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Knowledge Manipulation,
Behavior Based Analysis,
General Announcements

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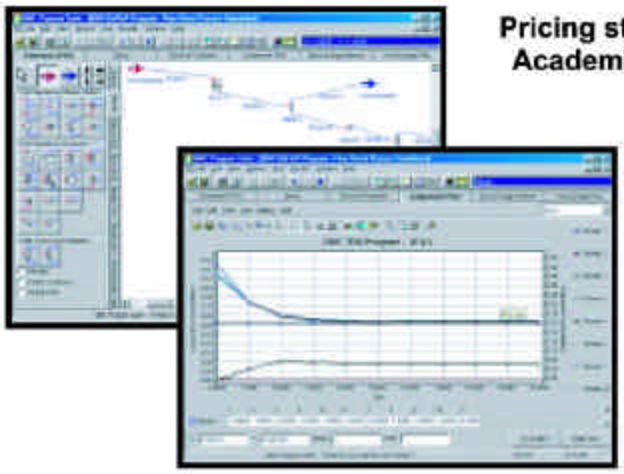

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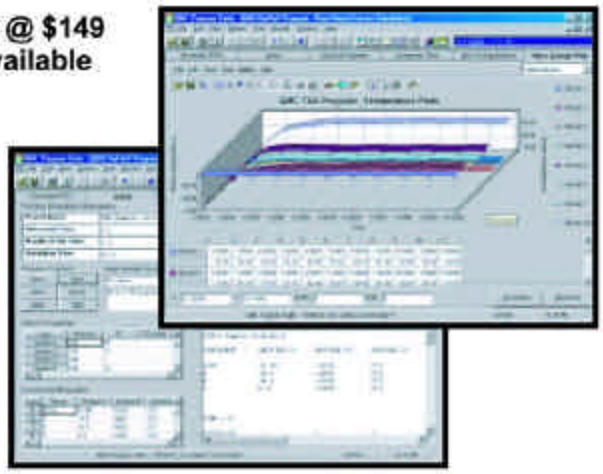

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Check out PC AI's 15 year cumulative index at:
http://www.pcai.com/web/indexes/Cumulative_index.html or http://www.pcai.com/web/issues/back_issue_summary.html

1995

9 #1 Intelligent Tools
9 #2 Fuzzy Logic / Neural Networks
9 #3 Object Oriented Development
9 #4 Knowledge-Based Systems
9 #5 AI Languages
9 #6 Business Applications

1996

10 #1 Intelligent Applications
10 #2 Object Oriented Development
10 #3 Neural Networks / Fuzzy Logic
10 #4 Knowledge-Based Systems
10 #5 Genetic Algorithm & Modeling
10 #6 Business Applications Sold Out

1997

11 #1 Intelligent Applications (Intelligent Web Search Engines)
11 #2 Object Oriented Development (Expert Systems on the Web)
11 #3 Neural Nets / Fuzzy Logic (Expert Systems)
11 #4 Knowledge-Based Systems (Data Mining)
11 #5 Data-Mining and Genetic Algorithm (Expert Systems)
11 #6 Business Applications (Neural Networks)

1998

12 #1 Intelligent Tools & Languages (Automated Agents)
12 #2 Object Oriented Development (Java Based AI)
12 #3 Neural Nets / Fuzzy Logic (Modeling)
12 #4 K nowledge-Based Systems (Modeling Methodology)
12 #5 Data Mining and Discovery (Knowledge Management)
12 #6 Business Applications (Neural Networks)

1999

13 #1 Intelligent Tools & Languages (Knowledge Verification)
13 #2 Rule and Object Oriented Development (Data Mining)
13 #3 Neural Nets & Fuzzy Logic (Searching)
13 #4 Knowledge-Based Systems (Fuzzy Logic)
13 #5 Data Mining (Simulation and Modeling)
13 #6 Business Applications (Machine Learning)

2000

14 #1 Intelligent Applications
14 #2 Intelligent Web Applications & Object Oriented Development
14 #3 Intelligent Web Portals, Neural Networks and Fuzzy Logic
14 #4 Knowledge Management, Expert Systems, Intelligent EBusiness
14 #5 Data Mining, Modeling & Simulation, Genetic Algorithms

2001

15 #1 Intelligent Applications
15 #2 AI Web Apps, OOD, AI Language
15 #3 Intelligent Business Rules & Fuzzy Logic (Petri Nets in Prolog, Knowledge for Sale)
15 #4 Knowledge Management and Decision Support (Brief History of AI)
15 #5 Data Mining, Modeling, Simulation and Analysis, Natural Language Processing
15 #6 AI to Combat Terrorism (Rule-Based Expert Systems, Hal - 2001, Multi-agent Network Planning)

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Theme: Expert Systems and Knowledge Representation and Management

Volume 17, Number 4

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Editorial

Artificial Intelligence on Mars

In the past few weeks we have witnessed yet another example (remember Deep Space 1) of AI technology leaving this planet and beginning to explore space — this time Mars, our nearest planetary neighbor. NASA and JPL have long been leaders in new technology such as intelligent applications and agents (See this issues *AI and the Net* for information on AI at JPL). Their concept of "disposable expert systems", more than two decades ago, ignited my initial interest in AI. These expert systems tested and controlled space bound components, such as fuel cells and space toilets, before they left for space. The principal concept behind these expert systems was their cost savings – the developmental cost was small compared to the cost of staffing and training personnel for these short-term diagnostic and monitoring projects. The life cycle for these computer-based experts consisted of 3 to 6 months development; use it for approximately 9 to 12 months and then retirement – a revolutionary concept for its time.

On Mars, this automation saves lives by gathering the valuable scientific data without risking human life. In the past, the primary reason for sending human explorers is our ability to adapt to unplanned situations and handle routine activities without tremendous planning and programming. For example, the instruction "go to top of hill on other side of that rock, and pick up a medium size rock sample" is easy for human to do but would be a major programming task in traditional languages such as C++. Today, robots can do this, enabling the initial and risky exploring without placing humans at risk. Man may still go to Mars, but with a much better understanding of what to expect.

Speaking of autonomous vehicles, back here on earth, we have the latest update from Paul on the DARPA Challenge, and now a new race that this challenge help spawn (See this issues Robotics Column - *DARPA Grand Challenge Race Update*). You do not have to travel to distant worlds to benefit from autonomous technology. Here, artificial intelligence can potentially saving lives by removing the human from risky situations, such as supply trucks in combat areas. There are also non-combat uses.

The Spirit Rover is and will be sending back an enormous amount of information and data to be analyzed and converted to increase our knowledge of the planet Mars. If collected independently and without correlation to the rest of the returned data, this data remains just that – data. Only when combined with other information and data, does this raw data become useful knowledge. For example, NASA and JPL are combining color images, via different color filters, with spectral analysis, and other inputs to increase their knowledge of the planet. Crucial to this activity is its knowledge representation – how the data stored, retrieved, shared, and analyzed. The use of the latest analysis techniques such as pattern matching, data mining, visual analysis requires a solid knowledge representation foundation. Knowledge organization and representation has the same impact on corporations and businesses.

In this issue, we have Joseph C. Giarratano Ph.D. reviewing the state of knowledge representation (See *The Knowledge of Representation: From Micro to Massive*). In addition, Dr. Yuri Iserlis explores different knowledge representations based on the fundamental AI technology used (See *What Computers are Capable of: The Expert Systems and AI Systems*). There is also the issue of finding information in different formats and even different languages. To help us understand Unicode, an advance in textual representation, Elizabeth Thede examines the pros and cons of Unicode. (*See Searching Beyond the Tower of Babel: Unicode and Text Retrieval*).

This is a knowledge packed issue – enjoy.

Terry Hengl

Product Updates

Behavior Based Analysis

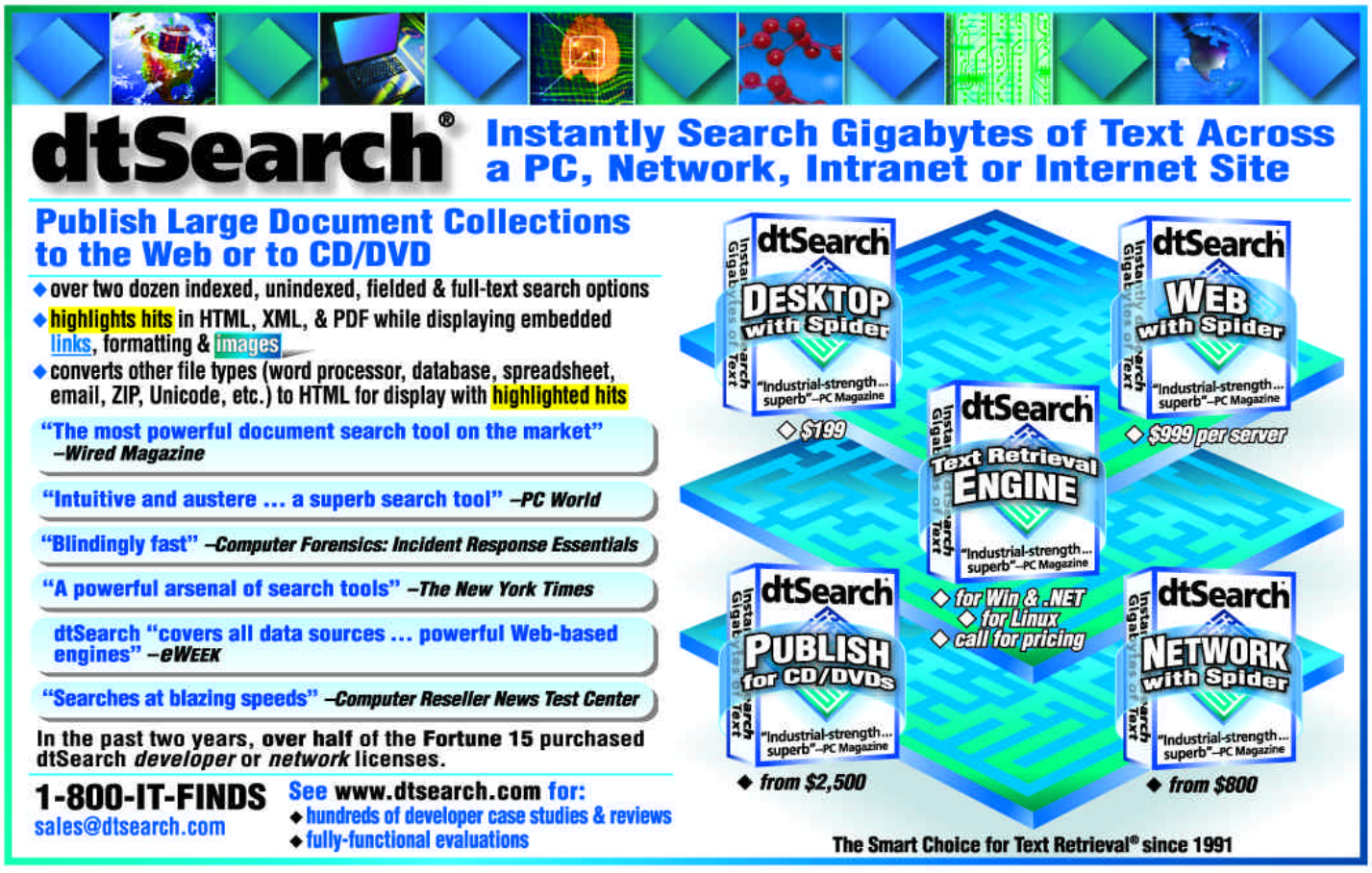
TDWI Issues Study: Building the Real-Time Enterprise

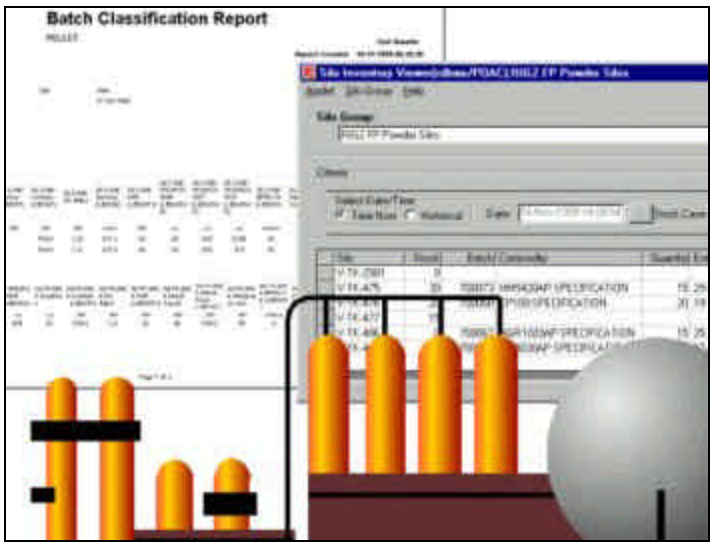
The Data Warehousing Institute (TDWI) released a new study entitled: *Building the Real-Time Enterprise*. Results indicate that four out of five real-time Business Intelligence (BI) solutions currently online are successful. The study's survey included responses from 846 BI professionals, 108 (13 percent) indicated they had implemented a real-time BI solution. 38 percent of those with a BI solution claimed they were highly successful, and another 42 percent reported fair success. Because the real-time field is new and rapidly evolving, the study recommends that real-time infrastructures be designed with flexibility to enable scalability, performance, and availability. This study also offers a detailed description of each stage involved in building a real-time business intelligence infrastructure. Topics covered include collecting operational data, what to consider when building a low-latency data store, how and where to store such data, building versus buying, business activity monitoring, business process management, real-time predictive analysis and other related topics. The report offers a section on key success factors. 37 percent were planning to deploy real-time projects, 56 percent of those planned to deploy within 12 months; the other half were not sure or had no plans to deploy a real-time project. The largest portion of qualified survey respondents (49 percent) were corporate IT professionals. The remainder were independent consultants (26 percent), business users/sponsors (19 percent), vendors (3 percent) or professors and students (3 percent). Report sponsors include: Ascential Software Corporation, Business Objects, Celequest Corporation, DataMirror, Informatica Corporation, and Teradata, a division of NCR. TDWI uses the term "business intelligence" or BI as an umbrella term that encompasses ETL, data warehouses, reporting and analysis tools, and analytic applications

The Data Warehousing Institute
Voice: 206.246.5059
www.dw-institute.com
To download the report: *www.dw-institute.com/display.asp?id=6841*

Track Material through a Supply Chain

Resolution Integration Solutions, Inc, (RIS) announces the release of its "Batch Tracking Solution," an enhancement to the Resolution Release 5.1. Product tracks material through a





logistics system automatically identifying batches as required as well as composition tracking and estimation routines. Implement for an entire facility, or in one business area at a time, and dynamically configure to match changing user business processes. Batch tracking uses the Resolution capability to: Track material movement from one location in a facility to another location; Maintain a material history in any location at any time; Store / access laboratory data; Store / access real-time data; Track events; and Maintain plans and schedules. Batches are tracked through processing equipment and silos / tanks. They can reside in one silo at a time and be moved around sequentially, or a batch can be split and pieces then reside in different silos. Multiple batches may reside in the same silo at the same time. A silo containing multiple batches may be mixed and re-batched

Resolution Integration Solutions, Inc.
Voice: 440.519.1919
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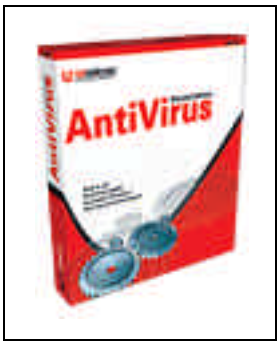
www.ris-resolution.com



New version of desktop antivirus suite

BitDefender announces the achievement of a 100% detection in the antivirus test organized by the Virus Bulletin (*www.virusbtn.com*) for the recently launched BitDefender Standard Edition v7 (for MS Windows), part of the new desktop protection suite from BitDefender. Besides BitDefender Standard Edition's virus scanning capabilities, BitDefender Professional Edition also features a behavior-based analysis module, Internet protection (e-mail, browser, instant messaging or active content filtering) and privacy control. The application scans and disinfects the most popular archives (ZIP, RAR, ARJ, ACE, CAB RPM, etc.) and allows a second action on infected files discovered on-access. File Zone and Net Zone are on the desktop to allow transparent scanning and show users in real time what happens to their system. The BitDefender desktop suite is distributed in retail stores across through BitDefender partners. BitDefender security solutions enable protection against threats that endanger a network, from a small local area to large multi-server, multi-platform WAN's. BitDefender Professional is available in four international languages – English, French, German and Spanish and available for download on the company's website (*www.bitdefender.com*). A free 30-day product evaluation is available at the end of which the product can be registered for $44.95.

SOFTWIN
www.softwin.ro
www.bitdefender.com

Business Intelligence

Business Rules with Amzi! 7.0 and Eclipse

Amzi! announces Amzi! Prolog + Logic Server 7.0 featuring the Eclipse IDE to provide state-of-the-art tools for developing and debugging logic-bases for business rules, pricing, configuration, workflow planning and other intelligent applications. Amzi! Eclipse IDE is an extension of the open source, multi-platform development environment produced by Eclipse.org. Eclipse brings to Prolog the IDE features of syntax coloring in the editors, automatic error detection on save, project support, tight integration with source control systems, sophisticated builders, cross referencing and outline capabilities. The source code debugger combines

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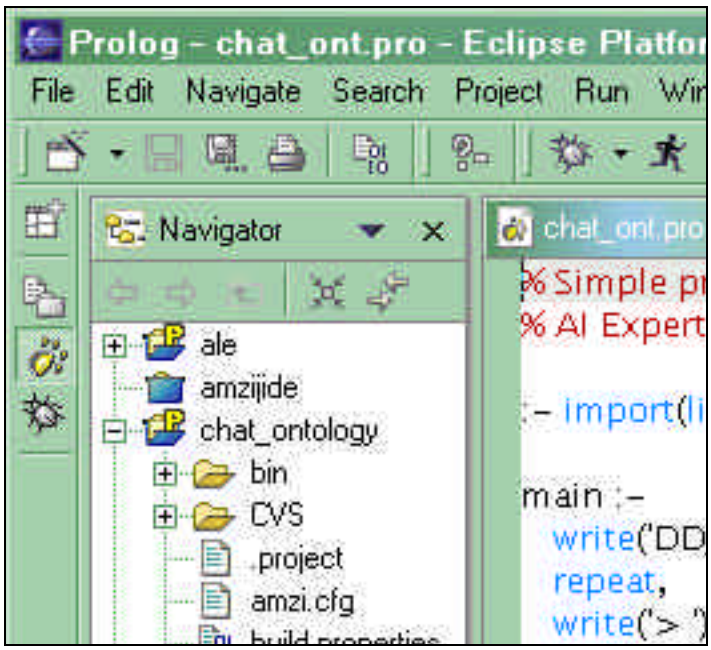

conventional debugging tools (breakpoints, pause, step-into and step-over options), with clear Prolog concept presentation (backtracking, unification and cut). As a program executes, the line of source code is highlighted in different colors depending on the state at that line, showing Prolog backtracking through Prolog source code. A separate window has the full call stack and at each level the variable bindings for the clause being executed. For the beginning Prolog user this means that logic becomes transparent, demystifying the rippling effects of recursion and unification. The professional user can debug Prolog logicbases embedded in other programming languages or running on Web servers. Applications are debugged while running either on the developer's workstation or remotely on a separate machine and operating system. Amzi! and Eclipse run under Windows, Linux, Solaris and HP/UX, and Amzi! is readily ported to other platforms. Amzi! 7.0 is available in a number of editions, from Student to Enterprise: Student Edition ($29) for personal and educational use; Developer Edition ($299); Professional Edition ($1,499); and the Enterprise Edition ($4,999) for sophisticated multi-platform, server-based applications. Educational institutions can purchase Student LAN Editions for various size labs ($149 - $999). Amzi! is also available as a Free Edition for personal and educational use; a full Prolog development system including the Amzi! Eclipse IDE, but with the traditional command-line debugger (instead of the full source code debugger).

eclipse + Amzi!

With Eclipse:

World class, multi-platform, extensible development environment

Source code debugging for Prolog logicbases running in other programs and on remote (Web) servers

Code outlines and project cross references

Team development tools

With Amzi!:

World class, multi-platform, extensible Logic Programming tools

ISO Standard

High performance for 24/7 server deployment

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You Can:

Automate the logical rules and relationships that run an organization

Develop integrated logic base components

Use professional development tools and methodologies

Customize knowledge representation and reasoning engines for individual application needs

Apply advanced ontology concepts and develop semantic web applications

Download www.amzi.com

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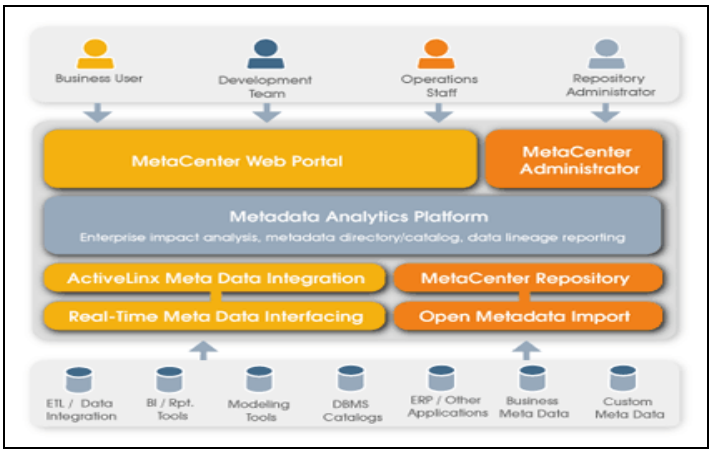
Knowledge Management



MetaCenter 3.0

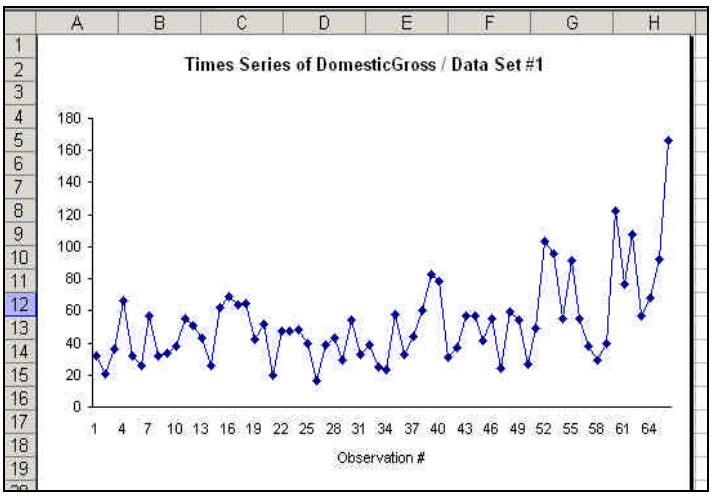
Data Advantage Group announces MetaCenter 3.0, a third generation enterprise meta data management platform designed for the distributed real-time enterprise. A single window into the information system environments unlocks the contextual and relational information stored in transactional, business intelligence, database, data integration, data quality and data modeling applications. Business requirements, business rules and corporate standards are documented, audited and seamlessly tied to the technical data underlying their execution. Empowers technical and business users to collaborate in analyzing and managing the knowledge represented in corporate information systems. Organizations benefit through improvements in employee productivity, eliminating duplicative work, institutionalization of knowledge and standards and a reduction in operational risk. Key features include ActiveLinx, a patent pending technology for real-time access to meta data in third party applications which creates persistent relationships between meta data objects across applications.

Interdependencies and interrelationships are modeled and maintained across applications without mapping these systems into a semantic neutral database structure. Built around open standards and compliant with the Object Management Group's Meta Object Facility (MOF) and Common Warehouse Metamodel (CWM) specifications. Supports XML import and export, including support for the XML Metadata Interchange (XMI) protocol. Adds to the catalogue of ActiveLinx, with support for IBM's DB2 UDB database, MicroStrategy Business Intelligence Platform, and Business Objects Data Integrator along with the existing supported products including ERwin, Business Objects Reporting, Informatica PowerCenter/PowerMart, and the Oracle and MS SQL Server databases.

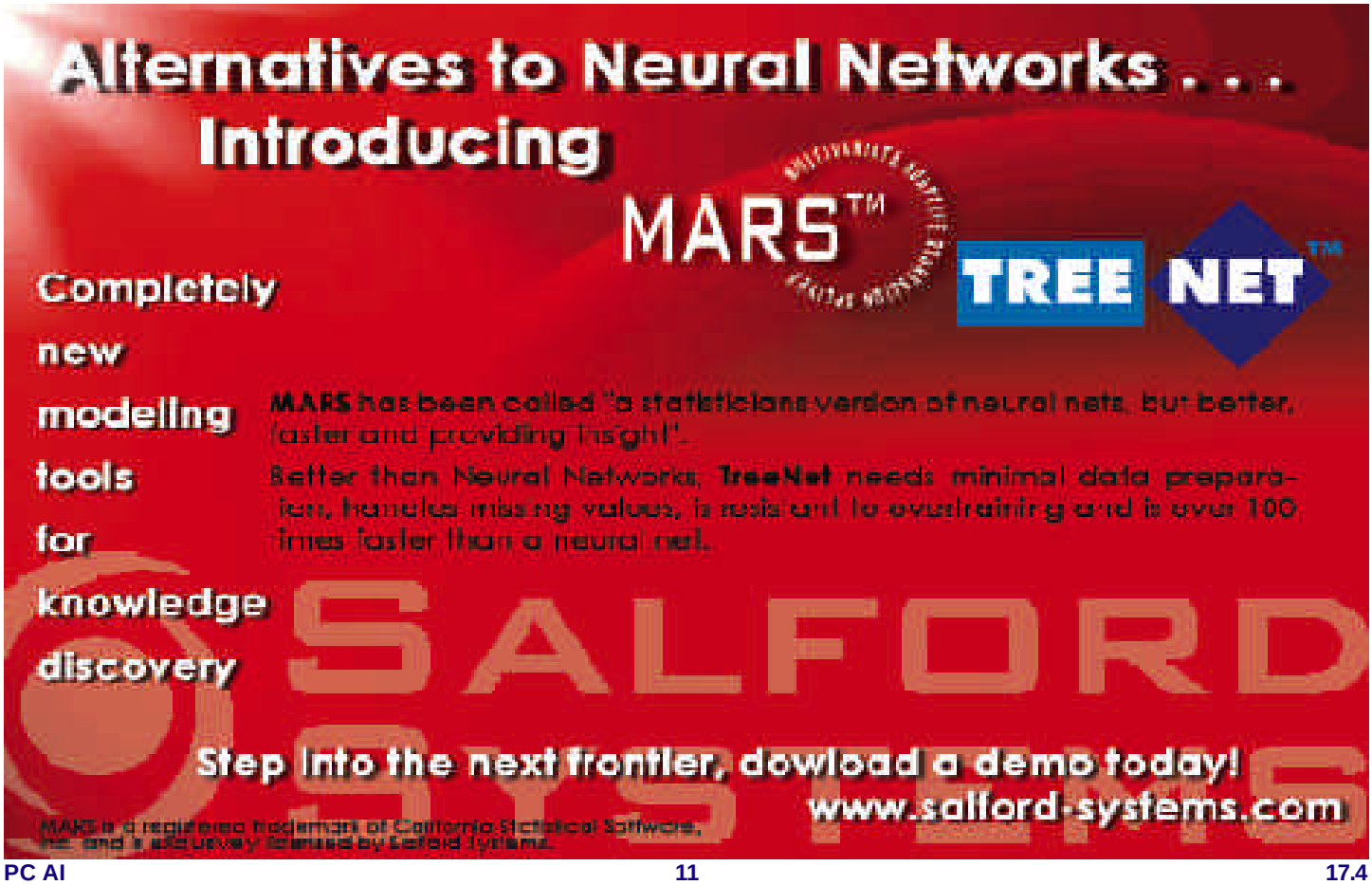
Data Advantage Group, Inc.
Voice: 415.469.4300
sales@dag.com
info@dag.com

StatTools Adds Custom Statistics to Excel

Palisade Corporation announces StatTools, a statistics add-in for Microsoft Excel combining intuitive data management with the analytical power of statistics. Complete statistics toolset replaces Excel's built-in statistics with more robust calculations, but users remain in the familiar spreadsheet environment. Allows users to create customized statistical procedures and make them available to other StatTools users. Using Excel's built-in VBA language, users access data management, charting, and reporting tools. Custom procedures are displayed on the StatTools menu and



transferred to other StatTools users. Package features dynamically hot-linked calculations, so any change in data value automatically updates the statistics report. Provides full-function data and variable management and imports data, any file read in Excel can be accessed. Data management functions include categorical data, stacked and unstacked data types, variable transformations, and random sample generation. User defines more than a thousand different datasets and any number of variables within each dataset. Variables are not constrained by column size; StatTools Pro allows over 16 million cases for a variable. Both the Standard and Professional versions provide current standard procedures for statistical inference, forecasting, classification analysis, summary analyses and graphs, normality tests, and quality control. Professional version incorporates a complete, object-oriented pro-



gramming interface. Custom statistical procedures may be added using Excel's built-VBA programming language. Price is $295 for Standard, $495 for Professional with free technical support for the first 30 days, then through a maintenance plan. A trial version available at *www.palisade.com/html/trial_versions.html*

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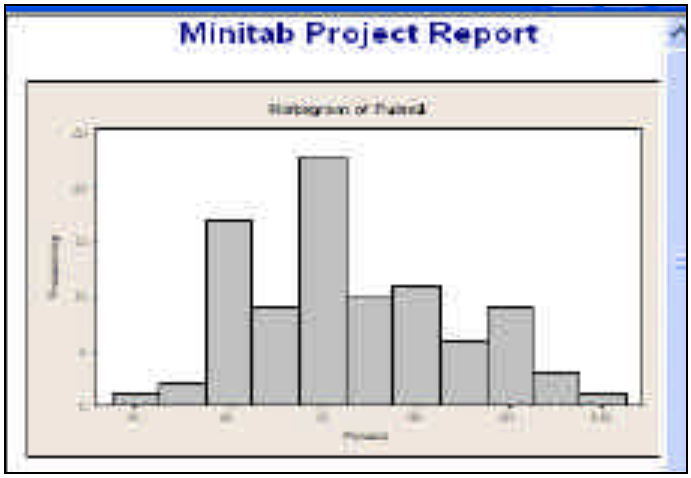

New Release of MINITAB Statistical Software

Minitab Inc. announces the availability of Release 14 of MINITAB Statistical Software for Windows. Extensive graphical enhancements mark the most significant developments in the statistics software. Important advances in the new release include: Expanded and simplified graph creation and editing; Enhanced graph appearance, plus many new options to increase graph flexibility; New quality tools including multivariate control charts and process capability analysis, enhanced attribute gage R&R; New statistical features including partial least squares, expanded DOE, and additional reliability analysis methods; Customizable menus, toolbars, and settings used to create shareable profiles. A free, fully functional demo version available for download from the Minitab website at: *www.minitab.com/14*

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Languages

CxC® Parallel Programming Software at SC2003

Engineered Intelligence (EI), announces the release of the latest version of its CxC software for parallel computing at SC2003, the Supercomputing conference. Benchmark testing was done with the original double precision LINPACK code using 500 X 500 Matrix size on HP high performance systems with 1.5 Ghz Itanium dual processors, 6 MB cache and 12 GB RAM. Running CxC's virtual parallel computing benchmark on two processors, EI was able to achieve 250% of the standard LINPACK benchmark performance of a single Itanium processor configuration. This super-linear performance is attributed to the higher speed of the cache memory when using 10 virtual processors in CxC. EI also added new functionality for multi-dimensional arrays to CxC, based on customer demand.

