February 10, 2016

MEMORANDUM

TO: Jayanth Banavar
   Dean, College of Computer, Mathematical, and Natural Sciences

   Charles Caramello
   Associate Provost and Dean, Graduate School

FROM: Elizabeth Beise
       Associate Provost for Academic Planning and Programs

SUBJECT: Proposal to Establish a Post-Baccalaureate Certificate of Professional Studies in
         Data Science (PCC log no. 15028)

On January 31, 2016, Chancellor Caret gave final approval to your proposal to offer a
new iteration of the Post-Baccalaureate Certificate of Professional Studies with a focus in Data
Science. A copy of the approved proposal is attached.

This Post-Baccalaureate Certificate program is effective Spring 2016. Please ensure that
this program is fully described in the Graduate Catalog and in all relevant descriptive materials,
and that all advisors are informed.

MDC/
Enclosure

cc: Andrew Harris, Chair, Senate PCC Committee
    Barbara Gill, Office of Enrollment Management
    Reka Montfort, University Senate
    Erin Taylor, Division of Information Technology
    Pam Phillips, Institutional Research, Planning & Assessment
    Anne Turkos, University Archives
    Linda Yokoi, Office of the Registrar
    Alex Chen, Graduate School
    Wolfgang Losert, College of Computer, Mathematical, and Natural Sciences
    Samir Khuller, Department of Computer Science
January 31, 2016

Dr. Wallace Loh  
President  
University of Maryland, College Park  
1101 Main Administration Building  
College Park, MD 20742

Dear Wallace,

Thank you for forwarding the request of the University to add a new iteration of the Post-baccalaureate Certificate of Professional Studies with a focus in Data Science.

I am pleased to approve this request. I am confident that the addition of this new option will meet with great success.

Sincerely,

Robert L. Caret  
Chancellor

cc: Mary Ann Rankin, Senior Vice President and Provost  
Charles Caramello, Associate Provost and Dean, Graduate School  
Jayanth Banavar, Dean, College of Computer, Mathematical & Natural Sciences
Program: Graduate Certificate in Professional Studies in Data Science

Department/Unit: Computer Science

College/School: CMNS

Proposal Contact Person (with email): Amol Desphande amol@cs.umd.edu

Type of Action (check one):

☐ Curriculum change (includes modifying minors, concentrations/specializations and creating informal specializations)
☐ Curriculum change is for an LEP Program
☐ Rename a program or formal Area of Concentration
☐ Establish/Discontinue a formal Area of Concentration
☐ Other:

☐ Establish a new academic degree/certificate program
☐ Create an online version of an existing program
☐ Establish a new minor
☐ Suspend/Discontinue a degree/certificate program
☐ Establish a new Master or Certificate of Professional Studies program
☐ New Professional Studies program will be administered by Office of Extended Studies

*Italics indicate that the proposal must be presented to the full University Senate for consideration.*

Approval Signatures - Please print name, sign, and date. Include additional lines for multi-unit programs.

1. Department Committee Chair  A. Udata Shankar  /Signature/  Oct 13, 2015
2. Department Chair  S. Khuller  /Signature/  04/13/2015
4. Dean  Jayant R. B.  /Signature/  12/9/15
5. Dean of the Graduate School (if required)  Chandra  /Signature/  12/4/2015
6. Chair, Senate PCC  Andrea Harris  /Signature/  12/4/2015
7. University Senate Chair (if required)  Elizabeth F. Beine  /Signature/  2/10/2016

Instructions:
When approved by the dean of the college or school, please send the proposal and signed form to the Office of the Associate Provost for Academic Planning and Programs, 1119 Main Administration Building, Campus-5031, and email the proposal document as an MSWord attachment to pcc-submissions@umd.edu.

Summary of Proposed Action (use additional sheet if necessary):

The College of Computer, Mathematical, and Natural Sciences, Department of Computer Science submits this proposal to create a face-to-face Graduate Certificate in Professional Studies in Data Science. The 12 credit (4 course) program will provide a broad introduction to the field of Data Science, including how to extract and clean data, how to store and manage large volumes of data, and how to analyze such data and extract insights from it.
PROPOSAL FOR

NEW INSTRUCTIONAL PROGRAM

UNIVERSITY OF MARYLAND AT COLLEGE PARK, MARYLAND

Graduate Certificate in Professional Studies in
Data Science

PROPOSED INITIATION DATE: Fall 2016
I. OVERVIEW and RATIONALE

A. Briefly describe the nature of the proposed program and explain why the institution should offer it.

The proposed 12-credit, four course, Graduate Certificate in Professional Studies in Data Science, offered by the nationally ranked Department of Computer Science (CMSC), is intended to provide a broad introduction to the field of Data Science, including how to extract and clean data, how to store and manage large volumes of data, and how to analyze such data and extract insights from it. Data Science requires the ability to integrate data, operate on data at scale, analyze data, make predictions, find patterns and form and test hypothesis. It incorporates practices from a variety of fields in computer science, chiefly Machine Learning, Statistics, Databases, and Visualization.

