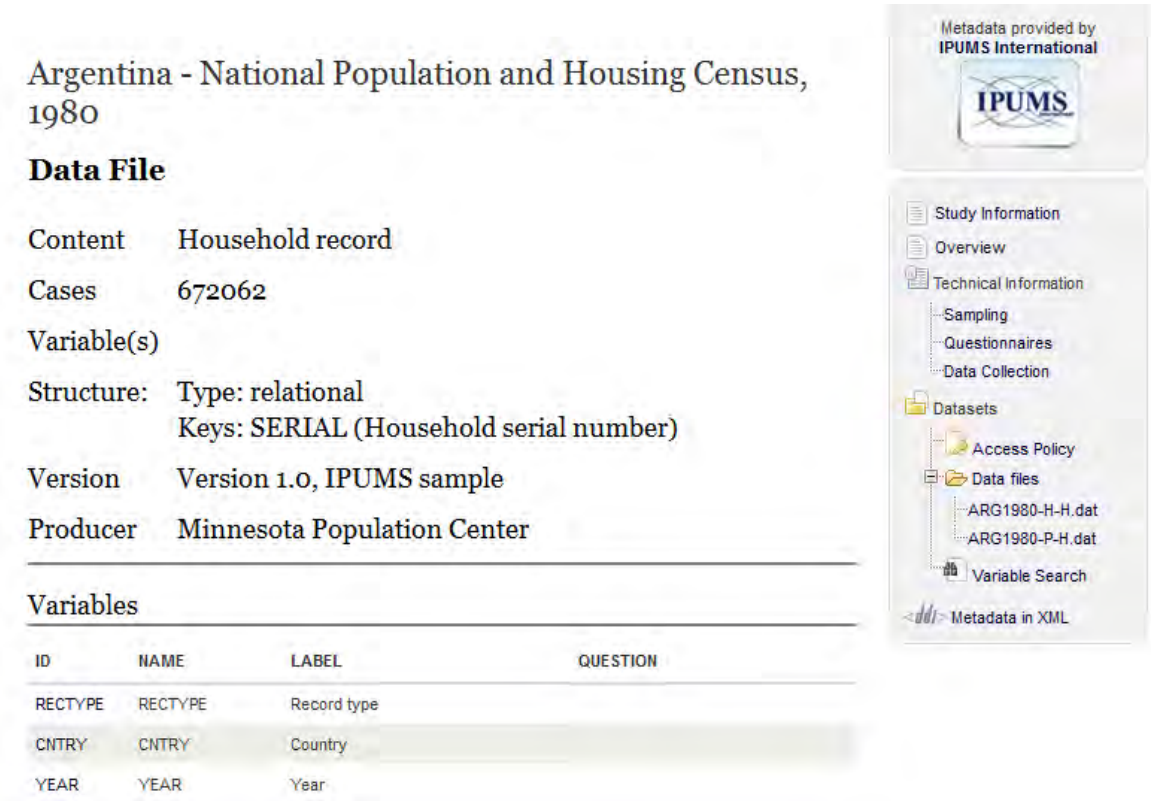


Figure 9 General Data Set Information

Finally, the data file more concretely describes the actual physical file.

EXAMPLE 11

```
ddi:Datafile_1 a disco:Datafile;
    dcterms:identifier "ARG1900-P-H.dat";
    dcterms:description "Person records"@en;
    disco:caseQuantity 2667714;
    dcterms:format "ascii";
    dcterms:provenance "Minnesota Population Center"@en;
    owl:versionInfo "Version 1.0, IPUMS sample"@en;
    dcterms:spatial [
        # This is the DC-strictly compatible way to do it
        a dcterms:Location;
        rdfs:label "Argentina, national coverage"@en
    ];
    dcterms:temporal "PeriodOfTime"@en;
    dcterms:subject "To be defined"@en.
```

§ 5. Studies and StudyGroups

A simple `Study` supports the stages of the full data lifecycle in a modular manner. A `Study` represents the process by which a data set was generated or collected. Literal properties include information about the funding, organizational affiliation, abstract, title, version, and other such high-level information. The key criteria for a study are: a single conceptual model (e.g. survey research concept), a single instrument (e.g. questionnaire) made up of one or more parts (ex. employer survey, worker survey), and a single logical data structure of the initial raw data (multiple data files can be created from this such as a public use microdata file or aggregate data files). In some cases, where data collection is cyclic or on-going, data sets may be released as a `StudyGroup`, where each cycle or "wave" of the data collection activity produces one or more data sets. This is typical for longitudinal studies, panel studies, and other types of "series" (to use the DDI term). In this case, a number of `Study` objects would be collected into a single `StudyGroup`.

Studies (`Study`) may be contained in at most 1 `StudyGroup` and groups of studies may include 0 to n studies. Studies (`Study`) may have 0 to n instruments (`Instrument`) relationships to instruments (`Instrument`). Particular instruments (`Instrument`), however, are connected with exactly 1 `Study`. Studies (`Study`) may have `DataFile` connections with 0 to n data files (`DataFile`) and data files (`DataFile`) must have 1 to n `DataFile` relationships to studies (`Study`). Studies (`Study`) are associated with 0 to n variables (`Variable`) using the object property `Variable`. On the other hand,

variables (Variable) must be related to 1 to n studies (Study). Studies (Study) may have 0 to n logical data sets (LogicalDataSet) (product) and logical data sets (LogicalDataSet) must have 1 to n product relationships to studies (Study).

§ 5.1 Coverage, References to DDI-XML Files, and Kind of Data

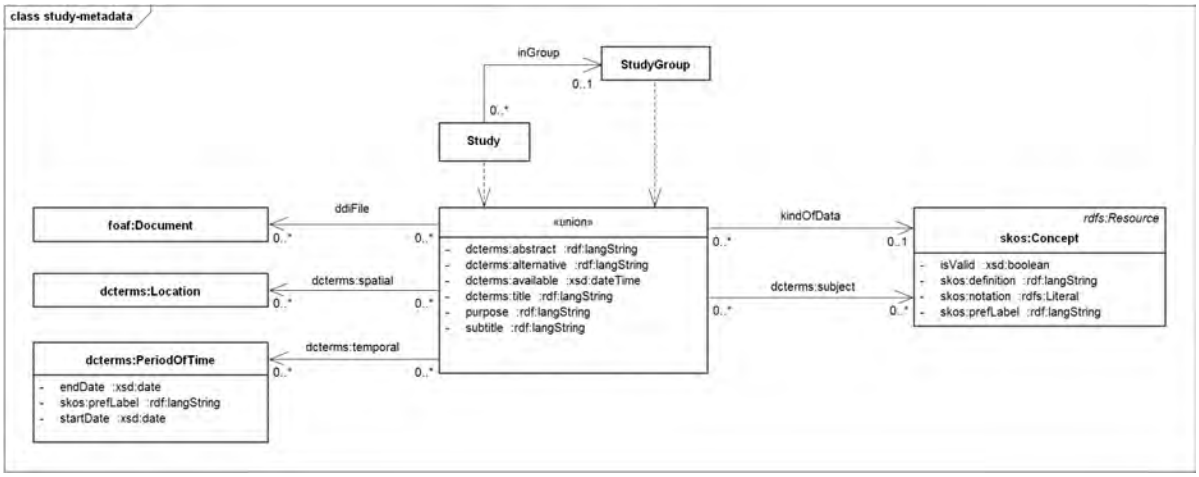


Figure 10 Coverage, References to DDI-XML Files, and Kind of Data

Studies (Study) or groups of studies (StudyGroup) (the union of **Study** and groups of studies (**StudyGroup**)) may have different datatype properties. Studies (Study) or groups of studies (StudyGroup) may have an abstract (dcterms:abstract), a title (dcterms:title), a subtitle (subtitle), an alternative title (dcterms:alternative), a purpose (purpose), and information about the date and the time since when the Study is publicly available (dcterms:available). Studies (Study) or groups of studies (StudyGroup) may have multiple object properties. The object properties kindOfData and dcterms:subject guide to skos:Concepts. kindOfData describes, with a string or a term from a controlled vocabulary, the kind of data documented in the logical product(s) of a Study. Examples include survey data, census/enumeration data, administrative data, measurement data, assessment data, demographic data, voting data, etc. Coverage describes the temporal, spatial and topical coverage of a study. Coverage specifies the population from which observations for a particular topic can be drawn. You can use dcterms:subject to describe the topical coverage of studies (Study) and groups of studies (StudyGroup). ddiFile to foaf:Documents which are the DDI-XML files containing further descriptions of the Study or the StudyGroup. Use dcterms:temporal for temporal coverages related to the union of studies (Study) and groups of studies (StudyGroups). For the spatial coverage use dcterms:spatial. The cardinalities of all the object properties are in both directions 0 to n. The only exception is that studies (Study) and groups of studies (StudyGroup) may have 0 or 1 kindOfData relationships to skos:Concepts.

§ 5.2 Relationships to Agents

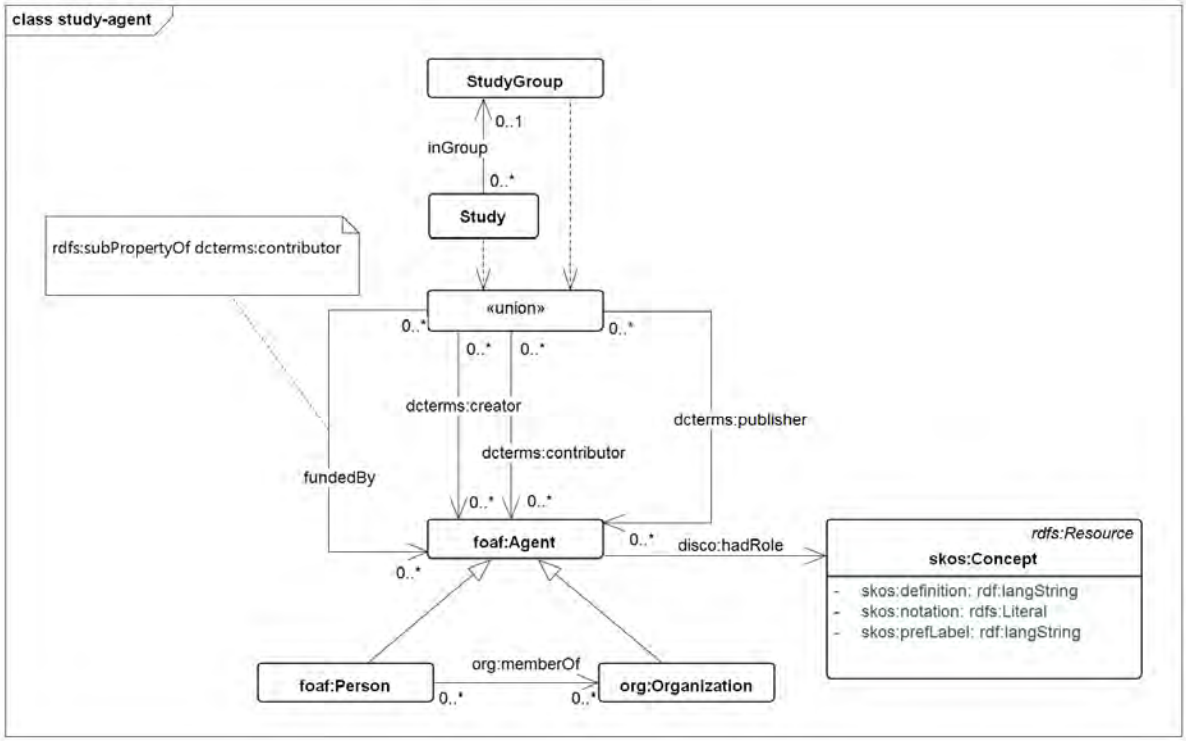


Figure 11 Relationships to Agents

Creators (`dcterms:creator`), contributors (`dcterms:contributor`), and publishers (`dcterms:publisher`) of Studies (`Study`) and groups of studies (`StudyGroup`) are `foaf:Agents` which are either `foaf:Persons` or `org:Organizations` whose members are `foaf:Persons`. Studies (`Study`) or groups of studies (`StudyGroup`) may be funded by (`fundedBy`) `foaf:Agents`. The object property `fundedBy` is defined as sub-property of `dcterms:contributor`. The cardinalities of these object properties are in both directions always 0 to n. `foaf:Agents` may have roles such as analyst, data modeler, programmer, and co-investigator. These roles are represented using `skos:Concepts`. `foaf:Agents` and `skos:Concepts` are related by `disco:hadRole`. Roles can be defined (`skos:definition`), identified (`skos:notation`), and described (`skos:prefLabel`).

§ 5.3 Analysis Units and Universes

`Universe` is the total membership or population of a defined class of people, objects or events. A population is the number of statistical units sharing at least one common property which is of interest in a statistical analysis. There are two types of population, target population and survey population. A target population is the population outlined in the survey objects about which information is to be sought. A survey population (also known as the coverage of the survey) is the population from which information can be obtained in the survey. `AnalysisUnit` is defined as follows: The process of collecting data focuses on the analysis of a particular type of subject. If, for example, the adult population of Finland is being studied, the `AnalysisUnit` would be individuals or persons.

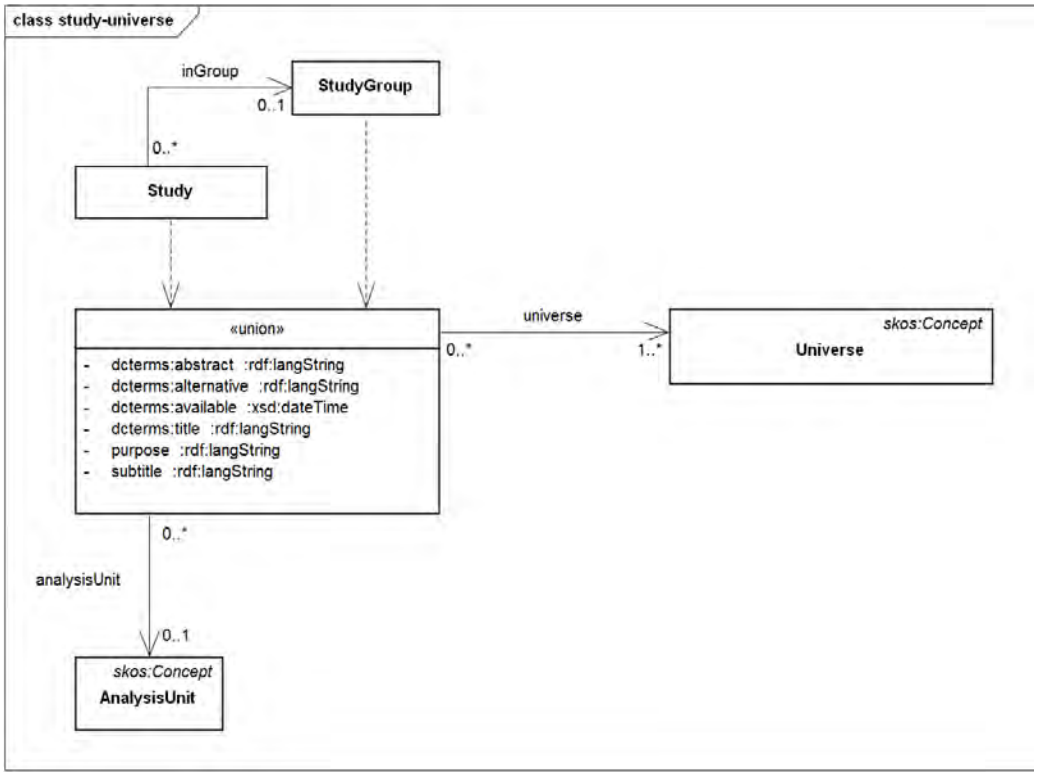


Figure 12 Study, Universe and AnalysisUnit

Studies (`Study`) and groups of studies (`StudyGroup`) must have 1 to n universes (`Universe`) and 1 particular `Universe` may be in a `Universe` relationship with 0 to n unions of Studies (`Study`) and groups of studies (`StudyGroup`). Universes (`Universe`) are sub-classes of `skos:Concepts`. For universes (`Universe`) you can state definitions using `skos:definition`. The union of `Study` and `StudyGroup` may have 0 or 1 `AnalysisUnit` reached by the object property `AnalysisUnit` and a specific `AnalysisUnit` may be in a `AnalysisUnit` relationship to 0 to n studies (`Study`) or groups of studies (`StudyGroup`). `AnalysisUnit` is specified as a sub-class of `skos:Concepts`.

§ 6. General Metadata

§ 6.1 Identification

In DDI, a lot of entities hold particular identifiers. This can be identifiers for different versions of DDI, but also persistent identifiers for, e.g. persons or organizations, that are encoded in a particular identifier scheme, e.g. ORCID or FundRef. In general, such identifiers can be added to each entitiy in DDI-RDF, since every entity is defined as an `rdfs:Resource`. General metadata elements which can be used on every resource in a DDI-RDF description include:

- `skos:prefLabel` (`rdf:langString`): the preferred label of this element
- `adms:identifier` (`rdfs:Resource`, `adms:Identifier`): the identifier of this element

Each Disco resource must have an identifier (see figure below). The identifier is stated using the object property adms:identifier pointing from any rdfs:Ressource to 1 to n identifiers (adms:Identifier). The class adms:Identifier can include the actual identifier itself and information on identifier scheme, its version, and its agency.

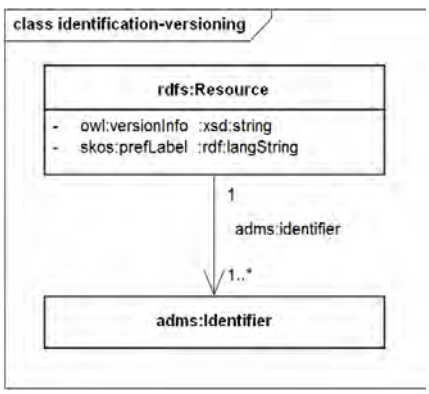


Figure 13 Identification

EXAMPLE 12

```
ddi:Study_1 a disco:Study;
  dcterms:title "National Population and Housing Census, 1980"@en;
  adms:identifier [ a adms:Identifier;
    skos:notation "us:ddi:us.mpc:ARG_1980_PHC_v01_A_IPUMS:1";
    adms:schemaAgency "DDI Alliance"@en.
  ];
  dcterms:creator [
    rdfs:label "Minnesota Population Center"@en;
    skos:notation "MPC";
    adms:identifier [ a adms:Identifier;
      skos:notation "us.mpc";
      adms:schemaAgency "DDI Alliance"@en.
    ];
  ].
```

See section 'Asset Description Metadata Schema (ADMS)' for more information about the reuse of ADMS for representing identifiers.

§ 6.2 Versioning Information

Use of the `owl:versionInfo` property is recommended to indicate the version number and/or additional versioning text of entities.

Any entity can have version information. As you can see in the next UML class diagram, the property owl:versionInfo has rdfs:Resource as domain. As a consequence, each DDI object can have attached versioning information. However, the most typical cases are:

- Version of the metadata (e.g., DDI file or RDF file), where the subject is the URL of the file
- Version of the study (e.g., as a study goes through the life cycle from conception through data collection, etc.), where the subject is a `Study`
- Version of the data files, where the subject is a `DataFile`.

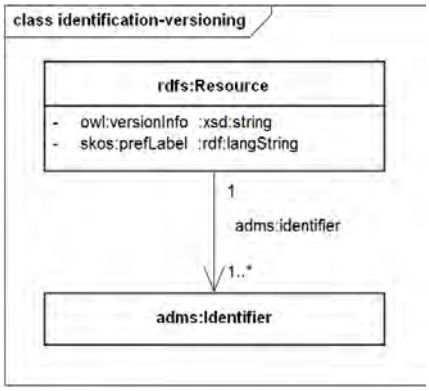


Figure 14 Versioning Information

§ 6.3 Links to Related Files

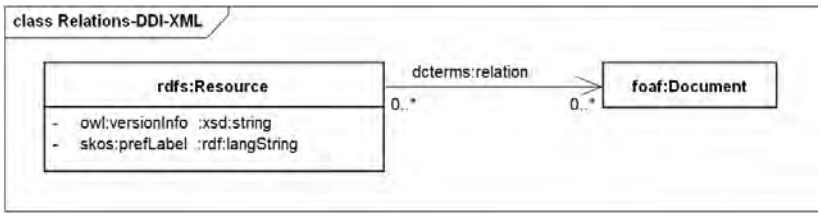


Figure 15 Links to Related Files

§ 6.3.1 Relations to DDI-XML Files

Since the Discovery Vocabulary only covers a subset of an original DDI-XML file, it may be worthwhile to have a relationship to the original DDI-XML file. Such a relationship can be represented using `dcterms:relation`. This way, every element can be related to any `foaf:Document`. The cardinalities are in both directions 0 to n.

§ 6.3.2 Relations Between Publications and Studies

So far, we can use the general property `dcterms:relation` for relations between publications and studies. The domain of `dcterms:relation` is `rdfs:Resource` and the range is `foaf:Document`. Other kinds of relations could be primaryLiterature and secondaryLiterature.

§ 6.4 Access Rights Statements and Licenses

Every logical dataset may have access rights statements and licensing information attached to it. For those purposes, the Dublin Core properties `dcterms:accessRights` and `dcterms:license` are used.

Access rights are defined in a **`dcterms:RightsStatement`** object, which may reference an external document stating the access rights in more detail (`rdfs:seeAlso`). For `dcterms:RightsStatements` descriptions (`dcterms:description`) and labels (`skos:prefLabel`) can be assigned:

EXAMPLE 13

```
ddi:Dataset_1 a disco:LogicalDataSet ;
  dcterms:accessRights ex:AccessRights1 .

ddi:AccessRights_1 a dcterms:RightStatement ;
  dcterms:description "Everybody may see access this document." ;
  rdfs:seeAlso <http://www.example.org/access.html> .
```

License information is captured in a **`dcterms:LicenseDocument`**, which is a subtype of `dcterms:RightsStatements`:

EXAMPLE 14

```
ddi:Dataset_1 a disco:LogicalDataSet ;
  dcterms:license ddi:License_1 .

ddi:License_1 a dcterms:LicenseDocument ;
  dcterms:description "Published under Open Content License." ;
  skos:prefLabel "OCL 1.0" ;
  rdfs:seeAlso <http://opencontent.org/opl.shtml> .
```

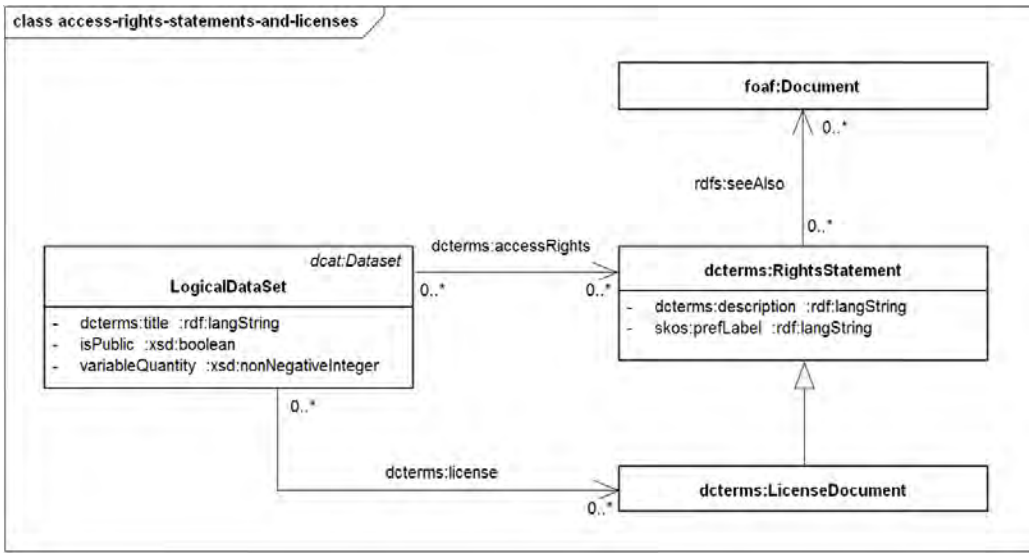


Figure 16

Access Rights Statements and Licenses

Logical data sets (`LogicalDataSet`) may have `dcterms:accessRights` relationships to `dcterms:RightsStatements` and `dcterms:license` connections with `dcterms:LicenseDocument`. `dcterms:RightsStatements` is associated with `foaf:Documents` using the object property `rdfs:seeAlso`. The multiplicities for these object properties are in any case 0 to n.