Engineered Intelligence
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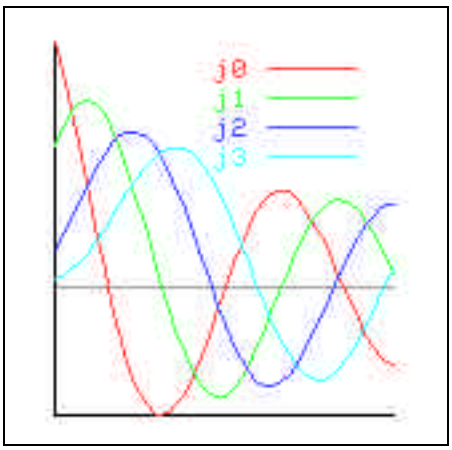
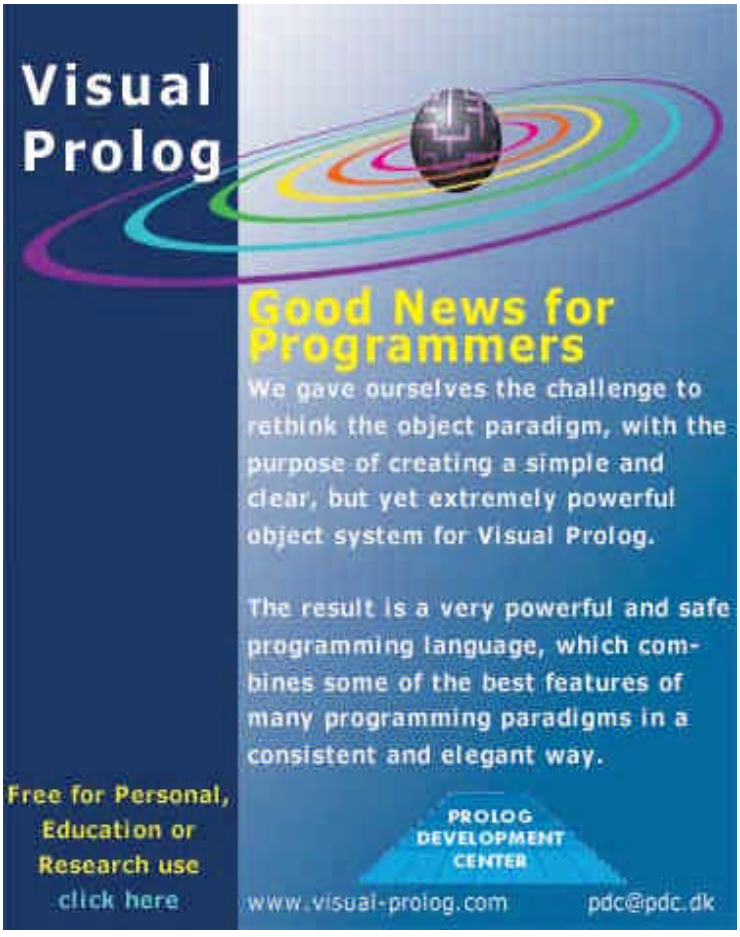


C++ Graphical Library

SoftIntegration, Inc. announces the release of cross platform SoftIntegration C++ Graphical Library (SIGL) 1.1, a solution for 2D/3D graphical plotting within the C/C++ framework. Plots are generated using SIGL for display in a local monitor, through the Web, or saved in a file with different file formats. New features are included for royalty free application distribution. It contains a plotting class with many member functions for visu-



alization to simplify the graphical plotting for C++ users. Compile and link code with the Graphical Library in the desired C++ compiler. All functions in SIGL are supported in Ch, an embeddable C/C++ interpreter. The same graphical application are compiled in C++ or run from Ch directly without compilation. The graphical library is for applications where the convenience of use and speed and performance are important. Design and deploy the graphical application running across different platforms. There is no royalty for distribution of compiled code linked with SIGL. Available for Windows, Solaris, Linux, HP-UX, and Mac OS X (requires XDarwin with the OroborOSX window manager in Mac OS X). Starts at $299 for a single-user license; Educational discounts available.

SoftIntegration, Inc.
Voice: 530.297.7398
info@softintegration.com
www.softintegration.com

Miscellaneous Tools and Utilities for Data and Knowledge Manipulation

Wireless Antivirus for Palm and Pocket PC

Global Hauri, announces ViRobot Expert Wireless protecting handheld devices from viruses and worms. Antivirus software runs an active scanner at the desktop level and uses minimum computing resources to block viruses and malware in real-time, while applying a level of Antivirus technology. Protects against new threats and updates the virus protection on handheld devices. Provides continuously running real-time scans that check the latest updates for virus definitions and deletes any virus or malicious code. ViRobot Pocket PC version can be managed under the umbrella of ViRobot Management Server (VMS) for the corporate environment, providing deployment and management capability to corporate IT. Available at *www.globalhauri.com* Recommended retail price $19.95.

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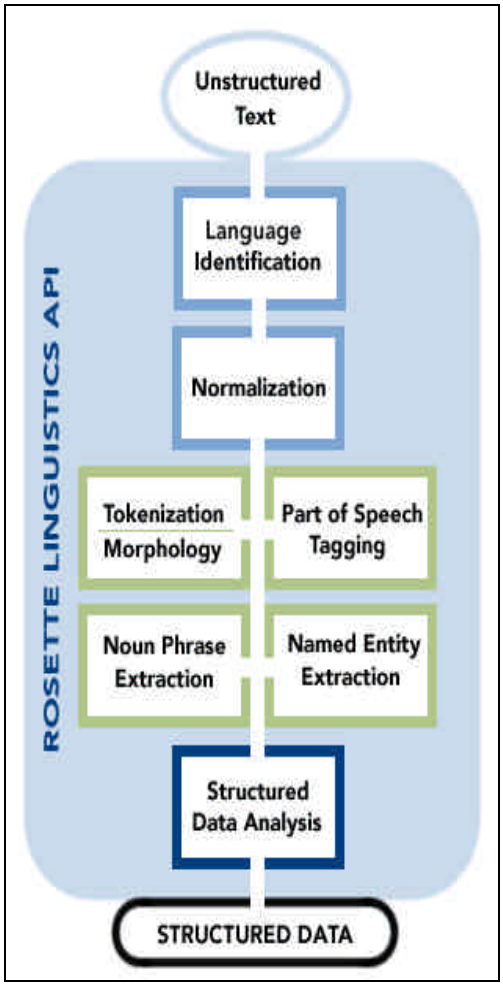
Natural Language

dtSearch® Adds Basis Technology API Support for Enhanced Chinese, Japanese and Korean Language Text Retrieval

dtSearch Corp., announces it has integrated the dtSearch Text Retrieval Engine with Basis Technology's Rosette Language Analyzers. Multinational company usage includes general information retrieval, Internet and Intranet site searching, and access to technical documentation, which benefit from Basis Technology's morphological approach to Asian text analysis. IT companies



seeking to expand their marketing efforts in Asia find a particular benefit to integration with the Rosette Language Analyzers as well as benefiting dtSearch customers in Asia, and other customers working with Asian text. Rosette Language Analyzers are part of the Rosette Globalization Platform, Basis Technology's suite of interoperable products designed for applications that analyze and process all the world's languages. These language analysis products deliver high-quality and high-performance solutions for the linguistic analysis of Asian, Arabic, and European languages. The analyzers are based on linguistic, as opposed to purely statistical, algorithms and rely on unique code to each language, resulting in a more accurate analysis. dtSearch products have over two dozen indexed, unindexed, fielded and full-text search options, including full Unicode support and special forensics options. The product line highlight hits in HTML and PDF while displaying embedded links, formatting and images. The products also convert other file types (word processor, database, spreadsheet, email, ZIP, XML, Unicode, etc.) to HTML for display with highlighted hits. The dtSearch Engine provides the API access to the Rosette Language Analyzers letting developers add dtSearch text searching and built-in file format support to Web-based and other applications. The product includes support for SQL, Delphi, Java, C++, C++.NET, C#, VB.NET, and ASP.NET. The dtSearch Engine comes in two versions, one for Win & .NET, and one for Linux (for Java and C++ programmers).

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Object Oriented Development

EiffelStudio 5.4

Eiffel Software announces EiffelStudio 5.4 for Windows, .NET, Unix, and Linux, the next step in the development of Eiffel technology designed for businesses interested in building reusable, business-critical applications. Additions from the previous version include: Increased compiler speed and runtime performance; Improved support for multithreading; Integrated .NET debugger within the environment; Enhancements to the cross-platform GUI builder, EiffelBuild, allowing users to create projects with multiple window definitions and to determine constants used in the GUI; Support for mouse wheel in editor; Cluster tree remains open between compilations; Support for adding .NET resources to .NET projects; Transparent call of overloaded .NET routine from Eiffel; Added first support for new convert keyword; Support for runtime checked preconditions and post conditions on external routines; Support for effecting a deferred routine by an external one and vice versa. Pricing for the Windows and Linux versions of EiffelStudio is $ 4,799, Unix version is $7,999.

Eiffel Software
www.eiffel.com

Robotics

Bee Activity Analysis Assists in Biologically Inspired Robot Design

Georgia Tech Research News announces a new computer vision system for automated analysis of animal movement (honey bee activities, in particular) is expected to accelerate animal behavior research, which has implications for biologically inspired robot and computer design. With an 81.5 percent accuracy rate, the system automatically analyzes bee movements and labels them based on examples provided by human experts. Bees are marked with a bright-colored paint and returned to an observation hive and videotaped for 15 minutes. Computer vision-based tracking software converts the video of the marked bees into x- and y-coordinate location information for each animal in each frame of the footage. Some segments of this data are hand labeled by a researcher and then used as motion examples for the automated analysis system. In future work, Balch and his colleagues will build a system that learns executable models of these behaviors and then runs the models in simulation to reveal the accuracy of the models. Researchers don't yet know if these models will yield better computer programming algorithms, though they are hopeful based on what previous research has revealed. In related research with Professors at Emory University's Yerkes National Primate Research Center, Balch and Khan are also observing monkeys with a similar computer vision system. They hope these studies will yield behavior models to be implemented in computer code. The research team is learning about the spatial memory of and social interaction among monkeys. The project is funded by a grant from the National Science Foundation.

Georgia Tech
www.cc.gatech.edu/~borg/biotracking

Voice & Speech Recognition

Digital Dictation

Ultimate Interactive Desktops Inc. develops digital dictation and voice information systems, including speech recognition, and other technology services. Staff is currently composed of a small team of specialists, most with extensive knowledge of computing science or engineering. The principal at Ultimate Interactive Desktops Inc. has future goals to assist government agencies, education institutions and commercial clients with speech project planning, automation, development, and implementation. For a

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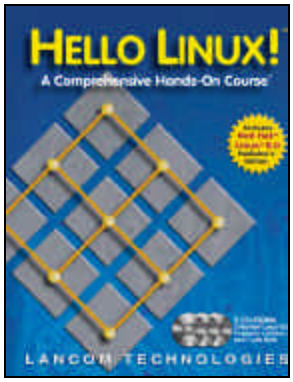
Annoucements



Hello Linux!

Lancom Technologies announces *Hello Linux! A Comprehensive Hands-On Course* in soft cover of 1,020 pages. With a track record for explaining technical aspects of OSs in a non-technical manner, Lancom developed a detailed and comprehensive resource for beginners to start the process of mastering Linux. *Hello Linux!* is designed as a step-by-step introductory companion and reference with clear explanations, hands-on exercises, and study review questions. Order this book directly from the publisher for $99.95 plus shipping and applicable taxes.

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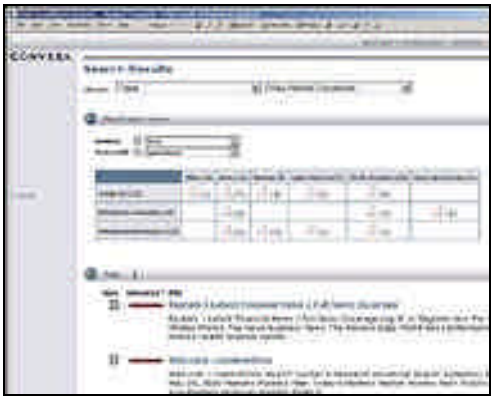

FBI Selects Convera

Convera announces the Federal Bureau of Investigation has selected Convera's RetrievalWare as a search and categorization platform within the Agency's new Investigative Data Warehouse. The initial software deployment value is approximately $1.5 million. After the events of September 11th, the FBI created a sophisticated Secure Collaborative Operational Prototype Environment (SCOPE) with a counter-terrorism and intelligence data repository. RetrievalWare was selected by the FBI for the repository to improve the sharing of intelligence information and

collaboration across multiple government agencies, enhancing the government's ability to prevent terrorist attacks.
RetrievalWare will work with other tools to help FBI analysts identify critical intelligence within the massive information repository that they use to drive investigative and intelligence activities. Specific RetrievalWare capabilities required by the FBI for the project include extensive security options, real-time message profiling, breadth of language support, multimedia search, scalability and powerful new dynamic classification capabilities.
Information sharing among intelligence agencies essential to national security will be assisted by RetrievalWare's ability to cut through enormous amounts of data to find minute details agents need to respond to possible homeland security threats.
RetrievalWare will also ensure FBI agents can search authorized information in other agency databases, in addition to the FBI's own data repository.

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Magenta Research awarded U. S. government contract for pro A/V

Magenta Research announces they have been awarded a Federal Supply Schedule contract under Multiple Award Schedule 58 I, for Professional Audio/Video, Telecommunications and Security Solutions Products and/or Services. The contract runs until November 2008. Federal Supply Schedule (FSS) contracts are issued by the U. S. General Services Administration (GSA), the largest buyer of goods and services in the world. The award represents a business partnership between Magenta and the Federal community. Magenta Research will participate in the government's on-line shopping service, GSA Advantage! and be listed as an FSS contractor on the Schedules E-Library website at www.fss.gsa.gov/elibrary. For reference, Magenta's contract number is GS-03F-0012P. The company offers an adaptive, robust and cost-effective series of transmitter, receiver and distributive systems for a large variety of A/V and command-and-control applications, including dynamic signage, courtroom image distribution and financial floors.

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Call for Papers

Robot-Mathematician Articles

The second issue of the semi-annual mathematical journal "Relational logic" (ISSN 1728-225X, *www.relational-logic.com*) has been published. The theme is the artificial intelligence of mathematician (robot-mathematician). The journal joins researchers to work at the artificial intelligence of mathematician (robot-mathematician). There are 10,000 premiums of $10,000 each for the best works in this area. The basic purpose is construction of algorithms and the programs realizing the robot-mathematician such that this robot will be better than any natural mathematician. Robot-mathematician simultaneously should be the robot-programmer (because programming is a branch of mathematics). They are requesting electronic articles to appear in the next issue. Any computer editor will work, but they are requesting LaTeX-epsilon. Articles should be directed to: *articles@relational-logic.com*, *mamalkov@hotmail.com* or *rl@malkov.msk.su*.

Relational Logic
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(Continued on Page 62)

The Knowledge of Representation:

From Micro to Massive

By Joseph C. Giarratano, Ph.D.

Today, an increasing number of powerful tools aid in the creation and management of Knowledge Representations (KR). The key requirement in KR creation is for the creator to have sufficient knowledge to select the most efficient and effective representation. Since there is an abundance of choices, we start by reviewing the KR fundamentals and some popular AI methodologies that use them.

Who Needs KR Anyway?

Modern AI technology owes its great success to a simple yet powerful axiom: knowledge is power. Back in the 1950's, people attempted to build AI programs with a minimum of knowledge since their holy grail was pure intelligence that did not rely on accumulated knowledge. An AI system should be able to determine the solution to a problem from scratch, using a minimum of knowledge and a maximum of intelligence.

Modern AI systems use knowledge much more than intelligence -- in fact they are idiots because they have no common sense. Even expert systems are at most idiot savants because they are useless outside their domain of expertise. The world's best chess player, IBM's Big Blue, which has consistently beaten the human chess champion, would fail miserably at tic-tac-toe. That's why knowledge and its representation are so important today -- they make systems successful!

In principle, this is not a bad idea as a large knowledge base is difficult to maintain – ask anyone who administers databases. Knowledge is a precious yet fragile resource:

* new facts enter the knowledge base,

* old facts may become obsolete and require deletion,

* old facts need modification.

While people manually maintaining this type of knowledge find it difficult, computers with the proper software can do it quite easily. In the worse case, the computer crashes or halts, with potentially disastrous consequences.

Some expert system development tools, such as CLIPS, have a built in Truth Maintenance System (TMS). The TMS checks whether facts and rules, which depend on other facts, should be removed or modified. This problem occurs if new facts are introduced that conflict with existing facts. A TMS is invaluable when maintaining an expert system having thousands of facts — manually checking each new fact against existing facts and rules is impractical from a time and cost perspective.

Some very sophisticated AI programs were written in the 1950's and 60's and initially achieved great success in limited problem domains, such as proving mathematical theorems of geometry. Unfortunately, their performance outside their domain was often very brittle. In addition, truth maintenance became a problem as the programs were enhanced, which introduced new bugs. New viruses could invade the system taking advantage of new software and new anti-virus software is added. All of these changes increase the entire software ecology.

Just the Facts

As mentioned earlier, the first commercial AI successes in the 1970's were based on the realization that knowledge is power. Expert systems achieved their successes by relying on large knowledge bases rather than creating an intelligent program that did not require knowledge. These expert systems used KR, in the form of IF THEN rules — which were based on studies of how humans use knowledge. When a person looks at a red traffic light, he does not consider the electromagnetic frequency of red light, or note it is the same color as human blood and then reason that a red light may mean stop.

Logic programming in languages such as PROLOG are an attempt to represent knowledge using first-order propositional logic and second-order predicate calculus. Such systems use backward chaining to reason from an initial hypothesis to the facts that support it. PROLOG is a fourth generation language that includes a runtime engine

to aid in the execution of facts. Runtime engines are characteristic of fourth generation languages and account for the great success of these languages. Many of today's successful business rule systems are based on these runtime engines. Expert system development tools such as CLIPS have a forward chaining engine that reasons from facts to the conclusions that follow. New knowledge can be inferred from existing rules and facts.

Some expert system development tools have both forward and backward chaining. In a similar manner, relational databases have a Structured English Query Language (SQL) database engine to quickly determine the answers to complex data queries. The primary characteristic of fourth generation languages is that they allow the programmer to concentrate on what the problem is rather than how to find the answer.

third generation languages such as C, C++, Java and C# have no runtime engine and the programmer must explicitly specify the algorithm for solving the problem.

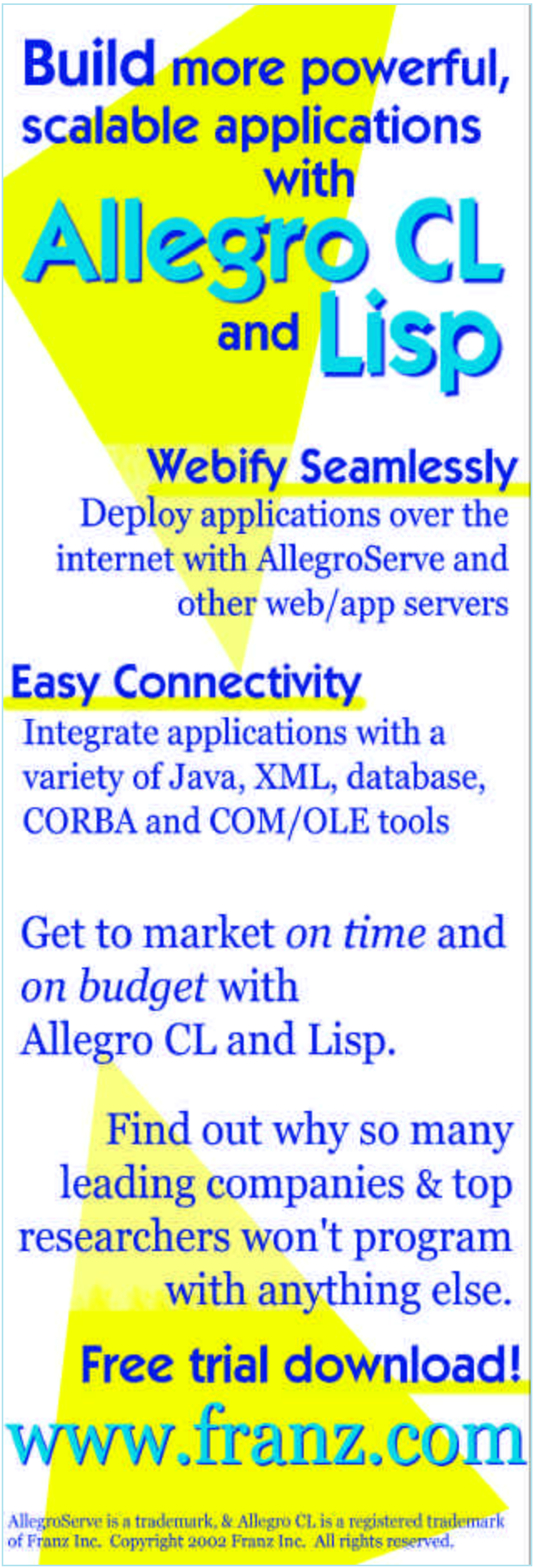
In contrast, third generation languages such as C, C++, Java and C# have no runtime engine and the programmer must explicitly specify the algorithm for solving the problem. The inclusion of objects in a third generation language simply supplies information hiding, enabling larger programs to be constructed; but programming is still done manually. Unfortunately, objects do not make it easier for the programmer to determine what must be done. The programmer must now be more intelligent — remembering thousands of classes.

Even visual editors that help generate code simply copy existing code for the objects rather than creating new code as do the fourth generation languages. What programmers need is an object engine that brings in objects as needed and frees the programmer from having to continually look up how to call objects.

People use rules to quickly guide them in situations ranging from commonsense to complicated skills such as a heart bypass operation. For example, a rule such that *IF the traffic light is red THEN stop* is a lot easier to remember than using intelligence and the analogy of the color of a red light being the same as that of blood. Reasoning by analogy is something even people are not good at or else we would have far fewer wars. AI systems don't do it very well in unrestricted domains because they lack common-sense and knowledge of traffic laws, human nature, and the world in general. People know thousands of rules that guide them efficiently through life. Building an expert system today is not about writing the expert system development tool but converting knowledge from humans into the expert system knowledge-base and making sure the rules are consistent, complete and do not conflict.

Powerful software assists in the knowledge acquisition process, and other tools are available to help the knowledge engineer (or domain expert) design the expert system to run as intended. Some expert systems offer graphical interfaces to show the rule network and its interactions during operation. These tools save a lot of time and cost compared to manually entering the rules and then debugging the system.

The main problem with expert systems has been speed. As with humans, it takes time for expert systems



to make inferences about facts. People and computer-based expert systems only operate at about two inferences per second when their knowledge base is very large. This may seem astounding today when computers operate in the gigahertz clock speeds but those speeds measure the most elementary computer operations. The problem is that with hundreds of thousands of rules and millions of facts, it takes time for an expert system or a human to do pattern matching to decide which, if any, of hundreds of thousands of rules should be activated. In addition, each problem has its own domain of knowledge. For simplier systems, the speeds are much faster.

For example, it has been estimated that a person needs to know approximately 50,000 rules to play an expert game of chess. This is not a simple game in which the player only knows how the pieces move, but also recognizes advanced winning strategies. Considering that commonsense, social interactions, work, recreation, driving, eating, etc all involve millions of rules and facts its amazing people can even do two inferences per second. The limitation of approximately two rules a second also places a restriction on whether a baseball player can hit a pitch or a driver can avoid an auto accident. In both cases, speeds of up to a hundred miles an hour are involved (and reaction times of milliseconds) and there is not much time to reason whether the ball player should swing at the ball, or the driver should swerve to avoid an accident.

Different data structures, such as Rete, have been devised to speed up inferences in expert systems. Using Rete, rules are not represented explicitly as IF THEN statements but in the form of a data structure called the rule network. This network attempts to improve performance by observating that, in most real world situations, only a few facts are relevent at a time. The Rete network optimizes the rules by looking for common patterns. For example, if one rule is triggered and a second one depends on the same facts, the triggered first rule serves to aid in triggering the second one. For example if you are hungry, you may go into a restaurant, a grocery store or your neighbor's kitchen to find food. The hunger rule triggers other rules rather than each rule having to determine if you are hungry in every situation.

COTS Knowledge

Commercial off the Shelf (COTS) products have been around for decades. In the past, expert systems were developed from scratch by knowledge engineers with rules manually created for every new problem domain from medical and equipment diagnosis to configuring computers or oil refineries. Today, thousands of expert systems have been developed and the key to developing a new one, with minimum cost and maximum efficiency is to reuse existing domain knowledge.

The term *ontology* has come to mean the complete set of rules and knowledge that an AI system must have to function. Originally, the term ontology came from philosophy and referred to things that exist. Modern AI uses COTS knowledge in the process of ontological engineering to define requirements and implementing the knowledge base used to create and maintain a working system. Such reuse is invaluable in creating systems that are easy to develop and maintain.

The business of ontologies is rapidly growing as the need for new expert systems, which are developed quickly, encourages companies to develop ontology libraries. This trend is simply a modern version of the encyclopedia or reference book — except the knowledge resides in an AI system instead of in a book. Major companies such as IBM and Microsoft are just a few of the major yet conservative companies that are developing and selling ontologies.

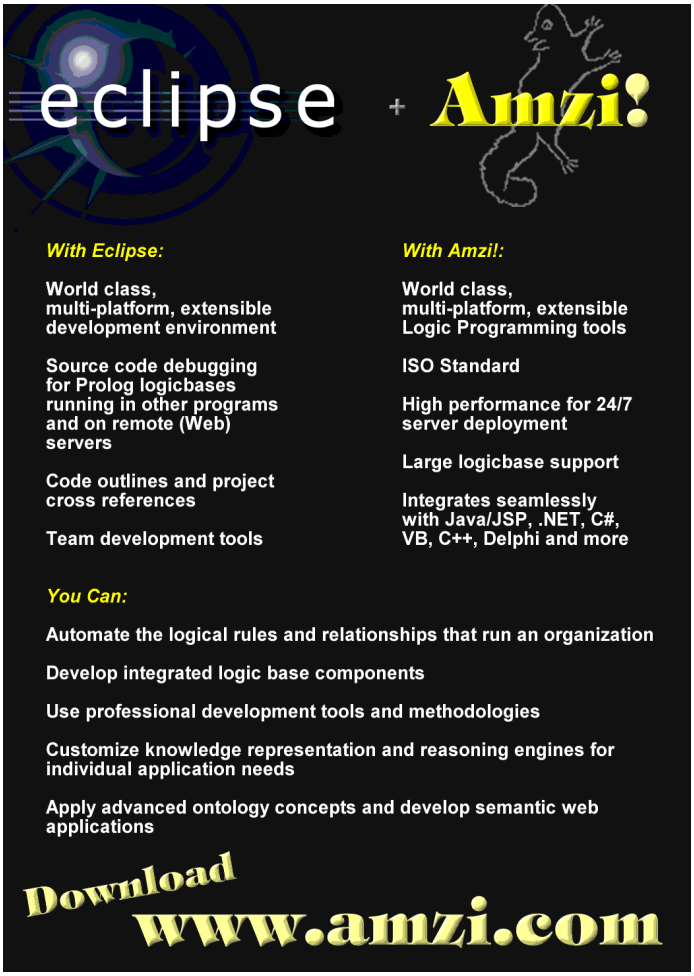
Ontologies are not limited to expert systems; any AI system that uses explicit knowledge can reuse previously developed ontology. Although ontologies may be formalized in logic systems to make them self-consistent, they tend to be limited to applications that are represented well by logic — such as the operation of a power or chemical plant. If the real world were governed by logic, it would be much simpler. This is where fuzzy logic, rough sets and other mathematical tools for dealing with uncertainty have achieved much success.

Explicit and Implicit Knowledge

The knowledge of rules is explicit since people create the rules. Other types of knowledge are not explicit yet people could not function without them. A simple example of implicit KR is the knowledge needed to move your hand. Almost anyone can do this, yet how does one explain this knowledge in terms of IF THEN rules?

Rules that have been used for a long time generate new connections between the neurons in the brain. Rather than calling up the explicit knowledge rules, the brain rewires itself with shortcuts. Instead of a new driver remembering the explicit rule IF the light is red THEN stop, the foot of many experienced driver's automatically presses down on the gas pedal.

Artificial Neural Networks (ANN) have proven invaluable, as an AI knowledge representation, in solving many problems that were not easily solvable by traditional algorithms; such as the classic Traveling Salesman Problem (TSP). In this problem the object is to



visit a number of cities only once by the shortest possible route. While the solution is simple for a few cities, the time required to solve it goes up by the factorial of the number of cities — eventually becoming infeasible for any computer to solve if the number is large enough. Even 30 cities is not a trivial case.

The TSP is an important type of problem because it occurs in so many real world situations ranging from efficient routing of packets through a network to delivery of postal packages in the least amount of time. ANN have been applied to this problem with great success. While they do not always generate the optimum solution, an ANN usually supplies a good solution that may only differ from the optimum solution by a few percent.

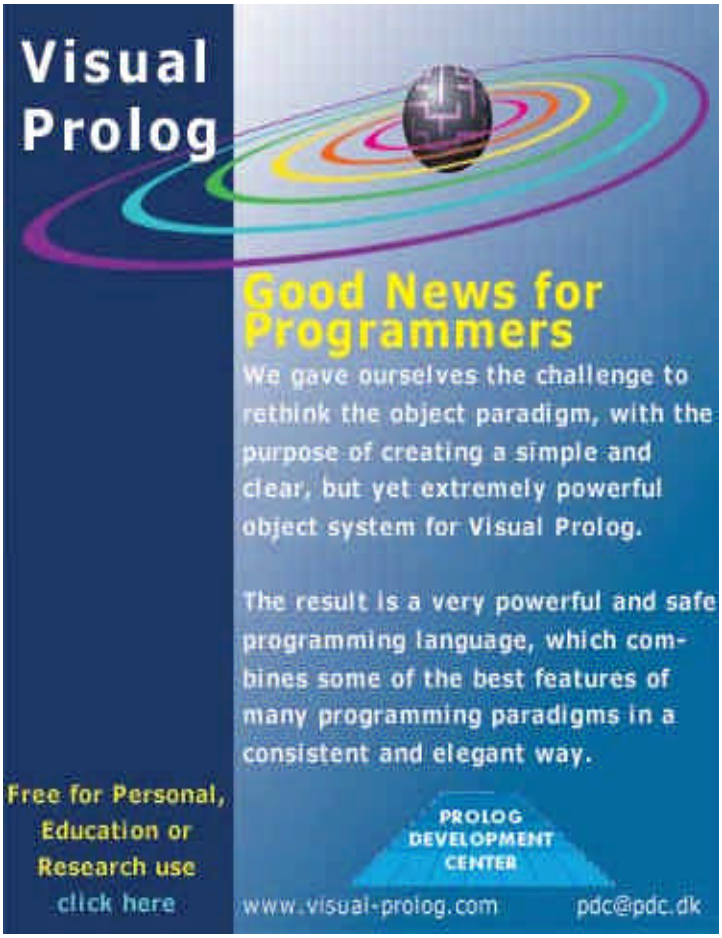
ANN stores their knowledge implicitly in the network connections. Because there is no explicit knowledge, their major drawback is the difficulty of understanding how they work – what is the knowledge that has been embedded in the network and how is it verified. While it may seem tempting to ignore this detail and just be happy with a good solution, a potential problem is that the solution may be brittle and break down for certain minor variation. A number of ANN's have been developed that attempt to explain explicitly the knowledge encoded in the interconnections. So far, however, for many of these systems, the explicit knowledge created is still not satisfactory.

Let's Evolve

Knowledge representation comes in many forms. By far the most successful is in the entertainment industry. The billion-dollar success of animated movies such as *The Lord of the Rings*, and video games illustrate this new success. For example, the KR of the animated characters hacking and slashing each other in the battle scenes is not explicit. Instead, artificial life forms are created for the characters and allowed to evolve different battle sequences using the Massive computer program designed to create huge crowd scenes of 100,000 artificial lifeforms. Rather than the movie director deciding on every hack and slash of thousands of characters, the digital life forms try to survive the battles and the director simply picks what looks to be the best battle sequence.

Evolutionary algorithms are finally practical because of the power of modern computers. Hundreds or thousands of software entities, digital life forms, compete to survive and reproduce according to a utility function supplied by the programmer in games, simulations and entertainment. The characteristic of these systems is that the knowledge is implicit and grows as the digital life forms evolve to survive. Just as people learn, so do these life forms.

Colleges are now starting to offer courses and even degrees in AI, video games, and entertainment since this is a multibillion-dollar industry. No longer considered simply a branch of computer science, AI is a stand-alone discipline that draws on a variety of other disciplines such as video, music, business, economics, etc.



Conclusion

There has been an evolution in KR from the early days in which knowledge was made explicit in expert systems to the implicit knowledge of ANN trained to some task, to the modern day evolutionary systems which discover their own knowledge. The choice of a particular representation depends on the particular problem being solved. With all the choices available today, the knowledge engineer has a cornucopia to choose from and so must choose wisely.

With the growth of the Internet, knowledge representation has also evolved from centralized to decentalized to peer to-peer (p2p)serverless systems. In 2003, some 30,000 Internet-linked computers were used to compute how a protein folds up to fit as compactly as possible, an important problem that is too time consuming for even supercomputers. Distributed knowledge representations using file sharing systems such as Overnet and eDonkey may finally allow AI systems to evolve into self-organizing knowledge networks that are truly intelligent, not just knowledgeable in a restricted domain.