Data Science is an emerging field encapsulating interdisciplinary activities used to create data-centric products, applications or programs that address specific scientific, socio-political, or business questions. Data Science is also commonly referred to as big data analytics, predictive analytics, advanced analytics, etc. It is making deep inroads in industry, government, health, and journalism, and many other disciplines. The Harvard Business Review has called “Data scientist” the “sexiest job of the 21st century”, and due to the growing need for data science, there is a significant shortage of trained data scientists.

The program will be offered during the fall and spring semesters and take one year to complete. CMSC expects a large number of professionals in the area to be interested in the program.

B. How big is the program expected to be? From what other programs serving current students, or from what new populations of potential students, onsite or offsite, are you expecting to draw?

<table>
<thead>
<tr>
<th>Year</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Enrollment</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
</tbody>
</table>

This program will target individuals working at government, technology and educational organizations in the Washington D.C., Maryland, and Virginia [DMV] region who are seeking to enhance their current education and learn new skills to advance in their organizations.

II. Curriculum

A. Provide a full catalog description of the proposed program, including educational objectives and any areas of concentration.

The Graduate Certificate in Professional Studies in Data Science provides a broad introduction to the field of Data Science, including how to extract and clean data, how to store and manage large volumes of data, and how to analyze such data and extract insights from it. Data Science encapsulates interdisciplinary activities used to create data-centric products, applications or programs that address specific scientific, socio-political, or business questions; this topic is also commonly referred to as big data analytics, predictive analytics, advanced analytics, etc. It incorporates practices from a variety of fields in computer science, chiefly Machine Learning, Statistics, Databases, and Visualization.

The 12-credit, 4 course curriculum may be completed in one academic year. Students enroll in two 3-credit courses per 16-week term (fall and spring).
B. List the courses (number, title, semester credit hours) that would constitute the requirements and other components of the proposed program. Provide a catalog description for any courses that will be newly developed or substantially modified for the program.

The following program courses, to be created and submitted for VPAC approval, will be 3-credit, and managed and taught by CMSC:

**CMSC 641: Principles of Data Science, 3 credits**
An introduction to the data science pipeline, i.e., the end-to-end process of going from unstructured, messy data to knowledge and actionable insights. Provides a broad overview of what data science means and systems and tools commonly used for data science, and illustrates the principles of data science through several case studies.

**CMSC642: Big Data Systems, 3 credits**
An overview of data management systems for performing data science on large volumes of data, including relational databases, and NoSQL systems. The topics covered include: different types of data management systems, their pros and cons, how and when to use those systems, and best practices for data modeling.

**CMSC643: Machine Learning and Data Mining, 3 credits**
Provides a broad overview of key machine learning and data mining algorithms, and how to apply those to very large datasets. Topics covered include linear models, classification techniques, Bayesian analysis, recommendation systems, and systems for large-scale machine learning.

**CMSC644: Algorithms for Data Science, 3 credits**
Provides an in-depth understanding of some of the key data structures and algorithms essential for advanced data science. Topics include random sampling, graph algorithms, network science, data streams, and optimization.

The program schedule is as follows (CMSC642 may be moved to the spring and either CMSC643 or CMSC644 will replace it in the fall).

<table>
<thead>
<tr>
<th>Term</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>CMSC641: Principles of Data Science</td>
</tr>
<tr>
<td></td>
<td>CMSC642: Big Data Systems</td>
</tr>
<tr>
<td>Spring</td>
<td>CMSC643: Machine Learning and Data Mining</td>
</tr>
<tr>
<td></td>
<td>CMSC644: Algorithms for Data Science</td>
</tr>
</tbody>
</table>

C. Describe any selective admissions policy of special criteria for students selecting this field of study.

Applicants must meet the following minimum admission criteria as established by the Graduate School:

- Applicants must have earned a four-year baccalaureate degree from a regionally accredited U.S. institution, or an equivalent degree from a non-U.S. institution.
- Applicants must have earned a 3.0 GPA (on a 4.0 scale) in all prior undergraduate and graduate coursework.
- Applicants must provide an official copy of a transcript for all of their post-secondary work.

