

# SPORTS ADMINISTRATION

SPS Certificate website: <https://sps.northwestern.edu/graduate-certificates/>

## Sports Analytics, Graduate Certificate

The Graduate Certificate in Sports Analytics focuses on the skills necessary to work in today's data-intensive and data-driven world. This online certificate provides the technical and leadership training required for key positions in sports team management and analytics. Building upon Northwestern University's graduate program in predictive analytics and data science, it reviews key technologies in analytics and modeling, probability theory, applied mathematics, statistics and programming. It shows how analytic techniques may be utilized in evaluating player and team performance and in sports team administration.

## Sports Communication, Graduate Certificate

This certificate allows students to explore both sports marketing and online communication strategies across multiple platforms. How do you manage messaging, brand consistency, content curation, fan engagement, etc. through the various online channels that exist today and may emerge tomorrow? Combining courses from the Sports Administration and Information Design & Strategy programs, this certificate is designed for those interested in or already working in communications careers in the multi-faceted sports industry.

## Global Sports Communication, Graduate Certificate

The graduate certificate in Global Sports Communication, offered on Northwestern's Doha, Qatar campus, prepares students to work in the growing global sports industry, focusing on strategic communication, media marketing, and leadership. Graduates of the program will build communication skills specific to the sports industry and will be well-prepared for communication, marketing, and promotional roles in the Middle East sports industry.

## Certificates Offered

- Global Sports Communication, Graduate Certificate (<https://catalogs.northwestern.edu/sps/certificates/graduate/sports-administration/global-sports-communication-graduate-certificate/>)
- Sports Analytics, Graduate Certificate (<https://catalogs.northwestern.edu/sps/certificates/graduate/sports-administration/sports-analytics-advance-graduate-certificate/>)
- Sports Communication, Graduate Certificate (<https://catalogs.northwestern.edu/sps/certificates/graduate/sports-administration/sports-communication-graduate-certificate/>)

## Sports Administration Courses

### MSA 400-0 Sports in the Social Context (1 Unit)

This course introduces the tools used to research and write graduate-level papers in a framework of a critical examination of the sociology of sports in the United States and abroad. The course will also explore the history of the social phenomena that have shaped the world of sports. Students will be assigned readings that underscore how sports reflects the values of the larger society. Some of the issues include inequality in sports, commercialization and globalization of sports, the myth of

the amateur athlete in big-time college sports, and behaviors deemed deviant in the world of sports. The course emphasizes writing skills, pushing students to examine their strengths and weaknesses, and helping them find effective ways to do solid research. Students will be assigned projects to demonstrate a proficiency in research and writing.

### MSA 400-DL Sport in the Social Context: Core Issues in Sports Administration (1 Unit)

This course introduces the tools used to research and write graduate-level papers in a framework of a critical examination of the sociology of sports in the United States and abroad. The course will explore the history of the social phenomena that have shaped sports. Students will be assigned readings that underscore how sports reflects the values of the larger society. Some of the issues include inequality in sports, commercialization and globalization of sports, the myth of the amateur athlete in big-time college sports, and behaviors deemed deviant in the world of sports.

### MSA 401-0 Sports Research Methods and Quantitative Analysis (1 Unit)

This course provides a broad introduction to data analysis and statistical methods, as they relate to the sports industry. Students will learn how to use these methods to better understand and analyze issues central to sports management. Quantitative tools are used as part of a larger exploration of the business economics of sports.

### MSA 401-DL Sports Research Methods and Quantitative Analysis (1 Unit)

This course provides a broad introduction to data analysis and statistical methods, as they relate to the sports industry. Students will learn how to use these methods to better understand and analyze issues central to sports management. Quantitative tools are used as part of a larger exploration of the business economics of sports.

### MSA 402-0 Fundamentals of Sports Marketing (1 Unit)

This course will provide students the necessary theoretical and practical hands-on knowledge of marketing principals and techniques as it related to the sports industry through the in-depth study of the sport marketing mix. The course also covers marketing strategies as they relate to businesses, such as the sporting goods industry and broadcasting. Additionally, students will explore the sports marketing industry at the professional, collegiate, and amateur levels through discussion of its many facets including: market research and segmentation, advertising, branding, sponsorship, licensing, public relations and media relations.

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This course will provide students the necessary theoretical and practical hands-on knowledge of marketing principals and techniques as it related to the sports industry through the in-depth study of the sport marketing mix. The course also covers marketing strategies as they relate to businesses, such as the sporting goods industry and broadcasting. Additionally, students will explore the sports marketing industry at the professional, collegiate, and amateur levels through discussion of its many facets including: market research and segmentation, advertising, branding, sponsorship, licensing, public relations and media relations.

### MSA 403-0 Organization of Sports (1 Unit)

The overall objective of this course is to develop students' understanding of the frameworks of organizations and to facilitate critical analysis of organizational theories and leadership styles. The coursework is intended to support students through readings, small and large group discussion, and analysis that informs their careers as aspiring sports professionals. This course will also provide a familiarization with the sports industry and the types of organizational structures that are prevalent.

### MSA 403-DL Management and Organization of Sports (1 Unit)

The overall objective of this course is to develop students' understanding of the frameworks of organizations and to facilitate critical analysis of organizational theories and leadership styles. The coursework is intended to support students through readings, small and large group discussion, and analysis that informs their careers as aspiring sports professionals. This course will also provide a familiarization with the sports industry and the types of organizational structures that are prevalent.

