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Automatic Feedback Framework for Deriving Educational Ontologies

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Abstract – Automatic feedback generation is an important feature of Computer Assisted Assessment (CAA) systems. Feedback can help learners to diagnose their learning status and educational knowledge. The education ontology is created in the protégé tool. Questions are generated and the examinee's is to provide the answers for the given questions. System will generate the adaptive feedback based on the user's response. Learner's answer will be assessed from the ontology. And then based on the examinee's response the adaptive feedback is generated for right and wrong answers. Adaptive Feedback can be both human readable format and machine readable format. Users learning status can be identified from the adaptive feedback. Feedback can be generated from the metadata of items. Adaptive feedback can help learner's knowledge level and examinees can improve their knowledge level.

Index Terms – The Taxonomy of education objectives, Architecture of concept map assessment tool, Different types of CAA, Class hierarchy, Artificial Intelligence.

1. INTRODUCTION

This Automatic feedback generation has several advantages over traditional paper-and-pencil (P&P) Assessment. Also CAA (Computer Assisted Assessment) is used for assessing student learning with the help of computer. There are many types of assessments that exist. They are computer based assessment and online assessment. Assessment can be categorized [5] as either summative (for grading purposes) or formative (to give feedback to assist the learning process). Automatic generated feedback can help learners to discover their level of assimilation of certain topics [1], or learn by assessment [2]. Generally, automatic generated feedback can be divided into two categories: they are positive feedback and negative feedback they are also known as adaptive and non-adaptive feedback.

For non-adaptive feedback, hints or explanations can be embedded in items and systems can deliver them according to user's responses. One positive aspect of this approach is that items can be written in forms such as multiple choices, fill in blank, and so on. These forms make it feasible to share and reuse items, and further to construct item banks [3]. Item banks are collections of questions, often produced collaboratively across a subject domain that can be grouped according to difficulty, the type of skill or topic. The drawback of this approach is that the embedded feedback is intended for human reading instead of machine understanding. And therefore, it is infeasible for machines to model personal learning status to behave adaptively.

1.1. Feedback in Computer-based Instruction

Feedback is any message generated in response to a learner's action. System-based feedback proposes a theory-based framework to assist educators, programmers, and instructional design specialists in incorporating effective feedback into educational software and programs. One of the main advantages of computer based education is the ability to provide immediate feedback on individual responses.

1.2. Feedback in Computer-based Instruction

There are many case in points of Informative being used in both pro forma education and professional backdrop in which they have establish their ability and limitations.Ancestral computer aided instruction (CAI) systems support learning by encoding sets of exercises and the combined solutions, and by providing predefined remediation actions when the students' answers do not match the encoded solutions.

1.3. Research Problem

Items are used in standard form to produce adaptive feedback, which makes these items sharable and reusable. The generated feedback is both human readable and machine understandable, which guarantees the interoperability of the present framework. A framework for generating feedback from metadata of items is proposed.

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2. RELATED WORK

The word ontology was taken from philosophy. Guarino and Giaretta are proposes to use the words 'Ontology' (with capital 'O') and 'ontology' refers to the philosophical and knowledge engineering senses respectively [10]. Gruber defined ontology as follows [7]:

"Ontology is an explicit specification of a conceptualization"

This definition became the most quoted in literature and by the ontology community. Based on Gruber's definition, many definitions of what ontology is were proposed. Brost modified slightly Gruber's definition as follows [8]:

"Ontologies are defined as a formal specification of a shared conceptualization "

Gruber's and Borst's definitions have been merged and explained by Student and colleagues as follows [9]:

"Ontology is a formal explicit specification of a shared conceptualization "

Conceptualization refers to an abstract model of some phenomenon in the world by having identified the relevant concepts of that phenomenon. Explicit means that the type of concepts used, and the constraints on their use are explicitly defined. Formal refers to the fact that the ontology should be machine-readable. Shared refers the notion that the ontology captures consensual knowledge Guarino and Giaretta collected and analyzed the following seven definitions [10]:

- Ontology as a philosophical discipline.
- Ontology as an informal conceptual system.
- Ontology as a formal semantic account.
- Ontology as a specification of conceptualization.
- Ontology as presentation of a conceptual system via a logical theory
  - Characterized by specific formal properties.
  - Characterized only by its specific purposes.
- Ontology as the vocabulary used by a logical theory.
- Ontology as a specification of a logical theory.

Guarino and Giaretta proposed to consider an ontology as [11]:

A Logical theory which give an explicit, partial account of a conceptualization.

