NEW NEWARK MAJOR

Business Analytics and Information Technology

Approved by the Faculty on April 26, 2013

Michael N. Katchakis
Professor and Chair, Department of Management Science and Information Systems
Rutgers Business School - Newark and New Brunswick
Objective: Rutgers Business School will offer a new undergraduate major designed to prepare students for a career in Business Analytics. This is essentially the same as the major we currently offer in New Brunswick under the same name.

Need:

- **Manyika et al. (2011)** reveal that businesses, driven by accumulation of huge amounts of data, cheap hardware and software, and competition, will seek to monetize these data. They estimate that by 2018, in the United States alone, need for personnel with appropriate skills will lie between 140 to 190 thousand more than educational institutions can produce at current activity.

- From the Mission statement of the Analytics Section of INFORMS (2012):
  - the Business Analytics and Information Technology major will focus on promoting the use of data-driven analytics and fact-based decision making in practice.
  - Analytics is seen as both (i) a complete business problem solving and decision making process, and (ii) a broad set of analytic methodologies that enable the creation of business value.

- **The BAIT curriculum promotes the integration of**
  a wide range of analytic techniques and the end-to-end analytics process. The curriculum finishes with capstone activities that illuminate significant innovations and achievements in specific steps and/or in the execution of the process as a whole, where success is defined by the impact on the business.

- **The MSIS department has been receiving gradually increasing numbers of inquiries from employers and students regarding the establishment of the BAIT major in Newark.**

*http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation*
New Brunswick: BA-IT Major

- **Approved** by the RBS faculty in May 2011

- **Available** Now.
  Starting with Rutgers graduating class of 2014

- All RBS students are free to take any of the BAIT courses to strengthen their career prospects.

- **Balanced** combination of:
  - *Business Analytics* – taking advantage of the information:
    - To better understand business and customers
    - To make smart plans and decisions
  - *Information Technology* – computer systems managing information
BAIT Curriculum Designed by

- **Distinguished Rutgers Faculty**
  - Andrzej Ruszczynski
  - Douglas Jones
  - Farid Alizadeh
  - Hui Xiong
  - Jaideep Vaidya
  - Jonathan Eckstein, coordinator
  - Xiaodong Lin

- **Distinguished Representatives from:**
  - Accenture
  - Bloomberg (2)
  - Citi Group (2)
  - Deloitte
  - Johnson and Johnson
  - Oliver Wyman (subsidiary of Marsh and McLennan)
  - Price Waterhouse Coopers
  - Thomson Reuters

Thomas A. Capone, Chairman & CEO, MTP-USA:

"Business Analytics and Information Technology (BAIT) is the future of business"
RBS
Newark BAIT Major

BAIT-Related Core Courses
Required for All Business Majors (Newark)

• Management Information Systems
  – IT: computer tools for storing and organizing information

• Introduction to Business Research Methods
  – Statistical tools for understanding what your data mean

• Production and Operations Management
  – Analytics / decision making and planning
  – Building mathematical models of business situations
  – Also builds spreadsheet skills
Newark BAIT Curriculum:

- All RBS core courses
- Five required courses
  - Time Series Modeling for Business *
  - Business Decision Analytics under Uncertainty *
  - Foundations of Business Programming *
  - Business Data Management *
  - Capstone ***
- At least three electives drawn from
  - Cyber Security
  - Database Management Systems
  - Computer Networking Applications
  - Large-Scale Business Data Analysis *
  - Enterprise Information Architecture *
  - Data Mining for Business Intelligence (Sp. Topics) *
  - Risk Modeling *
  - Optimization Modeling *
  - BAIT Internship, By arrangement with the Career Development Center and RBS Career Management
- Relational Database within Web Applications **
- VBA/Excel programming for Investments **
- Up to two courses from approved “external” list

* = New for Newark, as in the BAIT – NB, ** = New for Newark and New Brunswick, under development
*** = New for Newark
Business Analytics (BA) Concentration

Students must take:

- Time Series Modeling for Business
- Business Decision Analytics under Uncertainty
- Plus at least one of the courses below
  - Large-Scale Business Data Analysis
  - Data Mining for Business Intelligence
  - Risk Modeling
  - Optimization Modeling
Information Technology and Analytics– a natural progression

- Information technology (IT)
  - How do we set up the firm’s information systems?
  - How do we organize and manage the firm’s data?

