OFFICE OF THE CHANCELLOR

January 25, 2024

Dr. Darryll J. Pines
President
University of Maryland, College Park
1101 Thomas V. Miller, Jr. Administration Building
College Park, MD 20742

Dear Darryll:

The Board of Regents met in public session on Friday, December 15, 2023, at the University of Maryland, Baltimore. During the meeting, the Board approved the proposal from the University of Maryland, College Park to offer the Master of Science (M.S.) in Data Science.

This Board action follows the recommendation for approval made at the Committee on Education Policy and Student Life meeting on November 29, 2023.

Sincerely yours,

Jay A. Perman
Chancellor

cc: Alison Wrynn
        Candace Caraco
        Zakiya Lee
        Denise Wilkerson

INSTITUTIONS // BOWIE STATE UNIVERSITY · COPPIN STATE UNIVERSITY · FROSTBURG STATE UNIVERSITY · SALISBURY UNIVERSITY
TOWSON UNIVERSITY · UNIVERSITY OF BALTIMORE · UNIVERSITY OF MARYLAND, BALTIMORE · UNIVERSITY OF MARYLAND, BALTIMORE COUNTY
UNIVERSITY OF MARYLAND CENTER FOR ENVIRONMENTAL SCIENCE · UNIVERSITY OF MARYLAND, COLLEGE PARK · UNIVERSITY OF MARYLAND
EASTERN SHORE · UNIVERSITY OF MARYLAND GLOBAL CAMPUS **REGIONAL CENTERS //** UNIVERSITIES AT SHADY GROVE · UNIVERSITY SYSTEM
OF MARYLAND AT HAGERSTOWN · UNIVERSITY SYSTEM OF MARYLAND AT SOUTHERN MARYLAND

PCC Proposal to Establish a Master of Science in Data Science (Senate Document #23-24-11)

TO	**Darryll J. Pines	President**
FROM	**Christopher Jarzynski	Chair, University Senate**

I am pleased to forward the accompanying legislation for your consideration and approval. Wendy Stickle, Chair of the Programs, Curricula & Courses (PCC) Committee, presented the PCC Proposal to Establish a Master of Science in Data Science (Senate Document #23-24-11), which the University Senate approved at its meeting on November 1, 2023. Please inform the Senate of your decision and any administrative action related to your conclusion.

Approved: _(signature)_ **Date:** **11-02-2023**

Darryll J. Pines
President

Copies of this approval and the accompanying legislation will be forwarded to:

Jennifer King Rice, Senior Vice President and Provost
Veronica Marin, Executive Secretary and Director, University Senate
Jay Rosselló, Vice President of Legal Affairs and General Counsel
Dylan Baker, Associate Vice President for Finance and Personnel
John Bertot, Associate Provost for Faculty Affairs
Elizabeth Beise, Associate Provost for Academic Planning & Programs
Rhonda Smith, Director, Division of Academic Affairs
Michael Cummings, Director, Data Science and Analytics Master of Professional Studies
Amy Chester, Director, Science Academy

PCC Proposal to Establish a Master of Science in Data Science

PRESENTED BY	Wendy Stickle, Chair, Senate Programs, Curricula, and Courses Committee
REVIEW DATES	SEC – October 20, 2023	SENATE – November 1, 2023
VOTING METHOD	In a single vote
RELEVANT POLICY/DOCUMENT	
NECESSARY APPROVALS	Senate, President, USM Board of Regents, and the Maryland Higher Education Commission

ISSUE

The College of Computer, Mathematical, and Natural Sciences proposes to establish a Master of Science in Data Science. This program exists currently as an iteration of the Master of Professional Studies (MPS) program. The 30-credit MPS program (titled Data Science and Analytics) has been in operation since the Winter 2019-2020 term. Master of Professional Studies programs were first approved in 2005, when the University System of Maryland Board of Regents and Maryland Higher Education Commission approved an expedited review process for master's and graduate certificate programs that respond quickly to the changing market needs of working professionals. Once a new iteration of the MPS is approved through campus PCC review, it only needs approval by the USM Chancellor to become official.

A limitation of offering this program as an MPS iteration is that all Professional Studies programs must use the same generic Federal Classification of Instructional Programs (CIP) code, rather than a CIP code that accurately describes the program content. Those who search for academic programs by using the CIP codes related to Data Science will not find this program. Moreover, some CIP codes are designated as "STEM" eligible by the US Department of Homeland Security, and international students with F1 visas who graduate from STEM designated programs may continue to work in the United States for two years longer than students in non-STEM designated programs. The generic CIP code for Professional Studies programs does not qualify as STEM-designated, even if the academic content of the Professional Studies program is STEM-related, as is the case with this program.

Consequently, the college proposes to transition the current program from a Master of Professional Studies program to a stand-alone Master of Science program in order for the program to be classified more accurately. The 30-credit curriculum will remain the same.

The Master of Science in Data Science will provide students with an education in the theory and practice of data science including mathematical and statistical foundations, computational approaches, and communication considerations. In addition to the fundamentals of data science, the program covers data science-relevant probability and statistics, algorithms, big data systems, machine learning, data mining, and analysis of networks. The program consists of 10 required 3-credit courses. The program is a non-thesis program and will have both an in-person and distance

education version. Students who finish the program successfully will be able to design, conduct, and interpret data analysis tasks. Students will be able to communicate data analysis findings and will be able to apply methods and tools of statistics, machine learning, and computer science to data studies.

The proposal was approved by the Graduate School PCC committee on September 27, 2023, and the Senate Programs, Curricula, and Courses committee on October 6, 2023.

RECOMMENDATION(S)

The Senate Committee on Programs, Curricula, and Courses recommends that the Senate approve this new academic program.

COMMITTEE WORK

The committee considered this proposal at its meeting on October 6, 2023. Michael Cummings, Amy Chester, and John Fourkas, from the College of Computer, Mathematical, and Natural Sciences, presented the proposal and answered questions from the committee. The committee unanimously approved the proposal.

ALTERNATIVES

The Senate could decline to approve this new academic program.

RISKS

If the Senate declines to approve this new degree program, the university will lose an opportunity to apply a more accurate Federal CIP code to an existing program thereby making the program more marketable.

FINANCIAL IMPLICATIONS

There are no significant financial implications with this proposal as the program already exists as a self-supported Master of Professional Studies program.

912: DATA SCIENCE

In Workflow

1. CMNS PCC Chair (jpresson@umd.edu; fourkas@umd.edu)
2. CMNS Dean (rinfanti@umd.edu)
3. Academic Affairs Curriculum Manager (mcolson@umd.edu)
4. Graduate School Curriculum Manager (jfarman@umd.edu)
5. Graduate PCC Chair (jfarman@umd.edu)
6. Dean of the Graduate School (jfarman@umd.edu; sroth1@umd.edu)
7. Senate PCC Chair (mcolson@umd.edu; wstickle@umd.edu)
8. University Senate Chair (mcolson@umd.edu)
9. President (mcolson@umd.edu)
10. Board of Regents (mcolson@umd.edu)
11. MHEC (mcolson@umd.edu)
12. Provost Office (mcolson@umd.edu)
13. Graduate Catalog Manager (bhernand@umd.edu; fantsao@umd.edu)

Approval Path

1. Thu, 27 Apr 2023 21:52:25 GMT
   John Fourkas (fourkas): Approved for CMNS PCC Chair
2. Fri, 28 Apr 2023 17:35:03 GMT
   Robert Infantino (rinfanti): Approved for CMNS Dean
3. Wed, 06 Sep 2023 18:16:55 GMT
   Michael Colson (mcolson): Approved for Academic Affairs Curriculum Manager
4. Fri, 29 Sep 2023 20:03:14 GMT
   Jason Farman (jfarman): Approved for Graduate School Curriculum Manager
5. Fri, 29 Sep 2023 20:08:41 GMT
   Jason Farman (jfarman): Approved for Graduate PCC Chair
6. Wed, 04 Oct 2023 20:48:08 GMT
   Stephen Roth (sroth1): Approved for Dean of the Graduate School
7. Sat, 07 Oct 2023 17:29:43 GMT
   Wendy Stickle (wstickle): Approved for Senate PCC Chair
8. Mon, 29 Jan 2024 15:43:41 GMT
   Michael Colson (mcolson): Approved for University Senate Chair
9. Mon, 29 Jan 2024 15:43:53 GMT
   Michael Colson (mcolson): Approved for President
10. Mon, 29 Jan 2024 15:43:58 GMT
    Michael Colson (mcolson): Approved for Board of Regents
11. Mon, 29 Jan 2024 15:44:06 GMT
    Michael Colson (mcolson): Approved for MHEC
12. Mon, 29 Jan 2024 15:44:17 GMT
    Michael Colson (mcolson): Approved for Provost Office

New Program Proposal

Date Submitted: Wed, 26 Apr 2023 19:13:16 GMT

Viewing: 912 : Data Science
Last edit: Fri, 26 Jan 2024 16:38:57 GMT

Changes proposed by: Michael Cummings (mcummin1)

Program Name

Data Science

Program Status

Active

Effective Term

Fall 2024

Catalog Year

2024-2025

Program Level

Graduate Program

Program Type

Master's

Delivery Method

On Campus

Departments

Department
Computer, Mathematical, and Natural Sciences

Colleges

College
Computer, Mathematical, and Natural Sciences

MHEC Inventory Program

Data Science

CIP Code

30.7001 - 30.7001

HEGIS

079902

Degree(s) Awarded

Degree Awarded
Master of Science

Proposal Contact

Michael Cummings, Amy Chester

Proposal Summary

The University of Maryland Science Academy is pleased to submit this proposal for an MS in Data Science. The MPS in Data Science and Analytics has been a very successful program since launching in 2019 and this proposal is to convert that program to an MS in Data Science. CIP Code: 30.7001 Data Science, General

(PCC Log Number 23006)

Program and Catalog Information

Provide the catalog description of the proposed program. As part of the description, please indicate any areas of concentration or specializations that will be offered.

The Master of Science in Data Science provides students education in the theory and practice of data science including mathematical and statistical foundations, computational approaches, and communication considerations. In addition to the fundamentals of data science the program covers data science-relevant probability and statistics, algorithms, big data systems, machine learning, data mining, and analysis of networks. The program consists of 30-credit course work. It is a non-thesis program.

Catalog Program Requirements. Please click on the help bubble for more specific information about formatting requirements.

Course	Title	Credits
DATA601	Probability and Statistics	3
DATA602	Principles of Data Science	3
DATA603	Principles of Machine Learning	3
DATA604	Data Representation and Modeling	3
DATA605	Big Data Systems	3
DATA606	Algorithms for Data Science	3
DATA607	Communication in Data Science and Analytics	3
DATA612	Deep Learning	3
DATA641	Natural Language Processing	3
DATA698	Research Methods and Study Design	3
Total Credits		**30**

Sample plan. Provide a term by term sample plan that shows how a hypothetical student would progress through the program to completion. It should be clear the length of time it will take for a typical student to graduate. For undergraduate programs, this should be the four-year plan.

Full time

Term 1:
DATA601 Principles of Data Science
DATA602 Probability and Statistics
DATA603 Principles of Machine Learning

Term 2:
DATA604 Data Representation and Modeling
DATA605 Big Data Systems
DATA641 Natural Language Processing

Term 3:
DATA606 Algorithms for Data Science
DATA698 Research Methods in Data Science

Term 4:
DATA607 Communication in Data Science and Analytics
DATA650 Cloud Computing

Part Time

Term 1:
DATA601 Principles of Data Science
DATA602 Probability and Statistics

Term 2:
DATA603 Principles of Machine Learning
DATA604 Data Representation and Modeling

Term 3:
DATA606 Algorithms for Data Science
DATA698 Research Methods in Data Science

Term 4:
DATA607 Communication in Data Science and Analytics
DATA650 Cloud Computing

Term 5:
DATA605 Big Data Systems
DATA641 Natural Language Processing

List the intended student learning outcomes. In an attachment, provide the plan for assessing these outcomes.

