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ABSTRACT

This paper begins with background on intelligent agents (software programs built to perform certain specific tasks for the user). A taxonomy that categorizes intelligent agents by the degree of intelligence embedded in the software is presented. Applications of today's intelligent agents are discussed, including specific examples of the following: (1) agents that watch, i.e., look for specific information or events; (2) agents that can learn from observing users' behavior; (3) agents that can retrieve, which are capable of searching for information in an intelligent fashion; (4) agents that can assist in specific tasks; (5) agents that can converse with the user; (6) agents that can collaborate, providing assistance in several areas related to collaboration; and (7) agents that can do comparison shopping. World Wide Web addresses for the agents described are listed. (AEF)

Using Intelligent Agents to Assist Educators

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Introduction

Now that information is both abundant, practically universally available, and inexpensive, what is the result of losing the "information float" time that has traditionally been available to educators? What happens when educators lose the time to read new information, digest new information, incorporate new information into lessons, and develop a new finished piece to present to students? Likewise, from the students point-of-view what happens when the amount of information that they are exposed to is escalating so rapidly they are overwhelmed?

-What happens to the teaching and learning processes when each of us has access to the databases of the world, when virtually (and perhaps literally) any piece of data on any subject is "out there" for the getting? Will we find this abundance of data availability truly a boon to learning?

-What happens when the Internet is available to everyone and "data" in almost any form is practically free for the asking and flows nonstop from any point to any point? Will educators and students be able to get the necessary and appropriate inputs for learning in a timely manner?

-What is our reaction when on-line services can get for us data on any topic at any time for minimal cost; when we can shop, explore, discover, and create new information on the fly? Will we be delighted that all of the information in the universe is now at our disposal? Or, will we soon find that we are overwhelmed with the quantity of information available, and that asking for data on a subject is likely to result in a "data dump" of unprecedented proportions?

-What if we are not able to sort, filter, collect and analyze the needed data in a timely manner? What if the amount of data (much of it unneeded and unwanted) buries us in an avalanche of minutia? What then? How will we deal with the age of "information superabundance"? What then?

Today educators, as much as anyone, are faced with the dilemma of dealing with what has become an information overload. Faced with this era of data abundance, what educators and students need are helpers or some sort of "intelligent assistance". However, it is might be possible to survive (perhaps even prosper) in the age of information hyperabundance with some help from "intelligent agents" (IA's). Already even these first generation IA's have to a degree developed the capability to find needed data in a timely manner; to sort through data and rearrange it into a more useable format; to know what is wanted and not wanted; to learn over time what is and isn't important to the user; to recognize when something relevant has arrived and inform those who need to know; to be vigilant and watch for needed information and deliver it just in time; even to coach students and to answer some of their questions.

The list of tasks that intelligent agents might someday (now?) perform is rather extensive. For example, IA's could navigate, browse, retrieve, sort, organize, filter, summarize, and store data. Further, IA's could monitor and alert when data change or arrive. They could schedule appointments and remind when the appointment arrives. They could guide, advise, teach, critique and explain in an intelligent tutor role. They could even solicit information and distribute information.

Background

Intelligent agents (a.k.a. software agents and/or knowbots) are, in simplest terms, software programs built to perform certain specific tasks for the user. According to Alan Kay, IA's had their origin in the late 1950's and have been on the rise over the last ten years.[1] Indeed, in their crudest form, they are simply macros or programs which automate steps in a software package. The earliest form of intelligent agents (although they weren't called such) were macros that the user developed for his or her own use. In programs such as Lotus 1-2-3, Excel, or Word Perfect, users could "program" steps or automate key strokes so that these steps would occur repeatedly when given the execution command (usually a certain key stroke). Certainly these early macros were not really "intelligent" in any sense of the word, but they did automate previously repetitive manual tasks, and appeared to be doing something clever when executed.

Later generations of these macro commands have appeared in the form of intelligent tutors or assistants. Again, many programs, such as the Microsoft Office products now have intelligent tutors (wizards) embedded in their systems to assist the user in performing tasks or in finding help. Just as the earlier macros automated keystrokes, these intelligent tutors or advisors in some cases automate sequences of keystrokes at a higher level. For example, in Excel, the "wizard" will actually build a graph for you. Simply define the range of data, and the wizard looks at the data, decides which of the various graph types is appropriate, and then develops the graph with very minimal input from the user. Not always is the wizard correct, but very often the correct type and form of graph is developed. This represents a distinct improvement from having to study how to build graphs, then actually perform the keystrokes to produce the graph. In reality, these improved versions of the earlier macros haven't any real intelligence either, but appear to be doing some intelligent work. Their contribution to managing data is sizeable, even though they are very crude in the programming behind them.