§ 6.5 Coverage of Studies, Logical Datasets, and Data Files

Coverage comprehends the key features of the scope of the data (e.g. geographic product occupation). Studies (`Study`), logical datasets, and data files may have a spatial, temporal, and topical coverage. Unlike in DDI-XML, there is no dedicated Coverage type in DDI-RDF. The comprehensive description by spatial, temporal, and topical coverage is directly attached to the respective study, logical dataset, and datafile (using DCMI terms).

For spatial coverage, `dcterms:spatial` is used, pointing to any geographic location (`dcterms:Location`):

EXAMPLE 15

```
ddi:Study_1 dcterms:spatial <http://sws.geonames.org/2921044/> .
```

In this example, Geonames is used to refer to a spatial region, in this case, the country Germany. Geonames provides URIs for continents, countries, regions, and cities, among others, and is therefore a possible option to use for describing spatial coverage.

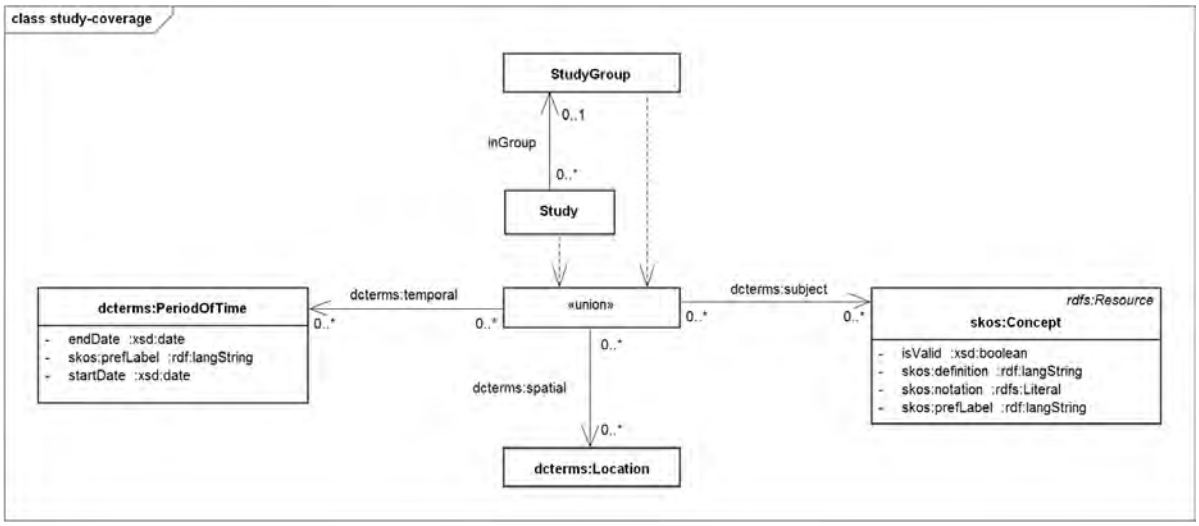


Figure 17 Study Coverage

For temporal coverage, `dcterms:temporal` is used pointing to `dcterms:PeriodOfTime`. For time periods, labels can be attachted (`skos:prefLabel`). It is also possible to define start (`startDate`) and end dates (`endDate`). Please note that these properties are a feature at risk, since the domain is not Disco. Maintainers of the domain ontology may introduce their own properties for this purpose. A possible way to describe temporal coverage is the use of the W3C time ontology:

EXAMPLE 16

```
ddi:Study_1 dcterms:temporal [
  a time:Interval ;
  time:hasBeginning [ time:inXSDDateTime
    "2012-01-01T00:00:00+01:00"^^xsd:dateTime ];
  time:hasEnd [ time:inXSDDateTime
    "2012-01-31T23:59:59+01:00"^^xsd:dateTime ] ] .
```

This example describes a study that has been conducted between January 1st and January 31st.

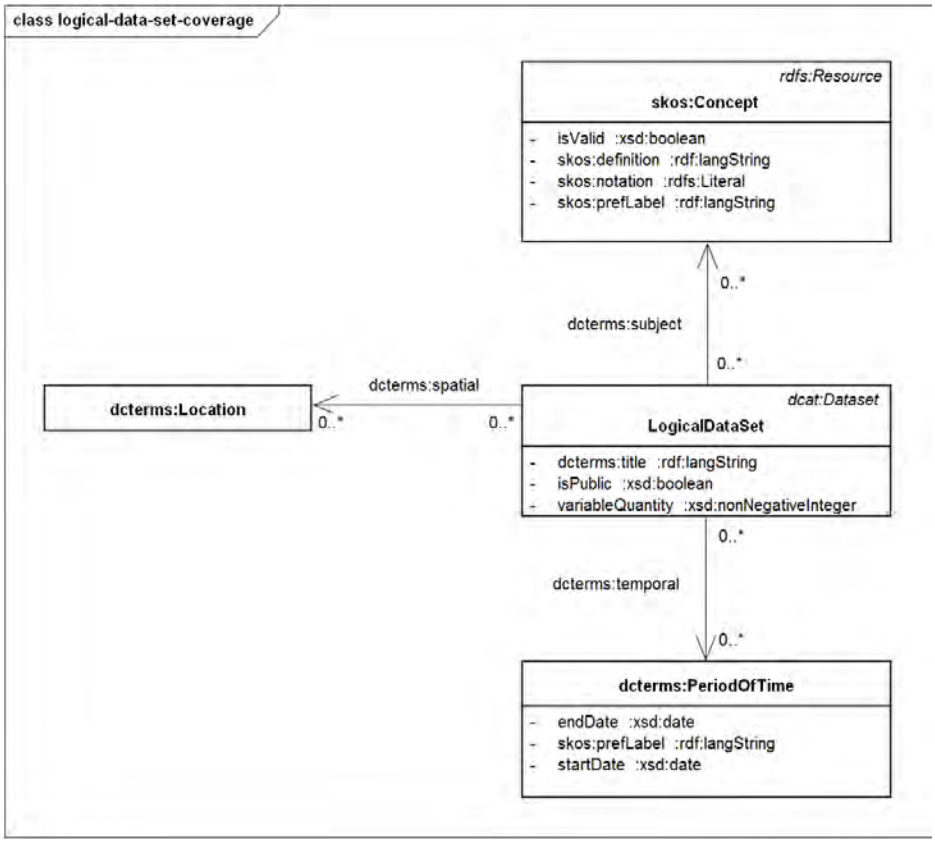


Figure 18 LogicalDataSet Coverage

Topical coverage can be expressed using `dcterms:subject`. DDI-RDF foresees the use `skos:Concept` for the description of topical coverage:

EXAMPLE 17

```
ddi:Study_1 dcterms:subject [
  a skos:Concept ;
  skos:prefLabel "Alcohol consumption" ] .
```

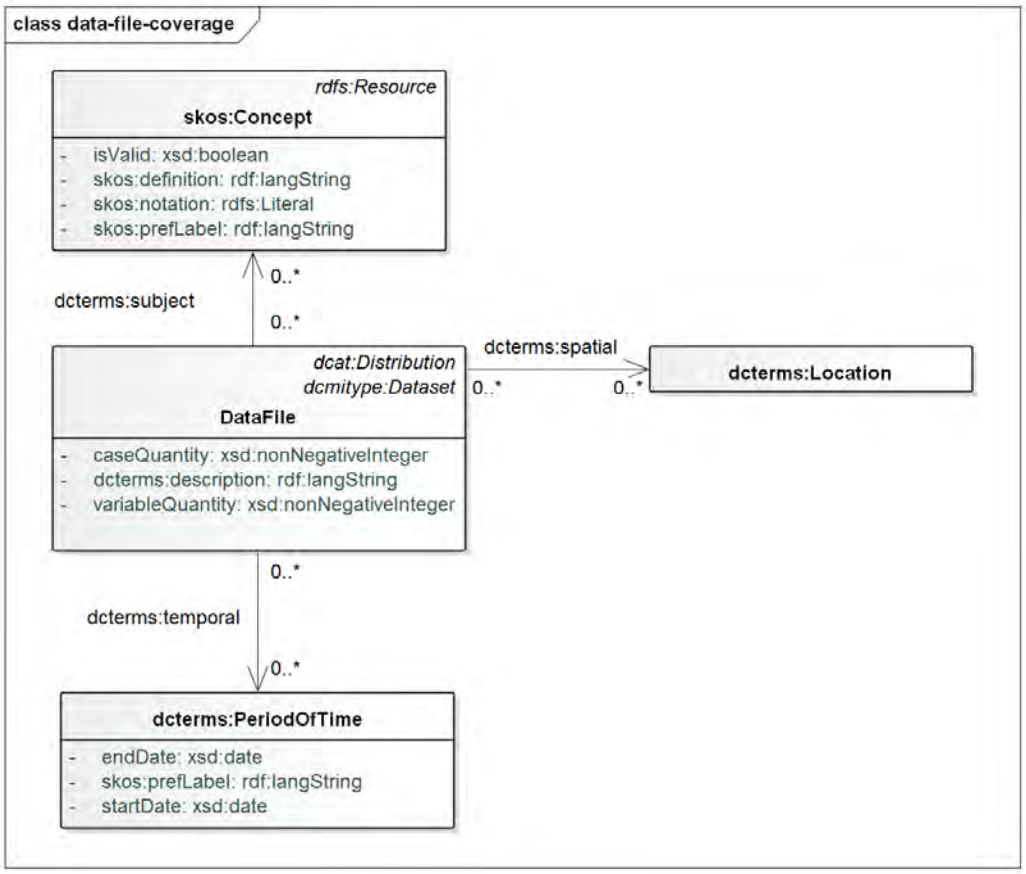


Figure 19

DataFile Coverage

The multiplicities for each of the three object properties `dcterms:subject`, `dcterms:temporal`, and `dcterms:spatial` are in any case 0 to n.

§ 6.6 Other General Dublin Core Metadata Properties

The following elements from Dublin Core may be used to describe general metadata of DDI-RDF elements (see the DC definitions for more detailed descriptions):

- `dcterms:abstract` (used with `Study`): an abstract of the study
- `dcterms:alternative` (used with `Study`): an alternative name for the study
- `dcterms:available` (used with `Study`): the date (or date range) at which this study has or will become available
- `dcterms:title` (used with `Study`, `LogicalDataSet`): the element's title
- `dcterms:description` (used with `RepresentedVariable`, `DataFile`, `Instrument`, `Variable`, `dcterms:RightsStatement`): a human readable description of the element
- `dcterms:provenance` (used with `DataFile`): defines the provenance information for the data file. The object is a `dcterms:ProvenanceStatement`.

§ 7. Data Sets, Data Files, and Descriptive Statistics

Data sets have two representations in our model: a logical representation, which describes the contents of the data set, and a physical representation, which is a distributed file holding that data. It is possible to format data files in many different ways, even if the logical content is the same. In our model the `LogicalDataSet` represents the content of the file (its organization into a set of variables (`Variable`)). The `LogicalDataSet` is an extension of the `dcat:DataSet` class. Physical, distributed files are represented by the class `DataFile`, which is itself an extension of the `dcat:Distribution`. `DescriptiveStatistics` , i.e. `SummaryStatistics` as well as `CategoryStatistics`, are associated with data files (`DataFile`) by the object property `statisticsDataFile`. Descriptive statistics simply describe what the data shows. See also the entry on descriptive statistics in the OECD glossary of statistical terms.

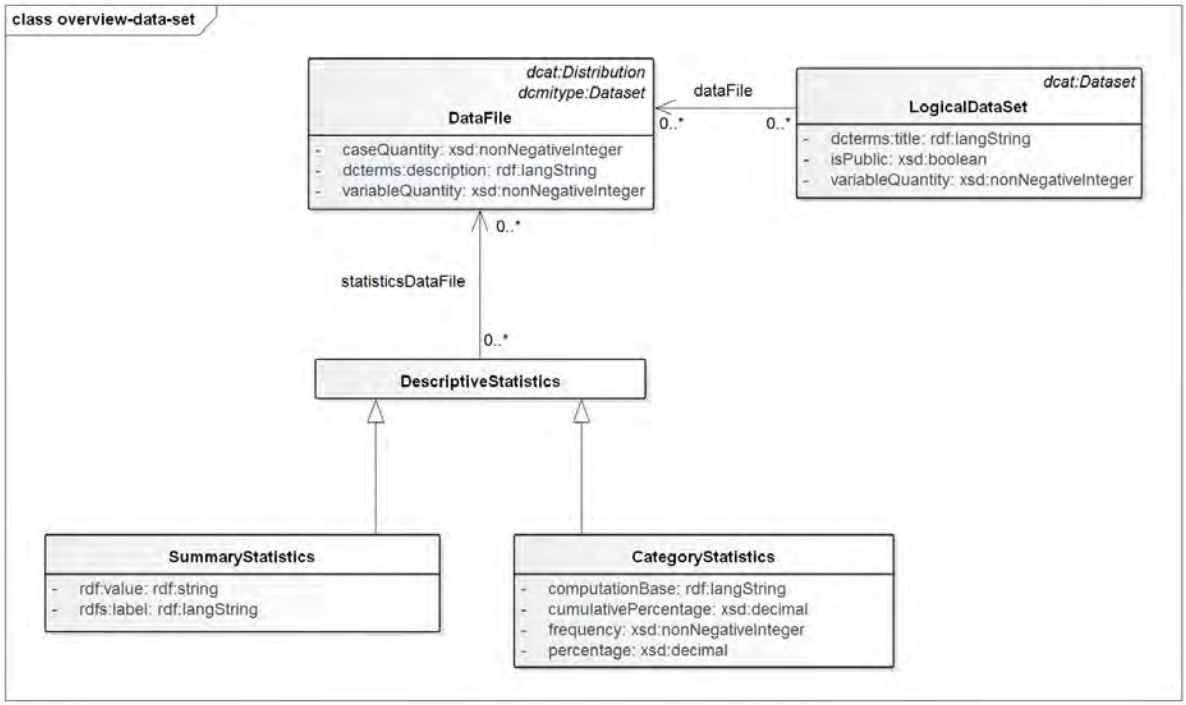


Figure 20 Overview: Data Sets, Data Files, Descriptive Statistics

Logical data sets (`LogicalDataSet`) and data files (`DataFile`) are connected using the object property data files (`DataFile`). A specific logical data set (`LogicalDataSet`) may be linked to 0 to n data files (`DataFile`) and a particular `DataFile` may be connected with 0 to n logical data sets (`LogicalDataSet`) via `DataFile`. `DescriptiveStatistics` are accociated with data files (`DataFile`) by the object property `statisticsDataFile`. A concrete `DescriptiveStatistics` object may have `statisticsDataFile` relationships to multiple (0 - n) data files (`DataFile`). Data files (`DataFile`), however, may have 0 to n `statisticsDataFile` relations to `DescriptiveStatistics` instances.

§ 7.1 LogicalDataSet

Each study has a set of logical metadata (`LogicalDataSet`) associated with the processing of data, at the time of collection or later during cleaning, and re-coding. `LogicalDataSet` represents the microdata dataset.

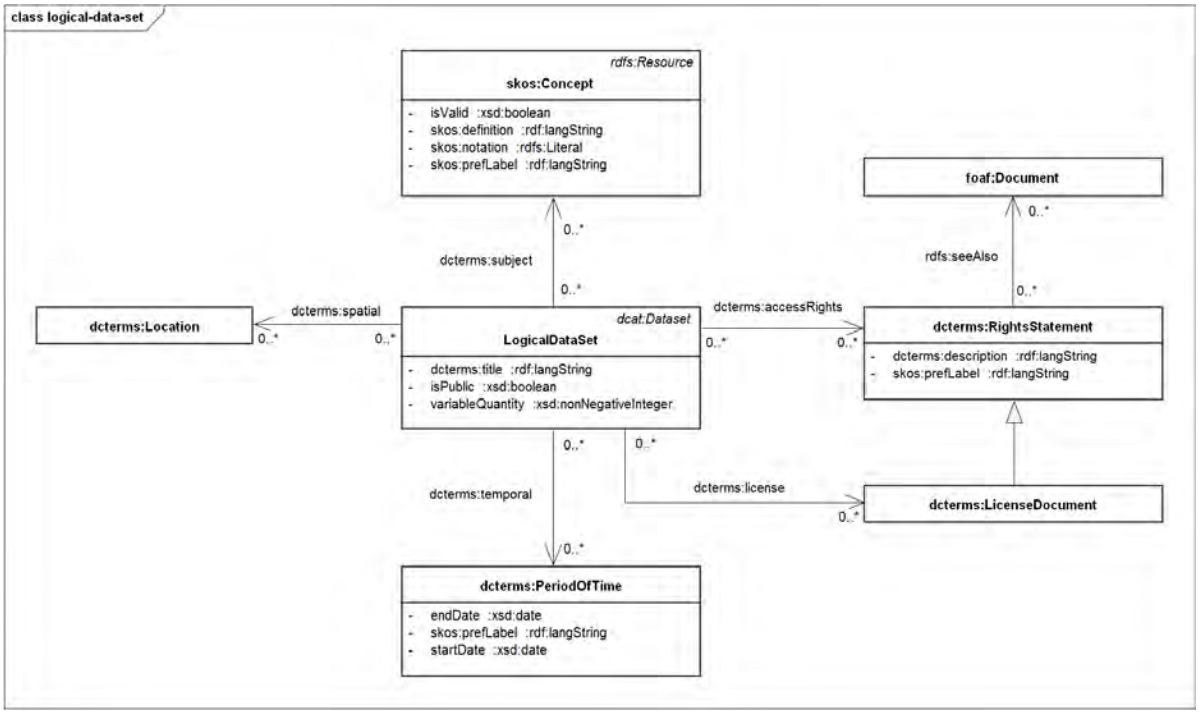


Figure 21 LogicalDataSet

`LogicalDataSet` is defined as a sub-class of `dcat:Dataset`. You can state a title (`dcterms:title`) and a flag indicating if the microdata dataset is publicly available (isPublic). You can specify access rights (`dcterms:accessRights`) and LicenseStatements (`dcterms:license`) for microdata datasets. For a `LogicalDataSet` the three dimensions of coverage

can be specified: Spatial (dcterms:spatial), temporal (dcterms:temporal), and topical (dcterms:subject). The cardinalities of the object properties dcterms:spatial, dcterms:temporal, dcteerms:subject, dcterms:accessRights, and dcterms:license are 0 to n. Microdata datasets may have Instrument associations to multiple (0 - n) instruments (Instrument) and instruments (Instrument) are connected with multiple (0 - n) logical data sets (LogicalDataSet). Each LogicalDataSet has exactly 1 Universe (Universe) and one specific Universe may be in multiple (0 - n) Universe relations to logical data sets (LogicalDataSet). Logical data sets (LogicalDataSet) may contain (variable) 0 to n variables (Variable) and variables (Variable) must be contained in 1 to n logical data sets (LogicalDataSet). Logical data sets (LogicalDataSet) can be aggregated (aggregation) to 0 to n data sets (qb:DataSet) and data sets (qb:DataSet) can be aggregations of 0 to n logical data sets (LogicalDataSet). At last, logical data sets (LogicalDataSet) refer to 0 to n data files (DataFile) using the object property data files (DataFile) and data files (DataFile) may be linked to 0 to n logical data sets (LogicalDataSet). The class qb:DataSet is defined in the RDF Data Cube Vocabulary. 0 to n data sets (qb:DataSet) may point to multiple (0 - n) variables (Variable) (inputVariable). Please note that this property is a feature at risk, since the domain is not Disco. Maintainers of the domain ontology may introduce their own property for this purpose. Just like there is the caseQuantity data property on DataFile, there is also the data property variableQuantity on DataFile and LogicalDataSet. This is useful to have when (1) no variable level information is available and when (2) only a stub of the RDF is requested e.g when returning basic information on a study of file, we do not need to return information on potentially hundreds or thousands of variables references or metadata.

> EXAMPLE 18
>
> ```
> ddi:Dataset_1 a LogicalDataSet;
>     dcterms:accessRights ddi:AccessRights_1;
>     disco:dataFile ddi:Datafile_1;
>     disco:instrument ddi:Questionnaire_1;
>     disco:variable ddi:AR80A401, ddi:AR80A402, ddi:AR80A404, ddi:AR80A407, ddi:AR80A411.
> ```

§ 7.2 DataFile

The collected data result in the microdata represented by the DataFile. Data sets have a logical representation, which describes the contents of the data set, and a physical representation, which is a distributed file holding that data. It is possible to format data files in many different ways, even if the logical content is the same. data files (DataFile), which are also dcmitype:Datasets as well as dcat:Distributions, represents all the physical distributed data files containing the microdata datasets.

