LEARNING INTERFACE FOR E-LEARNING

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Abstract- This system is an artificial intelligence entity, with the power of natural language processing, as a virtual teacherfor learning and assessment of statistical inference, available through the Internet for student use.It has a logical reasoning engine and uses two knowledge bases, one for statistical inference and the other for rules of Englishgrammar and general knowledge to facilitate learning. Thesystem is called Learning Interface for E-Learning (LIEL). It provides lessons in inferential statistics. The user can ask questions in English and have a dialogue with virtualteacher. The system answers the questions or asks forclarification regarding what is required from it. It searches its knowledge bases(KB), uses its first order predicate logicreasoning engine and converses with the student using itsNatural Language Processing (NLP) sub-system. It is aimed to provide a multimedia experience. The system uses the following programming languages for itsdifferent functions: AIML for knowledge base, Prolog forreasoning, HTML and Java script for web client, Java for web server and AIML interpreter and Linux shell script forcommunication.This system has potential applicationsoutside academicenvironment such as web-based online marketing and helpdesk diagnostics in different sectors and can be used as assistantlecturer for other courses and subjects by changing itsknowledge-base.

Keywords- Education and Information Systems -Computer -Assisted Instruction -Artificial Intelligence -Conversational -Robots -Natural Language Processing.

I. INTRODUCTION

Imagine that you can talk with your computer in natural language and she understands what you say. We are not referring to voice activated word processors. Goal is something like Mr. DATA in star trek. Imagine for deciding about a subject you consult with your computer and make a brainstorming session that is helpful. Or using this program toentertain and inform old people who are sometimes lonely. Talk with a complicated database system and getting results instead of writing SQL code. Applications of a natural language-processing program that can do logical reasoning are unlimited. This project is a step in thisdirection. The post graduate students from the business school doing Research Methods have different backgrounds. The students are introduced to multivariate data analysis in this course. It is assumed that the students have considerable exposure to basic univariate statistics, statistical inference and correlation & simple linear regression. However, even the students with exposure to statistics, either because they learnt it long ago or they haven't learnt to apply, find it difficult to do the first quiz on basic concepts. The students were given a two weeks quick revision of these concepts. Still the first test inthe course, which is on their basic knowledge in inference, turns out to be tough for them. Also they were suggested to consult certain internet resources. They came back with more questions. However, with a student teacher interactive session, the concepts became clearer to the student. The idea for this project stems from this experience. Goal was creating virtual teacher who can understand plain English questions of a student and answer them, explain the concepts, give examples and perform the assessment24/7 on the internet with a friendly animated human character interface.

II. BASIC APPROACH FOR THE SYSTEM DEVELOPMENT

Observing what takes place during a typical student teacher oneto one interaction,to explain a particular idea/concept, revealedthat (1) the teacher knows the background and urgency of thestudent or finds out (2) chooses an appropriate example or usessuitable terms and explains (3) from the students reactionsincluding emotional and body language inputs from the student the teacher chooses the next step of showing a graph ora video clip or a formula or a computation to take the student closer to the goal of understanding the problem. All these involve a good amount of naturallanguage processing in the first place. Reasoning abilities and availability of the relevant knowledge bases on general facts,specific to the course and about the student are also requiredand used.

III. NATURAL LANGUAGE PROCESSING

Natural language processing (NLP) is the formulation and investigation of computationally effective mechanisms forcommunication through natural language. This involves naturallanguage generation and understanding. NLP is a multiplediscipline field, which involves general linguistics, cognitivescience, Artificial Intelligence (AI) and computational linguistics. Due to its generic complexity, NLP confronts many problems to solve. Recently, ALICE (Artificial Linguistic Internet Computer Entity) which can work as a conversationalist and-alone program

won Loebner prize, in the competition for AI programs that try to pass a version of Turing test. ALICE is abbreviation of Artificial Linguistic Internet Computer Entity. Alice can talk with the user through a textinput/output interface. She has 44000 categories as general knowledge.

