WP2: PMKI core data model and extensions

Project Deliverable D2.3:
Documentation of the PMKI data model

PMKI–Public Multilingual Knowledge Infrastructure

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0.5	31/10/2017	Armando Stellato	Draft for Finalization * removal of the legacy Lemon model * updated references * added "Other Vocabularies" section
0.4	24/10/2017		Feedback
0.3	03/10/2017	Armando Stellato	Review and Update
0.2	26/04/2017	Najeh Hajlaoui	Review
0.1	19/04/2017	Brahim Batouche	First version

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[1] SharePoint accessible from OP environment.

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1. INTRODUCTION

According to the literature presented and the analysis carried out in delivery D 2.2, the OntoLex-Lemon suite of ontologies is the best candidate model for PMKI project. This ontology suite builds on top of and improves the original Lemon ontologies and introduces reuse of SKOS for the management of conceptual information in lexical resources.

We present in this delivery the documentation of PMKI data model describing its classes, its object properties, and its data properties. The public documentations of Skos[2], Lemon[3], and OntoLex core[4] are created with LODE service[5], where OntoLex core documentation describes the basic classes and properties of the core module of the suite. The OntoLex suite is composed of different modules: OntoLex core, syntax/semantic[6], decomposition[7], variation/transformation[8], metadata (lime)[9]. Also, more modules (such as the lexicography one) are being discussed within the OntoLex community at the time of writing, and will be probably developed in the near future, while others (such as the metadata one) might evolve, reflecting these additions or the changes and improvements brought to the rest of the suite. The documentation of OntoLex-lemon[10] gives a large description with example of these modules[11].

This delivery is composed into five sections, where the section 2 gives the documentation of Skos ontology. In section 3 we give documentation of Lemon ontology. In section 4 we give documentation of OntoLex modules. We conclude in section 5.

2. SKOS

SKOS (Simple Knowledge Organization System, (World Wide Web Consortium (W3C), 2009)) is an area of work developing specifications and standards to support the use of knowledge organization systems (KOS) such as thesauri, classification schemes, subject heading systems and taxonomies within the framework of the Semantic Web (Figure **1**).

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[2] http://www.essepuntato.it/lode/reasoner/http://www.w3.org/2004/02/skos/core#

