Office of the Provost
University of Maryland, Baltimore County
1000 Hilltop Circle
Baltimore, MD 21250

PHONE: 410.455.2333
FAX: 410-455-1107
www.umbc.edu

August 1, 2025

Sanjay Rai, PhD
Secretary
Maryland Higher Education Commission
217 E. Redwood Street
21st Floor
Baltimore, MD 21202

Dear Secretary Rai:

UMBC's Department of Computer Science and Electrical Engineering is pleased to submit a proposal to establish a Master of Science (M.S.) in Applied Data Science.

The M.S. in Applied Data Science will combine advanced teaching methods with state-of-the-art tools, offering rigorous academic training and hands-on, real-world projects. The program will prepare students for careers in high-demand fields such as technology, healthcare, finance, and government, with a strong foundation in data science applications across science, engineering, IT, and public policy. Emphasizing innovation, entrepreneurship, and collaboration with public and private partners, the program will support economic development and the commercialization of new ideas. It will be delivered at UMBC's Catonsville campus, offering students an affordable and accessible pathway to gain expertise in a field that is essential to Maryland's economic and technological future.

Thank you very much for your consideration of this request.

Sincerely,

Manfred H. M. van Dulmen
Provost and Senior Vice President for Academic Affairs

Cc: Crystal Williams, Assistant Vice Provost for Curriculum Development
Yonatan Harris, Executive Assistant to the Vice Provost for Academic Affairs

Office Use Only: PP#

Cover Sheet for In-State Institutions
New Program or Substantial Modification to Existing Program

Institution Submitting Proposal	UMBC

Each action below requires a separate proposal and cover sheet.

- (●) New Academic Program
- ( ) New Area of Concentration
- ( ) New Degree Level Approval
- ( ) New Stand-Alone Certificate
- ( ) Off Campus Program
- ( ) Substantial Change to a Degree Program
- ( ) Substantial Change to an Area of Concentration
- ( ) Substantial Change to a Certificate Program
- ( ) Cooperative Degree Program
- ( ) Offer Program at Regional Higher Education Center

Payment Submitted: (●) Yes ( ) No Payment Type: (●) R*STARS # 3207367 ( ) Check # Payment Amount: 850.00 Date Submitted: 08/01/2025

Department Proposing Program	Department of Computer Science and Electrical Engineering
Degree Level and Degree Type	Graduate, Master of Science (MS)
Title of Proposed Program	Applied Data Science
Total Number of Credits	30
Suggested Codes	HEGIS: 070799 CIP: 30.7001
Program Modality	(●) On-campus ( ) Distance Education (fully online) ( ) Both
Program Resources	(●) Using Existing Resources ( ) Requiring New Resources
Projected Implementation Date (must be 60 days from proposal submission as per COMAR 13B 02 03.03)	( ) Fall (●) Spring ( ) Summer Year: 2026
Provide Link to Most Recent Academic Catalog	URL: https://catalog.umbc.edu/
Preferred Contact for this Proposal	Name: Crystal Williams Title: Assistant Vice Provost for Curriculum Development Phone: 410-455-3862 Email: crysw1@umbc.edu
President/Chief Executive	Type Name: Manfred H. M. van Dulmen Provost and Senior Vice President for Academic Affairs Signature: [signature] Date: 6/10/2025
	Date of Approval/Endorsement by Governing Board:

Revised 4/2025

University of Maryland Baltimore County (UMBC)
Master of Science (M.S.) in Applied Data Science Narrative

A. Centrality to Institutional Mission and Planning Priorities:

1. Provide a description of the program, including and how it relates to the institution's approved mission

The UMBC Department of Computer Science and Electrical Engineering (CSEE) proposes to launch a Master of Science (M.S.) in Applied Data Science. Upon final approval, after a short transition period, the proposed M.S. in Applied Data Science will replace the existing Data Science track in the M.P.S. in Professional Studies as UMBC's primary graduate degree in the data science domain. The rigorous nature of our master's and doctoral programs is consistent with UMBC's role as one of three principal centers for research and doctoral-level training in the University System of Maryland (USM) as an R-1 (Very High) Carnegie classification. The CSEE department and College of Engineering and Information Technology (COEIT) work closely with their respective advisory boards and UMBC's Office of Institutional Advancement to build external relations to make sure that we are responsive to the regional and national needs of our industry stakeholders and providing affordable, accessible ways to effectively enhance the professionalism and diversity of Maryland's data science workforce.

Offered at UMBC's campus in Catonsville, the proposed M.S. in Applied Data Science will be a non-thesis, course-based degree consisting of 10 courses/30 credits, with six core and four elective courses. Core courses focus on the practical and applied aspects of data science. Elective courses allow students to dive deeper or specialize in more granular topics that are relevant to their personal interests or professional needs.

Table 1: List of frequently used abbreviations and their full names.

Abbreviation	Full Name
COEIT	College of Engineering and Information Technology
CSEE	Computer Science and Electrical Engineering
DOIT	Division of Information Technology
DPS	Division of Professional Studies
M.S.	Master of Science
M.P.S.	Master of Professional Studies
UMBC	University of Maryland Baltimore County
USM	University System of Maryland

The program will integrate advanced teaching methodologies with cutting-edge tools of data science. Students will not only receive rigorous academic training but also engage in real-world projects, benefiting both the university community and the citizens of Maryland. The program will provide academically talented students with a strong foundation in data science, preparing them for further graduate and professional study in specialized fields. Graduates will be equipped with the skills and knowledge necessary for professional careers in data science-related industries. By focusing on areas such as science, engineering, information technology, econometrics, and public policy, the program will contribute directly

to the economic development of the state and region. Graduates will be equipped with highly sought-after skills that are essential for driving innovation and growth in industries such as technology, healthcare, finance, and government. The program will foster an entrepreneurial mindset among students, encouraging them to innovate and create new solutions using data science technologies. Through collaborations with public agencies and the corporate community, students will have opportunities to commercialize their ideas and contribute to the development of new products and services. UMBC is dedicated to fostering a diverse and inclusive learning environment, and the M.S. in Applied Data Science program will reflect this commitment by welcoming students from diverse cultural and ethnic backgrounds. Additionally, the program will promote lifelong learning by providing students with the skills and knowledge they need to adapt to evolving technologies and industries throughout their careers.

2. Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is an institutional priority

As presented in the USM 2020 Strategic Plan's Theme 2: Maryland's Economic Development and the Health and Quality of Life of Its Citizens-Ensuring Maryland's Competitiveness in the New Economy, a major goal is to enhance programs essential to the state's overall competitiveness in critical areas such as STEM, education, health care, data science. The USM Strategic Plan also provides a call to "Fuel Maryland's knowledge-based economy and enhance the quality of life of its citizens by increasing the number of graduates produced in workforce areas that are key to the state's ability to thrive and compete (including STEM, education, nursing, health care, data science, and other disciplines) and promoting improved health care and other critical services." (p.16) By launching this new graduate degree program, UMBC expects to continue directly contributing to USM's strategic priorities by creating a new graduate degree to help meet these critical needs in the State and region.

UMBC's Strategic Plan declares "UMBC is a dynamic public research university integrating teaching, research, and service to benefit the citizens of Maryland ... UMBC contributes to the economic development of the state and the region through entrepreneurial initiatives, workforce training, K-16 partnerships, and technology commercialization in collaboration with public agencies and the corporate community. UMBC is dedicated to cultural and ethnic diversity, social responsibility, and lifelong learning" (p.5). Data-related initiatives are identified as an institutional priority, which UMBC is already actively involved with through innovative education, research, and assorted local, regional, and global partnerships. These goals are reflected in UMBC's institutional priorities and aligned with the USM's 2020 Strategic Plan and the 2022 MHEC Statewide Plan[1].

3. Provide a brief narrative of how the proposed program will be adequately funded for at least the first five years of program implementation.

The program will be funded entirely through tuition revenues managed by the Division of Professional Studies (DPS). Additional support services such as technology support, library services, marketing, and related academic/program support will be drawn from UMBC's existing institutional capabilities. Special learning experiences, research opportunities, and/or technologies for students may be funded through faculty-led grant efforts, such as UMBC's federal Scholarship-for-Service program, and/or obtained via internships with local companies or government organizations, including BWTECH.

[1] http://dlslibrary.state.md.us/publications/Exec/MHEC/ED11-105(b)(3)(i)_2022.pdf (visited April 3, 2024)

4. **a) Provide a description of the institution's a commitment to ongoing administrative, financial, and technical support of the proposed program.**

Data-related studies like data science are an institutional priority under UMBC's Strategic Plan. As such, and since data science across government and industry sectors continues to be a critical concern for Maryland and the world, UMBC is committed to providing the necessary administrative, financial, and technical support to launch, grow, and sustain this master's in applied data science. Technical support for students and faculty is available through Blackboard and other web-based technologies supported by UMBC's Division of Information Technology (DOIT), in-class time, and faculty office hours.

b) Provide a description of the institution's a commitment to continuation of the program for a period of time sufficient to allow enrolled students to complete the program.

The launch of this new graduate degree will present no challenge or obstacles to currently enrolled (or future) students from completing their graduate studies in data science at UMBC.

B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan:

1. **Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State.**

UMBC's first graduate data science program, the Data Science track in the Master of Professional Studies (M.P.S.), was launched in response to a critical and compelling regional need for qualified data science professionals. This initiative was driven by a focus group consultation, which included input from federal, state, and local employers in the Baltimore and Washington metropolitan areas, who identified a growing demand for skilled talent in the field of data science. At the time of its launch, there were limited graduate programs in data science within Maryland, making UMBC's program a vital resource for meeting the increasing workforce demand for data scientists. The program was strategically designed to address this need and is now offered at UMBC's Main Campus.

2. **Provide evidence that the perceived need is consistent with the Maryland State Plan for Postsecondary Education**.

The 2022 MHEC Statewide Plan[1] recognizes data science and IT fields as key industries for Maryland's development, highlighting the importance of public universities like UMBC offering such in-demand programs. This not only provides affordable and accessible education but also creates a robust pool of highly educated future employees to meet critical workforce needs in the state. Furthermore, offering a graduate degree in data science aligns with MHEC's goals and guidance, reflecting Maryland's higher education priorities. The program supports lifelong learning and career development for working professionals, reinforcing its relevance in the rapidly evolving field of data science.

The 2022 MHEC Statewide Plan also emphasizes the need for expanded STEM and data science education in Maryland, a goal that UMBC's Data Science program directly supports. Initiatives and legislation from the state government, such as the establishment of the Maryland Institute for Innovative Computing (MIIC) and the Maryland Technology Internship Program (MTIP), further enhance UMBC's commitment to preparing students for real-world data science challenges and opportunities within the state.

The 2022 State Plan for Higher Education was ratified by the Maryland Higher Education Commission on June 22, 2022. In January 2024, the Governor also issued an executive order on digital services[2]. The latter executive order provides detailed guidance on the responsible and ethical use of AI and Data. It also establishes an AI Subcabinet tasked with developing and implementing a comprehensive AI action plan to operationalize the State's AI principles and establish appropriate "guardrails" for agencies' use of AI. Additionally, the AI Subcabinet will promote AI knowledge, skills, and talent in state government, further driving demand for Data Science programs. In the closely related field of AI and Machine Learning, Governor Moore has announced significant initiatives to revitalize state government and modernize Maryland's Department of IT Services and Operations, positioning Maryland at the forefront of cutting-edge and emergent technology to better serve the state. This includes the appointment of a first-ever AI advisor to oversee Maryland's AI strategy[3,4].

The data science field presents ongoing and compelling needs in the region, and UMBC's M.S. in Applied Data Science is well-positioned to address these needs by fostering knowledge advancement and addressing critical societal demands. Leveraging UMBC's established reputation and a flexible curriculum, the program is poised to meet the growing demand for skilled data science professionals, directly supporting the goals of the 2022 MHEC Statewide Plan and USM Strategic Plan. UMBC's commitment to innovation and education in data science allows prospective students to upgrade their skills to meet the evolving job market requirements, ensuring that Maryland remains competitive in the data science industry.

