SWAD-Europe Thesaurus Activity

Deliverable 8.8

Migrating Thesauri to the Semantic Web

Guidelines and case studies for generating RDF encodings of existing thesauri

Abstract:

This document presents guidelines, methods and examples for migrating current thesaurus systems to RDF based thesaurus systems. Thesauri with both 'standard' and 'non-standard' structure are considered. Three case studies are presented.

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Comments on this document are welcome and should be sent to the authors or to the ⊣ public-esw-thes@w3.org list. An archive of this list is available at ⊣ http://lists.w3.org/Archives/Public/public-esw-thes/.

Contents

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1. Introduction [⊣ back to contents]

This document describes principles, guidelines and examples for the process of publishing a thesaurus on the semantic web.

The stages of this process are: (1) Generate an RDF encoding of the thesaurus, (2) error checking and validation of the encoding, (3) publishing the encoding on the web.

This document first describes an approach for migrating 'thesauri with standard structure' [⊣ Section 2]. Here, a 'thesaurus with standard structure' includes any thesaurus whose structural features coincide with the set of structural features described by ISO 2788:1986 [⊣ ISO2788] even if the principles of construction differed from those described by the standard.

Thus a 'thesaurus with standard structure' consists of two types of term: 'preferred' and 'non-preferred'; and five types of term-to-term relationship: 'broader' (BT), 'narrower' (NT), 'related' (RT), 'use' (USE) and 'use for' (UF); where BT NT and RT are allowed only between preferred terms, USE relates a non-preferred term to a preferred term, and UF is the inverse of USE; terms may be annotated with 'scope notes'.

This document then describes an approach for migrating 'thesauri with non-standard structure' [⊣ Section 3]. Here a 'thesaurus with non-standard structure' includes any thesaurus with structural features that are not described by the standard ISO 2788:1986 [⊣ ISO2788].

The goal when migrating thesauri with non-standard structure is to preserve all the unique features of a thesaurus, while also providing a framework for interoperability with other thesauri.

Section 4 comprises three worked examples of migrating thesauri to the semantic web:

- The first example [⊣ Section 4.1] is the APAIS Thesaurus [⊣ APAIS], a standard monolingual thesaurus, currently available in a native XML format. An RDF/XML encoding this thesaurus is generated using a single XSLT transformation.
- The second example [⊣ Section 4.2] is the English Heritage Aircraft Type Thesaurus [⊣ ATT], a standard monolingual thesaurus, available as a relational database. An RDF encoding of this thesaurus is generated from comma-delimited database output using a short java program.
- The third example [⊣ Section 4.3] is GEMET [⊣ GEMET], a non-standard multilingual

thesaurus, currently available in a native XML format. An RDF/XML encoding of GEMET is generated using multiple XSLT transformations.

2. Thesauri with Standard Structure [⊣ back to contents]

A 'thesaurus with standard structure' is here defined as any thesaurus conforming to the following structural restrictions:

- The thesaurus consists of a set of terms, a set of term-to-term relationships, and a set of term annotations.
- A 'term' is any word or phrase.
- There are two types of term, 'non-preferred' and 'preferred'.
- The following term-to-term relationships are allowed between preferred terms only: 'broader' (BT), 'narrower' (NT), 'related' (RT).
- The term-to-term relationship 'use' (USE) directs a user from a non-preferred term to its preferred alternative; 'use for' (UF) is the inverse of 'use'.
- Terms may be annotated with 'scope notes'.

An example of an extract from a typical rendering of a standard thesaurus is below:

Extract from rendering of standard thesaurus

```
Therapy
NT    Back care

Back care
BT    Therapy
RT    Back pain

Back pain
UF    Backache
RT    Back care
      Musculoskeletal disorders

Musculoskeletal disorders
UF    Bone disorders
RT    Back pain
```

This is the traditional, *term-oriented*, view of a thesaurus, oriented towards use by people via print media.

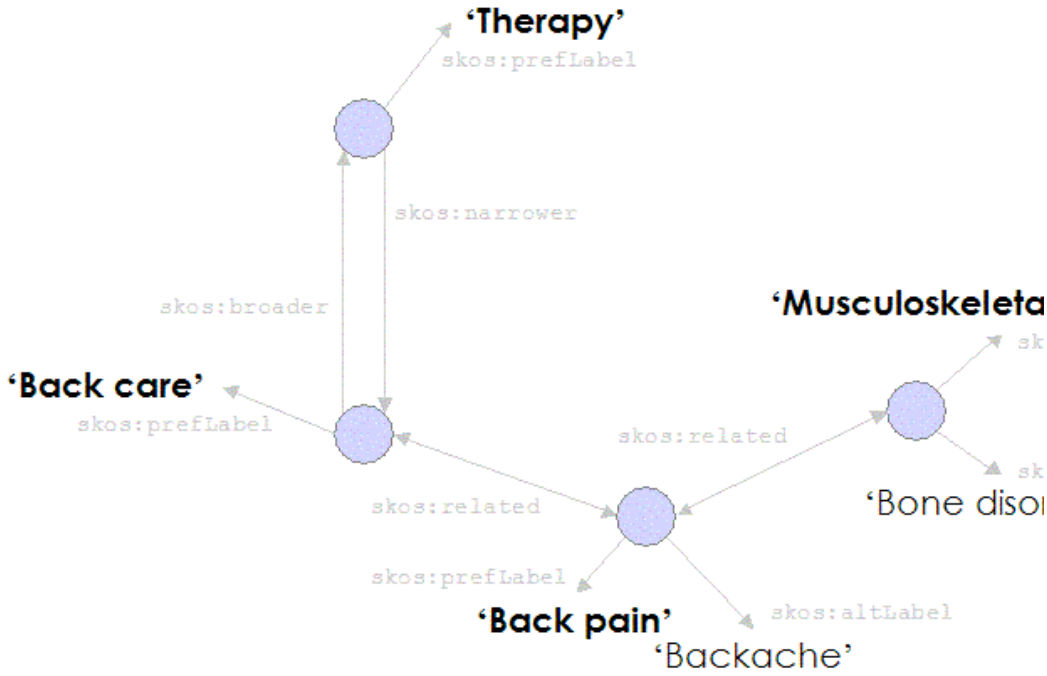
It is recommended to use the SKOS-Core RDF vocabulary [⊣ SKOS SCHEMA] [⊣ SKOS GUIDE] as the basis for an RDF encoding of a thesaurus with standard structure. Re-using existing RDF vocabularies whenever possible is highly desirable, as it provides a basis for programmatic interoperability.

