

GOUCHER
—college—

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February 6, 2019

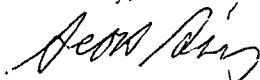
James A. Fielder, Ph.D.
Secretary of higher Education
Maryland Higher Education Commission
6 North Liberty Street
Baltimore, MD 21201

Dear Secretary Fielder:

Goucher College is requesting Commission authorization to offer a new Bachelor of Arts Degree in Integrative Data Analytics. This innovative new program uses existing faculty resources at Goucher, replacing Mathematics major.

An electronic copy of the proposal has been submitted to the MHEC academic proposals address. Please contact me at ssibley@goucher.edu or at 410-337-6288 if you need additional information.

Sincerely,



Scott Sibley, Ph.D.

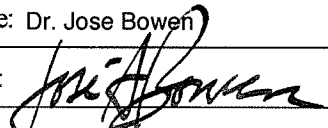
Interim Provost

Institution Submitting Proposal	Goucher College
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Each action below requires a separate proposal and cover sheet.

- | | |
|---|---|
| <input checked="" type="radio"/> New Academic Program | <input type="radio"/> Substantial Change to a Degree Program |
| <input type="radio"/> New Area of Concentration | <input type="radio"/> Substantial Change to an Area of Concentration |
| <input type="radio"/> New Degree Level Approval | <input type="radio"/> Substantial Change to a Certificate Program |
| <input type="radio"/> New Stand-Alone Certificate | <input type="radio"/> Cooperative Degree Program |
| <input type="radio"/> Off Campus Program | <input type="radio"/> Offer Program at Regional Higher Education Center |

Payment Submitted: <input checked="" type="radio"/> Yes <input type="radio"/> No	Payment Type: <input type="radio"/> R*STARS <input type="radio"/> Check	Payment Amount: 850	Date Submitted: 2/8/19
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Department Proposing Program	Mathematics		
Degree Level and Degree Type	B.A.		
Title of Proposed Program	Integrative Data Analytics		
Total Number of Credits	36		
Suggested Codes	HEGIS:	CIP: 30.0801	
Program Modality	<input checked="" type="radio"/> On-campus <input type="radio"/> Distance Education (<i>fully online</i>) <input type="radio"/> Both		
Program Resources	<input checked="" type="radio"/> Using Existing Resources <input type="radio"/> Requiring New Resources		
Projected Implementation Date	<input checked="" type="radio"/> Fall <input type="radio"/> Spring <input type="radio"/> Summer Year:		
Provide Link to Most Recent Academic Catalog	URL: https://catalog.goucher.edu/		
Preferred Contact for this Proposal	Name:	Scott Sibley	
	Title:	Interim Provost	
	Phone:	(410) 337-6288	
	Email:	ssibley@goucher.edu	
President/Chief Executive	Type Name:	Dr. Jose Bowen	
	Signature:		
	Date of Approval/Endorsement by Governing Board:	Date: 2/8/19	

Revised 12/2018

Academic Program Proposal
Goucher College
Integrative Data Analytics

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.**

The Integrative Data Analytics (IDA) major in the Center for Data, Mathematical, and Computational Sciences (CDMCS) at Goucher College provides an education grounded in data, mathematical, and computational sciences with a focus on data and its applications. The major has three parts: entry, exploration, and specialization. Every student will take 3 entry courses and 3 exploration courses, and then they will take 3 additional specialization courses and a capstone, either in the Center for Data, Mathematical, and Computational Sciences (CDMCS) or another academic center. Students choosing to specialize within CDMCS will focus on advanced data and mathematical sciences concepts. And, those specializing in other academic centers will focus on the application of data analytics within that discipline.

The values and goals of Goucher's IDA program are to produce graduates prepared and competitive in their field: well-grounded in a mathematical foundation and with computational competence, with the ability to analyze large datasets, with an interdisciplinary perspective that has a human and ethical focus, and with a perspective that a liberal arts college has the unique ability to provide. As such, the IDA program aligns seamlessly with the Mission of Goucher College, which states, "Goucher College is dedicated to a liberal arts education that prepares students within a broad, humane perspective for a life of inquiry, creativity, and critical and analytical thinking." Relatedly, Goucher is dedicated, according to its ideals, "to a liberal arts education that prepares students within a broad, humane perspective for a life of inquiry, creativity, and critical and analytical thinking." The IDA program is committed to experiential learning on and off campus as well as abroad, requiring students to apply and extend what has been learned in the classroom and will support students in scholarship, extension and connection to other disciplines, and supporting work involved in social change and the outside world.

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

Under Goucher College's new General Education requirements, students now take two semesters of data. The first requirement is a foundational course such as Introduction to Statistics, or Introduction to Data Analytics. The other is a discipline-specific course that engages students within a specific discipline or practice. Examples of this include data linguistics taught by a writing professor, data visualization taught in a design course, or geographic information systems taught in history. IDA is a natural extension of this requirement, giving those students who build upon these experiences a place to deepen their knowledge.

This program was first endorsed by two standing faculty governance committees: the Curriculum Committee and the Budget and Planning committee, and then the program was approved by the entire faculty via a majority vote on December 10th.