Learning Outcomes
Design, conduct and interpret data analysis tasks
Communicate data analysis tasks and findings
Apply methods and tools of statistics, machine learning, computer science, to data studies

New Program Information

Mission and Purpose

Describe the program and explain how it fits the institutional mission statement and planning priorities.

This proposal is to transition the current MPS in Data Science and Analytics program to an MS in Data Science. The MPS in Data Science and Analytics launched in Winter 2019 and has seen great success and high demand. For the Fall 2023 semester, the program has over 450 completed applications as of 31 March 2023. The program had 75 registered majors during Fall 2022, a 23% increase from the prior year.

The new MS in Data Science will be directly aligned with the mission of the University, which states, in part the following.

"As a land-grant institution, the University shares its research, educational, cultural, and technological strengths with the Maryland citizenry and other constituencies. Its collaborations with State, federal, private and non-profit partners promote economic development and improve quality of life."

The last few years have seen the emergence and rapid growth of professional education in the sciences, in particular in Data Science and other fields linked to computer science. The explosion of data and computing power has placed Data Science at the forefront of a much broader wave of new research areas requiring professional training including Machine Learning and Immersive Media. Data Science is a fundamental area and provides a basis for a range of new knowledge and skills that can be broadly applied. The University of Maryland is the best place in the region for professionals to gain these skills. U.S. News & World Report ranks UMD the highest in the region for computer science and applied mathematics.

This program will offer students the opportunity to engage in foundational technical course work in data science and analytics. The program will focus on five thematic competencies for the art and science of the new field of data science and analytics: Statistics, Machine Learning, Computing, Communication, and Professional Practice. The program will consist of 30-credit course work in the following thematic areas.
1. Statistics — Statistics here are the standard statistics subsumed by general linear models (e.g., linear regression, ANOVA, t-tests, f-tests, and multivariate extensions); discrimination, classification, ordination (e.g., PCA, MDS), linear discriminant analysis, factor analysis, and related methods; permutation and randomization methods; Bayesian estimation.
2. Machine learning — Machine learning here represents methods that are not subsumed by general linear models or other traditional distributional model-based statistics. Includes such things as: support vector machines; artificial neural networks and their derivatives and extensions; decision tree induction; random forests; other ensemble methods; affinity analysis; association rule learning; deep learning.
3. Computing — Computing here are those topics that are traditionally taught in computer science programs though restricted here to only include those core elements most necessary for professional practice in data science and analytics. Included here: programming using scripting/interpretative languages (e.g., shell, Python).
4. Communication — Communication here comprises methods and practice of communicating data science and analytics concepts, methods and results in written, verbal, and electronic media.
5. Research/professional practice — Research/professional practice here means actual design, execution, and communication of a data science and analytics project.

Program Characteristics

What are the educational objectives of the program?

When students graduate from the program, they should be able to design, conduct, interpret and communicate data analysis tasks and studies using methods and tools of statistics, machine learning, computer science, and communications.

Describe any selective admissions policy or special criteria for students interested in this program.

Admission is for the fall semester only. Applicants must meet the following minimum admission criteria as established by the Graduate School:

Applicants must have earned a four-year baccalaureate degree from a regionally accredited U.S. institution, or an equivalent degree from a non-U.S. institution.
Applicants must have earned a 3.0 GPA (on a 4.0 scale) in all prior undergraduate and graduate coursework.
Applicants must provide an official copy of a transcript for all of their post-secondary work.
International applicants must fulfill all requirements relating to international academic credentials, evidence of English proficiency, financial certification, and visa documentation.
In addition, applicants must submit the following:

Required items:
Statement of purpose.
Curriculum vitae/resume.
Evidence (e.g., transcripts) of quantitative abilities by taking two courses in calculus, linear algebra and/or statistics.
Evidence (e.g., transcripts, certificates) of computer programming proficiency in one or more interpreted or compiled languages.

Optional items:
Two letters of recommendation.
Graduate Record Examination (GRE) scores.

Summarize the factors that were considered in developing the proposed curriculum (such as recommendations of advisory or other groups, articulated workforce needs, standards set by disciplinary associations or specialized-accrediting groups, etc.).

The factors that were considered in developing the proposed curriculum derive largely from our professional experiences working in areas related to data science, careful study of other data science curricula at other institutions, and educational/training needs articulated by major employers.

Select the academic calendar type for this program (calendar types with dates can be found on the Academic Calendar). Please click on the help bubble for more specific information.

Traditional Semester

For Master's degree programs, describe the thesis requirement and/or the non-thesis requirement.

non-thesis

Identify specific actions and strategies that will be utilized to recruit and retain a diverse student body.

The primary recruitment activities will be via the CMNS Science Academy. The Science Academy uses a diverse, targeted approach when recruiting students. This digital strategy focuses on UMD alumni, current UMD graduating seniors, and working professionals in the DMV area. The admissions review process reviews for not only academic readiness but also diversity in experiences, industries, backgrounds, and career aspirations to recruit a diverse student body.

To attract a diverse student population, we will engage in the following activities:
• Representing the program in educational fairs, conferences and events, e.g. the National Leadership Conference of the National Society of Black Engineers, GEM Grad Labs.
• Advertising the program to the National Society of Black Engineers (NSBE), the Society of Women Engineers (SWE), and the Association for Women in Computing (AWC).
• Direct mailing and email campaigns to domestic and international colleges
• Outreach to UMD Campus organizations and clubs
• Holding online (virtual) open houses, information sessions and career panels
• Outreach to US Military to attract veterans
• Social media and online advertising
• Establishing graduate scholarships to provide financial aid to underrepresented minority applicants

Once enrolled, the Science Academy staff, and faculty are committed to creating and fostering a supportive environment for all students to thrive. We regularly share resources and opportunities for counseling, support, and funding. All students are expected to complete and honor the TerrapinSTRONG orientation and initiatives. Students are encouraged to take part in Grad School programs that address diversity and inclusion in higher education, build communities of support and success, and create meaningful dialogue among graduate students. Such programs include"Cultivating Community Conversations" and the "Annual Office of Graduate Diversity and Inclusions Spring Speaker Services." Faculty that are involved in the Science Academy represent many departments, have a diversity of appointments (both tenure track, professional track, and adjunct) exposing students to many future career paths. The Science Academy and faculty provide student advising, academic support, and career guidance to students to retain all students and support timely graduation.

Our student retention efforts will consist of:
• Holding "Women in Engineering, Computing and STEM" seminars to addresses the obstacles faced by women in today's technical workplace and guide our women students to maneuver through the internship and job application process
• Requiring students to attend mandatory advising sessions with the program adviser to ensure that the students' study plans are in line with their interests and career goals, and that the students make satisfactory progress toward meeting the degree requirements
• Implementing an early warning system that detects students struggling with core courses and alerts the academic advisor, who meets with the students and designs a study plan to get them back on track

Relationship to Other Units or Institutions

If a required or recommended course is o#ered by another department, discuss how the additional students will not unduly burden that department's faculty and resources. Discuss any other potential impacts on another department, such as academic content that may significantly overlap with existing programs. Use space below for any comments. Otherwise, attach supporting correspondence.

Three of the courses are co-listed versions of courses in common with the programs in Bioinformatics and Computational Biology, and Machine Learning: BIOI/DATA/MSML601, Probability and Statistics; BIOI/DATA/MSML602, Principles of Data Science; and BIOI/DATA/MSML603, Principles of Machine Learning. These three courses are foundational to modern quantitative and computational-based science, and thus are common to the existing programs and the proposed program. All the remaining core courses will be new to the program, and some electives may be accepted from other programs. All programs are managed by the Science Academy.

Accreditation and Licensure. Will the program need to be accredited? If so, indicate the accrediting agency. Also, indicate if students will expect to be licensed or certified in order to engage in or be successful in the program's target occupation.

No accreditation or licensure is required for the program.

Describe any cooperative arrangements with other institutions or organizations that will be important for the success of this program.

n/a

Faculty and Organization

Who will provide academic direction and oversight for the program? In an attachment, please indicate the faculty involved in the program. Include their titles, credentials, and courses they may teach for the program. Please click on the help bubble for a template to use for adding faculty information.

The CMNS Science Academy will work closely with the department chairs of Computer Science, Mathematics, and Electrical and Computer Engineering for shared academic oversight. The Dean of the College will assign a faculty director to the program who will provide academic and advising oversight to incoming and admitted students. Professor Michael Cummings has been serving in this role for the MPS in Data Science and Analytics since 2019. In addition, the faculty director is responsible for instructor selections and appointments and works collaboratively with the Science Academy and OES when appropriate. A full list of faculty to be involved in the program is attached.

Indicate who will provide the administrative coordination for the program

The Science Academy in the College of Computer, Mathematics and Natural Science will provide administrative coordination for the program, in collaboration with the Office of Extended Studies. The Office of Extended Studies provides program development support (budget development and projections, in house marketing research, preparation of PCC document), program management (UMD policies and procedures compliance, program website, data requests), student and program services (admission support, scheduling, registration, billing and payment, graduation, appeals), and financial management (faculty contracts, payment processing, course charge processor, net revenue distribution).

Resource Needs and Sources

Each new program is required to have a library assessment prepared by the University Libraries in order to determine any new library resources that may be required. This assessment must be done by the University Libraries. Add as an attachment.

see attached.

Discuss the adequacy of physical facilities, infrastructure and instructional equipment.

No additional physical facilities, infrastructure and instructional equipment is required for this program. Existing facilities (e.g., classrooms) and resources (e.g., instructional equipment) will be used, and these are demonstrably adequate for the proposed program. It is anticipated that most of the instruction will be in the evenings, as befitting the target student population of working adults. Thus, the use of classrooms will be outside the hours used for instruction by most other programs.

Discuss the instructional resources (faculty, staff, and teaching assistants) that will be needed to cover new courses or needed additional sections of existing courses to be taught. Indicate the source of resources for covering these costs.

For each course an instructor will be needed. The Director of the Science Academy, Faculty Director, and participating department chairs will recruit instructors and work closely with the faculty in the development of teaching materials. Costs for instructors and teaching assistants/graders (as needed for larger enrollment) will be covered from program revenue. In addition, any costs for development of teaching materials will be handled through the new CMNS Science Academy covered by program revenue.

In addition, the Science Academy works with the departments/units developing courses on instructor selections and appointments.

Discuss the administrative and advising resources that will be needed for the program. Indicate the source of resources for covering these costs.

The CMNS Science Academy will provide the academic and advising oversight to incoming and admitted students. Revenue generated from the program will be used to support administrative and advising resources including a Program Manager. No state resources will be used to support the program

Use the Maryland Higher Education Commission (MHEC) commission financial tables to describe the program's financial plan for the next five years. See help bubble for financial table template. Use space below for any additional comments on program funding. Please click on the help bubble for financial table templates.

The financial plan is attached. The program will generate sufficient revenue to be self sustained.

Implications for the State (Additional Information Required by MHEC and the Board of Regents)

Explain how there is a compelling regional or statewide need for the program. Argument for need may be based on the need for the advancement of knowledge and/or societal needs, including the need for "expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education." Also, explain how need is consistent with the Maryland State Plan for Postsecondary Education. Please click on the help bubble for more specific information.

See support document attachment, Market Analysis, for a full analysis of the market as of March 2023. Our research indicates a much faster than average growth in computer and information research scientist positions nationally in the next 10 years. As more jobs become available in this area, it is our responsibility to respond to this need by preparing the workforce. Our graduates will complete the program with the skills and knowledge to fill the open positions in the market. Our program directly aligns with the Maryland State Plan for Postsecondary Education and the principles of public

education in the State of Maryland. This program in the Science Academy increases access to higher education (specifically graduate level education) and increases the diversity of graduate students

Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program. Possible sources of information include industry or disciplinary studies on job market, the USBLS Occupational Outlook Handbook, or Maryland state Occupational and Industry Projections over the next five years. Also, provide information on the existing supply of graduates in similar programs in the state (use MHEC's Office of Research and Policy Analysis webpage for Annual Reports on Enrollment by Program) and discuss how future demand for graduates will exceed the existing supply. As part of this analysis, indicate the anticipated number of students your program will graduate per year at steady state.) Please click on the help bubble for specific resources for finding this information.

