Semantic Services in e-Learning: an Argumentation Case Study

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Abstract

This paper outlines an e-Learning services architecture offering semantic-based services to students and tutors, in particular ways to browse and obtain information through web services. Services could include registration, authentication, tutoring systems, smart question answering for students' queries, automated marking systems and a student essay service. These services – which might be added incrementally to the portal – could be integrated with various ontologies such as ontologies of educational organisations, students and courses.

In this paper, we describe a few scenarios in the e-learning domain and illustrate the role of a few services. We also describe in some detail a service doing semantic annotation of argumentation in student essays for allowing visualisation of argumentation and providing useful feedback to students.

Keywords: Semantic Services for e-Learning, Services Composition, Semantic Web, Argumentation in Student Essays

Introduction

The current Web was designed primarily for human interpretation and use (McIlraith *et al.*, 2001). Originally a repository for text and images, the Web has been turning into a provider of services. These include information-providing services (e.g. currency exchange rates, weather web cameras) and world altering services (e.g. flight booking). These are currently built through hand-coded information extraction code locating and extracting relevant information from HTML pages written for humans. However, this approach is error-prone and will fail every time the presentation layout is changed. A better approach would be to provide machine-readable content that can be used by agents/programs to perform intelligent activities.

The aim of the semantic web is exactly to provide this extra layer, to add structure or meaning to what is on the Web thus allowing intelligent navigation, personalisation, querying and retrieval. This structuring could be performed by annotating documents in the web with semantics that can be later used by computers/agents to reason and perform sophisticated tasks for users. Therefore, in order to achieve the goals of the semantic web, computers must have access to structured collections of information and a set of inference rules that can be used to perform automated reasoning (Berners-Lee et al., 2001; Hendler et al., 2002). An important pre-condition for realizing the goal of the semantic web is therefore the ability to annotate web resources with semantic information. To carry out this task, users need appropriate *knowledge representation languages*, *ontologies*, and *support tools*. Knowledge representation languages provide the semantic interlingua for expressing knowledge precisely. The Semantic Web "layer cake" (Berners-Lee 2001, Hendler 2001) shows the proposed layers of the Semantic Web with higher-level languages using the syntax and semantics of lower levels: e.g. RDF builds on top of XML and Ontologies on top of RDF (Figure 1). We will focus on ontologies, as they serve as core structure for semantic portals (Studer et al., 2002). We describe semantic portals in the section titled "Demystifying Semantic Portals".

Our test bed is academic life of an institution, seen through the student semantic portal. Differently from traditional portals, such as 'Amazon' or 'Yahoo', in our student semantic portal inference processes are performed in order to provide intelligent services.

Our work has so far concentrated on two components of the portal: the student essay system (Moreale and Vargas-Vera, 2004; Moreale and Vargas-Vera, 2003) and a question-answering component called AQUA (Vargas-Vera et al., 2004; Vargas-Vera et al., 2003). AQUA searches for answers in different resources such as ontologies and documents on the web. We envisage the use of these components as part of a student semantic portal, seen as a door to obtain knowledge.

The main idea behind the student essay component consists in extracting arguments from a particular type of document: essays written by students. Extraction of arguments from documents is an interesting research problem in natural language research and has many potential applications, ranging from text classification and document summarisation to the semantic web. For instance, document summarisation could improve the performance of search engines dramatically: by allowing searching the summary of a document (rather than its full text), it would focus on relevant documents and skip the irrelevant information currently obtained by keyword-based search engines.

Research into identification of arguments in research papers has relied on a conceptualisation of academic paper structure: a paper is typically seen as containing an introduction, results and other interesting sections (e.g. paper contributions, usually identified through some heuristics). However, student essays presents a somewhat different challenge: while containing background and approach comparisons, they do not usually contain original contributions to knowledge. More importantly, their structure is less predictable than that of academic papers and cannot therefore be totally relied upon in devising a strategy for argument extraction.

In this paper, we present the proposal for a student semantic portal with several services, including a student essay service providing annotation of student essays using an argumentation categorisation devised specifically for student essays. We claim that a visualisation of the arguments presented in student essays could benefit both tutors and students. On the one hand, it would enable time-constrained tutors to easily locate the most "interesting" (argumentation-rich) parts of student essays, allowing them to determine if the essay covers the required "points" and probably spot correlations between highlighted parts. On the other hand, such a visualisation could help students "see" if their essay contains enough of the expected type of argumentation.

The main contributions of this paper are as follows: a proposal for a student semantic portal, the outline of a few e-learning scenarios, a categorisation schema for student essays used by the student essay service, one of the components of our portal, which is described as a case study.

The paper is organised as follows: we first introduce semantic portals and possible roles of the semantic web in e-learning; we then describe our proposed architecture for e-learning services (annotations, ontologies and services) including an e-learning scenario. We discuss a case study covering an essay annotation service after discussing the research background on argumentation schemas in papers and argument modelling. The section entitled "Proposed Solution" describes our proposed annotation schema, illustrating how the service may be used in an e-learning scenario. Finally, the paper presents our conclusion.

Demystifying Semantic Portals

The multiplication of web sites led to the need for web portals, sites providing access to collections of interesting URLs and "dumb" (i.e. keyword-based) search for information. Similarly, a semantic portal can be seen as an entry point to knowledge resources that may be distributed across several locations. However, differently from "dumb" web portals, semantic portals are "smarter" and carry out intelligent reasoning behind the scenes. They should offer semantic services including semantics-based browsing, semantic search and smart question answering. *Semantic browsing* locates metadata and assembles point-and-click interfaces from a combination of relevant information (Quan and Karger, 2004): it should be allow easy navigation through resources, since it may be used by users with any level of computing knowledge. *Semantic search* enhances current search engines with semantics: it goes beyond superficial keyword matching by adding semantic information, thus allowing easy removal of non-relevant information from the result set. *Smart question answering* is the technique of providing precise answers to a specific question. For instance, given a question such as "Which country had the highest inflation rate in 2002?", the system would directly reply to the question with the name of the country, as opposed to the approach of current search engines (such as Google) which might present users with web pages from the Financial Times. All these services would be built on top of functionality such as machine access to semantic information and semantic ranking (Stojanovic et al., 2001). *Semantic ranking* may be useful in those cases when too many results are returned: it allows alleviating information overload by ordering the results using different criteria. An example is ranking by popularity news stories in an electronic newsletter (http://kmi.open.ac.uk/news/planetarchive.html).

We envision a scenario where educational services can be mediated on student behalf. The user/student will confirm that suggestions are acceptable. The advantage of having a semantic portal is that students need not look for courses distributed across many locations (unlike current solutions). Moreover, semantic services perform inferences in the background (taking into account student preferences) as opposed to having users manually searching the traditional way.

From a pedagogical perspective, semantic portals are an "enabling technology" allowing students to determine the learning agenda and be in control of their own learning. In particular, they allow students to perform semantic querying for learning materials (linked to shared ontologies) and construct their own courses, based on their own preferences, needs and prior knowledge. By allowing direct access to knowledge in whatever sequence students require them, *just-in-time learning* (Stojanovich, 2001b) occurs. At the other end of the spectrum, tutors are freed from the (now student-run) task of organising the delivery of learning materials but must produce materials that stand on their own. This includes properly describing content and contexts in which each learning material can be successfully deployed. One possibility is metadata, i.e. tags about data that allow describing, indexing and searching for data.