International students must fulfill all requirements relating to international academic credentials, evidence of English proficiency, financial certification, and visa documentation. These requirements are found at the Graduate School's Web site: [http://www.gradschool.umd.edu/prospective_students/international_admissions.html](http://www.gradschool.umd.edu/prospective_students/international_admissions.html).
Additional requirements determined by the Department of Computer Science that exceed the minimum Graduate School requirements:

Prior coursework establishing quantitative ability (i.e. calculus, linear algebra, basic statistics, etc.). Proficiency in programming languages, demonstrated either through prior programming coursework or substantial software development experience.

III. STUDENT LEARNING OUTCOMES AND ASSESSMENT

The purpose of this assessment plan is to set clear guidelines, identify articulated outcomes, and ensure avenues for continuous improvement for each graduate certificate program managed by the Program Oversight Committee and housed in the Graduate School. It is our mission to provide programs that meet UMD’s institutional goals and objectives for educational activities.

Learning outcomes:

1. Students will learn the different components of the data science pipeline and how to go from unstructured, messy data to knowledge and insights; and they will be able to create specific requirements for a data-centric application used to address a specific problem or question.
2. Students will be learn the key steps in acquiring and integrating data, including how to do data cleaning, entity resolution, information extraction, and data integration.
3. Students will learn to choose an appropriate data model and an appropriate data management system for a given big data application.
4. Students will be able to decide which machine learning techniques are applicable to a problem they intend to solve, and will be able to implement those without using pre-built libraries.
5. Students will be able to decide which algorithms are applicable to their big data applications.
6. The students will be able to use a variety of statistical toolkits, software packages, and systems for processing and extracting insights from large volumes of data.

Assessment Methods:

1. Hands-on programming assignments
2. Homework
3. Exams

IV. FACULTY AND ORGANIZATION

A. Who will provide academic direction and oversight for the program?

Graduate School Representative
Charles Caramello, Dean of the Graduate School

Graduate Director
Amol Deshpande, Associate Professor, Department of Computer Science

Office of Extended Studies Administrative Support and Oversight
Terrie Hruzd, Director of Programs

B. If the program is not to be housed and administered within a single academic unit, provide details of its administrative structure.
The **Graduate Certificate in Professional Studies in Data Science** will be housed in the Graduate School, which will be responsible for its oversight. The Program Oversight Committee, or designates, will administer the program. A faculty member from the college will serve as the Graduate Director and will provide academic leadership. The Office of Extended Studies will provide coordination.

**Administrative Coordination**
The Office of Extended Studies (OES) will provide program development support (including budget development and projections), program management that includes scheduling, marketing research, planning and management, financial management (including faculty contracting and faculty pay processing), and student services management (including support for admissions, registration, payment, financial aid, and other campus services).

**V. OFF-CAMPUS PROGRAMS (if necessary)**
A. *If at Shady Grove—indicate how students will access student services.*

Not applicable

B. *If on-line—describe the concerns in “Principles and Guidelines for Online Programs” are to be addressed.*

Not applicable

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

Not applicable

B. *Will the program require or seek accreditation? Is it intended to provide certification or licensure for its graduates? Are there academic or administrative constraints as a consequence?*

Not applicable

C. *Are students in other programs permitted to enroll in courses in this program? Can students substitute courses from other institutions?*

Courses offered for the **Graduate Certificate in Professional Studies in Data Science** are limited solely to students who have applied and have been admitted to this program. Other UMD graduate students are not permitted to register for courses in this program. Certificate students are not allowed to substitute non-program courses from the University of Maryland or another institution to satisfy the program requirements. Additionally, students who do not complete the program may not apply the program courses toward another graduate degree. Only courses taken while admitted to the program will count toward the Certificate.

D. *What are the protocols for students unwilling or unable to follow courses in sequence, e.g. would they have to wait for the next cycle or next cohort?*

Students will have a maximum of five years to complete the Certificate. For a student who does not complete the courses in the proposed sequence, the student may enroll in any courses offered in a particular term if the prerequisites are met. The student may continue in the program by taking the necessary courses when offered. If the department recognizes a significant need to offer a particular course in a specific term, the department may opt to offer the course to meet students’ needs.
E. What is the exit strategy if the program proves not to be viable? How are canceled courses handled?

