Applying and Extending Semantic Wikis for Semantic Web Courses

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Abstract. This work describes the application of semantic wikis in distant learning for Semantic Web courses. The resulting system focuses its application of existing and new wiki technology in making a wiki-based interface that demonstrates Semantic Web features. A new layer of wiki technology, called "OWL Wiki Forms" is introduced for this Semantic Web functionality in the wiki interface. This new functionality includes a form-based interface for editing Semantic Web ontologies. The wiki then includes appropriate data from these ontologies to extend existing wiki RDF export. It also includes ontology-driven creation of data entry and browsing interfaces for the wiki itself. As a wiki, the system provides the student an educational tool that students can use anywhere while still sharing access with the instructor and, optionally, other students.

Keywords: wikis, semantic wikis, distance learning, linked data

1 Introduction

A wiki helps multiple people at a distance to cooperate in writing and sharing documents. The Semantic Web enables people of multiple institutions to create data that machines on the web can exchange and share. A semantic wiki combines these types of systems: it lets multiple people at multiple places cooperate in making documents and data, along with the programs that retrieve, organize and present this data. Distance learning is another form of distant collaboration, in which not just documents and data are exchanged, but also skills and knowledge, and the means of conveying them. The ability of semantic wikis to enable distance and collaborative development of Semantic Web systems has special ramifications for distant learning about the Semantic Web.

The Master's course *Capita Selecta Thema - Semantic Web* of the Informatics faculty at the Open Universiteit applied semantic wikis as distance education tool. Now the software and the didactic technique developed for and used in this course are being adapted and extended for an upcoming Bachelor's course on the Semantic Web. As with most Open Universiteit courses, these Semantic Web courses apply distance learning techniques. Students in both courses develop, as part of their graded assignments, Semantic Web systems on semantic wikis. This work explains and demonstrates this application of semantic wikis as course material in distance learning about the Semantic Web.

This paper starts with a discussion of related work in semantic wikis. We then describe Semantic Web educational activities at the Open Universiteit and our use of semantic wiki's in them. The last section presents OWL Wiki Forms, an extension of existing semantic wiki's developed for Semantic Web courses.

2 Related Work

A variety of related research and systems apply to our wiki-based approach for developing courseware for distant learning about the Semantic Web. This section starts by presenting a broad selection of concepts and tools that apply to Semantic Web courses. We then present the central tool we apply: Semantic MediaWiki. This section concludes with the wiki interface tool we use most: Semantic Forms.

2.1 Foundational Semantic Web tools

Our application of semantic wikis as Semantic Web courseware is influenced and supported by Semantic Web tools beyond wikis. This section starts by presenting Protégé, an ontology editor that many Semantic Web courses use. We then present a progression of different systems that lead to semantic wikis.

Protégé-OWL (or just *Protégé*) is a GUI-editor for developing ontologies, queries and rules in Semantic Web formats [7]. Protégé supports development and visualization of RDF, RDFS, OWL and SWRL. It is easily installed and free of charge. Protégé is frequently used in courses about the Semantic Web. Protégé is a good implementation of many technical Semantic Web components. However, it functions mostly as a stand-along back-end developer's interface, lacking as such a direct end-user interface.

Semantic browsers such as Tabulator [3] form one type of easily accessible end-user interface to Semantic Web data. While they offer search and analysis interfaces in a variety of ways, they usually have a view for a single resource, shown as a table of the resource's properties with their assigned values. In earlier work, we presented a semantic browser whose focus was generating outline structure, whose links than lead to such tabular annotation displays for given resources [12].

Wikis provide an important and large-scale online source for highly collaborative authoring of information. Initiatives such as Wikiwijs [13] provide platforms on which teachers share education material with each other. Wikis are also helpful for distance learning because their interfaces make facilitate online collaboration.

The best-known wiki is *Wikipedia*[1]. Wikipedia's *infoboxes* provide annotations of pages using a simple editing format, which results in tabular displays of facts for given Wikipedia pages. Infobox displays resemble semantic browsing in their structured presentation of properties and linked values. An important difference, however, is that each page's infobox is human-edited separately, whereas semantic browsers automatically generate their displays.