See support document attachment, Market Analysis, for a full analysis of the market as of March 2023. Our research indicates a much faster than average growth in computer and information research scientist positions in the field nationally (21%) in the next 10 years. Growth in the state of Maryland is projected at 7%. Lastly, following the enrollment trends at other Maryland programs, our successful MPS enrollments, coupled with the projected job growth in this area, the program anticipates enrollment greater than 40 students per year. These positions are found across the federal government, software publishers, professional and technical services, hospitals, higher education, and other employment locations.

Identify similar programs in the state. Discuss any di#erences between the proposed program and existing programs. Explain how your program will not result in an unreasonable duplication of an existing program (you can base this argument on program di#erences or market demand for graduates). The MHEC website can be used to find academic programs operating in the state. Please click on the help bubble for specific information on finding similar programs within the state.

Other similar programs in the State of Maryland are research focused degrees. Our program will be differentiated and attractive to the professional learner in its applied nature. While other programs in the state do exist, most are either research focused and or only available in an online or blended space. The UMD program will be available both in person and online with an applied and experiential approach.

Discuss the possible impact on Historically Black Institutions (HBIs) in the state. Will the program affect any existing programs at Maryland HBIs? Will the program impact the uniqueness or identity of a Maryland HBI?

We do not foresee any negative impacts on the uniqueness or identity of any Maryland HBIs. Rather, we see our program complementary in several ways. First, most HBIs in the state do not have related degree programs, and thus our program provides HBI students more opportunities for an advanced degree in an area not presently offered at their current institution. Second, there is distinct differentiation between the somewhat related programs at Maryland HBIs. The Applied Computer Science MS program at the University of Maryland, Eastern Shore (UMES) and the Advanced Computing MS program at Morgan State University, although listed in our market research document, are fundamentally different in subject matter coverage from the Data Science MS covered by this proposal. The UMES and Morgan State programs are more broadly computer science-focused (sans theoretical aspects of the field). These degree programs are geared toward students who would be employed in various areas of computer science. Our degree program is geared toward data-informed or data-driven employment opportunities and emphasizes the interdisciplinary nature of data science

Supporting Documents

Attachments

DATA_Market_Research_MS_2-10-23.xlsx
MS in Data Science Budget.xlsx
Library Assessment.docx
Faculty List Template- DS.docx
Appendix 2 Summary of Learning Outcome Assessments 7-31-2023.pdf

Administrative Documents

PCC_Presidential_Approval_23-24-11.pdf
23532 University of Maryland College Park MS in Data Science 1-16-2024.pdf
UMCP - MS in Data Science BOR 12-15-2023.pdf

Key: 912

					OES In-House Market Research: Other Institution Comparison			
					Program Name = Data Analytics, MS			
Institution	**Website**	**Delivery Method**	**Degree Name & Type (MPS, MA, MS, MPH, etc.)**	**# of Credits**	**Tuition (course or credit)**		**Target Population**	**Prior Education/ Pre-Requisites**
					Resident	**Non-Resident**		
Big Ten Institutions								
University of Illinois Urbana-Champaign	https://cs.illinois.edu/academics/graduate/professional-mcs/online-master-computer-science-data-science	Online	Data Science, MCS (Master of Computer Science)	32 credits (8 4-credit courses)	$670/credit		Students interested in the art of extracting new knowledge and finding meaningful information in a massive sea of data	Applicants should hold a 4-year bachelor's degree. Students with a bachelor's degree in a field other than CS are encouraged to apply, but to succeed in graduate-level CS courses, they must have prerequisite coursework or commensurate experience in object-oriented programming, data structures, algorithms, linear algebra, and statistics/probability. Applicants without this can strengthen their application for admission by passing the optional Data Structures Proficiency Exam.
Indiana University Bloomington	https://datascience.indiana.edu/programs/ms-data-science-online/index.html	Online and F2F	Data Science, MS	30 credits	$485.00/credit	$797.50/credit	*Online Program: Designed to provide convenience and flexibility to midcareer professionals. *Residential Program Applied Data Science Track: This track is ideal for students with a background in the humanities, social sciences, or any other non-STEM field, as well as for students uninterested in a math-oriented course load *Residential Program Computational and Analytical Track: Designed for students who have a strong STEM background and are ready to advance their career as data specialists.	Applicant must hold a U.S. bachelor's degree from a regionally accredited institution or foreign equivalent.. Online Program: Before applying to this program, you should have a basic understanding of the programming languages Python and R, in addition to math and probability. *Residential Program Computational and Analytical Track: GRE score (quantitative) of 160 or higher, A grade of B or higher in college calculus I and II, A grade of B or higher in a college-level algorithms or data structure course, A grade of B or higher in two college-level programming courses.
University of Iowa	https://grad.admissions.uiowa.edu/academics/data-science-ms	F2F	Data Science, MS	30 credits	$1,002/credit	$2,625/credit	The Master of Science program in data science aims to train the next generation of data scientists with the analytical and technical skills to explore, formulate, and solve complex data-driven problems in science, industry, business, and government.	Applicant must have Three Letters of Recommendation; unofficial or official transcripts sent to admissions
University of Michigan Ann Arbor	https://lsa.umich.edu/stats/masters_students/mastersprograms/data-science-masters-program.html	F2F	Data Science, MS	30 credits	$1,790/credit	$3,247/credit	Full-time students interested in the confluence of (1) Computer and Information Sciences (2) Statistical Sciences, and (3) Domain Expertise.	Applicant must hold a U.S. bachelor's degree from a regionally accredited institution or foreign equivalent. While a Data Science undergraduate major is not required, it is expected that applicants will have at least the following background before they join: 2 semesters of college calculus, 1 semester of linear or matrix algebra, 1 introduction to computing course
Michigan State University	https://stt.natsci.msu.edu/graduate-programs/prospective-students/ms-in-data-science.aspx	F2F	Data Science, MS	30 credits	$812/credit		The MSDS prepares professional students for the demands of tomorrow's workplace in data-driven decision making. Data science is an emerging interdisciplinary field whose purpose is the extraction of actionable insights from data. It employs theories and techniques from the core areas of statistics, computational mathematics, computer science, and information science. Our MSDS provides high-quality training in state-of-the-art data analysis and computational methods. We include coverage of the principles	Required application materials include a 2-page letter of motivation (combined personal statement and academic statement, please do not submit two separate letters); a detailed CV/resume including all relevant industrial experience if applicable; full official transcripts from undergraduate and/or graduate institutions, sent by the granting institutions (unofficial copies can be uploaded by the applicant); a minimum of three letters of recommendation sent directly by the recommenders (not attached to the application);if the mother tongue of the candidate is not English, or the candidate is not a
University of Minnesota Twin Cities	https://datascience.umn.edu/masters	F2F	Data Science, MS	31 credits	$1,128/credit	$1,412/credit	Students who want a strong foundation in the science of Big Data and its analysis by gathering in a single program the knowledge, expertise, and educational assets in data collection and management, data analytics, scalable data-driven pattern discovery, and the fundamental concepts behind these methods.	A four-year bachelor's degree from an accredited college or university in computer science, math, statistics, engineering, natural sciences, or a related field. A minimum GPA of 3.5 (or the equivalent in other grading scales) in undergraduate coursework is normally expected to be considered for admission. Mathematics: Calculus (2 semesters), Multivariable Calculus (1 semester), Linear Algebra (1 semester), Statistics (1 semester), Computer Programing (2 semesters), Experience with mathematical software environments such as Matlab, R or the equivalent is a definite plus, but not a total substitute for experience with a general-purpose programming language. A class on advanced data structures is also a plus.
University of Nebraska-Lincoln	https://graduate.unl.edu/academics/programs/COMP-MS	F2F	Computer Science, MS	30 credits	$472/credit	$1,285/credit	The School of Computing offers opportunities for students to develop teaching skills in support of undergraduate instruction and to enhance research skills in support of the department's active research programs. The goal is to build a foundation for future scientific discovery, engineering innovation, and scholarly and professional achievement.	Applicant must submit an Application for Admission with $50 non-refundable application fee. One set of transcripts; Curriculum vitae Three letters of recommendation; GRE is not required; Statement of purpose, including research interests, objectives, and potential SoC faculty names
Northwestern University	https://sps.northwestern.edu/masters/data-science/	Online	Data Science, MS 4 Specializations: Analytics and Modeling, Artificial Intelligence, Data Engineering, or Analytics Management	36 credits	$4,550/course		Students interested in learning how to utilize relational and document database systems and analytics software built upon open-source systems such as R, Python, and TensorFlow.	Applicant must hold a U.S. bachelor's degree from a regionally accredited institution or foreign equivalent.
Northwestern University	https://sps.northwestern.edu/masters/data-science/	F2F	Accelerated Data Science, MS	12 Courses	$14,715/per quarter		Students are encouraged to find and arrange part-time internships or roles with area organizations. international and domestic students are encouraged to apply for the accelerated option. Admitted international students are eligible to apply for and receive a student visa.	Applicant must hold a U.S. bachelor's degree from a regionally accredited institution or foreign equivalent.
Penn State Great Valley	https://greatvalley.psu.edu/academics/masters-degrees/data-analytics	F2F	Data Analytics, MS	30 credits	$1,160/credit	$1,877/credit	Students typically are fresh out of undergraduate studies. Through its emphasis on research, this program is designed to prepare you for entry into doctoral programs in data analytics. The curriculum has five required courses and three electives. You'll take a research methods class and must	Applicant must hold a U.S. bachelor's degree from a regionally accredited institution or foreign equivalent.
Penn State Great Valley	https://greatvalley.psu.edu/academics/masters-degrees/data-analytics	F2F	Data Analytics, MPS	31 credits	$1,160/credit	$1,877/credit	Intended for professionals looking to acquire analytical skills relevant to the workplace, the curriculum consists of six required courses and three electives. The program culminates in a capstone course that builds upon the theories, technology, and skills learned in previous coursework.	Applicant must hold a U.S. bachelor's degree from a regionally accredited institution or foreign equivalent.
Purdue University	https://www.stat.purdue.edu/academic_programs/graduate/gradDSfinance.html	F2F	Data Science in Finance Residential Program, MS	33 credits	$ 347.85/credit	$ 948.30/credit	The goal of the program is to equip students with the tools necessary to pursue a career in a quantitative financial field. The 2-year course work provides students with comprehensive and practical knowledge of the mathematical, statistical, and computational skills. The following courses are	Included in this application you must submit the following: Short answer items, each with less than 200 words (The Statement of Purpose on the application package is not required.); GRE scores (optional; Diversity Essay: required for U.S. applicants only; English proficiency scores: required for all non-native English speakers; Recommendation letters are required to be submitted
Rutgers University New Brunswick	https://sas.rutgers.edu/m-s-in-data-science	F2F	Data Science, MS- Statistics Track Data Science, MS- Computer Science Track	Statistics Track- 30 credits CS Track- 36 credits	$1,034/credit	$1,758/credit	The Statistics track directs its focus towards the data analysis aspects of the Data Science field, whereas the Computer Science (CS) track concentrates more on its computer science aspects.	Applicant must hold a U.S. bachelor's degree from a regionally accredited institution or foreign equivalent. Prerequisites: Multivariate Calculus, Linear Algebra, Introduction to Probability, Theory of Statistics, Two courses in statistical computing or computer science, including advanced programming

Students receive lectures through Coursera's massive open online course (MOOC) platform, but are advised and assessed by Illinois faculty and teaching assistants on the more rigorous set of assignments, projects, and exams required for university degree credit.

GRE and letter of recommendations are not required to apply.

If you don't have a STEM background, consider taking Data Science Essentials: a self-paced package of online coursework that can help you prepare for the successful completion of the M.S. in Data Science degree.

