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A Common Terminology Services (CTS) Back-end to Protégé

Harold R Solbrig

Christopher G Chute, M.D., Dr. P.H.

Division of Biomedical Informatics

Mayo Clinic

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Outline

- Purpose of the project
- Characteristics of Terminology Links
- The Common Terminology Services (CTS) specification
- Protégé as a CTS Client
- Protégé as a CTS Server
- Issues, discussion and next steps

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Purpose of the Project

1) **Use Protégé to create an interface between** terminology **and the** information model

2) **Use Protégé to extend standard terminologies and (potentially) author new content.**

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Terminology

- **An integrated collection of terms, definitions, annotations, and relationships**
- **Defines the specialized language of a discipline or subject area**

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Terminology and Ontology

Terminology - *Define* the language / tokens used in a given domain

Ontology - *Describe*s domain knowledge in a generic way and provides understanding of a domain*

*Asunción Gómez-Pérez – Tutorial on Ontological Engineering: IJCAI'99

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Information Model

- **Describes what information is required to accomplish a particular task or process**
- **Consists of named collections of data elements and their relationships**
- **Typically includes definitions of each of the elements, how they are used, possible values (at least on a conceptual level)**

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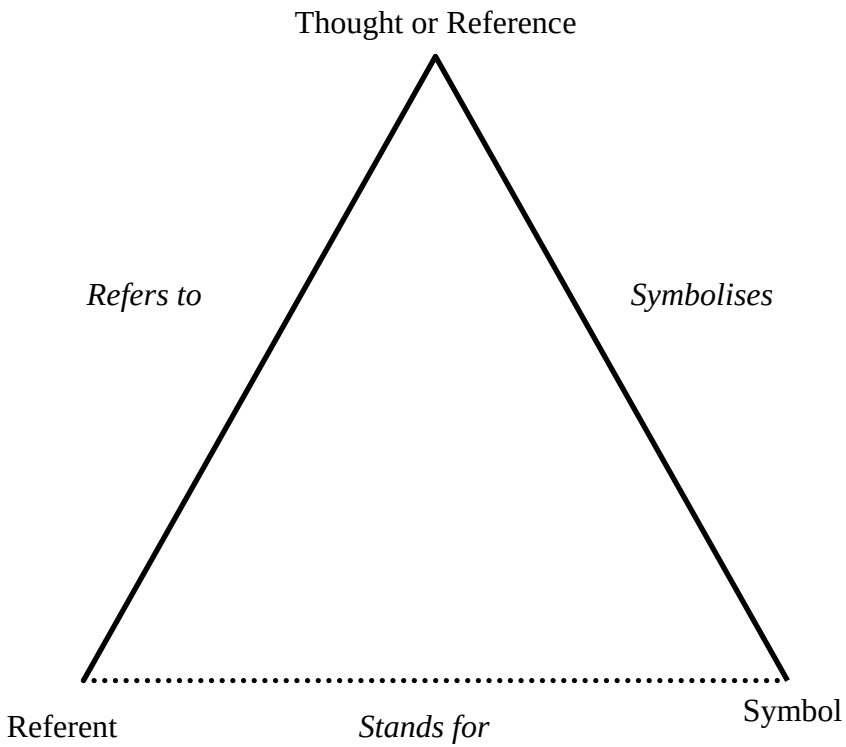
Ogden's Semiotic Triangle



C.K Ogden and I. A. Richards. *The Meaning of Meaning.*

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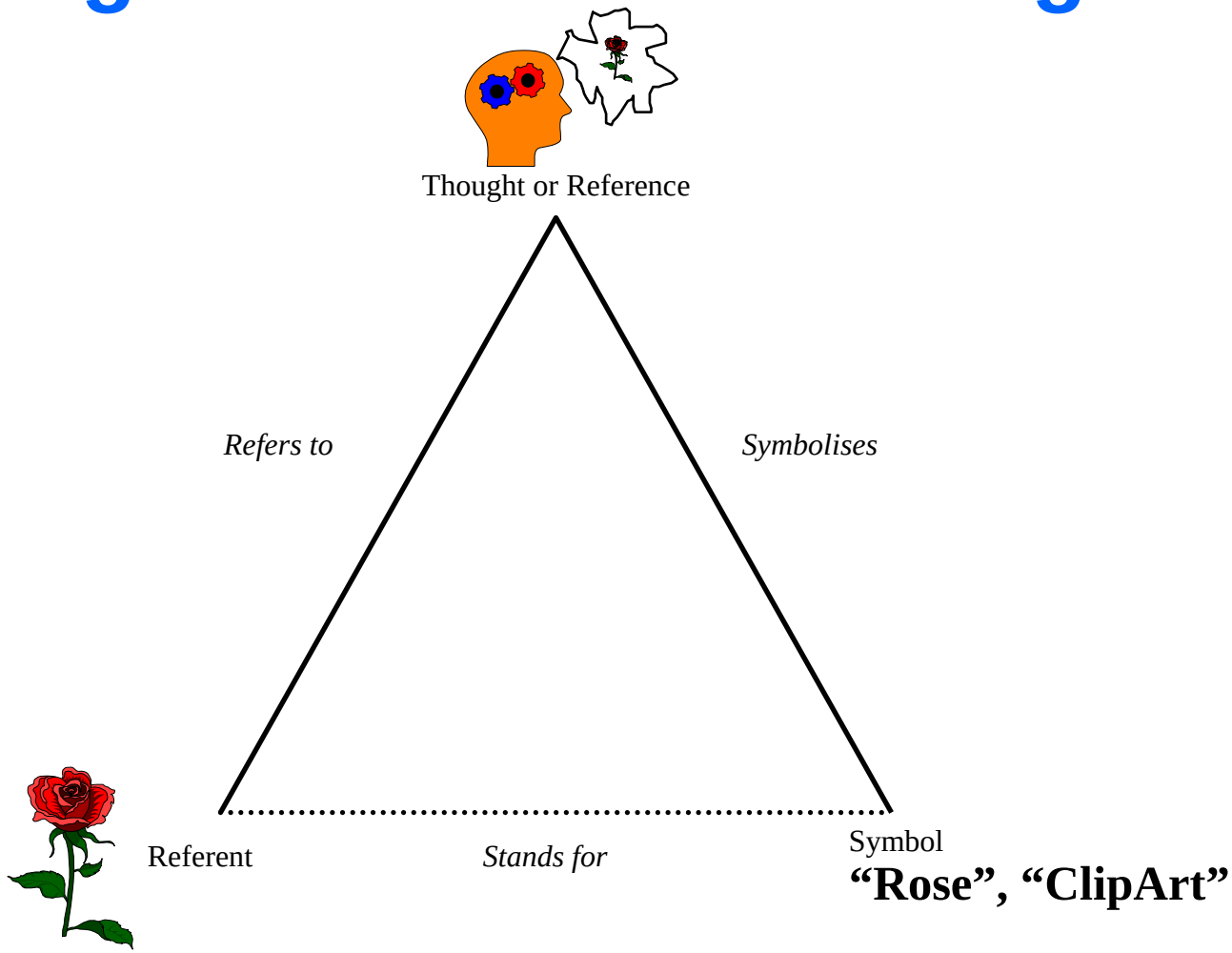

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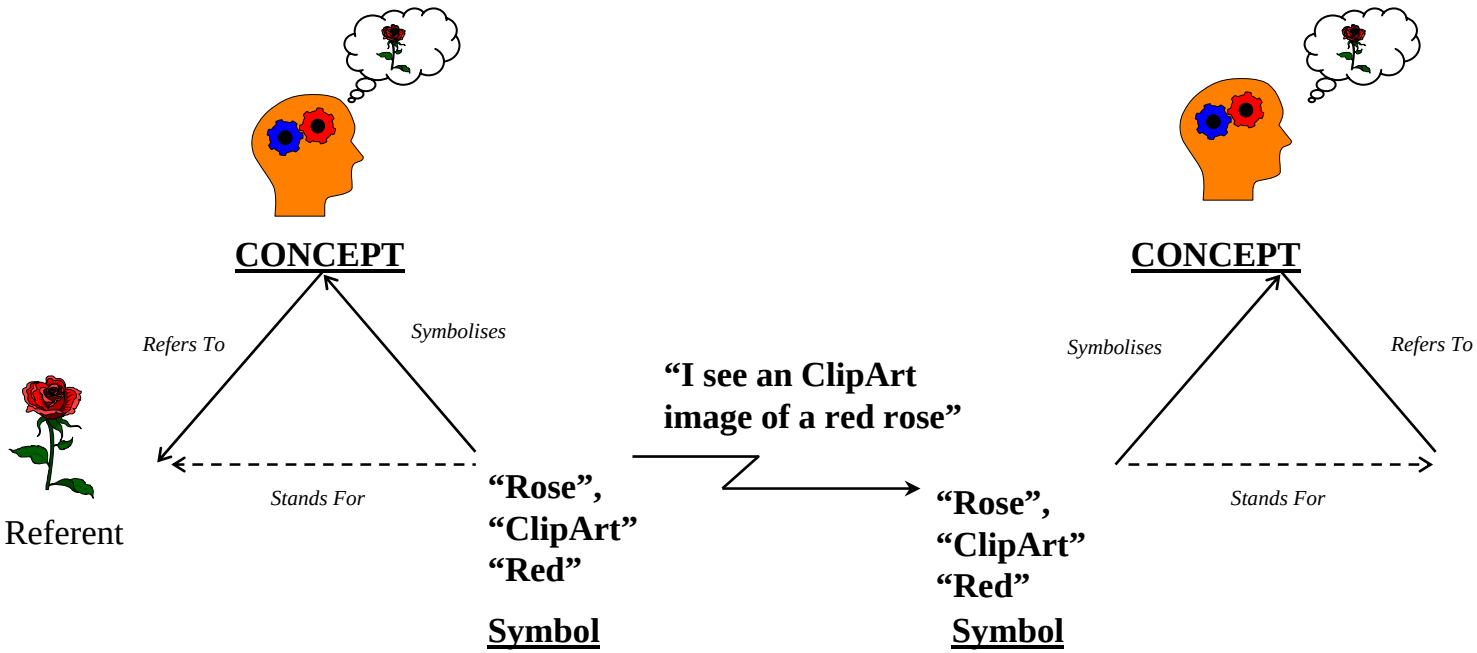
The Communication Process



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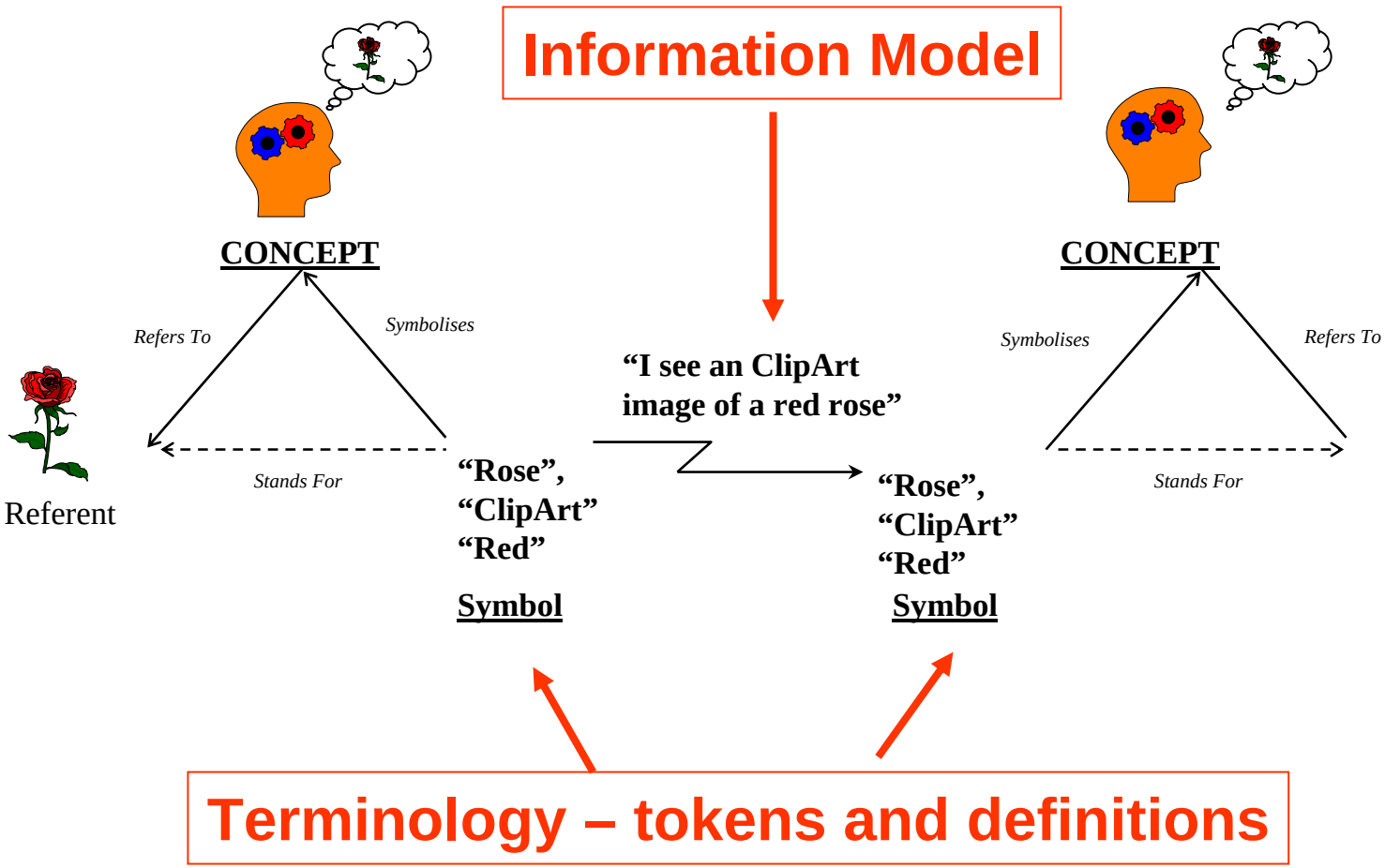
The Communication Process



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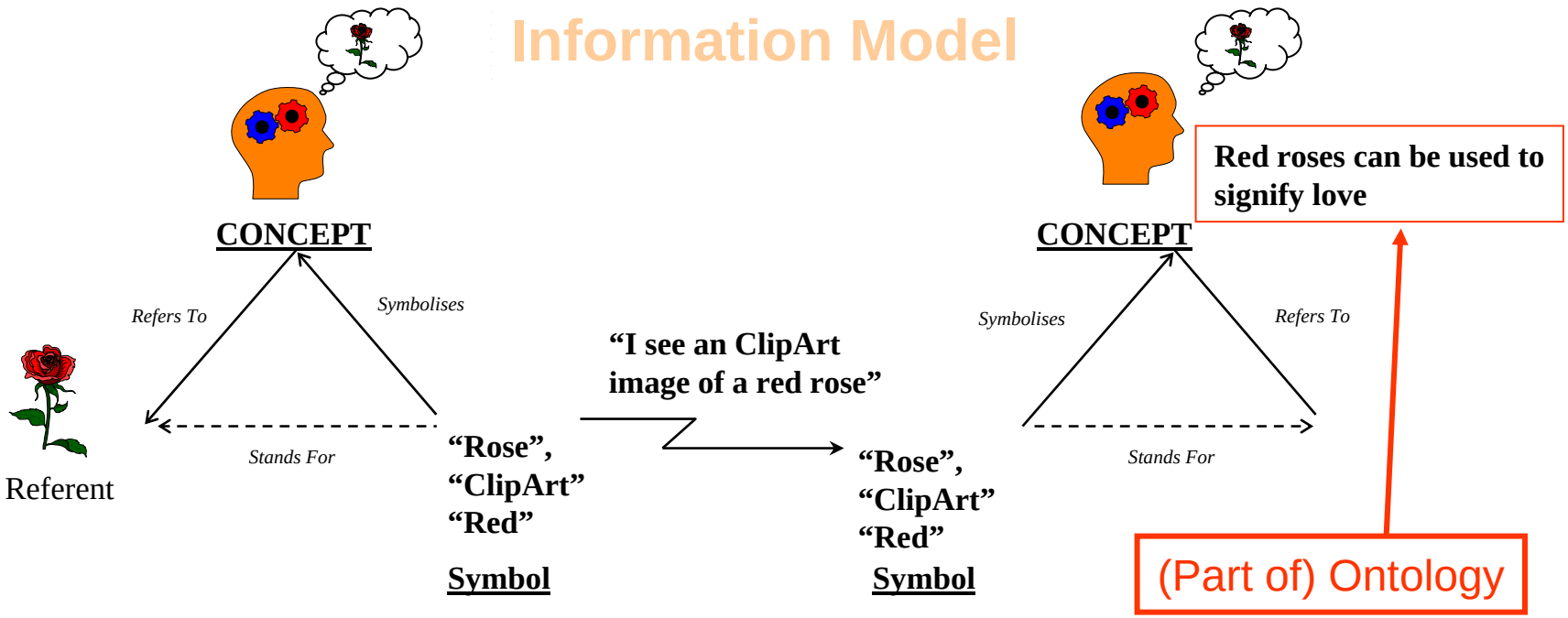
The Communication Process



Terminology – tokens and definitions

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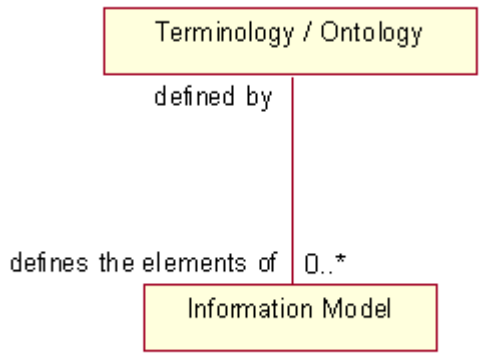
Terminology and Information Models

- There can be many information models that reference the same terminology
- It is the shared terminological references that allows be searched, compare aggregated