The *DBpedia* project brings Wikipedia's infoboxes into the Semantic Web by converting them to RDF and providing Semantic Web-based querying and browsing interfaces to the infobox data [1]. DBpedia data is then integrated into the Linked Open Data dataset [4]. All this makes the infobox format on Wikipedia a large and important source of annotations on the Semantic Web. The most important technology for wikis is *MediaWiki*[2], which is used for, among other things, Wikipedia.

2.2 Semantic MediaWiki

Semantic wikis are wikis that add crowd-editing of data to that of documents. With semantic wikis, people can add, manage, distribute and present data with wiki interfaces as they do with documents, but so that machines process the data as well. The most important software for semantic wikis is *Semantic MediaWiki (SMW)* [9], an extension of MediaWiki. This tool supports making systems that follow the vision and high-level functionality of the Semantic Web. However, the individual Semantic Web components only become explicitly visible in SMW's RDF export feature.

Semantic MediaWiki, like MediaWiki, is free of charge and open source, and therefore not only easily acquired, but also easy to build further as assignments for student projects. There are at least 216 active, public Semantic MediaWiki installations online with several types of applications, for fields such as companies, culture, training and management, and 33 specifically for education [14]. The industrial use of SMW for data management is growing of, as shown by the development and adoption of industry-oriented Semantic MediaWiki extensions such as SMW+[3].

Table 1 shows how various Semantic Web constructs are mimicked by or directly implemented in features from the incremental layers of SMW technologies. Semantic MediaWiki starts by recognizing that MediaWiki itself has features similar to Semantic Web components, as indicated in the "MediaWiki" column of Table 1. The next column show features of the SMW extension that build on top of MediaWiki to add Semantic Web features. The final column shows the indirect Semantic Web support provided by Semantic Forms, which is an extension on top of Semantic MediaWiki.

First, SMW treats each MediaWiki link like a triples joining the current page with the link end via an unspecified property. The foundation of Semantic

[1] `http://www.wikipedia.org`
[2] `http://www.mediawiki.org/`
[3] `http://www.ontoprise.de/en/solutions/smw-plus/`

Table 1. Ontological features implemented in progressive layers of Semantic MediaWiki technologies

Feature		**MediaWiki** [9]*	**SMW** [9]*	**Semantic Forms** [8]
RDF	triples	`[[xxx]]` link (untyped), infoboxes [1]	`[[`*pred*`::`*obj*`]]` queried and exported as triple	infobox assigns SMW annotation
	`type`	category	export	infobox assigns category
	`Property`		property	infobox/form row
RDFS	`datatype`		SMW *datatype*: affects query, display, sorting and export	specialized input field
	`Resource`	page	export as URI from wiki	each page annotated by infobox/form
	`Class`	category	exported	usually own infobox/form
	`domain`			property assignment to infobox/form
	`range`			`autocompletion on category`
				"`Has default form`" property
	`subClassOf`	categories in categories	in queries and export	
	`subPropertyOf`		SMW subproperty: queries and export	
OWL	`inverseOf`		`invert-property` template [15]	
	`sameAs`, `equivalent-Class/Property`	`#REDIRECT`	in query processing [15]	
			export uses SMW's *equivalent URI* [16] and *ontology import* [15]	

**all content of this column cites this reference unless stated otherwise*

MediaWiki is its typed links, which extend MediaWiki link syntax by adding specified properties. This handling as triples becomes literal in the RDF export feature.

In addition to this Semantic Web-based foundation of typed links, SMW has many smaller, albeit sometimes more indirect, equivalences of Semantic Web functionality. SMW offers a variety of datatypes. These influence how their data is displayed and sorted, as well as explicit coding in RDF export. MediaWiki's special page namespace for categories offers a rough equivalent of Semantic Web classes in internal behavior. SMW extends this by class-like handling of categories in queries, and by explicitly making categories be classes in RDF export. Semantic MediaWiki adds a wiki page namespace for properties, whose members then function as equivalents of Semantic Web properties, and are exported explicitly as such.

Categories of categories in MediaWiki have subclass-like inheritance in internal Semantic MediaWiki queries. SMW has its own subproperties, with similar internal inheritance, and also with explicit RDF export. The `invert-property` template distributed with Semantic MediaWiki provides interface behavior similar to that indicated by `owl:inverseOf`. MediaWiki's `#REDIRECT` is treated by SMW queries in some ways as `owl:sameAs`. Most important for the ability to link internal data to the Linked Data cloud are Semantic MediaWiki's import ontology and equivalent URI functions, which link given internal pages to previously existing external Web resources.

