1 The virtual Campus Project

2 Abstract

Virtual Campus is a joint project of the universities of Hannover, Osnabrück and Hildesheim. Its purpose is to exploit the widespread resources offered by the Internet and integrate them with lectures of the local curriculum in an educational environment. The Osnabrück Institute of Semantic Information Processing is to develop a system on logic programming in course of this project. Up to now a prototype has been accomplished which may be regarded as a framework for any kind of Internet educational environment. The present system provides facilities with respect to:

user environment: The system manages user data and application processes on the server and provides remote access via Internet connections.

classes: The system supports data interchange between learners and teachers. By offering both private and public sections of a database, the system ensures confidential handling of user data as well as common access.

open environment: Lectures may be enriched and broadened by integrating manuals, scripts and related material from remote facilities.

interface application: The system supplies a general application interface therefore a large number of UNIX applications may be integrated in the system. This has so far been accomplished for PROLOG and LISP.

further offerings: An online tutorial system assists the students during developing process to avoid typical mistakes and to grasp the underlying principles more easily.

3 The Virtual Campus project

Virtual Campus is a joint project of the universities of Hannover, Osnabrück and Hildesheim.

The project was launched in July 1997 as a three year research project. Its aim is to integrate Internet technologies into education and to develop lectures and environments for courses on "logic programming" and "human and machine interaction in machine translation" accessible through the Internet. The University of Osnabrück is represented in the project by the

Institute for Semantic Information Processing, where the development of the logic programming component takes place.

The Virtual Campus approach is to exploit the widespread resources offered by the Internet and integrate them with lectures of the local curriculum in an educational environment. Such a setting containing both local and remote resources with respect to an educational goal (e.g. logic programming) may be regarded to as a Virtual Campus, i.e. a virtual university, where the world wide teaching and research is put together, where people can meet and communicate (at least via *Internet Relay Chat* and *Electronic Mail*).

4 Aspects of Learning with the Web

4.1 Expectations of the Society

Academic, community, business, and government leaders are calling upon schools and universities to graduate a different kind of student than a generation ago. This is in response to the challenges posed by the new global economy, where the knowledge and skills of a nation's workers are the key to its competitive success. Among the skills called for in students are commitment to life long learning, critical thinking, problem solving, written communication, and the ability to work collaboratively. Although these skills have always been valued, the call for them represents such an important demand that schools place increased emphasis on their development [Ows97].

The Web, enthusiastically called "Information-Highway" or even "Information-Super-Highway", is considered to be both suited medium to promote these abilities and at the same time important application with respect to future economic, scientific and social success which requires these skills. The estimated importance of the Web as both future core technology and ideal medium for distance education is due to two offerings. First the Web may be used as a communication channel in which many different types of media (audio, video, pictures and texts) may be included. Second it is considered to make information and knowledge available from all over the world regardless of place and time.

4.2 On Knowledge and the Web

The public esteem of the Web's capabilities as knowledge provider should not prevent one to ask what kind of knowledge it is, that is made accessible by the Web and whether it is identical to that which is normally referred

to as knowledge. Traditionally, knowledge is defined in opposition to belief, i.e. for a person p who knows a fact f several conditions have to be fulfilled: (1) f has to be true, (2) p has to be sure that f is true and (3) p has to have good reasons (like common accordance) to be sure that f is true [Aye96]. It is possible to speak of mathematical, economical, political even of theological knowledge. Speaking of knowledge does not refer to some abstract knowledge in and on itself, but on a set of definitions and rules with respect of domains (like mathematics or divinity) which have been agreed to be held for true [Fey75]. It follows from this that knowledge is always connected to a specific background involving cultural traditions as well as political and economic interests.[Coy97]

This leads to the conclusion that the knowledge provided by the Web is a heterogeneous mixture without assurance of quality, validity and duration.[Coy97] I.e. the user who wants to benefit from the widespread information on the Web has to have the above mentioned skills first, which are, according to common opinion, regarded as fostered by the Web. This vicious circle backfires the educational goal of learning on the Web, unless it is supported by tutorial guidance. Due to this fact the Virtual Campus approach is to connect the offerings of the Web with the coaching and mentoring of a human tutor.