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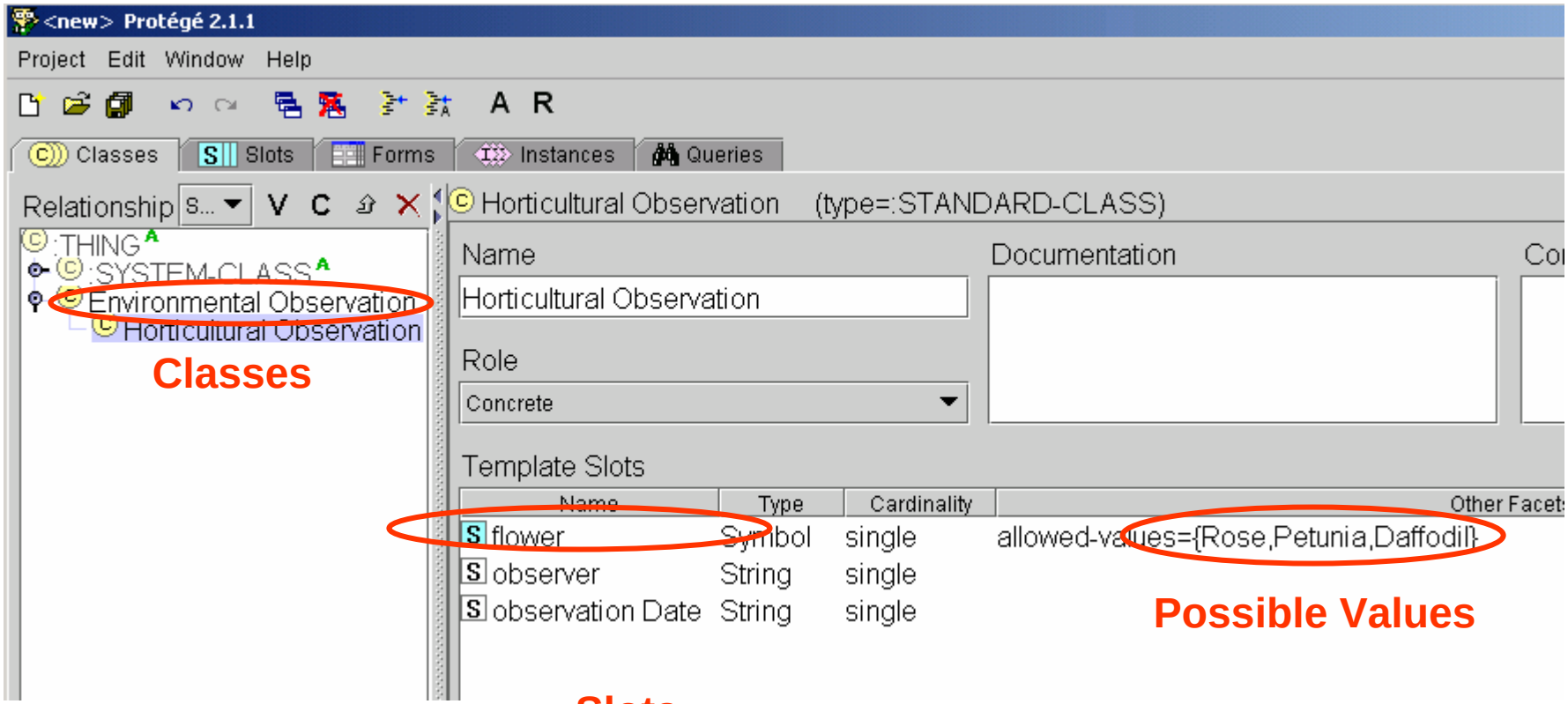
Terminology Links



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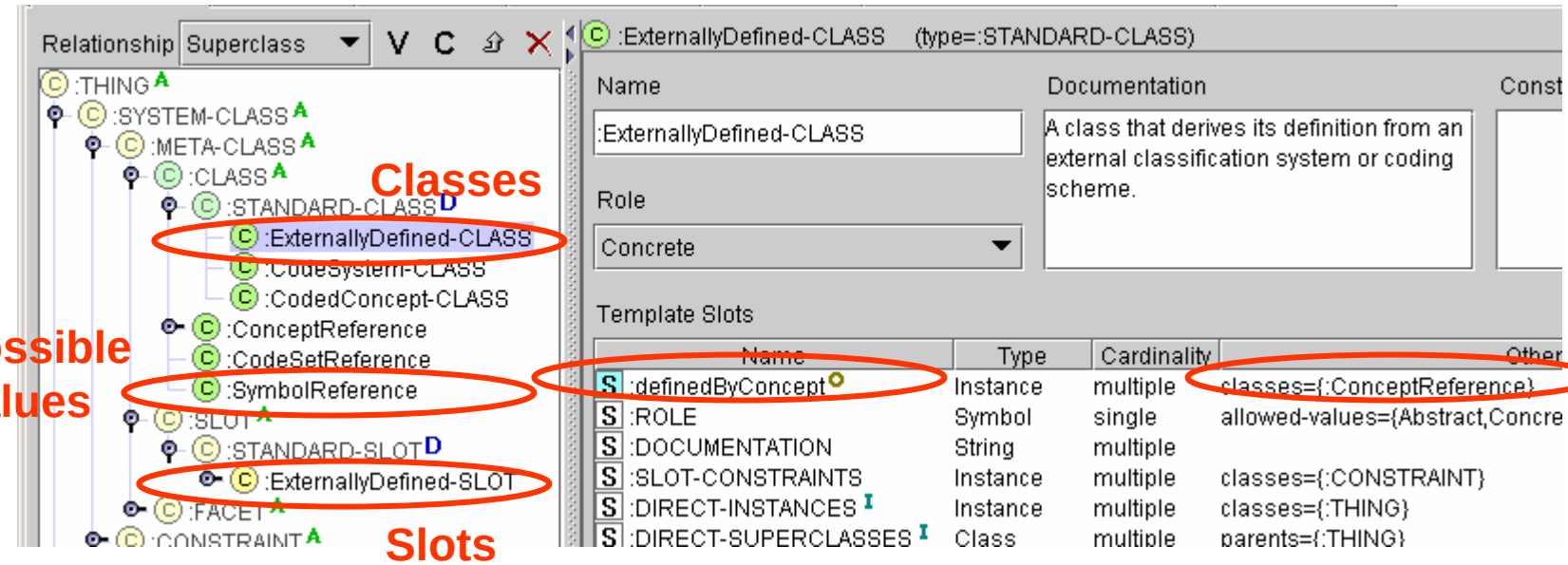
Concept References



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Concept References

- Concept resources can include
  - Existing taxonomies
  - Trade and specialty nomenclature
  - Standardized code sets (e.g. country codes)
  - Reporting and classification schemes
  - Ontologies
  - ...

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Concept References

- **Resource characteristics**
  - **Format and structure can vary widely**
  - **Availability can vary from simple ASCII lists of code value pairs to complex ontology services such as the Apelon DTS or DIG**

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Referencing Concepts

- **Creating a manageable solution**
  - **Create a generic model of terminology content**
  - **Define an interface layer that allows queries to be posed in terms of the generic model**

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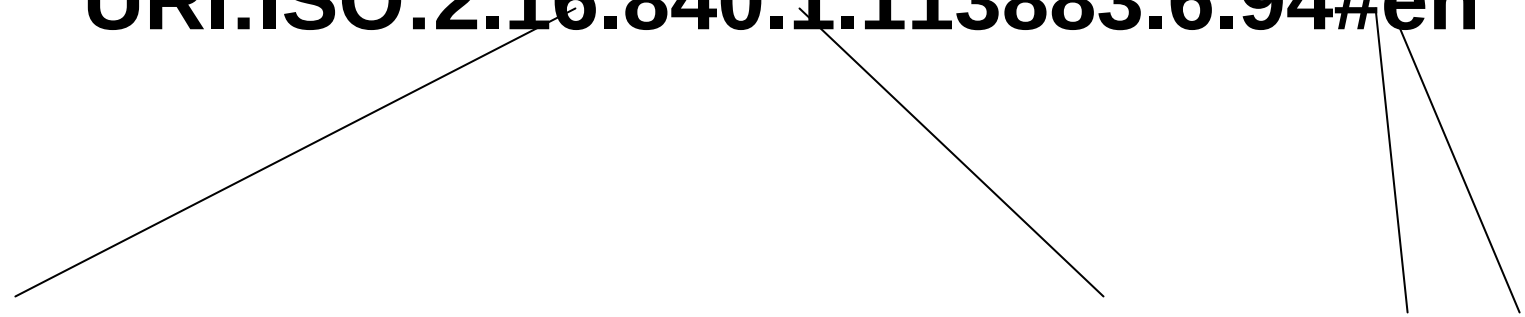
Concept Code URI

URI:ISO:2.16.840.1.113883.6.94#en



2.16.840.1.113883.6.94

en

Code System

Concept Code

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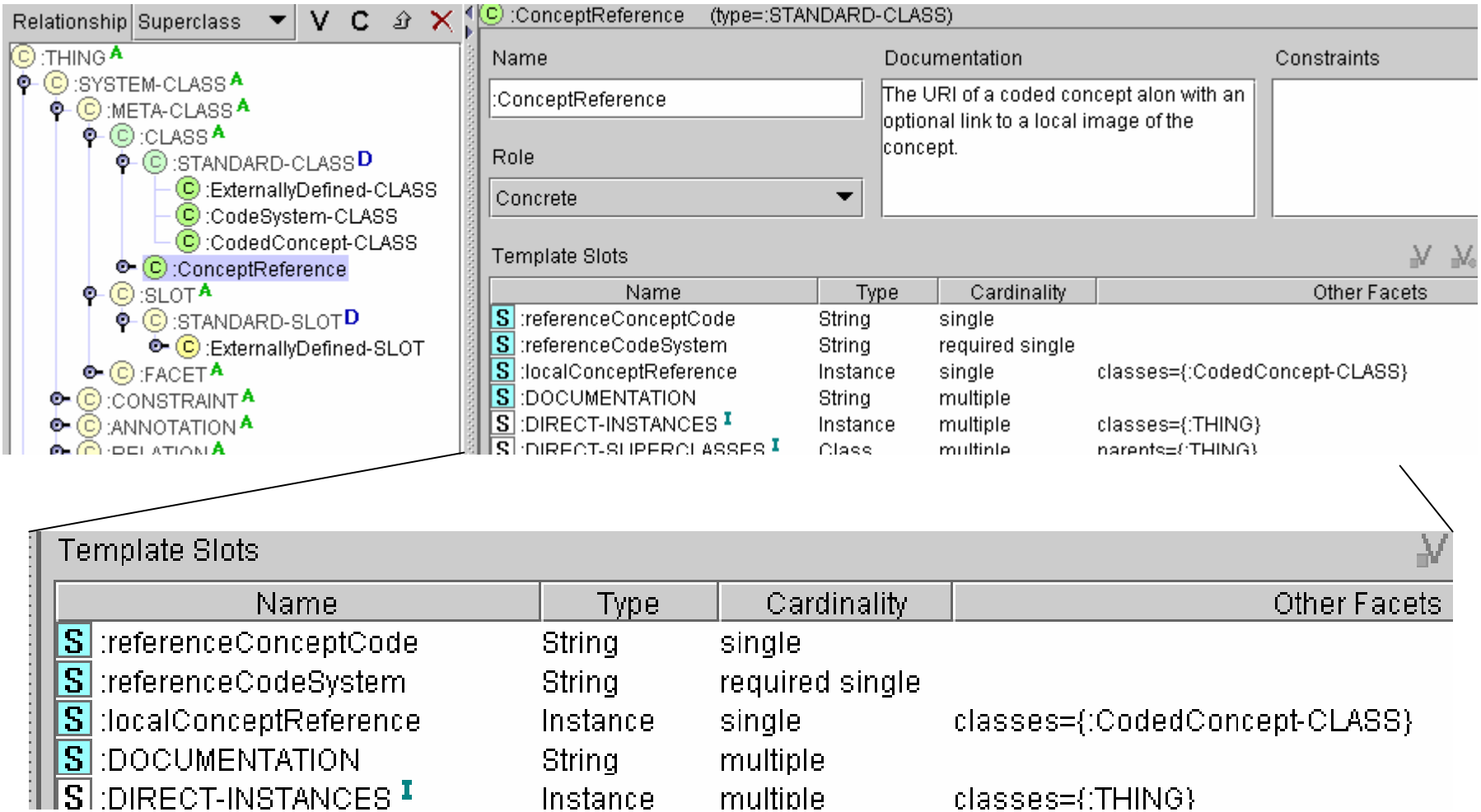
Concept References



Template Slots

Name	Type	Cardinality	Other Facets
S :referenceConceptCode	String	single	
S :referenceCodeSystem	String	required single	
S :localConceptReference	Instance	single	classes={:CodedConcept-CLASS}
S :DOCUMENTATION	String	multiple	
S :DIRECT-INSTANCES I	Instance	multiple	classes={:THING}

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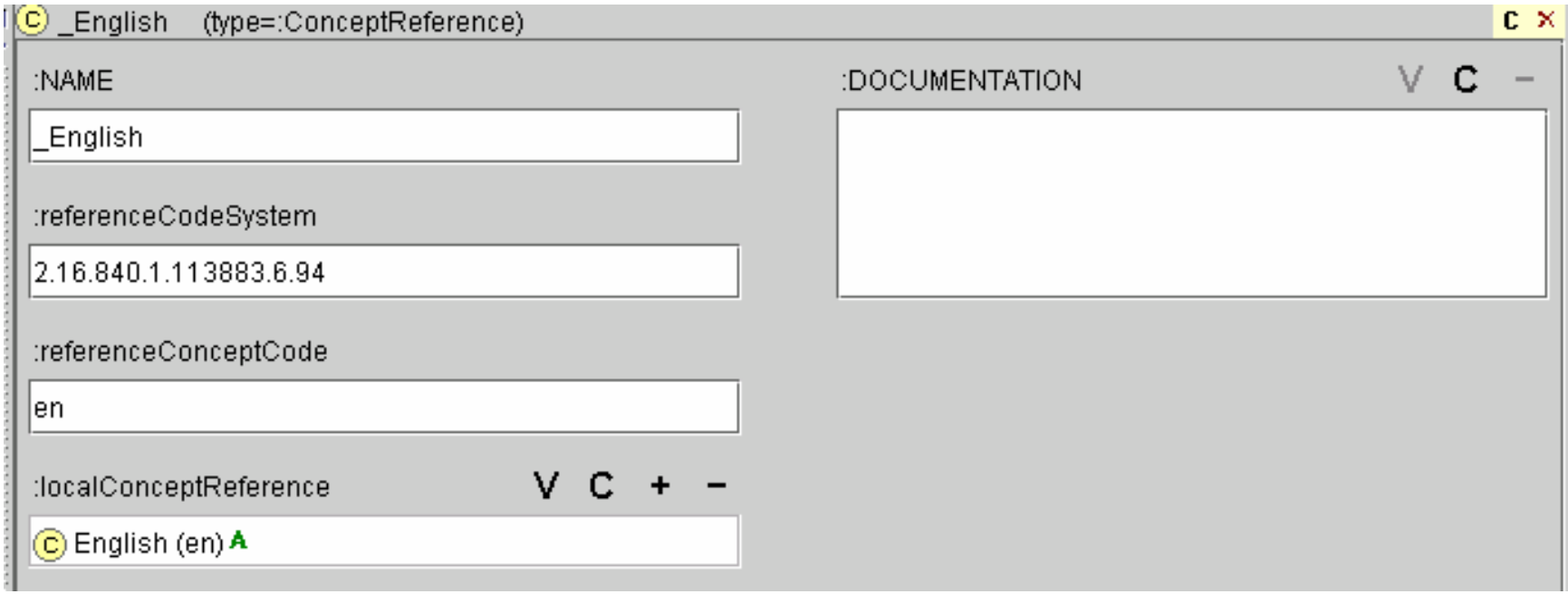
ConceptReference Example



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Why Terminology Services?

Terminology Resources are Heterogeneous

- **Structure** - varies from code/value pairs to complex formalisms such as NCI Thesaurus or SNOMED-CT
- **Size –** varies from 3 or 4 entries to well over half a million
- **Format –** can be CSV's, SQL Tables, XML Documents, OWL

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Why Terminology Services?

Terminology = content + *software*

- **Sophisticated text search algorithms**
- **DL style inference**
- **Distribution, authoring, performance...**

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The Common Terminology Services (CTS) API

- (Relatively) Simple API
- Read-only
- A specification on how to do things like
  - List supported code systems
  - Get code system information
  - Search coded concepts by text
  - Traverse relationships
- Draft HL7 / ANSI Standard

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CTS Example

8.3.5 Determine Whether Two Concept Codes are Related

```
boolean areCodesRelated(
        in CodeSystemId                 codeSystem_id,
        in ConceptCode                  source_code,
        in ConceptCode                  target_code,
        in RelationshipCode             relationship_code,
        in RelationQualifierCodeList    relationQualifiers,
        in boolean                      directRelationsOnly
        )
        raises (UnknownConceptCode,
                UnknownCodeSystem,
                UnknownRelationshipCode,
                UnknownRelationQualifier,
                UnexpectedError);
```

Listing 41: areCod

Determine whether the supplied concept codes are related

Parameters:

- **codeSystem_id** - the code system of the parent and child codes
- **source_code** - the concept code that occurs as the source of the relationship
- **target_code** - the concept code that occurs as the target of the relationship
- **relationship_code** - the concept code that identifies the relationship
- **relationQualifiers** - an optional list of relationship qualifier codes. If the relatio qualifiers that match all of the qualifiers in the list will be considered.
- **directRelationsOnly**- TRUE means test direct relationships only, FALSE means If the relationship is not transitive, the result is the same no matter the setting

areCodesRelated returns TRUE if one of the following conditions holds:

1. There is a direct relationship of type relationship_code between source_code
2. There is a direct relationship of type relationship_code between target_code symmetric.
3. Source_code equals target code and the relationship is reflexive.
4. directRelationsOnly is FALSE, relationship_code is transitive and there is a rel transitive closure of relationship_code starting at source_code.
5. directRelationsOnly is FALSE, relationship_code is transitive and symmetric ar

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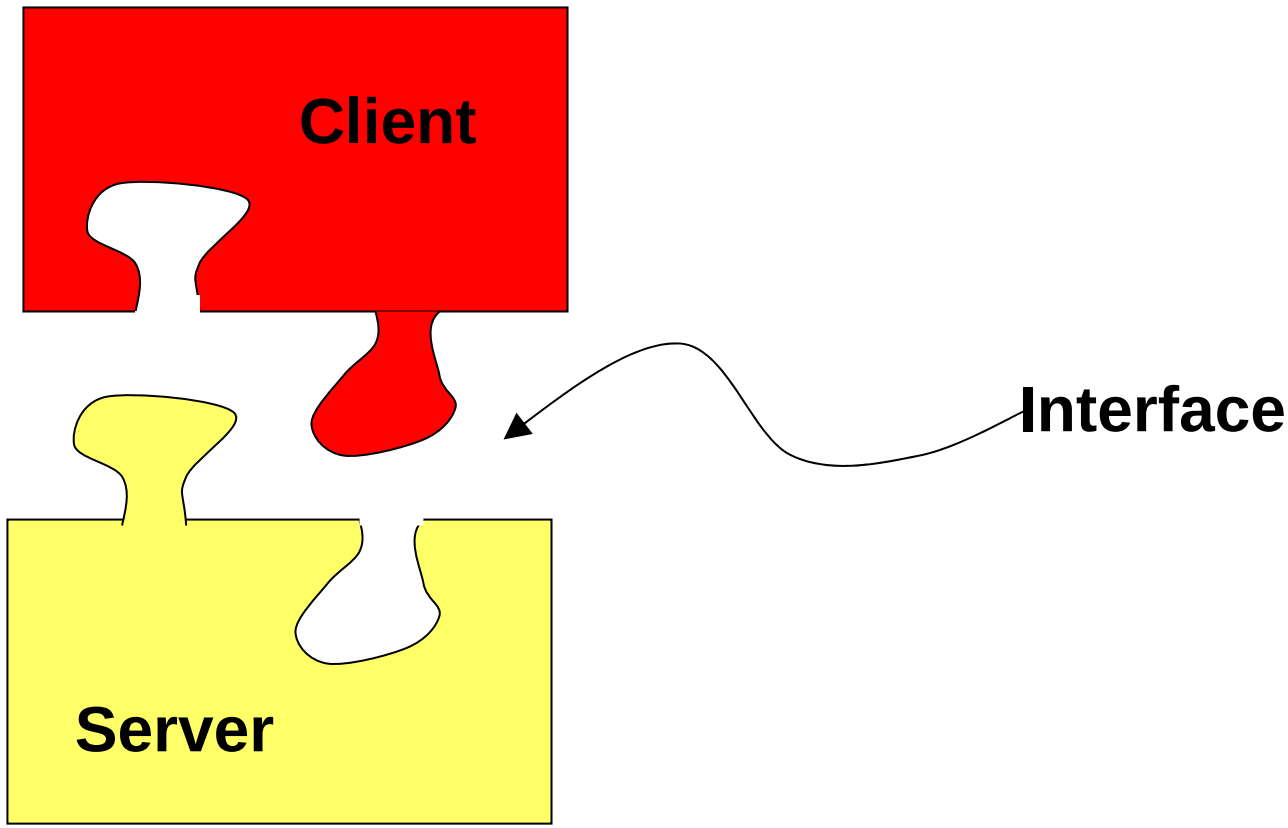
CTS Interface Specification



