# MS in Business Analytics Program
## (58 Credit-Hours)
### Daniels College of Business, University of Denver
Revised: August 4, 2022

**Program Learning Outcomes:**
1. Graduates will develop and execute architectures, policies, and practices that properly manage the full data lifecycle needs of an enterprise. [Data Management]
2. Graduates will balance the tradeoffs a business must consider in selecting the target level of data quality and completeness; will select the appropriate way to display and interpret large amounts of business data; and will identify, implement, and interpret the appropriate analytic modeling techniques to inform business decisions. [Analytic Modeling]
3. Graduates will analyze the enterprise decision processes, identify key participants, assess their relationships to effective execution, and use business analytics to support corporate decision-making. [Business Decision-Making]
4. Graduates will integrate the appropriate data management techniques, analytic modeling methodologies, and business decision strategies to bring the enterprise to the appropriate business outcomes. [Critical Thinking]
5. Graduates will effectively communicate the recommendations driven by their analysis to the appropriate decision-makers. [Communication]
6. Graduates will perform effectively as part of the decision-making team, in conjunction with other analysts and stake-holders. [Collaboration and Teamwork]
7. Graduates will recognize ethical challenges in the field of data and analytic-driven decision-making, and will identify appropriate approaches to these challenges. [Ethics]

### INFO 4100 Survey of Business Analytics (4 Credit Hours)
This course provides an overview of business analytics: how business data are collected, processed, and analyzed to support decision making. It will address both how to assess and use data that is readily available as well as how to start with corporate strategy and determine what data is needed, how to generate and process it. The course will also explore how corporate culture, ethics, and globalization can affect data management and analytic decision-making.

Learning Outcomes:
1. Describe the core elements of the corporate decision-making process.
2. Learn the principles and application of data modeling in a business setting.
3. Construct and evaluate data models for a data warehouse with data marts.
4. Summarize the tools and approaches used in business analytics to support decision-making.
5. Understand how ethics, privacy, security, and international and cultural differences affect the data and analytic environment.

### INFO4000 Introduction to Business (4 Credit-Hours)
The Introduction to Business course is an introduction to provides an overview of the business arena, how a business operates, and the supporting functions that are needed in any business enterprise, but specifically how they relate to analytics. Students will identify forms of ownership and the processes used in operations, marketing, accounting, finance, personnel, information technology and general management. Moreover, students will learn about social responsibility and business ethics in concurrence with the Daniels College legacy.

Learning Outcomes:
1. Understand the fundamental principles and activities of for-profit, commercial corporations, which collectively establish the business foundations of analytics.
2. Develop a business plan for establishing analytics in an organization.
3. Demonstrate basic understanding of the traditional functional areas of business.
4. Understand how all business functions contribute data for analytics while they also contribute to the profit motive.

### INFO 4140 Business Databases (4 Credit-Hours)
This is an introductory database course which will cover enterprise database design, modeling and implementation. Students with existing proficiency in databases can substitute another BIA graduate course.

Learning Outcomes:
1. Understand, create, normalize, and use relational database models.
2. Use SQL to define, load, query, and modify databases.
3. Use SQL Server 2012 to create SQL code to build, populate and query databases.

### INFO 4120 Python Programming
Python is a popular general purpose programming language which is well suited to a wide range of problems. With the right set of add-ons, it is comparable to domain-specific languages such as R and MATLAB. Python is a scripting language. The following topics will be covered: Importing data, Reading and writing files, Cleaning and Managing Data, Merging and joining DataFrame objects, Plotting and Visualization, Statistical Analysis, Fitting data to probability distributions and Linear models. Packages: Pandas, NumPy, matplotlib, statsmodels, Scikit-learn, and IPython.

Learning Outcomes:
1. Understand and use the basic components of coding (sequential, conditional, and looping structures) using the Python language.
2. Be able to perform basic and advanced data management tasks using Python including reading and writing data, cleaning, and reshaping datasets.
3. Use Python to perform exploratory and statistical analysis of data, to include the techniques taught in STAT4610.
4. Use Python to create analytic models to analyze data and to produce results and insights that can be used in the business decision-making process.

### STAT 4610 Business Statistics (4 Credit-Hours)
This course introduces students to the basic analytical tools in statistics and business analytics, and provides the theoretical concepts and skills that are building blocks for future courses. The approach is to present students with a "corporate" view of how statistical tools are used to analyze data and facilitate business decision-making. Students will familiarize themselves with all of the statistical techniques and models presented in the course and will demonstrate knowledge in applying the appropriate techniques and models to various data sets and interpreting and communicating the results of the analysis. The Microsoft Excel Data Analysis and Solver Toolkits will be used to conduct statistical analyses, allowing students to become more proficient overall in using Microsoft Excel and to place their emphasis on applications to core business disciplines, statistical reasoning, and proper interpretation of results.

