Artículo **Revista de Docencia e Investigación Educativa**
Septiembre 2015 Vol.1 No.1 91-100

ISD for Distributed Learning through Collaborative Agents

FALLAD-VILLEGAS, Jalil*†, HUESO-GUERRERO, Judith, y MANCILLA-VILLA, Raúl

Universidad de Guadalajara, Av. Juarez 976, 44100 Guadalajara, Jal., México +52 33 3825 499

Recibido Enero 13, 2015; Aceptado Junio 17, 2015

Resumen

El propósito de este trabajo es discutir las teorías sobre agentes colaborativos e implicaciones para la teoría del aprendizaje distribuido como un marco en el diseño instruccional y la creación de agentes de colaboración y sus implicaciones para el diseño de entornos en línea.
En la primera parte de los de papel, definiciones y conceptos sobre la Teoría del Aprendizaje Distribuido y el Agente Inteligente, así como el Agente de Colaboración será presentado y discutido. En la segunda parte del artículo, voy a tratar de presentar ideas sobre las implicaciones de ISD cuando un agente inteligente y / o agentes de colaboración se utilizan en un sistema educativo. Se hacen las ideas sobre el diseño del diseño instruccional que un agente de colaboración podría tener con el fin de promover una experiencia de aprendizaje eficaz para sus usuarios.

ISD, el aprendizaje distribuido, agentes de colaboración.

Abstract

The purpose of this paper is to discuss the theories on collaborative agents and implications for the distributed learning theory as a framework on the instructional design and building of collaborative agents and its implications for designing online environments.
In the first part of the paper, definitions and concepts regarding the Distributed Learning Theory and the Intelligent Agent as well as the Collaborative Agent will be presented and discussed. In the second part of the paper, I will attempt to present thoughts about the implications on ISD when an intelligent agent and/or collaborative agents are used in an educational system. The insights are done regarding the design of the instructional design that a collaborative agent might have in order to promote an effective learning experience to their users.

ISD, Distributed learning, collaborative agents

Citación: FALLAD-VILLEGAS, Jalil*†, HUESO-GUERRERO, Judith, y MANCILLA-VILLA, Raúl. ISD for Distributed Learning through Collaborative Agents. Revista de Docencia e Investigación Educativa 2015, 1-1: 91-100

* Correspondencia al Autor (Correo Electrónico: jfallad@cucsur.udg.mx)
† Investigador contribuyendo como primer autor.

Definitions

Nowadays, Stolovitch & Keeps (1999) posited the professional literature provides enough empirical evidence that support the fact that Distributed Learning has an important role on instructor-led instruction. For Stolovitch & Keeps (1999) Distributed Learning represents a methodologically distinct variation from Distance Education that responds to calls for supporting needs of individuals on terms that they are increasingly defining for themselves (I need to clarify).

Even as well-designed and well-implemented distance learning courses and programs have become ubiquitous features on teaching and learning, this discipline is experiencing a significant expansion of its methodological framework. Distance learning and Distributed Learning has the same root but they are different. There are operational differences between Distance learning and Distributed Learning that affects how performance improvement interventions are positioned and implemented. Distributed Learning differs from distance learning in that it tends to focus on the needs of individuals looking for immediate access to information, performance support tools, and instructional opportunities (Serenko & Detlor, 2004). Distributed Learning also tries to maximize connections between and among learners and resources, regardless of their relative physical locations. Thus, in a Distributed Learning setting a learner may be at some physical or centralized site, whereas the resources that are needed may be at some physical distance from that centralized location. What is important is the connection that exists between and among learners and resources regardless of their physical locations.

Distributed Learning (**theory**) as well as Distance Learning has its roots in the socio-constructivism philosophy where the members of a group of learners construct their knowledge in two different processes. The first process, each member of the group learn about each other and each member share their new knowledge with the community and then, the second process will be done, where new knowledge is created as a product of the interaction of the knowledge of members of the group (Salomon, 1993) and creating a Intelligent network (Markus & Magedanz, 1998). It is important to remark that this new knowledge is created under the consensus of the group. This consensus is a key point in order to ensure the prevalence of the knowledge within the group as well when this new knowledge will be shared with another group of learners (Barnes, 2002).

Distributed learning can be considered as an adult learning approach as well as a lifetime learning process (Reigeluth, 1999). These two statements are made under the basis of the specific requirements that are needed in order to conduct this kind of learning approach. The requirements are mainly special for the learners characteristics, the nature of tasks and activities that will be carried out which are related to the content of the subject matter, and for the evaluation process.

