Business Intelligence and Analytics Education, and Program Development: A Unique Opportunity for the Information Systems Discipline

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"Big Data," huge volumes of data in both structured and unstructured forms generated by the Internet, social media, and computerized transactions, is straining our technical capacity to manage it. More importantly, the new challenge is to develop the capability to understand and interpret the burgeoning volume of data to take advantage of the opportunities it provides in many human endeavors, ranging from science to business. Data Science, and in business schools, Business Intelligence and Analytics (BI&A) are emerging disciplines that seek to address the demands of this new era. Big Data and BI&A present unique challenges and opportunities not only for the research community, but also for Information Systems (IS) programs at business schools. In this essay, we provide a brief overview of BI&A, speculate on the role of BI&A education in business schools, present the challenges facing IS departments, and discuss the role of IS curricula and program development, in delivering BI&A education. We contend that a new vision for the IS discipline should address these challenges.

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1. BUSINESS INTELLIGENCE AND ANALYTICS (BI&A)

> "So what's getting ubiquitous and cheap? Data. And what is complementary to data? Analysis. So my recommendation is to take lots of courses about how to manipulate and analyze data: databases, machine learning, econometrics, statistics, visualization, and so on."[1]

Big data has become big time. In July 2012, Columbia University and New York City announced plans to invest over $80 million dollars in a new Center for Data Science, which is expected to generate thousands of jobs and millions of dollars in tax revenues from 100 startup companies over the next ten years [Associated Press 2012]. According to the McKinsey Global Institute Report [2011], Big Data is the next frontier for innovation, competition, and productivity. Business intelligence and analytics (BI&A), data science applied to business, has similarly gained much attention in both the academic and IT practitioner communities over the past two decades. Universities are beginning to respond to the research and educational demands from industry. In this essay, we provide a brief overview of BI&A, speculate on the role of BI&A education in business schools, and discuss the role of Information Systems (IS) curricula in delivering BI&A education, the challenges facing IS departments, and the new vision for the IS discipline.

Big Data is an emerging phenomenon. Computing systems today are generating 15 petabytes of new information every day—eight times more than the combined information in all the libraries in the U.S.; about 80% of the data generated everyday is textual and unstructured data. According to McKinsey [2011], Big Data is defined as what firms cannot handle with typical database software. New and different technologies are needed to handle the 3 Vs of volume (from gigabytes to petabytes), velocity (from batch to near-time data and real-time streams), and variety (from structured records to semistructured and unstructured text [Russom 2011]. The need to store and analyze big data has been reported in many areas including agriculture, astronomy, business, elections, law, medicine, quantum physics, search engines, terrorism, and tourism [Anderson 2008; The Economist 2010]. With an overwhelming amount of sensor-generated data and user-generated contents available from social media, we are at a terabyte and even petabyte scale of data management [The Economist 2010]. But it is not just size alone that distinguishes big data.

Businesses face new challenges, not only in big data management, but also in big data analysis, which requires new approaches to obtain insights from highly detailed, contextualized, and rich contents. Enterprise data management and advanced data, text, and Web analytics are essential and critical for turning data into actionable insights and intelligence [The Economist Intelligence Unit 2011; Russom 2011]. The Institute for Operations Research and Management Science (INFORMS) defines *business analytics* in the following way: "Analytics facilitates realization of business objectives through reporting of data to analyze trends, creating predictive models for forecasting, and optimizing business processes for enhanced performance." INFORMS identifies three main categories of analytics: (1) descriptive—the use of data to find out what happened in the past; (2) predictive—the use of data to find out what could happen in the future; and (3) prescriptive—the use of data to prescribe the best course of action for the future. We use BI&A as a unified term to describe information-intensive concepts and methods to improve business decision making. BI&A includes the underlying architectures, analytical tools, database management systems, data/text/Web mining techniques, business applications, and methodologies.

[1]"Hal Varian Answers Your Questions" (2/25/08).
http://www.freakonomics.com/2008/02/25/hal-varian-answers-your-questions/.

The main objectives are to support interactive and easy access to big and diverse data, enable manipulation and transformation of these data, and most importantly, to provide business managers and analysts with understanding, the ability to conduct appropriate analyses, and to take informed actions.