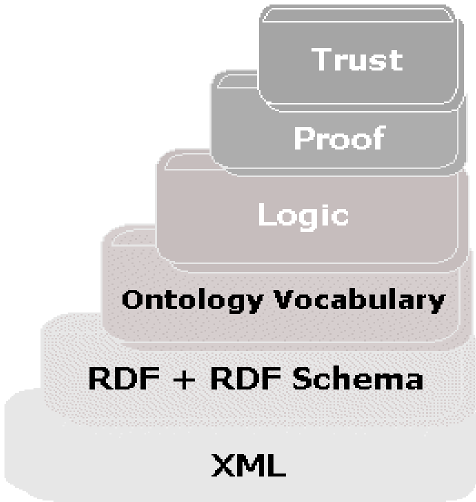

Figure 1 - Semantic Web Layers

XML (http://www.w3.org/XML/) allows users to add arbitrary structure to their document by creating tags to annotate a web page or text section. Although the meaning of XML tags is intuitively clear, tag names by themselves do not provide semantics (Stojanovich *et al.*, 2001b). XML (DTDs and XML-Schema, www.w3.org/XML/Schema) is not appropriate for propagating semantics through the semantic web, but is used as a "transport mechanism". RDF (Resource Description Framework) (Hayes, 2002; Lassila and Swick, 1999) and RDFS (Brickley and Guha, 2000) provide a basic framework for expressing metadata on the web, while current developments in web-based knowledge representation, such as DAML+OIL (DAML+OIL, 2001) and OWL (http://www.w3.org), build on RDF to provide more sophisticated knowledge representation support.

Relation between e-Learning and the Semantic Web

E-learning is an area which can benefit from Semantic Web technologies. Current approaches to e-Learning implement the teacher-student model: students are presented with material (in a limited personalized way) and then tested to assess their learning. However, e-learning frameworks should take advantages of semantic services, interoperability, ontologies and semantic annotation. The semantic web could offer more flexibility in e-learning systems through use of new emergent semantic web technologies such as collaborative/discussion and annotations tools.

Annotation

Annotation is the activity of annotating text documents written in plain ASCII or HTML with a set of tags that are the names of slots of the selected class in an ontology. In particular, in an e-learning context, the ontology could include a class called Course with a slots entitled "name" (indicating the name of the course), "has-level" (year/difficulty of the course), "has-provider" (educational establishment offering the course) and "objectives" (indicating learning outcomes). Then documents can be annotated using any of these slots.

There are initiatives to standardize annotations using a common language. One of the major problems of this approach is "who is going to do the annotations?". Not many people are willing to annotate resources unless they can see an immediate gain in doing it. Therefore, alternative approaches should be considered, including (semi-)automated systems. This approach was taken in the student essay annotation system described later.

Annotation tools for producing semantic markup include Annotea (Kahan *et al*., 2001); SHOE Knowledge Annotator (Heflin and Hendler, 2001); the COHSE Mozilla Annotator (Bechhofer and Goble, 2001); AeroDAML (Kogut and Holmes, 2001); Melita (Ciravegna *et al.*, 2002) and, OntoMat-Annotizer (Handschuh *et al*., 2001).

- Annotea provides RDF-based markup but does not support information extraction nor is it linked to an ontology server. It does, however, have an annotation server which makes annotations publicly available.
- SHOE Knowledge Annotator allows users to mark up pages in SHOE guided by ontologies available locally or via a URL. SHOE-aware tools such as SHOE Search can query these marked up pages.
- The COHSE Mozilla Annotator uses an ontology server to mark up pages in DAML. The results can be saved as RDF.
- AeroDAML is available as a web page. The user simply enters a URL and the system automatically returns DAML annotations on another web page using a predefined ontology based on WordNet.
- Melita, like MnM, provides information extraction-based semantic annotation. Work on Melita has focused on Human-Computer Interaction issues such as limiting intrusivity of the information extraction system and maximizing proactivity and timeliness in suggestions. Melita does not provide sophisticated access to the ontology, unlike MnM. In this sense Melita explored issues complementary to those explored in developing MnM and the two approaches could be integrated.
- OntoMat, which uses the CREAM annotation framework, is closest to MnM in both spirit and functionality. Both allow browsing of predefined ontologies as a means of annotating the web pages displayed using their HTML browsers. Both can save annotations in the document or as a knowledge base. While MnM already provides automated extraction, this is currently only planned for Ontomat.
- MnM (Vargas-Vera *et al.,* 2002) is an annotation tool which provides both automated and semi-automated support for marking up web pages with semantic contents. MnM integrates a web browser with an ontology editor and provides open APIs to link up to ontology servers and for integrating information extraction tools. It is an early example of the next generation of ontology editors: web-based, oriented to semantic markup and providing mechanisms for large-scale automatic markup of web pages.

Ontologies

Ontologies are explicit formal specifications of the terms in the domain and the relations among them (Gruber, 1993): they provide the mechanism to support interoperability at a conceptual level. In a nutshell, the idea of interoperating agents able to exchange information and carrying out complex problem-solving on the web is based on the assumption that they will share common, explicitly-defined, generic conceptualizations. These are typically models of a particular area, such as product catalogues or taxonomies of medical conditions. However, ontologies can also be used to support the specification of reasoning services (McIlraith et al., 2001; Motta, 1999; Fensel and Motta, 2001), thus allowing not only 'static' interoperability through shared domain conceptualizations, but also 'dynamic' interoperability through the explicit publication of competence specifications, which can be reasoned about to determine whether a particular semantic web service is appropriate for a particular task.

Ontologies can be used in e-learning as a formal means to describe the organization of universities and courses and to define services. An e-learning ontology should include descriptions of educational organizations (course providers), courses and people involved in the teaching and learning process. Some suggestions are outlined below using snapshots created using WebOnto (Domingue, 1998).

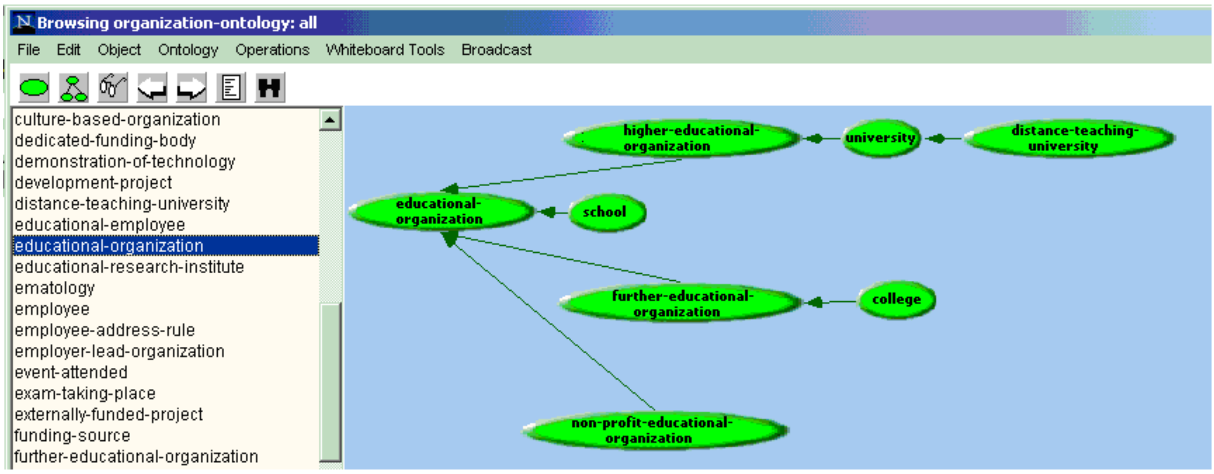

Figure 2 - e-learning Ontology : Educational-Organization

Scenario

Let us consider Maria's scenario. Maria wants to enroll in an English course in a University in Britain in summer 2004. A smart search service could analyze Maria's current location, locate English courses run by British Universities and book a ticket for Maria to reach her destination from start location. This is a simple scenario which the broker can split into several simple semantic services such as enroll-in-a-course, payment, accommodation, arrange-transport and so on. A formal specification for Maria's request is shown below. It is written in First Order Logic using Prolog notation (Clocksin & Mellish, 1981).

```
request  :-    enroll( maria, english_course) &
               location( english_course, britain) &
               time( english_course, summer_2004)
```

By using the Educational-Organization ontology, we could reformulate the request as follows:

```
request  :-    enroll( maria, english_course) &
               is-a( educational_organisation, university)
               location( english_course, britain) &
               time( english_course, summer_2004)
```

This request could be submitted by the user in natural language. It could then be processed by a natural language parser that would map it into first order logic predicates. Then the request needs to be reformulated and expressed in terms of entities and relations in the subscribed ontology. This is achieved by using similarity algorithms to perform the mapping. If the similarity algorithm does not succeed in this mapping, then the user would have the possibility of entering data using templates instantiated with values (services) specified in the ontology.

