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ABSTRACT

The feasibility of conducting computer science courses in artificial intelligence at a small liberal arts college is examined. The following problems are examined in detail: isolation; student abililty, motivation and expectation; equipment; and faculty readiness. Providing a focus to the discussion, three issues are addressed in terms of combating isolation--the choice of the textbook, the resources of the Internet, and the use of the library. (AEF)

Small College AI

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An ideal AI environment

When I was in graduate school, I learned in an environment devoted to the advancement of artificial intelligence. I worked with people who had the minds and the dedication to their specialties, along with an advanced level of equipment, to move toward making significant contributions to their field. Those of us who were focussed on computational linguistics had our own lab, which had equipment that was dedicated to our pursuit. That lab had a combination lock, and all of the CL research people had the combination. There were no hours of availability to the specialized equipment - it was open for our use at all hours. Indeed, some of my work from those days, still in my files, is time stamped 4 am. There seemed to be no end of commitment to the pursuit of specialized knowledge. And we were not isolated. All of the most important people in the field, from John McCarthy on, came through at some point during my graduate years, giving talks and attending seminars. In addition, the faculty were successful and capable in their specialized fields, and the students persevered with the expectation that they were carving future career paths for themselves.

A real AI environment

I now teach at a small, liberal arts college, where it has been my task, among other tasks, to develop the computer science program. I teach many different computer science courses, many of them advanced. I cannot limit myself to artificial intelligence, much less computational linguistics. I can't even limit myself to computer science, for I have taught our core course in the Twentieth Century. We face ongoing budget constraints, which affect computer science; and it is simply unfeasible that our equipment be designed to support arcane artificial intelligence specialties. And our students, while interested and reasonably hardworking, are mostly not headed for graduate school and specialized knowledge. Finally, as a small, liberal arts college, we do not partake of the research institution circuit.

But as a liberal arts college we remain a legitimate site for Computer Science study, as is verified by the existence of guidelines for such programs set out in "A Revised Model Curriculum for a Liberal Arts Degree in Computer Science" set out by the ACM (Communications of the ACM, Vol. 39, No. 12, December, 1996), which reminds us of our special place: "A liberal arts education strives to maintain balance between a breadth of study in a variety of fields and a deeper understanding of a major subject area."

So - what is the task?

What, then, is the feasibility of maintaining a reasonably sophisticated course or set of courses in artificial intelligence? Can it be done? Should it be done? I think the answer to these questions is yes, because I have found that the subject matter does connect with the goals of my small college students in perhaps surprising ways, and because I have found that the technical problems are surmountable. Let me address this issue by isolating the different parts of the problem, as I have suggested them above. I will discuss the problems of isolation, student ability, motivation, and expectation, equipment, and, finally, faculty readiness. I pull isolation to the forefront because this allows me to bring up three issues that will provide focus to the discussion - the choice of the text book, the resources of the Internet, and the use of the library.

Combating isolation: the textbook

There has been an interesting though incomplete jelling of opinion recently, it seems, about how AI is to proceed, which is in the direction of what is called the intelligent agent. This has as a symptom the wide adoption of one text, Stuart Russell and Peter Norvig's Artificial Intelligence: A Modern Approach (Prentice-Hall, 1995). According to information provided by the publisher, 35 of the top 40 computer science programs in the nation use this text. This adoption rate occurs in a field of a number of competing, very fine texts, some of them with long histories of use. So, on the one hand, the text gives us a community within which to work: the community, that is, of those who have adopted the text and who therefore, presumably, subscribe to its point of view. But there is another interesting way in which the book combats isolation.

While the book indicates widespread consensus, the issues here are still up for grabs. As the authors define "intelligent agent" in the preface "the problem of AI is to describe and build agents that receive percepts from the environment and perform actions." (Russell and Norvig, p. vii) A percept can be defined as the list of stimuli, or perceptions, for the environment that the agent stores, derives further information from, and acts upon. Not everyone agrees with this. Marvin Minsky, for one, has raised some doubts about "intelligent agents" in two separate interviews, one presented in Communications of the ACM (Vol. 37, No. 7, July 1994), and the other in Hal's Legacy: 2001's Computer as Dream and Reality (MIT Press, 1997), because they do not correspond to his notions of intelligence and general problem solving.

But I should not digress too far into this AI controversy. The point to be made for the present discussion is that the definition of the field is an ongoing pursuit, and a course in AI should be taught with a sense of that incompleteness. Part of the excitement I have been able to generate comes from this sense of unsettled matter, which people out there, as well as ourselves, are taking an active role in shaping. The Russell and Norvig texts helps contribute to this sense.

