WASHINGTON COLLEGE

June 15, 2022

James D. Fielder, Jr., Ph.D.
Secretary of Higher Education
Maryland Higher Education Commission
Nancy S. Grasmick Building 10th Floor
6 North Liberty Street
Baltimore, MD 21201

Dear Dr. Fielder,

The attached proposal lays out the rational for a Bachelor of Science in Data Science incorporating statistics, machine learning, operations research, computer science and mathematics at its core. As part of this evolution in our curriculum and academic offerings, faculty in the Department of Mathematics and Computer Science have onboarded several faculty members with industry experience and expertise in data science and machine learning.

We believe that the B.S. in Data Science aligns with and advances the liberal arts mission of Washington College, and will help us attract academically talented students, especially from historically underrepresented groups. We believe in situating this major in the overall liberal arts context where students are prepared for serious ethical reflection in every class. Like all Washington College majors, the Data Science major is firmly grounded in the values of liberal learning: analytical thought, clear communication, imagination, ethical sensitivity, and civic responsibility. The major draws on existing courses and faculty expertise and indeed, is a part of a larger eye towards workforce development in the region and state overall. Washington College is very well-positioned to offer this major with existing resources with a commitment to additional resources as needed to allow for program growth.

Thank you for your consideration. We look forward to hearing from you soon.

Sincerely,

Michael Harvey, Ph.D.
Provost and Dean of the College

Office Use Only: PP#

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

Institution Submitting Proposal	Washington College

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 # 378236 (●) Check # 378236
Payment Amount: 850.00
Date Submitted: 6/15/2022

Department Proposing Program	Mathematics and Computer Science	
Degree Level and Degree Type	Bachelor of Science	
Title of Proposed Program	Data Science	
Total Number of Credits	128	
Suggested Codes	HEGIS: 799.00	CIP: 30.7001
Program Modality	(●) On-campus	( ) Distance Education (*fully online*)
Program Resources	(●) Using Existing Resources	( ) Requiring New Resources
Projected Implementation Date	(●) Fall ( ) Spring ( ) Summer	Year: 2022
Provide Link to Most Recent Academic Catalog	URL: https://www.washcoll.edu/people_departments/offices/registrar/2021%20-%202022%20Washington%20College%20Catalog.pdf	
Preferred Contact for this Proposal	Name: Kerrin Ehrensbeck	
	Title: Director of Institutional Research	
	Phone: (410) 778-7862	
	Email: kehrensbeck2@washcoll.edu	
President/Chief Executive	Type Name: Michael Sosulski	
	Signature: [signature]	Date: 06/15/2022
	Date of Approval/Endorsement by Governing Board:	

Revised 1/2021

Proposal for Data Science B.S. Degree at Washington College

A. Centrality to Institutional Mission and Planning Priorities:

1. *Provide a description of the program, including each area of concentration (if applicable), and how it relates to the institution's approved mission.*

Washington College seeks the creation of a new, interdisciplinary program in Data Science that will advance the liberal arts mission of the college and better meet the needs of our students and prepare them to be critical thinkers and actors in the 21st century. The proposed program builds on current strengths within the department of Mathematics and Computer Science. It allows students to gain a broad foundation in concepts and techniques essential for success at the interface between these two disciplines, statistics, and other fields of interest. The new program will support our mission, specifically developing "habits of analytical thought and enhancing our "broad curriculum of study."

While data science is a new concept to describe a suite of technical and investigative skills, the heart of the subject is rooted in mathematics, statistics, and computer science. Our proposed program therefore draws on these subjects for the core of the program. Data science does not exist within a vacuum, however, and domain-specific knowledge is essential for students to leverage their technical expertise in different fields. Our electives help students gain that domain expertise. The data practicum and the Senior Capstone Experience bring together the technical and domain specific knowledge, allowing students to complete data science projects from start to finish. Along with Washington College's distribution requirements, we aim for students to have the ability to use data as a lens to critically examine important issues in the world.

Data science is often concerned with questions of generalization and prediction, which are fraught with ethical potholes. By situating this program within Washington College's broader liberal arts context, where students are prepared for serious ethical reflection within every class, we provide our students with a strong foundation for ethically interrogating their work.

The Department of Mathematics and Computer Science views this major as a step towards a broader data science initiative at the College, should the College wish to pursue such a path. The practice of data science, machine learning, and artificial intelligence creates ethical questions, different avenues for artistic expression, and new methods to understand academic fields. We envision Washington College as a place to both practice and critique data science. Our data science major reflects this vision, and we hope the College will continue to develop programs that create opportunities for students with less interest in the technical details to explore data science and its implications as well.

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

The Data Science program supports Washington College's Strategic Plan. Washington College wants to be innovative and keep pace with the challenges and changing opportunity in today's world. Specifically, the creation of this program will support Goal 1, Objective D, listed below for context:

GOAL 1: Reaffirm the College's core mission of providing a superior liberal arts education to prepare our students for the challenges of the 21st century.

Objective D: Expand opportunities for interdisciplinary cooperation to meet emerging student interests.

The new program will be an institutional priority. Faculty and administration both believe in its creation. The addition of a Data Science program was approved by the faculty in related departments, the entire natural science division, the curriculum committee, and the full faculty as a whole (and in that order).