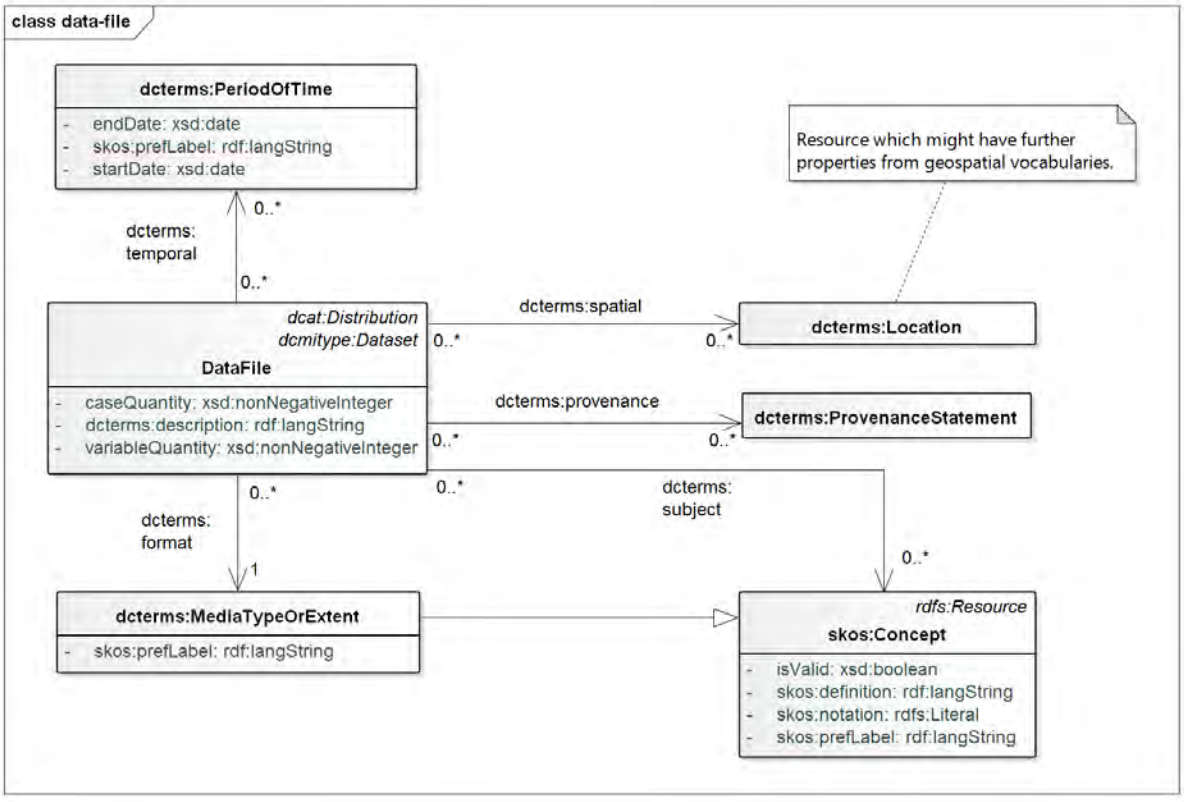


Figure 22 DataFile

EXAMPLE 19

```
ddi:Datafile_1 a disco:Datafile;
  dcterms:identifier "ARG1900-P-H.dat";
  dcterms:description "Person records"@en;
  disco:caseQuantity 2667714;
  dcterms:format "ascii";
  dcterms:provenance "Minnesota Population Center"@en;
  owl:versionInfo "Version 1.0, IPUMS sample"@en;
  dcterms:spatial [
      # This is the DC-strictly compatible way to do it
      a dcterms:Location;
      rdfs:label "Argentina, national coverage"@en
  ];
  dcterms:temporal "PeriodOfTime"@en;
  dcterms:subject "To be defined"@en.
```

It is possible to describe data files (DataFile) (dcterms:description). Data files (DataFile), case quantities (disco:caseQuantity) and versions (owl:versionInfo) can also be stated. Using the object property dcterms:format, data files (DataFile) formats can be defined. Data files (DataFile) must have exactly 1 dcterms:format relationship to an instance of the class dcterms:MediaTypeOrExtend which is a sub-class of skos:Concept. Specific formats can be assigned to multiple (0 - n) data files (DataFile). Provenance information can be assigned to data files (DataFile). Data files (DataFile) may have multiple (0 - n) dcterms:provenance relationships to dcterms:ProvenanceStatements. Dcterms:ProvenanceStatements, however, may have 0 to n dcterms:provenance relations to data files (DataFile). The topical, spatial, and temporal coverage of data files (DataFile) is realized by the object properties dcterms:subject, dcterms:spatial, and dcterms:temporal, all with the cardinalities 0 to n on both sides. Just like there is the caseQuantity data property on DataFile, there is also the data property variableQuantity on DataFile and LogicalDataSet. This is useful to have when (1) no variable level information is available and when (2) only a stub of the RDF is requested e.g when returning basic information on a study of file, we do not need to return information on potentially hundreds or thousands of variables references or metadata.

§ 7.3 DescriptiveStatistics

An overview over the microdata can be given either by the descriptive statistics or the aggregated data. **DescriptiveStatistics** may be minimal, maximal, mean values, and absolute and relative frequencies. qb:DataSet originates from the RDF Data Cube Vocabulary, an approach to map the SDMX information model to an ontology. A qb:DataSet represents aggregated data (also known as macrodata) such as multi-dimensional tables. Aggregated data are derived from microdata by statistics on groups, or aggregates such as counts, means, or frequencies. **SummaryStatistics** pointing to variables and **CategoryStatistics** pointing to categories and codes are both descriptive statistics.

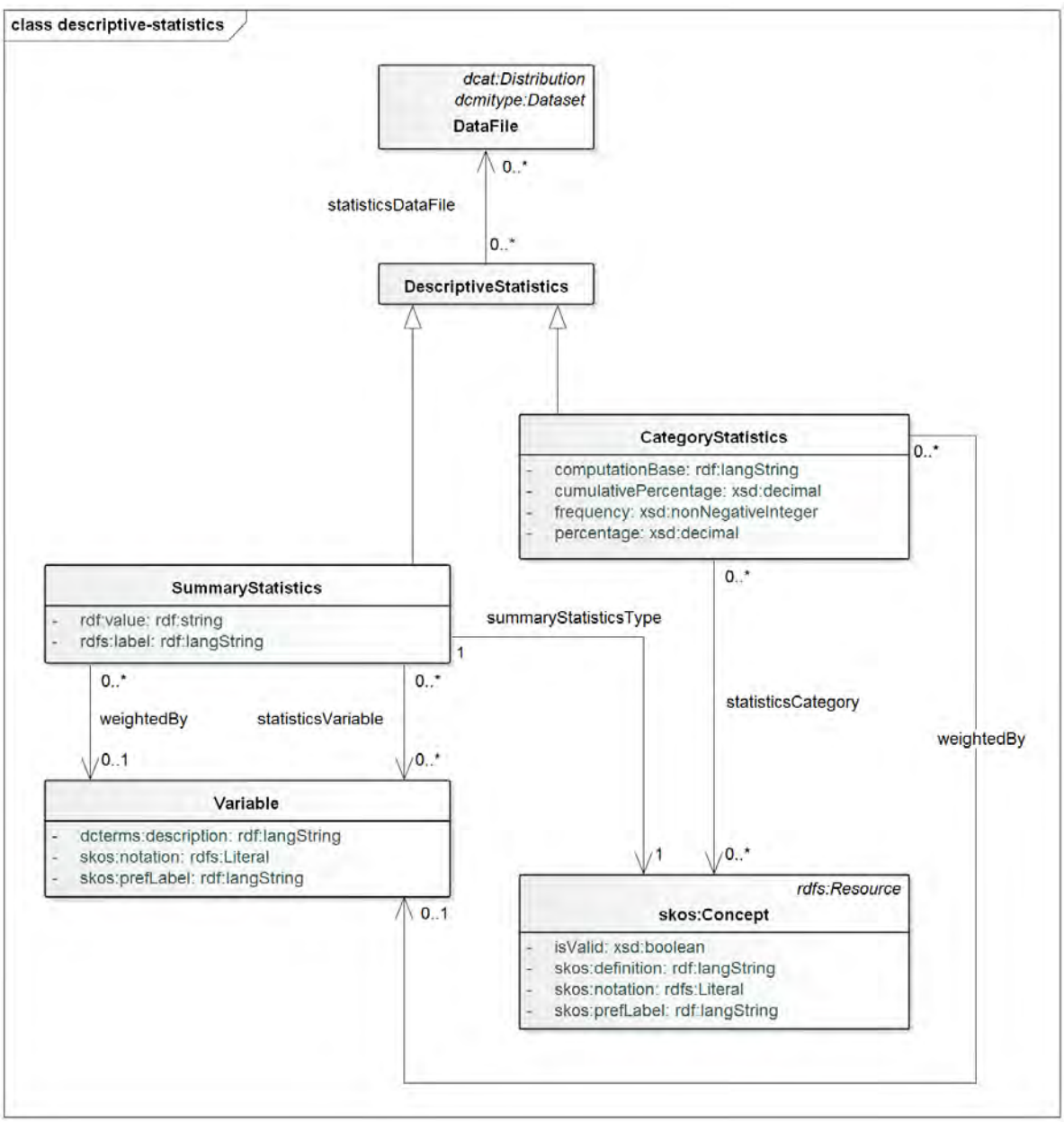


Figure 23 DescriptiveStatistics

`DescriptiveStatistics` may have `statisticsDataFile` relations to 0 to n data files (`DataFile`) and data files (`DataFile`) may be in 0 to n `statisticsDataFile` relations to `DescriptiveStatistics` individuals. `SummaryStatistics` point to 0 to n variables (`Variable`) using the object property `statisticsVariable`. Variables (`Variable`), however, may be in 0 to n of such relationships to `SummaryStatistics` objects. `CategoryStatistics` may be connected with 0 to n `skos:Concepts` using the property `statisticsCategory` and `skos:Concepts` representing codes (values) and categories (value labels) may be in 0 to n of such relationships. `SummaryStatistics` and `CategoryStatistics` may have a `weightedBy` relation to a `Variable`. A statistical weight is an amount given to increase or decreased the importance of an item.

> EXAMPLE 20
>
> ```
> ddi:CatStatistics_1 a disco:CategoryStatistics;
>   disco:frequency 13314444;
>   disco:percentage 49.97;
>   disco:statisticsCategory ddi:SexM;
>   disco:statisticsDataFile ddi:Datafile_1.
>
> ddi:CatStatistics_2 a disco:CategoryStatistics;
>   disco:frequency 1336270;
>   disco:statisticsCategory ddi:SexF;
>   disco:statisticsDataFile ddi:Datafile_1.
> ```

Available category statistics types are `frequency`, `percentage`, and `cumulativePercentage`. Available summary statistics types are organized in the controlled vocabulary SummaryStatisticsType. Each summary statistics type is a

skos:Concept. Particular summary statistics types are included into a disco:SummaryStatistics class with the property disco:summaryStatisticType. The particular value is modelled with rdf:value. More information on the SKOS representation of the controlled vocabulary SummaryStatisticsType can be found at the DDI-controlled-vocabularies project page. There are two possibilities to define new types of summary statistics. First, the term 'other' with a new value can be used in association with the existing vocabulary. Second, a new vocabulary can be defined. In the ISSP example below, the term 'other' is used in class issp:XYZ_17, though not included in the following tables.

There are two properties which describe details of a category or summary statistic value, `computationBase` and `weightedBy`.

`computationBase` expresses if the cases - which are the basis of the computation of a statistics value - are valid, invalid or the total of both. In statistics, missing data (i.e. invalid data), or missing values, occur when no data value is stored for the variable in an observation. Missing data are a common occurrence and can have a significant effect on the conclusions that can be drawn from the data. The usage of `computationBase` for frequency differs from the usage for the percentage statistics and the summary statistics. A distinction regarding `computationBase` doesn't apply to frequency as category statistic. The following table describes the details of usage of `computationBase` in dependency of the respective statistics type.

Table 1: Description of Statistics of Valid/Invalid Cases

Statistics Type	computationBase			
	valid	invalid	total	not used
Category Statistics Type				
frequency	n/a	n/a	n/a	++
percentage	++	+	++	n/a
cumulativePercentage	++	+	++	n/a
Summary Statistics Type				
percentage	++	+	n/a	n/a
Any other summary statistics type	++	+	++	n/a

Legend: ++ used frequently, + rarely used, n/a not applicable

`weightedBy` defines the weight variable of a category or summary statistic computation respectively value. It can also be used to indicate if a weight variable is used but the related variable is not known. `weightedBy` may be assigned to a category statistic value or to a summary statistic value.

Table 2. Description of Statistics of Non-weighted/Weighted Variables

Statistics Value of ...	Value of weightedBy
unweighted variable	not used
weighted variable Weight variable is not known.	Reference to blank node
weighted variable Weight variable is known.	Reference to weight variable

The following example shows different categories of an ISSP data set and the values of the related summary and category statistics. Each category is defined as a skos:Concept and the used name is issp:category_X, which is the corresponding category value in the frequency table above (see Figure 23, second column).

The category issp:category_1 is the category with the code 1 (skos:notation '1'), the category label 'Yes, have partner; live in same household' (skos:prefLabel 'Yes, have partner; live in same household') and which is valid (`disco:isValid` true). Please note that the property `isValid` is a feature at risk, since the domain is not Disco. Maintainers of the domain ontology may introduce their own property for this or a similar purpose. issp:XYZ_1 defines the frequency (disco:frequency '15893') of the category issp:category_1 (disco:statisticsCategory issp:category_1).

> EXAMPLE: ISSP 2011 (International Social Survey Programme)

PARTLIV Living in steady partnership

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes, have partner; live in same household	15893	60,6	63,7	63,7
	2 Yes, have partner; don't live in same household	1089	4,2	4,4	68,0
	3 No partner	7983	30,5	32,0	100,0
	Total	24965	95,2	100,0	
Missing	0 Not available (GB)	936	3,6		
	7 Refused	66	,3		
	9 No answer	249	,9		
	Total	1251	4,8		
Total		26216	100,0		

Figure 24 Example Category Statistics: Frequency Table of Variable PARTLIV (ISSP 2011)

WRKHRS Hours worked weekly

			Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1		7	,0	,0	,0
	2		11	,0	,1	,1
	3		15	,1	,1	,2
	...					
	36		197	,8	1,4	24,9
	37		332	1,3	2,3	27,2
	38		457	1,7	3,2	30,4
	39		203	,8	1,4	31,8
	40		3430	13,1	24,1	55,9
	41		63	,2	,4	56,4
	42		544	2,1	3,8	60,2
	43		172	,7	1,2	61,4
	...					
	90		19	,1	,1	99,1
	91		12	,0	,1	99,2
	92		2	,0	,0	99,2
	93		1	,0	,0	99,2
	94		1	,0	,0	99,2
	95		3	,0	,0	99,3
	96	96 hours and more	106	,4	,7	100,0
	Total		14237	54,3	100,0	
	Missing	0 NAP (Code 2 or 3 in WORK)	11033	42,1		
		98 Don't know; TW: Time varies	385	1,5		
		99 No answer	561	2,1		
		Total	11979	45,7		
Total			26216	100,0		

Figure 25 Example Category Statistics: Frequency Table of Variable WRKHRS (ISSP 2011)

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
WRKHRS Hours worked weekly	14237	95	1	96	41.74	14.265
Valid N (listwise)	14237					

Figure 26 Example Summary Statistics: Descriptive Statistics of Variable WRKHRS (ISSP 2011)

```
@prefix issp: <http://www.issp.org/>
@prefix ddi-cv: <http://rdf-vocabulary.ddialliance.org/DDICV#>

issp:Category_1
  a skos:Concept;
  skos:notation "1";
  skos:prefLabel "Yes, have partner; live in same household";
  disco:isValid true.

issp:Category_3
  a skos:Concept;
  skos:prefLabel "valid total";
  disco:isValid true.

issp:Category_2
  a skos:Concept;
  skos:notation "0";
  skos:prefLabel "Not available (GB))";
  disco:isValid false.

issp:Category_4
  a skos:Concept;
  skos:prefLabel "missing total";
  disco:isValid false.

issp:XYZ_1
  a disco:CategoryStatistics;
  disco:statisticsCategory issp:Category_1;
  disco:frequency 15893.

issp:XYZ_2
  a disco:CategoryStatistics;
  disco:statisticsCategory issp:Category_2;
  disco:frequency 936.

issp:XYZ_3
  a disco:CategoryStatistics;
  disco:statisticsCategory issp:Category_1;
  disco:percentage 60.6.
  disco:computationBase "total".
```

```
issp:XYZ_4
  a disco:CategoryStatistics;
  disco:statisticsCategory issp:Category_2;
  disco:percentage 3.6;
  disco:computationBase "total";
  disco:weightedBy issp:WeightVariable_1.

issp:XYZ_5
  a disco:CategoryStatistics;
  disco:statisticsCategory issp:Category_1;
  disco:percentage 63.7;
  disco:computationBase "validOnly".

issp:XYZ_6
  a disco:CategoryStatistics;
  disco:statisticsCategory issp:Category_1;
  disco:cumulativePercentage 63.7;
  disco:computationBase "validOnly".

# optional: harmonized CategoryStatistics resource if computationBase and category is the same
issp:XYZ_7
  a disco:CategoryStatistics;
  disco:statisticsCategory issp:Category_1;
  disco:percentage 63.7;
  disco:cumulativePercentage 63.7;
  disco:computationBase "validOnly".

# SummaryStatistics of variable PARTLIV
issp:XYZ_8
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:PARTLIV;
  disco:summaryStatisticType ddicv-sumstats:ValidCases;
  rdf:value "24965".

issp:XYZ_9
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:PARTLIV;
  disco:summaryStatisticType ddicv-sumstats:PercentOfValidCases;
  rdf:value "95.2".

issp:XYZ_10
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:PARTLIV;
  disco:summaryStatisticType ddicv-sumstats:InvalidCases;
  rdf:value "1251".

issp:XYZ_11
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:PARTLIV;
  disco:summaryStatisticType ddicv-sumstats:PercentOfInvalidCases;
  rdf:value "4.8".

# SummaryStatistics of variable WRKHS
issp:XYZ_12
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:WRKHRS;
  disco:summaryStatisticType ddicv-sumstats:ValidCases;
  rdf:value "14237".

issp:XYZ_13
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:WRKHRS;
  disco:summaryStatisticType ddicv-sumstats:Minimum;
  rdf:value "1".

issp:XYZ_14
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:WRKHRS;
  disco:summaryStatisticType ddicv-sumstats:Maximum;
  rdf:value "96".

issp:XYZ_15
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:WRKHRS;
  disco:summaryStatisticType ddicv-sumstats:ArithmeticMean;
  rdf:value "41.74".
```

```
issp:XYZ_16
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:WRKHRS;
  disco:summaryStatisticType ddicv-sumstats:StandardDeviation;
  rdf:value "14.265".

# SummaryStatistics of variable WRKHS not included in the tables
issp:XYZ_17
  a disco:SummaryStatistics;
  disco:statisticsVariable issp:WRKHRS;
  disco:summaryStatisticType ddicv-sumstats:Other;
  rdfs:label "Gini Coefficient";
  rdf:value "0.63".
```

Microdata Information System (MISSY)

Figure 27 Summary Statistics

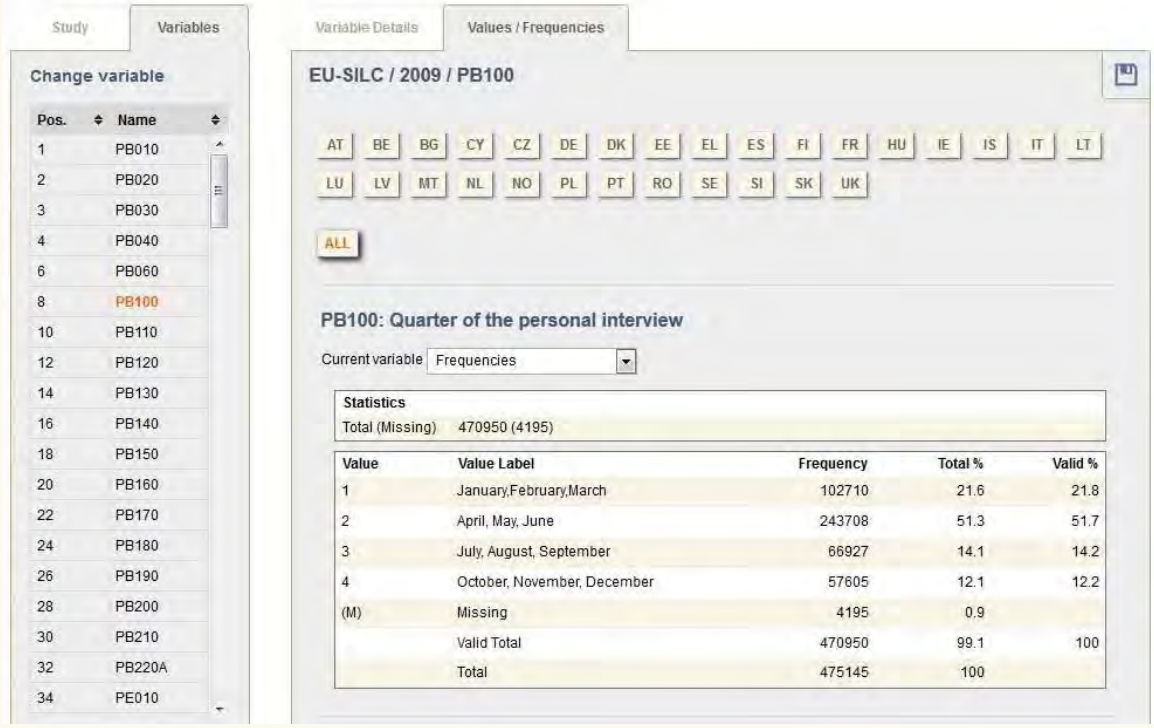


Figure 28 Category Statistics

```
# minimum
# -------
missy:Minimum
  a disco:SummaryStatistics;
  disco:statisticsVariable missy:PB100;
  disco:summaryStatisticType ddicv-sumstats:Minimum;
  rdf:value "1".
```

```
# maximum
# -------
missy:Maximum
  a disco:SummaryStatistics;
  disco:statisticsVariable missy:PB100;
  disco:summaryStatisticType ddicv-sumstats:Maximum;
  rdf:value "4".

# arithmentic mean
# ----------------
missy:Mean
  a disco:SummaryStatistics;
  disco:statisticsVariable missy:PB100;
  disco:summaryStatisticType ddicv-sumstats:ArithmeticMean;
  rdf:value "2.17".

# standard deviation
# ------------------
missy:StandardDeviation
  a disco:SummaryStatistics;
  disco:statisticsVariable missy:PB100;
  disco:summaryStatisticType ddicv-sumstats:StandardDeviation;
  rdf:value "0.9061".

# valid cases
# -----------
missy:ValidCases
  a disco:SummaryStatistics ;
  disco:statisticsVariable missy:PB100 ;
  disco:summaryStatisticType ddicv-sumstats:ValidCases;
  rdf:value "470950".

# percent of valid cases
# ----------------------
missy:PercentOfValidCases
  a disco:SummaryStatistics;
  disco:statisticsVariable missy:PB100;
  disco:summaryStatisticType ddicv-sumstats:PercentOfValidCases;
  rdf:value "99.1".

# invalid cases
# -------------
missy:InvalidCases
  a disco:SummaryStatistics;
  disco:statisticsVariable missy:PB100;
  disco:summaryStatisticType ddicv-sumstats:InvalidCases;
  rdf:value "4195".

# percent of invalid cases
# ------------------------
missy:PercentOfInvalidCases
  a disco:SummaryStatistics ;
  disco:statisticsVariable missy:PB100 ;
  disco:summaryStatisticType ddicv-sumstats:PercentOfInvalidCases ;
  rdf:value "0.9" .

# total cases
# -----------
missy:TotalCases
  a disco:SummaryStatistics;
  disco:statisticsVariable missy:PB100;
  disco:summaryStatisticType ddicv-sumstats:NumberOfCases;
  rdf:value "475145".

# codes and categories
# --------------------
missy:1
  a skos:Concept ;
  skos:notation "1" ;
  skos:prefLabel "January,February,March" ;
  disco:isValid true .

missy:Missing
  a skos:Concept ;
  skos:notation "M" ;
  skos:prefLabel "Missing" ;
```

```
  disco:isValid false .

# valid cases
# -----------
missy:CS1
  a disco:CategoryStatistics ;
  disco:statisticsCategory missy:1 ;
  disco:frequency 102710 ;
  disco:percentage 21.6 ;
  disco:cumulativePercentage 21.8 ;
  disco:computationBase "valid" .

# invalid cases
# -------------
missy:CS2
  a disco:CategoryStatistics ;
  disco:statisticsCategory missy:Missing ;
  disco:frequency 4195 ;
  disco:percentage 0.9 ;
  disco:computationBase "invalid" .
```

§ 8. Variables, Variable Definitions, Representations, and Concepts

When it comes to understanding the contents of the data set, this is done using the `Variable` class. Variables (`Variable`) provide a definition of the column in a rectangular data file, and can associate it with a Concept, and a `Question`. Variables (`Variable`) are related to a `Representation` of some form, which may be a set of codes and categories (a "codelist") or may be one of other normal data types (dateTime, numeric, textual, etc.) Codes and Categories are represented using skos:Concept and skos:ConceptScheme. Variable definitions (`RepresentedVariable`) encompasse study-independent, re-usable parts of variables like occupation classification.

