

An Experiment with the Student Advisor System

Jong G. Lim
Department of Computer Science
Columbia University
New York, New York 10027

February, 1988

CUCS-359-88

This report summarizes a trial of the Student Advisor, a natural language question-answering system developed at Columbia University to assist computer science majors in course selection, carried out during the Spring '88 registration period with students from the Department of Computer Science. Included in this report are a brief overview of the current status of the system, a description of the circumstances present at the time of the trial, a list of answered and unanswered questions, and a statistical summary of all the questions asked. The report is useful as a benchmark for future development of the system and as a casual reference on the behavior and appropriateness of a natural language Q/A system for anyone who is working towards building one.

1 System Overview

The Student Advisor system used in the experiment is a complete natural language question-answering system capable of understanding a moderately large set of English sentences, finding or deriving an answer to a question using its knowledge base and an auxiliary rule based inferencer, and generating user-oriented answers and explanations.

An ATN syntactic parser takes an input sentence and builds a syntactic parse tree from it. Then a semantic interpreter based on Woods' semantic pattern-action rule ([Woods 77]) uses the parse tree to transform the sentence into appropriate query or assertion propositions. The parser and the semantic interpreter are disjoint and non-incremental.

Next the KB Query/Inferencer modules attempt to verify the query proposition by

examining the KI-one based knowledge base. When the truth value of a proposition cannot be determined directly from the knowledge base, the rule-based inferencer is invoked to derive it. Some questions result in multiple query propositions and question-variables (e.g. "Which hardware courses are offered this semester?") in which case the variables are bound to the values in the knowledge base that satisfy all the propositions.

Finally, Student Advisor forms case-frame proposition(s) representing the answers and passes to the generator that produces natural language responses as well as explanations that are based on the inference trace and a context tree which incorporates user's focused plans derived by the goal derivation process based on Perrault and Allen's rules ([Allen and Perrault 80]).

All the modules of Student Advisor are written in MacLisp except for the generation module which is written in PROLOG.

For a more detailed and comprehensive description of the Student Advisor system, refer to [Weida 87].

2 Experiment Conditions

During three days of registration (Jan 20th - Jan 22nd), a supervised terminal was set up inside the CS department where approximately 40 students volunteered to try the system. Some students had already met their advisor and others were waiting around to meet one. Several of the volunteers had already registered or had a clear idea about which courses they were registering for, but the majority were still shopping around to select the right courses. Even though the system is designed for undergraduates, some graduate students as well as a number of faculty members tried the system. Students who volunteered on the second day (Jan 21st) were mostly seniors; this was because the terminal was set up near the senior student advisor's office where students lined up waiting to meet their real advisor. Students who had their own accounts could try the system directly from their own terminal. About five people tried the system this way.

Everyone who tried the system left a transcript of the dialogues. (See section 7.) About fifteen students filled in a questionnaire and many others expressed their views verbally to the supervisor. (See section 3.)

The ratio of answered questions to unanswered ones (See section 4.) might have been lower if the volunteers had tried the system without the supervisor to whom they could ask questions

regarding acceptable question types and without the built-in introduction which revealed a list of some successfully answered question types. Of course, those who tried it remotely from their own terminals were not influenced by them.

3 Overall Impressions

Three questions were asked to the users after they had finished using the system:

1. Did the system answer your questions satisfactorily? Why or why not?
2. Do you have any suggestions for modifications to the system?
3. Did you have any questions that you particularly wanted to ask, but were unable to?

The answers to the first question ranged evenly from "yes, questions were answered very well" to "no, could not answer most of my questions." Those who tried a relatively large number of questions answered "moderately well" or "the basic questions."

The response to the second question included the following:

- Make it run faster.
- Get rid of the PROLOG system messages.
- Incorporate course evaluation summaries in the knowledge base.
- Handle time conflicts among courses.
- Negative answers to the should-take and can-take questions do not support explanations while positive answers do. Vice versa would make more sense.
- Add knowledge of mathematics and electrical engineering course offerings that are prerequisites or substitutes for CS courses.
- Provide an editing facility so that it becomes easy to fix the last sentence entered in case it contains a typo or syntactic error.
- Display a list of similar words when a typo or unrecognized word is entered.
- Add more course descriptions -- topics covered, course requirements etc.
- Allow course names to be substituted by course numbers -- e.g. accept both "Can I take w4705" and "Can I take NLP"
- Establish cross references among course name, topics, and languages.

In summary of the responses to the third question, below is the list of questions that the students wanted to ask but were unable to. Some of them also appear in the journal and a lot more unanswered questions are listed in section 6.