**MSA 404-0 Sports Business: Finance, Accounting and Economics (1 Unit)**

This course provides students with knowledge of financial management and managerial economics as they relate to the sports industry. The focus will be on understanding accounting and finance vocabulary, using financial information to analyze the performance of sports organizations, developing budgets for an organization or department, explaining salary cap logistics/impact, understanding tax implications and stadium financing options - all to make better organizational decisions.

**MSA 404-DL Sports Business: Finance, Accounting and Economics (1 Unit)**

This course provides students with knowledge of financial management and managerial economics as they relate to the sports industry. The focus will be on understanding accounting and finance vocabulary, using financial information to analyze the performance of sports organizations, developing budgets for an organization or department, explaining salary cap logistics/impact, understanding tax implications and stadium financing options - all to make better organizational decisions.

**MSA 405-0 Legal and Ethical Issues in Sports Management (1 Unit)**

This course introduces the theories and concepts of applied ethics by focusing on legal questions, race and gender issues, public relations, budgeting, recruiting (in the collegiate context), evaluations, personnel, exploitation, and athletic reform in both the corporate and collegiate sport industries. Awareness of legal implications for the industry reduces the probability of litigation.

**MSA 405-DL Legal and Ethical Issues in Sports Management (1 Unit)**

This course introduces the theories and concepts of applied ethics by focusing on legal questions, race and gender issues, public relations, budgeting, recruiting (in the collegiate context), evaluations, personnel, exploitation, and athletic reform in both the corporate and collegiate sport industries. Awareness of legal implications for the industry reduces the probability of litigation.

**MSA 406-0 Sports Public Relations and Crisis Management (1 Unit)**

This course examines the implications and mitigation of crisis and risk in the sports industry, with emphasis placed on managing public relations. Students develop the tools necessary to identify organizational vulnerabilities and to design and implement crisis strategies and communications to prevent these situations, and manage the situations effectively, should they occur. The course pays particular attention to public relations strategies for communication with internal and external constituencies.

**MSA 406-DL Sports Public Relations and Crisis Management (1 Unit)**

This course examines the implications and mitigation of crisis and risk in the sports industry, with emphasis placed on managing public relations. Students develop the tools necessary to identify organizational vulnerabilities and to design and implement crisis strategies and communications to prevent these situations, and manage the situations effectively, should they occur. The course pays particular attention to public relations strategies for communication with internal and external constituencies.

**MSA 407-0 Sports Labor Relations and Negotiation (1 Unit)**

This course focuses on the legal issues of labor relations and negotiations as they relate to the sports industry. Focus on the major professional team sport leagues, with some international Olympic issues. Legal areas of contracts, antitrust law, labor law, arbitration, collective bargaining, and agency issues.

**MSA 412-0 Sponsorships 2.0: Adding Value to Sports, Brands, Fans, and Communities (1 Unit)**

In this class, we will deconstruct some of the world's most innovative partnerships from the inside out. You will learn how to think like a sponsor, including how to set measurable objectives and how to bullet proof sponsorship selection to linking activation to business goals and how to measure return on investment. Participants will also learn sponsorship through the lens of the sports rightsholder, gaining the skills and tools to sell sponsorship to team, league, event, venue, athlete or program. Also covered: pricing, negotiating, servicing and licensing.

**MSA 413-0 Advertising Project: Sports Brand Management (1 Unit)**

Concepts presented in this course include positioning, targeting, brand building and measurement, and how advertising, PR and experiential marketing are used to drive brand equity. Based on lectures, guest speakers, readings, classroom and homework exercises, case studies, and a major group project, the course is designed to present students with a practical, hands-on opportunity to work on current issues facing actual sports-industry businesses. The major small group project involves students collaborating in a consulting role with industry professionals from assigned "client companies". The project requires students to meet with their client and with their student-group members outside of class hours to ensure a well-delivered final product.

**MSA 421-DL The Business of Esports (1 Unit)**

In this course, students will become familiar will learn the various elements unique to the esports ecosystem including understanding different game genres, examination of the publisher's role in esports, different competitive structures, and the organization of professional teams and players. Students will examine the potential for growth and risks in the esports industry. The course will discuss differences between traditional sports and esports, the culture of esports including streaming, media platforms, inclusivity, online toxicity and sportsmanship, and scholastic esports.

**MSA 441-0 Complexities of Management and Marketing in the Olympic Movement (1 Unit)**

Students will analyze the actions of the International Olympic (IOC) Committee and study the bidding process for Olympic games to understand the global business dynamics of the Olympic marketing industry and the "Olympic Movement." Topics will include an examination of the global infrastructure and organization of the Olympic Movement; the Olympic charter and IOC goals; case study presentation on a TOP Olympic sponsor; and a general overview of a host city's obligations and opportunities regarding construction of venues, government support and participation, infrastructure, marketing, security, and more.

**MSA 445-0 Entrepreneurship in the Sports Industry (1 Unit)**

Entrepreneurial companies are disrupting the sports industry. From big data to wearable technology to mobile/social media, new companies are growing quickly to solve pressing challenges for leagues, teams, events, and athletes. This course is designed to help prepare students for a career path in sports entrepreneurship. More specifically, having a big idea is the start of launching a new venture. Building businesses requires raising capital, hiring the right people, acquiring customers, implementing strategy, and communicating to internal and external audiences. By the end of this class, students will have the framework in place to start their own company in the sports industry. Recommended prior course: MSA 404-0 or MSA 404-DL.

**MSA 445-DL Entrepreneurship in the Sports Industry (1 Unit)**

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**MSA 451-0 Information Technology in Sports (1 Unit)**

The Technology of Sport provides an interactive tour of technology, related products/services that form technical solutions, and the current and future state of technology as it relates to sports. MSA 451 goes beyond the what of technology, and explores the how highlighting technological impacts on the sports business landscape. Students will learn the terms and tools that comprise technology, specifically those most applicable to the sports industry and within a sports business setting. The course will evaluate student's comprehension of technological concepts, implementation of those concepts, and tangible business enhancements. A midterm examination and a final project are used to advance students' application of these technological skills.