4.3 The Educational Background

As mentioned above, student skills with respect to critical thinking, problem solving, written communication, and the ability to work collaboratively have always been appreciated. Due to the fact that up to now these skills have been taught and acquired with printed material, it would be absurd to state that the Web is the only tool that teachers and students should use to develop these abilities. No medium, in and of itself, is likely to improve learning in a significant way when it is used to deliver instruction. Nor is it realistic to expect the Web to develop in students any unique skills. What the Web can offer, in contrast to traditional media, is information that is instantly available, often very up-to-date, worldwide in scope, and presented in a more motivating format for students to explore. So the advantages of Web use are twofold: it appeals very much to the way many students now prefer to learn, and it provides, embedded in adequate settings, educational opportunities for students unable to attend campus.

The changes in education with respect to the integration of new technologies require considerable reflection: not only about the way new systems might be integrated, but also how existing educational models have to be

modified as well. This involves technical considerations as well as sociological aspects of learning without the existence of a physical classroom. But until now even basic conceptual problems regarding distance education have not been solved. For example: do new techniques require a new educational setting or are the traditional methods of lecturing independent in regard to physical presence in one room?

Distance education has to face this task and develop concepts how the Web may be utilised for educational purposes.

5 Technical Requirements of Distance Education

Exploiting the rich area of available multimedia technology requires network connections which support high data transfer at a feasible speed (high bandwidth) and guaranteed quality of service to offer an acceptable and sufficient solution for virtual classrooms and remote teaching ([TWP97], [Flu96]).

Up to now, there are two major approaches to fulfil this requirements: (1) *Asynchronous Transfer Mode* (ATM) networks and (2) the *Multicast Backbone* (MBone). The basic idea behind ATM is to transmit all information in small fixed size packets called cells[Tan96]. The cells are 53 bytes long of which 5 bytes are header and 48 bytes are play-load. The use of a cell-switching technology is threefold. First it is highly flexible and can handle both constant rate traffic (audio, video) and variable rate traffic (data) easily. Second at the very high speeds envisioned, digital switching of cells is easier than using traditional multiplexing techniques. Third broadcasting is essential for television distribution.

5.1 ATM Networks

ATM networks are connection orientated. Making a call requires first sending a message to set up the connection. After that, subsequent cells all follow the same path to the destination. Cell delivery is not guaranteed, but it is guaranteed that if they arrive they will arrive in the correct order. ATM networks are organised like traditional Wide Area Networks (WANs), with lines and routers (switches). The intended speed of ATMs are 155 Mbps and 622 Mbps, with the possibility of speeds in the gigabit range later. There are many applications for ATM networks including long-distance telephone service, video on demand and ATM campus Local Area Networks (LANs) [Tan96].

In the context of distance education, ATM may be utilised for broadcasting lectures from one university to another. Due to the involved costs

concerning the hardware requirements and establishing an ATM connection, ATM technology is far from being acceptable regarding students dialling up campus from home.

5.2 MBone

MBone is used to for broadcasting live audio and video in digital form over the Internet. Technically, MBone is a virtual overlay network on top of the Internet [Tan96]. It consists of multicast-capable islands connected by tunnels. Each island (typically a LAN) supports native multicast to its hosts. The tunnels propagate MBone packets between the islands, using the existing Internet Protocol (IP) connections. Each island has to have one or more *multicast routers* (mrouters) which are logically connected by tunnels.

Since MBone is an application on top of the Internet transport layer it is possible (theoretically), given the right topology of the LAN, to participate even with modem or ISDN connections in MBone facilities, but the received quality will be poor, due to the low bandwidth of modem and ISDN connections.

5.3 Technical Problems

Although the Web breaks down the long-standing physical and temporal barriers of access to education, it can create new kinds of barriers for students. These include computer hardware that malfunctions, difficulty in setting up software to access an educational institution or Internet service provider, and encountering constant busy signals when dialling up from home. Once a student gains access the problems are not over either. Heavy on-line traffic can overload popular Web sites so that they respond very slowly or simply do not respond, and annoying drops in telephone line connections occur all too frequently. Added to these technical problems is the cost of dialling up the institution if the student is not within local calling distance, and the cost of using an Internet service provider when the institution cannot be accessed directly [Lan96].