For building ontologies is to reuse large ontologies like SENSUS to create domain specific ontologies and knowledge bases:

"Ontology is a hierarchically structured set of terms for describing a domain that can be used as a skeletal foundation for a knowledge base."

According to this definition, the same ontology can be used for building several knowledge bases, which share the same skeleton or taxonomy. Extensions of the skeleton should be possible at the low level by adding domain-specific sub concepts or at the high level by adding intermediate or upper level concepts that cover new areas.

The community calls them light weight and heavy weight ontologies respectively. Light weight ontologies include concepts, concept taxonomies, relationships between concepts, and properties that describe concepts. Heavy weight ontologies add axioms and constraints to light weight ontologies.

Ontologies are widely used for different purposes like Natural Language Processing (NLP), Knowledge Management (KM), e-Commerce, Intelligent Integration of Information (III), the semantic web etc., US hold and Jasper defined an ontology as [12]:

"Ontology may take a variety of forms, but it will necessarily include a vocabulary of terms and some specification of their meaning. This includes definitions and an indication of how concepts are inter-related which collectively impose a structure on the domain and constrain the possible interpretations of terms."

2.1. Domain Ontology

The first step in devising an effective learning representation system, and words, is to achieve an able ontological resolution of the field. Weak analyses lead to confused learning bases. Empire ontology specifies the concepts, and the connection between ideas, in an express subject area rather than define only generic concepts. Without ontologies, or the concept that underlie learning, there cannot be a words for representing Learning. Ontological dissection clarifies the formation of Learning. Given a domain, its ontology forms the nature of any system of learning illustration for that domain.

2.2. Ontology as Taxonomy

Ontology provides the taxonomy in a machine-readable and machine processable form. However, an ontology is more than its corresponding taxonomy, it is a full specification of a domain.Each link between two nodes in taxonomy represents a "sub classification-of" relation or a "super classification-of" relationship.

2.3. Ontology as Vocabulary

Decoding the terms from one language to another, for example from English to French, does not change the ontology keep secret. But the conceptualizations that the terms in the vocabulary are intended to capture.

2.4. Ontology as Content Theory

Ontologies is the advance version of Non-natural (NN) vacillation of focus between content theories and mechanism theories. Sometimes, the NN community gets excited by some

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structure such as rule systems, frame languages, neural nets, fuzzy logic, constraint propagation, or unification. The mechanisms are proposed [12] as the secret of making intelligent machines. It cannot do much without a good content theory of the domain on which it is to work. Once a good content theory is available, many different mechanisms might be used equally well to implement effective systems, all using essentially the same content. AI researchers have made several attempts to characterize the essence of what it means to have a content theory.

2.5. Ontology as Taxonomy

An Adaptive Web Based Concept Map Assessment Tool. The architecture of an adaptive web-based concept map assessment is a tools.

The architecture of Concept Map Assessment Tool, illustrated in Figure 2.1, is comprised of five modules: (i) the *Interaction Monitoring Module* (IMM), which is responsible for (a) collecting data concerning the learner's observable behaviour, (b) activating the other modules according to the learner's actions (i.e. activation of the (DM) after the accomplishment of an activity and (AFGM) after the completion of the activity or in case the learner asks for support/help), and (c) updating the with the newly acquired information (e.g. feedback components provided, duration of the activity's elaboration, etc.), (ii) the *Diagnostic Module* (DM) that supports the assessment of the learner's concept map, based on the similarity of the map with the expert's one, (iii) the *Adaptive Feedback Generation Module* (AFG), which is responsible to generate the appropriate feedback, according to the learner's knowledge level, preferences and interaction behaviour, (iv) the *Presentation Module* which is responsible for the presentation of (a) the constituent parts of the concept mapping task that will be available to the learner during the accomplishment of the activity and (b) the feedback after generated by the AFGM, and (v) the *Data Storage*, containing *the Domain Knowledge* and the *Learner Model*.

