

# RXNORM in OWL

This is an experimental dataset in support of the SNOMED Workshop "Interoperation and Analytics of EHR Data: Use Cases for Problem List, Laboratory Results, Anatomic Pathology and Medications" and should not be considered a permanent resource.

This file has not been reviewed by pharmacists and NLM makes no claim of completeness or accuracy.

Goal: Download the RxNorm in OWL distribution and load it into Protégé.

Pre-requisites:

1. PC/Mac with at least 15G RAM
2. Desktop [Protégé 5.5.0-beta-7](#) \* installed with bundled jre (version 7)
  - a. run.bat edited to increase -Xmx15000M (similar if .sh is on your installation)
  - b. [ELK Reasoner](#) exists in plugins folder (org.semanticweb.elk-0.4.3.jar)

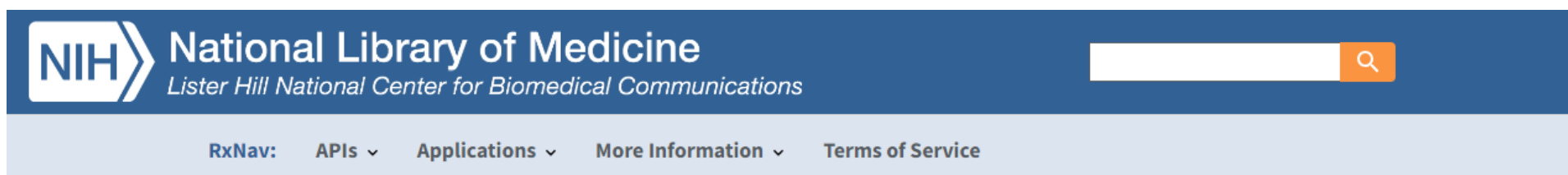
```
run.bat
1 setlocal
2 cd /d %~dp0
3 C:\Protege-5.5.0-beta-7\jre\bin\java -Xmx15000M -Xms200M -Xss16M -XX:CompileCommand=exclude,javax/swing/text/GlyphView,getBreakSpot
-DentityExpansionLimit=100000000 -Dlogback.configurationFile=conf/logback-win.xml -Dfile.encoding=utf-8 -Dorg.protege.plugin.dir=plugins -classpath
bundles/guava.jar;bundles/logback-classic.jar;bundles/logback-core.jar;bundles/slf4j-api.jar;bin/org.apache.felix.main.jar;bin/maven-artifact.jar;bin/proteg
e-launcher.jar org.protege.osgi.framework.Launcher %1
```

↑ This PC > Windows (C:) > Protege-5.5.0-beta-7 > plugins

Name	Date modified	Type	Size
cellfie-2.1.0.jar	12/17/2018 4:49 PM	Executable Jar File	10,629 KB
code-generation-2.0.0.jar	12/17/2018 4:49 PM	Executable Jar File	133 KB
existentialquery-2.0.0.jar	12/17/2018 4:49 PM	Executable Jar File	14 KB
explanation-workbench-3.0.0.jar	12/17/2018 4:49 PM	Executable Jar File	317 KB
ontograf-2.0.3.jar	12/17/2018 4:49 PM	Executable Jar File	1,039 KB
org.coode.dlquery-4.0.1.jar	12/17/2018 4:49 PM	Executable Jar File	27 KB
org.semanticweb.elk-0.4.3.jar	12/17/2018 4:49 PM	Executable Jar File	858 KB
org.semanticweb.hermit-1.3.8.413.jar	12/17/2018 4:49 PM	Executable Jar File	1,854 KB
owldoc-3.0.3.jar	12/17/2018 4:49 PM	Executable Jar File	263 KB
owlviz-5.0.3.jar	12/17/2018 4:49 PM	Executable Jar File	283 KB
rdf-library-3.0.0.jar	12/17/2018 4:49 PM	Executable Jar File	3,122 KB
snap-sparql-query-plugin-6.0.0.jar	5/16/2022 3:14 PM	Executable Jar File	1,181 KB
sparql-query-plugin-3.0.0.jar	12/17/2018 4:49 PM	Executable Jar File	19 KB
swritab-plugin-2.0.6.jar	12/17/2018 4:49 PM	Executable Jar File	14,357 KB

\* Protégé 5.5.0-beta-7 is based on OWLAPI4 and supports ELK version 0.4.3, together capable of displaying class equivalencies in the Class hierarchy and Description panels. Later versions of Protégé and ELK have limited support for viewing these equivalencies and are slated to be fixed with the official Protégé 5.6.0 (released 230209, yet to be tested with this distribution).