More recently, "intelligent agents" have begun to appear which represent a significant advance in capability. This new generation of software agents has a significantly improved ability to assist in

the data collection and data management functions. Combining elements from other fields (e.g., expert systems, neural networks, object-oriented technology, case-based reasoning, etc.) the latest generation of software agents moves closer to the ideal agent--one which can function more autonomously to assist the user. These latest incarnations of intelligent agents can retrieve information from sources, find information when directed to do so, alert when information has arrived, shop for the best prices for items, even learn what kind of information is needed. These agents can do everything from automatic routing of e-mail to gathering of stock quotations to building customized newspapers. Furthermore, this latest generation represents only the beginning. Future editions of intelligent agent software promise to become still more autonomous in their operation, perhaps even learning from the user.

Intelligent Agent Taxonomy

Intelligent agent software can be categorized in various ways, for example, by the degree of "intelligence" embedded in the software, by the mission/task performed, by the technologies used, etc. Therefore, a simple classification scheme is not possible. However, one useful means of classification is by the amount of "intelligence" contained in the software. In this type of categorization, there are four main types. The simplest type is that of end-user programmable (or "simple") agents.[2] These agents rely on end-user programming to carry out relatively simple operations. This is usually done by some sort of macro-like programming or scripting language. An example of this type of agent is the software package NewWave Agents from Hewlett-Packard.[3] Using a BASIC-like language, users can program the software to automate certain functions. Edify's Workforce is another automation tool for developing user specific intelligent agents by writing code--in this case dragging modules rather than actually writing programs.[4] Simple agent software can be very effective in automating repetitive tasks (e.g, voice-telephony, fax, database queries, etc.), but they are actually nothing more than fancy macros. Many of these packages require a rather large investment in the learning curve involved to become proficient in using them which limits their utility for most of us.

Further along the taxonomy of intelligent agents are those packages which are termed KBS (knowledge-based systems) agents.[5] KBS agents are "smart" because they obtain all or part of their functionality from knowledge-based technology. They may rely on rules or other expert systems techniques to function effectively in assisting the end-user. More expensive and difficult to build than simple agents, these KBS agents add functionality by being more flexible in accomplishing tasks. Instead of having to be programmed for each instance, they can rely on generalities to accomplish similar tasks. However, once developed their functioning is very rigid, requiring changing of the internal logic to adjust to new situations. Magic Cap is an example of a KBS agent software package. In Magic Cap rules can be specified which will govern how the computer deals with e-mail or files documents, etc.[6] Other software packages in this genre are Telescript Agents, and PersonaLink Agents (both of which are distributed or network packages). Likewise, internet intelligent agent software, such as Pointcast, allows the user to customize retrieval of information so that the information is tailored to what is needed or wanted.

The most advanced of the current types of intelligent agent software are those packages which can create self-learning agents. These packages learn to automate functions by observing the behavior of the user, through examples, observations, and feedback over a period of time.[7] The agent

eventually "learns" what the end-user does and offers to automate these situations. For example, the "agent" would observe that e-mail with administrative message content is often deleted and suggest that function be automated. Examples of this type of agent software are NewT and Open Sesame! software packages.

Finally, just in the formative stages are software agents which collaborate. These applications would allow agents to interact with each other and learn or cooperate with each other. Much of the research today is in the area of collaborative agents or multiple agents.[8] Many problems exist which must be solved before these types of agents will emerge fully, however, such as the communications problem, the loss of control, the impact of malevolent agents (e.g, viruses) on workflow, the need for standard "languages", etc.

Applications

Today intelligent agents are performing several important tasks rather successfully. Although most of these applications are first generation tools and techniques, they are already having a significant positive impact on organizations. Most of them assist users in dealing with the vast information available on the internet.

(NOTE: The web addresses for these agents are listed at the end of the paper.)

Agents that Watch - Watcher agents operate autonomously, looking for specific information or events. When information relevant to the user is found, the agent can either notify the user directly (e.g. with a news flash or email) or store the information for future access (e.g., for a personalized newspaper). For an educator, having instant notification that information in a particular subject has just become available can be invaluable. These types of agents can help insure that educators are aware of the most current information and have access to it.

