



MARQUETTE
UNIVERSITY

HELEN WAY KLINGLER
COLLEGE OF ARTS AND SCIENCES

Handbook

for

Interdisciplinary Data Science Majors

2020-2021

Department of Mathematical and Statistical Sciences

INTRODUCTION

The Department seeks to provide each of its majors with a broad understanding of data science. This broad understanding serves as a coherent framework in which the student can place his or her developing knowledge and technical skill. Moreover, the Department seeks to provide each student with a solid foundation in the central ideas and methods of modern data science. It seeks to produce data scientists who know, understand, and can apply these central ideas and methods to real problems.

Data science is dynamic. It grows constantly. It evolves continuously. It regularly experiences revolutionary transformation. The Department seeks, therefore, to produce data scientists who can adapt and grow along with their chosen profession.

The Department does not seek to train its majors in any particular conceptual methodology or software product. Rather, the goal is to provide its majors with the power to succeed in today's data centric world as well as tomorrows. Students will, however, acquire ample specific knowledge during their education.

PROGRAM EDUCATIONAL OBJECTIVES

Within a few years of graduation, we expect alumni of our program to be applying the skills, knowledge and values they have learned at Marquette University to solve problems and to effect positive changes in a complex world. Specifically, our graduates are:

1. Working to solve meaningful problems using data driven decision making, as employees in industry or government, students seeking advanced degrees, or merely as engaged citizens;
2. Communicating and collaborating effectively with colleagues, clients and those in other fields;
3. Pursuing excellence and continued learning as a lifelong endeavor, especially in a world overflowing with data; and
4. Growing into ethical and informed leaders and role-models in their profession and in their community.

ADVISING and PRE-REGISTRATION

A student planning to complete a major in Interdisciplinary Data Science should enroll in COSC 1010¹ and MATH 1450² in the first semester of his or her freshman year and in COSC 1020 and MATH 1451³ in the second semester. As soon as he or she has decided to major in the Department, the student should report to the Department office (room #340 of Cudahy Hall) to declare a major and to be assigned a departmental advisor. From this time on the student meets with the advisor to discuss course selections for the next semester and general academic progress.

¹ Upon request, 4 credits for COSC 1010 will be awarded to those students who scored a 4 or 5 on their Advanced Placement (AP) Computer Science A test.

² Upon request, 4 credits for MATH 1450 will be awarded to those students who scored a 4 or 5 on their Advanced Placement (AP) Calculus AB test or who scored a 3, 4, or 5 on their AP Calculus BC test.

³ Upon request, 4 credits for MATH 1451 will be awarded to those students who scored a 4 or 5 on their AP Calculus BC test.

STUDENT LEARNING OUTCOMES

Upon completion of all required coursework, Interdisciplinary Data Science majors will be able to:

1. Represent and manipulate data in effective ways.
2. Manipulate data using package/tools and by “ad hoc” data handling.
3. Use mathematical, computational and statistical tools to detect patterns and model performance.
4. Use computational principles and tools to tackle issues addressable by data science.
5. Use a solid foundation in data science to independently learn new methodologies and technologies in the emerging field of data science.

REQUIREMENTS FOR THE INTERDISCIPLINARY DATA SCIENCE MAJOR

REQUIRED COURSES

All students must take the following sixteen courses:

COSC 1010	Introduction to Software Development	4 sem. hrs.
COSC 1020	Object-Oriented Software Design	4 sem. hrs.
COSC 2100	Data Structures	3 sem. hrs.
COSC 4610	Data Mining	3 sem. hrs.
COSC 4800	Principles of Database Systems	3 sem. hrs.
MATH 1450	Calculus 1	4 sem. hrs.
MATH 1451	Calculus 2	4 sem. hrs.
MATH 2100/2350	Discrete Mathematics / Foundations of Mathematics	3 sem. hrs.
MATH 2450	Calculus 3	4 sem. hrs.
MATH 3100	Linear Algebra and Matrix Theory	3 sem. hrs.
MATH/COSC 3570	Introduction to Data Science	3 sem. hrs.
MATH 4700	Theory of Probability	3 sem. hrs.
MATH 4720/4740	Statistical Methods / Biostatistical Methods and Models	3 sem. hrs.
MATH 4780	Regression Analysis	3 sem. hrs.
INDS 4997	Capstone in Data Science	3 sem. hrs.