3. *Provide a brief narrative of how the proposed program will be adequately funded for at least the first five years of program implementation. (Additional related information is required in section L.)*

For the immediate future, Data Science will require no additional funding outside of our department budgets. Since this is an interdisciplinary program, it will be supported by several departments. In the first five years of its implementation, it is not likely to attract enough additional students to Washington College to require a full line. If, of course, the program attracts a large number of students, funding will be available to support a new line to support those students. Washington College is also working on grant opportunities to expand outreach related to our new Data Science program which will also provide additional staffing. However, the program is not contingent upon the success of those grants. Moving some faculty resources towards dedicated data science courses will require some instructors to help fill holes that are occupied by the new discipline. Washington College is dedicated to committing to those positions in the form of a VAP as the program gets off the ground. A tenure-track position will become available as market demands and funding becomes available.

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

    b) *continuation of the program for a period of time sufficient to allow enrolled students to complete the program.*

If, by chance, we decided to discontinue the program, we would allow sufficient time for enrolled students to complete the program with no issues. In this instance, this would be easy to satisfy since there are few courses specific to the proposed program.

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

1. *Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State in general based on one or more of the following:*
    a) *The need for the advancement and evolution of knowledge*

    b) *Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education*

    c) *The need to strengthen and expand the capacity of historically black institutions to provide high quality and unique educational programs*

Currently students interested in Data Science can do so at a small number of colleges in Maryland. Washington College is well positioned to help fill this void and provide Maryland students with a choice to attend a small college and major in an important and emerging field.

The program we propose is unique in that it offers machine learning and operations research to the mix of available courses. Students completing the Data Science program will be prepared for a variety of disciplines, career opportunities, and post-graduate education while gaining an ethical internal core to tackle modern data science analysis and applications.

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

The Maryland State Plan for Post-secondary Education (2017-2021) has three goals: access, innovation, and student success. We believe that the proposed program will improve student success across several strategies listed. Our plan includes a practicum and a senior capstone experience where we will be encouraging new partnerships akin to Strategy 8, 10 and 11. This may assist in career advising via direct intern and externships (Strategy 7) and it will improve the student experience in a direct way (Strategy 6). Our students' experience in data science encourages risk in a safe environment with collaborations with many internal and external partnerships and grant relationships.

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

1. *Describe potential industry or industries, employment opportunities, and expected level of entry (ex: mid-level management) for graduates of the proposed program.*
2. *Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program.*
3. *Discuss and provide evidence of market surveys that clearly provide quantifiable and reliable data on the educational and training needs and the anticipated number of vacancies expected over the next 5 years.*

There are many industries and career paths for students who will through our Data Science program. The chart below gives some examples of potential fields. The average projected growth rate of these fields is 18.84% over the ten years compared to only 7.7% growth for all other occupations. According to the U.S. Bureau of Labor Statistics, the average of the median annual wage for the jobs below is $98,860 to $159,010 compared to a median 2021 salary of $45,760 for all other occupations.

Occupation Code	Occupation	2020	2030	US Growth	US Median Salary 2021
11-3021	Computer and Information Systems Managers	482	534.6	10.9%	$159,010
15-1245	Database Architect	168	181.2	7.8%	$98,860*
15-1221	Computer and Information Research Scientist	33	40.2	21.9%	$131,490
15-1256	Software Developer	1,847.9	2,257.4	22.2%	$110,140*
15-2098	Data Scientist	63.2	83	31.4%	$100,480
	Totals and Averages	**2594.1**	**3096.4**	**18.84%**	**$119,996**

** 2020 median wage*

4. Provide data showing the current and projected supply of prospective graduates.

	2017-18	2018-19	2019-20	2020-21	2021-22	Average
Computer Science Degrees	8	17	11	15	11	12
Computer Science Course Enrollment	296	293	292	214	171	253
Mathematics Degrees	8	11	13	8	8	10
Mathematics Course Enrollment	584	604	507	486	360	508

The chart below gives the combined number of Computer science (CIP code 11) and Mathematics (CIP code 27) graduates at similar institutions in the state and at institutions outside of the state that we consider to be peers. These numbers coupled with the data from Washington College give us reason to believe that we will continue to have a healthy supply of Data Science graduates in the coming years.

Number of Graduates						
MD Private Institutions	**2015-2016**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**Average**
Goucher College	9	18	11	12	14	13
Hood College	22	34	9	19	21	21
McDaniel College	14	18	14	20	16	16
Mount St. Mary's University	11	12	26	22	31	20
Stevenson University	86	55	61	61	49	62
Peer Institutions						
Juniata College	23	21	29	25	16	23
Lake Forest College	22	22	28	26	29	25
Muhlenberg College	23	28	21	24	29	25
Ursinus College	34	20	31	31	17	27
Washington & Jefferson University	17	14	24	17	20	18

D. Reasonableness of Program Duplication:

1. Identify similar programs in the State and/or same geographical area. Discuss similarities and differences between the proposed program and others in the same degree to be awarded.

2. Provide justification for the proposed program.

Data Science is a field in high demand and yet there are few offerings in the region. Our offerings provide unique opportunities in machine learning and operations research that are often not seen in most programs that do provide data science and the offerings in data science are rather slim. As proposed this program is likely to draw mostly from our own pool, and thus, we do not anticipate competing with offerings elsewhere. We do, however, hope to promote more of the applied aspects of our program to

others who may seek to use the same model. Tables of some of our comparison schools are listed below.

