

American Association for Artificial Intelligence

Fifteenth Conference on Innovative Applications of Artificial Intelligence

IAAI-03 SUMMARY OF APPLICATIONS

Since 1989, the American Association for Artificial Intelligence has sponsored the Innovative Applications of Artificial Intelligence Conference. IAAI awards spotlight recently deployed applications that make a significant impact on an organization, and yield an impressive return on investment due to their use of artificial intelligence techniques. Further, these applications utilize AI technology in novel ways, pointing the way towards new trends in intelligent systems.

A look back through the fifteen years of the conference award winners yields a glance at the evolution of the field. For a summary of applications from the past two conferences, please visit the AAAI e-Press Room's Background Information page in www.aaai.org/Pressroom/pressroom.html. There you will find a host of applications by major corporations and government agencies.

In 1997, AAAI expanded the scope of IAAI. Recognizing the growing number of emerging applications that were still in a pilot phase, a second track was added to the conference. The emerging applications selected for this track, while not yet fully deployed, are far enough along in their development process to indicate that the approach is useful and development will continue to fruition in eventual deployment.

This white paper summarizes each of the 20 applications selected for this year's IAAI conference – four deployed, award-winning applications, as well as 16 emerging applications. The Proceedings of IAAI-03, including the complete technical papers describing each application, are available from AAAI Press (www.aaai.org).

IAAI-03 AWARD WINNERS

This year's four award-winning applications represent a diverse set of deployed applications, each making a significant impact within their organizations. They are ordered in the same sequence as they will be presented at the conference.

- **Organization:** **Educational Testing Service & Hunter College**
Application Title: Criterion Online Essay Evaluation:
An Application for Automated Evaluation of Student Essays
- Summary:** Educational Testing Service is a leading supplier of fair and valid assessment instruments. Criterion is a commercially deployed, web-based system that provides automated scoring and evaluation of student essays, providing specific feedback for students to improve their writing skills. The application is intended to relieve the load on teachers faced with reading and providing detailed feedback on perhaps 30 essays or more every time a topic is assigned. Criterion combines automated essay scoring and diagnostic feedback detecting errors in grammar, usage, mechanics, and undesirable style.
- Return on Investment:** Outperforms baseline algorithms, and some of the tools agree with human judges as often as two judges agree with each other.
- AI Technology:** Natural language processing, machine learning

- **Organization:** **NASD (National Association of Securities Dealers)**
Application Title: The NASD Securities Observation, News Analysis & Regulation System (SONAR)
- Summary:** SONAR monitors the NASDAQ Over the Counter and futures stock markets for potential insider trading and fraud against investors through misrepresentation.
- SONAR has been in operational use at NASD since December 2001, processing approximately 10,000 news wire stories and SEC filings, evaluating price/volume models for 25,000 securities, and generating 50-60 alerts per day for review by several groups of regulatory analysts and investigators. The application has greatly expanded surveillance coverage to new areas of the market and increased accuracy significantly over an earlier system.
- In one case, NASD undertook a search using SONAR for post-911 bioterror products. In the aftermath of that tragedy and subsequent anthrax attacks, a number of companies began touting “anti-bioterror” products in order to inflate the apparent value of their offerings. The search

netted at least three companies, which the SEC took to criminal court.

Return on Investment: Significant improvements in accuracy over predecessor system (SWAT). While SONAR generates less than half as many alerts as SWAT, more than three times as many of those alerts are reviewed for possible prosecution. In addition, the time to review an alert is reduced by 50-66% - from 30-60 minutes down to 15-20 minutes. Over 4 months, this totaled a savings of roughly 6000 hours reviewing breaks. Annually, this equals a savings of nine positions (out of about 30), which have been redirected to greater detail in later stages of review, resulting in more comprehensive and accurate regulation.

AI Technology: Natural Language Processing text mining, rule-based inference, uncertainty, fuzzy matching, text search agents, knowledge-based system

□ **Organization:** Tokyo University of Science,
Information Media Center (Japan)

Application Title: A Cellular Telephone-Based Application for Skin-Grading to Support Cosmetic Sales

Summary: Door-to-door sales is one of the most popular sales strategies in Japan. Skin Customer Relationship Management (Skin-CRM) is a sales support system for door-to-door sales of cosmetics based on a skin-image grading system. Using a cellular phone with a camera, email software and a web browser, the sales people take a picture of a customer's skin using the camera on their phone with a small cheap magnifier to get the right scale. The picture is sent to the analysis system by email. The results are output as a page in html format available on a customer-accessible website. An e-mail is sent when the results are available, usually within minutes. Sales people check the result by using a web browser on their cellular phone. The output includes a grading result, and also recommendations for care and cosmetics that are most suitable for this customer.