- Analytics: using the information
  - *Understanding* what the information means – finding trends and relationships
  - *Planning and decision making* (possibly complicated) using the information
  - *Operations Research methods in Business Action*!

- Information systems must do increasing amounts of analytics
BUSINESS ANALYTICS AND INFORMATION TECHNOLOGY

JOBS: Projected shortage of 140,000-190,000 people with deep analytical talent in the US by the year 2018.

Source: “Big data: The next frontier for innovation, competition, and productivity,” McKinsey Global Institute, June 2011
Why a student would be interested?

• There is a shortage of qualified IT hires

• Analytics is currently a “hot” business topic
  – But with staying power

• Interesting, useful material
  – Not tied to one particular industry
  – Important skills
Business Analytics Careers:

- Life Sciences
- Transportation & Logistics
- Automotive
- Information Technology
- Energy
- Financial Services
- Entertainment
- Government
- Wholesale Trade
- Manufacturing
- Banking
- Electronics
- Retail Trade
- Food Processing
- Consulting
BACKGROUND on Data-Driven Analytics:

Decisions based on facts: Data.
BACKGROUND on Data-Driven Analytics:

Policy Decisions based on facts: Data.
BACKGROUND on Data-Driven Analytics:

BIG - Data-Driven Analytics

BIG DATA

3V: Volume - Variety - Velocity

1 TB (=10^9 GB) unit
1 PB (= 10^3 TB =10^6 GB) unit
1 EB (= 10^3 PB =10^6 TB) unit ... ZB ... YB
Recent IBM Study

Big Data (4Vs): This is just the beginning

- Percentage of uncertain data needs to be addressed (Veracity)

Increase in Variety, Volume and Velocity

Volume in Exabytes

2010 - 2015

Percent of uncertain data

Sensors & Devices
Social Media
VoIP
Enterprise Data

© 2012 IBM Corporation
Big Data Sources — by Sector

• Banking - Financial Services
  1. Customer Insights—Integrating transactional data (CRM/Payments) and unstructured social feeds
  2. Regulatory Compliance
  3. Risk exposures across asset classes
  4. Trading, Limit Order Books (LOBs) etc
  5. Fraud Detection in credit cards financial crimes (AML) in banks

• Healthcare
  1. Drug effectiveness based on electronic health records (EMR)
  2. Estimate Side Effects and Adverse Drug Effects (ADEs) profiles of marketed drugs
  3. Patient Data Analysis - personalized medicine
  4. Telemedicine, m-Health and e-Health systems
  5. Cost of Care and Drug effectiveness analysis based on electronic health records (EMR)
  6. Claims Analytics—Analyze insurance claims data for fraud detection & preferred treatment plans

• Communications
  Call Data Records (CDRs) and activity in networks, capacity planning, etc.

• Entertainment • Retail Manufacturing • Marketing • Media • Military • Security
Big Companies needs
NEW NEWARK MAJOR

Business Analytics and Information Technology

Government

FOR IMMEDIATE RELEASE
March 29, 2012

Contact: Rick Weiss 202 456-6037 rweiss@ostp.eop.gov
Lisa-Joy Zgorski 703 292-8311 lisajoy@nsf.gov

OBAMA ADMINISTRATION UNVEILS “BIG DATA” INITIATIVE:
ANNOUNCES $200 MILLION IN NEW R&D INVESTMENTS

Aiming to make the most of the fast-growing volume of digital data, the Obama Administration today announced a “Big Data Research and Development Initiative.” By improving our ability to extract knowledge and insights from large and complex collections of digital data, the initiative promises to help solve some of the Nation’s most pressing challenges.