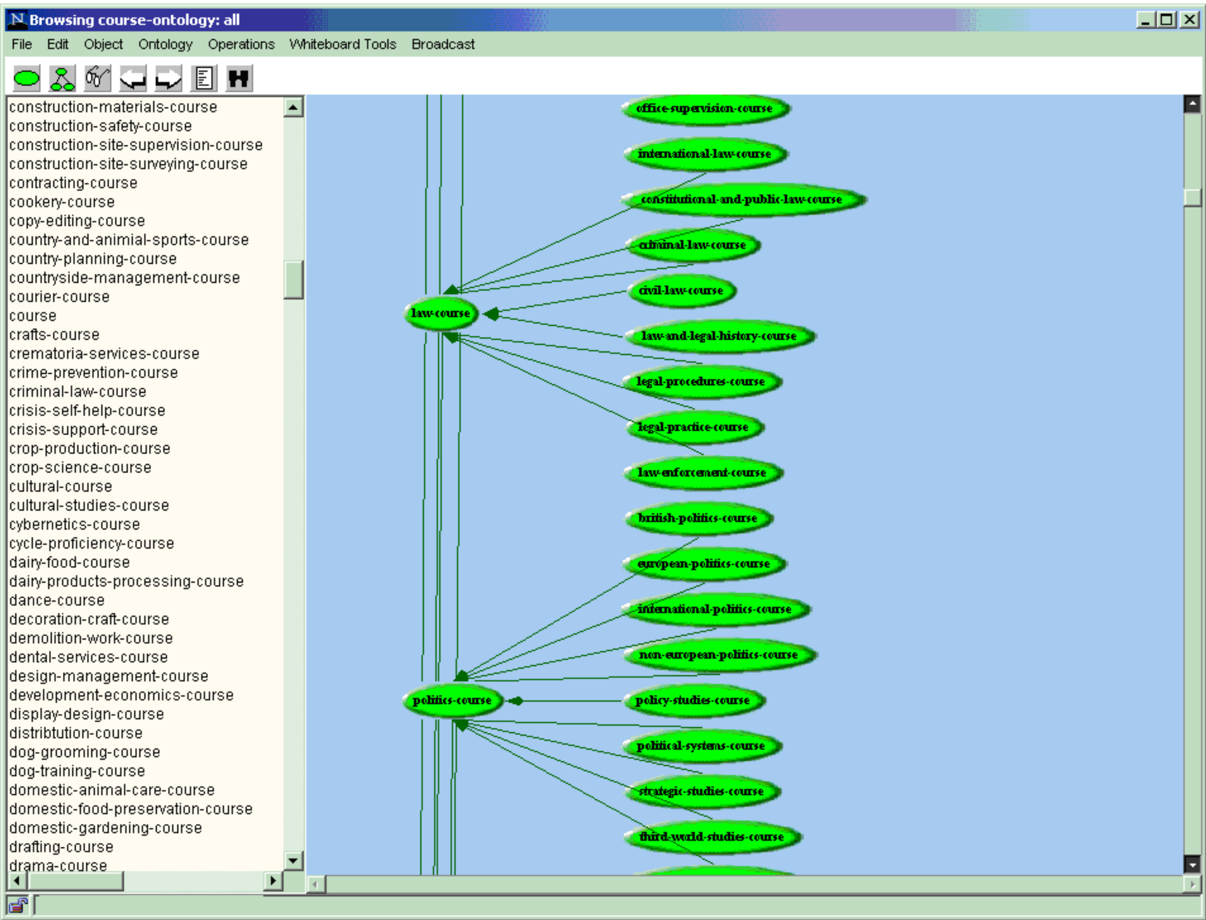

Figure 3 - e-learning Ontology: Courses

The broker splits the goal into sub-goals and requests a set of semantic services which should take Maria's constraints into consideration before taking decisions on her behalf.

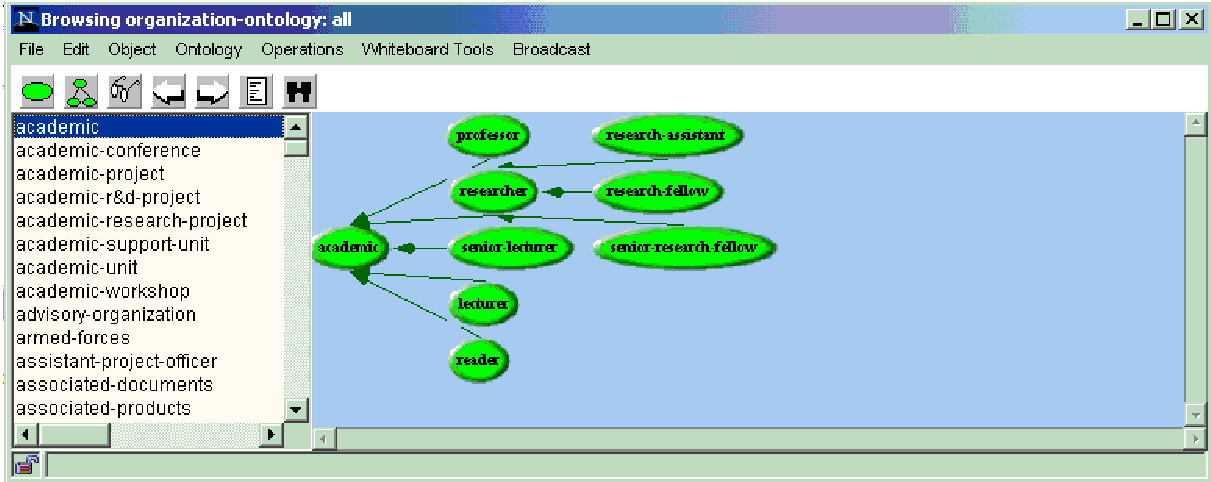

Figure 4 - e-learning Ontology: Academic

Services

Services can be seen as functions in Functional Programming Languages. Complex services can be obtained by combining simple services. In the simplest case, composition can be reduced to compose functions like in Mathematics. If we take this perspective, then a semantic service is a function with Parameters, Preconditions & Effects, Input and Output. Then the composition can be defined formally as follows:

```
F1 o F2 o . . . o Fn (X) = (F1(F2(F3 . . . (Fn(X)) ..))
```

However, the combination of services can be more complex. Semantic services can be described as Logic statements. Then the composition problem can be seen as merging logic statements with constraints. Work reported in (Vargas-Vera 1994; Vargas-Vera 1995) describes an automatic system which combines logic programs using program histories. This approach could be adapted to the composition problem since each service can be seen as a logic program and we also have histories for each service describing its functionality and restrictions imposed by the service creator. Further research needs to be carried out in this direction.

Another, equally important challenge, which needs to be addressed in the web services arena is that, when services are subscribed to different ontologies, then our framework has to deal with ontology mapping between ontologies. There are several approaches to ontology mapping such as the one taken in the GLUE system (Doan et al., 2002); Noy et al. also developed a tool for ontology alignment (Noy et al. 2000).

Architecture of the Student Semantic Portal

This section describes our proposed architecture for a student semantic portal. Architecturally, a semantic portal consists of a user who has access to services, repositories and databases through an interface. Figure 5 gives an overview of the overall architecture in the e-learning scenario and specifies details of services in the e-learning domain.