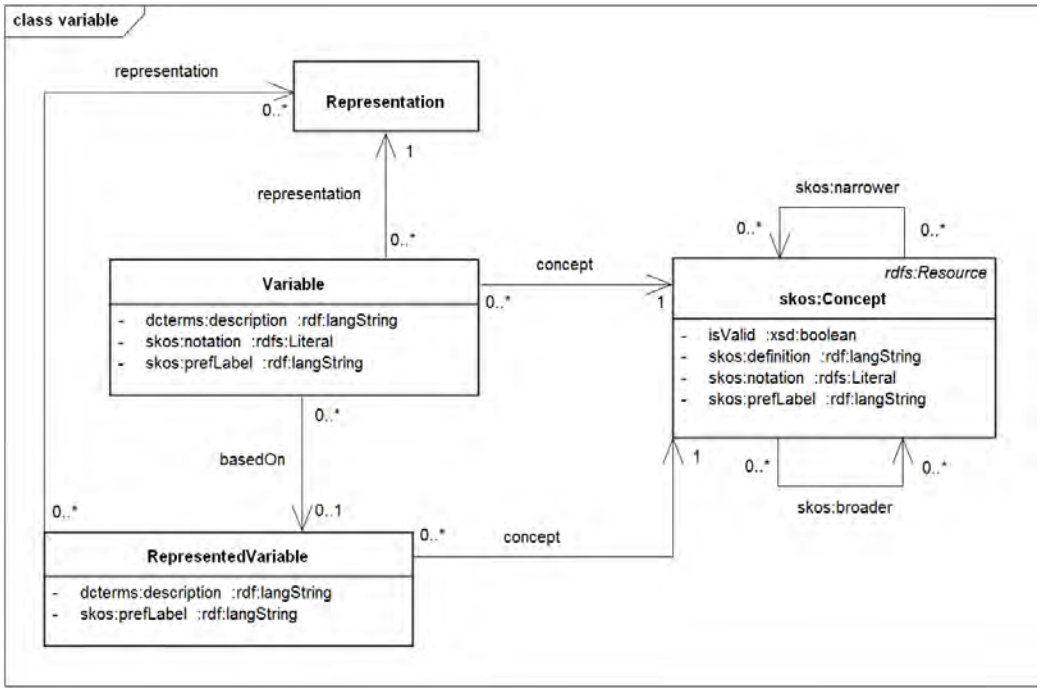


Figure 29

Variables, Variable Definitions, Representations, and Concepts

Variables (`Variable`) may be based on (`basedOn`) 0 or 1 variable definitions (`RepresentedVariable`) and variable definitions (`RepresentedVariable`) can be in 0 to n `basedOn` relationships to variables (`Variable`). Both variables (`Variable`) and variable definitions (`RepresentedVariable`) have `Representation` object properties with the class `Representation` as range. Variables (`Variable`) must have exactly 1 `Representation` and variable definitions (`RepresentedVariable`) may have 0 to n `Representation` connections to `Representation`. On the other hand, representations have 0 to n links to variable definitions (`RepresentedVariable`) and to variables (`Variable`). Variables (`Variable`) as well as variable definitions (`RepresentedVariable`) have both 1 connection to the concept which should be measured. Concepts have 0 to n relationships to variables (`Variable`) and variable definitions (`RepresentedVariable`) using the object property `concept`.

Disco variables are inline with statistical variables, where experiments examine the relationship between variables. In the RDF Data Cube vocabulary, variables are used as dimensions, measures, or attributes to

identify and describe observations.

§ 8.1 Variable and Variable Definition

`Variable`s provide a definition of the column in a rectangular data file. `Variable` is a characteristic of a unit being observed. A variable might be the answer of a question, have an administrative source, or be derived from other variables (e.g. age group derived from age). `RepresentedVariable`s encompasse study-independent, re-usable parts of variables like occupation classification.

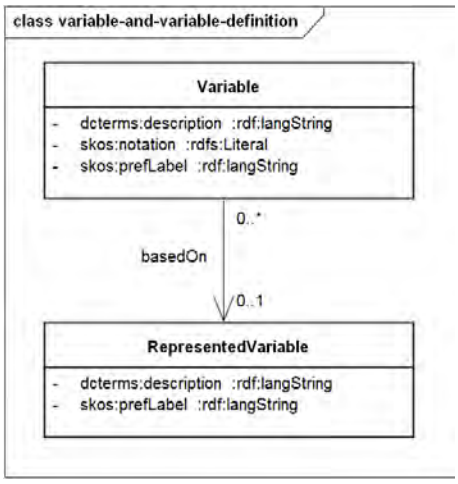


Figure 30 Variables and RepresentedVariables

Variables (`Variable`) can be described (`dcterms:description`), `skos:notation` is used to associate names to variables and labels can be assigned to variables via the datatype property `skos:prefLabel`. Variable definitions (`RepresentedVariable`) can also be described using `dcterms:description`. Labels can be assigned to variable definitions (`RepresentedVariable`) via the datatype property `skos:prefLabel`. Variables (`Variable`) may be based on (`BasedOn`) 0 to 1 `RepresentedVariable`. `BasedOn` also connects variable definitions (`RepresentedVariable`) with 0 to n variables (`Variable`). Variables (`Variable`) and variable definitions (`RepresentedVariable`) are connected with exactly 1 `skos:Concept` via `Concept`. `skos:Concept` have this connection to 0 to n variables (`Variable`) and variable definitions (`RepresentedVariable`). Variables (`Variable`) are represented by 1 `Representation` and variable definitions (`RepresentedVariable`) are represented by multiple (0 - n) representations (`Representation`). Representations (`Representation`) may be linked to 0 to n variables (`Variable`) and their definitions. Variables (`Variable`) may have (`Question`) 0 or more questions (`Question`) and questions (`Question`) may be associated with 0 to n variables (`Variable`). `Universe` is used to link 1 `Universe` to 0 to n variables (`Variable`) and 0 to n universes (`Universe`) to 0 to n variable definitions (`RepresentedVariable`).

The following example illustrates the three variables Sex, Age and Citizenship.

> EXAMPLE 21

```
ddi:AR80A401 a disco:Variable;
  dcterms:identifier "AR80A401";
  skos:prefLabel "Sex"@en, "Sexe"@fr;
  dcterms:description "This variable indicates the person's gender."@en;
  disco:basedOn ddi:SexVD;
  disco:question ddi:QuestionGender.

ddi:AR80A402 a disco:Variable;
  dcterms:identifier "AR80A402";
  dcterms:description "This variable indicates the person's age in years."@en;
  skos:prefLabel "Age"@en, "Âge"@fr.
  disco:basedOn ddi:AgeVD;
  disco:question ddi:QuestionAge.

ddi:AR80A407 a disco:Variable;
  dcterms:identifier "AR80A407";
  dcterms:description "This variable indicates whether or not the person
is a naturalized citizen of Argentina."@en;
  skos:prefLabel "Citizenship"@en, "Citoyenneté"@fr;
  disco:basedOn ddi:CitizenshipVD;
  disco:question ddi:QuestionCitizenship.
```

The three variables refer to universe, representations and concepts in their `RepresentedVariable`.

EXAMPLE 22

```
 ddi:SexVD a disco:RepresentedVariable;
   disco:universe ddi:UniversePerson;
   disco:representation ddi:SexRepr;
   disco:concept ddi:IpumsC1;
   skos:prefLabel "Sex"@en, "Sexe"@fr;
   dcterms:description "Sex data element"@en.

ddi:AgeVD a disco:RepresentedVariable;
   disco:universe ddi:UniversePerson;
   disco:representation ddi:AgeRepr;
   disco:concept ddi:IpumsC1;
   skos:prefLabel "Age"@en, "Sexe"@fr;
   dcterms:description "Age data element"@en.

 ddi:CitizenshipVD a disco:RepresentedVariable;
   disco:universe ddi:UniverseNonArgentines;
   disco:representation ddi:CitizenshipRepr;
   disco:concept ddi:IpumsC2;
   skos:prefLabel "Citizenship"@en;
   dcterms:description "Citizenship data element"@en.
```

§ 8.2 Representation

The `Representation` of a variable is the combination of a value domain, datatype, and, if necessary, a unit of measure or a character set. `Representation` is one of a set of values to which a numerical measure or a category from a classification can be assigned (e.g. income, age, and sex: male coded as 1). `Questions` (`ResponseDomain`), variables (`Variable`) (`Representation`), and variable definitions (`RepresentedVariable`) (`Representation`) may have representations. `Representation` is defined as sub-class of the union of `rdfs:Datatype` (e.g. numeric or textual values), `skos:ConceptScheme`, and `skos:OrderedCollection`, as for example questions may have as response domain a mixture of a numeric response domain containing numeric values (`rdfs:Datatype`) and an unordered code response domain (`skos:ConceptScheme`) as well as an ordered code response domain (`skos:OrderedCollection`).

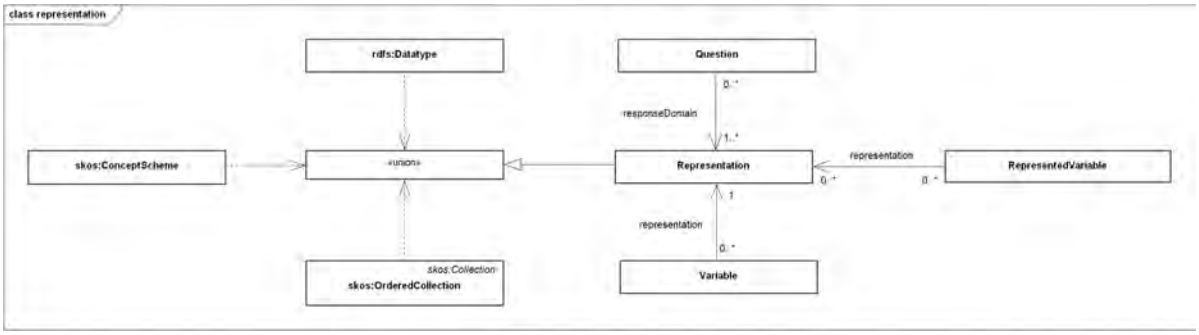


Figure 31 Representation

Questions (`Question`) (`responseDomain`), variables (`Variable`) (`representation`), and variable definitions (`RepresentedVariable`) (`representation`) may have representations. Questions (`Question`) must have 1 to n representations (`representation`), variables (`Variable`) must have exactly 1 `Representation`, and variable definitions (`RepresentedVariable`) may have 0 to n representations (`Representation`). Each `Representation` can be in 0 to n `Representation` relationships with questions (`Question`), variables (`Variable`), and variable definitions (`RepresentedVariable`).

The following example shows the representations of the three previously introduced variables Sex, Age and Citizenship. All of them refer to the particular concepts.

EXAMPLE 23

```
   ddi:SexRepr a skos:ConceptScheme, disco:Representation;
     skos:hasTopConcept ddi:SexM, ddi:SexF.

ddi:AgeRepr a skos:ConceptScheme, disco:Representation;
  skos:hasTopConcept ddi:Age0, ddi:Age1, ddi:Age99.

ddi:CitizenshipRepr a skos:ConceptScheme, disco:Representation;
  skos:hasTopConcept ddi:CYes, ddi:CNo, ddi:CUnknown, ddi:CNIU.
```

§ 8.3 Codes and Categories

DDI concepts, hierarchies of DDI concepts, code values, and category labels are represented by `skos:Concepts`. SKOS defines the term **`skos:Concept`**, which is a unit of knowledge created by a unique combination of characteristics. In context of statistical (meta)data, concepts are abstract summaries, general notions, knowledge of a whole set of behaviours, attitudes or characteristics which are seen as having something in common. Concepts may be associated with variables and questions. A **`skos:ConceptScheme`**, also defined within the SKOS namespace, is a set of metadata describing statistical concepts. `Skos:Concept` is reused to a large extent to represent DDI concepts, codes, and categories.

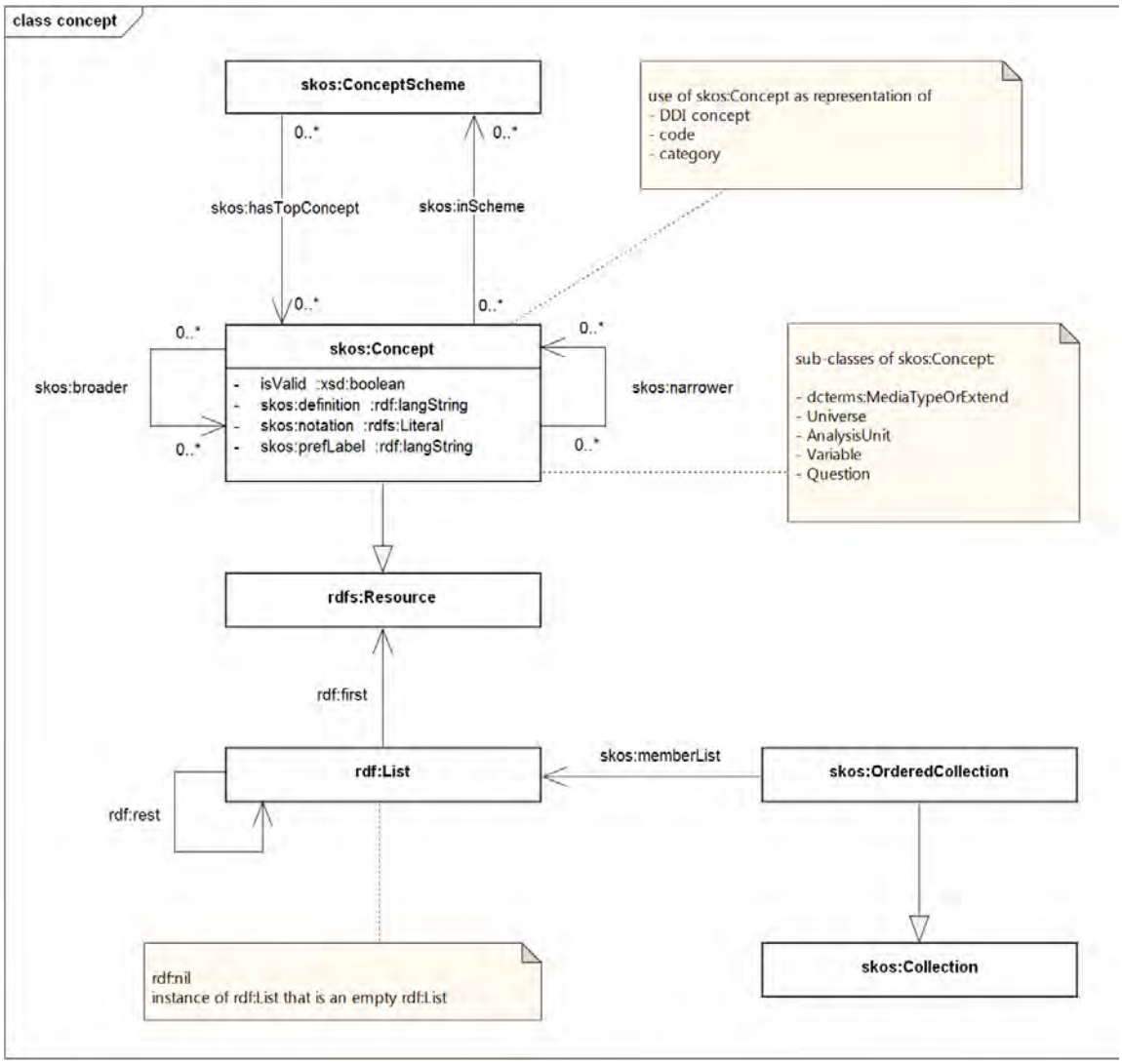


Figure 32 skos:Concept and skos:ConceptScheme

DDI concepts can be described using `skos:definition`. Furthermore, you can describe code values (`skos:notation`) and category labels (`skos:prefLabel`). Hierarchies of DDI concepts can be built using the object properties `skos:broader` and `skos:narrower`. The domains and the ranges of `skos:broader` and `skos:narrower` are `skos:Concept`. The cardinalities are in both directions 0 to n. `Skos:Concept` may be organized in 0 to n `skos:ConceptSchemes` by means of `skos:inScheme`. `skos:ConceptSchemes` may have multiple (0 - n) `skos:Concept` as parts. The top concept in a specific ConceptScheme is indicated by `skos:hasTopConcept` pointing to 0 to n top `skos:Concept`. A specific `skos:Concept` may be the top concept to multiple (0 - n) `skos:ConceptSchemes`.

EXAMPLE 24

```
ddi:SexRepr a skos:ConceptScheme, disco:Representation;
  rdfs:label "Code list for Sex (SEX) - codelist class"@en;
  rdfs:comment "This code list provides the gender."@en;
  skos:hasTopConcept ddi:SexM, ddi:SexF.

ddi:SexM a skos:Concept;
```

```
  skos:notation "1";
  skos:prefLabel "Male"@en, "Homme"@fr;
  skos:inScheme ddi:SexRepr.

ddi:SexF a skos:Concept;
  skos:notation "2";
  skos:prefLabel "Female"@en, "Femme"@fr;
  skos:inScheme ddi:SexRepr.
```

EXAMPLE: ISSP 2011 (International Social Survey Programme)

PARTLIV Living in steady partnership

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes, have partner; live in same household	15893	60,6	63,7	63,7
	2 Yes, have partner; don't live in same household	1089	4,2	4,4	68,0
	3 No partner	7983	30,5	32,0	100,0
	Total	24965	95,2	100,0	
Missing	0 Not available (GB)	936	3,6		
	7 Refused	66	,3		
	9 No answer	249	,9		
	Total	1251	4,8		
Total		26216	100,0		

Figure 33 Example Category Statistics: Frequency Table of Variable PARTLIV (ISSP 2011)

```
@prefix issp: <http://www.issp.org/>

issp:Category_1
  a skos:Concept;
  skos:notation "1";
  skos:prefLabel "Yes, have partner; live in same household";
  disco:isValid true.

issp:Category_2
  a skos:Concept;
  skos:notation "2";
  skos:prefLabel "Yes, have partner; don't live in same household";
  disco:isValid true.

issp:Category_3
  a skos:Concept;
  skos:notation "3";
  skos:prefLabel "No partner";
  disco:isValid true.

issp:Category_4
  a skos:Concept;
  disco:isValid true.

issp:Category_5
  a skos:Concept;
  skos:notation "0";
  skos:prefLabel "Not available (GB))";
  disco:isValid false.

issp:Category_6
  a skos:Concept;
  skos:notation "7";
  skos:prefLabel "Refused";
  disco:isValid false.

issp:Category_7
  a skos:Concept;
  skos:notation "9";
  skos:prefLabel "No answer";
  disco:isValid false.

issp:Category_8
  a skos:Concept;
  disco:isValid false.
```

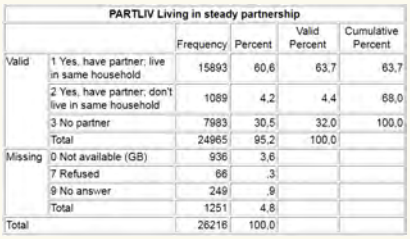
NOTE

Please note that only code and categories are part of the turtle example.

§ 8.4 Ordering

In DDI, variables, logical data sets, questions, and categories are typically organized themselves in a particular order. For obtaining this order, `skos:OrderedCollection`s are used. For example, a collection of variables is represented as being of the type `skos:OrderedCollection` containing multiple variables (each represented as `skos:Concept`) in a `skos:memberList`.

EXAMPLE: ISSP 2011 (International Social Survey Programme)



PARTLIV Living in steady partnership

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes, have partner; live in same household	15893	60,6	63,7	63,7
	2 Yes, have partner; don't live in same household	1089	4,2	4,4	68,0
	3 No partner	7983	30,5	32,0	100,0
	Total	24965	95,2	100,0	
Missing	0 Not available (GB)	936	3,6		
	7 Refused	66	,3		
	9 No answer	249	,9		
	Total	1251	4,8		
Total		26216	100,0		

Figure 34 Example Category Statistics: Frequency Table of Variable PARTLIV (ISSP 2011)

The following example shows an ordered collection of categories represented using abbreviated and complete syntax forms.

```
@prefix issp: <http://www.issp.org/>

issp:XYZ_1
  a disco:Variable;
  skos:notation "PARTLIV";
  skos:prefLabel "Living in steady partnership";
  disco:representation issp:OrderedCollection_1.

# abbreviated syntax:
issp:OrderedCollection_1
  rdf:type skos:OrderedCollection;
  skos:memberList (
    issp:Category_1
    issp:Category_2
    issp:Category_3
    issp:Category_4
    issp:Category_5
    issp:Category_6
    issp:Category_7
    issp:Category_8 ).

# complete syntax:
issp:OrderedCollection_1
  rdf:type skos:OrderedCollection;
  skos:memberList [
    rdf:first issp:Category_1; rdf:rest [
    rdf:first issp:Category_2; rdf:rest [
    rdf:first issp:Category_3; rdf:rest [
    rdf:first issp:Category_4; rdf:rest [
    rdf:first issp:Category_5; rdf:rest [
    rdf:first issp:Category_6; rdf:rest [
    rdf:first issp:Category_7; rdf:rest [
    rdf:first issp:Category_8;
    rdf:rest rdf:nil.] ] ] ] ] ] ] ].
```

If no order inside a collection of variables and questions is necessary, they are represented as unordered `skos:ConceptSchemes`. The classes Variable, LogicalDataSet, and Question are defined as sub-classes of `skos:Concept`.