Additional Resources

An excellent general talk on Knowledge Representation
www.nas.cl.uh.edu/murphy/Representation/csci6530_April2003_files/v3_document.htm

Example of a commercial ontology development tool,
www.ontologyworks.com

Many links with detailed information on knowledge representation
dmoz.org/Reference/Knowledge_Management/Knowledge_Representation

Information about the CLIPS expert system tool
www.ghgcorp.com/clips/CLIPS.html

Special thanks to Scott Browder for information about digital animation.

PCAI

Joseph C. Giarratano is a professor of Computer Science at the University of Houston Clear Lake and co-author of the internationally used textbook, *Expert Systems Principles and Practice, 4th Edition*. He can be contacted at *giarratano@cl.uh.edu*.

Integrating JESS and Java into a Student Advising Expert System:

The Virtual Student Advising Program (VSAP)

By Edwin S. Wong and Lisa J. Burnell

Abstract

Colleges often require students to complete complex and difficult to organize academic criteria before they can obtain their degree. Furthermore, frequent changes to these degree requirements can be hard to follow with the impact on students hard to understand. This problem suggests the need for a software system that assists students, advisors and administrators by supplying current, accurate and concise degree planning information. We have created a Java-based system that integrates the Java Expert System Shell (JESS) within a flexible framework; creating an intelligent application that guides students through the advising process — analogous to a human advisor. The Virtual Student Advising Program (VSAP) includes a central knowledgebase of rules in a format that is convenient for frequent modification. To offer a seamless interface with Java, which performs the rule-based reasoning, we designed this KnowledgeBase (KB) to work with JESS. The student advisement process, as emulated by VSAP, offers personalized degree related information specific to a students' major, status and preferences. This interactive system accomplishes this process by integrating several key features including a degree planner, semester specific scheduler and an external rule editor that allows an administrator to modify degree rules without modifying any program code.

Introduction

College students face many challenges, but an overriding one is obtaining that baccalaureate degree. Due to the complicated and changing nature of degree requirements, a faculty advisor must oversee the students' progress toward a degree. In addition to complicated degree rules, these frequently changing requirements make it difficult for even advisors to stay current.

Most universities have enrollment sites with sample degree plans and requirements posted to assist students with their enrollment process. While these resources enable students to enroll electronically and check for scheduling errors (e.g. two courses overlap in time), they do not examine how the selected courses fit together in an overall graduation plan. They do not consider course difficulty, when courses are available, and other heuristics used by student advisors. Therefore, we created a Java-based system that integrates the Java Expert System Shell [1] within a flexible framework to guide a student through the degree planning and course-scheduling process (See PC AI 17.3 for an interview with the creator of JESS). By allowing students to customize their own degree plans, time spent with academic advisors can focus on student development and long term career planning.

While aiding in the planning, scheduling and advising process required to complete a college student's degree, VSAP offers students the resources and knowledge to troubleshoot issues with their current degree plan. A profile of student preferences and a transcript of completed courses enable the system to generate customized degree plans that the student manually customizes. The student also creates course-by-course schedules that the system checks for requirement compliance. The system explains the errors it finds in plans and schedules, enabling the student to make corrections. By enabling the students and advisors to communicate this information electronically, advisors can review degree plans and send comments back to the students, without physically meeting.

Previous attempts at our university and elsewhere have produced various reasonable advising tools, particularly when they used knowledge available in university and departmental documents (e.g., specific course prerequisites).

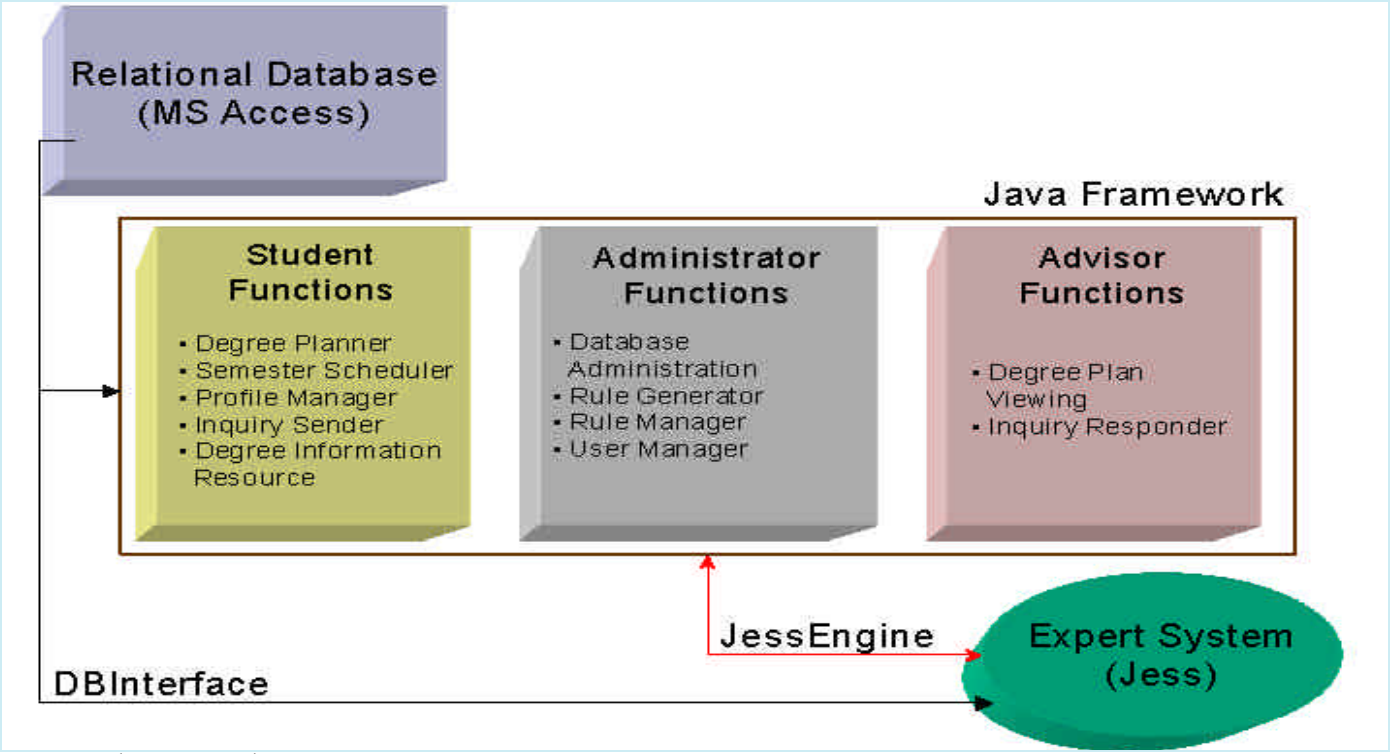
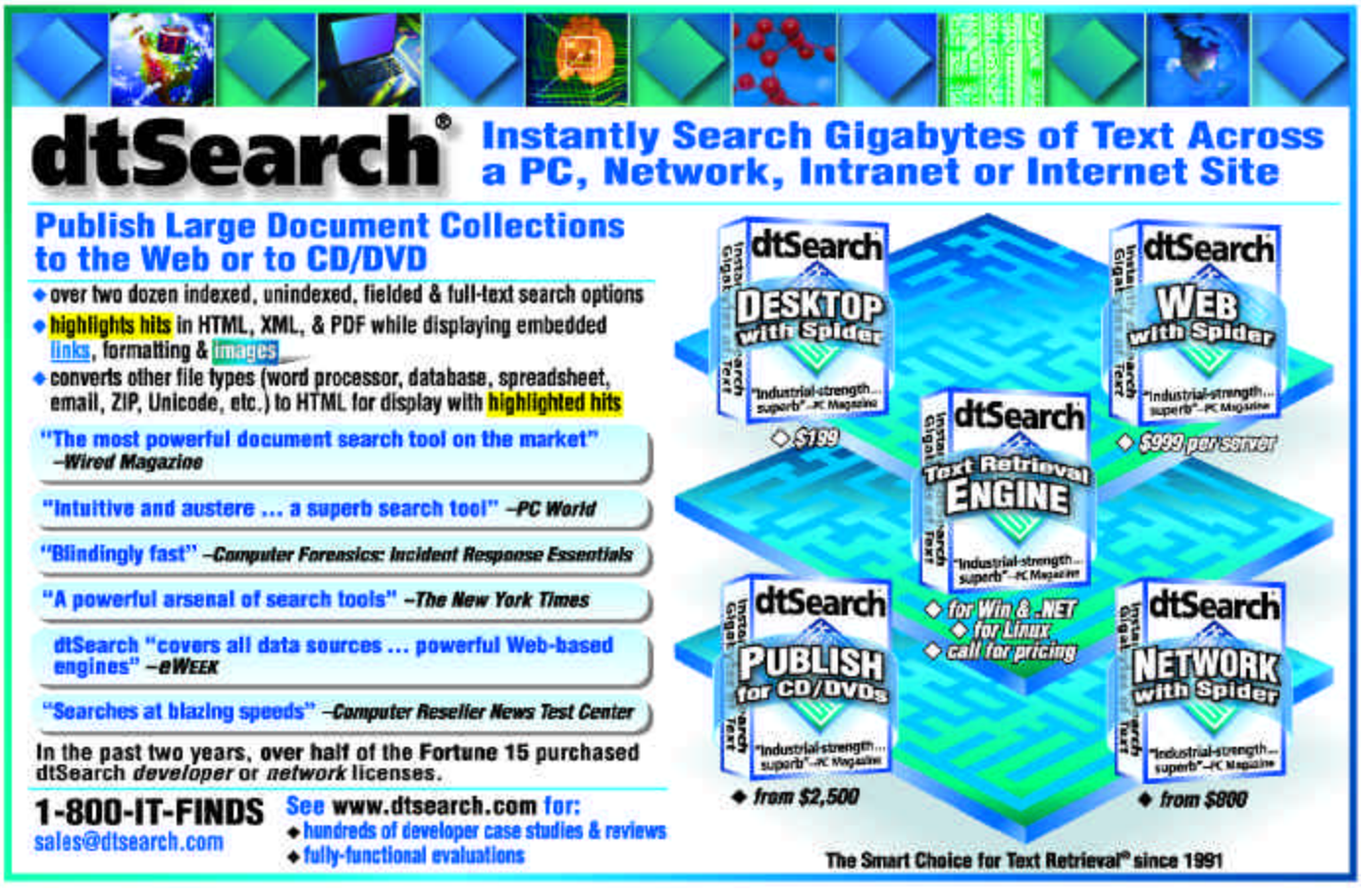


Figure 1: The VSAP Architecture.

However, these previous attempts suffer from two major problems. First, they lacked the flexibility to accommodate frequently changing rules, requirements and domain terms since someone has to manually update the system. Second, they do not represent the unwritten, experienced-based heuristics used by advisors who must consider a student's preferences and limitations.

We begin this article with a brief description of the overall software architecture and how the JESS knowledgebase integrates with the rest of the system. We present the knowledge representation strategy employed,



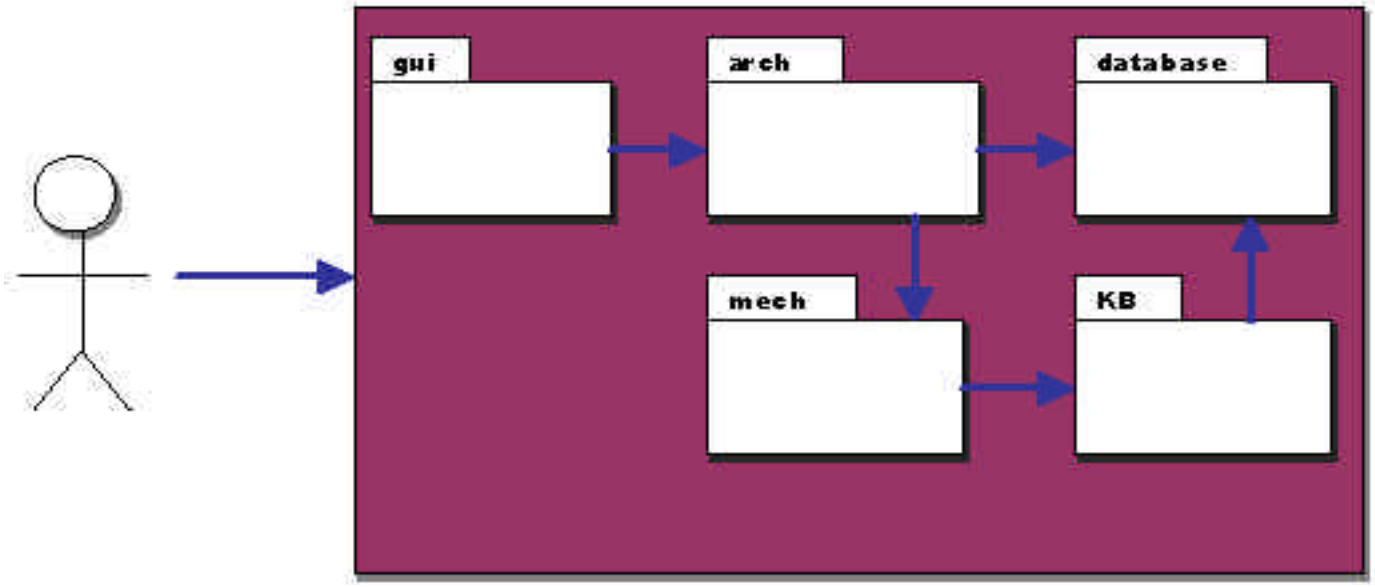


Figure 2: VSAP framework package interaction.

including analysis and representation of academic rules. We close with a look at current and planned capabilities for the system.

Software Architecture

VSAP was created using a development methodology known as Contingency Theoretic System Development (CTSD), which adapts principles from management organization theory to the development and maintenance of software systems [1, 2]. The CTSD approach is focused on design for maintainability, a crucial requirement for complex, dynamic systems such as VSAP.

The primary architectural decision made in VSAP was to separate the knowledge based on two criteria: the degree of change (how frequently a rule might change over time) and the degree of complexity (determining how abstract the data is). A simple example of complexity is the fact that "a student must be a junior with a GPA greater than 3.0 in all math and science courses". We determined the degree of change by interviewing advisors and an analysis of degree requirement changes over time at three universities, includes large, small, private, and public institutions.

Figure 1 illustrates the overall VSAP architecture. A core Java framework centrally controls data communication. Communication between the framework and the relational database is bi-directional with interactions occurring though a modular DBInterface. Information from the database populates JESS's working memory while the Jess reasoning engine communicates bi-directionally with the framework. The framework queries the expert system to verify requirements. After verification, the Jess Engine returns the results back to the framework. The framework's core packages (Figure 2) include:

Arch – Basic objects that logically represent a real-world entity controlled by the user — Student, Degree and Semester are examples of objects required for creating a degree plan.

Database – Dynamic objects dependent upon the individual school, and change frequently. Stored in a relational database the system accesses these objects through Java Database Connectivity [4] — objects in the database package include Course, Section and Instructor.

GUI – Graphical User Interface components, all of which implement Swing (Sun's set of lightweight GUI components with more powerful screen displays than the raw Abstract Windowing Toolkit (AWT)). Many of the objects in this GUI package are custom Virtual Advisor user interface components.

Knowledgebase – Objects and mechanisms that interact with the expert rule based system, used for determining adherence to degree rules.

Mech – Mechanisms frequently used within VSAP — system properties, file access algorithms, and search algorithms.

Integrating Java and the Knowledge Base

The knowledgebase's declarative and modular representation supports both the explanation of the reasoning process as well as any rule modifications. An explanation of the reasoning process enables students to understand the systems results, while the rule modification history accommodates rapidly changing rules. University requirements, as well as course requirements, are constantly changing to fit the needs of the university, and vary among universities. Administrators, typically a lead advisor, modifies, deletes and adds course attributes by using an editor to change the KB, avoiding the need to interface with the rules directly.

Since we chose to exclusively use Java on VSAP, we decided on JESS as the expert system shell because of its pure Java implementation. Data passes seamlessly between Jess and the main Java framework through both embedded JESS and object reflection. One distinguishing

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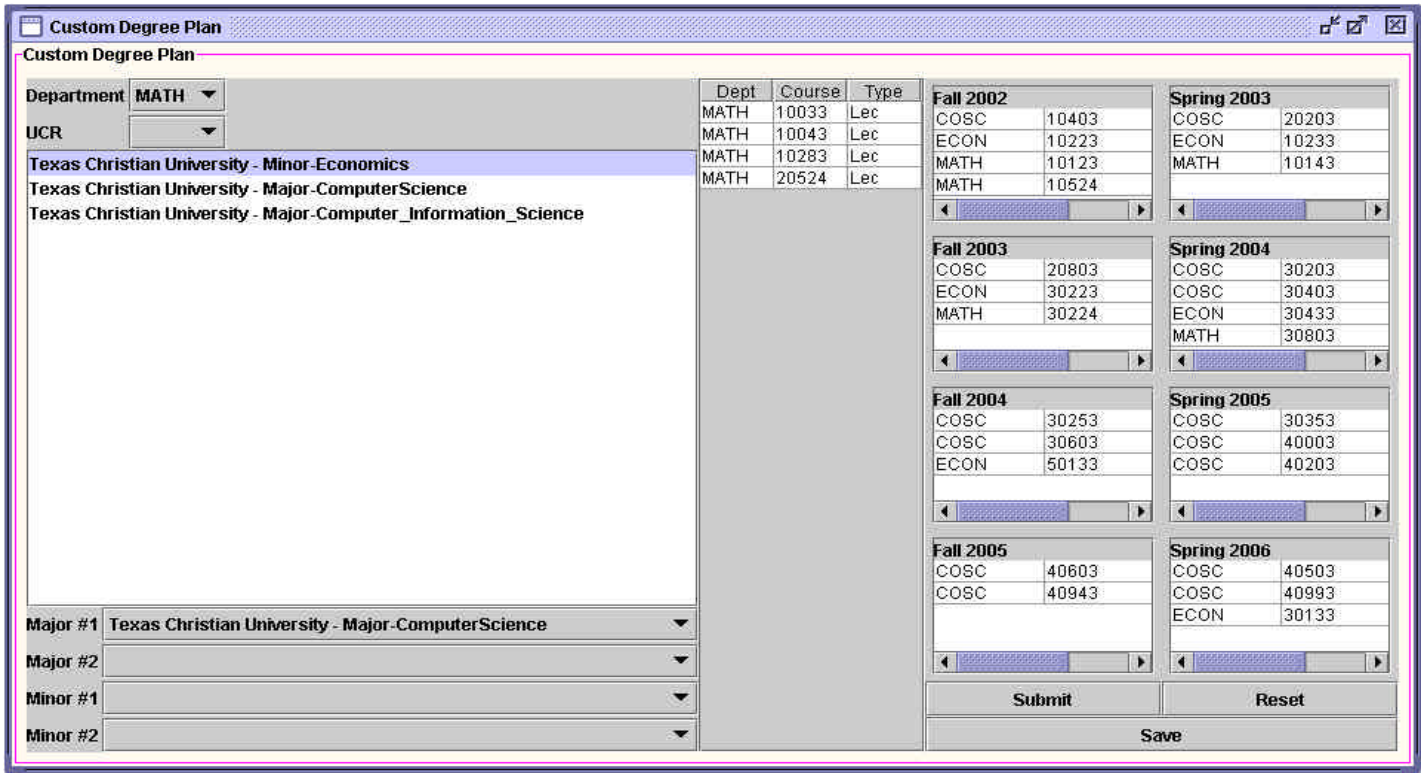


Figure 3: Custom Degree Planner Interface.

feature of Java, in contrast to other object-oriented languages, is the ability to instantiate and reference objects after compilation time. This mechanism, known as reflection [5], provides features such as observing class fields, constructing new objects and array manipulation. JESS takes advantage of these features by including Java objects in JESS code. For example, within a JESS module, a Java Hashtable facilitates multi-field iteration. VSAP takes advantage of this reflection capability by passing values as input, and accepting output from the JESS reasoning

engine through Java objects generated at runtime. For example, the following JESS statement passes a Java object from the JESS engine to the Java framework representing a return code for a reasoning query.

```
(store returnVal (bind ?x1 (new
      java.lang.Integer 0)))
```

The bind function associates the JESS variable *x1* to a new instance of an Integer object. The store function associates the Java variable *returnVal* to JESS's variable *x1*. References to objects reflected by the JESS engine are obtained in the Java framework through JESS's Value object. *Value* is the general class used for representing all JESS data types. For example, the Java statement below obtains the object representation of a JESS reference.

```
Rete rete = new Rete();
Value val = rete.fetch("returnVal");
Integer result = (Integer)val.
      externalAddressValue(null);
```

Class *Rete*, the inference engine, interfaces JESS with the Java framework. The *externalAddressValue* method of *Value* returns a general Java Object, which is cast back to an Integer. The parameter of *externalAddressValue* method is a Context object, which is the scope of the variable within JESS. In the preceding case, the variable represented by *val* is global in scope, and the variable context is null.

The mechanism for interfacing with the JESS engine from within Java is similar to the method of embedding SQL using JDBC. The *Rete* object in the standard JESS package is the intermediary for executing JESS instructions; obtaining the status of the engine and fetching stored properties. When the engine is expected to return data, it is done through the general *Value* object.

Rule Analysis and Organization

The overall rule scheme is to create a distinct rule for each school specified requirement. In addition to defining rules for required courses to satisfy a major or minor; the school may offer specialized programs. For instance, a student may also choose to satisfy Pre-Med or Honors Program requirements. In addition, many rules are highly complex due to the variety of ways rules may be satisfied. For example, general curriculum requirements, in which certain selections from mathematics, science and liberal arts courses must be made, can be satisfied in a number of ways, and may depend on the student's declared major.

Analysis of common university academic rules indicates that requirements occur in select patterns. Rules in VSAP fall under two primary categories: course and program. First, to enroll for courses in a given term, the student must fulfilled specific prerequisites for that course. For example, introductory courses may have no prerequisites, while senior level courses may require fulfillment of other courses or other constraints before enrollment. Course prerequisites fall under the following categories.

Required Courses – The most common course prerequisite. The system can also infer required courses through transitivity. For example, consider the following three courses: *Data Structures*, *Techniques in Programming*, and *Introduction to Programming*. The *Data Structures* course prerequisite is *Techniques in Programming*, which requires *Introduction to Programming*.

Therefore, *Data Structures* contains the implied prerequisite of *Introduction to Programming*. This derivation of required courses simplifies the implementation of this category of rules.

Hours Requirements – This is related to having a particular standing when taking a course and is independent of other prerequisites. For example, senior standing may be defined as a student having taken at least 84 semester hours of course work.

Course Offerings – Ideally, students could take any courses they need during any semester of their academic career, subject to prerequisites. However, at some schools courses are only available once a year or even once every few years. Therefore, the system verifies course offerings when evaluating whether the student should take certain courses.

Course prerequisites, defined within the relational database, are loaded directly into JESS for evaluation — in the form of facts. On submitting a course to JESS for prerequisite evaluation, VSAP generates a pattern match based upon primary key attributes of department, course number and course type. The system initiates checks on credit hour requirements, required courses and semester offerings when there is a pattern match with the student's status. This status includes the courses added during construction of the degree plan. These results return to the main Java application through JESS value references.

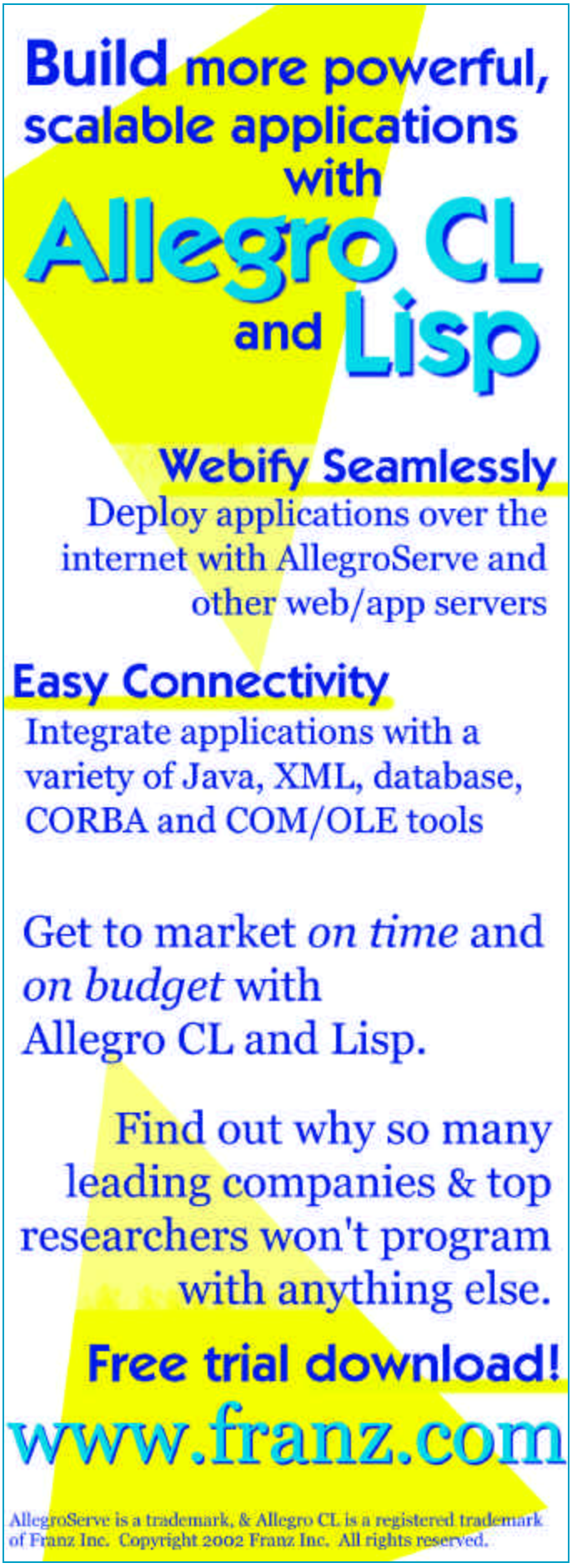
...an advising tool that remains with a student throughout their college career, whereas many advisors do not.

VSAP evaluates a second category of rules — program rules specific to majors in a particular department or college within the university. The system can apply any number of program rules to a particular degree plan, all checks being independent of any other rules. Similar to specific course prerequisites, program requirements consist of rule combinations in the following categories:

Fulfillment of Specified Courses – The simplest type of requirement involves students completing a specified set of courses. For example, a computer science degree requires the completion of a sequence of nine courses. Verification of this type of rule involves a simple pattern match.

Credit Hour Requirements – Most universities require the completion of a minimum number of credit hours before graduation. Although, a simple verification of this requirement is possible within the main Java application, several functions such as the system generated degree planner require this count while searching for an appropriate degree plan.

Subsets of Courses – Many departments allow course selection from within a set of courses. For example, the general university curriculum may require completion of at least one



course from each of four categories to gain experience in different fields. JESS' set operation facilities provide support for these rule types.

The system evaluates degree program rules at the conclusion of degree plan construction. Although default program requirements are in a student's degree preference file, requirements can change at runtime, allowing the student to run hypothetical plans. Program requirements are in separate files that implement a modified JESS syntax. All rules available to the user are loaded at application startup, and are parsed appropriately. Upon selection for verification, the syntactically correct JESS rule is loaded into the JESS engine for subsequent evaluation against a specified degree plan.

Other rules check that student preferences (e.g. afternoon courses, night classes) and constraints (e.g. no more than 12 hours per semester) are satisfied. The custom degree planner also offers heuristic advice. For example, a student may be able to enroll in 17 hours of math and science courses, but the system may strongly advise against this, depending on the student's GPA and perhaps other factors.

Implementation

The implementation of the VSAP architecture focuses on two primary features: the Custom Degree Planner and the System Degree Planner. The custom degree planner (Figure 3) is essentially a rule verifier that allows student to enter completed courses or courses already planned to be taken. The custom mode allows the user to modify rules to test alternate scenarios. The system degree planner, an extension of the custom degree planner, attempts to find an optimal degree plan to satisfy specified rules and preferences. Before iterating through semesters, the system derives a list of courses based on the rules the user has selected. Course selection simply adds required courses, while making selections based upon preferences. The planning algorithm starts selecting courses from choices with the weakest prerequisites. Any derived prerequisite courses are added to the list of scheduled courses.

The VSAP system represents data in a variety of ways depending on that data's usage. Degree plan data is maintained within a relational database, subject to modification by a designated administrator. Student specific information is stored locally on the user's computer. VSAP implements general key/value system properties using the System class within Java. Locations of specific user profiles and preference files are stored with other runtime properties. Furthermore, the system uses XML to encode degree preferences that the user can access and modify via system properties. The system also uses XML specified files to save working sessions, implement custom vocabularies for holding semester information and courses stored within a semester. XML in VSAP implements features with the Java API for XML Parsing [6] . As discussed earlier, the degree requirements are represented using expert system rules.

VSAP also provides a semester specific scheduler, administrator data-management functions, and the ability to contact a real advisor. The semester scheduler operates by using a previously generated degree plan, which maps typical course offerings with courses needed by the student. The scheduler uses various matching algorithms to find a schedule that best fits the student's preferences. For example, the user can specify preferences for night classes or attempt to schedule away from early morning classes. The current administrator functions include

the ability to add, delete, and modify courses, prerequisites, and degrees via a simple GUI interface. When extra assistance is necessary in creating a successful degree plan, the student and a human advisor can communicate. This feature allows advisors to send their comments on a student's degree plan back to the program for it to be input and displayed for the student to read. In the future, advisors will have direct access to a student's degree plan to help correct it.

Conclusions and Future Work

VSAP serves as an advising tool that remains with a student throughout their college career, whereas many advisors do not. The current version of the system is in informal use within one department and has been beta-tested at another university. Additional work remains before there is full release to other departments and universities, but the basic rule framework exists for further expansion. Other future enhancements include improving the ease of use and functionality for administrators and advisors. This approach can significantly improve the maintainability of systems that must cope with frequently changing and complex knowledge.

Acknowledgments

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What Computers are Capable of:

The Expert Systems and AI Systems

By Dr. Yuri Iserlis

Expert Systems and Artificial Intelligence

Expert Systems (ES) are a category of programs based on the theory and methods of artificial intelligence, a branch of computer science focusing on the development of computer systems that simulate the processes of problem solving based as close as possible on human brain functions.

The first expert systems appeared in the late sixties. Today, they exist in many forms, from medical diagnosis to investment analysis and from counseling to production control. With the advancements of the last decade, today's expert system users can choose from dozens of commercial software packages. At present, we accept as routine such expert systems as weather forecasting, online mapping and driving directions, diagnostic systems for automotive repair shops, and so on.

Many large corporations use expert systems in their business. The list of the companies using expert system technology is long and varied: NASA, HP, American Express, Lockheed, Boeing, DaimlerChrysler AG, various power, gas and oil processing plants, etc.

The characteristics that make expert systems more effective than other computer based applications include:

- Provides a structure method for combining the knowledge of many experts in a specific field;
- Stores an unlimited quantity of information, indefinitely, and works much faster than a human;
- Available 24 hours a day, and is accessible at a long distance over a network;
- Able to explain how they derived their information requests and ultimate suggestions;
- Able to process client's uncertain responses and, by combining several pieces of uncertain information, may still be able to make strong recommendations;
- Able to accumulate the knowledge of highly skilled employees for a company — this is especially useful when the company may lose that person.

Types of Expert Systems and AI Based Systems

Expert systems and AI systems fall into a number of major categories (not exclusive). These products are based on AI technology or have an AI component. There are many other applications not covered, and some vendors could fit in multiple categories, but due to space limitations, they are only included in one.

Acquisition and Interpretation of Data - These categories retrieve, analyze, filter and restore missing data as well as mine data, transform data in another format, and so on. Examples of this category include:

- Netrics Data Quality Software by Netrics Inc. (*www.netrics.com*) enables cleansing of mission-critical data. Netrics' products attempt to deliver near-perfect accuracy no matter how "dirty" and error-prone the data is.
- Nuggets by Data Mining Technologies, Inc., (*www.data-mine.com*) is an application that builds models to uncover hidden facts and relationships. These models can predict new data; allow generalizing and revealing which indicators (i.e. variables) most impact decisions.
- WizWhy by Wizsoft (*www.wizsoft .com*), is a data-mining tool that analyzes the data and issues predictions. By automatically determining the if-then rules in the data it is able to summarize the data, highlight interesting phenomena in the data as well as cases deviating from the rules, reveal all necessary and sufficient conditions and generate predictions for new cases.

