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Metadata Model

Main Author:
Georgi Goguadze

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1 Introduction

Metadata describe information about an object, its properties and relations to other objects. This definition is too general for a practical application. One needs to specify which objects are under consideration and which properties and relations of these objects are of the interest.

The objects we are dealing with in the MoWGLI project are pieces of mathematical knowledge coming from different applications. One of the goals of the project is to administrate, search, retrieve, and manage the libraries of the mathematical knowledge coming from different sources. In order to manipulate these pieces and reuse them by different mathematical applications they have to be annotated with metadata of several kinds.

We classify metadata in three categories. Firstly, some basic administrative metadata, such as title, author, date of creation, copyright etc. are required. Secondly, there can be a set of other common metadata, such as several kinds of semantic dependencies which all the applications agree at. Finally, every application can have specific additional metadata in a separate module.

Summarizing, metadata in MoWGLI is *the set of annotations assigned to items of the library of mathematical knowledge and collections of items. These annotations serve to facilitate the administration of the library, the search and retrieval of mathematical knowledge and the reuse of the knowledge by different mathematical applications*

1.1 Some Definitions

In this section we define some basic notions used in this specification. We also introduce the general classes of Mathematical Resources which are the Resources to be annotated with metadata.

Datatype

A property of distinct values indicating common features of those values and operations on those values.

Value Space

The set of values for a given datatype.

URI

URI stands for Uniform Resource Identifier. A generic URI (see [1] for more information) is made of a formatted (structured) string of characters whose intended meaning is associated with the applications managing it.

Resource

In RDF, resource is a class of electronic resources identified by a URI

MathResource

In this report we address the resources of mathematical knowledge. **MathResource** is defined as a subclass of a general **Resource** class.

MathItem

Mathematical item is an information entity, carrying some mathematical semantics. Examples of mathematical items are definitions, axioms, theorems, and so on. The class **MathItem** is defined as a subclass of MathResource

Collection

The **Collection** is a subclass of a **MathResource** describing the hierarchical collections of mathematical items. A collection contains objects whose URI's share a common URI prefix identifying the collection.

1.2 Structure of Metadata

In the next sections we define the metadata element set using tables in which the introcuced entities are numbered in order to represent hierarchies of nested elements. In parallel, we explain the meaning of each defined element.

The MoWGLI metadata is classified in three categories:

- **Administrative** metadata with following sub-categories:
  - **General** administrative metadata
  - **Lifecycle** metadata important for versioning
  - **Technical** describing the format and the requirements for usage of the resource
  - **Rights** for copyright information
- **Mathematical** metadata with following sub-categories:
  - **Relation** for different kinds of mathematical relations between mathematical items
  - **Classification** describing the relation of a resource to a particular (one or more) mathematical classification system
- **Application-dependent** metadata, currenlty only one additional module.
  - **Educational** annotations for the eLearning application
  - **Publishing** annotations for the publishing application
  - **FormalMath** for the needs of formal mathematical systems

Several standards for metadata element sets and their best practice recommendations are used as a basis for our specification. These are Dublin Core Metadata Element Set (see [4]), IEEE and IMS Learning Object Metadata (see [9]), some vocabularies from the metadata of European Libraries and Electronic Resources in Mathematical Sciences (EULER) [6], Creative Commons Metadata [2], some parts of metadata of `OMDoc` - the XML semantic markup language for mathematical documents (see [10]), and the educational metadata of the ActiveMath learning environment (see [7]).

The metadata elements from different standards are annotated with appropriate namespaces: **dc** for Dublin Core, **lom** for LOM, **cc** for Creative Commons, **omdoc** for `OMDoc` and **am** for ActiveMath.

1.2.1 Position of Metadata in the Document

We allow to store the metadata withing the content item as well as outside of it. Since metadata provides administrative and semantic annotations of items and connections between them, it is sufficient for some of the knowledge retrieval tools to be applied only to the metadata, without a need to load the content of the items these metadata are associated to.

Therefore, we define two ways of connecting the item and its metadata:

- Refer to the metadata from the item. For this, the `metadata` element must have a unique identifier. The referring item should have an empty `metadata` element pointing to the identifier of the corresponding standalone metadata element.
- Refer to the item from the metadata. For this the `metadata` element should pointing to the unique identifier of the corresponding content item.

We also allow for elements without metadata to inherit them from the embracing grouping elements.

2 Administrative Metadata

The category of **Administrative** metadata is mostly using Dublin Core Metadata Element Set[1] enhanced with some refinements of Learning Object Metadata (LOM) [2] standard. We also follow some guidelines drawn by the `OMDoc` metadata specification [10].

For the Rights section the Creative Commons metadata[3] refinements are used.

2.1 General Metadata

In the sub-category **General** six Dublin Core (shortly DC) elements are introduced : `title`, `description`, `creator`, `publisher`, `source`, and `language`.

The elements `title` and `description` consist of text possibly in different languages. In order to specify the language of the `title` and `description` we have adopted the attribute `xml:lang` with values from the code set ISO 639:1988 and Sub-code a country code from the code set ISO 3166-1:1997. The `xml:lang` attribute can be assigned to any metadata element that needs to be internationalized at each level of granularity. Apart from it, the `language` element of DC is used to identify the primary language of the annotated item. For the values of this element the same representation format is used as for the values of `xml:lang`.

We introduce the Role of a `creator` and `contributor` as defined in Open eBook publication structure specification (see [11]. The values for the Role property are a subset of a large vocabulary of so-called relator codes of MARC (Machine-Readable Cataloging Record).[4] `Role` property has possible the values:

aut	Author - person mainly responsible for the content of the resource
ant	Scientific antecedent - author of the work the resource is based upon
clb	Collaborator making a limited contribution to the resource
edt	Editor who prepares a document for publication
ths	Thesis advisor under whose supervision the resource is created
trc	Transcriber - making a copy of the original material in another format
trl	Translator of the resource content from one language to another

Additionally, the `creator` and `contributor` have ID-s that are unique identifiers needed for referring to them. This identifier is used by the date element in the lifecycle module (as explained later) for referring to the creator or contributor who updates the document.

The value for the `publisher` element is the name of the organization responsible for publishing the resource.

The `source` element should contain an absolute URI of the resource.

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[1] `http://www.purl.org/DC`

[2] `http://ltsc.ieee.org/doc/wg12/LOM-WD3.html`

[3] `http://creativecommons.org/metadata/spec-1.0b2`

[4] see `http://www.loc.gov/marc/marc.html`

Nr	Name	description	Value Space	Datatype
1.1	**General**	The category of administrative metadata		
1.1.1	dc:title	A name by which the resource is known		LangString
1.1.1.1	short_name	A property of a title describing a short name for the resource		LangString
1.1.1.2	alternative_name	A property of a title describing an alternative title of the resource		LangString
1.1.2	dc:description	Description of the content of the resource		LangString
1.1.3	dc:creator	The creator of the item		LangString
1.1.3.1	role	The role of the creator	aut ant clb edt ths trc trl	String
1.1.3.1	identifier	The identifier of the creator		ID
1.1.4	dc:contributor	The contributor of the item		LangString
1.1.4.1	role	The role of the contributor	aut ant clb edt ths trc trl	String
1.1.4.1	identifier	The identifier of the contributor		ID
1.1.5	dc:publisher	An entity responsible for making resource available		String
1.1.6	dc:source	The resource URI		URI
1.1.7	dc:language	The language of the content of the resource	language code set ISO 639:1988 and Sub-code a country code from ISO 3166-1:1997	String
1.1.8	dc:identifier	An unambiguous reference to the resource within a given context		URI
1.1.8.1	mowgliIDScheme	Formal Identification System in use	URI URL DOI ISBN	String

2.2 Lifecycle and Technical Metadata

The Lifecycle Metadata is relevant for most of the mathematical applications. Version control and the management of change is difficult for the management of mathematical knowledge. In some cases, one needs to specify not only the version of the resource item but also the version of the program that generated, proved, etc. this item.