Pointcast and **fishwrap** are examples of this type of agent. They are basically sophisticated search engines coupled with formatted delivery items. By tailoring these agents, you can receive information meeting your interests at convenient times. Pointcast, for example, serves the information in the form of a realtime screen saver.

Remind U-Mail will send you an email when an important event is coming up. This is an agent whose obvious use would be to remind educators and/or students about key dates and suspenses.

NetMinder is another watcher agents, in this case watching for changes in key web sites and then emailing you with the news that a change has occurred. If you are using information from web sites in a course, it is helpful to know when that web site has changed.

Amazon.com, the world's largest on-line bookstore, has agents that will watch for books on a particular subject and notify you (via email) when one is found .

Webcatcher is a free e-mail service which sends subscribers lists of new URL's which are relevant to their interests chosen from a list of about 100 topics.

Agents that can Learn - This type of agent supposedly "learns" from observing your behavior. A learning agent is capable of tailoring its performance to an individual's preferences by learning from a user's past behavior. For an educator with limited time to visit the many internet sources of information and sort through that information, these agents can be most useful. Soon hypertext guides will be able to lead you through documents, only stopping on the passages which are relevant to the purpose. Intelligent agents can assess your familiarity with the information and decide which parts you need to see. They can, to a degree, learn what is of value to you and assist you in finding that information.

An example is a Windows application that provides access to Usenet newsgroups, **smart newsreader**. It lets you grade read articles and conversations and then makes sure that the more interesting ones stay near the top of the list. As newsgroup articles are read, users can express preferences which can be used to rank new articles and threads according to interest. The more articles read and ranked, the better the agent learns what is relevant to the user.

Likewise, Intel's **selection recognition agent** dynamically generates hyperlinks between information on your desktop and relevant web sites and applications.

Lifestyle finder from Andersen consulting attempts to match you up with internet sites which would be of interest to you.

Agents that can Retrieve - These agents are capable of searching for information in an intelligent fashion. The most obvious example is an Internet search agent which can conduct complex searches by interpreting the search criteria defined by a user. Being able to at least partially automate the search process (beyond just using basic search engines) is extremely useful and time saving for educators. Further, IA's can even create personalized newspapers, containing only information desired.

Autonomy agent is a good example of a type of information retrieval agent. Through simple text input and using neural network technology, autonomy agents train themselves to retrieve information of relevance to the user. The more the agents are trained, the smarter they become in finding the correct information. Autonomy agent can also be used to create a custom newspaper from over hundreds of newspapers across the country.

CNN++ is an intelligent newsfilter which can retrieve information based on keyword searches.

NEWSpot is a free e-mail service that delivers custom news summaries from Mercury Mail. Users can choose from more than 20 categories and get delivery several times per day.

In like manner, **Robobear** can scan Usenet newsgroups for multimedia (pictures, sounds, videos) based upon criteria selected by the user.

WebWhacker, is an "off line" web browser for Windows95 and NT. Users can preselect the Web sites that they want to monitor and set a schedule for Web pages, text, graphics and HTML links to be delivered to their desktop computers automatically and unattended.

AdHound searches the classified ads of hundreds of newspapers and will email you when it finds what you are looking for (Note: **Job Hound** looks for job opportunities for you in the databases of Morgan & Banks!).

Agents that can Assist in specific tasks - Assist agents perform specific tasks to assist users. For example, an agent could determine that the reason a user was unable to receive e-mail was because his mailbox was full and generate a message to that effect. Based on some expert system rules, the agent might even be able to diagnose and fix the problem automatically. However, there is potential for helper agents to assist educators also.

A useful example is **NetMechanic**, which searches your site for broken links and informs you of them. As more educators use web sites for distributing information to students, for example, more attention needs to be paid to keeping the links correct and working.

Webbie from IBM can remember where you have been on the web, what you found and recall any word on any page you might have visited. Before you visit a page, it can alert you whether the site is available and make an assessment of how slow the access time will be for visiting the page.

Agents that can "Converse" - These agents provide entertainment (currently) as they interact and "converse" with the user. The first of these was Eliza, but there are now many more. Within the near future, they might provide information such as you might look up in an encyclopedia via dialogue. Although at the current time, most of the chatterbot agents are only for amusement, more and more they will begin to resemble intelligent tutors who can provide information on demand. Already the potential exists to create agents to assist in providing information in a timely manner to students.

