

LexOWL: A Bridge from LexGrid to OWL

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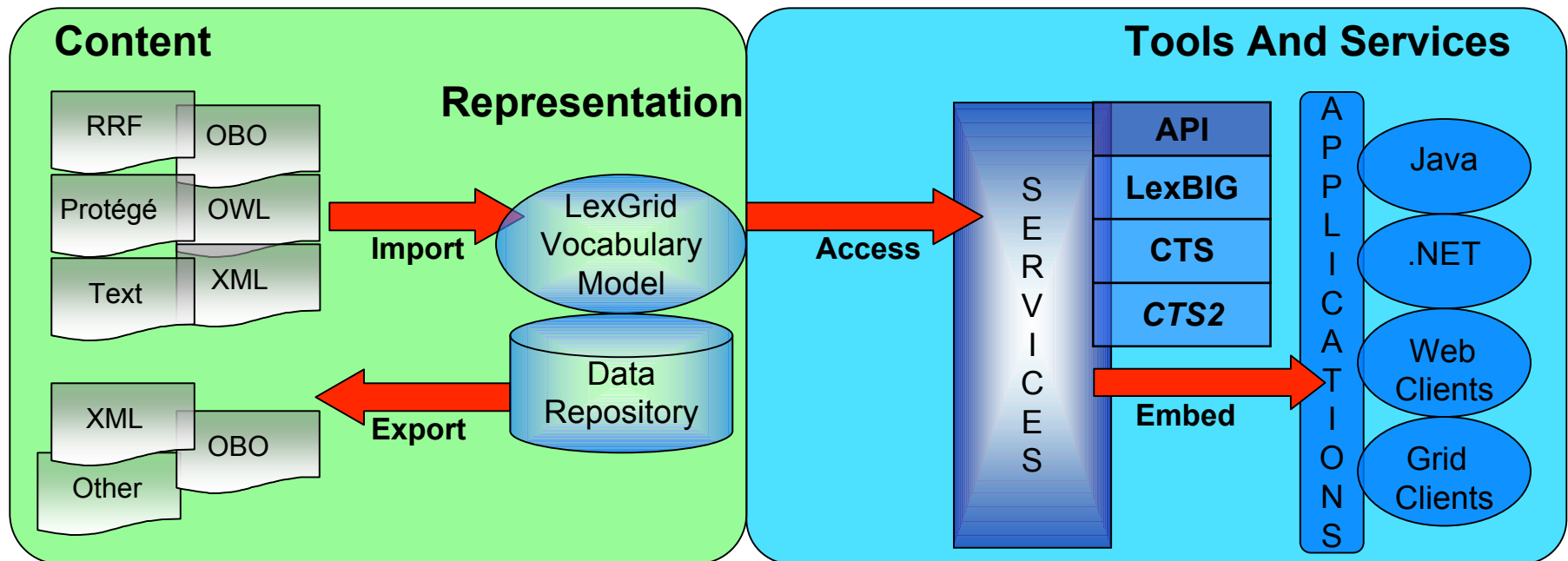
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Introduction

- LexGrid (Lexical Grid) provides
 - A common information model to represent multiple vocabulary/ontology sources
 - A scalable and robust API for accessing such information
- The Semantic Web community provides:
 - OWL: formal, sound, and complete logic-based
 - Tools:
 - Editor: Protégé
 - Reasoner: RACER, FaCT, FaCT++, Pellet