Institution	Responsible department(s)	Major	Minor	Other
Tier 1				
Bard	-	-	-	-
Centre	Math, CS	X	X	-
Dickinson	Interdisciplinary	X	-	-
Franklin and Marshall	-	-	-	-
Gettysburg	CS	-	X	-
Hamilton College	-	-	-	-
Kenyon College	-	-	-	-
Lafayette	Interdisciplinary	-	X	-
Swarthmore	-	-	-	-
Trinity College	-	-	-	-
Washington and Lee University	Interdisciplinary | Business	-	2X	-
Williams	-	-	-	-
Tier 2				
Beloit College	Interdisciplinary	2X	-	-
Earlham College	CS	X	X	-
Hobart and William Smith	-	-	-	-
Kalamazoo	-	-	-	-
Rhodes College	-	-	-	-
Sarah Lawrence College	-	-	-	-
St. Lawrence University	Joint Math+CS+Stat	X	X	-
Wooster	Joint Math+CS	X	X	-

Table 1: Data science programs at peer and aspirant institutions
(Tiers 1 and 2. See Table 2 for others.)

Institution	Responsible department(s)	Major	Minor	Other
Tier 3				
Albion	Joint Math+CS	X	-	-
Alleghany	-	-	-	-
Goucher	Math, CS	X	-	Dist. reqt.
Juniata	Data Science	X	X	-
Lake Forest College	Joint Math+CS	X	X	-
Muhlenberg College	-	-	-	M.S. + cert
St. Mary's College of MD	-	-	-	-
Transylvania University	-	-	-	-
Ursinus	-	-	-	-
Washington and Jefferson	-	-	-	CIS conc.
Wheaton College (IL)	-	-	-	-
Wheaton College (MA)	-	-	-	-
Maryland (untiered)				
Mt. Saint Mary's College	Joint Math+CS	X	X	cert.
Salisbury University	Math	X	X	-
University of Maryland	CS	X	-	M.P.S.

Table 2: Data science programs at peer and aspirant institutions, continued – (tier 3 and three Maryland institutions not on the peer and aspirant list)

Institution	Math foundations	Stats	Ethics	Intro to Data Science	CS	Machine Learning	Databases	Electives	Other Data Science	Capstone
Ours	2	2	X	X	1	X	X	3	-	X
Tier 1										
Centre	5	1	-	X	3	X	-	-	1	X
Dickinson	2	2	X	X	1	X	X	3	-	X
Tier 2										
Beloit (analytics)	-	-	-	X	2	-	X	6	1	-
Beloit (science)	3	1	-	X	2	X	X	5	1	-
Earlham	3.5	2	-	X	3	X	X	-	-	X
St. Lawrence	3	2	-	X	3	X	X	3	-	X
Wooster	4	2	-	X	3	-	X	(minor)	2	X
Tier 3										
Albion	5	2	-	-	2	-	X	NA		
Goucher	2	2	-	-	1	X	-	3	-	X
Juniata	3	1	-	X	1	elect.	-	4+ 6	2	-
Lake Forest	1	2	-	X	2	elect.	elect.	5	-	-
Maryland (untiered)										
Salisbury	3	1	-	X	3	-	elect.	5	1	X
Mt. St. Mary's	2	-	(dist.)	X	3	X	elect.	5	3	X
UMD	1	1	-	X	1	X	X	3	-	-

Table 3. Comparison of data science majors amongst those programs that have a data science major

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

1. *Discuss the program's potential impact on the implementation or maintenance of high-demand programs at HBI's.*

   The addition of the new Data Science program will have minimal impact on HBIs. The closest to Washington College is the University of Maryland, Eastern Shore (UMES). UMES does not have a data science program. It is most likely for data science to draw from the same pool of students as computer science and mathematics. Thus, we do not see that this program will drive major enrollment growth at Washington College. Rather, this is alternative path that may better prepare our "would-be" mathematicians and computer scientists for the increasingly data-driven workforce.

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

1. *Discuss the program's potential impact on the uniqueness and institutional identities and missions of HBIs.*

   The data science program we are proposing will not impact the uniqueness and institutional identities and missions of HBIs. We are providing a new path of program completion for students in mathematics and computer science at Washington College with a practicum for applying that work.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes (as outlined in COMAR 13B.02.03.10):

1. *Describe how the proposed program was established, and also describe the faculty who will oversee the program.*

   The program was proposed by the faculty of the Department of Mathematics and Computer Science. It was then approved by the Natural Science Division, the Curriculum Committee, and the entire faculty of Washington College. It will be overseen by the department chair of the Department of Mathematics and computer Science.

2. *Describe educational objectives and learning outcomes appropriate to the rigor, breadth, and (modality) of the program.*

   Students will understand the core topics of data science, their utility and application.

   Students will communicate in both oral and written forms to diverse audiences.

   Students will develop a broad foundation of reasoning and analytical skills that can be applied to many fields.

   Students will understand the societal impact of their work and discipline.

   Students must demonstrate responsible and ethical behavior.