Institution	Link	Format	Program	Credits	Resident/Credit	Nonresident/Credit	Program Description	Admission Requirements
University of Wisconsin–Madison	https://guide.wisc.edu/graduate/statistics/statistics-ms/statistics-data-science-ms/#text	F2F	Statistics: Data Science, MS	30 credits	$1,014/credit	Nonresident: $2,125/credit Minnesota: $1607/credit	The MS Statistics: Data Science program is intended for three types of students: *VISP students: Students from the Visiting International Student Program (Stat VISP or Math VISP). They may request transfer of up to 15 credits from their VISP coursework. *Workforce students: Students coming with 5 or more years in the workforce who have worked extensively with data and are seeking a well-rounded training. *General students: Students who have BS degrees or expected to obtain BS degrees prior to the first semester as MS Statistics: Data Science students.	Applicant must hold a U.S. bachelor's degree from a regionally accredited institution or foreign equivalent. Students admitted to the MS Statistics: Data Science program are expected to have: Calculus and Analytic Geometry 1, Calculus and Analytic Geometry 2, Calculus--Functions of Several Variables, The Theory of Single Variable Calculus (or another advanced analysis course), The Theory of Single Variable Calculus (or another advanced analysis course), R for Statistics I, R for Statistics II, Introduction to Probability and Mathematical Statistics I, Introduction to Probability and Mathematical Statistics II.

State of Maryland System Institutions: Overseen by MHEC (http://mhec.maryland.gov/publications/Pages/research/index.aspx)

Institution	Link	Format	Program	Credits	Resident/Credit	Nonresident/Credit	Program Description	Admission Requirements
Bowie State University	https://www.bowiestate.edu/academics/colleges/college-of-arts-and-sciences/departments/computer-science/graduate/masters-degree/	F2F	Computer Science, MS- Data Science Specialization	36 credits	$439/credit	$723/credit	Students interested in focusing on core competencies in machine learning, data mining, data visualization, and cloud computing.	Applicants must hold a bachelor's degree from a regionally accredited institution and have a cumulative grade point average of 2.5 or better (on a 4.0-point scale). In addition, the following prerequisites are required: Calculus of One Variable (i.e. Calculus I and II), One additional mathematics course beyond Calculus, (e.g. Linear Algebra, Differential Equations, Abstract Algebra, Advanced Calculus, Discrete Structures, Probability and Statistics), COSC 503 - Software Design and Development (or equivalent)
Capitol Technology University	https://www.captechu.edu/degrees-and-programs/masters-degrees/technical-mba-business-analytics	Online	Technical Master of Business Administration in Business Analytics	36-39 credits	$630/credit		The program provides the essential knowledge to enter into the industry in a role managing data assets of budgets, employment, marketing and other data science duties, all of which are essential to the success of a profitable business.	No Information Given
Hood College	https://www.hood.edu/graduate/academics/programs/computer-science-ms	33 credits	Computer Science, MS	33 credits	$1073/credit		This program is ideal for individuals who want to acquire or update their skills in cutting-edge computer science technologies – and tackle the challenges inherent in capturing, storing, sharing, transferring and analyzing data.	For students applying to the computer science program, please submit the following to the Graduate School: One copy of official transcripts from each institution of higher education attended. A résumé of work experience. Applicants to the graduate program in computer science are expected to have a strong background in computer science and mathematics. Four foundation courses introduce students to algorithms and programming, computer organization and design, advanced data structures and discrete mathematics. Students holding a baccalaureate degree in computer science will normally be exempted from all foundation courses. Other students may...
Frostburg State University	https://www.frostburg.edu/academics/majorminors/graduate/ms-applied-computer-science/index.php	F2F or Online	Computer Science, MS- Database concentration	30 credits	$456/credit	$588/credit	This program prepares students for exciting career opportunities with the government, in network security, web development and a host of other rewarding fields. Unlike theory-based graduate programs, the FSU applied computer science master's degree is highly experiential.	Students without Computer Science degree or background may be required to take up to two foundation courses as part of their program of study before entering the degree program courses.
Johns Hopkins University	https://ep.jhu.edu/programs-and-courses/programs/data-science/	Online or Hybrid	Data Science, MS	30 credits	$4,920 per course *Per-course tuition is $5,872., but with dean support from the Whiting School of Engineering, students receive a decreased out-of-pocket cost.		This program is designed to prepare graduates to succeed in specialized jobs involving everything from the data pipeline and storage, to statistical analysis and eliciting the story the data tells	Applicants must hold a bachelor's degree from a regionally accredited institution. Prior education must include the following prerequisites: (1) three semesters or five quarters of calculus, which includes multivariate calculus; (2) one semester/term of advanced math (discrete mathematics is strongly preferred but linear algebra and differential equations will be accepted); (3) one semester/term of Java or Python (C++ will be accepted but the student must be at least also somewhat knowledgeable in Java or Python); and (4) one semester/term of Data Structures. Linear Algebra or Differential Equations will be accepted in lieu of Discrete Mathematics. A grade of B– or better must have been earned in each of the prerequisite courses.
Loyola University Maryland	https://www.loyola.edu/academics/data-science/graduate	Online	Data Science, MS	31-34 credits	$925/credit		The master's program provides the skills you need to become a data scientist. As part of the program, Loyola's strong commitment to social justice encourages students to engage with nonprofits.	Applicants must hold a bachelor's degree from a regionally accredited institution. A student is expected to have had a college-level introductory statistics course. A mathematics boot camp prior to the start of the program may be required for students without sufficient mathematics background as determined by the program directors.
McDaniel College	https://www.mcdaniel.edu/node/2380	Online or Hybrid	Data Analytics, MS	30 credits	$675/credit		You'll notice right from the start that the Professional Master of Science in Data Analytics at McDaniel College is uniquely designed to prepare you for professional success. Every course in the curriculum integrates skills and knowledge that prepares the student to think more critically and through a more peripherally focused lens. This requirement highlights not only our...	Applicants must hold a bachelor's degree from a regionally accredited institution with a minimum GPA of 2.75. Prior education must include the following prerequisites: One course in Statistics (required), One course in Calculus (recommended).
Morgan State University	https://www.morgan.edu/advanced-computing-ms/ms_advancedcomputing	Online or F2F	Advanced Computing, MS	30 credits	$455/credit	$894/credit	This new program is designed for students who have recently completed a bachelor's degree program in Computer Science or a related field and wish to enhance their career, explore research opportunities in Computer Science, and apply their acquired skills in multi-disciplinary teams or for specific focus. The program also meets the needs of students who are already in the workforce and wish to update or improve their knowledge of current computer science.	Applicants must hold a bachelor's degree from a regionally accredited institution with a focus in Computer science or a related field.
Notre Dame of Maryland University	https://www.ndm.edu/grad-prof-studies/academics/programs/analytics	Online	Analytics, MS	36 credits	$580/credit		More professionals are needed to manage the architecture of knowledge from traditional- and online-based resources. The online Master of Science in Analytics helps you become an asset in your current role or prepare for the jobs of tomorrow, with a curriculum focused on multidisciplinary competencies in knowledge management technologies, qualitative processes and economic principles of change risk management.	Applicants must hold a bachelor's degree from a regionally accredited institution.
Towson	https://www.towson.edu/fcsm/departments/computerinfosci/grad/computersci/	F2F	Computer Science, MS Data Science Track	33 credits	$642/credit	$1,158/credit	The master's in computer science provides a comprehensive curriculum with a solid scientific and technical foundation for pursuing either doctoral work or advanced positions in business, industry and government. Graduates find high-profile jobs as software developers, web developers, computer security analysts and e-commerce analysts.	Baccalaureate degree in computer science from a regionally accredited college or university**, or a baccalaureate degree from a regionally accredited college or university** in any other field and completion of one to three preparatory courses from among MATH 263, COSC 501* and COSC 502*. An undergraduate GPA of 3.00 for full admission, or 2.75 for conditional admission, is required.
University of Maryland, Baltimore County	https://professionalprograms.umbc.edu/data-science/https://professionalprograms.umbc.edu/data-science/masters-of-professional-studies-data-science/	F2F	Data Science, MPS	30 credits	$850/credit	$1,352	UMBC's Master of Professional Studies (MPS) in Data Science program prepares students from a wide range of disciplinary backgrounds for careers in data science. In the core courses, students will get a fundamental understanding of data science through classes that highlight machine learning, data analysis and data management. The core courses will also introduce students to ethical and legal implications surrounding data science.	Applicant must have an undergraduate degree in any subject; Students must have prior coursework to include college-level math, statistics, and programming. Students who do not have prior coursework or industrial experience should take online courses in statistics, linear algebra, and programming. Minimum undergraduate GPA of 3.0 on a 4.0 scale.

University of Maryland, Eastern Shore	https://wwwcp.umes.edu/cset/	F2F	Applied Computer Science, MS	30 credits	$346/credit $641/credit	No Information Given	Admission requirements include a bachelor's degree in a technology related field, such as Engineering Technology, Computer Science, Information Technology, Software or Computer Engineering, Networking, Information Security, or related disciplines. Applications from prospective students with bachelor's degrees in non-technical fields may be considered for admission. All applicants must show a strong record of academic achievement, as indicated by official transcript(s), three letters of recommendation, and a statement of purpose.
UMGC UMD Global Campus	umgc.edu/academic-programs/masters-degrees/data-analytics.cfm	Online	Data Analytics, MS	36 credits	$694/credit	This program is designed to help prepare you for work in the high-demand field of data science and analysis in a public- or private-sector organization. Potential career fields include data mining, machine learning, and predictive modeling for large data sets.	Applicants must hold a bachelor's degree from a regionally accredited institution. We recommend a background in software programming and statistics. If you do not have demonstrated experience or prior coursework in programming, you may be required to complete additional coursework.

