# Table of Content

1  INTRODUCTION  

1.1  THE D2R MAPPING PROCESS  
1.2  THE D2R MAP PROCESSOR  

2  LANGUAGE SPECIFICATION  

2.1  ROOT ELEMENT: MAP  
2.2  TOP-LEVEL-ELEMENTS  
  2.2.1  DBCONNECTION  
  2.2.2  NAMESPACE  
  2.2.3  PREPEND/POSTPEND  
  2.2.4  PROCESSORMESSAGE  
2.3  MAPPING ELEMENTS  
  2.3.1  CLASSMAP  
  2.3.2  PROPERTY MAPPINGS  
  2.3.2.1  DatatypePropertyBridge  
  2.3.2.2  ObjectPropertyBridge  
2.4  PATTERNS  
2.5  TRANSLATION TABLES  

---

**Contact:** Chris Bizer (chris@bizer.de)

**Version of this document:** V0.1.1 / 5.5.2003
1 Introduction

D2R is a declarative language to describe mappings between relational database schemas and OWL ontologies. The mappings can be used by a D2R processor to export data from a relational database into RDF.

Semantic Web is an extension of the current Web, in which data is given a well-defined meaning by representing it in RDF and linking it to commonly accepted ontologies. This semantic enrichment allows data to be shared, exchanged or integrated from different sources and enables applications to use data in different contexts.

Most formatted data today is stored in relational databases. To be able to use this data in a semantic context, it has to be mapped to RDF, the data format of the Semantic Web.

The data model behind RDF is a directed labelled graph, which consists of nodes and labelled directed arcs linking pairs of nodes. To export data from a RDBMS into RDF, the relational database model has to be mapped to the graph-based RDF data model.

This document defines the syntax and semantics of the D2R MAP language.

Further information and usage examples of D2R MAP are found at http://www.wiwiss.fu-berlin.de/suhl/bizer/d2rmap/D2Rmap.htm.

1.1 The D2R Mapping Process

The D2R mapping process executed by the D2R processor has four logical steps:

1. Selection of a record set from the database using SQL
2. Grouping of the record set by the d2r:groupBy columns.
3. Creation of class instances and identifier construction.
4. Mapping of the grouped record set data to instance properties.
For each class or group of similar classes a record set is selected from the database. Second, the record set is grouped according to the groupBy columns of the specific ClassMap. Then the class instances are created and assigned an URI or a blank node identifier. Finally, the instance properties are created using datatype and object property bridges.

The division between step three and four allows references to blank nodes within the model and to instances dynamically created in the mapping process.

1.2 The D2R MAP Processor

A D2R processor prototype is publicly available under GNU LGPL license. The processor is implemented in Java and is based on the Jena API. It exports data as RDF, N3, N-TRIPLES and Jena models. It is compliant with all relational databases offering JDBC or ODBC access. The processor can be used in a servlet environment to dynamically publish XHTML pages containing RDF, as a database connector in applications working with Jena models or as a command line tool.

2 Language Specification

A D2R Map is a well-formed XML document. D2R-defined elements are distinguished by belonging to the D2R namespace:  
http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RMap/0.1#

2.1 Root Element: Map

Description:
Root element of the D2R-Map

Attributes:
xmlns, optional
   D2R namespace declaration.
versionInfo, optional
   Version Information.

Example:

<d2r:Map
   xmlns:d2r="http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RMap/0.1#"
   d2r:versionInfo="$Id: TestMap.d2r, v 1.4 2002/07/31 19:44:09 Chris Exp$">
   <!-- D2R Map -->
</d2r:Map>
2.2 Top-Level-Elements

2.2.1 DBConnection

**Description:**
Defines a ODBC or JDBC database connection.

**Attributes:**
- odbcDSN, *optional*  
  ODBC data source name.
- jdbcDriver, *optional*  
  JDBC driver.
- jdbcDSN, *optional*  
  JDBC data source name.
- username, optional  
  login name, if required by the database.
- password, *optional*  
  password, if required by the database.

**Example:**

```
<d2r:DBConnection d2r:odbcDSN="E-ShopDB"
  d2r:login="admin"
  d2r:password="bla" />
```

2.2.2 Namespace

**Description:**
Maps a prefix to a specific namespace. The defined prefixes can be used in class and property mappings.

**Attributes:**
- prefix, *required*  
  Namespace Prefix
- namespace, *required*  
  Namespace URI

**Example:**

```
<d2r:Namespace d2r:prefix="eb"
  d2r:namespace="http://www.example.org/eBusiness/1-2002#" />
```

2.2.3 Prepend/Postpend

**Description:**
Adds Text, XHTML, XML or RDF at the beginning or at the end of the output file.
**Attributes:**
fragment, **optional**
   Fragment of Text, XML or RDF.
href, **optional** *(Not implemented in V0.1)*
   URL of an external fragment to be imported.