[3] http://www.essepuntato.it/lode/reasoner/http://www.lemon-model.net/lemon#

[4] http://www.essepuntato.it/lode/http://www.w3.org/ns/lemon/ontolex#

[5] http://www.essepuntato.it/lode

[6] http://www.essepuntato.it/lode/http://www.w3.org/ns/lemon/synsem#

[7] http://www.essepuntato.it/lode/http://www.w3.org/ns/lemon/decomp#

[8] http://www.essepuntato.it/lode/http://www.w3.org/ns/lemon/vartrans#

[9] http://www.essepuntato.it/lode/http://www.w3.org/ns/lemon/lime#

[10] https://www.w3.org/2016/05/ontolex/

[11] Each modules has its proper prefix: ontolex: http://www.w3.org/ns/lemon/ontolex#, synsem: http://www.w3.org/ns/lemon/synsem#, decomp: http://www.w3.org/ns/lemon/decomp#, vartrans: http://www.w3.org/ns/lemon/vartrans#, lime: http://www.w3.org/ns/lemon/lime#.
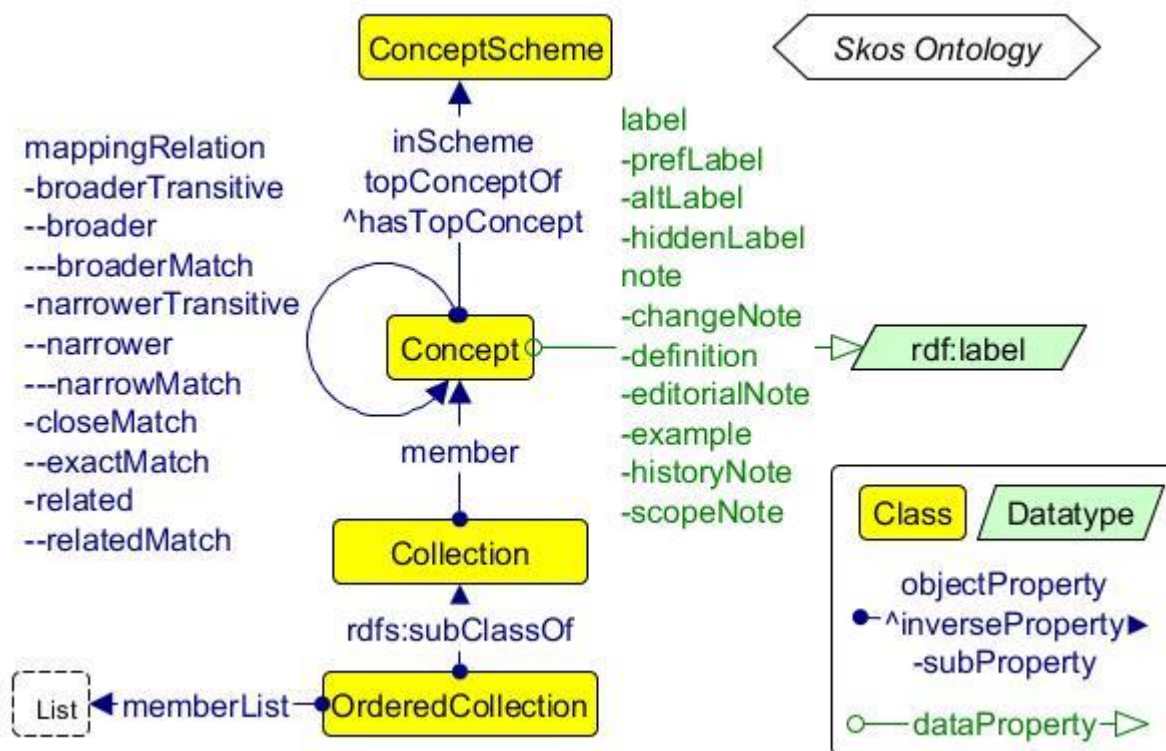

Figure 1 Skos ontology

2.1. Classes

The SKOS classes treat the KOS, and they are Concept, Collection, Order Collection and Concept Scheme.

Class	Label	Comment
Concept	Concept	
Collection	Collection	
OrderCollection	Order Collection	
ConceptScheme	Concept Scheme	

2.2. Object Properties

The object properties of SKOS describe the characteristic link of the previous classes.

Property	Label	Comment
broader	has broader	Broader concepts are typically rendered as parents in a concept hierarchy (tree).
broadMatch	has broader match	broadMatch is usually adopted to describe cross-thesauri broader relationships
broaderTransitive	has broader transitive	A superproperty of broader representing the transitive closure of the broader relation

`closeMatch`	has close match	A cross-thesauri relation stating the closeness of two concepts
`exactMatch`	has exact match	A cross-thesauri relation relating two skos concepts which, though being different resources in the RDF semantics, express de facto the same concept in the domain of discourse
`member`	has member	A property listing the concepts belonging to certain collection
`memberList`	has member list	
`narrower`	has narrower	Narrower concepts are typically rendered as children in a concept hierarchy (tree).
`narrowerMatch`	has narrower match	
`narrowerTransitive`	has narrower transitive	Inverse of `broaderTransitive`
`related`	has related	skos:related is disjoint with skos:broaderTransitive
`relatedMatch`	has related match	A cross-thesauri relation for related concepts
`hasTopConcept`	has top concept	A property listing the top concepts for a given scheme (subject of the triple)
`mappingRelation`	is in mapping relation with	These concept mapping relations mirror semantic relations, and the data model defined below is similar (with the exception of skos:exactMatch) to the data model defined for semantic relations. A distinct vocabulary is provided for concept mapping relations, to provide a convenient way to differentiate links within a concept scheme from links between concept schemes. However, this pattern of usage is not a formal requirement of the SKOS data model, and relies on informal definitions of best practice.
`inScheme`	is in scheme	A property relating concepts with the scheme(s) they belong to. Note that this property is not inherited across concept hierarchies
`semanticRelation`	is in semantic relation with	An (intended to be) abstract property subsuming all semantic relations in the skos vocabulary
`topConceptOf`	is top concept in scheme	Inverse of `hasTopConcept`

2.3. Data properties

The data properties of SKOS provide attributes for previous classes.