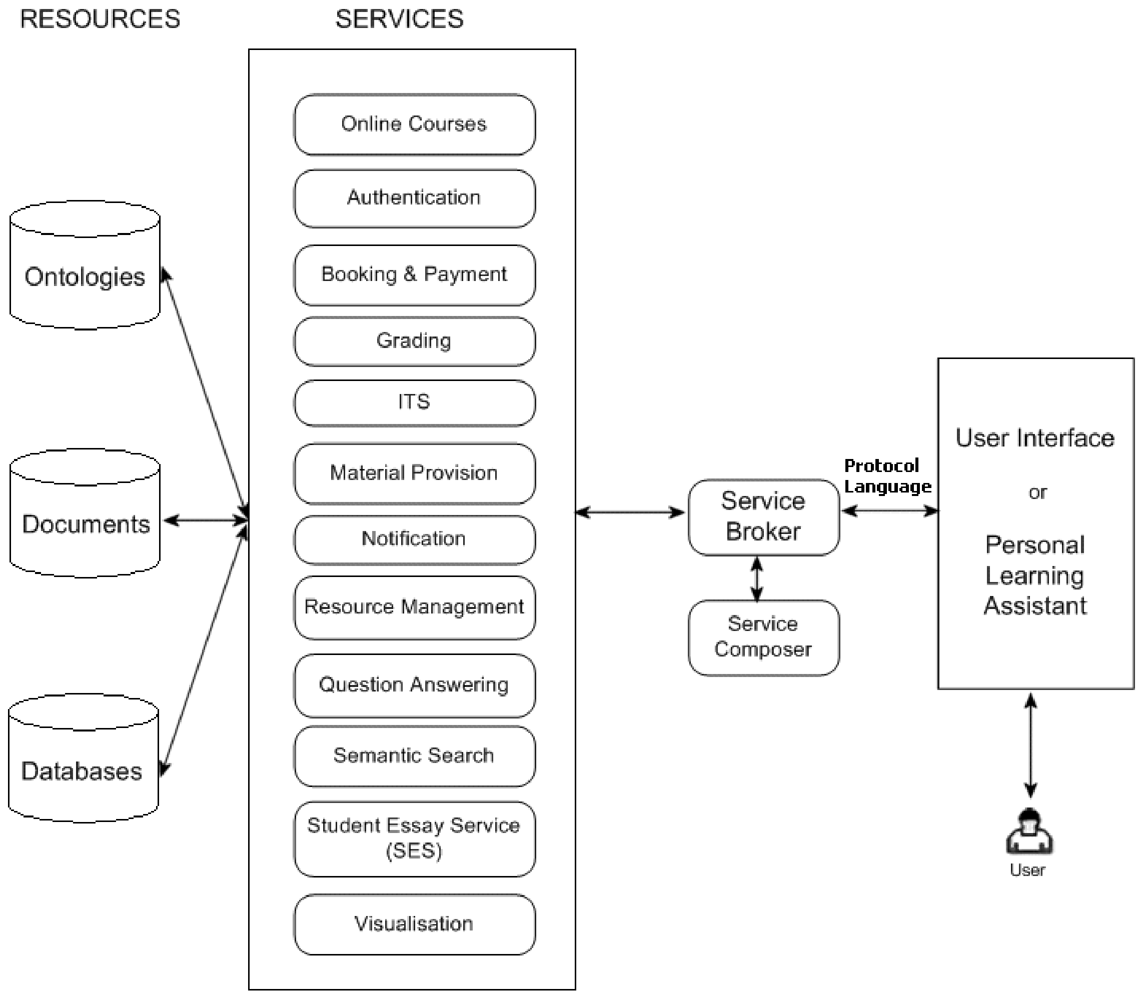

Figure 5 - Proposed Architecture for e-Learning Services

In this architecture, the first step would be registering each service with a registry (not shown), so that services can then be invoked through the service broker. The broker is a central component in this distributed architecture: it allows communication between service providers and requesters. In particular, it attempts to match a request for a service to the closest service that can provide that functionality. Services interact with resources and, in particular, subscribe to relevant ontologies. Other resources include databases and documents published on the internet.

An e-learning portal might include services such as smart question-answering, exam marking, intelligent tutoring systems, online courses and a service to help students improve their essays. Of these services, we have so far deal with the implementation of a question-answering service (AQUA) and a student essay service (SES). AQUA is described in detail elsewhere and we refer the reader to these papers (Vargas-Vera et al., 2004; Vargas-Vera et al., 2003) for a more thorough description.

This paper will deal with SES, a service that annotates argumentation in student essays to help students write better essays that answer the essay question.

Scenario

To illustrate the architecture, we will now go through an e-learning scenario. A student first searches for an online course (optionally specifying any constraints): the broker handles the request and returns a set of choices satisfying the query. If no course is found, the user can register with a notification service. Otherwise, the user may find a suitable course among the offerings and then makes a final decision about registering for the course.

Processing the registration can be seen as a complex service involving registering with the system (resource management), creating a confirmation notification, creating a student account (authentication/authorisation), providing learning materials (provide materials) and processing payment (booking & payment) if applicable. Once all this is in place, the student can start the course. As part of the course, a student will be logging on and checking her learning agenda (e.g. next assignment due). This request is answered by combining several sources of information, such as course schedule, current date and student progress to date (e.g. completed units). Let us imagine that the student needs to submit an essay on topic X. The student will be able to submit the essay for annotation of argumentation in it. The broker will redirect this query to the Student Essay Service (SES) which, in turn, will make use of argumentation ontologies and tutor-specified settings. If a visualisation of the argumentation was also requested, the SES will forward this request to the visualisation service via the broker. This visualisation service would simply return a visualisation, given a dataset, similarly to the chart option in Microsoft Excel. This concludes our e-learning scenario which exemplified the use of several services. More details of SES, question types and annotation schemas follows in the next few sections.

Case Study

To illustrate the rationale behind SES, we first need to introduce the concept of argumentation.

Argument Modelling Background

Argumentation research spans from argumentation found in research papers to knowledge representation tools supporting the construction of rhetorical arguments.

An important strand of research has focused on paper structure, producing metadiscourse taxonomies applicable to research papers. In his CARS model (Table 1), Swales (Swales, 1990) synthesised his findings that papers present three moves: authors first establish a territory, then a niche and finally they occupy this niche. Although his analysis focused on the introductory part of an academic paper, his model has nevertheless been influential.

Move 1: Establishing a Territory		
Step 1	Claiming Centrality	**Recently, there has been wide interest in…**
Step 2	Making Topic Generalisations	*A standard procedure for assessing has been…*
Step 3	Reviewing Items of Previous Research	Verbs like *show, demonstrate, establish*
Move 2: Establishing a Niche		
Step 1a	Counter-claiming	Negative or quasi negative quantifiers (*no, little*); Lexical negation (verbs like *fail* or *lack*, adjectives like *misleading*); negation in the verb phrase, questions, expressed needs/desires/interests (*The differences need to be analysed*), logical conclusions, contrastive comments and problem-raising
Step 1b	Indicating a gap	
Step 1c	Question-raising	
Step 1d	Continuing a tradition	
Move 3: Occupying a Niche		
Step 1a	Outlining purposes	This, the present, we, reported, here, now, I, herein
Step 1b	Announcing present research	
Step 1c	Announcing principal findings	*The purpose of this investigation is to …*
Step 1d	Indicating RA structure	*The paper is structured as follows…*

Table 1 - Swales's CARS model

Others (Teufel et al., 1999) extend Swales's CARS model by adding new moves to cover a whole paper. Their annotation schema aims to mark the main element in a research paper: its purpose in relation to past literature. They classify sentences into background, other, own, aim, textual, contrast and basic categories.

