

HOW TO IMPROVE ARTIFICIAL INTELLIGENCE THROUGH WEB

Senior Lecturer Adrian LUPAȘC, PhD
“Dunarea de Jos” University from Galati

Abstract: *Intelligent agents, intelligent software applications and artificial intelligent applications from artificial intelligence service providers may make their way onto the Web in greater number as adaptive software, dynamic programming languages and Learning Algorithms are introduced into Web Services. The evolution of Web architecture may allow intelligent applications to run directly on the Web by introducing XML, RDF and logic layer. The Intelligent Wireless Web’s significant potential for rapidly completing information transactions may take an important contribution to global worker productivity.*

Artificial intelligence can be defined as the study of the ways in which computers can be made to perform cognitive tasks. Examples of such tasks include understanding natural language statements, recognizing visual patterns or scenes, diagnosing diseases or illnesses, solving mathematical problems, performing financial analyses, learning new procedures for solving problems. The term expert system can be considered to be a particular type of knowledge-based system. An expert system is a system in which the knowledge is deliberately represented “as it is”. Expert systems are applications that make decisions in real-life situations that would otherwise be performed by a human expert. They are programs designed to mimic human performance at specialized, constrained problem-solving tasks. They are constructed as a collection of IF-THEN production rules combined with a reasoning engine that applies those rules, either in a forward or backward direction, to specific problems.

Keywords: *Artificial intelligence, computer software system, Web*

Jel Classification: *L - Industrial Organization, L8 - Industry Studies: Services, L86 - Information and Internet Services; Computer Software*

An intelligent agent is a computer software system that is situated in some environment and capable of autonomous action and learning in its environment to meet its design objectives. Intelligent agents have the following characteristics: reactive – they perceive their environment and respond; proactive – they exhibit goal – directed behaviour; and social – they interact with other agents.

Real-time intelligent agent technology offers a powerful Web tool. Agents are able to act without the intervention of humans or other systems; they have control both over their own internal state and over their behaviour. In complexity domains, agents must be prepared for the possibility of failure. This situation is called nondeterministic. Normally, an agent will have a repertoire of actions available to it. This set of possible actions represents the agent's capability to modify its environments.

The key problem facing an agent is that of deciding which of its actions it should perform to satisfy its design objectives. Agent architectures are really software architectures for decision-making systems that are embedded in an environment. The complexity of the decision-making process can be affected by various environmental properties.

Distributed artificial intelligence is concerned with coordinated intelligent behaviour: intelligent agents coordinating their knowledge, skills, and plans to act or solve problems, working towards a single goal or towards separate, individual goals that interact. Distributed artificial intelligence provides intellectual insights about organization, interaction, and problem solving among intelligent agents.

In building the Intelligent Wireless Web, can envision the use of parallel PC clusters coordinated by artificial intelligence service providers to carry out complex tasks utilizing the principles of distributed artificial intelligence. Adaptive configurations of such clusters will enable the task assignments to be distributed by artificial intelligence servers to PCs within the cluster having the need of capabilities that may be highly specialized.

The basic assumption of distributed artificial intelligence is that, in general, a single isolated intelligent agent does not possess enough knowledge or resources to complete a problem-solving task. On the contrary, it is envisioned that complex problem solving in real-world domains will be performed by communities of specialized intelligent agents, able to collaborate with each other toward the accomplishment of a given common goal and to negotiate the use of resources in the most effective way. The ability to communicate with other agents is therefore considered essential for an agent to exhibit intelligent behaviours.

An artificial intelligence provider is used as the development environment for distributed artificial intelligence systems, using an extension to HTTP designed to support server-to-server communication. In particular, new methods enable a client agent to invoke a specific service on a server. The implementation of a specialized HTTP server would be able to deliver distributed artificial intelligence applications over the Web. In addition to implementing standard HTTP, the artificial intelligence server would offer a library of high-level functions to dynamically generate HTML pages and a server-to-server communication method.