The SKOS-Core RDF vocabulary is oriented towards use by computer programs via the semantic web. It is based on a *concept-oriented* view of a thesaurus, primarily because this makes programmatic manipulation and maintenance of the data much simpler. In the concept-oriented view:

- Each preferred term becomes the 'preferred label' for a 'concept'.
- Non-preferred terms become 'alternative labels' for concepts.
- A 'label' can be any string of characters, or any symbol or image.
- Relationships such as 'broader' 'narrower' and 'related' are relationships of meaning, and are hence relationships between concepts ('semantic relations').
- Concepts may have annotations such as scope notes and definitions.
- The meaning (intension) of a concept should be inferred from the combination of its preferred label, its alternatives labels, any annotations, and its neighbouring concepts.

An illustration of the RDF model of the above thesaurus extract, based on the SKOS-Core schema, is below:

Extract of thesaurus as RDF model



The above model has the following RDF/XML serialisation:

RDF/XML serialisation of thesaurus extract

```
<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:skos="http://www.w3.org/2004/02/skos/core#"
   xml:base="http://www.examplenamespace.com/">

<skos:Concept rdf:about="001">
   <skos:prefLabel>Therapy</skos:prefLabel>
   <skos:narrower rdf:resource="002"/>
</skos:Concept>

<skos:Concept rdf:about="002">
   <skos:prefLabel>Back care</skos:prefLabel>
   <skos:broader rdf:resource="001"/>
   <skos:related rdf:resource="003"/>
</skos:Concept>

<skos:Concept rdf:about="003">
   <skos:prefLabel>Back pain</skos:prefLabel>
   <skos:altLabel>Backache</skos:altLabel>
   <skos:related rdf:resource="002"/>
   <skos:related rdf:resource="004"/>
</skos:Concept>

<skos:Concept rdf:about="004">
   <skos:prefLabel>Musculoskeletal disorders</skos:prefLabel>
   <skos:altLabel>Bone disorders</skos:altLabel>
   <skos:related rdf:resource="003"/>
</skos:Concept>

</rdf:RDF>
```

Case studies 4.1 [⊣ Section 4.1] and 4.2 [⊣ Section 4.2] below provide in depth examples of generating an RDF encoding of a standard thesaurus.

3. Thesauri with Non-Standard Structure [⊣ back to contents]

Here a 'thesaurus with non-standard structure' includes any thesaurus with structural features that are not described by ISO 2788:1986 [⊣ ISO2788].

When migrating such a thesaurus to the semantic web, it is desirable to preserve all of the unique features of the thesaurus, i.e. to generate an RDF encoding that preserves all of the information encoded in the thesaurus. However, it is also desirable to provide at least some basis for interoperability. In this way, specialised applications can operate on the unique and specific features of the thesaurus, and generalised thesaurus applications can still recognise the standard features of the thesaurus and operate on them.

To achieve this aim, it is recommended that a *schema extension* be created for each thesaurus with non-standard structure. This is an RDF Schema that captures all of the features of the thesaurus, but where all of the new classes and properties are derived from the classes and properties of the SKOS-Core RDF vocabulary [⊣ SKOS SCHEMA][⊣ SKOS GUIDE] via sub-class and sub-property statements.

As an example of this, consider the GEMET thesaurus [⊣ GEMET]. GEMET uses most of the standard thesaurus features:

- It consists of a set of 'descriptors' (preferred terms), which may be related to each other via the properties 'broader' 'narrower' and 'related'.

It also has some non-standard features:

- Each 'descriptor' is related to a 'theme'.
- Each 'descriptor' is related to a 'group'.
- Each 'group' is related to a 'super-group'.

Both the groups, super-groups and themes have been given labels that indicate that they represent concepts in their own right. Therefore, three new classes may be created as part of the extended schema to capture these types (`gemet:Theme`, `gemet:Group`, `gemet:SuperGroup`) and these classes may be defined as sub-classes of the `skos:Concept` class. The `gemet:SuperGroup` class is defined as a sub-class of `skos:TopConcept` class, because this type represents the nodes that sit at the very top of the hierarchy.