- 1. 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.**

Goucher's mathematics major and minor are in the process of being discontinued. Goucher College submitted a request to suspend the mathematics program on August 24, 2018, and that request was approved by MHEC on October 31, 2018. Students who matriculated in fall 2018 are the last group who will be able to declare a major or a minor in mathematics. Mathematics program financial resources, both staffing and other financial support, will be transferred to the proposed program. The existing faculty will receive College financial support for retraining in the proposed program. One existing program faculty member will be replaced with a faculty member with a specialty in the proposed program.

By transferring existing resources to the proposed program, Goucher will be able to adequately fund the proposed program for at least the first five years of its implementation.

- 1. Provide a description of the institution's a commitment to ongoing administrative, financial, and technical support of the proposed program *and* continuation of the program for a period of time sufficient to allow enrolled students to complete the program.**

The proposed program will replace the existing mathematics program. General education courses offered under the mathematics program will continue under the proposed program, as will mathematics courses required by majors or minors in other programs. Courses required by students majoring in the proposed program will replace those required by students majoring or minoring in mathematics. The number of courses offered under the proposed program, and therefore the staffing needed for the proposed program, will be the same as for the mathematics program. The administrative, financial, and technical supports already in place for the mathematics program will be transferred to the proposed program. By transferring existing resources to the proposed program, Goucher is committed to providing the necessary administrative, financial, and technical support necessary to ensure the success of the proposed program.

Goucher is strongly committed to continuing the proposed program for a period of time sufficient to allow enrolled students to complete the program. Due to the demonstrated need and demand for such a program (explained in the next section), Goucher College believes the IDA major will attract numerous students via the market demand and the interdisciplinarity of the program, and thus, be more successful than the former mathematics major. In addition, the college has invested in retraining current faculty to plan for the long-term continuation and success of the proposed program. Goucher's commitment is further demonstrated by fulfilling its commitment to students majoring or minoring in programs that are being discontinued, such as the mathematics program. All of the students in discontinued programs will be able to complete their intended major or minor in these programs while remaining at, and graduating from, Goucher.

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.**

It is often noted that the amount of data we produce grows exponentially, with roughly 90 percent of it created in the previous year. A recent article in Forbes estimates that we are created roughly **2.5 quintillion** bytes of data in 2018. Concurrently, we have also developed technologies and algorithms that allow us to make sense of vast troves of data, with breathtaking results like Google's AlphaZero which plays games at superhuman capacity and the introduction of self-driving cars along with more mundane results like speech recognition and product recommendations. One interesting aspect of the story of AlphaZero is that the people who study the game of Go professionally have learned new ways of thinking about the game from studying the moves the computer made. In fact, it does not seem far-fetched to think that data analytics has the potential not just to offer new facts about the world, but also new ways of thinking and understanding in various disciplines. Indeed, the new sciences of data would seem to promise revolutionary insights across all disciplines, from the humanities and fine arts to the social and natural sciences.

While these tools are incredibly powerful, they must be understood to be wielded effectively and ethically. We propose to train students not just in the techniques of data science but also provide them with the conceptual apparatus they will need to know which techniques are most fruitful in which situation, and how to extend techniques when standard approaches do not suffice.

The societal need for properly trained data scientists seems hard to overstate. There is a treasure trove of information available, but a deep shortage of skilled scientists who can make meaningful sense of that information. The need in Maryland is particularly acute given our state's deep connections with the Federal government, information technology and the health sciences. Indeed all these sectors and others need skilled and agile thinker to analyze economic trends, social media indicators, psychological data, medical records and images, public health data, data available to autonomous robots, financial transactions, product recommendation capacities and much more.

Goucher has a deep commitment to serving minority and educationally disadvantaged students, and a program in data science will provide a powerful vehicle to place such students in highly remunerated jobs. We have and are continuing to develop mechanism for addressing college readiness differentials in our student population.

While Goucher is not a Historically Black Institution, we do not anticipate this program competing with programs at such institutions.

1. Provide evidence that the perceived need is consistent with the [Maryland State Plan for Postsecondary Education](#).

On page 12 of the Maryland State Plan for Postsecondary Education, a number of employment sectors are listed as being particularly strong in Maryland. Each of these fields has been advanced by data analysis recently, and we only expect this trend to continue. Our program could prepare students to enter a meaningful job in any of the sectors listed.

The state plan also discusses trying to ameliorate student debt; because data analysis jobs are well-paid this program should help with that by giving students a path to a well-paying job in a number of disciplines, including disciplines which are not normally associated with high salaries.

Many of the goals of the plan are concerned with students who might struggle in higher education. Goucher is committed to the success of all of our students, and we have and are developing specific support systems. For example, we have recently created a Quantitative Reasoning Center, which helps students develop the quantitative skills needed to be successful in their coursework.

We are also in the process of professionalizing our student advising, which will address Strategy 6; we are working to bring our Career Development Services more deeply into our curriculum (Strategy 7) and would point to this program as an example of engaging in experimentation (Strategy 11).

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

In an article in June 2018, the Bureau of Labor Statistics reported that employment in mathematical science occupations, which includes data analytics, is projected to grow 27.9 percent in the ten years from 2016 to 2026^[1]. They project this means about 50,400 new jobs, with much faster growth than the average across all jobs. Jobs in the mathematical sciences are broken down into four subcategories by the Bureau, and 3 of the 4 are included in their list of the 30 fastest growing occupations. Their table showing this growth is included below. We note that the Bureau includes data scientists in the sub-category of “Statisticians”. Graduates of the Integrative Data Analytics major could go on to careers the categories of Statisticians, Operations research analysts, or even Mathematicians, in some cases with additional educational training (often Masters’ degrees are sufficient, as discussed below, but a doctorate could also be pursued).