**Example:**

```
<d2r:Prepend>
   <rdf:Description about="http://www.w3.org/Home/Lassila">
      <s:Creator>Ora Lassila</s:Creator>
   </rdf:Description>
</d2r:Prepend>
```

---

### 2.2.4 ProcessorMessage

**Description:**
Sends a message to the D2R processor. How the message is interpreted depends on the specific processor.

**Attributes interpreted by D2R processor prototype V0.1:**
saveAs, **optional**
   Path where to save the resulting output.
outputformat, **optional**
   Jena output format e.g. RDF/XML, RDF/XML-ABBREV, N-TRIPLE, N3

**Example:**

```
<d2r:ProcessorMessage saveAs="c:\test.rdf" outputformat="N-TRIPLE">
```

---

### 2.3 Mapping Elements

The content of the database is mapped to classes of the ontology using d2r:ClassMap, d2r:DatatypePropertyBridge and d2r:ObjectPropertyBridge elements.

**Example:**
The following ClassMap selects data about customers and their credit cards and maps the data to the eb:Customer class.

```
<d2r:ClassMap
d2r:type="eb:Customer"
d2r:sql="SELECT Tab_K_Kunde.KundenNr, Tab_K_Kunde.FullName,
         Tab_K_Kunde.Anrede, Tab_K_Kunde_Kreditkarte.CCNo
      FROM Tab_K_Kunde_Kreditkarte INNER JOIN Tab_K_Kunde ON
      Tab_K_Kunde_Kreditkarte.KundenNr = Tab_K_Kunde.KundenNr;"
d2r:groupBy="Tab_K_Kunde.KundenNr"
d2r:uriPattern= "http://example.org/customers#@@Tab_K_Kunde.KundenNr@@">
```
2.3.1 ClassMap

ClassMaps are used to map the result of an SQL query to a class or to a group of similar classes. An example of a group of similar classes are different subclasses of a person class, all with similar properties, e.g. Student, Researcher, Professor, PhDStudent, Employee. ClassMaps are containers for property mappings.

Two attributes are required: An SQL statement to select data from the database and the groupBy attribute containing a columnlist to group the rows of the result set.

Instances are identified by an URI or by a blank node identifier. URIs can be created with the d2r:uriColumn and d2r:uriPattern attributes. If no column or pattern is used, instances are identified as blank nodes.

**Attributes:**

- **id, optional**
  - ID of the ClassMap. Used to refer to the map with d2r:referredClass attributes. If a d2r:type is defined for the ClassMap, the type can also be used in references.

- **type, optional**
  - URI of an OWL Class.

- **sql, required**
  - SQL-Statement for selecting data from the database.

- **groupBy, required**
  - Column or column list used to group the rows of the result set. All rows with the same groupBy column values are used to create one instance.

- **uriColumn, optional**
  - Database column containing instance URIs.

- **uriPattern, optional**
  - Pattern to create instance URIs.

**Example:**

Table: Books

<table>
<thead>
<tr>
<th>ISBN</th>
<th>Title</th>
<th>Keyword</th>
</tr>
</thead>
<tbody>
<tr>
<td>1235647</td>
<td>Programming with C++</td>
<td>Programming</td>
</tr>
<tr>
<td>1235647</td>
<td>Programming with C++</td>
<td>C++</td>
</tr>
</tbody>
</table>
D2R Map Fragment:

```xml
<d2r:ClassMap
    d2r:type="book:Book"
    d2r:sql="SELECT * from Books;"
    d2r:groupBy="book.ISBN"
    <d2r:DatatypePropertyBridge
        d2r:property="book:title" d2r:column="Books.Title"/>
    <d2r:DatatypePropertyBridge
        d2r:property="book:hasKeyword" d2r:column="Books.Keyword" />
</d2r:ClassMap>
```

RDF Result:

```xml
<rdf:RDF>
    <book:Book rdf:about="http://example.org/books#1235647"
        book:title="Programming with C++">
        <book:hasKeyword>Programming</book:hasKeyword>
        <book:hasKeyword>C++</book:hasKeyword>
    </book:Book>
</rdf:RDF>
```

Example: Mapping to a group of similar OWL classes:

In order to map the result of an SQL query to a group of similar classes, use a `d2r.ClassMap` together with a `d2r:ObjectPropertyBridge` for creating the appropriate `"rdf:type"` property.