3. Download the RxNorm-in-OWL at: <https://lhncbc.nlm.nih.gov/RxNav/news/RxNorm-in-OWL.html>



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**Defined RxNorm-in-OWL with SNOMED CT Classes**

## Opening the Defined RxNorm ontology

1. File -> Open -> /unzipped/directory/Defined-RxNorm-with-SNCT-classes-YYYY-MM-DD.owl

The screenshot shows the Protégé ontology editor interface. The 'File' menu is open, and the 'Open...' option is selected. The main workspace displays the ontology 'untitled-ontology-57' with a search bar and a 'DL Query' tab. The 'Ontology metrics' panel on the right shows counts for various metrics, and the 'Class axioms' and 'Object property axioms' panels are also visible. The bottom status bar indicates 'To use the reasoner click Reasoner > Start reasoner' and 'Show Inferences' is checked.

File Edit View Reasoner Tools Refactor Window Help

New... Ctrl-N

Open... Ctrl-O

Open from URL... Ctrl+Shift-O

Open recent

Save Ctrl-S

Save as... Ctrl+Shift-S

Gather ontologies... Ctrl+Shift-G

Export inferred axioms as ontology...

Reload Ctrl+Shift-R

Edit active ontology catalog... Ctrl-L

Edit ontology catalog file...

Loaded ontology sources...

Check for plugins...

Close window Ctrl-W

Preferences...

Exit

untitled-ontology-57 (http://www.semanticweb.org/wynner/ontologies/2023/0/untitled-ontology-57) : [http://www.semanticweb.org/wynner/ontologies/2023/0/untitled-ontology-57]

web.org/wynner/ontologies/2023/0/untitled-ontology-57

DL Query x

g/wynner/ontologies/2023/0/untitled-ontology-57

g/wynner/ontologies/2023/0/untitled-ontology-57/1.0.0

Ontology metrics:

**Metrics**

Axiom	0
Logical axiom count	0
Declaration axioms count	0
Class count	0
Object property count	0
Data property count	0
Individual count	0
Annotation Property count	0

**Class axioms**

SubClassOf	0
EquivalentClasses	0
DisjointClasses	0
GCI count	0
Hidden GCI Count	0

**Object property axioms**

SubObjectPropertyOf	0
EquivalentObjectProperty	0

Ontology imports | Ontology Prefixes | General class axioms

Imported ontologies:

Direct Imports +

Indirect Imports

To use the reasoner click Reasoner > Start reasoner ☒ Show Inferences

2. Import the SNOMED CT OWL as a Direct Import after generating SNOMED CT in OWL (follow steps a,b and c below if you do not have a copy) by selecting the Direct Imports circular plus sign.
- [Download](#) the most recent snomed-owl-toolkit\*executable.jar.
  - Download the monthly [RF2 distribution](#) from NLM.
  - Generate the OWL from RF2 with the command [here](#).

The screenshot shows the Protégé OWL editor interface. The top menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The address bar shows the URL (https://mor.nlm.nih.gov/) and the file path [C:\Users\wynner\Desktop\rxnorm-snomedct\230112\Defined-RxNorm-with-SNCT-classes-2023-01-11\_23-58-32.owl].

The 'Active Ontology' tab is selected, showing the 'Ontology header' section with the following information:

- Ontology IRI: https://mor.nlm.nih.gov/
- Ontology Version IRI: e.g. https://mor.nlm.nih.gov/1.0.0

The 'Annotations' section is empty, indicated by a plus sign icon.

The 'Ontology metrics' panel on the right displays the following data:

Metrics	
Axiom	2764380
Logical axiom count	208653
Declaration axioms count	116157
Class count	116101
Object property count	9
Data property count	5
Individual count	0
Annotation Property count	43

The 'Class axioms' section shows:

Class axioms	
SubClassOf	184041
EquivalentClasses	24612
DisjointClasses	0
GCI count	0
Hidden GCI Count	24582