IV. REASONING

Different reasoning capabilities can be added to the system. In this virtual teacher sy stem deductive reasoning is used to derive new facts from the existing facts in the knowledge bases. Alice does not understand the logical connections of the facts. Since itwas decided to use Alice in a major way to implement the scheme, in this project her reasoning ability is improved with Prolog and she has learned some deductive reasoning formulas. Other reasoning abilities like common sense reasoning, deductive reasoning, and defeasible reasoning can also be provided, but not attempted at this stage. (See references 3-9)

V. KNOWLEDGE BASES

Two types of knowledge bases and a database are envisaged inthe scheme. The general knowledge base of Alice is used for an intelligent conversation with the student. Alice can learn newer facts either supervised or unsupervised. In addition for helping the students with basic statistical inference, her specificknowledge is improved with an additional statistical knowledgebase. This knowledge base also contains examples and information on relevant video clips, graphs, formulae and computational programs. To enable the choice of appropriate examples for a particular student based on her background, a database giving student profile is added. This dbase can be built either using the conversation mode or by a form required to be filled by the student at the first interaction with the system.

VI. INPUT OUTPUT INTERFACE

In the simplest possible case the input from the student like the questions and the other information sought is in the form oftext. The system outputs text /graphs /video clips on the screen. It is also possible to have voice input and output and an animated agent interacting with the student. It gives the elements of the system developed to implement the virtual teacher. In the next section, how these elements are put together in the system is explained. At the start of the project some integration has already been done. The developments that are specific to this project are highlighted.

VII. SYSTEM DESIGN

The new and the modules that existed prior to the project Logic processor is connected to AIML interpreter through a <system> tag that is for calling external executable programs (in this system, the Prolog logic processor). AIML is the abbreviation for Artificial Intelligence Markup Language. It is an easy to use XML type language for communicating with and teaching the robot. Alice uses AIML for storing and retrieving its KB.

VIII. LOGIC PROCESSOR SUB SYSTEM

The user types the question in English. The virtual teacherlooks for patterns and goes to the reasoning engine to find the answer. Logic processor is capable of common-sense reasoning overlimited categories and uses some of the argumentation theory's logical reasoning rules. System can do logical reasoning andupdate its knowledge bases according to the new information itcollects from conversations. Logic processor is written withProlog language and is linked to the Java code of the NLP and AIML interpreter with shell scripts under Linux. If question directly uses one of the known common-sense reasoning categories of the system then it draws the answer from the logical module, if it fails then goes back to the AIML module and uses either the general knowledge KB specific KB foranswering.

First order predicate logic was selected and within the boundaries of argumentation theory, Modus Tollens, ModusPonens and Hypothetical Syllogism and within the boundaries of common-sense reasoning predicates “is”, “does” and “has”were incorporated to the program. For example, if I “do”cycling and cycling “is” exercise, Alice+ (enhanced Alice) canconclude that I “do” exercise by combining two predicates andone modus ponens deduction. There can be virtually unlimited number of predicates that can be programmed to be used for common-sense reasoning. CYChas built a collection of 10,000 predicates. CYC is a program that has a large knowledge-base. It started by Dr. Lenat 18 yearsago. It has its own language that is called, CycL. This language is an extension of Lisp. CycL, the CYC® representation language, is a large and extraordinarily flexible knowledge representation language. Recently an interface is built between CYC and ALICE that gives the integrated system beautiful and user-friendly NLP and interface of ALICE with great reasoning abilities of CYC. Argumentation Theory contains several rules and methods of reasoning. Three fundamental methods were coded to program.