LexGrid Conceptual Overview

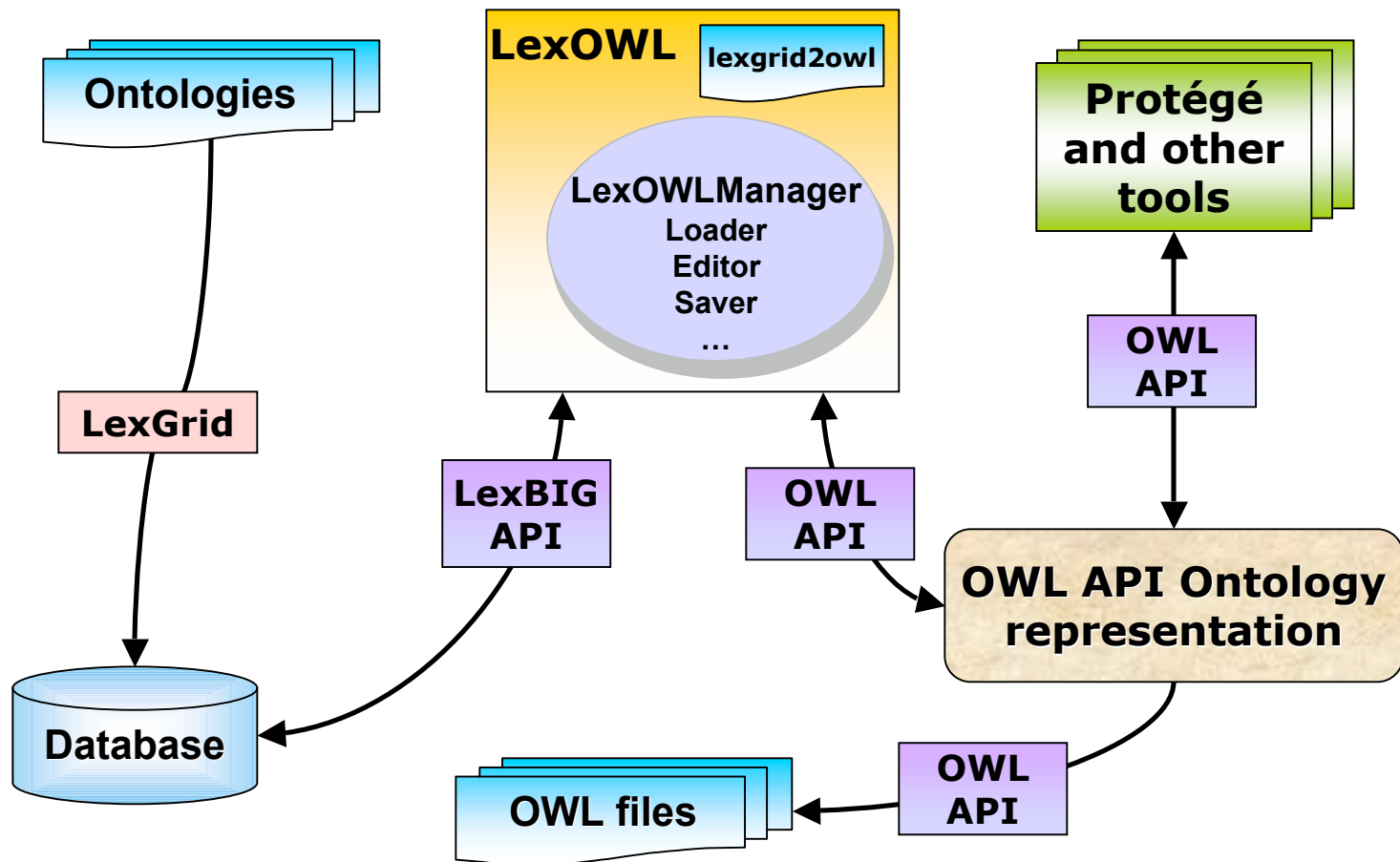


<http://www.lexgrid.org>

LexGrid Model

- CodeScheme
- Entity
 - Concept
 - Association
 - Instance
- Property
 - Presentation
 - Definition
 - Comment

LexOWL Overview



LexOWL Mapping Specification

- LexGrid to OWL mapping
- LexGrid2OWL meta-ontology

LexGrid to OWL Mapping

Ontology Information

LexGrid Element	OWL Element	Comment
approxNumConcepts	lexgrid2owl:approxNumConcepts	domain:Ontology
codingScheme	owl:ontology	
defaultLanguage	xml:lang	
formalName	dc:title	
isNative	lexgrid2owl:native	domain:Ontology
localName	rdfs:label	
registeredName	URI	
representsVersion	owl:versionInfo	
source	dc:source	
copyright	dc:rights	

LexGrid to OWL Mapping

= approxIllumConcepts	40
= codingScheme	generations
= defaultLanguage	en
= formallname	generations
= isIltative	true
= registeredIname	http://www.owl-ontologies.com/generations.owl#
= representsVersion	An example ontology created by Matthew Horridge
Ⓜ IgCommon:entityDescription	generations

Ontology Annotations:	
Annotations	+
native	"1"
label	"generations"
versionInfo	"An example ontology created by Matthew Horridge"
title	"generations"
comment	"generations"
approxNumConcepts	"40"

LexGrid to OWL Mapping Concept

LexGrid Element	OWL Element	Comment
concept	owl:class	
conceptCode	rdf:ID	ID cannot start with numeric and no space
conceptStatus	lexgrid2owl:conceptStatus	
isActive	lexgrid2owl:isActive	
isAnonymous		
isInferred		
isDeclined		
propertyLink		
comment	rdfs:comment	
definition	lexgrid2owl:Definition	OWL class with annotation properties
instruction		
EntityProperty		
presentation	lexgrid2owl:Presentation	OWL class with annotation properties
isPreferred		
degreeOfFidelity		
matchIfNoContext		
representationalForm		

LexGrid to OWL Mapping – Class

```
[Term]
id: TAIR:0000025
name: mid reproductive
def: "middle stages of reproductive phase" [TAIR:lr]
synonym: "principal growth stages 6.1-6.3" []
xref_analog: PMID:11449047
is_a: TAIR:0000306 ? reproductive
```

```
Coding Scheme: arabidopsis_development.ontology
Concept Code: TAIR:0000025
Entity Description: mid reproductive
Is Active: true
Presentation: mid reproductive
  Property Name: textualPresentation
  Property Id: P1
  Is Preferred: true
Presentation: "principal growth stages 6.1-6.3"
  Property Name: synonym
  Property Id: P4
  Is Preferred: false
Definition: middle stages of reproductive phase
  Property Name: definition
  Property Id: P2
  Is Preferred: false
  Source: TAIR , Role: null, SubRef: lr
ConceptProperty: PMID
  Property Name: Database_References
  Property Id: P3
```

LexGrid to OWL Mapping

Coding Scheme: arabidopsis_development.ontology
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Property Name: synonym
Property Id: P4
Is Preferred: false
Definition: middle stages of reproductive phase
Property Name: definition
Property Id: P2
Is Preferred: false
Source: TAIR , **Role:** null, **SubRef:** lr
ConceptProperty: PMID
Property Name: Database_References
Property Id: P3

Class Annotations: TAIR:0000025	
Annotations	
hasDefinition	 definition52
hasPresentation	 presentation106
hasPresentation	 presentation107
label	"mid reproductive"