3. *Explain how the institution will:*
   a) *provide for assessment of student achievement of learning outcomes in the program*

   All departments at Washington College undergo a two year cycle of student learning outcomes assessment. In addition, we also have a separate assessment cycle for our general education requirements. These outcomes are delivered to the assessment committee, necessary stakeholders and archived by Institutional Research. They are used for internal purposes and future accreditation requirements.

   b) *document student achievement of learning outcomes in the program*

4. *Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements*

Course Number	Course Name	Credits
MAT 109	Statistical Inference and Data Analysis	4
MAT 209	Statistical Inference and Data Analysis II	4
MAT 240	Discrete Mathematics	4
MAT 280 or MAT 370	Linear Algebra -or- Operations Research	4
CSI 111	Computer Science I	4
MAT/CSI 220	Data Science	4
CSI 360	Machine Learning	4
CSI 310	Database Systems	4
CSI 450	Data Ethics and Practicum	4
DAT-SCE	Data Science Senior Capstone Experience	4
ELECTIVES	-Students choose 3 from below-	
MAT 370 or MAT 280	(if not counted above)	
MAT 320 CSI 112 ECN 320 ENV 211 PHY 252 CSI 380 BUS 357 CSI 420 PHL 310 SOC 306	Probability Computer Science II Econometrics Intermediate Geographic Information Systems Scientific modeling and data analysis Design and Analysis of Algorithms Quantitative Finance Artificial Intelligence Philosophy of Science Research Methods in Sociology	4 each

5. Discuss how general education requirements will be met, if applicable.

General education requirements at WC are not different for Data Science students. These consist of:

- A first-year seminar course in research and writing
- Writing across the discipline in 4 courses (one per year) starting with the first-year seminar and culminating in the SCE (mentioned above)
- The foreign language requirement of 2 4-credit classes or an upper level course
- Three 4-credit courses across natural science and quantitative departments. The courses listed above could count for 2 of these courses with one lab science completing the requirement.
- Three 4-credit courses across the humanities and fine arts (at least one in each)
- Three 4-credt courses across the social sciences from two separate departments

6. Identify any specialized accreditation or graduate certification requirements for this program and its students.
N/A

7. If contracting with another institution or non-collegiate organization, provide a copy of the written contract.
N/A

8. Provide assurance and any appropriate evidence that the proposed program will provide students with clear, complete, and timely information on the curriculum, course and degree requirements,nature of faculty/student interaction, assumptions about technology competence and skills,technical equipment requirements, learning management system, availability of academic supportservices and financial aid resources, and costs and payment policies.

The catalog entry will be attached and available on our website. It gives clear and complete details about the completion of the requirements of the program. Students have regular advising appointments regularly with faculty advisors. Courses are run via our LMS: canvas with two educational/instructional technologists. Financial aid and cost resources are made available in the same locations. As always, these resources and faculty are always available on the web and via email.

9. Provide assurance and any appropriate evidence that advertising, recruiting, and admissionsmaterials will clearly and accurately represent the proposed program and the services available.

Our Enrollment Management and Marketing team works directly with faculty when putting together their materials to be sure that information is clear and accurate. The website will also be a major resource for students. At Washington College, websites are maintained by individual departments with support from an Assistant Dean of Marketing in Academic Affairs. This helps assure the content is up to date and accurate. The catalog is revisited on a yearly basis and made available as a pdf.

H. Adequacy of Articulation

1. *If applicable, discuss how the program supports articulation with programs at partner institutions. Provide all relevant articulation agreements.*
   N/A

I. Adequacy of Faculty Resources (as outlined in COMAR 13B.02.03.11).

1. *Provide a brief narrative demonstrating the quality of program faculty. Include a summary list of faculty with appointment type, terminal degree title and field, academic title/rank, status (full-time, part-time, adjunct) and the course(s) each faulty member will teach (in this program).*

At Washington College, the computer science and mathematics faculty teach a variety of courses throughout our curriculum rather than a few select one or two classes per professor. Tenure and tenure-track faculty with PhDs comprise the majority of our staffing with a diversity of personalities and perspectives. Expertise in data science, engineering, operations research, number theory, combinatorics, graphics, programming and more are fundamental to creating an atmosphere of rich and vibrant ideas. These culminate in rich and exciting senior capstone projects with the students, as well as a variety of special topics courses. A summary of our faculty in the department and some courses they have offered are provided at the beginning of the following page.

Faculty Name	Degree	Title & Rank	Status	Courses
Dylan Poulsen	PhD – Mathematics	Chair, Assistant Professor, Tenure Track	Full-time	MAT 109, MAT 111, MAT 112, CSI 340, CSI 370
Shaun Ramsey	PhD – Computer Science	Associate Professor, Tenured	Full-time	CSI 104, 111, 112, 250, 320, 330, 410, 420, 430, 440
Austin Lobo	PhD – Computer Science	Associate Professor, Tenured	Full-time	CSI 111, 112, 210, 230, 310, 380, 460
Gabe Feinberg	PhD – Mathematics	Assistant Professor, Tenure Track	Full-time	MAT 111, 112, CSI 240, 350
Kyle Wilson	PhD – Applied Mathematics	Assistant Professor, Tenure Track	Full-time	MAT 109, CSI 100, 111, 112, 220, 360, 380
Emerald Stacy	PhD – Mathematics	Assistant Professor, Tenure Track	Full-time	MAT 106, 107, 111
Jordan Tirrell	PhD – Mathematics	Assistant Professor, Tenure Track	Full-time	MAT 109,111, CSI 240
Jesse Andrews	BS, ABD	Director of Quantitative Skills Center	Full-time	MAT 111, 112, 230, 240, 330, 410