Diagnosis and Abnormal Condition Management – These categories recognize the condition of human health or the technical condition of complex industrial systems. Examples of this include:

- EasyDiagnosis by Easydiagnosis (*www.easydiagnosis.com*), a division of MatheMedics - *www.mathemedics.com*, offers automatic online medical diagnosis for consumers.

- Intelligent Objects by Gensym Inc. (*www.gensym.com*) is an ES for Abnormal Condition Management (ACM) applications that proactively detect, diagnose, and recover from process problems in real time.

- Transformer Oil Analyst (TOA) developed by Delta-X Research (*www.hydracen.com/dx*). TOA quickly warns the staff of any suspicious symptoms or trends. When there is a suspected equipment or insulating fluid problem, the TOA application enables the user to review both historical and current status quickly.

- ASTD by Intellectual Systems, Inc.(Russia - *www.mosotd.ru*) is a real-time hybrid ES for a pipe line's gas compressor station.

Decision-making or Decision Support - These categories includes the following subcategories: Decision Management, Decision Optimization, Customer and Account Management, Fraud Management, Scoring and Predictive Modeling, Risk Management, etc. Examples include:

- A variety of expert systems developed by Fair Isaak, Inc, (*www.fairisaac.com/fairisaac)* such as: BlazeAdviser, Blaze Decision System, Decision Optimizer, Payment Optimizer, Strategy Science, Model Builder for Decision Trees, StrategyWare, Capstone DecisionManager, etc.

- ReThink by Gensym Corporation (*www.gensym.com*), helps manage the increasing speed and complexity of business data through simulation, analysis, and automation. Unlike traditional simulation tools, ReThink supports the entire business process lifecycle from as-is analysis, to design, to online automation.

Design and Management Solutions – After consideration of a large number of variable parameters for solving innovation tasks, it enables optimization of design while finding the best management decisions.

- Goldfire Innovation and Goldfire Intelligence developed by Invention Machine (*www.invention-machine.com*). Some companies use for design goals the TRIZ (see below)

Control and Monitoring - These categories help monitor operation and control certain functions of machinery for heavy industry. Many corporations that developed Supervisory Control and Data Acquisition Systems (SCADA), used the expert systems for different control levels of industrial plants. Here there are companies such as: Emerson Process Management (*www.emersonprocess.com*), Matrikon (*www.matrikon.com*), REDUCT & Lobbe Technologies (*www.reduct.com*), etc.

Prediction - This category enables forecasting of possible outcomes for observable situations. This category includes weather forecasting, scoring and predictive modeling, risk management and other financial forecasting:

- NeuralWorks Predict, developed by Neuralware Inc (*www.neuralware.com*), is an integrated tool for rapidly creating and deploying prediction and classification applications. Predict combines neural network technology with genetic algorithms, statistics, and fuzzy logic to automatically find optimal or near-optimal solutions for a wide range of problems.

- Developed by NeuroDimentions Inc. (*www.nd.com*) the following products can perform similar tasks: The neural network modeling software Neuro Solutions 4.2 is a tool for solving data modeling problems. The technical analysis software TradingSolutions 2.1 combines neural network and genetic algorithm technologies with traditional technical analysis to create a highly effective tool for financial modeling.

- Predict, developed by Partek (*www.partek.com*), is a toolkit for predictive modeling to deploy models for forecasting unknown cases.

- Intellect, developed by BioComp Systems (*www.biocompsystems.com*), deploys solutions created in the desktop tools iManageData, iModel, iUnderstand and iImprove, and is an on-line intelligent server-based system which helps industry customers by predicting product and process performance on-line.

Analysis and Reporting Tools - There are a number of applications including the following:

- The KBX Data Management Suite by KBACE Technologies (*www.kbace.com*), offers an innovative solution for transferring data from an ERP (Enterprise Resource Planning) System to end-user desktops in both a memory and time efficient manner. All reports are designed for use with Microsoft Office.

- MicroStrategy 7i developed by MicroStrategy Inc (*www.microstrategy.com*) is an Industrial-Strength Business Intelligence application for integratiing reporting, analysis, and information delivery capabilities into one platform.

- PowerAnalyzer by Informatica Corporation (*www.informatica.com*) is designed for the mass deployment and adoption of business analytics.

Manufacturing – One of the first and most active areas of expert system and AI related activities.

- Gensym Corporation (*www.gensym.com*) — e-SCOR enables users to simulate various configurations, test the robustness of the supply chain and identify the required service levels. It can help identify the weak links and areas for improvement in supply chain, saving time and money. e-SCOR is highly flexible and is ideal for performing "what-if" analyses.

Marketing and Trade Management – A key use of artificial intelligence to determine marketing potential and business opportunities.

- Campaign Optimizer, Preview Reporting, Opportunity Mapper, etc. by PreVision Marketing LLC (*www.previsionmarketing.com*) offers full customer marketing database design, development, management and hosting services for clients looking to outsource their multi-channel customer marketing data management.

- Ward Systems Group (*www.wardsystems.com*) issues the AI Trilogy, a new package of business and scientific software. The AI Trilogy contains the NeuroShell Predictor, NeuroShell Classifier neural net software, and GeneHunter Genetic Algorithm (GA) software together in one package.

- CycAnswers Cycorp, Inc (*www.cyc.com*) is the knowledge-based question-answering product, based on years of common sense reasoning research that supplies answers to client's questions.

Human Resource Management Systems (HRMS) – *The use of AI technology to find human technical talent.*

- CCHKnowledgepoint (*www.knowledge point.com*), a developer of human resource solutions since 1987, designed a new Performance Impact Workplace for Small-to Medium Businesses (SMB).

- ESI (Expert Solutions International - *www.esi-knowledge.com*) supplies knowledge based solutions and workforce management optimization products.

e-Learning Systems (ELS) - supplies individual or group education and training for different disciplines on the basis of special tools. These learning tools and services allow faster learning enabling quicker adoption to today's challenges. ELS may include Learning Management Systems and Course Management

systems. Here are some developers and providers of e-Learning systems:

- GeoLearning, Inc. (*www.geolearning .com*) is a developer of e-learning delivery platforms and Web-based training solutions for organizations, companies, and government agencies.

- WebCT (*http://webct.com*) is a provider of integrated e-learning systems for higher education. They deliver advanced educational technology that supports a full range of teaching and learning styles.

- CompanyCollege.com (*www. companycollege.com*) is the e-learning solution from Business Training Library, a provider of training solutions for small companies. CompanyCollege offers online learning that is inexpensive, easy to use and customizable.

Expert System Components

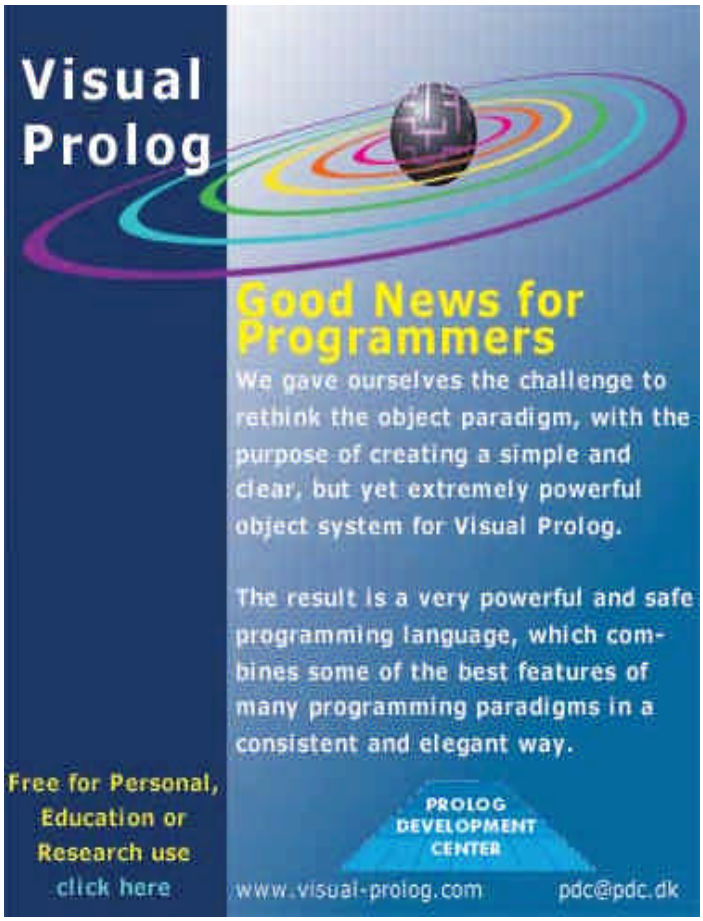
Generally, expert systems include several key components:

- Data input/output
- Knowledge base or mathematical /logical models
- Inference engine
- Explanation system
- Intellectual editor for the knowledge base
- User interface

The main component of the expert system is its knowledge base - an organized collection of facts, heuristics and other information on the subject of the system's domain. Developers generate an expert system using a process known as knowledge engineering. During this process, the knowledge engineer (or alternatively domain expert) acquires knowledge on the domain from human experts and other sources. The part of the expert system that applies the knowledge to the problem is the inference engine. The explanation system explains the basis for the conclusion, reached by the expert system. The intellectual editor is a tool for correcting, learning or self-learning of the knowledge base. The friendly user interface enables inexperienced users to specify problems for the system to solve and to understand the system's conclusions.

Expert Systems Technologies

Expert systems technologies are typically based on the types of knowledge bases or mathematical /logical models used for solving the particular problem and the associated inference. Here are some examples of different types of technologies (not a complete list):



Model Based Reasoning – Using a modeling environment to explore data, create algorithms, and create custom tools that offer early insights and competitive advantages.

- In this field MATLAB, Simulink, Stateflow, etc. from The Mathworks, Inc. (*www.mathworks. com*) have become fundamental tools for engineering and scientific work. MATLAB integrates mathematical computing, visualization, with a language to provide a flexible environment to explore data, create algorithms, and create custom tools offering early insights and competitive advantages. Simulink is an interactive tool for modeling, simulating, and analyzing dynamic, multi-domain systems. Stateflow is an interactive design tool for modeling and simulating event-driven systems.

- Opal-RT Technologies, Inc. (*www.opal-rt.com*) specializes in new low-cost PC based tools for large-scale simulation, rapid control prototyping, and software or system testing with hardware-in-the-loop.

- Quality Monitoring and Control (QMC – *www.qmc.net*) QMC provides computer programming applications and associated technical consulting for the process industries. Their unified approach and custom programming assists clients in using data effectively, improve energy efficiency, maximize product quality, and maintain optimum control.

- StatSoft (www.statsoft.com) a provider of the STATISTICA product line, statistical software based on the COM architecture and high-end technologies (such as multithreading and support for distributed processing for large enterprise installations). It features built-in Visual Basic scripting and it allows access of data from virtually anywhere. Products include STATISTICA Data Miner, Text Miner, Quality Control Miner, Web STATISTICA Server, Knowledge Portal, and many more.

Case-Based Reasoning (CBR) - A CBR system compares the problem with previous cases, and then suggests the most successful course of action. Typically, in addition to manually built CBR systems, data mining methods are also used. You can find a list of CBR's software vendors on the AI-CBR site (*www.ai-cbr.org*).

Evolutionary Model Reasoning - An evolutionary algorithm is a class of algorithms that finds approximate solutions to difficult-to-solve problems. They are inspired by mechanisms from biological evolution such as natural selection, mutation and recombination to find the best configuration for a specific system within specific constraints.

- These algorithms are developed by

Frontline Systems, Inc. (*www.solver. com*) in their Solver's products.

Stochastic Model Reasoning - Bayesian Belief Networks (BBN) use a tree-based structure rather than the logical "if-then". Bayesian systems iteratively use probabilities for finding any solutions.

- The Netica APIs (Application Program Interfaces) are a family of powerful Bayesian Network toolkits from the Norsys Software Corporation (*www.norsys.com*). They enable the building of Bayesian Belief Networks and Influence Diagrams, do probabilistic inferencing, learning nets from data, modifying nets, and save and restore nets.

Fuzzy Logic Reasoning - Fuzzy logic is the emulation of human reasoning on computers. The key concepts in fuzzy logic are the linguistic variable and membership function. A linguistic variable is a variable whose value is a word. (For example, the linguistic variable "temperature" might have the values: "normal", "high," "cold," "huge", "danger" and "freezing,"). A membership function describes these linguistic values in terms of numerals. For example, to describe the word "cold", we can say, "If temperature is below 40 degrees, we can say it's definitely cold." The linguistic variables and their membership functions allow fuzzy logic to perform the imprecise, non-numerical reasoning performed in a similar manner as humans.

- Aptronix (*www.aptronix.com*) is developing their Ultimate Fuzzy Design Tool - FIDE (Fuzzy Inference Development Environment).

Brain Simulation Reasoning - Artificial Neural Networks (ANN) are named after the cells in the human brain, that include billions of neuron cells. Artificial Neural Networks are formed from hundreds or thousands of simulated neurons connected together in much the same way as the brain's neurons. Neural networks are fast, tolerant of imperfect data, and do not need formulas or rules. ANN's are good at pattern recognition, generalization, and trend prediction. Neural networks learn from experience, because they are trained by repeatedly reviewing examples. Each example includes both inputs (information you would use to make a decision) and outputs (the resulting decision, prediction, or response).

- NeuralWorks Professional II/PLUS by NeuralWare Inc. (*www.neural ware.com*) is a comprehensive neural network technology platform that implements over 28 standard paradigms in an advanced model development workbench that is both integrated and extensible.

TRIZ Systems - TRIZ is a Russian acronym for Theory of Inventive Problem Solving that provides systematic methods for solving design and technological problems. This practical problem-solving paradigm was invented and developed by Genrich Altshuller, who discovered that technological systems evolve according to specific laws. TRIZ is rapidly gaining popularity with worldwide innovation communities by virtue of its success in guiding creative thinking and innovative product development.

- The Altschuller Institute for TRIZ studies (*www.aitriz.org*) has been founded to complete more related research. Companies and groups appeared, such as Technical Innovation Center (*www.triz.org*), Ideation International (www.ideationtriz.com), Got Innovation etc. (*www. gotinnovation. com*) that are evolving ideas and principles, innovated by G. Altshuller. Their products include software, training, publications, e-learning and consulting services.

Hybrid Technologies - Many industrial expert systems combine

different technologies, taking advantage of the strengths of each technology. For example, the expert system NuEngineer of Numan Intelligence, Inc. (*www.numan.com*), generalizes many existing Intelligent Search Algorithms such as Heuristic Search, Genetic Algorithms, Optimization, Gradient, and Neural Networks.

- The expert system FlexTool from CynapSys, Inc, (*http://cynapsys.com*) uses Genetic Algorithm, Neural Network, and Matlab Fuzzy Expert System for the scientific and business fields.

Tools for Expert System Development

There are a number of different programming approaches, programming languages and development environment. Here are a few:

Programming Languages for Expert Systems – Almost every high level programming language ever created, and many lower languages, have been used to develop AI and ES applications. The most common are: LISP, Prolog and C/C++ followed by Java. Here is some information on two programming languages Prolog and LISP, which were key to programming languages for Artificial Intelligence for the last two decades. Prolog is a full, industry-standard programming language, ideally suited to writing rules. Common Lisp is well suited to large programming projects, dynamic modifications and explorative programming.

- In the 1980s, several versions of Prolog came out, including Cogent Prolog, Turbo Prolog (Borland), Amzi! Prolog (*www.amzi.com*), and LPA (Logic Programming and Associates - *www.lpa.co.uk*). AMZI and LPA are medium-priced Prolog implementations with excellent integration with the web, Delphi, Java, and many other programming environments and platforms. Another successful and attractively priced implementation is also available from Visual Prolog (*www.visual-prolog.com*) from the Prolog Development Center (PDC - *www.pdc.dk*), the successor of Turbo Prolog.

- The two major dialects **of** LISP in use today are Common Lisp (*www.lisp.org/table/history.htm#common)* and Scheme (*www.lisp.org/table/related-languages.htm#scheme*). Franz Inc. (*www.franz.com*), currently the primary supplier of LISP development environments, created Allegro CL, a dynamic object-oriented development environment for Common Lisp/CLOS.

Shells - A shell is an expert system without a knowledge base. A shell furnishes the expert system developer with the inference engine, user interface, and the explanation and knowledge acquisition facilities. All of this makes it unnecessary to rebuild the components for each new expert system.

- SMECI is an expert system shell from Ilog (*www.ilog.com*) based on Lisp.

- EXSYS, Inc. (*www.exsys.com*) always focuses on solving real-world problems through a practical easy-to-use development paradigm.

- Acquire, a product from Acquired Intelligence, Inc. (*www.aiinc.ca/acquire/acquire.shtml*) is both a knowledge base authoring tool and an expert system shell.

- CLIPS (*http://clisp. cons.org*) is a productive development and delivery expert system tool offering a complete environment for the construction of rule and/or object based expert systems.

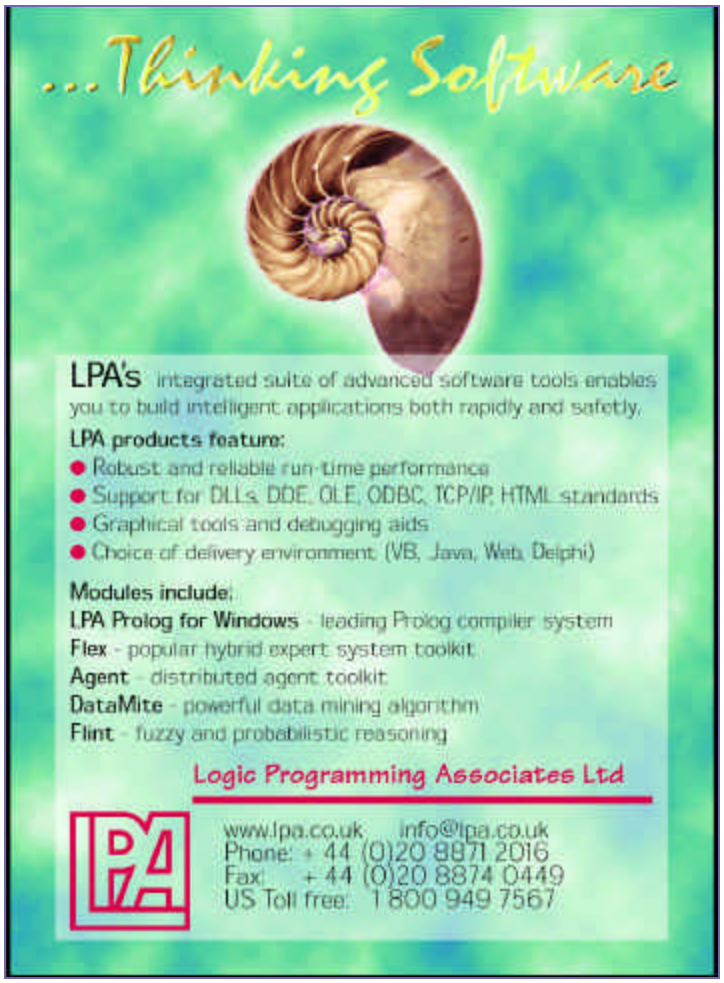
- Using Jess (*www.sandia.gov*), it is possible to develop Java software that has the capacity to reason using knowledge you supply in the form of declarative rules (see PC AI 17.3 for an insightful interview with the creator of JESS).

SDK and Environments - Using shells to write expert systems generally greatly reduces the cost and time of development (compared with writing the expert system from scratch). Software Development Kits (SDK) expands the capabilities of shells in various directions. Here are come examples of SDK and environments, all though most AI products provide an some form of environment.

- G2 by Gensym Corporation (*www.gensym.com*) is a graphical, object oriented software platform for rapidly building real-time expert system application.

- GURU, product of Micro Data Base Systems (*www.mdbs.com*), is a total system for developing applications that combine expert system and database technology.
- The DX Solution Series product line, developed by Knowledge Industries (*www.kic.com/index.html*), consists of three components: DXpress, WIN-DX and API-DX.

Machine Learning Systems **(MLS)** — are becoming an important part of the expert system environment. In contrast to performance systems that acquire knowledge from human experts, machine-



learning systems acquire knowledge automatically from examples, i.e., from source data. MLS are frequently used in learning neural network, knowledge bases, using inductive rule based algorithms, and evolution-based genetic algorithms, etc. MLS usually use data-driven hypothesis-driven and multi-strategy constructive induction.

- Developed by MLnet Online Information Service (*www.mlnet.org*), the PNC2 Rule Induction System is a free machine-learning tool that automatically induces rules from data using the newly invented PNC2 Cluster Algorithm (*www.newty.de/pnc2/pnc2.html*) by Lars Haendel.

Web-enabled Expert systems

Here are some popular web-enabled products and services:

- EXSYS, Inc. (*www.exsys.com*) is the first company providing the ability to run knowledge automation expert systems on the Web. Over the years, the EXSYS tools have been enhanced in many ways.

- Amzi! Prolog (*www.amzi.com*) has a server based Prolog implementations ideal for integration with the web.

- Webcom, Inc. (*www.webcominc.com*) produces WebSource Configurator, an application that automates, simplifies, and accelerates a company's sales process. As a user responds to on-line questions on a product, similar to a sales consultant, the software is adapting and preparing the next set of questions to specify the product.

- LPA (Logic Programming and Associates - *www.lpa.co.uk*) has excellent integration with the web and web development tools.

- Vanguard Software Corporation (*www.vanguardsw.com*) is developing the following products: DecisionPro is an iIntegrated software for management decision analysis, risk management, forecasting, optimization, and modeling and Vanguard Vista, a Web-based survey tool that enables users to create, post, and track survey results online.

- SellitPro from Galileobas, Inc. (*www.galileobas.com/sellitpro.htm*) is an expert systems tool for Product Configuration and Pricing Sales/ Manufacturing automation for handling complex product configurations.

For more information on some of these products, see the *PC AI Buyer's Guide* on page 64.

Conclusion

Although technical progress in the last decade has been satisfactory, as shown in sample examples above (far from complete), the number of widespread expert systems in use today is less than was expected. Now embedded expert systems tend to be more successful than advisory systems. In my opinion, the primary reason for the lower usage of expert systems in advisory type roles is the very expensive procedures of retrieving knowledge in a short time. Developments in machine-learning systems could accelerate the number of new expert systems we see in the future.

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Demonstrating Prolog Usage:

Building a Simple Game Program

By Wan Hussain Wan Ishak

Abstract

To demonstrate the use of Prolog and how programming in Prolog is easy and efficient, this paper describe an implementation of the game *booby-trap*, a game similar to Minesweeper found on most personal computers with windows.

Introduction

Prolog (Programming in Logic) is a well known programming language in the field of Artificial Intelligence (AI). Although Prolog has much in common with Lisp (List Processing), only Prolog has a built in automated reasoning system or inference engine. Since its invention in 1972 by Alain Colmerauer and his colleagues at the University of Aix-Marsielle, France, there have been many versions of Prolog. These include Turbo Prolog [1] – now supported by the Prolog Development Center *www.pdc.dk*), BinProlog [2] (*www.binnetcorp.com/BinProlog*), SICStus Prolog (Intelligent Systems Laboratory, 1995 - *www.sics.se/sicstus*) and LamdaProlog [3]. There are also many other popular Prolog's such as Logic Programming Associates Prolog (LPA - *www.lpa.co.uk*) and AMZI Prolog (*www.amzi.com*). Dozens of Prolog books and tutorials mention other lesser-known Prologs.

Covington [4], one of many who tout Prologs versatility as a programming language, points out how it can implement a variety of algorithms; not just those for which it was specially designed. Prolog consists of two main components: facts and rules. The facts describe relationships between objects whereas the rules define relationships between groups of facts. Prolog is primarily based on three main concepts: pattern matching, automatic backtracking and tree-based data structuring.

In the real world, logic-programming languages such as Prolog have not fulfilled their potential when compared to other conventional programming languages [5]. This was not due as much to limitations in the language as to the ebb and flow of popular media and general computer hype. According to Somogyi, logic-programming languages have theoretical advantages over conventional programming languages, however they have not had the same impact on the computer industry. Although this claim may be true in general, in AI research many intelligent and knowledge-based systems have been successfully developed and deployed using Prolog [4]. Many of these applications would be much harder to develop in languages other than Prolog. Furthermore, Prolog is an "expressive" programming language, which contrasts with conventional "imperative" languages (see sidebar on imperative languages). Prolog contains a number of advanced features, including high-level declarative programming, automatic dynamic memory allocation and deallocation, built in database functionality, incremental compilation and meta-programming [6]. In his book, Luger [7] states that Prolog has made many contributions to AI problem solving with its declarative semantics and built-in unification.

Today, Prolog's have been enhanced with development environments and many integrated tools to simplify implementation. This paper describes the implementation of a simple game program using LPA Win-Prolog. This particular Prolog offers several tools for application development, including a tool for developing Graphical User Interface (GUI), namely the LPA Dialog Editor. This tool lets you draw screens and generate and test the Prolog code in-situ. The LPA Dialog Editor is implemented entirely in LPA Win-Prolog using the buit-in predicates described in the this article.

GUI Development

The GUI, an important element in system development, must support an interactive interaction between the system and the user. LPA's Win-Prolog allows interactive dialog development utilizing a window dialog with GUI elements and control features along with a message handler to interpret the control messages.

Win-Prolog offers two class types for developing dialogs: window class and control class. A window class supplies a skeleton framework for developing dialogs. The Window control class provides the means to embed control objects into windows with several control classes such as button, edit, list box, combo box, static, scrollbar and graphics. Using the Dialog Editor plug-in (Figure 1), the user controls objects by click and drag on the scratch window. The Dialog Editor plug-in is a toolkit for easy development of GUIs and it allows easy

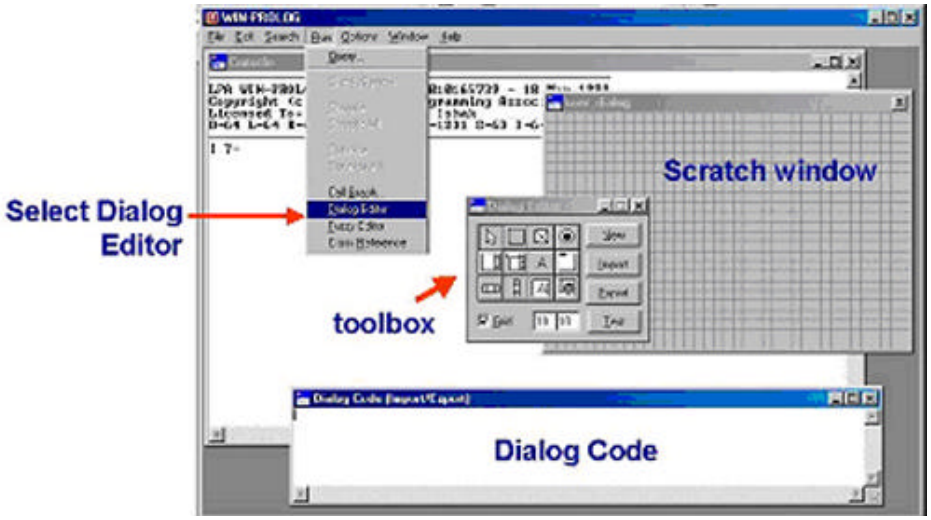


Figure 1: The Dialog Editor plug-in.

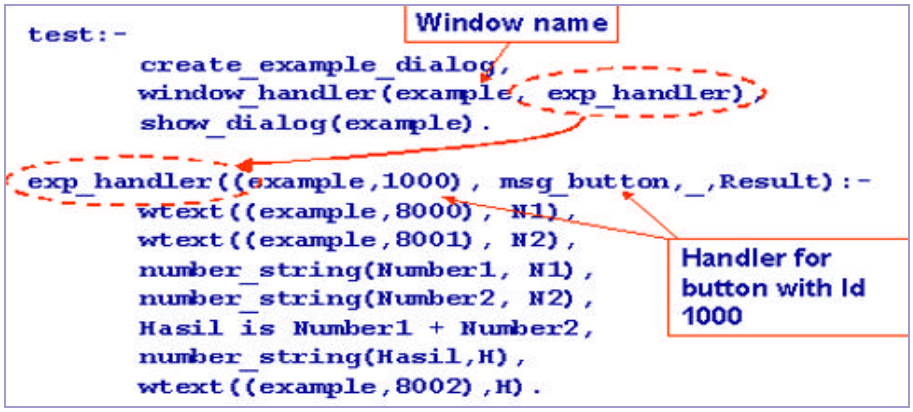


Figure 2: Creating and defining handler for the example window.

Table 1: Built-in Predicates for Window Development	
Predicate	**Description**
wdcreate/7	**Create a dialog window**
wcreate/8	**Create a window**
wccreate/8	**Create a control window**
wucreate/6	**Create a user MDI window**
wtcreate/6	**Create a text window**
wcount/4	**Get windows char, word and line counts**
wtext/2	**Get or set the window text**

creation and maintenance of the dialog code.

Clicking the export button on the toolbox lets you view the dialog code. The code appears in a dialog code window. The code must be paste into a program file.

Win-Prolog provides several built-in predicates for GUI development. The Dialog Editor automatically creates some of these predicates, such as wdcreate/7 and wccreate/8. The window predicates are shown in Table 1.

Other predicates support the control classes. These predicates are shown in Table 2.

Massage Handling

After designing the interface and placing the source code into the program file, the window handler is specified. This handler catches any message generated by the window and performs the specified action. The relation between a window and its handler can be defined using the window_handler(Window, Handler) predicate (Figure 2). For example, the window handler could be exp_handler. Hence, the relation between example window and exp_handler is defined as window_handler(example, exp_handler).

A Booby-Trap Game

The booby-trap game is similar to Minesweeper except the rules and how it plays are slightly different (Figure 3). After the player selects a button, the game returns a score. If the button is a trap then the total score is reset to zero.

The development of a program such as this game involves the following steps:

Select and drag - Create the buttons and edit control to display the score.

Defined the handler - The handler is used to link the button with the appropriate user defined action.

Table 2: Built-in Predicates for Control Classes		
Control Class	**Predicate**	**Description**
Button Class	**wbtnsel/2**	**Get or set the selection status of the given radio or checkbox "button".**
List box class	**wlbxadd/3**	**Add an item to a list box**
	wlbxdel/2	**Delete an item from a list box**
	wlbxfnd/4	**Find a string in a list box**
	wlbxget/3	**Get an item from a list box**
	wlbxsel/3	**Get or set selection in a list box**
Edit box class	**wedtsel/3**	**Get or set selection in an "edit" control window**
	wedtfnd/6	**Find a text string in an "edit" control window**
	wedtlin/4	**Get offsets a line in an "edit" control window**
	wedtpxy/4	**Convert between linear offset and x, y coordinates in "edit" windows**
	wedttxt/2	**Get or set the text of the given "edit" window**

Preparing the trap button - Some buttons are randomly selected and set as traps.

Click & draw

The developer selects the button control from the toolbox and places it on the scratch window (Figure 4). After the buttons are arranged side-by-side in rows and columns, the edit control used for displaying the score is added. Two additional buttons are added to perform the *New Game* and *Close* functions.

Handler

Each button has its own unique ID number as a reference. When the user clicks a button, the handler for the appropriate button is called, with the unique id, and the appropriate action is performed. In this game, only the *New* and *Close* buttons have a specific action and all of the others buttons shared the same action – depending on whether or not the button is a trap. Buttons listed in id/1 are the trap buttons while the others are not (List 1).