(how hard is ai)
(how is the robotics department)

(how many technical elective courses are offered)
 (how many more technical electives do i need to fulfill my requirement)
 (if i want to major in robotics should i be in cs department rather
 than in ee)
 (what courses do i have to take)
 (what do i need to take now)
 (what material does nlp cover)
 (which courses can i take)
 (which courses do i have prerequisites for)
 (which courses use the c programming language)
 (which hardware courses should i take)
 (which of the prerequisites for scientific computation i did i take)
 (why not)

4 Statistical Summary

The following data comes from analyzing the journal file. (See section 7.)

Total users ----- 37
 Total queries -- 375

Answered ----- 146

```

+++++
Y/N ----- 20
W/ Prolog generator - 126
Subtotal ----- 146
+++++
What ----- 48
Who ----- 25
Can ----- 18
When ----- 16
Should ----- 10
Which ----- 9
Is ----- 7
How ----- 4
May ----- 3
Assertion ----- 3
Could ----- 1
Does ----- 1
Do ----- 1
Will ----- 1
Subtotal ----- 146
+++++

```

Unanswered ----- 176

```

Unrecognized words ---- 1061
  Lexicon ----- 89
  Misspelled ----- 17

```

¹For many of the questions that were not answered due to unrecognized words in the questions, entering the unrecognized words into the lexicon may not be enough to produce an answer.

Parsing -----	19
Semantics -----	51
Subtotal -----	176
bye -----	37
(bye) -----	7
"BYE" -----	1
Error or crash -	8
Total -----	375

5 Answered Questions

Below is the list of question asked by the user that are answered correctly by the system.

Duplicates are removed.

```
(can i take ai)
(can i take advanced computer architecture)
(can i take artificial intelligence)
(can i take computer graphics)
(can i take neural network)
(can i take digital-logic)
(can i take topics in advanced robotics)
(can i take topics in robotics)
(can i take digital-computer-systems-design-2)
(can i take knowledge-based-expert-systems)
(can i take scientific-computation-1)
(can i take data base)
(can i take graphics)
(can i take nlp)
(could i take natural language processing)
(does discrete-math-1 require calculus-1)
(how many classes does maguire teach)
(how many classes does unger teach)
(how many courses does allen teach)
(how many courses does kaiser teach)
(is ai offered this semester)
(is data structures offered in the evening)
(is discrete math i offered this semester)
(is greenleaf teaching fundamental-algorithms)
(is kender teaching graphics)
(is software-lab offered this semester)
(may i take computer vision)
(may i take software engineering)
(should i take ai)
(should i take advanced computer architecture)
(should i take neural network computing)
(should i take operating systems)
(should i take topics in advanced robotics)
(should i take knowledge-based-expert-systems)
(should i take scientific-computation-1)
(should i take nlp)
(should i take graphics)
(should i take software lab)
(what are prerequisites of nlp)
(what are the prerequisites for ai)
```

(what are the prerequisites for automata theory)
 (what are the prerequisites for combinatorial theory)
 (what are the prerequisites for operating systems)
 (what are the prerequisites for topics in advanced robotics)
 (what are the prerequisites for scientific-computation-1)
 (what are the prerequisites of fundamental algorithms)
 (what are the prerequisites of os)
 (what are the required courses)
 (what are the topics covered in ai)
 (what courses are offered this semester)
 (what courses are offered)
 (what courses are required)
 (what courses do i take now)
 (what courses does bantz teach)
 (what courses does bashkow teach)
 (what courses does kaiser teach)
 (what courses does kender teach)
 (what does bantz teach)
 (what does computer graphics cover)
 (what does yemini teach)
 (what is allen teaching)
 (what is foster teaching)
 (what is taught by unger)
 (what is unger teaching)
 (what is required)
 (what theory courses are offered this semester)
 (what time is ai offered)
 (what time is data structures offered)
 (what topics are covered in discrete-math-1)
 (what topics are covered in artificial intelligence)
 (what topics are covered in ai)
 (what topics are covered in vlsi)
 (what topics are covered in advanced computer architecture)
 (what topics are covered in nlp)
 (what topics are covered in data structures)
 (what topics are covered in calculus-1)
 (what topics are covered in knowledge-based-expert-systems)
 (what topics are covered in scientific-computation-1)
 (what topics are covered in fundamental algorithms)
 (what topics are covered in graphics)
 (when does ai meet)
 (when does data structures meet)
 (when does neural network meet)
 (when does software-lab meet)
 (when is ai offered)
 (when is automata theory offered)
 (when is combinatorial theory offered)
 (when is nlp offered)
 (which are the prerequisites of ai)
 (which classes meet in the evening)
 (which courses does allen teach)
 (which hardware classes are offered this semester)
 (which required courses are offered)
 (which required courses are offered this semester)
 (which theory classes meet in the evening)
 (which topics are covered in ai)
 (which topics are covered in nlp)
 (who is teaching graphics)