LexGrid to OWL Mapping

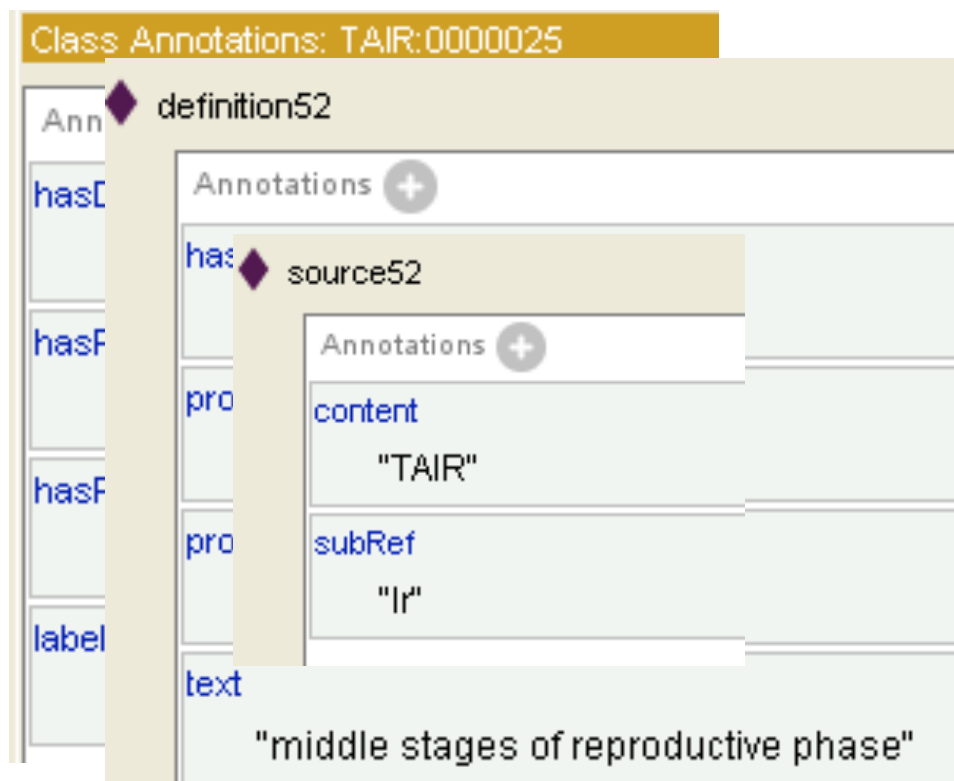
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Is Active: true
Presentation: mid reproductive
 Property Name: textualPresentation
 Property Id: P1
 Is Preferred: true
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 Property Name: synonym
 Property Id: P4
 Is Preferred: false
Definition: middle stages of reproductive phase
 Property Name: definition
 Property Id: P2
 Is Preferred: false
 Source: TAIR , **Role:** null, **SubRef:** lr
ConceptProperty: PMID
 Property Name: Database_References
 Property Id: P3

Class Annotations: TAIR:0000025

Ann	◆ definition52
hasC	Annotations +
hasF	hasSource ◆ source52
hasF	propertyID "P2"
hasF	propertyName "definition"
label	text "middle stages of reproductive phase"

LexGrid to OWL Mapping

Coding Scheme: arabidopsis_development.ontology
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Entity Description: mid reproductive
Is Active: true
Presentation: mid reproductive
 Property Name: textualPresentation
 Property Id: P1
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 Property Name: synonym
 Property Id: P4
 Is Preferred: false
Definition: middle stages of reproductive phase
 Property Name: definition
 Property Id: P2
 Is Preferred: false
 Source: TAIR , **Role:** null, **SubRef:** lr
ConceptProperty: PMID
 Property Name: Database_References
 Property Id: P3



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Property Name: definition
Property Id: P2
Is Preferred: false
Source: TAIR , **Role:** null, **SubRef:** lr
ConceptProperty: PMID
Property Name: Database_References
Property Id: P3

Class Annotations: TAIR:0000025

Annotations +

Constant Individual Property values

presentation106

Annotations +

propertyID	X	o
"P1"		
propertyName	X	o
"textualPresentation"		
text	X	o
"mid reproductive"		

Types +

LexGrid to OWL Mapping

Coding Scheme: arabidopsis_development.ontology
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Entity Description: mid reproductive
Is Active: true
Presentation: mid reproductive
Property Name: textualPresentation
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Property Id: P2
Is Preferred: false
Source: TAIR , **Role:** null, **SubRef:** lr
ConceptProperty: PMID
Property Name: Database_References
Property Id: P3

Class Annotations: TAIR:0000025

Annotations +

ha presentation107

Annotations +

ha propertyID
"P4"

ha propertyName
"synonym"

lak text
""principal growth stages 6.1-6.3""

Types +

LexGrid to OWL Mapping –ConceptProperty

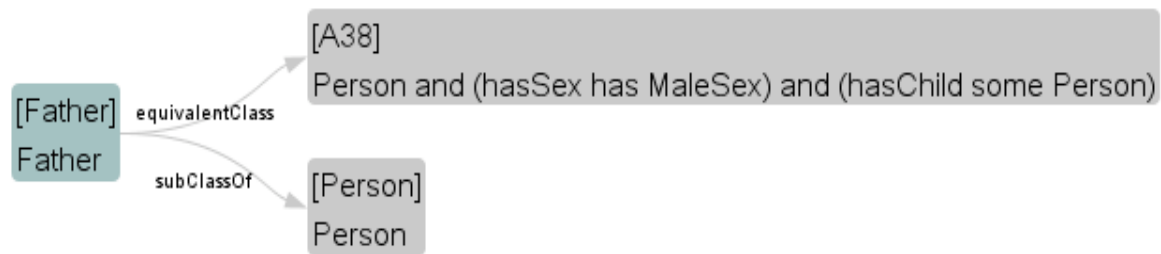
Coding Scheme: pizza -
<http://www.co-ode.org/ontologies/pizza/2005/10/18/pizza.owl#>
Concept Code: A17
Entity Description: Hot or Medium or Mild
Is Active: true
Is Anonymous: true
Presentation: Hot or Medium or Mild
Property Name: textualPresentation
Property Id: P0002
Is Preferred: true
ConceptProperty: owl:unionOf
~~**Property Name:** type~~
~~**Property Id:** P0001~~