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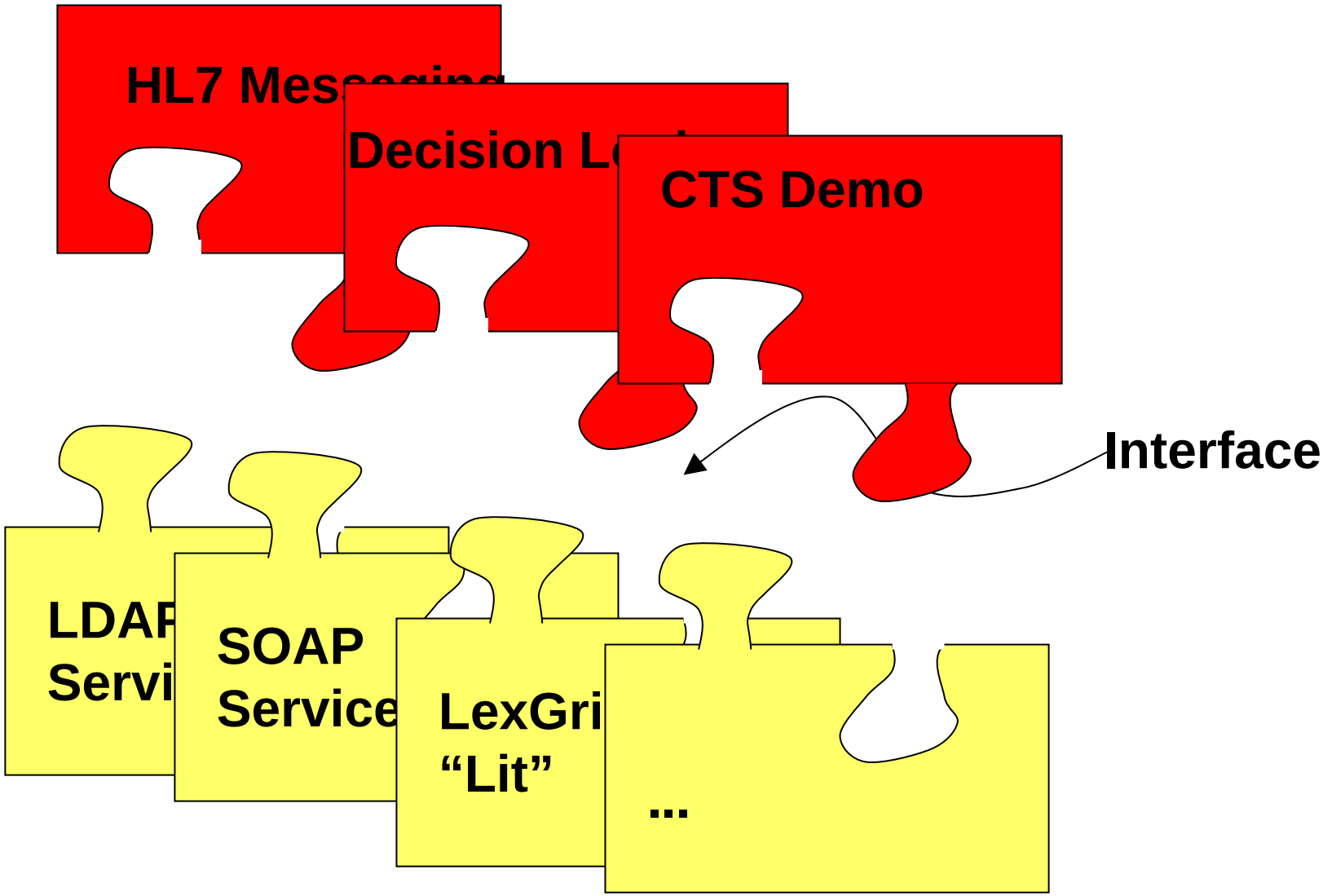

SOAP Test

File Tools

URL: http://informatics.mayo.edu:8180/axis/services/VocabRuntimeService?wsdl

Disconnect

Method: areCodesRelated

Execute

Result

```
Boolean
|_value - true
```

Message Sent

```
<soap:Envelope xmlns:xsi='http://www.w3.org/2001/XMLSchema-instance' xmlns:xsd='http://www.w3.org/2001/XMLSchema' xmlns:soap='http://schemas.
  <soap:Body soap:encodingStyle='http://schemas.xmlsoap.org/soap/encoding/' xmlns:soap='http://schemas.xmlsoap.org/soap/envelope/'>
    <n:areCodesRelated>
      <codeSystem_id xsi:type='xsd:string'>2.16.840.1.113883.6.101</codeSystem_id>
      <source_code xsi:type='xsd:string'>200000000X</source_code>
      <target_code xsi:type='xsd:string'>207ZF0201X</target_code>
      <relationship_code xsi:type='xsd:string'>hasSubtype</relationship_code>
      <relationQualifiers xsi:nil='1'/>
      <directRelationsOnly xsi:type='xsd:boolean'>false</directRelationsOnly>
    </n:areCodesRelated>
```

Message Received

```
<soapenv:Envelope xmlns:soapenv='http://schemas.xmlsoap.org/soap/envelope/' xmlns:xsd='http://www.w3.org/2001/XMLSchema' xmlns:xsi='http://www.
 <soapenv:Body>
  <nsl:areCodesRelatedResponse soapenv:encodingStyle='http://schemas.xmlsoap.org/soap/encoding/' xmlns:nsl='urn://hl7.org/CTSVAPI'>
   <areCodesRelatedReturn xsi:type='xsd:boolean'>true</areCodesRelatedReturn>
  </nsl:areCodesRelatedResponse>
 </soapenv:Body>
</soapenv:Envelope>
```

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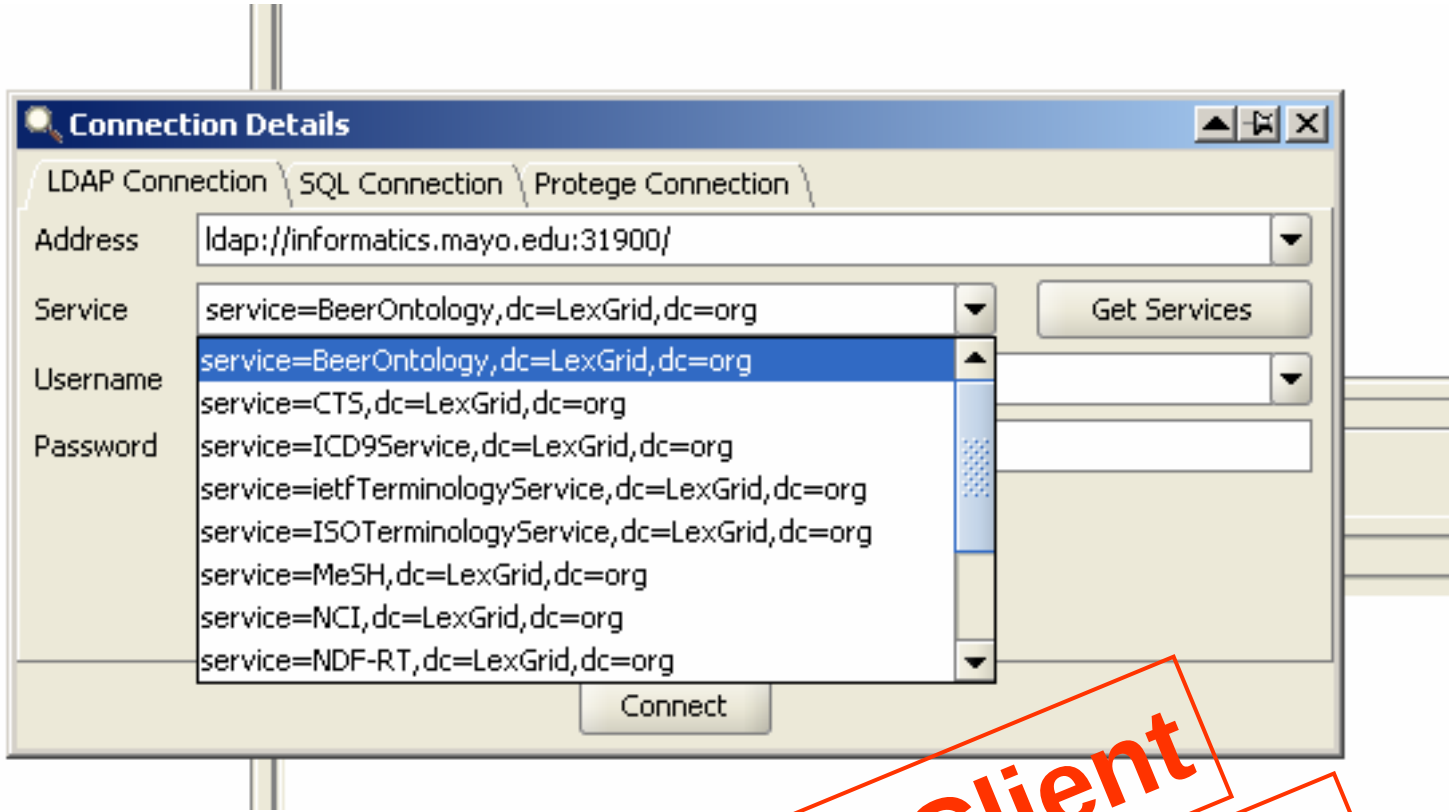

Java Client

LDAP Server

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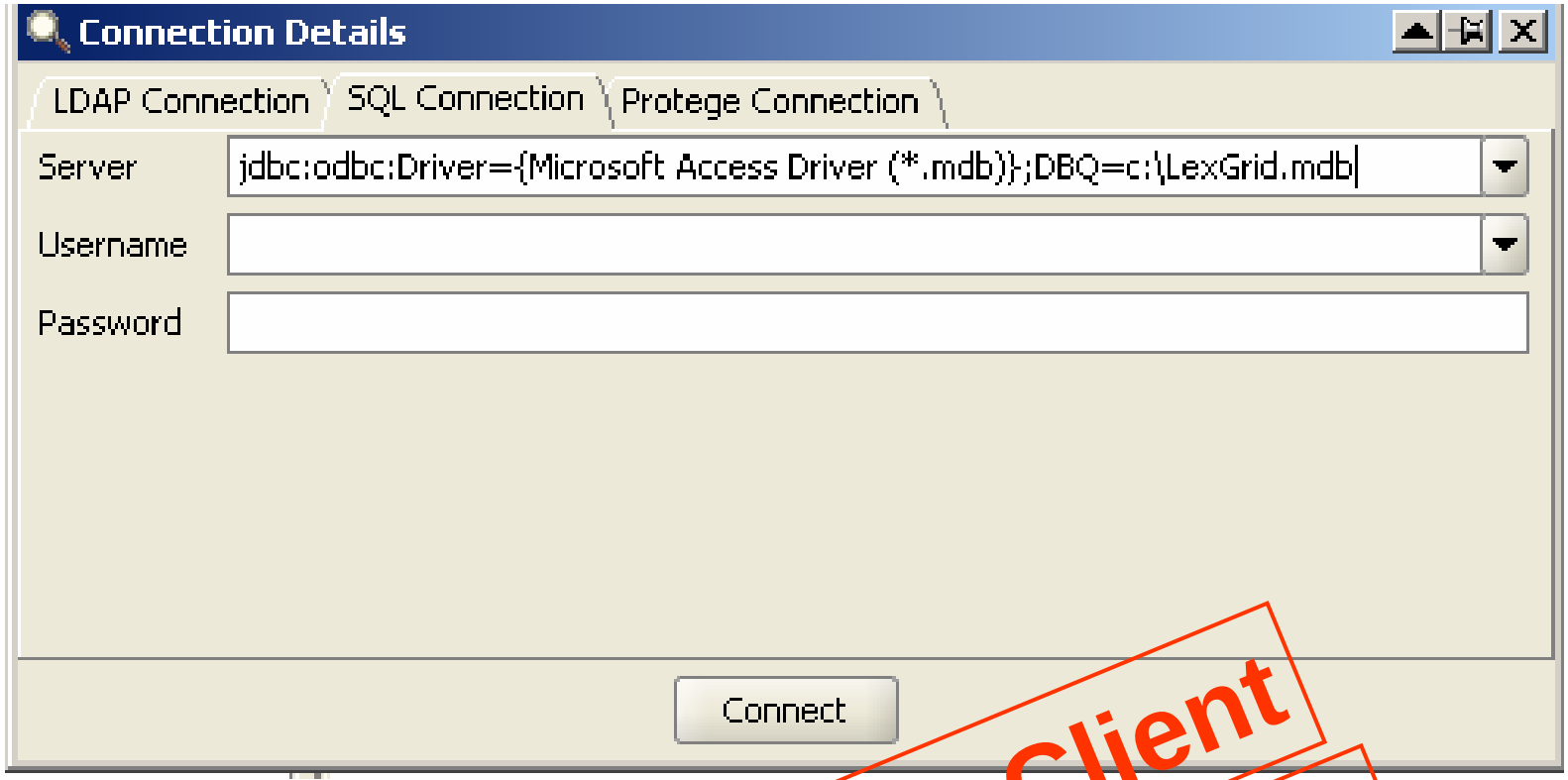

Java Client

SQL Server

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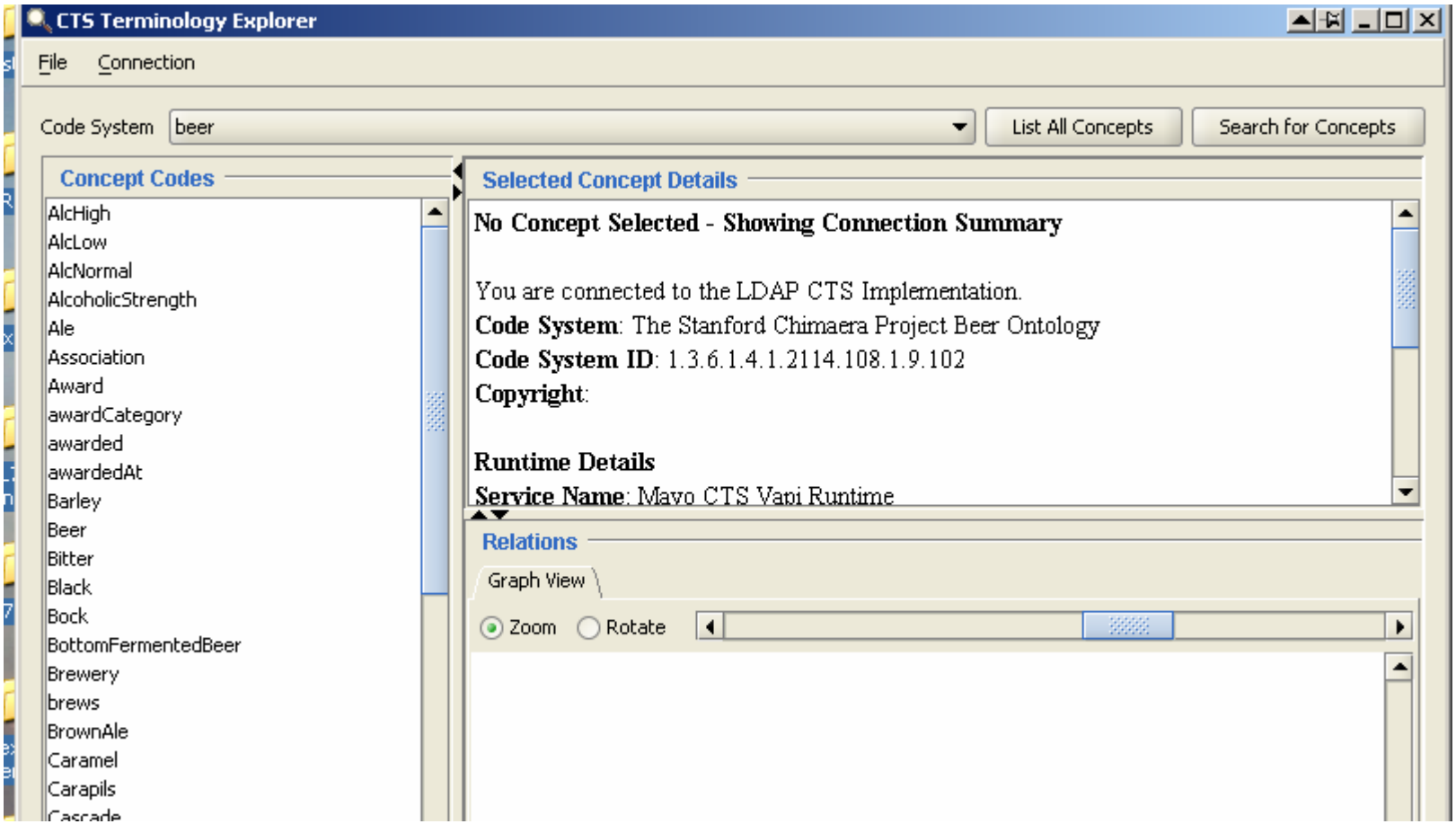
CTS Terminology Explorer
File
Connection
Code System
beer
List All Concepts
Search for Concepts
Concept Codes
AlcHigh
AlcLow
AlcNormal
AlcoholicStrength
Ale
Association
Award
awardCategory
awarded
awardedAt
Barley
Beer
Bitter
Black
Bock
BottomFermentedBeer
Brewery
brews
BrownAle
Caramel
Carapils
Cascade
Selected Concept Details
No Concept Selected - Showing Connection Summary
You are connected to the LDAP CTS Implementation.
Code System: The Stanford Chimaera Project Beer Ontology
Code System ID: 1.3.6.1.4.1.2114.108.1.9.102
Copyright:
Runtime Details
Service Name: Mayo CTS Vapi Runtime
Relations
Graph View
Zoom
Rotate