(who is teaching ai)
 (who is teaching software-lab)
 (who is teaching data base)
 (who is teaching nlp)
 (who is teaching combinatorial theory)
 (who teaches ai)
 (who teaches artificial intelligence)
 (who teaches data base)
 (who teaches nlp)
 (who teaches scientific-computation-1)
 (who teaches data structures)
 (who teaches fundamental algorithms)
 (will nlp be offered next semester)

6 Unanswered Questions

6.1 Lexicon

Listed below are the questions that couldn't be parsed due to their usage of words that are not included in the lexicon. For many of the questions below, entering the unrecognized words into the lexicon may not be enough to produce an answer.

- A brief description of a course is used in place of a course name:

(do i have to take an introductory course in programming)
 unrecognized word-programming

- Some students were surprised to find out that the system couldn't recognize the following words that are frequently used among the registering students and advisors:

(who is the TA for combinatorial theory)
 unrecognized word-TA

(who are the tas of automata theory)
 unrecognized word-TAS

(how many students were in the course last semester)
 unrecognized word-STUDENTS

(who are the computer science professors)
 unrecognized word-PROFESSORS

(How many courses have I taken toward my degree)
 unrecognized word-DEGREE

(What theory courses meet at night)
 unrecognized word-NIGHT

(How many points do I need to graduate)
 unrecognized word-POINTS

(how many points do i have)
 unrecognized word-POINTS

(what room number is software-lab being held in)

unrecognized word-NUMBER

(do I have the number of credits to graduate)
unrecognized word-NUMBER

(Which is the load of the ai course)
unrecognized word-LOAD

(how many years does ms program normally take)
unrecognized word-YEARS

(what are my deficiencies)
unrecognized word-DEFICIENCIES

(have I fulfilled my major requirement)
unrecognized word-FULFILLED

(have I finished my major courses)
unrecognized word-FINISHED

(what material does the graphics course cover)
unrecognized word-MATERIAL

(what courses are needed to graduate)
unrecognized word-NEEDED

- A multi-word course name in the generated English sentence contains underscores (because hyphens aren't accepted in Prolog). Students looked at them and used the underscored course name in asking further questions about the course:

(what topics are covered in Neural_network_computing)
unrecognized word-NEURAL_NETWORK_COMPUTING

(when is computer_organization_1 offered)
unrecognized word-COMPUTER_ORGANIZATION_1

(can i take data_base)
unrecognized word-DATA_BASE

- A lot more synonyms are desired as course names:

(who teaches natural languages?)
unrecognized word-NATURAL

(what are the prerequisites for scientific computing)
unrecognized word-SCIENTIFIC

(should i take scientific computation)
unrecognized word-SCIENTIFIC

(what topics are covered in scientific computation)
unrecognized word-SCIENTIFIC

(do i have to take scientific computation)
unrecognized word-SCIENTIFIC

(who teaches scientific comp)
unrecognized word-SCIENTIFIC

(what are the prerequisites for scientific computation 1)
unrecognized word-SCIENTIFIC

(do i have to take scientific-computation-i)
unrecognized word-SCIENTIFIC-COMPUTATION-I

(Is computer networks offered this semester)
unrecognized word-NETWORKS

(Is networks offered this semester)
unrecognized word-NETWORKS

(Is Computer networks required for the degree)
unrecognized word-NETWORKS

(Is Networks required)
unrecognized word-NETWORKS

(should i take software design lab)
unrecognized word-DESIGN

(who teaches database systems)
unrecognized word-DATABASE

(should i take digital-computer-system-design-2)
unrecognized word-DIGITAL-COMPUTER-SYSTEM-DESIGN-2

(who teaches data structure)
unrecognized word-DATA

(is discrete math offered in this semester)
unrecognized word-DESCRETE

(is software design lab offered this semester)
unrecognized word-DESIGN

(who is teaching a-i)
unrecognized word-A-I

(can i take neuro network)
unrecognized word-NEURO

(does discrete math require calculus)
unrecognized word-CALCULUS

(does discrete math require calculus I)
unrecognized word-CALCULUS

- The sentence pre-processor doesn't work properly with arabic numbers. This must be due to the standard function *explode* in MacLisp. (CommonLisp version doesn't have this problem.):

(what are the prerequisites for scientific computation 1)
unrecognized word-SCIENTIFIC

(does discrete math require calculus 1)
unrecognized word-CALCULUS

- Some students sought on-line help:

(help)
unrecognized word-HELP

(?)
unrecognized word-?

