NISTIR 7945

NIST Ontological Visualization Interface for Standards: User's Guide

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Executive Summary

The NIST Ontological Visualization Interface for Standards (NOVIS) was developed at the National Institute of Standards and Technology (NIST) to provide an interactive visual interface to the terminology used in a variety of standards related to sustainable manufacturing. The area of sustainable manufacturing is rapidly evolving and includes a network of information standards that define the language of discourse for this new area. Traditional document style standards and dictionary style definitions are very limiting when it comes to getting a holistic picture of the sustainability landscape for manufacturing. The task of understanding the challenges in achieving a sustainability objective is very difficult when non-experts have to browse through several pages of document standards to find relevant information. The NOVIS tool provides a means for people to interactively visualize, browse, and query these standards. Furthermore, while the tool presented here supports the area of sustainable manufacturing specifically, its applicability is not limited to that area. This paper describes how to use the NOVIS tool and includes an example of how to use the tool to support sustainable manufacturing.

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1 Introduction

This document describes the functions of the NIST Ontological Visualization Interface for Standards (NOVIS). NOVIS was developed at the National Institute of Standards and Technology (NIST) to provide an interactive visual interface to the terminology used in a variety of standards related to sustainable manufacturing. The NOVIS tool, and a reference ontology comprised of a selected set of standards, was developed as part of the Sustainable Manufacturing Program [1] at NIST. The area of sustainable manufacturing is rapidly evolving and includes a network of information standards that define the language of discourse for this new area. Traditional document style standards and dictionary style definitions are very limiting when it comes to getting a holistic picture of the sustainability landscape for manufacturing. The task of understanding the challenges in achieving a sustainability objective is very difficult when non-experts have to browse through several pages of document standards to find relevant information. The NOVIS tool provides a means for people to interactively visualize, browse, and query these standards. Furthermore, while the tool presented here was developed to support the area of sustainable manufacturing specifically, its applicability is not limited to that area. This paper describes how to use the NOVIS tool and includes an example, which demonstrates the features.

In brief, NOVIS works by visualizing the terminology found in different standards documents. The terminology is captured in an ontology [2] using the Web Ontology Language (OWL) [3]. The ontology forms a large and densely networked graph of terms. NOVIS presents portions of this dense graph that are relevant to a user's request, and displays them visually using colored and labeled nodes and edges. Terms are represented as nodes in the graph. Edges are used to illustrate the relationships between terms. Other aspects of a term are represented as properties of the nodes. For example, each node has as a property a textual description that is the definition of the term. NOVIS supports the following functions:

- an interactive visual interface for navigating large and dense networks of terms
- simple and advanced querying methods
- custom visualization controls
- the ability to export selected terms into other formats

The remainder of this document describes how to install NOVIS, the user interface, an example of using NOVIS, and finally how additional standards beyond those included in the software distribution can be added to the tool including those from other domains. Most of the examples described in this document use standards from the International Organization for Standardization (ISO) [4]. OWL classes and properties in these examples are identified using an *italicized font*.

2 System environment and Installation

The NOVIS tool runs on Java [5] version 1.6 or higher[1]. To install Java, visit http://www.java.com/en/download/index.jsp and follow the instructions. Once Java is installed on your computer, you can launch the NOVIS application by double clicking on the NOVIS Java Archive (JAR) file.

The NOVIS tool was developed using Protégé [6] for creating and adding to the OWL ontology. The visualization interface is based on a Java Application Programming Interface (API) called Prefuse [7]. These packages are not necessary to use the application but modifications to the application would use these tools. The use of Protégé for expanding the ontology is discussed in section 5. Other software that interfaces with the tool includes HyperText Markup Language (HTML) browsers and Microsoft Excel. These interfaces are discussed in section 3.7.

3 User Interface

This section describes the NOVIS user interface and its basic operations including:

- viewing a terminology graph
- loading an ontology
- navigating the graph
- customizing the visualization
- using the quick search feature
- creating an advanced search query
- exporting nodes to an HTML document, and exporting nodes to an Excel spreadsheet

The NOVIS application is controlled through the main window, which presents a view of the terminology graph. From this window, you can open windows for advanced view control and advanced search queries. The main window displays the graphical representation of the selected node, with panels showing a color key and additional node information. The advanced view control window lets you control various viewing options. The advanced search query window contains a series of fields into which you can input specific search criteria.

3.1 Viewing a terminology graph and the *NOVIS Main* window

NOVIS' main window is a clickable interactive interface. The window displays concepts from the ontology used to capture the terms from standards. The concepts are presented as a graph where the nodes represent not only individual terms but also standards and

[1] Certain commercial software products are identified in this paper. These products were used only for demonstration purposes. This use does not imply approval or endorsement by NIST, nor does it imply that these products are necessarily the best for the purpose.

other concepts. Edges represent relationships between these concepts. The ontology is described in more detail in section 5. Figure 1 below illustrates the main window.

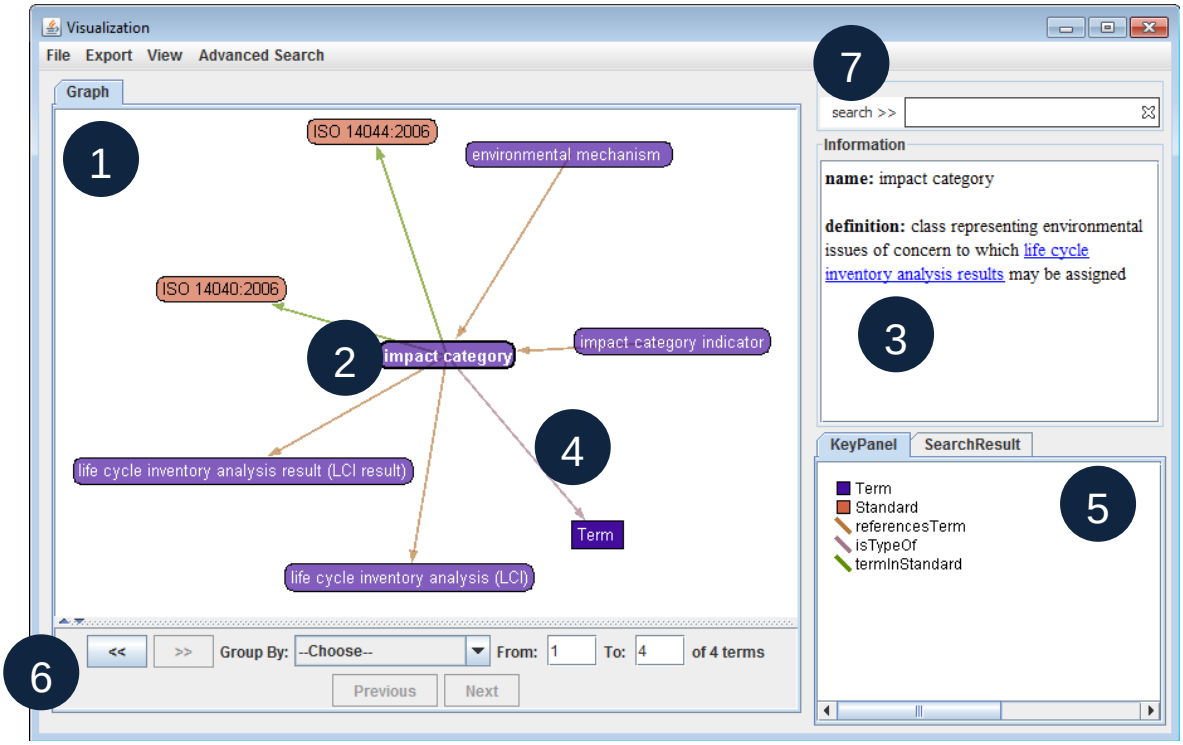


Figure 1 The NOVIS Main window

Area 1: Graph panel. This area contains the graphical representation of a selected node.

Area 2: Selected node. The selected node, in this case, **impact category**, is displayed in bold in the center of the graph panel.

Area 3: Properties of the selected node. This area displays the properties of **impact category**, such as *name* and *definition*. You can click on the text highlighted in blue in the *definition* property to either visit another node or be taken to a web page on one's internet browser.

Area 4: Object properties of the selected node. The other nodes, surrounding the selected node, are connected to it via object properties. The nature of the relationship between the two nodes is shown when the mouse pointer hovers over either term, or by referring to the key panel shown in Area 5.

Area 5: Key panel/quick search result. There are two tabs for this panel. The first one, "KeyPanel," displays the legend for different types and relationships. For example, **impact category** is in purple because it is a *Term*. The second tab lists the results of the quick search entered in Area 7. You can click on the various results to select and display those nodes in Area 1.

Area 6: Visualization options. In this area you can select how many terms to show on the graph at once, or group all of the related nodes by a common property (e.g., the standards the terms are contained in). The use of this area is described in more detail below in Section 3.4.

Area 7: Quick search field. You can perform quick searches for nodes based on a node's name. The results are shown in Area 5.

3.2 Loading an ontology

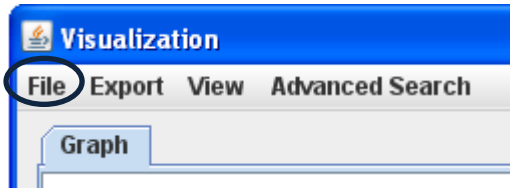
The NOVIS distribution comes with ontologies that represent publically available standards for sustainable manufacturing. NOVIS can be used to generally display ontologies of terminologies but the ontologies must conform to certain conventions. These instructions assume a working knowledge of ontology definition in OWL. To load your own OWL ontology it must meet the following two requirements. Your ontology will meet these requirements if you follow the editing steps described below:

- The top level classes in the ontology must be subclasses of the *Thing* class by explicitly asserting that these top level classes are *subClassOf* of the *Thing* class.