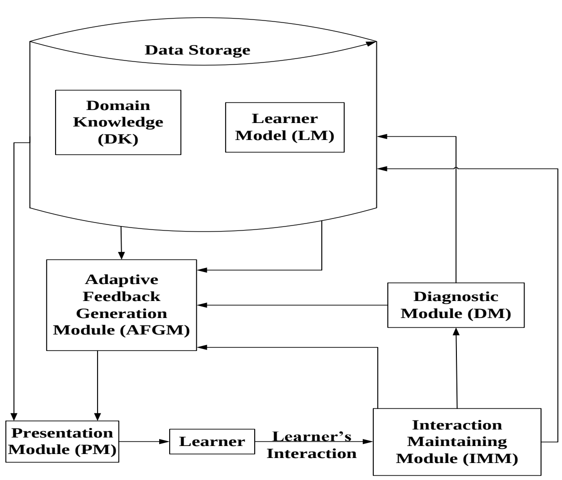

Figure 1 The Architecture of Concept Map Assessment Tool

2.6. Assessment Activities

The design of the activities is based on the following a three-step

(i) Elicit learners' prior knowledge.

(ii) Identify learners' initial knowledge level as far as the new concepts are concerned.

(iii)Diagnose learners' unknown concepts, incomplete understanding, and false beliefs, and (b) the learners to activate their existing knowledge.

2.7. Adaptive Feedback Generation in Concept Map

The architecture of Concept map Generation and its modules, focusing on the representation of the domain knowledge and the learner model, the diagnosis of the learner's knowledge and the generation of the adaptive feedback. The discriminative characteristics of Concept map are: the conceptual structure of its domain knowledge, which is based on the notion of assessment goals that the learner can select the qualitative diagnosis process and the quantitative estimation of the learner's knowledge level, the adoption of multiple informative and tutoring feedback components and the stepwise feedback presentation, the adoption of error-task related questions based on a categorization of learner's common errors, the adoption of the two levels of the tutoring feedback units and the adaptation of feedback to the learner's knowledge level, preference and interaction behaviour. An adaptive web-based concept map tool, aims to support learning through the assessment process.

2.8. Automatic Feedback and Resubmissions as Learning Aid

This work mainly focused on student's Feedback based on automatic assessment of student's solutions is an important aid for student's learning process in self-study and distance learning. Learning tools that automatically assess and give feedback on learners' performance provide valuable help for both teachers and learners. From Lauri Malmi's [13] point of view, the main motivation is to save time and increase the amount of feedback on large courses. For learners, automatic feedback is very useful, because it supports self-study and distance learning. It is often much better to get instantly even simple feedback than to get advanced human feedback many days afterwards, or even worse to get no feedback at all.

Generally it allows learners to *resubmit* their answers after getting feedback from the system. Thus, learners can reconsider their answers to find and understand the errors they have made, and submit a revised version of the answer. The number of allowed submissions is typically a parameter determined by the teacher and some systems utilize *random data* in assignments. For programming assignments, this typically means randomized input instead of fixed input for the programs to be tested.

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2.9. Intelligent System for Personalized Instruction in a Remote

In this method the lessons are dynamically generated according to learner's knowledge level. The adaptive behaviour of the system, the functionality of the various modules and the opportunities offered to learners are presented [1].

INSPIRE is comprised of five different modules

(A) The *Interaction Monitoring Module* that monitors and handles learner's responses during his/her interaction with the system.

(B) The *Learner's Diagnostic Module*, which processes data recorded about the learner and decides on how to classify the learner's knowledge,

(C) The *Lesson Generation Module* that generates the lesson contents according to learner's knowledge goals and knowledge level.

(D) The *Presentation Module* that generates the educational material pages sent to the learner.

(*E*) The *Data Storage*, which holds the *Domain knowledge* and the *Learner's Model*.

2.10. Review of Computer-Assisted Assessment

Computer-Based Assessment (CBA) involves a computer program marking answers that entered directly into a computer, whereas optical mark reading uses a computer to mark scripts originally composed on paper. Portfolio collection is the use of a computer to collect scripts or written work. Computer-based assessment can be subdivided into stand-alone applications that only require a single computer, applications that work on private networks and those that are designed to be delivered across public networks such as the web (online assessment).

A multiple choice item consists of four elements: the stem of the question, options, correct responses and distracters. Tests are collections of subject-specific items, possibly drawn from item banks. There are a variety of different question types (e.g. multiple choice, multiple response, hotspot, matching, ranking, drag and drop, multiple steps and open ended) and feedback mechanisms (including automatic feedback in objective testing, model answers, annotated test, or mixed mode with intervention from the teacher).

Assessment can be categorised as either summative (administered for grading purposes) or formative (to give feedback to assist the learning process).

