Support of Online Learning through Intelligent Programs

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INTRODUCTION

Distance learning through the Internet is changing educational paradigms. Learning approaches, teaching methods, students' expectations with instructional activities, and financial expectations are issues that challenge professionals and educational institutions (O´Donoghue, Singh & Dorward, 2001; Parikh & Verma, 2002). The growing availability of Internet access at working places and residences, in addition to a global market where education is a competitive advantage, are reasons for keeping the growth of investments in information technology for distance education. The distance education commercial arena currently involves universities, governments, and general educational institutions. Individuals and companies keep investing in educational programs for professional qualification, or even for keeping employees up to date with new technologies and market opportunities.

The Internet can offer the learning process a variety of benefits (Fuks, Gerosa & Lucena, 2002), and there are several aspects pointing to the advantages of Internet education for individuals and enterprise (Hasebrook, 1999). Wilson (2002) argues that distance learning integrates technology, connectivity, curricular content, and human resources. According to Eastmond (1998), distance education is becoming widely accepted as means for higher education to provide broader access and achieve cost efficiencies while maintaining quality programs, while the overwhelming reason cited by students is convenience (Guernsey, 1998).

However, there are also barriers to online instruction (Meyen & Yang, 2003). Barriers related to the technical aspects of online instruction may have changed, while some related to attitudes, policies, and resources may still persist. Cravotta (2003) argues that the story of distance learning is not that it can do everything or that it is problem free. In reality, it brings a new set of problems to the learning table. However, it enables us to do much more than we could before. Students also identified the lack of face-to-face interaction as a drawback to the online environment, as reported by Sullivan (2001).

The number of research projects and publications reporting experiences with distance learning and education has also been growing. It is an interdisciplinary matter coping with investigation in areas such as information technology, telecommunications for exchanging data, educational approaches, instructional techniques, and learning preferences. In this contribution, the focus is on the relationship between online learning and artificial intelligence (AI) methods and techniques. We review some of the related literature and report on our own experience in this context.

BACKGROUND

Origins of Intelligence

Since the beginning of recorded history, people have been fascinated with the idea of non-human, artificially intelligent embodied creatures acting as assistants. People have, for example, often embraced the romantic dream of robots as butlers who would someday putter about the living room performing mundane household tasks. Though automata of various sorts have existed for centuries, it is only with the development of computers, control theory, and AI since the 1950s that anything resembling autonomous assistants/agents has begun to appear.

Alan Turing, famous for his work on computability (Turing, 1937), posed the question: "Can machines think?" (Turing, 1950, p. 433). His test, where a person communicates via a teletype with either a person or a computer, became known as the Turing test. The Turing test requires a conversational computer to be capable of fooling a human at the other end. It is the Turing test that inspired the birth of the AI community in the 1950s. At that time, and after some work with

neural networks (deemed a failure at the time due to the difficulty of learning weights), AI researchers were focusing on symbolic search-based systems and on exploring heuristic search to prove logic theorems. Initial successes thus led to heuristic search of symbolic representations becoming the dominant approach to AI. The 1960s saw much progress. LISP (McCarthy, 1960) was just invented, and the course was set for representing the world with symbols and using logic to solve problems (McCarthy & Hayes, 1969). At the same time, the General Problem Solver (Newell, Shaw & Simon,1959), which given a suitable representation could solve any problem, was created. Problems solved were in simple, noise- and error-free symbolic worlds, with the assumption that such solutions would generalize to allow larger, real-world problems to be tackled. Researchers did not worry about keeping computation on a human time-scale, using the increases in hardware performance to constantly increase the possible search space size, thus solving increasingly impressive problems.

During the 1970s, search became well understood (Nilsson, 1971). Symbolic systems still dominated, with continuing hardware improvements allowing steady, successful progress. Robots were created (Nilsson, 1984) which lived in special block worlds, and could navigate around and stack blocks sensibly. Such simplified worlds avoided the complexity of real-world problems. The assumption underpinning all the symbolic research, that simple symbolic worlds would generalize to the real world, was about to be found wanting. In the 1980s expert systems were created to try to solve real problems. It has been realized that "common sense" (McCarthy, 1983) was required in addition to specialized domain knowledge to solve anything but simple micro-world problems. A sub-field of AI, knowledge representation came into being to examine approaches to representing the everyday world. Unfortunately, the idea of "common sense" proved impossible to represent, and knowledge-based systems were widely viewed to have failed to solve real-world problems. At the same time, the back-propagation algorithm (Rumelhart, Hilton & Williams, 1986) caused a resurgence of interest in connectionist approaches, previously deemed a failure.

The late 1980s and early 1990s saw the decline of search-based symbolic approaches. Researchers focused on the creation of embodied, grounded systems using the "world as its own best model" (Brooks, 1991, p. 583). This had some initial successes; however, it too failed to scale up to real-world problems of significant complexity. Connectionist approaches were aided by new parallel hardware in the early 1990s, but the complexity of a parallel architecture led such systems to fail in the marketplace.

Towards the end of the 1990s, knowledge engineering, widely seen as costly and hard to re-use, was superseded by machine learning techniques. Pattern-learning algorithms (Mitchell, 1997) could classify suitable domains of knowledge with as much accuracy as manual classification. Hybrids of traditional and embodied AI started to appear as new approaches. The dream of indirect human computer interaction (Kay, 1990; Negroponte, 1970), coupled with early ideas on intelligence (Minsky, 1986), led to the new field of agent-based computing. Experiments with interface agents that learned about their user (Maes, 1994) and multi-agent systems where simple agents interact to achieve their goals (Wooldridge & Jennings, 1995) dominated the research. Such agent systems were all grounded in the real world, using proven AI techniques to achieve concrete results.

The gauntlet thrown down by early researchers has been variously taken up by new ones in distributed AI, robotics, artificial life, distributed object computing, human-computer interaction, intelligent and adaptive interfaces, intelligent search and filtering, information retrieval, knowledge acquisition, end-user programming, programming-by-demonstration, e-commerce, e-learning, and a growing list of other fields.

E-Learning

E-learning is a valuable extension of the distance education paraphernalia, enabled by the new information and communication technologies. Distance education normally occurs in a different place from teaching and as a result requires special techniques of course design, special instructional techniques, special methods of communication, as well as special organizational and administrative arrangements (Moore, 1996). E-learning is often described as the use of network technology, namely the Internet, to design, deliver, select, administer, and extend learning.

Due to the flexibility provided to students and teachers, both in space and time, e-learning may be a source of great joy to its users and an important source of financial resources for many organizations.