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PROTÉGÉ 5.6.5 TOOL FOR CREATING ONTOLOGIES IN *WEB ONTOLOGY LANGUAGE* (OWL)

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Abstract: Protégé 5.6.5 is an open source tool for creating ontologies, with notable improvements in performance and updates to the OWL API. Although it does not offer direct integration with healthcare standards such as HL7 and DICOM, its semantic modeling capability facilitates interoperability through complementary tools. In healthcare, Protégé supports the creation of clinical decision support and knowledge management systems, boosting data analysis and sharing.
Keywords: Modeling, OWL, Ontology, OWLAPI, Protégé.

INTRODUCTION

Protégé 5.6.5, developed by *Stanford* University, is more than just an ontology editor. It is a robust platform that enables users to model complex knowledge domains. This particular version brings refinements that optimize workflow and expand the possibilities for ontology developers. *Protégé* 5.6.4 has established itself as an essential tool for managing ontologies efficiently and accurately. Protégé allows researchers, developers and professionals from various fields to build knowledge models intuitively and collaboratively (PROTÉGÉ 2025).

Protégé is a cross-platform tool that can be installed on Windows, MacOSX and GNU\ Linux to build ontologies, domain models and applications based on ontology knowledge. It is an ontology development environment for the Web that makes it easy to create, upload, modify and share ontologies for visualization and collaborative editing, and was developed by *Stanford* University's Biomedical Informatics Research Center (SANCHES, 2017).

According to *Protégé*'s *website*, version 5.6 was released on October 28, 2024 The recently released version 5.6.5 brings a series of improvements and new features aimed at enhancing the user experience and functionality of the tool (PROTÉGÉ 2025).

This article provides an in-depth analysis of the improvements implemented in Protégé 5.6.5 compared to version 5.6.4. Through a detailed and comprehensive comparison, the article aims to help experienced users choose the version best suited to their needs, taking into account aspects such as compatibility with OWL 2, flexibility in analyzing inconsistencies, general stability and other improvements, and to describe the main features of *Protégé* 5.6.5.

DEVELOPMENT

PROTÉGÉ

Protégé 5.6.5 is a free and open source ontology editor for building intelligent systems that has had *bug* fixes and improved *software* stability, containing new feature implementations, as can be seen below:

Improved User Interface

Version 5.6.5 features a more user-friendly and intuitive user interface, making it easier to navigate and manipulate ontologies. Improvements to the interface include:

- **Responsive Design:** The interface adapts better to different screen sizes, making it more viable to use on mobile devices.
- **Improved Navigation:** The menu structure has been reorganized to make it easier to access the main features.

Figure 1 shows *Protégé* 5.6.5 installed on *Linux Mint and* Table 1 shows all the formats saved by *Protégé* 5.6.5.

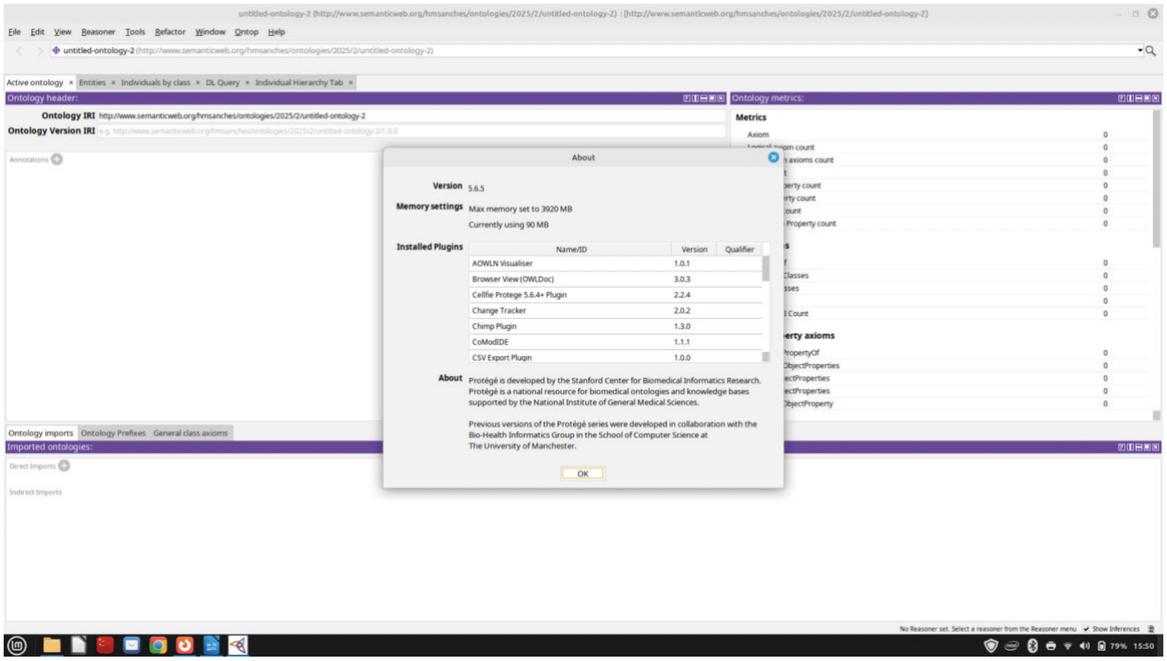

Figure 1: *Protégé* 5.6.5 installed on *Linix Mint*.