The Department fully expects to offer courses each semester as proposed; however, if a course is canceled, it will be either offered in a subsequent semester or students may take one term/semester longer to complete the program. If the program does not prove to be viable, the department will ensure that courses are offered in a manner that permits all existing students to complete the program.

VII. COMMITMENT TO DIVERSITY

The University of Maryland is an equal opportunity institution with respect to both education and employment. The University does not discriminate on the basis of race, color, national origin, sex, age, or handicap in admission or access to, or treatment or employment in, its programs and activities as required by federal (Title VI, Title IX, Section 504) and state laws and regulations.

Through its actions and statements of policy the University of Maryland has demonstrated a commitment to diversity by creating programs of study which explore the experiences, perspectives, and contributions of a wide variety of cultures, groups, and individuals; and as sought to create a campus environment which encourages tolerance and respect for individuals regardless of differences in age, race, ethnicity, sex, religion, disability, sexual orientation, class, political affiliation, and national origin.

The Graduate Certificate in Professional Studies in Data Science will use the model established by the University of Maryland’s commitment to diversity by marketing and recruiting applicants from various professional organizations with demonstrated respect for individuals regardless of differences in age, race, ethnicity, sex, religion, disability, sexual orientation, class, political affiliation, and national origin. Course content will also demonstrate opportunities for instruction on tolerance and inclusion.

VIII. REQUIRED PHYSICAL RESOURCES
A. Additional library and other information resources required to support the proposed program. You must include a formal evaluation by Library staff.

See attached evaluation from University of Maryland Libraries.

B. Additional facilities, facility modifications, and equipment that will be required. This is to include faculty and staff office space, laboratories, special classrooms, computers, etc.

None.

C. Impact, if any, on the use of existing facilities and equipment. Examples are laboratories, computer labs, specially equipped classrooms, and access to computer servers.

This program does not require additional resources.

IX. RESOURCES NEEDS AND SOURCES
A. List new courses to be taught and needed additional sections of existing courses. Describe the anticipated advising and administrative loads. Indicate the personnel resources (faculty, staff, and teaching assistants) that will be needed to cover all these responsibilities.

The following courses will need to be approved by VPAC:
- CMSC 641: Principles of Data Science, 3 credits
- CMSC642: Big Data Systems, 3 credits
- CMSC643: Machine Learning and Data Mining, 3 credits
- CMSC644: Algorithms for Data Science, 3 credits

The Department of Computer Science will hire for the following position to ensure that this self-support program has no impact on advising and administrative resources for the unit’s traditional programs: Administrative Coordinator. Tuition revenue will be used to support all salaries and benefits.

It is proposed that tuition be charged at a flat rate for the program’s first year (anticipated 10 students) of $4,000 per course with an estimated increase of 5% per year. All students will pay all associated mandatory fees and the graduate application fee.

B. List new faculty, staff, and teaching assistants needed for the responsibilities in A, and indicate the source of the resources for hiring them.

Faculty selection and appointments are made by the Department of Computer Science. All faculty must be full or Professional Track members of the Graduate Faculty with a terminal degree in Computer Science or related field and approved by the Dean of the Graduate School to teach. Instructors in this self-support program may not teach overload. University of Maryland faculty who in teach in the program will be compensated using overloads. The faculty may include Professional Track faculty, retired faculty, and professionals in the field.

The Department of Computer Science will hire for the following position to ensure that this self-support program has no impact on advising and administrative resources for the unit’s traditional programs: Administrative Coordinator. Tuition revenue will be used to support all salaries and benefits.

C. Some of these teaching, advising, and administrative duties may be covered by existing faculty and staff. Describe your expectations for this, and indicate how the current duties of these individuals will be covered, and the source of any needed resources.

Approval of all faculty overloads for teaching and advising will be in accordance with University of Maryland policy and procedures. The Oversight Committee is responsible for the overall administrative management of the program.

D. Identify the source to pay for the required physical resources identified in Section VIII. above.

Tuition revenue will be used to cover the program expenses (see separate budget page).

E. List any other required resources and the anticipated source for them.

See above.

F. Complete the additional proposal and financial tables as required by MHEC.

See attached pdf.

