AN INTERDISCIPLINARY COURSE ON ARTIFICIAL INTELLIGENCE DESIGNED FOR A LIBERAL ARTS CURRICULUM*

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ABSTRACT

This article introduces a course the author recently designed; and which was first taught in Fall 2006. The course provides an introduction to the field of artificial intelligence (AI) focused at non-majors as part of a liberal arts curriculum. The course provides an overview of the foundational science and philosophy at the heart of AI from an interdisciplinary perspective. The course largely focuses on the diverse applications to many fields of endeavor, and the impact AI is beginning to have on areas of society as well as the potential future impact. The course draws together topics from diverse fields including computer science, philosophy, psychology, game theory, among others. One of the goals of the course is to engage students from disciplines outside the computing sciences, while drawing on the strengths of their individual backgrounds. A secondary objective is to raise awareness among students outside of the computing sciences that there is more to computer science than programming and mathematics (e.g., that some CS topics are highly interdisciplinary). A key teaching element of this course is that of utilizing prior knowledge for discussion context.

INTRODUCTION

In Spring 2006, the author began the design of a course, "Artificial Intelligence in Society", meant to introduce what the field of artificial intelligence (AI) is really all about to an interdisciplinary mix of students. The author is a member of the computer science

faculty at the Richard Stockton College of New Jersey, a primarily undergraduate liberal arts institution. The course, "AI in Society," is designed not for computer science majors, but rather it has been designed as an elective available to students of all majors as part of the liberal arts curriculum.

Stockton College has a unique approach to the liberal arts curriculum. In addition to teaching courses in their own disciplinary programs, all faculty design and teach courses within the General Studies program. These courses are organized into five categories: (1) General Interdisciplinary Skills; (2) General Arts and Humanities; (3) General Natural Science and Math (GNM); (4) General Social Science; and (5) General Integration and Synthesis. The courses in these categories are not designed for any particular major and are open to all students. They are distinct from courses offered within traditional disciplinary programs. Some are "non-major" versions of "major" courses; while others are unique in topic to Stockton's General Studies program (e.g., there are GNM courses on "Sports and Math", "The Mathematics of Gambling", "The Physics of Music"). The course presented in this article, "AI in Society", is offered as a GNM. Students from all majors are required to take at least 8 General Studies courses, including at least two from the GNM category.

The objectives of the "AI in Society" course are four-fold. The first is to introduce the field of AI as an interdisciplinary science to a diverse student audience for which the concept of AI may seem more like science fiction than true science. Secondly, the course engages students from academic disciplines at the foundation of AI who typically are not exposed to this relatively new but important field of study. Third, elements of the course encourage students to see the potential applications of AI within their own fields. Finally, the course builds awareness of some of what computer science is all about for those who may not have an accurate perception. Due to the latter, students who have not declared a major are exposed to exciting examples of computer science innovations, potentially sparking an interest in our field.

The course covers topics from the fields at the foundation of AI, as well as those closely related to AI. Topics are presented from philosophy (e.g., philosophy of mind [15], logic, and rationality), psychology (e.g., nature of intelligence), economics (game theory), a very gentle overview of elementary cognitive neuroscience; while tying it all together under the theme of designing machines capable of intelligent behavior.

The course uses several media to introduce topics. For example, the students are assigned readings of articles of the pioneering scientists and philosophers (e.g., [11], [14], [16], [18], [20]), as well as readings from the popular science literature (e.g., [4], [8]), with the latter being a bit more accessible to the non-major student with minimal mathematics and science background. Hollywood's portrayal of AI is also very useful. Specific films that are used in this course include Kubrick's "2001: A Space Odyssey" [9], its sequel "2010" [7], the recent Spielberg film "AI" [17], and the 1980s film "WarGames" [3]. The last of these, "WarGames," offers useful contrast to the others in that it is not a futuristic science-fiction story. Additionally, freely available video presentations of recent scientific work have been used (e.g., Google TechTalks such as [10],[19]), as well as videos available on the Internet for DARPA's Grand Challenge [6] and examples of multi-robot interaction such as RoboCup [12]. The author also conducts live classroom demonstrations of mobile robots used in his research. Students participate in weekly group discussion of AI technology publicized in the news. Specifically, AAAI's "AI in the News" webpage [1],

which keeps track of dozens of news sources for AI related articles, is among the required readings of the course. Table 1 provides a sampling of some of the topics discussed in the class, along with some of the required readings and/or videos used to cover the topics.

Table 1: Sampling of Topics and Required Readings and Videos for the Course

Topic	**Readings / Videos**
Turing and AI	[18]
Philosophy of Mind	[16]
Human-like Problem Solving	[11]
Collective Problem Solving	[4][19]
Evolving Intelligence	[8]
Natural Language Communication	[20][2]
Rationality	[14]
Present Day Applications of AI	[1][6][12],etc
Fictional AI	[3][7][9][17]

PRIOR KNOWLEDGE

The challenge in designing the course was to find ways to introduce students with wide-ranging academic and cultural backgrounds to a highly interdisciplinary field while making minimal assumptions about commonly shared background. In fact, the course itself has no pre-requisites. It is a sophomore-level course, although students enrolled spanned all academic years. The two largest groups were sophomores (37.5%) and juniors (37.5%). The next largest group was freshmen (22%) and the remaining 3% of the class were seniors.