Formats Saved by Protégé 5.6.5
RDF/XML Syntax
Turtlle Syntax
OWL/XML Syntax
OWL Functional Syntax
Manchester OWL Syntax
OBO Format
Latex Syntax
JSON-LD

Table 1: Formats saved by *Protégé* 5.6.5.

The format that will be used to create the ontology is **OWL/XML Syntax** and it is interoperable with the *Health Level Seven* (HL7) and *Digital Imaging and Communications in Medicine* (DICOM) standards.

Support for New Ontology Formats

Protége 5.6.5 expands its support for different ontology formats, allowing data to be imported and exported in formats such as OWL, RDF and XML. This facilitates interoperability with other tools and systems.

Collaboration tools

With the growing need for collaborative work on ontology projects, version 5.6.5 introduces new tools that allow multiple users to work simultaneously on the same project. The main features include:

- **Version Control:** Allows users to track changes made to ontologies and revert to previous versions if necessary.
- **Comments and annotations:** Users can add comments and annotations directly to ontology elements, facilitating communication between team members.

Integration with other tools

The new version of Protége offers better integration with other tools and platforms, such as:

- **APIs for Custom Development:** Developers can create customized plugins and extensions to meet the specific needs of their projects.
- **Integration with Database Systems:** The ability to connect to external databases allows users to import and export data more efficiently.

Performance Improvements

Version 5.6.5 includes performance optimizations that make Protége faster and more responsive, especially when dealing with large and complex ontologies. This is crucial for users working with large volumes of data.

Protégé 5.6.5 use cases:

Protége 5.6.5 is used in several areas, including:

- Development of ontologies for domain and knowledge modeling
- Creating knowledge-based applications
- Integration of data and knowledge from different sources
- Checking the consistency of ontology and reasoning
- Teaching and research in artificial intelligence and semantic web engineering
- Biomedicine
- Social Sciences
- Artificial Intelligence

Below are some of the most appropriate resources for knowledge modeling.

- **New visualization plugin:** Protégé 5.6.5 includes a new visualization plugin that allows users to visualize ontologies in new and interesting ways.
- **Bug fixes:** Protégé 5.6.5 includes several bug fixes that improve the stability and usability of the tool.
- **Performance:** Protégé 5.6.5 is faster and more efficient than previous versions.

Advanced Features and Technical Details:

Detailed OWL support:

- Protégé 5.6.5 offers full support for all versions of OWL (OWL 2 included), enabling the creation of expressive ontologies rich in semantics.
- Features such as cardinality restrictions, properties of objects and data types, and complex axioms are implemented efficiently.

Robust Inference Mechanism:

- Integration with reasoners such as HermiT and Pellet allows complex inferences to be made, such as classifying classes, checking consistency and discovering implicit relationships.
- This is crucial to ensure the quality and accuracy of ontologies.

Flexible Plugin Architecture:

- The vast collection of plugins available extends Protégé's functionality, allowing the tool to be customized to meet the specific needs of each project.
- Plugins for graphic visualization, data import/export in various formats (RDF, JSON, etc.) and real-time collaboration are examples of powerful extensions.

Debugging and validation tools:

- Protégé 5.6.5 includes tools for identifying and correcting errors in ontologies, such as logical inconsistencies and constraint violations.
- This guarantees the quality and usability of the ontologies created.

Protégé website:

- Explore the comprehensive documentation, tutorials and examples of ontologies available on the official website.

Protégé Community:

- Participate in forums and mailing lists to interact with other users and developers.

- Explore existing ontology repositories.

Table 2 shows a comparison between Protégé 5.6.4 and 5.6.5, summarizing the main differences between versions 5.6.3 and 5.6.4. The choice of the ideal version depends on the specific needs of each user.

Web Ontology Language (OWL)

According to the W3C,2024 *the Web Ontology* Language (OWL) is a Semantic *Web* language designed to represent rich and complex knowledge about things, groups of things and relationships between things. OWL is a language based on computer logic such that the knowledge expressed in OWL can be exploited by computer programs, for example, to check the consistency of that knowledge or to make implicit knowledge explicit. OWL documents, known as ontologies, can be published on the *World Wide Web* and can refer to or be referenced from other OWL ontologies. OWL is part of the W3C's Semantic *Web* technology stack, which includes RDF, RDFS, SPARQL, etc (W3C, 2025).