2. *Demonstrate how the institution will provide ongoing pedagogy training for faculty in evidenced-based best practices, including training in:*
    a) *Pedagogy that meets the needs of the students*

Currently, faculty members have access to a variety of professional development and pedagogical training opportunities at Washington College. All faculty members are eligible for annual conference travel funds. Junior faculty receive support for project NExT (if it applies), summer science research funds and a junior leave. Faculty also have access to the Washington College Center for Teaching and Learning that offers a wide variety of programming on pedagogical development as well as Faculty Enhancement Funds that are used to further the scholarly pursuits of faculty members. We are departmental members of MAA which provide access to some journals, and other journals are available through the library. There is no shortage of opportunities and funds to help keep our faculty up-to-date with pedagogy, best teaching practices and scholarships.

b) The learning management system

Washington College has two full-time Instructional Technologists that are responsible for management of Canvas, our learning management system. They hold workshops throughout the year for faculty to provide training on the new features that are available as well as provide refreshers on commonly used pieces. Additionally, during new faculty orientation, faculty members are introduced to the Instructional Technologists and the services they provide. The Instructional Technologists are available throughout the year to meet with faculty about how best to incorporate the learning management system into their courses.

c) Evidenced-based best practices for distance education, if distance education is offered.

At the current time we are not offering distance education courses.

J. Adequacy of Library Resources (as outlined in COMAR 13B.02.03.12)**.**

1. *Describe the library resources available and/or the measures to be taken to ensure resources are adequate to support the proposed program.* ***If the program is to be implemented within existing institutional resources****, include a supportive statement by the President for library resources to meet the program's needs.*

    This program will be implemented using existing institutional resources. A statement of support from our President addressing this piece of the proposal and K.1 is included in our submission application.

K. Adequacy of Physical Facilities, Infrastructure and Instructional Equipment (as outlined in COMAR 13B.02.03.13)

1. *Provide an assurance that physical facilities, infrastructure and instruction equipment are adequate to initiate the program, particularly as related to spaces for classrooms, staff and faculty offices, and laboratories for studies in the technologies and sciences. If the program is to*

be implemented within existing institutional resources, include a supportive statement by the President for adequate equipment and facilities to meet the program's needs.

This program will be implemented using existing institutional resources. A statement of support from our President addressing this piece of the proposal and J.1 is included in our submission application.

2. *Provide assurance and any appropriate evidence that the institution will ensure students enrolled in and faculty teaching in distance education will have adequate access to:*

a) An institutional electronic mailing system, and
b) A learning management system that provides the necessary technological support for distance education

Our means of delivery is in-person. However, in case of distance educational needs (like those required due to COVID-19 or otherwise), canvas provides teleconferencing capabilities. However, our academic technology offers Zoom-pro licensing to faculty who require it. All students, faculty and staff receive an email upon registration and employment at Washington college.

L. Adequacy of Financial Resources with Documentation (as outlined in COMAR 13B.02.03.14)

1. *Complete **Table 1: Resources and Narrative Rationale**. Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year. Also provide a narrative rationale for each resource category. If resources have been or will be reallocated to support the proposed program, briefly discuss the sources of those funds.*

Table 1 represents the total resources coming into the Data Science program. In putting this proposal together, we assume a modest increase in tuition of 2% over the next five years will be the reason for the availability of additional resources. The number of F/T students is given based on the current number of students who have declared Computer Science or Mathematics as their major.

TABLE 1: RESOURCES:					
Resources Categories	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1. Reallocated Funds	0	0	0	0	0
2. Tuition/Fee Revenue (c + g below)	$ 2,466,607	$ 2,515,939	$ 2,566,258	$ 2,617,583	$ 2,669,935
a. Number of F/t Students	47	47	47	47	47
b. Annual Tuition/Fee Rate	$ 52,481	$ 53,531	$ 54,601	$ 55,693	$ 56,807
c. Total F/T Revenue (a x b)	$ 2,466,607	$ 2,515,939	$ 2,566,258	$ 2,617,583	$ 2,669,935
d. Number of P/T Students	0	0	0	0	0

e. Credit Hour Rate	0	0	0	0	0
f. Annual Credit Hour Rate	0	0	0	0	0
g. Total P/T Revenue (d x e x f)	0	0	0	0	0
3. Grants, contracts, & Other	0	0	0	0	0
4. Other Sources	0	0	0	0	0
Total (Add 1-4)	$ 2,466,607	$ 2,515,939	$ 2,566,258	$ 2,617,583	$ 2,669,935

*2.Complete **Table 2: Program Expenditures and Narrative Rationale**. Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year.*

Program expenditures are built using only budgetary expenses directly associated with Data Science. For example, even though the program has requirements outside of the Computer Science and Mathematics Department, only faculty directly in the Data Science program are represented in the table. Faculty who teach classes in other departments that can count towards the degree are not included here because our budget is not constructed in that way.