We adopt the Lifecycle module mostly from the LOM specification.

The value for `date` element is represented in the format defined by XML schema datatype `dateTime` [5] based on ISO 8601 norm for dates and times. The date-time representation format is : CCYY-MM-DDThh:mm:ss ('CC','YY','MM' and 'DD' for century, year, month and day respectively, T is a date-time separator, and 'hh','mm' and 'ss' stand for hours, minutes and seconds

[5] `http://www.w3.org/TR/xmlschema-2/#dateTime`

respectively).

Following the `OMDoc` practice, we introduce two properties of the `date` element: `action` (not present in LOM) specifying the temporal type of the modification performed on the resource and `who` pointing to the ID of the contributor who performed this action. Referring to the contributor looks more reasonable than defining contributors once in the general metadata and the second time in a Lifecycle module, as it is done in LOM.

The element `version` has values taken from ISO/IEC 10646-1:2000, and a `resource` pointing to the URI of the previous version.

Every version can also have a property `Status` that speaks about the development status of the resource.

Nr	Name	Description	Value Space	Datatype
1.2	**Lifecycle**	The category of lifecycle metadata		
1.2.1	dc:date	The date and time a certain action was performed on the resource		dateTime
1.2.1.1	omdoc:action	Specifies the action at given date	new updated imported frozen normed	String
1.2.1.2	omdoc:who	Refers to the ID of contributor		ID
1.2.2	lom:version	Version of the item	ISO/IEC 10646-1:2000	String
1.2.2.1	resource	The reference to the previous version of the resource		URI
1.2.3	lom:status	The status of the current item	draft final revised unavailable	String

Closely connected to the `Lifecycle` metadata are the technical annotations of the resource. Consider the LOM element `requirement`. It specifies the requirements for operating with the given resource. This includes the minimum and maximum version of the technology required in order to process the knowledge resource. For instance, some proof automatically generated by COQ system is valid for all versions of COQ between 1.x.y and 1.x'.y'.

Some other standard technical characteristics are defined in the `Technical` module, such as the `format` and `size` of an element. For the `type` of resource in this section we use the vocabularies of Dublin Core. The most relevant for all MoWGLI partners are the values used by the `OMDoc` specification – 'text' and 'dataset'.

Nr	Name	Description	Value Space	Datatype
1.3	**Technical**	Technical characteristics of the resource		
1.3.1	dc:format	The format of the resource	Mime types based on IANA registration RFC 2048:1996	String
1.3.2	dc:type	type of the resource	collection dataset event image interactive_resource service software sound text physical_object	String
1.3.3	lom:size	Actual size (uncompressed) of the resource	"0"-"9"	byte
1.3.4	lom:requirement	requirements for using the resource multiple requirements are connected by logical AND	resource	URI
1.3.4.1	lom:orComposite	composite requirement is satisfied when one of the components is satisfied logical OR	resource	URI
1.3.4.2	lom:name	Name of the required technology		String
1.3.4.3	lom:minimumversion	Lowest possible version of the technology required	ISO/IEC 10646-1:2000	String
1.3.4.4	lom:maximumversion	Highest possible version of the technology required	ISO/IEC 10646-1:2000	String

2.3 Copyright Annotations

For the `Rights` element of DC we introduce a refinement different from the ones in LOM. We adopt the metadata for rights from the Creative Commons Metadata standard. It divides the license characteristics in three types: `permissions`, `prohibitations` and `requirements`.

Permissions are the rights granted by the license and might have the following values:

- 'Reproduction' - the work may be reproduced
- 'Distribution' - the work may be distributed, publicly displayed, and publicly performed
- 'Derivative_Works' - derivative works may be created and reproduced

Prohibitions are the things the license prohibits. It can have a value 'Commercial_use' stating that rights may be exercised for commercial purposes.

Requirements are restrictions imposed by the license with following values:

- 'Notice' - copyright and license notices must be kept intact
- 'Attribution' - credit must be given to copyright holder and/or author
- 'Copyleft' - derivative works, if authorized, must be licensed under the same terms as the work

These values of types and their definitions are cited from the Creative Commons Metadata Draft (v 1.0b2)[6].

Nr	Name	Description	Value Space	Datatype
1.4	**Rights**	Rights Category		
1.4.1	dc:rights	Information about rights held in and over the resource		
1.4.1.1	cc:permissions	Rights granted by the license	reproduction distribution derivative_works	String
1.4.1.2	cc:prohibitions	things prohibited by the license	commercial_use	String
1.4.1.3	cc:requirements	restrictions imposed by the license	notice attribution copyleft	String

3 Mathematical Metadata

The MoWGLI partners have developed different mathematical applications using different representation formats, logical foundations, and classification systems for mathematics. Despite of having different purposes of research, they still all deal with mathematical knowledge. The properly designed standard for mathematical metadata gives an opportunity to annotate the collections of mathematical items and semantic connections between them in a way, understandable by different applications.

3.1 Mathematical Relations

There are numerous relations of different kinds between mathematical objects and semantics of these connections is not less important the semantics of the objects themselves. Therefore, we shall try to classify the basic `kinds` of mathematical relations.

LOM specification introduces pairs of mutually reverse relations. If one of them is provided in the content, the reverse can be automatically generated. We intorduce set of values for kinds of relations and an additional property `relDirection` specifying the direction of the relation.

Let us define the semantics of the `kinds` of mathematical relations introduced.

- *requires* means the reference to the required knowledge
- *is_instance_of* means that the current item is an instance of the concept it relates to
- *is_generalization_of* means that the current item is a generalization of the item it relates to
- *for* is used when the current item serves the item referred to e.g., proof for a theorem, definition for a concept
- *example_for* is applied if the given item is an example for some concept
- *counterexample_for* is applied if the given item is a counterexample for the some concept
- *lemma_for*, *corollary_for* and *assumption_for* are used when the current item serves as lemma, corollary or assumption respectively for the item referred to, i.e., an assertion can be a lemma w.r.t. another assertion
- *citation* is a reference to a bibliographical entry

We also introduce the `OMDoc` relation `alternative` that states that one mathematical item is alternative to another. For example, one can provide several alternative definitions of the set of real numbers, several different proofs of the main theorem of algebra, or several (thousands) of statements equivalent to the axiom of choice. Additional properties of this relation such as `entailed_by`, `entails_by` and `equivalent_by` might provide the references to other mathematical resources proving that either the two given items are mathematically equivalent or one entails (or is entailed by) the other.

[6]see `http://creativecommons.org/metadata/spec-1.0b2`

Nr	Name	Description	Value Space	Datatype
2.1	**Relation**	Relations Category		
2.1.1	dc:relation	Relations between items		URI
2.1.1.1	lom:kind	The kind of mathematical relation	requires for lemma_for corollary_for generalization_for is_instance_of example_for counterexample_for citation	String
2.1.1.2	relDirection	The direction of the relation	straight reverse	String
2.1.2	omdoc:alternative	Alternative Items	resource	URI
2.1.2.1	omdoc:entailed_by	means that the alternative is entailed by the statement in the resource referred to	resource	URI
2.1.2.2	omdoc:entail_by	reverse of the previous relation	resource	URI
2.1.2.3	omdoc:equivalent_by	alternative is equivalent by the statement in the resource referred to	resource	URI

3.2 Mathematical Classification Systems

There exists several well-established Mathematical Classification Systems.

The Dublin Core element `subject` can contain the keyword from a controlled vocabulary. The vocabulary depends on the Schema property of the `subject` element. We use the following mathematical classification systems:

- LCSH - Library of Congress Subject Headings
- MSC - 2000 Mathematics Subject Classification
- DDC - Deway Decimal Classification
- CCS - Computing Classification System

The choice of the classification systems is due to the wide usage of this standards and common practice, e.g. in the EULER project that approves these classification systems to be well-suitable for the management of digital libraries of mathematical publications.