- Others:

(is combinatorial theory only 40 minutes per session)
unrecognized word-ONLY

(is os a good course)
unrecognized word-GOOD

(is Kender a good instructor)
unrecognized word-GOOD

(What is the meaning of digital logic)
unrecognized word-MEANING

(How many people took the course last semester?)
unrecognized word-PEOPLE

(who are the computer science teachers)
unrecognized word-TEACHERS

(describe computer graphics)
unrecognized word-DESCRIBE

(who is peter allen)
unrecognized word-PETER

(how long does ms program normally take)
unrecognized word-LONG

(where is the admissions office)
unrecognized word-ADMISSIONS

(did I take enough courses to fulfill my major requirement)
unrecognized word-ENOUGH

(did i take the correct courses to fulfill my major)
unrecognized word-CORRECT

- And, as expected, there were some ill-natured students:

(tell me more about your mother)
unrecognized word-MORE

(are you an idiot)
unrecognized word-IDIOT

(who wrote the program)
unrecognized word-WROTE

6.2 Syntax

Questions that couldn't be parsed due to the reasons other than the usage of unrecognized words are listed below. For some of the questions that refer back to previous questions, both the previous questions and the corresponding responses are listed together.

(Is AI offered this semester)
(At what time)

(when is AI offered)
(and what about nlp)

(should i take topics in advanced robotics)
You should not take Topics_in_advanced_robotics.
(why not)

(what topics does the graphics cover)

(can you recommend a course to take)

(who teaches data structures this semester)

(what topics are covered in the data structures)

(how hard is nlp)

(may i take computer vision)
You can not take Vision.
(Why i can not take vision)

(what topics courses are being taught this semester)

(am I qualified for the Master's program)

(how many graphics classes are there)

6.3 Semantics

Questions listed below were parsed successfully but couldn't be answered for various reasons. The reasons for the individual unanswered questions aren't analyzed, yet. For some of the questions that refer back to previous questions, both the previous questions and the corresponding responses are listed together.

(do I have the prerequisites for automata theory)

(what does Maguire do)

(which courses do I have the prerequisites for)

(Is computer architecture offered this semester)

(which hardware course should I take)

(what do I need to take now)
(what courses do i need to take)
(how many credits of computer courses do i need to take)
(is there any prerequisites for operating systems)
(how many courses do i have to take)
(what courses do i have to take)
(is networks-and-data-bases required)
(what topics are in fundamental algorithms)
(what courses should i take)
(is discrete math offered this semester)
(what is required in topics in advanced robotics)
(What are the topics in VLSI)
(what are the courses required to graduate)
(where am I)
(can i take computer graphics next semester)
(what do i do now)
(where is software-lab going to be taught)
(where is ai going to meet)
(where does ai meet)
(Which is the schedule of the ai course)
(what courses are covered in computer graphics)
(what topics are covered in combinatorial theory)
(what should I take)
(how many requirements do i still have)
(how many classes do i have)
(how many classes do i have to take)
(do i have to take ai)
(what courses do i have to take)
(what do I need to take now)
(what time is it offered)

(what time is data structures offered)
 Data_structures is offered from 1810 to 1925.
 (is it offered during the summer)

 (does discrete math require calculus-1)

 (what is discrete-math-1 like)

 (is discrete-math-1 hard)

 (can I graduate with a computer science major)

 (how many courses do I need to graduate)

 (do i have to take graphics)

 (do i have to take data-structures)

 (do i have to take graphics)

 (how many classes do i have to take)

 (what classes do i have to take)

 (do i have to take plt)

 (what classes do i have to take)

7 Journal File

A journal of dialogues is in the file <MCKEOWN.ADVISOR>SURVEY.JRN. There are a total of 37 journal files appended together in this file each one of which is captured between two lines similar to the following:

```
[Journal begin, VT100: HOWARD.JRN.1, Thu 21 Jan 88 12:21:01PM]
[Journal end: HOWARD.JRN.1, Thu 21 Jan 88 12:32:12PM].
```

The file is 76 pages (193405 bytes) long.

References

- [Allen and Perrault 80] Allen, J. F. and Perrault, C. R.
Analyzing Intention in Utterances.
Artificial Intelligence 15(1):143-178, 1980.
also in Readings in Natural Language Processing in pp. 441-458.
- [Weida 87] Weida R.
Outline of the Student Advisor System.
Technical Report, Department of Computer Science, Columbia University, New York, NY, May, 1987.
- [Woods 77] Woods, W. A.
Lunar Rocks in Natural English: Explorations in Natural Language Question Answering.
In Zampoli, A. (editor), *Linguistic Structures Processing*. Elsevier North-Holland, New York, NY, 1977.