American Association for Artificial Intelligence

Innovative Applications of AI 2002 (IAAI-02)

Summary of Winners

IAAI-02 includes 18 papers – 7 deployed award-winning applications that spotlight new AI technologies with measurable benefits, and 11 emerging applications that showcase tools and techniques for next-generation intelligent applications.

Deployed Award-Winning Applications

MiTAP, Text and Audio Processing for Bio-Security: A Case Study
(MITRE Corp.)

Description: Prototype system for monitoring infectious disease outbreaks and other global events. It provides multi-lingual, global access to medical experts and others involved in humanitarian assistance and relief work. Multiple information sources (e.g., newswire feeds, epidemiological reports, email, online news, and audio/video data) in multiple languages (English, Chinese, French, German, Italian, Portuguese, Russian and Spanish) are automatically captured, filtered, translated, summarized and categorized by disease, region, information source, person and organization. Critical information is automatically extracted and tagged for searching. MiTAP currently stores 800,000 articles and processes an additional 2,000 to 10,000 daily. This application uses emerging DARPA-funded language processing technologies from the TIDES program. A TIDES World Press Update, a daily newsletter created by a user and available to MiTAP users and subscribers.

AI Technology Used: Multiple natural language processing technologies, machine learning, rules, machine translation

Results: Close to 100 user accounts, daily average of 7 users. Anecdotal results suggest MiTAP is a "labor-saving and intelligence gathering tool".

"I look it [TIDES World Press Update] over each day and consider it a tool in the war on terrorism" (Advisor on bioterrorism in a White House office since Sept. 13, 2001.)

"Superb work and an asset to the new war in which information sometimes trumps fire and steel. My staff uses it daily." (Vice-Admiral, Director of Warfighting Requirements (N7), the Pentagon)

"MiTAP has clearly become a national asset. It is enhancing our national security and, perhaps, altering the course of the war by informing those making decisions on topics critical to our understanding of the forces arrayed against us. This is a war, like all others, decided by information, but the opposition is obscure, affecting, and affected by, voices we cannot hear unless something like MiTAP amplifies and illuminates them." (Former Fleet Surgeon, Third Fleet, US Navy)

RightNow eService Center:
Internet Customer Service Using a Self-Learning Knowledge Base
(RightNow Technologies, Inc.)

Description: Customizable product that delivers customer service via the Internet. The system uses AI techniques for self-learning to facilitate automatic construction, maintenance (growth and organization of the knowledge bases), and navigation. It also uses metaknowledge relating to the usefulness of and relationships among answers to users' questions to enable the system to automatically provide most relevant possible answer to a user's question.

AI Technology Used: Integrates collaborative filtering, swarm intelligence, fuzzy logic, natural language processing, text clustering, and classification rule learning.

Results: Customers report dramatic decreases in support costs and increases in customer satisfaction. Statistics show an average of 87% of users able to answer their questions using eService Center.

Staff Scheduling for Inbound Call Centers and Customer Contact Centers
(Blue Pumpkin Software)

Description: Director is a scheduling application to optimize staffing for customer contact centers currently in use in approx. 800 call centers. Generates work schedules that satisfy and optimize a wide range of constraints (legal, union, corporate policy, employee preferences, etc.) and service quality metrics. The system can also schedule meetings and trainings, and can generate workforce plans for future hiring based on anticipated increases in user demand. Customers include 3M, Apple Computer, Federal Express, GE, AT&T, Time-Warner Cable, Verizon, Yahoo!, AOL, EDS, Cannon and more.

AI Technology Used: Constraint-based system using AI search techniques (depth-first backtracking, beam search, iterative sampling, simulated annealing-like algorithm).

Results: A one-week schedule for 150 agents (at 15 minute granularity) is generated in under 5 minutes on a Pentium-III desktop machine; a 1000-agent scenario takes 30-60 minutes. Anecdotal results include customer Borders Group (books, music, movies retailer) reports increased agent productivity by 53%, 33% reduction in expenses by more efficient staff allocation, customer service levels of 88% during peak holiday period with most calls answered in under 10 seconds, 25% reduction in recruiting and training expenses. SGI reported a 37% increase in agent productivity, a 40% improvement in customer service, and a 47% increase in caller satisfaction ratings. Timberline Software and Compaq Canada report similar impressive quantifiable results.