Nr	Name	Description	Value Space	Datatype
2.2	**Classification**	Mathematical classification of the resource		
2.2.1	dc:subject	The topic of the content of the resource (controlled vocabulary)	depends on the Schema	String
2.2.1.1	mathClassificationSchema	The name of the mathematical classification system used	LSCH MSC DDC CCS	String
2.2.2	dc:keyword	The topic of the content of the resource (uncontrolled vocabulary)		String

4 Application Dependent Metadata

The currently discovered needs other than educational applications are already covered by the administrative and mathematical metadata. The formal mathematical systems use basic administrational metadata and are able to generate some of the mathematical relations automatically. The Web-publishing applications use administrative metadata and keywords from different mathematical classification systems. They could also certainly profit from using mathematical relations.

The additional needs of the more researched educational applications are covered in the next module.

4.1 Educational Metadata

Here we define additional metadata that are introduced for educational purposes in ActiveMath - a Web-based learning environment for mathematics (that actually goes beyond application only for mathematics). Therefore, elements introduced in this section will have a namespace **am** which stands for ActiveMath.

These educational metadata include more kinds of relations between items as well as some other pedagogical metadata.

Pedagogic Relations

We enrich the `Relation` element with a property `am:Kind`. It describes the ActiveMath kinds of relations between mathematical items. Let us introduce the values of this property and define their meaning:

- *is_based_on* means the reference provided by the author who decides that it is pedagogically important that the learner reads the item he refers to although the content of the current item may not mathematically depend on it
- *exercise_for* is applied if the given item is an exercise for some concept
- *similar* is applied to state the similarity of examples and other items
- *elaboration_for*, *motivation_for*, *introduction_for*, *conclusion_for* are applied if the given item may serve as an elaboration, motivation, introduction or conclusion for the specified item
- *has_situation* connects the item to its `situation-description`. One item can use more than one `situation-description`

Nr	Name	Description	Value Space	Datatype
3.1	**Educational**	Educational Metadata		
3.1.1	dc:relation			URI
3.1.1.1	am:kind	Kind of pedagogical relation between mathematical items	has_situation is_based_on similar elaboration_for motivation_for introduction_for conclusion_for exercise_for	String

Other Educational Metadata

For the use in an adaptive learning environment, the pedagogical aspects of an item have to be represented. IMS or IEEE provide some general pedagogical metadata elements, such as `difficulty` or `learning_context`. For the specific needs in our application, we defined the following pedagogical metadata.

- `difficulty` describes the author's view on the level of difficulty of the element. It has possible values *very_easy*, *easy*, *medium*, *difficult*, and *very_difficult*, adapted from LOM specification.
- `abstractness` describes author's view on the level of abstractness of the element. It has possible values *concrete*, *neutral*, and *abstract*.
- `learning_context` describes knowledge bases that contain material from different sources. It has possible values of which are the ones defined in the IMS implementation of a LOM standard of IEEE: *primary_education, secondary_education, higher_education, university_first_cycle, university_second_cycle, university_post_grade, technical_school_first_cycle, technical_school_second_cycle, professional_formation, continuous_formation, vocational_training.*

- `Field` describes the field of study to which the given exercise belongs. `field` has possible values *mathematics, statistics, engineering, psychology, biology, chemistry, physics, computer science, economics, history, other*. It enables the ActiveMath system to provide appropriate elements for students from fields different from mathematics.

ActiveMath delivers appropriate exercises for different users and learning situations. Furthermore, the impact of success or failure on the user model depends on the characteristics of the exercise. Therefore, we use metadata to describe pedagogical aspects of an exercise.

- The `competence_level` element is used to differentiate between the different pedagogical levels that exercises aim at. It has the following possible values:
  - *knowledge*. This kind of exercise tests if a certain knowledge is available, i.e., if certain facts can be reproduced by the learner.
  - *comprehension*. These exercises test whether the learner has understood the material he has acquired.
  - *application*. These exercises test whether the learner can apply the knowledge he has acquired
  - *transfer*. These exercises test whether the learner can apply the acquired knowledge on a concept when it occurs in a new context.
- The `exercise_type` element specifies the pedagogical type of the exercise. It has the possible values
  - *comprehension_question*. By solving these exercises, the user can control his knowledge himself. The user's answer is not evaluated by the system.
  - *calculate*. The learner has to solve the exercise by calculating the result.
  - *give_example*. To solve this exercise, an example that fulfills the given conditions has to be given.
  - *prove*. The learner has to prove a given assertion.
  - *make_hypothesis*. The learner should find and formulate a hypothesis.
  - *model*. These exercises require mathematical modeling.
  - *choose, fill_in*. The learner has to answer a multiple choice question or fill in the blanks.
  - *explore*. Here, the learner will explore a mathematical concept and eventually verbalize what he found out.
  - *collaborate*. The learner is urged to collaborate to others in order to solve a problem.
  - *visualize*. The learner has to visualize the problem, e.g. by drawing a picture.
  - *explain*. The learner has to give an (informal) explanation
- The `teacher` element specifies the teachers feedback on possible activities of the learner. It has the possible values: *typical_error, reaction, feedback*.

Nr	Name	Description	Value Space	Datatype
3.1.2	lom:difficulty	The difficulty level of the resource item	very_easy easy medium difficult very_difficult	String
3.1.3	am:abstractness	The abstractness level of the resource item	concrete neutral abstract	String
3.1.4	lom:learning_context	The learning context of the resource item	primary_education secondary_education higher_education university_first_cycle university_second_cycle university_post_grade technical_school_first_cycle technical_school_second_cycle professional_formation continuous_formation vocational_training	String
3.1.5	lom:field	The field of study the exercise is for	mathematics statistics engineering psychology biology chemistry physics computer_science economics history other	String
3.1.6	am:competence_level	The competence level to be trained	knowledge comprehension application transfer	String
3.1.7	am:exercise_type	The type of action to be performed by the user	comprehension_question calculate give_example prove make_hypothesis model choose fill_in explore collaborate visualize explain	String
3.1.8	am:teacher	The feedback of a teacher on the actions of a user	typical_error reaction feedback	String

4.2 Metadata for Publishing

For a publishing application it is useful to refine the notion of the type of the item. We import the following values for it from the metadta of the EULER project:

Nr	Name	Description	Value Space	Datatype
3.2	**Publishing**	Metadata for Publishing		
3.2.1	euler:type	The type of the resource item for publishing application	text.article text.monograph text.preprint text.proceedings text.serial text.techreport text.thesis text.bibliography text.lecture_notes text.review image image.moving.film	String

4.3 Metadata for Formal Mathematical Applications

For the needs of formal mathematical applications we refine the notion of relation. We introduce two additional kinds of relations - 'refRel' describing a referenced variable, and 'refSort' describing a referenced sort of Calculus of Infductive Constructions (CIC). We also define the following additional properties for relations:

- `sort` describing a referred CIC sort with values 'Set', 'Prop' and 'Type' representing the corresponding CIC sorts.
- `position` describing the position of a reference in a referring object. Its values are 'MainHypothesis', 'InHypothesis', 'MainConclusion', 'InConclusion' and 'InBody'. This values represent a classification of mathematically meaninngful positions for a reference in the referring object.
- `depth` describing a depth index associated to the position of a reference in the referring object. It has an integer value representing the number of premises of a hypothesis or a conclusion.

These metadata are used in the HELM project, therefore the helm namespace is assigned to them.