At a local level, the same occupational subcategories, as well as related subcategories, are projected to grow in both the state of Maryland and in the Baltimore city and county regions^[2].

- **Describe potential industry or industries, employment opportunities, and expected level of entry (*ex: mid-level management*) for graduates of the proposed program.**

A search on Glassdoor (glassdoor.com) resulted in 1465 jobs using the keywords “data analyst” in Baltimore alone. Graduates with a major in Integrative Data Analytics would be qualified for an entry-level job as a Data Analyst. Selected companies with current openings for Data Analyst in the greater Baltimore-Columbia area include:

Company Name	Type of Company	Job Title
Jellyfish	Digital marketing solutions	Data Analyst
IMPAQ International	Social science research firm	Data Analyst - Medicare Claims
Northrop Grumman	Global security company	Information Systems Technical Analyst, Level 2 or 3
T. Rowe Price	Investment management firm	Business Insights Analyst
Mercy Health Services	Healthcare provider	Data Analyst
The Denzel Group	IT recruiting firm	Data Analyst
University of Maryland Medical Center	Healthcare provider	Transplant Data Analyst

These positions lie in a variety of fields, from social science to medical fields. This demonstrates the need for discipline-focused training in data analytics and the benefit that the broad training provided by a liberal arts education can be both to graduates and potential employers.

In Maryland alone, there are several prospective employers for graduates with a degree in data analytics. A sampling of potential employers includes:

- Government:

- a. National Security Agency
- b. National Institutes of Health
- c. National Institute of Standards and Technology (Gaithersburg)
- d. U.S. Census Bureau (Suitland)
 - Government contractors:
 - a. Booz Allen Hamilton
 - b. Lockheed Martin (Bethesda)
 - c. Varen Technologies
 - Private sector:
 - a. HelioCampus (Bethesda) - provides data analytics to postsecondary institutions
 - b. RedOwl (Baltimore) - develops data screening systems for corporate security
 - c. Asymmetrik (Annapolis Junction) - consulting group for business analytics
 - d. Data Tribe (Fulton) - aids start-up companies

● **Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program.**

As noted above, the Bureau of Labor Statistics (BLS) projects jobs in data-related jobs in the mathematical sciences category to grow at an exponential rate in the next ten or so years. Additionally, in the BLS list of the “industries with the fastest growing output 2016-2026”^[3], we see “data processing, hosting, and related services”, as well as “other information services” listed, with a projected growth of 43.4 and 71.7, respectively, from 2016 to 2026. On the BLS list of “industries with the fastest growing wage and salary employment”^[4], we see “management, scientific, and technical consulting services” has a projected increase of 319,000 jobs from 2016 to 2026 (with a projected 1,691,500 jobs in 2026).

Salaries for those in data analytics positions are also high, and expected to rise. The table below presents several figures for current positions in data analysis.

Source	Job Title	Minimum Salary	Median Salary	Maximum Salary
Robert Half 2019 Technology Salary Guide ^[5]	Data Scientist (in Baltimore, MD)	\$105,832	\$125,145	\$180,250

Glassdoor	Data Analyst (Baltimore, MD) ^[6]	\$53,000	Average (median not given): \$69,006	\$92,000
Payscale	Data Analyst (Baltimore, MD) ^[7]	\$39,000	\$53,000	\$71,000
Robert Half 2019 Technology Salary Guide	Data Analyst/Report Writer (in Baltimore, MD)	\$84,202	\$100,425	\$142,140
Bureau of Labor Statistics ^[8]	Computer and Information Research Scientist (Baltimore-Columbia-Towson)		\$113,750	

The table below, from the BLS, shows that a high proportion of jobs in data fields are held by people with only a Bachelor's Degree, which demonstrates that graduates of the IDA program will be qualified for many of the available jobs.

Educational Attainment for workers 25 and older by detailed occupation, 2016-7 (BLS)^[9]

2016 National Employment Matrix title	Bachelor's Degree	Master's Degree	Doctoral or Professional Degree
Mathematician	30.1	42.4	21.4
Operations Research Analyst	43.0	28.1	5.5
Statistician	30.1	42.4	21.4
Mathematical Science Occupations (other)	30.1	42.4	21.4
Database administrators	44.0	25.0	2.7

Information security analysts	41.2	23.6	2.7
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A higher starting salary or more variety in employment opportunities may be obtained with a certification or advanced degree. There are plenty opportunities for further education post-graduation in Maryland, including:

Certifications (online):

- Johns Hopkins' Certificate in Government Analytics (<http://advanced.jhu.edu/academics/certificate-programs/government-analytics/>)
- University of Maryland- University College's Foundations in Business Analytics Graduate Certificate (<https://www.umuc.edu/academic-programs/graduate-certificates/foundations-in-business-analytics.cfm>) (college-level courses in programming and statistics necessary for admission to the program, both of which would be satisfied by a IDA major)

Masters or Phd Programs:

- Johns Hopkins University
 - DrPh in Public Health Informatics
 - Master of Science in Data Science
 - Master of Science in Information Systems
 - Online Master of Science in Applied Economics
 - Online Master of Science in Government Analytics
 - Online Post-Master's Certificate in Quantitative Methods
 - PhD in Health Sciences Informatics
 - PhD in Machine Learning
- Loyola University Maryland
 - Master of Science in Data Science
- Notre Dame of Maryland University
 - Master of Science in Analytics in Knowledge Management
- University of Maryland-Baltimore County
 - Master of Science in Information Systems
- University of Maryland-College Park
 - Master of Information Management
 - Master of Professional Studies in Geospatial Information Sciences
 - Master of Professional Studies in Geospatial Intelligence
 - Master of Science in Business, Marketing Analytics
 - Online MBA - Specialization in Information Systems & Business Analytics
 - Ph.D. in Information Studies - Concentration in Big Data/Data Science
- University of Maryland - University College
 - Master of Science in Data Analytics

Provide data showing the current and projected supply of prospective students

	2019	2020	2021	2022	2023
Number of anticipated students	0	15	27	42	52

Provide data showing the current and projected graduation of students

	2023	2024	2025	2026	2027
Number of anticipated graduates	5	10	12	15	15

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.**

Data Science and Analytics are nascent, growing fields, as alluded to in earlier sections of this proposal. In Maryland, there is only one other undergraduate program -- Loyola University of Maryland offers an undergraduate degree in Data Science. Demographically, we are quite different schools. On their website, Loyola reports that for undergraduate enrollment in the 2017-2018 academic year, 22% of the enrolled students were students of color, and 1% were international students, with 18% of their students were reported to be from Maryland. In contrast, Goucher’s undergraduate enrollment for the 2017-2018 academic year had 32% students of color, with 3.7% international students, with 35.8% from the state of Maryland. We serve a more diverse student body.

Further, Loyola’s undergraduate data science program offers only two courses (in economics), as electives, outside of the mathematics, computer science and information science classes required for the major (fields traditionally associated with data science). As we have discussed, the IDA major encourages interdisciplinary work outside of traditional data science fields, offering three-course tracks in economics, peace studies, and environmental science, to name a few. Loyola’s program is more focused on information systems, data management, and business, while the proposed IDA major is designed to focus more on learning to apply the tools and ideas of data science, grounded primarily in mathematics, statistics, and computer science, to other disciplines. A number of schools offer a Master’s degree in Data Science, including Loyola, Johns Hopkins University and University of Maryland - Baltimore County.

As mentioned previously, our Integrative Data Analytics program is also distinguished in that it is inherently interdisciplinary. The closest comparable program can be found at Denison University in Ohio (<https://denison.edu/academics/data-analytics/degree-requirements>). At this time, there are only a handful of undergraduate data science and analytics programs in the country.

1. Provide justification for the proposed program.

Actuaries, business analysts and statisticians are well positioned in our region. Washington, DC also has tremendous need for federal employees with technical expertise that extends beyond a traditional mathematics or computer science degree.

At Goucher, we have recently discontinued our mathematics major. This new proposed IDA program uses some of the existing mathematics faculty and other resources. This program integrates both the mission of the College, as well as recommendations from the Mathematical Association of America, the Society of Actuaries and the National Science foundation.

We also see this as a way to collaborate with other disciplines at Goucher. With this major, we will work closely with environmental studies, business, peace studies, and economics. With this program, we can better serve our students' diverse interests.

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.**

Goucher's program is not in direct competition with any high demand program at an area HBI. There is currently no comparable data science or data analytics degree offered at a Maryland HBCU.

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.**

We do not see any impact on the identity or mission of an HBI in the region. The two nearest HBI's, Coppin State and Morgan State do not offer Data analytics or Data science undergraduate programs at this time.

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 IDA program was established through a collaborative effort involving the entire mathematics and computer science faculty. Years ago, the mathematics and computer science faculty advocated for replacing the traditional mathematics graduation requirement with a data analytics graduation requirement. Goucher College is now in its second year of this new requirement. All students take foundational data analytics courses before applying those data analytics techniques in their major. This

proposed IDA program is that next step in building out the College's commitment to Data Analytics as part of a liberal arts education. The IDA program will bolster the graduation requirement while supplying a new focused, interdisciplinary program in one of today's most important and growing fields.

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

The IDA major allows students to specialize in an existing discipline outside of the CDMCS. In this case, the major's learning goal is as follows:

- Students will apply data analysis, mathematical modeling, and computational techniques to solve complex problems in a discipline.

In the case that a student chooses to specialize within the CDMCS, then the learning goal is as follows:

- Students will understand why existing data analysis, mathematical modeling, and computational techniques are able to solve complex problems, so they can extend or create new data analysis, mathematical modeling, or computational techniques in any field.

Learning Outcomes. A student will be able to ethically:

- Construct cogent arguments using data and a logical progression of steps from premise to conclusion;
- Analyze and interpret information derived from a set of data and realize the limitations of that analysis;
- Demonstrate a proficiency in technologies that support problem solving and understanding of data, mathematical, and computational sciences' concepts;
- Synthesize and integrate conceptual information and apply it to new situations

1. Explain how the institution will provide for assessment of student achievement of learning outcomes in the program and document student achievement of learning outcomes in the program.

The program will be included in the Goucher College annual assessment process, the Goucher College program review process, and the annual course evaluation process. Goucher College has a comprehensive and sustained process for assessing student learning outcomes in all courses and programs that is overseen by the Institutional Assessment Team, and framed by the College Assessment Plan. All assessment at Goucher College is completed on a regular annual cycle of course and program assessment consistent with core and program outcomes for students.