Data property	Label	Comment
notation	notation	This property is mainly used to describe legacy ID codes adopted for identifying resources in the pre-RDF version of the thesaurus. Legacy codes are usually associated to dedicated Datatypes.
altLabel	alternative label	The range of skos:altLabel is the class of RDF plain literals. This property lists alternative lexicalizations used to describe resources in a thesaurus, other than their preferred label.
changeNote	change note	An type of note, describing changes brought to the subject resource
definition	definition	A definition for the subject resource
editorialNote	editorial note	This property provides notes scoping out of the semantics of the resource, and addressing instead its role as a resource in the thesaurus, from the editorial point of view
example	example	A property reporting real use cases for the adoption of a concept, usually in natural language
hiddenLabel	hidden label	The range of skos:hiddenLabel is the class of RDF plain literals.
historyNote	history note	A particular kind of note, very similar to an editorial note, but focused on the evolution of the described resource
note	note	An (intended to be) abstract property, subsuming the various types of notes in skos
prefLabel	preferred label	A resource has no more than one value of skos:prefLabel per language tag, and no more than one value of skos:prefLabel without language tag.
scopeNote	scope note	

3. ONTOLEX-LEMON

The OntoLex-Lemon (Cimiano, McCrae, & Buitelaar, 2016) model is the result of the conjoint effort of several researchers participating in the OntoLex W3C Community Group. The realization of the model started from the original LEMON model by (McCrae, Spohr, & Cimiano, 2011), described in the previous section; later development has then been informed by other models realized by the members of the community (Cimiano, Buitelaar, McCrae, & Sintek, 2011; Pazienza, Stellato, & Turbati, Linguistic Watermark 3.0: an RDF framework and a software library for bridging language and ontologies in the Semantic Web, 2008; Montiel-Ponsoda, Aguado de Cea, Gómez-Pérez, & Peters, Enriching ontologies with multilingual information, 2011; Francopoulo, et al., 2006)

The OntoLex-Lemon suite is composed of a set of modules, namely:

- OntoLex core[12],
- Syntax/semantic[13],
- Decomposition[14],
- Variation/transformation[15],
- Metadata (lime)[16],

All of the modules may be imported all together from the collection-profile lemon-all[17].

The following subsections give the documentation of the syntax/semantic, decomposition, and variation and transformation modules. These modules are inspired from Lemon ontology, in adding some classes/properties, where the following Figure illustrates all the modules in specifying the prefix.

The full specification of the OntoLex suite of ontologies revolving around the Lemon model is available here https://www.w3.org/2016/05/ontolex/

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[12] http://www.w3.org/ns/lemon/ontolex#