Nr	Name	Description	Value Space	Datatype
3.3	**Formal-Math**	Metadata for Formal Mathematics		
3.3.1	dc:Relation	The relation betweeen items		URI
3.3.1.1	helm:kind	Formal kinds of relation	refRel refSort	String
3.3.1.2	helm:sort	The referred CIC sort	Set Prop Type	String
3.3.1.3	helm:position	The position of a reference in the referring object	MainHypothesis InHypothesis MainConclusion InConclusion InBody	String
3.3.1.4	helm:depth	The depth index associated to the position of a reference		Integer

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5 Appendix. RDF Schema Specification

```
<?xml version="1.0"?>

<!--
  RDF Schema declaration for the MoWGLI Metadata Element Set
  2003/03/1
  comments, etc. to george@activemath.org
-->

<!DOCTYPE rdf:RDF [
        <!ENTITY rdfns 'http://www.w3.org/1999/02/22-rdf-syntax-ns#'>
        <!ENTITY rdfsns 'http://www.w3.org/2000/01/rdf-schema#'>
        <!ENTITY dcns 'http://purl.org/dc/elements/1.1/'>
        <!ENTITY dcqns 'http://purl.org/dc/terms/'/>
        <!ENTITY dctypens 'http://purl.org/dc/dcmitype/'>
        <!ENTITY mowglins 'http://mowgli.cs-unibo.it/metadata-schema#'>
        <!ENTITY lomns 'http://ltsc.ieee.org/wg12'>
        <!ENTITY omdocns 'http://www.mathweb.org/omdoc'>
        <!ENTITY amns  'http://www.activemath.org'>
        <!ENTITY helmns 'http://helm.cs.unibo.it'>
        <!ENTITY eulerns 'http://www.emis.de/projects/EULER'>
   ]>

<rdf:RDF xmlns:rdf="&rdfns;"
         xmlns:rdfs="&rdfsns;"
         xmlns:dc="&dcns;"
         xmlns:dcq="&dcqns;"
         xmlns:dctype="&dctypens;"
 xmlns:lom="&lomns;"
 xmlns:omdoc="&omdocns;"
 xmlns:am="&amns;"
 xmlns:helm="&helmns;"
   xmlns:euler="&eulerns;">
```

```
<!-- Description of Schema -->

<rdf:Description rdf:about="&mowglins;">
  <rdf:value>The MoWGLI Metadata Schema</rdf:value>
  <dc:title>The MoWGLI Metadata Element Set</dc:title>
  <dc:publisher>The MoWGLI Project</dc:publisher>
  <dc:contributor><rdf:value>George Goguadze</rdf:value></dc:contributor>
  <dc:description>The MoWGLI metadata vocabulary is a simple vocabulary
      intended to facilitate discovery of mathematical resources.
  </dc:description>
  <dc:language>English</dc:language>
  <dc:relation rdf:resource="http://ww.cs.unibo.it/mowgli/"/>
  <dc:date>2002-03-01</dc:date>
</rdf:Description>

<!-- Classes : mowgli resources -->

<rdfs:Class rdf:ID="MathResource">
  <rdfs:comment>Mathematical resources</rdfs:comment>
  <rdfs:label>MathResource</rdfs:label>
  <rdfs:subClassOf rdf:resource="&rdfsns;Resource"/>
  <rdfs:isDefinedBy rdf:resource = "&mowglins;" />
</rdfs:Class>

<rdfs:Class rdf:ID="MathItem">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&mowglins;MathResource"/>
  <rdfs:label>MathItem</rdfs:label>
  <rdfs:comment>Mathematical item</rdfs:comment>
</rdfs:Class>

<rdfs:Class rdf:ID="MathCollection">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subclassOf rdf:resource="&mowglins;MathResource"/>
  <rdfs:label>MathCollection</rdfs:label>
  <rdfs:comment>The collection of mathematical items</rdfs:comment>
</rdfs:Class>

<!-- definition of the categories of metadata and their subcategories -->

<!-- Administrative metadata -->

<rdfs:Class rdf:ID="Adnimistrative">
  <rdfs:subClassOf rdf:resource="&rdfsns;MathResource"/>
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>Administrative</rdfs:label>
  <rdfs:comment>The category of administrative metadata</rdfs:comment>
</rdfs:Class>

<!-- General metadata section -->

<rdfs:Class rdf:ID="General">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>General</rdfs:label>
  <rdfs:subClassOf rdf:resource="&mowglins;Adnimistrative" />
  <rdfs:comment>The general metadata needed for adiministrational
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purposes</rdfs:comment>
</rdfs:Class>

<rdfs:Property rdf:about="&dcns:title">
  <rdfs:isDefinedBy rdf:resource="&dcns;"/>
  <rdfs:label>dc:title</rdfs:label>
  <rdfs:comment>A name by which the resource is known</rdfs:comment>
  <rdfs:domain rdf:resource="&mowglins;General" />
  <rdfs:range rdf:resource="&rdfns;Literal" />
</rdfs:Property>

<rdfs:Property rdf:ID="short_name">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subPropertyOf rdf:resource="&dcns;title"/>
  <rdfs:label>Short_Name</rdfs:label>
  <rdfs:comment>A short name for a resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mowglins;General"/>
  <rdfs:range rdf:resource="&rdfns;Literal"/>
</rdfs:Property>


<rdfs:Property rdf:about="&dcqns;alternative">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subPropertyOf rdf:resource="&dcns;title"/>
  <rdfs:label>alternative</rdfs:label>
  <rdfs:comment>A property of a title describing an alternative
   title  of the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="&rdfns;Literal"/>
</rdfs:Property>

<rdfs:Property rdf:about="&dcns;description">
  <rdfs:isDefinedBy rdf:resource="dcns;"/>
  <rdfs:label>dc:description</rdfs:label>
  <rdfs:comment>Description of the content of the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="&mogwlins;Literal"/>
</rdfs:Property>

<rdfs:Property rdf:about="&dcqns;abstract">
  <rdfs:isDefinedBy rdf:resource="&dcqns;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;description"/>
  <rdfs:label>dcq:abstract</rdfs:label>
  <rdfs:comment>Abstract of the content of the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="&mogwlins;Literal"/>
</rdfs:Property>

<rdfs:Property rdf:about="&dcns;creator">
  <rdfs:isDefinedBy rdf:resource="&dcns;"/>
  <rdfs:label>dc:creator</rdfs:label>
  <rdfs:comment>The Creator of the resource item</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="&rdfns;Literal"/>
</rdfs:Property>

<rdfs:Property rdf:about="&dcns;contributor">
  <rdfs:isDefinedBy rdf:resource="&dcns;"/>
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  <rdfs:label>dc:contributor</rdfs:label>
  <rdfs:comment>The Creator of the resource item</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="&rdfns;Literal"/>
</rdfs:Property>

<rdfs:Class rdf:ID="DCPerson">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>DCPerson</rdfs:label>
  <rdfs:comment>The Creator and Contributor united in one resource
needed for definition of domain of the role property</rdfs:comment>
</rdfs:Class>

<rdf:DCPerson rdf:ID="creator"/>
<rdf:DCPerson rdf:ID="contributor"/>

<rdfs:Class rdf:ID="Role">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>RoleValue</rdfs:label>
  <rdfs:comment>The value set for the Role of the Creator
and Contributor of DC</rdfs:comment>
</rdfs:Class>

<Role rdf:ID="aut"/>
<Role rdf:ID="ant"/>
<Role rdf:ID="clb"/>
<Role rdf:ID="ths"/>
<Role rdf:ID="trc"/>
<Role rdf:ID="trl"/>

<rdfs:Property rdf:ID="role">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;creator"/>
  <rdfs:label>role</rdfs:label>
  <rdfs:comment>The role of creator</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;DCPerson"/>
  <rdfs:range rdf:resource="&mogwlins;Role"/>
</rdfs:Property>

<rdfs:Property rdf:ID="role">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;contributor"/>
  <rdfs:label>role</rdfs:label>
  <rdfs:comment>The role of creator</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;DCPerson"/>
  <rdfs:range rdf:resource="&mogwlins;Role"/>
</rdfs:Property>

<rdfs:Property rdf:ID="identifier">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;creator">
  <rdfs:label>identifier</rdfs:label>
  <rdfs:comment>The identifier of the creator of the
   resource item</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;DCPerson"/>
  <rdfs:range rdf:resource="&rdfns;Literal"/>
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</rdfs:Property>

