SOUTHERN ASSOCIATION OF COLLEGES AND SCHOOLS
COMMISSION ON COLLEGES
SUBSTANTIVE CHANGE PROSPECTUS
UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Doctor of Philosophy in Data Science

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<tr><td colspan="2">Name of Institution:
University of North Carolina at Charlotte (UNC Charlotte)</td></tr>
<tr><td colspan="2">Location:
9201 University City Blvd., Charlotte, NC 28223</td></tr>
<tr><td rowspan="4">Name and Title of Individual Completing the Prospectus:
Dr. Douglas Hague, Executive Director and Professor of Practice, School of Data Science

Dr. Christine Robinson, Assistant Provost for Institutional Effectiveness and Analytics</td><td>Telephone:
704-687-5666
(704) 687-5385</td></tr>
<tr><td></td></tr>
<tr><td>Internet Address:
dhague@charlotte.edu
Crobinson@uncc.edu</td></tr>
<tr><td>Date Submitted:
June 21, 2024</td></tr>
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List of Degrees

List of degrees that the institution is authorized to grant. As a subset of each degree, list majors available.

Abstract

The proposed face-to-face doctoral program in Data Science (DTSC) fulfills a need created by the increasing demand at the high end of the marketplace for data scientists. While most needs for data science talent are fulfilled through undergraduate and Master's programs like the existing B.S. and M.S. degrees in Data Science and Business Analytics (DSBA), Statistics, and Computer Science at UNC Charlotte, there is a gap in the production of Ph.D.s in the data science field. The proposed program offers specialization for different profiles of data science professionals. The proposed Ph.D. program in Data Science will provide doctoral-level education to students seeking data science careers both in academia and in industry. Charlotte area industries, especially the finance industry, have long partnered with UNC Charlotte and are supporting this extension of the data science programs to include the Ph.D. The proposed program is a terminal research degree that is transdisciplinary by design and lays emphasis on the mastery of the data science tools and methodologies from diverse disciplines (computer science, social sciences, business, etc.) and on responsible stewardship of data to cover the broad value of data science in various domains across society. Strong emphasis will be placed on providing students the opportunity to demonstrate mastery of knowledge in multiple data science application domains including, but not limited to, financial services, political science, sociology, marketing, management information systems, operations management, criminal justice, public administration, geography, public health, earth and environmental sciences, engineering, urban management, and economics. As opposed to discipline specific programs, the research for these students and faculty will mix and integrate methods from a broad range of disciplines as well as develop new methodologies as may be required. The proposed term for the first students will be January 10, 2025. The projected number of students in the first cohort is eight (combination of Spring and Fall of 2025). This program is not cohort based and will be ongoing.

We expect student applications from three primary areas 1) graduates with M.S. degrees in Data Science and Business Analytics, which now number over 1000, and similar M.S. degree holders within the Charlotte area and beyond, 2) students completing a B.S. in Data Science and Business Analytics or related field within the US (we now have over 300 B.S. degree students in Data Science at UNC Charlotte alone) and 3) qualified international students with STEM based backgrounds. We also expect graduates to go to both industry and academia. In particular, the Charlotte banking and financial services companies have hired many Ph.D. graduates in data science related fields and continue to support the University's program expansion to offer a Ph.D. in this field. Kennesaw State's experience shows a robust demand from both industry and academia in their placements.

UNC Charlotte has the strength to take on this program due to the robust nature of both the undergraduate program in data science (300+ students) and the longer existing M.S. programs (350+ students). UNC Charlotte was the third School of Data Science to launch in the U.S. in 2020 and has continued to grow and expand both the academic and research programs in data science. The School's annual budget is currently $2M, with the Division of Academic Affairs providing an additional $1M in recurring annual funds to expand the data science programs (including this proposed Ph.D.).

