Knowledge Engineering Projects by Our Postgraduate Students

Gel Image Analysis

Team members of the best MTech (Knowledge Engineering) project for 2003:

(L-R): Teo See Koy, Choo Chee Seng, Chang Kok Meng and Lim Chee Hong

The above students hold exciting jobs at DSTA, which include developing simulation software (e.g. imagery and visual software, computer generated forces, simulation engine etc.) and integrating simulation systems. Kok Meng is a project manager, Chee Hong and See Koy are project leaders and Chee Seng is a development engineer from the simulation and war gamming division in DSTA.

The students have the following comments on the course:

"The Master of Technology course in Knowledge Engineering is a very good course. The practical and in-depth nature of the course curriculum provided us with invaluable technical hands-on knowledge, which proved to be useful in many areas of our work. The course was tough, as we had to attend two evening classes per week, and each subject would always include at least a project assignment. The advantage that we have is that we are working in the same division and we know one another very well. This greatly reduced the time needed in coordinating meetings to do project assignments. This was especially true for the second year project. The course also proved to be a challenge to us in terms of time management, as we needed to balance work, studies and personal commitments. Our family lives were especially productive though - Kok Meng became a proud father twice; both See Koy and Chee Hong became a new husband and new father respectively in the two-year span of the course!"

The team worked on a project for the Bioprocessing Technology Centre to analyze a gel image. Through electophoresis, the contents of the protein can be analyzed, compared and identified by the images of spots that are generated in the process. The project aims to come out with an automated process to help the laboratory scientists identify and match the spot images within a short time. The first process involves some simple image processing which will remove noise. This will be followed by spot identification process to identify the spots and finally a spot matching process to match the spots. KE techniques such as clustering, search strategies and pattern matching methods were employed in the spots identification and matching process.

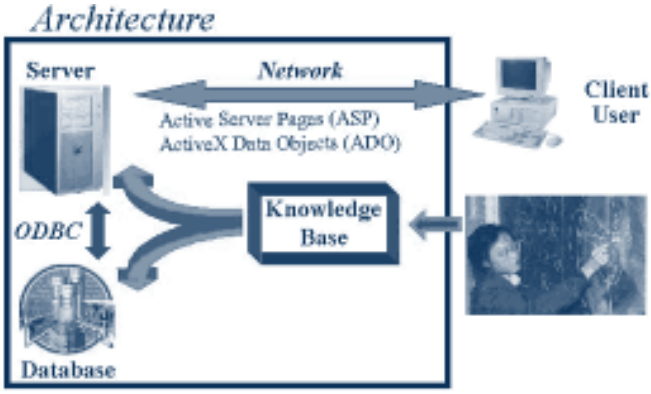
The team has this to say:

"The project required us to put into practice what we have learnt in the course, from conducting interviews with the domain expert in the knowledge acquisition phase, to managing user and sponsor expectations during the whole project cycle. The knowledge acquisition process was very time consuming as we had to spend a lot of time understanding the background domain (proteomics) which we have no experience or background in, and the extensive literature surveys. We also spent quite a large amount of time in coming out with different solution proposals, as we had not done something similar before. Finally, we formulated the design and subsequently implemented and tested out the system. The users and sponsors were very supportive throughout the project, providing us with background information and actual data to be analyzed. In conclusion, we are extremely grateful to ISS, the project sponsors KooPrime and BTC for providing us with this opportunity to work on such an interesting and challenging project. It has been a fulfilling experience."

The project's sponsor from KooPrime, Mr. Lim Teck Sin, who also helped supervise the team and liaise with the researchers from BTC, was very impressed with the team. Mr. Lim has this to say: "The KE Gel Imaging Team is one of the strongest teams I have ever supervised. The project started off well with the problem neatly divided into modules. Each member's role is properly defined so that accountability is clear. With that, the team worked diligently and synergistically to meet the milestones set. The resultant deliverable is a set of modules that are well designed. The modules can either run standalone or execute one after another so as to pattern-match two gel images. This modular approach is scalable because it allows other future teams to focus on just specific modules if further enhancement is needed. Due to shortage of time, the current state of development does not allow end-to-end automation because the modules are all command lines that have to be executed manually. Once the modules are fully integrated, they will become a usable solution for the proteomics researchers. Current state-of-the-art requires researchers to manually identify 'landmarks' before the systems can mark out all the spots. The students' work attempts to auto-identify 'landmarks', hence improving the productivity of researchers. It is noted that students were able to take generic algorithms and tailor them to meet the specialised needs of the bio-domain. Certain algorithms were eventually found to be unsuitable. The students objectively reported their findings and proceeded to try other approaches. This is much appreciated as integrity of the researchers is one of the most important factors in any R&D work."

Ms. Ong Lean Suan, their project advisor from ISS, was equally pleased with their performance. "The team was very responsible, hardworking and unafraid to take up new challenges. Their conduct was very professional, and they made such a good impression that the project sponsors and end-users have specially requested for more quality ISS students for their future projects!"