<rdfs:Property rdf:ID="identifier">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;contributor">
  <rdfs:label>identifier</rdfs:label>
  <rdfs:comment>The identifier of the contributor of the
   resource item</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;DCPerson"/>
  <rdfs:range rdf:resource="&rdfns;Literal"/>
</rdfs:Property>

<rdfs:Property rdf:about="&dcns;publisher">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:publisher</rdfs:label>
  <rdfs:comment>An entity responsible for making resource
   available</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="&rdfns;Literal"/>
</rdfs:Property>

<rdfs:Property rdf:about="&dcns;source">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:source</rdfs:label>
  <rdfs:comment>The absolute URI of the resource </rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="http://www.w3.org/TR/xmlschema-2/#anyURI"/>
</rdfs:Property>

<rdfs:Class rdf:ID="MowgliLang">
  <rdfs:isDefinedBy rdf:resource="http://www.w3.org/WAI/ER/IG/ert/iso639.htm"/>
  <rdfs:isDefinedBy rdf:resource="http://www.w3.org/International/O-misc-iso3166.html"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>MowgliLang</rdfs:label>
  <rdfs:comment>The enccoding of the language of the resource which is
represented as a two-letter code as defined by the code set ISO 639:1988
and a sub-code a country code from the code set ISO 3166-1:1997</rdfs:comment>
</rdfs:Class>

<rdfs:Property rdf:about="&dcns;language">
  <rdfs:isDefinedBy rdf:resource="&mowglins;#"/>
  <rdfs:label>dc:language</rdfs:label>
  <rdfs:comment>The primary language of the content of the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="&mogwlins;MowgliLang"/>
</rdfs:Property>

<rdfs:Property rdf:about="&dcns;identifier">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:identifier</rdfs:label>
  <rdfs:comment>An unambiguous reference to the
resource within a given context</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="&rdfns;Literal"/>
</rdfs:Property>

<rdfs:Class rdf:ID="MowgliIDScheme">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
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```
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>MowgliIdSchemes</rdfs:label>
  <rdfs:comment>The formal identification systems
   used in MoWGLI</rdfs:comment>
</rdfs:Class>

<MowgliIDScheme rdf:ID="URI"/>
<MowgliIDScheme rdf:ID="URL"/>
<MowgliIDScheme rdf:ID="DOI"/>
<MowgliIDScheme rdf:ID="ISBN"/>

<rdfs:Property rdf:about="&mowglins;mowgliIDScheme">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;identifier">
  <rdfs:label>mowgliIDScheme</rdfs:label>
  <rdfs:comment>Formal Identification System in use</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;General"/>
  <rdfs:range rdf:resource="&mogwlins;MowgliIDScheme"/>
</rdfs:Property>


<!-- The LifeCycle section -->

<rdfs:Class rdf:ID="Lifecycle">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>Lifecycle</rdfs:label>
  <rdfs:subClassOf rdf:resource="&mowglins;Adnimistrative" />
  <rdfs:comment>The lifecycle metadata needed for version management </rdfs:comment>
</rdfs:Class>

<rdfs:Property rdf:about="&dcns;date">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:date</rdfs:label>
  <rdfs:comment>The date and time a certain action
   was performed on the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Lifecycle"/>
  <rdfs:range rdf:resource="http://www.w3.org/TR/xmlschema-2/#dateTime"/>
</rdfs:Property>

<rdfs:Class rdf:ID="Action">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>Action</rdfs:label>
  <rdfs:comment>The definition of types of actions to be performed on a
   resource</rdfs:comment>
</rdfs:Class>

<Action rdf:ID="new"/>
<Action rdf:ID="updated"/>
<Action rdf:ID="imported"/>
<Action rdf:ID="frozen"/>
<Action rdf:ID="normed"/>

<rdfs:Property rdf:about="&omdocns;action">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;date"/>
  <rdfs:label>omdoc:action</rdfs:label>
  <rdfs:comment>Specific action at given date</rdfs:comment>
```

```
  <rdfs:domain rdf:resource="&mogwlins;Lifecycle"/>
  <rdfs:range rdf:resource="&mogwlins;Action"/>
</rdfs:Property>

<rdfs:Property rdf:about="&omdocns;who">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&mowglins;action"/>
  <rdfs:label>omdoc:who</rdfs:label>
  <rdfs:comment>Refers to the  person who performed the action</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Action"/>
  <rdfs:range rdf:resource="&mogwlins;DCPerson"/>
</rdfs:Property>

<rdfs:Class rdf:ID="MowgliVersion">
  <rdfs:isDefinedBy rdf:resource="http://www.ietf.org/rfc/rfc2279.txt"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>MowgliVersion</rdfs:label>
  <rdfs:comment>The version format used in mowgli taken from ISO/IEC
10646-1:2000</rdfs:comment>
</rdfs:Class>

<rdfs:Property rdf:about="&lomns;version">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>lom:version</rdfs:label>
  <rdfs:comment>The version of the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&rdfns;Lifecycle"/>
  <rdfs:range rdf:resource="&mogwlins;MowgliVersion"/>
</rdfs:Property>

<rdfs:Property rdf:about="&mowglins;resource">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&lomns;version"/>
  <rdfs:label>resource</rdfs:label>
  <rdfs:comment>The reference to the previous version</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Lifecycle"/>
  <rdfs:range rdf:resource="http://www.w3.org/TR/xmlschema-2/#anyURI"/>
</rdfs:Property>

<rdfs:Class rdf:ID="MowgliLifecycleStatus">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>MowgliLifecycleStatus</rdfs:label>
  <rdfs:comment>The values for status of the item</rdfs:comment>
</rdfs:Class>

<MowgliLifeCycleStatus rdf:ID="draft"/>
<MowgliLifeCycleStatus rdf:ID="final"/>
<MowgliLifeCycleStatus rdf:ID="revised"/>
<MowgliLifeCycleStatus rdf:ID="unavailable"/>

<rdfs:Property rdf:about="&lomns;status">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>lom:status</rdfs:label>
  <rdfs:comment>The status of the current item </rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Lifecycle"/>
  <rdfs:range rdf:resource="&mogwlins;MowgliLifeCycleStatus"/>
</rdfs:Property>
```

```
<!-- Technical section -->

<rdfs:Class rdf:ID="Techinical">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>Techinical</rdfs:label>
  <rdfs:subClassOf rdf:resource="&mowglins;Adnimistrative" />
  <rdfs:comment>Technical metadata describing the format and the
requirements for the usage of the resource</rdfs:comment>
</rdfs:Class>

<rdfs:Class rdf:ID="Mimetype">
  <rdfs:isDefinedBy rdf:resource="http://www.isi.edu/in-notes/rfc2048.txt"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>Mimetype</rdfs:label>
  <rdfs:comment>The mime types based on IANA registration
  RFC 2048:1996</rdfs:comment>
</rdfs:Class>

<rdfs:Property rdf:about="&dcns;format">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:format</rdfs:label>
  <rdfs:comment>The format of the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Technical"/>
  <rdfs:range rdf:resource="&mogwlins;Mimetype"/>
</rdfs:Property>

<rdfs:Class rdf:ID="DCType">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>DCType</rdfs:label>
  <rdfs:comment>The type of the Resource in Dublin Core</rdfs:comment>
</rdfs:Class>

<DCType rdf:ID="collection"/>
<DCType rdf:ID="dataset"/>
<DCType rdf:ID="event"/>
<DCType rdf:ID="image"/>
<DCType rdf:ID="interactive_resource"/>
<DCType rdf:ID="service"/>
<DCType rdf:ID="software"/>
<DCType rdf:ID="sound"/>
<DCType rdf:ID="text"/>
<DCType rdf:ID="physical_object"/>

<rdfs:Property rdf:about="&dcns;type">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:type</rdfs:label>