C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State:

1. The Master's in Applied Data Science program will open up various employment opportunities in the rapidly growing field of data science. Graduates can pursue careers in technology, finance, healthcare, government, and education. The table below lists some potential job roles and their expected entry levels:

Table 2: A list of potential job roles of the future graduates of the proposed program.

Job Title	Expected entry level and responsibilities
Data Scientist	Entry Level: Junior Data Scientist, Data Analyst Responsibilities: Analyzing data, building predictive models, presenting insights to stakeholders
Data Analyst	Entry Level: Junior Data Analyst, Statistical Assistant Responsibilities: Collecting and analyzing data, reporting findings to businesses, identifying trends and patterns

[2] https://governor.maryland.gov/news/press/pages/governor-moore-announces-action-to-transform-maryland-executive-branch-digital-services.aspx (visited April 3, 2024)

[3] https://governor.maryland.gov/news/press/pages/governor-moore-announces-major-action-to-rebuild-state-government-and-modernize-maryland-department-of-information-technolo.aspx (visited April 3, 2024)

[4] https://baltimorefishbowl.com/stories/marylands-it-department-adds-new-roles-including-leaders-in-ai-and-accessibility/ (visited April 3, 2024)

Data Manager	Entry Level: Data Project Manager, Junior Data Manager Responsibilities: Overseeing data flow and processes, ensuring data integrity, managing data architecture
Data Architect	Entry Level: Junior Data Architect Responsibilities: Designing and implementing data architecture, managing databases, ensuring data security
Data Engineer	Entry Level: Junior Data Engineer Responsibilities: Preparing raw data for analysis, developing data architecture and tools, testing and maintaining data systems
Business Analyst	Entry Level: Junior Business Analyst Responsibilities: Analyzing business processes, identifying opportunities for improvement, communicating technical information to businesses
Software Engineer	Entry Level: Junior Software Engineer, Software Development Intern Responsibilities: Designing and developing software systems, maintaining software applications, collaborating on software projects
Machine Learning Engineer	Entry Level: Machine Learning Engineer, Machine Learning Solutions Lead Responsibilities: Developing AI systems and machines, applying machine learning algorithms, testing and launching advanced tools
Data Modeler	Entry Level: Data Modeler, Modeling Geologist Responsibilities: Building database blueprints, ensuring data accessibility and usability, consulting with executives on data standards

These roles offer a wide range of opportunities for individuals with skills in data analysis, programming, statistics, and machine learning.

2. At the global level, Forbes[5] projects that the data science market will reach $407 billion by 2027 and is expected to contribute a substantial 21% net increase to the United States GDP by 2030. Furthermore, 64% of businesses believe that data science will enhance their overall productivity, indicating growing confidence in its transformative potential.

   Our region, the National Capital Region comprising MD-DC-VA, has become the nation's second-largest hub for data science-related employment, trailing only California. This surge is primarily propelled by a comprehensive adoption of AI within federal government agencies, including the Department of Defense (DoD), and by private sector providers of defense and aerospace products, software, and services.

   According to a recent report[6], the National Capital Region accounted for 7.54% of AI job postings, which was approximately half the share of IT job postings (14.05%) and slightly higher than its share of all job postings (6.36%) in 2018. By 2023, the situation underwent a significant change. The region's portion of AI job postings rose to 12.63%, ranking second only to California's 19.03%. This figure now aligns closely with the region's share of IT job postings (12.77%) and is more than double its share of all job postings (5.83%).

[5] https://www.forbes.com/advisor/business/ai-statistics/#sources_section

[6] UMD-LinkUp AI Maps, "From West to the Rest: Growing Geographic Dispersion of AI Jobs in America," page 15, Jan. 2024.

This surge in demand is fueled by widespread adoption of AI across various U.S. federal government agencies, including the Department of Defense. Many key suppliers of equipment, software, and services to federal agencies and the DoD are located in the MD-DC-VA region. Notable companies include Northrop Grumman, Lockheed Martin, Huntington Ingalls, Booz Allen Hamilton, Accenture, and Deloitte. Additionally, the region is home to Amazon HQ2 and Capitol One's corporate headquarters.

Data from Stanford University's AI Annual Report[7] show significant growth in data science-related job openings in Maryland, making it one of the leading states in AI job gains between 2018 and 2023.

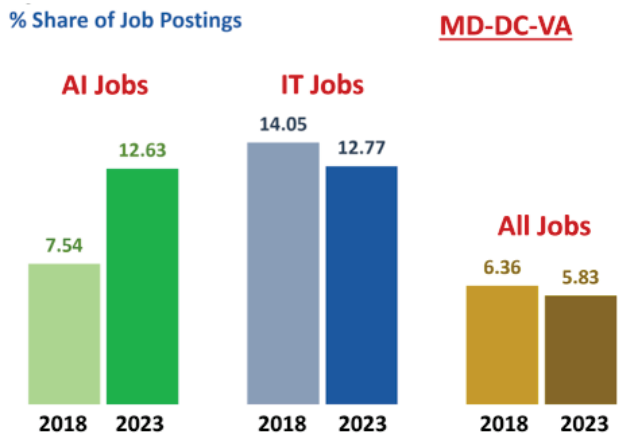

Figure 1: Number of artificial intelligence (AI) and information technology (IT) jobs in National Capital Region 2018 vs. 2023. Source: https://www.aimaps.ai/download/whitepaper-sheets/from-west-to-the-rest-(white-paper1).pdf

According to Lightcast, a labor market analytics tool, the Baltimore and Washington DC metropolitan areas are hotspots for data science-related jobs. When queried about the number of job postings over the past 10 years for data science, Lightcast[8] reported that there were 4,848 job postings in the Baltimore and Washington DC MSAs, as compared to 1,333 for the national average, showing that the regional demand for data scientists was much higher than the national average.

3. In October 2023, President Joe Biden and Secretary of Commerce Gina Raimondo designated Baltimore as one of 31 "federal tech hubs." This designation[1] will unlock tens of millions of dollars in funding across the region, part of a nationwide initiative aimed at maintaining American competitiveness in various technological fields. Following this announcement, Baltimore anticipates significant advancements in machine learning, artificial intelligence, and biotechnology, particularly focusing on leveraging data to inform clinical decisions and enhance patient outcomes. With this designation, our city becomes eligible for approximately $500 million in federal funds allocated for projects in the area over the next five years. According to the Greater Baltimore Committee[9], this tech hub designation is projected to generate $3.2 billion in economic impact and create 52,000 jobs over the next five years. Therefore, it's imperative to provide training for business professionals, particularly in the application of AI within the biotech sector, to support our local economy.

[7] https://aiindex.stanford.edu/report/
[8] https://professionalprograms.umbc.edu/data-science/job-data-data-science/
[9] https://gbc.org/greater-baltimore-committee-issues-rfp-for-new-regional-brand-narrative/ (visited April 3, 2024)

4. The table below shows the number of students enrolled in the Data Science track of the MPS from 2020 to 2024. The rapid increase in the early years was due to the rising demand for data science professionals and there were not many graduate programs focusing on data science. Since 2020, the number of graduate programs in data science increased exponentially, please see figure below.

Table 3: Number of graduate data science students at UMBC since 2020.

	Fall 2020	Fall 2021	Fall 2022	Fall 2023	Fall 2024
No. of students	158	274	525	609	424

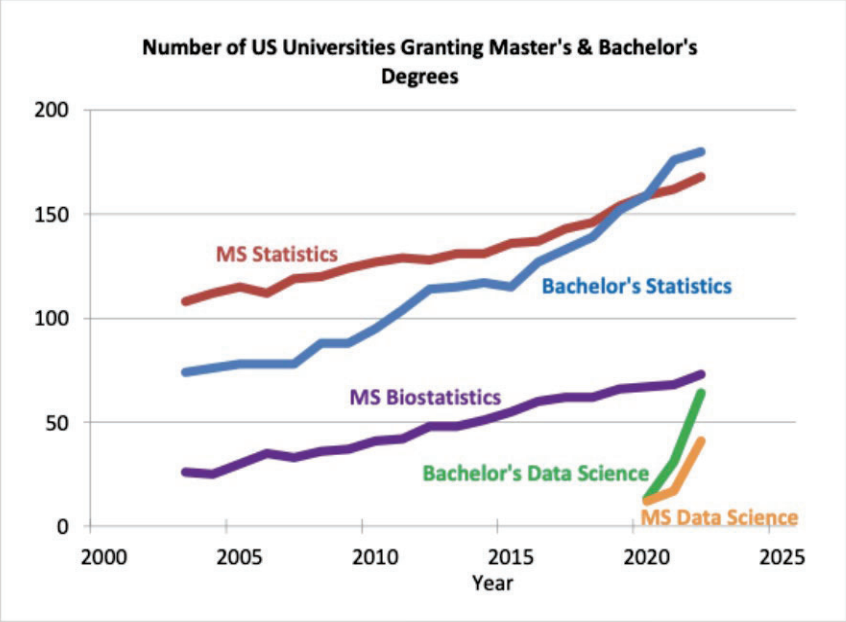

Figure 2: The number of universities granting statistics, biostatistics, and data science master's and bachelor's degrees. Compiled from NCES IPEDS data. Source: https://magazine.amstat.org/blog/2023/12/01/degreesstats2022/

For Fall 2024, we have received more than 1400 applications for the Data Science track of the existing MPS program. Because of constrained resources, we admitted a small fraction of them. We expect and plan to keep the number of newly enrolled students around 100 in the following five years of the proposed new MS program.

D. Reasonableness of Program Duplication:

1. UMBC's DPS identified and compared data science programs in the region. UMBC believes that this proposed M.S. in Applied Data Science program aligns with and supports the 2022 MHEC Statewide Plan and USM's Strategic Plan. While some program overlap may exist with other data science programs, UMBC's goal is to offer flexibility, affordability, and accessibility to students looking to upgrade their skills and meet the growing workforce demands.

2. A comparison of regional programs with UMBC's proposed M.S. in Applied Data Science is provided in Appendix 2.
3. UMBC, as a Center of Academic Excellence, is well-positioned to offer this M.S. in Applied Data Science program, which equips students with the necessary skills for data-driven careers in management, analysis, research, and more.
4. As described in sections B and C, there is very strong market demand in the MD-DC region for master's trained data scientists. Some of this need is already being filled by UMBC's existing Data Science track in the Master of Professional Studies. This is a proposal to transform the existing program into the MS format, with no plans to increase enrollment and thus no harm to other existing data science programs as UMBC continues to meet the part of the strong market demand for graduates that it is already meeting.

E. Relevance to High-demand Programs at Historically Black Institutions (HBIs):

1. We identified two recently established graduate data science programs at HBIs. One is at Morgan State University (MSU), and the other is at University of Maryland Eastern Shore (UMES).
2. MSU's program has a stronger focus on data visualization, while UMBC's proposed program has a more general focus on data science. Students in the MSU program take four to five course per semester and complete the program in one year. The UMBC program is designed for working professionals to take two to three courses and complete the program in two years. With no increase in enrollment planned for the proposed UMBC M.S. in Applied Data Science over the existing Data Science track in the UMBC MPS, we anticipate no impact or harm to the program at MSU.
3. In addition to having very little overlap, the M.S. in Data Science offered at UMES is in a different geographical location and best suited to serve the needs of Maryland's population in the Delmarva peninsula, whereas UMBC is better suited for students residing in the greater Baltimore metropolitan region. We anticipate no impact or harm to the UMES program.
4. While some other related programs may exist, UMBC's program focuses on the interdisciplinary nature of data science, providing students with a broad skill set to excel in the field.