**MSA 451-DL The Technology of Sport (1 Unit)**

The Technology of Sport provides an interactive tour of technology, related products/services that form technical solutions, and the current and future state of technology as it relates to sports. MSA 451 goes beyond the what of technology, and explores the how highlighting technological impacts on the sports business landscape. Students will learn the terms and tools that comprise technology, specifically those most applicable to the sports industry and within a sports business setting. The course will evaluate student's comprehension of technological concepts, implementation of those concepts, and tangible business enhancements. A midterm examination and a final project are used to advance students' application of these technological skills.

**MSA 453-0 Intercollegiate Sports Management (1 Unit)**

Students will examine some of the core tenets of sport management within collegiate athletic departments. The course will take an in-depth look at administrative leadership as it pertains to human resources issues such as management style analysis and diversity training, and development and fundraising initiatives and campaigns, including alumni relations and motivation between coaches and administrators and coaches and teams/players. Students participate in an on-site facility management and game-day operations practicum.

**MSA 455-0 NCAA Compliance (1 Unit)**

NCAA rules and infractions can seem mysterious and arbitrary, given the way they are covered by the media. The NCAA has rules and processes that affect the daily workings of any NCAA institutions, particularly Division I. This course provides students with a working knowledge of NCAA compliance issues by examining and applying the bylaws of the NCAA (with a focus on Division I). Students will examine case studies to gain experience in applying this knowledge to everyday NCAA issues. Enforcement procedures, waivers processes, and the evolution of the NCAA rules will be examined as well. This course will offer valuable insights into career paths in NCAA compliance, college administration, and how the world of college sports really works.

**MSA 455-DL NCAA Compliance (1 Unit)**

This course provides students with a working knowledge of NCAA compliance issues by examining and applying the bylaws of the NCAA

(with a focus on Division I). Students will examine case studies to gain experience in applying this knowledge to everyday NCAA issues. Enforcement procedures, waivers processes, and the evolution of the NCAA rules will be examined as well. This course will offer valuable insights into career paths in NCAA compliance, college administration, and how the world of college sports really works.

**MSA 457-0 Front Office Operations (1 Unit)**

This class will provide students with a working knowledge of the issues facing sports teams and organizations. This will include both for-profit and not-for-profit organizations. Students will apply critical thinking and analysis to the various stakeholders' interest in the business and operations of sports teams and organizations. This will include teams, leagues, municipalities, financial institutions, fans, corporations and other related companies that do business with the aforementioned entities. The class will utilize real life examples of organizational structures, actual team financials, economic models and discussion.

**MSA 458-DL Digital Media in Sports (1 Unit)**

This course will examine the impact of new technology on the business of sports, focusing on topics such as Over-the-Top (OTT) video distribution, social media, fantasy sports, eSports, data & analytics, stadium technology, digital advertising, and youth & amateur sports, among other subjects. In addition to covering the major leagues and media companies, the course will also provide insight into entrepreneurial ventures and start-ups that are reshaping the sports landscape.

**MSA 460-0 Deviance and Violence in Sports (1 Unit)**

This course examines the social and cultural meaning of deviance and violence in sport. Drawing from social science, legal cases, popular media, and contemporary events, students learn the various definitions of deviance and violence, as well as explore the ways in which the government, athletic associations, and players themselves manage, regulate, and perpetuate these behaviors. Topics include the prevalence of violence both on and off-field, the use of performance-enhancing drugs, extreme weight loss, and gambling.

**MSA 460-DL Deviance and Violence in Sports (1 Unit)**

This course examines the social and cultural meaning of deviance and violence in sport. Drawing from social science, legal cases, popular media, and contemporary events, students learn the various definitions of deviance and violence, as well as explore the ways in which the government, athletic associations, and players themselves manage, regulate, and perpetuate these behaviors. Topics include the prevalence of violence both on and off-field, the use of performance-enhancing drugs, extreme weight loss, and gambling.

**MSA 463-0 Globalization in Sports (1 Unit)**

The intent of this course is to develop the student's understanding of the global impact of sport. The overall objective is to examine the ways in which sport has developed internationally and influences culture, economics, nationalism, and social values. The class will aggressively dissect various aspects of international sports such as governing bodies, events, ethnic relations, marketing/sponsorships, media evolution, and agency. This course will attempt to give students the ability to process, analyze, and articulate the expansion of sport on a global level.

**MSA 463-DL Globalization of Sport (1 Unit)**

The intent of this course is to develop the student's understanding of the global impact of sport. The overall objective is to examine the ways in which sport has developed internationally and influences culture, economics, nationalism, and social values. The class will aggressively dissect various aspects of international sports such as governing bodies, events, ethnic relations, marketing/sponsorships, media evolution, and

agency. This course will attempt to give students the ability to process, analyze, and articulate the expansion of sport on a global level.

**MSA 475-DL Global Sports Communication (1 Unit)**

This course provides an understanding of the sports communications industry at both the collegiate and professional levels. Topics include the role of communications in management, news release writing, working with and using various forms of media, crisis management, pitching stories, interviews, and ethics.