Colleges & Universities in the Washington DC - Baltimore MD area

Institution	Link	Format	Program	Credits	Cost		Description	Requirements
American University	https://www.american.edu/programs/sh grad/data-science/	F2F or Online	Data Science, MS	30 credits	$1,866/credit		American University's MS in Data Science prepares students to acquire, process, analyze, and present complex data.	The program is open to all students with a bachelor's degree from an accredited institution that have a cumulative grade point average of at least a 3.00 (on a 4.00 scale). Students without sufficient mathematical background as determined by the program directors may be required to complete a mathematical boot camp prior to starting the program.
Catholic University of America	https://engineering.catholic.edu/academ ics/graduate/data-analytics/masters/index.html	F2F or Online	Data Analytics, MS	30 credits	$1,250/credit		The curricula for the graduate certificate and master's degree were developed with guidance from lead industry partner Booz Allen Hamilton and is designed to meet the workforce needs of businesses, government agencies, and non-profit organizations. The program is intended for those with	Applicants must hold a bachelor's degree from a regionally accredited institution.
Columbia University	https://www.datascience.columbia.edu/ master-of-science-in-data-science	F2F	Data Science, MS	30 credits	$2,178/credit		Individuals looking to strengthen their career prospects or make a career change by developing in-depth expertise in data science.	Requires: Undergraduate degree, prior quantitative coursework (calculus, linear algebra, etc.), Prior introductory computer programming coursework
George Mason	https://www.gmu.edu/progra m/data-analytics-engineering ms	F2F or Online	Data Analytics Engineering, MS	30 credits	$679.46/credit	$1,474/credit	Designed to provide students with an understanding of the technologies and methodologies necessary for data-driven decision-making. It is aimed at students who wish to become data scientists and analysts in finance, marketing, operations, business/government intelligence and other information intensive groups generating and consuming large amounts of data.	Applicants must have completed a baccalaureate degree from a regionally accredited program with an earned GPA of 3.00 or better in their 60 highest-level credits. Applicants are expected to have completed a degree in engineering, business, computer science, statistics, mathematics, or information technology, with demonstrated foundational competence in calculus, statistics, and computer programming.
Georgetown University	https://analytics.georgetown.edu/about/	F2F	Data Science and Analytics, MS	30 credits	$2,358/credit		The Data Science and Analytics program provides students with a rigorous training in computational, mathematical, and statistical methods to prepare them for careers in data science and analytics.	This program is appropriate for students who have recently completed degrees with significant mathematical or statistical emphasis, as well as for mid-career professionals who seek professional advancement or a shift in career track.
George Washington University	https://www.programs.gwu.edu/data-analytics	F2F	Data Analytics, MS	30 credits	$2,035/credit		Designed to address the growing demand for professionals skilled in big data and data analytics.	Bachelor's degree with a GPA of at least 3.0 on a 4.0 scale for the last 60 hours of coursework; two courses in mathematics beyond pre-calculus; one year of science with laboratory; courses in computer science using a structured language, discrete structures, data structures, and computer architecture.
Howard University	https://programs.howard.edu/applied-data-science-analytics-ms	Online	Applied Data Science & Analytics, MS	30 credits	$1,481/credit		Howard Graduate School's fully online interdisciplinary M.S. in Applied Data Science and Analytics program prepares data-driven leaders to generate, analyze, interpret, and present complex data in compelling ways that drive solutions to real-world problems. Whether you are interested in	Applicant must have an Online GradCAS application; Statement of purpose/ Statement of academic interest (500-1,000 words); GRE scores not required; Official transcripts sent to GradCAS; 3 letters of recommendation; Bachelor's degree from an accredited college or university Resume or Curriculum Vitae; Autobiographical statement (500-750 words)
James Madison University	https://www.jmu.edu/grad/pr ograms/snapshots/computer science-info-security.shtml	Online	Computer Science, Information Security Concentration, MS	30 credits	$1,065		This concentration is offered in a remote, electronic distance-learning format that, while satisfying all requirements for the Master of Science program, is especially appropriate for people with professional interests in information security. Further information can be obtained from the program website at	No Information Given
Radford University	https://www.radford.edu/content/csat/h ome/daim.html	F2F	Data and Information Management	30 credits	$748/credit	$923/credit	As the volume of information continues to explode, so does the need for IT professionals who can maximize the value of information assets while getting the right data to the right people at the right time.	The Master's in Data and Information program requires a solid foundation in computer science. Students entering the program must have a strong academic background covering the topics in: Introduction to Databases, Principles of Computer Science III, Procedural Analysis and Design, Business Calculus, Calculus and Analytic Geometry I.
University of Virginia	https://onlinedatasciencemasters.virgini a.edu/	F2F or Online	Data Science, MS	32 credits	$1,377/credit		The new online Master of Science in Data Science (MSDS) from the University of Virginia School of Data Science expands the accessibility of our cutting-edge curriculum beyond Charlottesville.A part-time master's in data science designed for working professionals	Applicants to the Master of Science in Data Science (MSDS) program must earn an undergraduate degree prior to the start of the summer term in which the program starts. A specific undergraduate major or program of study is not required. Students must complete each of the following prerequisites: Single variable calculus, Linear algebra or matrix algebra, Introductory statistics, Introductory programming.
Virginia Tech	http://analytics.cs.vt.edu/edu-daas.php	Blended	Data Analysis and Applied Statistics, MA	33 credits	$806.75/credit	$1,626/credit	Students seeking admission to the M.A. DAAS degree are those wishing to expand their statistical knowledge beyond the material presented in graduate service courses, tackling more specialized topics, whether they are taught statistical methodology by the Department of Statistics or by other programs/departments on campus.	The Department of Statistics and the DAAS program encourage applications from students in fields other than mathematics and statistics to apply. However, successful applicants will have taken Calculus I and II, and a basic Statistics class as an undergraduate and have done well in those courses. In addition, applicants should be able to demonstrate some experience in computer programing, either in a classroom or professional setting.

Other Major Institutions Offering Similar Programs

Institution	Link	Format	Program	Credits	Cost		Description	Requirements
University of Virginia	https://dsi.virginia.edu/degrees/msds-degree	F2F	Data Science, MS	32 credits	$705/credit	$1,125/credit	Students looking to expand their knowledge and skills in the data science field.	Completed pre-requisite courses in single variable calculus, linear algebra or matrix algebra, introductory statistics, and introductory programming.
Drexel University	https://drexel.edu/cci/academics/gradua te-programs/ms-in-data-science/	Online or F2F	Data Science, MS	45 credits	$1,396/credit		Designed for students with or without a bachelor's degree in Data Science. Students looking to gain data analytics knowledge to enhance their current role or seeking a career change.	A four-year bachelor's degree from a regionally accredited institution. Those without a prior degree or sufficient work experience in Computer Science, Software Engineering, or Math (plus programming) may have to take additional prerequisites before pursuing advanced computer science courses.

OES In-House Market Research: Projected Enrollment Information				
Program Name = Data Science, MS				
Occupation	**# of Jobs in the Field**	**Where Professionals are Employed**	**Professional Salary Information**	**Projected Job Growth**
Information from U.S. Bureau of Labor Statistics' Occupational Outlook Handbook				
Computer and Information Research Scientists	33,500 (2021)	31% - Federal government, excluding postal service 20% - Computer systems design and related services 16% - Research and development in the physical, engineering, and life sciences 6% - Software publishers 5% - Colleges, universities, and professional schools; state, local and private	$131,490 per year (2021) $63.22 per hour (2021)	21% (Much faster than average) 2021-2031
Information from State of Maryland's Occupational and Industry Projections				
Computer and Information Research Scientists	2,873 (2021)	**Top 12** - Computer systems design and related services; - Management and technical consulting services; - Architectural and engineering services; - Scientific research and development services; - Colleges and universities; - Management of companies and enterprises; - Commercial equip. merchant wholesalers; - Wired telecommunications carriers; - Other financial investment activities; - Elementary and secondary schools; - Insurance carriers; - Data processing, hosting and related services;	Annual Mean Wage: $123,324 Annual 10th Percentile: $87,880 Annual 75th Percentile: $142,438	2018-2028 Increase by 7%

OES In-House Market Research: Projected Enrollment Information													
Five-Year Enrollment Trends													
Year	Bowie State University	Capitol Technology University	Frostburg State University	Hood College	Johns Hopkins University	Loyola University Maryland	McDaniel College	Morgan State University	Notre Dame of Maryland University	Towson	University of Maryland, Baltimore County	University of Maryland, Eastern Shore	UMGC UMD Global Campus
	Computer Science, MS-Data Science Specialization	Technical Master of Business Administration in Business Analytics	Computer Science, MS-Database concentration	Computer Science	Data Science, MS	Data Science, MS	Data Analytics, MS	Advanced Computing, MS	Analytics, MS	Computer Science, MS Data Science Track	Computer Science, MS	Applied Computer Science	Data Analytics, MS
2017	32	0	40	53	97	23	0	0	9	135	128	10	1998
2018	31	3	47	36	179	29	0	0	5	136	132	12	2048
2019	30	5	70	33	249	34	0	0	6	130	155	9	1993
2020	25	3	58	33	347	44	22	2	4	143	101	7	2106
2021	36	3	49	34	456	35	68	10	5	105	178	7	2126
Projected													

Five-Year Degree Recaps													
Year	Bowie State University	Capitol Technology University	Frostburg State University	Hood College	Johns Hopkins University	Loyola University Maryland	McDaniel College	Morgan State University	Notre Dame of Maryland University	Towson	University of Maryland, Baltimore County	University of Maryland, Eastern Shore	UMGC UMD Global Campus
	Computer Science, MS-Data Science Specialization	Technical Master of Business Administration in Business Analytics	Computer Science, MS-Database concentration	Computer Science	Data Science, MS	Data Science, MS	Data Analytics, MS	Advanced Computing, MS	Analytics, MS	Computer Science, MS Data Science Track	Computer Science, MS	Applied Computer Science	Data Analytics, MS
2018	12	0	27	28	0	0	0	0	1	40	34	4	137
2019	12	0	11	13	5	0	0	0	4	32	62	4	115
2020	15	1	20	8	28	3	0	0	3	36	61	5	92
2021	6	1	26	10	37	3	0	0	4	45	70	4	83
2022	8	2	24	11	89	9	2	2	0	33	36	1	113

The learning outcomes for the program will be assessed using a combination of formative and summative assessments during and at the completion of each semester. Each course in the program will have homework assignments, practice sets, and other assessments that will be graded with feedback to help assess the student's learning. Midterms and final exams or projects will be cumulative assessments to determine if and to what level the student mastered the learning outcomes for each course.

The assessments will be appropriate to the nature of the course content and the course learning objectives. Both individual assessments and group assessments will be required in the program. This type of variation best mimics the work and industry expectations. The assessments of the program will mirror work products in the industry and prepare students for jobs in industry. For example, many of the elective courses include final projects, presentations and assignments where students have to work with real data sets. Students will be expected to process the data, and perform tasks and make recommendations that are expected of an entry level data scientist/AI engineer.

Lastly, students will also be challenged to complete reflective assessments to apply knowledge and skills in their future professional work. This work will assist students in the job search process and enable them to identify, apply to, and earn positions in this field. The assessments will all follow best practices for adult and professional students. As the student progresses through the curriculum and satisfies learning objectives, they will align with and accomplish the program-level learning outcomes.

MS in Data Science					
Five-Year Program Budget					
Tuition Revenue	Year 1	Year 2	Year 3	Year 4	Year 5
A. Total enrolled students	9	19	20	21	23
First year enrollment	9	10	10	11	12
Second year enrollment		9	10	10	11
B. Total # of 3-credit Courses (by enrollment year)	8	10	10	10	10
# of courses offered for students in year one of the program	8	8	8	8	8
# of courses offered for students in year two of the program		2	2	2	2
C. Per Course Rate	$4,000	$4,120	$4,244	$4,371	$4,502
Total Tuition Revenue	$288,000	$403,760	$424,360	$472,058	$531,240
Direct Expenses	Year 1	Year 2	Year 3	Year 4	Year 5
A. Instructor Salaries and Fringe	$134,927	$173,936	$179,154	$184,529	$190,065
1. Subtotal: Instructor salaries	$103,870	$133,900	$137,917	$142,055	$146,316
Average 3-credit course salary	$13,000	$13,390	$13,792	$14,205	$14,632
Program specific courses (100% FTE)	7	7	7	7	7
Shared courses (33% FTE)	3	3	3	3	3
2. Fringe Benefits: 29.9%	$31,057	$40,036	$41,237	$42,474	$43,749
Total Direct Expenses	$134,927	$173,936	$179,154	$184,529	$190,065
Total Annual Tuition Revenue	$288,000	$403,760	$424,360	$472,058	$531,240
Total Annual Direct Expenses	$134,927	$173,936	$179,154	$184,529	$190,065
Total Annual OES Administrative Fee	$28,800	$40,376	$42,436	$47,206	$53,124
Annual Distributable Revenue	$124,273	$189,448	$202,770	$240,323	$288,051

Indirect Expenses					
	Year 1	Year 2	Year 3	Year 4	Year 5
Administrative Salaries and Fringe	$53,692	$55,303	$56,962	$58,671	$60,431
1. Administrative Salaries	$39,596	$40,784	$42,007	$43,268	$44,566
Director (20% FTE)	$25,846	$26,621	$27,420	$28,243	$29,090
Faculty Director Stipend	$15,000	$15,450	$15,914	$16,391	$16,883
Program Manager (33% FTE)	$13,750	$14,163	$14,587	$15,025	$15,476
2. Fringe Benefits: 35.6%	$14,096	$14,519	$14,955	$15,403	15,865
Hourly Wages	$38,736	$51,648	$52,552	$53,474	$54,414
1. Hourly Wages	$36,000	$48,000	$48,840	$49,697	$50,571
Graders for program specific courses ($6K per course)	30,000	42,000	42,840	43,697	44,571
Graders for shared courses ($2K per course)	6,000	6,000	6,000	6,000	6,000
2. Hourly Wages Benefits: 7.6%	$2,736	$3,648	$3,712	$3,777	$3,843
Marketing	$2,500	$2,575	$2,652	$2,732	$2,814
1. Marketing	2,500	2,575	2,652	2,732	2,814
Equipment	$1,500	$1,545	$1,591	$1,639	$1,688
1. Equipment	1,500	1,545	1,591	1,639	1,688
Travel & Recruitment	$1,500	$1,545	$1,591	$1,639	$1,688
1. Travel & Recruitment	$1,500	$1,545	$1,591	$1,639	$1,688
Total Indirect Expenses	$97,928	$112,616	$115,349	$118,155	$121,035

Net Revenue	Year 1	Year 2	Year 3	Year 4	Year 5
OES Distribution to CMNS	$124,273	$189,448	$202,770	$240,323	$288,051
Indirect Expenses	$97,928	$112,616	$115,349	$118,155	$121,035
Balance	**$26,345**	**$76,832**	**$87,421**	**$122,169**	**$167,016**

DATE: April 25, 2019
TO: Matthew M. Nessan, Associate Director, Programs; Office of Extended Studies
FROM: On behalf of the University of Maryland Libraries:
Nevenka Zdravkovska, Head, STEM Library
Maggie Saponaro, Head of Collection Development
Daniel Mack, Associate Dean, Collection Strategies & Services

RE: Master of Professional Studies in Data Science and Analytics - Library Collection

Assessment

The University of Maryland Libraries are providing this assessment in response to a proposal by the Science Academy of the College of Computer, Mathematical, and Natural Sciences (CMNS) to create a Master of Professional Studies (MPS) in Data Science and Analytics. This program asked that we at the University of Maryland Libraries assess our collection resources to determine how well the Libraries support the curriculum of this proposed MPS in Data Science and Analytics.