The Semantic MediaWiki Linked Data extension (*SMW-LDE*) is an extension on top of SMW+ that gives a wiki improved access to external linked data [2]. This improved access includes unification of data from multiple external sources in internal querying and in other aspects of the wiki interface. SMW-LDE illustrates the growing role of semantic wikis for linked data. While such external data integration is an important part of Semantic Web systems in general, our work here focuses more on ontology modeling on the wiki and the exporting and integration of data from these ontologies made on the wiki.

2.3 Semantic Forms

Semantic Forms (here just *"Forms"*) is an extension on top of Semantic MediaWiki that facilitates the entry of data and automates its presentation for browsing [8]. Data entry facilitation comes as a form-based user interface for adding annotations to wiki pages. Semantic Forms then generates presentations of this form-entered data for each wiki page in tables similar to Wikipedia infoboxes, providing automatically rendered semantic browsing of data in the wiki. The rightmost column of Table 1 shows how Semantic Forms implements certain Semantic Web system features. Here we make our own observations and comparisons, since Forms does not explicitly target Semantic Web functionality but instead implements more general data management.

The *infoboxes* in Semantic Forms are MediaWiki templates. MediaWiki *templates* serve as functions that accept parameters in generating wiki page code. Each parameter in a Forms infobox template corresponds with a SMW property. A call to an infobox template from a wiki page generates SMW code that assigns the parameter value to the given property for that page.

Forms offers special form-based interfaces to let the user enter the specifications that drive the generation both of these templates for infobox displays and of the forms that populate them. Through these special forms, the user indicates which properties appear in each infobox/form pair, and optionally which category the infobox puts its pages into. Semantic Forms applies the SMW datatype of each property to determine interface details of how its forms accept data input for that property. By specifying in this manner the properties asked for in each form and the appearance of each type of infobox, the user sets up the equivalent of a data model for the wiki.

Some Semantic Form features reflect certain aspects of the properties `rdfs:domain` and `rdfs:range`. That a property is assigned to a form and an infobox suggests that the form's class is included in its domain. Similarly, Forms's "`autocompletion on category`" parameter of form value input field specifications suggests a `rdfs:range` for the property. In addition, some `rdfs:range` interface behavior shows in the assignment of default forms to pages linked from a given property that have not yet been created.

These features of MediaWiki, Semantic MediaWiki and Semantic Forms offer a semantic browsing environment with forms for entering data. Installations of these tools let users create and export RDF code for integration with Semantic Web sets such as the Linked Data Cloud. In addition, administrators can fine-tune their installations so that the user interface reflects additional constructs from the Semantic Web. In the next section, we discuss our application of these tools to Semantic Web educational activities. The section after that presents the OWL Wiki Forms extension of these tools, for use in upcoming courses.

2.4 Ontowiki

There are other semantic wikis beyond Semantic MediaWiki. One that is particularly relevant to this work and its venue is OntoWiki [6]. While, the collection of semantic features OntoWiki offers is similar to that of Semantic MediaWiki and its extensions, it is not built on top of MediaWiki. Advantages that OntoWiki has SMW include smoother integration with existing Linked Data sources and direct internal support of OWL constructs. For our work here, we apply Semantic MediaWiki and its extensions because they comprise a larger development endeavor with a wider variety of data processing features.

3 Applying Semantic Wikis to Semantic Web Courses

The semantic wiki technologies from the previous section apply to making a variety of Semantic Web systems. This section describes our application of these technologies to administer classes and student projects about the Semantic Web.

3.1 Bachelor's Thesis Project

The *Semantic Friendly Forms* Bachelor's thesis project at the Open Universiteit built an extension of Semantic Forms [5]. The primary functionality it adds is a form-based interface for modifying pre-existing code for input forms and data presentation tables. With just Semantic Forms, on the other hand, the form pages for page forms and infoboxes only created them. Any subsequent changes were edited manually.