BACKGROUND	Statements describing some (generally-accepted) background knowledge
OTHER	Sentences presenting ideas attributed to some other specific piece of research outside the given paper
OWN	Statements presenting the author's own new contributions;
AIM	Sentences describing the main research goal of the paper;
TEXTUAL	Statements about the textual section structure of the paper;
CONTRAST	Sentences contrasting own work to other work;
BASIS	Statements to the effect that current work is based on some other work or uses some other work as its starting point;

Table 2 - Teufel's Annotation Schema (modified)

The authors claim that this methodology could be used in automatic text summarization, as this requires finding important sentences in a source text by determining their more likely argument role. However, theirs is not an implemented system. Experiments in manual annotation showed that the schema can be successfully applied by human annotators.

Hyland (Hyland, 1998) describes a metadiscourse schema that distinguishes between textual and interpersonal types in academic texts (Table 3). Textual metadiscourse refers to devices allowing the recovery of the writer's intention by explicitly establishing preferred interpretations; they also help form a convincing and coherent text by relating individual propositions to each other and to other texts. Interpersonal metadiscourse expresses a writer's persona by alerting readers to the author's perspective towards the information and the readers themselves.

Category	Function	Examples
Textual Metadiscourse		
Logical connectives	express semantic relation between main clauses	In addition, but, therefore, thus, and
Frame markers	explicitly refer to discourse acts/text stages	Finally, to repeat, our aim here, we try
Endophoric markers	refer to information in other parts of the text	Noted above, Fig 1, table 2, below
Evidentials	refer to source of information from other texts	According to X, (Y 1990), Z states
Code glosses	help reader grasp meaning of ideational material	Namely, eg, in other words, such as
Interpersonal Metadiscourse		
Hedges	Withhold writer's full commitment to statements	Might, perhaps, it is possible, about
Emphatics	Emphasise force of writer's certainty in message	In fact, definitely, it is clear, obvious
Attitude markers	Express writer's attitude to prepositional content	Surprisingly, I agree, X claims
Relational markers	Explicitly refer to/build relationship with reader	Frankly, note that, you can see see
Person markers	Explicitly reference to author(s)	I, we, my, mine, our

Table 3 - Hyland's Taxonomy: Functions of Metadiscourse in Academic Texts

Other research has focused on supporting construction of rhetorical arguments and tools for "making thinking visible" or help with essay writing (Sharples and O'Malley, 1988). Both Belvedere (Suthers et al., 1995) and SenseMaker (Bell, 1996) are about the development of scientific argumentation skills in unpracticed beginners and focus on rhetorical relations between propositions (evidence, claims and explanations). Their approach would not be suitable in our case, since our annotation schema aims to model generic (not only scientific) argumentation.

Link Type	Link
General various useful links	Is about, uses, applies, is enabled by, improves on, impairs, other link
Problem-related Links to connect to concepts that are research problems	Addresses Solves
Supports / Challenges Links to use for connecting evidence and arguments to concepts that are hypotheses or positions taken by the author	Proves, refutes, is evidence for, is evidence against, aggress with, disagrees with, is consistent with, is inconsistent with
Similarity Links to tie together similar concepts, or concepts to be specified as different	Is identical to, is similar to, is analogous to, shares issues with, is different to, is the opposite of, has nothing to do with, is not analogous to
Causal Links to tie up causes and effects, or indicate that certain conditions have been eliminated as possible causes	Predicts, envisages, causes, is capable of causing, is prerequisite for, is unlikely to affect, prevents

Table 4 - Rhetorical Relations in ScholOnto's ClaiMaker Tool

Finally, ScholOnto is a project aiming to model arguments in academic papers and devise an ontology for scholarly discourse (Buckingham Shum et al., 2002). They classify claims as general, problem-related, taxonomic, similarity or causal.

They view academic research papers as a set of inter-linked parts and their approach is to manually link statements in one paper with statements in others, leading to a network of cross-referring claims being constructed. However, our motivation is different, because we are dealing with student essays, from which we want to extract arguments in an automated way. Although automated extraction of arguments is difficult, we believe that a shallow analysis of the text can still give us clues about arguments in student essays.

Our argumentation categories are: definition, reporting, positioning, strategy, problem, link, content/expected, connectors and general.

Compared to Teufel's annotation scheme, our schema lacks an AIM category, as student essays implicitly aim to answer the essay question. Similarly, Teufel's distinction between OTHER and OWN (troublesome for human annotators) is irrelevant in our domain. Conversely, the content/expected category is student essay-specific: it includes cue phrases identifying content expected to be found in the essay. Yet, overall, there are remarkable similarities across these taxonomies (Moreale and Vargas-Vera, 2003, Table 6).

Category	**Description**	**Cue phrases** (examples)
DEFINITION	Items relating to the definition of a term. Often towards the beginning. IS_ABOUT, COMPARISONS	is about, concerns, refers to, definition; is the same; is similar /analogous to;
REPORTING	Sentences describing other research in neutral way	"X discusses", "Y suggests", "Z warns"
POSITIONING	Sentences critiquing other research VIEWPOINTS	"I accept", "I am unhappy with", "personally";
STRATEGY	Explicit statements about the method or the textual section structure of the essay	"I will attempt to", "in section 2"
PROBLEM	Sentences indicating a gap or inconsistency, question-raising, counter-claiming	"There are difficulties", "is problematic", "impossible task", "limitations"
LINK	Statements indicating how categories of concepts relate to others TAXONOMIC, EVIDENCE, CAUSAL	"subclass of", "example of", "would seem to confirm", "has caused"
CONTENT/ EXPECTED	Any concept that the tutor expects students to mention in their essay. Tutor-editable	Essay-dependent
CONNECTORS	Links between propositions may serve different purposes (topic introduction, support, inference, additive, parallel, summative, contrast, reformulation)	"With regard to", "As to", "Therefore", "In fact", "In addition", "Overall", "However", "In short"
GENERAL	Generic association links	"is related to"

Table 5 - Our Taxonomy for Argumentation in Student Essays

A last strand of research involves Rhetorical Structure Theory (RST). RST (originally developed at the Information Sciences Institute, USC), is designed to enable the analysis of text: it focuses on specifying the evident role of every part of text (Mann, 1988). RST has been applied to enhancing e-rater with discourse-marking capabilities (Burstein *et al.*, 1998). While this is a generic (not a student essay or academic-specific) categorisation, it has its rightful place here.

Category Name	***Relationship to Other Categorisations***	
DEFINITION	• ClaiMaker: is about	
COMPARISON	• Teufel's CONTRAST	
REPORTING	• Swales: Move 1, Step 3; • Teufel: OTHER; • Hyland: EVIDENTIALS	
POSITIONING	• Swales: Move 2 (Establishing a Niche); • Teufel's CONTRAST; • Hyland: Emphatics, Attitude markers, Person markers	Hyland: Interpersonal Metadiscourse
VIEWPOINT	• Hyland: Hedges	
STRATEGY	• Swales: Purpose: M3, S1a; Structure:M3, S1d • Teufel: TEXTUAL; • Hyland: Endophoric markers	
PROBLEM	• Swales: Move 2 (Establishing a Niche)	
TAXONOMIES	• ClaiMaker: Taxonomic	
EXPECTED/ CONTENT		
CONNECTORS	• Hyland: Logical Connectives, Frame Makers, Code glosses	Hyland: most of Textual Metadiscourse
GENERAL	• ClaiMaker: General link type (except is about)	

Table 6 - Our Essay Metadiscourse Taxonomy and Other Categorisations

Proposed Solution

After examining the appropriateness of various Natural Language Processing (NLP) techniques (Moreale and Vargas-Vera 2003), we concluded that the best solution for our purposes would be finding claims in student essays by using an approach that combines cue phrases with a set of patterns. We started off by defining gazetteers of cue phases and patterns written as regular expressions. The set of patterns were organised based on our categories (Table 5).

The proposed architecture of SES comprises: segmentation, categorization and annotation modules.

- The segmentation module obtains segments of student essays by using a library of cue phrases and patterns.
- The categorisation component classifies the segments as one of our categories.
- The annotation module annotates relevant phrases as belonging to one of our defined categories. These annotations are saved as semantic tags. Future implementation of the system could use machine learning for learning cue phrases.