Return on Investment: Skin-CRM has been deployed within seven cosmetics companies already with about 10,000 sales people using the system. (Potential market size is about one million sales people in Japan, or about 10 million dollars per month.)

AI Technology: Data mining, expert system

- **Organizations:** **SISCOG (Portugal), NSB BA (Norway)**
- Application Title:** TPO: A System for Scheduling and Managing Train Crew in Norway
- Summary:** Using CREWS, a generic tool for scheduling railway crews, this award winner describes deployment of CREWS for the Norwegian State Railways. Deployed in 2000, the system schedules and manages the work of 1,800 personnel, 1,000 engine drives and 800 ticket inspectors allocated to 39 bases across Norway.
- Return on Investment:** Planners use less time to produce a complete schedule. Management has been able to check consequences of new rules, while bargaining with the unions was taking place. Gained time is primarily used to make better plans and to create more alternatives for the next and later timetable periods. It is expected that the knowledge built into the system will make it easier to recruit and train new planners. More reliable and complete statistics have already contributed to improvement of cost control and pricing of services. Hidden costs have become visible and the use of the system has contributed to a reorganization of the scheduling process and a clarification of many issues that needed to be addressed.
- AI Technology:** Beam search, heuristics, frame-based representation

EMERGING APPLICATIONS

- **Organization:** **Novator Systems (Toronto, Canada)**
Application Title: Building Agents for the Customer Service Front
- Summary:** A domain independent AI platform for creating conversational customer service agents that use a variety of natural language understanding and reasoning methods to interact with customers and resolve their problems. The platform is being applied to customer service applications such as: technical diagnosis of wireless service delivery problems, product recommendations, order management, quality complaint management and sales recovery.
- Evaluation:** Support a low cost 'self-serve' customer service solution, demonstrating the ability of the automated system to reduce call center costs and give customers more access to information.
- AI Technology:** Natural language, reasoning
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- **Organizations:** **University of Texas at Austin, Information Sciences Institute at University of Southern California, Massachusetts Institute of Technology, SRI International, The Boeing Company, University of Massachusetts at Amherst, Northwestern University, Information Extraction and Transport Corporation**
- Application Title:** A Knowledge Acquisition Tool for Course of Action Analysis
- Summary:** Uses a general-purpose knowledge-based system, SHAKEN, which lets subject matter experts, unassisted by AI technologists, assemble models of mechanisms and processes from components. In this instance, SHAKEN is used for the specific task of acquiring and reusing knowledge from experts for military Course of Action analysis. This can then be used to produce high-level COA assessments.
- Evaluation:** The system has been tested and evaluated by domain experts. Results showed that experts with very little training in knowledge representation were able to author nontrivial systems through the interface. Experts could articulate formal knowledge, in a way consistent with and building upon, the pre-existing knowledge in the system. The experts' overall assessment was that a COA analysis capability such as the one tested could ultimately be very

useful in solving operational problems: the software can work through tedious details and double-check all potential COAs, especially when the commanders are tired, under pressure, and under time constraints.

AI Technology: Knowledge acquisition, knowledge-based systems, knowledge verification, declarative inference, normative simulation, empirical simulation, analogical reasoner, limited natural language input

□ **Organization:** **University at Albany, SUNY**
Application Title: Searching for Hidden Messages:
Automatic Detection of Steganography

Summary: Detects secret messages hidden in seemingly innocuous media files (e.g., electronic images, audio and video). Uses machine learning to automatically detect hidden messages.

Evaluation: Preliminary positive results. Machine learning algorithms work in both content- and compression-based image formats, outperforming at least one current hand-crafted steganalysis technique. Current work can detect previously seen steganography techniques that the system trained on.

AI Technology: Machine learning

□ **Organization:** **University of Southern California**
Information Sciences Institute
Application Title: Transparent Grid Computing: A Knowledge-Based Approach

Summary: Intelligent middleware for on-the-fly configuration and tuning of dynamic virtual organizations of distributed, high-performance Grid computing. Initial work has been done in capturing knowledge and heuristics about how to select application components and computing resources and use that knowledge to generate automatically executable job workflows for the Grid.