**MSA 476-DL Principles and Practice of Strategic Communication and Public Relations (1 Unit)**

This course looks at the broad range of theoretical perspectives applied to strategic communication and public relations. It explores normative theories that underpin organizational understandings of strategic communication and PR by considering approaches, practices and strategies in this field. In so doing participants will gain a working understanding around subjects such as the PR industry conventions, structure and operations; strategic communication audiences and public opinion; stakeholders theory; issues management and crisis management; among others. The course pays particular attention to public relations strategies for communication with internal and external constituencies.

**MSA 477-DL Audiovisual and Online Media Productions (1 Unit)**

Media literacy is a competence that is often used by sports administrators to shape the array of messages that relate to the sports venture they administer, but more importantly to engage with the media in the narratives that could benefit or damage the reputation of their clients. This course has three primary goals: (a) Provide students with the media literacy tools needed to uncover the power of the media in controlling images and stories, (b) Help students to understand the role of the media in the construction of beliefs, the mobilization of publics, and the fostering of emotions. (c) Provide participants with the necessary lexicon to engage with media professionals and to understand the basics of media production.

**MSA 479-DL Practical Experience in Global Sports Communication (1 Unit)**

The Practical Experience in Global Sports Communication course is an opportunity for students to demonstrate their mastery of the global sports communication certificate curriculum and a firm understanding of the fundamental principles of strategic communication, media marketing, and leadership that guide the diverse and growing global sports industry. This course will combine theories taught in the previous certificate courses with practical, hands-on applications allowing students to bring their unique experiences to the classroom.

**MSA 490-0 Special Topics (1 Unit)**

This class will be offered periodically to address special topics in Sports Administration. Please check the MSA website for specific topics.

**MSA 498-0 Capstone Class (1 Unit)**

The capstone project course is the culmination of the MSA program and demonstrates a student's mastery of the curriculum and a firm understanding of the fundamental principles that guide the diverse field of sports administration. Students may choose this course to fulfill their capstone requirement. Students should have completed 9 of 11 courses in the program, with all core courses completed.

**MSA 498-DL Capstone (1 Unit)**

The capstone project course is the culmination of the MSA program and demonstrates a student's mastery of the curriculum and a firm understanding of the fundamental principles that guide the diverse field of sports administration. Students may choose this course to fulfill their

capstone requirement. Students should have completed 9 of 11 courses in the program, with all core courses completed.

**MSA 499-0 Independent Study (1 Unit)**

An independent study is a customized course of study undertaken by a single student under the guidance of an instructor. Independent studies are comparable in their demands to other graduate-level courses. Please see the SPS Graduate Student Handbook and your academic advisor for more information about independent study registration.

**MSA 579-0 Practicum in Sports Administration (1 Unit)**

This course will provide a framework for the development of your professional skills throughout the internship. Students will become familiar with a variety of techniques in networking, professionalism, and problem-solving in order to get the most out of their work experience. Students will share their experiences with classmates throughout the course in order to provide a framework for discussion and learning. As the experience in the internship is the most valuable piece of the class and where most of your energy, knowledge, and motivation will be expended, this class will not hold in-person class meetings, but will require weekly assignments, online class participation, as well as a final paper.

**MSA 579-DL Practicum In Sports Admin (1 Unit)**

This course will provide a framework for the development of your professional skills throughout the internship. Students will become familiar with a variety of techniques in networking, professionalism, and problem-solving in order to get the most out of their work experience. Students will share their experiences with classmates throughout the course in order to provide a framework for discussion and learning. As the experience in the internship is the most valuable piece of the class and where most of your energy, knowledge, and motivation will be expended, this class will not hold in-person class meetings, but will require weekly assignments, online class participation, as well as a final paper.

**MSA 590-0 Thesis Research (1 Unit)**

This final project is meant to represent the culmination of students' experience in the program and must demonstrate mastery of the curriculum and ability to conduct sustained independent research and analysis. The project may be applied or may be a traditional scholarly paper, in both cases a write-up following the paper's program-specific guidelines is required. Students must submit a proposal and secure a first reader in order to register; for further details students are advised to review the student handbook and contact their academic advisor.

**MSDS 400-DL Math For Data Scientists (1 Unit)**

Students learn techniques for building and interpreting mathematical models of real-world phenomena in and across multiple disciplines, including linear algebra, discrete mathematics, probability, and calculus, with an emphasis on applications in data science and data engineering. Provides students with a firm understanding or review of these fields of mathematics prior to enrolling in courses that assume understanding of mathematical concepts.

**Prerequisite:** None.

**MSDS 401-DL Applied Statistics with R (1 Unit)**

This course teaches fundamentals of statistical analysis. This includes evaluating statistical information, performing data analyses, and interpreting and communicating analytical results. Students will learn to use the R language for statistical analysis, data visualization, and report generation. Topics covered include descriptive statistics, central tendency, exploratory data analysis, probability theory, discrete and continuous distributions, statistical inference, correlation, multiple linear regression, contingency tables, and chi-square tests. Selected contemporary statistical concepts, such as bootstrapping, are introduced

to supplement traditional statistical methods. Recommended prior course: MSDS 400-DL.

#### **MSDS 402-DL Introduction to Data Science (1 Unit)**

This course introduces the field of data science, which combines business strategy, information technology, and modeling methods. The course reviews the benefits and opportunities of data science, as well as organizational, implementation, and ethical issues. The course provides an overview of modeling methods, analytics software, and information systems. It discusses business problems and solutions for traditional and contemporary data management systems, and the selection of appropriate tools for data collection and analysis. The course also reviews approaches to business research, sampling, and survey design.