Class Description: Spiciness

Equivalent classes 

- Hot
- Medium
- Mild

LexGrid to OWL Mapping – Anonymous Concept



Class Description: Father

Equivalent classes +

- **Person**
and hasChild some Person
and hasSex value MaleSex

Superclasses +

- **Person**

LexGrid to OWL Mapping Association

LexGrid Element	OWL Element'	Comment
association	DatatypeProperty ObjectProperty ¹	
forwardName	rdf:ID rdf:label	
inverse	owl:inverseOf	
isAntiReflexive	lexgrid2owl:antiReflexive	
isAntiSymmetric	lexgrid2owl:antiSymmetric	
isAntiTransitive	lexgrid2owl:antiTransitive	
isFunctional	owl:FunctionalProperty	
isNavigable	lexgrid2owl:navigable	
isReflexive	owl:ReflexiveProperty	
isReverseFunctional	owl:InverseFunctionalProperty	
isSymmetric	owl:SymmetricProperty	
isTransitive	owl:TransitiveProperty	
isTranslationAssociation		
reverseName	lexgrid2owl:reverseName	
associationQualifer		

LexGrid to OWL Mapping – Predefined Association Name

Coding Scheme: pizza -
<http://www.co-ode.org/ontologies/pizza/2005/10/18/pizza.owl#>
Concept Code: RocketTopping
Entity Description: CoberturaRocket
Is Active: true
Is Anonymous: false
Presentation: CoberturaRocket
Property Name: textualPresentation
Property Id: P0001
Is Preferred: true
ConceptProperty: true
Property Name: primitive
Property Id: P0002

Association Graph Association Tree

- [-] CoberturaRocket as association source
 - [-] disjointWith**
 - [SpinachTopping] CoberturaDeEspinafre
 - [PepperTopping] CoberturaDePimentao
 - [OnionTopping] CoberturaDeCebola
 - [PetitPoisTopping] CoberturaPetitPois
 - [OliveTopping] CoberturaDeAzeitona
 - [LeekTopping] CoberturaDeLeek
 - [TomatoTopping] CoberturaDeTomate
 - [MushroomTopping] CoberturaDeCogumelo
 - [AsparagusTopping] CoberturaDeAspargos
 - [CaperTopping] CoberturaDeCaper
 - [GarlicTopping] CoberturaDeAlho
 - [ArtichokeTopping] CoberturaDeArtichoke
 - [-] subClassOf**
 - [VegetableTopping] CoberturaDeVegetais
- [+] hasSpiciness
- [+] CoberturaRocket as association target

Class Description: RocketTopping

Equivalent classes +

Superclasses +

- VegetableTopping
- hasSpiciness some Medium

Inherited anonymous classes

Individuals +

Disjoint classes +

- GarlicTopping
- PetitPoisTopping
- CaperTopping
- MushroomTopping
- ArtichokeTopping
- TomatoTopping
- OnionTopping
- SpinachTopping
- LeekTopping
- AsparagusTopping
- OliveTopping
- PepperTopping

LexGrid to OWL Mapping – Other Associations


Coding Scheme: pizza - <http://www.co-ode.org/ontologies/pizza/2005/10/18/pizza.owl#>
Concept Code: hasTopping
ConceptProperty: false
Property Name: isDatatypeProperty
Property Id: P0015
ConceptProperty: true
Property Name: isObjectProperty
Property Id: P0016

Association Graph Association Tree


- [-] null as association source
 - [-] inverseOf
 - ... [isToppingOf]
 - [-] hasRange
 - ... [PizzaTopping] CoberturaDaPizza
 - [-] hasDomain
 - ... [Pizza] Pizza
 - [-] subPropertyOf
- [-] null as association target
 - [-] inverseOf
 - ... [isToppingOf]