General Characteristics of an Agent

The central element of intelligent behaviour is the ability to adapt or learn from experience. Having the ability to adapt to changes in the environment or to get better at tasks through experience became a significant differentiator for any intelligence system. Any agent that can learn has an advantage over one that cannot. Thus, by adding learning or adaptive behaviour to an intelligent agent elevates it to a higher level of ability. A learning agent can also adapt to a user's likes or dislikes. Furthermore, when the agent is working in collaboration with other agents, it can learn which agents to trust and cooperate with, and which ones to avoid. A learning agent can recognize situations it has been in before and improve its performance based on prior experience.

The intelligent agent systems are based on four basic ideas (Bradshaw, 1997). (1) A set of semi-structured message types can form a basis for an intelligent information sharing system. (2) Sets of "if-then" rules can be used to conveniently specify automatic processing for these messages. These rules may include multiple levels of reasoning. (3) The use of semi-structured message types for processing them can be greatly simplified by a consistent set of display-oriented editors for composing messages, constructing rules, and defining new message templates. Finally, (4) the initial introduction or later evolution of a group communication system can be much easier if there is an incremental adoption path, which is, a series of small changes. Here, one of the biggest challenges is the tailored agents for semiformal systems where the tailoring sometimes becomes radical where the user can modify the structure of the system in order to fulfil user's specific needs (Bradshaw, 1997).

Definitions for an agent

The integration of new information technologies in the education system is the enhancement of the access of knowledge and culture in order for the education system to improve its role of knowledge transfer and citizen training. Bradshaw (1997, page 223) posited three main reasons for it: (1) *to develop autonomy and individual learning*. (2) *To remove barriers because of the geographical isolation*, and (3) *to open the education system to the external world and facilitate synergy with local resources*.

There is not very much agreement about what a software agent is. It seems that definition will depend on the nature of the agent or on what the agent does. It is also clear that software agents and hardware agents are interlinked, and this condition makes its definition more complicated. However, in order to have a general scope about intelligent systems is important to have a general definition about what an agent is.

Franklin and Graesser (cited by Murch & Johnson, 1999, page 11) have defined an agent as:

> "…An autonomous agent is a system situated within and part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future…"

Nwana & Azarmi (1997, page 5) have posited "…a component of software and/or hardware which is capable of acting exactingly in order to accomplish tasks on behalf of its user…" as light definition for an agent.

Detlor (cited by Serenko & Detlor, 2004; page 364) defines Intelligent Agents as "long-lived software programs, which act autonomously, monitor and react to the environment, and communicate and collaborate with other agents and users".

Perhaps, a good approach about the definition for an agent is to establish the reasons why an agent is needed. Nowadays, the modern life is becoming too complex and demands from us more time that we do not have. Sometimes agents perform activities that humans are unable to perform. Sometimes agents can work faster and more accurate than humans, such as the case of the information, that in other times was an important issue, now it is accessible to everyone (of course internet accessibility is needed). In current modern times, more important than information itself, is how we manage the information by filtering and retrieving it from the databases in a useful and personalize way and in a quick fashion. Everyday, more and more people need more and more information but they need it in different, customized ways. Here is when an intelligent agent can help.

Nwana & Azarmi (1997) show a list of types of agents as following: collaborative, interface, mobile, information/internet, reactive and hybrid.

The current purpose for an agent present by Murch and Johnson (1999) is "…agents employ subagents. Agents are able to traverse any computer connected to the web and utilize resources by negotiation with computers and other agents. They are more sophisticated and focus on solving abstract request…"

The future agents (2005-2050) are described by Murch and Johnson, 1999, page 39) as "agent can activate and inhabit real world robotics and pursue goals beyond the virtual…", and "…agents are self-replicating and can design agents tailored to specific needs. Agents develop agents to carry out their tasks and needs as required. These manager agents are independent, and self-motivating, and in many respects have human capability…"

One of the promissory agents for a near future is an agent that promotes collaborative knowledge production (Mohammadian, 2004). The rationale for having collaborative agent systems is a specification of the goal of DAI (Nwana & Azarmi, 1997). Knowledge is everywhere; most of the time is unstructured or at least is not well-structured. This situation can lead us into a poor or inappropriate use and exploited situation. Recent works advocate collaboration in support of knowledge production. Collaboration production will stand out as a tool to mediate, but not eliminate, the differences between views of the design of a system (Mohammadian, 2004). These agents emphasize autonomy and cooperation with other agents in order to perform tasks for their owners in open and time-constrained multi-agent environments (Nwana & Azarmi, 1997).