A Decision-Support System for Quote Generation
(IBM T.J. Watson Research Center)

Description: A prototype agent-based system to assist suppliers in responding to requests for quotes in a business-to-business e-commerce supply chain. The system provides suggested ways of fulfilling requests and shows alternatives that illustrate tradeoffs in quality, cost and timelines, which allows the decision maker to consider alternatives that reduce cost and improve customer value. The system shows ways to combine orders from multiple RFQs to improve production efficiency and cost reduction. It shows the human decision maker ways to possibly substitute and/or relax requirements to improve efficiency and profitability.

AI Technology Used: Intelligent agents for retrieving requests for quotes, finding supply items to fulfill the RFQ, and generate and evaluate possible solutions.

Results: Working prototype with ideas to extend the system using probabilistic reasoning and data mining techniques.

UTTSExam: A Campus-Wide University Exam-Timetabling System
(National University of Singapore)

Description: Automated exam scheduling system that has scheduled 27,235 students taking one or more of 1,250 exams in one of 11 venues.

AI Technology Used: Genetic algorithm with consistency checking.

Results: Once data entry was complete, the system scheduled 100,599 student examinations in less than 5 minutes, was conflict-free, and enabled last minute changes. Previously this task was done manually, took several weeks, and was error-prone.

A Structure Based Configuration Tool: Drive Solution Designer (DSD)
(University of Bremen, encoway GmbH, University of Hamburg, and Lenze AG)

Description: Complex product configuration system used by sales engineers to make on-site quotes for drives (e.g. for printing and sorting machines, automated saws, etc.). The system fulfills the functional requirements of the user from a large and highly complex catalog of components, and optimizes the solution for price, production efficiency, and delivery time. The system includes thousands of different engines, gears, engine controllers and additional components and their variants manufactured by Lenze. Currently the system is used by approx. 150 sales engineers for design layout, finding the appropriate configuration of components.

AI Technology Used: Heuristic, constraint-based configuration using depth-first search, knowledge-based representation, several inferencing techniques, constraint propagation.

Results: The time for a sales engineer to generate an offer has been reduced from an average of 4 hours to 30 minutes, and from an error-prone (and associated costs) manual method to an almost 0% error-rate; reduced costs for solutions with better performance. The system chooses more standard components more often which reduced production and maintenance costs.

Development and Deployment of a Disciple Agent for (Military Conflict) Center of Gravity Analysis
(George Mason University for the U.S. Army War College)

Description: A learning agent shell (in the expert systems shell vein) that can be used to build instructable knowledge-based systems for intelligent computer-aided instruction. Much of the knowledge can be input by the expert, with refinement by the knowledge engineer, reducing the knowledge acquisition bottleneck.   The shell, Disciple-RFK was used in this paper, for an application area called Center of Gravity analysis to teach students to identify those strategic characteristics, capabilities or localities from which a military force derives its power, strength or will to fight. The COG agent application supports students in developing a COG analysis report for a war scenario thus imparting knowledge of the processes involved in such strategic thinking.

AI Technology Used: Knowledge based representation, object ontology, task reduction rules and mixed-initiative reasoning.

Results: Disciple was used successful in the COG course in both the Winter and Spring sessions, resulting in the USAWC deciding to continue and expand the integration of Disciple in this course for the next academic year and beyond. Some of the COG students also took a "Military Applications of AI" course and used the Disciple-RFK shell to train a personal COG agent for a particular scenario.

Emerging Applications

Getting from Here to There: Interactive Planning and Agent Execution for Optimizing Travel
(University of Southern California, Information Sciences Institute and Fetch Technologies)

Description: An automated, responsive business travel planning system to aid the traveler not only in initial travel planning, but to provide updates on real conditions (flight delays, fare changes, etc.) that can affect travel. The Travel Assistant is an integrated travel planning and monitoring assistant, organizing the preliminary travel plans, and evaluating tradeoffs such as taking a car or taxi to the airport. Intelligent agents can monitor travel conditions, fare reductions, earlier connecting flights that are available, etc. and notify the system as required so the user can easily adapt as conditions change. Further, if a flight is delayed by more than an hour, the system can automatically fax to the car rental counter and hotel to ensure the user will have a car and hotel room upon (eventual) arrival.

AI Technology Used: Hierarchical constraint planning, intelligent agents.

Results: This experimental system is in use internally at USC/ISI and the developers plan to make it more widely available on the Web as part of the Electric Elves Project.

WhyNot: Debugging Failed Queries in Large Knowledge Bases
(University of Southern California, Information Sciences Institute)

Description: WhyNot guides a user in debugging a failed query to a large knowledge-base. When a query returns "unknown", the system generates a small set of plausible partial proofs to guide the user to analyze why a query could not be answered successfully. It helps the user identify what knowledge might have been missing, or where the system might have failed to make a relevant inference.