Description: hasTopping

Domains (intersection) +

-  **Pizza**


Ranges (intersection) +

-  **PizzaTopping**

Equivalent object properties +

Super properties +

Inverse properties +

-  **isToppingOf**

Disjoint properties +

Property chains +

LexGrid to OWL Mapping AssociationQualifier

Result Browser

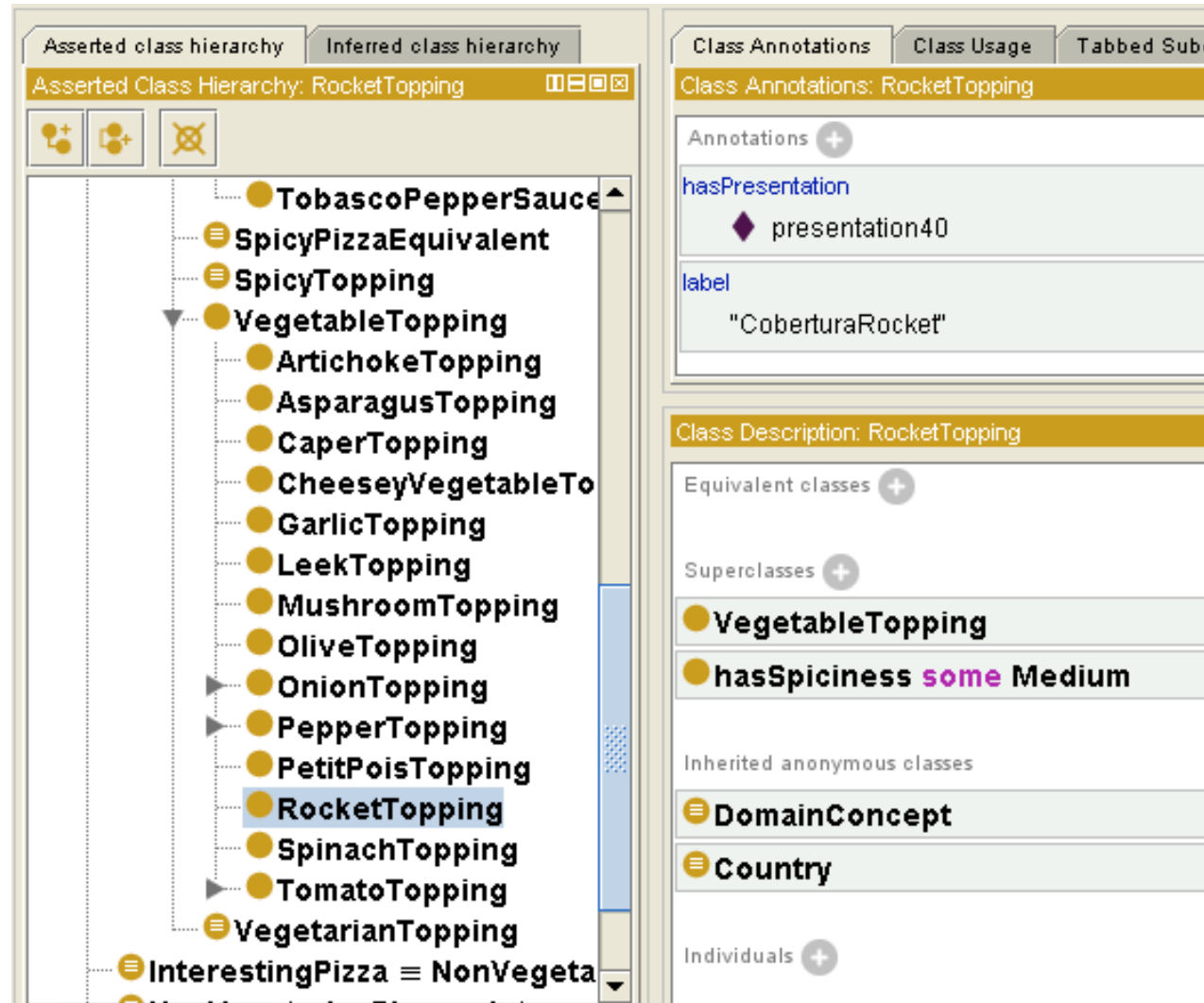
SultanaTopping - CoberturaSultar
FishTopping - CoberturaDePeixe
Veneziana - Veneziana
SpinachTopping - CoberturaDeEsj
ParmesanTopping - CoberturaDef
HamTopping - CoberturaDePresui
Hot - Picante
SundriedTomatoTopping - Cobert
IceCream - Sorvete
HotSpicedBeefTopping - Cobertur
PetitPoisTopping - CoberturaPetit
FourSeasons - QuatroQueijos
ArtichokeTopping - CoberturaDeA
FruttiDiMare - FrutosDoMar
Cajun - Cajun
Country - Pais
MeatyPizza - PizzaDeCarne
LeekTopping - CoberturaDeLeek
Soho - Soho
RocketTopping - CoberturaRocke
HerbSpiceTopping - CoberturaDel
PeperoniSausageTopping - Cober
SpicyPizzaEquivalent - PizzaTemp
RedOnionTopping - CoberturaDet
SpicyPizza - PizzaTemperada
InterestingPizza - PizzaInteressar
Caprina - Caprina
AmericanHot - AmericanaPicante

Coding Scheme: pizza -
<http://www.co-ode.org/ontologies/pizza/2005/10/18/pizza.owl#>
Concept Code: RocketTopping
Entity Description: CoberturaRocket
Is Active: true
Is Anonymous: false
Presentation: CoberturaRocket
Property Name: textualPresentation
Property Id: P0001
Is Preferred: true

Association Graph Association Tree

- [-] CoberturaRocket as association source
 - [+] disjointWith
 - [+] subClassOf
 - [-] hasSpiciness
 - [...] [Medium] Media (:owl:someValuesFrom)
 - [+] CoberturaRocket as association target

LexGrid to OWL Mapping



The screenshot displays a software interface for mapping LexGrid to OWL. It is divided into two main sections: a class hierarchy on the left and a detailed view of the 'RocketTopping' class on the right.