**Prerequisite:** None.

#### **MSDS 403-DL Data Science in Practice (1 Unit)**

This is a case study course that gives students an opportunity to gain experience solving business problems and applying core skills needed for data science technical and leadership roles. The course provides an introduction to digital transformation, industry use cases, designing and measuring analytics projects, data considerations, data governance, digital trust and ethics, enterprise architecture and technology platforms, and organizational change management. Students act as data scientists, as strategists and leaders, evaluating alternative analytics projects and solving digital transformation challenges. Students learn how to apply a step-by-step development process, creating digital transformation roadmaps and addressing real-world business problems.

**Prerequisite:** None.

#### **MSDS 410-DL Supervised Learning Methods (1 Unit)**

This course introduces traditional statistics and data modeling for supervised learning problems, as employed in observational and experimental research. With supervised learning there is a clear distinction between explanatory and response variables. The objective is to predict responses, whether they be quantitative as with multiple regression or categorical as with logistic regression and multinomial logit models. Students work on research and programming assignments, exploring data, identifying appropriate models, and validating models. They utilize techniques for observational and experimental research design, data visualization, variable transformation, model diagnostics, and model selection.

**Prerequisite:** (1) MSDS 400-DL and (2) MSDS 401-DL.

#### **MSDS 411-DL Unsupervised Learning Methods (1 Unit)**

This course introduces data modeling for studies in which there is no clear distinction between explanatory and response variables. The objective may be to explain relationships among many continuous variables in terms of underlying dimensions, latent variables, or factors; to find a lower-dimensional representation for multivariate cross-classified data, as with log-linear models; to construct a visualization of variables, as with traditional multidimensional scaling and t-distributed stochastic neighbor embedding; or to identify groups of variables and/or objects that are similar to one another, as with cluster analysis and biclustering. Students work on research and programming assignments, exploring multivariate data and methods.

**Prerequisite:** MSDS 410-DL.

#### **MSDS 413-DL Times Series Analysis and Forecasting (1 Unit)**

This course covers key analytical methods and techniques used in the analysis and forecasting of time series data. Specific topics include the role of forecasting in organizations, exploratory data analysis, stationary and non-stationary time series, autocorrelation and partial autocorrelation functions, univariate autoregressive integrated moving average (ARIMA) models, seasonal models, Box-Jenkins methodology, regression models with ARIMA errors, multivariate time series analysis,

and non-linear time series modeling including exponential smoothing methods, random forest analysis, and hidden Markov modeling.

#### **MSDS 420-DL Database Systems and Data Preparation (1 Unit)**

In this course students explore the fundamental concepts of database management and data preparation. Focusing on applications in large-scale-data analytics projects, the course introduces relational database systems, the relational model, normalization process, and structured query language (SQL). The course discusses topics related to data integration and cleaning, database programming for extract, transform, and load (ETL) operations. Students learn NoSQL technologies for working with unstructured data and document-oriented information retrieval systems. They learn how to index and score documents for effective and relevant responses to user queries. Students acquire hands-on programming experience for data preparation and data extraction. Recommended prior programming experience or MSDS 430-DL.

**Prerequisite:** MSDS 402-DL or MSDS 403-DL.

#### **MSDS 422-DL Practical Machine Learning (1 Unit)**

The course introduces machine learning with business applications. It provides a survey of machine learning techniques, including traditional statistical methods, resampling techniques, model selection and regularization, tree-based methods, principal components analysis, cluster analysis, artificial neural networks, and deep learning. Students implement machine learning models with open-source software for data science. They explore data and learn from data, finding underlying patterns useful for data reduction, feature analysis, prediction, and classification.

**Prerequisite:** (1) MSDS 400-DL, (2) MSDS 401-DL, and (3) MSDS 402-DL or MSDS 403-DL.

#### **MSDS 430-DL Python for Data Analysis (1 Unit)**

This course introduces core features of the Python programming language, demonstrating fundamental concepts in computer science. It provides an in-depth discussion of data representation strategies, showing how data structures are implemented in Python and demonstrating tools for data science and software engineering. Working on data analysis problems, students employ various programming paradigms, including functional programming, object-oriented programming, and data stream processing. Special attention is paid to the standard Python library and packages for analytics and modeling.

**Prerequisite:** None.

#### **MSDS 432-DL Foundations for Data Engineering (1 Unit)**

This course provides an overview of the discipline of data engineering. It introduces software and systems for data science and software development as required in the design of data intensive applications. Students learn about algorithms, data structures, and technologies for storing and processing data. Students gain experience with open-source software, text editors, and integrated development environments. Students employ best practices in software development, utilizing tools for syntax checking, testing, debugging, and version control. The course also introduces formal models, simulations, and benchmark experiments for evaluating software, systems, and processes.

**Prerequisite:** MSDS 420-DL or CIS 417-DL.

#### **MSDS 434-DL Analytics Application Engineering (1 Unit)**

This course covers programming components essential to the development of analytics applications. The focus is analytics software engineering. Students learn to develop single-system/desktop solutions as well as client-server solutions. They learn about web-based, client-server solutions employing a variety of front-end and back-end system components. Students develop software, working on open-source

programming, database, and systems integration projects. They employ best practices in software development.

**Prerequisite:** (1) MSDS 432-DL and (2) MSDS 422-DL or CIS 435-DL.

#### **MSDS 436-DL Analytics Systems Engineering (1 Unit)**

This course introduces design principles and best practices for implementing large-scale systems for data ingestion, processing, storage, and analytics. Students learn about cloud-based computer architecture and scalable systems for data science. They learn how to package and distribute containerized computer software. They apply tools of systems analysis, evaluating end-to-end performance and resource utilization in batch, interactive, and streaming environments. Students review formats and protocols for application programming interfaces. They compare data models, resource requirements, and performance of applications implemented with relational versus graph database systems.