ELECTIVES

To complete the major, 6 additional semester hours of upper-division (3000- or 4000-level) COSC or MATH courses are required. A partial list of available choices is given below:

COSC 4500	Visual Analytics	3 sem. hrs.
COSC 4600	Fundamentals of Artificial Intelligence	3 sem. hrs.
MATH 4630	Mathematical Modeling and Analysis	3 sem. hrs.
MATH 4710	Mathematical Statistics	3 sem. hrs.
MATH 4760	Time Series Analysis	3 sem. hrs.

Special topics courses (MATH/COSC 4931) are also routinely offered by the faculty.

In addition, Marquette's Computer Engineering (COEN) major offers upper division electives in computer architecture, graphics, security, intelligent systems, and other topics. Students are

normally permitted to substitute up to six credits of COEN electives toward the COSC elective requirement, but must apply for a waiver from the MSSC Undergraduate Committee on a course by course basis.

COURSE SELECTION

An Interdisciplinary Data Science major must satisfy the requirements for the major as well as the graduation requirements of the College of Arts and Sciences as described in the University Undergraduate Bulletin. Both the requirements for the major and the general requirements of the College are flexible enough to allow each student to select a variety of courses. The following comments are intended to aid students in making these selections.

Most elective INDS courses are offered either every other semester, or every fourth semester (once every two years) in a standard rotation. Consult your advisor for a predicted schedule of offerings. In addition, the Department occasionally offers special courses not yet part of the regular curriculum. These will be listed in the Timetable of Classes as MATH 4931 (Topics in Mathematical or Statistical Sciences) or COSC 4931 (Topics in Computer Science).

A student interested in the mathematical aspects of Data Science, including both mathematical modeling and numerical analysis, should seriously consider a major or minor in Mathematics to go with his or her major in Interdisciplinary Data Science, or perhaps a major in Computational Mathematics. The requirements for combined programs are described later in this document. The MSSC department offers electives in a wide range of areas in applied mathematics, statistics, and theoretical mathematics, as well as graduate-level courses in computational sciences.

A student interested in applications of computing in media or entertainment may consider completing the requirements for the Minor in Digital Media or Minor in Fine Arts – Graphic Design. A student interested in applications of computing in business may consider completing the requirements for the Minor in Business Administration or the Minor in Entrepreneurship. These are described in the University Undergraduate Bulletin.

Both the College of Engineering and the College of Business Administration offer a number of data related courses. Interdisciplinary Data Science majors may find some of these useful as electives. Courses from other Colleges can sometimes be used to satisfy the elective requirements for a major in Interdisciplinary Data Science, but students must apply for a waiver from the MSSC Undergraduate Committee. Consult your advisor before attempting any such cross-college substitutions.

For electives outside the Department, courses that enhance communication and reasoning skills are the most beneficial to the data science professional. There are a number of such courses to be found in the offerings of the Departments of English and Philosophy.

COMBINED MAJORS AND MINORS IN INTERDISCIPLINARY DATA SCIENCE AND OTHER AREAS

MAJOR IN INTERDISCIPLINARY DATA SCIENCE AND MINOR IN MATHEMATICS

A student with a major in Interdisciplinary Data Science needs to complete the math requirements for the minor in mathematics. There are nine additional credit hours of MATH courses (three more upper division MATH). If an INDS major decides to embark on a MATH minor after completing MATH 2100, substitutions for the MATH 2350 requirement may be allowed, but students must apply for a waiver from the MSSC Undergraduate Committee.

MAJOR IN INTERDISCIPLINARY DATA SCIENCE AND IN MATHEMATICS

A student majoring in both Interdisciplinary Data Science and Mathematics must complete seventy-one credit hours of INDS and MATH courses. This total includes fifteen additional credit hours of MATH courses in addition to the fifty-six credit hours required of the INDS major. The required courses include: (a) COSC 1010, 1020, 2100, 4610 and 4800; (b) two approved electives from COSC or MATH; (c) MATH 1450, 1451, 2350 (in place of MATH 2100), 2450, 3100, 3570, 4700, 4720, 4780, and 15 additional hours of upper division MATH courses as outlined in the Mathematics major handbook; and (d) INDS 4997.