The ANTX Intelligent User Interface Project



The Challenge

Currently, tutorials delivered via CD ROM or networks consist mainly of media-rich Web pages linked by hyperlinks. The student goes from page to page by clicking on the hyperlinks. This is analogous to reading a book. This method of reading Web pages makes the learning process inflexible and cannot replace a live tutorial where a trainer is available to provide assistance and to moderate the learning process to suit the needs of the student. Furthermore, the impersonal and often cold environment of conventional online systems does little to motivate or to inspire the learner. The challenge is to create an intelligent tutorial system whereby it will seem to the student that someone is monitoring his progress and guiding his learning experience. This will make the system more interactive and the learning process more lively and interesting.

The Solution

The knowledge engineering techniques employed to design the intelligent system components included:

- Knowledge acquisition methods such as interviews with experienced trainers, and an exhaustive literature survey on the subjects of online learning and educational psychology
- Knowledge modeling methods to model courseware metadata and to record important events during a student's interaction with the system
- Fuzzy rule-based inferencing techniques that is capable of modeling many aspects of decision-making by an experienced trainer

The result is an online tutorial system with an intelligent user-interface that is capable of delivering and managing courseware for any subject matter. One of the cornerstones of AntX is the integration of emotion and the learning interface which helps motivate the learner in the absence of a live tutor. When a learner performs well, he is praised; learners who encounter difficulties are given encouragement. These are realised through a friendly avatar who appears in response to events or at regular intervals (for example, when the learner spends too much time browsing just a couple of pages from an introductory topic). To add a more personal touch, the system also remembers the page the learner was browsing when he last logged out, and can return to this page when he logs in next.

The integration of the emotion-aware interface with mentor-like intelligence is the highlight of the AntX. The mentor's recommendations are presented through the friendly avatar. The avatar serves a dual purpose:

- To present a more personal and friendly interface to the system
- To guide the learner

Through the use of fuzzy rules, the system is capable of mapping the most suitable learning route for learners of differing expertise, and to guide slower learners back on the recommended learning route, as specified by the subject matter expert. What does this mean for the subject matter expert? Their role is to supply the courseware materials and the associated metadata. The rest in particular the intelligent capabilities, is taken care of by AntX. The system is therefore very generic and is amenable to being used in a diverse range of subject matters, with very little effort required on the part of subject matter experts.

AntX presents an interesting model for blending knowledge engineering techniques and the online learning paradigm that challenges the conventional and often ineffective online learning models.

Irene D'Orville, Francisco Dy and Peter Ong How Tiong who worked on the project:

"Three people, almost strangers, came to work together on a topic that we had hardly any knowledge on. This sums up our experience at the start of the project.

How to start? How to begin? Since we knew nothing, anything we did could not make it worst. We decided to look at Content first, so all team members were given the task to just find out about Content. We ended up in the library reading different books and different concepts. After a few weeks of reading on various topics, we felt that we were getting nowhere and were discouraged. It was at this lowest peak that one team member had a bright idea. "Shouldn't we be using the tools that were taught in Knowledge Acquisition?" he questioned. It was then that we realised we had been taught all the tools and all we needed were to apply them.

We started following the procedures to acquire knowledge, arranging for interviews with the Domain Expert and also looking up other similar web sites to get an idea on what was required and how we could make a better program than existing ones. The project started to become more interesting as a seed of an idea started forming and we were beginning to see the light of what we wanted to do. Then we were hit with the next obstacle. We knew what we wanted to do, but how to do it? What was the right software tool to use and did we know this software? This sent us back to more reading of books and especially journals to see what authors proclaimed as the latest and best software. We came up with several softwares: Cold Fusion, Drumbeat, ASP, SQL, ActiveX, etc. We were not familiar with any of them, so this sent us out in a hurry to buy trial softwares to have a feel for them. Finally we settled on ASP. One of the main reasons was also cost. We could write ASP programs very easily using notepad! As we got into the uphill mood of creating something from nothing, we started becoming more creative. We started having fun and this could be seen in our presentations to our advisors. We used newspaper cut-outs on e-learning and even had our personal photographs incorporated in the project presentation.

The team originally comprises of four members. In the midst of the project, we had to deal with one of the team members dropping out from the course. We managed to find a replacement but that replacement did not last long as well. With some re-juggling of tasks amongst the remaining team members, we managed to keep the ball rolling. All in all, it takes a good team to work together and arrive at some form of synergy where everyone has a role to play. When you start seeing the glimmer of light to a solution, that is when the fun and creativity comes in and at the end of it - there is a great sense of satisfaction and achievement. On top of that, our rapport and friendship lasted even after the project ended. Last, but not least, we would like to thank our advisors, Ernie Ong and Lean Suan, as well as our user, Esther Tan, for the guidance given us without which the project would not have been a success."