Determination of Need and Program Approval

Student Demand

The demand for Data Science programs, including those with Ph.D. degrees, has soared in recent years. We originally identified over 20 Ph.D. programs in data science across the U.S. Since our original search in 2021, several more Ph.D. programs have been launched and we have knowledge of several more in the approval process at their universities. The UNC Charlotte School of Data Science is fielding a consistent flow of inquiries from current students and alumni about when they can expect to enroll in a Ph.D. program in data science. Given these inquiries, our survey of alumni, and discussion with other universities with Ph.D. degrees in data science, we expect student demand for this program from three areas, 1) current Data Science and Business Analytics M.S. holders from UNC Charlotte, as well as other U.S. based M.S. programs in statistics, computer science, etc.; 2) students currently enrolled in the B.S. in Data Science and Business Analytics offered by UNC Charlotte and other U.S. based undergraduate degree holders in related fields; and 3) qualified international students with STEM based backgrounds. In conversations and surveys with currently enrolled and graduated DSBA students, we found them to have a strong desire to continue their studies in data science at the doctoral level, but have often struggled to find data science Ph.D. programs that fit their geographic needs. Because of the anticipated connection of the DSBA master's program and the proposed program, a steady number of DSBA students are expected to apply to the proposed program.

A survey of recent DSBA alumni was recently conducted to gauge their interest in the Ph.D. program in Data Science. Over 25% of the School's 341 alumni responded. According to the survey, 84% would have been moderately (28%) or very (56%) interested in continuing to a Ph.D. program in Data Science. Of these alumni, 61 (71% of respondents) are still interested in applying once the program begins.

The demand for doctoral education in data science within the state of North Carolina is particularly astute. Only three similar doctoral programs are located in the state of North Carolina: the Ph.D. in Geospatial Analytics at North Carolina State University (NCSU), the Ph.D. in Health Informatics at UNC Chapel Hill, and the renamed Ph.D. in Computational Data Science and Engineering at NC A&T. Two of these programs are only concentrated on particular specialty domains (geospatial analytics and health informatics) and the third evolved from a Ph.D. in Computational Science and Engineering and retains its focus on engineering. While the School's proposed program is most similar to the NC A&T program, the proposed Ph.D. in Data Science at UNC Charlotte is a broader, transdisciplinary program capturing diverse application domains based on data science techniques such as marketing, management information systems, operations management, education, public policy, urban and environmental sciences, and computational social sciences; it will be the first comprehensive doctoral program in data science in the state of North Carolina. Producing higher numbers of Ph.D. graduates in this field is necessary to ensure sufficient supply of graduates to fill positions in industry. As an example, several of our industry partners in Charlotte have over 100 Ph.D. graduates in data science working inside their corporations. These teams are expected to continue to grow over time.

While there is no comprehensive data science program at the doctoral level in the UNC System, there are six institutions who offer master's programs in data science in the state of North Carolina: UNC Charlotte, NC State, UNC Wilmington, Appalachian State University, Winston-Salem State University and Duke University. In particular, two UNC System data science programs – the M.S. in DSBA at UNC Charlotte and the MSA program at NC State are experiencing a steady increase in enrollment growth. The following table shows the consistently strong enrollment growth in both programs.

Year	NC State MSA Graduates	UNC Charlotte DSBA Graduates
2008	23	0
2009	35	0
2010	39	0
2011	39	0
2012	38	0
2013	81	0
2014	79	0
2015	86	1
2016	113	24
2017	118	42
2018	111	57
2019	111	54
2020	118	82
2021	116	81

Assessment of Job Market

The Bureau of Labor Statistics predicts that data scientists will experience one of the highest job growths

between 2020 and 2030 (>30%). Currently the vast majority of data science practitioners have graduate degrees (93%). Of data science jobs today, 12% hold a Ph.D. degree (40% in artificial intelligence positions, a type of data scientist). NC State Institute for Advanced Analytics regularly tracks the job supply and demand across North Carolina as well as the nation. Concurrently, a UNC Chapel Hill preliminary study showed:

> "high labor market demand for individuals with a master's degree in data science. All five of the occupations identified as being most closely aligned with a master's degree in data science are projected for more than double the growth (14%) over the next decade than the projected growth across all occupations nationwide over the same time period (5.8% growth). Statewide occupational projections mirror national projections among likely occupations for an individual with a master's degree in data science, providing a promising outlook on occupations utilizing data science skills. Pairing long-range occupational projections with recent job posting data, employers nationwide were looking to hire Data Scientists nearly twice as often over the past year as the second most-common job title (Biostatisticians). A trend at both the state and national level is the emergence of biostatistics, as job titles including the term account for the second and third most-common titles (Biostatisticians and Biostatistics Managers) over the last year."