  <rdfs:comment>The type of the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Technical"/>
  <rdfs:range rdf:resource="&mogwlins;DCType"/>
</rdfs:Property>

<rdfs:Property rdf:about="lomns;size">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>lom:size</rdfs:label>
  <rdfs:comment>Actual size of the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Technical"/>
  <rdfs:range rdf:resource="http://www.w3.org/1999/XMLSchema-datatypes/byte"/>
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</rdfs:Property>


<rdfs:Class rdf:ID="Requirement">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&mowglins;Technical"/>
  <rdfs:label>Requirement</rdfs:label>
  <rdfs:comment>The tecnology required for using the resource</rdfs:comment>
</rdfs:Class>


<rdfs:Property rdf:about="&lomns;requirement">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>lom:requirement</rdfs:label>
  <rdfs:comment>The technical requirements for using the resource (for multiple
  requirements all are required - logical AND)</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Technical"/>
  <rdfs:range rdf:resource="&mogwlins;Requirement"/>
</rdfs:Property>

<rdfs:Property rdf:about="&lomns;orComposite">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&mowgli;requirement"/>
  <rdfs:label>lom:orComposite</rdfs:label>
  <rdfs:comment>Composite requirement is satisfied when one of the components is satisfied
  - logical OR</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Technical"/>
  <rdfs:range rdf:resource="&mogwlins;Requirement"/>
</rdfs:Property>

<rdfs:Property rdf:about="&lomns;name">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&mowglins;requirement"/>
  <rdfs:label>lom:name</rdfs:label>
  <rdfs:comment>The name of the technology required</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Requirement"/>
  <rdfs:range rdf:resource="&mogwlins;Literal"/>
</rdfs:Property>

<rdfs:Property rdf:about="&lomns;minimumversion">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&mowglins;requirement"/>
  <rdfs:label>lom:minimumversion</rdfs:label>
  <rdfs:comment>Lowest possible version of the technology required</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Requirement"/>
  <rdfs:range rdf:resource="&mogwlins;MowgliVersion"/>
</rdfs:Property>

<rdfs:Property rdf:about="&lomns;maximumversion">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&mowglins;requirement"/>
  <rdfs:label>lom:maximumversion</rdfs:label>
  <rdfs:comment>Highest possible version of the technology required</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Requirement"/>
  <rdfs:range rdf:resource="&mogwlins;MowgliVersion"/>
</rdfs:Property>

<!-- Rights section-->
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<rdfs:Class rdf:ID="Rights">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>Rights</rdfs:label>
  <rdfs:subClassOf rdf:resource="&mowglins;Adnimistrative" />
  <rdfs:comment>Rights metadata describing the copyright information </rdfs:comment>
</rdfs:Class>

<rdfs:Class rdf:ID="SubRights">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&mowglins;Rights">
  <rdfs:label>Right</rdfs:label>
  <rdfs:comment>The copyright information</rdfs:comment>
</rdfs:Class>

<SubRights rdf:ID="permissions"/>
<SubRights rdf:ID="prohibitions"/>
<SubRights rdf:ID="requirements"/>

<rdfs:Class rdf:ID="Permissions">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/
  <rdfs:subClassOf rdf:resource="SubRights"/>
  <rdfs:label>Permissions</rdfs:label>
  <rdfs:comment>Rights granted by the license</rdfs:comment>
</rdfs:Class>

<Permissions rdf:ID="reproduction"/>
<Permissions rdf:ID="distribution"/>
<Permissions rdf:ID="derivative_works"/>

<rdfs:Class rdf:ID="Prohibitions">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="SubRights"/>
  <rdfs:label>Prohibitions</rdfs:label>
  <rdfs:comment>things prohibited by the license</rdfs:comment>
</rdfs:Class>

<Prohibition rdf:ID="commercial_use"/>

<rdfs:Class rdf:ID="Requirements">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="SubRights"/>
  <rdfs:label>Requirements</rdfs:label>
  <rdfs:comment>Restrictions imposed by the license</rdfs:comment>
</rdfs:Class>

<Requirements rdf:ID="notice"/>
<Requirements rdf:ID="attribution"/>
<Requirements rdf:ID="copyleft"/>

<rdfs:Property rdf:about="&dcns;rights">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:rights</rdfs:label>
  <rdfs:comment>Information about rights  held  in and over  the resource</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Rights"/>
  <rdfs:range rdf:resource="&mogwlins;SubRights"/>
</rdfs:Property>
```

```
<rdfs:Property rdf:about="&ccns;permissions">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;rights"/>
  <rdfs:label>cc:permissions</rdfs:label>
  <rdfs:comment>Rights granted by the license</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;SubRights"/>
  <rdfs:range rdf:resource="&mogwlins;Permissions"/>
</rdfs:Property>

<rdfs:Property rdf:about="&ccns;prohibitions">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;rights"/>
  <rdfs:label>cc:prohibitions</rdfs:label>
  <rdfs:comment>Things prohibited by the license</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;SubRights"/>
  <rdfs:range rdf:resource="&mogwlins;Permissions"/>
</rdfs:Property>

<rdfs:Property rdf:about="&ccns;requirements">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;rights"/>
  <rdfs:label>cc:requirements</rdfs:label>
  <rdfs:comment>Restrictions imposed by the license</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;SubRights"/>
  <rdfs:range rdf:resource="&mogwlins;Permissions"/>
</rdfs:Property>

<!-- Mathematical metadata-->

<rdfs:Class rdf:ID="Mathematical">
  <rdfs:subClassOf rdf:resource="&rdfsns;MathResource"/>
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>Mathematical</rdfs:label>
  <rdfs:comment>The category of mathematical metadata</rdfs:comment>
</rdfs:Class>

<!-- Mathematical Relations -->

<rdfs:Class rdf:ID="Relation">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>Relation</rdfs:label>
  <rdfs:subClassOf rdf:resource="&mowglins;Mathematical" />
  <rdfs:comment>Different kinds of mathematical relations</rdfs:comment>
</rdfs:Class>

<rdfs:Property rdf:about="&dcns;relation">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:relation</rdfs:label>
  <rdfs:comment>Relations between items</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Relation"/>
  <rdfs:range rdf:resource="http://www.w3.org/TR/xmlschema-2/#anyURI"/>
</rdfs:Property>

<rdfs:Class rdf:ID="MathRelationKind">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>MathRelationKind</rdfs:label>
  <rdfs:comment>The kinds of mathematical relation</rdfs:comment>
</rdfs:Class>
```

```
<MathRelationKind rdf:ID="requires"/>
<MathRelationKind rdf:ID="for"/>
<MathRelationKind rdf:ID="lemma_for"/>
<MathRelationKind rdf:ID="corollary_for"/>
<MathRelationKind rdf:ID="generalization_for"/>
<MathRelationKind rdf:ID="is_instance_of"/>
<MathRelationKind rdf:ID="example_for"/>
<MathRelationKind rdf:ID="counterexample_for"/>
<MathRelationKind rdf:ID="citation"/>

<rdfs:Property rdf:about="&mowglins;kind">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;relation"/>
  <rdfs:label>kind</rdfs:label>
  <rdfs:comment>The kind of mathematical relation</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Relation"/>
  <rdfs:range rdf:resource="&mogwlins;MathRelationKind"/>
</rdfs:Property>

<rdfs:Property rdf:ID="relDirection">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;relation"/>
  <rdfs:label>relDirection</rdfs:label>