Business demand for BI&A has been demonstrated by a number of studies [LaValle et al. 2010, 2011]. In a recent IBM Global CIO Study [2011b], 83 percent of CIOs responding to the survey identified BI&A as the top priority for increasing competitiveness over the next three to five years. According to a survey on the current state of business analytics by Bloomberg Businessweek Research Services [2011], 97 percent of companies with revenues of more than $100 million are using some form of business analytics. A recent IBM Tech Trends survey [2011a] found that business analytics is the new technology most adopted as businesses struggle to automate processes and make sense of an ever-increasing amount of data. Successful BI&A applications have been reported in a broad range of industries, from health care and airlines, to major IT and telecommunication firms [Watson 2009].

2. KNOWLEDGE AND SKILLS

The McKinsey Global Institute Report [2011] predicted that by 2018, the United States alone will face a shortage of 140,000 to 190,000 people with deep analytical skills, as well as a shortfall of 1.5 million data-savvy managers with the know-how to analyze big data to make effective decisions. Job postings looking for data scientists and business analytics specialists abound these days.

There is a clear shortage of professionals with the "deep" knowledge required to manage the three Vs of big data: volume, velocity, and variety [Russom 2011]. But there is also a clear demand for individuals with the deep knowledge to manage the three perspectives of business decision making: descriptive, predictive, and prescriptive analytics.

The depth of the required knowledge to conduct data analytics is not trivial. To compound the complexity, there is a high degree of fragmentation and consolidation in the analytics industry. As Michael Stonebraker put it in a recent keynote address (Big Data Disruption Summit, Feb 15, 2012, Boston MA).

> "The focus of analytics in the past was "Little Analytics" on Big Volume, like finding an average closing price of MSFT on all trading days in the last 3 years - a request easily expressed in SQL. Now there is demand for "Big Analytics" on Big Data, which may include complex math operations, such as machine learning or clustering."

The current state of the analytics software industry makes it very difficult and cumbersome to conduct analyses without a deep perspective of the underlying systems and technologies. For example, the popular statistics packages: SPSS, SAS, and R suffer from weak or nonexistent data management capability. On the other hand, relational database management systems (RDBMS) are not suitable for the matrix operations that underpin much advanced analytics. This means that BI&A analysts will have to be proficient in both worlds: analytical tools and RDBMS.

BI&A is an interdisciplinary area that integrates data management, database systems, data warehousing, data mining, natural language processing (also called text analytics and text mining), network analysis/social networking, optimization, and statistical analysis. But beyond these technical and analytical skills, there is a demand for persons who are able to understand business needs, interpret the analyses performed on big data and provide leadership for data-informed decision making in their

organizations. The following sections enumerate some of the knowledge and skills that are required in each of these three areas for effective BI&A.

2.1 Analytical Skills

There are many techniques that draw from disciplines such as statistics and computer science, particularly machine learning, that can be used to analyze data. Coverage of the following techniques, among others, should be part of academic programs intended to produce BI&A professionals:

— data mining, including association rule mining, classification, cluster analysis, and neural networks;
— deviational analysis and anomaly detection;
— geospatial and temporal analysis;
— network analysis and graph mining;
— opinion mining and sentiment analysis;
— optimization and simulation;
— statistical analysis, including decision tree, logistic regression, forecasting, and time series analysis;
— econometrics;
— text mining and computational linguistics.

2.2 Information Technology (IT) Knowledge and Skills

The IT skills required for BI&A professionals include a variety of evolving topics [Chaudhuri et al. 2011]:

— relational databases;
— data mart and data warehouse;
— ETL—extract, transform, and load operations;
— online analytical processing (OLAP);
— visualization and dashboard design;
— data/text/Web mining techniques;
— massive data file systems, such as Hadoop;
— software for manipulating massive data, such as MapReduce;
— semistructured and unstructured data management, XML, tagged html;
— social media and crowd sourcing systems;
— Web services/APIS/mashups;
— Web collection/crawling and search engines (both surface and deep Web);
— cloud computing;
— mobile Web and location aware application.

2.3 Business Knowledge and Communication Skills

To be able to provide useful insights and decision making support, the BI&A professional must be capable of understanding business issues and framing the appropriate analytical solutions. Listening to what the business needs and being aware of what the business intends to accomplish is of fundamental importance. At a minimum, the necessary business domain knowledge for BI&A professionals includes fundamental knowledge in the areas of accounting, finance, marketing, logistics, and operations management.