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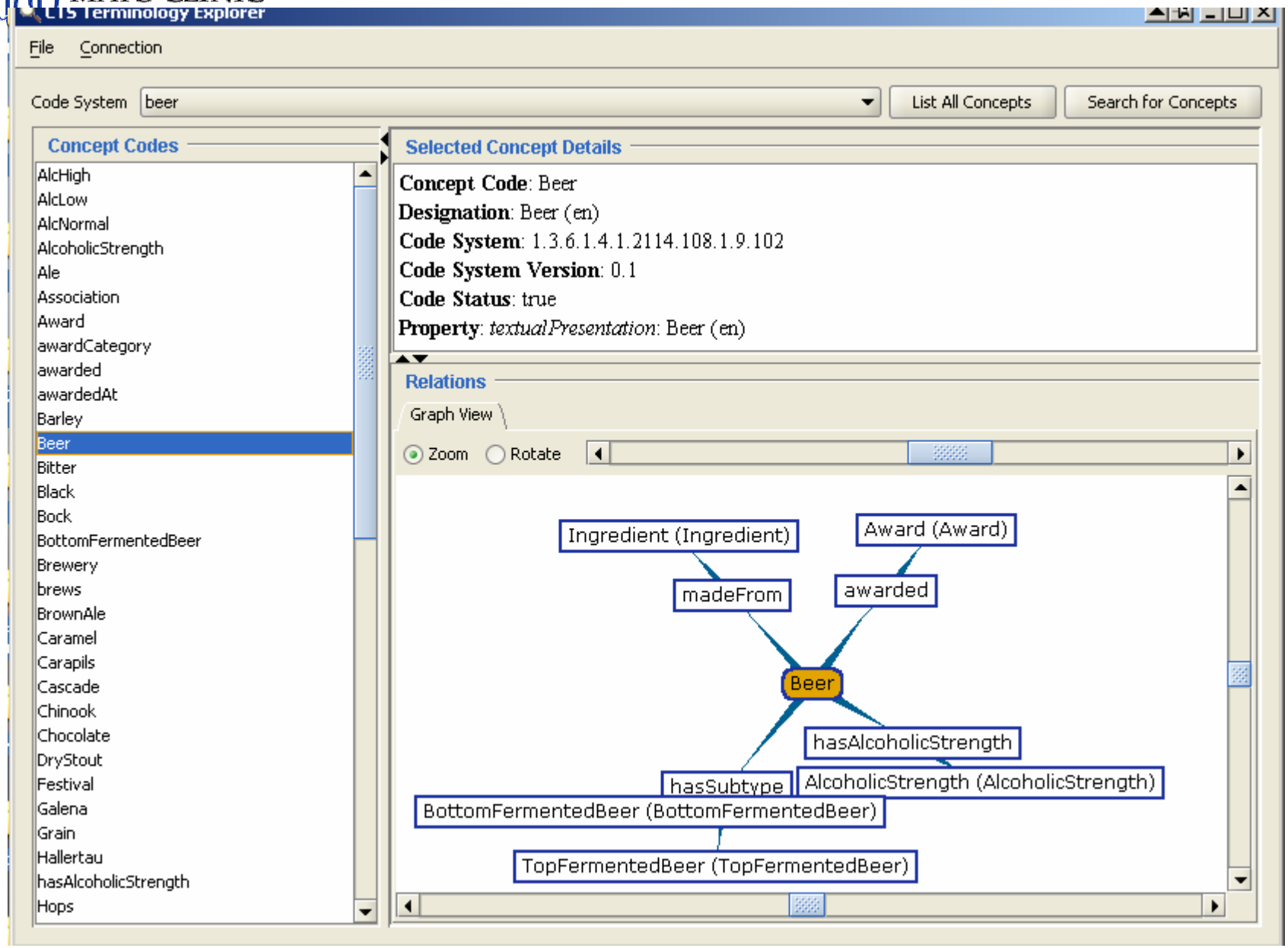
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Barley
Beer
Bitter
Black
Bock
BottomFermentedBeer
Brewery
brews
BrownAle
Caramel
Carapils
Cascade
Chinook
Chocolate
DryStout
Festival
Galena
Grain
Hallertau
hasAlcoholicStrength
Hops
Selected Concept Details
Concept Code: Beer
Designation: Beer (en)
Code System: 1.3.6.1.4.1.2114.108.1.9.102
Code System Version: 0.1
Code Status: true
Property: textualPresentation: Beer (en)
Relations
Graph View
Zoom
Rotate
Ingredient (Ingredient)
Award (Award)
madeFrom
awarded
Beer
hasAlcoholicStrength
hasSubtype
AlcoholicStrength (AlcoholicStrength)
BottomFermentedBeer (BottomFermentedBeer)
TopFermentedBeer (TopFermentedBeer)

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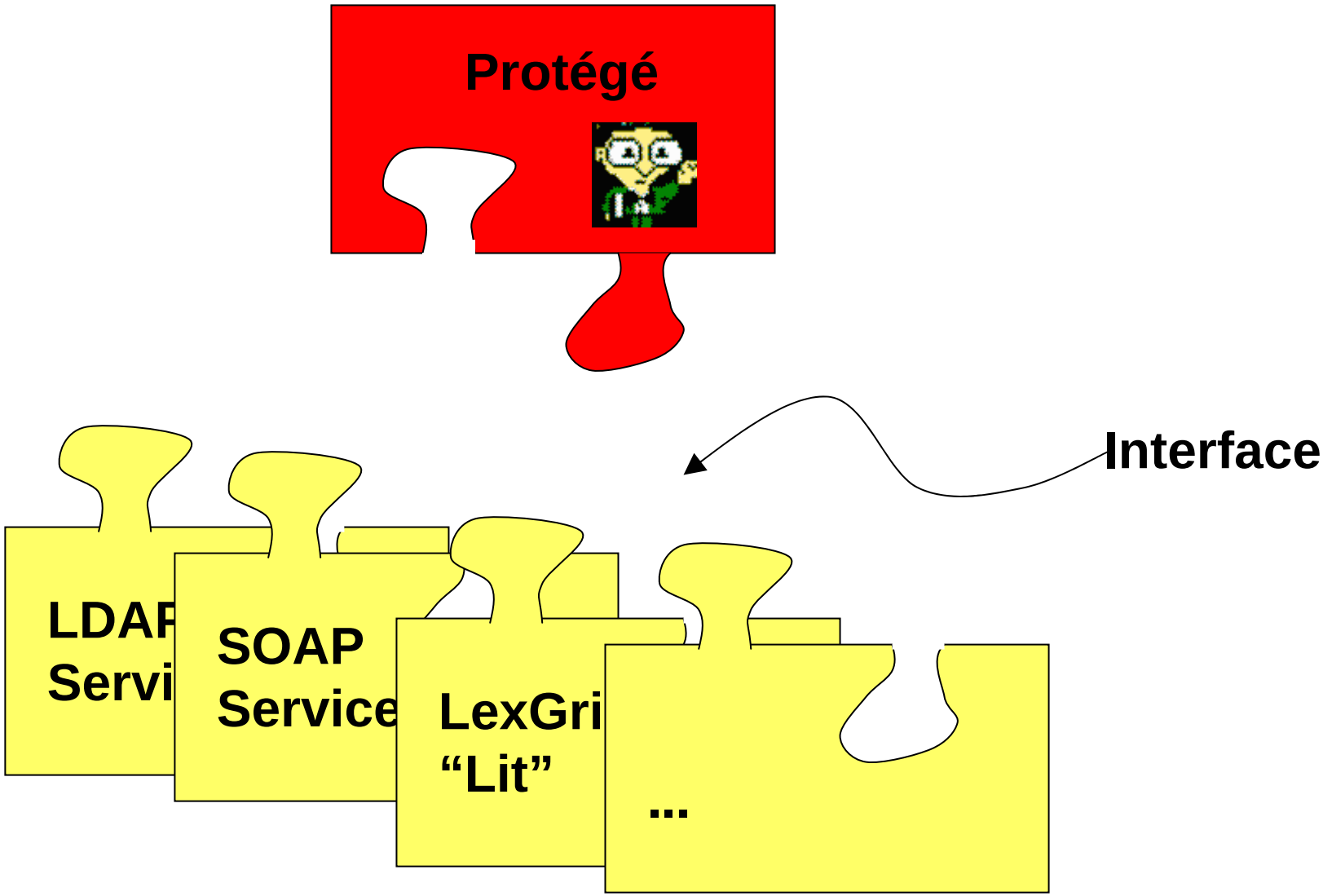
Protégé as a CTS Client



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Protégé as a CTS Client

Need to create a terminology model

- **Code System**
- **Concept Code**
- **Designation**
- **Description**
- **Annotation**
- **Relationship**

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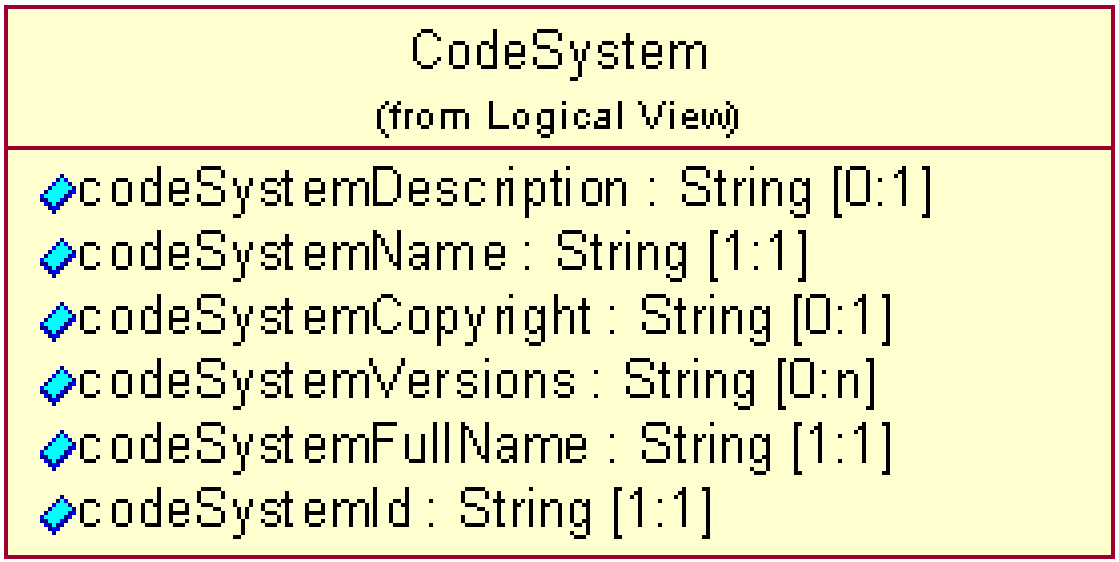
Terminology Model
Code System



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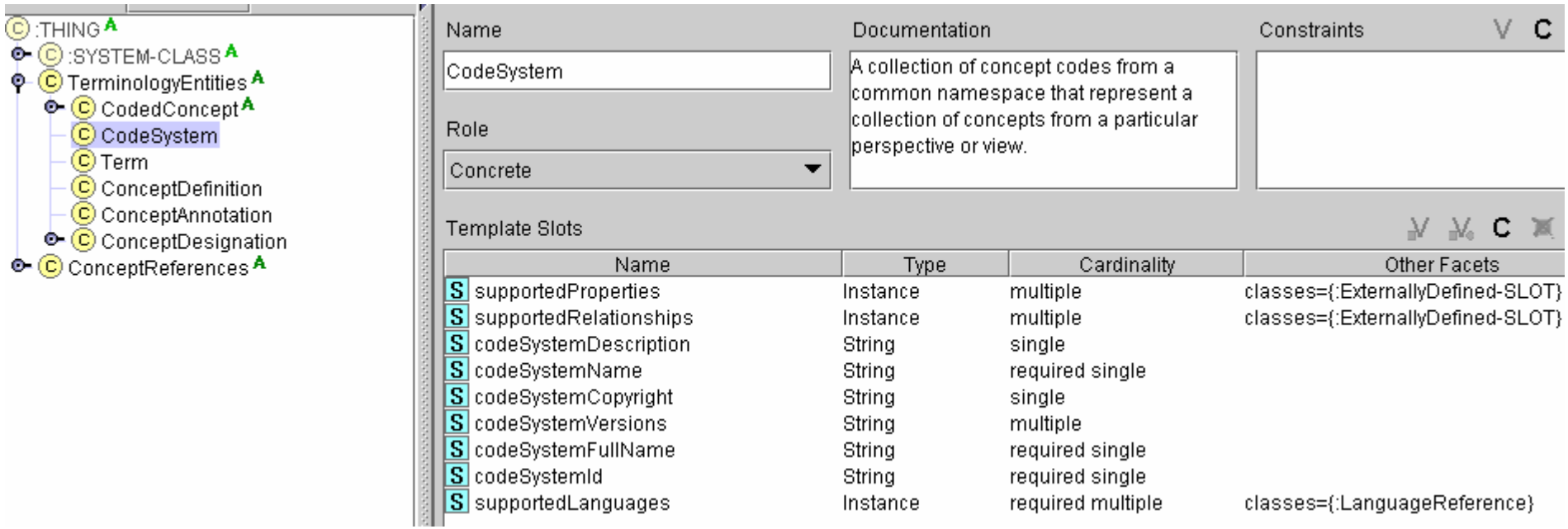
Terminology Model
Code System



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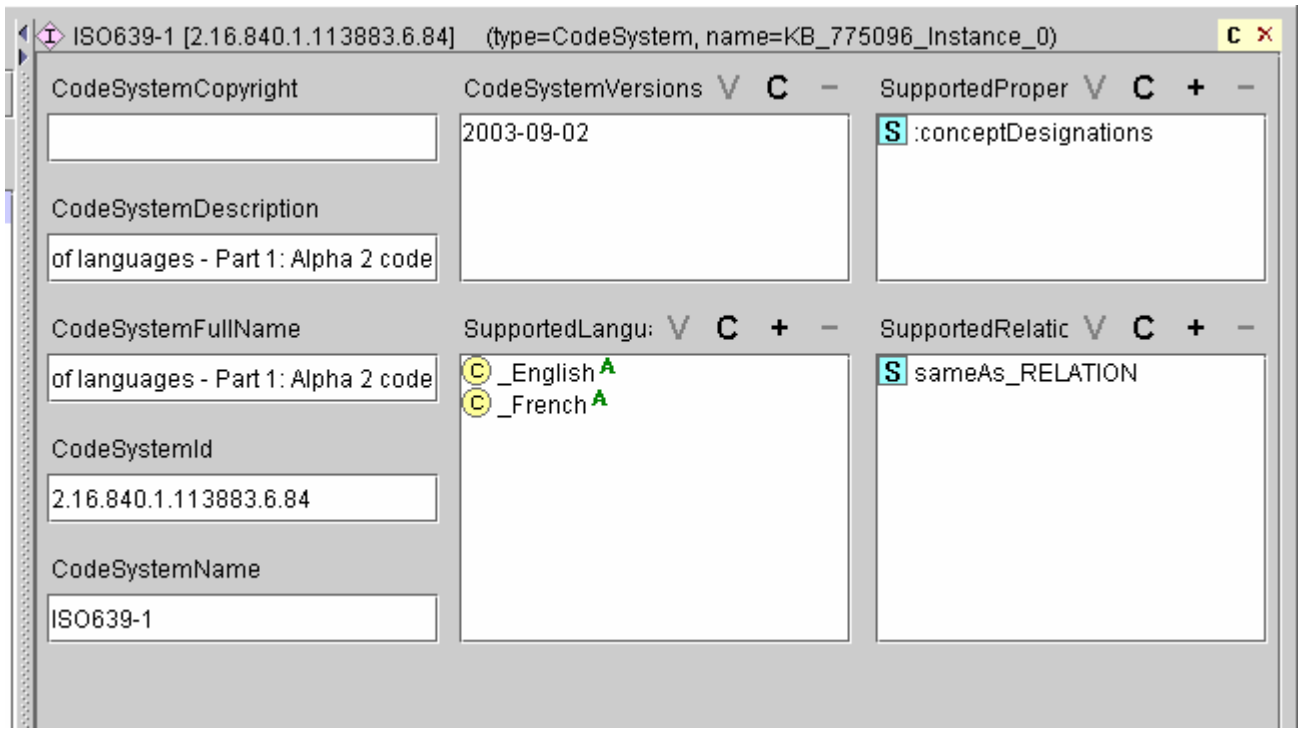
Terminology Model
Code System - Example



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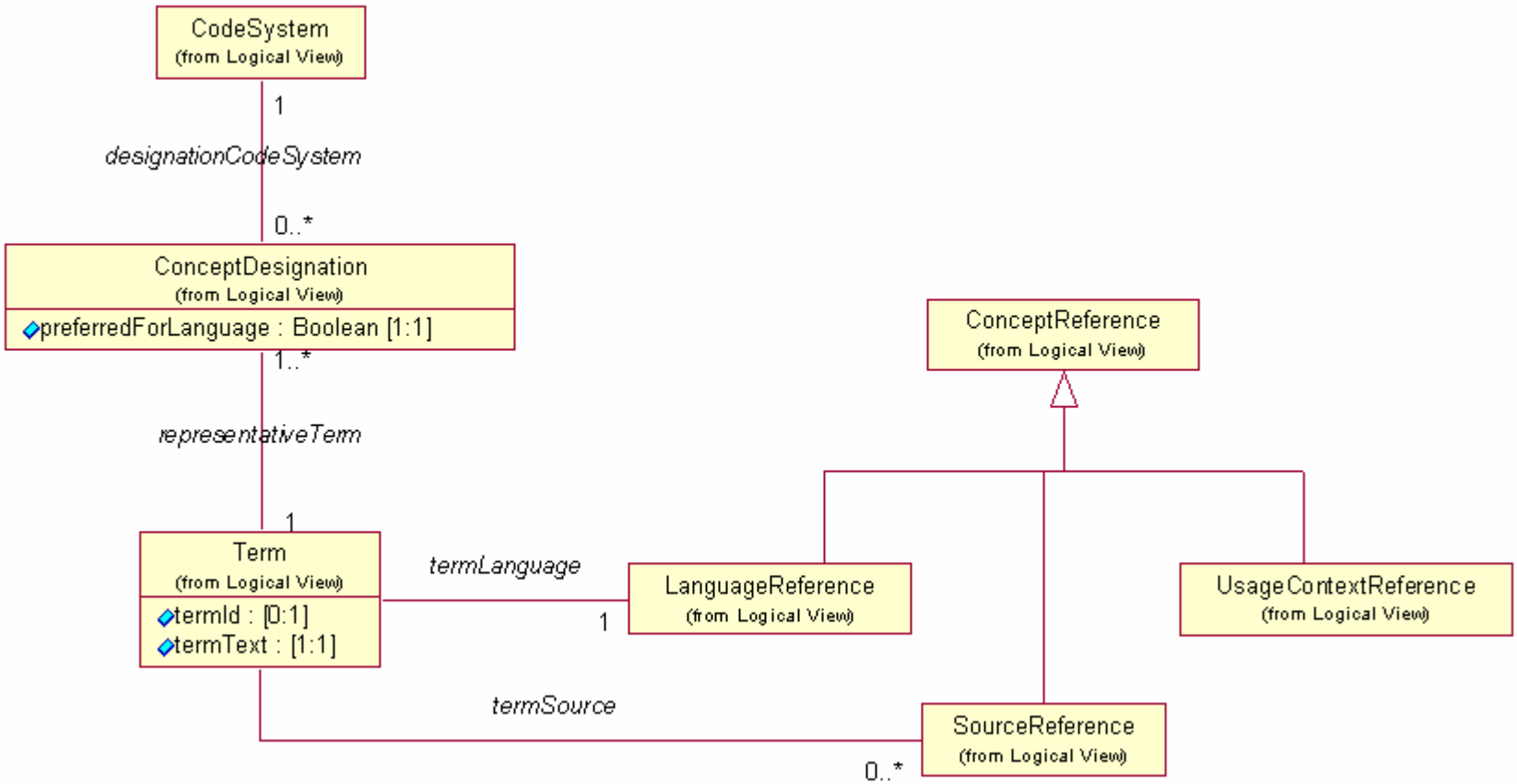
Terminology Model
Terms & Designations