Classes of GEMET extended schema (in RDF/N3 serialisation)

```
@prefix gemet: <http://www.eionet.eu.int/gemet/schema#> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .

  gemet:Theme  a  rdfs:Class;
    rdfs:label  'Theme';
    rdfs:subClassOf  skos:Concept.

  gemet:Group  a  rdfs:Class;
    rdfs:label  'Group';
    rdfs:subClassOf  skos:Concept.

  gemet:SuperGroup  a  rdfs:Class;
    rdfs:label  'Super Group';
    rdfs:subClassOf  skos:TopConcept.
```

Because every 'theme' is broader in sense than the 'descriptor' to which it is related, the property linking a concept to a theme may be defined as a sub-property of the `skos:broader` property. The same is true for 'descriptors' and 'groups', and also for 'groups' and 'super-groups'.

Properties of GEMET extended schema (in RDF/N3 serialisation)

```
@prefix gemet: <http://www.eionet.eu.int/gemet/schema#> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .

  gemet:broaderTheme  a  rdf:Property;
    rdfs:label  'broader theme';
    rdfs:subPropertyOf  skos:broader;
    rdfs:domain  skos:Concept;
    rdfs:range  gemet:Theme.

  gemet:broaderGroup  a  rdf:Property;
    rdfs:label  'broader group';
    rdfs:subPropertyOf  skos:broader;
    rdfs:domain  skos:Concept;
    rdfs:range  gemet:Group.

  gemet:subGroupOf  a  rdf:Property;
    rdfs:label  'sub-group of';
```

```
    rdfs:subPropertyOf   skos:broader;
    rdfs:domain   gemet:Group;
    rdfs:range   gemet:SuperGroup.
```

So to recap, for a thesaurus with non-standard structure, first design a schema extension based on the SKOS-Core RDF vocabulary to capture any non-standard features, then generate an RDF encoding of the thesaurus based on the SKOS-Core RDF vocabulary and the schema extension.

Case study 4.3 [┤ Section 4.3] provides an in depth example of this method for the GEMET thesaurus.

4. Case Studies [┤ back to contents]

4.1. APAIS Thesaurus [┤ back to contents] -

The Australian Public Affairs Information Service Thesaurus [┤ APAIS] is available as an XML download [┤ APAIS XML], with an accompanying Document Type Definition (DTD) [┤ APAIS DTD] which is based on the Z39.50 profile for thesaurus navigation [┤ ZTHES]. The XML document root `<thes>` element contains a number of `<term>` elements, an example of which is below:

Extract from APAIS Thesaurus native XML

```
<thes>
  <term>
    <termId>R1722</termId>
    <termName>Aboriginal archaeology</termName>
    <termType>PT</termType>
     <termNote>Use for the study of Aboriginal and Torres Strait
     Islander prehistoric culture chiefly through excavation and description
     of its material remains</termNote>
    <termCreatedDate>1986</termCreatedDate>
    <termModifiedDate>9/04/2002</termModifiedDate>
    <relation>
      <relationType>UF</relationType>
      <termId>N0003</termId>
      <termName>Aboriginal prehistory</termName>
      <termType>ND</termType>
    </relation>
    <relation>
      <relationType>UF</relationType>
      <termId>N0651</termId>
      <termName>Prehistory, Aboriginal</termName>
      <termType>ND</termType>
    </relation>
    <relation>
      <relationType>BT</relationType>
      <termId>R0064</termId>
      <termName>Archaeology</termName>
      <termType>PT</termType>
    </relation>
    <relation>
      <relationType>RT</relationType>
      <termId>R1723</termId>
      <termName>Aboriginal history</termName>
      <termType>PT</termType>
    </relation>
    <relation>
      <relationType>RT</relationType>
      <termId>R0009</termId>
      <termName>Aborigines</termName>
      <termType>PT</termType>
    </relation>
  </term>
  ...
</thes>
```

The APAIS thesaurus is classified here as a thesaurus with standard structure, because it consists only of terms, with the relations UF USE BT NT RT between them. Therefore it can be mapped directly into the SKOS-Core 1.0 schema with no loss of information.

An RDF/XML encoding of this thesaurus can be generated from the source XML using an

XSLT transformation. The full XSLT stylesheet is linked from this reference [⊣ APAIS XSLT]. Appendix I [⊣ Appendix I] walks through this stylesheet in detail, explaining its features.

The complete XSLT stylesheet, when applied to the above excerpt from the APAIS thesaurus, generates the following snippet of RDF/XML:

RDF/XML generated from transformation

```
<rdf:RDF
          xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
          xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
          xmlns:skos="http://www.w3.org/2004/02/skos/core#"
          xmlns:dc="http://purl.org/dc/elements/1.1/"
          xml:base="http://www.nla.gov.au/apais/thesaurus/" >

          <skos:ConceptScheme rdf:about="http://www.nla.gov.au/apais/thesaurus">
                   <dc:title>Australian Public Affairs Information Service (APAIS) th
         </skos:ConceptScheme>

          <skos:Concept rdf:about="R1722">
                    <skos:inScheme rdf:resource="http://www.nla.gov.au/apais/thesaurus
                    <skos:prefLabel>Aboriginal archaeology</skos:prefLabel>
                    <skos:altLabel>Aboriginal prehistory</skos:altLabel>
                    <skos:altLabel>Prehistory, Aboriginal</skos:altLabel>
                   <skos:related rdf:resource="R0009"/>
                   <skos:broader rdf:resource="R0064"/>
                   <skos:related rdf:resource="R1723"/>
                   <skos:scopeNote>Use for the study of Aboriginal
                   and Torres Strait Islander prehistoric culture chiefly
                   through excavation and description of its material
                   remains</skos:scopeNote>
         </skos:Concept>

         ...

</rdf:RDF>
```

One point to note is that the numbering scheme from the native XML format has been used as the basis for the concept URIs. It is recommended wherever possible to base concept URIs on existing identifiers.

