

# BACHELOR OF SCIENCE IN DATA SCIENCE

Data is a key resource that enables organizations to be effective and remain competitive in today's rapidly changing environment. With the expanding use of the internet, social media, video, sensory data and the internet of things, the volume of structured and unstructured data is growing exponentially. At the same time, technological innovation and the emergence of cloud storage has dramatically driven down the cost of storing the large volume of data that is being generated. Organizations are now keenly aware that they have large amounts of data available to them, that the data is valuable for achieving competitive success and that they need new technologies and techniques to harness the power of their data. Data Science is an emerging field that addresses these needs of organizations.

Data Science is dedicated to the extraction of insights and knowledge from vast amounts of data and translating the knowledge into action to achieve desired outcomes. By nature, data science is multi-disciplinary, drawing from many areas such as mathematics and statistics, information theory and technology, including machine learning, statistical learning, computer programming, data engineering, pattern recognition, visualization, predictive analytics, data warehousing, and high-performance computing.

The Bachelor of Science in Data Science (BSDS) is an interdisciplinary program that is designed to provide students with a strong balance in both the theory and practice of creating knowledge from data that can be used by organizations to take reasoned action and to solve real-world problems. It is based on the belief that students need to do more than acquire basic skill set in the areas described above, they must also be comfortable in their ability as story tellers, to explain the importance of their analysis in ways that can be easily understood by others. To prepare students for a career in data science, students will work on real problems and data during their course of study that are provided by organizations in many different areas including business, nonprofit, health care and sports.

## Students with a degree in BSDS will be able to:

- Demonstrate knowledge of programming principles and structured programming.
- Demonstrate the fundamental concepts for acquiring, storing, and processing large amounts of structured and unstructured data.
- Demonstrate knowledge of applying data visualization concepts and principles for effective information communication based on the appropriate audience
- Demonstrate knowledge of cloud computing concepts and its applications.
- Describe the fundamental concepts of managing and utilizing massively large data bases and distributed data processing.
- Demonstrate knowledge of understanding and implementing techniques for solving problems using machine learning and related project pipelines.
- Demonstrate an ability to manage a problem in data science from the point of problem definition through delivery of a solution
- Demonstrate the ability to communicate results of data analysis effectively and provide actionable recommendations to decision makers.

## Faculty

### Department Chair

Suhong Li

### Professor

Abhijit Chaudhury

### Professor

Janet Prichard

### Associate Professor

Kenneth Sousa

### Associate Professor

Chen Zhang

### Assistant Professor

Gianluca Bero

### Assistant Professor

Geri Louise Dimas

### Assistant Professor

Monica (ML) Tlachac

### Assistant Professor

Riazat Ryan

### Executive in Residence

Thomas Dougherty

### Lecturer

Francis Varin

### Lecturer

Michelle Varin

## Bachelor of Science in Data Science Degree Requirements:

### General Education Requirements

### Data Science Degree Requirements:

ISA 210	Introduction to Data Science	3
ISA 221	Introduction to Programming	3
ISA 310	Data Visualization	3
ISA 330	Programming for Data Science	3
ISA 340	Introduction to Machine Learning	3
ISA 341	Database Management System Principles	3
ISA 343	Infrastructure and Cloud Computing	3
ISA 360	Data Warehousing in the Age of Big Data	3
ISA 460	Big Data Analytics	3
ISA 490	Data Science Capstone	3
Two (ISA) Technology Electives (at least 1 must be at the 400 level)		6

### Science Requirements

SCI 373 & SCI L373	Artificial Intelligence and Robotics and Artificial Intelligence and Robotics Laboratory	4
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### Mathematics Requirements

MATH 121	Calculus and Analytic Geometry I (Course can be used in place of MATH 110 in Gen Ed)	3
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MATH 201	Statistics I (Can double count to meet GEN ED requirement)	3
MATH 226	Linear Algebra	3
MATH 350	Statistics II	3
<b>Business Administration Minor Requirement</b>		
ACG 203	Principles of Financial Accounting	3
ISA 201	Introduction to Information Technology and Analytics	3
FIN 201	Financial Management	3
MGT 200	Management Principles and Practice	3
MGT 201	Operations Management	3
MKT 201	Foundations of Marketing Management	3
<b>Two Non-Business Electives</b>		<b>6</b>
<b>Two Business Electives</b>		<b>6</b>
Open Elective		3

A minimum of 120 credit hours is required for graduation.