**Prerequisite:** (1) MSDS 432-DL and (2) MSDS 422-DL or CIS 435-DL.

#### **MSDS 440-DL Real-Time Interactive Processing and Analytics (1 Unit)**

This course introduces application engineering and analytics within an integrated environment and full-stack development process. Students learn how to implement client-side, web-based applications using a model-view-controller framework. Students work with server-side systems for responding to website requests and database queries. Students learn how to prepare indices for efficient and relevant search across large document collections. They learn how to implement real-time analytics applications for interactive environments, finding information from databases and document collections, making service and product recommendations, and detecting anomalies or security violations. This is a case study and project-based course with a strong programming component.

#### **MSDS 442-DL Real-Time Stream Processing and Analytics (1 Unit)**

This course introduces application engineering and analytics within stream and event processing environments. Data feeds or sources include monitoring of continuous processes through electronic sensors, observing channels of communication and social interaction, and tracking goods through production lines and distribution channels. The course reviews stream-processing systems designed to provide high throughput and low latency. It introduces data models and algorithms for analyzing event logs and understanding business processes. Special attention is given to applications in operations support, logistics, and supply chain management. This is a case study and project-based course with a strong programming component, including work with relational and graph.

#### **MSDS 450-DL Marketing Analytics (1 Unit)**

This course provides a comprehensive review of data science as it relates to marketing management and business strategy. The course allows students to work with data relating to customer demographics, marketing communications, and purchasing behavior. Students perform data cleansing, aggregation, and analysis, exploring alternative segmentation schemes for targeted marketing. They design tools for reporting research results to management, including information about consumer purchasing behavior and the effectiveness of marketing campaigns. Conjoint analysis and choice studies are introduced as tools for consumer preference measurement, product design, and pricing research. This is a case study and project-based course involving extensive data analysis. Recommended prior course: MSDS 411-DL.

**Prerequisite:** MSDS 420-DL and MSDS 422-DL.

#### **MSDS 451-DL Financial and Risk Analytics (1 Unit)**

Building upon probability theory and inferential statistics, this course provides an introduction to risk analytics. Examples from economics and finance show how to incorporate risk within regression and time series models. Monte Carlo simulation is used to demonstrate

how variability in data affects uncertainty about model parameters. Additional topics include subjectivity in risk analysis, causal modeling, stochastic optimization, portfolio analysis, and risk model evaluation. Recommended prior course: MSDS 413-#DL.

**Prerequisite:** (1) MSDS 420-DL and (2) MSDS 422-#DL .

#### **MSDS 452-DL Web and Network Data Science (1 Unit)**

This course shows how to acquire and analyze information from the web. It provides a comprehensive review of web analytics, including website usage and search performance metrics. The course introduces the mathematics of network science, including random graph, small world, and preferential attachment models. Students compute a variety of network metrics as they analyze software systems, website structure, connections in information and social networks, and user interactions through electronic communications and social media. They employ network/graph algorithms within a graph database system. This is a case study and project-based course with a strong programming component.

#### **MSDS 453-DL Natural Language Processing (1 Unit)**

A comprehensive review of text analytics and natural language processing with a focus on recent developments in computational linguistics and machine learning. Students work with unstructured and semi-structured text from online sources, document collections, and databases. Using methods of artificial intelligence and machine learning, students learn how to parse text into numeric vectors and to convert higher dimensional vectors into lower dimensional vectors for subsequent analysis and modeling. Applications include speech recognition, semantic processing, text classification, relevant search, recommendation systems, sentiment analysis, and topic modeling. This is a project-based course with extensive programming assignments.

**Prerequisite:** (1) MSDS 420-DL or CIS 417-DL and (2) MSDS 422-DL or CIS 435-DL.

#### **MSDS 454-DL Advanced Modeling Techniques (1 Unit)**

This advanced modeling course is divided into two major sections. The first section concerns theory and application of stochastic processes, including Markov processes. The second section concerns Bayesian statistics, including Bayesian belief modeling. Throughout the course, students explore applied probability models that represent business processes in graphs or networks. Students execute simulation experiments, both discrete-event and process simulations. This is a case study and project-based course with an extensive programming component.

#### **MSDS 455-DL Data Visualization (1 Unit)**

This course begins with a review of human perception and cognition, drawing upon psychological studies of perceptual accuracy and preferences. The course reviews principles of graphic design, what makes for a good graph, and why some data visualizations effectively present information and others do not. It considers visualization as a component of systems for data science and presents examples of visualizing categorical, hierarchical, relational, temporal and spatial data. It reviews methods for static and interactive graphics and introduces tools for building web-browser-based presentations. This is a project-based course with programming assignments.

**Prerequisite:** (1) MSDS 400-DL and (2) MSDS 401-DL.

#### **MSDS 456-DL Sports Performance Analytics (1 Unit)**

An introduction to sports performance measurement and analytics, this course reviews roles of athletes at each position in sports selected by the instructor. With a focus on the individual athlete, the course discusses the development and use of accurate assessments and variability due to factors such as body type, climate, and training regimen. The course reviews athletic performance measurements, including jumping ability, running speed, agility, and strength. Students work with player on-field

and on-court performance measures. The course utilizes exploratory data analysis, predictive modeling, and presentation graphics, showing real-world implications for athletes, coaches, team managers, and the sports industry.

**Prerequisite:** (1) MSDS 400-DL and (2) MSDS 401-DL.

#### **MSDS 457-DL Sports Management Analytics (1 Unit)**

This course provides a comprehensive review of financial, statistical, and mathematical models as they relate to sports team performance, administration, marketing, and business management. The course gives students an opportunity to work with data and models relating to sports team performance, tactics, and strategy. Students employ modeling methods in studying player and team valuation, sports media, ticket pricing, game-day events management, loyalty and sponsorship program development, and customer relationship management. The course makes extensive use of sports business case studies.