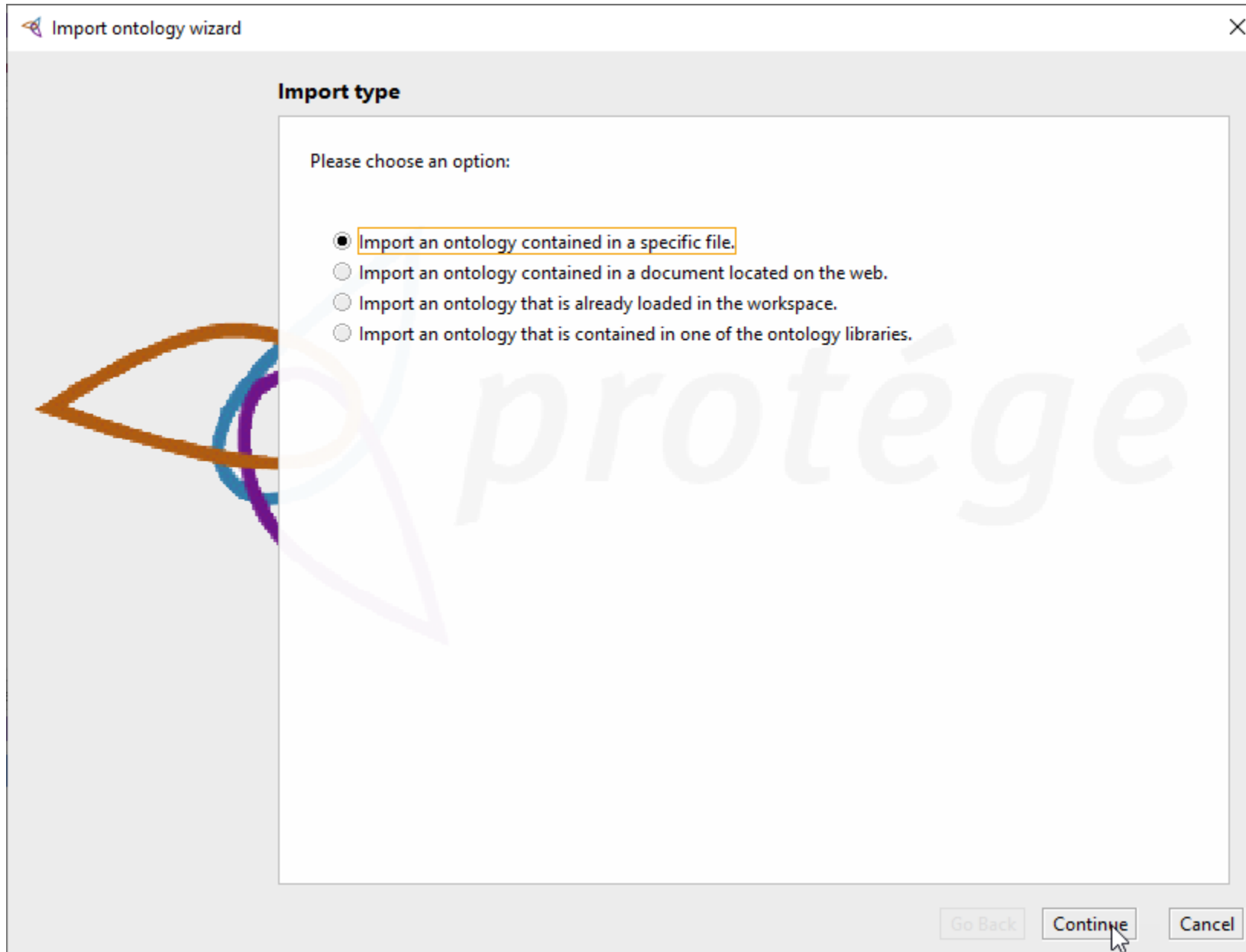
The 'Object property axioms' section shows:

Object property axioms	
SubObjectPropertyOf	0

The 'Imported ontologies' panel at the bottom shows the 'Direct Imports' button (a green plus sign) highlighted, with a mouse cursor hovering over it. The 'Indirect Imports' section is empty, indicated by a plus sign icon.

The bottom status bar indicates: To use the reasoner click Reasoner > Start reasoner ☒ Show Inferences

3. The Import ontology wizard will begin. Select Import and ontology contained in a specific file.



Import ontology wizard

**Import type**

Please choose an option:

- ☒ Import an ontology contained in a specific file.
- ☐ Import an ontology contained in a document located on the web.
- ☐ Import an ontology that is already loaded in the workspace.
- ☐ Import an ontology that is contained in one of the ontology libraries.

Go Back Continue Cancel

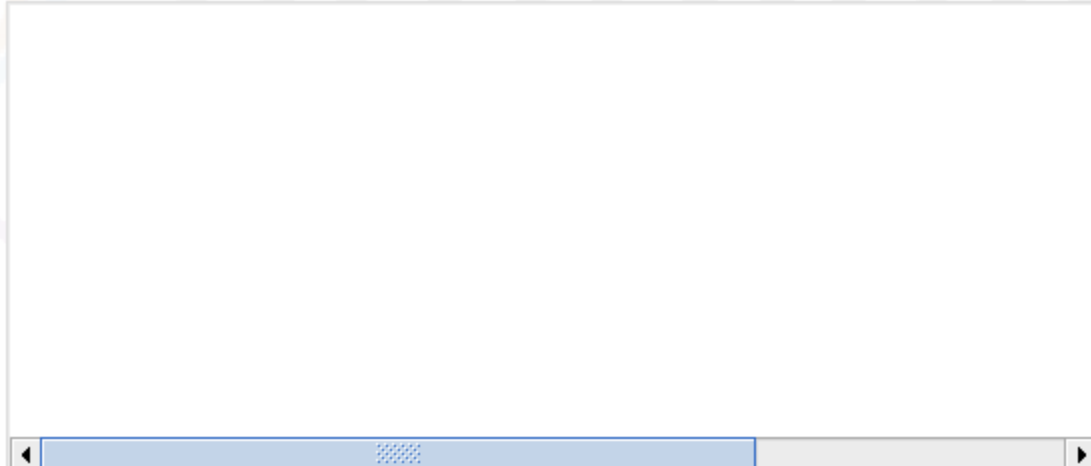
**Import from local file**

Please specify the path to a file that contains an ontology. You can use the browse button to show a file chooser dialog.

