

It's All In The Data

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2002

ANNUAL REPORT

Acxiom Data Engineering Laboratory

A Collaboration of
Acxiom Corporation and
The University of Arkansas at Little Rock
Donaghey College of Information Science and Systems Engineering

with additional support provided by
The Arkansas Science and Technology Authority

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Preface

By Dr. John Talburt / Acxiom Corporation, ADEL Director



This preface to the 2002 Annual Report for the Acxiom Data Engineering Laboratory (ADEL) is an opportunity for me to underline the significance of several events that transpired during our second year of operation. Last year, we achieved a number of milestones in our vision of a joint university/industry applied research model.

One of the most important milestones during 2002 was the hiring of ADEL's full-time program manager, Judy Camp. Ms. Camp's arrival on the scene brought ADEL a new level of stability and provided a personal presence that has been evident to all of our stakeholders. Her tireless work in organizing ADEL's activities, especially in her proposal writing efforts, has laid the foundation for more success in the future.

Last year also saw a new Acxiom group, InfoBase Development, participate in research activities through ADEL. Its data-mining project, sponsored by Chuck Howland and Rasesh Patel, also brought with it new research investigators. The University of Arkansas at Little Rock's Donaghey College of Information Science and Systems Engineering (the UALR CyberCollege) provided the new research talent, Dr. Ningning Wu and her graduate students, Yanbin Ye and Linda Ning.

Last year, we made our first serious attempt to obtain federal funding for projects, primarily through the National Science Foundation. In November, the entire ADEL staff, along with UALR CyberCollege Dean Mary Good, visited Dr. Michael Pazanni, Director of the Division of Information and Intelligent Systems, at NSF Headquarters in Washington, DC. After hearing our presentation about ADEL and our unique approach to University-Industry applied research, Dr. Pazanni and his staff encouraged us to send both full proposals and "white papers," especially for projects that would involve working with large amounts of "real world" data.

We have done both--an ITR proposal from Dr. Coskun Bayrak sponsored by Acxiom Global Data Development, which was to develop an intelligent system for extracting information from structured and semi-structured documents, and a "white paper" by Dr. Mihail Edi Tudoreanu for research into "the Visual Analysis of Stream Data."

The second annual Conference on Applied Research in Data Engineering sponsored by ADEL and the UALR CyberCollege was held November 1, 2002. It was again successful in bringing together faculty and students with Acxiom's technical leaders for information sharing and for seeding new research projects.

In addition to these new developments, we also saw confirmation of Acxiom Corporation's original purpose for beginning the ADEL collaboration. Both of ADEL's first-year research projects on information retrieval ("Browser Harness" and "WebGrabber") have been developed into Acxiom production systems used by the Data Content Group.

Within the pages of this annual report, you will find additional details related to ADEL's on-going mission, including the exciting promise of continued, cost-effective applied research and the growth of diverse collateral benefits from the Acxiom Corporation and UALR partnership made possible by ADEL.

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Introduction

The Acxiom Data Engineering Laboratory (ADEL) began with help from the Arkansas Science and Technology Authority (ASTA) in March 2001, as a joint venture between Acxiom Corporation and the UALR Donaghey College of Information Science and Systems Engineering (CyberCollege). The joint venture has been a productive means to marshal the data development resources needed for Acxiom to maintain its global leadership in Customer Data Integration and in data technology. In Year One, ADEL sponsored three, successful applied research projects with ASTA's support; in Year Two, it sponsored two more projects, again with ASTA's support, which will be completed in August 2003. ADEL has also organized two, annual conferences for the dissemination and sharing of research between regional university and business professionals. The ADEL staff also visited program directors at the National Science Foundation (NSF) in Washington, D.C., and submitted a NSF grant proposal in December 2002, which is still pending. It has also continued to expand the ADEL website. In Year Three, ADEL expects to sponsor several new projects for which it will continue to seek federal grant support. It will also organize its regional conference on applied research in data engineering.