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

Major: The proposed major requires ten 4-credit courses. The program requirements below include the course title, a general education requirement designation, if applicable, and the course prefix and number for an existing course or the course level for a new course, and the number of credits. Specifically, (DA-F) denotes the Data Analytics-Foundational level general education requirement and (DA-AC) denotes the Data Analytics-Across the Curriculum level general education requirement. Course descriptions follow these program requirements.

Entry Courses: A student must complete

- Calculus Through Data and Modeling (DA-F) (MA 172, 4 credits)
- Introduction to Computer Science (CS 116, 4 credits)

and one of the following:

- Statistical Methods for the Sciences (DA-F) (MA 268, 4 credits)
- Statistical Linear Models (DA-F) (100 level, 4 credits)

Exploration Courses: A student must complete

- Applied Linear Algebra for Data Science (DA-AC) (300 level, 4 credits)
- Prerequisite: Calculus Through Data and Modeling, Introduction to Computer Science, Statistical Methods for the Sciences, or Statistical Linear Models.

and two of the following:

- Nonparametric Statistics (DA-AC) (200 level, 4 credits)
- Prerequisite: Any DA-F course
- Introduction to Machine Learning (DA-F) (300 level, 4 credits)
- Prerequisite: Introduction to Computer Science
- Mathematical Modeling (DA-AC) (300 level, 4 credits)
- Prerequisite: Calculus Through Data and Modeling

Specialization Courses: A student must complete a sequence of three courses, including at least one course at the 300- or 400-level, that collectively lead to a data-driven capstone within a discipline. Specific specialization courses are listed in the Course Descriptions and Instructors section found below.

Capstone: A student must complete a 400-level data-driven capstone experience in any program.

Thus, the Integrative Data Analytics major requires 40 credits, and in addition, the Integrative Data Analytics major offers 7 courses that fulfill one of Goucher's two General Education Requirements (DA-F and DA-AC, as defined above). Furthermore, the major requires at least 12 credits at the junior (300-level) or senior (400-level) levels, satisfying 13B.02.02.16I(2).

In addition to DA-F and DA-AC courses, Goucher students must take the following as a part of their General Education requirements.

Credits of General Education (Goucher Commons Curriculum) required: 53-61 credits Total

(1 x 4cr First Year Seminar course = 4)

(3 x 4 cr Center Pair Exploration courses = 12; see below for how these satisfy three requirements under 13B.02.02.16E(2)(a))

(1x 4 cr Race, Power, Perspective course = 4)

(1 x 4 cr Environmental Studies course = 4)

(2 x 4 cr Data Analytics courses (for the Mathematics requirement of 13B.02.02.16E(2)(a)) = 8)

(2 x 4 +2 cr Foreign Language course(s) = 10, 8 or 4 credits depending upon placement)

(3 x 4 Writing requirement courses (for the English Composition requirement of 13B.02.02.16E(2)(a)) = 12 credits)

(Study Abroad requirement = variable credits, minimum 3 credits)

(Capstone course = variable credits, typically 2-4)

This General Education program, which is specified as part of Goucher's graduation requirements, is designed to satisfy MHEC's section 13B.02.02.16E(1) in the Graduation Requirements section.

Goucher's Center Pair Exploration courses span four areas:

- CPEA, taught by the Center for Art and Media and the Center for Dance, Music and Theatre
- CPEB, taught by the Center for Education, Business, and Professional Studies and the Center for People, Politics, and Markets
- CPEC, taught by the Center for Geographies of Justice and Cultures and the Center for Humanities
- CPED, taught by the Center for Natural Science and the Center for Psychology.

Students in the Integrative Data Analytics majors will take one four credit CPEA or CPEC course to satisfy 13B.02.02.16E(2)(a)'s Arts and Humanities requirement, one four credit CPEB course to satisfy 13B.02.02.16E(2)(a)'s Social and Behavioral Science requirement, and one four credit CPED course to satisfy 13B.02.02.16E(2)(a)'s Biological and Physical Sciences requirement.

To satisfy Goucher's graduation requirements, a student must earn at least 120 credits. The Integrative Data Analytics major is 40 credits, General Education is at least 53 credits, which leaves at least 27 elective credits.

Course Descriptions and Instructors:

Calculus Through Data and Modeling, 4 credits: This course provides an introduction to topics in single and multivariable calculus, and focuses on using calculus to address questions in the natural and social sciences. Students will learn to use the tools of calculus to process, analyze, and interpret data, and to communicate meaningful results, using scientific computing and mathematical modeling. Topics include functions as models of data, differential and integral calculus of functions of one and several variables, differential equations, and estimation techniques. Instructors: Brody, Cutrone, Grotheer, Le, Webster

Introduction to Computer Science, 4 credits: Introduction to the discipline of computer science and algorithmic thinking through the study of a programming language. Students will master writing small computer programs to solve computational problems. Object oriented programming is introduced. Instructors: Brody, Zimmerman

Statistical Methods for the Sciences, 4 credits: An introduction to statistics with special attention given to methods used in 200, 300, and 400 level science courses. Topics include descriptive statistics, probability models, random variables, expectation, sampling, the central limit theorem, confidence intervals, hypothesis testing, two-sample problems, analysis of variance, regression analysis, and an introduction to nonparametric methods. Instructors: Le, Webster