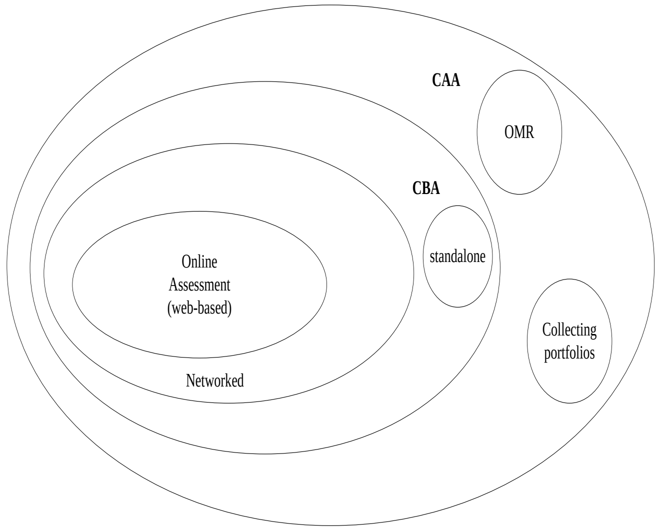

Figure 2 Different types of CAA

2.11. Review of Computer-Assisted Assessment

The related works are An Adaptive Web-based Concept Map Assessment Tool (COMPASS).

An Intelligent System for Personalized Instruction in a Remote Environment (INSPIRE), Automatic Feedback and Resubmission as Learning Aid, and A Review of Computer Assisted Assessment (CAA).

For comparing these related works there are several features are used, they are main process, main goal, tools that give support, domain ontology, algorithm that give support, feedback support, and graph construction from learner's response.

Features	**COMPASS**	**Automatic Feedback and Resubmission**	**INSPIRE**	**CAA**
Main Process	Assessment and learning process	Assessment and learning by resubmissions of works	Only learning process	Assessment ,learning and teaching process
Main goal	Based on learners knowledge level the assessment is done	Based on knowledge level learners can revise their solutions after getting feedback	Based on knowledge level of learners the lessons are dynamically generated.	Providing different and innovative assessment
Tools that give support	Uses Concept map assessment tools	No tools are used	No tools are used	No tools are used

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Tools that give support	Uses Concept map assessment tools	No tools are used	No tools are used	No tools are used
Use of core Domain ontology	Yes	Yes	Yes	Depends on the available resources
Algorithms that give support	No	Automatically assessed simulation algorithm	No	No
Adaptive Feedback Generation	Yes	Yes	No	Yes

Table 1 Comparative analysis of Related works

3. PORPOSED MODELLING

Items are used in standard from to produce adaptive feedback, which makes these items sharable and reusable and then the generated feedback is both human readable and machine understandable, which guarantees the interoperability of the present framework. The refined metadata schema supporting adaptive feedback generation and this schema is based on ontologies of a specific discipline and education objectives. Adaptive feedback is derived based on the examinee's responses. Domain ontology is developed in any particular discipline.

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Ontologies promise "a shared and common understanding of a domain that can be communicated between people and application systems". They attempt to formulate a thorough and rigorous representation of a domain by specifying all of its concepts, the relationships between them and the conditions and regulations of the domain. Ontologies can express hierarchical links between entities and other semantic relations.

An example of part of an ontology is provided in Figure 1, in which it is specified not only that an author *is a* person and that a book *is a* publication, but also that an author *writes* a book and that a book *has* chapters.

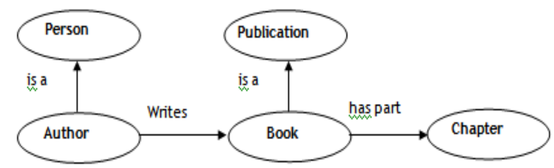

Figure 3 Example of a Small ontologies

3.1. Methodologies

There are different methodologies are adopted in order to achieve the above proposed problem statement. Educational ontologies are created using protégé tool by complete understanding of literature survey and a comparative analysis of the various feedback frameworks for educational ontologies.

Computer Assisted Assessment (CAA) has several advantages over traditional Paper-and-Pencil (P&P) assessment, among which is automatic feedback. Automatic generated feedback can help learners to discover their level of assimilation of certain topics [1], or learn by assessment [2]. Generally, automatic generated feedback can be divided into two categories: adaptive and non-adaptive. For non-adaptive feedback, hints or explanations can be embedded in items and systems can render them according to user's responses. One positive aspect of this approach is that items can be written in forms such as multiple choices, fill in blank, and so on. These forms make it feasible to share and reuse items, and further to construct item banks [3]. The drawback of this approach is that the embedded feedback is intended for human reading instead of machine understanding. And therefore, it is infeasible for machines to model personal learning status to behave adaptively.