Left Panel: Asserted Class Hierarchy: RocketTopping

- TobascoPepperSauce
- SpicyPizzaEquivalent
- SpicyTopping
- ▼ ● VegetableTopping
 - ArtichokeTopping
 - AsparagusTopping
 - CaperTopping
 - CheeseyVegetableTo
 - GarlicTopping
 - LeekTopping
 - MushroomTopping
 - OliveTopping
 - ▶ ● OnionTopping
 - ▶ ● PepperTopping
 - PetitPoisTopping
 - RocketTopping
 - SpinachTopping
 - ▶ ● TomatoTopping
- VegetarianTopping
- InterestingPizza ≡ NonVegeta

Right Panel: Class Annotations: RocketTopping

Annotations +

- hasPresentation
 - ◆ presentation40
- label
 - "CoberturaRocket"

Class Description: RocketTopping

- Equivalent classes +
- Superclasses +
 - VegetableTopping
 - hasSpiciness some Medium
- Inherited anonymous classes
 - DomainConcept
 - Country
- Individuals +

LexGrid to OWL Mapping

AssociationQualifier

Result Browser

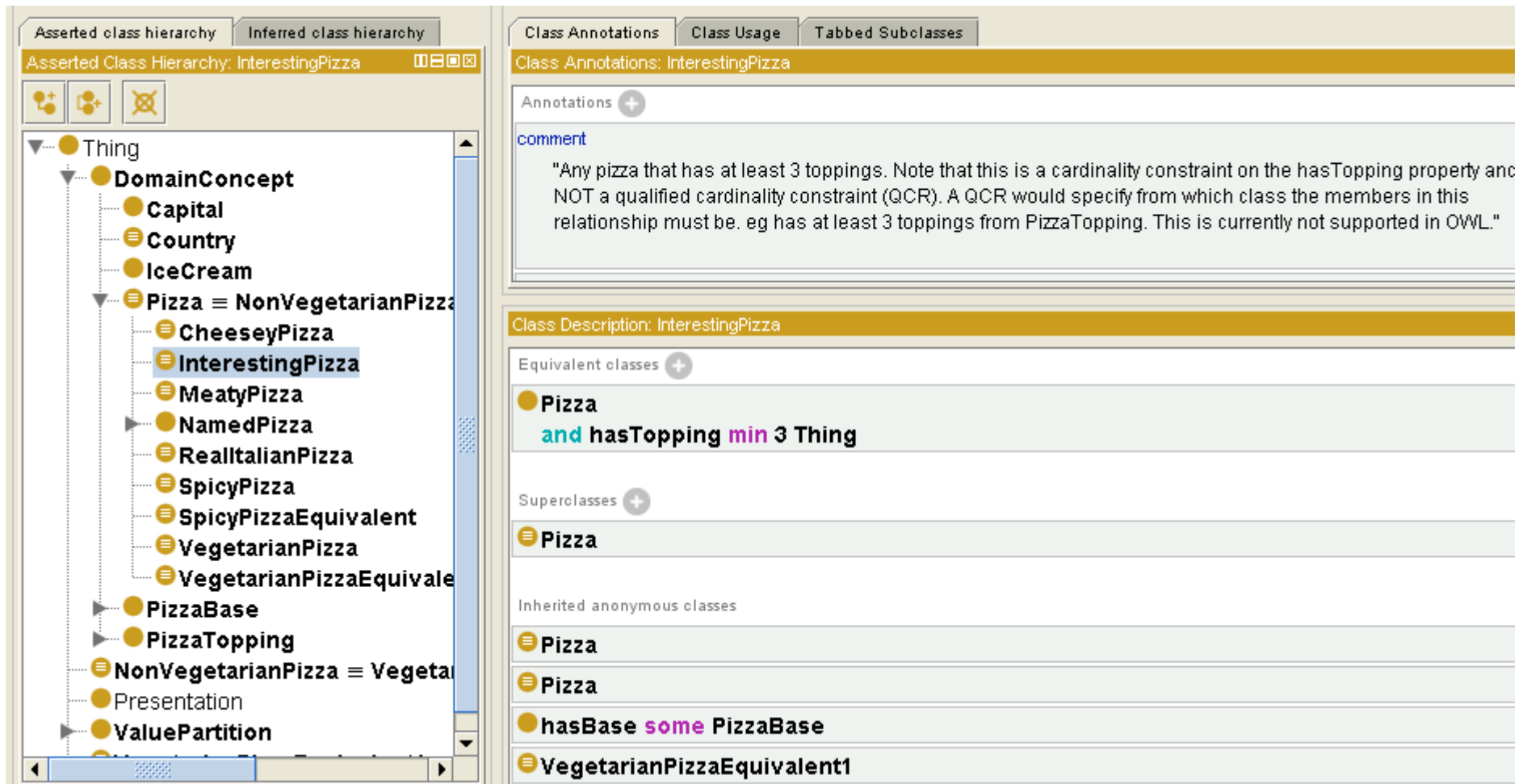
FishTopping - CoberturaDePeixe
 Veneziana - Veneziana
 SpinachTopping - CoberturaDeEsj
 ParmesanTopping - CoberturaDef
 HamTopping - CoberturaDePresu
 Hot - Picante
 SundriedTomatoTopping - Cobert
 IceCream - Sorvete
 HotSpicedBeefTopping - Cobertur
 PetitPoisTopping - CoberturaPetit
 FourSeasons - QuatroQueijos
 ArtichokeTopping - CoberturaDeA
 FruttiDiMare - FrutosDoMar
 Cajun - Cajun
 Country - Pais
 MeatyPizza - PizzaDeCarne
 LeekTopping - CoberturaDeLeek
 Soho - Soho
 RocketTopping - CoberturaRocke
 HerbSpiceTopping - CoberturaDel
 PenneroniSausageTopping - Cober

Coding Scheme: pizza -
<http://www.co-ode.org/ontologies/pizza/2005/10/18/pizza.owl#>
Concept Code: A69
Entity Description: (hasTopping min 3) and Pizza
Is Active: true
Is Anonymous: true
Presentation: (hasTopping min 3) and Pizza
Property Name: textualPresentation
Property Id: P0002
Is Preferred: true