To facilitate teaching topics from the foundational disciplines of AI without making assumptions of common student background, interactive group exercises were designed that brought students together through their "prior knowledge" [13].

For example, on the first day of class, after a brief overview of the course, the class was divided into groups of 4-5 students each. They were told that before we can truly begin discussing AI that we should begin with what intelligence itself is. The groups were given a set of questions to discuss and formulate answers to. First, they were to formulate a definition of "intelligence". Then, they were to list any creatures other than humans that they believe possess intelligence; or if intelligence is reserved only for humans, what innate characteristics make it so. Additional questions dealt with properties or abilities the students believe necessary for something to be intelligent. The purpose of the exercise was to unearth what the students believe "intelligence" is, and to discover any biases they may have against the notion of an artificially intelligent entity. Afterwards, the entire class discussed their answers.

The result of this exercise was an extremely lively discussion about the nature of intelligence. It also, unexpectedly, provided a very useful springboard for several topics discussed later in the course. For example, the small groups produced a rather diverse set of definitions and characteristics of intelligence. These definitions included aspects ranging from notions of rationality, knowledge, memory, the ability to learn, the ability to reason with common sense, etc. All of these became topics for discussion at later class sessions.

In many of these cases, similar "prior knowledge" exercises were used to draw out what students already knew of topics.

INTERDISCIPLINARY TOPICS

The course covers a broad range of topics from fields including philosophy, psychology, computer science, and economics, among others, using AI to draw everything together. The first topic discussed after the prior knowledge exercise on intelligence is the Turing Test for machine intelligence [18]. The students read Turing's original article on the subject and discuss the relevance of the proposed test. As a hands-on activity, the students interact with a version of Weizenbaum's ELIZA program [20], as well as a more modern ELIZA-like program, the Alice ChatBot [2].

Next, several topics from the philosophy of mind [15] are discussed at length. For example, Searle's notions of Strong AI and Weak AI are discussed [16]. Strong AI is the notion that the human mind is little more than a computational device, the implication of which is that computers can in principle be programmed to truly think. Strong AI embodies self-awareness and sentience. Weak AI on the other hand does not concern itself with whether it is possible for machines to truly think, but instead focuses on the design of machines that can act intelligently. Searle's Chinese Room problem is discussed along with his argument against the possibility of Strong AI.

The connection between rationality and intelligence [14] is discussed in the course. Several students in the class, during the discussion of intelligence indicated rationality as a key ingredient to what they view as intelligence. This opens the course to the introduction of elements of logical reasoning. When linking this to the notion of common sense knowledge, the challenges associated with ensuring a logically consistent knowledge base can be discussed. For example, Lenat indicates that the Cyc project has long given up trying to ensure a globally consistent knowledge-base in their effort to represent the whole of human common-sense in a logical form; instead focusing on representing "locally" consistent common sense knowledge [10]. This is tied together using fictional AI characters to make the theory more concrete for students with limited mathematics background. For example, HAL's seemingly irrational behavior in "2001: A Space Odyssey" [9] is explained in its sequel [7] by HAL's creator as due to a knowledge-base inconsistency (i.e., logically inconsistent instructions). Thus, HAL's behavior is actually quite rational in a logical reasoning sense, given that an inconsistent knowledge base entails any sentence.

Other topics of intelligence are introduced. For example, significant time is spent on the notion of collective intelligence (i.e., the notion that intelligence can be attributed to a collection of interacting entities). For example, the topic of swarm intelligence is presented, the growing field focused around the design of intelligent problem solving tools inspired by models of the relatively simple behavior of insect societies and other simple creatures [4]. This topic introduces students to some of the basic biological processes associated with the interaction patterns of colonies of wasps, bees, ants, and so forth, along with the basic computational elements and models. Of particular interest to the students in the class is a human collective problem-solving example. Specifically, von Ahn's work on "human computation" [19] is presented to the class, where he has been exploring how to utilize unused human brain cycles for problem solving by designing online games with an underlying problem solving purpose (e.g., his ESP game used to automatically label images with keywords). This topic engages student's interest with the idea that humans can be a

component of a larger intelligent system. More importantly, it offers an example of the concept of collective intelligence that goes beyond social insect models.

Other topics that are discussed include models of human problem solving [11], evolutionary models of problem solving [8], among others.

CATALOG DESCRIPTION OF COURSE

Writing a catalog description, within the usual tight limits, for such an interdisciplinary course to attract students with a diverse background is challenging. How does one adequately describe the diverse topics and applications, importance to other disciplines, etc in 80 words? The Stockton College catalog describes it with:

> "This course provides a broad overview and introduction to the field of artificial intelligence (AI) focusing on the impacts it has made on society during the past 50 years. Applications of AI are diverse ranging from manufacturing, medicine, finance, homeland security, and beyond. We will discuss articles by the pioneering scientists and philosophers who defined the field; film portrayals of AI; documentaries exploring applications and ethical issues; and current impacts highlighted in news of today."