Interoperability with HL7 and DICOM standards

While *Protégé* 5.6.5 does not offer native support for direct interoperability with *Health Level Seven* (HL7) and *Digital Imaging and Communications in Medicine* (DICOM), there are several strategies for achieving integration between these tools and Protégé:

HL7 is an international, voluntary, non-profit Standards Development Organization (SDO) that operates in the field of Health Information Systems, both for the clinical and administrative areas.

Digital Imaging and Communications in *Medicine* (DICOM) is a set of standards created to standardize the electronic format used to store and communicate images. DICOM is a set of standards created to guarantee the secure exchange and storage of images.

Knowledge Models:

- Protégé 5.6.5: Web Ontology Language (OWL)
- HL7: Fast Healthcare Interoperability Resources (HL7v2, FHIR)
- DICOM: Digital Imaging and Communications in Medicine (DICOM)
- Formats used: OWL, JSON, XML

Table 3 shows the interoperability of *Protégé* 5.6.5 with HL7 and DICOM.

Additional considerations:

- Integrating Protégé with HL7 and DICOM usually involves creating mappings between the data models of these standards and OWL ontologies.
- Additional tools and libraries, such as HAPI (HL7 API) and DCMTK (DICOM ToolKit), may be required to convert and process HL7 and DICOM data.
- The semantic interoperability provided by Protégé can bring significant benefits to the analysis and sharing of health data.

CONCLUSION

Protégé 5.6.5, with its performance improvements and updates to the OWL API, has established itself as an essential tool for creating ontologies, especially in complex domains such as health, where semantic interoperability with standards such as HL7 and DICOM is crucial; although direct integration requires additional tools and libraries, Protégé provides the basis for modeling knowledge and enabling data to be analyzed and shared more efficiently.

Feature/Improvement	Protégé 5.6.4	Protégé 5.6.5
Performance	Good performance, but with limited optimizations.	Significantly improved performance, especially in large ontologies.
Bug fixes	Previous bug fixes.	Additional bug fixes for greater stability and reliability.
Improvements to serializers	Previous version of the OWL API	Update to OWL API 4.5.24. Changes to serializers, such as the OBO serializer, which can result in major differences when saving ontology files.
Compatibility with Apple hardware	The OS X package depends on x86_64 emulation.	The OS X package now runs natively on arm64 CPUs, dramatically improving performance on Apple computers with M-series chips.
Usability improvements	Previous improvements.	Additional improvements to the user interface and workflow.
Processing escape characters when searching for entities	Problems with some escape characters	Correction to the processing of escape characters when searching for entities.
Saving equivalent objects in OWLCellRenderer	Problems saving equivalent objects	Correction to saving equivalent objects.
String rendering	Problems with some special characters	Improved string rendering, especially for backslashes and double quotes.
Sorting data/object property assertions	Inconsistent sorting	Sorting assertions of data/object properties in views of individuals.
Show depreciated entities" option	Not persistent	Option "Show deprecated entities" is now persistent.
Java migration	Previous version of Java	Migration to Java 11.

Table 2: Detailed comparison between Protégé 5.6.4 and 5.6.5.

Aspect	Protégé 5.6.5	HL7	DICOM	Formats used
Main function	Knowledge modeling and ontologies	Health data exchange	Exchange of medical images	**OWL, JSON, XML, RDF**
Standard	OWL	HL7v2, FHIR	DICOM	**OWL, JSON, XML, RDF**
Level of Abstraction	High level	Mid-level	Low level (*pixels*, images)	OWL, JSON, XML, RDF
Objective	Describing and structuring medical knowledge	Sharing clinical information between systems	Storing, transmitting and viewing medical images	OWL, JSON, XML, RDF
Applications	Clinical decision support systems, medical knowledge management, biomedical research	Electronic medical records, laboratory systems, radiology systems	Medical image archiving systems, radiology workstations, diagnostic imaging software	OWL, JSON, XML, RDF
Integration with Protégé 5.6.5	Possible, but requires additional tools and libraries. Improvements in version 5.6.5 may make integration easier due to updates to the OWL API and performance improvements.	Possible, but requires additional tools and libraries. Mapping HL7 models to OWL ontologies. Use of conversion tools (e.g., HAPI).	Possible, but requires additional tools and libraries. Mapping DICOM metadata to OWL ontologies. Use of DICOM image analysis tools (e.g. DCMTK).	OWL, JSON, XML, RDF
Benefits of Integration	Better interoperability, data validation, knowledge inference	Better interoperability, data validation, clinical data analysis	Better interoperability, medical image validation, image analysis	OWL, JSON, XML, RDF

Table 5: Interoperability of *Protégé* 5.6.5 with HL7 and DICOM.

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