The dynamic generation of HTML pages allows complex artificial intelligence applications to be delivered to end users without the need for specialized hardware and software support and using a simple and homogeneous interface model.

Intelligence usually refers to the ability to reason, solve problems, remember information, or learn new idea. The Web can be considered to be a massive information system with interconnected databases and remote applications providing various services. Although these services are becoming more and more user oriented, the concept of smart applications on the Web is still in its infancy.

One of the most sophisticated on the Web today is the Enterprise Information Portal, operating with the state-of-the-art mark-up languages to search, retrieve and repackage data. The Enterprise Information Portal is in the process developing into an even more powerful centre based on component-based applications called Web Services. Enterprise Information Portals provide ready access to information over intranets and the Internet.

Corporate portals have moved beyond the delivery of information; they also provide a way to integrate the many disparate systems and processes that are typically used within an enterprise. Corporate portals are able to use XML to integrate previously separate legacy systems and provide a single point of entry, or gateway, to these processes. Enterprise Information Portals now act as access centers that tie together people and data by linking e-mail, groupware, workflow, collaboration, and other mission-critical applications to portals.

The tools needed to continue evolving advanced Web capabilities are based mostly on XML standards, frameworks and Schema. The Wireless Application Protocol is an XML application that allows access to information via personal digital assistants (PDAs) and other handheld devices. The variety and power of these XML tools demonstrates the potential for Web development.

XML changes the Web by introducing the concept of metadata (that is, data about data). In XML, each piece of data includes not only the data itself but also a

description of the data. XML therefore describes data, not pages. It is about actual information content, but says nothing about the layout. The power of XML then is that it makes applications aware of what they are about. Once a spreadsheet is expressed in XML, it can link across the Web into other spreadsheets and into server-based applications. The ultimate result of adding XML to the Web will be a change of Web infrastructure.

The latest versions of Web browsers can read an XML document, fetch the appropriate style sheet, and use it to sort and format the information on the screen. The reader might never know that he is looking at XML rather than HTML, except that XML-based sites run faster and are easier to use. XML based semantic messaging revolutionizing distributed system development. Their main advantages include: more flexible data transfer, simplified interface management and simplified remote invocation.

Today, artificial intelligence applications using the Prolog computer language are already being used for Web applications. Prolog is a logic language that is well suited to problems that involve symbolic or nonnumeric computation. The name itself is short for PROgramming LOGic. New applications are being vigorously pursued in many fields, and it shouldn't be long before Web Services include a variety of artificial intelligence applications.

One approach to artificial intelligence is to implement methods using ideas of computer science and logic algebras. The algebra would establish the rules between functional relationships and sets of data structures. A fundamental set of instructions would allow operations, including sequencing, branching and recursion, within an accepted hierarchy. Logic structures have always appealed to artificial intelligence researchers as a natural entry point to demonstrate machine intelligence.

Today, the Web consist primarily of a huge number of data nodes; the data nodes are connected through hyperlinks to form "hyper-networks" that collectivity can represent complex ideas and concepts above the level of the individual data. The Web merely stores and retrieves information, even considering some of the "intelligent application" in use today (including intelligent agents, EIPs, and Web services). So far, the Web does not have some of the vital ingredients it needs, such as a global database schema, a global error-correcting feedback mechanism, a logic layer protocol, a method of adopting Learning Algorithms systematically throughout its architecture, or universally accepted knowledge bases with interface engines. So, the Web continues to grow and evolve, but it does not adapt – and adaptation is an essential element of learning. If the jury is still out on defining the Web as

intelligent, can still consider ways to change the Web to give it the ability to adapt and therefore to learn.

The Web may be nexus of much of information flow, but it is not overly smart. In the future the Web will need to do much more than pass raw data between people via search engines.