Though perhaps not as intractable nor systemic, these new barriers can undermine an otherwise well designed on-line educational experience and lead to both student and instructor frustration.

5.4 Conclusion

As a consequence one has to distinguish between multimedia applications in the Local Area Network (LAN) of a university (or school) and applications

which are utilised for distance education and broadcasted outside the LAN. The transfer time of video and audio data outside of high-speed networks can be unacceptably long and the received quality depends heavily on the actual bandwidth of the Web ([ZCL11]).

This leads to the conclusion that the degree of involved multimedia features has to be chosen with respect to the ability of the user (i.e. the student) to receive data in acceptable time and quality. All applications requiring ATM connections or constantly high bandwidth do therefore not fit into a setting, which is to enable remote access to campus by ISDN/modem connections.

6 The Osnabrück Interactive Tutor

The Osnabrück project is to develop applications by using the capabilities of Internet techniques with respect to the instructional needs in higher education. Up to now, a prototype has been accomplished which may be regarded as a framework for any kind of Internet educational environment.

6.1 Educational Setting

As mentioned above, distance education involves some basic social and educational problems which have not been solved yet and which might interfere with present educational goals. The Virtual Campus approach avoids these problems by concentrating on those areas where Internet technology may be used in enriching existing courses. This approach may be regarded as a step in combining the advantages of traditional lecturing with the advantages offered by the Web.

The educational goal of the Virtual Campus is threefold. First university lectures shall be enriched and broadened by integrating related material from remote facilities. This is to encourage learners to appreciate and take advantage of the full richness and diversity of material for an issue. Second, the initiative of the students and his/her responsibility are encouraged. Both are vital capabilities for life-long learning. Third, seminars which are to accompany a class or lecture may be transfered to the Web, in order to become more flexible in time and place.

The embedding of the environment in supervised lectures ensures that students neither get lost playing in the web, nor, overwhelmed by the diversity of the web, fail to use the offerings which might be important and helpful in regard to their task. Tutorial guidance in a Virtual Campus setting means coaching the learner in developing and fostering appropriate attitude and

behaviour toward knowledge acquisition and learning in a dynamic environment.

The experience gained by this approach may be used for further applications. But at this time it is not regarded reasonable to transfer complete lectures on the Web.