[13] http://www.w3.org/ns/lemon/synsem#

[14] http://www.w3.org/ns/lemon/decomp#

[15] http://www.w3.org/ns/lemon/vartrans#

[16] http://www.w3.org/ns/lemon/lime#

[17] http://www.w3.org/ns/lemon/all

Lemon-ontolex Ontology

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3.1. OntoLex core
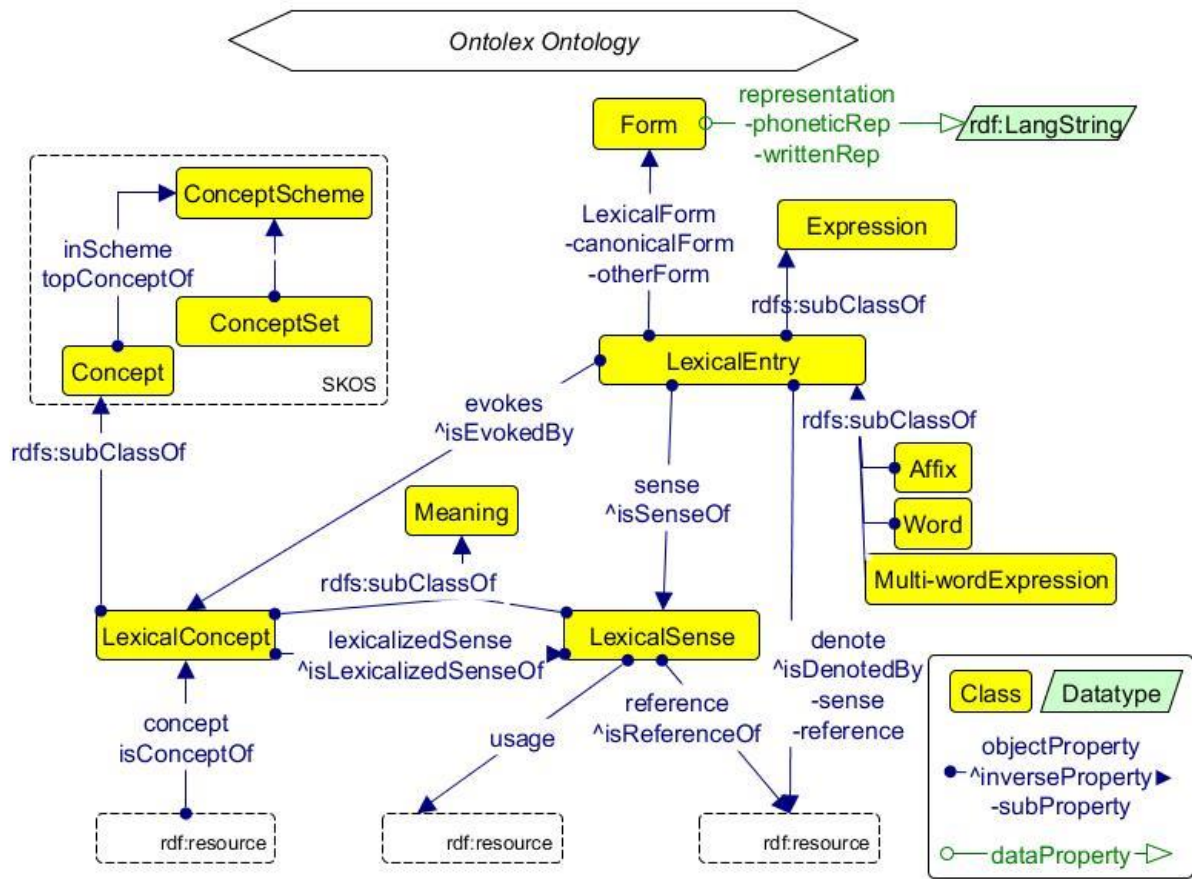
Figure 2 OntoLex Ontology

3.1.1. Classes

Class	Label	Comment
Affix	Affix	An affix is a lexical entry that represents a morpheme (suffix, prefix, infix, circumfix) that is attached to a word stem to form a new word.
Concept	Concept	
ConceptScheme	Concept scheme	
conceptSet	Concept set	A concept set represents a collection of lexical concepts
Expression	Expression	
Form	Form	A form represents one grammatical realization of a lexical entry.
LexicalConcept	Lexical concept	A lexical concept represents a mental abstraction, concept or unit of thought that can be lexicalized by a given collection of senses.
LexicalEntry	Lexical entry	A lexical entry represents a unit of analysis of the lexicon that consists of a set of forms that are

		grammatically related and a set of base meanings that are associated with all of these forms. Thus, a lexical entry is a word, multiword expression or affix with a single part-of-speech, morphological pattern, etymology and set of senses.
LexicalSense	Lexical sense	A lexical sense represents the lexical meaning of a lexical entry when interpreted as referring to the corresponding ontology element. A lexical sense thus represents a reification of a pair of a uniquely determined lexical entry and a uniquely determined ontology entity it refers to. A link between a lexical entry and an ontology entity via a Lexical Sense object implies that the lexical entry can be used to refer to the ontology entity in question.
Meaning	Meaning	
MultiWordExpression	Multi-word expression	A multiword expression is a lexical entry that consists of two or more words.
Word	Word	A word is a lexical entry that consists of a single token.