Combating isolation: the Internet

Being part of a community, feeling that we are not just taking/giving a course off on campus somewhere, is further enhanced by Internet access. This takes two forms. The first is the support provided in connection to the Russell and Norvig text.

Some of the things we have come to expect as support for a text is available at the text Web site, including, for example, the usual figures for use as transparencies. The text generates news, which we hear about, include the fact that it has been translated into Spanish, with translations into Japanese, Italian, and Chinese in the works. The support becomes more interesting through access to the syllabi of many of the courses taught around the world, which either the instructor or a teaching assistant has chosen to make public. This is truly valuable to the instructor, as a mine of ideas, and as a source of creating balance - the instructor's syllabus gets constructed in the context of many other syllabi out there. The students have found these "alternate" syllabi to be of interest. They have friends at these other schools, and they now share a new level of information.

The text home page also is being used as a clearing house for related information. A report on the developments concerning Deep Blue, for example, is clickable. There is even a set of course notes from someone from the University of Michigan. Perhaps the most valuable material at the site is the repository of code for the problems in the text, provided in Lisp, C++, Prolog, and (it is promised at this writing) Java. We have had source code for some time coming in various ways with texts; but I find that its presence at a central location, which is reachable by the global Internet audience, to be symbolically valuable.

My sense is that this is only the beginning of what could take place along the lines of course support. The materials need to be more dynamic and interactive. There have been flurries of group discussion among instructors, spurred on by the authors, most recently over the issue of the appropriateness for AI of the various programming languages. This kind of interactive discussion could take place among students from various institutions, sharing at the same time, for example, a specific programming assignment. There could also be some kind of tapping into research developments.

Combating isolation: the Library

My experience in the past with sending students off to the library for "research" has usually been pretty dismal. Students do not do research in traditional ways, and this is particularly true of computer science students. It seems that they do not regard the library as having a valid connection to the rest of their interests.

I have had some success in the AI course with this problem, by linking the library - especially the books I put on reserve - with the electronic experiences described above. By creating a sense of community with the world of research in AI, by treating the field as an unsolved problem, and then by talking about particular texts - Marvin Minsky's Society of Mind (Simon & Schuster, 1985), for example, or the new and compelling Hal's Legacy: 2001's Computer as Dream and Reality, mentioned above, or the Paul Graham text on ANSI Common Lisp (Prentice Hall, 1996), which the students have used but did not buy for the course, but is indeed on reserve in the library, I have generated a rise in the use of reserve materials.

It has helped, of course, that these works have the special verification of being referenced in various places on the World Wide Web. How deeply students use these materials I do not wish to investigate here, for I do think that is too much to ask at this stage in my development of these strategies. But they are exposing themselves to the material more than they have in the past because

they sense that the materials are an aspect of the unsolved problem, the incomplete adventure, of which they are a part.

Student ability, motivation, and expectation

Every year our computer science program, which is only five years old, gets a bit more serious and a bit more crowded with majors. We have responded to this by getting a bit tougher each year. But we still are not dealing with a group of majors who want to go off to graduate school in computer science, nor should we expect to. Traditionally our students go off to family businesses and to small companies. We might expect, therefore, that Artificial Intelligence is outside the realm of their concerns. But this is not the case, for several reasons, having to do both with their perceptions and with the way the course can be pitched to them. First of all, the problems and resulting algorithms and implementation in AI can be seen as an extension of traditional data processing. Many modules in AI systems employ rather obvious, although rigorous, programs, and these can be taught as an extension of what students already know. For example, a survey of AI text and syllabi reveals that search is an obligatory subject matter in the AI course, usually put early in the semester. Well, CS students have already been introduced to search as a topic in programming courses, and search in AI can be taught as an extension of that knowledge. Learning AI topics, therefore, can be seen as enhancing general computer science knowledge.

It is also true that the AI course becomes more legitimate to our students if the applications investigated are extensions of computing problems students already know. Futuristic visions of C3PO-level capability are fun for a while, but our students would like to see something more immediately workable and valuable. And of course this is possible, because there is a rich world of AI-implementation that can be observed. A good example is the issue of natural language interfaces for data bases. Most students have been through the data base management systems course, and have worked with structured query languages. They therefore can see the value of being able to query a data base with natural language utterances; they see how this would enhance the use of the database and extend the user population. The stage is therefore set for a deep-level investigation into problems of computational linguistics, including problems of pragmatics and knowledge representation.