Research Projects Started in 2002

1. Mining Hidden Information From Large Datasets--Dr. Ningning Wu (UALR-Information Science); Dr. Russel Bruhn (UALR-Information Science); Rasesh Patel (Acxiom Corporation); Linda Ning (UALR Graduate Student) and Yanbin Ye (UALR Graduate Student). May 2002-August 2003.

This project aims at investigating and developing data mining techniques to efficiently discover new and hidden knowledge from huge datasets. Acxiom expects to use the resultant knowledge obtained from this project to improve existing business rules.

2. An Architecture for Capturing, Storing, and Connecting Event Information to Facilitate Customer Data Integration--Dr. Ray Hashemi (UALR - Computer Science); Dr. Charles Ford (UALR - Computer Science); Steve Sieloff (Acxiom Corporation); Ashish Bansal (UALR Graduate Student); Nan Tang (UALR Graduate Student). May 2002-August 2003.

The initial work focuses on two areas: the development of an ontology for extracting features from narrative event announcements in online newspapers and a schema for building a related geographic index.

Research Projects Completed in 2002

1. Script, Semi-script, and Feature based HTML Document Filtering

(WebGrabber Phase I)--Dr. Ray Hashemi (UALR - Computer Science); Dr. Charles Ford (UALR - Computer Science); and Dr. Yeong-Tae Song (UALR - Computer Science). March 2001-May 2002.

The WebGrabber prototype delivered by the research team became production-ready at Acxiom in December 2001. Researchers report an extremely high overall accuracy for name recovery. Several system enhancements have improved the system's performance and automated the auditing of the compiled records.

2. Script, Semi-script, and Feature based HTML Document Filtering

(WebGrabber Phase II) --Dr. Ray Hashemi (UALR - Computer Science); Dr. John Talburt (Acxiom Global Data Development Business Unit) September 2001-May 2002.

This project is an extension of the original project designed to increase efficiency of the original prototype. It generalizes the architecture of the original prototype so that the same basic "web crawler engine" extracts a variety of text-based features beyond the basic name and title elements targeted by the original research.

3. Structured and Semi-structured Data Extraction from HTML Documents (Browser Harness)--Dr. Coskun Bayrak (UALR - Computer Science). April 2001-May 2002.

The original Browser Harness Version 1.0, delivered in May 2002, has had several added features, mostly related to usability. The current production version is now 1.4.0. One of the most important features added lets the operator select among three different options for the output format of the captured data, MS Access, CSV, or XML. Another helpful feature is that it can now automatically follow the "next results" links for sites that return a fixed number of items per page and display overflow items on separate pages.

Browser Harness is being used to support a new Acxiom product, the InfoBase Patriot Act Solution.

Other ADEL Activities

1. ADEL Staff visits the National Science Foundation in Washington, D.C.

The ADEL staff (John Talburt, Director; Joe Swaty, Associate Director, and Judy Camp, Program Manager) traveled to Washington, D.C. with UALR Donaghey CyberCollege Dean Mary Good to meet with National Science Foundation (NSF) Director, Division of Information and Intelligent Systems, Michael Pazzani and four other NSF Program Directors to talk about gaining NSF funding for projects, especially when in collaboration with Acxiom. After

receiving an overview of the CyberCollege from Dean Good and an overview of Acxiom and its role in collaboration with UALR through ADEL from Dr. Talburt, the NSF team gave suggestions for programs and advice for the writing of NSF grants in order to gain funding. The information gained from the trip has since allowed ADEL to submit a new grant as well as a "white paper" to the NSF for future research projects between the CyberCollege and Acxiom Corporation.

2. Project submitted to the National Science Foundation for grant funding:

Structured and Semi-structured Data Extraction from HTML Documents – Phase II – Submitted December 15, 2002--Dr. Coskun Bayrak (UALR - Computer Science); Dr. John Talburt (Acxiom Global Data Development Business Unit).