**New Courses requiring VPAC Approval**

**CMSC 641: Principles of Data Science, 3 credits**
An introduction to the data science pipeline, i.e., the end-to-end process of going from unstructured, messy data to knowledge and actionable insights. Provides a broad overview of what data science means and systems and tools commonly used for data science, and illustrates the principles of data science through several case studies.

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**CMSC644: Algorithms for Data Science, 3 credits**
Provides an in-depth understanding of some of the key data structures and algorithms essential for advanced data science. Topics include random sampling, graph algorithms, network science, data streams, and optimization.
Hilary L. Sazama  
Assistant Director, Office of Extended Studies  
University of Maryland  
College Park, MD 20742

14 September 2015

Dear Ms. Sazama:

The University of Maryland Libraries provide this assessment in response to the proposal to offer a Graduate Certificate in Professional Studies in Data Science within the Department of Computer Science, which is part of the CMNS college. You asked that we assess our collections to determine how well the Libraries will be able support the curriculum of this proposed graduate certificate. I have consulted with Nevenka Zdravkovska, Head of the Engineering and Physical Sciences Library. Ms. Zdravkovska has researched our collections in light of your proposal. We offer the following assessment, and conclude that the Libraries are able to support this program.

Serial Publications and Research Databases

In this technology-focused interdisciplinary field, curricular assignments and scholarly library research will rely primarily upon online serial publications. The University of Maryland Libraries currently subscribe to a large number of scholarly journals, almost all in online format, that publish current research in machine learning, statistics, big data, predictive and advanced analytics, as well as visualization. Most articles in journals that we do not own electronically are available through either the Libraries’ Article Express Program or via Interlibrary Loan. The Libraries’ “Database Finder” offers online access to databases that provide indexing and access to popular and scholarly journal articles, and other information sources. Many of these databases cover subject areas that would be relevant to this proposed graduate certificate. These databases can be accessed on campus or remotely by authenticating using UMD login credentials. Most of the relevant technology-focused research is available through the following databases to which the Libraries subscribe:

- IEEEExplore
- ACM Digital Library
- Web of Science, including the Data Citation Index subset

For industry and business aspect of data science the following databases are of interest:

- Business Source Complete
- Business and Industry

In addition, the general, multidisciplinary database Academic Search Premier provides information for nearly every area of academic study. Includes an enormous collection of the most valuable peer-reviewed full text journals, as well as additional journals, magazines, newspapers and books. In addition, Data-Planet Statistical Datasets provides easy access to statistics produced by the U.S. government, major international and intergovernmental organizations, professional and trade organizations, state government agencies, and universities.

As noted previously, in those instances in which either the Libraries do not subscribe to the journal or the journal articles are available only in print format, the Libraries can supply copies through the Libraries’ Article Express Program or via Interlibrary Loan.
Monographs

Even though most library research for this course likely will rely upon online journal articles, students may wish to supplement this research with monograph materials. In many cases, relevant monographs will be available electronically as our book collections are increasingly available in electronic rather than print format. For example, Safari Technical Books provides access to all online books published by O'Reilly. Monographs can be found by searching our WorldCat Discovery catalog.

Even in instances when the books are only available in print, the students will be able to take some advantage of the book collection by requesting specific chapters be sent to them through the Libraries' Article Express program. Faculty can also request, within fair use copyright guidelines, that sections of print books be made available digitally through course reserves.

Article Express and Interlibrary Loan

These services offer online delivery of bibliographic materials that otherwise would not be available online. As a result, remote users who take online courses may find these services to be quite helpful. Article Express and Interlibrary Loan are available free of charge. As a program developed specifically to support advanced research and teaching for graduate students and faculty, the Article Express service scans and delivers journal articles and book chapters within three business days of the student's request, provided that the items are available in print on the UM Libraries' shelves. In the event that an article or chapter is not available on campus, Article Express will automatically refer the request to Interlibrary Loan (ILL). Interlibrary Loan is a service that enables borrowers to obtain online articles and book chapters from materials not held in the University System of Maryland.

Student Services in the Libraries

The Libraries offer several programs that support student success. Subject specialists will provide students and other users with research support through individual consultation. Since this is an interdisciplinary program, librarians who work with collections and services for computer science, engineering, health, business, government and other areas will all be available for student assistance. The Libraries' Research Commons offer students mentoring in research methodologies, writing assistance, statistical consulting, and other services. Please note that the Libraries currently do not have a comprehensive licensed collection of data sets, nor software for their analysis installed on the computers in the Libraries.