Learning Outcomes:
1. Learn and understand the basic tenets of probability distributions, and be familiar with the distributions most often used in business modeling.
2. Conduct and interpret various statistical hypothesis testing techniques on single and multiple populations.
3. Construct analytic models, to include multiple regression and optimization or simulation models, and apply them in the functional areas of business such as finance, accounting, marketing, and operations.
4. Use the results of statistical analysis and analytic modeling to support business decisions, and communicate those results effectively to business leaders.
5. Demonstrate proficiency in performing data management, statistical analysis, and analytic modeling in a spreadsheet environment.

### INFO 4590 Optimization (4 Credit-Hours)
This course introduces students to the basic optimization modeling techniques and tools as practiced by business analysts to help their enterprises make better-informed decisions.  Applications will include mix, selection, assignment, distribution, transportation, financial management, planning, scheduling, and management implementations in a variety of business settings.  The course will focus on problem definitions, problem configuration, spreadsheet solutions, LP Software (LINGO) solutions, and interpreting and implementing results.

Learning Outcomes:
1. Understand the role that optimization plays in business analytics, and identify when optimization modeling is an appropriate technique to inform the decision-making process.

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2. Model optimization problems that involve linear programming, integer programming, binary integer programming, mixed-integer programming, and nonlinear programming.
3. Use spreadsheet modeling to configure and solve optimization problems.
4. Configure optimization problems for implementation in a commercial solver package.
5. Use a commercial solver (LINGO, GAMS, CPLEX, Pyomo or R) to solve optimization problems.

### INFO 4200 Capstone Planning (2 Credit-Hours)
This course prepares the student for the Capstone course by identifying a faculty advisor, company, data, and a business issue to be addressed in the Capstone course in the final quarter. (Must be taken two quarters prior to INFO4400, with the exception of off-cycle students, who will take it the quarter prior to INFO4400.) This course is for MSBA students only.

Learning Outcomes:
1. Students will produce a preliminary plan which identifies a company and a business issue with the associated data to be addressed in the capstone course in the final quarter.
2. Students will understand the role of an analytic business consultant and the business decision-making process.
3. Students will apply ethical analysis of business analytic scenarios to real-world analytic problems.

### INFO 4240 Data Warehousing (4 Credit-Hours)
This course introduces students to the main components of a data warehouse for business intelligence applications. Students will learn how a data warehouse fits into the overall strategy of a complex enterprise, how to develop data models useful for business intelligence, and how to combine data from disparate sources into a single database that comprises the core of a data warehouse. Students will also explore how to define and specify useful management reports from warehouse data. Prerequisites: INFO 4100, INFO 4140.

Learning Outcomes:
1. Plan, design, and model the data warehouse.
2. Build the data warehouse.
3. Extract, load and transform data into the data warehouse.
4. Perform multidimensional analysis on the data warehouse.
5. Build reports within the data warehouse environment.

### INFO 4260 Data Management Platforms
This course introduces students to the variety of data management platforms being used across the business landscape, and develops skills in using those platforms to manage data and perform analytics. These include Hadoop distributed file systems, Amazon Web Services, Microsoft Azure, and/or other locally-hosted and cloud-based services. Other topics, such as Apache Spark and High-Performance Computing may be introduced using University and College resources. Prerequisite: INFO 4240.

Learning Outcomes:
1. Students will create portals to data management systems and will run instances of these systems from their local environments.
2. Students will create file systems and load data onto local and cloud-based systems.
3. Students will leverage existing software packages (system-sourced and user-installed) in order to perform analytic modeling on the data in these environments.
4. Students will articulate the advantages and disadvantages of the various data management systems, and assess their utility for a variety of business applications.

### INFO 4281 Project Management (2 Credit-Hours)
In this course students examine the science, practice the art, and discuss the folklore of project management to enable them to contribute to and manage projects as well as to judge when to apply this discipline. The course also covers the use of MS Project Professional as a management tool and Crystal Ball as a Monte Carlo simulator for project exercises. Prerequisite: INFO 4100

Learning Outcomes:
1. Apply project management—consistently making the tradeoffs required to derive optimal outcomes based on copious hands-on experience.

2.  Justify flexibility in at least one of the three project constraints: scope, timeframe and resources, in order to deliver worthwhile results.
3.  Plan projects to optimize project results while taking into account the fact that projects seldom are executed according to plan.
4.  Find creative ways to bring projects back on schedule, explaining why simply throwing more resources at the problem tends to push the project further behind schedule.
5.  Demonstrate the advantages of the critical chain approach to managing projects while addressing its biggest challenge of getting stakeholder buy-in.
6.  Assess the value of formally executing the close step of any project in capturing information valuable for future projects.
7.  Compare and contrast the use of probability distributions versus point estimates for all critical project variables.
8.  Delineate the costs and benefits of using formal project management software tools such as Microsoft Project Professional.

### INFO 4300 Predictive Analytics (4 Credit-Hours)

This course is designed to prepare students for managerial data analysis and data mining, predictive modeling, model assessment and implementation using large data sets. The course addresses the how, when, why, and where of data mining. The emphasis is on understanding the application of a wide range of modern techniques to specific decision-making situations, rather than on mastering the theoretical underpinnings of the techniques. The course covers methods that are aimed at prediction, forecasting, classification, clustering, and association. Students will gain hands-on experience in using computer software to mine business data sets.  Prerequisite:  STAT 4610.