The Semantic Web is a vision of having data on the Web defined and linked in a way that can be used by devices, not just for display purposes but for automation, integration and reuse of data. The wireless communication process should start by talking to a personal or embedded device that recognizes the user's words and commands. It will connect seamlessly to the correct transmission device, drawing on whatever resources are required from around the Web. Perhaps only database search, sorting and retrieval are required. Or perhaps a specialized application program will be needed. In any case, the information will be evaluated and the content of the message with the appropriate supporting data to fill in the "blanks" will be provided.

The Web require fundamental upgrades in the physical and intellectual components to perform intelligent tasks, including: wireless networking infrastructure, personal and embedded devices, processing chips, semantic Web architecture, mobile Internet protocol, parallel processing artificial intelligence application over clustered networks, perhaps as Web Services, adaptive software languages and learning algorithms, speech recognition, understanding, synthesis and translation. These physical and software components are necessary to implement the Intelligent Wireless Web. They require changing software applications from dumb and static to intelligent and dynamic.

The Web's content is presently expanding at an enormous pace, but the quality of its structure is not improving. The only mechanism for network restructuring at present is the contributions of individual Web-designer subnetworks. This result in a Web that is weakly organized. Any system capable of dynamically adapting network structure and content must use information that is locally available to HTTP servers.

But the Web has limited control above individual HTTP servers. Many of the existing systems for flexible hypertext depend on extensive information being stored and managed. As a result, the control for the automatic adaptation of structure for the Web is limited to local networks.

The IT community seems to be leaning toward defining the Web in terms of a database with knowledge representation. Artificial intelligence based solutions for capturing and indexing vast amounts of Web information, that are already available.

Artificial intelligence related technologies are at the heart of all Internet search engine services.

For the Web to learn, it requires the capabilities of knowledge discovery, learning algorithms and self-organization. Then the Web will autonomously change its structure and organize the knowledge it contains by learning the ideas and preferences of its users.

Supplementary to adding artificial intelligence algorithms and agents to web services, the W3C suggests the use of better semantic information as part of Web documents and the use of next-generation Web languages such as XML and RDF.

The Semantic Web carries the vision of having data on the Web defined and linked in a way that it can be used by devices not just for display purposes but for automation, integration and reuse of data across various applications. To make this vision a reality for the Web, supporting standards and technologies must enable devices to make more sense of information on the Web. For the Web to scale, programs must be able to share and process data, even when these programs have been designed totally independently.

Web-enabled languages and technologies are being developed (RDF-schema), schema and ontology integration techniques are being examined, and Web services integration standards are being defined. The success of Semantic Web will depend on a widespread adoption of these technologies.

A framework for representing metadata is Resource Description Framework (RDF). The goal of RDF is to enable the automation of many Web-related activities, such as resource discovery. RDF is a model for metadata, and XML can be used to represent this model. Another goal of RDF is to define a mechanism for describing resources that makes no assumptions about a particular application domain, nor defines the semantics of any application. Such models are used to represent knowledge representation, to address reuse and components and to handle problems of schema evolution.

The road map for achieving a set of connected application for data on the Web in the form of a logical Web of data is called the Semantic Web. An underlying idea of semantic networks is the ability to resolve the semantics of a particular node by following an arc until a node is found with which the agent is familiar. The Semantic Web, in competition with artificial intelligence Web Services, forms a basic element of the Intelligent Wireless Web.

The Web was originally designed as an information space, with the goal that it should be useful not only for human-human communication, but also for interactions between devices. One of the major obstacles to this has been the fact that most

information on the Web is designed for human consumption, and even if it was derived from a database with meanings for its database elements, the structure of the data is not evident to an autonomous agent browsing the Web. Leaving aside the artificial intelligence problem of training devices to behave like people, the Semantic Web approach instead develops languages for expressing information in a form that a device can process.

The model general is the RDF. The basic model contains only the concepts of an assertion and quotation, making assertions about assertions. RDF applications are for metadata in which assertions about assertions are basic, even before logic.

The RDF model does not say anything about form of the reasoning engine. The proof will be a chain of assertions and reasoning rules, with pointers to all the supporting material. RDF at the logical level already has the power to express inference rules.