The main tasks that these agents perform are "… (1) solving problems that are too large for a centralized single agent to do, due to resource limitations or the sheer risk of having one centralized system; (2) allowing for the interconnecting and interoperation of an existing legacy system (previous system where the current systems come from); and finally, (3) providing solutions to inherently distributed problems, such as solutions which draw from distributed information sources such as distributed on-line information sources or distributed sensor networks…" (Nwana & Azarmi, 1997; page 8).

Learning paradigms for intelligent agents

Bigus & Bigus (2001) posited three major paradigms. These include supervised, unsupervised, and reinforcement learning. The first paradigm is the most common form of learning. This agent is trained by showing it examples of the problem state or attributes along with the desired output or action. By doing this, the learning agent makes a prediction based on the inputs and if the output differs from the desired output, then, the agent is adjusted or adapted to produce the correct output.

The second paradigm is used when the learning agent needs to recognize similarities between inputs or to identify features in the input data. The data is presented to the agent, and it adapts so that it partitions the data into groups. The clustering or segmenting process continues until the agent places the same data into the same group on successive passes over the data.

Finally, the third paradigm is the type of supervised learning used when explicit input/output pairs of training data are not available. This type of paradigm can be used in cases where there is a sequence of inputs and the desired output is only known after the specific sequence occurs. This process is called temporal credit assignment (Bigus & Bigus, 2001).

Another important distinction in learning agents is whether the learning is done on-line or off-line. On-line means that the agent is sent out to perform its tasks and that it can learn or adapt after each transaction is processed. On-line learning is like on-the-job training and places severe requirements on the learning algorithms.

The tasks must be done very fast and be very stable. In other hand, off-line learning is a place in an environment where the agent can focus on improving their skills without distractions. After a suitable training period, they are sent out to apply their newfound knowledge and skills (Bigus & Bigus, 2001).

My perspective on the theory

The main idea in using the socio-constructivism learning philosophy for the proposed approach in this paper is to promote the learning process through the using of collaborative intelligent agents. The fact of having learning material and activities from intelligent agents will enhance how to learn more effectively.

The main role of the use of intelligent agents are that they will search and build learning material that will fit the learners needs and create instructional activities that will allow that learning process to happen.

In this learning process there are two main characters, a collaborative agent (or group of them) and the learner. Both characters will learn from each other by sharing strengths and weaknesses of their findings during the learning process.

The same individual and group learning process that occurs on distributed learning might happen among a group of intelligent agents where each agent can learn from others and then after a consensus process they will share their findings to the learner.

Implications For Instructional Systems Design

Analysis

Due to the nature of the distributed learning, it helps to influence the way the learning process is conducted. The analysis process will be essential for the effectiveness of the ISD. The learner characteristics analysis is the most basic task to be conducted in the design of an intelligent agent. When the learner characteristics analysis is conducted, it is important to keep in mind the each learner will carry different needs and expectations of their learning (Barnes, 2000). In other words, ample learning needs, expectations and a combination of the two shall be considered. This requirement shall be not a problem since the main characteristic of the intelligent agent is to adapt to different condition and requirements from the learner (Bigus & Bigus, 2001). Perhaps one the most sensitive learner's characteristic is the learner's learning style and pace. Due to the use of a collaborative agent in a learning process is learning style per se because the agent(s) coaches the learner in the learning process as well the learner is doing the same to the agent(s). The learning style also carries some specific requirements for the evaluation process but this will be discussed in the evaluation section.

Another feature that needs to be analyzed is content. This feature is important because the nature of the subject matter carries out a special requirement whenever the learning process takes place. Not every science or discipline can be taught and learned the same way. In some cases, in order to conduct a learning process, the content must be highly related to the context, so the content could be understood. Examples for these types of content are the more complicated forms of sciences such as Math, Physics and Statistics.

Design

A common approach for designing agents is to define roles for team members (Serenko & Detlor, 2004). There are three different roles proposed by Weiss (1999); these roles are learning organizational roles, learning to benefit from market condition, learning to play better against an opponent. The first role is dealing with agents in groups that need to learn role assignments to effectively complement each other. In the second role, information agents selling and buying information units in an electronic marketplace need to be adaptive to their environmental conditions. In the third role, in adversarial domains a classical maximum strategy provides a conservative approach to playing games, where the exploitation of weaknesses in the strategy can lead to better results when playing against that particular opponent. By assigning well-defined roles for the agents, the collaboration and cooperation activities between the learner and the agent(s) and the activities from agents to agents will be possible. The better-defined tasks and activities for each agent(s), better effectiveness could be obtained. Weiss (1999) posited two different categories of learning: centralized and decentralized. The first category is dealing with when the learning process is happening through a single agent. The second category is concern about the learning is happened if several agents are working and engage on the same learning process. Any of those categories are looking the same goal, the expected learning outcome (product or behaviour) in the learner. But in order for an intelligent agent to perform an intelligent action, the agent has to be able to learn what is going on within the environment concerning the task (Bigus & Bigus, 2001).