Learning Outcomes:
1.  Identify and perform the steps in the data mining process.
2.  Explain, apply and interpret forecasting models, component analysis, and classification methods.
3.  Explain, apply, and interpret regression models, generalized linear models, logistic regression models, and hierarchical linear models.
4.  Understand the various time series analysis techniques available to the business modeler, and conduct time series analysis to improve business decision-making.

### INFO 4340 Data Mining and Visualization (4 Credit-Hours)

In this course, students create business intelligence tools such as balanced scorecards, data visualization and dashboards to inform business decisions.  The course will focus on the identification of metrics, measures, and key performance indicators for a variety of business operations, and will introduce numerous analytic methodologies to support the decisions made with regard to these metrics. The focus will be on the advantages and disadvantages of various modeling methodologies and implementations moving towards performance improvement and business understanding. Prerequisite:  STAT 4610.

Learning Outcomes:
1.  List the components of a balanced scorecard and their relationship to each other.
2.  Compare and contrast various ways to display and interpret voluminous amounts of business intelligence data.
3.  Assess the potential of key performance indicators for different types of enterprises.
4.  Articulate the value of key business metrics for the success of an enterprise.
5.  Explain, apply and interpret multivariate analysis of variance, principal component analysis, factor analysis, multi-level logistic regression, generalized linear modeling, hierarchical linear modeling, path analysis, and structural equation modeling.

### INFO 4360 Complex Data Analytics (4 Credit-Hours)

This course addresses the rapidly-growing demands on businesses created by the prevalence of big and unstructured data.  These include management of big data, big-data analytics, analysis of unstructured data (to include text mining), and management and analysis of real-time (streaming) data.  The focus will be on enhancing business decision-making in the presence of big data, and on how to create the greatest ROI with large and complex data sets.

Learning Outcomes
1.  Understand and implement analysis of unstructured data and text data in order to draw analytic conclusions from these data sets.

2. Perform analytics on very large or streaming data sets to enhance an organization's decision-making process, to include statistical inference, analytic modeling, and direct-solution techniques.
3. Perform analysis of the data that are available on social media platforms for the purpose of market and sentiment analysis.
4. Use platforms such as SPSS modeler or Python to access and analyze large and unstructured data sets.

## INFO 4381 Decision Processes (2 Credit-Hours)

This course addresses the process of decision making in the enterprise: who makes what decisions based on what information and for what purpose. Business Intelligence is premised on the HP motto: "In God we trust. All others bring data." But what is the cost of collecting and analyzing the data and presenting the results, and what decisions justify that cost? Is the transformation from data to decision always rational, and what are the common pitfalls for human decision makers? We examine the results of recent experiments from behavior economics and their relevance to making business decisions. Prerequisite:  INFO 4100.

Learning Outcomes:
1. Analyze enterprise decision processes, identify key participants and assess their relationships to effective execution.
2. Evaluate the tradeoffs between the costs and benefits of data driven decisions and contrast these with direct experimentation.
3. List and describe hidden traps in rational decision making such as anchoring, confirmation bias, etc.
4. Explain the paradox of choice: why more is less, and its impact on business decisions.

## INFO 4390 Analytic Modeling in R (4 Credit-Hours)

The use of R as a programming language for business analytics and data sciences is becoming increasingly popular across the business environment.  This course teaches the use of R for the entire spectrum of business analytics applications, to include data management and organization, data cleaning, statistical analysis, analytic modeling, and presentation of results.  Applications will include those addressed in STAT4610 and INFO4300, in addition to introducing further analytic modeling techniques that are of use to business analysts and data scientists.

Learning Outcomes:
1. Understand and use the R language to capture and organize data for use in statistical and analytic models.
2. Use R to perform exploratory and statistical analysis of data, to include the techniques taught in STAT4610, INFO4300, and INFO4340.
3. Use R to create analytic models to analyze data and to produce results and insights that can be used in the business decision-making process.

## INFO 4400 Capstone (4 Credit-Hours)

This course will give the student an opportunity to apply the knowledge and skills learned in this program to a real- world problem submitted by a partner business. Students will take a business problem from problem definition, model construction and data collection through analysis and presentation of results to recommendations for specific business decisions. Prerequisite:  INFO 4200.

Learning Outcomes:
1. Assume the role of Analytic Consultant.
2. Help their organization define the data-driven business problem.
3. Manage the data associated with their project.
4. Implement appropriate analytic models to solve the business problem.
5. Participate in the enterprise's business decision-making process.
6. Integrate all of the aspects of the analytic decision-making process to help the organization derive value from data-driven decision-making.
7. Communicate the results of their analysis to the appropriate decision-makers.
8. Perform as an effective member of the decision-making, analytic, and support teams.
9. Recognize ethical challenges associated with data-driven decision-making, and identify the appropriate actions to mitigate these.
10. Demonstrate the initiative as an effective analytic consultant.

**4 hours of Electives – Students who have a significant business background, or an undergraduate (or other) degree in business, my request to opt out of INFO4000, and may take an additional elective.  The electives may be taken from any graduate program on campus with the approval of the Program Director.**