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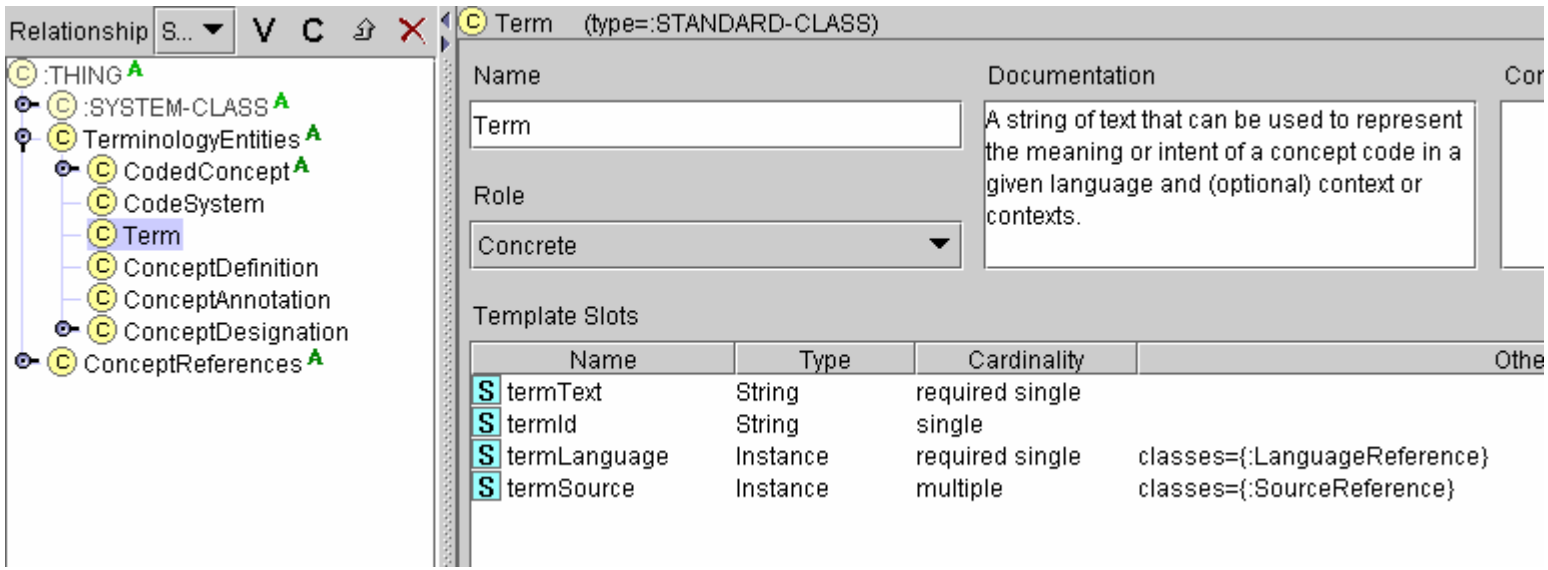
Terminology Model
Terms



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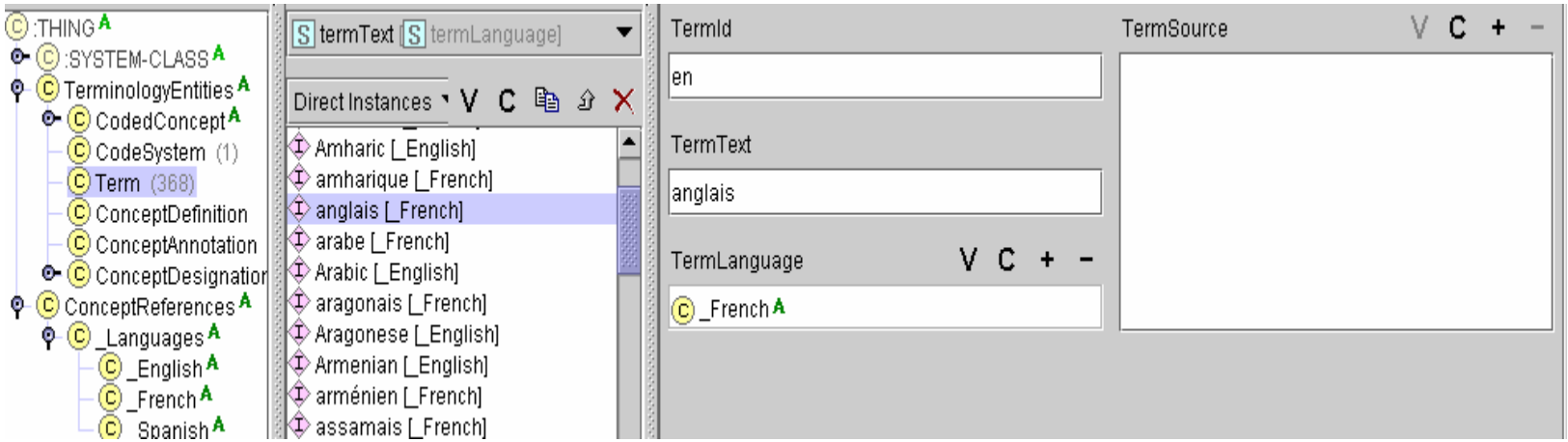
Terms - Example



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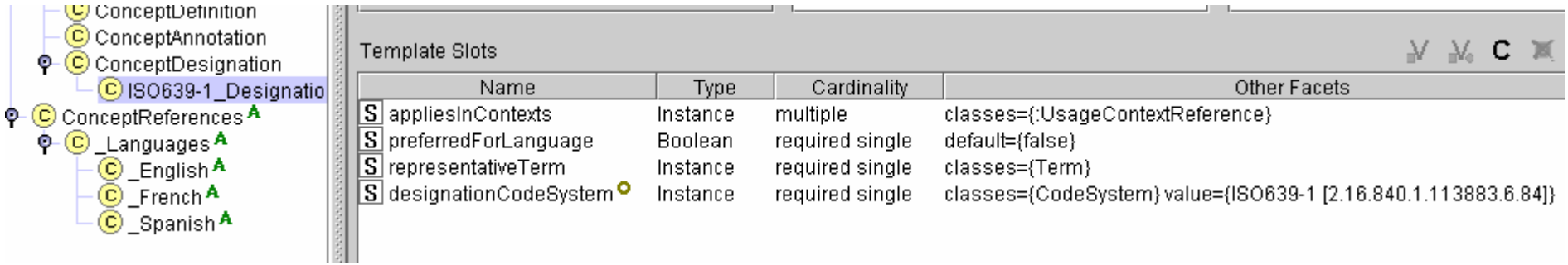
Terminology Model Designations



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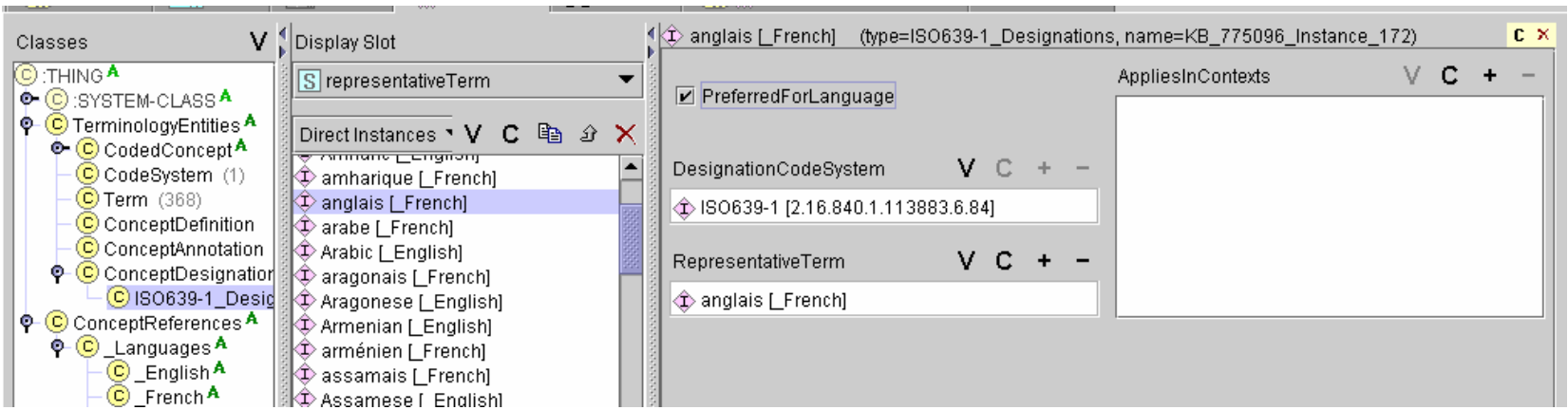
Terminology Model Designations - Example



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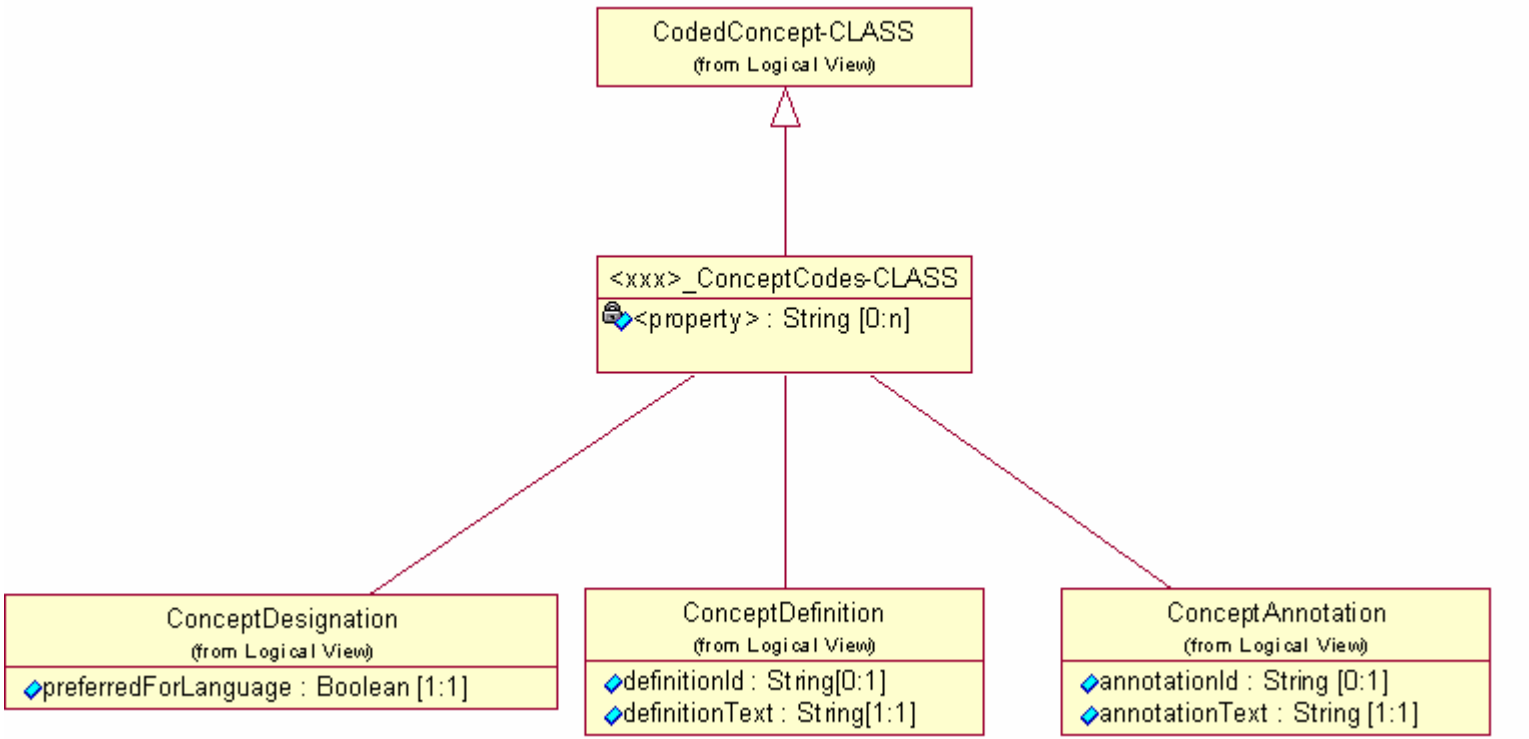
Terminology Model
Definitions, Annotations, etc.



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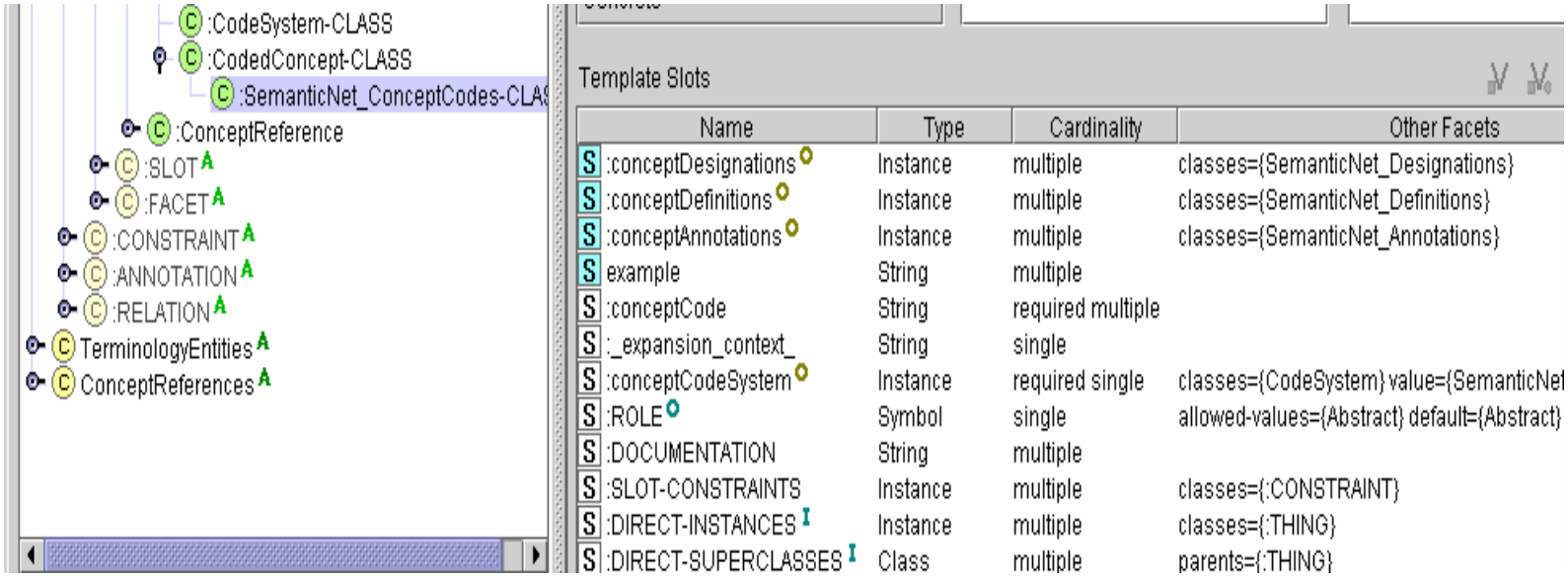

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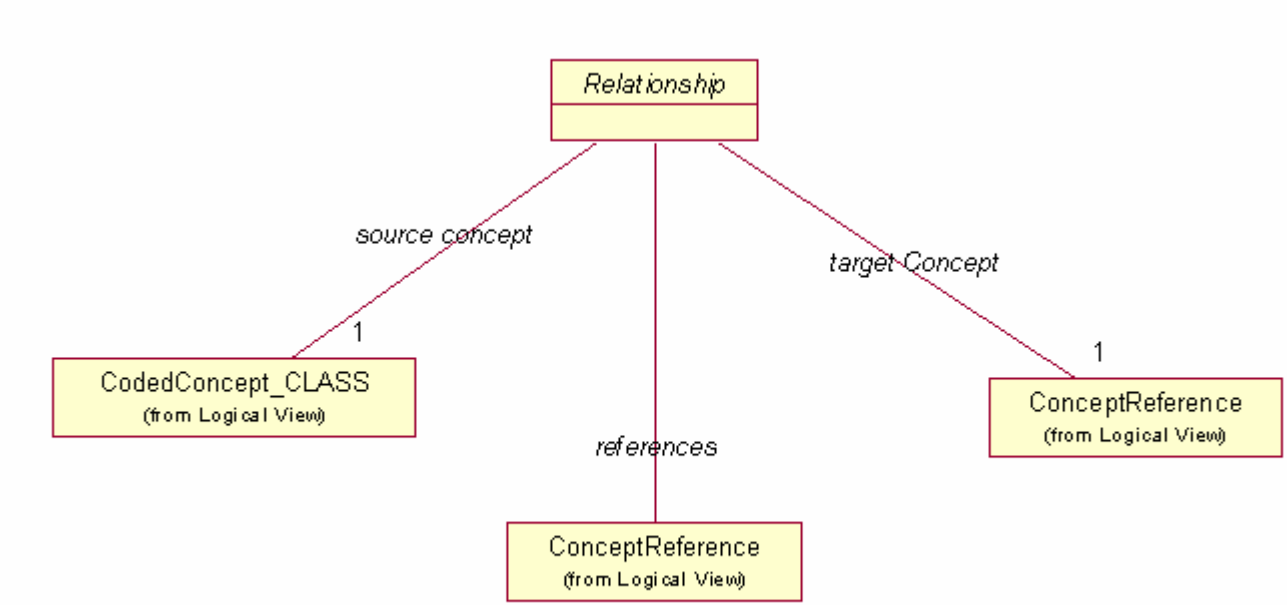
Terminology Model Relations



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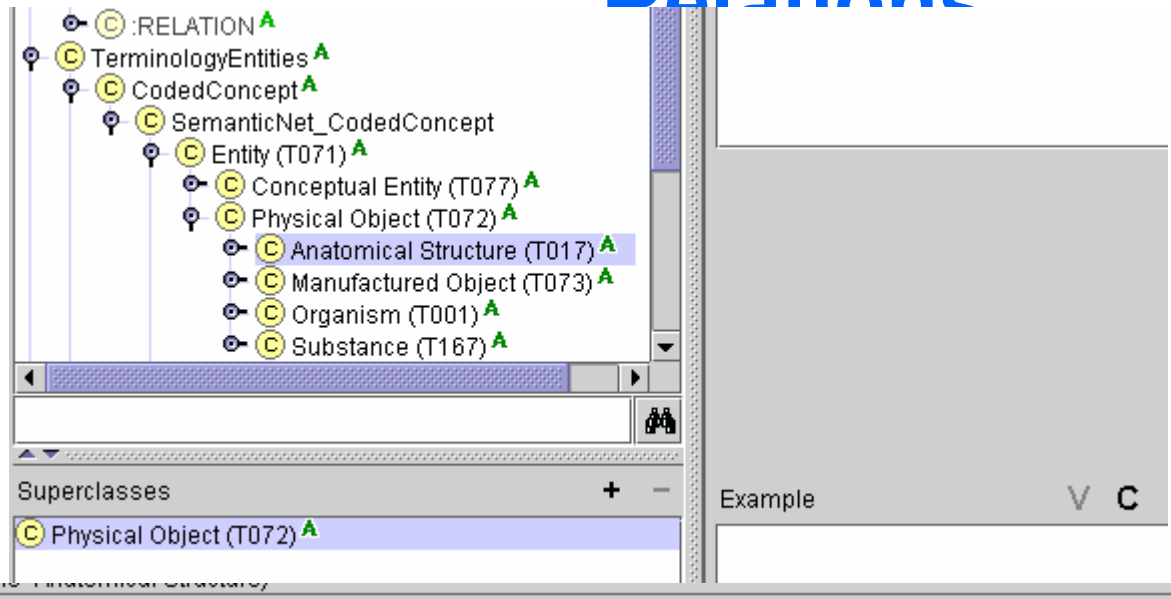
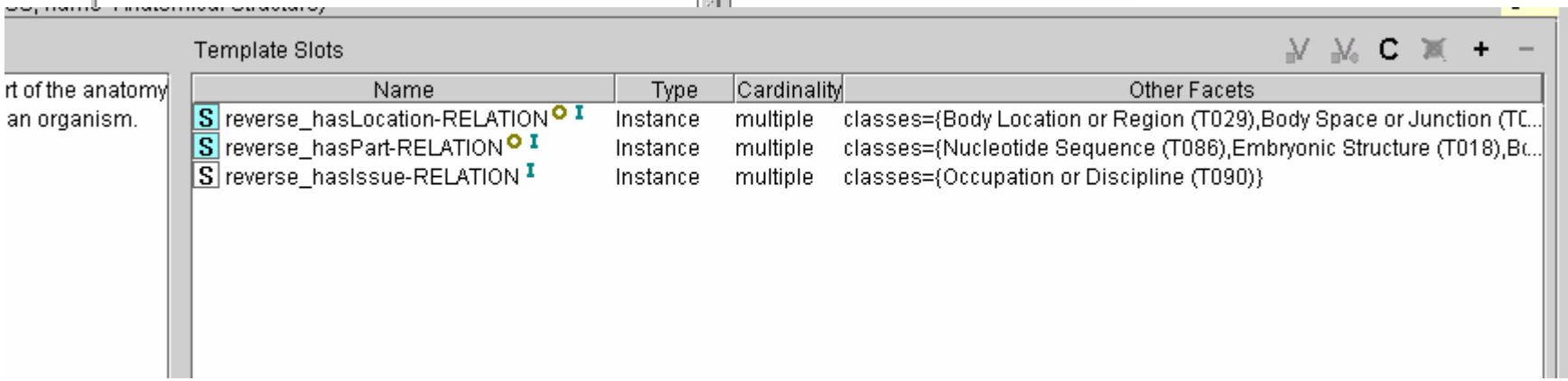
Terminology Model Relations