- **Modus Tollens (p É q), Øq \ Øp**
- **Modus Ponens (pÉ q), p \ q**
- **Hypothetical Syllogism (pÉ q), (qÉ r) \ (pÉ r)**

Virtual teacher system works based on 1St order predicate logic.The reason for this choice was that computer languagePROLOG contains rules of this logic and it was used forprogramming the project. If other languages such as C++,FORTRAN or Java

were going to be used, amount of codecould increase enormously. Prolog with logic within, andbacktracking mechanism to access the internal database causeda clean understandable and efficient code that can be maintainedand updated to incorporate more rules easily in later stages.A different approach for solving the same problem was taken by creators of CYC system that uses nThorder predicate logic.

IV. TRANSACTION PROCESS

ALICE is acollection of autonomous clients and serverscommunicating via TCP/IP, which includes AIMLand itsinterpreter, along with the Artificial Intelligence TransferProtocol AITP. Diagram 4 shows a subset of the processes involved in a typical transaction with ALICE. The client (ahuman) utilizes a browser to connect to the server installed on the host Alice: 1991 and transmits a query. The reply containsHTML markup for the video server and for the remote text-tospeech synthesis server. The browser interprets this HTML and initiates connections with the audio and agent hosts. Theprocess on Alice: 1991is a forking server, a protective shield against misbehaved clients. Once the forked child receives theclient's input query it initiates an atomic transaction with theserver on Emma: 1978this transaction consists of twoexchanges: first, the faux HTTP server reports the IP address ofits client and second, it retransmits the client query in itsoriginal HTTP format (specifically, a GET method). Theprogram "normalize" runs as a command line pump. Itprocesses one line of text input and removes all non-meaningful(to AIML) punctuation, converts to upper case, and replaces anumber of contractions and acronyms with theirexpandedforms. The result is one line of normalized text, suitable formatching with AIML patterns. Another line pump is gawk.

V. GUI-SUB SYSTEM

Systemhas a user friendly manner. Students can choose appearance of their teacher. A man, a woman, young orold is available to choose as preferred teacher. Also several options of different male and female voices are available to choose according to preferences of the user. Graphical user interface presents the 3D animated character as virtual teacher. It uses Microsoft agent technology called by a web page hosting on a web server. Virtual teacher can talk byusing Text To Speech (TTS) and Speech Application Programming Interface (SAPI) technologies. TTS is availablefrom Microsoft site to download and install over windows. Ifuser uses Linux as web client virtual teacher can appear as animated GIF. It is also possible to use Flash animated characters. Student can type and receive his answers as text and voice if he has installed TTS over his computer or text only. Ifuser wants he can install speech recognition software and train it with his voice and do a natural conversation with the virtual teacher.

VI. KNOWLEDGE BASES INTERPRETATION

The system has threeKB that are written in AIML language:

- **General knowledge KB**
- **Inferential statistics KB**
- **Student profiles KB**

The FirstKBenables the robot to do a meaningfulconversation with the student and the other two are used forteaching specific knowledge for the specific studentAutomatic detection of new patterns for which the robot doesnot already have specific answers, is defined as targeting.AIML is an XML language. This is an example of an AIMLpatterns:Example of an AIML category:

<category>
<pattern>WHAT ARE YOU</pattern>
<template>
<think><set name="topic">Me</set></think>
I am an intelligent computer program.
</template>
</category>

If this category is called, it will produce the response "I am an intelligent computer program.", In addition, it will use thethink> tag and will set the "topic" in its memory to "Me" for further pattern matching.

VII. MULTIMEDIA SUB-SYSTEM

Virtual teacher talks with the students, identifies their questions and depending on the topic, sometimes answers them with text using the GUI or guides them to the pre-made multimedialessons hosting on the webserver whenever additional support material for its lessons are necessary.