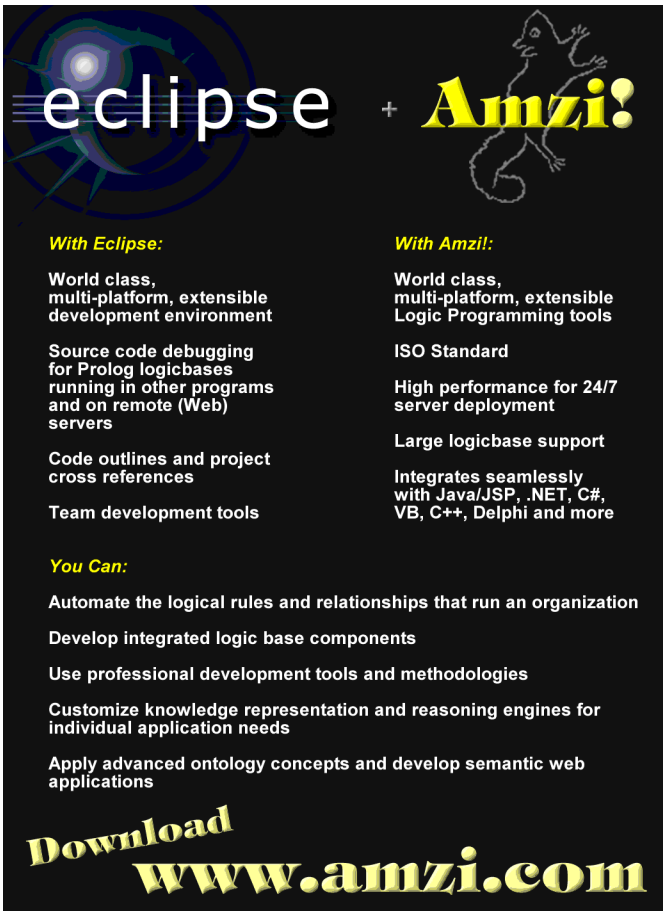
Figure 3: The Booby Trap Game Screen.

Preparing the trap button

The program randomly selects 50 buttons to be defined as a trap – assert in working memory (List 2).

Conclusion

Due to its vast capabilities, Prolog can be a difficult language to master or even to teach. However, programming with Prolog can be easy. As in many languages, programming by using existing example simplifies application development. While we illustrated how to develop a simple game program called booby-trap, we also demonstrated some of Prologs capabilities and how users can easily use this language to develop many types of applications. By providing high-level access to the Windows GUI, Prolog development environments, such as LPA, offers a Prolog system where areas such as games and intelligent interfaces are directly now addressible by the Prolog (only) developer. Next generation applications such as InFlow, IdeaProcessor and IntellX hint at some of the potential achievable using this powerful combination (see *www.orgnet.com*, *www.a-i-a.com/englishHomePage/IdeaProcessor.html* and *www.business-integrity.com/IntellX.html* for more information.)



```
% Run the dialog by typing "start"
% Create the dialog and defined the
%    handler

start:-
  % create the window
  create_booby_dialog, !,
  % defining the handler
  window_handler(booby,booby_handler),
  % show the dialog
  show_dialog(booby),
  % randomly choose the trap button
  create_trap(50).

% The handlers
% Called when user clicked the [X] on
%    the upper-right of the window
booby_handler(booby,msg_close,_,close).


% Called when user clicked close button
booby_handler((booby,1128),
    msg_button,_,close).


% Called when user clicked new button
booby_handler((booby,1129),
    msg_button,_,R):-
            !,
            start.


% Called when user clicked any button
%   and the button is a trap
booby_handler((booby,ID),
    msg_button,_,R):-
            id(ID),
            wtext((booby,ID),`F`),
            wtext((booby,8000),`0`),
            !,fail.


% Called when user clicked any button
booby_handler((booby,ID),
    msg_button,_,R):-
            wtext((booby,ID),`$`),
            wtext((booby,8000),X),
            number_string(Score,X),
            NewScore is Score + 10,
            number_string(NewScore,X2),
            wtext((booby,8000),X2),
            !,fail.
```

Listing 1: Booby-Trap Handler

```
% Create the trap button
create_trap(0).       % stopping criteria

% Randomly select the trap button
create_trap(Num_trap):-
    % 128 are the total number of buttons
            X is rand(128),
            Btt_ID is ip(X),
            not(id(Btt_ID)),!,
            assert(id(Btt_ID)),
            Red_Num_trap is Num_trap - 1,
            create_trap(Red_Num_trap).
```

Listing 2: Randomly creating the trap button.

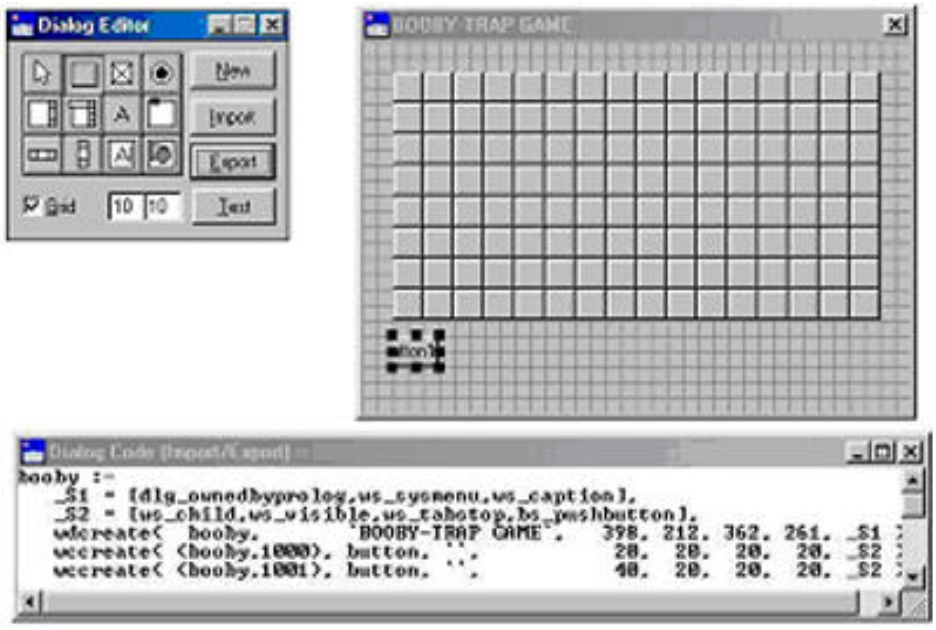


Figure 4: selects the button control from the toolbox and places it on the scratch window

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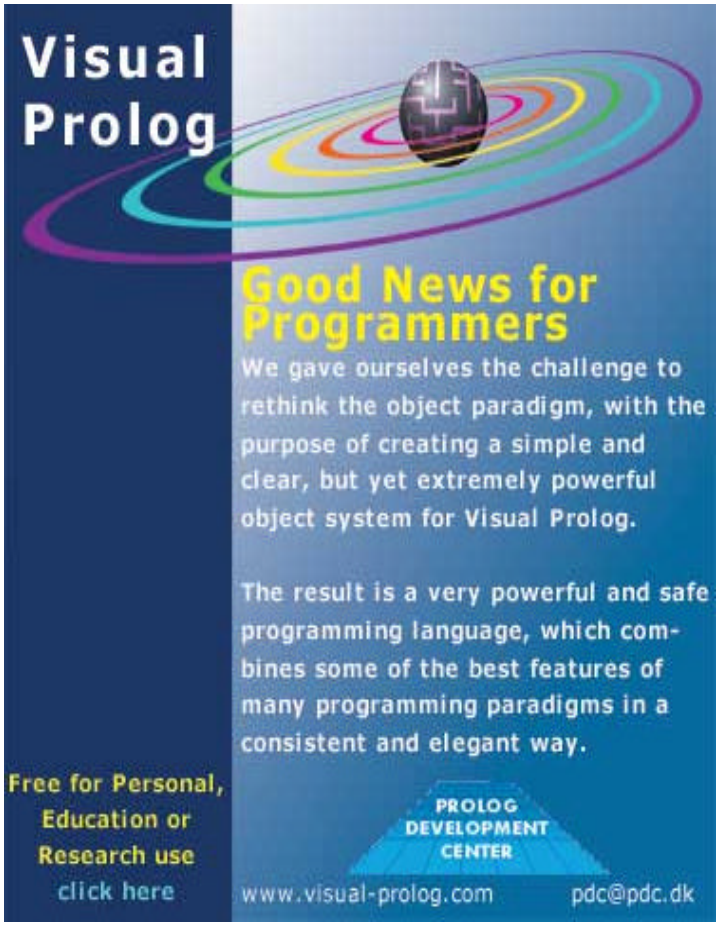

Imperative Programming

The imperative programming style describes computation in terms of program state changes and statements that change the program state. An example of a program state change would be selecting the "reply" button in an email program. Before that, the email program was displaying an email for you to read. After the state change, you now have a new email that is ready for you to edit (not just read).

Imperative programming languages have primitives very similar to the CPU's machine instructions. For example, Branch statements, memory assignment statements and add instructions. Imperative programs consist of a series of commands for the computer to perform. Almost all computer hardware is imperative — designed to execute the native code of the computer — machine code. At this level, the memory contents defined the state of the computer. Higher-level imperative style programming languages use variables to contain this state information.

Even though logic programming languages are theoretically superior to imperative programming languages such as C, C++ and Java, there are two reasons why current logic programming languages such as Prolog are not as widely used for application development.

1. Logic programming languages can be significantly slower than the equivalent program logic in an imperative language such as C. Therefore, application designers concerned with performance might not consider logic programming languages. As computer speeds continue to increase, and logic-programming languages become even more efficient, this reason could someday be eliminated.

2. Current logic programming languages do not detect as many errors in programs as compilers for imperative programming languages, which can reduce productivity. Programmers must find more errors themselves, usually during debug. Languages, such as Prolog, do not require type casting, which simplifies programming and increases flexibility. However, it also means the programmer is now responsible for finding many errors that a compiler with type checks would find.

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Appendix

```
% abolishing and declaring id/1 as a dynamic predicate
:- abolish(id/1), dynamic(id/1).

% creating dialog
create_booby_dialog:-
   _S1 = [dlg_ownedbyprolog,ws_sysmenu,ws_caption],
   _S2 = [ws_child,ws_visible,ws_tabstop,bs_pushbutton],
   _S3 = [ws_child,ws_visible,ss_right],
   _S4 =
[ws_child,ws_visible,ws_tabstop,ws_border,es_left,es_multiline,es_autohscroll,es_autovscroll],
   wdcreate(  booby,        `BOOBY-TRAP GAME`,  398, 212, 362, 271, _S1 ),

   % create buttons
   buttons(1,1,20,40,_S2),

   wccreate( (booby,1128),  button, `CLOSE`,    270, 210,  70,  30, _S2 ),
   wccreate( (booby,10000), static, `Score : `, 170,  10,  70,  20, _S3 ),
   wccreate( (booby,8000),  edit,   `0`,        250,  10,  90,  20, _S4 ),
   wccreate( (booby,1129),  button, `NEW`,       20, 210,  70,  30, _S2 ).

% create 128 buttons - then stop
buttons(Num,128,Left,Top,Prop):-
        !,
        createbutton(128,Left,Top,Prop).

% reset counter to 1
% only 16 buttons in a row
buttons(17,Id,Left,Top,Prop):-
        NewTop is Top + 20,
        buttons(1,Id,20,NewTop,Prop).

% create the buttons
buttons(Num,Id,Left,Top,Prop):-
        createbutton(Id,Left,Top,Prop),
        NewNum is Num + 1,
        NewId is Id + 1,
        NewLeft is Left + 20,
        buttons(NewNum,NewId,NewLeft,Top,Prop).

% create the button
createbutton(Id,Left,Top,Prop):-
        wccreate( (booby,Id),  button, ``, Left,  Top,  20,  20, Prop ).
```

Special Edition of
The Robotics Column

DARPA Grand Challenge Race Update:

A Report from the Front Lines

By Paul F. Grayson

It has the excitement of classic movies such as *Around the World in 80 Days* or *The Great Race* except that instead of a human hero, the vehicles themselves are the stars. This government-sponsored challenge (*www.darpa.mil/grandchallenge*) is bigger and more complex than any government challenge in the past. Just as in those great movies, this challenge has teams working against the clock to complete extraordinary feats and technical obstacles (see *The DARPA Challenge: What the Autonomous Vehicles are up Against* in the 17.3 issue of PC AI). This challenge is one of the most visible and challenging applications of Artificial Intelligence and Robotics currently under development. This article, the next in our series on this challenge, reviews the evolution and status of the challenge and how one team has progressed.

Introduction - What is the DARPA Grand Challenge

For those still unaware of the challenge, it is a 300-mile race of autonomous ground vehicles, between Los Angeles and Las Vegas, scheduled for March 13, 2004. The team finishing the designated route first, within a 10-hour time limit, will receive a cash award of $1 million. The Defense Advanced Research Projects Agency (DARPA) Grand Challenge will tentatively run annually until there is a winner, or until the Congressional authority that awards the cash prize expires, currently in 2007. True to the intent of the Grand Challenge, which establishes a desired level of autonomous performance, there are no limitations on how to achieve this performance. Although they are giving the participants as much creative license as possible, most teams will are modifying existing off-road vehicles.

The Department of Defense and Congress realize unmanned vehicle technology is critical to our military future. This challenge is an effort to bring attention and commercial resources to the technological issues associated with autonomous vehicles while creating opportunities for performance breakthroughs. The race has been set up to target non-government U.S. persons or entities such as companies and entrepreneurs, turning loose American ingenuity and innovation with the hope a new approach will be found. Non-US citizens can participate as part of a US-led team.

These vehicles must autonomously traverse the 300-mile route without any human interface or control. This includes the general route selection and navigation necessary to follow the Challenge route. Vehicles must sense their environment to perceive terrain features, ground conditions, obstacles, and particularly other Challenge vehicles; controlling their speed and direction to avoid or accommodate their environment. Since overall speed is the deciding factor and the 10-hour time limit will push vehicle speeds far beyond current technologies, everything must proceed quickly.

The only publicized requirements for entering the Challenge are an administrative application and the submission of a detailed technical paper describing the autonomous vehicle. Originally, once the organizers reviewed the technical papers for safety, compliance with the rules, and technical legitimacy, they were to approve the paper and the team could be an official participant and were invited to field a vehicle for the Challenge. Initially there were approximately 250 teams interested. The rules have since changed due to safety concerns, so that only 20 teams will initially compete in this challenge.

Although the teams will not have the precise course until just two hours before the start of the race, the route will consist of a variety of terrains between Los Angeles and Las Vegas. A series of midpoints and boundaries define a corridor within which the vehicles must remain. The corridor width will vary from miles across to ten feet, and will guide the vehicles across open terrain, winding trails, and paved roads, all cleared of non-Challenge traffic.

Once participants activate their vehicles on the starting line, DARPA will

take responsibility for all aspects of the race administration. By deploying a comprehensive network including field judges and electronic systems, DARPA will monitor and ensure operational safety for all vehicles on the route. Monitoring of vehicle progress will be available through designated observation points and detailed monitoring data from the Challenge Operations Center.

The DARPA Grand Challenge - The Race for Contracts: There is Already a Winner!

Since the cost of a vehicle's preparation for the DARPA Grand Challenge Race is expected to equal or exceed the total prize money, and there is only one prize, what is the motivation for the contestants? Many of the teams preparing vehicles are doing so with the goal of reaping some economic benefits after the race. These contestants have called it the "Race for Contracts" and have business plans to address their company's strategy after the race. Some teams plan businesses based on installing guidance systems while others plan to continue with other forms of automation.

If this is the ultimate goal of the contestants' start up companies, apparently there has already been a winner. While most contestants focus on this happening after the race, one team has done it before the race. VideOptions (*http://videoptions.com*) has stopped updating their web page, withdrawn their vehicle from the race and reported that they sold it to a Japanese car company for several times what the prize money would have been. Their spokesperson says that they are building six more for that customer, and have sold a copy of their guidance system to a German car company. If DARPA was planning to prevent the export of this technology and planning to publish the details of their design, it is too late. Other teams have reported being approached by big money buyers have not reported.

DARPA is quick to point out that it is not a "race" - it is

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A Race of Their Own: The IRRF "Open Challenge" Race, A Race for the Other 86+ Teams

DARPA has changed the original rules and announced they will limit the field of their race to 20 vehicles, while five times that number of vehicles is currently being built for the race. This is very unfortunate for the autonomous vehicle builders not selected – who have invested just as much time and resources. What are the other 86 teams to do with their vehicles and teams - enough vehicles for four additional races? This would be a huge resource and tremendous talent to waste. When else in history have you heard of so many racing vehicles existing with nowhere to race? To fill this gap, the teams themselves have formed the International Robot Racing Federation (IRRF - *http://irrf.org*) to promote robot races where members can. By making it a purely commercial venture, it becomes more fun, more sponsor friendly, and open to all (hence the use of the word *International*). They have also sought to correct each of the things that they found wrong with the DARPA version.

IRRF was created to promote good sportsmanship in autonomous vehicle racing while promoting the sport and educating the public to the social benefits of autonomous vehicles. It will also demonstrate component manufacture's products and offer forums for discussion of mutual interest. It is expecting to help promote a continuing series of races around the world.

Seven teams have already signed up for IRRF's Open Challenge Race schedule in September 2004.

Team	Team Leader	Website
5 BEST	Jaime Teuffer	
Team Armani	Michael Armani	www.armaniproject.com
Team AV Andrea Morga	Paul F. Grayson	aimagic.org
Team CyberRider	Ivar Schoenmeyr	www.cyberrider.org
Team Go It Alone	Aimo G. Jarvi	home.netcom.com /~aimo
Rapid Robots	Ron Fink	rapidrobots.com
Vista Engineering	Mike Lesh	www.me.vt.edu /grandchallenge

Some beneficial features of the IRRF, in case you are starting to feel the urge to join the driverless vehicle racing trend:

* Anyone from any country is welcome to race.
* Currently no entry fee
* Final rules will be published long before each race, giving builders and sponsors reasonable certainty of the requirements at the safety check and in the race.
* All sponsors are welcome to join both the IRRF racing organization and individual racing teams.
* The team leaders will have the race route with as much detail and as far in advance as possible.

Robots Continue Their Move To Become A Significant Part Of Society: Robot Joins The Diplomatic Corps.

A robot of the ASIMO series manufactured by Honda Motor Company (*www.asimo.honda.com*) made diplomatic history and the news by being included as a member of an official diplomatic delegation. Accompanying Japanese Prime Minister Junichiro Koizumi to Prague the robot carried out a number of diplomatic functions.

In true diplomat fashion the ASIMO robot laid a wreath of yellow and white chrysanthemums in front of the bust of Czech writer Karel Capek, creator of the word "robot". Then the Prime Minister Vladimir Spidla and his cabinet received the robot, as part of the Japanese delegation. Later the robot attended a state dinner with Prime Minister Vladimir Spidla, and is reported to have spoken perfect Czech, was witty and relaxed, toasted to the friendship between people and robots, and asked the PM to dance (the PM declined).

Another robot, computer generated Sakura Sanae (*www.mofa.go.jp/region/asia-paci/asean/year2003/cg2.html)*, is described as being young, beautiful, in touch with the pop culture and fluent in several languages. Sakura is part of the Japanese diplomatic corps and Tokyo's good will ambassador to the ASEAN nations. Some advantage over other diplomats is that Sakura can be sent to all 10 ASEAN countries at once and bridges the language barrier.

a "challenge". Although contestants feel that, since "DARPA's giving out the prize money, DARPA can call it what ever they want", the contestants still call it a race. DARPA further states there are no contracts connected to this race and participants have been warned that their design may be subject to export controls. At the same time, contestants have been told that their design will be made public and published after the race. These contradictory statements highlight the schizophrenic nature of a large bureaucracy - which describes DARPA. If this sounds confusing to you, it is even more confusing to the teams trying to compete for the million-dollar prize without being disqualified. Additionally the April First rules for the race have been extensively modified via memos, yet the official rules have not been updated. Reading the official rules only supplies part of the information and rules with which they will need. When asked about this, DARPA responded that the official update to the April First rules will appear before race day – not much help for teams needing to make technical decisions yesterday.

Finishing the 18 Month Long Administrative Gauntlet

At the end of 2003, the Challenge inspection team came by the American Industrial Magic team for an inspection. Although they had hoped to see a live demonstration of our three vehicles, with the short time before the race, there was not enough time to go to the remote facilities where these vehicles and their various components reside. They instead elected to come to the AIM racing team headquarters for the administrative overview of the project. Equipment photographs and a series of drawings were presented in response to their questions. Since AV Andrea Morgan (AV - Autonomous Vehicle) was here in the workshop, they were able to see the steering actuators move the front wheels at half racing speed. They left us with nine questions to answer in just a few days. These questions included:

* Radar - what imaging software are we going to use, how is motion compensated for, how is vehicle vibration removed, what is its vertical resolution?
* Who are our team members, what are their credentials and what is their commitment to this project?
* How does the route-planning portion of the software translate into servo commands?
* How is the GIS Photogrammetery registration and calibration problem solved?
* What is the manufactures name and product ID of the GIS software that our GIS Group has selected?
* What are the ship dates, test results and performance characteristics of the parts not yet installed? – Be sure to send pictures and shipping documents.
* What is the turning radius of AV Wendy Darling?
* How has the software integration problem been solved?
* What is our sponsor commitment? – Please provide copies of letters or e-mail from sponsor and copies of the shipping documents for the parts they are providing.

The next hurdle that teams must pass is the Qualification Inspection and Demonstration (QID) scheduled for the four days before the race. (The official April First rules still say that it is planned for the day before the race, but a recent memo makes it the four days before). Of the more than one hundred teams that started preparing for the race, only twenty-five have been invited to the QID.

At the QID the field will be narrowed farther with twenty-five teams competing for twenty race positions. DARPA initially predicted only five vehicles would pass this inspection, and none would finish the race the first year. It will be interesting to see how many vehicles pass the QID hurdle.

Late Friday night, 12/18/03, I received an e-mail from DARPA telling me that my three Vehicles AV Andrea

Figure 1: The M35A2 truck donated to American Industrial Magic by D. F. Gallager Construction Company of Mertztown, PA to be our AV Wendy Darling. Freddy Gallager has been automating trucks like this for years.

Figure 2: Computers mounted in the sleeper cab of one of the WesTrack trucks – today this should require a lot less space.

Morgan, AV Sydney Bristow, And AV Wendy Darling are not invited to the QID. While this was initially a big disappointment, it allows my team to focus on the International Robot Racing Federation races (*http://irrf.org* See IRRF Sidebar) and the 2005 DARPA Grand Challenge.

The Race to Prepare for the Next Race

This has become very much a race to raise the money needed for the next race. My teams' situation, which is similar to most of the 106 teams that signed up for the 2004 DARPA Grand Challenge, is that we need new sponsors and workers to help preparing for the IRRF races and the 2005 DARPA Grand Challenge. The 2004 DARPA race is over for these teams and the race to prepare for the other races has begun. This time, fundraising appears to be a little bit easier for the various teams. Some attribute the friendlier reception to the IRRF Race, which is no longer directly connected to the Department of Defense. The experience of a previously run race will also help.

As we prepare for the IRRF Open Challenge in Sept. 2004 and wait for the new civilian fundraising campaign to begin in February, we are busy building what we can with what we have. We are operating in bare-bones mode for the moment with work on AV Andrea Morgan -- the jackrabbit in our "tortoise and the hare". Since we are building from the pile of things that I had collected over the years as training aids and samples, we only have parts on hand for one vehicle. We are wiring our vehicles with lamp cord, using old wheel chair motors and controllers for servos to get things running. While not pretty, it works and we can claim a credit for recycling these parts. Vehicles AV Sydney Bristow (my personal favorite) and the tortoise of the three, AV Wendy Darling are all on hold until more parts become available (See the article in issue 17.3 of PC AI Online for pictures of these vehicles).

We have also begun the process of filing for 501c3 status as a Scientific Organization. Since we are already dependant on the good will and charity of others, the 501c3 status will make our position official. This is very similar to what most of the other teams are doing — only a few of the one hundred plus teams are profit-making companies. In our case, becoming a charitable organization will encourage contributions by allowing contributors to take a tax deduction for what they donate. That could help our fundraisers do their job. Although our team is anxious to see how our designs work with real hardware, we also believe that its implementation could save lives. The sooner our guidance system is on the road, the sooner we can test this theory.

Some of the Many Tasks

We plan to clone each of our race vehicles with a backup vehicle, using whichever one is running best on race day. Our second AV Wendy Darling vehicle is in Anchorage Alaska and we need to raise about $1,500 to have it moved to our headquarters in Traverse City.

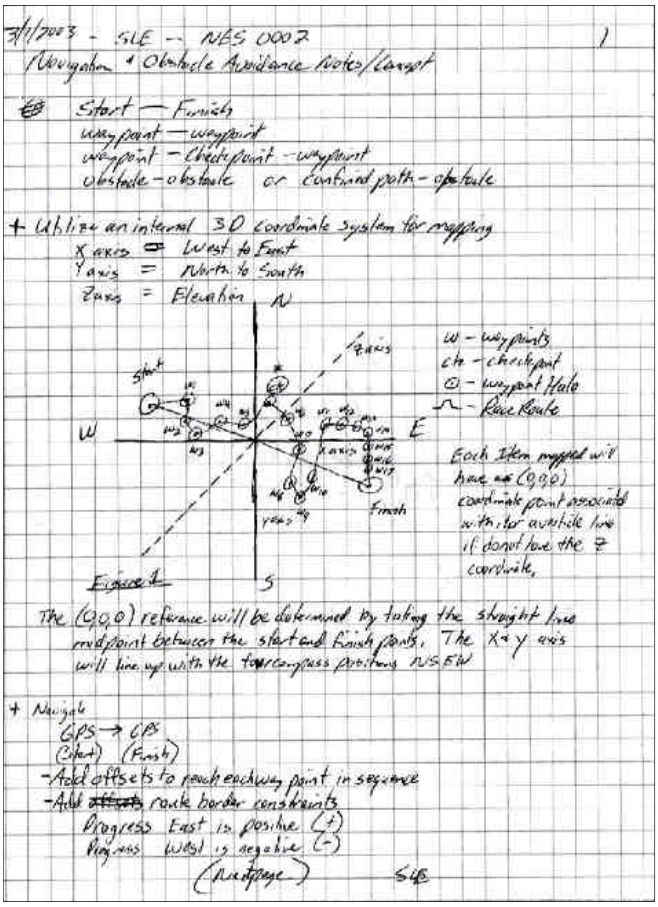

Figure 3: Over a hundred teams have been filling up laboratory notebooks, such as this one for the past year, puzzling over the problem **of** automating vehicles.

Figure 4: The AV Andrea Morgan drivers seat TV camera

Figure 5: This view looks through the car from the passenger's side.

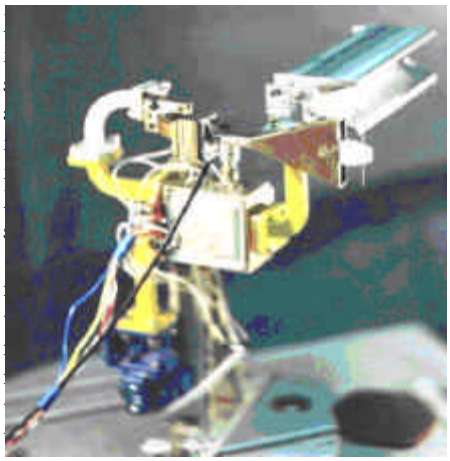

Figure 6: A miniature Russian radar designed for vehicles.

There are no landmarks other than plastic snow fence and possibly some concrete barriers protecting areas to be avoided. The accuracy or error of the GPS is 15 cm, which uses up most of the one-foot margin on each side in the narrowest places. An underpass that the vehicles have to pass through is ten feet wide and nine feet high. This width is not a problem since the vehicle will be outfitted with electronic curb feelers to easily detect the underpasses solid walls.

While the 2004 DARPA race route might not seem important, since we are moving on to other races, we are designing our guidance system to handle what we know about this route in case those same abilities are useful in other places in the world.

A driverless tractor-trailer truck was built years ago during the WesTrack Autonomous Vehicle project. *www.westrack.com/wt_03.htm*. This WesTrack driverless trucks drove 1.7 million vehicle miles in two years towing heavily loaded trailers. I recently talked to the people there and they indicated that when the project ended, the trucks were parked in the weeds, stripped and eventually sold for scrap. The empty hulk of one may still be there at the site. While it has been done before, it has never been done in as harsh an environment as the DARPA Grand Challenge presents.

I did my Naval Reserve time at the Navy's mobile robotics laboratory in San Diego as a visiting research engineer. Over the years the lab has had many names, but is the same small group of people, working on the leading edge of applied robotics that work there (*www.nosc.mil/robot.*) I met many extraordinary people there who are doing remarkable things and I hope to make use of that knowledge by leading three teams in the race.

The AV drivers seat TV camera (see Figure 4) is one of two for vision system testing. For racing, a pair of USB cameras will be hard mounted behind the windshield, with windshield wipers to keep the field of view clean. This is the minimalist approach to autonomous vehicle racing. The on board Inertial Navigation Subsystem (INS) will provide the acceleration information used to electronically stabilize the image and correct for vehicle and camera motion. This software makes up for using simple hardware. We want the cameras to provide stereo information to the photogrammetry software to capture 3D information about the terrain that surrounds the vehicles. The cameras taped to the vehicle for this test cost $28 each while the GIS software costs $250. Other cameras we have here cost from $5 to $15 so anyone can get involved no matter how limited their budget. In fact, the lack of money can cause people to come up with some very creative solutions to the problems —instead of purchasing canned solutions.

Each team needs to equip their vehicle with manual stops that put the vehicle into its shutdown mode. Yes, we even have a manual stop located on the front of the vehicle; which has caused a number of laughs as people try to imagine situations where you might use this one. Give up? It is on the nose of the vehicle in case you need to stop the vehicle when it is backing away from you.

Figure 5 shows the rat's nest of not yet bundled cables surrounding the linear actuator connected to one of the brake pedals. This linear actuator is quick acting and capable of producing 500 lbs of thrust. The addition of a second actuator to the brake pedal next to it will make a tractor-like individual wheel braking system for quick turns and stability control. We are following the example of modern Traction Control / Stability Control systems with this home brewed version. Through the vehicle, you can see one of the removed body panels with the PC AI logo resting against the milling machine. The body panels are printed on both sides so that sponsors logos show when pictures are taken of the vehicle's interior and exterior.

The SPTU-RU Radar (see Figure 6) is the miniature Russian radar, designed for vehicles, which we are considering using. We will consider any radar that will work. We are using Radar because dust clouds in the desert can block all optical systems. Sonar will provide short range information to augment the radar coverage of the area around the vehicle.

Figure 7 shows a typical sensor suite that the car parts manufacturers have been showing to the car companies as the master plan. Car companies are buying pieces of these master plans and making them available on current production models. Twice today, I was behind vehicles in traffic that had factory installed sonar sensors showing on their rear bumpers. Other sensors are less obvious. These features are in car show rooms under names such as Traction Control, Stability Control, Adaptive Cruise Control, Pre-crash Safety System, Lane Departure Warning, etc. Cars with these systems are starting to show up in junkyards so if you know what to look for you could be the first on your block to have all of these features installed on one vehicle. If you live on my block you will have to hurry, I have approximately a one-year head start.

Conclusions

We plan to create a road vehicle; a car, truck or bus with the intelligence on board to deal with the range of situations that typically confront drivers. The computer's ability to drive without blinking or a moment's inattention to the driving task has a huge potential for

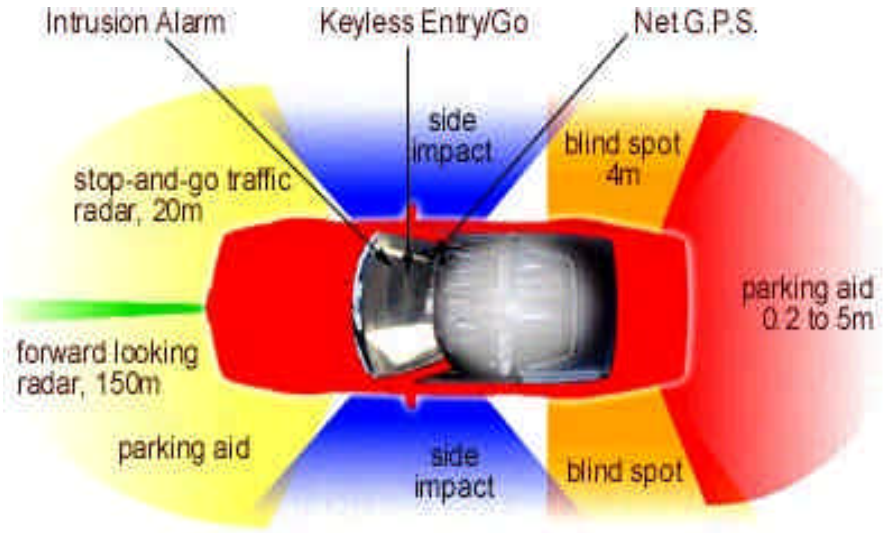

Figure 7: The sensor suite suggested by Macom for production cars.

saving lives due to traffic accidents. Since nearly all accidents are caused by operator error, the number of injuries that such a system could prevent is very large. Commercials on TV highlight the fact that you will want the other drivers on the road to have this system to protect you from their bad driving.