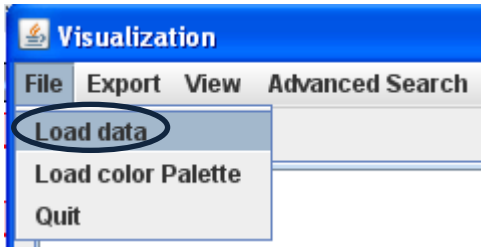
- A data property called *name* is needed for all the individuals. The domain of this property will be *Thing* and the range will be *String*. This data property must contain a value for each individual and that value will be the name of the term being represented.

The ontologies in the distribution or any ontology that conforms to these conventions may be loaded into NOVIS by following the steps shown in Figure 2 below.

1. Select "File".



2. Select "Load data".



3. Open the "sustainableTaxonomy.owl" file provided with NOVIS, or choose your OWL file from the directory.

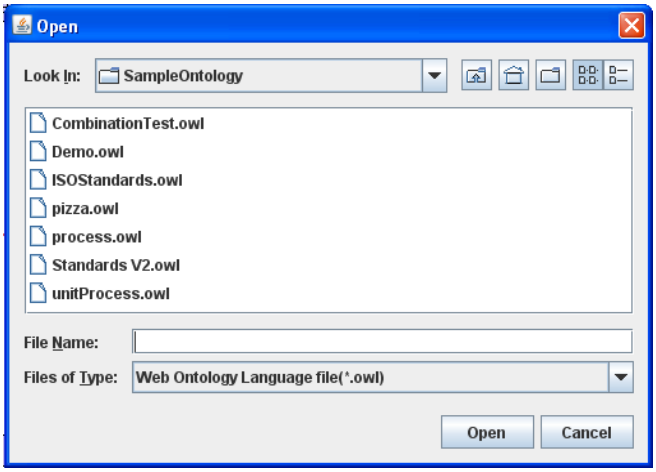


Figure 2 Loading data

3.3 Navigating the graph panel

The graph panel shows a term and its immediate relations as in Figure 3. It is navigated by clicking on any of the terms. To navigate to any individual shown on the graph, simply click on it. That individual will become the new selected node. You can also drag any of the individuals across the graph pane. To zoom in, scroll down on the scroll wheel. To zoom out, scroll up. Click on the blue links in the information panel to travel to that individual. To view the object properties of the selected individual, hover over it, and the properties will be shown in the center of each edge.

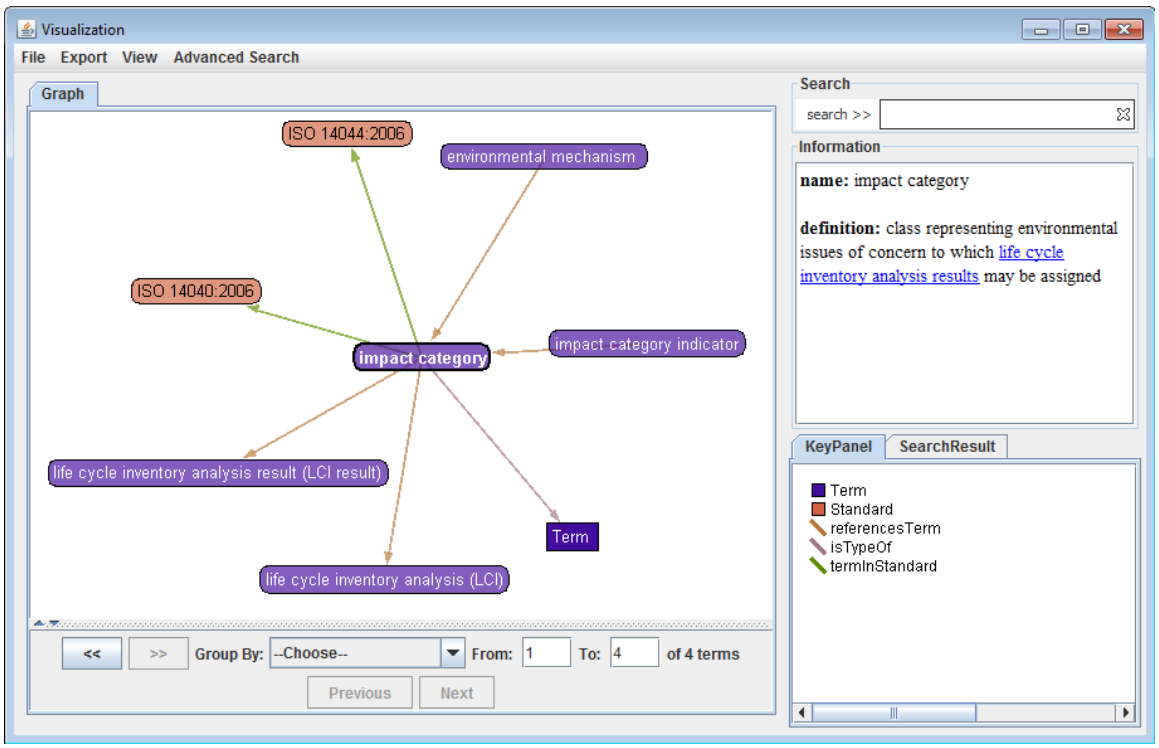


Figure 3 Navigating the graph panel

3.4 Customizing the visualization

As the size of the ontology expands, the graph visualization can quickly get unwieldy. To address this there are a number of ways to customize the view. There are settings associated with the view that can be changed so as to limit the amount of information displayed and to change how it is displayed. These features are described here.

3.4.1 Using the visualization options

The visualization panel gives more option to browse the graph. It contains four areas as shown in Figure 4.

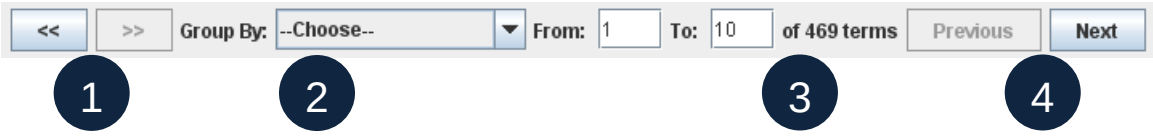


Figure 4 Visualization options

Area 1: Previous/Next node. The '<<' and '>>' buttons allow you to review previously navigated nodes. They function like the 'history' buttons on a web browser.

Area 2: Group By option. Figure 5 lists the types of relationships available in the ontology. When you choose a relationship the terms are highlighted that are related to the same target through this relationship. This option can be useful if many nodes are displayed and you want to see a subset related by a specific relationship.

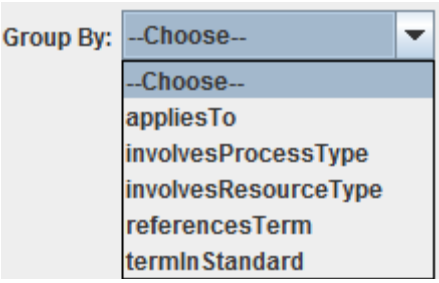


Figure 5 Available relationships

When you chose a relationship, for example *termInStandard*, another drop-down menu appears on the top right of the graph panel as is shown in Figure 6. This button allows you to define the target of the relationship. Suppose you want to group nodes that have the target "ISO 14065:2007" for the relationship *termInStandard*. Choose that value from the drop down list. The visualization is then updated by highlighting the nodes matching your request as shown in Figure 7. The other nodes become faded. In the example shown, it appears that "appeal", "accreditation body" and "accreditation" are terms included in the standard "ISO 14065:2007".