**Path**

C:\Users\wynner\Desktop\rxnorm-snomedct\230112\ontology-2023-01-09\_12-53-41.owl

Browse...

**Recent locations**

☐ Manually specify import declarations.

This is generally not needed as Protege will choose a reasonable default.

Go Back

Continue

Cancel

### Import verification

Please wait. Verifying import...



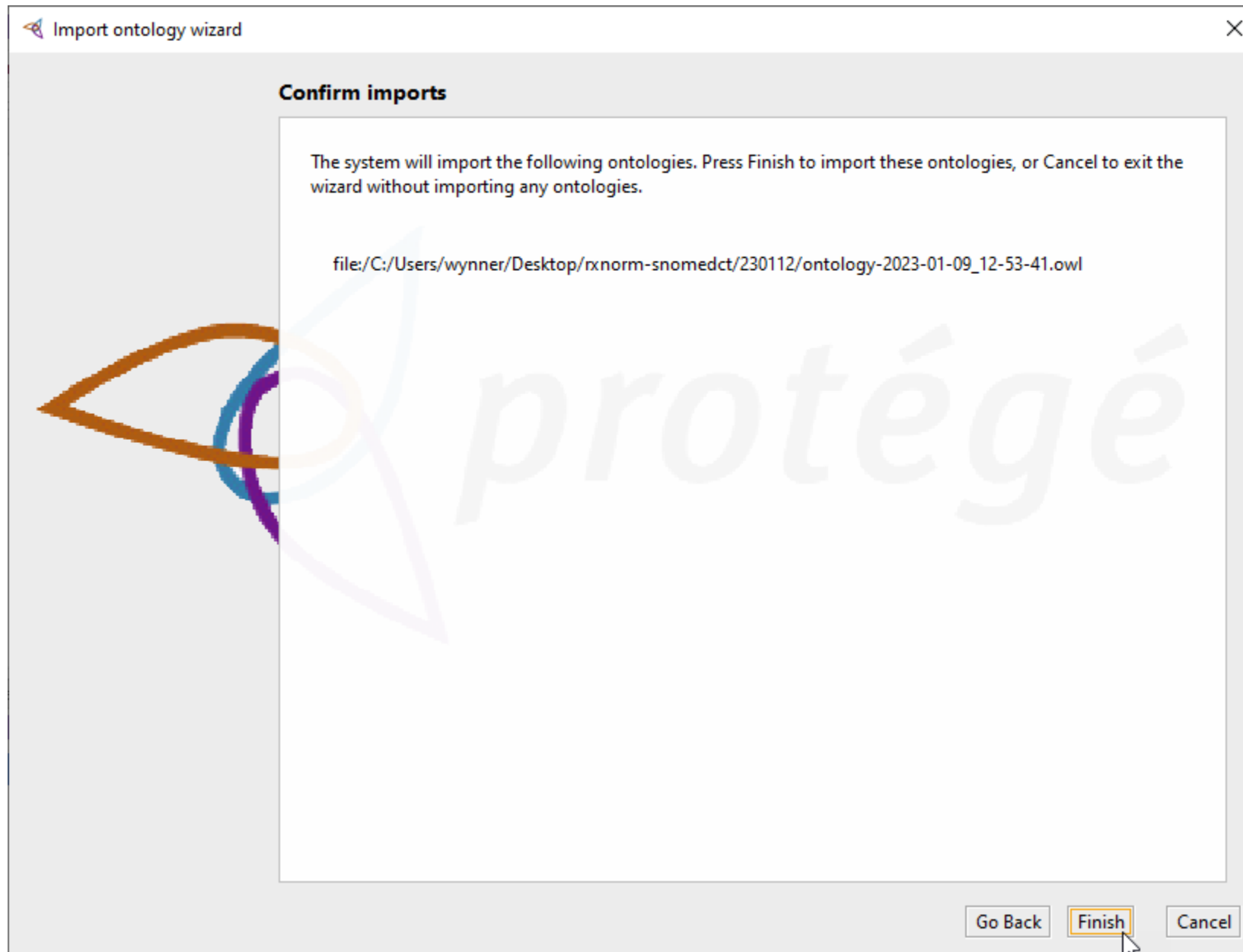
Go Back

Continue

Cancel



4. Select Finish to Confirm the SNOMED import. The Import ontology wizard will exit and the Active Ontology panel will display. When finished progressing, this Direct Import will display on the Active Ontology panel.