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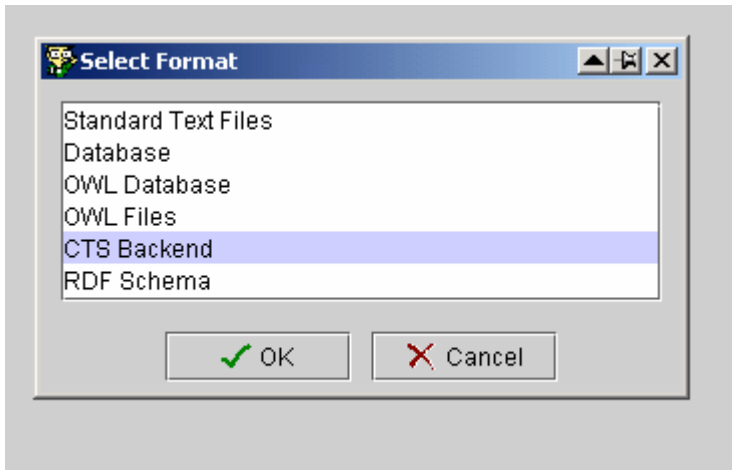
CTS Client
New File Dialog



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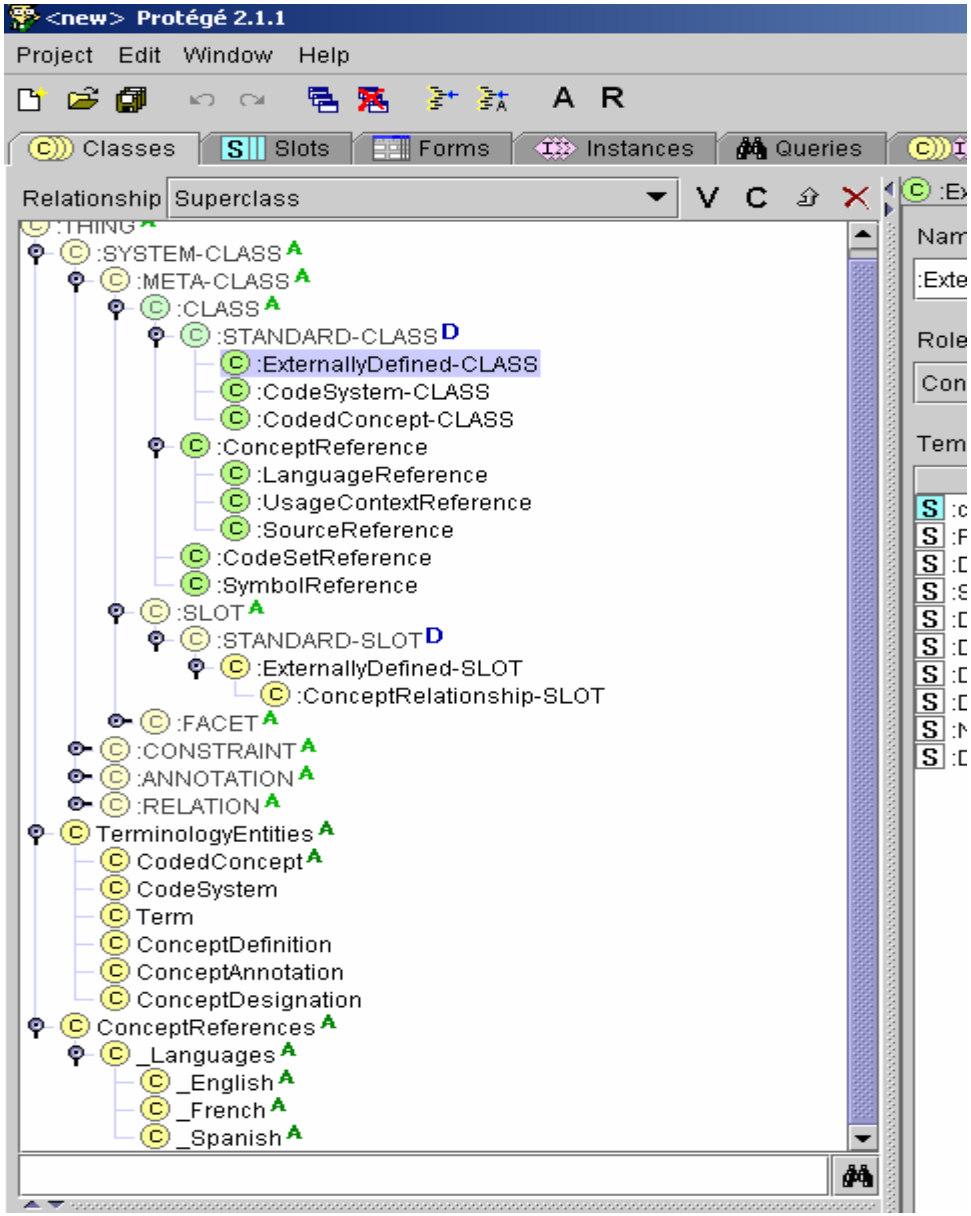
<new> Protégé 2.1.1
Project Edit Window Help
Classes Slots Forms Instances Queries
Relationship Superclass
:SYSTEM-CLASS A
:META-CLASS A
:CLASS A
:STANDARD-CLASS D
:ExternallyDefined-CLASS
:CodeSystem-CLASS
:CodedConcept-CLASS
:ConceptReference
:LanguageReference
:UsageContextReference
:SourceReference
:CodeSetReference
:SymbolReference
:SLOT A
:STANDARD-SLOT D
:ExternallyDefined-SLOT
:ConceptRelationship-SLOT
:FACET A
:CONSTRAINT A
:ANNOTATION A
:RELATION A
TerminologyEntities A
CodedConcept A
CodeSystem
Term
ConceptDefinition
ConceptAnnotation
ConceptDesignation
ConceptReferences A
_Languages A
_English A
_French A
_Spanish A

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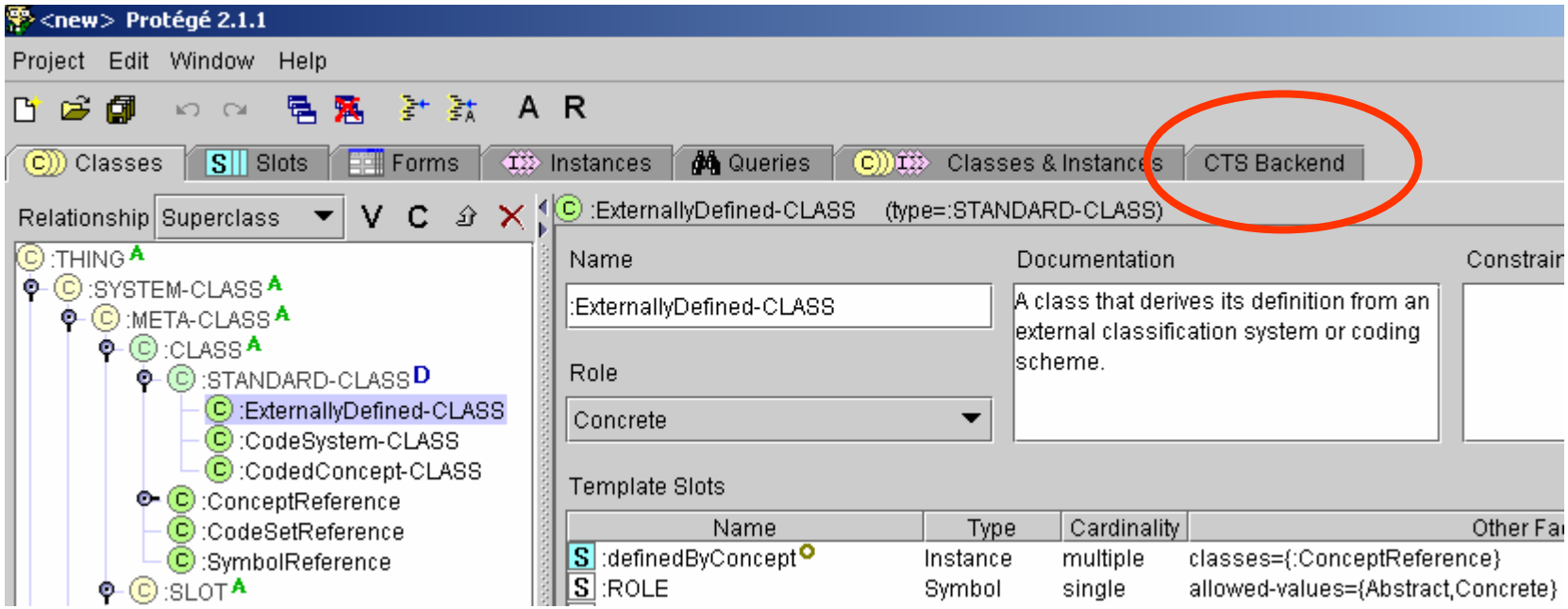
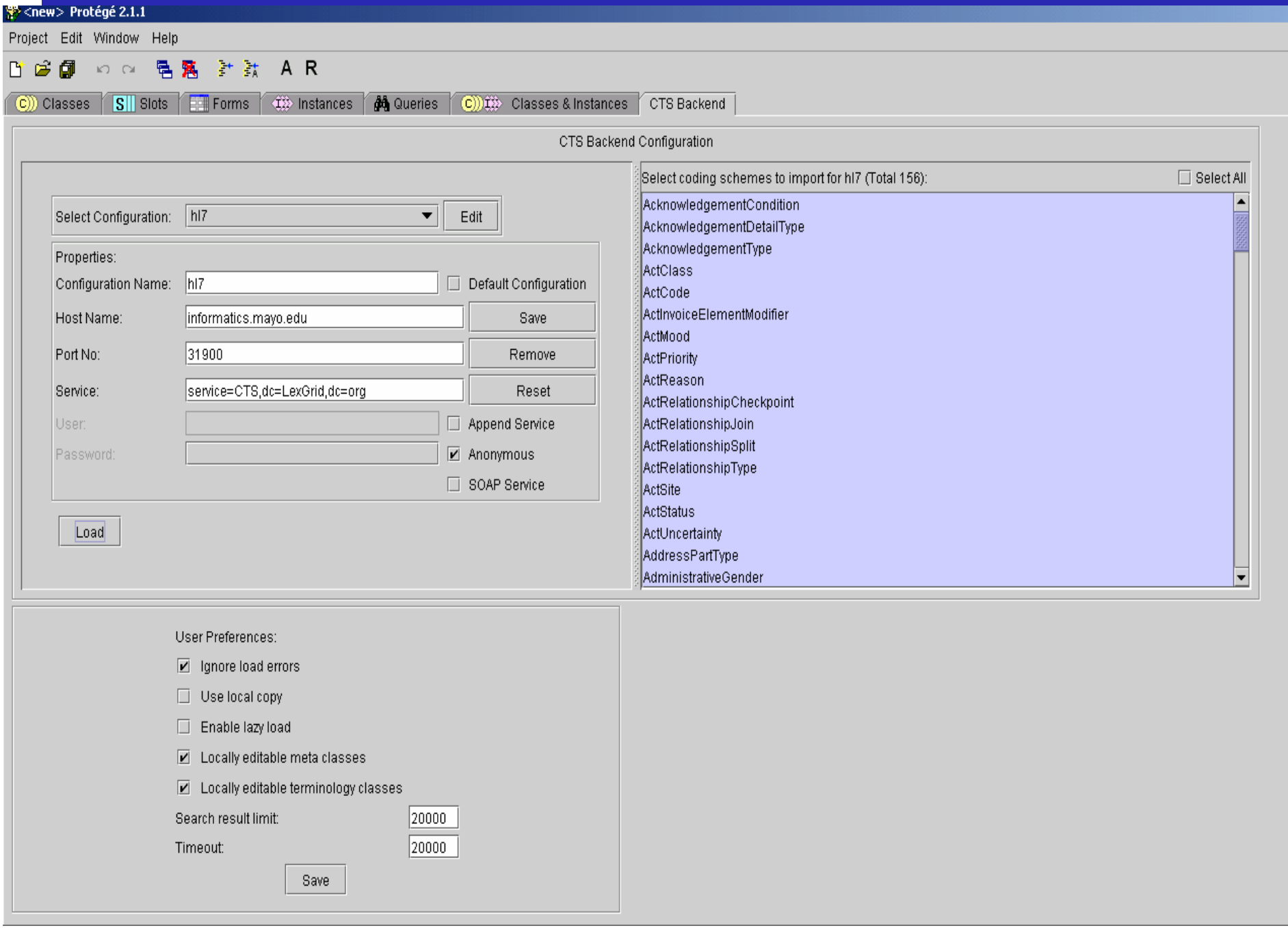
CTS Backend




<new> Protégé 2.1.1
Project Edit Window Help
Classes Slots Forms Instances Queries Classes & Instances CTS Backend
CTS Backend Configuration
Select Configuration: hl7 Edit
Properties:
Configuration Name: hl7 Default Configuration
Host Name: informatics.mayo.edu Save
Port No: 31900 Remove
Service: service=CTS,dc=LexGrid,dc=org Reset
User: Append Service
Password: Anonymous
SOAP Service
Load
Select coding schemes to import for hl7 (Total 156): Select All
AcknowledgementCondition
AcknowledgementDetailType
AcknowledgementType
ActClass
ActCode
ActInvoiceElementModifier
ActMood
ActPriority
ActReason
ActRelationshipCheckpoint
ActRelationshipJoin
ActRelationshipSplit
ActRelationshipType
ActSite
ActStatus
ActUncertainty
AddressPartType
AdministrativeGender
User Preferences:
Ignore load errors
Use local copy
Enable lazy load
Locally editable meta classes
Locally editable terminology classes
Search result limit: 20000
Timeout: 20000
Save

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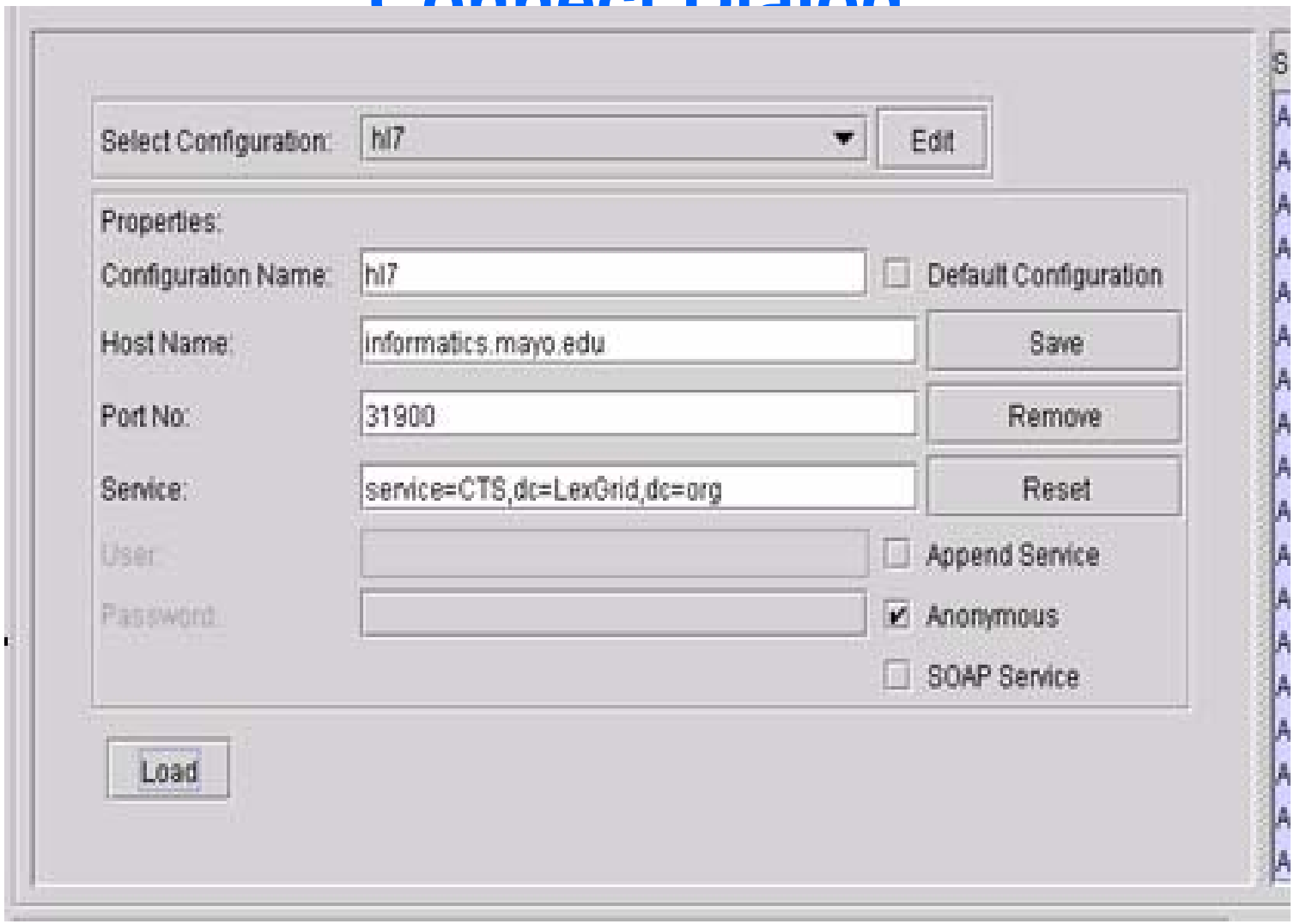
CTS Client Connect Dialog