The BI&A professional will also need business knowledge to properly communicate and work closely with business team members. By necessity, the BI&A analyst cannot operate in isolation from the business. The importance of an organization-wide culture for informed decision-making is emphasized by Davenport [2006]. To support

such a culture, adequate communication skills are really important. The analyst must be capable of explaining what he or she finds in terms that are easy for people to understand. He/she needs to tell the right story and broadcast the lessons learned so that business people understand.

In the next section, we elaborate on the different ways IS programs can structure their offerings to cover these skills and meet the increasing demand for BI&A professionals.

3. EDUCATION AND PROGRAM DEVELOPMENT

In their article, "The Current State of Business Intelligence in Academia," Wixom et al. [2011] report four key findings.

(1) Universities should provide a broader range of business intelligence (BI) skills within BI classes and programs.
(2) Universities can produce students with a broader range of BI skills using an interdisciplinary approach.
(3) Instructors believe they need better access to BI teaching resources.
(4) Academic BI offerings should better align with the needs of practice.

These findings suggest that academics may be behind the curve in delivering effective BI&A programs and course offerings to students.

The transformative nature of Big Data and BI&A provides opportunities and challenges for a number of disciplines and university departments. For example Columbia's new Institute for Data Sciences and Engineering will consist of five centers focused on digital and social media, smart cities, health analytics, cybersecurity, and financial analytics [Associated Press 2012]. Data science includes infrastructure and advanced data algorithms—the stuff of computer engineering and computer science. In contrast, BI&A within a business school is all about understanding interpretation, strategizing, and taking action to further organizational interests. The BI&A analyst uses the data and algorithms provided by the technologists in a hands-on fashion to gain insights for management. It seems obvious to us that the education to develop this unique combination of skills should reside in a business school. But in which academic department? In industry, to a large extent, BI&A is often decentralized and resides in disciplinary-based departments such as marketing, finance, research and development (R&D), and logistics [Morabito et al. 2011]. This might imply that data analytics should be a component in each functional area in business schools. Indeed, this is already happening to a large extent, especially in areas such as finance and marketing.

What role should IS play in BI&A education? Only in IS programs students are taught both data management and analytics. However, to succeed in this area, IS departments need to expand their vision and their capabilities. Since its inception in the 1970s, IS as an academic field has primarily focused on the needs of the IS function in business in an era where the major challenges involved the management of transaction data and the production of information for management. In the age of big data these problems remain but the emphasis in industry has shifted to rapid interpretation and business decision making based on huge volumes of information. This decision making largely takes place outside of the IS function, i.e., in business units such as marketing, finance, and logistics. Can IS programs serve the needs of these decision makers? Can we provide courses in data mining, text mining, social media analytics, and predictive analytics that are required to be taken by marketing and finance students? We should also ask ourselves about the skill sets needed by students. Should we recruit students with strong math and statistical skills, for example? We contend that a new vision for IS, or at least for some IS programs, should address these questions.

We believe that BI&A presents a unique opportunity for IS units in business schools to position themselves as a viable option for educating professionals with the necessary depth and academic rigor to tackle the increased complexity of BI&A issues.

IS programs that are housed within business schools have access to a variety of business courses, as well as courses intended to provide communication and presentation skills. Also, it is very common in business schools to house management science and statistics faculty in the same unit as IS. These synergies ought to be explored by offering BI&A knowledge and skills. We believe that BI&A education is interdisciplinary and should concentrate on fundamental and long-lasting concepts; it should combine knowledge and skills with an understanding of business domain knowledge and communication and presentation skills. The BI&A professional needs to have a combination of three areas of knowledge and skills: (1) analytical skills, (2) information technology knowledge and skills, and (3) business knowledge and communication skills.

But BI&A may also represent a disruptive technology, i.e., an innovation that helps create a new market and value network and eventually goes on to disrupt an existing market and value network, displacing an earlier technology [Christensen and Overdorf 2000]. The new era of big data, coupled with the trend of outsourcing and the advent of cloud computing presents profound challenges to the IS field.

4. PROGRAM OFFERINGS

There are many options for delivering BI&A education to address the urgent demand for BI&A professionals. Because of the depth of knowledge required, graduate programs are the obvious choice. A full-time MS program targeting incoming students, who have no or little experience with BI&A, can provide the right environment to cover the BI&A knowledge and skills described in the preceding. Two ways of structuring a MS program would be the following.