(https://mor.nlm.nih.gov/) : [C:\Users\wynner\Desktop\rxnorm-snomedct\230112\Defined-RxNorm-with-SNCT-classes-2023-01-11\_23-58-32.owl]

File Edit View Reasoner Tools Refactor Window Help

(https://mor.nlm.nih.gov/) Search...

Active Ontology x Entities x Individuals by class x DL Query x

Ontology header: ? ? ? ?

Ontology IRIhttps://mor.nlm.nih.gov/

Ontology Version IRIe.g. https://mor.nlm.nih.gov/1.0.0

Annotations +

Ontology metrics: ? ? ? ?

Metrics

Axiom	2764380
Logical axiom count	208653
Declaration axioms count	116157
Class count	116101
Object property count	9
Data property count	5
Individual count	0
Annotation Property count	43

Class axioms

	184041
es	24612
	0
unt	0
	24582

Object property axioms

SubObjectPropertyOf	0
	0

Ontology imports

Ontology Prefixes

General class axioms

Imported ontologies: ? ? ? ?

Direct Imports +

Indirect Imports

To use the reasoner click Reasoner > Start reasoner ☒ Show Inferences

(https://mor.nlm.nih.gov/) : [C:\Users\wynner\Desktop\rxnorm-snomedct\230112\Defined-RxNorm-with-SNCT-classes-2023-01-11\_23-58-32.owl]

File Edit View Reasoner Tools Refactor Window Help

< > (https://mor.nlm.nih.gov/) Search...

Active Ontology x Entities x Individuals by class x DL Query x

Ontology header: ? ? ? ? ?

Ontology IRIhttps://mor.nlm.nih.gov/

Ontology Version IRIe.g. https://mor.nlm.nih.gov/1.0.0

Annotations +

Ontology metrics: ? ? ? ? ?

Metrics

Axiom	4444853
Logical axiom count	569837
Declaration axioms count	470651
Class count	470469
Object property count	126
Data property count	11
Individual count	0
Annotation Property count	46

Class axioms

SubClassOf	413007
EquivalentClasses	156684
DisjointClasses	0
GCI count	322
Hidden GCI Count	30809

Object property axioms

SubObjectPropertyOf	125
---------------------	-----

Ontology imports Ontology Prefixes General class axioms

Imported ontologies: ? ? ? ? ?

Direct Imports +

<http://snomed.info/sct/900000000000207008/version/20230109>

sct

Ontology IRI: <http://snomed.info/sct/900000000000207008>

Version IRI: <http://snomed.info/sct/900000000000207008/version/20230109>

Location: C:\Users\wynner\Desktop\rxnorm-snomedct\230112\ontology-2023-01-09\_12-53-41.owl

Indirect Imports

To use the reasoner click Reasoner > Start reasoner ☒ Show Inferences

## 5. Select the 'ELK 0.4.3' reasoner. Then Select 'Start reasoner'

The screenshot shows the Protégé OWL editor interface. The 'Reasoner' menu is open, displaying the following options:

- Start reasoner (Ctrl-R)
- Synchronize reasoner
- Stop reasoner
- Explain inconsistent ontology
- Configure...

A red arrow points to the 'Start reasoner' option. The 'Ontology metrics' panel on the right displays the following data:

Metrics	
Axiom	4444853
Logical axiom count	569837
Declaration axioms count	470651
Class count	470469
Object property count	126
Data property count	11
Individual count	0
Annotation Property count	46

The 'Class axioms' panel displays the following data:

Class axioms	
SubClassOf	413007
EquivalentClasses	156684
DisjointClasses	0
GCI count	322
Hidden GCI Count	30809

The 'Object property axioms' panel displays the following data:

Object property axioms	
SubObjectPropertyOf	125

The 'Imported ontologies' panel shows the following information:

Direct Imports +

- <http://snomed.info/sct/900000000000207008/version/20230109>  
sct  
Ontology IRI: <http://snomed.info/sct/900000000000207008>  
Version IRI: <http://snomed.info/sct/900000000000207008/version/20230109>  
Location: [C:\Users\wynner\Desktop\rxnorm-snomedct\230112\ontology-2023-01-09\\_12-53-41.owl](C:\Users\wynner\Desktop\rxnorm-snomedct\230112\ontology-2023-01-09_12-53-41.owl)

Indirect Imports

To use the reasoner click Reasoner > Start reasoner ☒ Show Inferences

Persevere through each ELK Warning message by checking the box and selecting OK. Note: Selecting the check box may take some time to register with Protégé. This is expected.

