

IAAI-01
Innovative Applications of Artificial Intelligence Awards

Since 1989, the American Association for Artificial Intelligence has bestowed the Innovative Applications of AI award to groundbreaking applications that employ AI techniques. These applications must be deployed and demonstrate significant, quantifiable return on investment. A look through the 13 years of winning applications shows the maturing and growing utilization of AI in industry and government around the world. The return on investment reported by the winners is a compelling testament to the economic value of AI techniques.

In 1997, AAAI also included a new Innovative Applications of AI category for emerging applications – experimental systems that hold great promise and point the way to future trends in intelligent systems.

Copies of the complete papers describing this year's award winners are available in the Proceedings of the Thirteenth Innovative Applications of AI Conference available from AAAI Press <http://www.aaai.org/Press/press.html>

2001 Awards at a Glance

Deployed Applications

- **IBM** – Natural Language Sales Assistant – A Web-based Dialog System for Online Sales
- **Administrative Office of U.S. Courts et al** – CARMA: A Case-Based Range Management Advisor (for grasshopper pest management in Wyoming)
- **Australian Department of Defence** – Interchanging Agents and Humans in Military Simulation
- **DCS** – Automated Load Planning System (for the U.S. Marine Corps)
- **NASA** – Automated Mission Planner (for Antarctic satellite)

Emerging Applications

- **USC/ISI** – Electric Elves (agents) to support human organizations
- **University of Illinois at Urbana/Champaign** – Scaling up Context-Sensitive Text Correction
- **Kyushu University (Japan)** – Collaborative Kodama Agents with Automated Learning and Adapting for Personalized Web Searching
- **THALES/LCR (France)** – An Open Architecture for Multi-Domain Information Extraction
- **Ontario Cancer Institute et al (Canada)** – Integrating Case-Based Reasoning and Image Analysis
- **University of New Hampshire** – Constraint-Based Modeling of (computer network) Interoperability Problems
- **ENAC/LOG et al (France)** – Token Allocation Strategy for Free-Flight Conflict Solving (an autonomous on-board route trajectory solver)

Deployed Applications Winners

Organization: **IBM T. J. Watson Research Center**
Application: *Natural Language Sales Assistant – A Web-Based Dialog System for Online Sales*
Application Summary: IBM has developed a Web-based natural language dialog system for e-commerce that helps users find relevant information about products and services. The goal is to keep user interest in a particular web site by decreasing the time and effort required to navigate the site for useful information. Today, most e-commerce sites use keyword search engines that require the user know domain specific jargon. A few use natural language question and answer mode (www.askjeeves.com). IBM has taken it a step further, developing a natural language *dialog* system enabling users to more precisely describe their intentions. The result is a faster and more intuitive way of interacting with web sites. The application is now deployed as a live pilot.
Return on investment: User studies demonstrated that users prefer the more intuitive natural language over menu-driven site navigation (79% to 21% respectively.) Compared to the menu driven system, the average number of clicks used in the NL system was reduced by 63.2% and the average time reduced by 33.3%.
AI Techniques: Combines traditional AI rule-based techniques with taxonomy mapping, natural language processing, knowledge representation, rule-based taxonomy mapping, state-based dialog management, human computer interactions

Organization: **Admin. Office of U.S. Courts,**
Hastings Consulting Inc., & University of Wyoming,
Application: *CARMA: A Case-Based Range Management Advisor*
Application Summary: Grasshopper infestations in the western United States are a serious ongoing problem, annually consuming 21-23% of all rangeland. Before 1996, the federal government's Department of Agriculture shouldered about half the cost of treatment management for ranchers, as well as providing advice to ranchers about treatment selection. Federal budget cutbacks have ended this subsidy. CARMA is helping fill the void by advising ranchers in the most cost-effective responses to rangeland grasshopper infestations – whether chemical, biological, or do-nothing. The system predicts grasshopper forage consumption and suggests case-sensitive solutions. It provides advice comparable to that produced by

human experts. It recommends the most appropriate treatment and supports the recommendations with explanations of causal, economic and pragmatic factors. This includes a numerical estimate of the proportion of forage consumed and a cost-benefit analysis of the various treatment options.

Return on investment: CARMA has captured and codified the expertise of eight experts with a combined 18 years experience, delivering on demand. It is widely available via the University of Wyoming website and has been used by ranchers and pest managers every summer from 1996 to 2000. The system has also been used in several unanticipated ways: in pest management research, by industry to develop pest management strategies, and in state and federal pest management policy decisions. Development costs for the system were small, consisting of several years of graduate research assistant support, and license fees for Franz Allegro Common Lisp, the application development language.