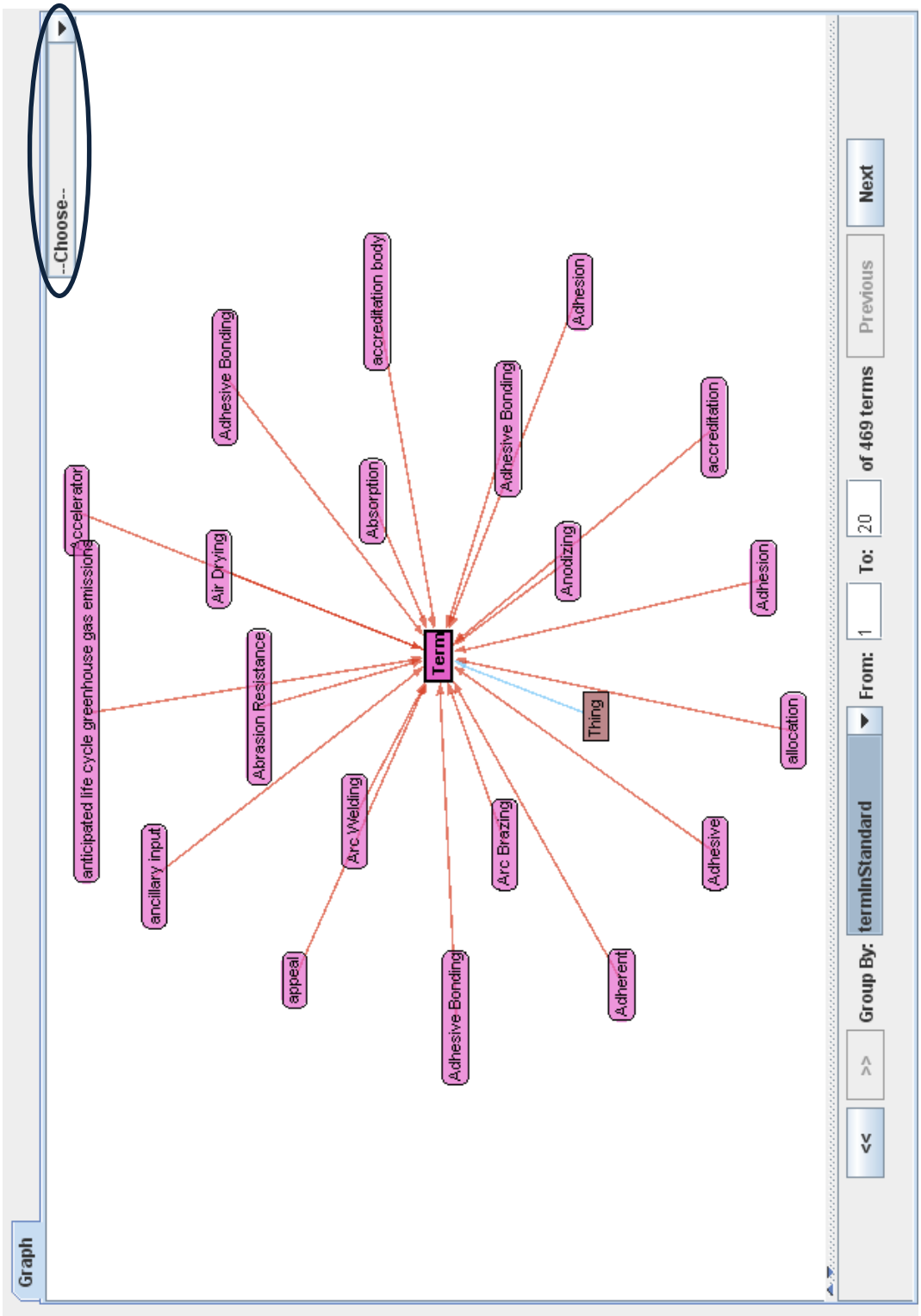


Figure 6 Drop-down menu for update

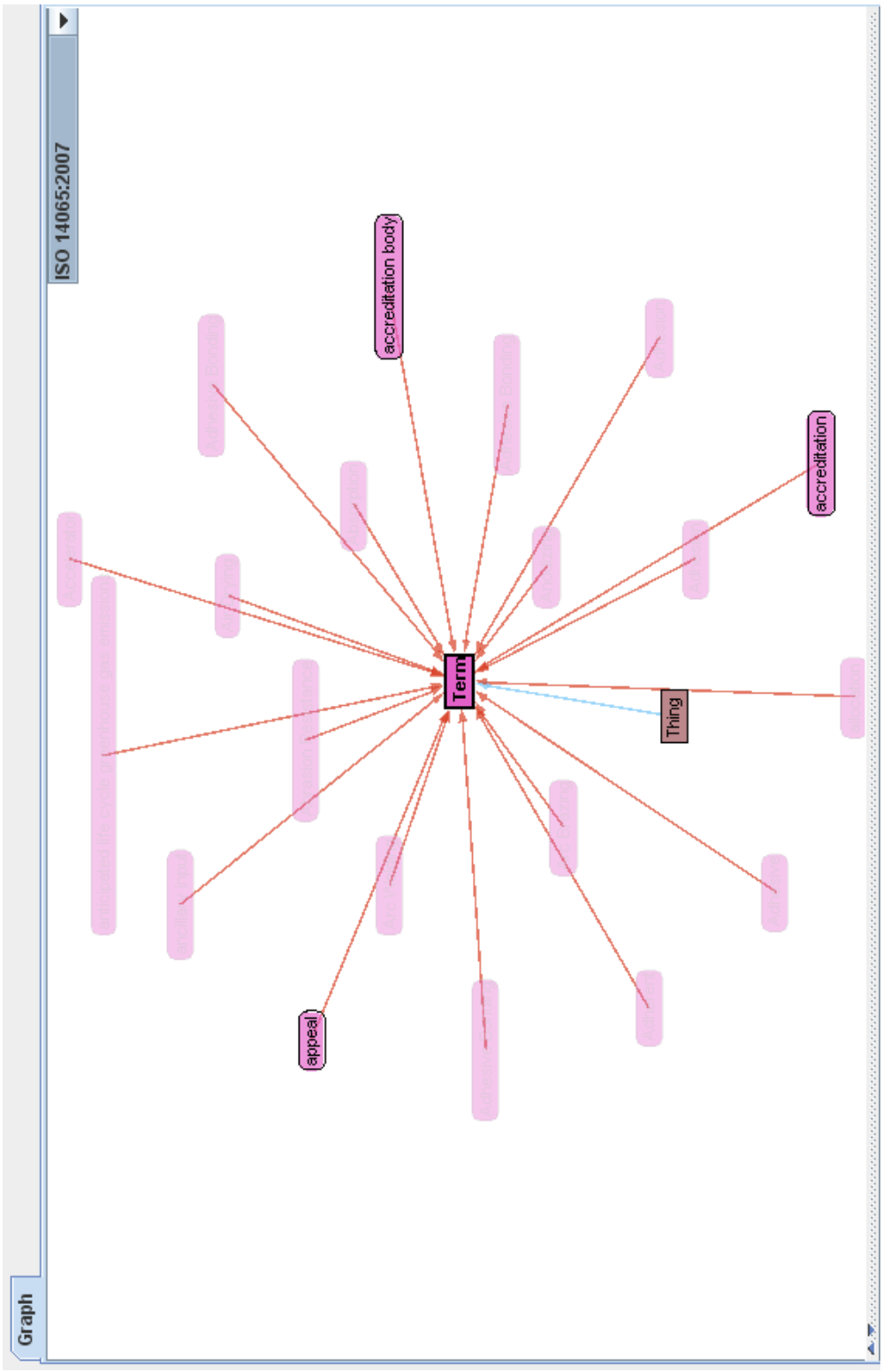


Figure 7 Graph panel after update

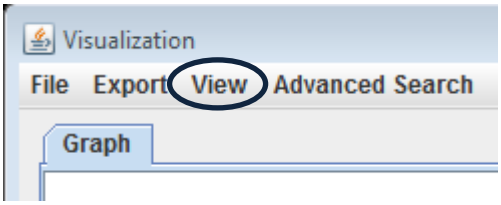
Area 3: Number of displayed terms. By default, ten terms are displayed at a time. The values in this area allow you to change the number of visible terms. This improves clarity by limiting the number of shown terms.

Area 4: Previous/Next terms. This button enables you to display the previous or next set of terms sorted in alphabetical order and related to the selected node.

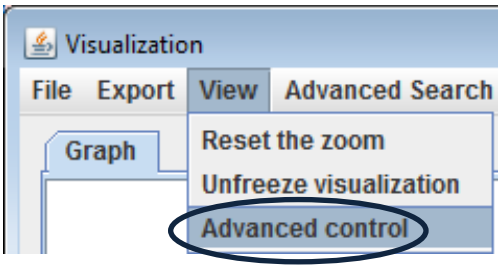
3.4.2 Changing the view settings

The visualization application uses a force directed layout algorithm [8] to present the selected portion of the information network. The algorithm applies attractive and repulsive forces to the nodes and edges displayed, and when these forces are balanced, the nodes arrange themselves into a visually pleasing orientation. The advanced view control allows you to adjust the parameters of the force directed layout algorithm, providing custom control over the visualization. The advanced view control window shown in Figure 8 is located as follows:

1. Select “View”.



2. Select “Advanced control”.



3. Change the settings to your choosing. Dragging the slider along each line will change these settings. The “Reset” button resets the parameters to their default values.

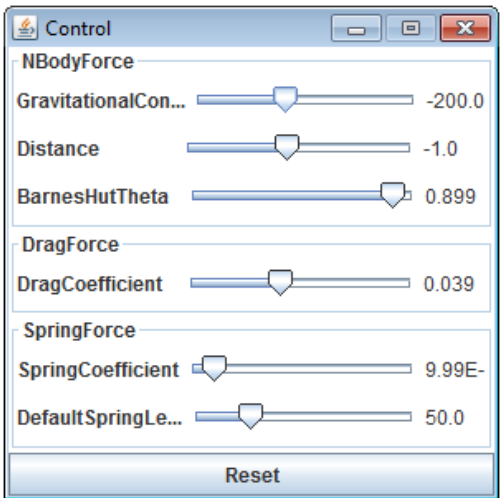


Figure 8 Advanced view control window

3.5 Using the quick search feature

The quick search allows you to look for a node that you know by name. It is based on a partial string match. For instance, if you type “bo” then the search returns every node with a name containing this string such as “bold”, “bonding” or “ boundaries”. This quick search shown in Figure 9 is different from the advanced search because you have to know the name of the node that you are looking for. It does not use the relationships established in the ontology.

1. Select the field for the quick search.
2. Type in the name of the individual you are looking for
3. Refer to the results panel on the bottom to see list of matches.
4. Click on a result in the list to view the node in the graph panel.

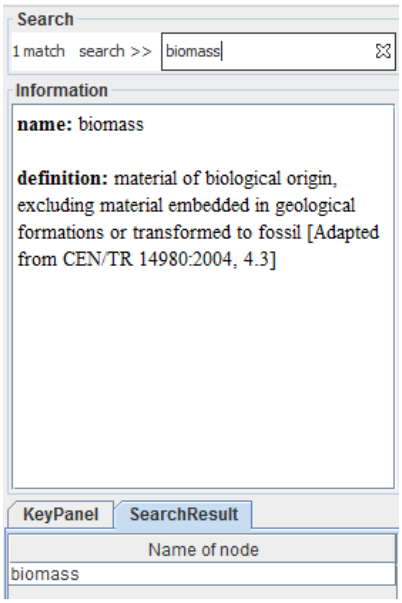


Figure 9 Quick search mechanism

3.6 Creating an advanced search query

The advanced search allows you to find all the nodes matching specific criteria. It is based on a query to look for individuals in the ontology through its relationships and attributes. We provide an interface to specify the relationships, the attributes, and their values. The application lists all the nodes matching this request. The advanced search supports more powerful requests than the quick search by using the semantics of the ontology. It also enables you to find a term without knowing its name. The window for the advanced search query is shown in Figure 10. The interface allows you to add predicates to your constraint. You can add three kinds of constraints. The first constraint is the constraint “Type” which refers to the classes in the ontology such as *Standard*, *Term* etc. “Property” is the second constraint and refers to the data properties of the ontology like *definition* or *source*. Finally you can also add a constraint “Relation” which refers to the object properties of the ontology. The properties *termInStandard* and *appliesTo* are two different object properties of the ontology.