This project compliments the feature-based HTML filtering project described previously. The initial project started in April 2001 and ended in completion in May 2002. The research attacks a different, but equally difficult, problem of extracting structured and semi-structured web-based information, but the structure will vary considerably from site to site. The objective of the research is to develop an interactive tool (nicknamed the "Browser Harness") that is operator-directed rather than fully automated like the WebGrabber.

Oftentimes, interesting structured and semi-structured data are not in database systems but in HTML pages, text pages, or papers. Obtaining relevant and high-quality information from sources like the web without using

sophisticated tools is extremely difficult and challenging. A vast quantity of semi-structured data stored in electronic form is not found in highly formatted HTML pages but in text files on local file systems.

If users want to extract significant amounts of the relevant data through a query interface, they need to focus on something more general than HTML files. Since HTML files are a special case of text files, a tool that handles text files can also handle HTML files. Therefore, the research is directed at developing a tool called "Structured and Semi-structured Data Extraction" (S2DE) for extracting web-based data from web pages using delimiters. S2DE is an interactive tool for semi-automatically determining the structure of such documents and then extracting data in various formats. With respect to the varying structure used in the source files, S2DE will also have capability to perform schema translation into the report's desired format through the use of a configurable graphical user interface (GUI). The non-programmer oriented GUI will allow the user to hierarchically decompose the file, outlining its interesting regions and then describing its semantics.

3. White paper submitted to the National Science Foundation:

Visual Analysis of Stream Data--Dr. Mihail E. Tudoreanu (UALR - Information Science); Dr. Mihail E. Tudoreanu (UALR - Information Science); Dr. Don Hinman (Acxiom Corporation); and Doug Christiansen (Acxiom Corporation).

Business and government information systems are creating enormous amounts of information at an increasing rate, often overwhelming users' abilities

to analyze it quickly with traditional decision support tools and analytical methods. In particular, this project seeks to understand how a stream of data is connected over time and how to use this information to interpret trends in the data in order for users to predict likely future outcomes. Streaming descriptive, transaction, and event data continue to saturate companies and agencies, confounding analysts' abilities to extract actionable information.

Given the human capacity to rapidly analyze and absorb large amounts of visual information, this project proposes research into graphical systems and methods, enabling the visual analysis of a rich set of historical data. The outcome would allow the system's users to quickly build animated representations of all potential relationships, even those not inherent in the data structure; understand how some factors influence others over time; and anticipate the likelihood of certain future outcomes related to these factors.

Similar scenarios could be analyzed in other applications, such as historical traffic patterns, leading to an understanding of where resources should be allocated to improve traffic flow. The ability to rapidly analyze streams of event data might also have application in areas of national security such as in threat analysis.

4. Conference on Applied Research in Data Engineering

The UALR CyberCollege, Acxiom, and ADEL again hosted the "Conference on Applied Research in Data Engineering" on the UALR campus. The event, held on November 1, 2002, attracted approximately 150 students, faculty members,

business people, and Acxiom associates from around Arkansas and the neighboring states of Alabama, Mississippi, Oklahoma, and Texas. This year's registrants included those from Arkansas universities such as the University of Arkansas (UA) at Little Rock; UA, Fayetteville; UA at Monticello; Arkansas State University (ASU); ASU at Mountain Home; University of Central Arkansas; Harding University; Arkansas Tech University; and UA Community College at Morrilton. However, the broadened interest for the event also brought registrants from the University of Alaska, the University of Oklahoma, Southern Methodist University, the University of Virginia, the University of Alabama at Huntsville, and the University of Mississippi.

Keynote speakers Dr. William Wulf, President of the National Academy of Engineering, and Margaret Dunham, Professor, Computer Science and Engineering, Southern Methodist University in Dallas, Texas, provided information about the field of data engineering and data mining to conference participants.