To launch the initiative, six Federal departments and agencies today announced more than $200 million in new commitments that, together, promise to greatly improve the tools and techniques needed to access, organize, and glean discoveries from huge volumes of digital data.
NEW NEWARK MAJOR

Business Analytics and Information Technology

INFORMS B.A. Awards

The Best of Applied Analytics

Edelman Competition and Awards Gala
INFORMS Prize
Daniel H. Wagner Prize
UPS George D. Smith Prize
Innovative Applications in Analytics Award
Educational Programs

- **The UPS George D. Smith Prize** is awarded to an academic department or program for effective and innovative preparation of students to be good practitioners of operations research, management science, or analytics.

2013 Analytics Conference UPS George D. Smith Prize Finalists:

- MIT Leaders for Global Operations Program
- Lehigh University Enterprise Systems Center and Department of Industrial and Systems Engineering
- Naval Postgraduate School, Department of Operations Research, Winner
Business Analytics and Information Technology

Educational Programs

The UPS George D. Smith Prize is awarded to an academic department or program for effective and innovative preparation of students to be good practitioners of operations research, management science, or analytics.

2013 Analytics Conference UPS George D. Smith Prize Finalists:

- University of Michigan, Ross School of Business, Tauber Institute, Winner
- Lehigh University Enterprise Systems Center and Department of Industrial and Systems Engineering
- Cornell University School of Operations Research and Information Engineering
The IAAA Prize is to recognize creative and unique developments, applications or combinations of analytical techniques. The prize promotes the awareness of the value of analytics techniques in unusual applications, or in creative combination to provide unique insights and/or business value. Similarly, the prize is not focused on implementation value created, but such value creation might add credibility to the innovation.

2013 Analytics Conference
Innovative Applications in Analytics Award:

Analytics for Power Grid Distribution Reliability in New York City
Cynthia Rudin, Massachusetts Institute of Technology;
Seyda Ertekin, Massachusetts Institute of Technology;
Rebecca Passonneau, Axinia Radeva, Ashish Tomar, Boyi Xie, Columbia University;
Example

- I go to an airline website and
  - Reserve a flight to Chicago
  - Pay by credit card
- A few weeks later, I go to the airport and get on the plane
Many of the IT Aspects are Visible

- Browsing flights and seats on the web
- Paying by credit card over the web
- Check-in and boarding passes at airport

Technology behind it...
Relational Databases

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### Linking Databases and Web Servers

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But there’s a lot of Analytics behind the scenes too...
What size plane to use on that flight?

- Where does that plane fly in from?
- Where does it go next?
- Need to understand customer demand for flight and relationship of the flight to the entire flight network
Data Analysis the Airline Needs

- What will customer demand for a given flight be, depending on ticket prices and date?
- How is demand for a particular departure shaping up?
- What factors influence consumer choice for flights?
- Where are fuel prices headed?
Flight crew and cabin crew

- Are they flying in from somewhere else first?
- If so, where?
- Where do they go next?
Setting up the route network
Analytics in use: Federal Government Policy
National Rail Capacity Model

- **Problem**
  - A US Senate Commission asked how much it would cost to expand US freight rail capacity to meet the demand in the year 2035?

- **Analytical Tools**
  - Forecasting
  - Parametric statistical model
  - Spreadsheet modeling
  - Microsoft access database

- **Real-World Problems**
  - Railroads were reluctant to share information
  - Risky: never before been modeled

- **Results**
  - It will require $148 billion investment to eliminate the congestion in the top map (shown at right), to achieve the bottom map. Results were presented at a press conference on Capital Hill.
Business Analytics and Information Technology

Analytics in use: International Business Decisions
Kazakhstan National Railroad – Reducing Operating Costs

- **Problem**
  - What changes can the National Railroad of Kazakhstan make to lower operating costs?

