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# NEURAL NETWORKS FOR INTELLIGENT AGENTS: A NEW HORIZON

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## Abstract

Intelligent agents are a rapidly-evolving development that have their roots in artificial intelligence and cognitive science. Neural networks can play an important role in lending significant capabilities to intelligent agents. These capabilities include the ability to adapt their model of the environment, their user, and their affect, as well as the ability to form correlated feature sets for processing by the agent.

## 1 INTELLIGENT AGENTS: A NEW HORIZON

One of the most exciting developments within the area of artificial intelligence (AI) is that of "intelligent agents" (IA). Intelligent agents have a very substantive evolutionary trail within AI but are just now emerging as a significant development with widespread commercial potential. The potential for IA applications in the near future is reminiscent of the excitement that accompanied the emergence of neural networks as a coherent computational discipline after 1987.

While intelligent agents make use of many time-honored aspects of AI technology, IAs represent a distinct evolution from classic AI. They have, or at least should have, three significant new capabilities:

- IAs are characterized by their ability to have *affect on their environment.* They are agents for their users, not passive systems. That is, they can actively make a schedule, screen a mail file, place an order, or do other tasks. This is their most distinctive characteristic.

- IAs should have the *ability to communicate with other IAs.* For example, a "meeting scheduling" IA for one person will have to consult with and negotiate with the "meeting scheduling" IA for another person, or with multiple agents for a group of people.

- IAs should have the *ability to adapt.* An "off-the-shelf" IA will have some domain knowledge, and some (generic) user knowledge. However, each IA should have the ability to learn more about its environment and/or task domain, and should be able to configure its processes to more effectively serve its user. Further, the agent will have to build up a deeper knowledge of its affect on its environment, so that it can assess the quality of and improve its capabilities to serve its user.

# 2 ISSUES IN INTELLIGENT AGENT DEVELOPMENT

There are a large number of issues in developing intelligent agents; issues which will certainly challenge researchers and developers of intelligent systems in ways that exceed the challenges of typical "expert systems" development. These challenges include (and are certainly not limited to):

- Developing a *model* not just of a task domain, but also *of a user*, and *of the agent's affect* on the environment.
- Developing a *temporal history capability*, so that the influence of previous actions and events (by the agent itself and by others, both human and agent) can be determined. Along with this, an ability to predict or assess the likely outcome of its actions is important.
- Developing *communications protocols* for dealing with other agents.

# 3 ROLE FOR NEURAL NETWORKS

There is an extraordinarily substantive role that neural networks can play in enabling intelligent agent's capabilities. These are in three major ways:

- Neural networks provide one of the most robust mechanisms available for adapting and learning. This can be applied to adapting models of the user, of the environment, and of the network's affect.
- Because the agent must intrinsically act on its environment, it needs to be able to learn to improve its performance over time. This is inherently a control issue. The *adaptive critic* paradigm, developed by Paul Werbos, is perhaps one of the best-suited mechanisms for doing this.
- One major use of IAs will be in data-dense, time-critical situations. Under such circumstances, neural networks can perform low-level data processing, and learn to extract and present the data features that are most necessary for decision-making by the IA.

The two invited papers in this session, one by Dr. Sam Leven, and another by Bryan Thompson et al., suggest ways in which neural network methods can be used to create more effective intelligent agents. While neither paper answers any of the questions that will be paramount in the minds of designers as they undertake these new challenges, they each contribute an avenue which can potentially yield fruitful answers. Leven's paper describes how different neural networks can each lend a different capability to an IA. He further indicates how this can influence interactions between IAs. Thompson's paper shows how two interacting adaptive critics can potentially build the higher level, "metacognitive" knowledge representations which will be needed in this area.

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