Association Graph Association Tree

- [-] (hasTopping min 3) and Pizza as association source
 - [+] subClassOf
 - [-] hasTopping
 - [...] [3] (:owl:minCardinality)
- [-] (hasTopping min 3) and Pizza as association target
 - [+] equivalentClass

LexGrid to OWL Mapping



The screenshot displays a software interface for class mapping. On the left, the 'Asserted class hierarchy' shows a tree structure starting with 'Thing' and including 'DomainConcept', 'Capital', 'Country', 'IceCream', 'Pizza', and various subtypes like 'CheesyPizza', 'InterestingPizza', 'MeatyPizza', etc. 'InterestingPizza' is highlighted. On the right, the 'Class Annotations' tab for 'InterestingPizza' shows a 'comment' annotation: "Any pizza that has at least 3 toppings. Note that this is a cardinality constraint on the hasTopping property and NOT a qualified cardinality constraint (QCR). A QCR would specify from which class the members in this relationship must be. eg has at least 3 toppings from PizzaTopping. This is currently not supported in OWL." Below this, the 'Class Description' tab shows 'Equivalent classes' including 'Pizza and hasTopping min 3 Thing', 'Superclasses' including 'Pizza', and 'Inherited anonymous classes' including 'Pizza', 'Pizza', 'hasBase some PizzaBase', and 'VegetarianPizzaEquivalent1'.

Evaluation

- Tested using ontologies from various sources:
 - OBO
 - OWL
 - UMLS Semantic Network
 - ICD 10 WHO
- Compared with different tools:
 - Use Protégé Prompt
 - Sampled concepts/associates for large ontologies
 - OBO2OWL, Protégé 3.3.1 OBO to OWL tab, Protégé 4.0 OBO loader
 - UMLS Semantic Network in OWL (Jiménez Ruiz)
 - ICD 10 WHO in OWL (Cardillo)

Evaluation

- OWL:
 - 5 OWL ontologies
 - Focus mostly on OWL Lite
 - LexGrid-generated ontologies are semantically equivalent with the original ontologies
- OBO:
 - 10 OBO ontologies
 - OBO2OWL, Protégé 3.3.1 OBO to OWL tab, Protégé 4.0 OBO loader
 - Semantically identical
 - Lexical information: represent differently

Evaluation

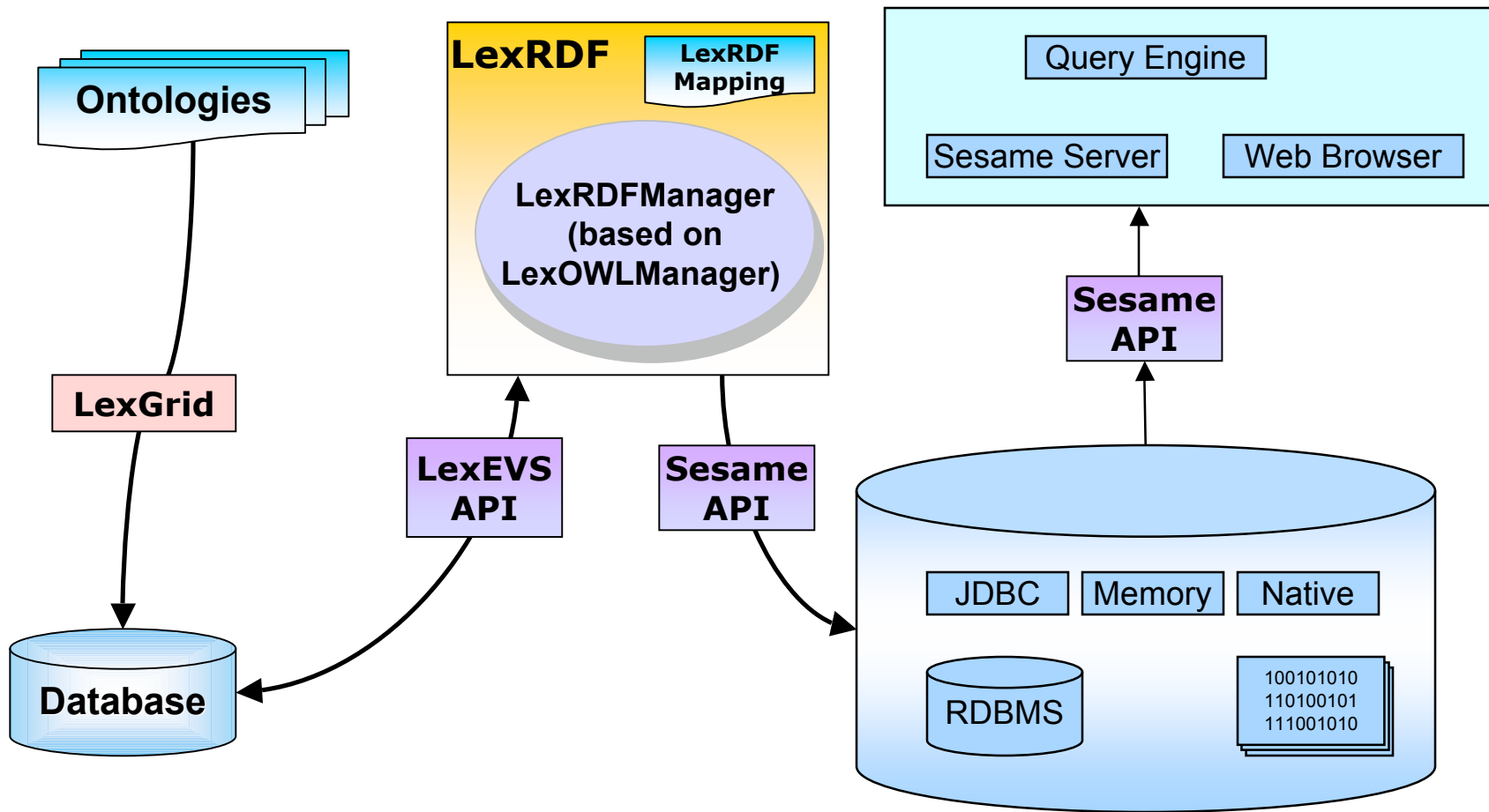
- UMLS Semantic Network
 - Compare with UMLS Semantic Network in OWL (Jiménez Ruiz)
 - Class Hierarchy: identical
 - Class names: UI (LexOWL), Name (Jiménez Ruiz)
 - Relations: classes+objectProperties (LexOWL)
- ICD 10 WHO:
 - Compare with the OWL file converted by Cardillo.
 - Class Hierarchy: identical
 - Exclusions, inclusions are handled as objectProperties (LexOWL)