F. Relevance to the identity of Historically Black Institutions (HBIs):

1. The proposed new program in Applied Data Science merely transforms the current track in the MPS to an MS and is not expected to impact the identity or mission of any HBIs.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes

1. This practitioner-oriented curriculum was developed by faculty within the UMBC Department of CSEE, drawing upon their expertise in the areas of data science and related disciplines. CSEE's industrial advisory board members also provide expert insights that inform the program. Program faculty, as subject-matter experts, also regularly discuss emerging trends or current events that may require updating or creation of curricular modules and/or incorporating specialized instructional tools/platforms such as Python, R, Jupyter, Hadoop, Spark, and other data science tools into the curriculum.

   The M.S. in Applied Data Science will be overseen by a full-time Graduate Program Director (GPD) and four full-time members of the CSEE faculty with a strong background in data science. The GPD, as a direct report to the Chair of Computer Science and Electrical Engineering, is supported as needed by the Chair in matters related to faculty/program oversight, mentoring, and related issues. The GPD also works with the UMBC DOIT, CSEE's IT office, DPS IT staff, and other campus leaders on technology innovations related to the program or any new learning capabilities/platforms deployed, such as data science labs and data analysis environments. The Data Science Graduate Program Director is a member of the Computer Science

Graduate Committee and works with that committee on areas of mutual interest and oversight, including recruiting, cross-program collaboration, new course ideas, and program innovations.

2. The curriculum in the M.S. in Applied Data Science program will offer a comprehensive foundation in data science principles and practices, beginning with an introduction to the field where students learn the essential concepts and tools. Students will then delve into data analysis and machine learning, gaining skills to build and evaluate models. Big data processing platforms are explored to handle large datasets efficiently, and data management techniques are taught to ensure data integrity and accessibility. A course in probability and statistics equips students with the necessary quantitative skills, culminating in a capstone project that allows students to apply their knowledge in a practical, real-world scenario.

   Students will be able to tailor their education by selecting at least four electives from the ten different pathways offered in varying formats. The pathways are:

   - Advanced computing and analytics,
   - Cybersecurity,
   - Data science analytics,
   - Economics/econometrics,
   - Healthcare analytics,
   - Management sciences,
   - Policy analysis,
   - Aging studies,
   - Project management, and
   - Clinical Informatics.

   These pathways offer elective courses aligned with their background and interests, enabling them to specialize in areas most relevant to their career goals.

   Additionally, the program will offer a suite of specialized DATA courses. Students will explore ethical considerations and privacy issues in data science, develop leadership skills specific to the field, and understand the mathematical foundations of machine learning. Courses on data structures and algorithms, data visualization and communication, deep learning, and natural language processing will provide further depth. Students will be able to study artificial intelligence and apply data science techniques to finance, ensuring they are well-rounded and prepared for diverse opportunities in the data science domain.

   As a program targeting adult learners and working professionals, courses in this proposed degree will be taught in in-person, hybrid, and online modalities to provide greater flexibility and accessibility to students. As with other workforce-oriented graduate programs in the region focusing on the data science discipline, students completing the core M.S. in Applied Data Science curriculum will be expected to:

   a. Successfully demonstrate knowledge of interdisciplinary data science principles, practices, theories, operational insights, industry organizations, and technologies associated with data science. (SLO-1)
   b. Effectively identify and analyze data, apply statistical and machine learning techniques, and make data-driven decisions. (SLO-2)
   c. Understand the role of data science within modern organizations and appreciate its assorted social/legal/policy/ethical issues. (SLO-3)

d. Demonstrate the ability to conduct scholarly and/or professional-level research and the various skills necessary in the data science profession such as team collaboration, critical thinking, time management, and effective communication. (SLO-4)

3. Learning outcomes to assess the program's success in meeting these objectives are included in Appendix 4. The UMBC Graduate School, COEIT, Department of CSEE, DPS, and Provost's Office track enrollments, retention, time-to-degree, and graduation rates for all programs. The Division of Professional Studies also is developing tools and mechanisms to track career placements. Appendix 6 describes the mechanisms used by the program to assess and document student learning competencies/outcomes (SLOs) in support of program objectives.

4. The M.S. in Applied Data Science program consists of 30 credits divided into 18 credits in the degree core and 12 credits as electives. The degree core includes a 3-credit capstone project research course. For increased curriculum flexibility, there is no set sequence of required courses, except that the project course (DATA 606) generally is taken after the other core courses have been completed successfully, and that students new to data science are encouraged to start with DATA 601 in their first semester. Additionally, prospective students holding certain current industry certifications may, upon proper documentation, request waiving DATA 601 and using another course to satisfy requirement (usually a fifth elective). Core courses are aligned with the needs and expectations of the data science industry and practitioners. Given the interdisciplinary nature of the data science field and the need to present students with the opportunity to be flexible in their study foci based on their specific interests or needs, they may take appropriate electives from another program or department to fulfill their credit requirements after consultation with their advisor to determine the course's relevance to the degree program and the student's qualifications. Students also may receive credit for conducting appropriate independent study projects or participating in industry or government-centric internships in the data science domain. Degree requirements for the M.S. in Applied Data Science are contained in Appendix 3. Course descriptions for core courses and electives owned by the Data Science program are shown in Appendix 7.

5. GenEd Requirements: N/A

6. Accreditation or Certification Requirements: N/A

7. Other Institutions or Organizations: The department does not currently intend to contract with another institution or non-collegiate organization for this program.

8. Assurances of Student Support: Detailed in Appendix 5.

9. The primary audience for the M.S. in Applied Data Science is early-to-midcareer working professionals in data science or related fields from government or industry within Maryland. Local and regional marketing will be conducted by the DPS, while national and international marketing is handled by the UMBC Graduate School. Marketing is accomplished via the program's website, department website, and other local or global marketing sites/activities by the Graduate School, COEIT, and DPS. All marketing materials and websites are reviewed regularly to ensure currency and accuracy of courses, degree paths, job outlooks, technology requirements, etc. Working with the Graduate School, COEIT, and DPS, the GPD is involved in the development and approval of degree marketing outreach to ensure it accurately reflects the program and services available at UMBC.

The M.S. in Applied Data Science program website, FAQ, advising information, syllabi, and marketing outreach will provide students with clear, complete, timely, and accurate information. This information will be on the program curriculum, course and degree requirements, how students and faculty will interact (both in class and for advising purposes), the expected/desired technology competencies, minimum technical requirements (e.g., computer and internet capabilities), identify the Learning Management System (LMS), and the range of academic policies and support services available (e.g., financial aid, degree completion, payment policies, academic integrity, etc.). Additional information for students may be found on the UMBC Graduate School, Registrar, Student Business Services, and Veterans Affairs websites.

As of Fall 2024, UMBC's existing Graduate Data Science Program is 62% male and 38% female. The program's diversity is significantly higher both for minority representation (40% vs. 26%) and for women (38% vs. 17%) compared to the broader data science field.

10. The M.S. in Applied Data Science requires 30 credits and 10 courses, as shown in Appendix 3. Appendix 7 provides descriptions for these courses.

H. Adequacy of Articulation - N/A

I. Adequacy of Faculty Resources

1. Faculty supporting the program are full-time, tenured, or tenure-track and hold terminal degrees in their respective fields. Specific course assignments have not yet been made and change on a regular basis. Appendix 8 lists faculty supporting the M.S. in Applied Data Science. Additional adjunct faculty may be included in the future based on program requirements.

2. Faculty teaching in this program have access to instructional development opportunities available via the UMBC Center for Applied Learning and Teaching (CALT) and other on-campus professional development activities. For any online elements of coursework, faculty can work with UMBC's own instructional design team to incorporate best (and accessible) practices when teaching in the online environment. UMBC's DOIT offers on-demand and in-person assistance to faculty on the use of Blackboard's many features to help ensure the platform fosters a quality learning experience for students and faculty, regardless of in-person, hybrid, or online modalities. Program and department faculty are encouraged to share best pedagogical practices with colleagues in this program and the broader CSEE department. Several internal grant opportunities exist to support innovation in faculty pedagogy as well.

J. Adequacy of Library Resources

1. On behalf of UMBC's President and Librarian, the Science Librarian of the Albin O. Kuhn Library has assessed the library resources required for this program. The assessment concluded that UMBC's library can meet the curricular and research needs of the M.S. in Applied Data Science program faculty and students with its current expansive in-person and online resources. (Note: To facilitate greater accessibility and affordability for students, wherever possible and practicable, UMBC's Graduate Data Science Program uses open-access materials and publicly available resources for instructional and enrichment activities.)

2. No additional library resources are required.

K. Adequacy of Physical Facilities, Infrastructure, and Instructional Equipment

1. UMBC has access to excellent resources and facilities for this program at its campus locations. There are sufficient classrooms and conference rooms at the Catonsville and Shady Grove campuses to accommodate students, all equipped with technology and software to support instruction, collaboration, and communication. UMBC's internet, software, and computing capabilities are more than adequate to meet program needs – including data science lab environments to facilitate data analysis, machine learning, and big data processing.

2. a) All faculty and students are assigned a UMBC institutional email address. Email is the primary form of outreach on campus and in the program.

   b) All faculty and students have access to the University's learning management system (Blackboard Ultra) for classroom and research purposes, in addition to other online collaborative tools supported by UMBC's DOIT such as Microsoft Office/360, Google Suite, and Webex. Should it be necessary, UMBC is well-equipped to handle pivots to remote learning, such as due to pandemics or weather emergencies. Faculty who want to take a deliberate and holistic approach to prepare their hybrid courses may be supported by UMBC's Planning Instructional Variety for Online Teaching (PIVOT) program. PIVOT focuses on best practices for using online instruction tools such as Blackboard, Panopto, Voice Thread, etc., that are also available at UMBC. To ensure access to instructional, research, and collaboration tools, the minimum computing requirements and technical competency expectations for students are posted on the program's website.

L. Adequacy of Financial Resources with Documentation

The M.S. in Applied Data Science will be self-supported through tuition revenue with the potential of receiving industry and faculty research support over time. As it is anticipated that enrollments will generate sufficient revenue to more than cover expenses, there is no significant financial impact with this proposal. As with all self-supporting graduate programs at UMBC, enrollment growth will be regularly monitored, additional full-time faculty will be hired, and/or existing part-time faculty will be invited to become full-time faculty to facilitate instruction and program activities across two campus locations. See Appendix 10 and 11 for program budget information.

M. Adequacy of Provisions for Evaluation of Program in Data Science

1. The CSEE faculty periodically reviews syllabi, rubrics, readings, labs, and projects to ensure a standard student experience and that materials used and presented remain relevant to and/or aligned with current industry trends, and best practices in the discipline, program objectives, and institutional priorities. The Department of CSEE and the university as a whole evaluate full-time faculty through the established promotion and tenure process in the traditional areas of teaching, research, and service. This process includes a review of their syllabi, labs, courseware, samples of student products, classroom observation, and student surveys. Adjunct faculty are evaluated by full-time faculty members regularly to ensure the quality of instruction, materials, and the student's course experience.

All faculty members at the university are evaluated via student surveys issued at the end of each semester. The data from these surveys are shared with the instructors and are publicly available, while any qualitative comments received are shared only with the instructors. Additionally, faculty are encouraged to work with their colleagues and the university's Center for Applied Teaching and Learning (CALT) or DOIT for additional opportunities to conduct objective course assessment and/or enhancement. The Graduate Program Director likewise solicits, investigates, and attempts to resolve any student concerns regarding course or instructor quality and/or effectiveness.

2. Program evaluation in Data Science is carried out through the assessment of learning outcomes. The primary outcomes for the M.S. in Applied Data Science and methods of outcome assessment are identified in Appendix 4. Along with the program and department, the COEIT Dean's Office regularly reviews student enrollment, retention, culture, and financial data from a strategic perspective to ensure program outcomes are aligned with the college's goals and the university's strategic plan. The university's Provost Office also engages in strategic and financial reviews of all programs. Exit surveys are conducted each year by the Office of Professional Programs as another gauge of the student educational experience and program quality.