AI Technology Used: The WhyNot partial proof generator is built into the inference engine of the PowerLoom Knowledge Representation & Reasoning system; uses natural deduction to perform inference combining forward and backward chaining.

Results: A first version of the system has been deployed to help debug queries to a version of the Cyc knowledge base containing over 1 million facts and over 35,000 rules.

An Analogy Ontology for Integrating Analogical Processing and First-Principles reasoning
(Northwestern University, Georgia Institute of Technology)

Description: There is mounting psychological evidence that much human cognition involves using analogies. This paper presents research work in integrating analogical processing into AI systems.

AI Technology Used: An analogy ontology that provides a formal, declarative representation of the contents and results of analogical reasoning; integration of analogical processing with first-principles reasoners.

Results: The paper discusses three demonstration systems that have used the analogy ontology: a crisis management analogical reasoner that answers questions about international incidents, a course of action analogical critiquer that provides feedback about military plans, and a comparison question-answering system for knowledge capture. Each system uses large, general-purpose knowledge bases.

Applying Perceptually Driven Cognitive Mapping to Virtual Urban Environments
University of Southern California, Institute for Creative Technologies

Description: This paper discusses a method for building a cognitive map of a virtual urban environment. The goal is to develop virtual humans with believable perceptual and spatial behaviors. This work is relevant to computer games, military training simulations, and immersive learning environments. It is the virtual equivalent of spatial mapping in mobile robotics needed for tracking its location, navigating, and determining where places are with respect to one another. It will enable virtual agents in simulations to behave in a more believable fashion – blocking a doorway with their body and then stepping back to invite the visitor in, avoiding snipers and ambushes, crowd control, etc.

AI Technology Used: Cognitive mapping, space representation.

Results: Research results enable virtual humans to map their environment using a realistic model of perception.

Toward Practical Knowledge-Based Tools for Battle Planning and Scheduling
(BBN Technologies, U.S. Army, Austin Information Systems)

Description: This paper describes the Course of Action Development and Evaluation Tool (CADET), a knowledge-based tool for developing realistic battle plans for large units of the U.S. Army (e.g., Division or Brigade). It plans across multiple dimensions, decomposing tasks into detailed actions; determines the

necessary supporting relations; allocates tasks and assets; takes into account dependencies between tasks and availability of assets; predicts enemy actions and reactions; devises counter-actions; and estimates paths of movements, timing requirements, attrition, and risk.

AI Technology Used: Integrates incremental planning and scheduling, knowledge based systems, rules.

Results: Several different experimental systems have been built using CADET. In addition, an extensive blind judging was performed comparing CADET-generated vs. human-generated plans. Where the humans plans took on average 16 person-hours, CADET plans took less than 2 minutes to generate and 20 minutes of human review and post-editing (0.4 hours.) The CADET system was found to perform on par with the human staff in a dramatically faster manner (almost two orders of magnitude) without loss of quality as compared to conventional, manual process.

Knowledge Formation and Dialogue Using the KRAKEN Toolset (Cycorp)

Description: KRAKEN is a natural language knowledge acquisition tool for the Cyc knowledge base. It allows subject-matter experts to make meaningful additions to an existing knowledge base without being computer experts. Users interact with KRAKEN via an NL interface, which translates back and forth between English and the KB's logical representation language. The Cyc KB is currently the largest general knowledge base in the world, housing roughly 1.4 million hand-entered rules interrelating 100,000+ concepts.

AI Technology Used: Natural Language, consistency checking, intelligent assistants.

Results: KRAKEN's performance was evaluated in an independent experiment by a team of domain experts unfamiliar with Cyc. They successfully entered new knowledge of cell biology. In this early version of KRAKEN, the system's responses were rated on a 0-3 point scale in terms of correctness, quality of representation and explanation, averaging 1.91. Further evaluation six months later showed marked improvements in the system.

AI on the Battlefield: An Experimental Exploration (U.S. Army, BBN Technologies, Northwestern University)

Description: This paper describes an experiment that loosely integrated several advanced research tools for performing successive steps in planning an Army Course of Action for a Brigade. Such planning involves a wide range of assets and capabilities: thousands of professional soldiers and officers, hundreds of combat and support vehicles, sophisticated intelligence and communication equipment and specialists, artillery and missiles, engineers, medical units, repair shops, and much

more. In battle, these assets may perform hundreds of complex tasks of multiple types: intelligence collection, movements, direct and indirect fires, construction of roads, bridges sand obstacles, transportation and handling of supplies, managing civilian populations, command and control, etc. The tools that were integrated included: COA Creater from Northwestern University that allows a user to sketch the high level COA into the computer with underlying semantic knowledge based representation; a COA statement tool (Alphatech) that enabled natural language entry of the COA statement; the Fusion Engine (Teknowledge) generates a single information file from the two separate input sources; an SML translator (Teknowledge) to translate knowledge fragments into SML schema; CADET (Carnegie Group now owned by BBN Technologies) that transforms the high level COA statement into a detailed plan/schedule of operation.