Once an RDF/XML transformation has been applied, the final step is to run well-formedness, syntax, and validation checks (see [⊣ RDF VALIDATE]) on the output.

The full output of this conversion is at this reference [⊣ APAIS OUT].

4.2. English Heritage Aircraft Type Thesaurus [⊣ back to contents] -

The English Heritage Aircraft Type Thesaurus (ATT) [⊣ ATT] is a monolingual thesaurus with standard structure. English Heritage uses a relational database to store and maintain this thesaurus. For this case study EH provided us with comma delimited files, one file for each table in the database.

The EH database schema for thesauri consists of the following tables (here each table illustrated with field headings and an example tuple):

'classification groups table'

CLA_GR_UID	DESCRIPTION	NAME	CLASS_TYPE	STATUS	OPS_SET
225		"AIRCRAFT TYPE"	"T"	"O"	

One tuple for each thesaurus (thesaurus metadata).

'terms table'

CLA_GR_UID	THE_TE_UID	TERM	INDEX_TERM	SCOPE_NOTE	STATUS
225	111367	"LANCASTER"	"Y"	"Four-engined bomber, developed by Avro from the	"P"

	twin-engined Manchester. Entered service in 1942 as the RAF's principal night bomber and took part in the 1,000 bomber raids as well as the famous Dam Busters raid."

One tuple for each term. A 'STATUS' value of "P" indicates a preferred term, "N" indicated a non-preferred term.

'term preferences table'

THE_TE_UID_1	THE_TE_UID_2
111425	111363

One tuple for each 'USE' relationship.

'term uses table'

THE_T_U_UID	TERM	CLA_GR_UID	BROAD_TERM_U_UID	TOP_TERM_U_
175943	"HAMPDEN"	225	153785	167503

One tuple for each 'BT' relationship.

'term relation table'

THE_T_U_UID_1	THE_T_U_UID_2
135606	133678

One tuple for each 'RT' relationship.

The generation of an RDF encoding of this thesaurus was done programmatically, using the Jena 2 [⊣ JENA] Java API for RDF. A link to the Java main class written to perform the conversion is at this reference [⊣ EH CONV], supporting classes here [⊣ EH TOK][⊣ SKOS JAVA].

To summarise the operations of this class, basically, an in memory RDF model is created, each comma delimited file (the output of a table) is parsed in turn and used to add statements to the model. More specifically:

- From the single tuple of the 'classification groups table' a resource representing the thesaurus is created, and typed as a `skos:ConceptScheme`. To this resource `dc:title` and `dc:description` properties are added with values from fields of this tuple.
- From each tuple of the 'terms table', if the 'STATUS' value is "P" (i.e. the term is a preferred term), a resource is created and typed as a `skos:Concept`. To this resource `skos:inScheme`, `skos:prefLabel` and `skos:scopeNote` properties are added.
- From each tuple of the 'term preferences table' a `skos:altLabel` property is added to the appropriate concept.
- From each tuple of the 'term uses table' `skos:broader`/`skos:narrower` statements are added between the appropriate concepts.
- From each tuple of the 'term relation table' `skos:related` statements are added between the appropriate concepts.

The model is then serialised, and this RDF file is then the output of the conversion.

Examine the Java class file itself for full details of the conversion program [⊣ EH CONV].

An extract of the RDF output of this conversion is at these references [⊣ EH

RDF/XML][┤ EH RDF/N3]

4.3. GEMET [┤ back to contents] -

GEMET is a multilingual thesaurus, publicly available as an XML download [┤ GEMET]. There is one XML file for each of the 16 languages in which GEMET is available. These XML files share the same markup structure and element names - only the element contents change with the language.

The extracts below are from the GEMET EN-GB (British English) XML file.

The 'thesaurus' element contains a list of 'descriptor' elements, an example of which is below:

A GEMET 'descriptor' element

```
<cds-thes>
  <thesaurus>
    <descriptor>
       <descriptor-term desc-id="7" desc-type="1" top="0">abandoned industrial site
       <broader-term desc-ref-id="4666">land setup</broader-term>
       <narrower-term desc-ref-id="2275">disused military site</narrower-term>
       <theme accronym="IND" theme-id="19">industry</theme>
       <theme accronym="NAT" theme-id="23">natural areas, landscape, ecosystems</th
       <theme accronym="PLL" theme-id="26">pollution</theme>
       <theme accronym="URB" theme-id="38">urban environment, urban stress</theme>
       <group group-id="1062" super-group-id="5499">ANTHROPOSPHERE (built environme
    </descriptor>
        ...
  </thesaurus>
</cds-thes>
```

The 'thesaurus' element also contains some 'super-group' elements, for example:

A GEMET 'super-group' element

```
<cds-thes>
  <thesaurus>
    <super-group super-group-id="2894">
       <super-group-name>SOCIAL ASPECTS, ENVIRONMENTAL POLICY MEASURES</super-group
    </super-group>
    ...
  </thesaurus>
</cds-thes>
```

Finally the 'thesaurus' element contains some 'descriptor-related' elements, for example:

A GEMET 'descriptor-related' element.

```
<cds-thes>
  <thesaurus>
     <descriptor-related desc-ref-id="9147" rel-desc-ref-id="9214"/>
     <descriptor-related desc-ref-id="9160" rel-desc-ref-id="4505"/>
     <descriptor-related desc-ref-id="12214" rel-desc-ref-id="1808"/>
    ...
  </thesaurus>
</cds-thes>
```

Because the 'group' 'super-group' and 'theme' constructs are non-standard thesaurus constructs, a schema extension must be defined for GEMET.