The increase in salary below represents the projection of a modest 3% per year cost of living adjustment.

TABLE 2: EXPENDITURES:					
Expenditure Categories	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1. Faculty (b + c below)	$ 709,338	$ 730,618	$ 752,536	$ 775,112	$ 798,366
a. #FTE	8	8	8	8	8
b. Total Salary	$ 567,470	$ 584,494	$ 602,029	$ 620,090	$ 638,692
c. Total Benefits	$ 141,868	$ 146,124	$ 150,507	$ 155,022	$ 159,673
2. Admin. Staff (b + c below)	$ 21,456	$ 22,100	$ 22,763	$ 23,446	$ 24,149
a. #FTE	0.5	0.5	0.5	0.5	0.5
b. Total Salary	$ 17,165	$ 17,680	$ 18,210	$ 18,757	$ 19,319
c. Total Benefits	$ 4,291	$ 4,420	$ 4,553	$ 4,689	$ 4,830
3. Support Staff (b + c below)	$ 28,500	$ 29,355	$ 30,236	$ 31,143	$ 32,077
a. #FTE	0.66	0.66	0.66	0.66	0.66
b. Total Salary	$ 22,800	$ 23,484	$ 24,189	$ 24,914	$ 25,662
c. Total Benefits	$ 5,700	$ 5,871	$ 6,047	$ 6,229	$ 6,415
4. Equipment	$0	$0	$0	$0	$0
5. Library	$ 2,600	$ 2,600	$ 2,600	$ 2,600	$ 2,600
6. New or Renovated Space	$ 0	$ 0	$ 0	$ 0	$ 0
7. Other Expenses	$ 12,700	$ 12,700	$ 12,700	$ 12,700	$ 12,700

TOTAL (Add 1-7)	$ 774,594	$ 797,373	$ 820,835	$ 845,001	$ 869,892

M. Adequacy of Provisions for Evaluation of Program (as outlined in COMAR 13B.02.03.15).

1. *Discuss procedures for evaluating courses, faculty and student learning outcomes.*
2. *Explain how the institution will evaluate the proposed program's educational effectiveness, including assessments of student learning outcomes, student retention, student and faculty satisfaction, and cost-effectiveness.*

The Data Science program will be subject to the same requirements for assessment and evaluation as existing programs at Washington College. Students complete course evaluations at the end of each course. These evaluations are delivered, in aggregate, to department chairs, the Associate Dean of Faculty and the Dean and Provost of the College for use in tenure and promotion decision making.

Washington College has worked hard to ensure that the assessment activities we pursue are directly meaningful and help us improve the teaching and learning priorities that we identify as being most important. We have established a regular practice of assessment that is manageable and sustainable. Every year each department completes a Student Learning Outcomes Assessment (SLOA) report that outlines measurable objectives, describes how assessment data are captures and presents student learning outcomes data. It also summarizes changes that departments have made in response to previous assessments. In addition, every three years, each department submits Department Program Assessment and Planning (DPAP) reports in which they reflect on the programmatic strengths and challenges of the previous three years and set a plan for moving forward. While SLOA reports focus on student learning outcomes, DPAP reports provide an opportunity to focus on issues other than student learning outcomes, such as enrollment growth, changes in the field and strategic academic priorities.

N. Consistency with the State's Minority Student Achievement Goals (as outlined in COMAR13B.02.03.05).

1. *Discuss how the proposed program addresses minority student access & success, and the institution's cultural diversity goals and initiatives.*

The recruitment and retention of minority students is a priority for Washington College. In fall 2015, 12.8% of undergraduates were minority students and 5.2% African American. The good news for the College is that the diversity of incoming classes has been steadily increasing, even exceeding 20% for first-time, full-time students in fall2016. That trend is consistent today with our institution still maintaining a 20% minority student population.

Washington College is committed to minority student access and success. We have hired an admissions counselor whose focus is on minority student recruitment. We have an Office of Intercultural Affairs with two professional staff members that support our minority students on campus as well as provide programming to educate the entire campus community. Faculty, staff, and students were invited to a diversity training in January. We also have a diversity committee on campus that has faculty, staff, and student members.

O. Relationship to Low Productivity Programs Identified by the Commission:

1. *If the proposed program is directly related to an identified low productivity program, discuss how the fiscal resources (including faculty, administration, library resources and general operating expenses) may be redistributed to this program.*

   N/A

P. Adequacy of Distance Education Programs (as outlined in COMAR 13B.02.03.22)

1. *Provide affirmation and any appropriate evidence that the institution is eligible to provide Distance Education.*
2. *Provide assurance and any appropriate evidence that the institution complies with the C-RAC guidelines, particularly as it relates to the proposed program*.

   N/A

Appendix A: Catalog Language

Requirements for a Bachelor of Science in Data Science

The major in data science consists of the senior capstone plus a minimum of twelve courses: nine core courses, and three electives.