The screenshot shows the Protégé ontology editor interface. The top menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The main window displays the ontology header with the IRI <https://mor.nlm.nih.gov/> and version IRI [e.g. https://mor.nlm.nih.gov/1.0.0](https://mor.nlm.nih.gov/1.0.0). The right sidebar shows ontology metrics, including Axiom count (4444853), Logical axiom count (569837), Declaration axioms count (470651), Class count (470469), Object property count (126), Data property count (11), and various GCI counts. The bottom section shows imported ontologies, including a direct import from <http://snomed.info/sct/900000000000207008/version/20230109>. An ELK Warning dialog box is overlaid in the center, with the following text:

**ELK Warning**

⚠ ELK supports DataHasValue only partially. Reasoning might be incomplete!

☒ Do not show further messages of this kind in this session  
(the messages can still be seen in the console if Protégé was started from the command line)

OK

(https://mor.nlm.nih.gov/) : [C:\Users\wynner\Desktop\rxnorm-snomedct\230112\Defined-RxNorm-with-SNCT-classes-2023-01-11\_23-58-32.owl]

File Edit View Reasoner Tools Refactor Window Help

(https://mor.nlm.nih.gov/) Search...

Active Ontology x Entities x Individuals by class x DL Query x

Ontology header: **Ontology IRI** https://mor.nlm.nih.gov/ **Ontology Version IRI** e.g. https://mor.nlm.nih.gov/1.0.0

Annotations +

Ontology metrics: **Metrics**

Axiom	4444853
Logical axiom count	569837
Declaration axioms count	470651
Class count	470469
Object property count	126
Data property count	11
Property count	0
Property count	46
	413007
	156684
	0
GCI count	322
Hidden GCI Count	30809
<b>Object property axioms</b>	
SubObjectPropertyOf	125

ELK Warning

ELK does not support SubDataPropertyOf. Axiom ignored:

☒ Do not show further messages of this kind in this session  
(the messages can still be seen in the console if Protégé was started from the command line)

OK

Ontology imports **Ontology Prefixes** General class axioms

Imported ontologies:

