Improving CS Student Retention with Intelligent Agents

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Abstract

In recent years, many Computer Science undergraduate programs have had to address declining enrollment. While the reasons behind the decline are complex: the dot-com bubble burst, the way we train students, the lack of intellectual excitement, and so on, educators are creatively trying to broaden students' interests in computing. In this paper, we present our plan to use some AI concepts, especially the concept of intelligent agents to initiate students' interests in AI, and more general, in Computer Science.

Introduction

To address the declining enrollment of computer science students in recent year, educators have put significant efforts in: developing new courses (such as game programming), introducing new media into the classroom (such as robots), teaching traditional CS courses in new ways, and participating in outreach programs to high school students. Our goal is not just to increase the number of CS students, but also to adapt our CS program based on the market's needs while simultaneously still teaching the fundamentals of computing and providing students the opportunities to be exposed to a wide variety of subjects. Accordingly, the effective incorporation of these new methods and techniques needs to occur at a number of different levels. According to the Cal Poly Pomona fact book in (Fact 2003), the majority of students dropping out occurs early when students are taking lower division introductory courses. Consequently, there is a great motivation to start the recovery process as early as possible.

Artificial Intelligence (AI) has been a strength in our department for years. It is one of the senior-level core courses that students need to take near the end of their undergraduate study. However, many students enroll in the course thinking that AI is what they have read in science fiction books and movies. In fact, if AI were not a required course, students may not pay too much attention to it. It is important to point out that once students are exposed to AI, most of them find the topics challenging yet interesting – for some, an experience they have never had before in a programming course. Thus, there is also the motivation to use the rich set of interesting AI topics to grab students' attention.

Although general AI topics may be too profound to be introduced in the lower-division courses, we can create a track of courses that gradually introduces AI concepts (simulated, or physical agents, are ideal platforms that map abstract theories into concrete applications). Since winter 2007, we have been studying robotic platforms, making improvements to our existing courses, and proposing new courses to establish a better learning environment for our students. The rest of this paper describes our plans.

Learning AI Step by Step

Introduction to Computer Science

Many students who take the first in a sequence of four programming courses in the CS major at Cal Poly have little or no prior programming experience and/or are poorly prepared in mathematics; consequently, they are at-risk of being unsuccessful in their first CS course. Our goal is for students to not only survive their first CS course but come away with an understanding of key algorithms and constructs. Carnegie Mellon University developed a novel tool, called Alice, to address retention levels of at-risk students. Alice is a free 3D interactive animation environment which utilizes a drag-and-drop direct manipulation environment allowing students to focus on problem-solving in their programs without being overwhelmed with programming language syntax and constructs. Since Alice has been available for several years, hundreds of 3D models have been developed for students to experiment with (these models are also free). We believe Alice is an ideal tool to introduce the concept of an Intelligent Agent to students with no background in AI. We will offer our Introduction to Computer Science (CS 140) course in winter 2008 utilizing Alice. Several projects will be assigned that will require students to assemble 3D virtual worlds with objects that will perceive, act, and react to other objects in the environment. Students will program the behavior of the each object thereby becoming familiar with basic AI concepts. We anticipate that this approach will improve student participation, encourage problem-solving, and will build expertise and confidence.

Introduction to Robotics

With completion of the Introduction to Computer Science course described above, students would have obtained a cur-

sory understanding of intelligent agents - a software agent that can perceive its environment and act and react somewhat rationally while trying to arrive at a goal state. The next step is to provide a platform from which students can further explore how to make an agent act rationally in its environment. We have proposed the creation of an introductory robotics course for undergraduates called, Introduction to Robotics. The major reason to have an introductory course rather than an advanced course is to attract students' attention in the early stage. We plan to cover topics such as robot behavior, sensing, robot control architectures, navigation and path planning. Some basic AI techniques will also be introduced such as hill climbing and simulated annealing. Each topic will be coupled with an individual or group project that reinforces the theoretical lessons learned. The possible projects include robot navigation, obstacle avoidance, line following, wall following and foraging. Upon the completion of this course, students are expected to acquire the knowledge for building intelligent agents that can accomplish simple tasks. They are also exposed to some useful AI techniques and experience the difficulties when linking theories with real-world applications. This experience better prepares students for future study while motivating them through the study of AI.

Prior work such as (Dodds *et al.* 2006) have shown the advantages of introducing physical robots in the classroom to enhance students' hands-on experience and motivate them for pursuing advanced education in AI and robotics. Another important aspect is that physical robots can help create cooperative learning environments; where students can sit together and work on problems in the lab instead of doing it all by their own because of the commute culture on our campus and the nature of programming. Additionally, learning and knowledge sharing can be greatly enhanced through student group projects. In summer 2007, we tested two robotic platforms (both cost about the same): Lego Mindstorm NXT and iRobot Create. The NXT robot better suits the needs of our proposed introductory course because of its versatile sensors, fast integration, Java programming support (such as LeJos). Two senior-level students have tested NXT's sensing capabilities and accomplished a simple wall-following task as an independent study. The students discovered that seemingly perfect theoretical solutions may not work well in a real world situation with the noisy sensing data and uncertainties – a new experience for them.

Artificial Intelligence

AI is a very broad field and can be applied to many different areas. We plan to use intelligent agents to introduce AI in our senior-level course, Artificial Intelligence (CS 420). For a regular 11-week quarter, we can select 3 to 4 topics from problem solving, planning, robotics, reasoning and learning. Traditionally, the AI project assignments have a lot to do with toy problems, like 8-puzzle and n-queen. We can design more practical projects if students have good knowledge in robotics. Examples of projects include: using A* to find the optimal path in a topological map; using local search for robot navigation in an environment with dense obstacles; task allocation with constraints; path planning; and using reinforcement learning for a robot to accomplish simple tasks. The purpose of using robots here is to help students easily see the effects of these AI techniques and be able to apply them to future problems.

With the fundamental concepts obtained in the two courses mentioned above, students will be at a better starting point to successfully take CS 420. Although many of the projects are robot based, we do not expect the students to spend too much time on robot configuration, which would deviate too far from our goal of passing on AI concepts and theories. We use Player/Stage (Gerkey, Vaughan, & Howard 2003) for most of the projects. A lab session will be dedicated for understanding the basic Player/Stage API and its configuration. Another possible installation of Player/Stage for Windows OS is to use RoboDeb (Jacobsen & Jadud 2007). We have tested both configurations with Java and C++ work. We are aware of the tradeoffs between physical robots and simulated robots as shown in (Blank *et al.* 2006; Veloso *et al.* 2006). We believe that using simulated robots has the advantages of shorter programming cycle, versatile applications, easy maintenance, less budget for an AI course. We have started to incorporate these new changes into CS 420 in Fall 2007 and will thoroughly evaluate the results using questionnaires at the end of the term.

Summary and Future Work

We have presented our plan to use the concept of intelligent agents in a series of courses to motivate students' interests in AI and Computer Science. We look forward to seeing the feedbacks from students and exploring more effective ways to engage students in learning.

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