The Student Essay Service (SES) allows visualisation of instances of argumentation categories within an essay, in a shallow version of "making thinking visible". The intuition is that essays with considerably more "highlighted text" contain considerably more argumentation – and actual "content" – and therefore are likely to attract higher grades (and be better essays) than essays with little highlighting.

In the e-learning scenario, SES annotates essays using argumentation categorisations stored as ontologies. Of course, further annotation flexibility can be provided by subscribing to ontologies defining alternative argumentation schemas.

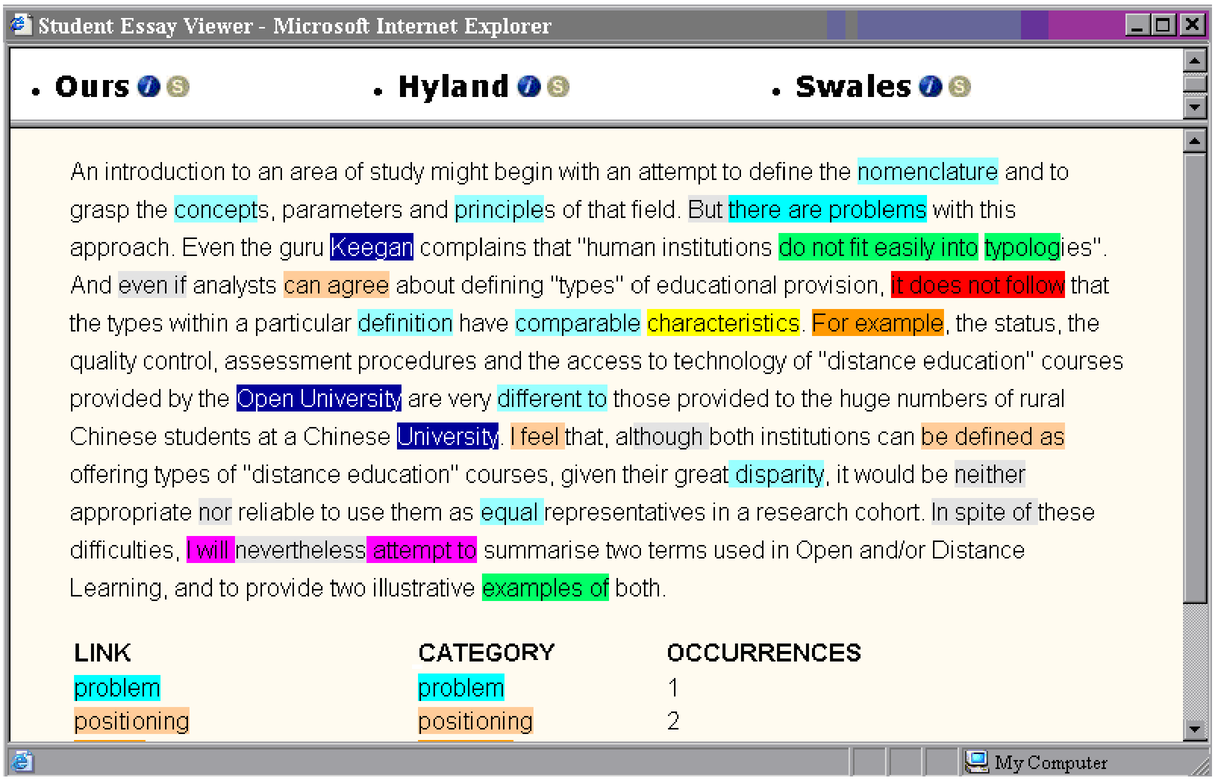

Figure 6 - Simple User Interface displaying annotated essay (using "Ours" categorisation)

The output of the SES (i.e. annotated text) would then be optionally (but fruitfully) combined with a visualisation of these annotations (provided by the Visualisation service) for the user to inspect. The exact look-and-feel would depend on the User Interface: Figure 6 shows a simple HTML-based visualisation of the annotations. At the top, the available argumentation categorisations can be explored. The main part contains the essay: this is initially displayed without any annotations. However, when a category is selected, the annotations relating to this category are displayed. Selecting a whole categorisation causes annotations relating to all its categories to be displayed (each colour corresponding to a different category, middle section of Figure 6). Below the essay, a count of links of each type is displayed for reference (bottom of Figure 6). An optional visualisation could be displayed even further down (or in a separate window, depending on user's preferences). Annotations could be saved in XML or RDF format.

Student Essay Service and its Role in e-Learning

The role of SES in an e-learning services architecture is evident: it can be used to give students feedback and it could even (eventually) be used to aid assessment. Visualisation of its annotations in particular could be useful to tutors who may refer to its automatic counts indicator, citation highlighting or simply use it to quickly gauge the amount and distribution of argumentation cues across an essay. Tutors, being "essay experts", approach the marking of an essay with a clear idea of what it should contain . SEV helps them quickly ascertain to what extent that essay matches their expectations and makes essay comparison in terms of argumentation (links) less time-consuming.

SES could also be used to provide formative assessment to students. Students are well advised to revise their essay before submission if not much argumentation was found. An improvement in the essay (more background and reasoned argumentation to match the question) should result in more highlighting. This may increase motivation in some students.

SES is based on some assumptions concerning the relationship between annotations and essay quality:

1) "Bad essays" generally have a lower number of annotations than better essays (i.e. are less "content-rich");
2) Critical analysis and background reviews are two essential elements in most essays. These annotations are expected to be the most important in terms of association with the human-assigned score;
3) The relative importance of annotation categories within an essay may vary across essays types.

In previous work, we tested these hypotheses and found them to be true to a certain extent (Moreale and Vargas-Vera 2003).

Annotation Categories and Essay Questions

Query classification gives information about the kind of answer our system should expect. The classification phase involves processing the query to identify the category of answer being sought. In particular, sentence segmentation is carried out: this reveals nouns, verbs, prepositions and adjectives. The categories of possible answers, which are listed below, extend the universal categorisation of traditional question answering systems (by adding to the six categories: what, who, when, which, why and where). We have so far applied SES to four different assignments. Our analysis of the essay questions in our testbed (see Table 7) showed that they were answered by essays with different "link profiles" (Table 8).

Question Asks…	*Assignment*	*Example*
1. Summary + How and Why	Ass 1, part 2	"In the light of Otto Peter's ideas… say how each type can or cannot serve these ideas and why"
2. Opinion about X	Ass 2, part 1	- "Who do you think should define the learners' needs in distance education?"
	Ass 4, part 3	- "State and define your views on the questions of whether the research is adequately addressing what you regard to be the important questions or debates"
3. Describe + Discuss	Ass 2, part 2	"Imagine you are student and your teacher has a strong leaning towards the technical-vocational orientation. Describe and discuss your experiences, using concepts and examples from text book 1."
	Ass 4, part 2	"Define and discuss any cultural factors you observe in relation to each of these questions"
3. Give example of X and Critique X	Ass 4, part 1	Provide examples of web links covering a wide range of choose aspects of open and distance education and write a short critique of each.

Table 7 - Examples of Essay Questions

The basic idea is that, depending on the essay question, we expect to find a different "distribution" of links in the essay themselves: e.g. a question asking for a "summary" is usually answered by an essay containing many "reporting" links. Table 8 matches essay questions with our essay metadiscourse categories.

Example of Question	*Links Expected to be Important*
1. Summary of X + How and Why	Essays answering such questions have a high number of the following link types: reporting, positioning, expected, is about, part and contrast.
2. Opinion about X	Essay has a high number of background, expected names, positioning. However part link does not seems very relevant
3. Describe and Discuss	Describe and Discuss essays feature a high number of support and positioning links. In the case of assignment 2, part 2, there was a low number of reporting links, as students were asked to describe a hypothetical situation; however, this may not always be the case.
4. Give an example of X and Critique X	In these essays, analysis and summative connector links are higher than "is about" and "contrast" links.