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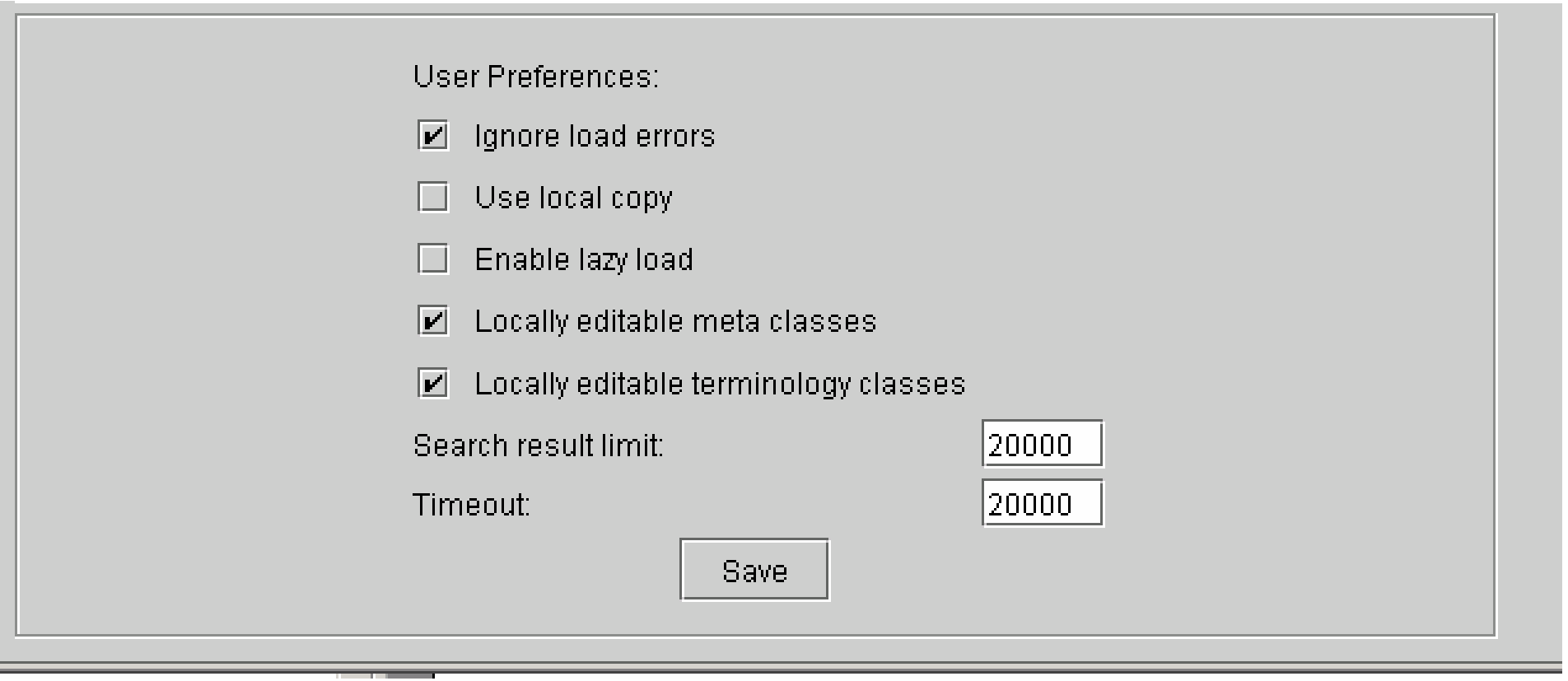
CTS Client Preferences



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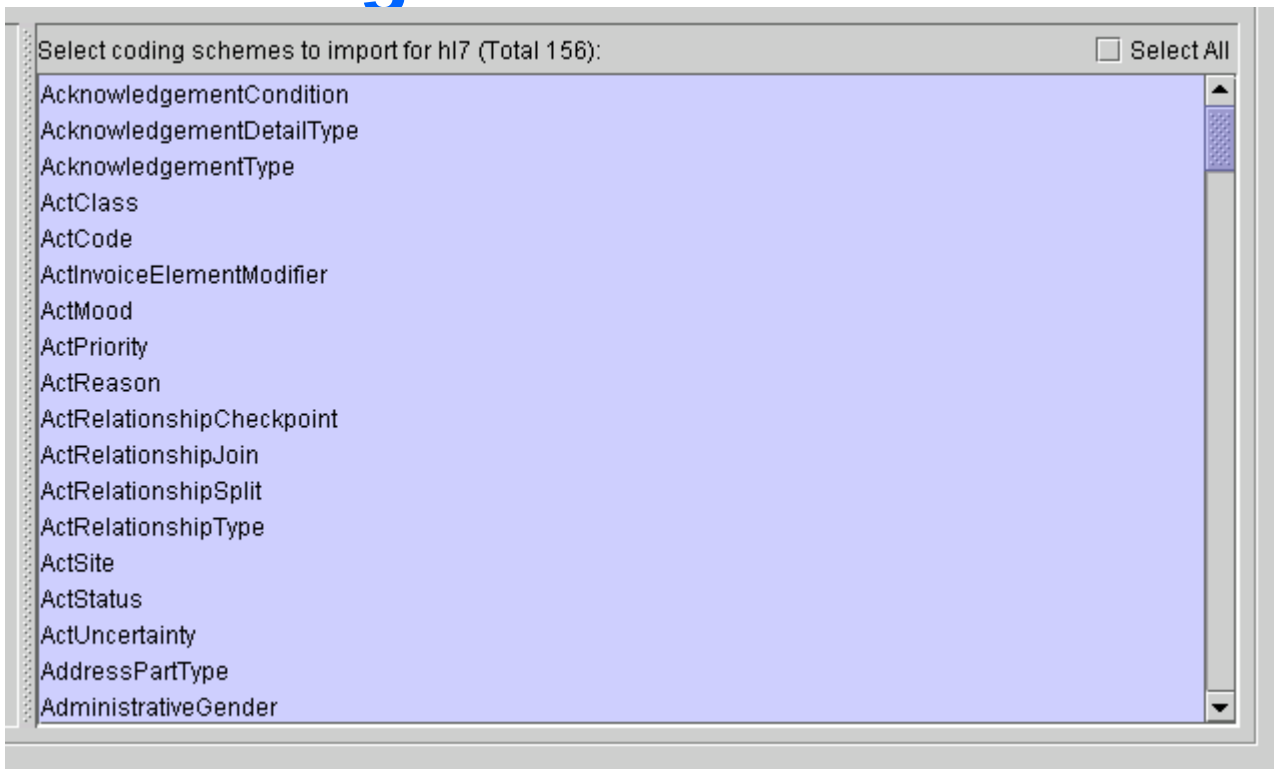
CTS Client
Coding Scheme Selection



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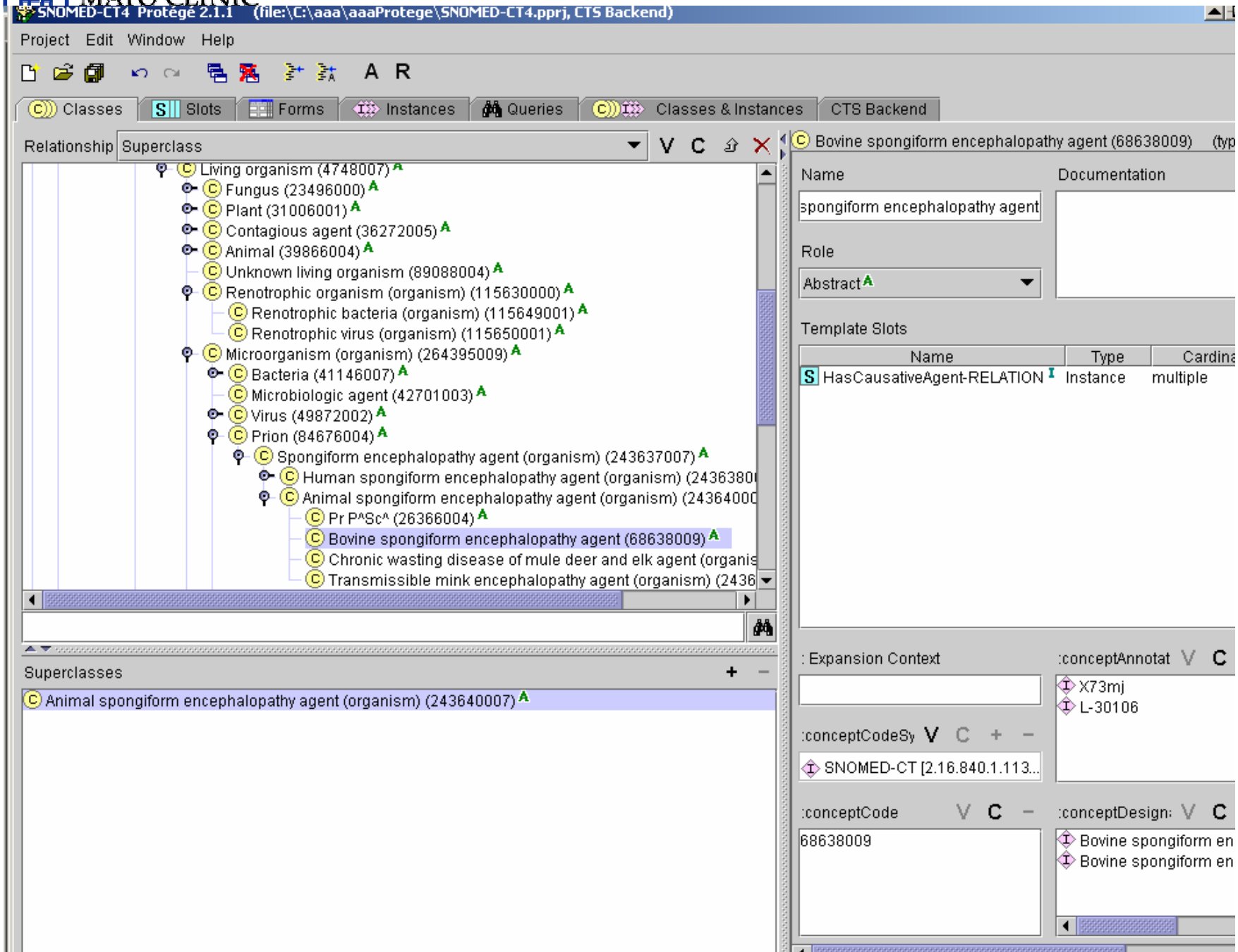
SNOMED-CT4 Protégé 2.1.1 (file:\C:\aaa\aaaProtege\SNOMED-CT4.pprj, CTS Backend)
Project Edit Window Help
Classes Slots Forms Instances Queries Classes & Instances CTS Backend
Relationship Superclass
Living organism (4748007) A
Fungus (23496000) A
Plant (31006001) A
Contagious agent (36272005) A
Animal (39866004) A
Unknown living organism (89088004) A
Renotrophic organism (organism) (115630000) A
Renotrophic bacteria (organism) (115649001) A
Renotrophic virus (organism) (115650001) A
Microorganism (organism) (264395009) A
Bacteria (41146007) A
Microbiologic agent (42701003) A
Virus (49872002) A
Prion (84676004) A
Spongiform encephalopathy agent (organism) (243637007) A
Human spongiform encephalopathy agent (organism) (2436380
Animal spongiform encephalopathy agent (organism) (2436400
Pr P^Sc^ (26366004) A
Bovine spongiform encephalopathy agent (68638009) A
Chronic wasting disease of mule deer and elk agent (organis
Transmissible mink encephalopathy agent (organism) (2436
Superclasses
Animal spongiform encephalopathy agent (organism) (243640007) A
Bovine spongiform encephalopathy agent (68638009) (typ
Name
spongiform encephalopathy agent
Documentation
Role
Abstract A
Template Slots
Name
Type
Cardina
HasCausativeAgent-RELATION I
Instance
multiple
: Expansion Context
:conceptAnnotat
X73mj
L-30106
:conceptCodeSy
SNOMED-CT [2.16.840.1.113...
:conceptCode
68638009
:conceptDesign:
Bovine spongiform en
Bovine spongiform en

MAYO CLINIC

Outline

- Purpose of the project
- Characteristics of Terminology Links
- The Common Terminology Services (CTS) specification
- **Protégé as a CTS Client**
- Protégé as a CTS Server
- Issues, discussion and next steps

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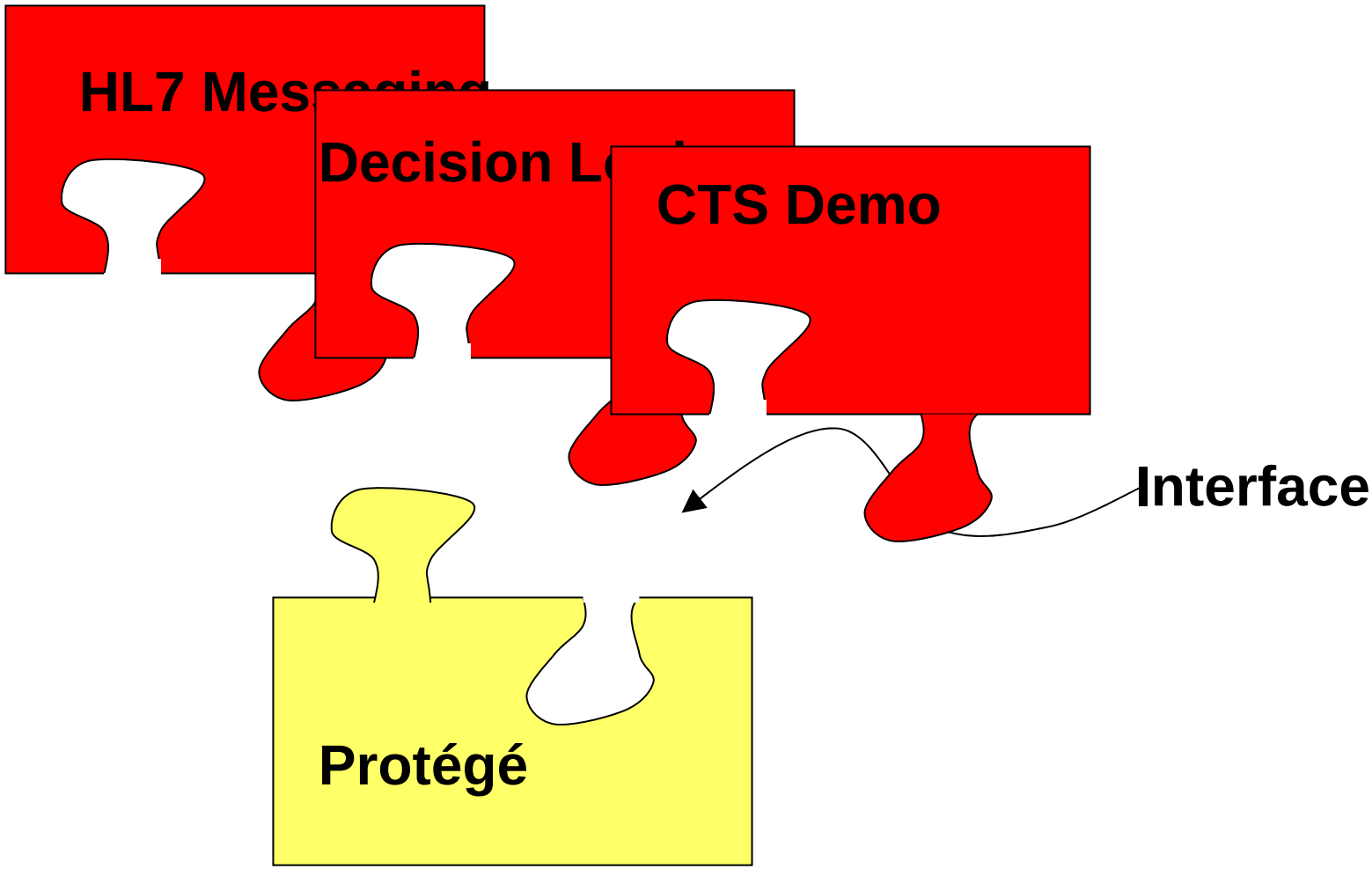
Protégé as a CTS Service



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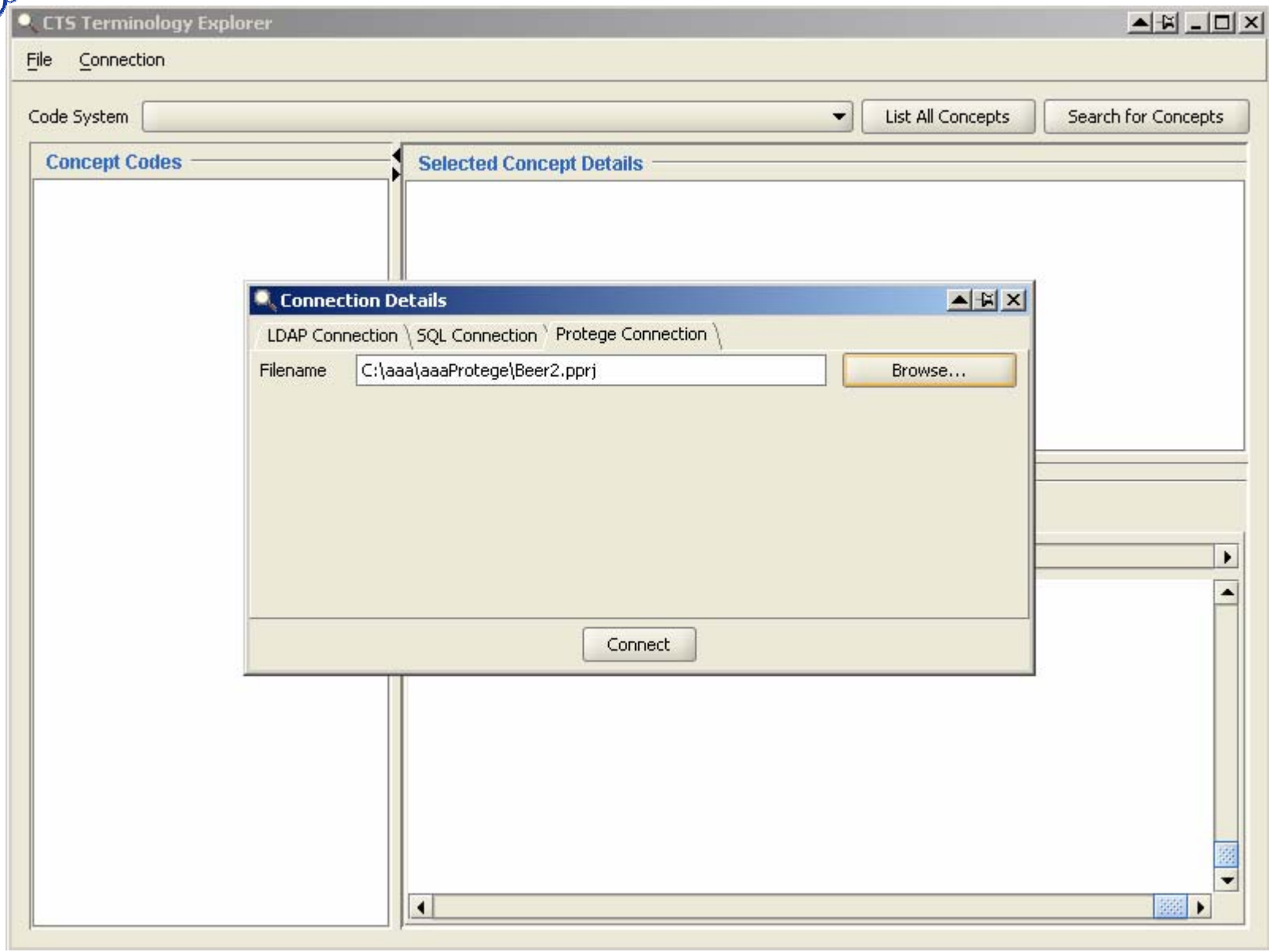
CTS Terminology Explorer
File
Connection
Code System
List All Concepts
Search for Concepts
Concept Codes
Selected Concept Details
Connection Details
LDAP Connection
SQL Connection
Protege Connection
Filename
C:\aaa\aaaProtege\Beer2.pprj
Browse...
Connect