   The university's accountability obligation includes a requirement that each academic program be reviewed periodically. Accordingly, the university conducts academic program reviews (APR) to gauge program effectiveness. The APR process serves purposes such as quality assurance, quality improvement, accountability, identification of strategies for improvement, and providing the institution with information for prioritization of resources.

   Taken together, the university has a robust, multi-stakeholder method to assess academic program effectiveness, learning outcomes, student retention, student/faculty satisfaction, and cost-effectiveness in the Data Science program. These methods are supported by continual internal evaluation of industry trends and needs to ensure the program continues to meet current and future industry and workforce requirements.

N. Consistency with the State's Minority Student Achievement Goals

1. UMBC was designated a Minority Serving Institution in 2017 and has a strong track record of producing graduates from diverse backgrounds in various fields, including Data Science. The university is pleased to report that minority representation enrolled in its Graduate Data Science Program is significantly higher both for minority representation (40% vs. 26%) and for women (33% vs. 17%) than the broader Data Science field.

   The university's Spring 2024 Diversity Report is available online.[10]

O. Relationship to Low Productivity Programs Identified by the Commission - N/A

P. Adequacy of Distance Education Programs in Data Science

[10] https://provost.umbc.edu/wp-content/uploads/sites/46/2024/05/UMBC-2024-Cultural-Diversity-Report.pdf

The proposed new M.S. in Applied Data Science may not be completed entirely online. However, as a program targeting adult learners and working professionals, courses in the proposed M.S. in Applied Data Science will be taught in-person, hybrid, and online modalities to provide maximum flexibility and accessibility to students in this critical field. This practitioner-oriented curriculum was developed by faculty within the Department of CSEE, drawing upon their expertise in Data Science and related disciplines. The program faculty and industrial advisory board members provide expert insights that inform the program. Program faculty also regularly discuss emerging trends or current events that may require updating or creating curricular modules and/or incorporating specialized instructional tools/platforms into the curriculum.

As part of the degree program, the online elements of this M.S. in Applied Data Science will be overseen by a full-time Graduate Program Director and four full-time members of the faculty with a strong background in Data Science. The GPD, as a direct report to the Chair of the CSEE Department, is supported as needed by the Chair in matters related to faculty/program oversight, mentoring, and related issues. Additionally, the Data Science Graduate Program Director is a member of the Computer Science Graduate Committee and works with that committee on areas of mutual interest and oversight, to include new course ideas and program innovations. The minimum computer and technical requirements for students are posted on the program's website. Technical support for the university's platforms is provided by the DOIT upon request to the Help Desk Request Tracker.

Students enrolled in online or hybrid elements of this program have access to the same technology support resources as all university students, including through the DOIT, Career Services, Off-Campus Student Services, Office of Equity and Inclusion, and the Graduate Student Association, among many others. Depending on the demands of the program, additional staff and resources may be allocated to assist as necessary, such as those on the Office of Professional Programs Student Success team. The university's library is well-equipped to support remote research and learning, offering a comprehensive suite of resources both online and in-person.

In addition to using the university's learning management system or producing their own instructional materials supporting online course modalities, faculty wishing to take a deliberate and holistic approach to prepare or modify their online or hybrid courses are supported by the Academic Success Center (for students) and Faculty Development Center (for instructors). Faculty teaching in online or hybrid modalities have access to instructional development opportunities through the Active Learning, Inquiry Teaching (ALIT) certificate program and Innovation for Teaching Effectiveness (INNOVATE) certificate program and other on-campus professional development activities and can work with the university's own instructional design team to incorporate best practices when teaching in hybrid or online environments.

Students enrolled in an online modality may conduct all necessary transactions entirely online. Official information about curriculum updates, new courses, internships, graduation deadlines, etc., are conveyed to students via the student email list as the program's official distribution medium and/or directly to the students who are on email lists maintained by the university's Graduate School (for graduations and academic affairs), Registrar (for scheduling), Student Business Services (for costs and financial aid), or other campus entities.

The university's Office of Accessibility & Disability Services (ADS) ensures that students with disabilities are afforded an equal opportunity to participate in and benefit from the programs, services, and activities

of the University through the provision of accommodations and reasonable modifications that result in equal access and full inclusion, reflecting the university's commitment to fostering an accessible and inclusive environment for all members of the community. Assistance from the ADS team is available to all university students regardless of learning modality.

Quality assurance of the curricular online components of the program is identical to those described in Section M above. Additional QA support and guidance regarding online learning may be requested from the university's DOIT or CALT when necessary or appropriate.

Appendix 1

Education and Training Needs by Source

According to the Bureau of Labor Statistics' Occupation Outlook Handbook, 'Data Scientist' is one of the most rapidly growing occupations in data and information analysis. Over the next decade, the job of a Data Scientist is projected to experience significant growth, with a 10-year growth rate of approximately 35%. In addition, Data Scientists command a competitive national average salary of $110,000. The data analytics industry is expected to see a substantial increase in demand, resulting in approximately 21,000 new job openings for Data Scientists each year, on average, over the next ten years. These job openings will primarily arise from workforce transitions to other fields, such as machine learning engineering and retirements from the labor force.[11]

The Baltimore-Washington region, in particular, has emerged as a vibrant hub for data science professionals. According to information gathered from *Lightcast*, a labor market analytics tool, there were 21,342 data science-related job postings in the Washington and Baltimore Metropolitan Statistical Area (MSA) in 2021. This surpasses the national average for an area of similar size, which stands at 5,250 job postings. The job posting activity in this region is also notably robust, with a monthly average of 1,834 postings in the Washington-Baltimore area, compared to the national average of 463 postings for an area of comparable size. Key employers in the region seeking data science talent include federal and state government agencies, major tech companies like Amazon, data science consultancies such as Deloitte and Accenture, and leading financial institutions like Capital One, among others.[12]

Moreover, as highlighted in the book 'The Industries of the Future' by Alec Ross (2016), the field of data science is undergoing a remarkable transformation. Over the two decades spanning from 2000 to 2020, the data analytics and machine learning market has expanded from a $3.5 billion industry with a small cadre of IT professionals to a colossal $175 billion market that plays a crucial role in supporting and enhancing the operations of a wide range of businesses, both large and small. The significance of data science in shaping the future of various industries cannot be overstated, and it is poised to continue its rapid growth and impact on numerous sectors.[13]

[11] https://www.bls.gov/ooh/math/data-scientists.htm

[12] Lightcast Labor Market Analytics Tool (Data on file)

[13] Ross, A. (2016). The Industries of the Future. Simon & Schuster.

Appendix 2

Greater Baltimore Metropolitan Region Program Duplication Discussion

Programs are listed alphabetically according to the name of the university that offers the program

Capitol Technology University (CTU)

CTU offers a Technical MBA in Business Analytics and Data Science, focusing on combining business management principles with data science and analytics skills. In contrast, UMBC's M.S. in Applied Data Science program is a more technically intensive curriculum designed to provide in-depth knowledge and practical skills in various aspects of data science.

Similarities

1. Core Emphasis on Data Science Fundamentals:

i. Both programs emphasize core data science concepts such as statistics, data analysis, big data, and analytics.

ii. Courses in both programs require an understanding of fundamental statistics.

2. Big Data and Analytics Systems:

i. Both programs include coursework related to big data management and analytics systems.

ii. Capitol's MBA-520 (Big Data Warehousing and Analytic Systems) and UMBC's DATA 603 (Platforms for Big Data Processing) cover similar content on handling large datasets and using big data technologies.

3. Applied Statistics:

i. Capitol's MBA-515 (Applied Statistics and Visualization for Analytics) and UMBC's DATA 608 (Probability and Statistics for Data Science) cover applied statistical methods and their relevance to data analysis.

Differences

1. Program Focus and Structure:

i. Capitol Technology University: The focus is on integrating business management with data science. The curriculum includes management courses and strategic decision-making alongside analytics.

ii. UMBC: The program is purely focused on data science, with a strong emphasis on technical skills, machine learning, and data management without a direct focus on business management.

2. Core Curriculum Content:

i. Capitol Technology University: MBA core courses (24-27 credits) include management subjects like Financial Management (MBA-615), Organizational Behavior (MBA-625), and Strategic Management (MBA-650), which are not covered in UMBC's M.S. program.

ii. UMBC: Core courses include specialized data science topics such as Data Structures and Algorithms (DATA 612), Machine Learning (DATA 602), and Data Management (DATA 604).

3. Technical Depth:

i. Capitol Technology University: The program provides a broader overview with courses such as Analytics and Decision Analysis (MBA-510) and Web Analytics (MBA-540). These courses integrate business decision-making with technical analytics skills.

ii. UMBC: Offers deeper technical content in data science with courses such as Deep Learning (DATA 621), Natural Language Processing (DATA 622), and Practical Deep Learning (DATA 621), focusing on advanced computational methods.

4. Capstone and Project Work:

i. Capitol Technology University: Does not explicitly mention a capstone project in the provided course list.

ii. UMBC: Includes a Data Science Project course (DATA 606), which provides hands-on experience with real-world data science projects, ensuring students apply their skills in practical scenarios.

5. Leadership and Ethical Issues:

i. Capitol Technology University: Courses like MBA-627 (Impact of Emerging Technology on Management and Public Administration) cover technology's impact on management and public policy, providing a broader context to data science applications.

ii. UMBC: Includes courses such as Ethical and Legal Issues in Data Science (DATA 605) and Leadership in Data Science (DATA 607), focusing specifically on ethical, legal, and leadership aspects within the data science domain.

While both CTU's Technical MBA in Business Analytics and Data Science and UMBC's M.S. in Applied Data Science programs aim to equip students with essential data science skills, they diverge significantly in focus and structure. CTU's program integrates business management with analytics, providing a holistic view suitable for managerial roles that require data-driven decision-making. CTU's program is 100% online. In contrast, UMBC's program delves deeply into technical aspects of data science, preparing students for specialized roles in data science and analytics with a strong foundation in machine learning, big data, and data ethics with different instructional modalities per course in order to suit a student's requirements: in-person, hybrid or online.

In short, CTU's program has a stronger focus on business applications, and they offer 100% of their courses online. The UMBC's proposed program has a stronger focus on data science theory and practice with different instructional modalities per course to suit a student's requirements: in-person, hybrid, or online.

Frostburg State University (FSU)

FSU offers an M.S. in Applied Computer Science with a Database Concentration.

FSU M.S. in Applied Computer Science with Database Concentration vs UMBC M.S. in Applied Data Science

FSU Core Courses	FSU Electives
COSC610 - Advanced Data Structures and Algorithms COSC625 - Advanced Software Engineering COSC630 - Web Development and Programming I COSC631 - Web Development and Programming II COSC640 - Database Systems I COSC641 - Database Systems II COSC645 - Data Mining COSC646 - Data Cloud COSC647 - Information Assurance	COSC591 - Seminar in Computer Science COSC594 - Field Experience in Computer Science COSC599 - Individual Problems in Computer Science COSC602 - Advanced Programming Concepts COSC690 - Special Topics in Database Systems COSC691 - Special Topics in Data Analytic Instruments COSC700 - Master Research Paper or Project

Frostburg State University's Master of Science in Applied Computer Science with its database concentration provides a robust foundation in database systems, data mining, and data warehousing, preparing students for roles focused on database administration and management. The general concentration offers a broad exposure to computer networking, software engineering, and artificial intelligence, equipping graduates for diverse technical

and managerial positions across various sectors. In contrast, UMBC's M.S. in Applied Data Science program emphasizes foundational skills in data science, including data analysis, machine learning, and big data platforms, with specialized courses in ethics, leadership, and advanced topics like deep learning and natural language processing. UMBC's program is tailored for those seeking expertise in data-driven decision-making and advanced analytics applications across industries. The programs cater to different career paths: Frostburg emphasizes applied computer science with a concentration choice, while UMBC focuses on comprehensive data science skills essential for contemporary data-centric roles.