For adaptive feedback, e.g. [2], [4], the adaptive is usually represented by the idea of gradual provision of appropriate information. This approach needs special computing structures to model learners, and classifies user's responses into several categories to produce feedback. Conformance implementations should include required metadata, and these annotations can be used beyond searching and copyright. Based on above considerations, frameworks of generating feedback from metadata of items are proposed.

3.2. Terminologies and Preliminaries

Ontology is a consensus in or between systems, it is essential in item banks. From the point of view of technique, ontology specifies technical details of items. For example, it declares the response type, format, media of items, so that a CAA system can correctly render questions for users. Form the point of view of pedagogy, it represents domain knowledge so that machines can perform intelligent behaviours, including

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finding items regarding a specific topic or chapter. These aspects have been reflected in the specifications published by standard organizations. In light of the fact that different disciplines have their respective knowledge map, classifications are discipline or course depended, and therefore they are not part of the standards.

Many languages are capable of representing ontology including Extensible Mark-up Language (XML). Ontology Web Language (OWL) [15] as the following language considerations.

- OWL is an international recognized standard for conveying web ontology.
- OWL-DL (OWL-Description Logic), a dialect of OWL, has solid logical foundations so that it can be balance between expressive power and computational complexity.
- OWL tools, including editor and reasoned, for applications. For each concept in ontology, it has a universally unique ID Uniform Resource Identifier (URI) to represent it.

3.3. Terminologies and Preliminaries

The elements in *T* of the dyads are concepts from the taxonomy of a discipline or a course. These conditions form a domain ontology. The relation between two concepts is *rdfs: subClassOf* (Resource Description Framework) another must be clarified. If concept *A* is *rdfs: subClassOf* concept *B* that is *B* is a kind of *A*. These relations are defined before constructing ontology using XML. There are several situations that the relation between two concepts is-a and is-part-of relationship. For example, “a car has an engine”. If developer adopt both relations of is-a and is-part-of, this will introduce unnecessary complexity. To solve this problem, each concept *C* in the taxonomy as “knowledge of C” is defined. Therefore, we can declare that the knowledge of some type of engine is a kind of the knowledge of car.

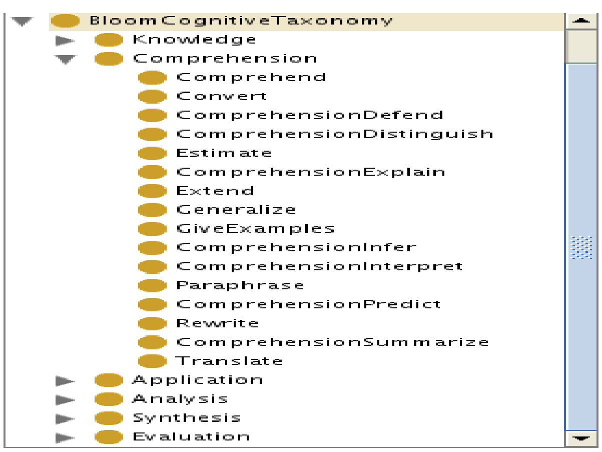

Figure 4 Taxonomy of education objectives

3.4. Diagnosis of learning status

To model learners, the first step is to evaluate their responses. The learner answer categorization schema proposed in [4] is adopted and try to classify responses into these classes. If a user submits a wrong answer, this answer does not belong to any class this is added in the wrong class and the system records the outcomes of the item. An assessment contains multiple items. With the interaction proceeds, the system records a user’s performance on different topics. And this information forms a concept map to judge the overall knowledge level of the examinee regarding an instructional unit.

3.5. Feedback generation

The feedback is divided into two classes. They are per item and per unit feedback. For item feedback, a rule-based natural language generation approach is utilized. These rules are activated by answers and annotations. For correct answers, the system will generate sentence like “answer is correct”. The *verb* and *topic* are the label of the corresponding education objective and the label of the corresponding concept regarding a certain discipline, respectively.

For wrong answers, the system generates a negative message to tell the learner what is wrong. For example, “the answer is missing”. For instructional unit, the system will provide a statistical report to examinees. These reports show the users’ abilities on different topics and types of question, e.g. answering, applying, so that they can adjust learning strategy or review certain chapters. Because these reports contain the knowledge level of users on certain topics and therefore can be used in adaptive learning systems [18] to infer which units are ready for a user to study, and which units shall not start at the current knowledge level.