6.2 Technical Aspects

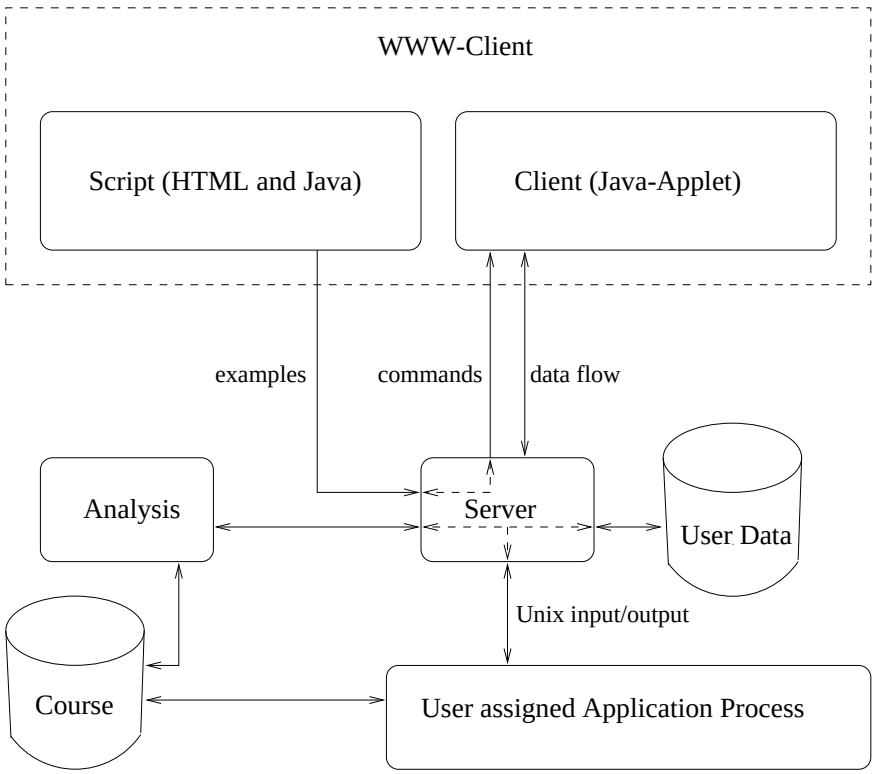

Figure 1: System

The Interactive Tutorial System is accessible by either the LAN of the university or dialup modem/ISDN connections. It is designed according to the *client–server* model[Ste90]. A server is a process that is waiting to be contacted by a client process so that the server can do something for a client. The client process sends a request across the network to the server requesting a service of some form. When the server process has finished

providing its service to the client, the server goes back to sleep, waiting for the next client request to arrive and the connection is terminated.

The client is realized as a JAVA applet as the user front end, which is embedded in a WWW–client (such as Netscape Communicator or Microsoft Internet Explorer). This enables the user to access the Interactive Tutor by familiar applications. The main idea of using JAVA for interactive Web pages is that a Web page can point to a small JAVA program, a so-called applet. When the browser finds the reference to an applet, the applet is downloaded to the client machine and executed there in a secure way [Tan96]. It is impossible for an applet to read or write any files that it is not authorised to access. It is also impossible for the applet to introduce viruses or cause any other damage. To achieve portability across machines, applets are compiled into byte-code, which is interpreted by a virtual machine that runs detached from the actual operating system. It is these byte-code programs that are pointed to by Web pages, similar the way images are pointed to. Since the applet is running locally, even if it is interpreted, its performance is sufficient for a Virtual Campus setting.

The server side contains a server, written in ANSI-C, a POSTGRES database and the application process (for example PROLOG and LISP). The server is a concurrent server, i.e. it invokes another process to handle each client request, so that the original server can wait for the next client process. This enables multiple user processes at the same time. Naturally, this type of server requires an operating system that allows multiple processes at the same time (like UNIX or Windows-NT).

The database is divided into several partitions with different access restrictions. Each user has access to her own data, the assignments and the partition with solutions of former exercises. Furthermore, reserved partitions in the database allow the students to store their accomplished assignments on the server. These partitions are non-readable to prevent cheating. The tutor has full access all over the database.

The application is currently either a PROLOG or a LISP process. Each user has a application process of her own as long as she is logged in. Although it runs on the server machine, the user may interact with the process the same way she could do on her own system. This is achieved by the mediating server which encapsulates the access to both the application and the database. The close communication between client and server results in a joint system which allows a user to access remote resources like a part of her own file system.

7 The Tutorial System

The present system is designed for accompanying a seminar on logic programming in PROLOG or LISP. The lecture on logic programming is held in the Institute of Semantic Information Processing in Osnabrück and is supported by a seminar where the students ask questions and the exercises are discussed. The Interactive Tutorial System can be used by the students additionally. It consists of an editor and a control panel which is connected to the server by the above mentioned applet. The control panel manages the