AI Techniques: Case-based reasoning, model-based reasoning, heuristic rules, opportunistic control strategy

Organization: **Australian Department of Defence,
Defence, Science, & Technology Organisation, Air Operations Division**

Application: *Interchanging Agents & Humans in Military Simulation*

Application Summary: This simulation investigates the effectiveness of flying tactics and sensor employment policies for maritime patrol and surveillance as a function of weather conditions, geography, and other factors that impact a mission. It allows the interchanging of software and human agents for each tactical decision maker on the aircraft (e.g., radar, sensors, etc.).

There are a number of factors modeled:

- the physical aircraft, its sensors, fuel consumption, etc.;
- the tactical onboard decision making processes;
- the environment (weather, sea state)
- several types of ships

As the aircraft's sensors and avionics are upgraded, the simulation enables operational analysts to develop new policies utilizing the upgraded capabilities. Putting humans in the loop enables testing, evaluating, and refining existing and new tactics.

Return on investment: Significant savings in dollars due to more efficient missions that use less time and fuel, and extending aircraft life through smarter operations.

AI Techniques: Intelligent agents, dMARS agent modeling language

Organization: **DCS (for the U.S. Marine Corps Department of Aviation)**

Application: *The T-AVB Automated Load Planning System*

Application Summary: This system enables automated, flexible, dynamic load planning for a modified container ship that provides logistics support to U.S. Marine Corps aircraft. The loading must support work centers repairing defective or broken aircraft components while en route to an operational theater, or, if needed, to continue operating until finally moved ashore. This is a multifaceted, complex planning problem, made more so by the order in which the required materials are delivered (or delayed) for loading. There is no formal training available for the planners. The lack of experience and training became clear during preparations for Desert Shield/Storm when time was short and there were no experts. Further, there is high attrition of experienced personnel as they get new orders, retire, forces are reduced, etc. The TALPS system provides training for new planners, inventory management, allows 'what if' scenarios with the current load, efficient loading, unloading and on-the-fly tracking of any cargo onboard.

Return on investment: Where manual load planning takes a minimum of 8 to 10 hours (resulting in a plan that could be rejected as unsafe, thus restarting the 10 hour clock), TALPS computes a safe load plan in about 10 minutes (conservative estimate.) The system provides cargo preparation schedules, load team assignments, and cargo flow schedules as by-products. Prior to TALPS, these would have been prepared manually after plan approval, each taking hours to prepare.

AI Techniques: Rule-based reasoning, PDC Visual Prolog

Organization: **NASA/ Jet Propulsion Laboratory**

Application: *RadarSAT(ellite)-MAMM Automated Mission Planner*

Application Summary: NASA developed this planner for RadarSAT, a Canadian Space Agency satellite. The joint NASA/CSA mission over the Antarctic gathered data on ice surface velocity from September to November 2000. The planning problem was to select a set of swaths for the satellite to travel and downlinks to transfer gathered data such that it covered the desired geographical region and science requirements while constrained by tight resource and operational dictums. Limited on-board tape recorder capacity and downlink opportunities constrain the amount of data that can be acquired and saved between downlinks.

- Return on investment:** Manual development of a 24-day mission plan containing 800 swaths requires over a work-year. The automated mission planning system reduced costs to one sixth of the manual planning effort, as well as enabling rapid generation of what-if scenarios for evaluating mission design tradeoffs, and on-the-fly re-planning during the mission when anomalies occur. The system is expected to reduce re-planning staff required for anomalies during the mission from four to one.
- AI Techniques:** JPL's ASPEN automated planning and scheduling tool, knowledge representation

Emerging Application Papers

- Organization:** **University of Southern California/
Information Sciences Institute, Intelligent Systems Division**
- Application:** *Electric Elves: Applying Agent Technology to Support Human Organizations*
- Application Summary:** Intelligent agents functioning as administrative assistants assist a human organization in routine tasks such as rescheduling meetings, selecting presenters for research meetings and demonstrations, tracking locations, organizing lunch meetings, ordering food for meetings, etc. AI technologies are employed for: agent-human interactions, agent-to-agent coordination, accessing multiple heterogeneous information sources, dynamic assignment of organizational tasks, and deriving information about organization members. In addition, Markov Decision Processes for agent 'adjustable autonomy' have been crafted to enable the agents to recognize their limits, thereby avoiding critical errors by letting people make the more important decisions while the Elves autonomously make the more routine decisions. The system is tied to individual user workstations, fax machines, voice, mobile devices such as cell phones and palm pilots. While it is currently being tested in a research environment, developers envision its utility in a variety of organizations including crisis response teams.
- Results to-date:** Electric Elves has been in operation 24 hours a day 7 days a week since June 1, 2000 in service to ISI's Intelligent Systems Division. It includes nine proxies for nine people, and plus two different matchmakers -- one flight tracker and one scheduler. The application's effectiveness is observed in automated meeting rescheduling which has significantly