RDF at the logical level is a query engine of specific algorithms and indexes. Although search engines that index HTML pages find many answers to search and cover huge part of the Web, they return many inappropriate answers. There is no notion of "correctness" to such searches. By contrast, logical engines have typically been able to restrict their output to provably correct answers, but have suffered from the inability to go through the mass of connected data to construct valid answers.

If an engine of the future combines a reasoning engine with a search engine, it may actually be able to construct proofs. It will be able to reach out to indexes that contain very complete lists of all occurrences of a given term, and then use logic to weed out all but those which can be of use in solving the given problem.

The Web may benefit from self-organizing software, adaptive protocols, and object-oriented dynamic languages to give the Web a significantly hunger of mobility and dynamism, as well as integration of devices and sensors embedded in the real world. Self-organizing network software refers to the ability of a network to organize and configure itself.

Adaptation means the ability of protocols and applications to learn and adapt to the changing conditions in the network, such as levels of congestion and errors. The next-generation programming language may also support intelligent, adaptive, complex software systems. Adaptive software may use information from the environment to improve its behaviour over time. Object-oriented dynamic language forms a higher level of abstraction, semantics, development, and reflection.

Adaptive software may offer to change this adding a feedback loop that provides information based on performance. The design criteria itself becomes a part of the program, and the program reconfigures itself as the environment changes.

At the question “how will the Web learn?”, it suggest a composition of the Semantic Web with its logic layer utilizing components of artificial intelligence agents, learning algorithms and artificial intelligence applications, including adaptive software available through Web Services.

Two basic options exist for locating Web intelligence. Web intelligence could be globally distributed throughout the Web as a layer of the infrastructure over Web protocols. Although the semantic Web architecture is not actually an artificial intelligence application in itself, it is a foundation for possible artificial intelligence applications that could be added to its logic layer.

An alternative approach is locating Web intelligence locally, centralized on an artificial intelligence portal (providing Web services) that is joined to its own cluster of Web computers. Each approach has a serious flaw. The artificial intelligence portal approach limits uniformity and access, while the global semantic Web approach faces combinatory complexity limitations.

Distributed computing is a model of data processing consisting of many small computers on a network working to do the same amount of processing as one supercomputer. The Internet, the world’s largest network, provides vastly more computer power than ASCI White’s 8.192 processors. By finding ways to allow many different computers to process smaller chunks of data, scientists hope to turn the Internet into the world’s largest supercomputers.

Locating Web intelligence on central artificial intelligence servers, each of which is joined to its own cluster of Web computers, provides a powerful component for local centralized Web intelligence.

An Intelligent Wireless Web is a network that provides any time, anywhere access to information resources with efficient user interfaces and applications that learn and thereby provide increasingly useful services whenever and wherever we need them.

It is certainly possible to develop intelligent application for the Internet without media (that is, audio/video) Web features and/or wireless capability. It is all suggestion, however, that Web media, such as audio, can lead to improved user interfaces using speech and the small wireless devices, widely distributed, can lead to easier access to large portions of the world’s population. The end result could be not just an intelligent Internet, but a widely available, easily accessible, user-friendly, Intelligent Wireless Web.

As a result, the concept of an Intelligent Wireless Web weaves together important concepts related to the growing and evolving system of information technology software and hardware known as the Internet. Intelligence (in particular,

the ability to learn) and “wireless” promise the delivery of increasingly capable information services to mobile users any time and anywhere.

Intelligent Wireless Web wove several important concepts related to intelligence (the ability to learn) wirelesses (mobility and convenience), and its advances in telecommunications and information technology that together promised to deliver increasingly capable information services to mobile users any time and anywhere.

It was certainly possible to develop intelligent applications for the Internet without media (audio/video) Web features or wireless capability. But, Web media such as audio could lead to improved user interfaces using speech and that small wireless devices widely distributed could lead to easier access for large portions of the world’s population. The end result could be not just an intelligent Internet but a widely available, easily accessible, user friendly, Intelligent Wireless Web.