Conclusion

The University of Maryland Libraries' serials holdings and research databases have an established record for providing bibliographic support for researchers and professionals in subject disciplines that are relevant to data science. These materials are supplemented by relevant monograph collections. In addition, the Libraries' Article Express and Interlibrary Loan services make materials that otherwise would not be available online, accessible to remote users in online courses. The Libraries also offer students a wide range of services to ensure their success. As a result, our assessment is that the University of Maryland Libraries are able to meet the curricular and research needs of the proposed Graduate Certificate in Professional Studies in Data Science.

Sincerely,

Daniel C. Mack
Associate Dean, Collection Strategies and Services
## Budget: Graduate Certificate in Data Science (DS)

The program is self-support. Instructors may not teach on-load.

### Estimated Program Revenue & Support

<table>
<thead>
<tr>
<th></th>
<th>Planning</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Total Tuition Revenue</td>
<td></td>
<td>$160,000</td>
<td>$336,000</td>
<td>$529,200</td>
<td>$740,880</td>
<td>$972,405</td>
</tr>
<tr>
<td></td>
<td>A. Total Annual Cohort</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>B. Total Courses: (3 credits each)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>C. Per course rate; Assumes 5% Increase</td>
<td>$4,000</td>
<td>$4,200</td>
<td>$4,410</td>
<td>$4,631</td>
<td>$4,862</td>
</tr>
<tr>
<td>II. Student Fee: On-Campus Mandatory Fee</td>
<td></td>
<td>$5,360</td>
<td>$11,042</td>
<td>$17,059</td>
<td>$23,428</td>
<td>$30,164</td>
</tr>
<tr>
<td></td>
<td>A. Rate per year (2 Terms); assumes 3% increase</td>
<td>268</td>
<td>276</td>
<td>284</td>
<td>293</td>
<td>302</td>
</tr>
<tr>
<td></td>
<td>B. Total number of students (per year)</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>III. Student Fee: Graduate School Application Fee</td>
<td></td>
<td>$750</td>
<td>$1,500</td>
<td>$2,250</td>
<td>$3,000</td>
<td>$3,750</td>
</tr>
<tr>
<td></td>
<td>A. Fee (one-time)</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>B. Total students in new incoming cohort</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>IV. Development Support (Courses)</td>
<td>$20,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A. Extended Studies Support</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>B. CMNS Support</td>
<td>20,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Estimated Program Revenue &amp; Support</td>
<td>$20,000</td>
<td>$166,110</td>
<td>$348,542</td>
<td>$548,509</td>
<td>$767,308</td>
<td>$1,006,319</td>
</tr>
</tbody>
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### Estimated Expenses