Serial Publications
The University of Maryland Libraries currently subscribe to a large number of scholarly journals, with almost all in online format that focus on various specialties within Computer Science applications, including Data Science, Big Data, Analytics, and Machine Learning. The Libraries subscribe to several of high ranked journals that are listed in Journal Citation Reports* under the categories: Mathematics, Interdisciplinary Applications or Computer Science, Interdisciplinary Applications. Among the journals relevant to data science and analytics are the following journals, all available online:
  • Computational Statistics and Data Analysis
  • EPJ Data Science
  • Statistical Analysis and Data Mining
  • International Journal of Data Science and Analytics [new journal]
  • Journal of Machine Learning Research
  • Machine Learning

Also, the Libraries have subscription to IEEE and ACM publications, which are numerous and can be accessed through the relevant databases, as discussed below.
Due the interdisciplinary research and instruction inherent in data science and analytics, there may be highly-ranked core journals to which the Libraries do not currently subscribe. However, articles in journals that we do not own likely will be available through Interlibrary Loan/Document Delivery.

Databases
The Libraries' Database Finder (http://www.lib.umd.edu/dbfinder) resource offers online access to databases that provide indexing and access to scholarly journal articles and other information sources. Many of these databases cover subject areas that would be relevant to this proposed program, especially since due to the interdisciplinary applications of data

science and analytics. Databases that would most be useful in the field of machine learning are

- IEEE Xplore
- ACM Digital Library
- ScienceDirect

In many and likely in most cases, these indexes offer full text copies of the relevant journal articles. In those instances that the journal articles are available only in print format, the Libraries can make copies
available to graduate students through either the Libraries' Scan & Deliver Program (http://www.lib.umd.edu/access/scan-deliver) or via Interlibrary Loan (more details given below).

Monographs
The Libraries regularly acquire scholarly monographs in data science and analytics and allied subject disciplines. Monographs not already part of the collection can usually be added upon request. The Libraries has also acquired many eBooks and eBook collections, like:

- Springer eBooks in Computer Science and Springer eBooks (2005-2011)
- SIAM eBooks
- SPIE eBooks
- Synthesis Digital Library (Morgan & Claypool)
- IEEE/Wiley eBooks

A search of the University of Maryland Libraries' WorldCat UMD catalog was conducted, using a variety of relevant subject terms. This investigation yielded sizable lists of citations of books that we own related to data science and analytics. In addition, we own hundreds of monographs published within the last five years, insuring the program has access to relevant and recent holdings. Additionally, the Libraries' membership in the Big Ten Academic Alliance (BTAA) increases these holdings. As with our own materials, graduate students can request that chapters be copied from these BTAA books if the books are not available electronically.

Scan & Deliver and Interlibrary Loan
These services offer online delivery of bibliographic materials that otherwise would not be available online. As a result, remote users who take online courses may find these services to be helpful. Scan & Deliver and Interlibrary Loan are available free of charge.
The Scan & Deliver service scans and delivers journal articles and book chapters within three business days of the request--provided that the items are available in print on the UM Libraries' shelves or in microform. In the event that the requested article or chapter is not available on campus, Scan & Deliver will automatically refer the request to Interlibrary Loan (ILL). Interlibrary Loan is a service that enables borrowers to obtain online articles and book chapters from materials not held in the University System of Maryland.

Additional Materials and Resources
In addition to serials, monographs, and databases available through the University Libraries, students in

the proposed program will have access to a wide range of media, datasets, software, and technology.

- Library Media Services (http://www.lib.umd.edu/lms) houses media in a variety of formats that can be utilized both on-site and via ELMS course media.
- GIS Datasets are available through the GIS Data Repository (https://www.lib.umd.edu/gis/data-and-resources).
- Statistical consulting and additional research support are available through the Research Commons (http://www.lib.umd.edu/rc), and technology support and services are available through the Terrapin Learning Commons (http://www.lib.umd.edu/tlc).

Additionally, although not likely to be highly used by this program, UMD does have a number of microform collections, which may be of use for interdisciplinary research. Finally, the STEM Library is a Patent and Trademark Resource Center and provides patent and trademark research consultation. The subject specialist librarian for Computer Science is Nevenka Zdravkovska (Nevenka@umd.edu) and will also serve as an important resource to programs such as the one proposed.

Other Research Collections
Because of the University's unique physical location near Washington D.C., Baltimore and Annapolis, University of Maryland students and faculty have access to some of the finest libraries, archives and research centers in the country vitally important for researchers in this discipline. These include the Library of Congress, the National Archives, the Smithsonian, and more available for research use.

Conclusion
With our substantial journals holdings and index databases, as well as additional support services and resources, the University of Maryland Libraries have the resources to support teaching and learning in data science and analysis. These materials are supplemented by a strong monograph collection and additional holdings through the Big Ten Academic Alliance. Additionally, the Libraries Scan & Deliver and Interlibrary Loan services make materials that otherwise would not be available online, accessible to remote users. As a result, our assessment is that the University of Maryland Libraries are able to meet the curricular and research needs of the proposed MPS in Data Science and Analysis to be offered from the College of Computer, Mathematical, and Natural Sciences (CMNS).

*Journal Citation Reports is a tool for evaluating scholarly journals. It computes these evaluations from the relative number of citations compiled in the Science Citation Index and Social Sciences Citation Index database tools.

Faculty Information- Data Science

The following faculty members are projected to teach in the program. All faculty are full-time unless otherwise indicated.

Name	Highest Degree Earned, Program, and Institution	UMD Title (indicate if part-time)	Courses
Babak Azimi-Sadjadi	Ph.D., ECE, UMD	Visiting Lecturer	DATA/MSML 603: Principles of Machine Learning
Sandra Cerrai	Ph.D., Mathematics, Scuola Normale Superiore of Pisa	Prof & Assoc Chair	DATA/MSML 601: Probability and Statistics
Michael Cummings	Ph.D., Organismic and Evolutionary Biology, Harvard University	Professor	DATA698: Research Methods and Study Design
Wojtek Czaja	Ph.D. Washington University, St. Louis	Professor	DATA 604: Data Representation and Modeling
Mohammad Taghi Hajiaghayi	Ph.D., Computer Science, MIT	Professor	DATA/MSML 602: Principles of Data Science
Leonid Koralov	Ph.D., Mathematics, SUNY at Stony Brook	Prof & Assoc Chair	DATA/MSML 601: Probability and Statistics
Alejandra Mercado	Ph.D., ECE, UMD	Associate Director	DATA/MSML 603: Principles of Machine Learning
Abdirisak Mohamed	Ph.D. Mathematics, Karlsruhe institute of Technology	Lecturer	DATA 606: Algorithms for Data Structures
Vincent Paul Lyzinski	Ph.D. in Applied Mathematics and Statistics, Johns Hopkins University	Associate Professor	DATA607: Communication in Data Science and Analytics
Arefeh A Nasri	Ph.D., Transportation Engineering, UMD	Visiting Lecturer	DATA/MSML 602: Principles of Data Science
Zoltan Safar	Ph.D., ECE, UMD	Director	DATA/MSML650: Cloud Computing
Giacinto Saggese	Ph.D. ECE, University of Illinois Urbana-Champaign	Lecturer	DATA 605: Big Data Systems
Shabnam Tafreshi	Ph.D., Computer Science, George Washing University	Asst Research Scientist, ARLIS	MSML641- Natural Language Processing
Jerry Wu	Ph.D., RF MEMS, George Washington University	Lecturer	MSML642: Robotics

UNIVERSITY OF
MARYLAND

OFFICE OF THE PRESIDENT

1101 Thomas V. Miller, Jr. Administration Building
College Park, Maryland 20742
301.405.5803 TEL
301.314.9560 FAX

November 15, 2023

Dr. Sanjay Rai
Acting Secretary
Maryland Higher Education Commission
6 N. Liberty Street
Baltimore, MD 21201

Dear Acting Secretary Rai:

I am writing to request approval for a new Master of Science program in Data Science. The proposal for the new program is attached. I am also submitting this proposal to the University System of Maryland for approval.

The proposal was endorsed by the appropriate faculty and administrative committees. I also endorse this proposal and am pleased to submit it for your approval.

Sincerely,

Darryll J. Pines
President
Glenn L. Martin Professor of Aerospace Engineering

DJP/mdc

cc: Candace Caraco, Associate Vice Chancellor
        Jennifer King Rice, Senior Vice President and Provost
        Amitabh Varshney, Dean, College of Computer, Mathematical, and Natural Sciences

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

Institution Submitting Proposal	University of Maryland, College Park

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 # JE322704 ○ Check # JE322704	Payment Amount: 850	Date Submitted: 11/14/220	

Department Proposing Program	College of Computer, Mathematical, and Natural Sciences
Degree Level and Degree Type	Masters; Master of Science
Title of Proposed Program	Data Science
Total Number of Credits	30
Suggested Codes	HEGIS: 070102 · 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 submisson as per COMAR 13B.02.03.03)	● Fall ○ Spring ○ Summer Year: 2024
Provide Link to Most Recent Academic Catalog	URL: https://academiccatalog.umd.edu/

Preferred Contact for this Proposal	Name:	Michael Colson
	Title:	Senior Coordinator for Academic Programs
	Phone:	(301) 405-5626
	Email:	mcolson@umd.edu

President/Chief Executive	Type Name:	Darryll J. Pines
	Signature:	Date: 11/15/2023
	Date of Approval/Endorsement by Governing Board:	

Revised 1/2021

A. Centrality to the University's Mission and Planning Priorities

Description. Since 2019, the University of Maryland, College Park has been offering an iteration of its Master of Professional Studies (MPS) in Data Science and Analytics. The goal of this proposal is to move the existing curriculum out from under the MPS umbrella and create a standalone Master of Science (MS) degree program, under the shortened name Data Science. The program curriculum is not changing. The transition to an MS will allow the program to be properly designated with a STEM CIP code. CIP codes that classify programs as STEM programs have become increasingly important as the development of STEM programs has become more incentivized. The current MPS program does not appear in the results for STEM program searches based on CIP codes or in STEM program reports for the institution, and therefore the state, despite the program's STEM content. Current students will benefit from having their program associated with a STEM CIP code. In particular, current international students studying here on F-1 visas will be able to qualify for an extended optional practical training (OPT) after they graduate and will thereby be more marketable to prospective employers. The program will continue to provide students with an education in the theory and practice of data science including mathematical and statistical foundations, computational approaches, and communication. In addition to the fundamentals of data science, the program covers data science-relevant probability and statistics, algorithms, big data systems, machine learning, data mining, and analysis of networks. The program consists of 30-credit course work and will be offered both in-person and through a fully online modality.

Relation to Strategic Goals. As written in our [mission statement](#), "UMD embraces its flagship status and land-grant mission to share its research, educational, cultural, and technological strengths to bolster economic development, sustainability, and quality of life in Maryland and beyond." The explosion of data and computing power has placed data science at the forefront of a much broader wave of new research areas requiring professional training that includes machine learning and immersive media. Data science is a fundamental area and provides a basis for a range of new knowledge and skills that can be broadly applied. UMD is the best place in the Washington, DC metropolitan region for professionals to gain these skills, as our programs rank among the nation's leaders in both [computer science](#) (17th overall) and [applied mathematics](#) (15th overall) graduate education. No school in the region ranks higher than UMD in these areas.