While people are less than perfect drivers, machines can be optimized for the task - as the technologies develops. Although accidents caused by equipment failures may occur, estimates for this are very small compared to those caused by human operators. Part of the reason flying is much safer, statistically, than driving is the high degree of automation now found on commercial airliners. It is time we apply this same automation to vehicles on the ground. The series of driverless vehicle races now being planned are a safe way to try out ground vehicle automation technology and see what works. They should be a lot of fun to watch as well. If you would like to become part of this adventure, you can:

- become a member of the IRRF at *http://irrf.org*
- join one of the 106+ teams involved in building cars for driverless races
- contribute time, money, or materials to one of the teams
- start a team of your own
- become a fan of this new technology based sport.

I plan to attend the 2004 DARPA race as a reporter for *PC AI Magazine Online* and I will report on the event. I know readers will want to know if they need to call in a helicopter gunship to stop a wayward race vehicle. There will no doubt be exciting happenings at the race. The publishing of the technical papers for each of the race vehicles should prove to be quite revealing.

See you at the races!

Paul F. Grayson is Chief Engineer at American Industrial Magic. His life long interest in robots led to his traveling around the USA to meet the people involved in robotics and his founding of the ROBOT CLUB of Traverse City, MI. *www.wdweb.com/robotclub/index.asp*. Mr. Grayson maintains an extensive collection of technical papers and books on the subject of robots and is frequently asked to speak on the subject. He can be reached at (231) 946-0187 or pgrayson@traverse.net.

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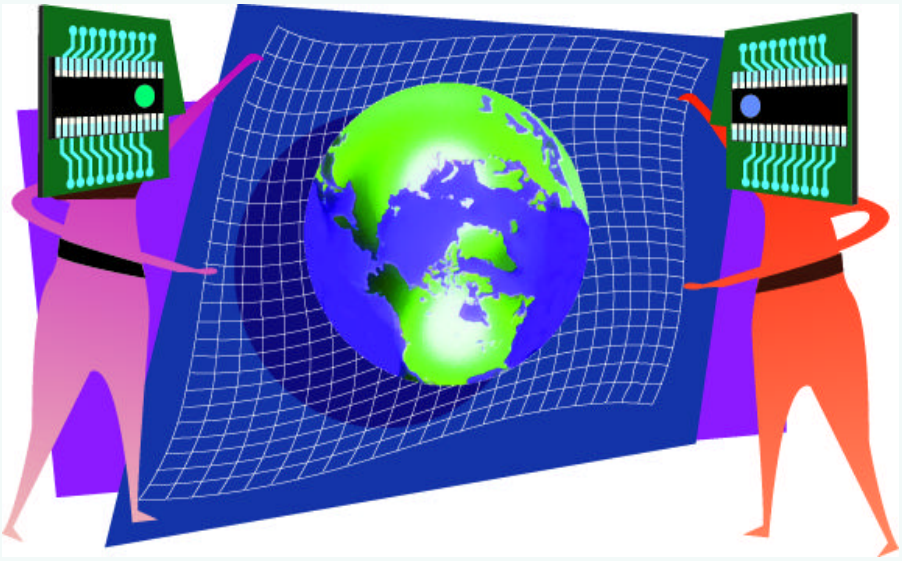


Mars has an Intelligent Spirit

Terry Hengl

As you know by now, NASA's latest mission to Mars (*http://mars.jpl.nasa.gov /mer*), after depositing the Spirit Rover on the Martian surface, has been collecting successes since its launch over 6 months ago. The science team lead, on leave from Cornell University for this academic year, is Steve Squyres, who makes the daily decisions on where the rover will go and what rocks to analyze. Dealing with a more intelligent device has simplified the manual controlling of rover, which is complicated by the 20 minute round trip delay between the earth, the rover and back. "They have vision, and can see obstacles," Squyres says. "We send a command to the vehicle. It executes it to the best of its ability, and maybe it succeeds and maybe it does not. And then, when it's finished, it sends the data back, and we do it again." This intelligent software also helps protects the rover from doing something that might harm itself – such as going off a cliff.

Smart rovers such as Sojourner used artificial intelligence to traverse Mars back in 1997. It had the decision-making capability to move around and determine a path for itself without requiring help from ground controllers. Artificial intelligence software was also included on NASA's Deep Space 1 in 1998, and again in the fall of 2002, Johnson Space Center (JPL) used the latest AI software to command the mission for a period of three months. This software decided which pictures to send back to Earth.

NASA (National Aeronautics and Space Administration) and JPL have invested heavily in AI and robotics and they have created a number of interesting web sites. Here are a few:

Behavior Control

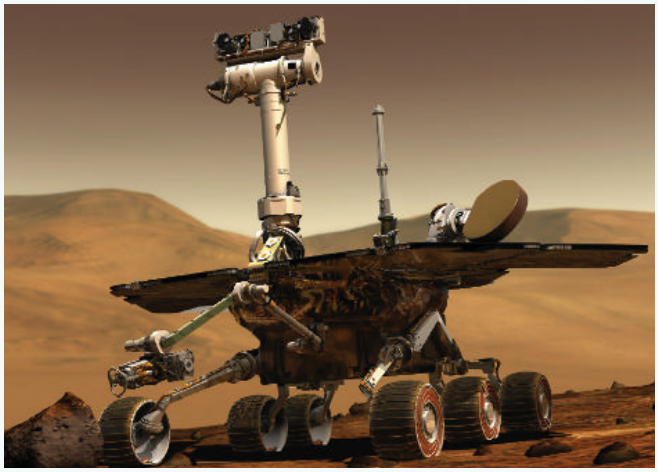
The Mars Exploration Rovers use behavior-based control to perform tasks autonomously on the surface of Mars (*www.jpl.nasa.gov/news/features/biosystems-101403.cfm*). Both scientists and engineers are looking at several approaches for controlling robots. One approach, *deliberative control*, is the most familiar to people with all of the robot's function planned and defined in detail. Various procedure models and programs precisely plan the entire sequences of action such as manufacturing an automobile. Unfortunately, if something does not follow the robot's plan (for example, if a navigation map is wrong or lacks detail), the robot must stop what it is doing and make a new map and a new plan of action – often requiring human help. This re-planning process become costly if repeated over time and can be very time consuming. To ensure the robot's safety, back-up programs must be developed and implemented to tell the robot to abort the main plan if the robot encounters unforeseen events such as navigating up to a hole.

The other approach, *reactive control*, eliminates maps and planning altogether and focuses on observing the environment. In this case, the robot knows to slow down if there is a rock or hole ahead. The JPL Telerobotics Research and Applications Group is led by Dr. Homayoun Seraji, and focuses on *behavior-based control*, which is more a reactive approach. Although robots can still follow a plan, behavior-based control enables them to stay aware of unexpected events. This approach offers the flexibility to adapt the plan to its environmental changes, similar to how a human handles that type of situation. This offers advantages in space exploration including reducing reliance on immediate communication, which is not possible with the communication delays.

JPL are currently focusing on a couple approaches to implementing behavior-based control: fuzzy logic and neural networks. The primary difference between them is that the fuzzy logic based robots start with a knowledge set that does not improve without human intervention, while neural network based robots start out with no knowledge and learn over time.

AI and Robotics Presentation

A web cast presentation on AI by JPL (*www.jpl.nasa.gov/webcast/ai*) is well



thought out with answers to common AI related questions. Although recorded in 2001, it is still very relevant and informative. There are links to other AI related sites within JPL at this site as well.

The Jet Propulsion Laboratory Robotics Page

JPL Robotics robotic researchers (*http://robotics.jpl.nasa.gov*) develop, integrate, and demonstrate innovative robotic and automation technologies, and support NASA missions while addressing other problems of national importance. Researchers work toward the goal of more efficient, lower cost missions dedicated to planetary surface and solar system exploration, Earth observations from space, astrophysical experiments in space and on the Moon, and the extension of human capabilities in space. This is NASA's primary center for creating robotic spacecraft and rovers. They also build smart machines that perform complicated tasks millions of miles from earth.

The Jet Propulsion Laboratory Artificial Intelligence Group

The Artificial Intelligence Group (*www-aig.jpl.nasa.gov*) performs basic research in the areas of Artificial Intelligence Planning and Scheduling, with applications to science analysis, spacecraft commanding, deep space network operations, and space transportation systems. This site has links to current and past projects.

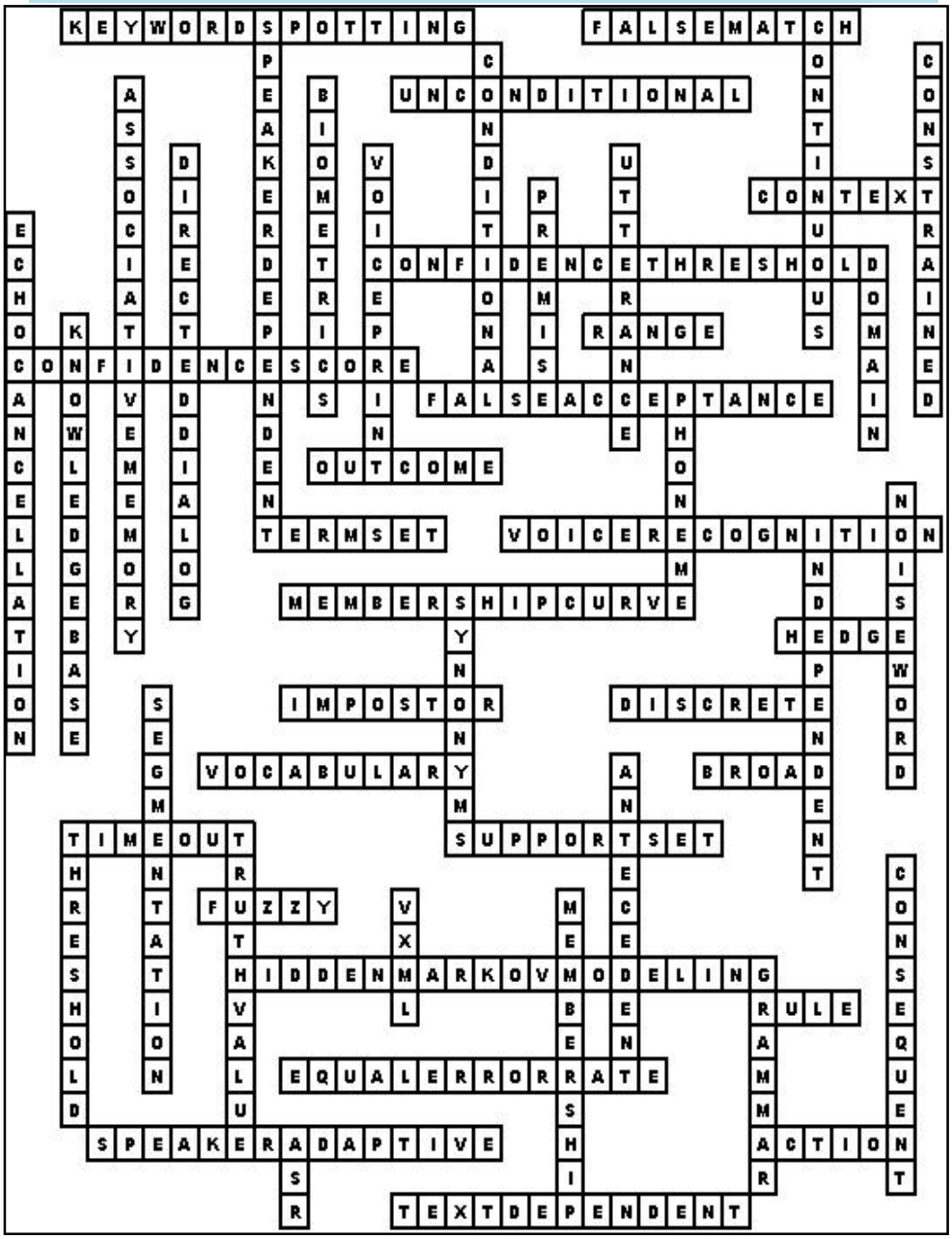
JPL Presentations

Dr. Ayanna Howard presents *Artificial Intelligence for Autonomous Control in Space* (*www.jpl.nasa.gov/events/ lectures/apr04.cfm*). It is a full presentation, available via the web using Real Audio. For robotics, a system must possess autonomous onboard perception, reasoning, and decision-making capability to function successfully in natural environments. A difficulty for planetary robotics is that the operation occurs in unknown, unsafe, and unexpected sites. To address these issues, they employ approaches that use human-inspired techniques, such as neural networks, fuzzy logic, and visual sensing to develop autonomous planetary robotic systems.

Solution to 17.3 Crossword Puzzle

Topic of this puzzle was: *Fuzzy Logic and Speech Recognition.*

Future puzzle topics will include robotics, LISP, AI languages, expert systems, agents, pattern matching, logic programming, machine learning and many other topics. The answers will appear in the following issue.



The Book Zone

Expert Systems: Principles and Programming

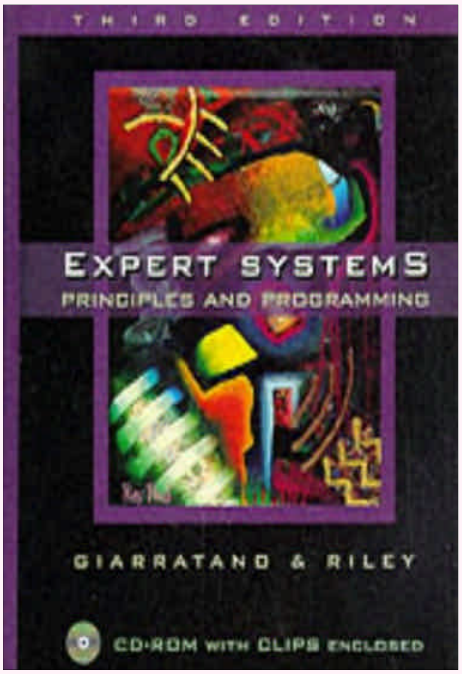
Knowledge Representation, Reasoning and Declarative Problem Solving

The Description Logic Handbook: Theory, Implementation and Applications

Managing Software Engineering Knowledge

Handbook on Ontologies

By Elisa Hicks



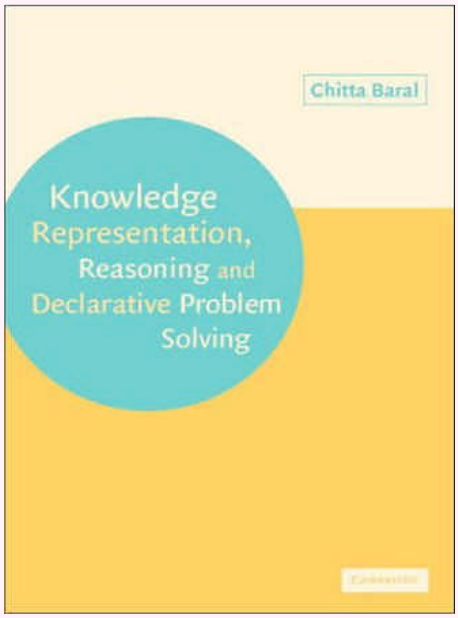
Expert Systems: Principles and Programming

By Joseph C. Giarratano and Gary D. Riley

This book combines the principles of expert systems theory with a discussion of practical applications using CLIPS, an expert systems shell developed by NASA and used by industry, education and government. After discussing the theory in many areas such as knowledge representation, inference methods, uncertainty reasoning, and the use of fuzzy logic with inexact reasoning, the readers are introduced to CLIPS and rule-based expert systems. The latest CLIPS source code and examples are included on the CD. The book would be of interest to students and professionals looking for a background on the programming and implementing expert systems.

Expert Systems: Principles and Programming by Joseph C. Giarratano and Gary D. Riley, December 2003, Brooks Cole, 752 Pgs, ISBN: 0534384471, $113

For more info: *www.brookscole.com/cgi-brookscole/course_products_bc.pl?fid=M2b&discipline_number=6&product_isbn_issn=0534950531#ancillaries*



Knowledge Representation, Reasoning and Declarative Problem Solving

By Chitta Baral

This book focuses on knowledge representation and reasoning, from a management perspective. It discusses knowledge-based intelligence using a declarative interface with a logical input language. This book illustrates how to write intelligent programs by giving them with the ability to express and reason about knowledge. AnsProlog, a language for both knowledge representation and reasoning as well as declarative problem solving is covered in detail. The organization of the book is very useful for knowledge engineers looking to gain a broader knowledge of these topics. The book also includes a comprehensive bibliography on the topic.

Knowledge Representation, Reasoning and Declarative Problem Solving by Chitta Bara, March 2003, Cambridge University Press, ISBN: 0521818028, 544 Pgs, $90

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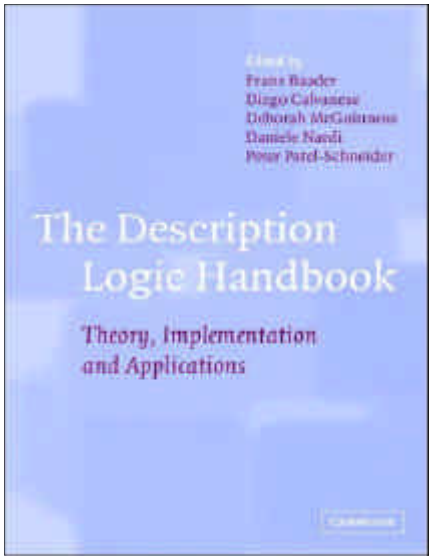

The Description Logic Handbook: Theory, Implementation and Applications

By Franz Baader, Diego Calvanese, Deborah McGuinness, Daniele Nardi and Peter Patel-Schneider

In the area of artificial intelligence concepts such as description logics and knowledge representation languages, have been around for many years. This book discusses research in the field on theory, implementation, and applications. This book provides value to new readers to the topic as well as those with advanced knowledge who will appreciate the coverage of theories based on practical understandings of the topics. Current researchers in the field wrote the chapters in this book and they carefully introduce the fundamental technical material before addressing the current state of the topic. This reference can be used as a tutorial or in conjunction with knowledge representation and artificial intelligence courses.

The Description Logic Handbook: Theory, Implement-ation and Applications, By Franz Baader, Diego Calvanese, Deborah McGuinness, Daniele Nardi and Peter Patel-Schneider, March 2003, Cambridge University Press, ISBN: 0521781760, 574 Pgs, $120

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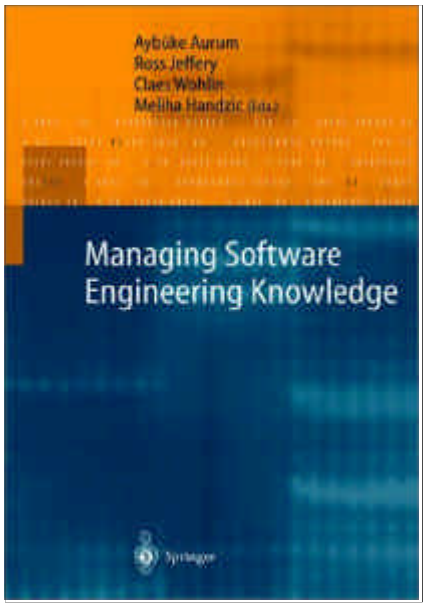
*www.amazon.com/exec/obidos/tg/detail/-/0521781760/ref=pd_bxgy_text_1/002-8162289-2704804?v=glance&s=books&st=**



Managing Software Engineering Knowledge

By Aybuke Aurum (Editor), Ross Jeffery, Claes Wohlin, Meliha Handzic, Aybueke Aurum

Software development, an extremely complex problem-solving activity, has a high level of uncertainty with technical challenges that include scheduling, cost estimation, reliability, performance, just to name a few. Changing requirements, team dynamics, and staff turnover further aggravates software development. Management of knowledge and experience is therefore a key method for systematic software development and process improvement. This text covers the basics of knowledge management as applied to software engineering, including several examples used in industry. There are four sections discussing the motives for knowledge management, the concepts and models used in knowledge management for software engineering, their application to software engineering, and practical guidelines for managing software engineering knowledge. This book offers an overview of best practice in knowledge management as applied to software engineering. Students, professional software developers and project managers will all find value in this book.

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Edited by Steffen Staab, University of Karlsruhe, Germany, Rudi Studer, University of Karlsruhe, Germany

Ontology is a description (such as a formal specification) of a concept or relationship that can exist for an agent or a community of agents. The concept enables knowledge sharing and reuse. The Handbook on Ontologies offers a comprehensive overview of the current state and future prospective of this field. Not only does the handbook demonstrate recently created standards, it also surveys methods that have been developed while showing how to bring both into practice. It's coverage of ontology infrastructures and applications that are the best of their kind.

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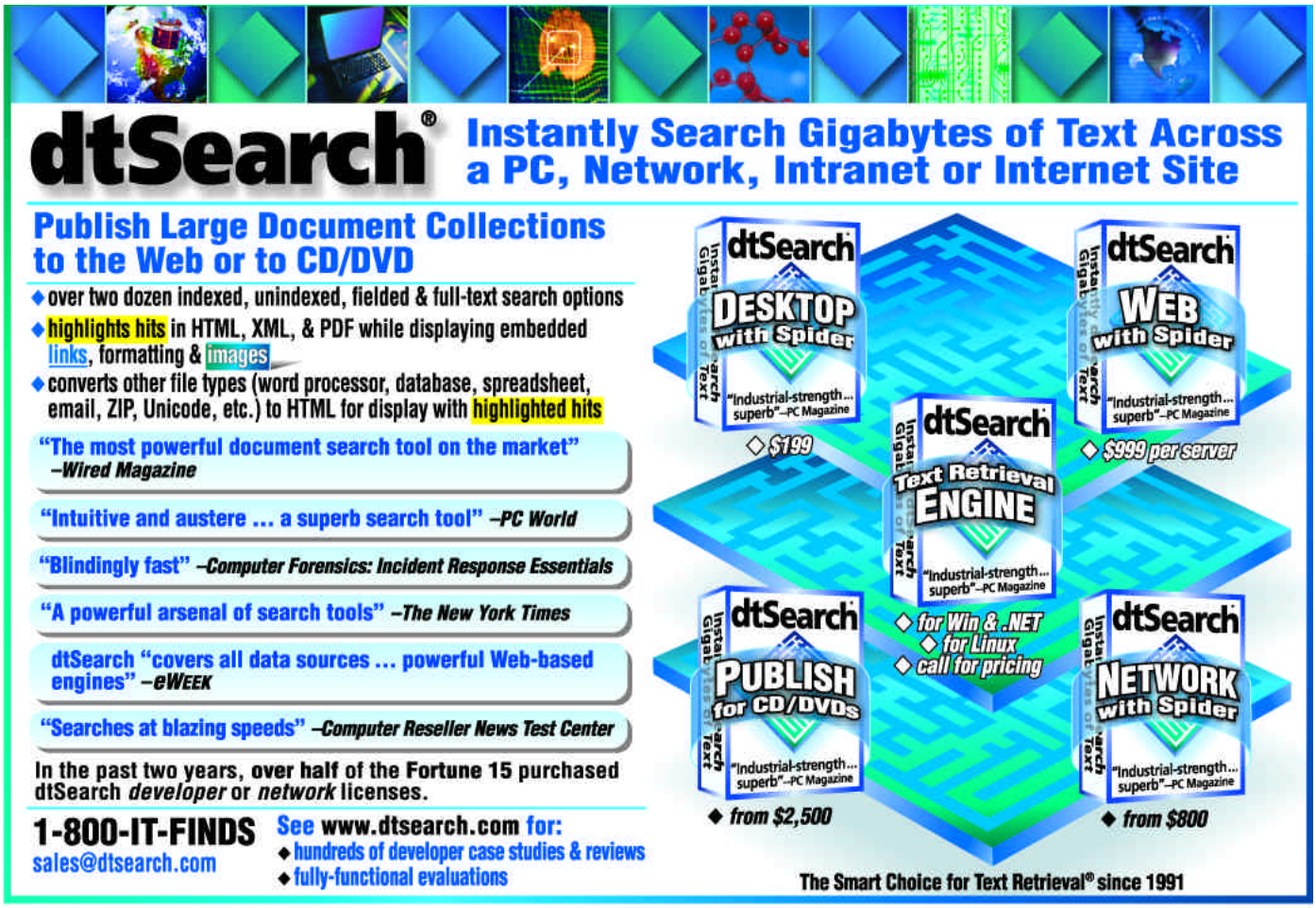

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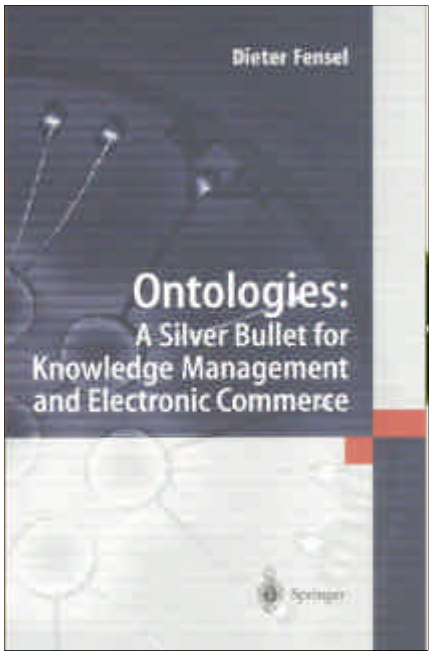

Ontologies - A Silver Bullet for Knowledge Management and Electronic Commerce - Second Edition

Dieter Fensel, Frije Universiteit Amsterdam, the Netherlands

The AI field has been developing Ontologies for decades to facilitate knowledge sharing and redistribution. Recently, experts in the fields of databases, information integration and retrieval, e-commerce, application integration, and knowledge management are using these concepts. This broadened interest is due to the information semantics provided by Ontologies and its ability to be processed by computers as well as communicate between agents, software artifacts and humans. This feature may make ontologies the backbone technology of the next web generation – possibly an AI original — the Semantic Web. Ontologies, which are currently applied in areas such as knowledge management, are frequently found in large company-wide networks and call centers and electronic commerce systems. Ontologies enable effective and efficient access to heterogeneous and distributed information sources. The author systematically introduces the notion of ontologies to the non-expert reader and demonstrates in detail how to apply this conceptual framework for improved intranet retrieval of corporate information and knowledge and for enhanced Internet-based electronic commerce. He also describes ontology languages (XML, RDF, and OWL) and ontology tools, and the application of ontologies. In addition to structural improvements, the second edition covers recent developments relating to the Semantic Web, and emerging web-based standard languages.

Ontologies - A Silver Bullet for Knowledge Management and Electronic Commerce - Second Edition, Springer, Published 2004, ISBN: 3-540-00302-9, 162 Pgs, Price: $34.95, Hardcover

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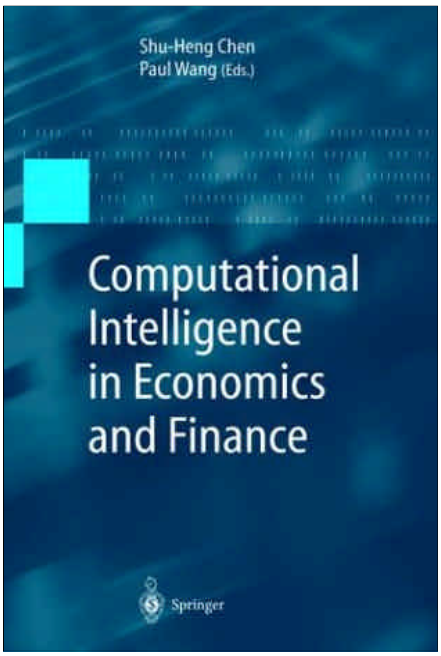

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With its ability to handle specific characteristics of economics and finance forecasting problems such as non-linear relationships, behavioral changes, or knowledge-based domain segmentation there has been a growth in the application

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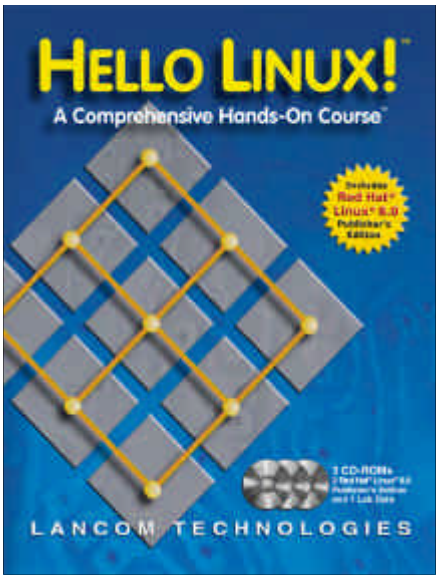

Hello Linux!

By Lancom Technologies

If you are interested in learning or using AI on a Unix based platform — *Hello Linux! A Comprehensive Hands-On Course* by Lancom Technologies (*www.lancom-tech.com*) is a good place to start. Two CDs of Red Hat Linux, in addition to a lab CD for performing hands on exercises with Linux, are included. This 1,000 page book is designed to be self-led or instructor led and covers the basics from what is Linux, how to install it, using commands, getting help to the more complex topics of creating and running Linux Scripts, Linux networking, and installing new kernels. Each section comes with a review to reinforce the topics covered with the answers for review at the end of the book. The Hands-On section contains helpful hints for working through the exercises as well as keyboard shortcuts. The exercises are quite extensive, as an example Chapter 6, Using Linux Commands, contains 51 exercises for the user to practice what has been taught in the section. Each chapter begins with a summary sheet indicating the primary focus of the chapter, what will be covered in detail, which commands are covered in the chapter and exercises, and what you will do during the exercises. The text is in an easy to read format and font and allows space in the margins for notes. The book is available directly from the publisher for $99.95 plus shipping.

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Searching Beyond the Tower of Babel:

Unicode and Text Retrieval

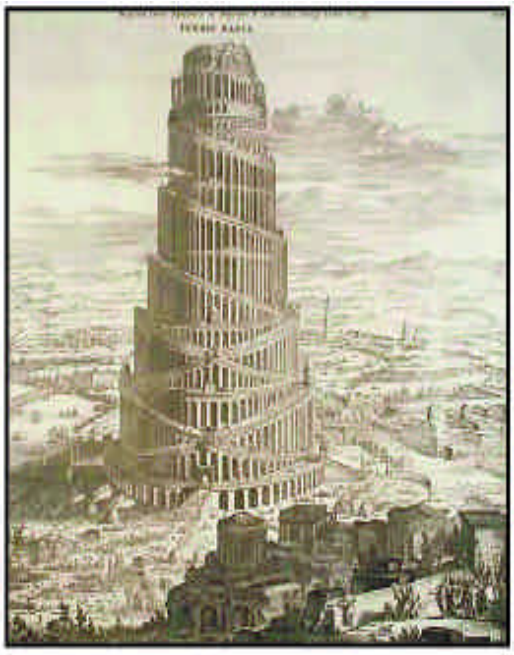
By Elizabeth Thede

And the Lord came down to see the city and the tower, which the sons of men had built. And the Lord said, "Behold, they are one people, and they have all one language; and this is only the beginning of what they will do; and nothing that they propose to do will now be impossible for them. Come, let us go down, and there confuse their language, that they may not understand one another's speech."

So the Lord scattered them abroad from there over the face of the earth, and they left off building the city. Therefore its name was called Babel, because there the Lord confused the language of all the earth; and from there the Lord scattered them abroad over the face of the earth. — Genesis

And so the Tower of Babel fell, and all of the earth's languages were "confused." Nevertheless, while understanding each other's speech remains a confusing prospect, we have made great progress in sifting through each other's computer texts.

(For purposes of text searching, this article uses the dtSearch product line as its example in discussing international language search issues. Many of the concepts, however, such as Unicode, have broad applicability.)



The Tower of Babel, by C. Decker, in 1679.

Unicode

In the beginning (not the Biblical beginning, but the DOS and early Windows beginning), the ASCII character set was the vehicle for expressing different languages. Each character had an allocation of a single byte, or eight bits. Taking eight bits to express each character made 256 (or 2 to the 8th power) characters available in the ASCII character set. English characters, punctuation, control characters (carriage return, backspace, etc.) and numbers took up the first 128 characters, leaving only 128 characters to work with for non-English text.

The major successor to the ASCII character set is Unicode, as defined by the Unicode Consortium, *www.unicode.org*. Unicode is now as close to a universal standard as there is in the computer world. All recent major operating systems, Web browsers, Office software and the like now support the Unicode standard.