Statistical Linear Models, 4 credits: An introduction to basic statistical principles, including basic probability, hypothesis testing and the normal distribution, this will culminate in the introduction of linear

regression and correlation, two of the most widely used techniques in statistics and mathematical modeling. Emphasis will be placed on appropriate application and analysis using these techniques. Deeper theoretical roots and implications will be saved for more advanced courses. Instructors: Chasmar, Cutrone, Grotheer, Le, Webster

Applied Linear Algebra for Data Science, 4 credits: Linear Algebra supports a large number of data science concepts. It provides both conceptual understanding and efficient implementation of algorithms for data science models. Topics to include the theory and application of vector spaces, jacobians, matrix manipulations, determinants, transformations, orthogonality, eigenvectors, eigenvalues. Instructors: Brody, Le

Non-Parametric Statistics, 4 credits: Nonparametric statistics include statistical techniques that are applicable when the distribution is unknown or not a normal distribution. This includes binomial tests, ranked tests, and tests for randomness. This will be approached through both theoretical and applied perspectives. Computational techniques such as bootstrapping and other resampling techniques are also included. Instructors: Le

Introduction to Machine Learning, 4 credits:The basic theory and practice of machine learning techniques. Topics will vary, but will broadly cover the concepts of regression, classification, learning theory, supervised and unsupervised techniques, deep learning and reinforcement learning. The course will include programming projects using a standard open source library (e.g. Torch or TensorFlow). Instructors: Brody

Machine Learning II, 4 credits: A deeper look at the theory and practice of machine learning. This course will develop the theoretical foundations of classical machine learning as well as deep learning. Topics from deep learning will include Convolutional Networks, Deep Neural Networks, Recurrent Networks, Autoencoders and Optimization Techniques. Topics from classical machine learning will include support vector machines, hidden markov models and a theoretical treatment of ML1 algorithms. Instructors: Brody, Webster (Specialization Course)

Mathematical Modeling, 4 credits:Mathematical modeling is the process of transforming a problem into a mathematical framework in order to analyze and solve it. Modeling is essential to understand patterns, make predictions, and determine outcomes in applications as varied as disease outbreak, the interaction of species in ecosystems, the spread of an oil spill, the pricing scheme of a product, or the transportation of a drug through the bloodstream. This project-based class will use datasets and computer software such as Excel and MATLAB to model and solve problems using differential equations, graphs, dimensional analysis, parameter estimation, and sensitivity analysis. Instructors: Grotheer

Signal Processing, 4 credits: Signal processing is the transformation of a signal, or set of data, into useful information. Signal processing is used in such applications as medical imaging, speech recognition, wireless communication, video processing, and seismology. In this course, students will use MATLAB to study sampling, discrete-time signals, filters, and transforms through application-based projects and in-

class labs. Students will look at applications in signal, image, and speech processing. Instructors: Grotheer, Webster (Specialization Course)

Databases, 4 credits:The study of the underpinnings of modern database design at the application level, with an implementation of a web-based transaction processing system. Deeper issues which are essential to effective database design include relational algebra, tuple calculus, data organization and indexing strategies, and query processing and optimization. Instructors: Kelliher, Zimmerman (Specialization Course)

Operations Research, 4 credits: Operations Research is the application of mathematical methods to decision-making, using modeling and optimization to solve problems with applications ranging from airport scheduling to identifying social networking communities. This course will cover modeling and solving linear programming problems (optimization problems with linear constraints), sensitivity analysis, network flow problems, and, time permitting, an introduction to integer programming. This course will be project-driven with applications drawn from the transportation, manufacturing, medicine, and online communities, to name a few. Instructors: Grotheer (Specialization Course)

Bayesian Statistics, 4 credits:Bayesian Statistics is both a set of statistical tools as well as a particular interpretation of statistical information. In Bayesian statistics, parameters or hypotheses are updated as evidence is introduced. This course will introduce Bayesian comparisons of means and proportions, Bayesian regression and inference using multiple models, and discussion of Bayesian prediction. Students will be using computer simulation methods found in R. Instructors: Le (Specialization Course)

Cryptography, 4 credits:This course will provide an introduction to cryptography aimed at Integrative Data Analytics majors in their third year focusing on classical and applied cryptography methods such as data privacy, authenticity and integrity. Topics include properties of integers; polynomials and finite fields; basics of algorithms; block chain technology; symmetric and public key cryptosystems; and cryptanalysis. Students enrolled in this course are not expected to have significant computer programming experience but will be expected to write simple code and do basic computations. Additionally, no previous knowledge of cryptography is necessary as the course introduces theory and application of theory to practical problems. Instructors: Chasmar, Le (Specialization Course)

Advanced Machine Learning, 4 credits: This course will cover advanced topics in machine learning. Topics will include computer vision, reinforcement learning, probabilistic graphical models and natural language processing. Instructors: Brody (Specialization Course)

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

As outlined in the previous section, all students in our program will be required to complete Goucher's general education requirements in order to satisfy Goucher's graduation requirements for a Bachelor of Arts degree. A comprehensive non-major advising program ensures that students enroll in appropriate general education requirement courses and that they are on pace to complete such requirements.

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

Not applicable

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

Not applicable

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 support services and financial aid resources, and costs and payment policies.