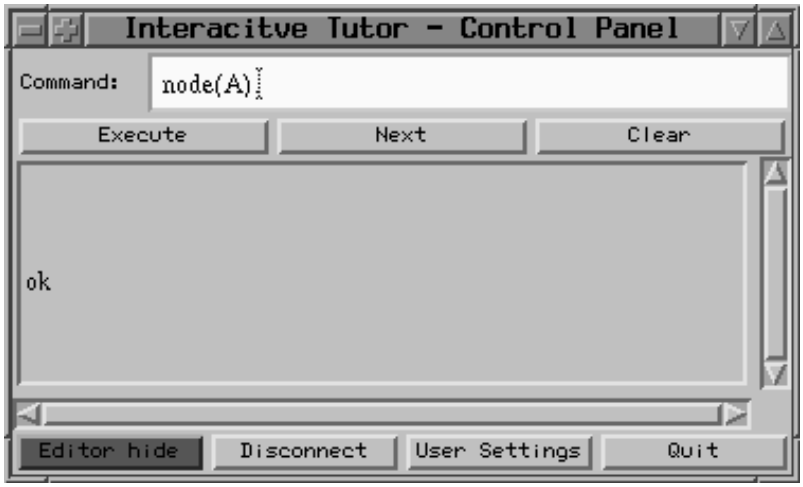

Figure 2: The Control Panel

communication with the server, including password handling, user preferences and input/output facilities. The editor offers the means to load, save and remove files from the user's partition of the server's database, to compile code and to save solutions, comments and messages to the corresponding partitions of the database. Due to the fact that the applet is embedded in a HTML-page, additional system features may be used at the same time while working on exercises. Such activities include using the PROLOG or LISP script or having access to former solutions, online-tutorials and related facilities or contacting the tutor (by eMail).

7.1 Further Offerings

Presently, work is done with respect to include a more sophisticated script which will allow interactions with the user. The script will be realized as

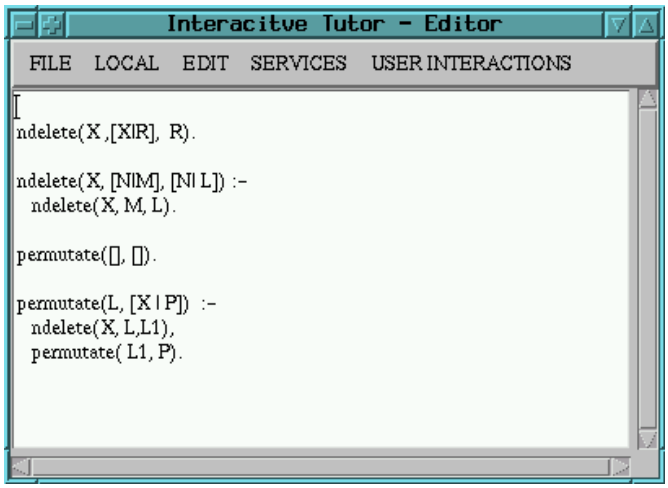

Figure 3: The Editor

HTML-pages containing both the lecture's script as HTML code and JAVA applets to illustrate the corresponding sections by examples. This will be achieved by an additional server located on the server side. Therefore, a further connection to the client and minor changes on the client side will be required as well. The script server will be managed by the main server where the overall communication is handled.

Additionally, a students project *Prolog Learning Online Tutor* (PLOT) takes place to develop a further component of the system which will analyse students solutions during the PROLOG developing process. This is to be done up to a defined level of complexity, which is at this time the permutation problem in PROLOG. PLOT will be built up of several components for syntactic and semantic analysis of the user's code, including a knowledge base of specimens of solutions. PLOT will examine the student's solutions in several steps:

1. syntactic mistakes like non-matching brackets,
2. flat semantic analysis of the program with regard of its run-ability or containing non terminating loops and undefined predicates.
3. A further semantic analysis: comparison of user program's set of solutions and the set of solutions of the corresponding specimen,
4. structure comparison of user's code and specimen.

In a special trace the user's mistakes are displayed and related to the corresponding parts of the script or manual. This is to put the finger on faults due to misunderstandings and false concepts as soon as possible. During the first lessons, when the user builds up models of how to formalise problems in PROLOG or LISP, this approach may be a great help to understand the involved concepts and to avoid frustrations.

7.2 Conclusion

Although it has been used for the last two semesters, the Interactive Tutor is still under development, therefore no evaluation will take place before the above mentioned components are finished. Nevertheless, it seems reasonable that the Virtual Campus approach offers several promising aspects for both students and universities:

- University lectures are enriched and broadened by integrating related material from remote facilities.
- Students may take advantage of the additional material, available on the Web and may be motivated to utilise the offerings of the Web for future tasks.
- An all-in-one tutorial system bundling Web resources with local resources in a guided environment may act as a filter between the bulk of accessible information and specific needs. This may help the student in learning both retrieving and classifying information from the Web in regard to a task and make critical use of the Web offerings.

It may well be the case that experience made in this project my be utilised to extend the project on transferring further seminars and classes on the Web, which could be guided by online tutors without physical presence of students, tutor and teacher. But before doing this, the problems mentioned above should be thoroughly considered.

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