In short, FSU's M.S. in Applied Computer Science program goes in depth about the theory and practice of computer science in general with their specialization focusing on databases and data mining. In this regard as well, our proposed program is data science centric (focusing more on application than theory) with a wider range of data-centric electives and core courses.

Johns Hopkins University (JHU)

JHU offers two data science degrees: an online MS in Data Science and in-person MSE in Data Science.

JHU's online MS in Data Science vs. UMBC's M.S. in Applied Data Science

JHU offers an online MS in Data Science degree. The program is designed for working professionals, offering flexibility with asynchronous and synchronous online courses. The program focuses on practical skills and theoretical knowledge in applied mathematics and computer science. Courses are taught by senior-level engineers and data scientists with practical experience.

Curriculum:

- **Foundation Courses:** Statistical Methods and Data Analysis, Algorithms for Data Science.
- **Required Courses:** Introduction to Optimization or Computational Statistics, Statistical Models and Regression, Data Science, Data Engineering Principles and Practice, Data Patterns and Representations.
- **Electives:**
  - **Applied and Computational Mathematics Electives:** Includes Real Analysis, Matrix Theory, Computational Methods, Discrete Hybrid Optimization, and others.
  - **Computer Science Electives:** Large-Scale Database Systems, Deep Neural Networks, Advanced Machine Learning, and more.
- **Specialization:** Flexibility to choose electives based on interests and career goals.

It is evident that the online MS in Data Science at Johns Hopkins is highly flexible, designed for working professionals. It emphasizes both theoretical and practical aspects of data science, offering a wide range of electives in applied mathematics and computer science. UMBC's M.S. in Applied Data Science combines theoretical knowledge with practical applications. It features a comprehensive curriculum with core courses and electives, and opportunities for hands-on experience through capstone projects or research. Both programs offer robust training in data science. JHU's program is more appealing for those needing maximum flexibility and a strong online component, while UMBC's program offers a traditional approach with a mix of online and on-campus courses, catering to those interested in domain-specific applications.

JHU's MSE in Data Science vs. UMBC's M.S. in Applied Data Science

The Data Science Master's program at the Johns Hopkins University is a fully residential program which provides

the training in applied mathematics, statistics and computer science to serve as the basis for an understanding, and appreciation, of existing data science tools. Their program aims to produce the next generation of leaders in data science by emphasizing mastery of the skills needed to translate real-world data-driven problems in mathematical ones, and then solving these problems by using a diverse collection of scientific tools.

Similarities between the JHU's MSE in Data Science and UMBC's M.S. in Applied Data Science programs

1. Core Curriculum: Both programs offer core courses that cover fundamental data science topics such as machine learning, data analysis, data management, and big data processing.
2. Capstone Projects: Both programs include a capstone project that allows students to apply their knowledge to real-world data science problems.
3. Ethics and Legal Issues: Both programs emphasize the importance of understanding ethical and legal issues in data science.

Differences:

1. Program Structure:

i. JHU offers a traditional M.S.E. in Data Science with a focus on a comprehensive list of approved courses primarily from the Department of Applied Mathematics and Statistics.

ii. UMBC proposes to offer a M.S. in Applied Data Science with flexible pathways tailored to specific industries such as cybersecurity, healthcare analytics, and economics.

2. Leadership Training:

i. UMBC includes a specific course on leadership in data science.

ii. JHU does not explicitly list a leadership course in their approved courses.

The JHU's target audience is students with a strong foundation in mathematics and computer science who are interested in a career in data science research or academia, while UMBC's target audience is students with a variety of backgrounds who are interested in a career in data science. The UMBC's program is particularly well-suited for working professionals who want to develop new skills or change careers.

Loyola University Maryland

Loyola University Maryland offers an online MS in data science degree

Similar Courses: Both programs cover fundamental topics in data science, including:

- Introduction to Data Science
- Data Management
- Machine Learning
- Ethical and Legal Issues in Data Science

Different Courses:

- Loyola offers courses such as Data Visualization, Database Systems, and Statistical Analysis.
- UMBC offers courses on Platforms for Big Data Processing, Leadership in Data Science, and specialized pathways like Cybersecurity, Healthcare Analytics, and Management Sciences.

Loyola's program is entirely online (and primarily asynchronous), while UMBC's proposed program offers a variety of delivery options, including on-campus, hybrid, and online (primarily synchronous) courses.

Maryland Institute College of Art (MICA)

MICA offers an MPS in Data Analytics and Visualization.

Similarities:

- Both programs cover essential topics in data science such as data analysis, machine learning, data management, and ethical/legal issues. They also emphasize hands-on experience with real data and practical applications of data science principles.

Differences:

- MICA focuses on data visualization, critical thinking, and design principles. Core courses include Data Visualization, Critical Thinking, Data Analytics, Data Management, and a Capstone Project.
- UMBC offers a broader selection of courses and pathways, including big data processing, data platforms, leadership, and specialized tracks like Cybersecurity, Healthcare Analytics, and Bioinformatics.

  Teaching and Audience:
- MICA targets students interested in integrating data science with creative design and visualization. UMBC aims at a diverse range of students from various fields, with pathways tailored to industry-specific applications.

The MPS in Data Analytics and Visualization program that MICA offers focuses heavily on data visualization. In contrast, the program from UMBC will cover the various aspects of applied data science beyond visualization.

McDaniel College

McDaniel College offers an M.S. in data analytics. Core courses include

- ANA 500 - Foundations of Data Analytics
- ANA 505 - Data Mining: Algorithms and Applications
- ANA 510 - Statistical Modeling
- ANA 515 - Data Preparation
- ANA 522 - Fundamentals of Programming in Python
- ANA 525 - Qualitative Methods
- ANA 530 - Quantitative Reporting and Modeling
- ANA 535 - Forecasting
- ANA 540 - Applied Machine Learning

McDaniel College's program is tailored for those seeking a comprehensive foundation in data analytics with a focus on practical applications and business intelligence. UMBC's program is designed for a broader audience with a focus on preparing students from diverse backgrounds for various specialized fields within data science and offers more pathways and interdisciplinary collaboration.

The data science program that McDaniel College has is either fully online or Hybrid (low residency), where students need to attend 3 days a semester. Our M.S. in Applied Data Science will offer online, hybrid, and in-person classes, allowing more flexibility than McDaniel's low-residency hybrid program.

Morgan State University (MSU)

MSU offers a graduate degree program leading toward an M.S. in data analytics and visualization.

Teaching Mode: MSU's M.S. in Data Analytics and Visualization program is currently offered on campus. They plan to add an online option later. UMBC students can take courses both online and on campus.

Core Courses: MSU's data science program, created within the Information Science & Systems department, offers core courses in data wrangling and visualization. Students can choose to focus on statistical data analytics or machine learning. However, UMBC's data science program, created by the Computer Science Department, emphasizes machine learning, exploratory data analysis, big data, and data management.
Electives: MSU offers 7 tracks, and students have to choose 3 courses from one track only. However, UMBC students can choose courses from 10 different tracks, and there is no requirement to stick with the same track.

In short, the Morgan State program has a stronger focus on data visualization, while UMBC's proposed program has a more general focus on data science. This is reflected in the course requirements for each program. The MSU program is structured differently than the UMBC program with regard to completion time (1 year versus 2 years at an average, respectively).

Notre Dame of Maryland University (NDMU)

NDMU offers an online MS in Analytics degree. Core courses include

- CST-530 Foundations of Analytics
- CST-531 Data Design and Management
- CST-532 Data Tools
- CST-540 Data Visualization
- CST-550 Project Management
- CST-610 Critical Inquiry
- CST-611 Data Security
- CST-620 Data Mining and Warehousing
- MAT-575 Applied Statistics
- MAT-576 Data and Decision Modeling

Similar Courses:

- Both programs cover foundational analytics, data management, and data visualization.
- Applied statistics and data mining are common topics.

Different Courses:

- NDMU includes courses in project management, critical inquiry, and data security.
- UMBC might offer more advanced machine learning, AI, and big data courses.

Teaching Style and Audience:

- NDMU offers its program online, targeting professionals needing flexible learning schedules.
- UMBC offers a mix of in-person and online options, focusing on both full-time students and working professionals.

Summary: The MS in analytics that Notre Dame offers is a completely online degree, whereas our M.S. in Applied Data Science would have different modalities of instruction: in-person, hybrid and online. Their degree requires students to only take 2 are electives (which students can only take from their business/economics program). None of the required courses appears to have a program specific course prefix. In this context, our program will have a majority of courses bearing our program's prefix (and are not cross listed with any other program's courses) and offer electives from a wider array of subjects across other fields relevant to data science.

Towson University

Towson University offers an M.S. in computer science with a track in data science. Core courses include

- COSC 519 Operating Systems Principles

- COSC 578 Database Management Systems
- COSC 600 Advanced Structures and Algorithm Analysis
- COSC 612 Software Engineering
- COSC 650 Computer Networks
- COSC 757 Data Mining
- Either COSC 880 COSC Project or COSC 897/COSC 898 Computer Science Thesis

Similar Courses

- COSC 578 Database Management Systems vs. DATA 604
- COSC 757 Data Mining vs DATA 602
- COSC 880 COSC Project vs DATA 606

As a broad-based computer science degree, the only significant curricular exposure to data science in Towson's program are at least 3 data science-related courses in the degree's specialty track in data science plus a student's thesis or project. By contrast, UMBC's proposed M.S. in Applied Data Science curriculum is entirely focused on data science topics, to include courses on non-technical topics such as leadership and laws/policies which give students with non-technical backgrounds an opportunity to advance their data science knowledge.

University of Maryland, College Park

The University of Maryland, College Park (UMCP) offers two graduate degrees: MS in Business Analytics and MS in Data Science (formerly MPS in Data Science and Analytics).

UMCP's MS in Business Analytics vs UMBC's M.S. in Applied Data Science Programs

Core Courses	Electives
BUDT730 Data, Models and Decisions BUDT703 Database Management Systems BUDT704 Data Processing and Analytics in Python BUDT737 Big Data and Artificial Intelligence for Business BUDT758T Data Mining and Predictive Analytics BUDT785D Data Visualization and Web Analytics	BUDT758V Operations Analytics (2 credits) BUDT758Z Computer Simulation for Business Applications (2 credits) BUDT758L Price Optimization and Revenue Management BUSI751 Decision Analytics (2 credits) BUDT758W Capstone Project in Business Analytics BUDT758A Business Communication (1 credit)

The MS in Business Analytics program at the UMCP offers a robust curriculum focusing on practical applications of data analysis and decision-making in business contexts. Courses like BUDT730 emphasize modeling and decision theory, complemented by hands-on training in Python-based analytics (BUDT704) and AI applications in business (BUDT737). Data visualization and web analytics (BUDT785D) further enhance skills crucial for interpreting and presenting data-driven insights. In contrast, UMBC's M.S. in Applied Data Science program provides a comprehensive foundation in foundational data science principles through courses such as DATA 601 and 602, emphasizing statistical analysis and machine learning. The program also delves into big data processing platforms (DATA 603) and includes a capstone project (DATA 606) to apply learned skills in real-world scenarios. Both programs offer strong technical training with UMCP focusing more on business applications while UMBC provides a broader base in data science

fundamentals and technologies.

In short, the UMCP's MS in business analytics is designed for students with a business background who want to develop their data analytics skills. The UMBC proposed M.S. in Applied Data Science is designed for students from a variety of backgrounds who want to pursue a career in data science. The UMCP's MS in business analytics program focuses on business concepts and applications. The UMBC's proposed M.S. in Applied Data Science is a more applied program, with a focus on developing the technical skills needed for data science jobs.