With this required condition, the ISD must promote and foster the learning about the subject matter and the environment that surround the agent. This means that the agent shall be able to learn from his previous experience and knowledge. The design of the learning process must carrying clear task-by-task procedure. Anchored instruction and scaffolding will be the chosen strategies in order to conduct an effective learning process. Anchored instruction strategy is based when previous knowledge can be used as a support a construction of new knowledge. And scaffolding instruction strategy is based on the previous knowledge is fully supports the creation of new knowledge. Here, the previous is a basic requirement in the learning process. They are chosen because the knowledge and meaning will be constructed by the use of previous knowledge and experiences from the learner as well from the agent(s) and it is required that the agent shall have an equivalent information or knowledge of the learner's (Bigus & Bigus, 2005). The exchange of information and knowledge between the agent(s) and the learner is needed in order to ensure the learning process. During this process is when both, the learner and the agent(s) learn from each other. By doing this, information sharing strategies and collaborative problem solving are also taking place in the learning process (Qi *et al*., 2002).

Weiss (1999, page 263) suggest that other learning methods or strategies can be applied such as: (1) rote learning (direct implementation of the knowledge and skills without requiring further inference or transformation from the learner). (2) Learning from instruction and by advice taking (operationalization-transformation into internal representation and integration with prior knowledge and skills). (3) Learning from examples and by practice (extraction and refinement of knowledge and the skills like a general concept or a standardization pattern of motion from positive and negative examples or from practical experience). (4) Learning by analogy (solution preserving transformation of knowledge and skills from a solved to a similar but unsolved problem). And (5) Learning by discovery (gathering new knowledge and skills by making observation, conducting experiments and generating and testing hypotheses or theories on the basis of the observational and experimental results).

Another feature that must be taken into account is the feedback which can be defined as a level of performance that has been achieved so far (Weiss, 1999). This feature leads to make three tasks: to supervise the learning process, reinforced learning and in the case of trial-and-error and self-organization processes, the unsupervised learning (no explicit feedback is provided and the objective is to find out useful and desired activities). Interactivity is another feature in ISD that must take in account for the design of the learning process where the communication feature starts its work in the learning system. The interactivity shall include the learners, agents, contents and outcomes as well the combination of them.

Development

Perhaps the most important influences on development in *Distributed Learning* are the technological developments such as accelerated desktop computer processor speed, platform-independent data-transmission protocols, the improved browser technology with such features as Java-enable client-server interactivity.

The content objects, and knowledge content distributors, the improved backend database technologies, the ubiquitous availability of commercial internet service providers and improved access to the bandwidth needed for large-file transmission (Stolovitch & Keeps, 1999). With the emerging of new communication and computer technologies many things are now possible, things that ten years ago we could consider impossible, examples of this, are the new communication gadgets like the new PDA, that are capable of being used for communication between user and another user, or a user and an agent(s) or an agent and another agent (Qi *et al*., 2002). Another example is the new hand-carry minicomputers that are economical accessible. This new gadgets are also capable to search and find on Internet information by a set of criteria.

Implementation

Stolovitch & Keeps (1999) list five challenges for distributed learning systems (pages 634-635). 1. "The courses that designers are expected to develop for distance and distributed learning contexts may not look like courses as we have always known them". 2. "A basic goal of any learning design is to establish parameters within which the outcomes of the particular design intervention can be achieved". 3 "The demand for traditional course offerings may wane in an era of alternative means for accessing content when and where it is needed". 4 "The distance learning experiences may serve as a surrogate for the training experiences with which most of us are familiar, but distributed learning experiences represent a completely new approach for supporting informational, instructional, and performance support needs for individuals".

Finally, 5 "The strategies used for constructing instructional designs must increasingly account for learner-determined and learner-navigated paths while also continuing to maintain instructor-directed and domain-dependent learning parameters".

These five challenges highlight the needs of some special skills and also are required of the learner such as the development of a way of thinking towards the emerging technology in order to use this approach. This fact, illustrates the importance that the learner characteristics analysis must be appropriately conducted.