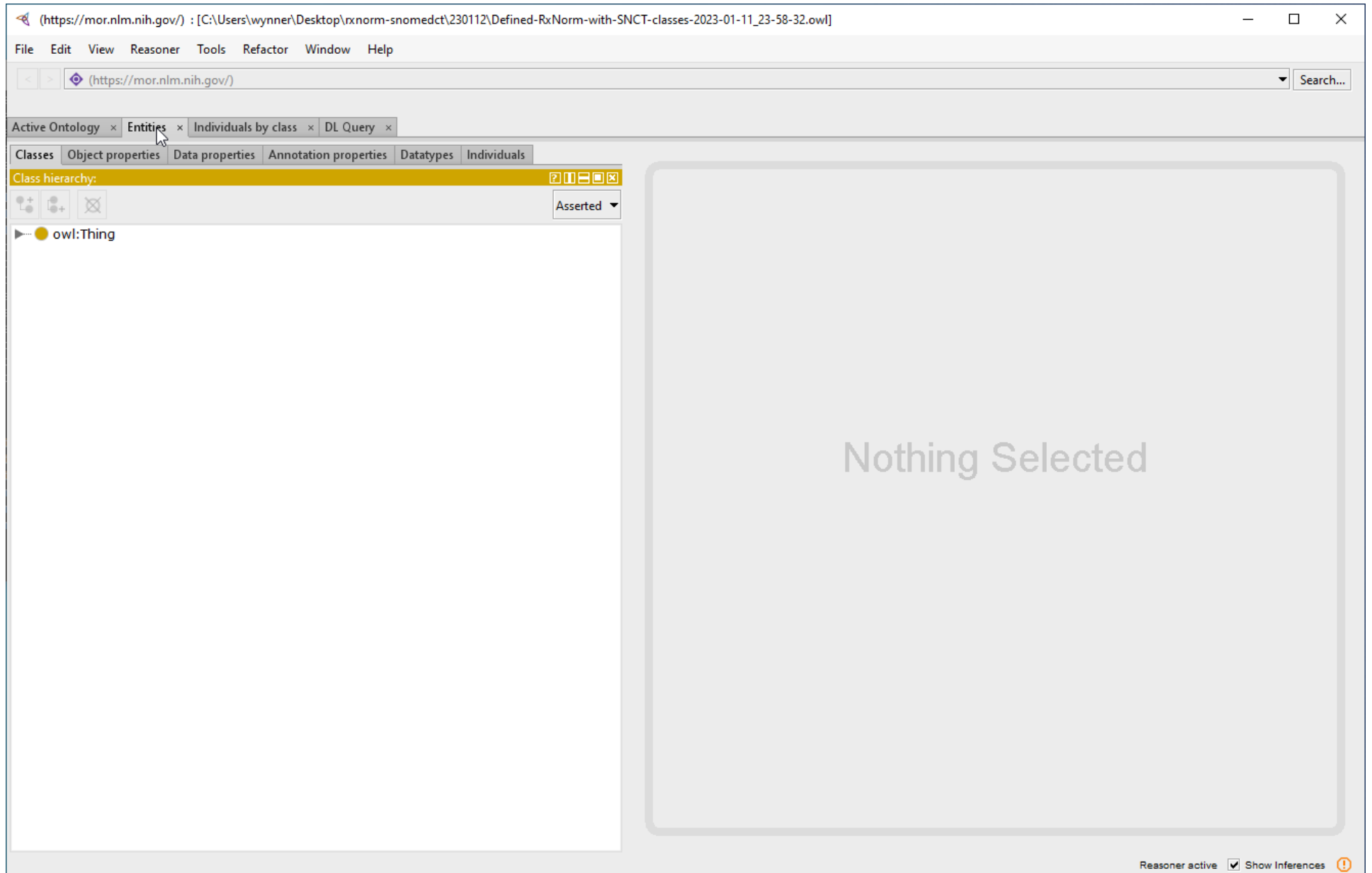
Direct Imports +

<http://snomed.info/sct/900000000000207008/version/20230109>  
sct  
Ontology IRI: <http://snomed.info/sct/900000000000207008>  
Version IRI: <http://snomed.info/sct/900000000000207008/version/20230109>  
Location: [C:\Users\wynner\Desktop\rxnorm-snomedct\230112\ontology-2023-01-09\\_12-53-41.owl](C:\Users\wynner\Desktop\rxnorm-snomedct\230112\ontology-2023-01-09_12-53-41.owl)

Indirect Imports

Reasoner active ☒ Show Inferences

Select the Entities tab.