All multimedia modulesare available over the internet using WWW server and digitalvideo streaming. 3D model that acts as virtual teachersometimes appears presenting a topic in digital video formatand sometimes a human teacher is used for lectures. Multimedia modules are:

· Assessments
· Animated graphs, diagrams, pictures and reconstructions of formulas
· Interactive step by step lessons, (Java applets, Shockwave and Flash modules)
· Digital video of the human teacher describing some topics
· Digital video of the 3D model (virtual teacher) describing some topics

VIII. AVOID INCONSISTENCY OF KB

Inconsistency in this case can be defined either as duplication of information with minor differences or

opposing information. With the present structure of the programs there are twoknowledge bases. One in the Prolog program and other in the collection of AIML files. Since certain relationships between certain objects need to be taught to the program explicitly by adding it to the KB of Prolog program it is possible to check the AIML collection by a simple search text string program before adding to KB. This method requires human supervision. To make the process automatic an epistemic logic decision making engine for real-time learning using belief revision axioms can be developed to add facts, remove facts or revise the KB.

IX. PROBLEMS AND SOLUTIONS

The positive side of using Prolog in this project is that it contains rules of first order predicate logic and internal backtracking. The negative side is that Prolog reports false if it doesn't have the clause in its predicate list. This is the result of the backtracking mechanism. A programming trick is to check its KB and if a fact is not there, instead of using internal logical inference it says "I do not know." And in the learning version ofthe program it asks: "I do not know this, Do I learn it or not" Then it is left to the user todecide thatnew fact should be added to present KB or not.Learning problem for the system can be defined as: Which type of learning should be used, on-line or off-line? Which subsystem should be enhanced for taking care of learning, AIMLinterpreter, pattern matching module or another sub-system? First approach to address this problem was teaching the rules to the system through AIML patterns. This method required a huge amount of RAM. Second approach was putting the facts and their relationships to Prolog code. In this case Prolog performance will decrease by increasing the number of facts. Finally the best method used was dealing with new facts that are not in the collection of KB as off-line learning and using Prolog for reasoning and AIML interpreter for pattern matching.

X. RESEARCH METHODOLOGY

It is planned to evaluate, using statistically designedexperiments, the effect of the number of hours spent with avirtual teacher in addition to attending the regular lectures by a human teacher.

The control groups of students with different backgrounds with respect to prior knowledge of statistical inference have the human teacher only. The hypotheses, regarding the outcomes and experiential benefits of using a virtual teacher, that are to be tested are as follows:

H1: The performance of the students is not significantly enhanced by the use of a virtual teacher.

H2: Learning experience of the students is not significantly improved by the use of a virtual teacher.

H3: Number of hours spent with a virtual teacher has nocorrelation with the performance of the students.

H4: Number of hours spent with a virtual teacher has nocorrelation with the learning experience of the students.

H5: The usefulness of a virtual teacher does not depend on the student's background.

For each student in the study the following variables are recorded:

· Number of hours (on-line learning) with a virtual teacher

· The final grade

· Results from questionnaire

- Enjoyment of learning
- Difficulty of course (difficult, medium, easy)
- Recommend this course to others (Y/N)
- How was a virtual teacher different from the human teacher?

· background of the student

- studied statistical inference before (and remembers)
- studied statistical inference before (and does not remember)
- did not study

· Since we have more than one response we go for amultivariate analysis of variance (MANOVA). Thelanguage data obtained from the questionnaire will be subjected to qualitative data analysis tools.

XI. IMPLICATIONS

An intelligent robot with reasoning abilities can work in the following jobs: online marketing representatives, smart interfaces, intelligent characters for games, enhanced virtual reality, improved machine translation, improved speech recognition, virtual teacher (specialized knowledge base), Companion for elders (general info), psychologist (expert knowledge base).

CONCLUSION

By using SAPI, TTS, MS-Agent,[13]and NLP technologies a system was created using AIML, JAVA and Prolog languages that acts as a virtual teacher, available for consultation for students continuously over the Internet, answering their questions patiently and guide them through new course material. This artificial intelligence entity can be replicated toteach different subjects by changing or adding to its specialized KB. Although most learners might prefer interacting with an organic teacher, as most essential functions of a human teacher are incorporated in LIVE, it can be more useful as a proxy teacher because of its availability, perfect memory, patience and maintenance cost.

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