## Courses

### ISA 201. Introduction to Information Technology and Analytics. 3 Credit Hours.

Information technology has become deeply integrated with every business function. This course covers the role of Information Technology in supporting business process and major enterprise wide strategic initiatives, including Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), Supply Chain Management (SCM), and e-Business. It examines the competitive impact of evolving technologies such as Mobile Computing and Social Networking. The course also covers the social, ethical, and security issues that arise with the use of technology. Various business scenarios/problems are presented to teach students how to use IT to formulate, analyze, and solve problems and to enhance their analytical skills. Students apply what they have learned and compete "team-to-team" in a sponsored course-wide analytical case.

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

### ISA 201G. Introduction to Global Information Technology and Analytics. 3 Credit Hours.

This course will provide a foundation of information technology concepts and application development in a global context. Students are expected to learn how various information technologies can be used to strengthen the business competitiveness globally, how information culture may vary in different countries, and how this variation may impact the adoption of information technologies. Students are expected to learn managerial issues pertaining to development of global information systems. Students will gain experience with database and spreadsheet tools (Access and Excel) which are necessary to be more productive in a global environment.

Prerequisites: BSIB major and GFOB 100G

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

### ISA 203. Honors Business Information Technology and Analytics. 3 Credit Hours.

This course introduces students to the key role that information technology plays in business organizations. Major topics include business information systems, information ethics and social issues, security, database fundamentals, telecommunication, e-commerce, m-commerce and traditional and emerging systems development methodologies. Students will also gain experience in developing a functional database application for a business case and then use the data in the database to create spreadsheet analyses to solve business problems related to the different business functions contained in the business case such as finance, marketing and management.

Prerequisites: Honors Program

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

### ISA 210. Introduction to Data Science. 3 Credit Hours.

This course will introduce students to the field of Data Science and help them gain a foundational understanding of Data Science basic principles and tools as well as an understanding of how Data Scientists contribute to solving meaningful problems across many domains. The concepts, techniques and tools presented in this course will serve as a gateway to more focused courses that lead to becoming an effective Data Scientist. The content of the course will include an introduction to the field of Data Science, what it means to be a Data Scientist, steps in a Data Science project understanding data, data collection and integration, exploratory data analysis, supervised and unsupervised machine learning, text mining, modeling, data product creation, evaluation, effective visualization and communication and ethical issues in Data Science. The focus will be on breadth rather than depth and integration of concepts.

Session Cycle: Fall

Yearly Cycle: Annual.

### ISA 221. Introduction to Programming. 3 Credit Hours.

This course introduces computer programming using high level programming languages. The course begins with a review of control structures and data types with emphasis on structured programming, syntax, repetition structures, decision structures, list and array processing. Emphasis is placed on programming methods, including creating and manipulating objects, classes, and using object-oriented tools such as the class debugger. This course also introduces students to the ideas of data abstraction and object-oriented programming. Other topics include simple analysis of algorithms, basic searching and sorting techniques, and an introduction to software engineering issues through code discussions.

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

**ISA 310. Data Visualization. 3 Credit Hours.**

This course examines the art and science of data visualization. It explores various visualization techniques and the way that shape, size, color, orientation, and motion influence the way information is comprehended. In this course we will study a wide-range of visualization techniques for creating effective visualizations. We will explore well established visualization techniques using products like Excel and Tableau, techniques that are used for visualizing social network through Gephi, while also pushing the boundaries of visualizations by developing our own using Python. Through class discussions we will discuss appropriateness of the various techniques while trying multiple techniques on the same dataset to explore the effectiveness of visual comprehension.