Unicode UCS-16 uses a double-byte or 16-bits to express all language characters. With 16-bits, the number of characters available skyrockets from

Unicode is not without some odd properties . . . Before clicking on that "special email-only offer" link, see *Unicode and Link Deception* (next page).

Most documents contain a heading indicating the language system, enabling easy search engine interpretation. Forensically recovered data is often an exception to the rule.

256 to 65,536 (or 2 to the 16th power). The Unicode Consortium assigns the 65,536 available characters into groups called subranges. Each subrange has 256 characters. Subrange 0 includes English letters and numbers, along with commonly used punctuation. For example, the letter *A* is character 65 of subrange 0.

While *A* is the 65th character of subrange 0, Unicode expresses this position in base 16 hexadecimal format as U+0041. (Unicode characters by convention start with U+. And 65 in base 10 is the same as 41 in base 16).

Although the U+ syntax is the convention for describing a Unicode character, the computer stores characters as individual bytes ranging from 0 to 255. For the English letter *A*, the representation under UCS-16 would consist of two bytes: one byte representing subrange 0, and another byte representing a 41 hexadecimal value. The last section in this article discusses issues relating to byte order: "big endian" vs. "little endian," and forensics.

The Unicode character designations distinguish between capital and lowercase letters. While *A* is U+0041, *a* is U+0061. Unicode also distinguishes accented characters, so, for example, *â* is U+00E2. What Unicode does not define is different fonts for the same character, or different ways of drawing a letter, such as Arial or Times Roman. Nor does Unicode define other letter attributes, such as italics, underlining, bold, size, or color. While these are not part of the Unicode standard, applications such as Web browsers and word processors may nonetheless hold and display this information along with Unicode text.

Unicode and Link Deception

When you move the cursor over a link in an email or a Web site, the URL appears in Unicode, offering reassurance that you know where the link is heading. But what may appear as a favorite Internet shopping site, *www.XYZshoppingsite.com*, may actually incorporate characters from other Unicode subranges masquerading as *www.XYZ shoppingsite.com*.

Underlying this deception is the fact that very different Unicode characters can share the same visual representation. For example, the English lowercase letter *i* (U+0069) looks the same as the roman numeral *i* (U+2170).

Accordingly, if you click a link in an email, think twice before revealing any confidential information such as a credit card number. Instead, retype the URL in a browser address bar, so you know exactly where you are going.

Different alphabets generally have different subranges associated with them. French, German and Spanish share subrange zero with English. Arabic, Hebrew and Greek each have their own subrange. Japanese, Chinese and Korean each have a number of subranges because of the large number of ideographs in those languages. Unicode even has a subrange for mathematical symbols.

Unicode text is not without some odd properties. Each character contains a unique value. However, certain characters can look identical and yet have very different meanings. For example, π the mathematical symbol and π the letter of the Greek alphabet look alike visually, but have different Unicode encodings. Before clicking on that "special email-only offer" link, see *Unicode and Link Deception* for a caution that arises from this visual similarity issue.

Unicode UCS-16 radically increases the number of international language characters available relative to the old ASCII standard. However, it is less efficient than the ASCII 8-bit encoding in that it takes up twice the space to represent each character. A newer UCS-32 standard is even less effecient in that it

Search Types	General Language-Neutral Application
Fuzzy, adjustable from 0 to 10 to sift through typographical deviations	Yes
Natural language with vector-space relevancy ranking	Yes
Variable term weighting	Yes
Phrase	Yes
Boolean (and/or/not)	Yes
Proximity and directed proximity	Yes
Wildcard	Yes
Macros	Yes
Numeric range	Yes
Fielded data (alone or combined with full-text searching)	Yes
Phonic/Soundex	No
Stemming and noise word adjustment	No; requires a Language Extension Pack or equivalent to work (see text discussion)
Advanced language-specific morphology (e.g. for Asian languages)	No; requires language analyzer plug-in through API
Synonym/concept/ thesaurus	No; requires language-specific plug-in through API

All terminology relates to the dtSearch product line.

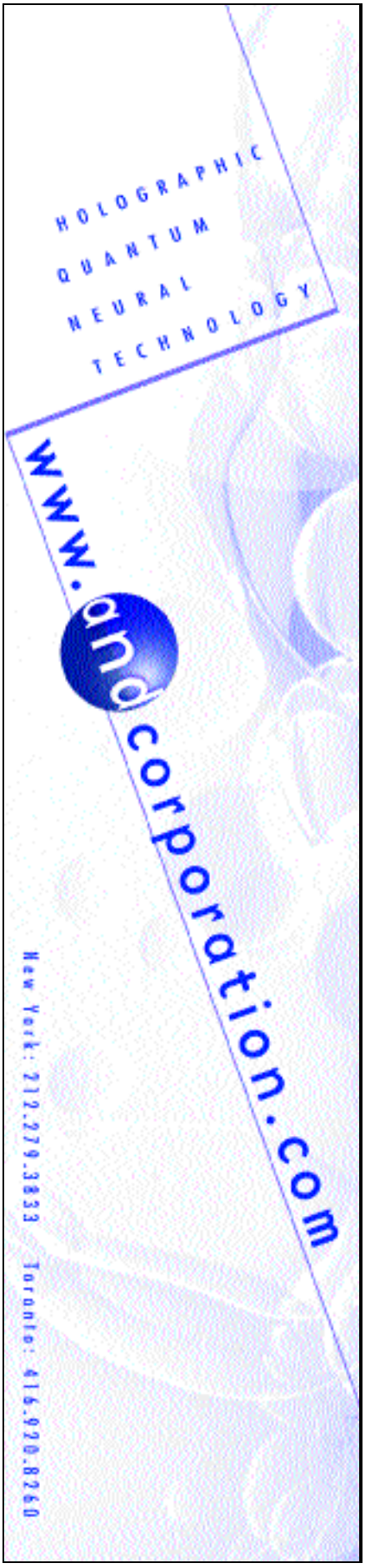
takes 4 times the space of the old ASCII standard to represent the single character. This outcome led to the development of yet another Unicode encoding standard, UTF-8.

Under UTF-8, all English characters and basic punctuation — i.e. the characters up through 127 of subrange 0 under UCS-16 — have single-byte representation. Other characters have two or three byte representation equivalent to their UCS-16 value. Because the majority of characters in most English text fall in the single-byte category, UTF-8 is generally a more efficient means of representing such text.

Unicode and Searching

While the Unicode standard is a great advance in making the text of any language easily representable, Unicode poses a unique set of issues for searching. One issue is Unicode's representation of the same numeric values with different encodings in different subranges. Performing a Unicode search for subrange 0 character *3* would not automatically retrieve the Gujarati number *3*. Likewise, a search for character *A* in subrange 0 would not find a very similar letter *A* in another subrange, or even an accented or lowercase version of *A* in subrange 0.

Programming in a certain level of insensitivity as the default for Unicode searching is a technique that dtSearch, for example, uses to avoid false misses resulting from Unicode anomalies. With the default insensitivity, a search for *3* would find the Gujarti *3*. A search for an *A* would retrieve lowercase and accented



Indexed vs. Unindexed Searching

Indexed searching is the most common method of searching through very large document collections, although exceptions exist. In forensics, an unindexed search may be useful for making an initial determination if a document collection is even relevant. In single-pass operations such as email filtering, unindexed searching is usually the norm. Generally, however, indexed searching is the standard for the sole reason that even across a very large document collection, an indexed search is usually instantaneous.

The following excerpt from the article "Distributed (Indexed) Searching: Evolution to XML," published in the July/August 2001 edition of *PC AI Magazine*, further explains indexed vs. unindexed searching:

> Randomly opening documents to find the correct one is a form of unindexed searching. Advanced unindexed searching might iterate over files looking for specific key words. The main drawback of this searching technique is slow speed; it is particularly inefficient for successive searching.
>
> The alternative to unindexed searching is indexed searching. As document collections grow from megabytes to gigabytes to terabytes, searching these large document sets usually mandates some form of indexing. Just as it is often faster to locate a particular topic using a book's index rather than thumbing through each page, it is faster to search for information using indexed computer files. Moreover, indexing with a modern full-text search program is easy — simply click on directories or drives and the search program does the work.
>
> For complex document formats such as Word, WordPerfect, Access, Excel, PowerPoint, PDF, ZIP, HTML, XML, etc., a code at the beginning of each document informs the program what formatting to expect as it parses the document. Good indexing programs can even fully index the occasional corrupt document (the one that a word processor suddenly refuses to open).
>
> Indexed search engines also operate over a network. If EnterpriseX has a 5,000-page policy manual, each employee could separately index it, saving and searching the resulting index. Alternatively, for improved efficiency, the network administrator could build one policy manual index for shared access. Hundreds of people can simultaneously search the index, with the network software simultaneously updating the index.

The search techniques that this article describes, including Unicode, fuzzy, Boolean, wildcard, etc., at least for the dtSearch product line, relate equally to indexed and unindexed searching. The major exception to this rule is natural language searching with vector-space density rankings, as this option requires indexing to determine word frequency in the documents.

versions of that letter. While the defaults for search sensitivity are adjustable, generally the broader the formulation of a Unicode search request, the smaller the number of false misses.

The text searching process does not just look for an exact sequence of letters or numbers that form a word or phrase, but it also looks for word variations, Boolean operations, contextual relevancy-ranking, and the like. What is most remarkable is what can work universally in a completely language-neutral capacity, using only Unicode and search engine functionality.

Language-Neutral Search Functionality

One of the most important issues for a search engine is sifting through typographical deviations that occur in words. Such deviations may result from different spellings of the same basic word, such as *defense* for an American spelling, and *defence* for a British spelling. They can also result from errors in scanning and OCR (Optical Character Recognition) processing. These character deviations can even result from mistyping, a problem that frequently plagues emails and email attachments.

In dtSearch, the fuzzy search algorithm adjusts from 0 to 10 at search time to look for typographical deviations. A search for *Tower of Babel* with a fuzziness of 1 would find *Tower of Babell*. With a fuzziness of 3, the search would find *Tour of Bagel*. While subject to adjustment, the fuzzy search default is to locate the first couple of letters in a word, and then to look for deviations in letters beyond that.

Fuzzy searching is similar to Unicode sensitivity adjustment in that the fuzzier a search, the more false misses it will avoid. In the use of fuzzy searching, howerever, it is also true that the fuzzier search, the more false hits it will retrieve. While *Tower of Babell* might be a desirable hit, a *Tour of Bagel* coffee shop might be completely off point. dtSearch, for example, allows fuzziness adjustments upon entering a search request — as opposed to hardwiring it into the search index — to enable easy adjustment at search time. See *Indexed vs. Unindexed Searching* for a further discussion of search indexes.

Because fuzzy searching looks for deviations in any characters relative to a search request, it works for all international languages, without distinction. Similarly, searching with wildcard character placeholders, such as a *?* to hold a single character space or an * to hold any number of character spaces, also works universally. Another example of a fully language-neutral search option is natural language searching.

dtSearch, for instance, processes natural language expressions through the vector-space method of assigning a relevancy rank to each document based on the density and rarity of search terms in that document relative to the entire document collection. In a search for *corpx takeover memo*, if *memo* appears in 10,000 documents, *takeover* appears in 2,500 documents, and *corpx* appears in only 3 documents, the *corpx* documents would come up as the most relevant.

Since vector-space natural language processing depends on the density and rarity of search terms in a document collection, it is language independent. If anything, the key factor in the operation of natural language searching relates more to the requirements of the document collection, then the actual language. For example, if the same *corpx takeover memo* search took place across a *corpx memo* document collection, then *corpx* and *memo* might be the most prevalent terms, and *takeover* documents would receive the highest relevancy rank.

A variant of natural language searching, which automatically ranks retrieved documents according to naturally occurring search term relevancy, is variable term weighting. This also works across different languages in the same way. For example, a search for the equivalent of *corpx:7 takeover:-3 memo:2* would work in any language, with *corpx* receiving an artificially high relevancy score, and *takeover* receiving a negative relevancy score.

Other search types that work universally across any language include: Boolean (and/or/not), phrase, proximity, and numeric range (subject to the Unicode considerations mentioned above). In contrast to these language-neutral search types, a few search features, most notably relating to noise word lists, stemming rules and concept/synonym/thesaurus definitions, do benefit from language-specific customization.

Language Customization

A search engine keeps its index size more compact and its general operations more efficient by essentially ignoring a few dozen words that are so common in a particular language as to be, for purposes of searching, mere "noise." English-language examples would include *the*, *of* and *for*. This English-language noise word list does not work, for example, for French, which would require adjustments to *le*, *la*, *de*, *pour*, etc, for optimal performance.

Another item that requires language-specific adjustment is stemming, a search feature that finds linguistically related words, such as in English *learn*, *learned*, *learns* and *learning*. Different languages have very diverse root word endings. Covering the pan-European area, dtSearch's UK distributor (*www.eureva.com*) has assembled a Language Extension Pack for over a dozen very diverse noise word lists and stemming rules, including Danish, Dutch, Finnish, German, Greek, Hungarian, Italian, Norwegian, Polish, Portuguese, Russian, Spanish, Swedish and Turkish.

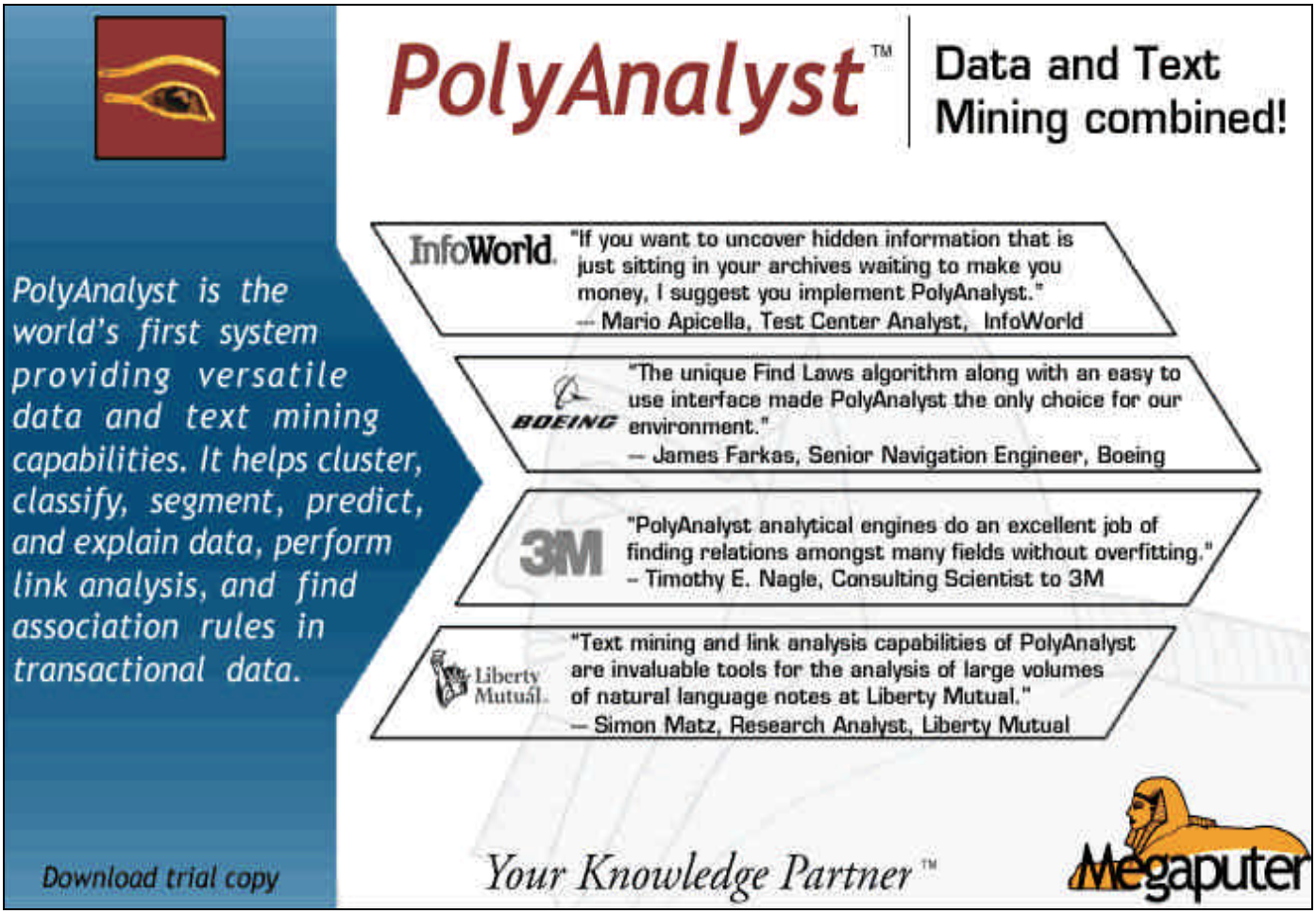
However, even simple stemming adjustments will not work for all languages. For example, in Arabic, the surrounding context for a word (*my*, *your*, *the*, *a*, masculine/feminine, etc.) can be expressed as characters in front of or behind the word. To use an English-language analogy, *the apple* or *my apple* are different prefixes or suffixes added to *apple*. To search for text in these languages requires adding the wildcard * in front and back of the root word as in **apple**.

For even more extreme morphological issues, such as those in Asian text, an API (application programming interface) allows a developer to plug-in full-fledged language-specific analyzers. For thesaurus/concept/synonym searching (going beyond Boolean searching, macros, and user-defined synonym rings) an API allows a developer to plug in a complete replacement to the built-in English-language thesaurus.

Unicode and Forensics

Most documents contain a heading indicating the language system, enabling easy search engine interpretation. Forensically recovered data is often an exception to the rule. Examples of forensically recovered data would be data recovered through a file undelete process, data recovered from unallocated computer space, or data recovered from partially recovered file fragments.

When a search engine encounters a document, a key issue is the



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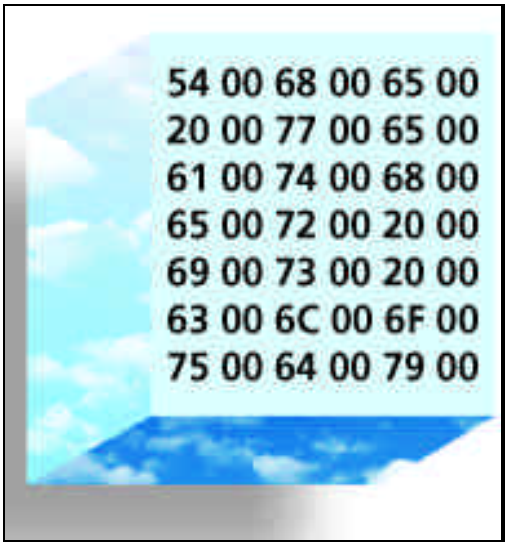

The weather is cloudy in little-endian Unicode.

determination of the text language. Absent Unicode, characters below 128 indicate the old ASCII English-language character set. A character of 128 or above, however, may represent any other language in the world. Without a clear indication in the document as to which langague is in use, it takes a fair amount of detective work for a text retrieval program to figure out even the broad category of language(s)—Middle Eastern, Western European, Eastern European, etc.—that the text of the document is in.

Unicode greatly reduces this ambiguity. Most Unicode documents embed information clearly identifying the Unicode encoding in use. Even when such information is missing, the only ambiguity in searching Unicode text is generally byte order.

If the subrange designation byte comes first, the Unicode representation goes by the name "big endian." If the character position byte comes first, the Unicode representation goes by the name "little endian." In either case, to determine big endian or little endian is a simple either/or search engine decision, in stark contrast to the complex linguistic analysis that forensically-retrieved non-Unicode text can require.

Conclusion

In sum, while the spoken languages of the world may indeed remain confused, through Unicode and other text retrieval techniques, searching after the fall of the Tower of Babel has made some genuine progress.

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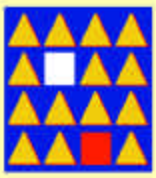

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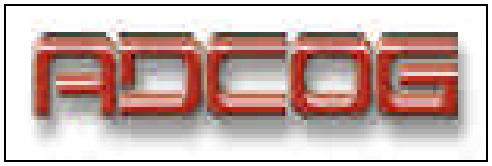

ADCOG 2004

The 3rd International Conference on Application and Development of Computer Games will be held April 26-27, 2004 at the University of Hong Kong, HKSAR. Deadline for paper submissions is February 2, 2004. The theme will be: Mobile and Network Games, its Technical issues and Social Implications. A mobile game should take advantage of wireless technology to integrate directly with the player's lifestyle and to sense intimate data such as player's location, proximity to other players, and the mood. Mobile gaming promises novel approaches to interactive entertainment precisely, as the console is ubiquitous and pervasive and accessible from any devices and through any networks. Once connected to the Internet supporting multi-players, a mobile device will drastically advance the game, due to the distance reduction among players, an increase in the number of participants and the change of the mental mode for their identities in the games. The mode change leads to many issues on technical and game designs, as well as legal aspects, social and family implications. From the parents' viewpoints, these games might encourage their children to visit locations beyond their permission. Game companies that use location-based play, may be at risk of legal liability in the case of accidents. This conference provides a forum for researchers and practitioners from the academic, industrial, and public sectors, to share their latest innovations on game development and applications and examine the wider impact, not just the technology but also other issues such as family, social and legal issues.

ADCOG
www.adcog.org

4th International Scientific School Conference

The fourth International Scientific School Conference on "Modeling and Analysis of Safety and Risk in Complex Systems" will be held in Saint-Petersburg, Russia June 22nd-25th, 2004. The following topics will be discussed: a. Risk model in economics and finances (Market risk; Operational and Liquidity risk; Credit risk; Security portfolio risk; Social efficiency risk problems; LP-model of non-success risk with groups of incompatible events) b. Risk models in engineering (Scenarios and models of safety and non-success risk; Identification and optimization in risk problems; Risk analysis and risk management; Multi-state system risk; Problems of development software for the risk modeling and analysis) c. Ordered lectures: risks of market for secondary non-ferrous metals. Authors who wish to participate in the School should submit the papers to sol@sapr.ipme.ru, before March 1, 2004 as doc-file (not more than 6 pages, type 11pt), that describe the urgency, novelty and contents of papers. Reviews will select papers. Invitations for accepted authors will be sent until March 25, 2004 by Email. The paper rules for publication in the Proceedings of the School MA SR – 2004 are available on the Website: *http://expert-info.org/risks/masr/masr2004.htm*

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sol@sapr.ipme.ru
http://expert-info.org/risks/masr/masr2004.htm

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IEEE/WIC/ACM Web Intelligence 2004

The 2004 IEEE/WIC/ACM International Conference on Web Intelligence (WI'04) will take place September 20-24, 2004 in Beijing, China. The Conference will be jointly held with the 2004 IEEE/WIC/ACM International Conference on Intelligent Agent Technology (IAT'04 *www.maebashi-it.org/IAT04*). The IEEE/WIC/ACM 2004 joint conferences are sponsored and organized by IEEE Computer Society Technical Committee on Computational Intelligence (TCCI) (*www.cs.uwm.edu/~xwu/tcci/index.shtml*), Web Intelligence Consortium (WIC) (*http://wi-consortium.org*), and ACM-SIGART (*www.acm.org/sigart*). WI 2004 provides an international forum for researchers and practitioners (1) to present the state-of-the-art of WI technologies; (2) to examine performance characteristics of various approaches in Web-based intelligent information technology; and (3) to cross-fertilize ideas on Web-based intelligent information systems development among different domains. By idea-sharing and discussions on the underlying foundations and the enabling Web intelligence technologies, WI 2004 will capture current important new models developments, new methodologies and

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http://groups.yahoo.com/group/pcai/join

or mail to:
pcai-subscribe@yahoogroups.com

new tools for building Web-based intelligent information systems. The topics include: World Wide Wisdom Web (W4); Social Networks and Social Intelligence; Knowledge Grids and Grid Intelligence; Web Mining and Farming; Semantics and Ontology Engineering; Web Agents; Web Services; Web Information Filtering and Retrieval; Intelligent Human-Web Interaction; Web Support Systems; and Intelligent E-Technology. Submit papers by April 4, 2004 at *www.maebashi-it.org/WI04* or *www.comp.hkbu.edu.hk/WI04*. Electronic submissions are required in PDF or PS files

IEEE Computer Society; Web Intelligence Consortium (WIC)
Association for Computing Machinery (ACM)
www.comp.hkbu.edu.hk/WI04

EuSpRIG 2004: Risk Reduction in End User Computing

EuSpRIG 2004: Risk Reduction in End User Computing will be held July 15 - July 16, 2004 at the Universitaet Klagenfurt, Klagenfurt, Austria. The European Spreadsheet Risks Interest Group (EuSpRIG) is issuing a Call for Papers for their fifth international conference on spreadsheet Risks, Development and Audit Methods. The theme is 'Risk Reduction in End User Computing.' The program will concentrate on raising the profile, management, and reduction of risks associated with spreadsheet use, spreadsheet development methods, audit tools and methods, productivity enhancements, and more. EuSpRIG are seeking full academic papers (up to 5,000 words) and management summaries (up to 2,000 words). Submit abstract to Program Chair by January 15, 2004, Submit full paper / management summary by March 1, 2004

EuSpRIG
www.eusprig.org

Conference

IEA/AIE-2004

The 17th International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems will be held in May 2004 in Ottawa, Canada. Emphasis will be on applications of artificial intelligence and knowledge-based systems to engineering and industrial problems, as well as to other areas. Topics include, but are not limited to: Adaptive Control; Applications to Manufacturing; Autonomous Agents; Applications to Design; Case-based Reasoning; Computer Vision; Data Mining; Distributed Problem Solving; Expert Systems; Fuzzy Logic; E-learning (special session) Genetic Algorithms; Genetic Programming; Internet Applications; Intelligent Interfaces; Intelligent Systems; KBS Methodology; Knowledge Processing; Knowledge Management; Human-Robot Interaction (special session); Model-based Reasoning; Natural Language Processing; Neural Networks; Planning and Scheduling; Reasoning Under Uncertainty; Machine Learning; Spatial Reasoning; System Integration; Speech Recognition; Temporal Reasoning. Information available at *http://isai.cs.swt.edu* for the Journal, the Society (ISAI), and the IEA/AIE Conferences:

IEA/AIE-2004
www.iea-aie2004.org

KMICE 2004

The Knowledge Management International Conference and Exhibition 2004 will be held February 13-15, 2004 in Penang, Malaysia. The theme is Towards Intelligent and Co-operative Nations. The topics and areas include, but not limited to: Knowledge Management Strategy; Knowledge and Data Sharing and Transfer; The Measurement and Impact of Knowledge Management; Tools and Technology for Knowledge Management; The Process of Managing Knowledge Management Project; E-Learning, E-Training and Executive Training; Organization/Corporate Memory; A Case Study on Knowledge Management; Current Knowledge Management Trends; Methodology in Knowledge Management; Content Management; Performance and Operation in Knowledge Management; The Usage of Software in Corporative Environment; Intelligent Information System; Knowledge Management Through Wireless Infrastructure; Knowledge Workers; Issues, Challenges and Constraint in K-Era; The Issue of Culture Variety and Cross-culture; and K-Economy, K-Community and K-Enterprise.

KMICE 2004
Voice: +604-9284646
kmice04@uum.edu.my
kmice04@yahoo.com
www.kmice.uum.edu.my/kmice04

CART Data Mining Conference/Contest

The CART Data Mining '04 Conference will take place in San Francisco, CA on March 22-24, 2003. This First International CART Conference will focus on the Data Mining technology of Leo Breiman, Jerome Friedman, Richard Olshen, Charles Stone(CART, MARS, TreeNet, PRIM). A student paper competition will focus on the technology of contest versions of CART, MARS, TreeNet or any combination of the above. The papers will be applied studies focused on the analysis of an interesting data set, or constructed Monte Carlo studies investigating the properties of the technologies. Tutorials are planned for Data Mining with Decision Trees, Advanced CART & Hybrid Modeling Techniques, and Predictive Modeling with Automated Regression Tools. Register by January 30th to save up to $100 on your registration.

CART Data Mining '04
info@cartdatamining.com
www.cartdatamining.com?pcaipr

Buyer's Guide

Expert Systems, Expert System Development System, Intelligent Tutors, Knowledge Representation & Management, Logic & Reasoning Systems, Machine Learning

Special Note on System Requirements: When *MS Windows* appears, this assumes Win 95. 98, NT, ME, 2000, XP, A Pentium Processor, 32MB RAM and 32MB Disk space available unless stated otherwise.