Companies seeking doctoral-level data scientists are broad, ranging from IT companies (e.g., Amazon) to finance companies (e.g., Capital One) to management consulting companies (e.g., Booz Allen Hamilton). The Bureau of Labor Statistics (BLS) highlighted this growing demand as follows:

> "The Rapid growth in data collection by businesses will lead to an increased need for data-mining services. Computer scientists will be needed to write algorithms that help businesses make sense of very large amounts of data. With this information, businesses understand their consumers better, making the work of computer and information research scientists increasingly vital (Source: BLS Occupational Outlook Handbook: Computer and Information Research Scientists)."

Given the large percentage of jobs that require a Ph.D., the limited number of Ph.D. programs in Data Science, and the anticipated trajectory of job market growth, UNC Charlotte is proposing a new Ph.D. program in Data Science. The proposed program is aimed at focusing on theories and techniques pertaining to data collection, data organization, and analytics for applications to real-world problems in a variety of domains of use, while instilling good societal stewardship of data. The program's real-world applications will be multidimensional in the sense that it will cover multiple domains such as marketing, operations management, public policy, education, urban and environmental management, engineering, and others.

As a Ph.D. program in an emerging field where increasing numbers of universities are creating data science programs at the undergraduate, master's, and doctoral levels, it is anticipated demand will be high at launch and sustained in the long term. Based on consultation with Kennesaw State about their experience with Data Science Ph.D. graduates, we do expect a sizable portion of our graduates to seek academic positions even though the industry job market and compensation is strong.

Alignment to Mission and Goals

As North Carolina's urban research university, UNC Charlotte is in a unique position to deliver on career-building expertise. It leverages its location in the state's largest city to offer internationally competitive programs of research and creative activity and exemplary undergraduate, graduate, and professional programs. UNC Charlotte established the School of Data Science (SDS) as the home for transdisciplinary data science and analytics programs. SDS and its predecessor, the Data Science Initiative (DSI), are key strategic initiatives that align with the University's strategic plan, Shaping What's Next. This new program aligns with the Goal B3: Expand…doctoral education… More specifically, Action B3.1.1 – Launch new doctoral programs in areas that contribute to becoming a top-tier research University.

The UNC System mission is "to discover, create, transmit, and apply knowledge to address the needs of individuals and society." A critical component of data science education is to guide students to develop data acumen. This requires exposure to key concepts in real-world data and problems that can reinforce the limitations of existing tools and stimulate the development of new ones, and ethical considerations that permeate many applications. By exposing students to real-world data and problems in society and business organizations, the program emphasizes educational and research opportunities in STEM that clearly align with UNC Charlotte's mission.

Program Approval

The approval process for graduate courses establishes the review procedures for all new and modified courses. This process begins with review and approval at the departmental level. In this case, SDS had a Ph.D. planning committee that consisted of six SDS tenured faculty. Due to the unique transdisciplinary nature of SDS, these six faculty also have appointments in the six different colleges that make up the governing structure of SDS. The proposed curriculum was reviewed at several faculty meetings for feedback. The proposal then proceeded through the school curriculum committee and multiple college deans before reaching the Graduate Council; this is a subcommittee of the Faculty Council and consists entirely of faculty. The Graduate Council is also responsible for ensuring the quality and content of the curriculum, as well as the resulting course and curriculum approvals. Finally, any proposals to establish new courses or programs (or modification of existing courses or programs) are reviewed by the Faculty Executive Committee and the Faculty Council for approval and implementation consideration.

The Ph.D. in Data Science program received input from faculty, administrators, and industry advisory boards at UNC Charlotte throughout the development of the proposal. In addition to the UNC Charlotte campus review process, the UNC System approval process now involves distribution of proposed new graduate programs to all institutions in the UNC System for review and comment prior to action by the UNC System Board of Governors. Comments, suggestions, and questions received during this review process were addressed and incorporated at each step of the review process. The UNC System Board of Governors approved the Ph.D. in Data Science on May 23, 2024.