Future Directions LexRDF

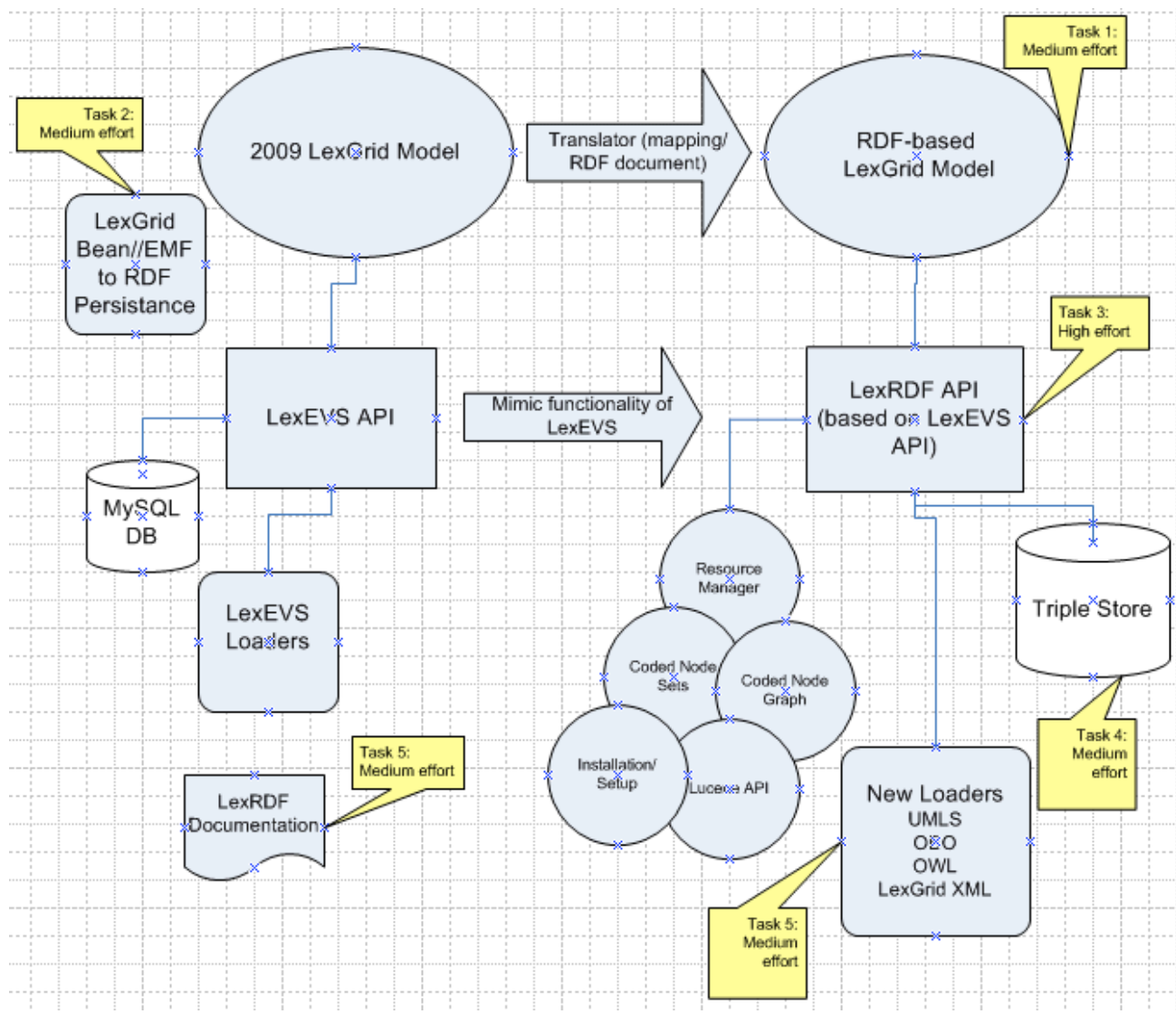
- Extend LexOWL: not only OWL Lite, but OWL full
- Focus more on lexical components
- Provide a grant unified model for the biomedical domain
 - Represent LexGrid model in W3C recommendation standards
 - Propose changes to standards where necessary
- Use a RDF triple store backend
- Provide API with standard tools

LexRDF

Initial implementation



LexRDF Ultimate Implementation



Conclusion

- Functionally connects LexGrid to OWL through an API bridge
- Provides LexGrid an OWL converter with a relatively well-defined interoperability
- Facilitates LexGrid to leverage the services and tools developed for OWL and the Semantic Web directly.

Thank you