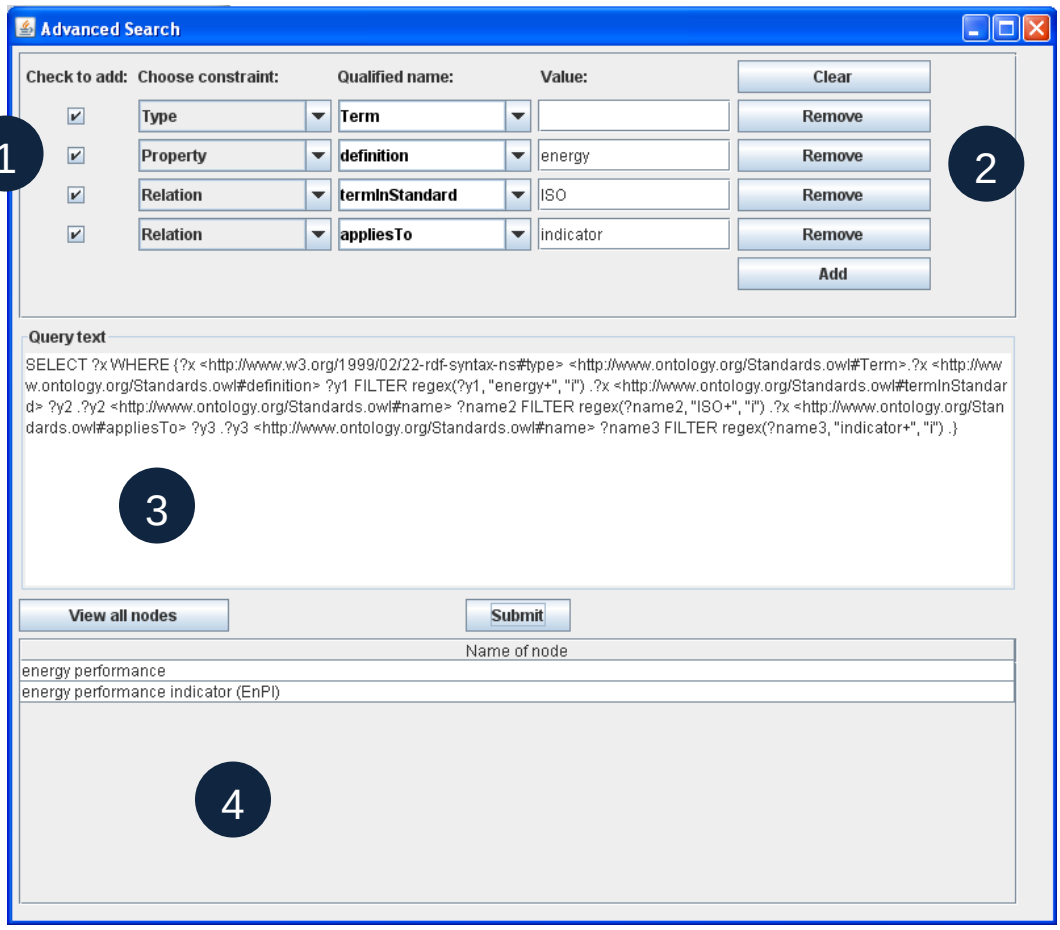


Figure 10 Advanced search window

Area 1: Query specifications. You can enter constraints for the search result here. The steps for creating a query are described later.

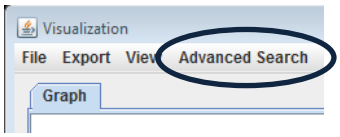
Area 2: Add/Remove buttons. You can choose to add or remove constraints to this query here, or clear the query entirely.

Area 3: Query text panel. You can see the actual text generated by the constraints entered in Area 1, as a SPARQL Protocol and RDF Query Language (SPARQL) [9] query. Currently, this field is not editable. Future versions may give advanced users the option of fine tuning their queries by editing the SPARQL query.

Area 4: Results panel. The results of the query are displayed here. You can click on each of these to display the individual in the main window, or choose to view all of the nodes in the main window by clicking the "View all nodes" button.

The following steps, shown in Figure 11, describe how to perform an advanced search.

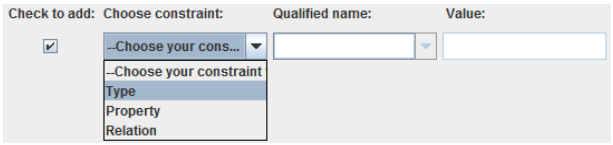
1. Select “Advanced Search”.



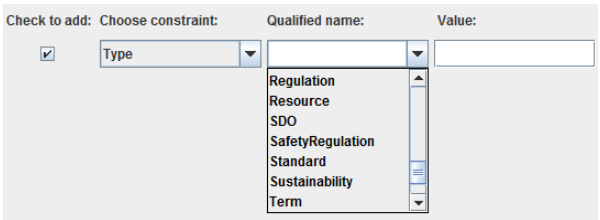
2. Select “Create query”.

3. To create your first constraint, first check the box.

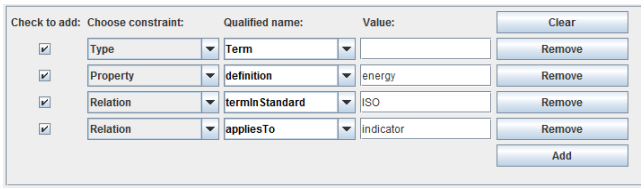
4. Select the type of constraint you want: type (class), property (data property), or relation (object property).



5. Select the specific type, property, or relation you want your results to contain. The dropdown list shows the available types and properties in the currently loaded ontology.



6. Select the value for the constraint.
   - “Type”: type in the partial or whole name of your intended result.
   - “Relation”: type in the partial or whole name of the individual you want your result to be related to.
   - “Property”: type in the string you want your results’ property to contain.



7. Click “Add” to add any other constraints for your search. When you are done, press “Submit”. Results will be displayed in the table at the bottom of the frame.

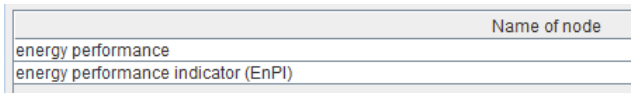
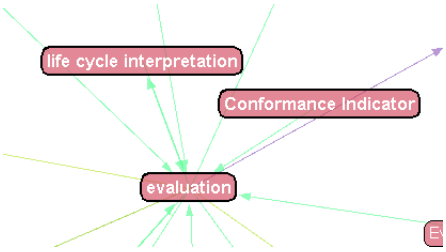


Figure 11 Advanced search mechanism

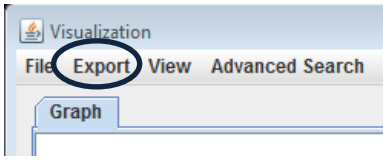
3.7 Exporting nodes into an HTML document/Excel spreadsheet

To provide more readable document than an OWL file, we also provide an export mechanism. It allows you to export the attributes for all the nodes or a selected subset of them. Using this mechanism you can get the attributes for each node in a single HTML or Excel document. Figure 12 shows you the step to export the nodes.

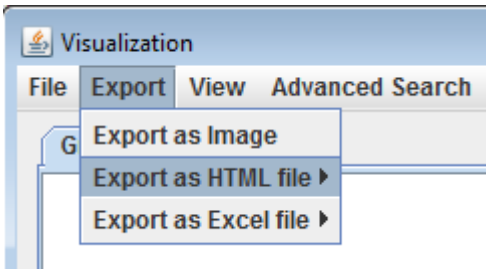
1. If you are exporting only select nodes: select each node in the graph by holding “Ctrl” and clicking each individual. Selected nodes will be bolded and outlined. If you are exporting all nodes, nothing needs to be selected.



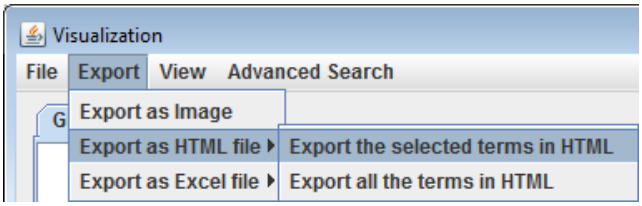
2. Select “Export”.



3. Select either “Export as HTML file” or “Export as Excel file”.



4. Select whether to export only the terms you have selected, or all of the terms.



5. Designate where you want to save your file, and click “Save”.

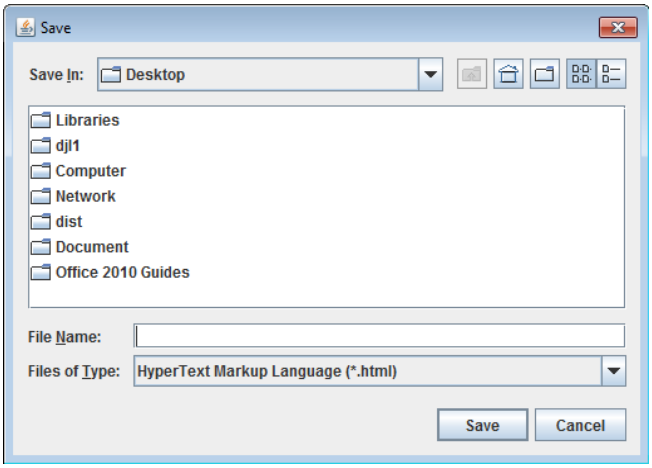


Figure 12 Exporting nodes

4 Manufacturing Example

This section shows an example for using NOVIS. In this example, we assume a manufacturer (that we are going to call the user) who wishes to evaluate his process’ energy efficiency. The user is looking for standards for help. The standard must be an International Organization for Standardization (ISO) standard.

To solve this problem, the user would create an advanced search query in NOVIS and would specify that he is looking for nodes that

- are Terms
- contain “energy” in their definition
- are in the terminology of standards with “ISO” in the name
- are related to indicators

Once the user gets our results, the user opens them in the graph panel to find the relevant standards. The advanced search window shown in Figure 13 illustrates constraints for the query. Different kinds of constraints are combined to model the request. The two terms matching with the query are displayed on the bottom of the frame. Figure 14 shows the resulting visualization. The user can see that the results are in the standard “ISO 50001:2011”.