The GEMET schema extension is below:

Extended RDF Schema for GEMET (in RDF/XML serialisation)

```
<!DOCTYPE skos [ <!ENTITY skos "http://www.w3.org/2004/02/skos/core#"> ]>
<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xml:base="http://www.eionet.eu.int/GEMET/skos-ext">

  <!-- This is the extension of SKOS-Core for the GEMET Thesaurus -->

  <rdfs:Class rdf:ID="SuperGroup">
     <rdfs:label>Super Group</rdfs:label>
     <rdfs:subClassOf rdf:resource="&skos;TopConcept"/>
  </rdfs:Class>
```

```
  <rdfs:Class rdf:ID="Group">
    <rdfs:label>Group</rdfs:label>
    <rdfs:subClassOf rdf:resource="&skos;Concept"/>
  </rdfs:Class>

  <rdfs:Class rdf:ID="Theme">
    <rdfs:label>Theme</rdfs:label>
    <rdfs:subClassOf rdf:resource="&skos;TopConcept"/>
  </rdfs:Class>

  <rdf:Property rdf:ID="acronymLabel">
    <rdfs:label>acronym label</rdfs:label>
    <rdfs:subPropertyOf rdf:resource="&skos;altLabel"/>
  </rdf:Property>

  <rdf:Property rdf:ID="broaderTheme">
    <rdfs:label>broader theme</rdfs:label>
    <rdfs:subPropertyOf rdf:resource="&skos;broader"/>
    <rdfs:range rdf:resource="#Theme"/>
  </rdf:Property>

  <rdf:Property rdf:ID="broaderGroup">
    <rdfs:label>broader group</rdfs:label>
    <rdfs:subPropertyOf rdf:resource="&skos;broader"/>
    <rdfs:range rdf:resource="#Group"/>
  </rdf:Property>

  <rdf:Property rdf:ID="subGroupOf">
    <rdfs:label>sub-group of</rdfs:label>
    <rdfs:subPropertyOf rdf:resource="&skos;broader"/>
    <rdfs:domain rdf:resource="#Group"/>
    <rdfs:range rdf:resource="#SuperGroup"/>
  </rdf:Property>

</rdf:RDF>
```

Because GEMET is a multilingual thesaurus, generation of an RDF encoding was done in two parts. First a file defining the *conceptual backbone* of GEMET in RDF was generated. Then files defining the labels for each of the concepts themes and groups were generated, one file for each language.

An extract from the GEMET conceptual backbone in RDF is below:

Extract of GEMET concept backbone in RDF

```
<rdf:RDF
     xmlns:gemet="http://www.eionet.eu.int/GEMET/skos-ext#"
     xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
     xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
     xmlns:skos="http://www.w3.org/2004/02/skos/core#"
     xmlns:dc="http://purl.org/dc/elements/1.1/"
   xml:base="http://www.eionet.eu.int/GEMET/" >
   <rdf:Description rdf:about="c_204">
     <skos:inScheme rdf:resource="../GEMET"/>
     <rdf:type rdf:resource="http://www.w3.org/2004/02/skos/core#Concept"/>
     <skos:narrower rdf:resource="c_10217"/>
     <gemet:broaderTheme rdf:resource="t_23"/>
     <skos:broader rdf:resource="c_4648"/>
     <gemet:broaderTheme rdf:resource="t_2"/>
   </rdf:Description>
   <rdf:Description rdf:about="c_11786">
     <skos:broader rdf:resource="c_11124"/>
     <skos:inScheme rdf:resource="../GEMET"/>
     <gemet:broaderTheme rdf:resource="t_4"/>
     <rdf:type rdf:resource="http://www.w3.org/2004/02/skos/core#Concept"/>
   </rdf:Description>
   <rdf:Description rdf:about="c_7962">
     <skos:related rdf:resource="c_7969"/>
     <skos:inScheme rdf:resource="../GEMET"/>
     <gemet:broaderTheme rdf:resource="t_36"/>
     <rdf:type rdf:resource="http://www.w3.org/2004/02/skos/core#Concept"/>
     <skos:narrower rdf:resource="c_7452"/>
     <gemet:broaderGroup rdf:resource="g_7956"/>
     <skos:related rdf:resource="c_7970"/>
   </rdf:Description>
   <rdf:Description rdf:about="g_14979">
     <gemet:subGroupOf rdf:resource="sg_5499"/>
```

```
    <rdf:type rdf:resource="skos-ext#Group"/>
    <skos:inScheme rdf:resource="../GEMET"/>
  </rdf:Description>
  <rdf:Description rdf:about="t_34">
    <rdf:type rdf:resource="skos-ext#Theme"/>
    <skos:inScheme rdf:resource="../GEMET"/>
  </rdf:Description>
</rdf:RDF>
```

The stylesheet used to generate this file is at this reference [⊣ GEMET BB XSLT]. Appendix II [⊣ Appendix II] walks through this stylesheet in detail. Any of the GEMET XML source files could be used equally as the source for this transformation.