(a) Create BI&A multicourse concentrations in existing MS IS programs. Such concentrations would utilize the already existing curriculum in technology, data management, business disciplines, and communication skills, and add the necessary analytics coverage.
(b) Create a Master of Science (MS) in BI&A.

A third choice for delivering a BI&A education is:

(c) Offer a graduate certificate program.

In all cases, the idea is to offer ample and deep coverage of BI&A knowledge and skills. Option (a) leverages existing programs and has been adopted by a number of schools including MIS departments at Carnegie Mellon University and the University of Arizona. This option provides knowledge of BI&A for students who will primarily find careers in IS groups in industry.

Option (b) requires the effort of developing a new program. A few universities have embarked on this endeavor. A nonexhaustive list includes North Carolina State University, Saint Joseph's University, Northwestern University, the University of Denver, and Stevens Institute of Technology. New MS programs are also about to be offered at New York University and Fordham University (collaborating with IBM in developing a new business analytics curriculum). New MS degree programs can be designed explicitly to attract analytically strong students, with undergraduate degrees in areas such as mathematics, science, and computer science, and to prepare these students for careers, not only in the IS or IT groups in industry, but also in functional areas such as R&D, marketing, media, logistics, and finance. Thus new MS degrees in BI&A

such as those at North Carolina and Stevens, are quite different from traditional MSIS programs in terms of admission requirements, subject matter, and placement expectations.

For working IT professionals who would like to expand into BI&A, a part-time MS, or option (c), graduate certificate programs, can be a good choice. These programs can be delivered online or on site and need to provide the skills that will complement the current IT or business experience of IT professionals and/or provide technical and analytical skills to business professionals in non-IT areas. Online programs that are currently available include Northwestern University's MS in Predictive Analytics program and Stanford University's Graduate Certificate on Mining Big Data. Such programs might help address the McKinsey report's "shortfall of 1.5 million data-savvy managers with the know-how to analyze big data to make effective decisions."

A key to success for a BI&A program is to really integrate the concept of learning by doing. Analytics in large datasets involves trial and error; insights can be generated only by repeatedly addressing the issues in many different ways. We advocate strong relationships and partnerships between academic programs and industry partners to foster the experiential learning aspect of BI&A. In addition to educating BI&A analysts, there is a need to equip current managers with the ability to make decisions based on analytics. IS programs can design concentrations in MBA programs to accomplish that, and/or offer graduate certificate programs or executive education for this larger market.

For illustrative purposes, we now present an overview and the driving forces and design philosophies of the BI&A Concentration of the University of Arizona's MS MIS program, and Stevens Institute of Technology's BI&A MS program. Other educational institutions can learn from these examples in designing their own BI&A courses, certificates, or programs.

4.1 The BI&A Concentration in the University of Arizona's MS MIS

The MS MIS program at the University of Arizona has always been a top program, currently ranked at #5 by U.S. News and World Report. In 2009, we created a 3-course BI&A concentration consisting of the following courses: (1) Business Intelligence, which covers the concepts of data warehouses, data marts, ETL, and dashboard design; (2) Data Mining for Business Intelligence, which covers predictive modeling, segmentation, association rules mining; and (3) Web Mining, which covers computational linguistics, text mining, Web data crawling, semi- and unstructured data manipulation, mashups, and so on. A student completes these concentration courses along with the other courses of the program, which focus on information technologies (relational databases, networking, and systems analysis and design), business concepts (accounting and finance, marketing, and operations), and business communications. The concentration has been a great success. A large number of students follow this concentration, and as expected, are able to secure jobs in BI&A upon graduation.

4.2 Stevens' MS in Business Intelligence and Analytics: A New Breed of Business School Students

The idea for the BI&A program originated from a committee charged with reviewing and overhauling the entire graduate curriculum at the Howe School of Technology Management, Stevens Institute of Technology. At the outset, the committee realized that management education was changing and that the new market place demanded a fresh look at the "business of business schools" [Simons 2011]. Major indicators of change included the business world's increasing need for innovators, entrepreneurs, and analytical thinkers. With regard to analytics, outside of the PhD program, there

were only a few students, taking mathematically-based courses. Of course, the need for managers, the product of our traditional MS and MBA programs, will continue in the foreseeable future. But, it seemed to the committee that the excitement in management education, and the means of satisfying unfulfilled demand, lay elsewhere.