Regarding the collaborative agents, there are some critics about agents and their uses. The most common critics are: (1) the agents are not new but merely an extension of the work done in artificial intelligence research and development. (2) Agents are not "intelligent". (3) Agents have been around for several years and have not taken off. (4) Agents will not enhance or develop the potential of the internet and other networks. (5) The applications for agents are severely limited. And finally, (6) the excessive searching using agents will cause response times problems on the internet. Despite the critics, it is well known that computers are becoming the vehicle for an increasing range of everyday activities. The acquisition of information becomes more and more computer-based. At the same time, an increasing number of untrained users are interacting with computers and unfortunately, these technological developments are not going hand in hand with a change in the way that people interact with computers (Murch and Johnson, 1999).

Finally, when an agent's learning Instructional System Design is using, a knowledge management will be need to be developed. Completing this task is highly important because of the fact that all of the knowledge and information that will come out from the learning process needs to be monitored and managed. This will require from the learner to acquire new skills about how handle the knowledge management after it has just been acquired.

Evaluation

The evaluation process will carry out activities that are very similar than those that is being used in Distance Education. This decision has been made because the nature of the learner's characteristics, are similar in both distance learning and distributed learning. Approach for the evaluation process will be a user-end approach and the instruments of evaluation are such as rubrics, specific outcomes or products. In all these cases the process of learning will be an essential part of the components in the evaluation process. The evaluation process could be carried out under an embedding approach as well the classic formative and summative approaches. Everything will depend on the subject matter nature and learner's characteristics but is clear that more and better evaluation resources will need to be developed or refined; among them are well-trained facilitators and evaluators, and the monitoring and the assessment instruments.

Conclusion

Using technology has some amount of exerted on its influence on the emergence of Distributed Learning but perhaps, the need of individual as well the organizations performance improvement is the most important variable that influences the start a distributed learning experience (Stolovitch & Keeps, 1999).

The need of training play a continuous important role in supporting the ongoing development of employee knowledge and skills but Stolovitch & Keeps (1999) posited that there are a growing recognition that training may be insufficient for the kinds of continuous, individual performance improvement that are enabled through distributed learning. Today's learning experience has different requirements from the learner as well from the technology. New approaches had emerged that will deal with today's challenges. The use of intelligent agents as promoters of learning is feasible and everyday are coming more reliable (Bryson, *et al*., 2002). A more careful examination of the learner's characteristics analysis will be required to be conducted as well as the design and the evaluation processes. But more of that, is that need for the learner of an acquisition of a new way of thinking toward the technology as well for new way of Instructional Systems Design.

References

Barnes, S. (2000). Bridging the differences between social theory and technological invention in human–computer interface design. *new media & society, 12(3):*353–372.

Bigus, J & J. Bigus. (2001). *Constructing intelligent agents using java*. 2nd Edition. John Wileys & sons. New York. USA.

Bradshaw, J. M. (1997). *Software Agents*. American Association for Artificial Intelligence Press. CA, USA.

Bryson, J J., Martin, L. D., McIlraith, S. A. & L. A. Stein. (2002). Toward Behavioral Intelligence in the Semantic Web. Computer, Nov., 48-54.

Mohammadian, M. (2004). *Intelligent agents for data mining and information retrieval*. Idea Group Publishing. USA.

Murch, R. & T. Johnson. (1999). *Intelligent software agents*. Prentice Hall PTR. New Jersey. USA.

Nwana, H. S. And Azarmi N. (editors). (1997). *Software agents and soft computing; toward enhancing machine intelligence*. Springer-Verlag. Berlin, Heidelberg, New York.

Qi, H., Wang, X., Iyengar., S. S. & K. Chakrabarty. (2002). High performance sensor integration in distributed sensor networks using mobile agents. The International Journal of High Performance Computing Applications, *Volume 16(3)*, pp. 325-335.

Reigeluth, C. M. (1999). *Instructional-Design theories and models; a new paradigm of instructional theory, Volume II.* Lawrence Erlbaum Associates, Publishers. New Jersey. USA.

Salomon, G. (1993). *Distributed cognitions; psychological and educational considerations*. Cambridge University Press. U.K.

Serenko, A & B. Detlor (2004). Intelligent agents as innovations. *AI & Soc*, 18: 364–381.

Stolovitch, H. & E. J. Keeps. (1999). *The handbook of human performance technology*. 2nd edition. Jossey-Bass/Pfeiffer. San Francisco, Ca. USA.

Weiss, G. (1999). *Multiagents systems*. The MIT Press, Cambridge, Massachusetts, USA.