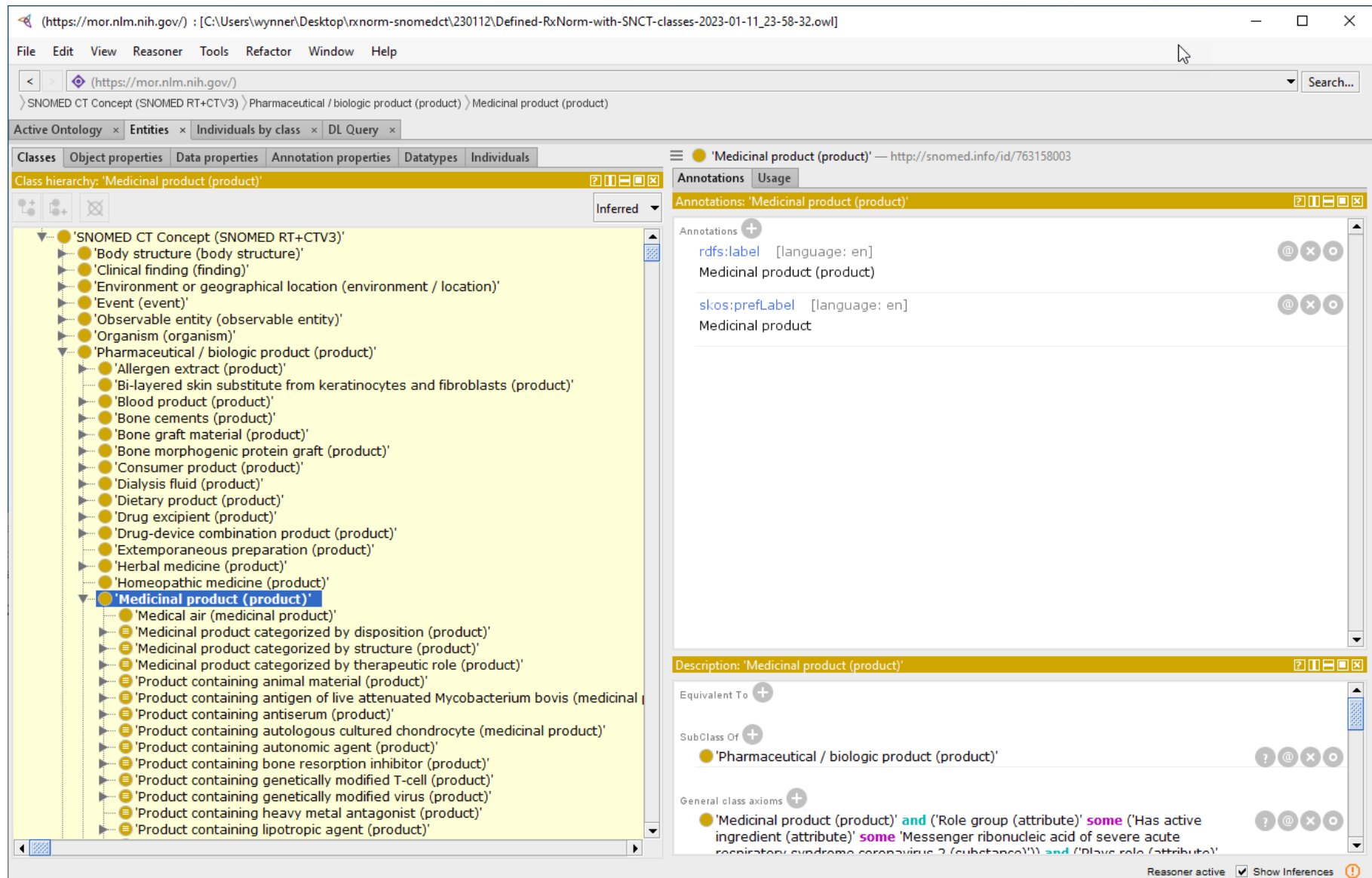


On the Classes tab, select the Inferred view.

The screenshot shows the Protégé OWL editor interface. The title bar indicates the file path: `(https://mor.nlm.nih.gov/) : [C:\Users\wynner\Desktop\rxnorm-snomedct\230112\Defined-RxNorm-with-SNCT-classes-2023-01-11_23-58-32.owl]`. The menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. Below the menu bar is a search bar with the text `(https://mor.nlm.nih.gov/)` and a "Search..." button. The main interface has a tabbed view with "Active Ontology", "Entities", "Individuals by class", and "DL Query". The "Entities" tab is active, and within it, the "Classes" sub-tab is selected. The "Class hierarchy:" section shows a tree view with "owl:Thing" as the root. To the right of the tree view is a dropdown menu with three options: "Asserted", "Asserted", and "Inferred". The "Inferred" option is currently selected, highlighted in blue, and a mouse cursor is pointing at it. The main display area on the right is a large gray rectangle with the text "Nothing Selected" in the center. At the bottom right, there is a status bar with the text "Reasoner active", a checked checkbox for "Show Inferences", and a warning icon.



A RxNorm class may also have more than one parent class. Navigating to each may be done via the Description panel.



Select **Search** to find identifier (IRI fragment) 1923428 *timolol 2.5 MG/ML Ophthalmic Solution*

Double-click the result. Protégé will open the SCD in the hierarchy. This is possible for any annotation value, etc.

The screenshot displays the Protégé ontology editor interface. On the left, a tree view shows the hierarchy of classes, with 'timolol 2.5 MG/ML Ophthalmic Solution' selected. The main pane shows the 'Annotations' tab for this class, listing various annotations including 'rdfs:label', 'xRef', and 'MMSL\_CODE'. A search dialog is open in the top right, showing the search results for '1923428'. The search results table has columns 'Found in', 'Entity', and 'Match'. The results show that '1923428' is found in the 'IRI' column, with the entity being 'timolol 2.5 MG/ML Ophthalmic Solution' and the match being 'http://mor.nlm.nih.gov/RXNORM/1923428'. Below the search dialog, the 'Description' tab for the selected class is visible, showing a complex logical definition for 'timolol 2.5 MG/ML Ophthalmic Solution'.

Search results for '1923428':

Found in	Entity	Match
IRI	'timolol 2.5 MG/ML Ophthalmic Solution'	http://mor.nlm.nih.gov/RXNORM/1923428
'has RxCUI'	'timolol 2.5 MG/ML Ophthalmic Solution'	'has RxCUI' 1923428
xRef	'timolol 2.5 MG/ML Ophthalmic Solution'	xRef RxCUI:1923428

Description: 'timolol 2.5 MG/ML Ophthalmic Solution'

Equivalent To:

- 'Medicinal product (product)' and ('Has manufactured dose form (attribute)' some 'Conventional release eye drops (dose form)') and ('Role group (attribute)' some (('Has basis of strength substance (attribute)' some 'Timolol (substance)') and ('Has concentration strength denominator unit (attribute)' some ML) and ('Has concentration strength numerator unit (attribute)' some MG) and ('Has precise active ingredient (attribute)' some 'Timolol maleate (substance)') and ('Has concentration strength denominator value (attribute)' value 1) and ('Has concentration strength numerator value (attribute)' value 2.5)))
- 'Product containing precisely timolol (as timolol maleate) 2.5 milligram/1 milliliter conventional release eye drops (clinical drug)'
- 'Preservative-Free timolol 2.5 MG/ML Ophthalmic Solution'

SubClass Of:

- 'Medicinal product (product)'
- 'Product containing only timolol in ocular dose form (medicinal product form)'

Known issues (230216):

- Branded drug products are purposefully primitive classes
- Some Obsolete concepts lacking definitional features required for logical definitions are primitive classes
- Not all SBDs are treed to class 'RXNORM SBDs (Brand Drugs)'
- SBDs of Status NotCurrent are treed to a Work in Progress class, 'RXNORM WIP SBDs (Brand Drugs)'
- Some Remapped SBDs of Status E are treed to 'RXNORM WIP SBDs (Brand Drugs)'