  <rdfs:comment>This property specifies the direction of the reference</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Relation"/>
  <rdfs:range rdf:resource="&mogwlins;RelDirection"/>
</rdfs:Property>


<rdfs:Class rdf:about="&mowglins;RelDirection">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdnfs;Literal"/>
  <rdfs:label>RelDirection</rdfs:label>
  <rdfs:comment>The direction of the relation</rdfs:comment>
</rdfs:Class>

<RelDirection rdf:ID="straight"/>
<RelDirection rdf:ID="reverse"/>

<rdfs:Property rdf:about="&omdocns;alternative">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;relation"/>
  <rdfs:label>omdoc:alternative</rdfs:label>
  <rdfs:comment>Alternative items</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Relation"/>
  <rdfs:range rdf:resource="&mogwlins;Alternative"/>
</rdfs:Property>

<rdfs:Class rdf:ID="Alternative">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="Relation"/>
  <rdfs:label>Alternative</rdfs:label>
  <rdfs:comment>The alternative items</rdfs:comment>
</rdfs:Class>

<rdfs:Property rdf:about="&omdocns;entatiled_by">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
```

```
  <rdf:subPropertyOf rdf:resource="&omdocns;alternative"/>
  <rdfs:label>omdoc:entatiled_by</rdfs:label>
  <rdfs:comment>Alternative was entailed by the statement refered to</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Alternative"/>
  <rdfs:range rdf:resource="http://www.w3.org/TR/xmlschema-2/#anyURI"/>
</rdfs:Property>

<rdfs:Property rdf:about="&omdocns;entails">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&omdocns;alternative"/>
  <rdfs:label>omdoc:entails</rdfs:label>
  <rdfs:comment>Alternative entails the statement refered to</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Alternative"/>
  <rdfs:range rdf:resource="http://www.w3.org/TR/xmlschema-2/#anyURI"/>
</rdfs:Property>

<rdfs:Property rdf:about="&omdocns;equivalemt_by">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&omdocns;alternative"/>
  <rdfs:label>omdoc:equivalemt_by</rdfs:label>
  <rdfs:comment>Alternative is equivalent by the statement refered to </rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Alternative"/>
  <rdfs:range rdf:resource="http://www.w3.org/TR/xmlschema-2/#anyURI"/>
</rdfs:Property>


<!-- Classification section -->

<rdfs:Class rdf:ID="Classification">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>Classification</rdfs:label>
  <rdfs:subClassOf rdf:resource="&mowglins;Mathematical" />
  <rdfs:comment>Describing the connection of a resource to a particular mathematical
  classification system</rdfs:comment>
</rdfs:Class>

<rdfs:Property rdf:about="&dcns;subject">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:subject</rdfs:label>
  <rdfs:comment>The topic of the content of the resource (controlled vocabulary)</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Classification"/>
  <rdfs:range rdf:resource="&mogwlins;Literal"/>
</rdfs:Property>

<rdfs:Class rdf:ID="MathClassificationScheme">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>MathClassificationScheme</rdfs:label>
  <rdfs:comment>The classification schemes for math used in MoWGLI</rdfs:comment>
</rdfs:Class>

<MathClassificationScheme rdf:ID="LSCH"/>
<MathClassificationScheme rdf:ID="MSC"/>
<MathClassificationScheme rdf:ID="DDC"/>
<MathClassificationScheme rdf:ID="CCS"/>

<rdfs:Property rdf:about="&mowglins;mathClassificationScheme">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
```

```
  <rdfs:label>mathClassificationScheme</rdfs:label>
  <rdfs:comment>Name of the classification system used</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Classification"/>
  <rdfs:range rdf:resource="&mogwlins;MathClassificationScheme"/>
</rdfs:Property>

<rdfs:Property rdf:about="&dcns;keyword">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>dc:keyword</rdfs:label>
  <rdfs:comment>The topic of the content of the resource (uncontrolled
  vocabulary)</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Classification"/>
  <rdfs:range rdf:resource="&mogwlins;Literal"/>
</rdfs:Property>


<!-- Application-dependent metadata -->

<rdfs:Class rdf:ID="Application-dependent">
  <rdfs:subClassOf rdf:resource="&mowglins;MathResource"/>
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>Application-dependent</rdfs:label>
  <rdfs:comment>The category of application-dependent metadata</rdfs:comment>
</rdfs:Class>

<!-- Educational section -->

<rdfs:Class rdf:ID="Educational">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>Educational</rdfs:label>
  <rdfs:subClassOf rdf:resource="&mowglins;Application-Dependent" />
  <rdfs:comment>Annotations for eLearning application</rdfs:comment>
</rdfs:Class>

<!-- Pedagogic Relations -->

<rdfs:Class rdf:ID="EduRelationKind">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&mowglins;MathRelationKind"/>
  <rdfs:label>EduRelationKind</rdfs:label>
  <rdfs:comment>The kinds of pedagogical relations</rdfs:comment>
</rdfs:Class>

<EduRelationKind rdf:ID="is_based_on"/>
<EduRelationKind rdf:ID="has_situation"/>
<EduRelationKind rdf:ID="similar"/>
<EduRelationKind rdf:ID="elaboration_for"/>
<EduRelationKind rdf:ID="motivation_for"/>
<EduRelationKind rdf:ID="introduction_for"/>
<EduRelationKind rdf:ID="conclusion_for"/>
<EduRelationKind rdf:ID="exercise_for"/>

<rdfs:Property rdf:about="&amns;kind">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;relation"/>
  <rdfs:label>am:kind</rdfs:label>
  <rdfs:comment>The pedagogical kinds of relations between items</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Educational"/>
```

```
  <rdfs:range rdf:resource="&mogwlins;EduRelationKind"/>
</rdfs:Property>

<!-- Other Pedagogical Metadata -->


<rdfs:Class rdf:ID="Difficulty">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>Difficulty</rdfs:label>
  <rdfs:comment>The difficulty level of the resource item</rdfs:comment>
</rdfs:Class>

<Difficulty rdf:ID="very_easy"/>
<Difficulty rdf:ID="easy"/>
<Difficulty rdf:ID="madium"/>
<Difficulty rdf:ID="difficult"/>
<Difficulty rdf:ID="very_difficult"/>

<rdfs:Property rdf:about="&lomns;difficulty">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>lom:difficulty</rdfs:label>
  <rdfs:comment>The difficulty level of the resource item</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Educational"/>
  <rdfs:range rdf:resource="&mogwlins;Difficulty"/>
</rdfs:Property>

<rdfs:Class rdf:ID="Abstractness">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>Abstractness</rdfs:label>
  <rdfs:comment>The anstractness level of the resource item</rdfs:comment>
</rdfs:Class>

<Abstractness rdf:ID="concrete"/>
<Abstractness rdf:ID="neutral"/>
<Abstractness rdf:ID="abstract"/>

<rdfs:Property rdf:about="&amns;abstractness">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>am:abstractness</rdfs:label>
  <rdfs:comment>The anstractness level of the resource item</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Educational"/>
  <rdfs:range rdf:resource="&mogwlins;Abstractness"/>
</rdfs:Property>

<rdfs:Class rdf:ID="LearningContext">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rfdns;Literal"/>
  <rdfs:label>LearningContext</rdfs:label>
  <rdfs:comment>The learning context of the resource item</rdfs:comment>
</rdfs:Class>

<LearningContext rdf:ID="primary_education"/>
<LearningContext rdf:ID="secondary_education"/>
<LearningContext rdf:ID="higher_education"/>
<LearningContext rdf:ID="university_first_cycle"/>
<LearningContext rdf:ID="university_second_cycle"/>
```

```
<LearningContext rdf:ID="university_post_grade"/>
<LearningContext rdf:ID="technical_school_first_cycle"/>
<LearningContext rdf:ID="technical_school_second_cycle"/>