Students may register and pay for courses, access their registration and financial aid information, access their faculty and key staff, seek advice and answers to academic and administrative questions, and access technology support online or in person. All course materials and information can be obtained online through the Canvas learning management system. Catalogs and college policy and requirements are all accessible online through the Goucher College website.

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

Faculty in this proposed program will work the marketing and communication division of the college to ensure all advertising, recruiting, and admissions materials that have been specifically designed for this program will clearly and accurately represent the proposed program. Furthermore, faculty in the program are tasked with keeping program web pages up to date.

H. Adequacy of Articulation

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

Not applicable.

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 faculty member will teach (in this program).**

The eight faculty in the Center for Data, Mathematical, and Computational Sciences (CDMCS) are highly accomplished teachers, scholars, and servant-leaders. They utilize best practices in pedagogy such as project-based learning (PBL), inquiry-based learning (IBL), master-based testing, and guided inquiry. The center heavily utilizes peer-led team learning and group-based content, projects, and assignments; most recently, the faculty have partnered with Goucher's Community Based Learning office to collaborate with a local non-for-profit in the city of Baltimore each semester in multiple classes to provide a hands-on data analytics experience as a semester-long group project. The faculty also regularly innovate their materials and teaching methods, often supported by Goucher awards, including a complete overhaul and

revitalization of the calculus sequence, which now incorporates data analytics. Our faculty consistently win internal teaching awards, such as the James M. Beall Professor of Mathematics and Computer Science and the Excellence in Teaching Award.

While teaching is the number one priority at Goucher and in CDMCS, the faculty still prioritize time to contribute to their fields, including pure and applied mathematics, computer science and programming, mathematics and computer science education, and data analytics. They have published over 30 peer-reviewed conference proceedings and journal articles, three book or book chapters, and more than 50 invited and peer-reviewed presentations. One faculty member won two awards from national learning assistance organizations this past year for her quantitative reasoning and tutor training research.

Finally, CDMCS faculty are heavily involved in service on and off campus, including on campus, locally, and nationally. The entire faculty serves on center-level and campus-wide committees, such as search committees and department administration. Two of our faculty serve as “Faculty in Residence,” living in a dorm and hosting campus-wide academic and social programming bridging the faculty role in a relatable way to students on campus. One of our faculty directs the Quantitative Reasoning Center, which provides STEM-based support to the campus student body. Currently, one of the faculty serves as Faculty Chair and as a Trustee, essential service positions to the entire campus community. Externally, one CDMCS faculty member is the current President of his Neighborhood Association, and several faculty serve as board and committee members on national organizations within their discipline.

Justin Brody, Ph.D in Mathematics, Associate Professor, Full-time, 50% participation in proposed program

Justine Chasmar, Ph.D in Engineering and Science Education, Full-time, 0% participation in proposed program

Joseph Cutrone, Ph.D in Mathematics, Visiting Assistant Professor, Full-Time, 0% participation in proposed program

Rachel Grotheer, Ph.D in Mathematical Sciences, Assistant Professor, Full-Time, 100% participation in proposed program.

Thomas Kelliher, Ph.D in Computer Science, Associate Professor, Full-Time, 0% participation in proposed program

Phong Le, Ph.D in Mathematics, Assistant Professor, Full-Time, 100% participation in proposed program.

Micah Webster, Ph.D in Mathematics, Associate Professor, Full-Time, 100% participation in proposed program

Jill Zimmerman, Ph.D in Computer Science, Professor, Full-Time, 0% participation in proposed program

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

Goucher College supports ongoing pedagogy faculty development and training in evidence-based best practices through its Center for the Advancement of Scholarship and Training. Specifically, workshops on pedagogy that meets students' needs and learning management training are offered on a regular basis.

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.**

Goucher College is prepared to support this new program through its existing library holdings, through the Baltimore Area Library Consortium, and through other library agreements. The library has a dedicated staff member to manage all programs, which would include the proposed new program. Services provided to students include research instruction and assistance, online tutorials, interlibrary loan, and a digital repository for theses and capstone projects. An initial search of the library online catalog returned about 762,000 articles related to data analytics, including 497,000 peer-reviewed publications, as well as 85,000 electronic and printed books.

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.**

No new physical space is needed for this program. The proposed program will be housed in existing facilities formerly used by the mathematics program.

- 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**

Not applicable.

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: RESOURCES

Resource Categories	2019- 2020	2020- 2021	2021- 2022	2022- 2023
1. Existing Funds	389,170	405,529	405,529	405,529
2. Tuition/Fee Revenue (c+g below)	678,750	1,221,750	1,900,500	2,353,000
a) # F/T Students	15	27	42	52
b) Annual Tuition/ Fee Rate	45,250	45,250	45,250	45,250
c) Total F/T Revenue (a x b)	678,750	1,221,750	1,900,500	2,353,000
d) # P/T Students	0	0	0	0

e) Credit Hr. Rate	1,478	1,478	1,478	1,478
f) Annual Credit Hr.	0	0	0	0
g) Total P/T Revenue (d x e x f)	0	0	0	0
3. Grants, contacts, & other external sources	0	0	0	0
4. Other Sources	0	0	0	0
TOTAL (add 1-4)	1,067,920	1,627,279	2,306,029	2,758,529

Table 1: Resources

a. **Reallocated Funds.** Funds will be reallocated from the existing mathematics program, which will be discontinued. These figures include salary, fringe benefits, and non-salary expenses for running the proposed program. Program will begin Fall 2019, so data for 2018-9 is not included. This category shows funds for the proposed program only. The proposed program would be situated within the Center for Data, Mathematical, and Computational Sciences (CDMCS), which also encompasses the computer science program and the Quantitative Reasoning Center.

b. Tuition and Fee Revenue. We do not anticipate part-time students participating in the proposed program. This category only shows revenue for students in the proposed program. The number of full-time students in the proposed program was modeled after recent growth in the number of students in the existing computer science program. Students will not enter the proposed program until 2019-2020. Therefore, there is no tuition/fee revenue in 2018-2019.

c. Grants and Contracts. We assume no external funding sources.

d. Other Sources. No other sources.

e. Total Year. Total of rows 1, 2, 3, and 4.