Expert Systems

Product Company	Description	System Requirements	Price
Exsys CORVID **Exsys Inc.**	Deliver decision-making knowledge, situation-specific answers and recommendations to prospects, clients and staff. Emulates a conversation with a human expert. Use for product selection, troubleshooting, tech support, diagnostics, regulatory compliance, predictive maintenance, automating routine tasks, capturing expertise/procedures, and bring knowledge assets and interaction to your Web site and wireless communications. Client-side or server-side delivery. Design can match the "look-n-feel" of existing Web sites. Modularize the system with Logic Block structure. Systems generate customized and automated email response and reporting. Combine expertise - several developed systems can be merged together. 30-day free demo at *www.exsys.com*, development/deployment services also available.	MS Windows NT 4.0 w/SP 3 or MS Windows, MS Internet Explorer ver. 5, 75 MB Free Disk Space, Minimum Screen Resolution: 1024 x 768 with standard fonts or 1156 x 864 with large fonts	Contact Vendor
KnowledgeWright Guide **Amzi! inc.**	Creates, tests and deploys knowledgebases that help website visitors select products or services, locate information, get answers to common questions, find solutions, learn from experts and more. Technicians create knowledgebases using a variety of objects in the graphical workshop. These can be rules, tables, formulas, facts, database interfaces, and questions for the user. Questions for the user can be formatted with HTML to embed images, videos and links. Answers are displayed in dynamically assembled web pages. Knowledgebases are deployed on the Web using either Windows or Unix servers. Free for academic, personal and evaluation use.	Windows or Linux web-server with CGI or Java Servlet capabilities.	$495
KnowledgeWright Professional and Enterprise **Amzi! inc.**	Creates knowledgebases of business rules for workflow management, advice, problem resolution, configuration, planning, support and more. Delivers knowledgebases on the web or in any software application. Design and develop knowledgebases in a graphical environment complete with knowledgebase analyzer and debugger. Includes two general-purpose reasoning engines, one for business rules advice and problem solving, the second for product and service support. The reasoning engine can be customized (by Amzi!) to fit your business structure and processes. Free download for evaluation at www.amzi.com.Free for academic, personal and evaluation use.	Windows or Linux web-server with CGI or Java Servlet capabilities. Optionally one or more of C++, Java, Delphi, Visual Basic.	$2,500 and $10,000

Expert Systems

Product Company	Description	System Requirements	Price
KnowledgeWright Support **Amzi! inc.**	Knowledgebase tool designed for delivering technical support on the Web. Support technicians work with the graphical workshop to create and maintain a knowledgebase of support solutions. These are entered in intuitive structures, with full HTML capabilities for providing clear dialogs with users while resolving problems, and provide explanations and relevant links when the correct solution is found. Runtime reasoning engine works as a technical support representative, developing hypothesis, prioritizing possibilities, interacting with the user to find the correct solution. If no solution is found, all information can be automatically forwarded via e-mail to human tech support. Knowledgebases can be deployed on the Web using Windows or Unix.	Windows or Linux web-server with CGI or Java Servlet capabilities.	$495; Free Download
StrataView **Goddard Information Systems Ltd.**	Collaborative business forecasting, planning and analysis tool provides empirical and judgmental forecasting and planning streams along with peer to peer and hierarchical collaboration. Forecasts automatically with OLAP decision support analysis across business hierarchy from international product requirements to a SKU by Ship-to demand, generating unit, equivalent measures, dollars, costs and margin forecasts. Complete enterprise forecasting and planning package when combined with production and inventory planning tools.	MS Windows and MS SQL	Contact Vendor
Udiagnose **UReason**	Tool creates 'intelligent' applications that automate fault detection and diagnosis. Allows domain experts - operators, process engineers or quality control managers - to express and execute their hypothesis concerning production problems, quality issues, etc. Offers Fault Detection, Model Based Reasoning, Fault Reduction and Feedback Driven Decision Support techniques in a graphical way. No programming needed to configure rules, establish models, data-mappings, signal validation rules, fault-trees, state diagrams or decision trees. Extensions and add-ins for access over web and to OPC available.	Windows XP, Pentium IV 2Ghz or higher, 512 Mb or higher	From € 5000 for a Standard Edition, off-line use stand-alone.
XpertRule Knowledge Builder **Attar Software**	Graphical and customizable multi-user development environment for medium to large-scale knowledge applications and components, with knowledge represented as Trees, Rules and Cases supported by an integrated inference engine. Flexible and scalable knowledge deployment options: PC standalone, COM+ Java Servlet or Java Applet, using XML for data exchange.	MS Windows	From $4,500

Expert System Development System

Product Company	Description	System Requirements	Price
Common Knowledge **Object Connections Australia Pty Ltd**	Cross-platform system automates and maintains business rules through the application lifecycle. Rules engine and a graphical rules design studio in the system allow developers to design, document, implement, and maintain their applications' business rules and logic externally in the form of Decision Tables, Trees, and scripting languages including JS, VBS, Perl and Python. Rule-sets changed on-the-fly without recompiling the applications, and are language and platform-independent, ideal for process control and operator guidance software development. Contact vendor for pricing on the Professional Edition. Compatible with Delphi, MS .Net, C++, Java, VB, WSH, etc.	MS Windows NT4/98/2000/XP, Linux/Unix/Solaris. P II 166MHz+. 128 MB RAM, 25-50 MB disk. MS IE V4+	Standard Ed $570 base system + Decision Table extender, $285 each rule.
Exsys CORVID **Exsys Inc.**	Deliver decision-making knowledge, situation-specific answers and recommendations to prospects, clients and staff. Emulates a conversation with a human expert. Use for product selection, troubleshooting, tech support, diagnostics, regulatory compliance, predictive maintenance, automating routine tasks, capturing expertise/procedures, and bring knowledge assets and interaction to your Web site and wireless communications. Client-side or server-side delivery. Design can match the “look-n-feel” of existing Web sites. Modularize the system with Logic Block structure. Systems generate customized and automated email response and reporting. Combine expertise, several systems can be merged together. 30-day free demo at *www.exsys.com*, development/deployment services also available.	MS Windows NT 4.0 with Service Pack 3 or MS Windows, MS Internet Explorer ver. 5, 75 MB Free Disk Space, Minimum Screen Resolution: 1024 x 768 with standard fonts or 1156 x 864 with large fonts	Contact Vendor

Expert System Development System

Product Company	Description	System Requirements	Price
Flex **LPA**	Hybrid expert system toolkit with frames, rules and procedures implemented within a logic programming environment. Employs an English-like Knowledge Specification Language for defining expertise in an intuituve manner. Supports both forward and backward chaining inferencing and various treatments of uncertainty including Bayesian Updating and Certainty Factors. Includes an automated questions and answer mechanism. Flex IDE includes browsers and graphing tools. Runtimes can be delivered within the Flex GUI or within a VB or Java or C/C++ GUI using the Intelligence Server toolkit from LPA.	MS Windows	Contact Vendor
Visual Rule Studio **Rule Machines Corp**	Microsoft Visual Basic ActiveX Add-on adds a purpose built rule editor with full syntax checking and debugging capability as well as an inference engine to Visual Basic Integrated Development Environment (IDE). Production Rule Language (PRL) represents logic rules stored in repositories called RuleSets. The process of maintaining expert systems is simplified by the logic code being isolated from the supporting VB code. Uses backward or forward chaining, or a combination of both and includes fuzzy logic operators.	MS Windows, VB 5.0 or 6.0	$285 - $5,995
WebFlex **LPA**	Internet expert system development toolkit based on Flex. Includes a web-based question/answer/explanation/validation sub-system which automatically generates HTML and JavaScript. Supports multiple connected users querying the same or different rulebases. Support for the back button in the browser allows users to go back and change their mind, resubmit their answers and see the results of the changes almost instantly. Code can be dynamically recompiled and executed on-the-fly for truly dynamic expert systems.	Internet web browser and Web Server such as IIS, Apache, PWS	Contact Vendor

Intelligent Tutors

Product Company	Description	System Requirements	Price
Abby Lite **Eidoserve**	Patented web technology interactive with customers. What the client thinks the customer will ask, is not always the case. Helps improve client's knowledge base surrounding customers and prospects through interactivity. A brand impact, convey information, gain reaction and response application.	Internet web browser. Flash 6.0 or greater	$99 per month
AliceClient Server **Isoft**	Exploits Alice's interactivity over data bases. Data mining engine on the server. Users access data in a transparent and secured way without volume limitations.	Windows NT, 2000, Unix	From $25,000

Knowledge Representation & Management

Product Company	Description	System Requirements	Price
Alice **Isoft**	Interactive Data Mining tool aimed at mainstream business users with a user-friendly interface. Data analysis and exploitation tool integrates both an OLAP engine and decision trees. Enables the analysis of data in real time.	Windows NT, 2000, Me, 98	From $7,500
Amadea **Isoft**	Intelligent integration platform transforms heterogeneous data into information in real time. Builds dynamically and without coding flexible data marts, analysis tables, and reports. Data Morphing concept enables a full traceability of the data transformation processes.	Windows NT, 2000	From $60,000
Cognos DecisionStream **Cognos Corporation**	ETL (extraction, transformation, and load) software makes operational data report-ready. Builds deploys, and manages a series of linked, dimensional data marts to form an integrated business intelligence (BI) system. Dimensional data marts organized by subject area (sales, finance, and marketing) and coordinated by data category (customer, product, and location). Flexible information stores allow adaption of data structures to respond to business changes (product line additions, mergers, consolidations). Multi-platform, server-based ETL engine and native support for all major relational database platforms. Intuitive graphical interface. Process data in short update windows. Dimensional framework.	Contact Vendor	Contact Vendor

Knowledge Representation & Management			
Product Company	**Description**	**System Requirements**	**Price**
Cognos Metrics Manager **Cognos Corporation**	Enterprise scorecarding models plans or strategies as a set of inter-connected performance indicators to communicate goal-driven metrics to employees across an organization. Metrics can be monitored and understood by all employees who can see how their decisions and actions affect the overall strategy with information that connects strategic priorities to their own priorities—the basis for accountability. Scorecarding communicates throughout the organization.	Contact Vendor	Contact Vendor
Cognos NoticeCast **Cognos Corporation**	Delivers business intelligence to users based on criteria they define as events happen. Delivers time-critical information to decision makers through automatic email-messages. Send emails to desktops or wireless devices such as personal digital assistants (PDAs) or digital cell phones. Users define personalized content to see when an event occurs along with relevant material to accompany notification or alert, and who else in the company should be automatically informed.	Contact Vendor	Contact Vendor
Cognos PowerPlay **Cognos Corporation**	OLAP (online analytical processing) software performs multidimensional analysis, creates reports, and shares them to make decisions. Any business or technical skill level can explore large volumes of summarized data to find answers to business questions by moving between levels of information. Interactively explore corporate data in any combination, from every angle. Wide range of graphical displays highlight trends and focus on the key factors driving the business. Analyze multiple aspects of a business to see how a value changes over time; how it compares across geography; how it changes against any other business dimension. PowerPlay reports and Cubes can be accessed by Web clients, or from Windows and Excel clients, all using the same application server.	Contact Vendor	Contact Vendor
Cognos ReportNet **Cognos Corporation**	All-in-one reporting software creates, modifies, and distributes any report your company requires, invoices, statements, weekly sales and inventory reports. Novice users build reports with drag-and-drop or create complex queries and dynamic, multi-object reports. Zero-footprint deployment, scalability to support hundreds of thousands of users, and ability to integrate with any application or environment. Integrated component of the BI from Cognos.	Contact Vendor	Contact Vendor
Cognos Visualizer **Cognos Corporation**	Uses visual reports ("visualizations") to communicate complex business data, display multiple measures simultaneously and create dashboards with a selection of maps and charts. View several reports at once to see how information correlates and make decisions. Integrated component of the BI from Cognos.	Contact Vendor	Contact Vendor
dtSearch Product Line **dtSearch Corp.**	Search across PCs, networks, intranets and Web sites; Publish document collections to the Web or CD/DVD. Features include: more than two dozen indexed, unindexed, fielded and full-text search options; hit highlighting in HTML and PDF while displaying embedded links, formatting and images; conversion of other file types (word processor, database, spreadsheet, email, ZIP, XML, Unicode, etc.) to HTML for display with highlighted hits; built-in Web Spider in dtSearch Desktop, Network and Web; special forensics features, and Engine APIs. See *www.dtsearch.com* for price list.	dtSearch product line generally support Win and .NET; a Linux version of the dtSearch Text Retrieval Engine is also available.	Contact Vendor
Exsys CORVID **Exsys Inc.**	Deliver decision-making knowledge, situation-specific answers and recommendations to prospects, clients and staff. Emulates a conversation with a human expert. Use for product selection, troubleshooting, tech support, diagnostics, regulatory compliance, predictive maintenance, automating routine tasks, capturing expertise/procedures, and bring knowledge assets and interaction to your Web site and wireless communications. Client-side or server-side delivery. Design can match existing Web sites. Modularize the system with Logic Block structure. Systems generate automated email response and reporting. Combine expertise - several developed systems can be merged together. 30-day free demo at *www.exsys.com*, development/deployment services also available.	MS Windows NT 4.0 w/SP 3 or MS Windows, MS Internet Explorer ver. 5, 75 MB Free Disk Space, Minimum Screen Resolution: 1024 x 768 with standard fonts or 1156 x 864 with large fonts	Contact Vendor
Fuzzy Query **Sonalysts, Inc.**	Database query and data analysis tool that uses fuzzy logic to better represent the underlying semantics of data analysis questions, and ODBC to provide connectivity to a wide range of existing data stores.	MS Windows	$59

For over 21 years, 14,000 users worldwide, including most of the Fortune 100 firms have made EXSYS the leader in Knowledge Automation Expert System Software and Development Services.

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Free 30-Day Evaluation.

Knowledge Representation & Management

Product Company	Description	System Requirements	Price
Intelligent Enterprise Search Consulting **Stottler Henke Associates, Inc.**	Uses AI techniques and a point-and-click simple user interface. Employees build a personal search "context" to enable the system to retrieve highly targeted results and filter out results unrelated to their search topic. Results are reranked by a measure of relateness to the topic, bringing the most personally relevant results to the top. Search user interface is close to a standard user interface used in most offices today so integration can be seamless across the enterprise.	Desktop interface to enterprise search: Win98/Pentium III+, 256MB RAM and 20GB HD. Server version available	Contact Vendor
ISYS:email.search 1.2 **ISYS Search Software**	Find e-mail messages using key words, names, phrases and dates in your Outlook and Outlook Express e-mails. High speed searching even across thousands of e-mails, three user-selectable search styles, hit highlighting, meaningful relevancy ranking, saved searches, and integration with your Outlook. Network connection: TCP/IP stack presented through WINSOCK v1.1+.	MS Windows. Min 64MB Memory, recommended 256MB. 100 MB (temp storage of query results).	$29.95
ISYS:sdk **ISYS Search Software**	Developer's solution based on ISYS search engine technology using the API in ISYS' off-the-shelf information retrieval software. Developers integrate sixth-generation search technology to OEM-defined applications. Programmers add natural-language and command-line query functionality capable of searching and retrieving information across disparate data sources and formats. Supports 125 file formats/30 languages. API can be integrated into third-party applications with minimal consulting resources. Free trial version of ISYS:desktop at website.	MS Windows. Network connection: TCP/IP stack presented through WINSOCK v1.1+. Min 64MB Memory, 100 MB).	Contact Vendor.
ISYS:web 6.0 **ISYS Search Software**	Sixth-generation, web-based information retrieval solution. Search technology supports 30 languages/125 file formats, including XML, Office documents, databases, email, zip files, Flash, WordPerfect, PDF, more. Offers natural-language search capabilities and query searching for advanced searches. Seamless searching of structured, unstructured and semi-structured information in a single query. Uses intelligent agent technology to notify users of new data that meets predefined criteria. Product deployed as a Web site search engine or as a corporate intranet solution. Download evaluation copy at their website.	MS Windows. Network connection: TCP/IP stack presented through WINSOCK v1.1 or later. Min 64 MB Memory, recom 256MB. 100 MB).	Contact Vendor

Knowledge Representation & Management

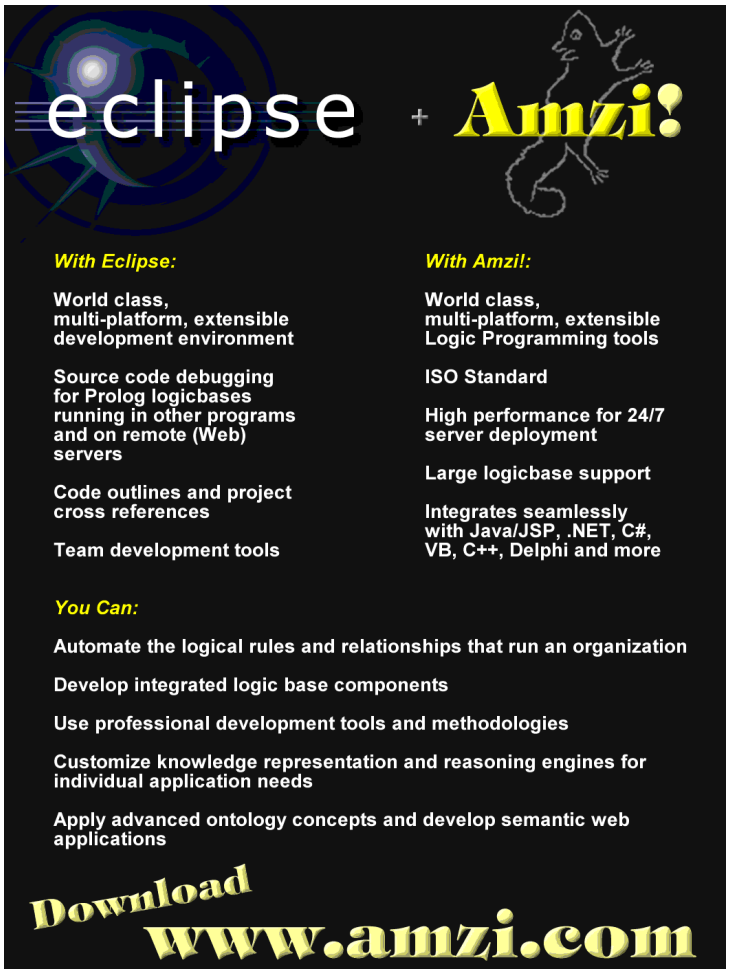
Product Company	Description	System Requirements	Price
ISYS:web.asp 6.0 **ISYS Search Software**	Plug-in search module integrates with Web sites using Microsoft Internet Information Server (IIS) environment. More flexibility than the ISYS:web when building a portal environment. Not a web server in its own right. Supports the Microsoft.NET Framework. ASP.NET developers can interface directly with the core ISYS engine and power Web-based applications with the search and retrieval features. Includes instructions and examples to help ASP.NET developers achieve this level of interoperability.	MS Windows. Network connection: TCP/IP stack presented through WINSOCK v1.1. Min 64MB Memory. 100 MB.	Contact Vendor
KnowledgeWright Custom Jigs **Amzi! inc.**	A "jig" is designed to be customizable to match many different knowledge representations and reasoning processes. Custom jigs are available for career advisor and athlete training planner and can be built for less and deliver lower cost deployment and maintenance. Includes a full graphical workshop for developing and debugging knowledgebases and a full array of runtime deployment options for the web and stand-alone applications.	Contact Vendor	Contact Vendor
MetaCenter 3 **Data Advantage Group, Inc**	Provides a window into information system environments that unlocks the contextual and relational information stored in transactional, business intelligence, database, data integration, data quality and data modeling applications. Delivers industry best practices to enhance corporate information asset knowledge base. Business requirements, business rules and corporate standards can be documented, audited and seamlessly tied to the technical data underlying their execution. Empowers technical and business users to collaborate in analyzing and managing the knowledge represented in corporate information systems. Institutionalizes knowledge, standards and unstructured information.	Platform-independent, web-enabled. Unix, Linux, Windows.	Contact Vendor
Soffront Knowledge Management System **Soffront Software, Inc.**	Search engine for pre-indexed knowledge articles created with an HTML editor. Supports Boolean and wild card search. Supports workflow to develop knowledge by a group of authors. Creates interactive knowledge articles, knowledge trees, FAQ, Hot topics, and knowledge alerts. Sets an expiration date on knowledge articles. Supports creation of knowledge articles from email which can also be emailed to subscribers.	Microsoft IE 5.5+ or Netscape 7.1+ with Java 1.1 VM and cookies enabled	Contact Vendor
Virtual Employee **Eidoserve**	Patented web technology is interactive with your customers. What the client thinks the customer will ask, is not always the case. Helps improve client's knowledge base surrounding customers and prospects through interactivity. A brand impact, convey information, gain reaction and response application.	Internet web browser. Flash 6.0 or greater	From $250 per month
VisualText **Text Analysis International, Inc.**	Integrated development environment extracts information from text, powers software applications such as content analysis, e-intelligence, knowledge management, eCRM, and text mining. Features NLP++ general programming language with specializations for natural language processing. Analyzers blend grammars, patterns, keyword, and statistical paradigms in a multi-pass framework and can be maintained by annotating text samples and letting the system create and generalize rules automatically. Development environment emphasizes a modify-and-test prototyping cycle. Text analyzers and knowledge bases can also be compiled for optimized performance.	MS Windows; 500MHz Pentium III+; 128MB RAM; 250MB hard disk space; Administrator permission on WinNT and Win2K.	Contact Vendor

Logic & Reasoning Systems

Product Company	Description	System Requirements	Price
Amzi! Prolog + Logic Server **Amzi! inc.**	Enables integration of intelligent components with conventional applications allowing you to add logic-bases that control processes, implement workflow rules, diagnose, and advise. Access a logic-base of rules like a database. Rules expressed in Prolog with built-in search and pattern matching capabilities. Encapsulated as a Java Class (JSP and Servlets), C/C++ Class, CGI Interface, .NET Class (VB, C#), Delphi Component, and DLL/SO API. Add Prolog predicates in Java, C/C++, C#, VB or Delphi. Logic-bases can reason over ODBC databases, use Sockets and use Unicode. Windows, Linux, Solaris, HP/UX.	Optionally one or more of C/C++, Java, Delphi, Visual Basic, C#, web server.	$29-$499; Free for personal use.

Logic & Reasoning Systems

Product Company	Description	System Requirements	Price
Exsys CORVID **Exsys Inc.**	Deliver decision-making knowledge, situation-specific answers and recommendations to prospects, clients and staff. Emulates a conversation with a human expert. Use for product selection, troubleshooting, tech support, diagnostics, regulatory compliance, predictive maintenance, automating routine tasks, capturing expertise/procedures, and bring knowledge assets and interaction to your Web site and wireless communications. Client-side or server-side delivery. Design can match existing Web sites. Modularize the system with Logic Block structure. Systems generate customized and automated email response and reporting. Combine expertise, developed systems can be merged together. 30-day free demo at *www.exsys.com*, development/deployment services also available.	MS Windows NT 4.0 w/SP 3 or MS Windows, MS Internet Explorer ver. 5, 75 MB Free Disk Space, Minimum Screen Resolution: 1024 x 768 with standard fonts or 1156 x 864 with large fonts	Contact Vendor
GeneMiner 2003 **Kdiscovery.com**	Intelligent data mining tool designed to utilize the automatic search and optimization capabilities of genetic algorithms. Takes raw input data and produces knowledge and rules for a wide variety of business and financial applications that need automated decision making with explanation capabilities. Users can build applications based on various practical application examples in the package including: stocks valuation, credit rating, direct marketing, medical screening, and several other business and financial applications.	Pentium PC or compatibles, MS Windows, 64 MB RAM and 100 MB available hard disk space, CD-ROM drive, VGA monitor or better.	$699
ISYL Fusion **Knowledge Netica**	Analysts workstation system scans textual information in documents, web pages, newswires, relational databases and direct input to perform conceptual and contextual correlations and submit validated hits and warnings of risks to analysts. Uses a large knowledge ontology in a Bayesian network with natural language processing techniques and weighted heuristic modules to achieve accuracy despite ambiguous input. Initial applications are in the homeland defense, stock analysis and insurance underwriting domains.	Internet web browser. Java script enabled browser such as IE 5.5 or Netscape 6.0	Contact Vendor



Next Issue

Scheduled articles and Buyer's Guide Themes include:

- Data Analysis & Mining
- Modeling
- Evolutionary & Genetic Algorithms
- Simulation
- Common Sense
- Creative Thinking
- Pattern Matching
- Intelligent Agents

Also scheduled in 17.5 are articles on Robotics, AI and the Net, AI Q crossword puzzle and the PC AI Bookzone.

Logic & Reasoning Systems

Product Company	Description	System Requirements	Price
LPA Prolog **LPA**	LPA Prolog and its optional toolkits support logic-based reasoning and inferencing coupled with various forms of knowledge representation. Couple with this is direct programmatic access to the Windows GUI and environment and the option to package up invisible intelligent components for integration with other languages and environments.	MS Windows	Contact Vendor
MailSmart - Auto Spam Identifier **Tropical Spring Innovation Center**	Uses AI techniques to identify spams and delete them. Automatically sniffs out behavorial patterns and keywords of spam mails, and does not require manual entry of rules or reliance on spammers' email addresses, and can adapt quickly to the users' environment. Also provides reasoning for its identification outcome.	MS Windows, 64 MB RAM, 20 MB hard disk space, CD-ROM drive, VGA monitor	$59
Predictive Suite **Predictive Dynamix, Inc.**	Integrated predictive modeling suite for model training and validation. Modeling technologies include neural networks, regression, self-organizing maps, dynamic clustering, fuzzy logic, genetic algorithms, and simulated annealing. Automated variable selection identifies key variables and variable interactions. Integrated graphical, statistical, and OLAP data analysis. Intelligent sampling for dataset reduction. Wizard mode for model building. Integrated pre- and post-processing and category and model lift analysis. Model deployment via ActiveX control in most common Windows application platforms.	MS Windows	Contact Vendor
ReCall **Isoft**	Supports all aspects of Case-Based Reasoning, from application design to integration with the Information System. Knowledge modeling provides an Object-Oriented graphical language for representing case structures and high level domain concepts in the form of a hierarchy of objects. Supports multiple inheritance, dynamic links, relations, functions, and taxonomies. Visual programming brings the expressive power of OO representation to non-IT specialists.	Windows NT/98/2000, Sun, IBM, Bull HP	From $10,000
Udiagnose **UReason**	Tool creates 'intelligent' applications that automate fault detection and diagnosis. Allows domain experts such as operators, process engineers or quality control managers to express and execute their hypothesis concerning production problems, quality issues, etc. Offers Fault Detection, Model Based Reasoning, Fault Reduction and Feedback Driven Decision Support techniques in a graphical way. No programming needed to configure rules, establish models, data-mappings, signal validation rules, fault-trees, state diagrams or decision trees. Extensions and add-ins for access over web and to OPC available.	Windows XP, Pentium IV 2Ghz or higher, 512 Mb or higher	From € 5000 Standard Edition, off-line stand-alone use.
Virtual Employee **Eidoserve**	Patented web technology is interactive with customers. What the client thinks the customer will ask, is not always the case. Helps improve client's knowledge base surrounding customers and prospects through interactivity. A brand impact, convey information, gain reaction and response application.	Internet web browser. Flash 6.0 or greater	From $250 per month.

Machine Learning

Product Company	Description	System Requirements	Price
Alyuda NeuroFusion **Alyuda Research, Inc.**	General-purpose neural networks library written in ANSI C++ and available as a separate DLL. Create, train and apply neural networks for both regression and classification problems. Constructive neural networks combined with proprietary algorithms of automatic data preprocessing, network design and training rather than back-propagation networks. All theoretical information is hidden inside the library, no tweaking required with architectures and training parameters. Development time is reduced due to a minimum set of functions.	MS Windows, 64MB RAM, 1 MB of free hard disk space	$399 commercial; $199 educational license
Alyuda NeuroIntelligence **Alyuda Research, Inc.**	Neural network software for scientists, engineers and AI experts. Solve real-world data mining, forecasting, modeling, decision support, signal processing and pattern recognition problems. Features data preprocessing techniques, automatic architecture search, training algorithms and extensive visualization of training and testing. Techniques for neural network design and optimization. Gain productivity in preprocessing data, finding network architecture, analyzing performance and applying a neural network to new data.	MS Windows, 64MB RAM, 10 MB of free hard disk space	$399. Educational discounts available.

Machine Learning

Product Company	Description	System Requirements	Price
Braincel 3.6 **Promised Land Technologies**	Neural net add-in to Microsoft Excel. Finds patterns in data, which enables you to forecast future patterns. Used for process control, stock and futures prediction, predicting good locations for sales outlets, and more. Uses a version of the standard neural net algorithm called "BackPercolation" (rather than the standard of "Backpropagation"), which converges on a solution.	MS Windows and MS Excel	$99 Academ-ic; $249 business users
Cart Decision Tree Software **Salford Systems**	Decision tree tool automatically sifts databases, searching for significant patterns and relationships and is a pre-processing complement to other data analysis techniques. In novice mode the software does all the control setting for the modeler. New controls allow subtle refinements for experienced users. Optional command line allows full automation of modeling, evaluation, report writing, and model deployment into scoring and prediction systems.	Windows 98 or higher. No NT 4. 64MB or higher of RAM.	Contact Vendor
Data Mining: Levels I, II & III **The Modeling Agency**	Learn how to mine data by attending vendor-neutral, application-oriented data mining courses. Participants learn about data mining capabilities, limitations, methods, tools, techniques, applications, advantages and pitfalls. Leave with notes, illustrations and references to valuable resources. Harness the complex patterns, interrelationships and profits hidden within your data. Courses are offered at desirable venues throughout North America, or may be offered at client's site.	No prerequisites for Level I. Levels II & III participant: previous exposure to statistics, modeling tools, or have attended Level I.	Series discounts apply for attending multiple levels
Data Mining Project Assessment **The Modeling Agency**	Creates a foundation for a data mining initiative thorough pre-project assessment, understanding key stakeholder motivations and vision, leveling expectations by educating on strengths and limitations, gaining an appreciation of each unit's business processes, confirming the alignment of important business questions with available resources, assuring end user adoption in advance, defining and valuating benchmarks for project performance, and requesting domain expert contribution for results interpretation. Guidelines provide estimates of works and cost, define responsibilities of client-vendor team, and provide reasonable flexibility required through the knowledge discovery process. Deliverables are detailed findings and recommendation reports and presentation by the senior consultant.	All platforms and data stores	Contact Vendor
Mars Predictive Modeling Software **Salford Systems**	Automates development and deployment of regression models. Software exploited via intelligent default settings so analysts at all levels can access innovations. Given a target variable and a set of candidate predictor variables it automates all aspects of model development, including: separating relevant from irrelevant predictor variables; transforming predictor variables exhibiting a nonlinear relationship with the target variable; determining interactions between predictor variables; handling missing values with new nested variable techniques; and conducting extensive self-tests to protect against overfitting.	Windows 98 or higher. No NT 4. 64MB or higher of RAM.	Contact Vendor
Predictive Suite **Predictive Dynamix, Inc.**	Integrated predictive modeling suite for model training and validation. Modeling technologies include neural networks, regression, self-organizing maps, dynamic clustering, fuzzy logic, genetic algorithms, and simulated annealing. Automated variable selection identifies key variables and variable interactions. Integrated graphical, statistical, and OLAP data analysis. Intelligent sampling for dataset reduction. Wizard mode for step-by-step model building. Integrated pre- and post-processing and category and model lift analysis. Model deployment via ActiveX control in most common Windows application platforms.	MS Windows	Contact Vendor
TreeNet Stochastic Gradient Boosting Software **Salford Systems**	Uses the “ultra-slow learning” concept where layers of information are gradually peeled away to reveal structure in the data. Models are composed of hundreds of small trees, each contributing an adjustment to the overall model. Capable of dealing with dirty and flawed data and resistant to data coding errors, even in the target variable. Automates missing values handling and predictor selection, is impervious to outliers and self tests to prevent overfitting.	Windows 98 or higher. No NT 4. 64MB or higher of RAM.	Contact Vendor
Vendor-Neutral Tools Data Mining Tools Survey **The Modeling Agency**	Study of the most appropriate data mining tools given an organization's IT and data resources, goals, user skills, budget and other criteria. List of potential tool candidates populated by TMA's senior-level consultants who are unbiased and aware of the landscape of data mining tools. Survey saves organizations time in researching, evaluating and selecting tools for their situation.	All platforms and data stores	Contact Vendor

Vendor Address

Company	Address	Phone and Email	Web Address
U.S. Vendors			
Amzi! inc.	5861 Greentree Road Lebanon, OH 45036	513.425.8050 *info@amzi.com*	*www.amzi.com*
Alyuda Research, Inc.	78 Maule Ave. Tukwila, WA 98188	425.928.3570 *sales@alyuda.com*	*www.alyuda.com*
Data Advantage Group, Inc	604 Mission Street 7th Floor San Francisco, CA 94105	415.947.0400 *info@dag.com*	*www.dag.com*
dtSearch Corp.	6852 Tulip Hill Terrace Bethesda, MD 20816	800.IT.FINDS *sales@dtsearch.com*	*www.dtsearch.com*
Eidoserve	445 Fort Pitt Blvd Pittsburgh, PA 15219	412.227.6594 *wscholar@eidoserve.com*	*www.eidoserve.com*
Exsys, Inc.	2155 Louisiana Blvd. NE Ste 3100 Albuquerque, NM 87110	505.888.9494 *info@exsys.com*	*www.exsys.com*
ISYS Search Software	8775 E. Orchard Rd. #811 Englewood, CO 80111	800.992.4797 *info@isysusa.com*	*www.isysusa.com*
KnowledgeNetica	16820 Hwy 10, Suite 120 Elk River, MN 55330	763.274.1000 *sales@knowledgenetica.net*	*www.knowledgenetica.com*
Predictive Dynamix Inc.	3715 Gramercy Houston TX, 77025	713.592.5840 *contact@predx.com*	*www.predx.com*
Promised Land Technologies	195 Church Street 11th Floor New Haven, CT 06510	203.562.7335 *support@promland.com*	*www.promland.com*
Rule Machines Corporation	51745 396th Ave. Frazee, MN 56544	218.334.3960 *info@rulemachines.com*	*www.rulemachines.com*
Salford Systems	8880 Rio San Diego Dr Ste 1045 San Diego, CA 92108	619.543.8880 *sales@salford-systems.com*	*www.salford-systems.com*
Soffront Software, Inc.	45437 Warm Springs Blvd Fremont, CA 94539	510.413.9000 *info@soffront.com*	*www.soffront.com*
Sonalysts, Inc.	215 Parkway North Waterford, CT 06385	860.326.3772 *fuzzyquery@sonalysts.com*	*fuzzy.sonalysts.com*
Stottler Henke Associates, Inc.	1107 NE 45th St., Suite 310 Seattle, WA 98105	206.545.9327 *info@stottlerhenke.com*	*www.stottlerhenke.com*
Text Analysis International, Inc.	1669-2 Hollenbeck Ave. # 501 Sunnyvale, CA 94087	408.746.9932 or 877.235.6259 *info@textanalysis.com*	*www.textanalysis.com*
The Modeling Agency	PO Box 7541 The Woodlands, TX 77387-7541	936.321.2177 *info@the-modeling-agency.com*	*www.the-modeling-agency.com*
Canadian Vendors			
Cognos Corporation	3755 Riverside Dr Station T Ottawa, ON K1G 4K9	613.738.1440	*www.cognos.com*
Goddard Information Systems Ltd	135 Main St. N, Ste 303 Markham, ON, L3P1Y2	905.896.4498 *info@strataview.com*	*www.strataview.com*
Vendors Outside North America			
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ISoft	Chemin de Moulon Gif sur Yvette France, 91190	33.1.69.35.3737 *info@isoft.fr*	*www.isoft.fr*
KDiscovery.com	31 Simei Street 4 #02-20 Republic of Singapore 529877	(65) 3442357 *info@kDiscovery.com*	*www.kdiscovery.com*
LPA	Studio 4, RVPB, Trinity Rd London England, SW18 3SX UK	+44.20887. 12016 *info@lpa.co.uk*	*www.lpa.co.uk*
Object Connections Australia Pty Ltd	PO Box 562 Wallsend, Australia, 2287	(61-2) 4950 0577 *info@objectconnections.com*	*www.objectconnections.com*
Tropical Spring Innovation Center	31 Simei St 4, Tropical Spring Ctr #02-20 Republic of Singapore 59877	*info@TropicalSpring.com*	*www.TropicalSpring.com*
UReason	Rooseveltstraat 18V NL-2321BM Netherlands	+31-71-5281700 *info@UReason.com*	*www.UReason.com*

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