Program Details

The UNC Charlotte Ph.D. in Data Science will provide research intensive doctoral-level education for students seeking data science careers in practice, research and teaching/academia. The program will emphasize the mastery of the data science discipline-specific concepts through a set of core courses. Emphasis will be placed on demonstrating mastery of knowledge in a specific subject area of data science through advanced research skills, the ability to synthesize, create innovative ideas and ultimately make original contributions to the discipline. The program requires students to have mastery and

understanding of statistics, machine learning, artificial intelligence and appropriateness, ethics, governance of data and data science research design. Our evaluation plans for the proposed Ph.D. in Data Science encompass the criteria to evaluate the quality and effectiveness of the program as well as the Student Learning Outcomes (SLO).

Course Requirements

The doctoral degree is awarded for depth of knowledge in a field and completion of scholarly research that advances the knowledge base in the area of concentration. This level of achievement is demonstrated by the successful completion of appropriate coursework and a dissertation defense. For graduates with a Bachelor's degree in a data science or related field, the Ph.D. in Data Science will require a minimum of 74 credit hours of study inclusive of 18 credit hours of dissertation research. Applicants who hold a relevant master's degree in data science or closely related field, either from UNC Charlotte or another institution, may be eligible to pursue the Ph.D. in Data Science with advanced standing. Eligibility for this accelerated option must be made at the time of admission to the program and is subject to review by the Graduate School. Under the advanced standing option, students must complete 44 credit hours, including 18 credit hours of dissertation research. All students must complete the Responsible Conduct of Research course (GRAD 8002) and the Academic Integrity course (GRAD 8990). Descriptions of all courses and a Schedule of Course Offerings are provided.

To satisfy the 36 credit-hours (or 6 credit-hours for the advanced standing option) of electives, the student will take a combination of DTSC 8000 (Special Topics in Data Science), other doctoral 8000-level classes, and other graduate courses at the 5000 to 7000 level when 8000-level equivalents are not available, provided that they would be relevant to their program of study and research. The student is allowed to take these electives from any graduate program or department at UNC Charlotte, subject to approval by the student's advisor and the Ph.D. Program Director. Students can also take individual studies classes (usually DTSC 8800). Each doctoral student is limited to 6 credits of individual studies classes (DTSC 8800); students with advanced standing are limited to 3 credits of DTSC 8800. Transfer credit can be counted towards electives. Electives other than DTSC 8000 and DTSC 8800 are listed as "AAAA XXXX" in the following table.

Advanced Standing Schedule

Year 1

Course No.	Course Title	Fall	Spring
DTSC 8600 (2 credits)	Research Design for Data Science	x	
DTSC 8601 (2 x 1 credit)	Data Science Research Seminar	x	x
DTSC 8110 (3 credits)	Statistics for Data Science	x	
DTSC 8130 (3 credits)	Ethics, Security, Privacy, & Governance of Data for Social Good	x	
GRAD 8302 (2 credits)	Responsible Conduct of Research		x

GRAD 8990 (0 credits)	Academic Integrity		x
DTSC 8120 (3 credits)	Fundamentals of Machine Learning		x
DTSC 8140 (3 credits)	Fundamentals of AI		x

Year 2

Course No.	Course Title	Fall	Spring
DTSC 8601 (2 x 1 credit)	Data Science Research Seminar	x	x
DTSC 8000 (3 credits)	Special Topics in Data Science	x	
DTSC 8800 (3 credits)	Independent Studies	x	
DTSC 8900 (10 credits)	Dissertation Research	2 cr	8 cr

Year 3

Course No.	Course Title	Fall	Spring
DTSC 8900 (10 credits)	Dissertation Research	9 cr	1 cr

Non-Advanced Standing Schedule

Year 1

Course No.	Course Title	Fall	Spring
DTSC 8600 (2 credits)	Research Design for Data Science	x	
DTSC 8601 (2 x 1 credit)	Data Science Research Seminar	x	x
DTSC 8110 (3 credits)	Statistics for Data Science	x	
DTSC 8130 (3 credits)	Ethics, Security, Privacy, & Governance of Data for Social Good	x	