Evaluation: The system has generated dozens of workflows with hundreds of jobs in real time. In a live demonstration at the 2002 Super Computing conference, it was used to generate workflows for 58 pulsar searches, scheduling over 330 jobs, and over 460 data transfers, consuming over eleven CPU hours on resources distributed over the Grid.

AI Technology: Planning, knowledge representation, heuristic control

- **Organization:** **Washington University in St. Louis**
Application Title: Say Cheese!: Experiences with a Robot Photographer
- Summary:** Experimental robot system that takes well-composed photographs of people at social events, such as weddings and conference receptions. The autonomous robot, Lewis, navigates through the environment, opportunistically taking photographs of people. The system uses two digital cameras mounted on an iRobot mobile robot platform.
- Evaluation:** Lewis has been deployed at a scientific conference (SIGGRAPH 2002) and actual wedding. At SIGGRAPH, the robot ran for a total of more than 40 hours over a period of five days during the conference, interacted with over 5,000 people, and took 3,008 pictures. Of those 3,008 pictures, 35% were either printed out or emailed to someone. At the wedding, Lewis ran for over two hours, taking 82 pictures in a 2,000 square foot area with 70 reception guests, some of whom were dancing. Only 2% of the pictures taken were printed or emailed. Face-finding is the most fragile component of the system.
- AI Technology:** Control layer (obstacle avoidance, relative motion, path planning and localization), task layer (for photography), and sensor abstraction layer.
- **Organization:** **Carnegie Mellon University**
Application Title: **Center for Automated Learning and Discovery**
Infrastructure Components for Large-Scale Information Extraction Systems
- Summary:** Initial proof-of-concept for a generalized information extraction architecture. The system has been applied to a biomedical application involving cell proteins. It extracts biologically important properties from certain images in biomedical publications, analyzing microscope images of cells, and extracting features relating to the subcellular localization of proteins depicted in these microscope images. It then associates these localization features with cell names and protein names from the caption accompanying the image.
- Evaluation:** Experimental validation of a multi-agent architecture for information extraction.
- AI Technology:** Lightweight, flexible blackboard system; representation; multi-agent architecture

- **Organization:** **Telestra Research Laboratories (Australia)**
The University of Melbourne (Australia)
- Application Title:** Applying Reinforcement Learning to Packet Scheduling in Routers
- Summary:** This research system addresses the problem for Internet service providers of guaranteeing quality service to users. Central to this problem is how routers should share network capacity between different classes of traffic. The decision needs to be made for each incoming packet – the packet scheduling problem – when the traffic class (e.g., video, voice and data) may not be known in advance and can vary dynamically. The system uses reinforcement learning to learn scheduling policies that satisfy the quality of service requirements of multiple traffic classes under a variety of conditions.
- Evaluation:** Preliminary results indicate that this approach can help network providers deliver a guaranteed quality of service to customers without manual fine-tuning of the network routers. In laboratory conditions using a simulation-based benchmark for performance measuring, significant performance gains were measured.
- AI Technology:** Reinforcement learning
- **Organization:** **Northwestern University**
- Application Title:** Qualitative Spatial Reasoning about Sketch Maps
- Summary:** Sketch maps are high-level representations that express the key spatial features of a situation for the task at hand, abstracting away the mass of details that would otherwise obscure the relevant aspects. Sketch maps today are typically drawn by hand on paper. This research effort is working to enable computers to become useful partners in geospatial problem solving, performing human-like reasoning about sketch maps. A research system is presented that enables construction of spatial representation, combined with analogical reasoning to provide a simple form of enemy intent hypothesis generation.
- Evaluation:** Proof of concept for computerized sketch map assistance, incorporating qualitative spatial representation and reasoning, to do a sophisticated task, a subset of enemy intent hypothesis generation.

AI Technology: Spatial representation, analogical reasoning, subset of Cycorp's Cyc knowledge base contents

□ **Organization:** **Texas A&M University**

Application Title: TEXTAL™: Artificial Intelligence Techniques for Automated Protein Structure Determination

Summary: An experimental system designed to automate the challenging process of inferring the atomic structure of proteins from electron density data of x-ray crystallography.

Evaluation: The system has been quite successful in determining various protein structures, even with average quality data. It has run on a variety of real electron density maps and automatically generated fairly accurate protein structures.