UMCP's MS in Data Science vs UMBC's M.S. in Applied Data Science Programs

UMCP MS in Data Science Courses	UMBC M.S. in Applied Data Science Courses
DATA601: Probability and Statistics	DATA608: Probability and Statistics for Data Science
DATA602: Principles of Data Science	DATA601: Introduction to Data Science
DATA603: Principles of Machine Learning	DATA602: Introduction to Data Analysis and Machine Learning
DATA604: Data Representation and Modeling	DATA604: Data Management
DATA605: Big Data Systems	DATA603: Platforms for Big Data Processing
DATA699: Capstone Research Project	DATA606: Data Science Project
DATA612: Deep Learning	DATA 621: Practical Deep Learning
DATA641: Natural Language Processing	DATA 622: Applications of Natural Language Processing

* Courses in blue are elective courses.

Similarities:

1. Core Courses: Both programs cover fundamental topics like data management, machine learning, data analysis, and big data processing.
2. Capstone Projects: Both programs include a capstone project where students apply their skills to real-world problems.

Differences:

1. Course Offerings:

i. UMCP includes courses like Scientific Computing, Statistical Methods, and Visualization and Presentation.

ii. UMBC includes courses such as Platforms for Big Data Processing, Ethical and Legal Issues in Data Science, and domain-specific pathways (e.g., cybersecurity, healthcare analytics).

2. Target Audience:

i. UMCP's program is geared towards students seeking a blend of theory and practice with a stronger emphasis on scientific research.

ii. UMBC's program is aimed at professionals looking to advance their careers with practical and leadership skills in data science.

3. Teaching Methods:

i. UMCP is more research-oriented, with a focus on computational and statistical methods.

ii. UMBC focuses on applied skills and practical knowledge that are suitable for working professionals.

As discussed above, UMCP's MS in Data Science and UMBC's proposed M.S. in Applied Data Science programs are similar to each other. By having campuses at different locations, UMBC targets a different set of students geographically.

University of Maryland Eastern Shore (UMES)

UMES offers an M.S in Data Science and Analytics Engineering degree.

Teaching Mode: UMES' Master's in Data Science and Analytics Engineering program is online. UMBC students can take their courses both online and on campus.

Core Courses: The core courses of the UMES data science program focus on statistical data analysis, whereas the emphasis at UMBC is machine learning, exploratory data analysis, big data, and data management.

Electives: UMES offers 11 elective courses, each focusing on different application areas of data science, such as cyber security, geospatial analysis, business analytics, robotics, and even tourism. UMBC offers four or more elective courses developed and taught by 11 different programs/departments.

Thesis: UMBC doesn't offer a thesis option, whereas the students at UMES can work on their thesis.

The M.S. in Data Science and Analytics Engineering that UMES offers is in a different geographical location and best suited to serve the needs of Maryland's population in the Delmarva peninsula whereas UMBC is better suited for students residing in the greater Baltimore metropolitan region.

University of Maryland, Global Campus (UMGC)

The UMGC offers an online Master of Science in data analytics. Core courses and electives are listed in the following table.

Core Courses Decision Analytics (DATA 605) AI Ethics (DATA 615) Data Visualization (DATA 625) Data Management (DATA 635) Machine Learning (DATA 645) Data Analytics Capstone (DATA 690)	**Pathway-1: AI/Machine Learning** Deep Learning and Neural Networks (DATA 655) Advanced Topics in Data Science (DATA 660) AI Applications (DATA 665) Specialization Project (DATA 675) Workplace Learning in Data Analytics (DATA 686)
Pathway-2: Marketing Marketing Management (MRKT 600) Consumer Behavior and Customer Relationship Management (MRKT 602) Brand Management and Integrated Marketing Communication (MRKT 603) International Marketing Management (MRKT 605)	**Pathway-3: Cybersecurity Management & Policy** Foundations of Cybersecurity Management (CMAP 605) Cybersecurity Defense Strategies (CMAP 615) Cybersecurity Risk Management (CMAP 625) Cybersecurity Governance (CMAP 635)
Pathway-4: Cybersecurity Technology Introduction to Cybersecurity (CTCH 605) Cybersecurity Threats and Analysis (CTCH 615) Cybersecurity for Systems and Networks (CTCH 625) Cybersecurity Attack Prevention Strategies (CTCH 635)	**Pathway-5: Digital Forensics & Cyber Investigation** Digital Forensics and Cyber Investigation Foundations (DFCS 605) Collection and Examination of Digital Evidence (DFCS 615) Windows Forensics and Security (DFCS 625) Linux Forensics and Security (DFCS 635)

The Master of Science in Data Analytics program at the University of Maryland Global Campus (UMGC) focuses on a comprehensive curriculum designed to equip students with essential skills in decision analytics, AI ethics, data visualization, data management, machine learning, and culminates in a data analytics capstone project. This program emphasizes practical applications of analytics across various domains. In contrast, the M.S. in Applied Data Science program at UMBC offers a rigorous foundation in data science through courses such as introduction to data science, data analysis and machine learning, big data processing platforms, data management, probability and statistics, and concludes with a capstone project. UMBC's program emphasizes both theoretical understanding and hands-on experience with data analysis and processing technologies. Both programs provide strong foundations in data-related disciplines but in terms of electives and pathways, UMBC offers more possibilities than UMGC, e.g. health IT, econometrics, policy analysis, aging studies, advanced computing, and project management. UMGC's program is online only, whereas UMBC's proposed M.S. in Applied Data Science program will be offered in-person and hybrid modalities, is a selective-admission program, and does not specifically target distance-learning markets.

Appendix 3

M.S. in Applied Data Science Degree Requirements

The required core curriculum of the M.S. in Applied Data Science (18 credits) is as follows:

- DATA 601 Introduction to Data Science
- DATA 602 Introduction to Data Analysis and Machine Learning
- DATA 603 Platforms for Big Data Processing
- DATA 604 Data Management
- DATA 608 Probability and Statistics for Data Science
- DATA 606 Capstone Project in Data Science

Students must take four 3-credit electives (12 credits) from the DATA program or the 10 pathways with the approval of their advisor. The UMBC Graduate Catalog provides information and descriptions for those courses.

Below is a *sample* listing of regularly recurring elective courses from the DATA program:

- DATA 605 Ethics and Privacy in Data Science
- DATA 607 Leadership in Data Science
- DATA 611 Essential Mathematics for Machine Learning: An Applied Guide
- DATA 613 Data Visualization and Communication
- DATA 621 Practical Deep Learning
- DATA 623 Hands-on Generative AI
- DATA 624 Data Science for Finance

For increased curriculum flexibility, there is no set sequence of required courses, except that the project (DATA 606) generally is taken after the other core courses have been completed successfully and that newly-admitted students to the data science program are recommended to start with DATA 601 in their first semester. Additionally, prospective students holding certain current industry certifications may, upon proper documentation, request DATA 601 to be waived, and that another course be used to satisfy that credit requirement (usually a fifth elective.)

<u>Pathways</u>

For their electives students may also choose courses from any of the identified pathways. Listed below are a sampling of courses from each pathway.

Advanced Computing and Analytics

- CMSC 615 Introduction to Systems Engineering
- CMSC 625 Modeling and Simulation of Computer Systems
- CMSC 627 Wearable Computing
- CMSC 628 Mobile Computing
- CMSC 636 Data Visualization
- CMSC 653 Information and Coding Theory
- CMSC 655 Numerical Computations
- CMSC 661 Principles of Database Systems
- CMSC 668 Service-Oriented Computing
- CMSC 671 Principles of Artificial Intelligence
- CMSC 673 Introduction to Natural Language Processing
- CMSC 675 Introduction to Neural Networks
- CMSC 676 Information Retrieval

- CMSC 678 Machine Learning

Clinical Informatics (with UMB)

- INFO 601: Foundations in Clinical and Health Informatics
- INFO 602: Clinical Information Systems
- INFO 604: Decision Support Systems in Healthcare

Cybersecurity

- CYBR 620 Introduction to Cybersecurity
- CYBR 650: Managing Cybersecurity Operations
- CYBR 658: Risk Analysis and Compliance

Data Science Analysis

- IS 661 – Biomedical Informatics Applications
- IS 706 – Interfaces For Info. Visualization & Retrieval
- IS 707 – Applications of Intelligent Technologies
- IS 721 – Semi-Structured Data Management
- IS 722 – Systems and Information Integration
- IS 728 – Online Communities
- IS 731 – Electronic Commerce
- IS 733 – Data Mining
- IS 777 – Data Analytics for Statistical Learning

Economics/Econometrics

- PUBL 604 – Statistical Analysis
- ECON 601 – Microeconomic Analysis
- ECON 602 – Macroeconomic Analysis
- ECON 611 – Advanced Econometric Analysis I
- ECON 612 – Advanced Econometric Analysis II
- ECON 652 – Economics of Health

Healthcare Analytics

- HIT658: Health Informatics I
- HIT759: Health Informatics II
- HIT723: Public Health Informatics
- HIT674: Process and Quality Improvement within Health IT
- HIT751: Introduction to Healthcare Databases

Management Sciences

- ENMG 650: Project Management Fundamentals
- ENMG 654: Leading Teams and Organizations
- ENMG 658: Financial Management
- ENMG 659: Strategic Management
- ENMG 660: Systems Engineering Principles
- ENMG 661: Leading Global Virtual Teams
- ENMG 663: Advanced Project Management Applications
- ENMG 664: Quality Engineering & Management
- ENMG 668: Project and Systems Engineering Management

- ENMG 690: Innovation and Technology Entrepreneurship

Policy Analysis

- ECON 600 Policy Consequences of Economic Analysis
- PUBL 601 Political and Social Context of the Policymaking Process
- PUBL 603 Theory and Practice of Policy Analysis
- PUBL 607 Statistical Applications in Evaluation Research
- PUBL 608 Applied Multivariate Regression Analysis

Project Management

- ENMG 650: Project Management
- ENMG 661: Leading Virtual/Global Teams
- ENMG 663: Advanced Project Management Applications

Appendix 4
Learning Outcomes & Assessments, M.S. in Applied Data Science

(SLO-1) Students will develop the ability to use programming languages and tools to collect, clean, and analyze data.

MEASURE: Students will be given program assignments and projects that require them to use programming languages and tools to collect, clean, and analyze data. As appropriate, each course will assess students based on exams, individual or group projects, presentations, papers, lab exercises, and/or case studies.

CRITERION: Successful completion of each course with a B or better grade. The individual faculty member and/or the Data Science Graduate Program Director (DS GPD) will meet with students not meeting this criterion to help improve their performance or determine their continued enrollment in the program. The DS GPD reviews syllabi at least annually to ensure relevancy, currency, and pedagogical appropriateness.

ASSESSMENT: Each semester starting in Fall 2026 or upon program launch.

(SLO-2) Students will learn how to use statistical and machine learning techniques to extract insights from data.

MEASURE: Homework assignments will be designed to require students to apply statistical and machine learning techniques to real-world data sets. As appropriate, each course will assess students based on exams, individual or group projects, papers, lab exercises, and/or case studies.

CRITERION: Successful completion with a B or better grade. The individual faculty member and/or the DS GPD will meet with students not meeting this criterion to help improve their performance or determine their continued enrollment in the program. The DS GPD reviews syllabi at least annually to ensure relevancy, currency, and pedagogical appropriateness.

ASSESSMENT: Each semester starting in Fall 2026 or upon program launch.

(SLO-3) Students will learn how to create and interpret data visualizations to communicate their findings to others.

MEASURE: Students will be asked to create and interpret data visualizations as part of their coursework assignments. As appropriate, each course will assess students based on exams, individual or group projects, presentations, papers, literature reviews, and/or case studies. Students will also review each other's data visualizations and provide feedback. This will help students to identify areas where they can improve their skills.

CRITERION: Successful completion with a B or better grade. The individual faculty member and/or the DS GPD will meet with students not meeting this criterion to help improve their performance or determine their continued enrollment in the program. The DS GPD reviews syllabi at least annually to ensure relevancy, currency, and pedagogical appropriateness.