Participants also attended sessions highlighting Acxiom sponsored research as well as Acxiom technology and culture. The conference attendees benefited from more than 18 hours of informative presentations on information technology research and curricula. They also heard presentations of selected research papers from universities such as UALR, UA-Fayetteville, the University of Central Arkansas, Arkansas State University, the University of Oklahoma, and the University of Houston – Texas. In addition, researchers from corporations

such as Acxiom and Lynn Incorporated - Houston, Texas, presented their on-going research.

5. Expanded Website

A full-featured website (<http://adel.ualr.edu>), developed for the Acxiom Data Engineering Laboratory during 2001, continued to expand in 2002. The site was used for online registration for this year's ADEL Conference on Applied Research in Data Engineering. In addition to supplying highlights of the conference, it also includes a posting of "Working Papers" from participants' presentations. Additionally, the site includes information and vita on principal investigators as well as regular *ADEL Updates*, giving news about research projects and other ADEL activities. The site also features direct links to UALR and CyberCollege websites as well as helpful links to Acxiom Corporation and the Arkansas Science and Technology Authority.

6. ADEL Staff and Researchers attend Governor's Economic Summit

ADEL Staff members, Dr. John Talburt, Joe Swaty, and Judy Camp, attended the Governor's Economic Summit held in Little Rock, and they were joined by ADEL project researchers Dr. Russel Bruhn (Chair, UALR Information Science); Dr. Yupo Chan (Chair, UALR Systems Engineering); Dr. Charles Ford (Chair, UALR Computer Science); Dr. Ray Hashemi (UALR Computer Science); Dr. Ningning Wu (UALR Information Science); and Rasesh Patel (Acxiom Corporation).

The group's interest in university-based research as a tool for moving the State's economy into the 21st Century was highlighted at this event, where Donaghey CyberCollege Dean Mary Good joined an impressive lineup of speakers to tout the need for technological education and more partnerships among state government, higher education, and the business sector in Arkansas. ADEL staff and researchers gained information about how university research is influencing the Arkansas economy. Experts speaking at the event see university-based research conducted in partnerships with industries as an avenue for educating, recruiting, and retaining a highly educated workforce in the State, and Dean Good stressed cooperation between all state universities as key to attaining this goal.

7. Faculty Tour of Acxiom Facilities

The ADEL staff and Allison Nicholas, Acxiom College Recruiting, arranged a special tour of the Acxiom Outsourcing Data Center in Conway for fourteen CyberCollege faculty members, including six new faculty members. The tour gave faculty and researchers an opportunity to explore future topics for research between the industry and university.

8. Publications

The following papers and presentations were supported in part through the Acxiom Data Engineering Laboratory at UALR:

Bayrak, C., Kolukisaoglu, H., & Sieloff, S. (2003). Data extraction from repositories on the web: A semi-automatic approach. Accepted for publication in the *World Wide Web Journal*, Kluwer Publications.

Bayrak, C., Kolukisaoglu, H., Chung, H., & Talburt, J. (2002, June 23-27) Information harnessing on the World Wide Web. In *Proceedings of the 6th Biennial World Conference on Integrated Design and Process Technology*, 1, Pasadena, CA.

Bayrak, C. (2002, July 22). Structured and semi-structured information extraction from the World Wide Web. Presented to the faculty and students of the Electrical and Computer Engineering Department at Karadeniz Technical University, Trabzon-Turkey.

Bayrak, C. (2002, July 6). Supervised information extraction. Presented to the faculty and students of the Electrical and Computer Engineering Department at Bogazici University, Istanbul, Turkey.

Hashemi, R. , Ford, C. W., Vamprooyan, T. & Talburt, J. (2002, November). Extraction of features with unstructured representation from html documents. In P. Isaias (Ed.), *Proceedings of the IADIS International Conference on WWW/ Internet 2002* (pp. 47-53). Lisbon, Portugal: *International Association for Development of Information Society*

Wu, N. (2003). Factor analysis based intrusion detection. Accepted for publication by *IEEE Workshop on Information Assurance*.

