Can Computers Think? – an Introduction to Computer Science, Programming, and Artificial Intelligence
Position Paper

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Our Position

We believe that interdisciplinary connections have to be integrated into introductory computer science courses in order to spark interest in computer science among a diverse group of undergraduate students. We also believe that AI can serve this function and have developed an introductory computer science course with a focus on AI, which we are currently (January 2008) teaching for the first time. This paper describes the course and we will report on our experiences with it at the symposium in March.

Context

This course is being developed in the context of a general restructuring of the computer science introductory sequence at Union College. Instead of a single introductory class that all majors go through, we will offer a collection of introductory classes each focusing on a different theme. Other themes, in addition to the AI theme, include robotics, media computation, game design, and scientific computing. All of these classes lead into a common course on data structures.

This restructuring stems from the belief that today computing is an inherently interdisciplinary field. Computing issues are relevant in almost all areas of study and advances in computing are often driven by applications and needs in other fields. We hope to convey this to the students through these themed courses and to interest students who would not necessarily take a pure CS course.

The students in the AI themed course will come from a variety of backgrounds. In addition to CS majors, neuroscience students will take this course to fulfill a computing requirement for their major and students from other majors will take this course to fulfill a general education requirement. The goal is that some of the students in the two latter groups continue studying computer science potentially leading to a minor, interdepartmental major or double major.

Description of the Planned Course

The course is an introduction to computer science and programming that uses artificial intelligence as an overarching theme. On the one hand, it will introduce students to algorithms, basic data structures, and programming techniques. On the other hand, it will discuss questions in the philosophy of artificial intelligence and introduce some basic methods from artificial intelligence (search, game playing, machine learning). The course website is at http://cs.union.edu/~striegnk/courses/cancomputersthink.

Our goals for this course include those common for introductory computer science courses: The students will be introduced to algorithmic problem solving, they will learn how to express algorithms in a specific programming language (Python), and they will get a basic understanding of how programs execute on a computer, how data is stored on a computer and how programming languages and computer processors interact.

In addition, we want students to understand that computer science is more than programming and that it is related to topics they are interested in (such as "cognitive abilities", "the human brain", "robots", or "science fiction").

Finally, the students will be introduced to the field of AI. While we are not able to present a comprehensive overview of the field or its methods, the students will be able to define AI and to identify AI solutions. They will also be aware of philosophical and ethical issues related to AI.

The first block of the course (approximately three weeks) will consist of two main strands. One strand will cover the fundamentals of computing. We will discuss algorithms, the role of programming languages in implementing algorithms, how computers run such implementations, and the students will learn the basics of Python (simple built-in datatypes and operations, variables, functions, simple control structures, and string manipulation).

In parallel to this, the students will do readings and we will have class discussions on artificial intelligence. The goal of these discussions will be to come up with a definition (or a set of definitions) of artificial intelligence. To this end, we will track some of the debate on whether machines can think, look at the history of AI, and discuss the different flavors of AI that have been and are being pursued.

While these two strands will run in parallel we feel that it is important to build as many bridges as possible between the two parts to show students that both of them are part of computer science. For example, in the first class the students will play with an ELIZA implementation. On the one hand, this will be the starter for the discussion on what is AI (Is ELIZA intelligent? If not, why not? What's missing?). On

the other hand, this exercise will lead into a module on algorithms (How do you think ELIZA works? Can you see patterns/rules that it is following?). As a follow up exercise, students will then experiment with a telephone based dialogue system, will find a high-level specification of the system's algorithm and will discuss whether or not this system is intelligent. Similarly, the module on computers architecture provides a basis for the discussion on whether symbol manipulating systems can be intelligent.

In the second block of the course, we will present a selection of AI topics in more detail and will do hands-on programming exercises around them. The selection is mostly determined by what is possible given the time and the introductory nature of the course and by the need to cover further computing topics. Specifically, we are planning to cover the following AI topics:

- the concept of rational agents; the students will do hands-on exercises with a simple stimulus-response agent
- the idea of machine learning, in particular, naive Bayesian learning for text classification tasks and neural nets for learning to control a stimulus-response agent
- artificial life; the students will work with implementations of Conway's game of life and boids
- (adversarial) search for a simple game playing agent

The computing concepts which will be introduced as part of these modules include complex datatypes (lists, tuples, dictionaries) and control structure for traversing them, recursion, file I/O, software design, modularity and reusability of code, and testing and documentation.

Throughout the whole course we will show and briefly explain lots of existing AI systems. We want the students to appreciate the wide range of research in AI and we want them to at least be aware of and develop a rough understanding of topics and problems we cannot cover in more detail in class. These presentations of AI systems will also be accompanied by discussions on ethical issues surrounding AI.

Planning Challenges

While preparing this course, we came across a number of issues that have been hard to resolve satisfactorily. For instance, it is hard to find appropriate educational material. The existing AI textbooks we have looked at are either too superficial for our taste or too advanced for our students. Therefore, we will not use a textbook, but provide papers and excerpts from various sources as needed.

We contemplated using a software package, such as the Pyro (http://www.pyrorobotics.org) or Breve (http://www.spiderland.org) packages, for the practical labs. This would allow our students to write more interesting and AI related programs more quickly. However, in our experience it is often hard for absolute beginners to clearly distinguish between what is provided by the programming language, what is provided by the development environment and what comes from any additional packages used. Therefore, we decided to not use a software package, but we will provide some modules during the second part of the course after the students have been introduced to the basics of programming.

We struggled with making the second part of the course coherent. We will use the intelligent agent story line as a motivation (Nilsson 1998; Russell & Norvig 2003). However, because of time constraints and the introductory level of the course, we can only look at a few topics in more detail. This implies the danger that the students come away with a very skewed picture of the field. We will try to mitigate this problem by including a greater variety of topics in our discussions of existing AI applications.

Similar Courses

In preparing this AI course, we collected ideas from a variety of existing courses with similar goals, topics and target audiences. We benefited from efforts to design AI courses that can be taught early in the computer science curriculum. For example, Lee Spector and John Klein at Hampshire College use the simulation environment Breve (Klein 2002) to introduce students to AI. The only prerequisite they require is one programming course. Merzbacher (2001) describes an AI course that accommodates CS majors as well as non-majors by almost completely eliminating practical exercises that require programming skills. While looking at the material and structure of these courses was helpful for us, the goal of our course is different: our main objective is to introduce the students to programming and computer science.

A number of courses use robotics to introduce students to computer science; see, for example, the introductory CS courses at Bryn Mawr College and MIT, or Union College's "Robots Rule!", which is another one in our collection of introductory CS courses. The AI course described in this paper covers a different selection of topics, which we believe to better fit the interests of neuroscience students (who are part of our target audience) and which may appeal to other students than those attracted by the robotics based course.

Outlook

We are currently teaching the course described in this paper for the first time. Even though the class is relatively small, we hope that we can use our experience and the feedback from the students to evaluate and improve the course. We are planning to conduct several surveys during the term to assess the course's content, structure, and presentation. We will present the results of this evaluation at the symposium.

References

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