MAJOR IN INTERDISCIPLINARY DATA SCIENCE AND OTHER MINOR.

Other common minors with a major in Interdisciplinary Data Science include the Minor in Business Administration or the Minor in Entrepreneurship from the College of Business Administration, or the Minor in Digital Media from the College of Communication. A student seeking one of these minors should follow the course requirements listed in the Undergraduate Bulletin.

Interdisciplinary Data Science Major SAMPLE CURRICULUM

<i>First Term</i>		<i>Freshman</i>		<i>Second Term</i>	
	<u>Sem. Hrs.</u>				<u>Sem. Hrs.</u>
COSC 1010	4			COSC 1020	4
MATH 1450	4			MATH 1451	4
ENGL 1001 or ESSV1 (MCC)	3			ENGL 1001 or ESSV1 (MCC)	3
PHIL 1001 or THEO 1001 (MCC)	3			PHIL 1001 or THEO 1001 (MCC)	3
	-----				-----
	14				14

<i>First Term</i>		<i>Sophomore</i>		<i>Second Term</i>	
	<u>Sem. Hrs.</u>				<u>Sem. Hrs.</u>
COSC 2100	3			MATH 3100	3
MATH 2350	3			MATH 3570 or COSC 3570	3
MATH 2450	4			MATH 4720 or 4740	3
CORE 1929 (MCC) or elective	3			CORE 1929 (MCC) or elective	3
Elective	3			DSCV (MCC) ^{4,5}	3
	-----				-----
	16				15

<i>First Term</i>		<i>Junior</i>		<i>Second Term</i>	
	<u>Sem. Hrs.</u>				<u>Sem. Hrs.</u>
COSC 4800	3			COSC 4610	3
MATH 4700	3			COSC or MATH Science elective	3
DSCV (MCC) ^{4,5}	3			DSCV (MCC) ^{4,5}	3
Electives	6			DSCV (MCC) ^{4,5}	3
	-----			Elective	3
	15				-----
					15

<i>First Term</i>		<i>Senior</i>		<i>Second Term</i>	
	<u>Sem. Hrs.</u>				<u>Sem. Hrs.</u>
MATH 4780	3			INDS 4997	3
COSC or MATH science elective	3			CORE 4929 (MCC) or elective	3
CORE 4929 (MCC) or elective	3			Electives	9
Electives	7				-----
	-----				-----
	16				15

⁴ The four courses in the Discovery Tier (DSCV) of the MCC must be completed in the same theme and include the following content areas: Humanities (HUM), Social Science (SSC), Natural Science and Mathematics (NSM) and one elective (ELE), which is an additional course from any of the three content areas. A maximum of two courses in the Discovery Tier can apply towards a primary major.

⁵ Students must also complete the Writing Intensive (WRIT) and Engaging Social System and Values 2 (ESSV2) requirements of the MCC. These requirements can be fulfilled through designated courses in the Discovery Tier or other degree requirements.

Interdisciplinary Data Science Major with Minor in Business Administration SAMPLE CURRICULUM

<i>First Term</i>		<i>Freshman</i>		<i>Second Term</i>	
	<u><i>Sem. Hrs.</i></u>				<u><i>Sem. Hrs.</i></u>
COSC 1010	4	COSC 1020		COSC 1020	4
MATH 1450	4	MATH 1451		MATH 1451	4
ENGL 1001 or ESSV1 (MCC)	3	ENGL 1001 or ESSV1 (MCC)		ENGL 1001 or ESSV1 (MCC)	3
PHIL 1001 or THEO 1001 (MCC)	3	PHIL 1001 or THEO 1001 (MCC)		PHIL 1001 or THEO 1001 (MCC)	3
	-----				-----
	14				14

<i>First Term</i>		<i>Sophomore</i>		<i>Second Term</i>	
	<u><i>Sem. Hrs.</i></u>				<u><i>Sem. Hrs.</i></u>
COSC 2100	3	MATH 3100		MATH 3100	3
MATH 2350	3	MATH 3570 or COSC 3570		MATH 3570 or COSC 3570	3
MATH 2450	4	MATH 4720 or 4740		MATH 4720 or 4740	3
CORE 1929 (MCC) or elective	3	CORE 1929 (MCC) or elective		CORE 1929 (MCC) or elective	3
ECON 1001	3	DSCV (MCC) ^{4,5}		DSCV (MCC) ^{4,5}	3
	-----				-----
	16				15