§ 9. Data Collection

The data collection produces the datasets in a data catalog. In some cases, where data collection is cyclic or on-going, data sets may be released as a StudyGroup, where each cycle or "wave" of the data collection activity produces one or more data sets. The data for the study are collected by an instrument. The purpose of an `Instrument`, i.e. an interview, a questionnaire or another entity used as a means of data collection, is in the case of a survey to record the flow of a questionnaire, its use of questions, and additional component parts. A questionnaire contains a flow of questions. A `Question` is designed to get information upon a subject, or sequence

of subjects, from a respondent.

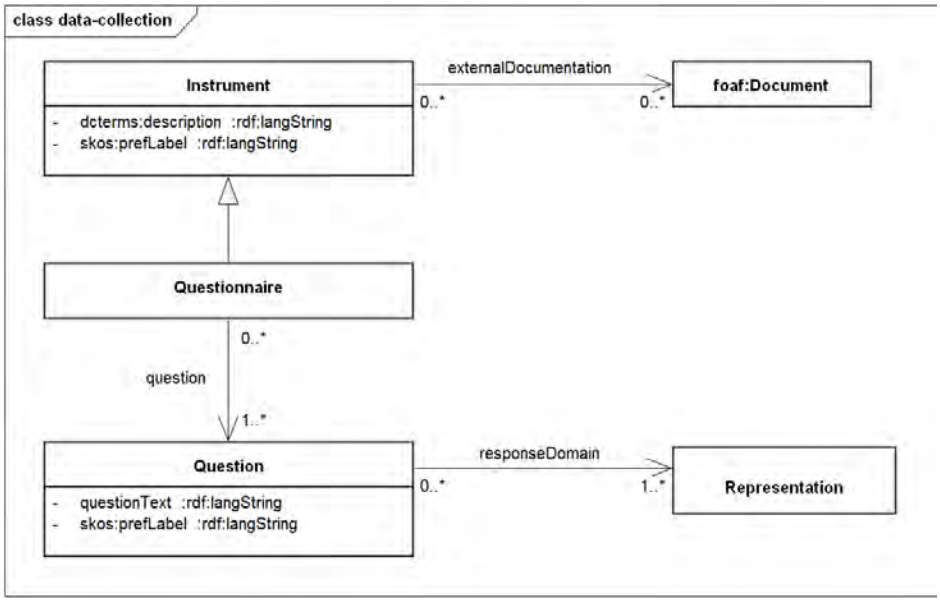


Figure 35 DataCollection

§ 9.1 Instrument

The data for the study are collected by an `Instrument`. The purpose of an `Instrument`, i.e. an interview, a questionnaire or another entity used as a means of data collection, is in the case of a survey to record the flow of a questionnaire, its use of questions, and additional component parts. A questionnaire contains a flow of questions.

Instruments (`Instrument`) can be labeled and described using (`dcterms:description`) and (`skos:prefLabel`). Instruments (`Instrument`) may have (`externalDocumentation`) multiple (0 - n) external documentations which are of the type `foaf:Documents`. `Foaf:Documents` may be external documentations of 0 to n instruments (`Instrument`). `collectionMode` are special instruments having at least 1 (1 - n) collection mode (`Question`), which is a `skos:Concept`. A specific collection mode can be associated with 0 to n questionnaires (`Questionnaire`). Questionnaires (`Questionnaire`) must contain 1 to n questions (`Question`) using the object property `Question`. Particular questions (`Question`) may be contained in 0 to n questionnaires (`Questionnaire`).

The following example illustrates a questionnaire with three example questions. The questions are defined the next section.

EXAMPLE 25

```
ddi:Questionnaire_1 a disco:Questionnaire;
  disco:question ddi:QuestionGender;
  disco:question ddi:QuestionAge;
  disco:question ddi:QuestionCitizenship.
```

§ 9.2 Question

A `Question` is designed to get information upon a subject, or sequence of subjects, from a respondent.

Questions (`Question`) have a question text (`questionText`), a label (`skos:prefLabel`), exactly 1 universe (`Universe`), multiple (1 - n) concepts (`concept`), and at least 1 response domain (`responseDomain`). Representations (`Representation`) may have 0 to n `responseDomain` relations to questions (`Question`). Particular universes (`Universe`) may be connected with 0 to n questions (`Question`). `Skos:Concepts` are associated with 0 to n questions (`Question`).

EXAMPLE 26

```
   ddi:QuestionGender a disco:Question;
     disco:questionText "2. Is the person a man or a woman? [] Man, [] Woman"@en.

   ddi:questionAge a disco:Question;
     disco:QuestionText "3. What is his or her age? _ _ Mark the age in
completed years at the date of the census for those younger than
one year old mark 00. For those younger than 10 years old, mark 01,
```

```
02, 03, etc. For those older than 99 years old, mark 99."@en.

   ddi:questionCitizenship a disco:Question;
     disco:QuestionText "6. [Immigration status] Only for persons who have
usual residence in Argentina and were born in another country.
[Questions 6A and 6B asked only of persons born outside Argentina
and who currently reside in Argentina.] B. Are you a naturalized
citizen of Argentina? [] Yes [] No [] Unanswered"@en.
```

§ 10. Use of Other Vocabularies

Widely accepted and adopted vocabularies are reused to a large extend. Many features of DDI can be addressed by classes and properties of other vocabularies, such as: describing metadata for citation purposes using the DCMI Metadata Terms (DCMI) [DCMI], describing catalogues of datasets using the Data Catalog Vocabulary (DCAT) [DCAT], describing aggregate data like multi-dimensional tables using the RDF Data Cube Vocabulary [RDF Data Cube Vocabulary], describing formal statistical classifications using the SKOS Extension for Statistics (XKOS) [XKOS], describing arbitrary (real, hypothesized, virtual, fictional) objects, processes and their attributes [SIO], and delineating code lists, category schemes, mappings between them, and concepts like topics using the Simple Knowledge Organization System (SKOS) [SKOS]. Furthermore, the external vocabularies Friend of a Friend (FOAF) [FOAF], the Organization Ontology (ORG) [ORG], the Asset Description Metadata Schema (ADMS) [ADMS], and the PROV Ontology (PROV-O) [PROV-O] are used. Whenever terms from other vocabularies are used within the Disco context, these terms are not re-defined but only applied for the purposes of disco.

It is distinguished between required, recommended and optional vocabularies that are reused. Required vocabularies contain classes and properties that are required in order to represent particular aspects of Disco completely. Recommended vocabularies hold classes and properties that are recommended to be used for representing particular aspects of Disco. Finally, optional vocabularies contain classes and properties that may support the modelling of particular aspects of Disco. This strongly depends on in which extent and for which purpose data is represented in Disco. Terms of optional vocabularies are not necessarily required for representing DDI metadata in Disco.

Required vocabularies are:

- DCMI
- SKOS
- DCAT

Recommended vocabularies are:

- FOAF
- ORG
- ADMS

Optional vocabularies are:

- PROV-O
- RDF Data Cube Vocabulary
- XKOS
- SIO

§ 10.1 DCMI Metadata Terms (DCMI)

DCMI is reused in order to describe general metadata of Disco constructs such as a study abstract (dcterms:abstract), a study or dataset title (dcterms:title), a human readable description of a Disco construct (dcterms:description), provenance information for a data file (dcterms:provenance), or the date (or date range) at which a study will become available (dcterms:available).

- Required classes DCMI are: dcterms:PeriodOfTime, dcterms:Location, dcterms:RightsStatement, dcterms:LicenseDocument, dcmitype:Dataset, dcterms:MediaTypeOrEvent

- Required properties DCMI are: dcterms:abstract, dcterms:alternative, dcterms:available, dcterms:title, dcterms:subject, dcterms:spatial, dcterms:temporal, dcterms:creator, dcterms:contributor, dcterms:publisher, dcterms:relation, dcterms:license, dcterms:accessRights, dcterms:description, dcterms:format

§ 10.2 Simple Knowledge Organization System (SKOS)

skos:Concept is reused to a large extent to represent DDI concepts, codes, and categories. SKOS defines the term skos:Concept, which is a unit of knowledge created by a unique combination of characteristics. In context of statistical (meta)data, concepts are abstract summaries, general notions, knowledge of a whole set of behaviours, attitudes or characteristics which are seen as having something in common. Skos:Concepts may be associated with variables, variable definitions, and questions and are reused to a large extent to represent DDI concepts (skos:prefLabel), codes (skos:notation), and category labels (skos:prefLabel). Skos:Concepts may be organized in skos:ConceptSchemes (skos:inScheme), sets of metadata describing statistical concepts. Hierarchies of DDI concepts can be built using the object properties skos:broader and skos:narrower. Topical coverage can be expressed using dcterms:subject. Disco foresees the use of skos:Concept for the description of topical coverage. Spatial, temporal, and topical coverage are directly attached to studies, logical datasets, and datafiles. Universes and AnalysisUnits are also skos:Concepts. Therefore the properties defined for skos:Concept can be reused. KindOfData, pointing to a skos:Concept , describes, with a string or a term from a controlled vocabulary, the kind of data documented in the logical product(s) of a Study. Using dcterms:format, DataFiles formats can be defined.

- Required classes of SKOS are: skos:Concept, skos:ConceptScheme, skos:OrderedCollection
- Required properties of SKOS are: skos:prefLabel, skos:definition, skos:notation, skos:hasTopConcept, skos:inScheme, skos:broader, skos:narrower, skos:memberList

§ 10.2.1 Uses of skos:Concept

In this sub-section, we describe all possible uses of the class skos:Concept.

- Code values: Code values are represented using the datatype property skos:notation with skos:Concept as domain.
- Category labels: Use skos:prefLabel and the domain class skos:Concept to describe category values
- DDI concepts: DDI concepts are described by the property skos:definition pointing from skos:Concept classes.
- Hierarchies of DDI concepts: Hierarchies of DDI concepts can be built using the object properties skos:broader and skos:narrower. The domains and the ranges of skos:broader and skos:narrower are skos:Concept.
- Organization in **skos:ConceptSchemes**: Skos:Concepts may be organized in skos:ConceptSchemes by means of skos:inScheme. The top concept in a specific ConceptScheme is indicated by skos:hasTopConcept pointing to top skos:Concept.
- Topical coverage: Topical coverage can be expressed using dcterms:subject. DDI-RDF foresees the use of skos:Concept for the description of topical coverage. Spatial, temporal, and topical coverage are directly attached to studies, logical datasets, and datafiles.
- Category linked to **CategoryStatistics**: CategoryStatistics like frequencies and percentages are associated to the respectve Category using the object property statisticsCategory. skos:Concept represents categories.
- Concepts of questions: Questions (Question) are associated with concepts via the object property concept.
- **Universe**: Each universe is also a skos:Concept. Therefore the properties defined for skos:Concept can be reused for universes.
- Collection Mode: Questionnaires (Questionnaire) may have multiple collection modes which are represented by skos:Concept.
- Concepts of variable definitions: Variable definitions are associated with concepts via the object property concept.
- Concepts of variables: Variables (Variable) are linked to concepts via the object property concept.
- Kind of data: KindOfData describes, with a string or a term from a controlled vocabulary, the kind of data documented in the logical product(s) of a Study. Examples include survey data, census/enumeration data,

administrative data, measurement data, assessment data, demographic data, voting data, etc. The range of kindOfData is `skos:Concept`

- `Format of data files`: Using the object property `dcterms:format`, data files (`DataFile`) formats can be defined. Data files (`DataFiles`) must have exactly 1 `dcterms:format` relationship to an instance of the class `dcterms:MediaTypeOrExtend` which is a sub-class of `skos:Concept`.
- **`AnalysisUnit`**: Each analysis unit is also a `skos:Concept`. Therefore the properties defined for `skos:Concept` can be reused for analysis units.

§ 10.3 Data Catalog Vocabulary (DCAT)

DCAT is a W3C standard for describing catalogs of datasets. DCAT makes few assumptions about the kind of datasets being described, and focuses on general metadata about the datasets (mostly using Dublin Core), and on different ways of distributing and accessing the dataset, including availability of the dataset in multiple formats. Combining terms from both DCAT and Disco can be useful for a number of reasons:

- Describing collections (catalogs) of research datasets
- Providing additional information about physical aspects (file size, file formats) of research data files
- Providing information about the data collection that produced the datasets in a data catalog
- Providing information about the logical structure (variables, concepts, etc.) of tabular datasets in a data catalog

The LogicalDataSet is an extension of the dcat:DataSet. Physical, distributed files are represented by the DataFile, which is itself an extension of dcat:Distribution.

EXAMPLE 27

```
ddi:DataCatalog_1
a dcat:Catalog;
dcat:record ddi:EuropeanStudy;
dcat:dataset ddi:EuropeanDataset;

ddi:EuropeanStudy
a dcat:CatalogRecord;
a disco:Study;
foaf:primaryTopic ddi:EuropeanDataset;
disco:product ddi:EuropeanDataset.

ddi:EuropeanDataset
a dcat:Dataset;
a disco:LogicalDataSet;
dcat:theme ddi:topics/WellBeing;
dcat:theme ddi:topics/PoliticalAttitudes;
dcat:keyword "Europe"@en;
dcat:keyword "Politics"@en.
```

- Required classes of DCAT are: dcat:DataSet, dcat:Distribution

§ 10.4 Friend of a Friend (FOAF) and Organization Ontology (ORG)

Within the context of Disco, FOAF as well as ORG are reused. Creators (dcterms:creator), contributors (dcterms:contributor), and publishers (dcterms:publisher) of Studies and StudyGroups are foaf:Agents which are either foaf:Persons or org:Organizations whose members are foaf:Persons. Studies and StudyGroups may be funded by (disco:fundedBy) foaf:Agents. The object property disco:fundedBy is defined as sub-property of dcterms:contributor.

- Recommende classes of FOAF are: foaf:Agent, foaf:Person, foaf:Document
- Recommende classes and properties of ORG are: org:Organization, org:memberOf

§ 10.5 Asset Description Metadata Schema (ADMS)

Especially persons and organizations may hold one or more persistent identifiers of particular schemes and agencies (e.g. ORCID, FundRef) that are not considered by the specific IDs of Disco. In order to include those identifiers and for distinguishing between multiple identifiers for the same class, ADMS is utilized. As a profile of

DCAT, ADMS aims to describe semantic assets, i.e. reusable metadata and reference data. The class adms:Identifier can be added to a rdfs:Resource by using the property adms:identifier. That identifier class can contain properties that define the particular identifier itself, but also its scheme, version and managing agency. However, although utilized primarily for describing identifiers of persons and organizations, it is allowed to attach an adms:Identifier class to all classes in Disco.

§ 10.6 PROV Ontology (PROV-O)

In order to represent detailed provenance information of Web data and metadata, classes and properties of PROV-O can be used. Thus, it can be used as a natural vocabulary to attach provenance information to Disco metadata. Terms of PROV-O are organized among three main classes: prov:Entity, prov:Activity and prov:Agent. While classes of Disco can be represented either as entities or agents, particular processes for, e.g. creating, maintaining and accessing data can be modeled as activities. Properties like prov:wasGeneratedBy, prov:hadPrimarySource, prov:wasInvalidatedBy, or prov:wasDerivedFrom describe the relationship between classes for the generation of data in more detail. In order to link from a disco:Study to its original DDI XML file, the property prov:wasDerivedFrom can be used. Moreover, PROV-O allows for representing versioning information by e.g., using the terms prov:Revision, prov:hadGeneration and prov:hadUsage.

§ 10.7 RDF Data Cube Vocabulary (QB)

The RDF Data Cube Vocabulary is a W3C standard for representing data cubes, that is, multidimensional aggregate data. A `qb:DataSet` represents aggregate data such as multi-dimensional tables. Aggregate data is derived from microdata by statistics on groups, or aggregates such as counts, means, or frequencies. Data cubes are often generated by tabulating or aggregating unit-record datasets. For example, if an observation in a census data cube indicates the population of a certain age group in a certain region is 12345, then this fact was obtained by aggregating that number of individual records from a unit-record dataset. Disco contains a property “aggregation” that indicates that a Cube dataset was derived by tabulating a unit-record dataset. Data Cube provides for the description of the structure of such cubes, but also for the representation of the cube data itself, that is, the observations that make up the cube dataset [Semantic Statistics]. This is not the case for Disco, which only describes the structure of a dataset, but is not concerned with representing the actual data in it. The actual data are assumed to sit in a data file (e.g. a CSV file, or in a proprietary statistical package file format) that is not represented in RDF.

§ 10.7.1 Examples

§ Simple case: provenance of aggregated data / relationship from aggregated data to microdata

Simple case

```
@prefix prov: <http://www.w3.org/ns/prov#> .

ddi:AggregatedDataSet
    a prov:Entity;
    prov:wasDerivedFrom ddi:MicrodataDataSet.

ddi:MicrodataDataSet a prov:Entity .
```

§ Complex case: detailed description of microdata variables resulting dimensions in aggregated data and aggregation method

Complex case

```
@prefix prov: <http://www.w3.org/ns/prov#> .

ddi:AggregatedDataSet
    a prov:Entity;
    prov:wasDerivedFrom ddi:MicrodataDataSet;
    prov:wasGeneratedBy ddi:AggregationActivity;
    prov:qualifiedDerivation [
        a prov:Derivation;
        prov:entity ddi:MicrodataDataSet;
        prov:hadActivity ddi:AggregationActivity ].
```

```
ddi:AggregationActivity
    a prov:Activity .

ddi:MicrodataDataSet
    a prov:Entity;
```

NOTE

- prov:Activity
  - reference to aggregation method described by CV
  - description of variables in the microdata data set / 0..n independent variables / 1..n dependent variables
  - description of the dimension in data cube
  - 1 activity per dimension
  - see more information in DDI-L field level documentation DDI 3.2 Aggregation

§ 10.8 SKOS Extension for Statistics (XKOS)

The use of formal statistical classifications is very common in research datasets - these are treated in Disco as SKOS concepts, but in some cases those working with formal statistical classifications may desire more expressive capability than SKOS provides. To support such users, the DDI Alliance also develops XKOS, a vocabulary which extends SKOS to allow for a more complete description of such classifications [eXtended Knowledge Organization System]. While the use of XKOS is not required by this vocabulary, the two are designed to work in complementary fashion. SKOS properties may be substituted by additional XKOS properties.

Which Datasets Have A Specific Statistical Classification and What Are Its Semantic Relations?

XKOS extends SKOS with two main objectives: the first one is to allow the description of statistical classifications, the second one is to introduce refinements of the semantic properties defined in SKOS. The semantic properties extend the possible relations that can be applied between pairs of skos:Concepts. SKOS allows the following relations: skos:broader than, skos:narrower than, and skos:related to. The first two are hierarchical relations, one in each direction. In Disco, these SKOS properties may be substituted by additional XKOS properties like xkos:generalizes, xkos:hasPart, xkos:caused, xkos:previous, and xkos:next.

One question, typically asked by social science researchers, could be to query all the datasets (disco:LogicalDataSet) which have a specific statistical classification (skos:ConceptScheme) like ISCO (International Standard Classification of Occupations) or ANZSIC (Australian and New Zealand Industry Classification). It is also possible to query on the semantic relationships which are defined for statistical classifications using XKOS properties. By means of these properties not only hierarchical relations can be queries but also for example part of relationships (xkos:hasPart), more general (xkos:generalizes) and more specific (xkos:specializes) concepts, and positions of concepts in lists (xkos:previous, xkos:next).

§ 10.9 Semanticscience Integrated Ontology (SIO)

The Semanticscience Integrated Ontology (SIO) provides a simple, integrated ontology of types and relations for rich description of objects, processes and their attributes. A `sio:SIO_000367` (Variable) represents a value that may change within the scope of a given or set of operations. For instance, in the context of a mathematics or statistics, a sio Variable is an information content entity that can be used to indicate the independent, dependent, or control variables of a study or experiment. Here, the similarity between sio Variable and `disco:Variable` is that, they are both associated to a concept e.g., Sex, Age and Citizenship.

§ 11. DDI-XML Bidirectional Mappings

The main intention of Disco is to provide a RDF representation of DDI resources for discovery purposes in the Linked Data web. Nevertheless, bidirectional mappings between disco and DDI Lifecycle (DDI-L) are provided. In this section, bidirectional mappings between Disco and DDI Lifecycle (DDI-L) is provided. It allows an easy adoption of the DDI Discovery Vocabulary for existing DDI metadata. XSLTs for converting any XML output of

DDI Codebook (DDI-C) and DDI-L are available at the DDI-RDF-tools project page.

Official Mapping Document

There is also an official document containing all bidirectional mappings between Disco and DDI-L: official mapping document These mapping tables will be transformed to the official specification in form of a turtle file and in form of html tables in this html specification.

Bidirectional Mappings between Disco and DDI-L

- DDI-L Disco. This should be a straight-forward mapping for all items used in Disco.
- Disco DDI-L. This should be a straight-forward mapping for all items in the Disco namespace.
- Only the standard XPath expression is defined as mapping (although there are several other XPath expressions for each mapping)
- Context:
  - The items from other vocabularies - used in Disco - need a context; then there could be a clear mapping path.
  - We need context information for mappings, as for example skos:notation can be mapped to variable labels and to codes.
  - Context information can be either a SPARQL query or an informal description as plain literal.

Mappings between Disco and other Versions of DDI-XML

In order to avoid inconsistencies (as mapping tables may changes over time), we only offer mappings between Disco and the concrete version DDI 3.1 of DDI-L. There are various mapping documents between DDI 3.1 and other DDI versions (like DDI 3.2 and DDI 2.1) on the DDI Alliance website.

Mappings between Disco and DDI 4

DDI 4 will be the next model-driven specification of DDI including mappings to multiple representations such as RDF, XML, relational databases, and Java. DDI 4 should have a clear mapping from DDI-XML 3.2. We assume that all items used in Disco will have a clear mapping to DDI-XML 3.2, and these items in DDI-XML 3.2 will have a clear mapping to items in the DDI 4 model (therefore to a representation in OWL/RDF as well). If the latter should not be possible, then a mapping of items in DDI-XML 3.2 to DDI 4 XML and DDI 4 RDF should be possible.

Turtle File Containing Mappings in RDF

The mappings are defined within a separate turtle file

- in order to execute SPARQL queries on the turtle file
- in order to generate mapping tables for the HTML spec out of the turtle file
- there is 1 turtle file containing mappings for Disco axioms and axioms of reused external vocabularies

Mapping Tables

- The following mapping tables are generated out of the official mapping document completely automatically to avoid inconsistencies.
- The mapping tables are structured in classes, object, and data properties.
- There can be classes and properties specified within the Disco namespace or within any other namespace which are then used by Disco.