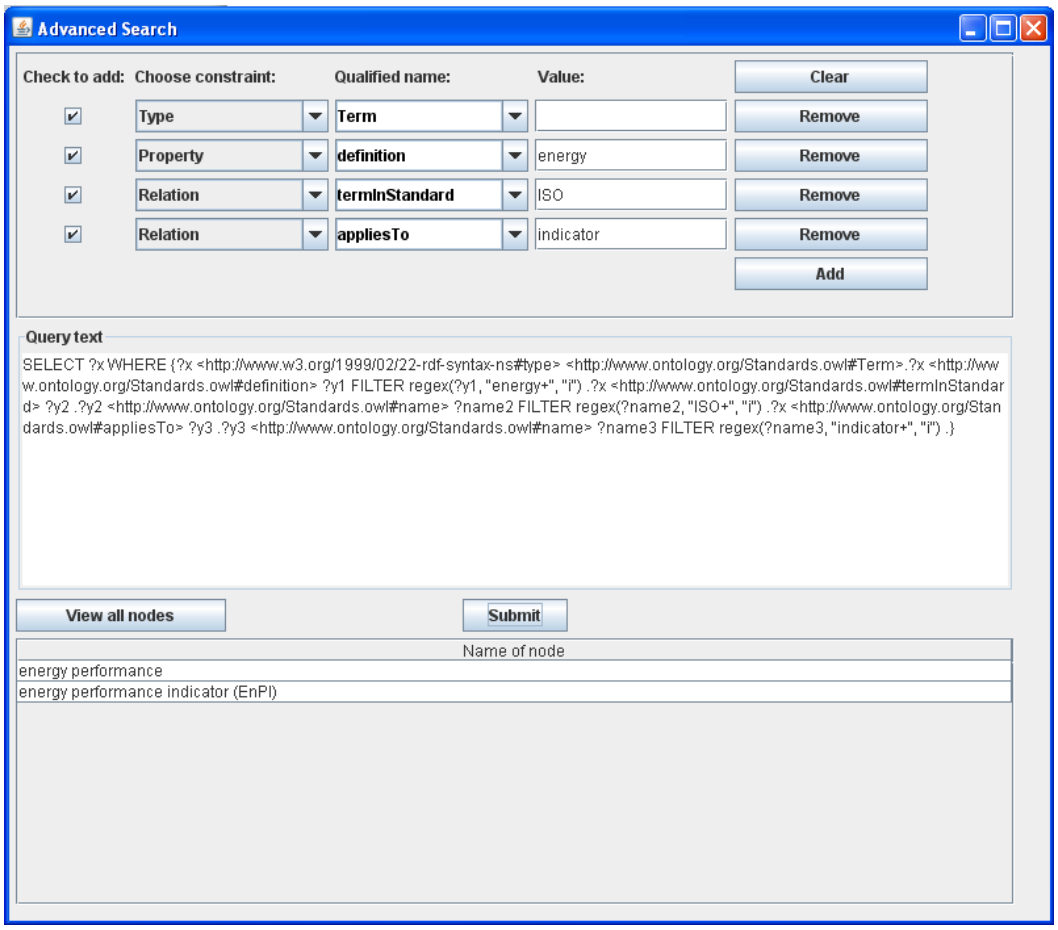


Figure 13 Example of query creation

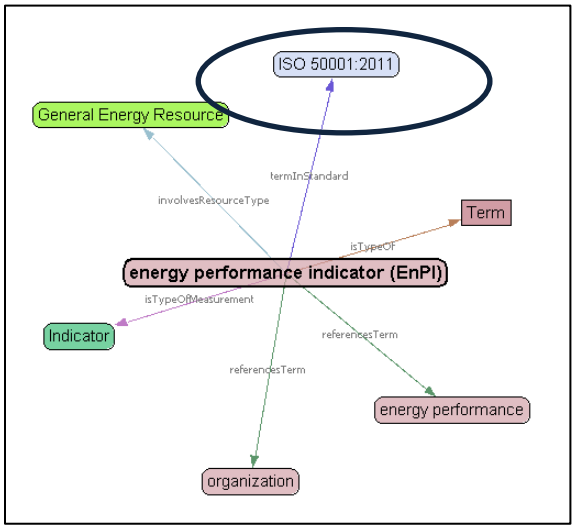


Figure 14 Results highlighting relevant standard

5 NOVIS Ontology and its Expansion

NOVIS currently comes with an ontology that contains terminology from a selected set of standards, along with some terminology from other sources. Details of the standards that are represented in the NOVIS ontology are described in the readme.txt file in the same folder. The supplied ontology is in OWL and may be expanded to include concepts and terminology from your own domain using a tool such as Protégé. This section will provide you some guidelines on expanding the ontology and use Protégé screen shots for illustration.

The most fundamental concept in the NOVIS ontology is *Term*. There are several relationships between this concept and the other concepts in the ontology, especially with the concept *Standard*. This relationship models that a term is in a standard or a term references a standard. Two different terms can also be related to each other either because they are similar or because one term references the other. Each relationship has a specific domain and a specific range. These concepts and relationships are described in greater detail in [2].

There are two ways to add new terminology to NOVIS:

- by directly editing the ontology;
- by using the NOVIS import interface for Excel files.

Each of these is described in this section.

5.1 Editing the ontology

The NOVIS ontology can be expanded with concepts and terminology from your own domain. To expand on the ontology create a new instance in the ontology (using an ontology editor of your choice) and give each instance a value for the data property *name*. Recall that *name* is required property for the NOVIS application. Recall that the other requirement is that the new instance be a subclass of *Thing*. The instances that you create may be subclasses of one of the classes in the NOVIS ontology such as *Standard* or *Term*, in which case they will be derived from *Thing*. Finally, you will want to create relationships between your new instances. This is done through the object properties. Some relationships are defined in the NOVIS ontology as shown in Figure 16. When you add relationships, take note of the domains for the relationship types.

The following describes how NOVIS is expanded using Protégé. First load the OWL file called “sustainableTaxonomy.owl” in Protégé. Once the file is loaded, you can browse the ontology. Figure 15 shows the NOVIS ontology in Protégé. The classes, object properties, data properties, and individuals tabs are our focus and are illustrated in Figure 15, Figure 16, Figure 17, and Figure 18. Classes define the top level concepts in the NOVIS ontology. Individuals represent instances in the ontology. Attribute of instances are represented using data properties. Relationships are represented through object properties.