<i>First Term</i>		<i>Junior</i>		<i>Second Term</i>	
	<u><i>Sem. Hrs.</i></u>				<u><i>Sem. Hrs.</i></u>
COSC 4800	3	COSC 4610		COSC 4610	3
MATH 4700	3	COSC or MATH Science elective		COSC or MATH Science elective	3
DSCV (MCC) ^{4,5}	3	DSCV (MCC) ^{4,5}		DSCV (MCC) ^{4,5}	3
OSCM 3001	3	DSCV (MCC) ^{4,5}		DSCV (MCC) ^{4,5}	3
BUAD 1060	1	BUAD 2100		BUAD 2100	3
Elective	3				
	-----				-----
	16				15

<i>First Term</i>		<i>Senior</i>		<i>Second Term</i>	
	<u><i>Sem. Hrs.</i></u>				<u><i>Sem. Hrs.</i></u>
MATH 4780	3	INDS 4997		INDS 4997	3
COSC or MATH science elective	3	CORE 4929 (MCC) or elective		CORE 4929 (MCC) or elective	3
CORE 4929 (MCC) or elective	3	MARK 3001		MARK 3001	3
INSY 3001	3	Electives		Electives	6
MANA 3001	3				
	-----				-----
	16				15

BS/MS Program in Interdisciplinary Data Science and Applied Statistics

SAMPLE CURRICULUM

<u>Fall 1</u>	<u>Sem. Hrs.</u>	<u>Spring 1</u>	<u>Sem. Hrs.</u>
COSC 1010	4	COSC 1020	4
MATH 1450	4	MATH 1451	4
ENGL 1001 or ESSV1 (MCC)	3	ENGL 1001 or ESSV1 (MCC)	3
PHIL 1001 or THEO 1001 (MCC)	3	PHIL 1001 or THEO 1001 (MCC)	3
	-----		-----
	14		14
 <u>Fall 2</u>	 <u>Sem. Hrs.</u>	 <u>Spring 2</u>	 <u>Sem. Hrs.</u>
COSC 2100	3	MATH 3100	3
MATH 2350	3	MATH 3570 or COSC 3570	3
MATH 2450	4	MATH 4720 or 4740	3
CORE 1929 (MCC) or elective	3	CORE 1929 (MCC) or elective	3
Elective	3	DSCV (MCC) ^{4,5}	3
	-----		-----
	16		15
 <u>Fall 3</u>	 <u>Sem. Hrs.</u>	 <u>Spring 3</u>	 <u>Sem. Hrs.</u>
COSC 4800	3	COSC 5610	3
MSSC 5700	3	COSC or MATH Science elective	3
DSCV (MCC) ^{4,5}	3	DSCV (MCC) ^{4,5}	3
Electives	6	DSCV (MCC) ^{4,5}	3
	-----	Elective	3
	15		-----
			15
 <u>Fall 4</u>	 <u>Sem. Hrs.</u>	 <u>Spring 4</u>	 <u>Sem. Hrs.</u>
MSSC 5780	3	MSSC 5710	3
COSC or MATH science elective	3	CORE 4929 (MCC) or elective	3
CORE 4929 (MCC) or elective	3	INDS 4997	3
Electives	7	Electives	9
	-----		-----
	16		15
 <u>Fall 5</u>	 <u>Sem. Hrs.</u>	 <u>Spring 5</u>	 <u>Sem. Hrs.</u>
MSSC 6010 Computational Probability	3	MSSC 6020 Statistical Simulation	3
MSSC 6040 Applied Linear Algebra	3	MSSC 6250 Statistical Machine Learning	3
MSSC 6240 Des. & Anal. of Sci. Exp.	3	MSSC 6975 Practicum for Stat. Consul.	3
	-----		-----
	9		9

BS/MS Program in Interdisciplinary Data Science and Computing with Big Data & Data Analytics Specialization