An Intelligent Wireless Web represent a network that provides any time, anywhere access through efficient user interfaces to applications that learn. Notwithstanding the difficulty of defining intelligence, it recognized that terms such as artificial intelligence, intelligent agents, smart machines, and the like refer to the performance of functions that mimic those associated with human intelligence.

All of information services are the next logical step, along with the introduction of variety of different portable user devices (Web-enabled cell phones, small portable computers) that have wireless connectivity. The result will be wireless technology as an extension of the present evolutionary trend in information technology. In addition, artificial intelligence and intelligence software application will make their way onto the Wireless Web. A performance index or measure may eventually be developed to evaluate the progress of Web intelligence.

The future wireless communication process should start with a user interface based on speech recognition by which we merely talk to a personal mobile device that recognizes our identity, words and commands. The personal mobile device would connect seamlessly to embedded and fixed devices in the immediate environment. The message would be relayed to a server residing on a network with the necessary processing power and software to analyze the contents of the message. The server could then draw necessary supplemental knowledge and services from around the world through the Internet.

To build this ideal future wireless communication process we must connect the following technologies, along with their essential components: connecting people to devices – the user interface, connecting devices to devices and connecting devices to people.

The physical components and software necessary to construct and implement the Intelligent Wireless Web require compatibility, integration, and synergy of five merging technology area: user interface – to transition from the mouse click to speech as the primary method of communication between people and devices); personal space – to transition from connection of devices by tangled wires to multifunction wireless devices; networks – to transition from a mostly wired infrastructure to an integrated wired/wireless system of interconnections; protocols – transition from the original IP to the new mobile IP; Web architecture – to transition from dumb and static application to new applications that are intelligent, dynamic and constantly learning.

In present, the network upgrades and integration seems endless. Even when new, advantageous technology becomes available, the existing legacy equipment retains value. Therefore, network integration is progressive and steady, but slow.

The vast system of interconnecting wired and wireless networks that make up the Internet is composed of several different types of transmission media, dominated by wired media but including: wired (fiber optic, coaxial cable, twisted pairs) and wireless (microwave, infrared and laser).

Wireless LAN technology is rapidly becoming a vital component of data networks. IEEE Standard 802.11 - compliant LANs produce applications based upon open systems. To optimize the operation of wireless systems, software options for interfacing wireless handheld appliances emulate various systems and directly connect to databases.

To achieve the mobility requirements of the Intelligent Wireless Web, the Wireless Appliance Protocol (WAP) provides a global standard for data-oriented services to mobile devices, thereby enabling any time, anywhere access. The anticipated result is to provide intelligent networking software for routing and tracking that leads to general changes in IP networking protocols toward mobile IP. Sitting on top of the entire layer infrastructure will be a new control-plane for applications that smooth routing.

Normally, the wireless communication process should start with the user talking to a personal, or embedded, device that recognizes the person's identity, words and commands. It will connect seamlessly to the correct transmission device, drawing on whatever resources are required from around the Web. In one case, only database search, sorting and retrieval might be required. Or in another case, a specialized Web service application program might be required. In any case, the information will be evaluated, and the content of the message will be argued with appropriate supporting data to fill in the "blanks".

Ideally, the wireless communication process should start with the user talking to a personal, or embedded, device that recognizes the person's identity, words, and commands. It will connect seamlessly to the correct transmission device, drawing on whatever resources are required from around the Web. In one case, only database search, sorting, and retrieval might be required. Or in another case, a specialized Web service application program might be required. In any case, the information will be evaluated, and the content of the message will be augmented with the appropriate supporting data to fill in the blanks.

For the Web to learn how to conduct this type of intelligent processing, a mechanism is required for adapting and self-organizing on a hypertext network. In addition, it needs to develop learning algorithms that would allow it to autonomously change its structure and organize the knowledge it contains, by "learning" the ideas and preferences of its users.