Wu, N. (2002, November 1). Mining association rules from very large datasets. Acxiom Data Engineering Laboratory Conference on Applied Research in Data Engineering, University of Arkansas at Little Rock.

Collateral Benefits of ADEL

The dictionary defines "collateral" as an adjective meaning "in parallel or running beside." It is a perfect word to describe the various types of special benefits that have grown from the success of the Acxiom Data Engineering Laboratory partnership:

1. Faculty recruitment and retention was critically important to both Acxiom and UALR during 2002, which resulted in additional support from Acxiom.

Working together, UALR's CyberCollege was able to recruit six internationally recognized faculty members in Information Technology and Applied Science in Fall 2002.

2. In working to better understand the corporate needs of Acxiom, the CyberCollege's Assistant Dean visited Acxiom's Development Unit located in Fayetteville in 2002.
3. Employee recruitment was also raised to a new level, based on the growing partnership, with a cooperative effort in early 2003 to identify and interview those students who would be interested in the unique corporate culture and work environment they could find at Acxiom as future employees. Internship opportunities for UALR students were also championed during the second half of 2002.
4. Reaching out to college students statewide, UALR was also pleased to host Acxiom's annual computer programming competition event on the UALR campus in February 2003.
5. Joe Swaty, ADEL Associate Director, and Jerry Adams, Acxiom University Relations, served together on the ADED Task Force for the Creation of Knowledge-Based Jobs, and the CyberCollege included the Acxiom partnership in presentations to State legislators during the Fall and Spring semesters 2002-2003.
6. Acxiom associates regularly attend meetings of the CyberCollege's CyberSecurity Task Force. The Task Force is developing a plan to allow

the CyberCollege to become a Center of Excellence in Information Assurance, as defined by the National Security Agency. It also outlined a new degree plan for a Minor in Information Assurance (IA) which was accepted by UALR Undergraduate Council to begin in Fall 2003; students in the IA Minor program (whether degree seeking or not) will also earn a Technical Certificate in Information Assurance. The architecture for the CyberCollege's IA Minor/Technical Certificate Program was built with advice from Acxiom associates, UALR faculty in the Departments Of Business And Criminal Justice, and members of local state and city governments as well as members of the Federal Bureau of Investigation. Through Acxiom's involvement, the new IA Minor will help educate students and researchers on emerging information assurance methods and lead to the creation of new technologies.

7. Judy Camp, ADEL Program Administrator, has shared her grant writing/editing skills with the CyberCollege. She has not only helped CyberCollege faculty with the submission of grants to the National Science Foundation, the Department of Defense, and Arkansas Science and Technology Authority but has also edited a grant for the University of Arkansas, Fayetteville in collaboration with Acxiom. She has also helped CyberCollege faculty members edit their research papers, resulting in publications for many, and she helped write the curriculum proposal for the new Information Assurance Minor.

8. The CyberCollege co-sponsored the 2002 ADEL Conference on Applied Research, giving it a unique opportunity to demonstrate its new Virtual Reality Center technology to academic and corporate guests from throughout the State and Nation. The CyberCollege also underwrote the travel expenses for conference keynote speaker Dr. William Wulf, President of the National Academy of Engineering.
9. The CyberCollege raised its visibility while visiting the National Science Foundation on Acxiom's behalf for future non-ADEL activities and NSF funding opportunities for CyberCollege programs, faculty, and students.
10. Jerry Adams, Acxiom University Relations, and UALR campus liaison Joe Swaty, ADEL Associate Director and CyberCollege Assistant Dean for Corporate Relations, held a meeting of the Acxiom/UALR Relationship Team in February 2003. The Team is comprised of Acxiom associates and UALR staff working together to expand beneficial partnership opportunities. The Team also includes representatives from UALR's business college and liberal arts college. The Relationship team held quarterly meetings during 2002-2003 on the UALR campus and Acxiom Conway campus.
11. The relationship with Acxiom's Steve Young in campus recruiting continues to expand with specific activities related to matching CyberCollege students and graduates with Acxiom's needs. An Acxiom recruitment and interview event was held on the UALR campus in March