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. Also provide a narrative rationale for each expenditure category.

Table 2: Expenditures				
Expenditure Categories	2020	2021	2022	2023
1. Faculty (b + c below)	385,367	401,726	401,726	401,726
a) # FTE	4.5	4.5	4.5	4.5
b) Total Salary	319,524	332,824	332,824	332,824

c) Total Benefits	65,843	68,902	68,902	68,902
2. Admin. Staff (b + c below)	0	0	0	0
a) # FTE	0	0	0	0
b) Total Salary	0	0	0	0
c) Total Benefits	0	0	0	0
3. Support staff	0	0	0	0
4. Equipment	0	0	0	0
5. Library	0	0	0	0
6. New or Renovated Space	0	0	0	0

7.Other Expenses Software, marketing, faculty development, and course development	8,214	8,214	8,214	8,214
8.TOTAL (add 1-7)	393,581	409,940	409,940	409,940

Table 2: Expenditures

1. **Faculty (number of full-time employees with salary and benefits):** As with Table 1, this table only shows salary and benefits for faculty participating in the proposed program. It does not include salary and benefits for other center faculty.
2. **Administrative Staff.** The proposed program has no dedicated administrative staff.
3. **Support Staff.** The proposed program has no dedicated support staff.
4. **Equipment.** The proposed program does not have dedicated equipment.
5. **Library.** The proposed program does not have library costs.
6. **New and/or Renovated Space.** The proposed program will use the existing space currently occupied by the existing mathematics program, which is being discontinued.
7. **Other Expenses.** This category shows the proportion of the Center’s operating budget which will be used in support of the proposed program.

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. 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.**

Goucher College has a systematic and sustainable system to assess teaching and learning at all levels and within all units of the institution, in compliance with MSCHE standards for assessment as well as best practice in assessing student learning outcomes. Learning outcomes will be assessed in this program using evidence-based rubrics applied to examinations, individual and group projects, portfolios, and papers. Student learning outcomes will be assessed in relationship to the quality of the work, and will be supported directly through core and elective

curricula. Faculty and courses will be regularly evaluated by students and by the academic director. The program overall will be evaluated on an ongoing basis by the program's advisory committee and periodically by outside evaluators. Data collected through assessment and evaluations processes on an annual basis are used to identify opportunities for program improvements and areas where additional resources are needed.

N. Consistency with the State's Minority Student Achievement Goals (as outlined in COMAR 13B.02.03.05).

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

The proposed program and Goucher College have a strong commitment to promoting diversity in our recruitment, admission and retention efforts of students, as well as in faculty hiring. The college has successfully recruited minority students via the Video Application (which seeks to eliminate many of the barriers certain minorities face in applying) and specific outreach to local institutions. These efforts have been successful, with 28% of students identifying as non-white in 2014 versus 39% in 2019. Among students who identify as African-American, there were 145 applicants in 2014 (10%) and 227 in 2018 (17%). Hispanic and Latino students were 123 in 2014 (9%) and 150 in 2018 (11%). Among students in the class of 2022 who disclosed their race, 42% self-identified as students of color.

The college has made efforts in educating its faculty around racial issues through a variety of workshops and seminars. In the Fall of 2015 we held a "What is Race" seven week seminar series organized and led by Faculty in response to the Baltimore Uprising. Recently, STEM Faculty also hold regular gatherings focused on Diversity, Equity and Inclusion in our classrooms.

The school has also established a Center for Race, Equity and Identity (CREI). This center supports all marginalized students and has established and ongoing programming for students of color, first-generation, socioeconomically disadvantaged, international and disabled students.

Faculty will be recruited and hired for the program with an emphasis on diverse candidates, a practice that will continue during implementation and program delivery, to attract and retain qualified faculty from diverse racial, socioeconomic, and geographical backgrounds.

[1] <https://www.bls.gov/opub/btn/volume-7/big-data-adds-up.htm>

[2] Tables from <https://www.dllr.state.md.us/lmi/iandoproj/wias.shtml>

[3] <https://www.bls.gov/emp/tables/industries-fast-grow-decline-output.htm>

[4] <https://www.bls.gov/emp/tables/industries-fast-grow-decline-employment.htm>

[5] From the Salary Calculator, <https://www.roberthalf.com/salary-guide/technology>

[6] Glassdoor notes that this is 18% below the national average; it is certainly possible graduates will work outside the greater Baltimore area.

[7] Entered "no years of experience" with a Bachelor's Degree from Goucher

[8] <https://beta.bls.gov/dataViewer/view/timeseries/OEUM00125800000015111113>

[9] <https://www.bls.gov/emp/tables/educational-attainment.htm#1>