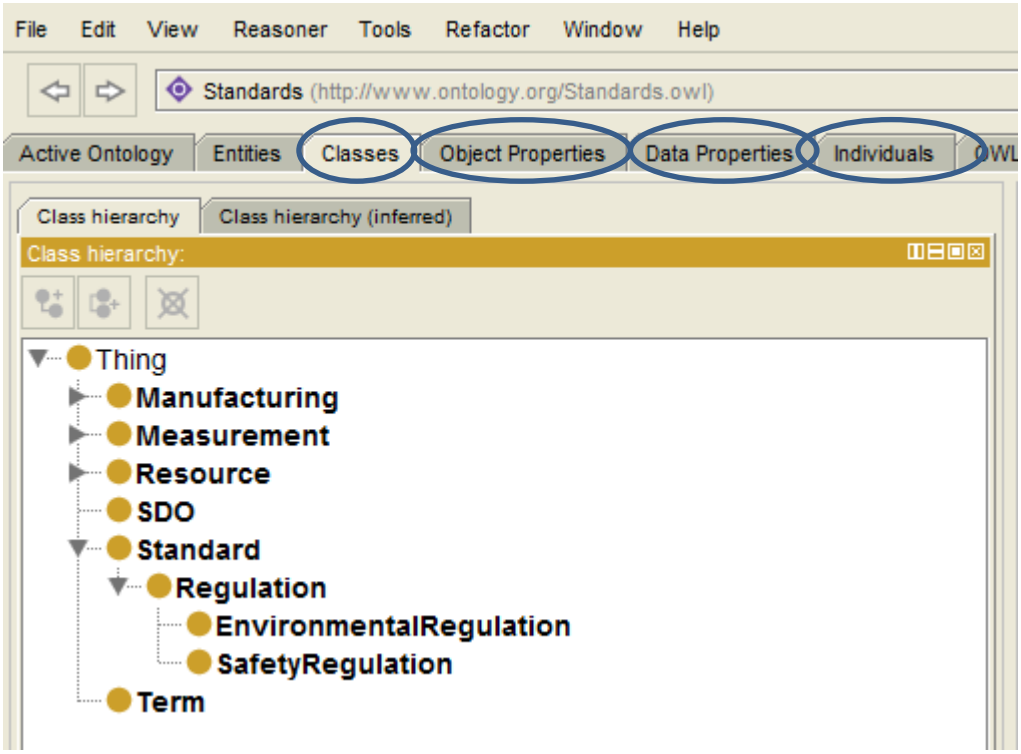


Figure 15 Protégé class tab

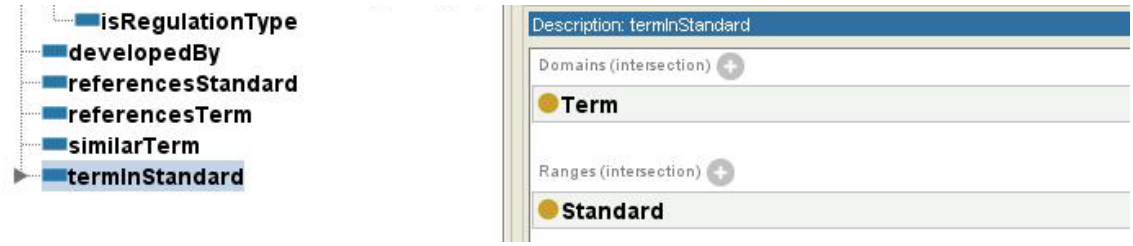


Figure 16 Object property tab for *termInStandard*

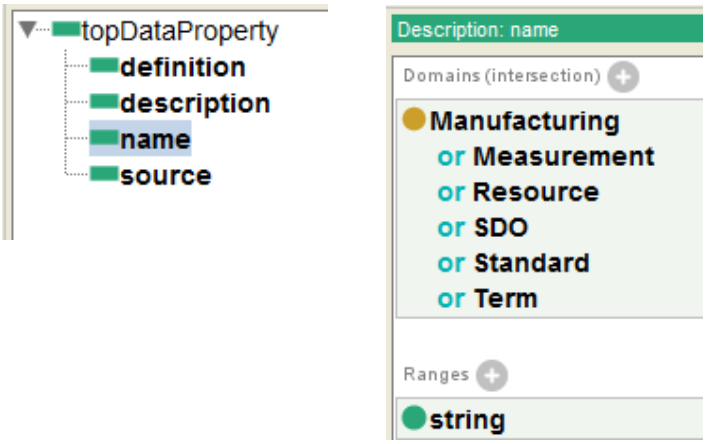


Figure 17 Data property tab for *name*

5.1.1 Adding an instance

In Protégé an instance is called an individual. To add an instance, go to individuals tab. On the left side you have all the classes of your ontology. When you select one of these classes such as *Standard*, all the instances of *Standard* appear in the members list. When you want to add another instance, you click on the button circled in red in the figure. Once you clicked on this button, another frame appears as is shown in Figure 19. On the bottom of this figure, you see a Uniform Resource Identifier (URI), which is the URI of the instance. In the NOVIS import plugin described below the URI's are made unique by appending a time stamp to the data property *name*. You may adopt this method or choose your own naming conventions but note that each URI must be unique. Once you have added the instance, it appears in your member list as shown in Figure 20.

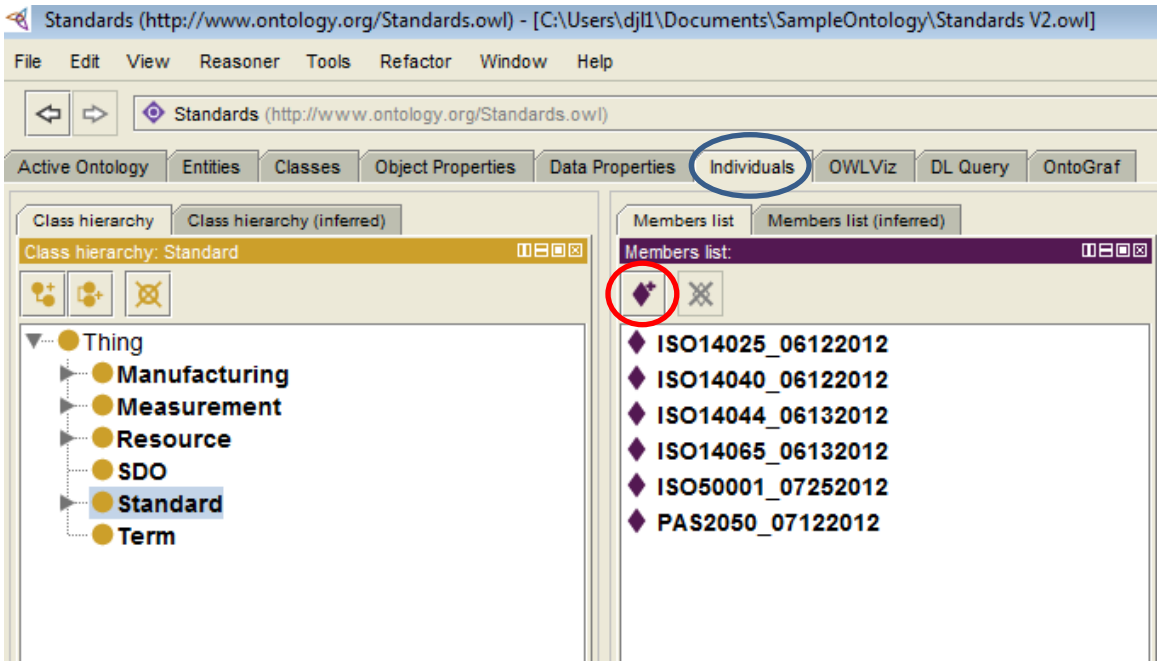


Figure 18 Protégé individuals tab with ISO Standards and Publicly Available Specification (PAS) 2050 [10]

Figure 19 Window for creating a new individual

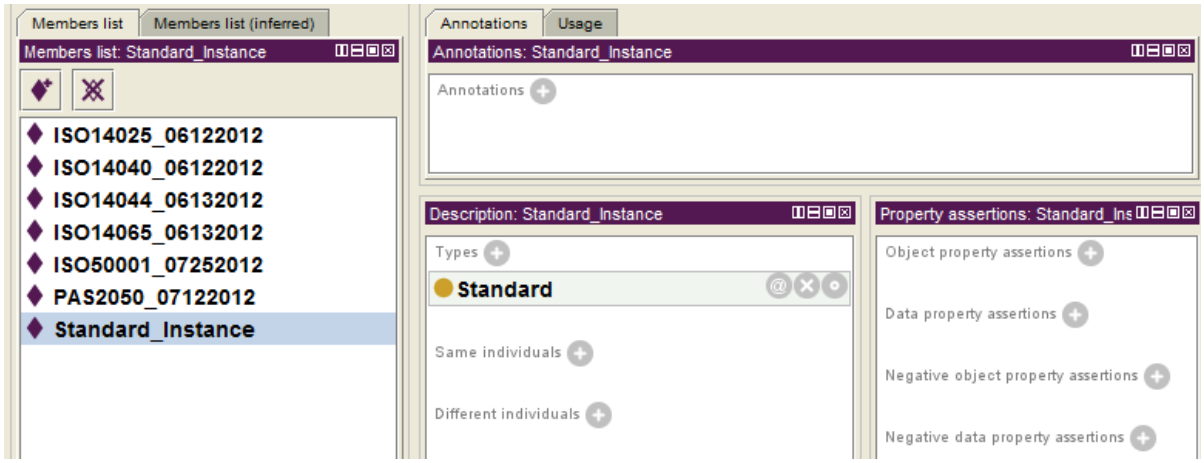


Figure 20 Added individual

5.1.2 Adding the attributes for an instance

Attributes are added as data properties. For each instance you must add an attribute *name* in order to use the NOVIS application. Other attributes are specific to only a few classes. After selecting in Protégé the instance for which you want to add an attribute, click on the button circled in Figure 21 to add a new data property. When you click on this button the frame show in Figure 22 appears. From here choose the attribute that you want to use and then assign it a value as seen in Figure 22 and Figure 23.

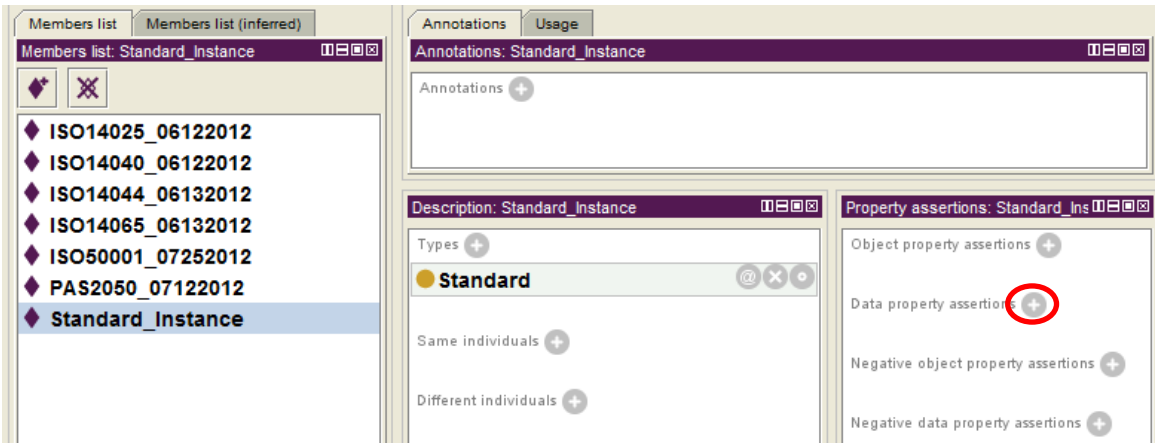


Figure 21 Adding an attribute

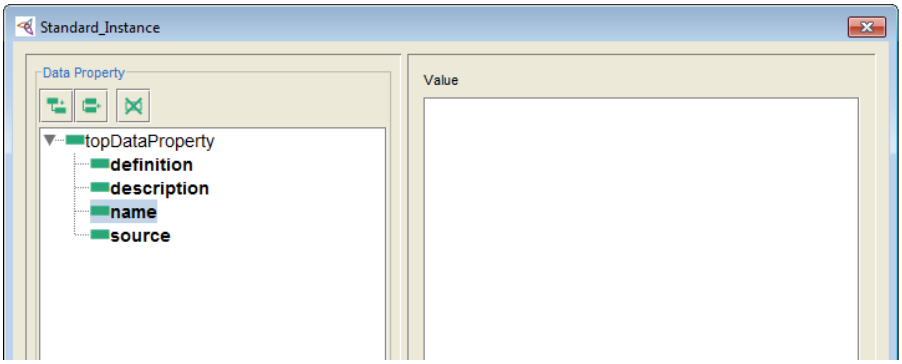


Figure 22 Choose the attribute

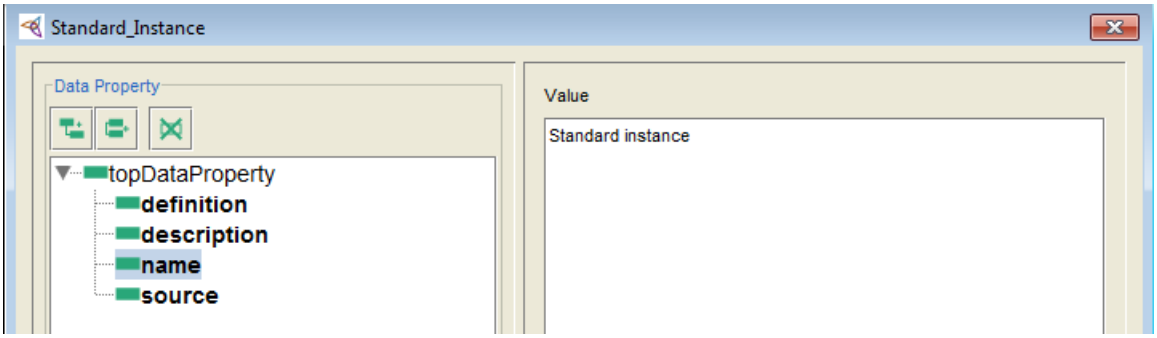


Figure 23 Add the value of the attribute

5.1.3 Establishing a relation between two instances

To relate an instance to another one you use object properties. Select the instance that will be the source of the relationship. Then click on the button highlighted in Figure 24 to add a new object property. Another frame appears as in Figure 25 and you choose the