Table 8 – Examples of Essay Questions and Expected Links

We then took all essays for assignment 1 and 2 (93 in all) and focused our attention on "link profiles" (Tables 8, 9): in particular, what link profiles could reasonably be expected in a satisfactory essay written for assignments 1 or 2. We performed a statistical analysis on the data (obtained from the 35 essays for which we had the required grade breakdown) to test our hypotheses. The results of this analysis are summarised in Table 9.

While positioning links are determinant in Assignment 2 part 1, overall, the importance of reporting links is apparent: essays at graduate and post-graduate level nearly always (at least in part) require showing that one has "done the reading". Where reporting links were not significantly correlated with grade, this seems related to students wandered off topic (e.g. they talked about Holmberg and his ideas at length, but did not spend most of their time and words on guided didactic conversation, something the question specifically asked about).

This suggests that – in order to detect if an essay is answering the question (i.e. not going off topic) – SES should make use of both a "generic" reporting link category and a more specific one ("specific reporting links" in Table 9). Examples of cues used for "specific reporting" in Assignment 1 part 2a were: Peters, industrial and Open & Distance Learning. In our specific e-learning scenario, specific reporting instances could be derived from query classification techniques (such as sentence segmentation) applied to the specific essay query and then revised by the tutor.

ID	Expected	Results	Analysis
Ass 1 Part 1	Many reporting links	- reporting links count significant ($r=0.730$; $N=12$; $p<0.01$) - positioning links count not significant - total link count significant: $r=0.624$; $N=12$; $p<0.05$ $F(1,10)= 6.385$; $p<0.05$	Spearman correlation and ANOVA F-statistic seems to support our expectations: reporting links are more important than positioning links in this type of essay.
Ass 1 Part 2a	high number of reporting, positioning and expected links.	- reporting more important than positioning - statistical significance for "specific reporting links": - a) "Peters" $r=0.744;n=12;p<0.01$ - b) "Peters+industrial+ODE" $r=0.717;n=12;p<0.01$ $F(1,14)=6.524$; $p<0.05$	Some students, while including sufficient reporting /expected links, managed to wander off topic (and hence their grade was not high). Better grades achieved by essays that stayed "on topic" ("specific reporting" links)
Ass 1 Part 2b		- significant correlation between score and specific reporting links: - $r=0.526;n=15;p<0.05$ ($r=0.586$ excluding "Holmberg") - no statistical significance for generic reporting or positioning links - expected not significant	Many students wandered off topic (discussed around Holmberg / expected stuff but not enough on guided didactic conversation or GDC). Hence, only reliable indicator is specific reporting links.
Ass 2 Part 1	positioning links important	- positioning links show a significant correlation with score: $r=0.538;n=20;P,0.05$	When background is not "at the forefront" in an essay question, positioning tends to be the determinant link type.
Ass 2 Part 2	-reporting (especially reporting on Schön)	- reporting links (generic): Spearman's Rho: 0.467; $n=20$; $p<0.05$; -specific reporting links $r=0.541$; $n=20$; $p<005$; - word count: $r=0.639;n=20;p<0.01$	Reporting links are important in this kind of essay, particularly links directly connected to the question (students sometimes tended to wander off topic). Word count is important, again, as this is the last part in Ass2 and some students overran their target in part 1.

Table 9. Expected/Actual Argumentation links (Assignments 1 and 2)

Student Essay System and Feedback

Students are often unclear about what exactly should go into a particular essay or get "side-tracked" and use too many words covering one aspect of the essay (e.g. background) at the expense of others (e.g. positioning). SES could help by alerting students to a lack of certain types of argumentation. Such a warning would be created when the link profile does not match the one set up by the tutor for the specific essay. For instance, if the question requires justifications or asks "why" and "how" questions, the tutor may have chosen to specify that the essay is to contain considerable "positioning" argumentation and therefore an essay containing mostly background material but little positioning argumentation will not be a satisfactory answer to the essay question. SES would therefore report this to the student.

Conclusions and Future Work

The main contribution of this paper is our outline architecture for e-learning services in the context of a semantic portal, the description of various scenarios within this architecture, including enrolment in a course and annotation of a student essay. We have used ontologies to describe learning materials, annotation schemas and ontology of services.

Our architecture moves away from the traditional teacher-student model in which the teacher determines the learning material to be absorbed by students and towards a new, more flexible learning structure in which students take responsibility for their own learning, determine their learning agenda, including what is to be included and in what order. As well as having more choice, students also have wider access to semantic technologies such as annotation tools. At the other end of the spectrum, tutors are freed from the task of controlling the delivery of learning materials (which is now controlled by the student) and their role focuses more on the production of materials that stand on their own by being properly annotated so that they can be located in the correct contexts by semantic services.

We have implemented a service that performs question-answering and one that carries out argumentation annotation in student essays. A feedback service could then use the essay question (possibly in the form of tutor-determined settings) to determine what categories are expected to be prominent in an essay and alert the user if a relevant category is missing or under-represented. This will give students valuable clues as to whether they are answering the question correctly.

There is clearly a lot more work needed to make this technology work well enough for large-scale deployment.

Further work may include implementing and evaluating a functional version of the portal with the components described here. More functionality could then be implemented or even simply be provided by invoking services made available elsewhere on the Web. This would be a further step towards a really open system that realises the goal of a Semantic Web.

In short, this paper has presented a proposal for a distributed e-learning architecture comprising several e-learning services. Possible services include question-answering, online courses, tutoring systems and automated marking systems. Currently, two components have been developed. One is AQUA, a question-answering system which looks for answers in different resources. The second component is a student essay service which uses a metadiscourse annotation schema for student essays. A visualisation service then also provides a visualisation of annotation categories relevant to the current question types. All the functionality described here is only part of what a full-fledged student semantic portal may eventually offer in the future but it is an important first step towards a really student-centred educational environment.

References

Bechhofer, S. and Goble, C. (2001). Towards Annotation Using DAML+OIL. *First International Conference on Knowledge Capture (K-CAP 2001)*. Workshop on Semantic Markup and Annotation. Victoria, B.C., Canada.

Bell, P. (1997). Using Argument Representations to Make Thinking Visible for Individuals and Groups. In R. Hall, N. Miyake, & N. Enyedy (Eds.), *Proceedings of CSCL '97: The Second International Conference on Computer Support for Collaborative Learning*, (pp. 10-19). Toronto: University of Toronto Press.

Berners-Lee, T., Hendler, J. and Lassila, O. (2001). The Semantic Web, *Scientific American*, May 2001.

Brickley and Guha, Brickley, D. and Guha, R.. Resource Description Framework(RDF) Schema Specification 1.0. Candidate recommendation, World Wide Web Consortium, 2000. See http://www.w3.org/TR/2000/CR-rdf-schema-20000327

Buckingham Shum, S., Uren, V., Li, G., Domingue, J., Motta, E. (2002). Visualizing Internetworked Argumentation, in *Visualizing Argumentation: Software Tools for Collaborative and Educational Sense-Making*. Paul A. Kirschner, Simon J. Buckingham Shum and Chad S. Carr (Eds.), Springer-Verlag: London.

Burstein, J. and Marcu, D. (2000). Toward Using Text Summarization for Essay-Based Feedback, *TALN 2000 Conference*, Lausanne, 16-18 October 2000.

Burstein, J., Kukich, K., Wolff, S., Lu, C., and Chodorow, M. (1998). Enriching automated essay scoring using discourse marking. *Proceedings of the Workshop on Discourse Relations and Discourse Markers*, Annual Meeting of the Association of Computational Linguistics, August, Montreal, Canada.

Ciravegna F., Dingli A., Petrelli D., and Wilks Y. (2002). User-System Cooperation in Document Annotation based on Information Extraction. *Proceedings of the 13th International Conference on Knowledge Engineering and Knowledge Management, EKAW02*, publisher Springer Verlag.