4. RESULTS AND DISCUSSIONS

Metadata is crucial for reusability and interoperability of items and the issues of deriving adaptive feedback from metadata are investigated. However it also charges educators with boring fill-in operations [19], and automatically generation of metadata has been a challenge of item authoring systems [20]. The problem of whether this framework is workable must be the answer.

It seems that the researchers have reached a consensus that standardized metadata is the key to share and reuse learning objects. By changing certain policies, large parts of metadata can be automatically generated by authoring software. For example, copyright holder, author and other similar information can be taken and filled in by querying the session manager or user profile. For the topics of items, the default settings of annotations are issued. Without explicitly stated, a low-level unit has identical annotations as the up-level unit

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that contains it. In case that the unit is exported individually, the system automatically copies up-level notes for it. These measures can reduce the burden of fill-in operations.

Automatic semantic annotation methods have been described in the literature [19]. These works provide potential solutions to this problem. Research efforts on Natural Language Processing (NLP) have produced the word ontology.

The ideas behind the Frame Net are to retrieve the meaning of a word from stereotyped patterns. And vice versa, these patterns can be used to generate sentences, including math problems [21]. Bloom's taxonomy suggests several typical verbs for each category, and their stereotyped situations can be used to generate sentences. Therefore, in case that an educator or agent can produce questions following these patterns, the metadata of education objectives is produced immediately as a side product.

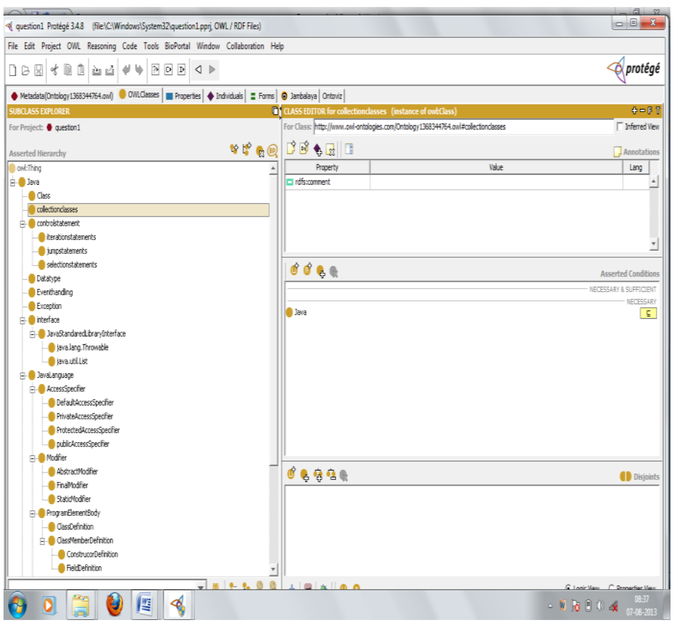

Figure 5.1 Class hierarchy

Knowledge representation and reasoning is an important area of ontology representation. Knowledge representation can easily be extended by means of meta-classes. Knowledge representation is based on frames and first order logic. In this chapter the java ontology is created using owl language. This chapter clearly describes the tools and techniques which are used to implementing the research concept to solve the defined problem in the very effective manner. For solving the problem various tools and techniques are used.

4.1. Developing Eclipse framework for interface

The Eclipse Platform uses plug-ins to provide all functionality within and on top of the runtime system.

This plug-in mechanism is a lightweight software component framework. Eclipse Platform to be extended using other programming languages such as C and Python, the plug-in framework allows the Eclipse Platform to work with typesetting languages like networking applications . The plug-in architecture supports writing any desired extension to the environment, such as for configuration management. Java support is provided in the Eclipse SDK, with support for other version control systems provided by third-party plug-ins. Examples of plug-ins include a UML plug-in for Sequence and other UML diagrams, a plug-in for DB Explorer, and many others.

5. CONCLUSION

In this Research Methodology for framework of automatic feedback generation from metadata of items are presented. A new aspect of framework is it relies on recognized standards compliant items and metadata rather than proprietary computing structures. Based on domain ontology and explicitly stated education objectives, the feedback in text form is automatically generated by using sentence templates. Therefore, educators may spend less time on writing feedback. At the same time, the information used to produce text feedback is machine understandable and human understandable and can also be used by intelligent tutoring systems to model learners, to recover related learning objects, and to suggest appropriate material for learning.

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