The terse description draws students in whose curiosity in minute details in the description entice them to enroll. For example, on the first day of class, the students completed a survey related to their background (e.g., majors). The survey included questions concerning why they are taking the course. Other than a few answers along the lines of "the time fit my schedule", the majority cited specific reasons some even referring to phrases from the short course description. For example, more than a few were interested in connections to homeland security. Two students, one a philosophy minor, were interested in the ethical issues of AI. The philosophy minor eventually became interested in topics of the philosophy of mind. There are several other examples of little things that students noticed and which drew them in. One student provided a rather "interesting" (for lack of a better word) response, stating that he thought the course was going to be about extraterrestrial life. The author of this article has not figured out what in the course description could have given that impression.

DIVERSITY OF MAJORS OF STUDENTS TAKING COURSE

Fall 2006 was the first time the course was offered. The enrollment cap was 30 with two additional students allowed in for a total enrollment of 32. The students enrolled represented 11 different majors. Additionally, three students have not declared a major. Figure 1 shows the distribution of majors enrolled in the course.

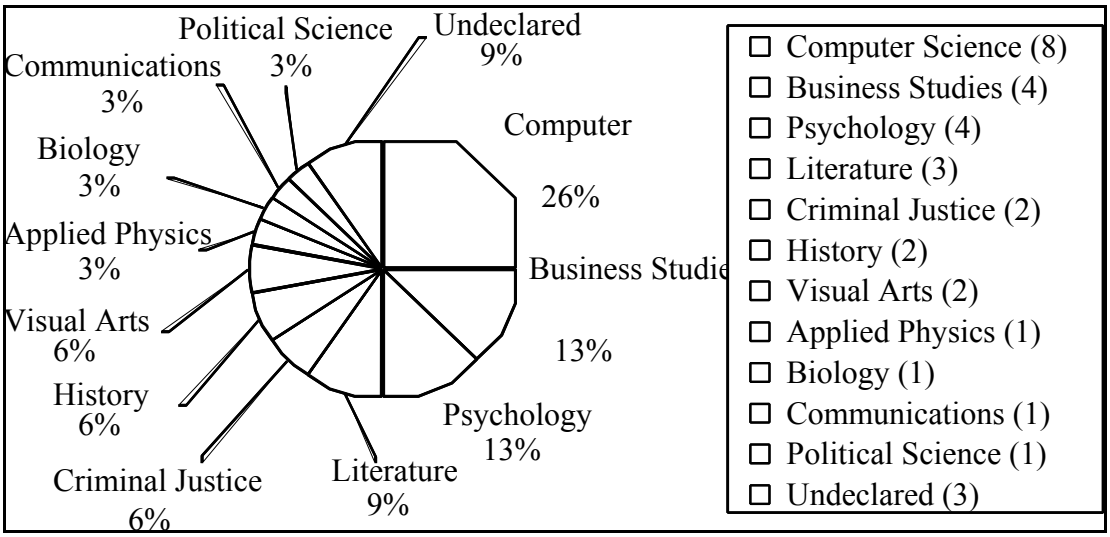

Figure 1: Distribution of majors of students enrolled in "AI in Society"

The largest group was eight computer science majors. Although the course is designed specifically for non-majors, it is open to all majors including computer science. The computer science majors enrolled in the course were naturally attracted to a course that may have appeared as a way of fulfilling a liberal arts requirement through what may have appeared to be a "computer science" course.

The next two largest groups were Psychology and Business, making up 12.5% each. Business Studies is the largest major at Stockton College; thus, the rather large group of students in this diverse course. The psychology students were naturally drawn to the course due to potential connections with cognitive science.

The next largest group (3 students), interestingly, was a group of Literature majors, making up 9% of the enrollment. They appear drawn by the potential literary elements of the course. For example, the course description specifically speaks of exploring the science of AI through the eyes of Hollywood by viewing and discussing films. These students have had some particularly interesting insights into the meaning of some of the theatrical elements of films that we have discussed.

Another 9% of the class was comprised of students who have not yet declared a major. These students are potential new recruits to the computing sciences, at a time when computer science enrollments are continuing to decline despite the very promising job outlook for computer science graduates [5].

Other majors enrolled include criminal justice, visual arts, and history (6% each), and physics, biology, communications, and political science (3% each).

CONCLUSIONS

This article has presented the design of a course for non-majors introducing the foundational elements of the field of AI. This course is an elective in the liberal arts curriculum at a liberal arts college. It is part computer science course, part psychology course, part philosophy course, and several smaller parts from other academic disciplines. In its first offering, it attracted students from 11 academic disciplines as well as a few

"undecided" majors, an interdisciplinary course for an interdisciplinary mix of students. Its general theme, however, is truly a topic of computer science, and thus can be useful in the promotion of the field beyond the usual disciplinary borders.

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