Data Science Major (9+3+SCE)

Required Core:

- MAT 109 Statistical Inference & Data Analysis
- MAT 209 Statistical Inference & Data Analysis II
- MAT/CSI 240 Discrete Mathematics
- MAT 280 Linear Algebra -or - MAT/CSI 370 Operations Research
- CSI 111 Computer Science I
- MAT/CSI 220 Data Science
- MAT/CSI 360 Machine Learning
- CSI 310 Database Systems
- CSI 450 Data Ethics and Practicum
- SCE – Data Science Senior Capstone Experience

Electives (take three):

- MAT/CSI 370 - Operations Research (if not counted in the core above)
- MAT 280 - Linear Algebra (if not counted in the core above)
- MAT 320 – Probability
- CSI 112 - Computer Science II
- ECN 320 – Econometrics
- ENV 211 - Intermediate GIS
- PHY 252 - Scientific modeling and data analysis
- CSI 380 - Design and Analysis of Algorithms
- BUS 357 - Quantitative Finance
- CSI 420 - Artificial Intelligence
- PHL 310 - Philosophy of Science
- SOC 306 - Research methods in Sociology
- Data Science SCE - Domain Expertise in the SCE from a discipline!

Data Science Minor (7 total courses)
Required:

- MAT 109 Statistical Inference & Data Analysis
- MAT 209 Statistical Inference & Data Analysis II - or - CSI 360 Machine Learning
- MAT/CSI 240 Discrete Mathematics - or - MAT 280 Linear Algebra - or - MAT/CSI 370 Operations Research
- CSI 111 Computer Science I
- CSI 220 Data Science

- CSI 310 Database Systems
  AND
  2 Electives that count for the major that may include core courses not counted above.

Appendix B. Course Descriptions

MAT 109. Statistical Inference and Data Analysis
Introduction to the appropriate methods for analyzing data and designing experiments. After a study of various measures of central tendency and dispersion, the course develops the basic principles of testing hypotheses, estimating parameters, and reaching decisions. C*redit for MAT 109 will not be given if taken before or subsequently to BUS 109, PSY 209, or ECN 215.*

MAT 209 Statistical Inference & Data Analysis II
A continuation of the theory and practice of data analysis and statistics in the natural and social sciences. Use of statistical software will be a significant part of this course. Common statistical mistakes and the careful and ethical application of statistical methods will be emphasized. Topics will include experimental design, multivariate linear regression, non-parametric and parametric inference, power calculations, logistic regression, chi-squared tests, and ANOVA. Prerequisite: MAT109 or equivalent, or permission of instructor.

MAT 220. Data Science (cross-listed as CSI 220)
The heart of data science is going from a deluge of numbers to ever-elusive insight. In this introduction we will focus on first principles: asking good questions, being aware of our assumptions, and understanding what it means to do good science. Topics will include exploratory analysis / descriptive statistics, statistical testing, and data visualization. The course will conclude with an introduction to recent data-driven machine learning models. We will discuss ethical issues pertaining to data and machine learning throughout the course, using current events and articles as they arise. The course will be both math and programming intensive, although in a heavily applied manner. *Prerequisite:* CSI 111 *or permission of the instructor.*

MAT 240. Discrete Mathematics (cross-listed as CSI 240)
An introduction to logic, reasoning, and the discrete mathematical structures that are important in computer science. Topics include proposition logic, types of proof, induction and recursion, sets, combinatorics, functions, relations, and graphs.

MAT 280. Linear Algebra
An introduction to linear algebra balancing computation and the reading, understanding, and writing of mathematical proofs. A selection of topics from systems of linear equations, matrices, vector spaces, bases, dimension, linear transformations, determinants, eigenvalues, change of basis, matrix representations of linear transformations, matrix decompositions, and applications of linear algebra. It is recommended that students take MAT 240 before this course. *Prerequisite: MAT 112 or permission of the instructor.*

MAT 320. Probability
Events and their probabilities, dependence, and independence. Bayes Theorem. Variates and expected values. Theorems of Bernoulli and De Moivre. Special distributions. Central limit theorem and applications. *Prerequisite: Mathematics 112 or permission of the instructor.*

MAT 360. Machine Learning (cross-listed as CSI 360)

This is a class in finding patterns. Machine learning methods fit models to data to build representations of the underlying relationships. These models can then be applied to do tasks like classification, regression, and generation. As an undergraduate-level introductory course we will focus on the core ideas and applications of the most important models, such as linear and logistic regression, nearest-neighbor methods, and support vector machines. We will give special emphasis to a variety of new deep learning techniques. *Prerequisite*: CSI 111 *or permission of the instructor.*

MAT 370. Operations Research (cross-listed as CSI 370)
This course tackles challenges that arise in the functioning (operations) of a complex organization, and then works to formulate, analyze, and solve corresponding mathematical decision models. Some of these challenges might involve: distributing tasks among processes competing for limited resources, arranging transportation between hubs to minimize cost, or scheduling employees' shifts to meet demands while lowering payroll costs. We'll develop mathematical and computational tools, understand how they work, and explore some of their historic usage in industry. Topics will include some combination of: linear programming & the simplex method; transportation & assignment problems; network models; dynamic programming; integer programming. Prerequisites: MAT/CSI 240: Discrete Mathematics or MAT 280 Linear Algebra *or permission of the instructor.*

CSI 111. Computer Science I
The objectives of this course are threefold: to introduce programming concepts and algorithmic development, to teach an object-oriented programming language, and to teach how to design, code, debug and document programs using the techniques of good programming style.