AI Technology Used: A range of technologies were integrated such as qualitative spatial interpretation of course-of-action diagrams to interleaved adversarial planning and scheduling.

Results: The cobbled system was used in an experiment conducted over three days involving eight Army officers. The system was easy to learn and generated detailed plans comparable in quality to manually generated plans – but dramatically faster.

Intelligent Control of Auxiliary Ship Systems
(The Johns Hopkins University Applied Physics Laboratory)

Description: This paper describes the Open Autonomy Kernel, a generic architecture for autonomous distributed process control. OAK is specifically designed to support difficult control programs for complex systems with incomplete sensor coverage with distributed control. It includes capabilities for fault detection and recovery, and goal-directed control. For the purposes of this paper, OAK's capabilities were tested on a reduced scale version of a US Navy destroyer's chilled water distribution system.

AI Technology Used: Cooperating autonomous agent systems, qualitative model-based reasoning.

Results: Fourteen multi-stage tests were conducted, with OAK performing 34 diagnose-plan-execute reconfiguration cycles successfully. The system was able to identify the most probable failure scenario when insufficient observables presented multiple indistinguishable situations. OAK was also able to respond to two unexpected hardware failures, correctly diagnosing the failures and successfully reconfiguring the system. In cases where multiple solutions were available, OAK was able to determine and select the solution deemed optimal in accordance with the fitness criteria expressed in the script-planner rule base. When no complete solution was available, the "best fit" partial solution was identified and executed.

Computational Vulnerability Analysis for Information Survivability
(Massachusetts Institute of Technology Artificial Intelligence Laboratory)

Description: This paper describes experiments in developing self-adaptive systems that can survive attacks, whether simple or insidious and covert. Given that the infrastructure of modern society is controlled by software systems, a successful attack to the electric power grid, for example, could be catastrophic. At MIT, this group is working on a Computational Vulnerability Analysis system to deduce and develop a comprehensive set of attack models. In particular its goal is to develop multi-stage attack models in which the compromise of one resource is used to facilitate the compromise of other, more valuable resources. Ultimately, the vision is to use these models online as part of a self-adaptive system that can survive attacks.

AI Technology Used: Model-based diagnosis.

Results: The system is currently in use in a limited way assessing vulnerabilities of the MIT AI Lab's own computing environment.

A Web-Based Ontology Browsing and Editing System
(SRI International, Boeing Research and Technology, University of Texas at Austin)

Description: This paper describes efforts to develop SHAKEN, a tool that enables domain experts to build knowledge bases with very little training -- without relying on AI scientists and engineers. SHAKEN is a collection of modules for different KB interaction tasks: browsing, editing and querying.

AI Technology Used: Knowledge Representation, reasoning (& certain modules implemented in Allegro Common Lisp).

Results: The system was extensively evaluated by an external organization that hired four biologists to build knowledge bases using SHAKEN. In addition, two knowledge engineers with some background in biology built comparable KBs in the same time period. The conclusion was that SHAKEN can enable domain experts to build competent KBs comparable to those built by experienced knowledge engineers using the same tools.

The 2001 Trading Agent Competition
(University of Michigan, Brown University, AT&T Labs – Research, North Carolina State University)

Description: This paper describes the second Trading Agent Competition, aimed at shedding light on research issues in automating e-trading strategies. It is based on a challenging market scenario in the domain of travel shopping. The competition

presents agents with difficult issues in bidding strategy, market prediction and resource allocation, and the goal is to focus research in this domain.

AI Technology Used: Multiple cooperating agents.

Results: Entrants in 2001 demonstrated substantial progress over the prior year, with the overall level of competence exhibited suggesting that trading in online markets is a viable domain for highly autonomous agents. The TAC servers have been under almost constant use since the competition by several of the participants running ongoing experiments. Instructors have used TAC in education, providing a useful framework for central AI and e-commerce concepts. The third TAC event is scheduled concurrently with AAAI-02 and IAAI-02 in late July in Edmonton – stay tuned!