Ciravegna, F. (2001a). Adaptive Information Extraction from Text by Rule Induction and Generalisation, *Proc. of 17th International Joint Conference on Artificial Intelligence (IJCAI 2001)* , Seattle, August 2001.

Ciravegna, F. (2001b). LP2 an Adaptive Algorithm for Information Extraction from Web-related Texts. *Proc. of the IJCAI-2001 Workshop on Adaptive Text Extraction and Mining* held in conjunction with the 17th International Conference on Artificial Intelligence (IJCAI-01), August, 2001.

Clocksin W. F. and Mellish C. S. (1981): Programming in Prolog, Springer-Verlag. 1981.

DAML+OIL can be found at http://www.daml.org/2001/03/reference.html

Doan, A.H., Madhavan, J., Domingos, P., Halevy, A. (2002). Learning to Map between Ontologies on the Semantic Web, *World Wide Web Conference WWW 2002*.

Domingue J. (1998). Tadzebao and WebOnto Discussing, Browsing, and Editing Ontologies on the Web. *Proceedings of the 11th Banff Knowledge Acquisition Workshop*, Banff, Alberta, Canada.

Fensel, D. and Motta, E. (2001). Structured Development of Problem Solving Methods. *Transactions on Knowledge and Data Engineering* 13(6):9131-932, 2001.

Gruber, T.R. (1993). A Translation Approach to Portable Ontology Specification. *Knowledge Acquisition*, 5(2): 199-220.

Handschuh, S., Staab, S. and Maedche A. (2001). CREAM - Creating relational metadata with a component-based, ontology-driven annotation framework. *First International Conference on Knowledge Capture (K-CAP 2001)*.

Hayes, P. (2002). RDF Model Theory, W3C Working Draft, http://www.w3.org/TR/rdf-mt/.

Hendler, J., Berners-Lee, T. and Miller, E. (2002). Integrating Applications on the Semantic Web, *Journal of the Institute of Electrical Engineers of Japan*, Vol. 122(10), October, 2002, p. 676-680. Online at: http://www.w3.org/2002/07/swint

Hyland, K. (1998). Persuasion and Context: The Pragmatics of Academic Metadiscourse, *Journal of Pragmatics* 30 (1998), 437–455.

Kahan J., Koivunen M., Prud'Hommeaux E., and Swick R. (2001). Annotea: Open RDF Infrastructure for Shared Web Annotations. In *Proc. of the WWW10 International Conference*. Hong Kong, 2001.

Kogut P. and Holmes W. AeroDAML (2001). Applying Information Extraction to Generate DAML Annotations from Web Pages. *First International Conference on Knowledge Capture (K-CAP 2001)*. Workshop on Knowledge Markup and Semantic Annotation, Victoria, B.C., Canada.

Kushmerick, N., Weld, D, and Doorenbos, R. (1997). Wrapper Induction for Information Extraction. *Proc. of 15th International Conference on Artificial Intelligence, IJCAI-97*.

Lassila, O. and Swick, R. R. (1999). Resource Description Framework (RDF): Model and Syntax Specification. Recommendation, World Wide Web Consortium, 1999. See http://www.w3.org/TR/REC-rdf-syntax/.

Mann, W.C. & Thompson, S.A. (1998). Rhetorical Structure Theory: Toward a functional theory of text organization. *Text*, 8(3), 243–281.

Maynard, D., Tablan, V., Cunningham, H, Ursu, C., Saggion, C., Bontcheva, K. and Wilks, Y. (2002). Architectural Elements of Language Engineering Robustness. *Journal of Natural Language Engineering – Special Issue on Robust Methods in Analysis of Natural Language Data*, Volume 8 Number 2-3.

McIlraith S., Son T.C.and Zeng H. Semantic Web Services, *IEEE Intelligent Systems*, Special Issue on the Semantic Web, Volume 16, No. 2, pp. 46-53, March/April, 2001.

Moreale, E. and Vargas-Vera, M. (2004). A Question-Answering System Using Argumentation. Third International Mexican Conference on Artificial Intelligence (MICAI-2004), *Lecture Notes in Computer Science (LNCS 2972)*, Springer Verlag, April 26-30, 2004. ISBN 3-540-21459-3.

Moreale, E. and Vargas-Vera, M. (2003). Genre Analysis and the Automated Extraction of Arguments from Student Essays, *7th International Computer Assisted Assessment Conference, CAA-2003*, Loughborough, England, 8th and 9th July 2003.

Motta, E. (1999). *Reusable Components for Knowledge Models*. IOS Press, Amsterdam.

Noy N, and Musen M. (2000). PROMPT: Algorithm and Tool for Automated Ontology Merging and Alignment. In *Proc. Of the 17th National Conference on Artificial Intelligence (AAAI)*.

Quan, D. and Karger D.R. (2004) How to Make a Semantic Web Browser, *13th International World Wide Web Conference, WWW 2004*, May 17-22 2004, New York, USA. www.ai.mit.edu/people/dquan/www2004-browser.pdf

Sharples, M. and O'Malley, C. (1988). A Framework for the Design of a Writer's Assistant. *Artificial Intelligence and Human Learning: Intelligent Computer-Aided Instruction*. J. Self, Chapman and Hall Ltd.

Smolensky, P., Fox, B., King, R. and Lewis, C. (1987). Computer-aided Reasoned Discourse or How to Argue with a Computer. In R. Guindon (Ed.). *Cognitive Science and its Applications for Human-Computer Interaction*, 109–162.

Stojanovic, N., Maedche, A., Staab, S., Studer, R. and Sure, Y. (2001a). SEAL – A Framework for Developing Semantic PortALs, *K-CAP'01*, October 22-23, 2001.

Stojanovic, N., Staab, S., Studer, R. (2001b). eLearning Based on the Semantic Web. In *Proceedings of the World Conference on the WWW and Internet WebNet2001*.

Studer, R., Sure, Y. and Volz, R. (2002). Managing User Focused Access to Distributed Knowledge, *Journal of Universal Computer Science (J.UCS)*, 8, 6, 662-672, 2002.

Suthers, D, Weiner, A, Connelly, J. and Paolucci, M. (1995). Belvedere: Engaging Students in Critical Discussions of Science and Public Policy Issues. *AI-Ed 95. 7th World Conference on Artificial Intelligence in Education*.

Swales, J.M. (1990). *Genre Analysis*. Cambridge University Press.

Teufel, S., Carletta, J. and Moens M. (1999). An Annotation Scheme for Discourse-Level Argumentation in Research Articles, *Proceedings of EACL'99*, 110–117.

Vargas-Vera, M. and Motta, E. (2004). AQUA - Ontology-based Question Answering System. Third International Mexican Conference on Artificial Intelligence (MICAI-2004), *Lecture Notes in Computer Science (LNCS 2972)*, Springer-Verlag, April 26-30, 2004. ISBN 3-540-21459-3.

Vargas-Vera, M., Motta, E. and Domingue, J. (2003). AQUA: An Ontology-Driven Question Answering System. *AAAI Spring Symposium*, New Directions in Question Answering, Stanford University, March 24-26, 2003.

Vargas-Vera, M., Motta, E., Domingue, J., Lanzoni, M., Stutt, A. and Ciravegna, F. (2002). MnM: Ontology Driven Semi-Automatic and Automatic Support for Semantic Markup. The 13th International Conference on Knowledge Engineering and Management (EKAW 2002), *Lecture Notes in Computer Science 2473*, ed. Gomez-Perez, A., Springer-Verlag, 2002, 379-391, ISBN 3-540-44268-5.

Vargas-Vera, M. (1995). *Using Prolog Techniques to Guide Program Composition*. PhD. Thesis, Dept. of Artificial Intelligence, Edinburgh University, 1995.

Vargas-Vera M. and Robertson D. (1994). An Environment for Combining Prolog Programs Based on Knowledge about their Construction. *The 10th Workshop on Logic Programming (WLP 94)*, University of Zurich, October 1994, pp 73-76, 1994.