Table: Persons

<table>
<thead>
<tr>
<th>PersonID</th>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>Chris Bizer</td>
<td>PhdStudent</td>
</tr>
<tr>
<td>46</td>
<td>Uwe Suhl</td>
<td>Full Professor</td>
</tr>
</tbody>
</table>

D2R Map Fragment:

```xml
<d2r:ClassMap
    d2r:sql="SELECT * from Persons;"
    d2r:groupBy="Persons.PersonID"
    d2r:uriPattern="http://www.fu-berlin.de#@@Persons.Name@@">
    <d2r:DatatypePropertyBridge
        d2r:property="iswc:name" d2r:column="Persons.Name"/>
    <d2r:ObjectPropertyBridge d2r:property="rdf:type"
        d2r:pattern="iswc:@@Persons.Position@"/>
</d2r:ClassMap>
```

RDF Result:

```xml
<rdf:RDF>
    <iswc:PhdStudent rdf:about="http://www.fu-berlin.de#Chris Bizer"
        <iswc:name>Chris Bizer</iswc:name>
```
2.3.2 Property Mappings

Property mappings define bridges between columns of the result set and instance properties.

If a value in the result set is NULL, no property of the specific type is defined for that instance.

2.3.2.1 DatatypePropertyBridge

Description:
A DatatypePropertyBridge defines a bridge between a column of the result set and a literal property of the instances created.

Attributes:
- property, required
  Qualified name of a datatype property.
- column, optional
  Column name in the result set.
- pattern, optional
  D2R pattern to create the property value.
- value, optional
  d2r:value adds an additional property with a fixed value to all instances of the class.
- translate, optional
  Id of a d2r:TranslationTable used to translate database to property values.
- xml:lang, optional
  Language identifier, e.g. "de", "en".
- datatype, optional (not implemented in D2R processor VO.1)
  XML datatype URI.
- useCollection, optional (not implemented in D2R processor VO.1)
  Instructs the processor to use a collection for multiple values of a single property. Options are: rdf:Bag, rdf:Alt, rdf:Seq.

Example:

```xml
<d2r:DatatypePropertyBridge d2r:property="per:FullName"
  d2r:column="Tab_K_Kunde.FullName"/>

<d2r:DatatypePropertyBridge d2r:property="eb:Number"
  d2r:pattern="Product no.: @@Tab_A-Artikel.ArtikelNummer@@"/>
```
2.3.2.2 ObjectPropertyBridge

Description:
ObjectPropertyBridge defines a bridge between a column of the result set and an object property of the instances created.

Attributes:
- property, required
  Qualified name of a datatype property.
- column, optional
  Column name in the result set.
- pattern, optional
  D2R pattern to create the property value.
- value, optional
  Adds an additional property with a fixed value to all instances of the class.
- translate, optional
  Id of a d2r:TranslationTable used to translate database to property values.
- referredClass, optional
  Reference to a d2r:ClassMap. The referredClass attribute is used to refer to dynamically created instances. The referred class is identified by it’s URI used in a d2r:type attribute or it’s d2r:id. A referredGroupBy attribute has to be used together with a referredClass attribute.
- referredGroupBy, optional
  Column or column list to identify the target instances of the referredClass. If more then one column is used to identify the referred instance, the order of the columns must match the column order in the referred class.
- useCollection, optional (not implemented in D2R processor VO.1)
  Instructs the processor to use a collection for multiple values of a single property. Options are: rdf:Bag, rdf:Alt, rdf:Seq.

Example:

```xml
<d2r:ObjectPropertyBridge d2r:property="per:Ccard"
d2r:referredClass="eb:CCard"
d2r:referredGroupBy="Tab_K_Kunde_Kreditkarte.CCNo"/>

<d2r:ObjectPropertyBridge d2r:property="eb:What"
d2r:pattern="http://www.mops.fu-berlin.de/shop/articles#@Tab_A-Artikel.ArtikelNummer@"/>
```
2.4 Patterns

Patterns can be used to transform column values before using them as property values. Patterns can also be used to merge several column values to one property value.

A Pattern is a string including column names marked with @@. The column names are replaced with their values in the transformation process.

Example:

```
d2r:pattern="http://www.mops.fu-berlin.de/shop/articles#@@Tab_A-Artikel.ArtikelNummer@@"
```

```
d2r:pattern="http://www.mops.fu-berlin.de/shop/articles#@@Tab_A-Artikel.ArtikelNummer@@-@@Tab_A-Artikel.OfferDate@@"
```

2.5 Translation Tables

Translation tables can be used to substitute column values before they are used as property values.

**TranslationTable**

D2r:TranslationTable is a container for d2r:Translations.

**Attributes:**

- **id,** required
  - ID of the translation table. The id is used by other elements to refer to the translation table.
- **href,** optional (not implemented in D2R processor VO.1)
  - Location of a translation table, if it is stored in an external file.

**Translation**

A d2r:Translation defines the translation of key to a value.

**Attributes:**

- **key,** required
  - Key to identify a translation.
- **value,** required
  - Corresponding value.

Example:

```
<d2r:TranslationTable d2r:id="Products2URI">
  <d2r:Translation d2r:key="12"
      d2r:value="http://www.producer1.com/products/Prod1" />
  <d2r:Translation d2r: key ="1"
  <d2r:Translation d2r: key ="124"
      d2r: value ="http://www.myCompany.de/products#124" />
</d2r:TranslationTable>
```