Prerequisites: ISA 221 or instructor permission, and sophomore standing  
Session Cycle: Fall, Spring

Yearly Cycle: Annual.

**ISA 311. Introduction to Cybersecurity. 3 Credit Hours.**

The rapid growth of IT and our dependence upon it have made it imperative that students understand the importance of security both in the workplace and at home. Smart devices have made our lives more convenient in recent years, however, they have also exposed us to increasing threats as bad actors find new ways of exposing our persona data as well as threatening businesses with ransomware. This course is designed to introduce students to the many aspects of cybersecurity using a hands-on approach in a virtual lab. This course will explore common threats such as SQL injection attacks, cross-site scripting, mobile and wireless security, packet sniffing and spoofing and how to best secure your personal and business assets. Additionally, public and private key security and encryption will be examined.

Prerequisites: ISA 201

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

**ISA 312. Mobile Device Application Programming. 3 Credit Hours.**

This is a course in programming methodologies for mobile applications. Students apply a program development process involving problem definition, graphic design methodologies, and pseudo coding. The course will be devoted to writing, debugging, testing, and deploying a variety of applications for mobile devices. Topics include software development kits for mobile applications, Java, and mobile website development.

Prerequisites: ISA 221

Session Cycle: Spring

Yearly Cycle: Varies.

**ISA 314. Visual Basic Programming. 3 Credit Hours.**

This is a course in programming methodologies using the popular Visual Basic.Net Language. Students apply a structured program development process involving problem definition, graphic design methodologies, and pseudo-coding. The course will be devoted to writing, debugging, testing and documenting a variety of programs for business applications. This course will provide students with the background and foundation for their continuing development as programmers.

Prerequisites: ISA 201 and junior standing

Session Cycle: Spring

Yearly Cycle: Varies.

**ISA 320. Information Technology in Supply Chain Management. 3 Credit Hours.**

The purpose of this course is to discuss how IT is used to enable supply chain management and to improve the performance of the supply chain. Major topics include the role of IT in the supply chain, enterprise resource planning (ERP), innovative technologies in the supply chain, IT enablers for supply chain performance, and internet-based supply chain and supply chain security. Hands-on exercises in a simulated SAP ERP system and real-world cases will be used in helping students understand course concepts. This course is cross listed with GSCM 320.

Prerequisites: ISA 201 and MGT 201 or MGT 201G

Session Cycle: Spring

Yearly Cycle: Annual.

**ISA 321. Advanced Java Programming and Data Structures. 3 Credit Hours.**

This course introduces students to intermediate and advanced features of the Java programming language by building on the foundation provided in ISA 221. Advanced Java topics include recursion, file I/O, abstract classes and interfaces, exception handling, generics, collection classes. The course also introduces students to the fundamental concepts of data structures and the algorithms that proceed from them. Topics include fundamental data structures (including stacks, queues, linked lists, hash tables, trees, priority queues, and graphs) and the analysis of algorithms based upon these data structures.

Prerequisites: ISA 221

Session Cycle: Fall

Yearly Cycle: Varies.

**ISA 330. Programming for Data Science. 3 Credit Hours.**

This course is an advanced Python programming course focusing on common programming tools used for Data Science application development with an emphasis on libraries commonly used by Data Scientists (NumPy, Pandas, etc). Data analysts often implement their solutions using programming languages such as R and Python. Because of this, it is critical that the data analyst/scientist be comfortable in such development environments and be able to understand when a solution needs to be programmatically developed. The course covers hands-on programming techniques for analytics which includes web scraping and other data extraction techniques, data transformation, data staging, data analysis, and finally data presentation and visualization. The course will give the students the skills to highlight their capability of producing notebooks appropriate for a data analytics/data science application.