3.1.2. *Object properties*

Object property	Label	Comment
CanonicalForm	Canonical form	The 'canonical form' property relates a lexical entry to its canoncical or dictionary form. This usually indicates the "lemma" form of a lexical entry.
concept	Concept	The 'concept' property relates an ontological entity to a lexical concept that represents the corresponding meaning.
denote	Denote	The 'denotes' property relates a lexical entry to a predicate in a given ontology that represents its meaning and has some denotational or model-theoretic semantics.
evokes	Evokes	The 'evokes' property relates a lexical entry to one of the lexical concepts it evokes, i.e. the mental concept that speakers of a language might associate when hearing the lexical entry.
inScheme	In scheme	
isConceptOf	Is concept of	This property formalizes the meaning of a Lexical Concept by linking it to a particular ontological meaning.
isDenotedBy	Is denoted by	The object property isDenotedBy is the inverse of the object property denotes.

IsEvokedBy	Is evoked by	The inverse relation to evokes.
isLexicalizedSenseOf	Is lexicalized sense of	The object property isLexicalizedSenseOf is the inverse property of lexicalized sense.
isReferenceOf	Is reference of	The object property isReferenceOf is the inverse property of reference.
isSenseOf	Is sense of	The property isSenseOf is the inverse property of sense.
lexicalForm	Lexical form	The 'lexical form' property relates a lexical entry to one grammatical form variant of the lexical entry.
Lexicalized sense	Lexicalized Sense	The 'lexicalized sense' property relates a lexical concept to a corresponding lexical sense that lexicalizes the concept
morphologicalPattern	Morphological pattern	The 'morphological pattern' property indicates the morphological class of a word.
otherForm	Other form	The 'other form' property relates a lexical entry to a non-preferred ("non-lemma") form that realizes the given lexical entry.
reference	Reference	The 'reference' property relates a lexical sense to an ontological predicate that represents the denotation of the corresponding lexical entry.
sense	Sense	The 'sense' property relates a lexical entry to one of its lexical senses.
usage	Usage	The 'usage' property indicates usage conditions or pragmatic implications when using the lexical entry to refer to the given ontological meaning.

3.1.3. *Data properties*

Data property	Label	Comment
PhoneticRep	Phonetic representation	The 'phonetic representation' property indicates one phonetic representation of the pronunciation of the form using a scheme such as the International Phonetic Alphabet (IPA).
representation	Representation	The 'representation' property indicates a string by which the form is represented according to some orthography.
writtenRep	Written representation	The 'written representation' property indicates the written representation of a form.

3.2. Synsem

3.2.1. *Class*

Class	label	comment
OntoMap	ontology mapping	An 'ontology mapping' (OntoMap for short) specifies how a syntactic frame and its syntactic arguments map to a set of concepts and properties in the ontology that together specify the meaning of the syntactic frame.
SyntacticArgument	syntactic argument	A 'syntactic argument' represents a slot that needs to be filled for a certain syntactic frame to be complete. Syntactic arguments typically realize a certain grammatical function (e.g. subject, direct object, indirect object, prepositional object, etc.).
SyntacticFrame	SyntacticFrame	A 'syntactic frame' represents the syntactic behavior of an open class word in terms of the (syntactic) arguments it requires. It essentially describes the so called subcategorization structure of the word in question, in particular the syntactic arguments it requires.

3.2.2. *Object property*

Object property	label	comment
condition	condition	The 'condition' property defines an evaluable constraint that derives from using a certain lexical entry to express a given ontological predicate.
isA	instansie van	The 'is a' property represents the single argument of a class or unary predicate.
marker	marker	The 'marker' property

		indicates the marker of a syntactic argument; this can be a case marker or some other lexical entry such as a preposition or particle.
`objOfProp`	object of property	The 'objOfProp' represents the 2nd argument or object of a binary predicate (property) in the ontology.
`ontoCorrespondence`	ontological correspondence	The 'ontoCorrespondence' property binds an argument of a predicate defined in the ontology to a syntactic argument that realizes this predicate argument syntactically.
`ontoMapping`	Ontologie abbildung	The 'ontoMapping' property relates an ontology mapping to its corresponding lexical sense.
`propertyDomain`	Property domain	'Property domain' provides a pragmatic restriction on the domain of the property referred to by this sense.
`propertyRange`	Property range	'Property domain' provides a pragmatic restriction on the range of the property referred to by this sense.
`subjOfProp`	Subject Of Property	The 'subjOfProp' property represents the 1st argument or subject of a binary predicate (property) in the ontology.
`submap`	submap	The 'submap' property relates a (complex) ontological mapping to a set of bindings that together bind the arguments of the involved predicates to a set of syntactic arguments that realize them syntactically.
`synArg`	syntactic argument	The object property synArg relates a syntactic frame to one of its syntactic arguments.
`synBehavior`	syntactic behavior	The 'syntactic behavior' property relates a lexical

		entry to one of its syntactic behaviors as captured by a syntactic frame.