**Prerequisite:** (1) MSDS 400-DL and (2) MSDS 401-DL.

#### **MSDS 458-DL Artificial Intelligence and Deep Learning (1 Unit)**

An introduction to the field of artificial intelligence, this course illustrates probability-rule-based generative models as well as discriminative models that learn from training data. The course reviews applications of artificial intelligence and deep learning in vision and language processing. Students learn best practices for building supervised learning models and, in particular, deep neural networks for classification and regression. Students also learn about feature engineering, autoencoders, and strategies of unsupervised and semi-supervised learning, as well as reinforcement learning. This is a project-based course with extensive programming assignments.

**Prerequisite:** (1) MSDS 420-DL or CIS 417-DL and (2) MSDS 422-DL or CIS 435-DL.

#### **MSDS 459-DL Knowledge Engineering (1 Unit)**

This course introduces knowledge representation as a subfield of artificial intelligence. It reviews methods for developing knowledge-based systems, providing examples of their use in intelligent applications and agents. The course makes heavy use of graph databases for storing information about words in semantic networks and for storing information about relationships. Students learn how to encode and access knowledge on the World Wide Web. They learn how to use knowledge bases for automated reasoning and question answering. This is a project-based course with extensive programming assignments. Recommended prior courses: MSDS 453-DL and MSDS 458-DL.

**Prerequisite:** (1) MSDS 420-DL or CIS 417-DL and (2) MSDS 422-DL or CIS 435-DL.

#### **MSDS 460-0 Decision Analytics (1 Unit)**

This course covers fundamental concepts, solution techniques, modeling approaches, and applications of decision analytics. It introduces commonly used methods of optimization, simulation and decision analysis techniques for prescriptive analytics in business. Students explore linear programming, network optimization, integer linear programming, goal programming, multiple objective optimization, nonlinear programming, metaheuristic algorithms, stochastic simulation, queuing modeling, decision analysis, and Markov decision processes. Students develop a contextual understanding of techniques useful for managerial decision support. They implement decision-analytic techniques using a state-of-the-art analytical modeling platform. This is a problem and project-based course.

**Prerequisite:** (1) MSDS 400-DL and (2) MSDS 401-DL.

#### **MSDS 460-DL Decision Analytics (1 Unit)**

This course covers fundamental concepts, solution techniques, modeling approaches, and applications of decision analytics. It introduces commonly used methods of optimization, simulation and decision

analysis techniques for prescriptive analytics in business. Students explore linear programming, network optimization, integer linear programming, goal programming, multiple objective optimization, nonlinear programming, metaheuristic algorithms, stochastic simulation, queuing modeling, decision analysis, and Markov decision processes. Students develop a contextual understanding of techniques useful for managerial decision support. They implement decision-analytic techniques using a state-of-the-art analytical modeling platform. This is a problem and project-based course.

**Prerequisite:** (1) MSDS 400-DL and (2) MSDS 401-DL.

#### **MSDS 462-DL Computer Vision (1 Unit)**

A review of specialized deep learning methods for vision, including convolutional neural networks and recurrent neural networks. Students work with raw image files, including digital representations of photographs, hand-written documents, x-rays, and sensor images. Students process image data, converting pixels into numeric tensors for subsequent analysis and modeling. The course illustrates real-world applications for visual exploration, discovery and navigation, and for image classification, facial recognition, remote sensing, and medical diagnostics. This is a project-based course with extensive programming assignments. Recommended prior course: MSDS 458-DL.

**Prerequisite:** (1) MSDS 420-DL or CIS 417-DL and (2) MSDS 422-DL or CIS 435-DL.

#### **MSDS 464-DL Intelligent Systems and Robotics (1 Unit)**

This course introduces reinforcement learning as an approach to intelligent systems, emphasizing applications such as robotic processes automation, conversational agents and robotics that mimic human behavior. Students implement intelligent agents to solve both discrete- and continuous-valued sequential decision-making problems. Students develop, debug, train, visualize, and customize programs in a variety of learning environments. The course reviews Markov decision processes, dynamic programming, temporal difference learning, Monte Carlo reinforcement learning, eligibility traces, and the integration of learning and planning. This is a case study and project-based course with a substantial programming component. Recommended prior course: MSDS 458-DL.

**Prerequisite:** (1) MSDS 420-DL or CIS 417-DL and (2) MSDS 422-DL or CIS 435-DL.

#### **MSDS 470-DL Analytics Entrepreneurship (1 Unit)**

This course prepares students for establishing and running a data-science-oriented entrepreneurial organization. Topics include evaluating preparedness for entrepreneurial work, activities that would help transform an idea into a running organization, identifying the right data, analytics tools, and resources platform, and aligning with unmet market demands. Students learn about growing a network of people and obtaining capital assets, creating innovative intellectual property and sharpening unique competitiveness, and making product development and marketing choices. Students develop essential elements of business plans in order to present a final business pitch for starting an entrepreneurial data science venture.

**Prerequisite:** (1) MSDS 400-DL, (2) MSDS 401-DL, and (3) MSDS 402-DL or MSDS 403-DL.

#### **MSDS 472-DL Analytics Consulting (1 Unit)**

Analytics consulting brings together consultative processes and tools for creating a trusted advisor relationship with clients. This course covers concepts, processes, and tools for developing consulting proposals. The course is structured around an analytics consulting simulation and students work in teams. Students learn how to identify and meet business requirements through gathering information, developing reports, and managing client relationships. The course also addresses ethical

issues and career challenges. The course is appropriate for students interested in or currently acting as an internal or external consultant. Considerations associated with operating your own consulting company are also addressed.