CSI 112. Computer Science II
The objectives of this course are twofold: (a) to study data structures, such as stacks, queues, trees, dictionaries, tables, and graphs, their efficiency, and their use in solving computational problems; and (b) to gain proficiency in an object-oriented programming language. Exercises in that language will provide an opportunity to design and implement the data structures. *Prerequisite:* CSI 111 (C+ or better recommended) *or permission of the instructor.*

CSI 252. Scientific Modeling and Data Analysis (Cross-listed as Physics 252)
This course serves as a focused introduction to programming for scientists and engineers. Topics include algorithm development, statistical tests, the fast Fourier transform (FFT), simulating the dynamics of systems represented by coupled ordinary differential equations (e.g. planetary motion via Runge-Kutta methods), numerical integration, root finding, fitting functions to experimental data, and the creation of publication-quality graphics. Students choose and complete an independent research project on a topic related to their major. This course enables students to integrate computation into advanced courses in theoretical and/or experimental science. Programming language: Python. *Prerequistites: MAT 112 and PHY 112 must be taken either prior to or at the same time as this course.*

CSI 310. Database Systems
An introduction to the design and use of databases together with insights into the key issues related to the use of database systems. The course covers the entity-relationship model; the hierarchical, network, and relational data models, and their languages; functional dependencies and normal forms; the use of SQL language, and the design and implementation of relational databases using MS ACCESS and MySQL. *Prerequisite:* CSI 111 *or permission of the instructor.*

CSI 380. Design and Analysis of Algorithms
The topic of this course is the design of computer algorithms and techniques for analyzing their efficiency and complexity. Types of algorithms include greedy algorithms, divide and conquer algorithms, dynamic programming, searching and sorting. *Prerequisite:* CSI 112 *and* CSI 240 *or permission of the instructor.*

CSI 420. Artificial Intelligence
Explores the principles and techniques involved in programming computers to do tasks that usually are thought of as requiring intelligence when done by people. State-space and heuristic search techniques, logic and other knowledge representations, and statistical and neural network approaches are applied to problems such as game playing, planning, the understanding of natural language, and computer vision. *Prerequisite:* CSI 112 *and* CSI 240 *or permission of the instructor.*

CSI 450 Data Ethics and Practicum - This course, intended to be taken near the end of the Data Science major, focuses on gaining hands-on experience on real problems. Students will select and work a series of data analysis projects in groups. Class time will focus on technical troubleshooting, ethical reflection, and presentations of work. The class seeks to expand students' imagination around their own role as ethical agents in the process of doing data science. Prerequisite: MAT 209 and MAT/CSI 220, or permission of instructor.

320. Econometrics
This course introduces the statistical tools that economists use to test and quantify their theories. Regression analysis is used to evaluate relationships between economic variables. The results are interpreted with the help of concepts like causality and significance. *Prerequisite: Economics 111 or 112, and Math 109 or Economics 215.*

ENV 211. Intermediate Geographic Information Systems
This second course in geographic information systems builds upon the theories discussed in Introduction to Geographic Information Systems and focuses on the more technical aspects of GIS. Laboratory activities teach the student to use more advanced functions of GIS software, and the fundamentals of advanced GIS analysis and display programs. The student will also learn to operate a precision GPS field data collector. *Prerequisite: ENV/ANT 109.*

BUS 357. Introduction to Quantitative Finance
This course provides an introduction to the application of mathematical models to the solution of financial problems, covering important topics in quantitative finance such as modeling risk-return relationships, risk management, optimal consumption decisions, portfolio analysis, correlation structure between securities and/or markets and the pricing of financial securities. This is a data-applied course, in which the student will work on real-world data. For the computational aspects of the course, the student will work with Microsoft Excel. After taking this course, students should be able to (1) model different types of financial data, (2) analyze financial models, (3) confidently use Microsoft Excel for calculations, optimization, and modeling, and (4) be aware of the limitations of the data and models in the financial world. *Prerequisite: BUS 209.*

PHL 310. Philosophy of Science

This course will begin with an exploration of the nature of scientific revolutions, along with an examination of some case studies of such revolutions from the history of science. We will go on to examine some current theories concerning the evolution of microbial life, as well as issues associated with the Darwinian understanding of biological evolution. Our primary concern will be the philosophical presuppositions and implications of such theories. On the methodological side, we will treat such issues as induction, falsification, the hypothetical-deductive method, scientific facts, experimentation, etc. *Prerequisite: Philosophy 100 or permission of the instructor.*

WASHINGTON COLLEGE

June 15, 2022

James D. Fielder, Jr., Ph.D.
Secretary of Higher Education
Maryland Higher Education Commission
Nancy S. Grasmick Building 10th Floor
6 North Liberty Street
Baltimore, MD 21201

Dear Dr. Fielder,

We are preparing a proposal for the approval of a Bachelor of Science degree in Data Science offered by the Department of Mathematics and Computer Science. I am writing to provide an assurance that the library resources, physical facilities, staffing, physical and digital infrastructure, and instruction equipment are adequate to support the proposed addition and have continued support from the institution. The change will be implemented within existing institutional resources and aligns with staffing commitments and ongoing support from the institution now and as it grows.

Thank you for your consideration of our proposal. We appreciate your service of higher education in the state of Maryland.
Sincerely,

Dr. Michael J. Sosulski
President of Washington College; Professor of German