decreased human email traffic and decreased the overhead of waiting for delayed members in meeting rooms. Human time involved in recruiting group members to make presentations at research meetings has been reduced to almost zero since the Electric Elves automatically make these selections in a way satisfactory to the group. Another benefit the group has identified is the personnel tracking web page where each person's agent posts and updates their whereabouts, thus avoiding the overhead of trying to track them down manually. The Elves also order lunch via fax.

AI Techniques: Knowledge-based and statistical matching, machine learning, multi-agent teamwork coordination, planning using Markov decision processes

Organization: **University of Illinois at Urbana/Champaign**

Application: *Scaling up Context-Sensitive Text Correction*

Application Summary: This experimental system goes beyond standard spell checkers to perform context-sensitive text correction using machine learning. While this can be done fairly well in limited domains with small grammars (20 to 40 words), the challenge tackled in this work is how to scale such capabilities up to broad domains and topics users would write about.

Results to-date: Demonstrates increased domain coverage (roughly 500 words) while providing high levels of performance.

AI Techniques: Natural language processing; machine learning

Organization: **Kyushu University (Japan)**

Application: *Collaborative Kodama Agents with Automated Learning and Adapting for Personalized Web Searching*

Application Summary: Groups of cooperating agents function as active personal web navigation assistants automatically learning about web sites and user preferences. Where traditional search engines catalog and store information about web sites in a static way, this system demonstrates the ability to adapt and change with the dynamically changing contents of the web and the user's ability to articulate his/her preferences.

Results to-date: Promising experimental results verify that Kodama can learn and adapt to the user's preferences over time.

AI Techniques: Natural language; Kodama (Kyushu University Open Distributed Autonomous Multi-Agent); reinforcement learning

Organization: **Thales/LCR (France)**

Application: *An Open Architecture for Multi-Domain Information Extraction*

Application Summary: With the growing number of information sources available on the Internet, as well as the rapidly changing information available on each, methods for automatically gathering and mining relevant textual information will be increasingly useful. This application uses natural language and machine learning techniques to find user-requested content.

Results to-date: This approach has been successfully tested on content from the AFP news wire.

AI Techniques: Distributed collaborative multi-agent platform, ontologies, knowledge acquisition and natural language processing

Organization: **Ontario Cancer Institute/ Princess Margaret Hospital et al**

Application: *Image Feature Extraction for Protein Crystallization: Integrating Image Analysis & Case-Based Reasoning*

Application Summary: With the technology (including robotics) available to conduct protein crystals growing experiments, the wet lab can prepare over sixty thousand crystallization experiments in a work week. This creates a need for an automatic image analysis system to analyze and classify outcomes. The system automatically stores the outcomes of experiments as images, extracts important image features, and uses them to automatically recognize different crystallization outcomes. Next it uses the outcomes of the image classification as part of case-based reasoning to plan crystallization experiments for new protein recipes.

Results to-date: Image classification accuracy of 85%. Promising progress indicates that it is worthwhile to continue to pursue this line of investigation.

AI Techniques: Integrated case-based reasoning and image analysis, data mining

Organization: **University of New Hampshire**

Application: *Constraint-Based Modeling of Interoperability Problems using an Object-Oriented Approach*

Application Summary: Modeling language for an application that checks the degree of compatibility between two networking devices that implement the same protocols in ATM (asynchronous transfer mode) networks.

AI Techniques: Constraint satisfaction, object oriented programming

Organization: **ENAC, CENA (France)**

Application: *Token Allocation Strategy for Free Flight Conflict Solving*

Application Summary: FACES is an autonomous on board flight path planner in free flight zones. It computes simple maneuvers that guarantee

conflict free flight paths for the ensuing 5 minutes. It can be integrated with current positioning, broadcasting and flight management technology.

Results to-date:

The system has been successfully tested with a traffic simulator on a busy traffic day over France. Of the 2,781 aircraft that entered the Free Flight zone in a day, 638 out of the 641 conflicts that occurred were solved without using vertical maneuvers, and the remaining three were easily solved with vertical maneuvers.

AI Techniques:

*A** algorithm