An extract from the GEMET Portuguese labels in RDF is below:

Extract of GEMET Portuguese labels:

```
<rdf:RDF
     xmlns:gemet="http://www.eionet.eu.int/GEMET/skos-ext#"
     xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
     xmlns:skos="http://www.w3.org/2004/02/skos/core#"
     xml:base="http://www.eionet.eu.int/GEMET/" >
  <rdf:Description rdf:about="c_204">
    <skos:prefLabel xml:lang="pt">paisagens agrícolas</skos:prefLabel>
  </rdf:Description>
  <rdf:Description rdf:about="c_11786">
    <skos:prefLabel xml:lang="pt">índices bióticos</skos:prefLabel>
  </rdf:Description>
  <rdf:Description rdf:about="c_4657">
    <skos:prefLabel xml:lang="pt">ecologia paisagística</skos:prefLabel>
  </rdf:Description>
  <rdf:Description rdf:about="g_8575">
    <skos:prefLabel xml:lang="pt">COMÉRCIO, SERVIÇOS</skos:prefLabel>
  </rdf:Description>
  <rdf:Description rdf:about="t_29">
    <gemet:acronymLabel>REC</gemet:acronymLabel>
    <skos:prefLabel xml:lang="pt">turismo</skos:prefLabel>
  </rdf:Description>
</rdf:RDF>
```

The stylesheet used to generate this file is at this reference [⊣ GEMET LB XSLT]. This stylesheet was run on each of the source XML files, to generate one labels file for each language.

Note that the extracts of GEMET in RDF/XML printed above are not exactly what would be expected as the outcomes of the XSLT stylesheets printed in the appendices. This is because the output of the XSLT transformations was run through an RDF parser to validate the RDF, and the RDF parser serialised the data using a slightly different form of RDF/XML. To learn more about RDF and the RDF/XML serialisation go to these references [RDF PRIMER][RDF XML].

The full output of the GEMET transformations is at the following reference [⊣ GEMET OUT].

References

[SKOS GUIDE]
SKOS-Core 1.0 Guide. Miles, A.J., Rogers, R., Beckett, D. SWAD-Europe Thesaurus Activity.
⊣ http://www.w3.org/2001/sw/Europe/reports/thes/1.0/guide/
[SKOS SCHEMA]
SKOS-Core 1.0 RDF Schema. Miles, A.J., Rogers, R., Beckett, D. SWAD-Europe Thesaurus Activity.
⊣ http://www.w3.org/2004/02/skos/core.rdf
[APAIS]
Australian Public Affairs Information Service Thesaurus (APAIS). National Library of Australia.
⊣ http://www.nla.gov.au/apais/thesaurus/
[APAIS XML]
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[APAIS DTD]
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[ATT]
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http://www.english-heritage.org.uk/thesaurus/aircraft/
[GEMET]
GEneral Multilingual Environmental Thesaurus (GEMET). European Environment Information and Observation Network (EIONET).
http://www.eionet.eu.int/GEMET
[ZThes]
Zthes: a Profile for Thesaurus Navigation in Z39.50 and SRW.
http://zthes.z3950.org/
[RDF VALIDATE]
W3C RDF Validation Service.
http://www.w3.org/RDF/Validator/
[JENA]
Jena - A Semantic Web Framework for Java.
http://jena.sourceforge.net/
[ISO2788] ISO (1986) ISO 2788:1986 Documentation - **Guidelines for the establishment and development of monolingual thesauri**. 2nd ed. (32 p.)

Associated Files

[APAIS XSLT]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/apais/apais.xslt
[APAIS OUT]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/apais/apais.rdf.xml
[EH CONV]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/eh/Converter.java
[EH TOK]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/eh/Tokenizer.java
[SKOS_JAVA]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/eh/SKOS.java
[EH RDF/XML]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/eh/eh_aircraft_extract.rdf.xml
[EH RDF/N3]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/eh/eh_aircraft_extract.rdf.n3
[GEMET BB XSLT]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/gemet/gemet_backbone.xslt
[GEMET LB XSLT]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/gemet/gemet_labels.xslt
[GEMET OUT]
http://www.w3.org/2001/sw/Europe/reports/thes/1.0/migrate/gemet/gemet.zip

Appendix I. APAIS XSLT Stylesheet Walkthrough

This section guides you through the elements of the XSL stylesheet that transforms the APAIS XML into SKOS/RDF.

The root element of the stylesheet is as follows:

Stylesheet root element

```
<xsl:stylesheet version="1.0"
         xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
         xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
         xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
         xmlns:skos="http://www.w3.org/2004/02/skos/core#">
```

```
        <xsl:output method="xml" version="1.0" encoding="UTF-8" indent="yes"/>

        <!-- All templates go here -->

</xsl:stylesheet>
```

The first template of the stylesheet matches the thes element, and sets up the root element for the target document, including all required namespace declarations:

The 'thes' template

```
<xsl:template match="thes">

        <rdf:RDF xmlns:dc="http://purl.org/dc/elements/1.1/"
        xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
        xmlns:skos="http://www.w3.org/2004/02/skos/core#"
        xml:base="http://www.nla.gov.au/apais/thesaurus/">

                <skos:ConceptScheme rdf:about="http://www.nla.gov.au/apais/thesaur
                        <dc:title>Australian Public Affairs Information Service (
                </skos:ConceptScheme>

                <xsl:apply-templates select="term"/>

        </rdf:RDF>

</xsl:template>
```

Note I've included the ConceptScheme declaration in this template.