<LearningContext rdf:ID="professional_formation"/>
<LearningContext rdf:ID="continuous_formation"/>
<LearningContext rdf:ID="vocational_training"/>

<rdfs:Property rdf:about="&lomns;learning_context">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>lom:learning_context</rdfs:label>
  <rdfs:comment>The learning context of the resource item</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Educational"/>
  <rdfs:range rdf:resource="&mogwlins;LearningContext"/>
</rdfs:Property>

<rdfs:Class rdf:ID="Field">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rfdns;Literal"/>
  <rdfs:label>Field</rdfs:label>
  <rdfs:comment>The field of study the resource is for</rdfs:comment>
</rdfs:Class>

<Field rdf:ID="mathematics"/>
<Field rdf:ID="statistics"/>
<Field rdf:ID="engineering"/>
<Field rdf:ID="psychology"/>
<Field rdf:ID="biology"/>
<Field rdf:ID="chemistry"/>
<Field rdf:ID="physics"/>
<Field rdf:ID="computer_science"/>
<Field rdf:ID="economics"/>
<Field rdf:ID="history"/>
<Field rdf:ID="other"/>

<rdfs:Property rdf:about="&lomns;Field">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>lom:Field</rdfs:label>
  <rdfs:comment>Th field of study the resource is for </rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Educational"/>
  <rdfs:range rdf:resource="&mogwlins;Field"/>
</rdfs:Property>

<rdfs:Class rdf:ID="CompetenceLevel">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>CompetenceLevel</rdfs:label>
  <rdfs:comment>The competence level to be trained</rdfs:comment>
</rdfs:Class>

<CompetenceLevel rdf:ID="knowledge"/>
<CompetenceLevel rdf:ID="comprehension"/>
<CompetenceLevel rdf:ID="application"/>
<CompetenceLevel rdf:ID="transfer"/>

<rdfs:Property rdf:about="&amns;competence_level">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>am:competence_level</rdfs:label>
  <rdfs:comment>The competence level to be trained</rdfs:comment>
```

```
  <rdfs:domain rdf:resource="&mogwlins;Educational"/>
  <rdfs:range rdf:resource="&mogwlins;CompetenceLevel "/>
</rdfs:Property>

<rdfs:Class rdf:ID="&mowglins;ExerciseType">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>ExerciseType</rdfs:label>
  <rdfs:comment>The type of action to be performed by the user</rdfs:comment>
</rdfs:Class>

<ExerciseType rdf:ID="comprehension_question"/>
<ExerciseType rdf:ID="calculate"/>
<ExerciseType rdf:ID="give_example"/>
<ExerciseType rdf:ID="prove"/>
<ExerciseType rdf:ID="make_hypothesis"/>
<ExerciseType rdf:ID="model"/>
<ExerciseType rdf:ID="choose"/>
<ExerciseType rdf:ID="fill_in"/>
<ExerciseType rdf:ID="explore"/>
<ExerciseType rdf:ID="collaborate"/>
<ExerciseType rdf:ID="visualize"/>
<ExerciseType rdf:ID="explain"/>

<rdfs:Property rdf:about="&amns;exercise_type">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>am:exercise_type</rdfs:label>
  <rdfs:comment>The type of action to be performed by the user</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Educational"/>
  <rdfs:range rdf:resource="&mogwlins;ExerciseType"/>
</rdfs:Property>

<rdfs:Class rdf:ID="Teacher">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfns:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>Teacher</rdfs:label>
  <rdfs:comment>The feedback of a teacher on the actions of a user</rdfs:comment>
</rdfs:Class>

<Teacher rdf:ID="typical_error"/>
<Teacher rdf:ID="reaction"/>
<Teacher rdf:ID="feedback"/>

<rdfs:Property rdf:about="&amns;teacher">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>am:teacher</rdfs:label>
  <rdfs:comment>The feedback of a teacher on the actions of a user</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Educational"/>
  <rdfs:range rdf:resource="&mogwlins;Teacher"/>
</rdfs:Property>

<!-- math publishing section -->

<rdfs:Class rdf:ID="Publishing">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&mowglins;Application-Dependent"/>
  <rdfs:label>Publishing</rdfs:label>
  <rdfs:comment>The category of metadata for publishing applications</rdfs:comment>
```

```
</rdfs:Class>

<rdfs:Class rdf:ID="EulerType">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;DCType"/>
  <rdfs:label>MowgliType</rdfs:label>
  <rdfs:comment>The type of the Mathematical Resource</rdfs:comment>
</rdfs:Class>

<EulerType rdf:ID="text.article"/>
<EulerType rdf:ID="text.monograph"/>
<EulerType rdf:ID="text.preprint"/>
<EulerType rdf:ID="text.proceedings"/>
<EulerType rdf:ID="text.serial"/>
<EulerType rdf:ID="text.techreport"/>
<EulerType rdf:ID="text.thesis"/>
<EulerType rdf:ID="text.bibliography"/>
<EulerType rdf:ID="text.lecture_notes"/>
<EulerType rdf:ID="text.review"/>
<EulerType rdf:ID="image"/>
<EulerType rdf:ID="image.moving.film"/>

<rdfs:Property rdf:about="&eulerns;type">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>euler:type</rdfs:label>
  <rdfs:comment>The type of the resource item for publishing application</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Application-dependent"/>
  <rdfs:range rdf:resource="&mogwlins;EulerType"/>
</rdfs:Property>


<!-- Fomal Math section -->

<rdfs:Class rdf:ID="FormalMath">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&mowglins;Application-Dependent"/>
  <rdfs:label>FormalMath</rdfs:label>
  <rdfs:comment>The category of metadata for publishing applications</rdfs:comment>
</rdfs:Class>

<rdfs:Property rdf:about="&helmns;kind">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdf:subPropertyOf rdf:resource="&dcns;relation"/>
  <rdfs:label>helm:kind</rdfs:label>
  <rdfs:comment>Formal kinds of relations</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Relation"/>
  <rdfs:range rdf:resource="&mogwlins;HelmKind"/>
</rdfs:Property>

<rdfs:Class rdf:ID="&mowglins;HelmKind">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfns:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>HelmKind</rdfs:label>
  <rdfs:comment>The class of helm kinds of relations</rdfs:comment>
</rdfs:Class>


<HelmKind rdf:ID="refRel"/>
```

```
<HelmKind rdf:ID="relSort"/>

<rdfs:Property rdf:about="&helmns;sort">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>helm:sort</rdfs:label>
  <rdfs:comment>The reffered CIC sort </rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Relation"/>
  <rdfs:range rdf:resource="&mogwlins;Sort"/>
</rdfs:Property>

<rdfs:Class rdf:ID="&mowglins;Sort">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfns:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>Sort</rdfs:label>
  <rdfs:comment>The referred CIC sorts</rdfs:comment>
</rdfs:Class>

<Sort rdf:ID="Set"/>
<Sort rdf:ID="Prop"/>
<Sort rdf:ID="Type"/>

<rdfs:Property rdf:about="&helmns;position">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>helm:position</rdfs:label>
  <rdfs:comment>The position of a reference in the referring object</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Relation"/>
  <rdfs:range rdf:resource="&mogwlins;Position"/>
</rdfs:Property>

<rdfs:Class rdf:ID="&mowglins;Position">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:subClassOf rdf:resource="&rdfns;Literal"/>
  <rdfs:label>Position</rdfs:label>
  <rdfs:comment>The position of a reference in the referring object</rdfs:comment>
</rdfs:Class>

<Position rdf:ID="MainHypothesis"/>
<Position rdf:ID="InHypothesis"/>
<Position rdf:ID="MainConclusion"/>
<Position rdf:ID="InConclusion"/>
<Position rdf:ID="InBody"/>

<rdfs:Property rdf:about="&helmns;depth">
  <rdfs:isDefinedBy rdf:resource="&mowglins;"/>
  <rdfs:label>helm:depth</rdfs:label>
  <rdfs:comment>The depth index associated to the position of the reference</rdfs:comment>
  <rdfs:domain rdf:resource="&mogwlins;Relation"/>
  <rdfs:range rdf:resource="&rdfns;Literal"/>
</rdfs:Property>

</rdf:RDF>
```