ASSESSMENT: Each semester starting in Fall 2026 or upon program launch.

(SLO-4) Students will demonstrate the ability to conduct scholarly and/or professional-level research and the various skills necessary in the data science profession such as team collaboration, critical thinking, time management, and effective communication.

MEASURE: Students will be assessed on their ability to develop and present scholarly or professional-grade written and oral deliverables such as analysis papers, presentations, and their capstone project. To meet these goals they will be expected to demonstrate effective organizational, time management, communication, critical thinking, and other such skills that contribute to an effective data science practitioner in the workplace. As appropriate, each course will assess students based on exams, individual or group projects, presentations, papers, literature reviews, and/or case studies.

CRITERION: Successful completion with a B or better grade. The individual faculty member and/or the GPD will meet with students not meeting this criterion to help improve their performance or determine their continued enrollment in the program. The GPD reviews syllabi at least annually to ensure relevancy, currency, and pedagogical appropriateness.

ASSESSMENT: Each semester starting in Fall 2026 or upon program launch.

Appendix 5
Student Support

The M.S. in Applied Data Science graduate program director and data science-affiliated full-time faculty members are responsible for advising. Other faculty involved with courses and specialization may also advise students and/or participate on capstone project committees. The DPS supports the CSEE department for program administrative support, recruitment, and marketing operations. Students in this program will have access to UMBC's wide range of support resources, such as the DOIT, Career Services, Off-Campus Student Services, Division of Institutional Equity, and the Graduate Student Association, among many others. Depending on the program's demands, DPS may allocate additional staff and resources to assist as necessary, such as those on the Office of Professional Programs Student Success team. UMBC students and faculty use Blackboard as the official campus Learning Management System for coursework and administration to support lecture, hybrid, and online learning modalities.

Students will be expected to have ready access to computers and the internet, with guidance on minimum technical requirements posted publicly on the program's website. Outside of lecture or in-person meetings, students and faculty will be expected to communicate through email, Blackboard, and UMBC's other collaborative platforms such as MyUMBC or Google Documents. Official information about curriculum updates, new courses, internships, graduation deadlines, etc., are conveyed to students via the student email list as the program's official distribution medium and/or directly to the students who are on email lists maintained by UMBC's Graduate School (for graduations and academic affairs), Registrar (for scheduling), Student Business Services (for costs and financial aid), or other campus entities. Technical support for UMBC's platforms, such as email and Blackboard, is provided by UMBC's DOIT upon request to the Help Desk Request Tracker. Information of interest to students, ranging from program and course information, academic expectations, tuition and fees, graduation requirements, and more, are located on UMBC's various public websites.

As of 2022, the only financial aid opportunities for this self-supported program are offered by the US government and are open to US citizens only. Information can be found online on our website[14]. Students seeking additional funding or employment to support their studies are encouraged to work with the Career Center to identify relevant opportunities.

UMBC's Office of Accessibility & Disability Services (ADS) under the Division of Academic Affairs ensures that students with disabilities are afforded an equal opportunity to participate in and benefit from the programs, services, and activities of the University through the provision of accommodations and reasonable modifications that result in equal access and full inclusion, which reflects UMBC's commitment to fostering an accessible and inclusive environment for all members of the UMBC community. Assistance from the ADS team is available to all UMBC students regardless of learning modality or campus location.

UMBC's Office of Equity and Inclusion has primary responsibility for managing UMBC's efforts related to Title IX as well as other civil rights issues, including discrimination, harassment, hate and bias. All faculty are considered 'responsible parties' regarding reporting requirements pursuant to UMBC's Title IX policies.

[14] https://professionalprograms.umbc.edu/scholarships-funding/

Appendix 6
Student Competencies Assessment

This appendix describes the quantitative and qualitative ways that M.S. in Applied Data Science students will be assessed in their courses, which are aligned with the program objectives described earlier.

Quantitative assessment

- Maintenance of a 'B' or better cumulative GPA.
- Quizzes, mid-term, and/or final examinations as appropriate.
- Practical examinations to evaluate competency with data science tools and techniques.
- Written project analyses and/or case studies.
- Written assignments, including in-class writing assignments and research papers that require students to conduct independent or team-based research and analysis to produce deliverables supporting course objectives
- Oral assignments that include both presentation of individual or group work and critiquing the work of others.
- Experiential learning opportunities as offered through faculty-led research opportunities, internships, field experiences, independent studies, among other opportunities.
- Capstone course.
- Other assessment mechanisms that may become relevant or required by the data science industry.

Qualitative assessment

- Academic advising at the program level to ensure students maintain academic and program expectations to proactively head off potential obstacles to success.
- Individual, peer-group, and/or in-class critiques of student work.
- Direct engagement between faculty and students in classroom, lab, or online platforms.
- Capstone courses (DATA 606) where students conduct a structured independent research effort to develop a scholarly or professional paper demonstrating their critical thinking skills, analytical capabilities, and/or accumulated technical expertise as a data science practitioner.

Appendix 7

M.S. in Applied Data Science Course Names and Descriptions (Core Courses and Program-Owned Electives)

DATA 601: Introduction to Data Science (3 cr.)

The goal of this class is to give students an introduction to and hands on experience with all phases of the data science process using real data and modern tools. Topics that will be covered include data formats, loading, and cleaning; data storage in relational and non-relational stores; data governance, data analysis using supervised and unsupervised learning using R and similar tools, and sound evaluation methods; and data visualization.

DATA 602: Introduction to Data Analysis and Machine Learning (3 cr.)

This course provides a broad introduction to the practical side of machine-learning and data analysis. This course examines the end-to-end processing pipeline for extracting and identifying useful features that best represent data, a few of the most important machine algorithms, and evaluating their performance for modeling data. Topics covered include decision trees, logistic regression, linear discriminant analysis, linear and non-linear regression, basic functions, support vector machines, neural networks, Bayesian networks, bias/variance theory, ensemble methods, clustering, evaluation methodologies, and experiment design.

DATA 603: Platforms for Big Data Processing (3 cr.)

The goal of this course is to introduce methods, technologies, and computing platforms for performing data analysis at scale. Topics include the theory and techniques for data acquisition, cleansing, aggregation, management of large heterogeneous data collections, processing, information and knowledge extraction. Students are introduced to map-reduce, streaming, and external memory algorithms and their implementations using Hadoop and its eco-system (HBase, Hive, Pig, and Spark). Students will gain practical experience in analyzing large existing databases.

DATA 604: Data Management (3 cr.)

This course introduces students to the data management, storage and manipulation tools common in data science. Students will get an overview of relational database management systems and various NoSQL database technologies, and apply them to real scenarios. Topics include: ER and relational data models, storage and concurrency preliminaries, relational databases and SQL queries, NoSQL databases, and Data Governance.

DATA 605: Ethical and Legal Issues in Data Science (3 cr.)

This course provides a comprehensive overview of important legal and ethical issues pertaining to the full life cycle of data science. The student learns how to think through the ethics of making decisions and inferences based on data and how important cases and laws have shaped the data science field. Students will use real and hypothetical case studies across various domains to explore these issues.

DATA 606: Data Science Project (3 cr.)

This is a semi-independent course that provides the advanced graduate student in the Data Science program the opportunity to apply the knowledge, skills and tools they've learned to a real-world data science project. Students will work with a real data set and go through the entire process of solving a real-world data science project. The project may be conducted with industry, government and academic partners, who can provide the data set, with guidance and feedback from the instructor.

DATA 607 Leadership in Data Science (3 cr.)

Course Description: In the rapidly evolving field of data science, technical expertise alone is not sufficient for success. Effective leadership is essential to navigate the complexities of data-driven decision-making and drive

impactful outcomes. The course is designed as a practical stage-by-stage field guide for our students to their careers in data science. It provides valuable insights and strategies for individuals at different career stages, from aspiring data science tech leads to seasoned data science executives. Through a comprehensive examination of several case studies, students will develop a deep understanding of the leadership skills, capabilities, and virtues necessary for success in the field of data science.

DATA 608 Probability and Statistics for Data Science (3 cr.)

Course Description: Data science relies heavily on the principles of probability theory and inferential statistics for extracting meaningful insight from complex datasets. DATA 608 introduces students to the essential concepts and tools of probability theory and statistics that form the backbone of data-driven decision-making processes. The course emphasizes a combination of theoretical tools, and application-oriented analysis to enable students to utilize statistical methods effectively in real-world data science scenarios.

This course consists of two major parts. In the first part, the key concepts of probability theory such as the probability space, different distribution functions, probability mass functions and densities, random variables, variance and covariance, expectation values and moments, conditional probability, independence, Bayes formula, laws of large numbers, and the central limit theorem are introduced. In the second part of the course, the basic concepts of statistical inference are covered. Among the covered topics, sampling methods, confidence intervals, hypothesis testing, and (one-way and two-way) ANOVA are discussed.

DATA 611 Essential Mathematics for Machine Learning: An Applied Guide (3 cr.)

Course Description: This course aims to provide fundamental yet necessary mathematics for graduate students to better understand machine learning methods and algorithms. Fundamental concepts of linear algebra, analytic geometry, matrix decompositions, vector calculus, and optimization are taught with Python.

DATA 613 Data Visualization and Communication (3 cr.)

Course Description: Data visualization is a critical skill in the modern era, enabling professionals to transform complex data into actionable insights. In DATA 613 Data Visualization and Communication, students will embark on a journey to master the art and science of visualizing data effectively. This graduate-level course equips students with the knowledge and skills necessary to create compelling data visualizations and communicate their findings to diverse audiences.

DATA 621 Practical Deep Learning (3 cr.)

Course Description: This course reviews modern methods used in deep learning and neural network design. The material focuses on a broad set of techniques that are commonly used in state-of-the-art neural network architectures. It includes methods used broadly, as well as network styles prevalent in specific sub-domains like computer vision, natural language processing, and social network analysis. The course does not review derivations of algorithms, but it explains methods with (somewhat gentle) math.

DATA 623 Hands-On Generative AI (3 cr.)

Course Description: This course introduces Generative AI (GenAI) by focusing on practical applications and hands-on experience with cutting-edge GenAI models. Students will learn to implement and apply GenAI models to generate text, images, music, and videos while addressing the ethical challenges inherent in GenAI.

DATA 624 Data Science for Finance (3 cr.)

Course Description: The aim of the course is to introduce and apply data science tools to model financial phenomena. This course is a first step towards better understanding financial issues with the help of data science.

The topics to be covered are accessing financial data via APIs, regression analysis for finance, time series analysis, net present value, simulation, and modern portfolio theory.

DATA 696 – Independent Study for Interns and Co-op Students (1-3 cr.)

Description: Supervision of student internship/co-op activities in the data science discipline. A short technical report that describes the activities conducted relevant to theoretical or operational concepts learned in other coursework and lessons gained through the internship/co-op experience is required at the end of the course. The course grade will be based on the technical report. The report will be submitted to the student's Graduate Program Director by the last day of the semester.

DATA 699 – Independent Study in Data Science (1-3 cr.)

Description: Individualized research activities under faculty supervision related to data science.

Appendix 8

Full-time Faculty Supporting the M.S. in Applied Data Science program

The CSEE faculty listed below supporting the M.S. in Applied Data Science are full-time regular faculty with data science expertise. Specific course/teaching assignments typically change on a regular basis. Additional faculty, including full-time, part-time, and/or adjuncts, may be included in the future to support instructional activities as needed.

Table 4: List of the names, ranks, and status of the CSEE faculty members and the courses they can teach in the proposed program.