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Total Instructional Salary</td>
<td></td>
<td>$79,800</td>
<td>$108,794</td>
<td>$112,058</td>
<td>$143,639</td>
<td>$147,949</td>
</tr>
<tr>
<td></td>
<td>A. Number of instructors</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1. Faculty Salary: assumes a 3% annual increase</td>
<td>15,000</td>
<td>15,450</td>
<td>15,914</td>
<td>16,391</td>
<td>16,883</td>
</tr>
<tr>
<td></td>
<td>2. Total Instructor Salary</td>
<td>60,000</td>
<td>61,800</td>
<td>63,654</td>
<td>65,564</td>
<td>67,531</td>
</tr>
<tr>
<td></td>
<td>B. Number of TAs (&lt; 15 students in course = No TA, 15-30 = 50% TA, 30+ = full TA)</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1. TA Salary: assumes a 3% annual increase</td>
<td>0</td>
<td>10,000</td>
<td>10,300</td>
<td>10,609</td>
<td>10,927</td>
</tr>
<tr>
<td></td>
<td>2. Total TA Salary</td>
<td>0</td>
<td>20,000</td>
<td>20,600</td>
<td>42,436</td>
<td>43,709</td>
</tr>
<tr>
<td></td>
<td>C. Total all salaries</td>
<td>60,000</td>
<td>81,800</td>
<td>84,254</td>
<td>108,000</td>
<td>111,240</td>
</tr>
<tr>
<td></td>
<td>D. Total Benefits (FICA 33%)</td>
<td>19,800</td>
<td>26,994</td>
<td>27,804</td>
<td>35,640</td>
<td>36,709</td>
</tr>
<tr>
<td>II. Academic Administration</td>
<td>$46,550</td>
<td>$47,947</td>
<td>$98,770</td>
<td>$101,733</td>
<td>$104,785</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A. Administrative Coordinator (@ 50% yr 1/2, 100% yr 3): assumes a 3% annual increase</td>
<td>35,000</td>
<td>36,050</td>
<td>$74,263</td>
<td>$76,491</td>
<td>$78,786</td>
</tr>
<tr>
<td></td>
<td>B. Total Benefits (FICA 33%)</td>
<td>11,550</td>
<td>11,897</td>
<td>24,507</td>
<td>25,242</td>
<td>25,999</td>
</tr>
<tr>
<td>III. Materials &amp; Supplies</td>
<td></td>
<td>$80</td>
<td>$80</td>
<td>$80</td>
<td>$80</td>
<td>$80</td>
</tr>
<tr>
<td></td>
<td>A. Cost per course (estimated)</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
</tr>
<tr>
<td></td>
<td>B. Total number of courses</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>IV. Development - Courses</td>
<td>$20,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A1. Development of New Courses: Faculty Time</td>
<td>5,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A2. Ttl # of new courses</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUBTOTAL: DIRECT PROGRAM EXPENSES</td>
<td>$20,000</td>
<td>$126,430</td>
<td>$156,821</td>
<td>$210,908</td>
<td>$245,452</td>
<td>$252,814</td>
</tr>
<tr>
<td>V. Student Fees (100% returned to campus)</td>
<td>$7,310</td>
<td>$14,942</td>
<td>$22,909</td>
<td>$31,228</td>
<td>$39,914</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>A. Campus Mandatory Fee</td>
<td>5,360</td>
<td>11,042</td>
<td>17,059</td>
<td>23,428</td>
<td>30,164</td>
<td></td>
</tr>
<tr>
<td>B. Graduate School Application Fee</td>
<td>750</td>
<td>1,500</td>
<td>2,250</td>
<td>3,000</td>
<td>3,750</td>
<td></td>
</tr>
<tr>
<td>C. Graduate School Administrative Fee</td>
<td>1,200</td>
<td>2,400</td>
<td>3,600</td>
<td>4,800</td>
<td>6,000</td>
<td></td>
</tr>
<tr>
<td>1. Fee assessed per each academic semester/term</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>2. Total number of semesters/terms per year</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3. Total number of students</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>VI. OES Administrative Fee</td>
<td>$16,000</td>
<td>$33,600</td>
<td>$52,920</td>
<td>$74,088</td>
<td>$97,241</td>
<td></td>
</tr>
<tr>
<td>A. 10% of tuition revenue for OES administrative costs</td>
<td>16,000</td>
<td>33,600</td>
<td>52,920</td>
<td>74,088</td>
<td>97,241</td>
<td></td>
</tr>
<tr>
<td>Total Estimated Expenses</td>
<td>$20,000</td>
<td>$149,740</td>
<td>$205,362</td>
<td>$286,737</td>
<td>$350,768</td>
<td>$389,968</td>
</tr>
<tr>
<td>Total Estimated Program Revenue &amp; Support</td>
<td>$20,000</td>
<td>$166,110</td>
<td>$348,542</td>
<td>$548,509</td>
<td>$767,308</td>
<td>$1,006,319</td>
</tr>
<tr>
<td>Net</td>
<td>$0</td>
<td>$16,370</td>
<td>$143,180</td>
<td>$261,772</td>
<td>$416,540</td>
<td>$616,351</td>
</tr>
</tbody>
</table>

Data Science Certificate Completion Assumptions

- # of terms per year: 2
- # of courses per term: 2
- # of courses per year: 4
- # of instructors per year: 4

To complete the 12-credit, 4 course program:

Students take 4 courses (12 credits) 12

Cumulative 5 Yr

| TTL Expenses | $1,402,575 |
| TTL Revenue/Support | $2,856,788 |
| TTL Net | $1,454,212 |
Addendum

The Department of Computer Science is committed to increasing the diversity of its student body and has undertaken several efforts over the last few years in that direction; the proposed certificate program will leverage those initiatives. A specific example is the "Women in Computing" group that has been making a strong and active effort to support female undergraduate students, graduate students, and faculty, through organizing social and educational activities, arranging participation in conferences like the "Grace Hopper Celebration of Women in Computing Conference", etc. The strategic plan developed internally by the department also outlines several outreach and recruiting initiatives that will be pursued in the near future.