Semantic Friendly Forms also provides forms for assigning certain RDF, RDFS and OWL properties to any property the semantic wiki uses. These Semantic Web standard properties are `rdf:type`, `rdfs:label`, `rdfs:comment`, `rdfs:domain`, `rdfs:range` and `owl:isInverseOf`. The form also lets users indicate that the current property is an `owl:SymmetricProperty`. In addition, Semantic Friendly Forms processes `rdfs:domain` annotations to determine which properties to include in autogeneration of forms and infoboxes.

Semantic Friendly Forms is implemented as PHP encoding of MediaWiki "Special pages", just as all of Forms and much of SMW is.

3.2 Master's Course

The Open Universiteit recently gave a one-time Master's "Capita Selecta Thema" course about the Semantic Web [11]. This course used Semantic MediaWiki, along with Semantic Forms and Semantic Friendly Forms, as the core with which students share their data and interfaces with the teacher, and with each other [11]. It was also used for the general course administration and as a platform for large student projects. Validation and some higher-level Semantic Web processing was carried out by external tools, including Protégé.

The challenge for each student was to make a system with the functionality and interface of the Semantic Web. Each student developed an ontology in OWL for their project on the semantic wiki. These ontologies then became populated and presented with Semantic Forms-based interfaces that the students made for them, in part with Semantic Friendly Forms. Each project also produced additional interfaces for its data in the form of SMW query result tables and code for showing them with the various presentations formats SMW offers. Finally, the students set up their projects so that the RDF export feature of Semantic MediaWiki export each as an RDF file that confirmed to their OWL-defined ontology.

The shared use of the course wiki allowed students to share their work in progress with the teacher. The teacher could access, use, and even edit the students systems at any time from any web browser. In this Master's course, all students worked on different project with different topics on a common wiki. Students could thus see each other's projects and code. In addition, student project sometimes used components of other student projects, as was encouraged.

Another communal online aspect of the course was its series of online sessions. We used the online lecture tool Elluminate[4] for a series of lectures. In these sessions, both teachers and students gave presentations. In addition, students were able to use Elluminate's Application Share tool to present and give demos of their projects on the common semantic wiki. Fig. 1 has a reproduction of an online session of this course, with demonstrator of a student's project on the wiki. Other forms of communication in the course are email, a discussion group, individual student-teach online sessions with demos and, of course, the wiki itself.

The definition of ontologies was a core part of each project. The students defined these in OWL as separate OWL files. They then used Semantic Forms and Semantic Friendly Forms to build the user interfaces that provided entry,