Name	Highest Degree Earned, Field, Institution	Rank	Status	Course(s)
Anupam Joshi	Ph.D., Computer Science, Purdue University	Professor	Full-time	DATA 607
Ergun Simsek	Ph.D., Electrical and Computer Engineering, Duke University	Assistant Professor	Full-time	DATA 601 DATA 606
Masoud Soroush	Ph.D., Computational Physics, Stanford University	Lecturer	Full-time	DATA 602 DATA 608
Ajinkya Borle	Ph.D., Computer Science, UMBC	Lecturer	Full-time	DATA 601 DATA 604
M. Ali Yousuf	Ph.D., Physics, Quaid-e-Azam University	Lecturer	Full-time	DATA 603 DATA 623
Frank Ferraro	Ph.D., Computer Science, Johns Hopkins University	Assistant Professor	Full-time	DATA 602 DATA 621
Tim Finin	Ph.D., Computer Science, Illinois Urbana-Champaign	Professor	Full-time	DATA 601 DATA 602
Rebecca Williams	Ph.D., Engineering Science, Dartmouth College	Assistant Professor	Full-time	DATA 613 DATA 623
Don Engel	PhD., Physics, University of Pennsylvania	Assistant Professor	Full-time	DATA 613
Manas Gaur	Ph.D., Artificial Intelligence, University of South Carolina	Assistant Professor	Full-time	DATA 621
Cynthia Matuszek	Ph.D., Computer Science, University of Washington	Associate Professor	Full-time	DATA 623 DATA 605
Tim Oates	Ph.D., Computer Science, University of Massachusetts	Professor	Full-time	DATA 602
Roberto Yus	Ph.D., Computer Science, University of Zaragoza	Assistant Professor	Full-time	DATA 605
Zeynep Kacar	Ph.D. Biostatistics, University of Maryland, College Park	Lecturer	Full-time	DATA 608 DATA 624

Appendix 9
Degree Path

There is no required path toward degree completion and students generally may take courses in any order. Most students are encouraged to start with DATA 601 (Introduction to Data Science), especially if they are new to the discipline. Other courses may be taken in any order except that the capstone project (DATA 606) is usually taken after completing the core courses – most often during a student's final semester.

There are no academic or knowledge prerequisites for the core courses required for degree completion. However, certain specialized electives may have academic, professional, or knowledge prerequisites, such as DATA 621 (Practical Deep Learning) or DATA 623 (Hands-on Generative AI). For highly specialized electives, students lacking the appropriate background are encouraged to speak with their respective program director and/or the course instructor before registering to determine their ability to complete such courses successfully.

Appendix 10

Table 5: Resources and Narrative Rationale

	Year 1	Year 2	Year 3	Year 4	Year 5
1. Reallocated funds	0	0	0	0	0
2. Tuition/fee Revenue (c + g below)	3877826.4	3991451.39	4108430.92	4228864.57	4352854.84
a. Number of F/T Students	193	193	193	193	193
b. Annual Tuition/Fee Rate	18688.32	19248.9696	19826.4387	20421.2318	21033.8688
Annual Credit Hour Rate	18	18	18	18	18
c. Total F/T Revenue (a x b)	3606845.76	3715051.13	3826502.67	3941297.75	4059536.68
d. Number of P/T Students	29	29	29	29	29
e. Credit Hour Rate	1038.24	1059.0048	1080.1849	1101.78859	1123.82437
f. Annual Credit Hour Rate	9	9	9	9	9
g. Total P/T Revenue (d x e x f)	270980.64	276400.253	281928.258	287566.823	293318.159
3. Grants, Contracts & Other External Sources	0	0	0	0	0
4. Other Sources	0	0	0	0	0
TOTAL (Add 1-4)	3877826.4	3991451.39	4108430.92	4228864.57	4352854.84

The proposed program is expected to generate a steady increase in tuition and fee revenue over its first five years, reflecting stable enrollment trends in both full-time and part-time student categories. Based on historical enrollment patterns, where over 50 new students have joined our graduate data science programs annually for the past five years, we anticipate sustained demand in this growing field of artificial intelligence.

In Year 1, total revenue is projected at $3,877,826, with contributions from 193 full-time students and 29 part-time students. Full-time enrollment will remain steady at 193 students per year, with tuition and fee rates increasing from $18,688 per student in Year 1 to $21,034 in Year 5. Correspondingly, full-time tuition revenue will rise from $3,606,846 in Year 1 to $4,059,537 in Year 5.

Part-time student enrollment is projected to hold at 29 students per year, with tuition calculated based on a per-credit-hour rate that increases incrementally from $1,038 in Year 1 to $1,124 in Year 5. Assuming an average of 9 credit hours per year per part-time student, revenue from this segment is expected to grow from $270,981 in Year 1 to $293,318 in Year 5.

With no reliance on reallocated funds, grants, contracts, or other external sources, tuition and fees will fully support the program's financial sustainability. By Year 5, total revenue is projected to reach $4,352,855, reflecting both modest tuition adjustments and consistent enrollment patterns.

Appendix 11

Table 6: Program Expenditures and Narrative Rationale

	Year 1	Year 2	Year 3	Year 4	Year 5
1. Faculty (b + c below)	201000	207030	213240.9	219638.127	226227.271
a. Number of FTE	1	1	1	1	1
b. Total Salary	150000	154500	159135	163909.05	168826.322
c. Total benefits	51000	52530	54105.9	55729.077	57400.9493
2. Admin. Staff	0	0	0	0	0
3. Support Staff	0	0	0	0	0
4. Technical Support and Equipment	3080	3172.4	3267.572	3365.59916	3466.56713
5. Library	0	0	0	0	0
6. New or Renovated Space	0	0	0	0	0
7. Other Expenses	1597304.79	1645223.93	1694580.65	1745418.07	1797780.61
TOTAL (add 1-7)	1801384.79	1855426.33	1911089.12	1968421.8	2027474.45

To ensure the program's success and long-term sustainability, we have carefully projected expenditures across key categories, accounting for faculty, technical support, and operational needs.

1. Faculty: The program will be supported by one full-time faculty member starting in Year 1, responsible for developing and teaching core courses, advising students, and contributing to program administration. The associated costs include:

- Salary Expenditures: Beginning at $150,000 in Year 1, with annual increases to accommodate cost-of-living adjustments and merit raises, reaching $168,826 by Year 5.
- Fringe Benefits: Estimated at approximately 34% of salary, starting at $51,000 in Year 1 and growing to $57,401 by Year 5.

2. Administrative Staff: No additional full-time administrative staff will be required, as the program will leverage existing institutional resources to handle administrative functions.

3. Support Staff: Similarly, the program will utilize existing support staff within the department, eliminating the need for additional hires.

4. Technical Support and Equipment: To provide the GPD with basic computing needs, funds will be allocated for software licenses, computing resources, and necessary upgrades. To keep pace with inflation and evolving technological needs, expenditures will start at $3,080 in Year 1 and increase to $3,467 by Year 5.

5. Library Resources: No additional library expenses are anticipated. The university's existing digital and physical library resources sufficiently support faculty and student research needs.

6. New or Renovated Space: The program will be housed within existing facilities, requiring no new construction or renovation.

7. Other Expenses: Faculty development, conference travel, memberships, marketing, office supplies, and technology services. Initial expenditures are projected at $1,597,305 in Year 1, rising to $1,797,781 by Year 5 to support program growth, faculty engagement, and continuous improvement.

Total Expenditures: Overall, total program expenditures will increase from $1,801,385 in Year 1 to $2,027,474 in Year 5, ensuring financial sustainability while maintaining high-quality instruction and student support.

	Year 1	Year 2	Year 3	Year 4	Year 5
Program Resources					
1. Reallocated funds	$0	$0	$0	$0	$0
2. Tuition/fee Revenue (c + g below)	$3,877,826	$3,991,451	$4,108,431	$4,228,865	$4,352,855
a. Number of F/T Students	193	193	193	193	193
b. Annual Tuition/Fee Rate	$18,688	$19,249	$19,826	$20,421	$21,034
c. Total F/T Revenue (a x b)	$3,606,846	$3,715,051	$3,826,503	$3,941,298	$4,059,537
d. Number of P/T Students	29	29	29	29	29
e. Credit Hour Rate	$1,038	$1,059	$1,080	$1,102	$1,124
f. Annual Credit Hour Rate	9.0	9	9	9	9
g. Total P/T Revenue (d x e x f)	$270,981	$276,400	$281,928	$287,567	$293,318
3. Grants, Contracts & Other External Sources	$0	$0	$0	$0	$0
4. Other Sources	$0	$0	$0	$0	$0
TOTAL (Add 1-4)	**$3,877,826**	**$3,991,451**	**$4,108,431**	**$4,228,865**	**$4,352,855**
Expenditure Categories					
1. Faculty (b + c below)	$201,000	$207,030	$213,241	$219,638	$226,227
a. Number of FTE	1	1	1	1	1
b. Total Salary	$150,000	$154,500	$159,135	$163,909	$168,826
c. Total benefits	$51,000	$52,530	$54,106	$55,729	$57,401
2. Admin. Staff (b + c below)	$0	$0	$0	$0	$0
a. Number of FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total benefits	0	0	0	0	0
3. Support Staff (b + c below)	$0	$0	$0	$0	$0
a. Number of FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total benefits	0	0	0	0	0
4. Technical Support and Equipment	$3,080	$3,172	$3,268	$3,366	$3,467
5. Library	$0	$0	$0	$0	$0
6. New or Renovated Space	$0	$0	$0	$0	$0
7. Other Expenses	$1,597,305	$1,645,224	$1,694,581	$1,745,418	$1,797,781
TOTAL (add 1-7)	**$1,801,385**	**$1,855,426**	**$1,911,089**	**$1,968,422**	**$2,027,474**

* Due to the nature of this Master's degree, most enrollment will draw from already existing UMBC full-time students who add the degree. As these students do not generate NEW revenues, the budget does not reflect revenue for these students.

Appendix 12

Educational Assessment Methods

Program evaluation is done by assessing learning outcomes using UMBC's existing policies and procedures.

CSEE faculty periodically review syllabi, rubrics, labs, and projects to ensure a standard student experience and that materials used and presented remain relevant viz-a-viz current industry trends.

The CSEE department and UMBC generally evaluate full-time faculty through the university's established promotion and tenure process in the traditional areas of teaching, research, and service. This process includes a review of their syllabi, labs, courseware, samples of student products, classroom observation, and student surveys.

Qualified adjunct faculty, upon verification of their academic and professional credentials, are appointed members of the UMBC Graduate School. Adjunct faculty are evaluated by full-time faculty members through regular curriculum reviews, mentoring, periodic classroom observation, and addressing student feedback promptly to ensure the quality of instruction and the student's educational experience.

All UMBC faculty (regular and adjunct) are evaluated via the administration of online student surveys issued at the end of each semester. The data from this survey is shared with the instructor and publicly available via IRADS, while any qualitative comments received are shared only with the instructor. Faculty are encouraged to work with their program director, colleagues, UMBC's Center for Applied Learning and Teaching (CALT), or the DOIT to conduct objective course assessment and/or pedagogical enhancement.

The Department of CSEE Chair and COEIT Dean regularly review student enrollment, retention, culture, and financial data from a strategic perspective to ensure program outcomes are aligned with Departmental and College priorities under UMBC's *Strategic Plan*. UMBC's Provost Office also engages in strategic and financial reviews of all UMBC programs. Exit surveys for graduating students are conducted each year by the Office of Professional Programs within the DPS as another gauge of the student's educational experience.

The USM's accountability obligation includes a requirement that each academic program be reviewed every seven years. Accordingly, UMBC conducts academic program reviews (APR) to gauge program effectiveness, quality, and culture. As recognized by USM and the Council of Graduate Schools, the APR process has five general purposes: quality assurance, quality improvement, accountability, identification of strategies for improvement, and providing the institution with information for prioritization of resources.

Taken together, UMBC has a robust, multi-stakeholder method to assess academic program effectiveness, learning outcomes, student retention, student/faculty satisfaction, cost-effectiveness, and workforce relevance. These methods are supported by continual internal UMBC evaluation of industry trends and needs to ensure its programs continue to meet current and anticipated industry and workforce requirements in Maryland and beyond.