§ 11.1 Representation of Mappings in RDF

- There is an ontology (in Turtle syntax) containing all mapping triples: mappings.ttl
- This Turtle file is generated out of the official mapping document automatically
- The next figure shows how the mappings between Disco and DDI-L is represented in RDF
- We also give an example of a concrete mapping between Disco and DDI-L

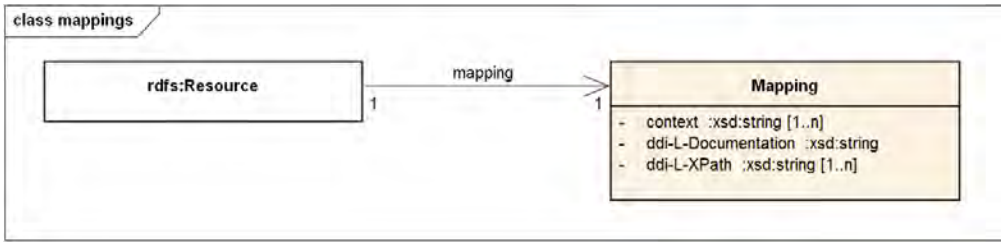


Figure 36

Representation of Mappings in RDF

Mapping Examples

```
skos:notation a rdfs:Class, owl:Class ;
disco:mapping [
    a disco:Mapping ;
    disco:ddi-L-XPath "//l:Variable/l:VariableName" ;
    disco:ddi-L-Documentation "http://www.ddialliance.org/Specification/DDI-
Lifecycle/3.1/XMLSchema/FieldLevelDocumentation/logicalproduct_xsd/elements/Variable.html"
    disco:context "skos:notation represents variable label" ;
    disco:context "SELECT ?notation WHERE { ?notation rdfs:domain ?variable. ?variable a disco:Variable. }" ]
```

§ 11.2 Classes

§ 11.2.1 Disco

#	property	domain class	range class	DDI-L	description	DDI-L Documentation
#1	disco:AnalysisUnit			r:AnalysisUnit		
#2	disco:RepresentedVariable					
#3	disco:DataFile					
#4	disco:DescriptiveStatistics					
#5	disco:SummaryStatistics					
#6	disco:CategoryStatistics			p:CategoryStatistics		
#7	disco:Instrument			d:Instrument		
#8	disco:LogicalDataSet					
#9	disco:Question			d:QuestionItem | d:MultipleQuestionItem		
#10	disco:responseDomain					
#11	disco:Questionnaire			d:Instrument	The instument of the study	
#12	disco:Study			s:StudyUnit		
#13	disco:StudyGroup					
#14	disco:Variable			//l:Variable		

§ 11.2.2 External

#	property	domain class	range class	DDI-L	description	DDI-L Documentation
#1	skos:ConceptScheme			//l:Variable/l:CodeScheme	Variables can have a coded representaion	

§ 11.3 Object Properties

§ 11.3.1 Disco

#	property	domain class	range class	DDI-L	description	DDI-L Documentation
#1	disco:analysisUnit					
#2	disco:basedOn					
#3	disco:collectionMode					
#4	disco:variable					
#5	disco:concept			//l:Vaiable/l:ConceptReference	Varialbe has a concept	
#6	disco:concept			//d:QuestionItem/r:ConceptReference	Question is defined by concept	

#7	"					
#8	disco:aggregation					
#9	disco:dataFile					
#10	disco:ddifile					
#11	disco:externalDocumentation					
#12	disco:fundedBy					
#13	disco:inGroup					
#14	disco:inputVariable					
#15	disco:instrument			//d:DataCollection/[d:QuestionItem d:MultipleQuestionItem]	The instrument of the study questionaire	
#16	disco:kindOfData					
#17	disco:product					
#18	disco:question			//l:Variable/l:QuestionReference	Variable can have a question	
#19	disco:question			//[d:QuestionItem d:MultipleQuestionItem]	Questions in a questionaire	
#20	disco:representation			//l:Variable/l:Representation/l:CodeRepresentation/[r:CodeSchemeReference l:NumericRepresentation l:TextRepresentation l:DateTimeRepresentation]	Variables can have a representation	
#21	disco:statisticsCategory					
#22	disco:statisticsDataFile					
#23	disco:statisticsVariable					
#24	disco:weightedBy					
#25	disco:universe			disco:universe	Variable can have a concept	

§ 11.3.2 External

#	property	domain class	range class	DDI-L	description	DDI-L Documentation
#1	dcterms:identifier			//l:Variable/l:VariableName	dcterms:identifier represents variable label	
#2	skos:prefLabel			//l:Variable/r:Label	skos:prefLabel represents the label of the variable	
#3	skos:prefLabel			//d:QuestionItem/d:QuestionItemName	Name of question	

§ 11.4 Data Properties

§ 11.4.1 Disco

#	property	domain class	range class	DDI-L	description	DDI-L Documentation
#1	skos:notation			//l:Variable/l:VariableName	skos:notation represents variable label	DDI-L Documentation
#2	disco:frequency			p:CaseQuantity		
#3	disco:isPublic					
#4	disco:isValid					
#5	disco:questionText			d:QuestionText		
#6	disco:percentage					
#7	disco:computationBase					
#8	disco:cumulativePercentage					
#9	disco:purpose			s:Purpose		
#10	disco:subtitle			r:SubTitle		
#11	disco:standardDeviation					
#12	disco:numberOfCases					
#13	disco:maximum					
#14	disco:mean					
#15	disco:median					
#16	disco:minimum					
#17	disco:mode					
#18	disco:startDate					

§ 11.4.2 External

#	property	domain class	range class	DDI-L	description	DDI-L Documentation
#1	skos:notation			//l:Variable/l:VariableName	skos:notation represents variable label	DDI-L Documentation
#2	skos:notation				skos:notation represents code	

§ 11.5 Overview of the Mapping from DDI-C and DDI-L to DDI-RDF

§ 11.5.1 Studies and StudyGroups

#	property	domain class	range class	DDI-C	DDI-L
1	universe	union of Study and StudyGroup	Universe	X	X
2	dcterms:subject	union of Study and StudyGroup	skos:Concept		X
3	dcterms:temporal	union of Study and StudyGroup	dcterms:PeriodOfTime		
4	dcterms:spatial	union of Study and StudyGroup	dcterms:Location		
5	kindOfData	union of Study and StudyGroup	skos:Concept		X
6	analysisUnit	union of Study and StudyGroup	AnalysisUnit		
7	dcterms:abstract	union of Study and StudyGroup	rdf:langString	X	X
8	dcterms:alternative	union of Study and StudyGroup	rdf:langString	X	X
9	dcterms:available	union of Study and StudyGroup	xsd:dateTime		X
10	dcterms:title	union of Study and StudyGroup	rdf:langString	X	X
11	purpose	union of Study and StudyGroup	rdf:langString		X
12	subtitle	union of Study and StudyGroup	rdf:langString	X	X
13	ddiFile	union of Study and StudyGroup	foaf:Document		
14	fundedBy	union of Study and StudyGroup	foaf:Agent		
15	dcterms:creator	union of Study and StudyGroup	foaf:Agent		X
16	dcterms:contributor	union of Study and StudyGroup	foaf:Agent		
17	dcterms:publisher	union of Study and StudyGroup	foaf:Agent	-	X
18	instrument	Study	Instrument		X
19	inGroup	Study	StudyGroup		X
20	dataFile	Study	DataFile		X
21	variable	Study	Variable	X	X
22	product	Study	LogicalDataSet		X
23	owl:versionInfo	Study			
24	skos:definition	Universe	rdf:langString		X

§ 11.5.2 General Metadata

#	property	domain class	range class	DDI-C	DDI-L
1	adms:identifier	disco:Study	adms:Identifier		X
2	adms:identifier	disco:StudyGroup	adms:Identifier		
3	adms:identifier	disco:AnalysisUnit	adms:Identifier		
4	adms:identifier	disco:Universe	adms:Identifier		
5	adms:identifier	disco:LogicalDataSet	adms:Identifier		
6	adms:identifier	disco:DataFile	adms:Identifier		X
7	adms:identifier	disco:DescriptiveStatistics	adms:Identifier		
8	adms:identifier	disco:SummaryStatistics	adms:Identifier		
9	adms:identifier	disco:CategoryStatistics	adms:Identifier		
10	adms:identifier	disco:Variable	adms:Identifier		X
11	adms:identifier	disco:RepresentedVariable	adms:Identifier		
12	adms:identifier	disco:Question	adms:Identifier		
13	adms:identifier	disco:Instrument	adms:Identifier		
14	adms:identifier	disco:Questionnaire	adms:Identifier		
15	skos_prefLabel	rdfs:Resource	rdf:langString		
16	dcterms:relation	rdfs:Resource	foaf:Document		
17	dcterms:description	dcterms:RightsStatement	rdf:langString		
18	skos:prefLabel	dcterms:RightsStatement	rdf:langString		
19	rdfs:seeAlso	dcterms:RightsStatement	foaf:Document		
20	skos:prefLabel	dcterms:PeriodOfTime	rdf:langString		
21	startDate	dcterms:PeriodOfTime	xsd:date		

22	endDate	dcterms:PeriodOfTime	xsd:Date		
23	skos:prefLabel	dcterms:MediaTypeOrExtent	rdf:langString		
24	org:memberOf	foaf:Person	org:Organization		

§ 11.5.3 Data Sets, Data Files, and Descriptive Statistics

#	property	domain class	range class	DDI-C	DDI-L
1	instrument	LogicalDataSet	Instrument		
2	dataFile	LogicalDataSet	DataFile		
3	aggregation	LogicalDataSet	qb:DataSet		
4	variable	LogicalDataSet	Variable		
5	universe	LogicalDataSet	Universe	X	
6	dcterms:title	LogicalDataSet	rdf:langString		X
7	isPublic	LogicalDataSet	xsd:boolean		
8	dcterms:accessRights	LogicalDataSet	dcterms:RightsStatement		X
9	dcterms:license	LogicalDataSet	dcterms:LicenseDocument		
10	inputVariable	qb:DataSet	Variable		
11	caseQuantity	DataFile	xsd:nonNegativeInteger		X
12	dcterms:description	DataFile	rdf:langstring		
13	owl:versioninfo	DataFile	string		X
14	dcterms:temporal	DataFile	dcterms:PeriodOfTime		
15	dcterms:spatial	DataFile	dcterms:Location		X
16	dcterms:provenance	DataFile	dcterms:ProvenanceStatement		
17	dcterms:subject	DataFile	skos:Concept		
18	dcterms:format	DataFile	dcterms:MediaTypeOrExtend		
19	statisticsDataFile	DescriptiveStatistics	DataFile		
20	statisticsVariable	SummaryStatistics	Variable		
21	invalidcases	SummaryStatistics	xsd:nonNegativeInteger		
22	maximum	SummaryStatistics	xsd:decimal		
23	mean	SummaryStatistics	xsd:decimal		
24	median	SummaryStatistics	xsd:decimal		
25	minimum	SummaryStatistics	xsd:decimal		
26	mode	SummaryStatistics	xsd:decimal		
27	standardDeviation	SummaryStatistics	xsd:decimal		
28	validCases	SummaryStatistics	xsd:nonNegativeInteger		
29	weightedInvalidCases	SummaryStatistics	xsd:nonNegativeInteger		
30	weightedMean	SummaryStatistics	xsd:decimal		
31	weightedMedian	SummaryStatistics	xsd:decimal		
32	weightedMode	SummaryStatistics	xsd:decimal		
33	weightedValidCases	SummaryStatistics	xsd:nonNegativeInteger		
34	statisticsCategory	CategoryStatistics	skos:Concept		
35	cumulativePercentage	CategoryStatistics	xsd:decimal		
36	frequency	CategoryStatistics	xsd:nonNegativeInteger		
37	percentage	CategoryStatistics	xsd:decimal		
38	weightedCumulativePercentage	CategoryStatistics	xsd:decimal		
39	weightedFrequency	CategoryStatistics	xsd:nonNegativeInteger		
40	weightedPercentage	CategoryStatistics	xsd:decimal		

§ 11.5.4 Variables, Variable Definitions, Representations, and Concepts

#	property	domain class	range class	DDI-C	DDI-L
1	skos:inScheme	skos:Concept	skos:ConceptScheme		
2	skos:hasTopConcept	skos:ConceptScheme	skos:Concept		
3	skos:broader	skos:Concept	skos:Concept		X
4	skos:narrower	skos:Concept	skos:Concept		
5	skos:definition	skos:Concept	rdf:langString		
6	skos:notation	skos:Concept	rdfs:Literal		X
7	skos:prefLabel	skos:Concept	rdf:LangString		
8	question	Variable	Question		X
9	universe	Variable	Universe	X	X
10	analysisUnit	Variable	AnalysisUnit		

11	concept	Variable	skos:Concept		X
12	representation	Variable	Representation		
13	basedOn	Variable	RepresentedVariable		
14	dcterms:description	Variable	rdf:langString		X
15	skos:notation	Variable	rdfs:Literal		X
16	skos:prefLabel	Variable	rdf:langString		X
17	concept	RepresentedVariable	skos:Concept		
18	universe	RepresentedVariable	Universe		
19	representation	RepresentedVariable	Representation		
20	dcterms:description	RepresentedVariable	rdf:langString		
21	skos:prefLabel	RepresentedVariable	rdf:langString		

§ 11.5.5 Data Collection

#	property	domain class	range class	DDI-C	DDI-L
1	universe	Question	Universe	X	X
2	concept	Question	skos:Concept		X
3	responseDomain	Question	Representation		
4	questionText	Question	rdf:langString		X
5	skos:prefLabel	Question	rdf:langString		X
6	question	Questionnaire	Question		
7	collectionMode	Questionnaire	skos:Concept		
8	externalDocumentation	Instrument	foaf:Document		
9	dcterms:description	Instrument	rdf:langString		X
10	skos:prefLabel	Instrument	rdf:langString		X

§ 11.6 Mapping from DDI-C to DDI-RDF

§ 11.6.1 Studies and StudyGroups

#	property	domain class	range class	mapping
1	universe	union of Study and StudyGroup	Universe	/codeBook/stdyDscr/stdyInfo/sumDscr/universe
2	dcterms:subject	union of Study and StudyGroup	skos:Concept	
3	dcterms:temporal	union of Study and StudyGroup	dcterms:PeriodOfTime	
4	dcterms:spatial	union of Study and StudyGroup	dcterms:Location	
5	kindOfData	union of Study and StudyGroup	skos:Concept	
6	analysisUnit	union of Study and StudyGroup	AnalysisUnit	
7	dcterms:abstract	union of Study and StudyGroup	rdf:langString	/codeBook/stdyDscr/stdyInfo/abstract
8	dcterms:alternative	union of Study and StudyGroup	rdf:langString	/codeBook/stdyDscr/citation/altTitl
9	dcterms:available	union of Study and StudyGroup	xsd:dateTime	
10	dcterms:title	union of Study and StudyGroup	rdf:langString	/codeBook/stdyDscr/citation/titl
11	purpose	union of Study and StudyGroup	rdf:langString	
12	subtitle	union of Study and StudyGroup	rdf:langString	/codeBook/stdyDscr/citation/subTitl
13	ddiFile	union of Study and StudyGroup	foaf:Document	
14	fundedBy	union of Study and StudyGroup	foaf:Agent	
15	dcterms:creator	union of Study and StudyGroup	foaf:Agent	
16	dcterms:contributor	union of Study and StudyGroup	foaf:Agent	
17	dcterms:publisher	union of Study and StudyGroup	foaf:Agent	
18	instrument	Study	Instrument	
19	inGroup	Study	StudyGroup	
20	dataFile	Study	DataFile	
21	variable	Study	Variable	/codeBook/dataDscr/var/@id
22	product	Study	LogicalDataSet	
23	owl:versionInfo	Study		
24	skos:definition	Universe	rdf:langString	

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§ 11.6.2 General Metadata

#	property	domain class	range class	mapping
1	adms:identifier	disco:Study	adms:Identifier	
2	adms:identifier	disco:StudyGroup	adms:Identifier	
3	adms:identifier	disco:AnalysisUnit	adms:Identifier	
4	adms:identifier	disco:Universe	adms:Identifier	
5	adms:identifier	disco:LogicalDataSet	adms:Identifier	
6	adms:identifier	disco:DataFile	adms:Identifier	
7	adms:identifier	disco:DescriptiveStatistics	adms:Identifier	
8	adms:identifier	disco:SummaryStatistics	adms:Identifier	
9	adms:identifier	disco:CategoryStatistics	adms:Identifier	
10	adms:identifier	disco:Variable	adms:Identifier	
11	adms:identifier	disco:RepresentedVariable	adms:Identifier	
12	adms:identifier	disco:Question	adms:Identifier	
13	adms:identifier	disco:Instrument	adms:Identifier	
14	adms:identifier	disco:Questionnaire	adms:Identifier	
15	skos_prefLabel	rdfs:Resource	rdf:langString	
16	dcterms:relation	rdfs:Resource	foaf:Document	
17	dcterms:description	dcterms:RightsStatement	rdf:langString	
18	skos:prefLabel	dcterms:RightsStatement	rdf:langString	
19	rdfs:seeAlso	dcterms:RightsStatement	foaf:Document	
20	skos:prefLabel	dcterms:PeriodOfTime	rdf:langString	
21	startDate	dcterms:PeriodOfTime	xsd:date	
22	endDate	dcterms:PeriodOfTime	xsd:Date	
23	skos:prefLabel	dcterms:MediaTypeOrExtent	rdf:langString	
24	org:memberOf	foaf:Person	org:Organization	

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§ 11.6.3 Data Sets, Data Files, and Descriptive Statistics

#	property	domain class	range class	mapping
1	instrument	LogicalDataSet	Instrument	
2	dataFile	LogicalDataSet	DataFile	
3	aggregation	LogicalDataSet	qb:DataSet	
4	variable	LogicalDataSet	Variable	
5	universe	LogicalDataSet	Universe	/codeBook/stdyDscr/stdyInfo/sumDscr/universe
6	dcterms:title	LogicalDataSet	rdf:langString	
7	isPublic	LogicalDataSet	xsd:boolean	
8	dcterms:accessRights	LogicalDataSet	dcterms:RightsStatement	
9	dcterms:license	LogicalDataSet	dcterms:LicenseDocument	
10	inputVariable	qb:DataSet	Variable	
11	caseQuantity	DataFile	xsd:nonNegativeInteger	
12	dcterms:description	DataFile	rdf:langstring	
13	owl:versioninfo	DataFile	string	
14	dcterms:temporal	DataFile	dcterms:PeriodOfTime	
15	dcterms:spatial	DataFile	dcterms:Location	
16	dcterms:provenance	DataFile	dcterms:ProvenanceStatement	
17	dcterms:subject	DataFile	skos:Concept	
18	dcterms:format	DataFile	dcterms:MediaTypeOrExtend	
19	statisticsDataFile	DescriptiveStatistics	DataFile	
20	statisticsVariable	SummaryStatistics	Variable	
21	invalidcases	SummaryStatistics	xsd:nonNegativeInteger	
22	maximum	SummaryStatistics	xsd:decimal	
23	mean	SummaryStatistics	xsd:decimal	
24	median	SummaryStatistics	xsd:decimal	
25	minimum	SummaryStatistics	xsd:decimal	
26	mode	SummaryStatistics	xsd:decimal	
27	standardDeviation	SummaryStatistics	xsd:decimal	
28	validCases	SummaryStatistics	xsd:nonNegativeInteger	

29	weightedInvalidCases	SummaryStatistics	xsd:nonNegativeInteger	
30	weightedMean	SummaryStatistics	xsd:decimal	
31	weightedMedian	SummaryStatistics	xsd:decimal	
32	weightedMode	SummaryStatistics	xsd:decimal	
33	weightedValidCases	SummaryStatistics	xsd:nonNegativeInteger	
34	statisticsCategory	CategoryStatistics	skos:Concept	
35	cumulativePercentage	CategoryStatistics	xsd:decimal	
36	frequency	CategoryStatistics	xsd:nonNegativeInteger	
37	percentage	CategoryStatistics	xsd:decimal	
38	weightedCumulativePercentage	CategoryStatistics	xsd:decimal	
39	weightedFrequency	CategoryStatistics	xsd:nonNegativeInteger	
40	weightedPercentage	CategoryStatistics	xsd:decimal	

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§ 11.6.4 Variables, Variable Definitions, Representations, and Concepts

#	property	domain class	range class	mapping
1	skos:inScheme	skos:Concept	skos:ConceptScheme	
2	skos:hasTopConcept	skos:ConceptScheme	skos:Concept	
3	skos:broader	skos:Concept	skos:Concept	
4	skos:narrower	skos:Concept	skos:Concept	
5	skos:definition	skos:Concept	rdf:langString	
6	skos:notation	skos:Concept	rdfs:Literal	
7	skos:prefLabel	skos:Concept	rdf:LangString	
8	question	Variable	Question	
9	universe	Variable	Universe	/codeBook/stdyDscr/stdyInfo/sumDscr/universe
10	analysisUnit	Variable	AnalysisUnit	
11	concept	Variable	skos:Concept	
12	representation	Variable	Representation	
13	basedOn	Variable	RepresentedVariable	
14	dcterms:description	Variable	rdf:langString	
15	skos:notation	Variable	rdfs:Literal	
16	skos:prefLabel	Variable	rdf:langString	
17	concept	RepresentedVariable	skos:Concept	
18	universe	RepresentedVariable	Universe	
19	representation	RepresentedVariable	Representation	
20	dcterms:description	RepresentedVariable	rdf:langString	
21	skos:prefLabel	RepresentedVariable	rdf:langString	

§ notes

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§ 11.6.5 Data Collection

#	property	domain class	range class	mapping
1	universe	Question	Universe	/codeBook/stdyDscr/stdyInfo/sumDscr/universe
2	concept	Question	skos:Concept	
3	responseDomain	Question	Representation	
4	questionText	Question	rdf:langString	
5	skos:prefLabel	Question	rdf:langString	
6	question	Questionnaire	Question	
7	collectionMode	Questionnaire	skos:Concept	
8	externalDocumentation	Instrument	foaf:Document	
9	dcterms:description	Instrument	rdf:langString	
10	skos:prefLabel	Instrument	rdf:langString	

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§ 11.7 Mapping from DDI-L to DDI-RDF