[4] `http://www.elluminate.com/`

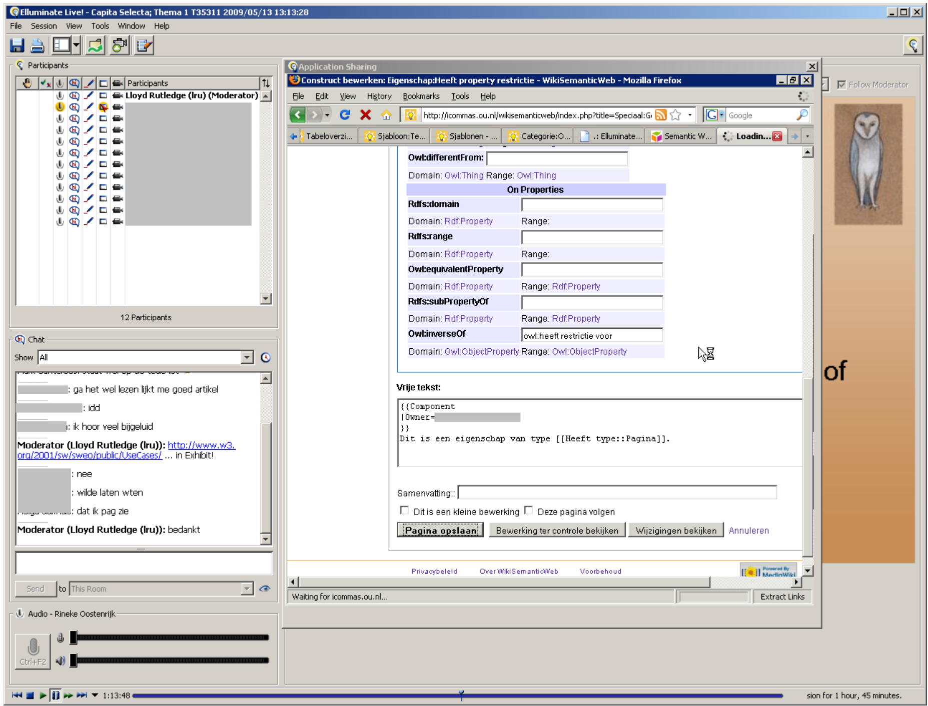

Fig. 1. Screen display of an online class with a semantic wiki

browsing and RDF exporting of data conforming to these ontologies. The ability of Semantic Friendly Forms to assist in the modification of existing infobox templates and forms was exploited by the students in building and implementing their ontologies. However, the defining of the data interface and of the OWL code it reflects remained technically separate tasks.

3.3 Master's Course Project on OWL

One of the student projects from this Master's course was about OWL itself [10]. This project provided form interfaces for annotating wiki pages with OWL properties and classes. It thus enables users to enter OWL-defined ontologies as SMW pages and Forms infoboxes. The project also processed some of these OWL constructs for OWL-related inferencing inside the wiki. As with Semantic Friendly Forms, this project offers a form page for defining properties. It also has form pages for annotating classes, restrictions and OWL properties on any resource. These four forms provide annotation with the majority of RDF, RDFS and OWL constructs. This project provided the entry of OWL-defined ontologies inside the wiki instead of as external files. However, these internally defined ontologies still had no automated influence on the creation of the entry forms and infoboxes for data populating these ontologies.

Like all students in the course, this student had no administrator access to the computer hosting the wiki while developing this project. Thus the project involved no PHP code. Instead, all functionality was encoded as SMW page and template code. While programming this functionality in PHP instead could improve performance, this project shows how much the wiki interface alone can define such interaction and processing of a semantic wiki installation.

3.4 Bachelor's Course

The Open Universiteit is developing a new bachelors course about the Semantic Web [5]. The techniques applied in this course are for the most part adaptations and extensions of those for the Master's course. One technical extension is of the semantic wiki course tools, which we package in the tool OWL Wiki Forms, described in the next section. This extension adds internal wiki interface behavior that more directly reflects the Semantic Web constructs used.

The Bachelor's course follows much of the approach of the Master's course. This includes communication via e-mail, discussion groups, wikis, individual online meetings and schedule online lectures. As with the Master's course, the core of the Bachelor's course is that each student builds a Semantic Web system on a semantic wiki. A key difference is that each student has the same assignments, and each student implements these on their own wiki, which the teacher can also access. In addition, all students can access a common course wiki for general course information as well as manuals and examples of the semantic wiki technology the course applies.

While the Master's course projects were general systems with high-level features, the Bachelor's course assignments are smaller in scale and focused more on understanding and applying individual components of Semantic Web technologies. This motivates one requirement in developing OWL Wiki Forms: that its interface directly reflects more individual Semantic Web technology components.

As with the Master's course, the Bachelor's courses system development is split up into assignments that represent different levels of Semantic Web technologies. These are: RDF and data, SPARQL and data presentation, RDFS, OWL and rules. When each assignment is given a passing grade, the starting point of the next assignment, which is in part the teacher's answer to the previous assignment, is loaded onto the student's wiki. In this way, all students start each assignment with the same foundation.

4 Extending SMW for Semantic Web Courses

This section presents the software that we developed for use in courses about the Semantic Web. The features and techniques from the software developed for the Semantic Friendly Forms project and the Master's class OWL project are unified and applied to the development of new software, *OWL Wiki Forms*