In our recently approved strategic plan, *[Fearlessly Forward: In Pursuit of Excellence and Impact for the Public Good](#),* UMD promises to "partner to advance the public good." One of the goals of this commitment is to "Catalyze innovation and entrepreneurship for inclusive economic development." One of the specific objectives of this commitment is to "Improve the vitality of the state of Maryland by growing and supporting the next generation of diverse innovators, creators, entrepreneurs, artists, and small businesses." Establishing this master's program with a STEM CIP code will attract to Washington, DC's Maryland suburbs more students who will advance their careers, enhance their organizations, and launch their own businesses, thereby bringing economic growth to the area.

Funding. Just as with the current MPS program, the MS program will be self-supporting with tuition revenue. Since the program already exists as a professional studies program, it does not require new resources. UMD already has the instructional, physical, and administrative resources to offer the program, which has been in existence with viable enrollment levels since 2019.

Institutional Commitment. UMD is committed to leveraging its strengths in technological and mathematical fields to providing highly skilled professionals for the state's workforce needs. The program has already proven to be successful with increased enrollments each year. In the unlikely event that the program is no longer financially viable, program faculty and staff would continue to support and teach the necessary courses to allow enrolled students to complete their degree within a reasonable and customary period of time.

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

Need. The need for this program can be summed up in COMAR 13B.02.03.08B(3): *Occupational and professional needs relative to upgrading vocational/technical skills or meeting job market requirements.* Data science has become pervasive in many fields and industries. As computing power also increases, there is a distinct need for data scientists with a high level of technical skill. This program incorporates statistics, machine learning, computing, communication, and research and project design. Data science has many applications and entire academic programs can be dedicated to a particular field's analytics, such as business or marketing analytics. This program, however, focuses on the science and math of data science.

State Plan. The proposed program aligns broadly with the 2022 *Maryland State Plan for Postsecondary Education,* specifically Priority 5, "Maintain the commitment to high-quality postsecondary education in Maryland," in particular, the Action Item to "Identify innovative fields of study." This program leverages the strengths of not just one academic department at UMD, but multiple departments--computer science, mathematics, and computer and electrical engineering—so that the program is comprehensive treatment of the technical fields involved in data science. The program combines both expert research faculty and industry leaders to bring students the foundational knowledge and industry expertise necessary to thrive in this field.

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

National and state projections show a dramatic increase in the number of data scientist positions. The United States Bureau of Labor Statistics indicates a 35% increase in the next 10 years with more than 59,000 jobs being added. Maryland state occupational projections show a 30.46% increase from 2020-2030 with more than 700 positions being added. UMD's existing MPS program currently has 115 students registered this fall term and has increased each year since the program's inception. Data scientist is just one related occupation. The National Center

for Education Statistics indicates via its [CIP SOC Crosswalk](#) that Data Science, General programs (CIP: 30.7001) are directly linked to a variety of occupations: Computer and Information Systems Managers, Natural Sciences Managers, Computer and Information Research Scientists, Database Architects, Software Developers, Statisticians, and Postsecondary Teachers. Beyond this list, having data science skills gives professionals an important competitive edge when we consider the applications of data science in a broad array of fields, such as business, health, entertainment, government and politics.

D. Reasonableness of Program Duplication

With data science becoming such a pervasive activity in so many different fields, it is not surprising that most Maryland institutions already have a master's program in or related to data science or analytics. Capitol Technology University, Johns Hopkins, Loyola, MICA, McDaniel, Morgan State, Notre Dame of Maryland University, UMGC all have Data Science programs listed on the state's inventory. Bowie State and Towson have a specialization in Data Science within their Computer Science master's programs. UMBC also has a professional studies program in Data Science. UMD even has a Survey and Data Science master's program that focuses on survey methodology and data science. Despite all of these existing programs, UMD's MPS program in Data Science and Analytics still has more than 100 registered students. This speaks to the great demand for a skill set that has a wide array of applications. Even in the Washington, DC metropolitan area, where UMD is located, American University, Catholic University, Georgetown, George Washington, and Howard University all have data science or analytics master's program. Again, UMD's program has been thriving in spite of the number of other programs. Our program is different from others and particularly attractive to professionals because of its applied nature and the technical expertise of our computer science, applied mathematics, and engineering faculty. We argue that data science, particularly at the graduate level, has become a core academic area that will only grow in importance not only in terms of demand but also an economic driver for the state and region.

E. Relevance to Historically Black Institutions (HBIs)

As indicated above, Bowie State and Morgan State both have related programs. We argue that data science, particularly at the graduate level, has become a core academic area that will only grow in importance not only in terms of demand, but also as an economic driver for the state and region.

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

We do not anticipate any negative impacts on the special identities of the HBIs in the state of Maryland as so many other institutions in the state offer data science programs.

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

Curricular Development. The factors that were considered in developing the proposed curriculum derive largely from our professional experiences working in areas related to data science, careful study of other data science curricula at other institutions, and educational/training needs articulated by major employers.

Faculty Oversight. Appendix A includes a list of faculty will be teaching in the program. The faculty come from a variety of technical backgrounds, including electrical engineering, computer engineering, mathematics, biology, computer science, mathematics, and transportation engineering.

Educational Objectives and Learning Outcomes. The learning outcomes for the program are as follows:

1. Design, conduct and interpret data analysis tasks.
2. Communicate data analysis tasks and findings.
3. Apply methods and tools of statistics, machine learning, computer science, to data studies.

Institutional assessment and documentation of learning outcomes. The learning outcomes for the program will be assessed using a combination of formative and summative assessments during and at the completion of each semester. Each course in the program will have homework assignments, practice sets, and other assessments that will be graded with feedback to help assess the student's learning. Midterms and final exams or projects will be cumulative assessments to determine if and to what level the student mastered the learning outcomes for each course.

The assessments will be appropriate to the nature of the course content and the course learning objectives. Both individual assessments and group assessments will be required in the program. This type of variation best mimics the work and industry expectations. The assessments of the program will mirror work products in the industry and prepare students for jobs in industry. For example, many of the elective courses include final projects, presentations and assignments where students have to work with real data sets. Students will be expected to process the data, and perform tasks and make recommendations that are expected of an entry level data scientist or Artificial Intelligence (AI) engineer.

Lastly, students will also be challenged to complete reflective assessments to apply knowledge and skills in their future professional work. This work will assist students in the job search process and enable them to identify, apply to, and earn positions in this field. The assessments will all follow best practices for adult and professional students. As the student progresses through the curriculum and satisfies learning objectives, they will align with and accomplish the program-level learning outcomes.

Course requirements. The program requires the following ten three-credit courses for a total of 30 credits.

Course Number	Course Title	Credits
DATA601	Probability and Statistics	3
DATA602	Principles of Data Science	3
DATA603	Principles of Machine Learning	3
DATA604	Data Representation and Modeling	3
DATA605	Big Data Systems	3
DATA606	Algorithms for Data Science	3
DATA607	Communication in Data Science and Analytics	3
DATA612	Deep Learning	3
DATA641	Natural Language Processing	3
DATA698	Research Methods and Study Design	3

A list of courses and descriptions is included in Appendix B

General Education. Not applicable for our graduate programs.

Accreditation or Certification Requirements. No accreditation or licensure is required for the program.

Other Institutions or Organizations. The offering unit is not planning to contract with another institution or non-collegiate organization for this program.

Student Support. The Science Academy in the College of Computer, Mathematics and Natural Science will provide administrative coordination for the program, in collaboration with the Office of Extended Studies. Students will be supported through the Science Academy for academic guidance and advising. They will also have access to the Graduate School Counseling and the Counseling Center resources. The Science Academy Program Manager will be the first point of contact for students, while the Office of Extended Studies, which provides administrative services for a host of professional programs, provides student and program services, such as admission support, scheduling, registration, billing and payment, graduation, and appeals. Students will see admission criteria, financial aid resources, costs, and complaint procedures on both the Science Academy website and the Extended Studies program page. For technical aspects of both the in-person and online versions of the program, specific technological competence and equipment will be included in the admission criteria. Learning management information will also be included in these materials.

Marketing and Admissions Information. Students will see admission criteria, financial aid resources, and costs on both the Science Academy website and the Extended Studies program page.

H. Adequacy of Articulation

Not applicable for this graduate program.

I. Adequacy of Faculty Resources

Program faculty. Appendix A contains a list of faculty members who will teach in the program. Faculty will primarily be from computer science, mathematics, and engineering backgrounds.

Faculty training. Faculty teaching in the program will use the university's learning management system along with its extensive electronic resources. They will have access to instructional development opportunities available across the College Park campus, including those offered as part of the Teaching and Learning Transformation Center, many of which are delivered in a virtual environment. Instructors will work with the learning design specialists on campus to incorporate best practices when teaching in the online environment.

J. Adequacy of Library Resources

The University of Maryland Libraries assessment concluded that the Libraries are able to meet, with current resources, the curricular and research needs of the program.

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

All physical facilities, infrastructure, and instructional equipment are already in place. No new facilities are required as this program already exists as an MPS program. For the online components of the coursework, UMD maintains an Enterprise Learning Management System (ELMS). ELMS is a Web-based platform for sharing course content, tracking assignments and grades, and enabling virtual collaboration and interaction. All students and faculty have access to UMD's electronic mailing system.

L. Adequacy of Financial Resources

Tables 1 and 2 contain the details of resources and expenditures.

Table 1 Resources:
The program will be self-supported through tuition revenue. There are no start-up costs because the program is already in operation as a Master of Professional Studies.
1. Line 1 shows no reallocated funds since the program is supported by tuition from existing students.
2. Graduate students will be paying tuition by the credit. We anticipate that 115 full-time students will be taking 8 courses per year and 9 part-time students (term-based) will take 8 courses per year.
3. The tuition rate will be $4000 per three-credit course with an assumed annual increase of 3%.
4. No external sources of funding are assumed.
5. No other sources of funding are assumed.

Table 2 Expenditures:

1. Faculty salaries are based on cost per course (some courses will have multiple sections).
2. We assume an annual increase of 3% in salaries with a corresponding 33% benefits rate.
3. Administrative positions include an academic director (1 FTE), a program manager (1 FTE), along with other administrative support (1 FTE).
4. Included is an annual 3% increase and a corresponding benefits rate of 33% for the academic director and program manager positions.
5. Other expenditures include an administrative fee for UMD's Office of Extended Studies and a modest budget for marketing, equipment, and travel and recruitment.

M. Adequacy of Program Evaluation

Formal program review is carried out according to the University of Maryland's policy for Periodic Review of Academic Units, which includes a review of the academic programs offered by, and the research and administration of, the academic unit (http://www.president.umd.edu/policies/2014-i-600a.html). Program Review is also monitored following the guidelines of the campus-wide cycle of Learning Outcomes Assessment (https://irpa.umd.edu/Assessment/loa_overview.html). Faculty within the department are reviewed according to the University's Policy on Periodic Evaluation of Faculty Performance (http://www.president.umd.edu/policies/2014-ii-120a.html). Since 2005, the University has used an online course evaluation instrument that standardizes course evaluations across campus. The course evaluation has standard, university-wide questions and allows for supplemental, specialized questions from the academic unit offering the course.

N. Consistency with Minority Student Achievement goals

The primary recruitment activities will be via the Science Academy, the offering unit for this program. The Science Academy uses a diverse, targeted approach when recruiting students. This digital strategy focuses on UMD alumni, current UMD graduating seniors, and working professionals in the Washington, DC metropolitan area. The admissions review process reviews for not only academic readiness, but also diversity in experiences, industries, backgrounds, and career aspirations to recruit a diverse student body.

To attract a diverse student population, we will engage in the following activities:
• Representing the program in educational fairs, conferences and events, e.g. the National Leadership Conference of the National Society of Black Engineers, GEM Grad Labs.
• Advertising the program to the National Society of Black Engineers (NSBE), the Society of Women Engineers (SWE), and the Association for Women in Computing (AWC).