In addition to these "concessions" made because of the perceived student body, it is important not to overlook the potential graduate students who are, indeed, in the crowd. With this small group of students the motivation should be built in, because artificial intelligence is one of the major areas that excites the imaginations of the masters student and the potential PhD. A corollary to the implications of the presence of this small group is the fact that students are often motivated simply by the intellectual content of the subject. Many of the students simply like the course, and do not worry about where it fits in.

"The Revised Model Curriculum for a Liberal Arts Degree in Computer Science" mentioned above notes that AI is "typically viewed by students" as one of the "fun courses," and this source of motivation, valid for all students, has particular application to small college liberal arts students, who are encouraged to think about their place, and their major's place, in the world. I tend to think of our technologically oriented CS majors as removed from the mainstream concerns of the other students majoring in mass communications, English, etc., but occasionally I get a surprise. When we started

the computational linguistics component of the AI course this past semester, for example, I had everyone make use of some text-generating Lisp code available over the Internet. The code picks up a base text provided by the user, creates a "knowledge base" of words and some structures, and then generates a new list of words based on grouping from the original, some randomness, etc. The assignment was to pick up a text from the Internet, Edgar Allen Poe's Raven, for example, and to create a new "poem" from the original. Analysis of what the code is doing was included in the assignment, along with some speculations about what the code was not doing, in terms of syntax, context, understanding, etc. I thought this would get us off the ground with the issues of language, but I was a bit concerned that the subject matter of the assignment was a bit too "literary" for the CS majors. This turned out to be an unnecessary worry. They all found it to be quite provocative; indeed, some of the CS majors turned out to be back-burner poets, and they used their own poems as the original texts.

In various ways, therefore, the small college student body does not constitute an insurmountable problem for the development of artificial intelligence as a course subject matter.

The Equipment Crisis

At Franklin Pierce we have mainly a DOS/Windows environment. Three labs have Pentium-based PCs linked by Novell NetWare, which provides support to the Internet via a local non-profit provider. These open labs are used by anyone on campus, and in most cases the activity on the machines consists of games and word processing. We also have one Mac lab, used mostly by the graphic arts people. Our Unix environment is limited. We certainly have no equipment or labs devoted to research in artificial intelligence.

However, while this environment must be judged as limited by research institution standards, and while its limitations do prevent delving into the more sophisticated areas of AI activity, it does provide a workable environment for most introductory projects. Search, reasoning, logic, computational linguistics, and some vision work are all possible with a simple Lisp. Computational linguistics projects, for example, while not as glamorous as those I remember from graduate school, can involve meaningful work with parsers and some implementation of semantic and pragmatic analysis. I use Allegro Lisp, which is a freeware download from the Franz Inc. site.

Where we fall short most seriously is in computer vision. We do not have the capability of accessing the bit configurations of individual pixels, much less anything more advanced. But I have developed a small, makeshift project in edge detection that allows us to get a feel for that "primal sketch" processing.

For an actual image, whose individual pixels we would access and manipulate, I substitute a simple text file, using 0 to 9 as a substitute for the pixel values. Students access this text file as a two-dimensional array, and they then proceed to do a neighborhood analysis to produce edges. This is a bit hokey, but it works.

Interestingly enough, students do not see any shortcoming here, and they find the exercise to be quite stimulating. I explain the limits of what we will be doing, and I paint a picture of the larger world of "real" vision processing, but the response I receive is that I am bringing up an

unnecessary issue. Most students understand the appropriateness of model building and working in scaled-down environments, more than I expected, it seems.

Faculty time and preparedness

It should be clear that I regard small college AI as a worthy enterprise, and that I regard most shortcomings as surmountable. However, I cannot be as optimistic in the area of time and general atmosphere for faculty to do this. Not that we don't work hard, and are not committed. But small colleges do not provide the time for the development of expertise that is necessary to do an outstanding job in the more advanced fields. The load of courses, core curriculum obligations, advising, committees, general college activities, works against expertise in specialized fields. I suspect that this might be especially true in technology, where demands are very great, and where the terrain keeps shifting. And I hope I have suggested here that the limits placed on this subject matter demand even more creativity, in finding ways to master the hurdles.

Of the various challenges associated with small college AI, the path is least clear here. Part of the answer is a unilateral commitment to the subject matter, devoid of the resources and awards that might normally accrue. Part of the answer also lies in a stronger campaign to persuade the college administration of the importance of what we do.

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