relationship and the subject of the relationship. You must be careful to use instances with a type matching the type previously defined for the domain of the relationship. For instance, for the relationship *termInStandard* the source of the relationship is a *term* and the target is a *Standard*. You can see the domain and the range of a relationship in the object properties tab. When you submit this addition, it appears on the main frame as shown in Figure 26.

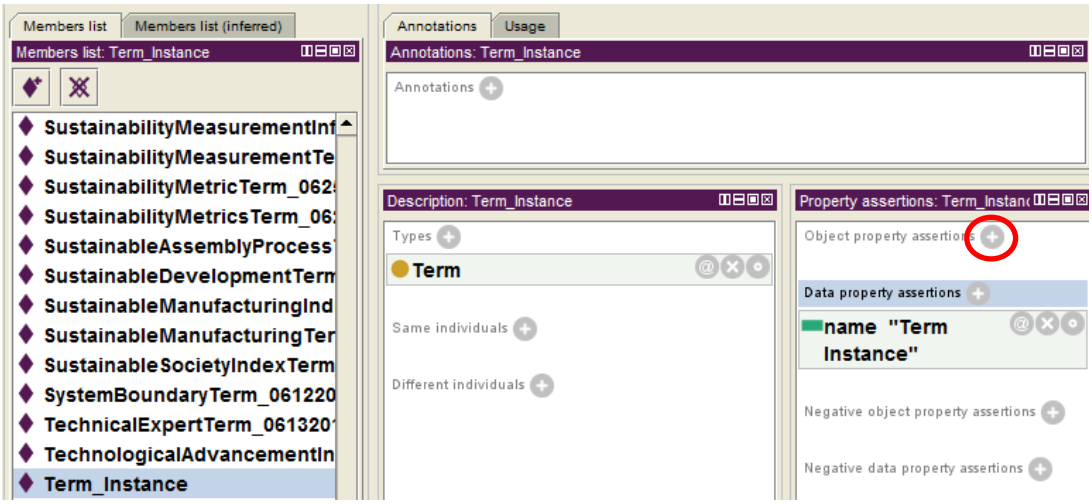


Figure 24 Add a relationship

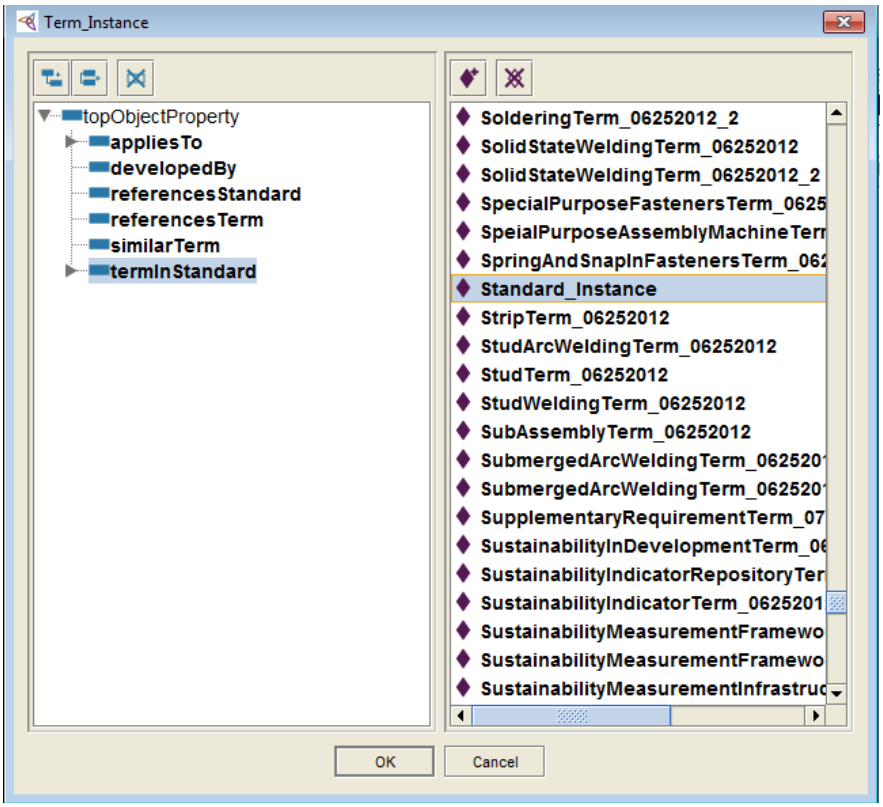


Figure 25 Choose the relationship and the target

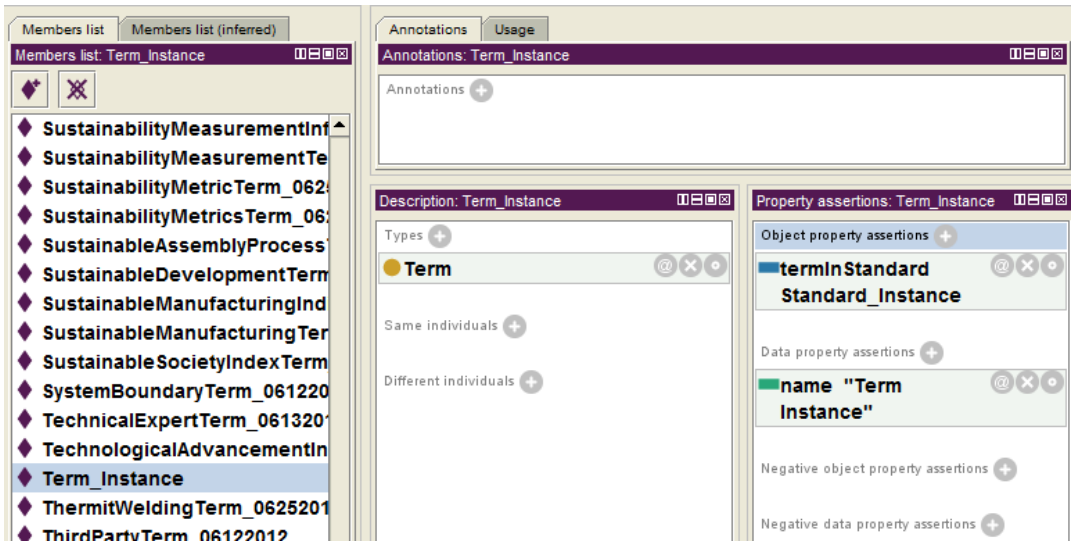


Figure 26 Added relationship and attribute

5.2 Adding terms and standards by using NOVIS import plugin

The NOVIS distribution also contains a plugin for Protégé to enable adding instances of *Term* and *Standard* in the ontology by using an Excel file. The plug in is packaged with the NOVIS application as a JAR file and is compliant with Protégé versions 4.1 and above. To use the plug-in, you need to add it in Protégé. To add the plug-in, put the jar file in the folder "plugins" of your Protégé installation. It is generally in *C:\Program Files\protege_installation_folder\plugins* as in Figure 27. When you open Protégé software, the plug in will appear as another button in the Tools menu as shown in Figure 28.

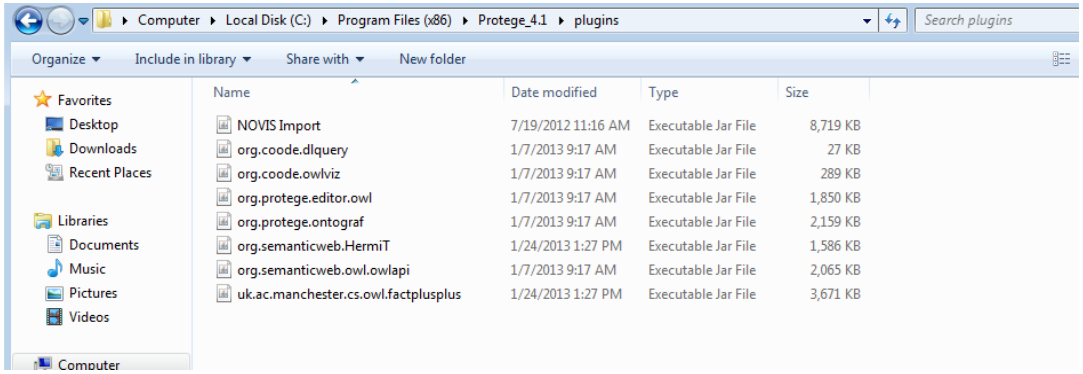


Figure 27 Add the plug-in in the Protégé plug-in folder

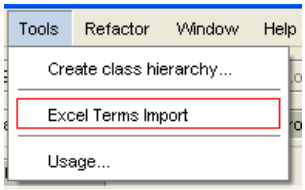


Figure 28 New menu item for importing the terminology

You just have to click on this button and choose your file to launch the plug-in. Figure 29 shows you the first frame which allows us to choose the file containing the terminology.