Note also that the root element contains an xml:base declaration. This allows us to use relative URIs throughout the generated document.

The next template is used to map each preferred term in the APAIS thesaurus to an skos:Concept declaration:

The 'term' template

```
<xsl:template match="term">
        <xsl:variable name="id" select="termId"/>
        <xsl:variable name="type" select="termType"/>

        <xsl:if test="$type='PT'">

                <xsl:choose>

                        <xsl:when test="count(relation[relationType='BT'])=0">
                                <skos:TopConcept rdf:about="{$id}">
                                        <skos:inScheme rdf:resource="http://www.n
                                        <skos:prefLabel><xsl:value-of select="ter
                                        <xsl:apply-templates select="relation"/>
                                        <xsl:apply-templates select="termNote"/>
                                </skos:TopConcept>
                        </xsl:when>

                        <xsl:otherwise>
                                <skos:Concept rdf:about="{$id}">
                                        <skos:inScheme rdf:resource="http://www.n
                                        <skos:prefLabel><xsl:value-of select="ter
                                        <xsl:apply-templates select="relation"/>
                                        <xsl:apply-templates select="termNote"/>
                                </skos:Concept>
                        </xsl:otherwise>

                </xsl:choose>

        </xsl:if>

</xsl:template>
```

Note that an xsl:if test is first used to determine whether the current term element is a preferred term. A second xsl:choose test is then used to determine whether the current preferred term is a top-level term in the thesaurus or not. If it is, an skos:TopConcept declaration is generated, otherwise an skos:Concept declaration is generated.

Also note that the termID values from the XML documents are being used as the basis for generating URIs for each concept in the thesaurus.

Further templates are then applied within the skos:Concept declaration, to generate the alternative labels, semantic relations and scope notes.

The 'relation' template generates the alternative labels and the semantic relations:

The 'relation' template

```
<xsl:template match="relation">
         <xsl:variable name="id" select="termId"/>
         <xsl:variable name="type" select="relationType"/>

         <xsl:if test="$type='UF'">
                  <skos:altLabel><xsl:value-of select="termName"/></skos:altLabel>
         </xsl:if>

         <xsl:if test="$type='BT'">
                  <skos:broader rdf:resource="{$id}"/>
         </xsl:if>

         <xsl:if test="$type='NT'">
                  <skos:narrower rdf:resource="{$id}"/>
         </xsl:if>

         <xsl:if test="$type='RT'">
                  <skos:related rdf:resource="{$id}"/>
         </xsl:if>

</xsl:template>
```

Finally the 'termNote' template generates any skos:scopeNote declarations:

The 'termNote' template

```
<xsl:template match="termNote">

         <skos:scopeNote><xsl:value-of select="."/></skos:scopeNote>

</xsl:template>
```

The complete stylesheet, when applied to the above excerpt from the APAIS thesaurus, generates the following snippet of RDF/XML:

RDF/XML generated from transformation

```
<rdf:RDF
          xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
          xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
          xmlns:skos="http://www.w3.org/2004/02/skos/core#"
          xmlns:dc="http://purl.org/dc/elements/1.1/"
          xml:base="http://www.nla.gov.au/apais/thesaurus/" >

          <skos:ConceptScheme rdf:about="http://www.nla.gov.au/apais/thesaurus">
                   <dc:title>Australian Public Affairs Information Service (APAIS) th
         </skos:ConceptScheme>

         <skos:Concept rdf:about="R1722">
                   <skos:inScheme rdf:resource="http://www.nla.gov.au/apais/thesaurus
                   <skos:prefLabel>Aboriginal archaeology</skos:prefLabel>
                   <skos:altLabel>Aboriginal prehistory</skos:altLabel>
                   <skos:altLabel>Prehistory, Aboriginal</skos:altLabel>
                  <skos:related rdf:resource="R0009"/>
                  <skos:broader rdf:resource="R0064"/>
                  <skos:related rdf:resource="R1723"/>
                  <skos:scopeNote>Use for the study of Aboriginal
                  and Torres Strait Islander prehistoric culture chiefly
                  through excavation and description of its material
                  remains</skos:scopeNote>
         </skos:Concept>

         ...

</rdf:RDF>
```

Appendix II. GEMET Backbone XSLT Stylesheet Walkthrough

The root template sets up the root element for the generated document, and applies further templates:

GEMET Backbone XSLT: Root template

```
<xsl:template match="cds-thes">

  <rdf:RDF
     xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
     xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
     xmlns:skos="http://www.w3.org/2004/02/skos/core#"
     xmlns:dc="http://purl.org/dc/elements/1.1/"
     xmlns:gemet="http://www.eionet.eu.int/GEMET/skos-ext#"
     xml:base="http://www.eionet.eu.int/GEMET/">

   <skos:ConceptScheme rdf:about="http://www.eionet.eu.int/GEMET">
     <dc:title>General Multilingual Environment Thesaurus (GEMET)</dc:title>
   </skos:ConceptScheme>

   <xsl:apply-templates select="//super-group"/>
   <xsl:apply-templates select="//descriptor"/>
   <xsl:apply-templates select="//theme" mode="resource"/>
   <xsl:apply-templates select="//group" mode="resource"/>
   <xsl:apply-templates select="//descriptor-related"/>

  </rdf:RDF>

</xsl:template>
```