The MS in Information Systems (MSIS) was of particular concern to the committee because it has always been the Howe School's largest and most successful MS degree. The MSIS was designed, in large part, to provide IT professionals with the management skills and business knowledge needed to allow them to rise to managerial positions within an IT organization. There was little emphasis on innovation and on the kind of analytical thinking demanded by the world of big data. Of course, the foundations for managing and interpreting large volumes of data existed in the form of courses in database, data warehousing, business intelligence, and data/text mining. But these courses were designed for students, who for the most part, lacked strong analytical skills.

To satisfy the burgeoning demand for data scientists and BI specialists, we decided that the Howe School needed a new degree program that fundamentally broke with prior assumptions underlying our MSIS program on both the supply and demand side. Namely, we needed to attract analytically strong students, with undergraduate degrees in areas such as mathematics, science, and computer science. Further, we had to satisfy the needs of business units rather than corporate IT or IT groups within traditional business units. We decided to develop an entirely new MS degree in BI&A that would be completely different from our MSIS and other MS degree programs in terms of both subject matter and admission requirements.

The MS in BI&A degree program was designed over a 6-month period. Over this period, the BI&A development team sought advice from a number of leaders of large analytics groups in the finance, telecommunications, and pharmaceutical industries. We also tested our design concepts by soliciting comments from a number of leading BI&A academics. This external vetting process greatly influenced the final design of the program. It was striking that every one of our industry advisors emphasized their need for analysts who had strong communication skills. Superior analysts also have to understand the business implications of their analyses and, importantly, be able to communicate their findings to management.

The program consists of 12 courses designed for full-time and part-time students with a strong technical background in science, mathematics, computer science, or engineering. The program is both theoretical and applied. It blends courses in databases, data warehousing, statistics, data mining, social networking, and risk modeling.[2] Each course combines relevant theories and techniques with examples and student exercises that illustrate industry applications of data analytics. The program culminates in a practicum course in which students apply the concepts, principles, and techniques learned in the BI&A courses to real-world problems in an industry of the student's choice. During the practicum, students work closely with a company on specific real applications, perhaps as part of an internship program. As recommended by our industry advisors, oral and written communications skills, team skills, analytical thinking, and ethical reasoning are emphasized throughout the curriculum.

Although the program is in a startup mode (approved in October, 2011), student interest is high. The number of enquiries about the program from midcareer professionals was a pleasant surprise. Some of these people already work in the data analytics field and others wish to learn more about the potential for analytics in their companies. To satisfy this demand, we have developed a 4-course graduate certificate in BI&A.

[2]http://stevens.edu/howeschool/bia

5. EDUCATION RESOURCES AND SUPPORT

Educational resources are now becoming available for instructors in the design and delivery of BI&A curricula. For example, Gartner Research provides white papers that can be used as assigned reading and references in students' term projects. Many leading BI&A software vendors provide a variety of resources including free software access for teaching and noncommercial research, book evaluation programs, teaching materials and training manuals, research reports, curriculum repositories, software training workshops, certificate programs, and guest speakers. The Appendix outlines the academic alliance programs of IBM, Microsoft, SAS, Teradata, and Walton College of Business at University of Arkansas.

Each BI&A program or individual instructor can focus on different perspectives of BI&A according to the resources and skill sets available, and the particular program's target students. The major challenge is to integrate and teach a diverse range of concepts, knowledge, and skills that previously have been taught in isolation by different disciplines. It is time for integration and synergy among multiple disciplines in business schools. BI&A education can help nurture the next generation of analytical thinkers who are both business and technically savvy. They should be able to collect, analyze, and interpret a large amount of structured or unstructured data, and turn the data into actionable information for strategic and tactical decision making in business.

6. CONCLUSION

As discussed in the preceding, the demand for BI&A education ranges from the three Vs of big data to the three perspectives of business decision making. The IS field has focused in the past on the data end of this spectrum of skills. To address the more analytical and interpretive end of the spectrum, IS departments will need faculty members who have analytical skill sets in areas that have previously been the province of computer scientists, management scientists, and even cognitive scientists. Can we hire faculty members with these skills? Or can we lead a coalition of faculty from other departments in the university who have these skills?