- Direct mailing and email campaigns to domestic and international colleges
- Outreach to UMD Campus organizations and clubs
- Holding online (virtual) open houses, information sessions and career panels
- Outreach to US Military to attract veterans
- Social media and online advertising
- Exploring establishing graduate scholarships to provide financial aid to underrepresented minority applicants

Once enrolled, the Science Academy staff, and faculty are committed to creating and fostering a supportive environment for all students to thrive. The staff regularly shares resources and opportunities for counseling, support, and funding. All students are expected to complete and honor the TerrapinSTRONG orientation and initiatives. TerrapinSTRONG is an onboarding course for all new faculty, staff, and students that "introduces and infuses its vision of inclusion and our institutional values across the university to create a more cohesive identity and a stronger commitment to community, connection and inclusion" (see https://terrapinstrong.umd.edu/). Students in the program are encouraged to take part in Graduate School programs that address diversity and inclusion in higher education, build communities of support and success, and create meaningful dialogue among graduate students. Such programs include "Cultivating Community Conversations" and the "Annual Office of Graduate Diversity and Inclusion's Spring Speaker Services." Faculty that are involved in the Science Academy represent many departments, have a diversity of appointments (both tenure track, professional track, and adjunct) exposing students to many future career paths. The Science Academy and faculty provide student advising, academic support, and career guidance to students to retain all students and support timely graduation.

Our student retention efforts will consist of:
- Holding "Women in Engineering, Computing and STEM" seminars to address the obstacles faced by women in today's technical workplace and guide our women students to maneuver through the internship and job application process.
- Requiring students to attend mandatory advising sessions with the program adviser to ensure that the students' study plans are in line with their interests and career goals, and that the students make satisfactory progress toward meeting the degree requirements.
- Implementing an early warning system that detects students struggling with core courses and alerts the academic advisor, who meets with the students and designs a study plan to get them back on track.

O. Relationship to Low Productivity Programs Identified by the Commission

N/A

P. Adequacy of Distance Education Programs

The distance-education version of the program will be entirely online. This will allow the program to reach a wider audience, including those in the Washington, DC area whose

professional commitments may not allow for regular travel to College Park. The online curriculum will be the same as the in-person curriculum. Learning outcomes, academic rigor and program curricula will be exactly the same for the online program as it is for the on-campus program. The program will go through periodic evaluations, at least every three years, by the Science Academy leadership and academic department chairs. Students will have access to the same services that online students and will be advised by both the Science Academy and the Office of Extended Studies.

Appendix A: Faculty for Data Science Program

The following faculty members are projected to teach in the program. All faculty are full-time unless otherwise indicated.

Name	Highest Degree Earned, Program, and Institution	UMD Title (indicate if part-time)	Courses
Babak Azimi-Sadjadi	Ph.D., Electrical and Computer Engineering, University of Maryland	Visiting Lecturer	DATA/MSML 603: Principles of Machine Learning
Sandra Cerrai	Ph.D., Mathematics, Scuola Normale Superiore of Pisa	Prof & Assoc Chair	DATA/MSML 601: Probability and Statistics
Michael Cummings	Ph.D., Organismic and Evolutionary Biology, Harvard University	Professor	DATA698: Research Methods and Study Design
Wojtek Czaja	Ph.D., Mathematics, Washington University, St. Louis	Professor	DATA 604: Data Representation and Modeling
Mohammad Taghi Hajiaghayi	Ph.D., Computer Science, MIT	Professor	DATA/MSML 602: Principles of Data Science
Leonid Koralov	Ph.D., Mathematics, SUNY at Stony Brook	Prof & Assoc Chair	DATA/MSML 601: Probability and Statistics
Alejandra Mercado	Ph.D., Electrical and Computer Engineering, University of Marylan	Associate Director	DATA/MSML 603: Principles of Machine Learning
Abdirisak Mohamed	Ph.D. Mathematics, Karlsruhe institute of Technology	Lecturer	DATA 606: Algorithms for Data Structures
Vincent Paul Lyzinski	Ph.D. in Applied Mathematics and Statistics, Johns Hopkins University	Associate Professor	DATA607: Communication in Data Science and Analytics
Arefeh A Nasri	Ph.D., Transportation Engineering, University of Maryland	Visiting Lecturer	DATA/MSML 602: Principles of Data Science
Zoltan Safar	Ph.D., ECE, University of Maryland	Director	DATA/MSML650: Cloud Computing
Giacinto Saggese	Ph.D. ECE, University of Illinois Urbana-Champaign	Lecturer	DATA 605: Big Data Systems
Shabnam Tafreshi	Ph.D., Computer Science, George Washing University	Asst Research Scientist, ARLIS	MSML641- Natural Language Processing
Jerry Wu	Ph.D., RF MEMS, George Washington University	Lecturer	MSML642: Robotics

Appendix B: Course Descriptions

DATA601 Probability and Statistics (3 Credits)
Provides a solid understanding of the fundamental concepts of probability theory and statistics. The course covers the basic probabilistic concepts such as probability space, random variables and vectors, expectation, covariance, correlation, probability distribution functions, etc. Important classes of discrete and continuous random variables, their inter-relation, and relevance to applications are discussed. Conditional probabilities, the Bayes formula, and properties of jointly distributed random variables are covered. Limit theorems, which investigate the behavior of a sum of a large number of random variables, are discussed. The main concepts random processes are then introduced. The latter part of the course concerns the basic problems of mathematical statistics, in particular, point and interval estimation and hypothesis testing.

DATA602 Principles of Data Science (3 Credits)
An introduction to the data science pipeline, i.e., the end-to-end process of going from unstructured, messy data to knowledge and actionable insights. Provides a broad overview of what data science means and systems and tools commonly used for data science, and illustrates the principles of data science through several case studies.

DATA603 Principles of Machine Learning (3 Credits)
A broad introduction to machine learning and statistical pattern recognition. Topics include: Supervised learning: Bayes decision theory, discriminant functions, maximum likelihood estimation, nearest neighbor rule, linear discriminant analysis, support vector machines, neural networks, deep learning networks. Unsupervised learning: clustering, dimensionality reduction, PCA, auto-encoders. The course will also discuss recent applications of machine learning, such as computer vision, data mining, autonomous navigation, and speech recognition.

DATA604 Data Representation and Modeling (3 Credits)
An introductory course connecting students to the most recent developments in the field of data science. It covers several fundamental mathematical concepts which form the foundations of Big Data theory. Among the topics included are Principal Component Analysis, metric learning and nearest neighbor search, elementary spectral graph theory, minimum and maximum graph cuts, graph partitions, Laplacian Eigenmaps, manifold learning and dimension reduction concepts, clustering and classification techniques such as k-means, kernel methods, Mercer's theorem, and Support Vector Machines. Some relevant concepts from geometry and topology will be also covered.

DATA605 Big Data Systems (3 Credits)
An overview of data management systems for performing data science on large volumes of data, including relational databases, and NoSQL systems. The topics covered include: different types of data management systems, their pros and cons, how and when to use those systems, and best practices for data modeling.

DATA606 Algorithms for Data Science (3 Credits)
Provides an in-depth understanding of some of the key data structures and algorithms essential for advanced data science. Topics include random sampling, graph algorithms, network science, data streams, and optimization.

DATA607 Communication in Data Science and Analytics (3 Credits)
Expected learning outcomes include that, in the context of data science and analytics, students should be able to: summarize, report, organize prose, statistics, graphics, and presentations; explain uncertainty, sensitivity/robustness, limitations; describe model generation and representation; discuss interpretations and implications; communicate effectively to diverse audiences within a business organization, and possibly other outcomes.

DATA612 Deep Learning (3 Credits)
Provides an introduction to the construction and use of deep neural networks: models that are composed of several layers of nonlinear processing. The class will focus on the main features in deep neural nets structures. Specific topics include backpropagation and its importance to reduce the computational cost of the training of the neural nets, various coding tools available and how they use parallelization, and convolutional neural networks. Additional topics may include autoencoders, variational autoencoders, convolutional neural networks, recurrent and recursive neural networks, generative adversarial networks, and attention-based models. The concepts introduced will be illustrated by examples of applications chosen among various classification/clustering questions, computer vision, natural language processing.

DATA641 Natural Language Processing (3 Credits)
Introduces fundamental concepts and techniques involved in getting computers to deal more intelligently with human language. Focused primarily on text (as opposed to speech), the class will offer a grounding in core NLP methods for text processing (such as lexical analysis, sequential tagging, syntactic parsing, semantic representations, text classification, unsupervised discovery of latent structure), key ideas in the application of deep learning to language tasks, and consideration of the role of language technology in modern society.

DATA650 Cloud Computing (3 Credits)
Presents the state of the art in cloud computing technologies and applications. Topics will include: telecommunications needs, architectural models for cloud computing, cloud computing platforms and services. Data center networking, server, network and storage virtualization technologies, and containerization. Cloud operating and orchestration systems. Security, privacy, and trust management; resource allocation and quality of service; interoperability and internetworking.

DATA698 Research Methods and Study Design (3 Credits)
Expected learning outcomes include that students should be able to: compose problem specifications relevant to work environment, create project descriptions, determine data and resource requirements, propose appropriate methods analytical methods, construct research plans; determine reporting requirements appropriate to various employment situations,

identify intended audiences and uses, propose supporting documentation, and possibly other outcomes. Includes ethical and legal considerations in data science.

Table 1: Resources

Resources Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Reallocated Funds	$0	$0	$0	$0	$0
2. Semester-Based Revenue (by year)	$3,680,000	$3,753,600	$3,828,672	$3,905,245	$3,983,350
a. Semester-based Annual Students	115	115	115	115	115
b. Semester-based Annual Courses	8	8	8	8	8
3. Term-Based Revenue (by year)	$288,000	$293,760	$299,635	$305,628	$311,740
c. Term-based Annual Students	9	9	9	9	9
d. Term-based Annual Courses	8	8	8	8	8
4. Tuition Per Course Rate (assumes 2% increase)	$4,000	$4,080	$4,162	$4,245	$4,330
5. Grants, Contracts, & Other External Sources	$0	$0	$0	$0	$0
6. Other Sources	$0	$0	$0	$0	$0
Total Tuition Revenue	**$3,968,000**	**$4,047,360**	**$4,128,307**	**$4,210,873**	**$4,295,091**

Table 2: Expenditures

Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Faculty (b+c below)	$1,729,000	$1,780,870	$1,834,296	$1,889,325	$1,946,005
a. #FTE	10.0	10.0	10.0	10.0	10.0
b. Total Salary	$130,000	$133,900	$137,917	$142,055	$146,316
c. Total Benefits	$42,900	$44,187	$45,513	$46,878	$48,284
2. Admin. Staff (b+c below)	$105,325	$108,485	$111,740	$115,092	$118,545
a. #FTE	2.0	2.0	2.0	2.0	2.0
b. Total Salary	$79,192	$81,568	$84,015	$86,535	$89,131
c. Total Benefits	$26,133	$26,917	$27,725	$28,557	$29,413
3. Total Support Staff (b+c below)	$103,740	$106,852	$110,058	$113,359	$116,760
a. #FTE	3.0	3.0	3.0	3.0	3.0
b. Total Salary	$78,000	$80,340	$82,750	$85,233	$87,790
c. Total Benefits	$25,740	$26,512	$27,308	$28,127	$28,971
4. Graduate Assistants (b+c)	$0	$0	$0	$0	$0
a. #FTE	0.0	0.0	0.0	0.0	0.0
b. Stipend	$0	$0	$0	$0	$0
c. Tuition Remission	$0	$0.00	$0	$0.00	$0
5. Equipment	$3,000	$3,000	$3,000	$3,000	$3,000
6. Library	$1,500	$5,000	$5,000	$5,000	$5,000
7. Hourly Workers	$50,000	$51,500	$53,045	$54,636	$56,275
8. Other Expenses: Operational Expenses	$200,000	$204,000	$208,080	$212,242	$216,486
TOTAL (Add 1 - 8)	$2,192,565	$2,259,707	$2,325,219	$2,392,654	$2,462,072