SAMPLE CURRICULUM

<u>Fall 1</u>	<u>Sem. Hrs.</u>	<u>Spring 1</u>	<u>Sem. Hrs.</u>
COSC 1010	4	COSC 1020	4
MATH 1450	4	MATH 1451	4
ENGL 1001 or ESSV1 (MCC)	3	ENGL 1001 or ESSV1 (MCC)	3
PHIL 1001 or THEO 1001 (MCC)	3	PHIL 1001 or THEO 1001 (MCC)	3
	-----		-----
	14		14
<u>Fall 2</u>	<u>Sem. Hrs.</u>	<u>Spring 2</u>	<u>Sem. Hrs.</u>
COSC 2100	3	MATH 3100	3
MATH 2350	3	MATH 3570 or COSC 3570	3
MATH 2450	4	MATH 4720 or 4740	3
CORE 1929 (MCC) or elective	3	CORE 1929 (MCC) or elective	3
Elective	3	DSCV (MCC) ^{4,5}	3
	-----		-----
	16		15
<u>Fall 3</u>	<u>Sem. Hrs.</u>	<u>Spring 3</u>	<u>Sem. Hrs.</u>
COSC 5800	3	COSC 5610	3
MSSC 5700	3	COSC or MATH Science elective	3
DSCV (MCC) ^{4,5}	3	DSCV (MCC) ^{4,5}	3
Electives	6	DSCV (MCC) ^{4,5}	3
	-----	Elective	3
	15		-----
			15
<u>Fall 4</u>	<u>Sem. Hrs.</u>	<u>Spring 4</u>	<u>Sem. Hrs.</u>
MSSC 5780	3	INDS 4997	3
COSC or MATH science elective	3	CORE 4929 (MCC) or elective	3
CORE 4929 (MCC) or elective	3	Electives	9
Electives	7		-----
	-----		-----
	16		15
<u>Summer Session 1</u>	<u>Sem. Hrs.</u>	<u>Summer Session 2</u>	<u>Sem. Hrs.</u>
GSM Elective (e.g. INTE 6000)	3	MSSC Computing elective	3
MSSC 6390 Professional seminar	1	MSSC 6390, Professional seminar	1
	-----		-----
	4		4
<u>Fall 5</u>	<u>Sem. Hrs.</u>	<u>Spring 5</u>	<u>Sem. Hrs.</u>
COSC 6931 Topics: Data Warehousing	3	COSC 6060 Parallel & Dist. Computing	3
COSC 6931 Topics: Business Intelligence	3	COSC 6931 Topics: Business Analytics	3
COSC Computing Elective	3	COSC 6390 Professional seminar	1
	-----		-----
	9		7

STUDENT COMPUTING FACILITIES

Katherine Reed Cudahy Hall houses the University's Information Technology Service (ITS) central computing facilities on the second floor, and MSSC department computing facilities on the first, third and fourth floors.

Marquette students, faculty and staff are granted accounts on the Emarq and CheckMarq systems maintained by ITS. Authentication credentials can be obtained from the ITS Help Desk (room CU 293) and are maintained throughout a student's enrollment at Marquette. Additional information regarding University computing facilities can be obtained by calling the ITS Help Desk at 288-7799.

The MSSC Department maintains its own independent computing facilities for both teaching and research purposes. Students enrolled in MSSC courses or as department majors are granted access to general purpose laboratories in CU 101, CU 310, and CU 412. In addition, students enrolled in particular courses or involved in research projects may be granted access to special-purpose laboratories in CU 145, CU 301, CU 310, CU 368, CU 392, or CU 410.

The MSSC network features Gigabit internal connectivity between seven subnets with a wide variety of computing hardware and operating systems. Solaris and Linux servers provide centralized file, mail, web and print services to Windows, Linux, Solaris and Mac clients. Computer configurations range from an in-desk PC classroom to laboratories of dual-head workstations for collaborative project work.

Although students may have their own computer equipment, the MSSC department provides sufficient facilities for all MSSC coursework. Students are encouraged to make use of department facilities; experience with heterogeneous computing environments provides a rich educational opportunity, and MSSC maintains a large body of software tailored to the needs and interests of department majors.

Additional information about MSSC department computing facilities can be obtained from the MSSC system administrator at 288-1580, or online at <https://www.marquette.edu/mathematical-and-statistical-sciences/>.