For the time being at least, the immediate need is for faculty with the theoretical and practical skills to develop and teach the BI&A courses by incorporating these educational resources. In the long term, a major challenge for the IS discipline in this new era is to develop faculty and new PhD graduates with the necessary BI&A knowledge and skills.

It is time that IS academic professionals understand not only the unique opportunities presented by big data and BI&A, but also the challenges facing IS departments. We should discuss and debate what the vision and directions can be, so that the IS discipline can provide appropriate leadership in BI&A education. Our education programs must address a range of issues, such as inclusion of faculty from other departments in the university, IS faculty development with necessary BI&A knowledge and skills, BI&A curriculum and program development, the required skill sets of students who should be admitted to BI&A programs, and future-directed IS PhD study and research topics.

APPENDIX

IBM Academic Initiates: www.ibm.com/academicinitiative

IBM Academic Initiative is a global program that facilitates the collaboration between IBM and educators to teach students the information technology skills they need to be competitive and keep pace with changes in the workplace. Faculty members, research professionals at accredited institutions, and qualifying members of standards organizations can join. Membership is granted on an individual basis.

Members get access to a wide range of assets for themselves and their students and can build collaborative partnerships with IBM and other institutions in the open source community.

IBM Academic Initiative members can get full versions of a large selection of IBM software, at no charge. Most of the software can be downloaded from the Software Catalog, and a few additional products are available on CD by request. Members can also request virtual access to some software through the Amazon Web Services cloud or to IBM Power Systems or System z enterprise computing environments.

In addition, the IBM SPSS Mining in Academia Program (MAP) provides no-cost use of IBM SPSS Modeler Premium data and text mining software for classroom teaching and noncommercial research. MAP can be used to extend current curricula, advance new curricula and courses, and support degree programs in data mining and predictive analytics.

Microsoft Dynamics Academic Alliance: www.microsoft.com/dynamicsaa

Microsoft Dynamics® is a line of enterprise resource planning (ERP) and customer relationship management (CRM) applications. The Microsoft Dynamics® Academic Alliance (DynAA) is a program for universities and colleges that incorporates Microsoft Dynamics software in business management and technology courses. Educational institutions that sign up for the program receive a support plan including free enhancements, 50 support incidents, E-Learning, training manuals and free product upgrades. Faculty have the opportunity to download one or more of the Microsoft Dynamics products for use on-premise, can use Microsoft Dynamics CRM Online, and have an opportunity to use Microsoft Dynamics in the cloud through a Microsoft Dynamics Partner for a nominal fee.

In addition, faculty members have access to Faculty Connection,[3] the curriculum repository site where faculty can share resources, find information about events, and post their own materials. Each solution comes with a dataset, or sample data, and there is also an additional set of cleansed datasets from actual Microsoft Dynamics customers. The DynAA program works to facilitate a community atmosphere through social media sites such as LinkedIn and Facebook, a faculty-mentoring program, regional advisory boards, and annual events. Each year, the DynAA hosts the Worldwide Microsoft Dynamics Academic Alliance Preconference and other workshops where faculty can learn more about the products, receive hands-on training, and learn how other faculty are integrating Microsoft Dynamics into the curriculum.

Faculty can sign up for Microsoft Dynamics in the classroom, which provides students a connection with Microsoft Dynamics internship and employment opportunities.[4] There are over 10,000 Microsoft Dynamics Partners that sell, implement, and support Microsoft Dynamics solutions for over 300,000 Microsoft Dynamics customers around the world. These partners can also help schools by serving as guest lecturers, serving on advisory boards, helping design curriculum, and hiring interns or college hires with Microsoft Dynamics experience.

SAS Global Academic Program: www.sas.com/academic

SAS® Global Academic Program provides education programs and resources to professors in the following areas.