- **Analytical Tools**
  - Shortest path algorithm
  - Microsoft access database
  - Oracle database
  - Oliver Wyman developed railroad planning models

- **Real-World Problems**
  - Huge databases
  - Different way of thinking about railroad operations
  - Language

- **Results**
  - We were able to identify several opportunities for more direct routing of trains that lead to over $25 million in savings to the railroad.

Source: David Lehrbach, April 2013
Analytics in use: International Business Decisions
South Africa Railroads – Locomotive Utilization

- **Problem**
  - How can Transnet, the South African freight railroad, better utilize their locomotives so they can haul more freight?

- **Analytical Tools**
  - Optimization (Integer Programming)
  - Mosel/Xpress Optimization Solver
  - Oracle database
  - C++

- **Real-World Problems**
  - Messy data
  - Multiple layers of acceptance
    - Management
    - Field operations

- **Results**
  - Presented a new operating plan that more efficiently utilized their locomotives and increased the amount of tons they could haul.

Source: Railway Gazette International

Source: David Hunt, July 2010
Brief Course Descriptions

BAIT Required

• **Time Series Modeling for Business.** The analysis of time-dependent data is critical to industries such as finance, marketing, retail, and accounting. This course introduces time-series models with emphasis on their practical applications in business. The goal is to show how dynamic financial and economic data can be modeled and analyzed using proper statistical techniques. The topics include methods for trend and seasonal analysis and adjustment, modeling and forecasting with autoregressive moving average (ARMA) processes, and model identification and diagnostics for time series. Other subjects include volatility and state space models. This course provides hands-on experience by pairing lectures on methodology with lab sessions using the SAS package to perform real-world data analyses.

• **Business Decision Analytics under Uncertainty.** This class introduces students to methods for planning problems that include both time evolution and uncertainty. It covers the ideas of dynamic programming, starting with classical decision trees, and shows how to apply Bayesian methods to derive tree probabilities. Students solve small problems by hand, and then write simple computer programs to solve more complicated problems. The course includes fundamental computer programming techniques for numerical calculations, including loops and arrays. For problems too complex to analyze exhaustively, the class will introduce sampling-based simulation techniques. Students write simple programs to implement Monte Carlo simulations (which can be much more efficient than using spreadsheets), and learn the basics of specialized packages for discrete-event simulation.

• **Foundations of Business Programming.** Business-oriented programming accounts for the vast majority of all programs written today. This course covers the principles of programming and software development in depth, with an emphasis on an object-oriented (OO) programming style, using an OOP language such as C++ or Java. The course will study the principles of object-oriented design using the UML modeling language. Also covers fundamental data structures and algorithm development for solving business problems.

**Prerequisite:** B or better grade in: 29:623:350 Structured Programming Applications & 29:623:319 Database Management Systems
Brief Course Descriptions continued

BAIT Required continued

- **Business Data Management.** Introduces principles and techniques for managing corporate data resources. Techniques for managing the design and development of large database systems, including data models, concurrent processing, data distribution, database administration, and data warehousing; demonstrates their use in business applications. Discusses principles of database systems, database design, database schemas, and database manipulation using SQL. Surveys advanced database management topics such as transaction control, distributed databases, data warehouses, database e-commerce applications, and object-oriented databases. In addition to conceptual material, provides significant hands-on experience using current database technologies.
  Prerequisite: B or better grade in: 29:623:350 Structured Programming Applications and 29:623:319 Database Management Systems

- **Capstone course:** The course provides the opportunity for students to work on projects that require them to apply a broad spectrum of skills learned in the major, including, database management, optimization, simulation, and statistical analysis. As a result, students gain valuable experience applying technical skills in a business environment. They are involved with activities that illuminate significant innovations and achievements in specific steps and/or in the execution of the process as a whole, where success is defined by the impact on the business.
Brief Course Descriptions continued

**BAIT Electives**

- **Information System Security.** The purpose of this course is to provide the student with an overview of information security and assurance in e-business and other cyber-environments. This course provides the foundation for understanding the key issues associated with protecting information assets, determining levels of protection and response to security incidents, and designing a consistent, reasonable information security system, with appropriate intrusion detection and reporting features. The fundamentals of threats, vulnerabilities, firewalls, secure access, intrusion detection, cryptography, disaster recovery techniques, and secure programming are covered.