Prerequisites: ISA 221 and sophomore standing

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

**ISA 332. E Business Models. 3 Credit Hours.**

E-Business is doing business activities over an IT platform that uses Internet-related protocols. E-Business activities include not only the business to consumer direct selling over the web but also business-to-business logistics, and all the back-end computer activities within the firm that use Internet protocols. Business organizations are implementing radical changes in the marketing, advertising, and delivery of their products and services. Through the implementation of electronic business technology, organizations are extending their boundaries beyond traditional "bricks and mortar" establishments to a new virtual marketplace that has global reach. Conventional business practices in the areas of advertising, marketing, production, and customer service are being radically transformed by this new platform that permits world-wide connectivity on 24/7 basis.

Prerequisites: ISA 201 and junior standing

Session Cycle: Varies

Yearly Cycle: Annual.

**ISA 340. Introduction to Machine Learning. 3 Credit Hours.**

This is an introductory course requiring no previous knowledge of machine learning. We focus on using Python, and machine learning libraries such as the scikit-learn library, and work through all the steps to create a successful machine learning application. This course does not focus too much on the math, but rather on the practical aspects of using machine learning algorithms to solve problems such as fraud detection. To ground this course we will supplement machine learning algorithms and techniques with case studies and problems such as: House Price Prediction, Handwritten Character Recognition, Credit Card Fraud Detection, Market Segmentation, Churn Prediction and Drivers, Customer Lifetime Value (CLV) Prediction, Photo Classification, People Identification, Document Classification and more.

Prerequisites: ISA 330 or instructor permission, and sophomore standing

Session Cycle: Every Semester

Yearly Cycle: Annual.

**ISA 341. Database Management Systems Principles. 3 Credit Hours.**

This course focuses on the principles of database design and application development in a database environment. Topics will include foundations of the database approach, objectives of this approach, advantages and disadvantages of database processing. A major emphasis will be placed on the Relational Database Model and will include techniques for designing and normalizing a Relational Database. Student projects will include developing application software using a database system.

Prerequisites: ISA 201

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

**ISA 343. Infrastructure and Cloud Computing. 3 Credit Hours.**

The computing infrastructure is constantly evolving due to the technological advancement and business needs. This course introduces the hardware, system software, the cloud and their integration to drive and support business. This course also brings together the technical knowledge and managerial knowledge in various class activities to demonstrate computing infrastructure's design, implementation and maintenance. Topics include computer hardware components, operating systems, computer networks, middleware, virtualization and Big Data support.

Prerequisites: ISA 201

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

**ISA 345. Web Design and Development. 3 Credit Hours.**

This course covers the basic principles of designing and implementing websites, focusing on the client-side technologies of web page creation. No programming background is required, although students will learn some programming through scripting languages. Course topics include web graphics, information structuring, development of interactive pages (using forms and JavaScript), event handling, implementation issues and techniques, web accessibility issues, and use of popular web development tools. Students will learn client side web development technologies such as HTML, JavaScript, jQuery, and Cascading Style Sheets.

Prerequisites: ISA 201

Session Cycle: Fall

Yearly Cycle: Annual.

**ISA 360. Data Warehousing in the Age of Big Data. 3 Credit Hours.**

The main objective of this course is to provide students with an overview of the design and implementation of distributed, parallel databases that could handle massively large data sets that may include billions of rows of data. The major topic include the introduction of big data and its processing architecture, data warehouse, database components and architecture, data distribution, access, storage and data protection, and database tools and utilities. This course offers practical, hands-on experience with retrieving and manipulating data with advanced Structured Query Language (SQL), Hadoop, and NoSQL database.

Prerequisites: ISA 341

Session Cycle: Spring

Yearly Cycle: Annual.

**ISA 391. Information Systems and Analytics Internship. 3 Credit Hours.**

ISA internships give students the opportunity for supervised employment in an area where they can apply the information system principles and techniques they have studied through our curriculum. Interns work at least ten hours per week, meet periodically with a supervising faculty member, and prepare a substantive report on their work experience.