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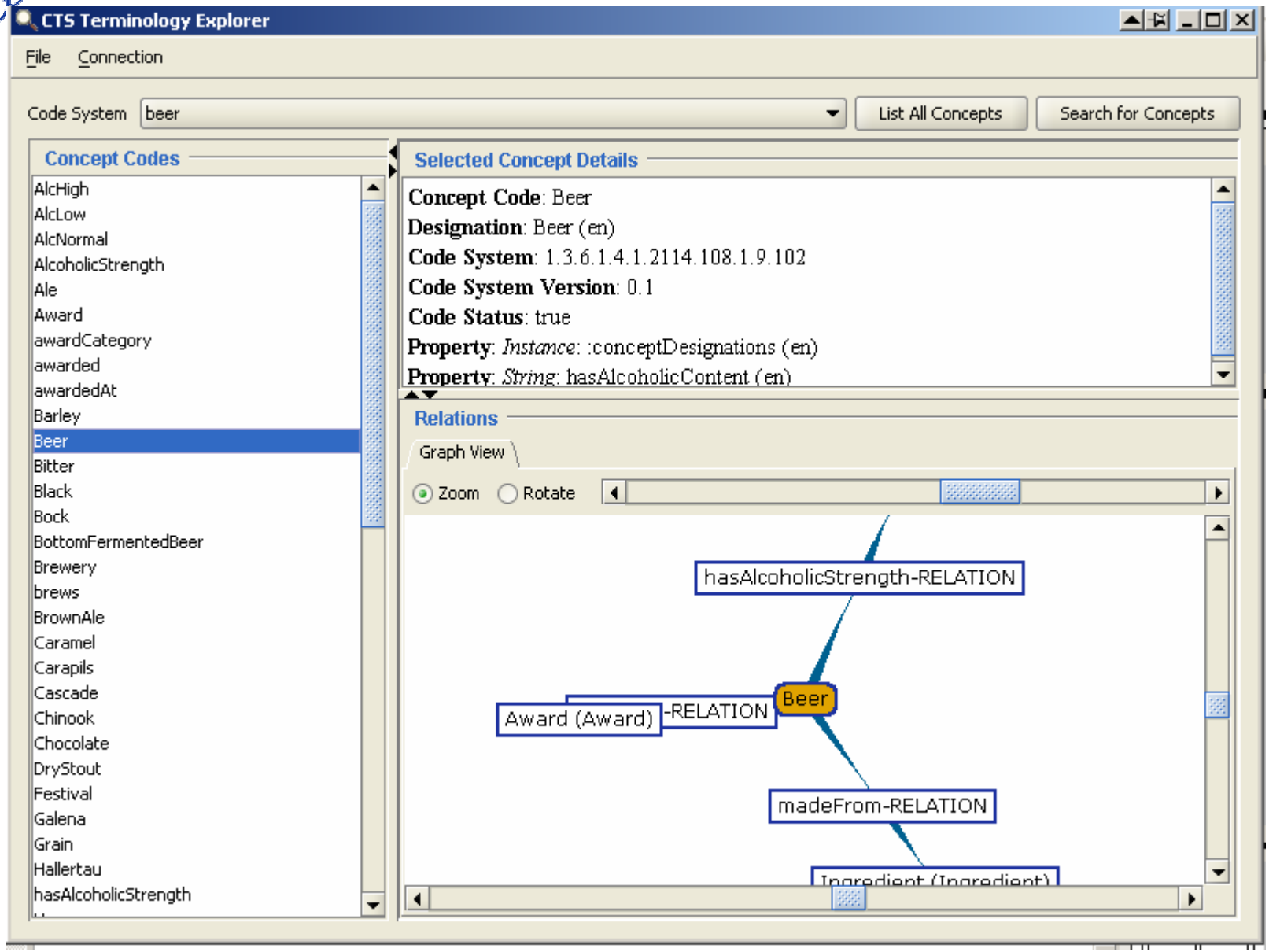
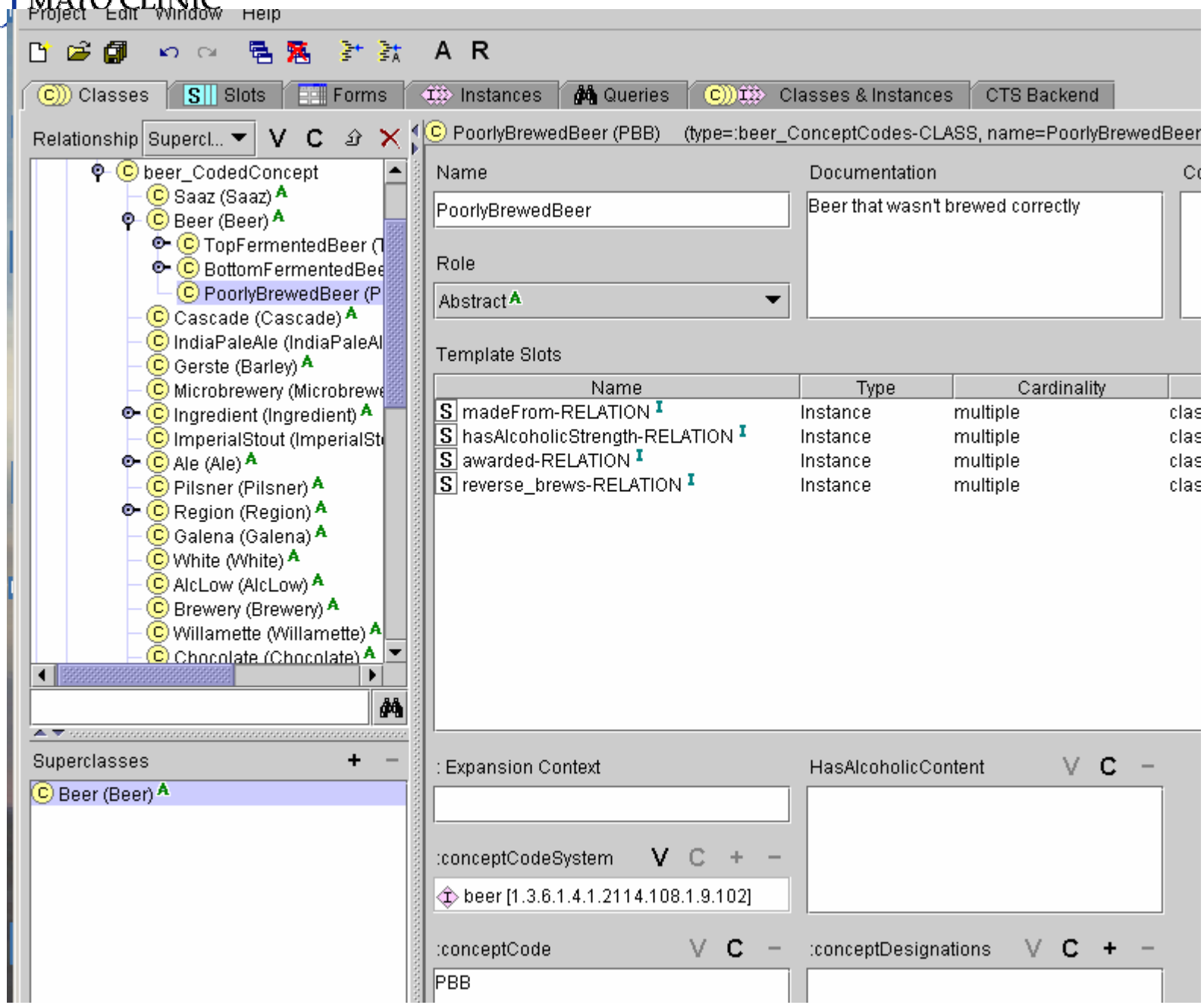

CTS Terminology Explorer
File
Connection
Code System
beer
List All Concepts
Search for Concepts
Concept Codes
AlcHigh
AlcLow
AlcNormal
AlcoholicStrength
Ale
Award
awardCategory
awarded
awardedAt
Barley
Beer
Bitter
Black
Bock
BottomFermentedBeer
Brewery
brews
BrownAle
Caramel
Carapils
Cascade
Chinook
Chocolate
DryStout
Festival
Galena
Grain
Hallertau
hasAlcoholicStrength
Selected Concept Details
Concept Code: Beer
Designation: Beer (en)
Code System: 1.3.6.1.4.1.2114.108.1.9.102
Code System Version: 0.1
Code Status: true
Property: Instance: :conceptDesignations (en)
Property: String: hasAlcoholicContent (en)
Relations
Graph View
Zoom
Rotate
hasAlcoholicStrength-RELATION
Award (Award)
-RELATION
Beer
madeFrom-RELATION


MAYO CLINIC
Project Edit Window Help
A R
Classes
Slots
Forms
Instances
Queries
Classes & Instances
CTS Backend
Relationship Supercl...
V C
beer_CodedConcept
Saaz (Saaz) A
Beer (Beer) A
TopFermentedBeer (T
BottomFermentedBee
PoorlyBrewedBeer (P
Cascade (Cascade) A
IndiaPaleAle (IndiaPaleAl
Gerste (Barley) A
Microbrewery (Microbrewe
Ingredient (Ingredient) A
ImperialStout (ImperialSt
Ale (Ale) A
Pilsner (Pilsner) A
Region (Region) A
Galena (Galena) A
White (White) A
AlcLow (AlcLow) A
Brewery (Brewery) A
Willamette (Willamette) A
Chocolate (Chocolate) A
Superclasses + −
Beer (Beer) A
PoorlyBrewedBeer (PBB) (type=:beer_ConceptCodes-CLASS, name=PoorlyBrewedBeer
Name
PoorlyBrewedBeer
Documentation
Beer that wasn't brewed correctly
Role
Abstract A
Template Slots
Name
Type
Cardinality
madeFrom-RELATION I
Instance
multiple
hasAlcoholicStrength-RELATION I
Instance
multiple
awarded-RELATION I
Instance
multiple
reverse_brews-RELATION I
Instance
multiple
: Expansion Context
HasAlcoholicContent V C −
:conceptCodeSystem V C + −
beer [1.3.6.1.4.1.2114.108.1.9.102]
:conceptCode V C −
PBB
:conceptDesignations V C + −

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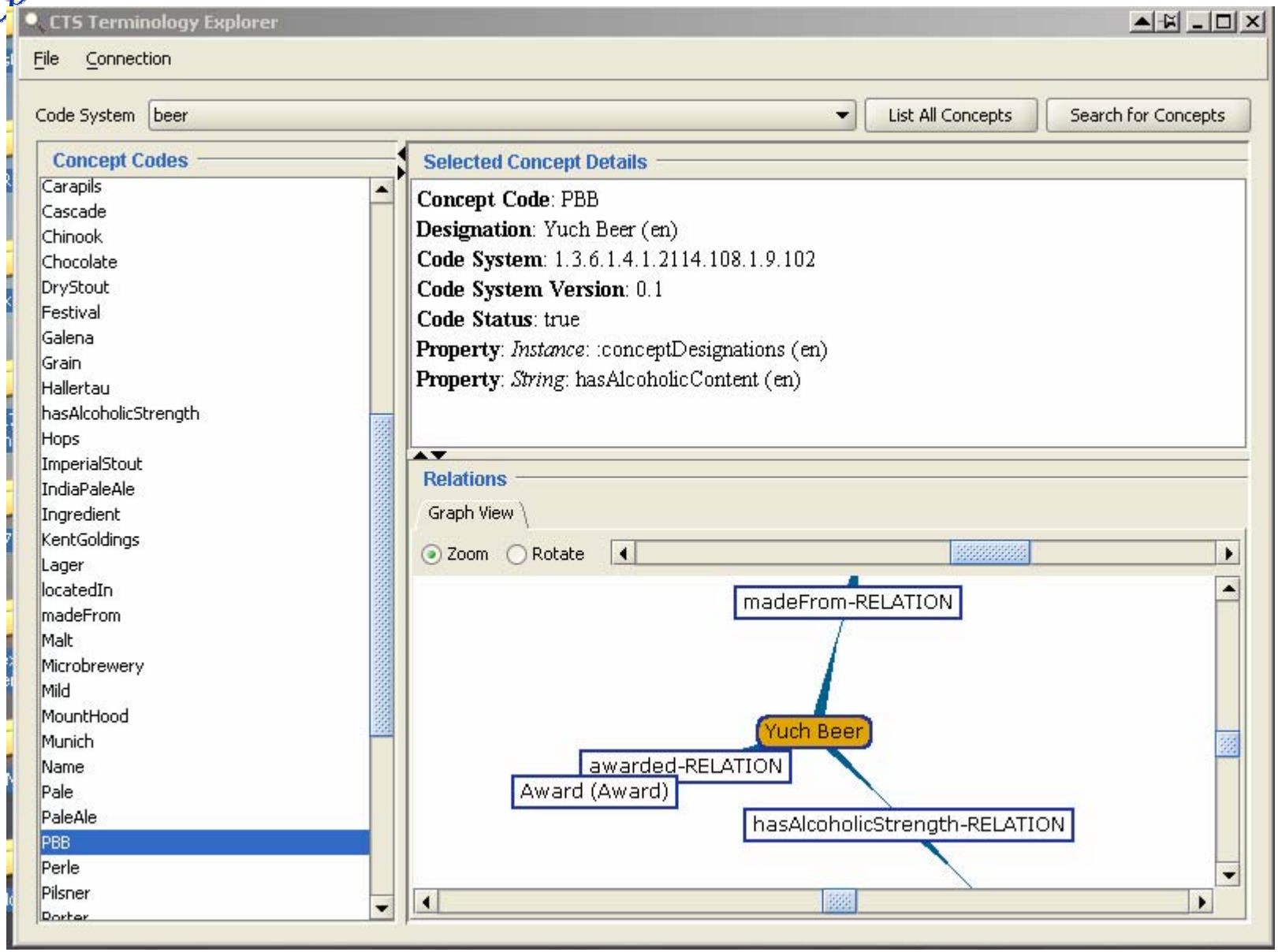
CTS Terminology Explorer
File
Connection
Code System
beer
List All Concepts
Search for Concepts
Concept Codes
Carapils
Cascade
Chinook
Chocolate
DryStout
Festival
Galena
Grain
Hallertau
hasAlcoholicStrength
Hops
ImperialStout
IndiaPaleAle
Ingredient
KentGoldings
Lager
locatedIn
madeFrom
Malt
Microbrewery
Mild
MountHood
Munich
Name
Pale
PaleAle
PBB
Perle
Pilsner
Selected Concept Details
Concept Code: PBB
Designation: Yuch Beer (en)
Code System: 1.3.6.1.4.1.2114.108.1.9.102
Code System Version: 0.1
Code Status: true
Property: Instance: :conceptDesignations (en)
Property: String: hasAlcoholicContent (en)
Relations
Graph View
Zoom
Rotate
madeFrom-RELATION
Yuch Beer
awarded-RELATION
Award (Award)
hasAlcoholicStrength-RELATION

MAYO CLINIC

Outline

- Purpose of the project
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- Protégé as a CTS Client
- Protégé as a CTS Server
- **Issues, discussion and next steps**

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Issues, etc.

- **Slow load time**
  - Appears comparable w/ OWL
  - Partially resolved w/ lazy loading
- **Need a SymbolReference**
  - Dynamically resolved Symbol
  - Ties in w/ DirectedBinaryRelation
- **Relations**
  - Need to reconcile w/ DirectedBinaryRelation
- **Need to make CTS Server a Protégé Server**

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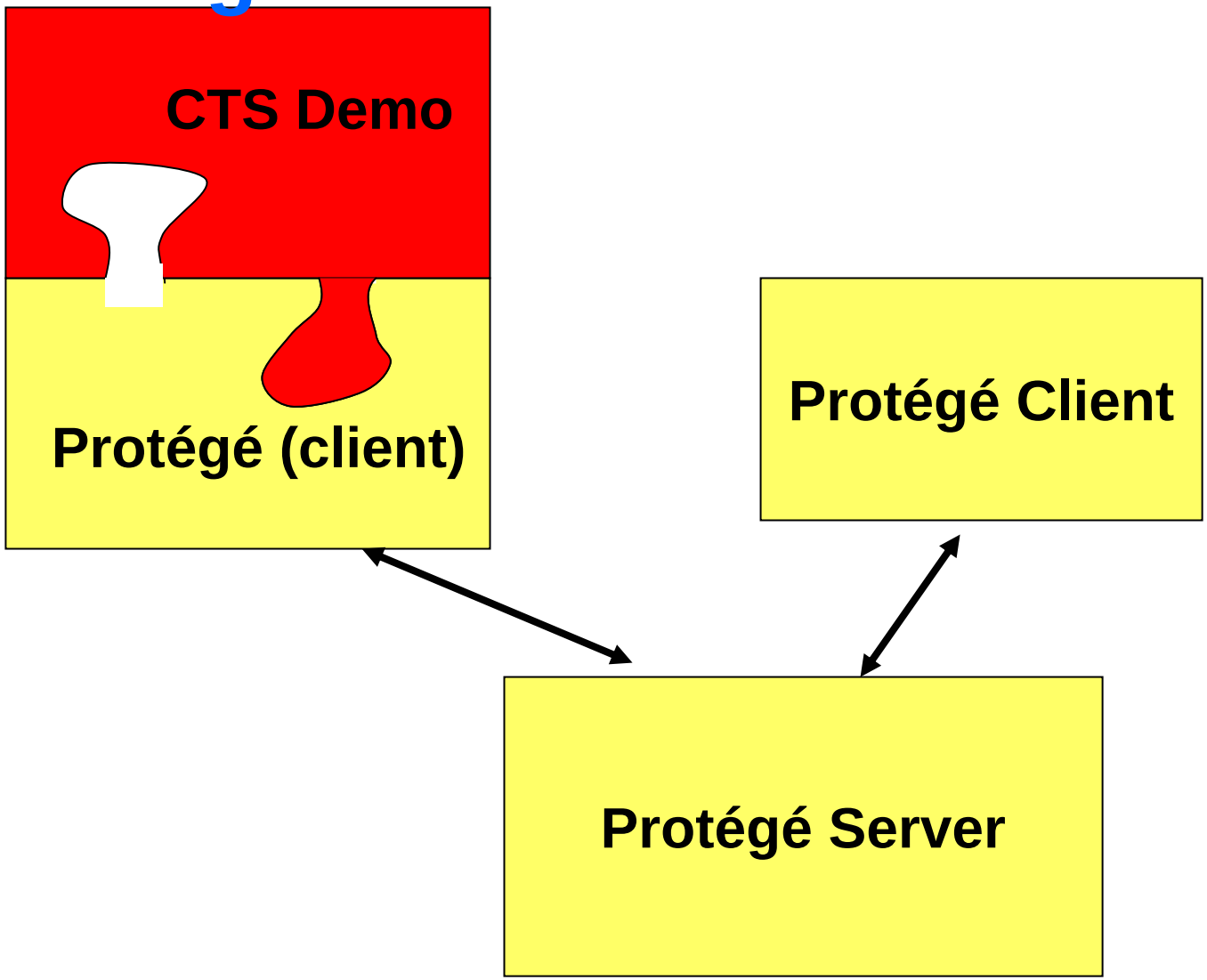
Protégé as CTS Server



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Issues, etc. (continued)

- Need to flesh out lazy loading
  - References occur all over
- Need to implement a hierarchy trimmer
  - Only keep references
  - Only keep graph branch points

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Credits

- **Deepak Sharma – author**
- **Dan Armbrust - CTS author**

This work was supported in part by a grant from the US National Library of Medicine: LM07319.