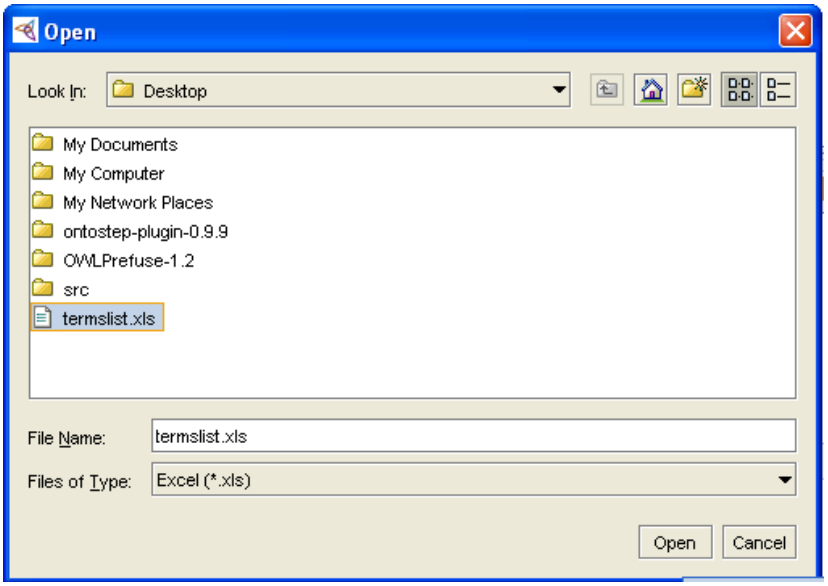


Figure 29 Choose the file

To import new instances, the first step is to create a spreadsheet in an Excel file which will contain the terms. The terms are defined by three attributes:

- name
- definition
- source

Moreover, a term can be contained in a standard and that must also be specified in the Excel file in this case. Figure 30 shows the Excel file template (that you can also find in the NOVIS package). The first column defines the name of the term. The second column is used for its definition and the third for its source. The last column specifies the standard in which the term is contained. Figure 31 shows an example spreadsheet containing several terms.

	A	B	C	D
1	Term name	Term definition	Term source	In Standard
2				
3				

Figure 30 Import file template

	A	B	C	D
1	Term name	Term definition	Term source	In Standard
2	Bolt	Bolts are cylindrical, externally threaded fasteners available with various shaped heads, which are assembled through holes in parts and tightened with internally threaded nuts.	ENGINEERS HANDBOOK	SampleStandard
3	Absorption	Process of attraction or attachment to a surface. The retention of foreign molecules on the surface of a substance.	http://www.itwresintech.com	SampleStandard
4	Catalyst	An accelerator, activator, or curing agent which chemically increases the rate of reaction in a coating.	http://www.itwresintech.com	SampleStandard2
5				

Figure 31 Example of import file with several terms

To establish a relation between a word in the definition and an individual in the ontology (individual that already exists in the ontology, or that the Excel file is going to create), you can add a tag to specify this. The example in Figure 32 illustrates how the term *Bolt* is connected to the term *SampleTerm* also in the Excel file.

1	Term name	Term definition	Term source	In Standard
2	Bolt	Bolts are cylindrical,externally threaded fasteners available with various shaped heads, which areassembled through holes in parts and tightened with internally threaded nuts.	<tag id="http://www.amazon.com/Tool-Manufacturing-Engineers-Handbook-Edition/dp/0872633519">Engineer's Handbook</tag>	
3	Screw	A threaded device used for fastening parts or transferring motion.	<tag id="http://www.toolingu.com/">ToolingU</tag>	
4	Product Category Rules	set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or moreproduct categories		ISO14025
5	SampleTerm	<tag id="bolt">bolt</tag>	SampleSource	
6				
7				
8				
9				
10				
11				

Figure 32 Adding a tag in the definition

Our file is now ready to be loaded. The plug-in imports the terms from the Excel file into the ontology. It starts by adding every term in the ontology then establishing the different property for each created term. However, it returns a warning in the following cases:

- If none of the individuals in the ontology has a name attribute matching the tagged word, the tag is removed and the plug-in displays a warning.
- If there is more than one individual with a name attribute matching the tagged word, the plug-in uses the first one found and displays a warning.

Figure 33 and Figure 34 show you a file with several mistakes and the warning that the plug-in shows to you. Note all the terms are created—even the terms with a removed tag. Here is an example:

Term name	Term definition	Term source	In Standard
Bolt	Bolts are cylindrical,externally threaded fasteners available with various shaped heads, which areassembled through holes in parts and tightened with internally threaded nuts.	<tag id="http://www.amazon.com/Tool-Manufacturing-Engineers-Handbook-Edition/dp/0872633519">Engineer's Handbook</tag>	
Screw	A threaded device used for fastening parts or transferring motion.	<tag id="http://www.toolingu.com/">ToolingU</tag>	
Fastener	A device that holds two or more objects together. A fastener is a <tag id="bolt">bolt</tag> or a <tag id="screw">screw</tag>, or even a button or a zipper.	<tag id="http://www.toolingu.com/">ToolingU</tag>	
Product Category Rules	set of specific rules, requirements and		ISO14025
SampleTerm	<tag id="none of this term">none of this term</tag>	SampleSource	
Bolt	Second term bolt	SampleSource	

Figure 33 Import file with mistakes or unknowns

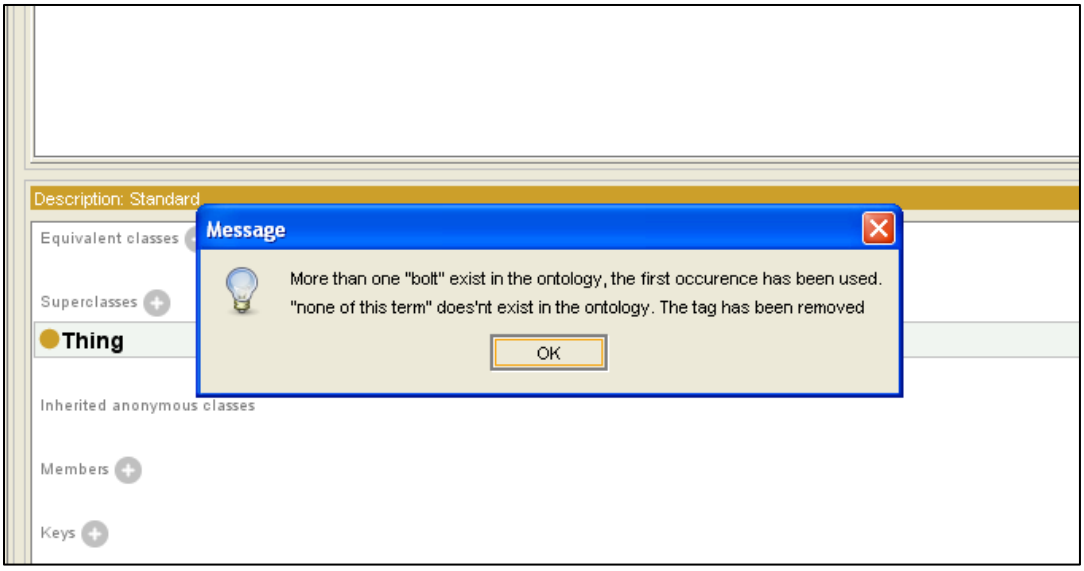


Figure 34 Warnings

The imported instance data becomes part of the ontology and is automatically saved. In the ontology unique identifiers are assigned for each instance. Those will be visible when the ontology is opened in an OWL viewer.

6 Summary

In summary, this document described the features and functionality of the NOVIS tool for visualizing and querying standards terminology. We encode standards information into an ontology that captures terminology in standards, and their interrelationships with other terms and standards. The visual navigation mechanism of the NOVIS tool allows users to browse a network of standards terminology. The graphical interface presents easy access to terms and their definitions, and helps users find other related terms and standards by clicking and navigating through links between terms. The advanced query interface allows users to generate queries by defining predicates for their search criteria. The document also described a plug-in for Protégé which aids in adding new content from other standards into the ontology. These features can contribute to improved comprehension of information contained in standards, than what is possible by reading through textual documents. More work is being done on expanding both the ontology and the set of terminology that is being represented. Defining a robust ontology is key to enabling meaningful and useful searches of the terminology and will be the subject of future work and collaboration with partners involved in this area of research.

Disclaimer

Certain commercial products may have been identified in this paper. These products were used only for demonstration purposes. This use does not imply approval or endorsement by NIST, nor does it imply that these products are necessarily the best for the purpose.

7 References

1. *Sustainable Manufacturing Program*; [cited 2013]; http://www.nist.gov/el/msid/lifecycle/sustainable_mfg.cfm
2. *What is an ontology;*[cited 2013]; http://www-ksl.stanford.edu/kst/what-is-an-ontology.html
3. *OWL Web Ontology Language*; [cited 2013]; more information at http://www.w3.org/TR/owl-features/.
4. *International Organization for Standardization;* [cited 2013]; more information at http://www.iso.org/iso/home.html
5. *Java*; [cited 2013]; available from http://www.java.com/en/download/index.jsp.
6. *Protégé*, [cited 2013]; available from http://protege.stanford.edu/
7. *Prefuse information visualization toolkit*; [cited 2013]; available from http://prefuse.org/.

8. *Fruchterman, T. M. J. and Reingold, E. M. (1991), Graph drawing by force-directed placement. Softw: Pract. Exper., 21: 1129–1164. doi: 10.1002/spe.4380211102*
9. *SPARQL Protocol for RDF;* [cited 2013]; more information at http://www.w3.org/TR/rdf-sparql-protocol/
10. *Publicly Available Specification 2050;* [cited 2013]; more information at http://shop.bsigroup.com/en/Browse-By-Subject/Environmental-Management-and-Sustainability/PAS-2050/