- **Large-Scale Business Data Analysis.** This course introduces students to fundamental statistical techniques for analyzing large-scale business data. The main goal is to provide systematic training in statistical models for massive datasets as well as programming, data management, and exploratory data analysis in real-world settings. The course equips students to develop context-sensitive models and perform model checking and diagnosis. Topics include parametric inference, logistic regression, nonlinear regression, causal inference, graphical models, dimension reduction, and model selection. Students are provided the opportunity to learn a comprehensive set of data analysis techniques through lessons, demonstrations, and programming labs. The material covered in this course is also designed to prepare students for taking the SAS programming certification exams.

- **Data Mining for Business Intelligence.** The key objectives of this course are two-fold: (1) to teach the fundamental concepts of data mining and (2) to provide extensive hands-on experience in applying the concepts to real-world business applications. The core topics covered in this course include classification, clustering, association analysis, and anomaly/novelty detection. The course consists of about 12 weeks of lecture, followed by 2 weeks of project presentations by students applying data mining techniques to applications such as financial fraud detection, Web usage analysis, customer churn analysis, customer segmentation, blog mining, text mining, and other business data analysis.
BAIT Electives continued

- **Enterprise Information Architecture.** Information Architecture refers to the way in which responsibility for information storage and processing is distributed throughout an organization, possibly in different and sometimes partially overlapping information systems; understanding this topic is critical when making additions or changes to an organization’s computing resources. This course covers this topic, introducing models, techniques and tools for integrating enterprise applications, data, technologies and infrastructure with business capabilities and processes. Specifically, it covers methods and models for Enterprise Information Architecture (EIA); reference architecture, open group architecture, service-oriented architecture, operational models, viewing information as a service, and conceptual frameworks such as TOGAF and Zachman. Other specific topics include data domains, information governance, management of metadata, master data, enterprise content, analytical applications, business performance, enterprise information integration, connectivity and interoperation. The course will explore new delivery models for IT services: cloud computing, intelligent utility networks, and dynamic warehousing.

- **Risk Modeling.** The course introduces the main concepts and models of decision-making under uncertainty when risk aversion plays a major role. The first topic is expected utility models, including their economic background and business applications. Next, mean-risk models are presented, along with their applications to finance. Then, the course covers the concepts of value at risk and average value at risk, including their applications. These topics serve as a foundation for models involving measures of risk. Finally, the course presents some of the most fundamental dynamic models, with applications to insurance, finance, and inventory management.

- **Information Analytics: VBA/Excel programming for Investments.** The purpose of this course is to teach the basics about Excel/VBA programming. This class enables the students to understand the important role excel/vba plays in the constantly evolving landscape of the financial and investment world. Many examples are given from applications related to Hedge Funds, Private Equity Funds, and Venture Capital.
Information Analytics: Relational Database within Web Applications. The purpose of this course is to teach the basics about the integration of relational databases and the World Wide Web. As more and more businesses create web pages on Internet, there is a great need for people with the technical knowledge to do interactive Web page development that interfaces with databases. Students will work with a server-side tool to build and query databases using html and SQL. This course will teach how to add more power and functionality to Web sites with database applications. Examples will include the design of powerful “shopping cart” applications and a fun interactive web game. The major emphasis of the course is SQL and how to utilize it to build, manipulate and create output from a database to a web page. Students will have an opportunity to work with SQL to create output from a database to a web page.

External Electives

- Business Logistics and Transportation [if enrollment permitted by SCMMS department]
- Introduction to Project Management [if enrollment permitted by SCMMS department]
- Demand Planning and Fulfillment [if enrollment permitted by SCMMS department]
- Marketing Research [if enrollment permitted by SCMMS department]
- Managing Technology [if enrollment permitted by MGB department]

More courses may be added to this list over time.