[5] `http://www.studieaanbod.ou.nl/T64211.htm`

Table 2. Ontological features implemented in OWL Wiki Forms

<table>
<tr><th colspan="2">Feature</th><th>Ontology editing</th><th>Browsing</th><th>Data Input</th></tr>
<tr><td>RDF</td><td><code>Property</code></td><td colspan="3">inherited by object and datatype properties</td></tr>
<tr><td rowspan="9">RDFS</td><td><code>datatype</code></td><td>pull-down menu on property form</td><td>associated SMW datatype sets display</td><td>determines Forms input type</td></tr>
<tr><td><code>Resource</code></td><td>own form</td><td></td><td></td></tr>
<tr><td rowspan="2"><code>Class</code></td><td rowspan="2">own form</td><td colspan="2">determines ...</td></tr>
<tr><td>infobox</td><td>form</td></tr>
<tr><td rowspan="2"><code>domain</code></td><td rowspan="2">property form value fields</td><td colspan="2">determines row in ...</td></tr>
<tr><td>infobox</td><td>form</td></tr>
<tr><td><code>range</code></td><td>autocomplete on class</td><td>new page links to form</td><td>value autocompletion</td></tr>
<tr><td><code>subPropertyOf</code></td><td rowspan="3">property form value fields autocomplete on property</td><td></td><td></td></tr>
<tr><td rowspan="8">OWL</td><td><code>inverseOf</code></td><td>shows in both</td><td></td></tr>
<tr><td><code>equivalent-Property</code></td><td></td><td></td></tr>
<tr><td><code>ObjectProperty</code></td><td>own form</td><td></td><td></td></tr>
<tr><td><code>DatatypeProperty</code></td><td>own form</td><td></td><td></td></tr>
<tr><td><code>Symmetric-Property</code></td><td rowspan="3">checkbox in property form</td><td>infoboxes</td><td></td></tr>
<tr><td><code>Transitive-Property</code></td><td>shows in chain of infoboxes</td><td></td></tr>
<tr><td><code>(Inverse-) Functional-Property</code></td><td></td><td></td></tr>
<tr><td><code>Restriction</code></td><td>own form</td><td></td><td></td></tr>
</table>

italics = still under development

(OWF). OWL Wiki Forms focuses on direct support for standard Semantic Web constructs in the wiki interface itself. Table 2 shows how OWF provides support for various Semantic Web components. It identifies four areas of support: *ontology editing*, *querying*, *browsing* and *data input*. Ontology editing consists of form-based interfaces for defining ontologies inside the wiki. Semantic MediaWiki queries should return not only the triples asserted in the wiki page code and infobox parameters but also the triples inferred by processing the relevant RDF, RDFS and OWL code.

OWL Wiki Forms also generates data display infobox based on the ontologies entered, which provide central browsing interface for the wiki. The tool similarly generates data input forms. Each of the following subsections discusses one of these semantic wiki interface components.

4.1 Ontology editing

The editing of ontologies is an important part of a complete Semantic Web system. One aim of this work is thus to include ontology editing features in OWL Wiki Forms. Its primary interface for letting user's edit ontologies is encoded using Semantic Forms. This gives the user a form-based interface for entering annotations using classes and properties from RDF, RDFS and OWL.

Our adaptation of Semantic Forms infobox templates provides the page display of this ontological data. It also ensures the corresponding annotations with categories and properties that we define for standard Semantic Web constructs by using Semantic MediaWiki. Our code for these constructs ensures that SMW's RDF export of any wiki content data includes the RDF, RDFS and OWL triples relevant for the ontologies around that data.

OWL Wiki Forms provides roughly the same forms for entering ontologies that the Masters course OWL project did: forms for general resources, classes, properties and restrictions. These correspond with, respectively, the Semantic Web standard classes `rdfs:Resource`, `rdfs:Class`, `owl:DatatypeProperty` `owl:ObjectProperty` and `owl:Restriction`. Each of these forms allows the entry of value assignments for properties from RDF, RDFS and OWL. Assignments using Semantic MediaWiki's equivalent URI and ontology import facilities cause all Semantic Web definitions entered with these ontologies forms to appear appropriately in RDF exports from the wiki. Fig. 2 shows screen displays for forms for classes and object properties.

Each of the five main OWF forms for editing ontologies provides for the entry of values for standard properties. Their entry here results in not only explicit RDF export of what is entered but also corresponding internal wiki behavior for data display and entry. The property forms have value entry fields for various standard properties. Two of these are `rdfs:domain` and `rdfs:range`. The values entered for these two particular properties have later influence on the entry and presentation of data in OWL Wiki Forms, as described later. For object property forms, the `rdfs:range` field accepts a class name. For datatype property forms, it has a pull-down menu for selecting the `rdfs:Datatype` of the property.