AI Technology: Case-based reasoning, pattern-matching, neural networks, heuristics

□ **Organization:** **University of Southern California**

Institute for Creative Technologies

Application Title: Guided Conversations about Leadership:
Mentoring with Movies and Interactive Characters

Summary: Experimental application designed for U.S. Army captains to learn leadership skills from experiences of others and through structured dialogue about issues raised in a vignette. The participant watches a short movie, interacts with a synthetic mentor and interviews characters in the story. The goal is for participants to learn the human dimensions of leadership (e.g., how to provide purpose, direction, motivation).

Evaluation: Two pilot tests have resulted in better understanding of the application domain and some success at achieving the goals of the project. Demonstrations of the system to Army officers ranging from lieutenant to general have been positive.

AI Technology: Coordination architecture, machine learning approach to natural language processing, automated animation of synthetic rendered human face.

- **Organization:** **Vanderbilt University**
Application Title: Teachable Agents
Learning by Teaching Environments for Science Domains
- Summary:** This National Science Foundation funded application introduces an innovative computer-based learning-by-teaching environment. Students teach science concepts to a multi-agent intelligent system, Betty's Brain, using concept map representations with a visual interface. The approach is based on cognitive science and education research – and the old adage about 'you can't teach it if you don't understand it'.
- Evaluation:** Extensive study in a fifth grade classroom in Nashville, TN demonstrated impressive results in terms of improved motivation and learning gains. Betty promotes deep understanding and self-assessment among students. Feedback from students and teachers indicates the environment motivates students and gets them spending a lot more time learning about complex scientific domains.
- AI Technology:** Multiple intelligent agents
- **Organization:** **The MITRE Corporation**
Application Title: Broadcast News Understanding and Navigation
- Summary:** Fully implemented system that supports intelligent and rapid search and processing of broadcast news video. The system provides intelligent segmentation, extraction, search, summarization, visualization and personalized multimedia generation. The system was motivated by a need to potentially search hundreds of thousands of programs broadcast each week globally, analyzing news by cross media processing of text, audio and motion imagery. A version of the system was deployed to a government organization responsible for information awareness and dissemination. Several of the underlying algorithms have found their way into a commercial video processing product.
- Evaluation:** Empirical evaluation demonstrates that users can find stories and answer questions nearly three times as fast as searching digital video with no loss in precision and recall.
- AI Technology:** Machine learning

- **Organization:** DaimlerChrysler AG (Germany), Stanford University
Application Title: A Probabilistic Vehicle Diagnostic System Using Multiple Models
- Summary:** Innovative on-board automobile fault detection and diagnostic system with low development and hardware costs.
- Evaluation:** A system prototype has been implemented and tested on a Mercedes-Benz E320 sedan, demonstrating advantages over traditional techniques.
- AI Technology:** Model-based representation, Bayesian network
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- **Organization:** Drexel University
Application Title: Secure Mobile Agents on Ad Hoc Wireless Networks
- Summary:** Experimental system to assure security for mobile agent systems on an ad hoc wireless network. The present testbed consists of dozens of mobile hosts, both PDAs and laptops, and hundreds of both static and mobile software agents. The researchers have developed novel mechanisms for integrating autonomous agent technologies with public-key and symmetric key encryption to support secure communication, at multiple OSI layers, among groups of hosts and agents. The agents can reason with and manipulate their network topology on the fly to improve security and enhance application performance. Network security is monitored by agents that manage keys, assess network traffic patterns, and analyze host behaviors. Agents can revoke address rights for suspicious hosts or agents, and adaptively re-route traffic at the network layer to improve system integrity.
- Evaluation:** The testbed is being tested in two ways. Informally, the development team uses the system during group events, lunch outings, etc, and more formally by staging demonstrations.
- AI Technology:** Multiple agents, meta-reasoning, machine learning
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- **Organization:** University College Dublin (Ireland)
Application Title: The Analogical Thesaurus
- Summary:** This experimental application promises to expand the conventional electronic thesauri available by extending capabilities to include analogical queries (e.g., Muslim

Evaluation: church, Hindu bible). It also has the potential to serve as an intelligent mapping component to any system using analogical or case-based reasoning.
AI Technology: Promising preliminary results.
Intelligent information retrieval

□ **Organization:** **SRI International**

Application Title: LAW: A Workbench for Approximate Pattern Matching in Relational Data

Summary: The Link Analysis Workbench is being developed to assist expert users in the intelligence community to identify and track situations of interest – terrorist and other criminal activity, signs of impending political upheaval abroad, etc. – in a sea of noisy and incomplete information. It assists users in creating and maintaining patterns against a large collection of relational data, and manipulating partial results.

AI Technology: Multiple pattern matching modules, ontology, knowledge representation, A* search.