The 'super-group' template generates individuals of the gemet:SuperGroup class:

GEMET Backbone XSLT: 'super-group' template

```
<xsl:template match="super-group">
  <xsl:variable name="id" select="@super-group-id"/>

  <gemet:SuperGroup rdf:about="sg_{$id}">
     <skos:inScheme rdf:resource="http://www.eionet.eu.int/GEMET"/>
  </gemet:SuperGroup>

</xsl:template>
```

The 'group' template generates individuals of the gemet:Group class:

GEMET Backbone XSLT: 'group' template

```
<xsl:template match="group" mode="resource">
  <xsl:variable name="id" select="@group-id"/>
  <xsl:variable name="sid" select="@super-group-id"/>

  <gemet:Group rdf:about="g_{$id}">
     <skos:inScheme rdf:resource="http://www.eionet.eu.int/GEMET"/>
     <gemet:subGroupOf rdf:resource="sg_{$sid}"/>
  </gemet:Group>

</xsl:template>
```

The 'theme' template generates individuals of the gemet:Theme class:

GEMET Backbone XSLT: 'theme' template

```
<xsl:template match="theme" mode="resource">
  <xsl:variable name="id" select="@theme-id"/>

  <gemet:Theme rdf:about="t_{$id}">
     <skos:inScheme rdf:resource="http://www.eionet.eu.int/GEMET"/>
  </gemet:Theme>

</xsl:template>
```

The 'descriptor' template generates individuals of the skos:Concept class:

GEMET Backbone XSLT: 'descriptor' template

```
<xsl:template match="descriptor">
  <xsl:variable name="id" select="descriptor-term/@desc-id"/>

  <skos:Concept rdf:about="c_{$id}">

  <skos:inScheme rdf:resource="http://www.eionet.eu.int/GEMET"/>
```

```
   <xsl:apply-templates select="broader-term"/>
   <xsl:apply-templates select="narrower-term"/>
   <xsl:apply-templates select="theme" mode="relation"/>

   <xsl:if test="count(broader-term)=0">
     <xsl:apply-templates select="group" mode="relation"/>
   </xsl:if>

   </skos:Concept>

</xsl:template>
```

Note again that throughout identifiers from the source XML document were used as the basis for relative URIs in the generated document.

Further templates are applied within the 'descriptor' template, to generate the statements linking a concept to broader and narrower concepts, and to themes. Also, if the concept has no broader concepts, then a statement linking the concept to the corresponding group is also added via an applied template. These templates are below:

GEMET Backbone XSLT: templates generating semantic relation statements

```
<xsl:template match="broader-term">
   <xsl:variable name="id" select="@desc-ref-id"/>

   <skos:broader rdf:resource="c_{$id}"/>

</xsl:template>

<xsl:template match="narrower-term">
   <xsl:variable name="id" select="@desc-ref-id"/>

   <skos:narrower rdf:resource="c_{$id}"/>

</xsl:template>

<xsl:template match="group" mode="relation">
   <xsl:variable name="id" select="@group-id"/>

   <gemet:broaderGroup rdf:resource="g_{$id}"/>

</xsl:template>

<xsl:template match="theme" mode="relation">
   <xsl:variable name="id" select="@theme-id"/>

   <gemet:broaderTheme rdf:resource="t_{$id}"/>

</xsl:template>
```

Finally the 'descriptor-related' template generates skos:related statements:

GEMET Backbone XSLT: 'descriptor-related' template

```
<xsl:template match="descriptor-related">
   <xsl:variable name="id" select="@desc-ref-id"/>
   <xsl:variable name="rid" select="@rel-desc-ref-id"/>

   <rdf:Description rdf:about="c_{$id}">
     <skos:related rdf:resource="c_{$rid}"/>
   </rdf:Description>

</xsl:template>
```

A snippet of what is generated by the backbone transformation is below:

Snippet of transformation result

```
<rdf:RDF
   xmlns:gemet="http://www.eionet.eu.int/GEMET/skos-ext#"
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xmlns:skos="http://www.w3.org/2004/02/skos/core#"
   xmlns:dc="http://purl.org/dc/elements/1.1/"
   xml:base="http://www.eionet.eu.int/GEMET/" >

   <skos:Concept rdf:about="c_204">
```

```
    <skos:inScheme rdf:resource="http://www.eionet.eu.int/GEMET"/>
    <skos:narrower rdf:resource="c_10217"/>
    <skos:broader rdf:resource="c_4648"/>
    <gemet:broaderTheme rdf:resource="t_23"/>
    <gemet:broaderTheme rdf:resource="t_2"/>
  </skos:Concept>
  ...
  <gemet:Group rdf:about="g_7007">
    <gemet:subGroupOf rdf:resource="sg_4044"/>
    <skos:inScheme rdf:resource="http://www.eionet.eu.int/GEMET"/>
  </gemet:Group>
  ...
  <gemet:SuperGroup rdf:about="sg_5499">
    <skos:inScheme rdf:resource="http://www.eionet.eu.int/GEMET"/>
  </gemet:SuperGroup>
  ...
  <gemet:Theme rdf:about="t_2">
    <skos:inScheme rdf:resource="http://www.eionet.eu.int/GEMET"/>
  </gemet:Theme>
  ...
</rdf:RDF>
```