The object property form also has three standard properties that refer to other properties. These are `rdfs:subPropertyOf`, `owl:inverseOf` `owl:equivalentProperty`. The form assists ontologists in entering values for these properties by providing autocompletion for existing property names.

Some OWL property classes have no additional OWL properties of their own. These include `owl:SymmetricProperty`, `owl:TransitiveProperty`, `owl:FunctionalProperty` and `owl:InverseFunctionalProperty`. Protégé uses checkboxes rather than class assignments to indicate that properties are members of these classes. Similarly, Semantic Friendly Forms uses a checkbox to indicate that a property is a `owl:SymmetricProperty` [5]. OWL Wiki Forms takes the same approach, using the checkbox feature in Semantic Forms. When such a box is checked, it generates code that assigns the given property to the corresponding class assignment. All four of these checkboxes are on object property forms. A checkbox for `owl:FunctionalProperty` is also on datatype property forms.

By providing relevant internal ontological structure with each RDF export, OWL Wiki Forms facilitates the integration of wiki-generated triples into broader Semantic Webs such as the Linked Data Cloud. For Semantic Web courses, such exports let students see their wiki-edited ontologies in other Semantic Web tools

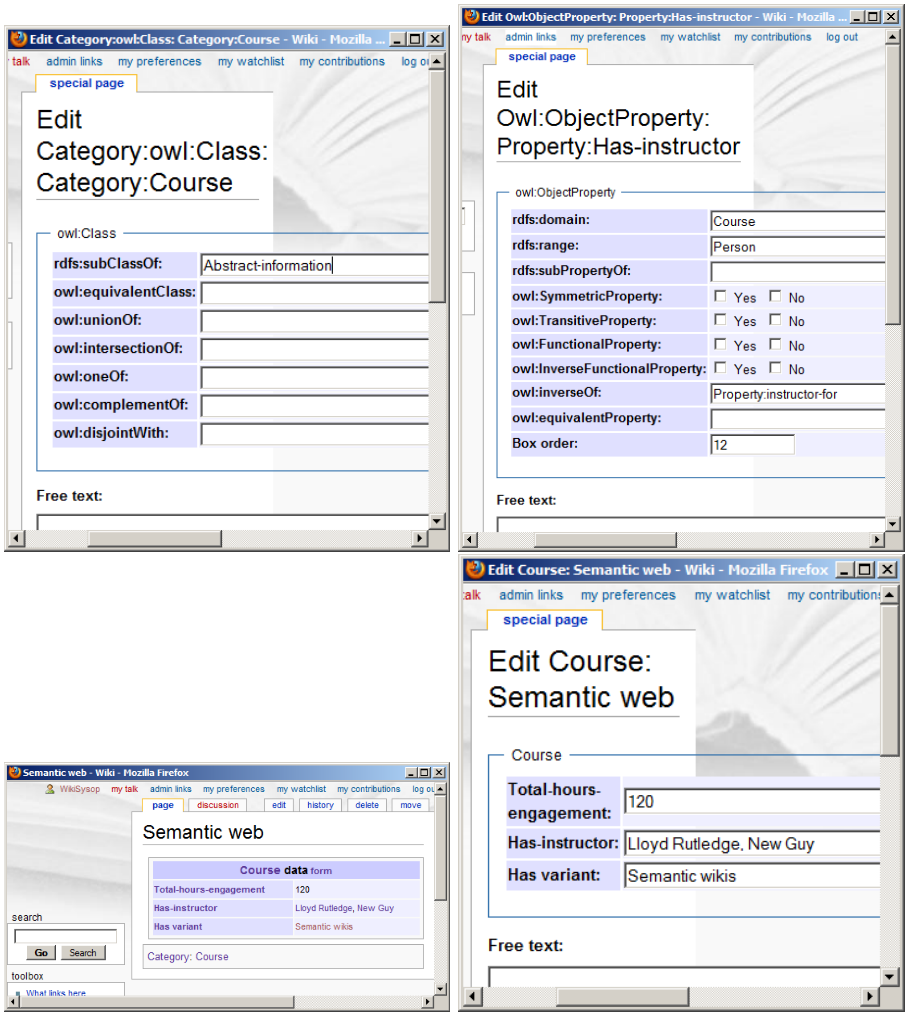

Fig. 2. Screen displays of the OWL Wiki Forms screen displays for a class form, an object property form, a page annotation form and an infobox

such as Protégé, and thus exercise with the integrability of the data their wiki implementations create. The ontologies entered via OWF also drive the inferencing, presentation and data input interfaces described later in this section. One limitation is that all of this processing currently only applies to ontological information entered via the wiki. Potential future work includes processing external ontological data for inferencing, browsing and data input assistance.