3.2.3. *Data property*

Data property	label	comment
optional	optional	The 'optional' property indicates whether a syntactic argument is optional, that is, it can be syntactically omitted.
topDataProperty	Top data property	

3.3. Decomp

3.3.1. *Class*

Class	label	comment
Component	Component	A component is a particular realization of a lexical entry that forms part of a compound lexical entry.

3.3.2. *Object property*

Object property	label	comment
constituent	constituent	The property 'constituent' relates a lexical entry or component to a component that it is constituted by.
correspondsTo	Corresponds to	The property 'correspondsTo' links a component to a corresponding lexical entry or argument.
subterm	subterm	The property 'subterm' relates a compound lexical entry to one of the lexical entries it is composed of.

3.4. Vartrans

3.4.1. *Class*

class	label	comment
ConceptualRelation	Conceptual relation	A relationship between two

		concepts
`LexicalRelation`	Lexical relation	A 'lexical relation' is a lexico-semantic relation that represents the relation between two lexical entries the surface forms of which are related grammatically, stylistically or by some operation motivated by linguistic economy.
`LexicoSemanticRelation`	Lexico-semantic relation	A 'lexico-semantic relation' represents the relation between two lexical entries or lexical senses that are related by some lexical or semantic relationship.
`SenseRelation`	sense relation	A 'sense relation' is a lexico-semantic relation that represents the relation between two lexical senses the meanings of which are related.
`TerminologicalRelation`	terminological relation	A 'terminological relation' is a sense relation that relates two lexical senses of terms that are semantically related in the sense that they can be exchanged in most contexts, but their surface forms are not directly related. The variants vary along dimensions that are not captured by the given ontology and are intentionally (pragmatically) caused.
`Translation`	translation	A 'translation' is a 'sense relation' expressing that two lexical senses corresponding to two lexical entries in different languages can be translated to each other without any major meaning shifts.
`TranslationSet`	Translation set	A 'translation set' is a set of translations that have some common source.

3.4.2. *Object property*

Object property	label	comment
category	category	The 'category' property indicates the specific type of relation by which two lexical entries or two lexical senses are related.
conceptRel	Concept relation	A relationship between two concepts
lexicalRel	Lexical Relation	The 'lexicalRel' property relates two lexical entries that stand in some lexical relation.
relates	relates	The 'relates' property links a lexico-semantic relation to the two lexical entries or lexical senses between which it establishes the relation.
senseRel	Sense relation	The 'senseRel' property relates two lexical senses that stand in some sense relation.
source	source	The 'source' property indicates the lexical sense or lexical entry involved in a lexico-semantic relation as a 'source'.
target	target	The 'target' property indicates the lexical sense or lexical entry involved in a lexico-semantic relation as a 'target'.
translatableAs	Translatable as	The 'translatableAs' property relates a lexical entry in some language to a lexical entry in another language that it can be translated as depending on the particular context and specific senses of the involved lexical entries.
trans	translation	The property 'trans' relates a TranslationSet to one of its translations.
translation	translation	The 'translation' property relates two lexical senses of two lexical entries that stand in a translation relation to

		one another.

3.5. Lime

3.5.1. *class*

Classe	Labelle	Comment
ConceptualizationSet	Conceptualization set	A conceptualization set represents a collection of links between lexical entries in a Lexicon and lexical concepts in a Concept Set they evoke.
LexicalLinkset	Lexical Linkset	A lexical linkset represents a collection of links between a reference dataset and a set of lexical concepts (e.g. synsets of a wordnet).
LexicalizationSet	Lexicalization set	A 'lexicalization set' is a dataset that comprises a collection of lexicalizations, that is pairs of lexical entry and corresponding reference in the associated ontology/vocabulary/dataset.
Lexicon	Lexicon	A lexicon represents a collection of lexical entries for a particular language or domain.