Prerequisites: ISA 221 and ISA 341 and junior standing is required.

**ISA 400. Introduction to Deep Learning. 3 Credit Hours.**

This course introduces the basic concepts of Neural Networks and Deep Learning. Students will learn the fundamental principles, formulations, underlying mathematics and deep learning implementation details in Pytorch. The course will also explore different deep learning model suitability for different data domains such as text, images and videos to deal with different tasks such as Natural Language Processing, Computer Vision, Decision Making, Healthcare and Financial Applications.

Prerequisites: ISA 340 and junior standing

Session Cycle: Fall

Yearly Cycle: Annual.

**ISA 410. Machine Learning with Robotics. 3 Credit Hours.**

This course is designed to provide an in-depth understanding of robotics and associated machine learning concepts. It will explore how the industry leverages both open-source and proprietary technologies to build sophisticated robotic systems. Students will engage in hands-on learning, both individually and in teams, through experiments in 3D simulation environments and with actual robotic hardware. They will have the opportunity to work with a diverse range of equipment, including the Turtlebot 3, as well as Softbank Robotics' NAO and Pepper humanoid robots. This course aims to equip students with the knowledge and skills necessary to navigate and contribute to the rapidly evolving field of robotics.

Prerequisites: ISA340 or with permission of instructor. Sophomore Standing

Session Cycle: Every Fall.

**ISA 421. Advanced Application Development. 3 Credit Hours.**

This course builds on the fundamental programming skills learned in ISA 221. The fundamentals of data types, input and output control structures, methods and objects are presented in the context of the Java programming language. Students will learn to develop Object Oriented server-side applications that mediate between an information source such as a database and client application running in a browser. Modern web application development design techniques and patterns, such as Model View Controller (MVC), are discussed and presented.

Prerequisites: ISA 221

Session Cycle: Spring

Yearly Cycle: Annual.

**ISA 441. Systems Analysis and Information Technology Consulting. 3 Credit Hours.**

Programming is only a small part of designing information systems. A systems analyst works like an investigative journalist, gathering information about the business problem so that an effective technology solution can be designed and constructed. This course teaches you what to look for and how to find it. You will learn structured techniques and less-structured guidelines which will aid in the search for understanding of the organization, its existing systems, and the proposed system. Programming design techniques are also covered. Teams of students will develop a plan for building a complete computer information system for a real or fictitious company.

Prerequisites: ISA 221 and ISA 341 and senior standing

Session Cycle: Fall

Yearly Cycle: Annual.

**ISA 442. Project Management and Practice. 3 Credit Hours.**

This course is intended to provide an introduction to Project Management as it applies to the Information Technology industry. The course will assist analysts, developers, team leaders and managers in developing an understanding of the purpose and benefits of project management by exposure to the concepts, practices, processes, tools, techniques, and resources used by the Project Manager during the project life cycle. The course will closely follow the framework of "best practices" of the Project Management Body of Knowledge, the leading professional standard for project management, with emphasis on its application to software and systems development projects.

Prerequisites: ISA 441 and senior standing

Session Cycle: Spring

Yearly Cycle: Varies.

**ISA 445. Advanced Web Programming. 3 Credit Hours.**

This course complements skills and content learned in ISA 345 Web Design and Development. The focus of ISA 345 is on browser/end user aspects of web operations while this course focuses on the server/provider aspects. Students will learn to develop server-side applications that mediate between an information source such as a database and the browser-end programs using popular web-application software. An introduction to XML and server side scripting is also presented.

Prerequisites: ISA 345

Session Cycle: Spring

Yearly Cycle: Alternate Years.

**ISA 460. Big Data Analytics. 3 Credit Hours.**

The explosive growth of structured and unstructured data in the form of emails, weblogs, tweets, sensors, video and text has necessitated the use of Big Data and advanced analytics techniques to support large scale data analytics. This course brings together key Big Data tools on a Hadoop platform to show how to efficiently manage data with three main characteristics; volume, velocity and variety. Topics include the Hadoop platforms, Teradata Aster, social media analytics, link analysis, and stream analytics.