**Prerequisite:** (1) MSDS 400-DL, (2) MSDS 401-DL, and (3) MSDS 402-DL or MSDS 403-DL.

**MSDS 474-DL Accounting and Finance for Analytics Managers (1 Unit)**

This course reviews principles of corporate finance and managerial accounting with a focus on the work of analytics managers. Analytics managers are often responsible for the profit-and-loss (P&L) of their projects and divisions which have certain unique needs in terms of workflow, co-#working with other businesses, cooperating with multiple stakeholders (especially IT), and employing highly specialized knowledge professionals. To support these responsibilities, students learn how to conduct breakeven (cost-volume-profit) analysis, apply discounted cash flow analysis, and compute return on investments. Students also learn how to read balance sheets, income statements, and cash flow statements. The course provides in-depth coverage of spreadsheet programming methods.

**Prerequisite:** MSDS 402-DL or MSDS 403-DL.

**MSDS 475-DL Project Management (1 Unit)**

This course introduces best practices in project management, covering the full project life cycle with a focus on globally accepted standards. It reviews traditional methods and shows how the project management maturity model, leadership, team development, and principles of negotiation apply to organizations of various types: hierarchical and matrix organizations, international teams, and virtual teams. Options in project management software systems are included. Using methods and models from this course, analytics managers and team leaders should experience greater project definition and structure. They should be able to execute data science and data engineering projects more effectively.

**Prerequisite:** None.

**MSDS 480-0 Business Leadership and Communication (1 Unit)**

This course introduces fundamental leadership theory and associated behaviors to enable students to excel in their analytics careers. The course examines the theory and practice of leadership at the individual and organizational levels, and discusses how to drive effective change at various stages in an enterprise analytics transformation process. Students spend three weeks on analytics-specific project management, in which they design an analytics project plan using an agile approach. Leadership challenges unique to analytics departments are addressed through the use of case studies and theory-based assignments. The course focuses on developing effective communication strategies and presentations that resonate across business and technical teams.

**Prerequisite:** None.

**MSDS 480-DL Business Leadership and Communications (1 Unit)**

This course introduces fundamental leadership theory and associated behaviors to enable students to excel in their analytics careers. The course examines the theory and practice of leadership at the individual and organizational levels, and discusses how to drive effective change at various stages in an enterprise analytics transformation process. Students spend three weeks on analytics-specific project management, in which they design an analytics project plan using an agile approach. Leadership challenges unique to analytics departments are addressed through the use of case studies and theory-based assignments. The course focuses on developing effective communication strategies and presentations that resonate across business and technical teams.

**Prerequisite:** None.

**MSDS 485-DL Data Governance, Ethics, and Law (1 Unit)**

This course introduces data management concepts, including data quality, integrity, usability, consistency, availability, and security. It considers the lineage or life cycle of data, sometimes referred to as data provenance. It reviews ethical, legal, and technical issues relating to data acquisition, data dissemination, and privacy protection. The course provides a management introduction to cybersecurity, including network, system, and database security. It reviews encryption and blockchain technologies. The course also covers United States and European Union law relating to data privacy and cybersecurity.

**MSDS 490-DL Special Topics in Data Science (1 Unit)**

Topics vary from term to term.

**Prerequisite:** Vary by topic.

**MSDS 491-DL Special Topics in Data Science-Analytics and Modeling (1 Unit)**

Topics vary from term to term.

**Prerequisite:** Vary by topic.

**MSDS 492-DL Special Topics in Data Science-Data Engineering (1 Unit)**

Topics vary from term to term.

**Prerequisite:** Vary by topic.

**MSDS 493-DL Special Topics in Data Science-Analytics Management (1 Unit)**

Topics vary from term to term.

**Prerequisite:** Vary by topic.

**MSDS 498-0 Capstone (1 Unit)**

The capstone course focuses upon the practice of data science. This course is the culmination of the data science program. It gives students an opportunity to demonstrate their business strategic thinking, communication, and consulting skills. Business cases across various industries and application areas illustrate strategic advantages of analytics, as well as organizational issues in implementing systems for data science. Students work in project teams, generating business plans and project implementation plans. Students may choose this course or the master's thesis to fulfill their capstone requirement.

**Prerequisite:** Completion of all core courses in the student's graduate program and specialization.

**MSDS 498-DL Capstone Class (1 Unit)**

The capstone course focuses upon the practice of data science. This course is the culmination of the data science program. It gives students an opportunity to demonstrate their business strategic thinking, communication, and consulting skills. Business cases across various industries and application areas illustrate strategic advantages of analytics, as well as organizational issues in implementing systems for data science. Students work in project teams, generating business plans and project implementation plans. Students may choose this course or the master's thesis to fulfill their capstone requirement.

**Prerequisite:** Completion of all core courses in the student's graduate program and specialization.

**MSDS 499-DL Independent Study (1 Unit)**

Topics vary from term to term.

**Prerequisite:** Vary by topic.

**MSDS 579-0 Practicum (1 Unit)**

**MSDS 590-DL Thesis Research (1 Unit)**

This final project is meant to represent the culmination of students' experience in the program and must demonstrate mastery of the curriculum and ability to conduct sustained independent research and analysis. The project may be applied or may be a traditional scholarly paper, in both cases a write-up following the paper's program-specific guidelines is required. Students must submit a proposal and secure a



first reader in order to register; for further details students are advised to review the student handbook and contact their academic adviser.