§ 11.7.1 Studies and StudyGroups

#	property	domain class	range class	mapping
1	universe	union of Study and StudyGroup	Universe	/ddi:DDIInstance/s:StudyUnit/r:UniverseReference/r:ID
2	dcterms:subject	union of Study and StudyGroup	skos:Concept	/ddi:DDIInstance/s:StudyUnit/r:TopicalCoverage/r:Subject
3	dcterms:temporal	union of Study and StudyGroup	dcterms:PeriodOfTime	
4	dcterms:spatial	union of Study and StudyGroup	dcterms:Location	
5	kindOfData	union of Study and StudyGroup	skos:Concept	/ddi:DDIInstance/s:StudyUnit/r:KindOfData
6	analysisUnit	union of Study and StudyGroup	AnalysisUnit	/ddi:DDIInstance/s:StudyUnit/r:AnalysisUnit
7	dcterms:abstract	union of Study and StudyGroup	rdf:langString	/ddi:DDIInstance/s:StudyUnit/s:Abstract/r:Content
8	dcterms:alternative	union of Study and StudyGroup	rdf:langString	/ddi:DDIInstance/s:StudyUnit/r:Citation/r:AlternateTitle
9	dcterms:available	union of Study and StudyGroup	xsd:dateTime	/ddi:DDIInstance/s:StudyUnit/r:Embargo/r:Date/r:SimpleDate
10	dcterms:title	union of Study and StudyGroup	rdf:langString	/ddi:DDIInstance/s:StudyUnit/r:Citation/r:Title
11	purpose	union of Study and StudyGroup	rdf:langString	/ddi:DDIInstance/s:StudyUnit/s:Purpose/r:Content
12	subtitle	union of Study and StudyGroup	rdf:langString	/ddi:DDIInstance/s:StudyUnit/r:Citation/r:SubTitle
13	ddiFile	union of Study and StudyGroup	foaf:Document	
14	fundedBy	union of Study and StudyGroup	foaf:Agent	/ddi:DDIInstance/s:StudyUnit/r:FundingInformation
15	dcterms:creator	union of Study and StudyGroup	foaf:Agent	/ddi:DDIInstance/s:StudyUnit/r:Citation/r:Creator
16	dcterms:contributor	union of Study and StudyGroup	foaf:Agent	/ddi:DDIInstance/s:StudyUnit/r:Citation/r:Contributor
17	dcterms:publisher	union of Study and StudyGroup	foaf:Agent	/ddi:DDIInstance/s:StudyUnit/r:Citation/r:Publisher
18	instrument	Study	Instrument	/ddi:DDIInstace/s:StudyUnit/d:DataCollection/@id
19	inGroup	Study	StudyGroup	//s:StudyUnit/ancestor::g:Group[1]/@id
20	dataFile	Study	DataFile	//s:StudyUnit/pi:PhysicalInstance/@id
21	variable	Study	Variable	/ddi:DDIInstance/s:StudyUnit/l:Variable/@id
22	product	Study	LogicalDataSet	//s:StudyUnit/l:LogicalProduct/@id
23	owl:versionInfo	Study		
24	skos:definition	Universe	rdf:langString	c:Universe/c:HumanReadable

§ notes

- (2): inf code list is defined use it as the identifier
- (9): the date the study is available to the public
- (13): the URI to the DDI file(s) defined via param to the xslt
- (21): suggested for identification

§ 11.7.2 General Metadata

#	property	domain class	range class	mapping
1	adms:identifier	disco:Study	adms:Identifier	/ddi:DDIInstance/s:StudyUnit/@id
2	adms:identifier	disco:StudyGroup	adms:Identifier	
3	adms:identifier	disco:AnalysisUnit	adms:Identifier	
4	adms:identifier	disco:Universe	adms:Identifier	
5	adms:identifier	disco:LogicalDataSet	adms:Identifier	
6	adms:identifier	disco:DataFile	adms:Identifier	//pi:PhysicalInstance/pi:DataFileIdentification
7	adms:identifier	disco:DescriptiveStatistics	adms:Identifier	
8	adms:identifier	disco:SummaryStatistics	adms:Identifier	
9	adms:identifier	disco:CategoryStatistics	adms:Identifier	
10	adms:identifier	disco:Variable	adms:Identifier	//l:Variable/l:VariableName
11	adms:identifier	disco:RepresentedVariable	adms:Identifier	
12	adms:identifier	disco:Question	adms:Identifier	
13	adms:identifier	disco:Instrument	adms:Identifier	
14	adms:identifier	disco:Questionnaire	adms:Identifier	
15	skos_prefLabel	rdfs:Resource	rdf:langString	
16	dcterms:relation	rdfs:Resource	foaf:Document	
17	dcterms:description	dcterms:RightsStatement	rdf:langString	
18	skos:prefLabel	dcterms:RightsStatement	rdf:langString	

19	rdfs:seeAlso	dcterms:RightsStatement	foaf:Document	
20	skos:prefLabel	dcterms:PeriodOfTime	rdf:langString	
21	startDate	dcterms:PeriodOfTime	xsd:date	
22	endDate	dcterms:PeriodOfTime	xsd:Date	
23	skos:prefLabel	dcterms:MediaTypeOrExtent	rdf:langString	
24	org:memberOf	foaf:Person	org:Organization	

§ notes

- (1): s:StudyUnit/r:Archive/a:ArchiveSpecific/a:Collection/a:CallNumber is also a candidate for identification

§ 11.7.3 Data Sets, Data Files, and Descriptive Statistics

#	property	domain class	range class	mapping
1	instrument	LogicalDataSet	Instrument	
2	dataFile	LogicalDataSet	DataFile	
3	aggregation	LogicalDataSet	qb:DataSet	
4	variable	LogicalDataSet	Variable	
5	universe	LogicalDataSet	Universe	
6	dcterms:title	LogicalDataSet	rdf:langString	//l:LogicalProduct/r:Label
7	isPublic	LogicalDataSet	xsd:boolean	
8	dcterms:accessRights	LogicalDataSet	dcterms:RightsStatement	ancestor::s:StudyUnit/a:Archive/a:DefaultAccess/a:AccessConditions
9	dcterms:license	LogicalDataSet	dcterms:LicenseDocument	
10	inputVariable	qb:DataSet	Variable	
11	caseQuantity	DataFile	xsd:nonNegativeInteger	//pi:PhysicalInstance/pi:GrossFileStructure/pi:CaseQuantity
12	dcterms:description	DataFile	rdf:langstring	
13	owl:versioninfo	DataFile	string	//pi:PhysicalInstance/@version
14	dcterms:temporal	DataFile	dcterms:PeriodOfTime	
15	dcterms:spatial	DataFile	dcterms:Location	pi:PhysicalInstance/r:Coverage/r:SpatialCoverage/@id | pi:PhysicalInstance/r:Coverage/r:SpatialCoverageReference/r:ID
16	dcterms:provenance	DataFile	dcterms:ProvenanceStatement	
17	dcterms:subject	DataFile	skos:Concept	
18	dcterms:format	DataFile	dcterms:MediaTypeOrExtend	
19	statisticsDataFile	DescriptiveStatistics	DataFile	
20	statisticsVariable	SummaryStatistics	Variable	
21	invalidcases	SummaryStatistics	xsd:nonNegativeInteger	
22	maximum	SummaryStatistics	xsd:decimal	
23	mean	SummaryStatistics	xsd:decimal	
24	median	SummaryStatistics	xsd:decimal	
25	minimum	SummaryStatistics	xsd:decimal	
26	mode	SummaryStatistics	xsd:decimal	
27	standardDeviation	SummaryStatistics	xsd:decimal	
28	validCases	SummaryStatistics	xsd:nonNegativeInteger	
29	weightedInvalidCases	SummaryStatistics	xsd:nonNegativeInteger	
30	weightedMean	SummaryStatistics	xsd:decimal	
31	weightedMedian	SummaryStatistics	xsd:decimal	
32	weightedMode	SummaryStatistics	xsd:decimal	
33	weightedValidCases	SummaryStatistics	xsd:nonNegativeInteger	
34	statisticsCategory	CategoryStatistics	skos:Concept	
35	cumulativePercentage	CategoryStatistics	xsd:decimal	
36	frequency	CategoryStatistics	xsd:nonNegativeInteger	
37	percentage	CategoryStatistics	xsd:decimal	
38	weightedCumulativePercentage	CategoryStatistics	xsd:decimal	
39	weightedFrequency	CategoryStatistics	xsd:nonNegativeInteger	
40	weightedPercentage	CategoryStatistics	xsd:decimal	

§ notes

- (7): not populated from DDI (could be set as an param to the xslt)
- (17): located in pi:PhysicalInstance/r:Coverage/r:TopicalCoverage (both subject and keyword)

§ 11.7.4 Variables, Variable Definitions, Representations, and Concepts

#	property	domain class	range class	mapping
1	skos:inScheme	skos:Concept	skos:ConceptScheme	
2	skos:hasTopConcept	skos:ConceptScheme	skos:Concept	
3	skos:broader	skos:Concept	skos:Concept	c:Universe/c:SubUniverse/@id
4	skos:narrower	skos:Concept	skos:Concept	
5	skos:definition	skos:Concept	rdf:langString	c:Universe/c:UniverseName
6	skos:notation	skos:Concept	rdfs:Literal	c:Universe/c:MachineReadable [skos:notation is only used to represent codes]
7	skos:prefLabel	skos:Concept	rdf:LangString	c:Universe/r:Label [skos:notation is only used to represent categories]
8	question	Variable	Question	//l:Variable/r:QuestionReference/r:ID
9	universe	Variable	Universe	//l:Variable/r:UniverseReference/r:ID
10	analysisUnit	Variable	AnalysisUnit	
11	concept	Variable	skos:Concept	//l:Variable/r:ConceptReference/r:ID
12	representation	Variable	Representation	
13	basedOn	Variable	RepresentedVariable	
14	dcterms:description	Variable	rdf:langString	//l:Variable/r:Description
15	skos:notation	Variable	rdfs:Literal	//l:Variable/l:VariableName
16	skos:prefLabel	Variable	rdf:langString	//l:Variable/r:Label
17	concept	RepresentedVariable	skos:Concept	
18	universe	RepresentedVariable	Universe	
19	representation	RepresentedVariable	Representation	
20	dcterms:description	RepresentedVariable	rdf:langString	
21	skos:prefLabel	RepresentedVariable	rdf:langString	

§ notes

- (12): not sure where to map to in DDI 3.1
- (13): coming in DDI 3.2

§ 11.7.5 Data Collection

#	property	domain class	range class	mapping
1	universe	Question	Universe	//l:Variable/r:UniverseReference/r:ID
2	concept	Question	skos:Concept	//l:Variable/r:ConceptReference/r:ID
3	responseDomain	Question	Representation	
4	questionText	Question	rdf:langString	//d:QuestionItem | d:MultipleQuestionItem/d:QuestionText/d:LiteralText/d:Text
5	skos:prefLabel	Question	rdf:langString	//d:QuestionItem/d:QuestionItemName | d:MultipleQuestionItem/d:MultipleQuestionItemName
6	question	Questionnaire	Question	
7	collectionMode	Questionnaire	skos:Concept	
8	externalDocumentation	Instrument	foaf:Document	
9	dcterms:description	Instrument	rdf:langString	d:Intrument/r:Description
10	skos:prefLabel	Instrument	rdf:langString	d:Instrument/r:Label

§ notes

- (4): question-text exists for multiple elements
- (5): the question name as label

§ 12. Mappings to other Models

§ 12.1 GSIM

§ 12.2 Schema.org

§ 13. Reference Implementations

§ 13.1 Microdata Information System (MISSY)

The Microdata Information System (MISSY) is an online service platform that provides systematically structured

metadata for official statistics. This includes data documentation at the study and variable level (6 series, 73 studies, 121 data sets, 22,719 variables, and 6,481 questions) as well as documentation materials, tools, and further information. We developed

1. an editor in compliance with DDI-Codebook, DDI-Lifecycle, and Disco to improve and simplify the process of documentation and
2. a web information system to provide the end user with various views on the metadata.

§ 13.1.1 Data Models

We use Disco as core data model and extend it with a project-specific data model as Disco does not meet all of our project requirements. We provide open-source reference implementations of the Disco and the project-specific data model in Java, see Software Resources below. As instances of these data models may be physically stored in multiple formats such as DDI-XML, Disco, relational databases, and Java, we offer persistence implementations for each of these models according to their individual persistence APIs. Diverse export routines (e.g., Disco and DDI-Lifecycle) are available to enable the reuse of metadata in other systems.

§ 13.1.2 Publications

- Bohr, J. (2007). Final Report MISSY User Survey. ZUMA Methodenbericht 01, Gesis - Leibniz Institute for the Social Sciences, Mannheim, Germany.
- Bohr, J., Hopt, O., Lengerer, A., Schroedter, J., & Wira-Alam, A. (2010). Microdata Information System MISSY: Metadata for the Microcensus Scientific Use Files (Final Report MISSY II). Gesis Technical Report 07, Gesis - Leibniz Institute for the Social Sciences, Mannheim, Germany.
- Bohr, J., Janßen, A., Lengerer, A., Lüttinger, P., Schroedter, J., & Wolf, C. (2007). Improvement of Access to Microdata for Research. Pilot Project for the Construction of a Service Center for Microdata of GESIS at ZUMA. ZUMA Methodenbericht 05, Gesis - Leibniz Institute for the Social Sciences, Mannheim, Germany.
- Bohr, J., Janßen, A., & Wackerow, J. (2006). Problems of Comparability in the German Microcensus over Time and the New DDI Version 3.0. IASSIST Quarterly, 30(2), 13–19.
- Janßen, A. & Bohr, J. (2006). Microdata Information System – MISSY. IASSIST Quarterly, 30(2), 5–11.
- Wira-Alam, A. & Hopt, O. (2009). Implementing DDI 3: The German Microcensus Case Study. IASSIST Quarterly, 33(1), 16–22.

§ 13.1.3 Software Resources

- disco-model - A Java implementation of the DDI-RDF Discovery Vocabulary
- Documentation of the Java implementation of the Disco model
- missy-model - Extension of the Disco model for MISSY

§ A. Vocabulary Reference

§ 1. Studies and StudyGroups

Class: `disco:Study`

A Study represents the process by which a data set was generated or collected.

Object Property: `disco:variable` (***Domain:***`disco:Study` ***-> Range:*** `disco:Variable`)

Indicates the Variable of a Study.

Object Property: `disco:inGroup` (***Domain:***`disco:Study` ***-> Range:*** `disco:StudyGroup`)

points from a Study to the StudyGroup which contains the Study.

Object Property: `disco:product` (***Domain:***`disco:Study` ***-> Range:*** `http://purl.org/linked-data/cube#LogicalDataSet`)

Indicates the LogicalDataSets of a Studies.

Class: `disco:StudyGroup`

In some cases, where data collection is cyclic or on-going, data sets may be released as a StudyGroup, where each cycle or wave of the data collection activity produces one or more data sets. This is typical for

longitudinal studies, panel studies, and other types of series (to use the DDI term). In this case, a number of Study objects would be collected into a single StudyGroup.

Class: `disco:AnalysisUnit` Sub Class of: `skos:Concept`

The process collecting data is focusing on the analysis of a particular type of subject. If, for example, the adult population of Finland is being studied, the AnalysisUnit would be individuals or persons.

Class: `disco:Universe` Sub Class of: `skos:Concept`

A Universe is the total membership or population of a defined class of people, objects or events.

§ 2. Data Sets, Data Files, and Descriptive Statistics

Class: `disco:LogicalDataSet` Sub Class of: `http://www.w3.org/ns/dcat#Dataset`

Each study has a set of logical metadata associated with the processing of data, at the time of collection or later during cleaning, and re-coding. LogicalDataSet represents the microdata dataset.

Object Property: `disco:variable` (***Domain:***`disco:LogicalDataSet` ***-> Range:*** `disco:Variable`)

points to Variable contained in the LogicalDataSet

Object Property: `disco:aggregation` (***Domain:***`disco:LogicalDataSet` ***-> Range:*** `http://purl.org/linked-data/cube#DataSet`)

points to the aggregated data set of a microdata data set.

Datatype Property: `disco:isPublic` (***Domain:***`disco:LogicalDataSet` ***-> Range:*** `xsd:boolean`)

The value true indicates that the dataset can be accessed (usually downloaded) by anyone.

Datatype Property: `disco:variableQuantity` (***Domain:***`disco:LogicalDataSet` ***-> Range:*** `xsd:nonNegativeInteger`)

This property can be used when (1) no variable level information is available and when (2) only a stub of the RDF is requested e.g when returning basic information on a study of file, no information on potentially hundreds or thousands of variables references or metadata has to be returned.

Class: `disco:DataFile` Sub Class of: `http://www.w3.org/ns/dcat#Distribution`

The class DataFile, which is also a dcmitype:Dataset, represents all the data files containing the microdata datasets.

Datatype Property: `disco:caseQuantity` (***Domain:***`disco:DataFile` ***-> Range:*** `xsd:nonNegativeInteger`)

case quantity of a DataFile.

Datatype Property: `disco:variableQuantity` (***Domain:***`disco:DataFile` ***-> Range:*** `xsd:nonNegativeInteger`)

This property can be used when (1) no variable level information is available and when (2) only a stub of the RDF is requested e.g when returning basic information on a study of file, no information on potentially hundreds or thousands of variables references or metadata has to be returned.

Class: `disco:DescriptiveStatistics`

SummaryStatistics pointing to variables and CategoryStatistics pointing to categories and codes are both DescriptiveStatistics. Summary statistics are used to summarize a set of observations, in order to communicate the largest amount of information as simply as possible. A category statistic or frequency is the value of a statistic associated with a category value (even it can be applied to numeric values of metric variables). A frequency is the number of times a data value occurs. There are frequency counts (absolute) and percentages (relative) of the values of individual variables. See also the Wikipedia entry on frequency in statistics.

Object Property: `disco:statisticsDataFile` (***Domain:***`disco:DescriptiveStatistics` ***-> Range:*** `disco:DataFile`)

Indicates the DataFile of a specific DesciptiveStatistics individual.

Class: `disco:SummaryStatistics` Sub Class of: `disco:DescriptiveStatistics`

For SummaryStatistics, maximum values, minimum values, and standard deviations can be defined.

Object Property: `disco:statisticsVariable` (***Domain:***`disco:SummaryStatistics` ***-> Range:*** `disco:Variable`)

Indicates the Variable of a specific SummaryStatistics individual.

Object Property: `disco:summaryStatisticsType` (***Domain:***`disco:SummaryStatistics` ***-> Range:*** `skos:Concept`)

summary statistics type

Object Property: `disco:weightedBy` (***Domain:***`disco:SummaryStatistics` ***-> Range:*** `disco:Variable`)

Defines the weight variable of a category or summary statistic computation respectively value. It can also be used to indicate if a weight variable is used but the related variable is not known. weightedBy may be assigned to a category statistic value or to a summary statistic value.

Class: `disco:CategoryStatistics` Sub Class of: `disco:DescriptiveStatistics`

For CategoryStatistics, frequencies, percentages, and weighted percentages can be defined.

Object Property: `disco:statisticsCategory` (***Domain:***`disco:CategoryStatistics` ***-> Range:*** `skos:Concept`)

Indicates the skos:Concept (representing codes and categories) of a specific CategoryStatistics individual.

Object Property: `disco:weightedBy` (***Domain:***`disco:CategoryStatistics` ***-> Range:*** `disco:Variable`)

Defines the weight variable of a category or summary statistic computation respectively value. It can also be used to indicate if a weight variable is used but the related variable is not known. weightedBy may be assigned to a category statistic value or to a summary statistic value.

Datatype Property: `disco:frequency` (***Domain:***`disco:CategoryStatistics` ***-> Range:*** `xsd:nonNegativeInteger`)

frequency

Datatype Property: `disco:percentage` (***Domain:***`disco:CategoryStatistics` ***-> Range:*** `xsd:decimal`)

percentage

Datatype Property: `disco:computationBase` (***Domain:***`disco:CategoryStatistics` ***-> Range:*** `rdf:langString`)

computation base

Datatype Property: `disco:cumulativePercentage` (***Domain:***`disco:CategoryStatistics` ***-> Range:*** `xsd:decimal`)

cumulative percentage

§ 3. Variables, Variable Definitions, Representations, and Concepts

Class: `disco:Representation`

The Representation of a variable is the combination of a value domain, datatype, and, if necessary, a unit of measure or a character set. Representation is one of a set of values to which a numerical measure or a category from a classification can be assigned (e.g. income, age, and sex: male coded as 1).

Class: `disco:RepresentedVariable`

RepresentedVariables encompasse study-independent, re-usable parts of variables like occupation classification. The Representation of a variable is the combination of a value domain, datatype, and, if necessary, a unit of measure or a character set. Representation is one of a set of values to which a numerical measure or a category from a classification can be assigned (e.g. income, age, and sex: male coded as 1).

Class: `disco:Variable`

Variables provide a definition of the column in a rectangular data file. Variable is a characteristic of a unit being observed. A variable might be the answer of a question, have an administrative source, or be derived from other variables.

Object Property: `disco:basedOn` (***Domain:***`disco:Variable` ***-> Range:*** `disco:RepresentedVariable`)

points to the RepresentedVariable the Variable is based on.

§ 4. Data Collection

Class: `disco:Question`

A Question is designed to get information upon a subject, or sequence of subjects, from a respondent.

Object Property: `disco:responseDomain` (***Domain:***`disco:Question` ***-> Range:*** `disco:Representation`)

The response domain of questions.

Datatype Property: `disco:questionText` (***Domain:***`disco:Question` ***-> Range:*** `rdf:langString`)

question text

Class: `disco:Instrument`

The data for the study are collected by an Instrument. The purpose of an Instrument, i.e. an interview, a questionnaire or another entity used as a means of data collection, is in the case of a survey to record the flow of a questionnaire, its use of questions, and additional component parts. A questionnaire contains a flow of questions.

Object Property: `disco:externalDocumentation` (***Domain:***`disco:Instrument` ***-> Range:*** `foaf:Document`)

points from an Instrument to a foaf:Document which is the external documentation of the Instrument.

Class: `disco:Questionnaire` Sub Class of: `disco:Instrument`

A questionnaire contains a flow of questions.

Object Property: `disco:collectionMode` (***Domain:***`disco:Questionnaire` ***-> Range:*** `skos:Concept`)

mode of collection of a Questionnaire

§ 5. Other properties

Class: `disco:Question`

A Question is designed to get information upon a subject, or sequence of subjects, from a respondent.

Object Property: `disco:universe` (***Domain:***`disco:Study`, `disco:StudyGroup`, `disco:RepresentedVariable`, `disco:Variable`, `disco:Question`, `disco:LogicalDataSet` ***-> Range:*** `disco:Universe`)

Indicates the Universe(s) of Studies, StudyGrous, RepresentedVariables, Variables, Questions, and LogicalDataSets.

Object Property: `disco:concept` (***Domain:***`disco:RepresentedVariable`, `disco:Question`, `disco:Variable` ***-> Range:*** `skos:Concept`)

points to the DDI concept of a RepresentedVariable, a Variable, or a Question

Datatype Property: `disco:questionText` (***Domain:***`disco:Question` ***-> Range:*** `rdf:langString`)

question text

Class: `disco:Instrument`

The data for the study are collected by an Instrument. The purpose of an Instrument, i.e. an interview, a questionnaire or another entity used as a means of data collection, is in the case of a survey to record the flow of a questionnaire, its use of questions, and additional component parts. A questionnaire contains a flow of questions.

Object Property: `disco:externalDocumentation` (***Domain:***`disco:Instrument` ***-> Range:*** `foaf:Document`)

points from an Instrument to a foaf:Document which is the external documentation of the Instrument.

Class: `disco:Questionnaire` Sub Class of: `disco:Instrument`

A questionnaire contains a flow of questions.

Object Property: `disco:collectionMode` (***Domain:***`disco:Questionnaire` ***-> Range:*** `skos:Concept`)

mode of collection of a Questionnaire

Object Property: `disco:question` (***Domain:***`disco:Variable`, `disco:Questionnaire` ***-> Range:*** `disco:Question`)

Indicates the Questions associated to Variables or contained in Questionnaires.

§ B. Combined UML Diagram

The following figure shows the object properties between the most important classes of the DDI-RDF Discovery Vocabulary. Additionally, the cardinalities of these object properties and class hierarchies are visualized.