2003. Ongoing efforts also include assistance with student internships and cooperative education opportunities.
12. The CyberCollege moved the Acxiom Data Engineering Laboratory offices to a more visible location in UALR's ETAS Building --- Room 309A, featuring adjoining conference rooms and high-profile signage in the building's open atrium.
 13. The CyberCollege and Acxiom relationship received coverage with the "topping out ceremony" for the new Acxiom building in downtown Little Rock. A feature photo of CyberCollege Dean Mary Good with Acxiom's Jerry Adams as well as other Acxiom partnership activities were included in issues of the CyberCollege's *HyperLink* newsletter, an on-line "e-zine," accessible via the CyberCollege website: <http://cybercollege.ualr.edu>
 14. The partnership for employee recruitment is an ongoing high priority as a collateral benefit of the Acxiom/UALR relationship, with UALR interns at Acxiom being announced on a regular basis, especially during the summer months. Direct ties between Acxiom's recruiters and the CyberCollege's Director of Academic Services have been established, giving Acxiom a direct link to the CyberCollege's growing student body.
 15. A highlight of Acxiom's partnership with UALR's CyberCollege was the joint hosting of the CyberCollege's annual awards ceremony on May 2, 2003. The ceremony was held in the auditorium of Acxiom's new River Market building and featured a special presentation of the CyberCollege's

“CyberPartner” award to Acxiom. Jerry Adams and Dr. John Talburt represented Acxiom on-stage to receive the award from Dean Mary Good.

Based on these examples of the collateral benefits already apparent in 2002-2003, there is much confidence that 2003-2004 will present additional opportunities for new and dynamic collateral benefits for the ADEL/UALR relationship.

Summary of Specific Third-Year Objectives

During 2003, the Acxiom Data Engineering Laboratory plans to:

1. Report on projects which will end in August 2003, specifically:
 - ***Mining Hidden Information From Large Datasets***--Dr. Ningning Wu (UALR-Information Science); Dr. Russel Bruhn (UALR-Information Science); Rasesh Patel (Acxiom Corporation), and
 - ***An Architecture for Capturing, Storing, and Connecting Event Information to Facilitate Customer Data Integration***--Dr. Ray Hashemi (UALR-Computer Science); Dr. Charles Ford (UALR-Computer Science); Steve Sieloff (Acxiom Corporation).
2. Continue to seek support from the National Science Foundation and other funding institutions to sponsor identified projects, including the following:
 - ***Structured and Semi-structured Data Extraction from HTML Documents – Phase II*** – Submitted to NSF on December 15, 2002--

Dr. Coskun Bayrak (UALR - Computer Science); Dr. John Talburt (Acxiom Corporation);

- **Visual Analysis of Stream Data**-- Dr. Mihail E. Tudoreanu (UALR - Information Science); Dr. Don Hinman (Acxiom Corporation); and Doug Christiansen (Acxiom Corporation);

- **InfoBase Data Mining—Phase II**—Dr. Ningning Wu (UALR – Information Science); Rasesh Patel (Acxiom Corporation); and Jeff Heard (Acxiom Corporation);

- **Optimized Approximate Query Results for a Large Distributed Database**—Dr. Charles Ford (UALR – Computer Science) and Dr. John Talburt (Acxiom Corporation); and

- **Semantically Enabled Autonomic Processing**—Dr. Rolf Wigand (UALR – Information Science); Dr. Mihail E. Tudoreanu (UALR – Information Science); Dr. Xiaowei Xu (UALR – Information Science); and Dr. John Talburt (Acxiom Corporation).

3. Plan the 2004 Conference on Applied Research in Data Engineering to be hosted on the UALR campus in Spring 2004 with a format similar to the previous two years for the dissemination of applied research conducted through ADEL and through other state and regional universities.