— *Teaching Materials*. Materials include course notes, slides and datasets for many of SAS' publicly offered courses. Instructors can use this material in its entirety or

[3]www.microsoft.com/education/facultyconnection/cb/default.aspx?c1=en-cb&c2=CB
[4]www.microsoft.com/studentstobusiness/home/default.aspx

incorporate select sections into their existing instructional materials. This material is free of charge and provides university instructors who teach a course using SAS software.
— *Certificate Programs and Curriculum Consulting*. SAS will work with universities to develop certificate programs in a variety of analytical areas. This program uses preexisting courses or ones developed in consultation with SAS. While your university will administer the program, the certificate will be cosponsored by SAS. Certificate programs exist in data mining, statistical methods and data analysis, and programming.
— *Data Mining for Educators Workshops*. This free-of change weeklong, invitation-only program occurs each summer and offers university-level professors an opportunity to learn more about incorporating SAS® Enterprise Miner™ into their curricula.
— *Training Discounts*. Professors and students who choose to enroll in SAS' classroom, Web-based or Self-Paced e-Learning can take advantage of a 50 percent academic discount.
— *Academic Software Bundles*. Several specially priced software bundles are available for universities, professors, and students. Whether for teaching, research, or professional development, SAS provides software through Internet access and standalone installations, as well as larger server-based installations.
— *Academic Book Evaluation Program*. SAS provides complimentary evaluation copies of SAS Press titles to university professors.
— *Guest Speakers and Workshops*. Expert speakers from SAS or industry can be provided to universities for presentations, seminars, or workshops that target students, faculty, or administrators interested in hearing about SAS software or analytical technology.
— *SAS Global Certification Program*. Through the successful completion of SAS Certification exam(s), the SAS Global Certification Program provides formal credentials to users who can demonstrate knowledge of SAS.

Teradata University Network: www.teradatauniversitynetwork.com

Teradata University Network (TUN), Teradata's academic offering for business intelligence, was developed over 10 years ago, working closely with leading academics. TUN is a free learning portal designed to help faculty to teach, learn, and connect with others in the fields of data warehousing, DSS/BI, and database. Leading academics are primarily responsible for the vision, development, and the evolution of TUN. The TUN Fellows, Executive Board, and Advisory Board work with Teradata, including senior management, as a team to ensure that TUN meets the needs of the IS academic community. One of the 2011-12 working committees is focused on establishing BI curricula, developing sample syllabi at the undergraduate and graduate levels, to support faculty new to business intelligence.

Teradata University Network is used by faculty through a free portal that includes course syllabi, access to software, Power Point presentations (with speaker's notes), cases, projects, assignments (with teaching notes), articles, research reports, and various other resources. Students access the same portal via a password provided by their faculty. This leads students to a subset of these materials, including access to software, cases, projects, and assignments (without teaching notes), and other materials.

TUN includes the Teradata DBMS, SQL Assistant/Web Edition. Also available via TUN is MicroStrategy eTrainer, a business intelligence solution. MicroStrategy's business intelligence platform delivers actionable information to business users via e-mail, Web and mobile devices. TUN faculty and students have access to MicroStrategy's

modules with supporting resources including a quick start guide, scripted demo, assignments, sample power points, and project assignments. Finally, TUN includes preloaded databases from several leading database textbooks.

Walton College of Business at University of Arkansas:
enterprise.waltoncollege.uark.edu

Enterprise Systems at the Walton College consists of four platform partners—IBM, Microsoft, SAP, and Teradata—along with several large real world datasets from Dillard's, Tyson, and Sam's Club. Additionally, a synthetically generated database named Hallux is available. These platforms provide a portal for business intelligence that includes data warehousing and data mining. Faculty can request accounts for themselves and their classes via the Enterprise Systems Web site.

There is a list of options for each of the platforms.

IBM: IBM DB2 overview and examples (multiple large datasets)

Data Mining Modules using IBM SPSS Modeler 14.2
— includes PowerPoint slides and tutorials for the commonly used data mining techniques of regression, logistics regression, decision trees, neural networks, nearest neighbor, clustering, and association analysis;
— data can be local files, DB2, SQL Server 2008, and Teradata tables.

Microsoft: SQL Server 2008 SQL examples (multiple large datasets)

Prebuilt cubes for demonstrations of slicing and dicing cubes and examples of building cubes
— Data Mining Modules using IBM SPSS Modeler 14.2, including PowerPoint slides and tutorials for the commonly used data mining techniques of regression, logistics regression, decision trees, neural networks, nearest neighbor, clustering, and association analysis.

SAP: Must be a SAP University Alliances Network school

BEx Analyzer—SAP analytical tool embedded in Excel to easily query and analyze data from a Tyson's R/3 dataset or other data sources. Documentation provides examples.

Teradata: Link to Teradata University Network

SQL examples and OLAP examples and data mining using Teradata Warehouse Miner.

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