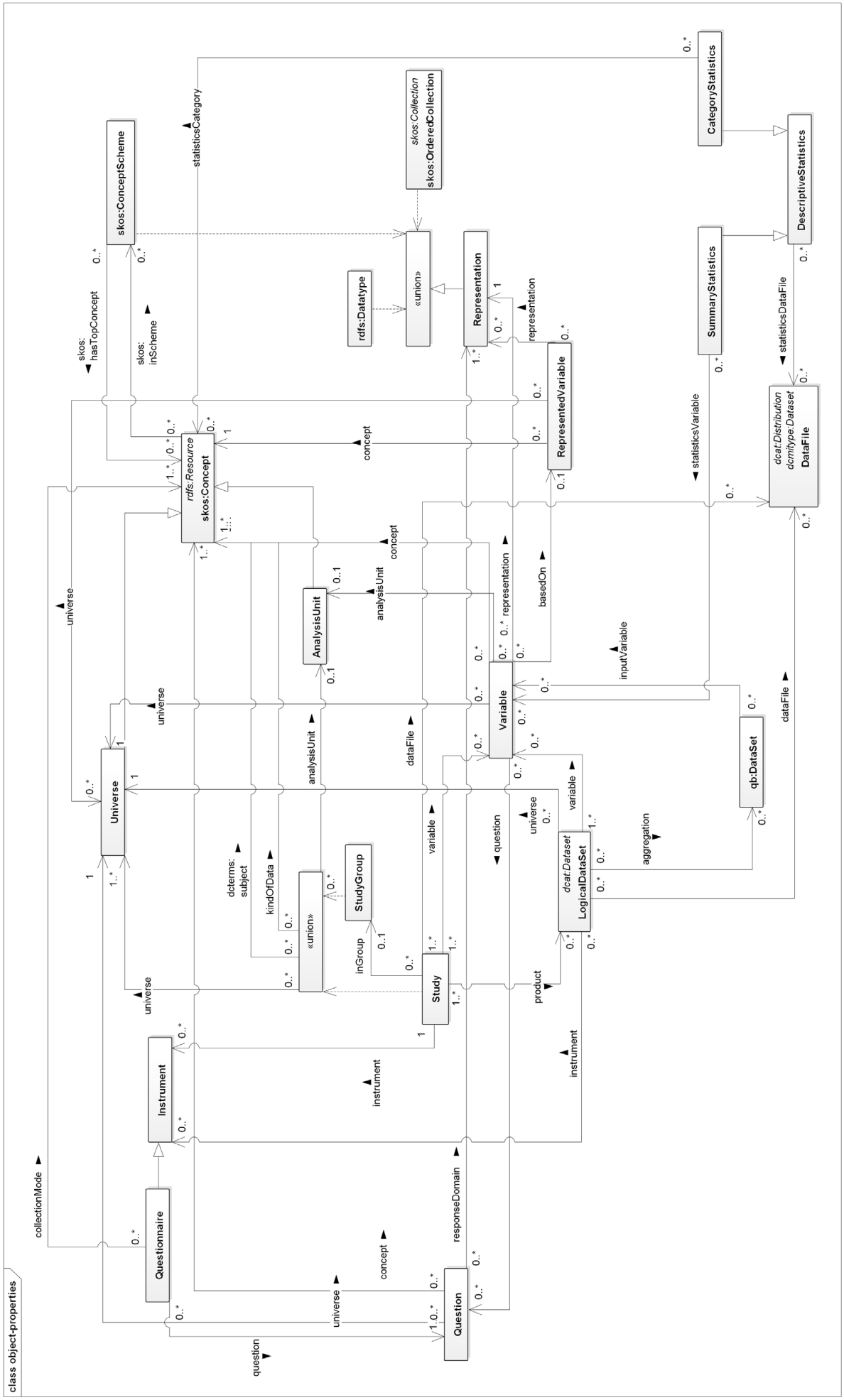

Figure 37 Combined UML Diagram (object properties only)

§ C. Use Cases and Example Queries

Vompras, Gregory, Bosch, Capadisli, and Wackerow [Scenarios] have written a paper describing typical use cases associated with the DDI-RDF Discovery Vocabulary. The specification the DDI-RDF Discovery Vocabulary does not contain the full list of all the possible use cases. The complete list can be found in the mentioned paper. We now show a couple of representative use cases associated with the DDI-RDF Discovery Vocabulary.

§ Searching for subjects and temporal coverage

Find studies from years 2000 and after about climate change.

EXAMPLE 28

```
SELECT ?studyTitle ?studyAbstract ?logicalDataSetTitle
WHERE {
  ?study a disco:Study ;
    dcterms:title ?studyTitle ;
    dcterms:abstract ?studyAbstract ;
    dcterms:subject [ skos:prefLabel “Climate Change” ] ;
    dcterms:temporal [ disco:startDate ?date ] ;
    disco:product ?logicalDataSet .

  ?logicalDataSet a disco:LogicalDataSet ;
    dcterms:title ?logicalDataSetTitle .

  FILTER (?date >= 2000)
}
```

§ Searching for particular access conditions and rights

Find titles of data sets which are publicly available under the Canadian Data Liberation Initiative Community policy. Optionally give links to the rights statement and the license.

EXAMPLE 29

```
SELECT ?logicalDataSetTitle
WHERE {
  ?logicalDataSet a disco:LogicalDataSet ;
    dcterms:title ?logicalDataSetTitle ;
    disco:isPublic ?isPublic ;
    dcterms:accessRights ?rightsStatement .

  ?rightsStatement skos:prefLabel ?rightsStatementLabel .

  FILTER (
    ?isPublic = "true" &&
    ?rightsStatementLabel = "Data Liberation Initiative Community"
  )

  OPTIONAL {
    ?rightsStatement rdfs:seeAlso ?rightsStatementURL .
  }
  OPTIONAL {
    ?logicalDataSet dcterms:license ?licenseDocument .
  }
}
```

§ Searching for particular questions

Find all studies with questions about commuting to work.

EXAMPLE 30

```
SELECT ?studyTitle ?studyAbstract
WHERE {
  ?study a disco:Study ;
    disco:instrument ?questionnaire ;
```

```
    dcterms:title ?studyTitle ;
    dcterms:abstract ?studyAbstract .
  ?questionnaire disco:question ?question .
  ?question disco:questionText ?questionText .

  FILTER (regex(?questionText, "commut.*work"))
}
```

Searching for particular variables

Find study groups where the study uses the species variable and has a variable defined as Bufo alvarius

EXAMPLE 31

```
SELECT ?studyGroupTitle ?studyGroupAbstract
WHERE {
  ?study a disco:Study ;
    disco:inGroup ?studyGroup ;
    disco:variable ?variable .

  ?studyGroup dcterms:title ?studyGroupTitle .
  ?studyGroup dcterms:abstract ?studyGroupAbstract .

  ?variable disco:concept ?variableConcept .
  FILTER (regex(?variableConcept, "species", "i"))

  ?variable disco:basedOn ?representedVariable .
  ?representedVariable disco:concept ?representedVariableConcept .
  FILTER (regex(?representedVariableConcept, "Bufo alvarius", "i"))
}
```

Representing relationships between persons, organizations and datasets

Within the context of Disco, we reuse other well elaborated and accepted vocabularies as often as possible and reasonable. DCMI, FOAF, ORG, ADMS, and PROV-O build one block of complementary vocabularies. Their use is shown in one combined use case. DCMI is used in order to describe general metadata, FOAF and ORG are used to describe persons and organizations, we use ADMS for the persistent identification of objects like persons and organizations, and PROV-O is used to provide provenance information. A typical scenario within the social sciences community could be the following one:

- John (foaf:Person) aggregates (disco:aggregation) microdata datasets (disco:LogicalDataSet) which are associated with (disco:product) the European study EU-SILC (disco:Study). The aggregate dataset is represented using qb:DataSet. The prov:Agent :john was associated with (prov:wasAssociatedWith) the prov:Activity :aggregationActivity. The :aggregationActivity used (prov:used) the prov:Entity :europeanDataSet (a European dataset), and generated (prov:wasGeneratedBy) a new prov:Entity :aggregatedEuropeanDataSet that aggregates the microdata in :europeanDataSet. The prov:Agent :john acted on behalf of (prov:actedOnBehalfOf) the organization :deri (prov:Agent, org:Organization). The European study (disco:Study) was funded by (disco:fundedBy) the research institution GESIS (org:Organization) for which John is working for (org:memberOf). In order to identify foaf:Persons and org:Organizations permanently, the object property adms:identifier is used pointing to adms:Identifiers. Further possible example queries using the vocabularies TERMS, FOAF, ORG, ADMS, and PROV-O would be: Which persons (foaf:Person), working for (org:memberOf) the research institute GESIS (org:Organization), created (dcterms:creator) the survey ALLBUS (Germany General Social Survey), which is a particular group of studies (disco:StudyGroup) in Germany?
- Which organizations (org:Organization) and which persons (foaf:Person) contributed (dcterms:contributor) to the creation of the European study EU-SILC (disco:Study)?
- Which persistent identifier (adms:identifier) are assigned to persons and organizations (foaf:Agent) publishing (dcterms:publisher) the European study EU-LFS (disco:Study)?

EXAMPLE 32

```
ddi:EuropeanStudy
  a disco:Study;
  disco:product ddi:EuropeanDataSet;
```

```
  disco:fundedBy ddi:GESIS;

ddi:John
  a foaf:Person;
  a prov:Agent;
  adms:identifier [ a adms:Identifier ];
  prov:wasAssociatedWith ddi:AggregationActivity;
  prov:actedOnBehalfOf ddi:DERI;
  org:memberOf ddi:GESIS.

ddi:EuropeanDataSet
  a disco:LogicalDataSet;
  a prov:Entity;
  disco:aggregation ddi:AggregatedEuropeanDataSet.

ddi:AggregatedEuropeanDataSet
  a qb:DataSet;
  a prov:Entity.

ddi:AggregationActivity
  a prov:Activity;
  prov:used ddi:EuropeanDataSet;
  prov:wasGeneratedBy ddi:AggregatedEuropeanDataSet;

ddi:DERI
  a prov:Agent;
  a org:Organization;
  adms:identifier [ a adms:Identifier ].

ddi:GESIS
  a org:Organization;
  adms:identifier [ a adms:Identifier ].

-----

SELECT
  ?person
WHERE
{
  ?person rdf:type foaf:Person.
  ?person org:memberOf ?gesis.
  ?gesis a org:Organization.
  ?allbus a disco:StudyGroup.
  ?allbus dcterms:creator ?person.
}

-----

SELECT
  ?organization ?person
WHERE
{
  ?organization rdf:type org:Organization.
  ?person rdf:type foaf:Person.
  ?euSILC rdf:type disco:Study.
  {?euSILC dcterms:contributor ?person}
  UNION
  {?euSILC dcterms:contributor ?organization}
}

-----

SELECT
  ?identifierOrganization ?identifierPerson
WHERE
{
  ?organization rdf:type org:Organization.
  ?orgnization rdf:type foaf:Agent.
  ?organization adms:identifier ?identifierOrganization.
  ?person rdf:type foaf:Person.
  ?person rdf:type foaf:Agent.
  ?person adms:identifier ?identifierPerson.
  ?euLFS rdf:type disco:Study.
  {?euLFS dcterms:publisher ?person}
  UNION
  {?euLFS dcterms:publisher ?organization}
}
```

§ Representing datasets using specific statistical classifications

XKOS extends SKOS with two main objectives: the first one is to allow the description of statistical classifications, the second one is to introduce refinements of the semantic properties defined in SKOS. The semantic properties extend the possible relations that can be applied between pairs of skos:Concepts. SKOS allows the following relations: skos:broader than, skos:narrower than, and skos:related to. The first two are hierarchical relations, one in each direction. In Disco, these SKOS properties may be substituted by additional XKOS properties like xkos:generalizes, xkos:hasPart, xkos:caused, xkos:previous, and xkos:next.

One question, typically asked by social science researchers, could be to query all the datasets (disco:LogicalDataSet) which have a specific statistical classification (skos:ConceptScheme) like ISCO (International Standard Classification of Occupations) or ANZSIC (Australian and New Zealand Industry Classification). It is also possible to query on the semantic relationships which are defined for statistical classifications using XKOS properties. By means of these properties not only hierarchical relations can be queried but also for example part of relationships (xkos:hasPart), more general (xkos:generalizes) and more specific (xkos:specializes) concepts, and positions of concepts in lists (xkos:previous, xkos:next).

The following figure gives an example inspired by the ANZSIC (Australian and New Zealand Industry Classification), which is a classification covering the field of economic activity. A small excerpt is shown here, limited to the classification object itself and its levels, as well as one item of the most detailed level (Class 6720 – Real Estate Services) and its parent items. Note that the URI employed in this example are entirely fictitious, since the ANZSIC has not yet been published as RDF.

For clarity, the properties of the classification items (code, labels, notes) have not been included in the figure.

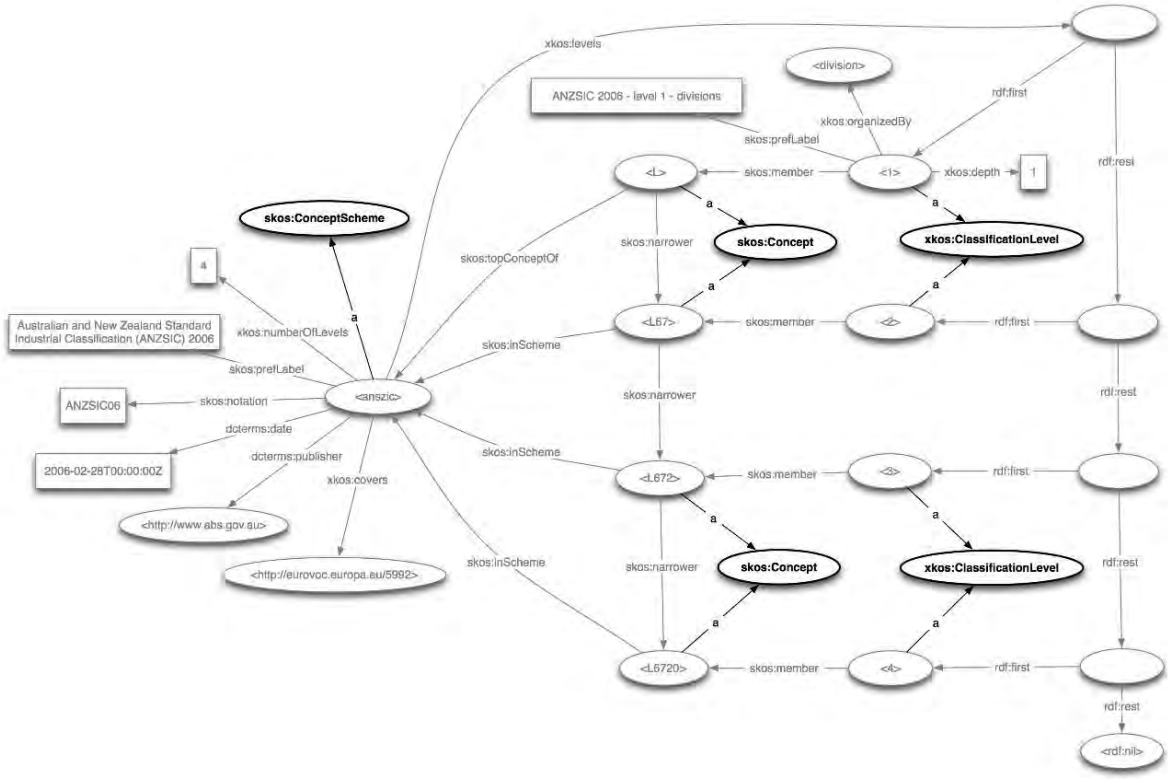

Figure 38 Statistical classification – ANZSIC

On the left of the figure is the skos:ConceptScheme instance that corresponds to the ANZIC 2006 classification scheme, with its various SKOS and Dublin Core properties. Additionnal XKOS properties indicate that the classification has four levels and covers the field of economic activity, represented here as a concept from the EuroVoc thesaurus. In this case, the coverage is intended to be exhaustive and without overlap, so xkos:coversExhaustively and xkos:coversMutuallyExclusively could have been used together instead of xkos:covers.

The four levels are instances of xkos:ClassificationLevel; they are organized as a rdf:List which is attached to the classification by the xkos:levels property. Some level information has been represented on the top level, for

example its depth in the classification (xkos:depth) and the concept that characterizes the items it is composed of (xkos:organizedBy). In the same fashion, concepts of subdivision, group and class could be created to describe the items of the lower levels.

The usual SKOS properties are used to connect the classification items to their respective level (skos:member) and to the classification (skos:inScheme or its specialization skos:topConceptOf) for the items of the first level). Similarly, skos:narrower is used to express the hierarchical relations between the items, but the subproperties defined in this specification could also be used. For example, xkos:hasPart could express the partitive relation between subdivision 67 ("Property Operators and Real Estate Services") and group 672 ("Real Estate Services").

§ Representing relationships between datasets, collections and data catalogs

While Disco and Data Cube provide terms for the description of datasets, both on a different level of aggregation, DCAT enables the representation of these datasets inside of data collections like repositories, catalogs or archives. The relationship between data collections and their contained datasets is useful, since such collections are a typical entry point when searching for data.

A search for data may consist of two phases. In a first phase, the user searches for different records described by dcat:CatalogRecord inside a data catalog. This search can differ according to the users' information need. While it is possible to search for metadata provided inside such a record like dcterms:title, dcterms:description, etc., the user can also formulate a query to search for more detailed information about the dataset (represented as dcat:Dataset) or its distribution (dcat:Distribution), which are part of the record. For example, a user may want to search for datasets covering a particular topic (dcat:keyword), particular temporal and spatial coverages (dcterms:temporal and dcterms:spatial), or particular formats in which a distribution of the data is available (dcterms:format). Instances of dcat:DataSet are also described by specific themes they cover (dcat:theme). Since these themes are organized in a theme taxonomy (implemented by a skos:ConceptScheme and classes of skos:Concept), these themes can also be used for an overall search in all datasets of the data catalog.

Nevertheless, the search of the first phase will result in one or presumably multiple hits of datasets. Hence, another search has to be executed in a second phase in order to find out which datasets are relevant for the user, e.g. particular universes or samples. The search regarding particular criteria in multiple Disco datasets materializes as those described in the previous two use case sections and those presented in [9]. However, the user may find data sets which are published in Data Cube. In order to discover the original microdata source of a qb:DataSet, the property prov:wasDerivedFrom can hold the link the particular DDI data set disco:Study.

A user searching for data regarding dissatisfaction with politics in Europe may find the records :EuropeanStudy and :AggregatedEuropeanData in a :DataCatalog. By analyzing the information given in the themes and keywords of the associated data sets, the user can decide which data set is best suitable for his information need. He notices also that :AggregatedEuropeanDataset has been derived from :EuropeanDataset and seems to cover only a subset of the microdata set. If he is interested in the microdata instead of aggregated data, he is thus able to find the underlying microdata set.

EXAMPLE 33

```
ddi:DataCatalog_1
a dcat:Catalog;
dcat:record ddi:EuropeanStudy;
dcat:record ddi:AggregatedEuropeanData;
dcat:dataset ddi:EuropeanDataset;
dcat:dataset ddi:AggregatedEuropeanDataset.

ddi:EuropeanStudy
a dcat:CatalogRecord;
a disco:Study;
foaf:primaryTopic ddi:EuropeanDataset;
disco:product ddi:EuropeanDataset.

ddi:AggregatedEuropeanData;
a dcat:CatalogRecord;
foaf:primaryTopic ddi:AggregatedEuropeanDataset.

ddi:EuropeanDataset
a dcat:Dataset;
a disco:LogicalDataSet;
dcat:theme ddi:topics/WellBeing;
```

```
dcat:theme ddi:topics/PoliticalAttitudes;
dcat:keyword "Europe"@en;
dcat:keyword "Politics"@en.

ddi:AggregatedEuropeanDataset
a dcat:Dataset;
a qb:DataSet;
dcat:theme ddi:topics/PoliticalDissatisfaction;
dcat:keyword "Europe"@en;
dcat:keyword "Politics"@en;
prov:wasDerivedFrom ddi:EuropeanStudy.
```

§ D. Acknowledgements

This work has been started at the first workshop on “Semantic Statistics for Social, Behavioural, and Economic Sciences: Leveraging the DDI Model for the Linked Data Web” at Schloss Dagstuhl - Leibniz Center for Informatics, Germany in September 2011 organized by Richard Cyganiak, Arofan Gregory, Wendy Thomas, and Joachim Wackerow. This work has been continued at these three meetings:

- Follow-up working meeting in the course of the 3rd Annual European DDI Users Group Meeting (EDDI11) in Gothenburg, Sweden in December 2011
- Second workshop on “Semantic Statistics for Social, Behavioural, and Economic Sciences: Leveraging the DDI Model for the Linked Data Web” at Schloss Dagstuhl - Leibniz Center for Informatics, Germany in October 2012
- Follow-up working meeting at GESIS - Leibniz Institute for the Social Sciences in Mannheim, Germany in February 2013

This work has been supported by contributions of the participants of the events mentioned above:

- Archana Bidargaddi (NSD - Norwegian Social Science Data Services)
- Thomas Hartmann (GESIS - Leibniz Institute for the Social Sciences, Germany)
- Sarven Capadisli (Bern University of Applied Sciences, Switzerland)
- Franck Cotton (INSEE - Institut National de la Statistique et des Études Économiques, France)
- Richard Cyganiak (DERI, Digital Enterprise Research Institute, Ireland)
- Daniel Gilman (BLS - Bureau of Labor Statistics, USA)
- Arofan Gregory (ODaF - Open Data Foundation, USA and DDI Alliance Technical Implementation Committee)
- Rob Grim (Tilburg University, Netherlands)
- Marcel Hebing (SOEP - German Socio-Economic Panel Study)
- Larry Hoyle (University of Kansas, USA)
- Yves Jaques (FAO of the UN)
- Jannik Jensen (DDA - Danish Data Archive)
- Benedikt Kämpgen (Karlsruhe Institute of Technology, Germany)
- Stefan Kramer (CISER - Cornell Institute for Social and Economic Research, USA)
- Amber Leahey (Scholars Portal Project - University of Toronto, Canada)
- Olof Olsson (SND - Swedish National Data Service)
- Heiko Paulheim (University of Mannheim, Germany)
- Abdul Rahim (Metadata Technologies Inc., USA)
- John Shepherdson (UK Data Archive)
- Dan Smith (Colectica, USA)
- Humphrey Southall (Department of Geography, UK Portsmouth University)
- Wendy Thomas (MPC - Minnesota Population Center, USA and DDI Alliance Technical Implementation Committee)

- Johanna Vompras (University Bielefeld Library, Germany)
- Joachim Wackerow (GESIS - Leibniz Institute for the Social Sciences, Germany and DDI Alliance Technical Implementation Committee)
- Benjamin Zapilko (GESIS - Leibniz Institute for the Social Sciences, Germany)
- Matthäus Zloch (GESIS - Leibniz Institute for the Social Sciences, Germany)

We would like to thank the following organizations which have supported this work:

- DDI Alliance
- GESIS - Leibniz Institute for the Social Sciences
- Schloss Dagstuhl - Leibniz Center for Informatics

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