The speed at which new technologies become available and the rate of technology change have increased. Therefore, to develop guidelines for strategic planning, we must consider two discordant requirements: first, to optimize the network's long-term investment while, second, optimizing the time to market for each new product. Finding the right balance is not easy. However, opportunities for wireless developers and service providers will exist when they can reach all mobile users by developing infrastructure to support any wireless carrier, any wireless network (TDMA, CMDA), any wireless device (digital cell phone, PDA), any wireless application, any Web format, any wireless technology (WAP, SMS), any medium (text, audio, TTS, speech recognition, or video).

Strategic planning for changes in the user interface (while small wireless devices proliferate) could focus on balancing innovations in software against innovations in hardware. For example, speech recognition and speech synthesis offer attractive solutions to overcome the input and output limitations of small mobile devices, if they can overcome their own limitations in memory and processing power. Therefore user interface opportunities could exist if the right balance for the client-server relationship between the small device and nearby embedded resources is achieved.

However, strategically, this will require integrating chip design engineering with specific software application engineering. It is no longer enough to build the fastest, most powerful chips possible, and then let software engineers design their applications to fit the available capability. Integrated application performance teams are essential to planning applications as speech synthesis and artificial intelligence requirements and then setting specifications for the combination of the small

device/embedded resource to properly achieve a balanced and efficient client-server, as well as peer-to-peer relationships.

Wireless communication may be driven by decentralized network architecture integrating services that today span several network technologies. The most fundamental change to network intelligence could come from intelligence produced by decentralized Web architecture, such as by upgrading the IP. Or intelligence could come from a centralized process, such as Web Services, which provides a particular function or component from a central server to multiple users around the world. However, there will be a growing recognition that centralized components, globally distributed, and modifications to the underlying Web architecture, locally accessed, are two faces of one coin. Certainly, integrated and simultaneous development appears necessary.

Regardless of how artificial intelligence applications are processed on the Web, a vital challenge will be the establishment of trusted information. The process must build trust of information and will include a form of information registration and validation.

Whether learning is achievable from artificial intelligence service providers through Web Services, or through changes in Web architecture, such as the semantic Web, or if the machine learning is achievable at all, remains extremely controversial. But it is often in response to challenges mired in controversy from competing paradigms that some latent capabilities may be uncovered. The virtue of controversies is that they motivate experts into uncovering dormant capabilities in response to the challenge.

In this context, it can say that artificial intelligence is already being introduced to the Web, but the jury is still out on whether the Web is, or will ever become, intelligent. As the Web increases the percentage of applications and protocols with learning algorithms, we can expect improvements in performance in both type and quality.

The Web may become a learning network through a combination of Semantic Web architecture and components of artificial intelligence agents and artificial intelligence applications built with adaptive software languages and connected to the Web via its logic layer. Web intelligent could be located globally – distributed throughout the Web as a layer over the infrastructure of Web protocols, as well as locally on artificial intelligence service providers, each of which is joined to its own cluster of specialized artificial intelligence application computers.

REFERENCES:

1. Bogdanowicz, K., D., *Scenarios for Ambient Intelligence in 2010*, ISTAG Report, European Commission, February, 2001;
2. <http://aima.cs.berkeley.edu/ai.html>;
3. <http://www.sciam.com>;
4. <http://www.web-iq.com>;
5. http://www.wirelessweek.com/index.asp?layout=weblinks&page=directories_links&link=0-Z&industry=Publishing;
6. McInerney, F., *Future Wealth*, Truman Talley Books, 2002;
7. Scott, Lewis, *Wireless PC-Based Services*, Prentice Hall PTR, 1st Edition, March, 2001;
8. Tamura, T., Oguchi, M., *Parallel database processing on a 100 node PC cluster: Cases for Decision Support Query Processing and Data Mining*, SC 97 Technical Paper, Institute of Industrial Science, 2001.