4.2 Querying and Browsing

Semantic MediaWiki has its own query language for internal data. One goal of OWL Wiki Forms is to have results from these queries include the inferencing that is defined by Semantic Web constructs entered in the wiki. Our initial means of programming this is as queries in infobox templates that find property assignments from that should infer properties of the current page, and then transform these query results into SMW code for the corresponding OWL assignments.

One important type of query result to include these inferences in is the property value display in infoboxes. In Wikipedia, Semantic Forms and OWL Wiki Forms, infobox templates provide a consistent table-based data report for the pages in a given category. Fig. 2 shows an infobox generated by OWL Wiki Forms. In Semantic Forms, a user determines the infobox rows and the properties they display. In OWF, on the other hand, infobox template code is generated automatically based on relevant ontologies in the system. OWL Wiki Forms determines each infobox's rows and how they appear by processing Semantic Web ontology constructs.

OWF also extends the processing of generation of specific Semantic Web constructs in generating infoboxes. The most important aspect of the infoboxes, the assigning of the rows themselves, is generated by OWL Wiki Forms by processing the `rdfs:domain` property. The processing by Semantic Friendly Forms of property domains [5] is applied here: if a property has a class as an `rdfs:domain`, then the property gets a row in the infobox for that class.

OWL Wiki Forms's generation of infoboxes applies the `rdfs:range` property by having links to nonexistent pages go to forms for the corresponding classes, so that the pages are registered with this class when the user later adds them. To do so, it generates code using Semantic Forms's "`Has default form`" property. Here, not only links from infoboxes trigger such forms, so do links anywhere in the wiki that lead to new pages for which range-based inferencing assigns them to a class.

OWF infoboxes show for each property not just the direct assignments from that page's form, as Semantic Forms does, but also the inferred values of the property. For example, infobox displays of values of symmetric properties show all values of this property for the current page, including names of pages with annotations with the same property pointing to the current page. Properties with an `owl:inverseOf` have each page in its triples show in the infobox of the other, albeit, unlike with `owl:SymmetricProperty` under different property names. Similarly, we plan development for `owl:TransitiveProperty` by having a value for such property rows in all infoboxes along the chain of pages link by the property.

4.3 Data Input

OWL Wiki Forms aims to process ontologies in order to guide the interface in assisting both system designers and data enterers. As with infoboxes, the `rdfs:domain` property determines the rows in a class's input form. The rdfs:range property, on the other hand, plays a different role here. Fig. 2 shows a screen display for a page's data input form, as generated by OWF processing of these and other properties.

One means of assisting data enterers is autocompletion on property value fields. To provide this, OWF processes the rdfs:range properties of each property in order to feed autocompletion in entering its values. Here, as the user types, autocompletion offers a pull-down menu of the wiki pagenames that are members of the classes in the property's range.

OWL Wiki Forms achieves this by generating corresponding Semantic Forms "autocomplete on category" parameter code. On the Semantic Web level, this gives the autocompletion the names of pages representing resources within the given classes. The user can still enter new names outside this list. As described earlier, such a new name will then appear in the resulting infobox as a link to a form for one of the range classes that generates a new page of that name.

5 Conclusion

The Informatics faculty of the Open Universiteit offers Semantic Web courses that apply semantic wikis. These wikis support the didactic approach of these courses, in which knowledge of the Semantic Web and its components and technologies is tested by means of system development assignments. The functionality of this semantic wiki supports writing and sharing course material, the implementation of student programming assignments, communication between the teacher and each student, and between the students. Since distance learning applies here, the communicative aspects of the wiki are particularly useful. The technical contributions of this work include new support for Semantic Web components directly within a semantic wiki interface. These functional extensions of current semantic wikis are programmed in the software package OWL Wiki Forms. More information about OWL Wiki Forms is available at its website at http://icommas.ou.nl/lru/OWLwikiForms/.

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