3.5.2. *Object property*

Object property	Label	Comment
conceptualDataset	Conceptual Dataset	The 'conceptual dataset' property relates a lexical link set or a conceptualization set to a corresponding concept set.
entry	entry	The 'entry' property relates a lexicon to one of the lexical entries contained in it.
lexicalizationModel	Lexicalization model	
lexiconDataset	Lexicon dataset	The 'lexicon dataset' property indicates the lexicon that contains the entries refered to in a lexicalization set or a conceptualization set.
linguisticCatalog	Linguistic catalog	The 'linguistic catalog' property indicates the catalog of linguistic categories used in a lexicon to define linguistic properties of lexical entries.

partition	partition	The 'partition' property relates a lexicalization set or lexical linkset to a logical subset that contains lexicalizations for a given ontological type only.
referenceDataset	Reference dataset	The 'reference dataset' property indicates the dataset that contains the domain objects or vocabulary elements that are either referenced by a given lexicon, providing the grounding vocabulary for the meaning of the lexical entries, or linked to lexical concepts in a concept set by means of a lexical link set.
resourceType	resource type	The 'resource type' property indicates the type of ontological entity of a lexicalization set or lexical linkset.

3.5.3. *Data type*

Data type	label	comment
avgAmbiguity	Average ambiguity	The 'average ambiguity' property indicates the average number of lexical concepts evoked by each lemma/canonical form in the lexicon.
avgNumOfLexicalizations	average number of lexicalizations	The 'average number of lexicalizations' property indicates the average number of lexicalizations per ontology element. The exact formula for calculating the average is indicated in the specification: http://www.w3.org/2016/05/ontolex/#lexicalization-set
avgNumOfLinks	average synonymy	The 'average synonymy' property indicates the average number of lexical entries evoking each lexical concept in the concept set.
concepts	concepts	The 'concepts' property indicates the number of lexical concepts defined in a concept set or involved in either a LexicalLinkset or ConceptualizationSet.
conceptualizations	conceptualizations	The 'conceptualizations' property indicates the number of distinct conceptualizations in a conceptualization set.
language	language	The 'language' property indicates the language of a lexicon, a lexical entry, a concept set or a lexicalization set.
lexicalEntries	Lexical entries	The 'lexical entries' property indicates the number of distinct lexical entries contained in a lexicon or lexicalization set.
lexicalizations	lexicalizations	The 'lexicalizations' property indicates the total number of lexicalizations in a lexicalization set,

		that is the number of unique pairs of lexical entry and denoted ontology element.
`links`	links	The 'links' property indicates the number of links between concepts in the concept set and entities in the reference dataset.
`percentage`	percentage	The 'percentage' property expresses the percentage of entities in the reference dataset which have at least one lexicalization in a lexicalization set or are linked to a lexical concept in a lexical linkset.
`references`	references	The 'references' property indicates the number of distinct ontology or vocabulary elements that are either associated with lexical entries via a lexicalization set or linked to lexical concepts via a lexical link set.

4. OTHER VOCABULARIES

As mentioned in D2.2, we will adopt other vocabularies for the representation of users and their actions such as FOAF (Friend Of A Friend Ontology (FOAF)), Dublin Core (DCMI Usage Board, 2012), PROV-O (Provenance Working Group, 2011) and metadata vocabularies such as DCAT and VoID (Alexander, Cyganiak, Hausenblas, & Zhao, 2011) (while LIME (Fiorelli, Stellato, Mccrae, Cimiano, & Pazienza, 2015) has been reported here being part of the OntoLex suite). We do not provide however here a full description of these vocabularies (which is however available online art their respective sources), as they will be adopted only in part, and mostly as application vocabularies by the tools that will be developed in this action, while SKOS and OntoLex-Lemon will be the core content modelling vocabularies.

5. CONCLUSION

We gave in this deliverable the documentation of SKOS and OntoLex/Lemon ontologies. The description of the OntoLex suite of ontologies has been split across it composing modules: ontolex core, syntax/semantic, decomposition, variation/transformation, and metadata (lime) modules.

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