Prerequisites: ISA 340 and ISA 341

Session Cycle: Fall

Yearly Cycle: Annual.

**ISA 470. Managing Global Information Resources. 3 Credit Hours.**

Information systems provide the framework for decision making across the functional areas of an organization and are major enablers of globalization. This course provides a foundation in the principles and concepts of managing information resources in a global environment. The course focuses on alternative approaches to managing information resources such as computers, communication networks, software, data and information in organizations. Students will learn how multinational corporations are using IT to develop business solutions and obtain competitive advantage. Emphasis will be placed on viewing the organization in a global perspective, with the associated technological, cultural and operational issues that influence information resource management. Several real-world cases will be used to enhance students' understanding of the course materials.

Prerequisites: ISA 201 and junior standing

Session Cycle: Fall

Yearly Cycle: Varies.

**ISA 472. IT Security and Risk Management. 3 Credit Hours.**

This course explores IT Security from the perspective of risk management. Assessment of IT systems is critical to developing strategies to mitigate and manage risks. This course focuses on effective assessment strategies that ultimately help the student to implement effective and proactive risk mitigation measures and risk management practices. This course focuses on the IT security threat environment, cryptography, securing networks, access control, firewalls, host hardening, application security, data protection, and incident response. A clear theoretical understanding supports a practical component. Students will learn to audit information systems and use contemporary security software including intrusion big data analysis.

Prerequisites: ISA 201 AND one of the following courses: ISA 221, ISA 311, ISA 341, ISA 343 and ISA 345. Junior Standing OR Permission of instructor

Session Cycle: Spring

Yearly Cycle: Alternate Years.

**ISA 490. Data Science Capstone. 3 Credit Hours.**

To become an expert data scientist students need practice and experience. By completing this capstone project students will get an opportunity to apply the knowledge and skills that were gained throughout this major. This capstone project will test student skills in data visualization, data wrangling, data organization, machine learning, analysis, and presentation. Projects will be drawn from real-world problems and will be conducted with industry, government, and academic partners. During the project, students engage in the entire process of solving a real-world data science project, from defining the problem or opportunity, collecting and processing actual data, selecting and applying state of the art data science techniques to the problem and identifying actionable results. Emphasis will be placed on problem solving via state of the art data science pipelines and practices, and on the ability to “tell a story” using verbal, analytical, written and visualization skills.

Prerequisites: ISA 340 or instructor permission and senior standing

Session Cycle: Spring

Yearly Cycle: Annual.

**ISA 497. Directed Study in Information Systems and Analytics. 3 Credit Hours.**

This course provides an opportunity for senior information systems and analytics majors to do independent, in-depth study or research. The student works on an individual basis under the direction of a member of the ISA department. Normally the course requires the student to develop a substantial paper or project.

Prerequisites: Permission of the instructor and department chair approval.

**ISA ST400. Special Topics in Information Systems and Analytics Introduction to Blockchain. 3 Credit Hours.**

This course introduces students to blockchain technology. Students will gain a full understanding of the technology from a management perspective. Students will gain the knowledge needed to understand where this emerging technology is being used and explore why companies are choosing to build their business on blockchain. We will explore how different vertical markets are using blockchain. The second half of the course will be hands-on with the students developing their own smart contract. Students will learn the Solidity programming language in order to write their own smart contracts. Existing smart contracts will be used to discuss techniques and ways to organize code. Heavy emphasis on testing will be done with a bounty like competition being used in the class which will reward students in finding flaws with each other's smart contracts. We will deploy the smart contracts in a private Ethereum environment so students understand the full development life cycle.

Prerequisites: ISA 221 or ISA 312 or ISA 314 or ISA 321 or ISA 330.