Millie, for example, can inform and answer questions about the Y2K problem.

MegaHAL learns from what you say to him and uses this information.

Another such agent is **Theresa**, an expert on Greek mythology.

Erin the Bartender serves drinks, keeps the bar in order and chats with customers.

Agents that can Collaborate – Collaborative agents provide assistance in several areas related to collaboration such as on line chat, finding colleagues, allowing joint preparation of lessons and

lectures, automatic passing of information, etc. Although only in the early formative stages, collaborative agents offer much promise and potential use for educators.

In this general category would be such agents as **ICQ** ("I seek you"), an agent program which alerts you in real time when somebody you know goes online.

Another example of this type is agent is **firefly** which attempts to recommend specific sites you will enjoy and connect you to people who like what you like. This could be most useful in seeking like-minded colleagues for collaborative research efforts for example.

Agents that can Shop - Some agents are capable of doing comparison shopping and finding the best price for an item. It is entirely possible that an intelligent agent, armed with your credit card number, could surf the Internet (or some commercial service) and purchase for you gifts according to your specifications. This type of application is just now being developed, but will appear soon. An agent could be charged with finding a CD player for under $300 with certain features and, upon finding such, actually have the authority to purchase the item. Even educators might find use in this information for shopping for items of use in the classroom (or for personal use).

Examples of this type of agent include **bargain finder** from Andersen consulting, which attempts to find the best price on CD's.

Another interesting shopping agent is a recent one, **Excite**. Excite lets you automatically shop for garden supplies, movies, jewelry, music and sports equipment.

Price Watch looks for the best prices in computers.

MX BookFinder looks for books at the best prices, including examining several of the online bookstores.

Conclusion

It appears that the era of the Intelligent Agent has begun. For educators this will be at least a partial solution to dealing with the information overload problem. As more and more information becomes available, it will be IA's which assist educators and students in managing this hyperabundance of data. Intelligent agents are already available to perform some functions and will rapidly acquire increasing levels of "intelligence", making them more valuable in providing assistance to educators.

Some Interesting WebSites:

Sources of IA information:

www.cs.umbc.edu/agents/
www.botspot.com

URL's for Agents:

www.agentware.com	(autonomy agent)
fishwrap-docs.www.media.mit.edu/doc/	(fishwrap)
www.agents-inc.com/	(firefly)
bf.cstar.ac.com/bf/	(bargain finder)
bf.cstar.ac.com/lifestyle/	(lifestyle finder)
ahoy.cs.washington.edu:6060/	(ahoy)
intel.com/iaweb/newsrdr/index.htm	(smart newsreader)
www.excite.com	(excite)
www.cs.umbc.edu/~smart-ht/	(CNN+ newsfilter)
ciips.ee.uwa.edu.au/~hutch/hal/HEX/	(HEX)
millie.y2klinks.com	(Millie)
www.pricewatch.com/	(Price Watch)
www.netmechanic.com/link_check.htm	(Net Mechanic)
www. http://georgia.flashpoint.com.au/	(Robobear)
www.oz.com/ov/agents/main_index.html	(Theresa)
www.mx.org	(MX Book Finder)
www.morganbanks.com.au/cgi-bin/profiler.cgi	(Job Hound)
www.adone.com/html/hound/adhound.html	(Ad Hound)
www.extempo.com/webBar/index.html	(Erin the Bartender)
calendar.stwing.upenn.edu/	(Remind U-Mail)
www.netmind.com	(Net Minder)
www.amazon.com	(Amazon.com bookstore)
connectedpc.com/iaweb/selagent/bottom.htm	(selection recognition agent)
www.merc.com/index.cgi	(NEWSpot)
www.dev-com.com/~rfactory/webcatcher.html	(WebCatcher)
www.networking.ibm.com/wbi/wbisoft.htm	(Webbie)
www.ffg.com/whacker/	(WebWhacker)

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[3]Intelligent Software Strategies, Vol XI, No. 1, pages 4-5.

[4]Intelligent Software Strategies, Vol XI, No. 1, pages 4-5.

[5]Intelligent Software Strategies, Vol XI, No. 1, pages 4-5.

[6]Intelligent Software Strategies, Vol XI, No. 1, pages 4-7.

[7]Intelligent Software Strategies, Vol XI, No. 1, pages 4-7.

[8]Intelligent Software Strategies, Vol XI, No. 1, pages 4-7.

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