GRAD 8302 (2 credits)	Responsible Conduct of Research		x
GRAD 8990 (0 credits)	Academic Integrity		x
DTSC 8120 (3 credits)	Fundamentals of Machine Learning		x
DTSC 8140 (3 credits)	Fundamentals of AI		x

Year 2

Course No.	Course Title	Fall	Spring
DTSC 8601 (2x1 credit)	Data Science Research Seminar	x	x
DTSC 8000 (3 credits	Special Topics in Data Science	x	
DTSC 8800 (3 credits)	Independent Studies	x	
AAAA XXXX (3 credits)	Elective to be determined	x	
AAAA XXXX (9 credits)	Elective to be determined		x

Year 3

Course No.	Course Title	Fall	Spring
AAAA XXXX (9 credits)	Elective to be determined	x	
AAAA XXXX (9 credits)	Elective to be determined		x

Year 4

Course No.	Course Title	Fall	Spring
DTSC 8900 (18 credits)	Dissertation Research	9 cr	9 cr

Student Learning Outcomes

This program will be delivered in a traditional face-to-face instructional environment. Courses will be taught on the UNC Charlotte main campus and at the UNC Charlotte Dubois Center in Uptown Charlotte. The Student Learning Outcomes of the Ph.D. in Data Science are outlined below:

Program Student Learning Outcomes	Measurement Instrument	Criteria for Proficiency (score, percentage, level of performance, etc.)
Students will describe and discuss the interdisciplinary and transdisciplinary foundations of Data Science	Written answer of student to DTSC Foundations question on the Ph.D. qualifying exam, as graded by ad hoc faculty committee	90% of students "Meet expectations" or "Exceed expectations" on the related qualifying exam question
Student will critically evaluate published scholarship in Data Science and allied knowledge fields	a. Written answer of student to related question on the Ph.D. qualifying exam, as graded by ad hoc faculty committee b. Written dissertation report, as assessed by members of student's dissertation examination committee	a. 90% of students "Meet expectations" or "Exceed expectations" b. 90% of students "Meet expectations" or "Exceed expectations"
Students will critically use concepts, theories and methodologies relevant to data science in fostering new or original knowledge in their primary area of scholarship	Written dissertation report, as assessed by members of student's dissertation examination committee	90% of students "Meet expectations" or "Exceed expectations"
Students will effectively write and present Data Science scholarship to peers, students, and members of the broader community outside of the field	Written dissertation report and dissertation presentation, as assessed by members of student's dissertation examination committee	90% of students "Meet expectations" or "Exceed expectations" on their dissertation report submitted by the examining committee
Students describe, discuss, and evaluate the responsibilities of Data Scientists regarding the ethics of data practices, security, privacy and governance of data, and action for social good	Written answer of student to question on data ethics and social good on the Ph.D. qualifying exam, as graded by ad hoc faculty committee	90% of students "Meet expectations" or "Exceed expectations" on the related qualifying exam question

Students will use appropriate data science tools and techniques, including applied statistical analysis, machine learning, artificial intelligence, to answer broader research questions in a data rich environment	Written answer of student to related questions on the Ph.D. qualifying exam, as graded by ad hoc faculty committee	90% of students "Meet expectations" or "Exceed expectations" on the related qualifying exam questions
Students will demonstrate the ability to identify, assess, select and/or develop appropriate data analytics methods and models for addressing a specific real-world issue from an evidence-based perspective	Written dissertation report and dissertation presentation, as assessed by members of student's dissertation examination committee	90% of students "Meet expectations" or "Exceed expectations" on their dissertation report submitted by the examining committee

Program Admission

Application to the proposed DTSC program will follow existing UNC Charlotte Graduate School admissions processes. The UNC Charlotte application process is completely online. To apply for graduate studies, all applicants must submit the following application materials to the UNC Charlotte Office of Graduate Admissions:

- Graduate School Application for Admission (online)
- Application Fee (payable online)
- Unofficial transcripts of all academic work attempted beyond high (secondary) school. An official (officially certified) final transcript must be submitted if an applicant is offered admission. International transcripts provided in a language other than English should be uploaded via the online application system, but an officially translated version should be uploaded as well.
- Official and satisfactory score on the Test of English as a Foreign Language (TOEFL), International English Language Testing System (IELTS), or Duolingo English Test (DET) English language proficiency test for applicants whose native language is other than English. A minimum score of 83 on the Internet-based TOEFL, overall band score of 6.5 on the IELTS, or minimum score of 115 on the DET is required. Additionally, minimum subscores of 18 on the TOEFL, 6.5 on the IELTS, or 115 on the DET are required. Applicants who meet one of the criteria identified on the website may be exempted from the language requirement.
- A personal and original statement of purpose (essay indicating research interests and motivation and one or more potential faculty advisor) in the range of 500 words, submitted online as part of the application submission process.
- Three letters of recommendation, two of which must be from faculty members (submitted online by recommenders).
- Official GRE/GMAT test scores. A waiver is available upon request and subject to the approval of the Ph.D. Program Director under specific circumstances (professional experience, for instance).
- A resume (submitted online).

As an option, applicants can submit a writing sample from their most recent degree and a sample of their recent research activities and output.

In addition to the general requirements for admission to the Graduate School, the following are required for admission to the DTSC Ph.D. program:

- Applicants with the equivalent to a U.S. bachelor's degree from a college or university accredited by an accepted* accrediting body, with an undergraduate GPA of 3.0 or above.
- Applicants with the equivalent to a U.S. master's degree from a college or university accredited by an accepted* accrediting body, in data science or in a related field, with a minimum undergraduate GPA of 3.0 and a minimum graduate GPA of 3.50 (on a 4.00 scale) in all graduate work are eligible to apply for Advanced Standing (see Degree Requirements for details).
- All appropriate credentials as required by the Graduate School.
- OPTIONAL: A satisfactory score (>50th percentile) from the aptitude portion of the GRE.

(* Accepted accrediting bodies: Accrediting Commission for Community and Junior Colleges (ACCJC) Western Association of Schools and Colleges, Higher Learning Commission (HLC), Middle States Commission on Higher Education (MSCHE), New England Commission of Higher Education (NECHE), Northwest Commission on Colleges and Universities (NWCCU), Southern Association of Colleges and Schools Commission on Colleges (SACSCOC), and WASC Senior College and University Commission (WSCUC).)

Required prerequisite courses and programming experience: Applicants may apply without having all prerequisites listed below, but they must be completed prior to matriculation. Proof of completion will be required for any outstanding prerequisites if an applicant is admitted and accepts their offer of admission. These prerequisites are often found in Data Science or related degrees (e.g., Computer Science, Statistics, Math, Quantitative Economics, Mathematical Finance, and Engineering). Strong candidates may be allowed to make up deficiencies in some areas, and may test out, at the discretion of the Data Science Ph.D. admissions committee.

- Calculus: A course or courses from an accredited college or university that covers concepts through multivariable calculus and functions in more than one dimension.
- Matrix Algebra or Linear Algebra: Evidence of proficiency in matrix algebra via a linear algebra or similar mathematics course from an accredited college or university.
- Statistics: At least two courses from an accredited college or university that cover concepts in probability and statistical inference.
- Programming Experience: This experience can be demonstrated by completion of a course in computer science from an accredited college or university or substantial experience working with a programming language (such as Python, R, Matlab, C++, or Java).

For candidates seeking admission in the Advanced Standing option, experience or courses in the following areas are suggested:

- Statistics: Multivariate statistics or one additional course above the statistics requirement above
- Machine learning: One or more courses or equivalent experience in machine learning, artificial intelligence, or other areas of algorithmic development
- Visualization and communication with data: One or more courses or equivalent experience in the visualization communication of data

- Databases: One or more courses or equivalent experience with the management of data that includes knowledge of SQL and data structures.

Students can be admitted to the program on a part-time basis, including under the Advanced Standing option.

Program Graduation

The DTSC program will follow the UNC Charlotte Graduate School requirements on residence. A student may satisfy the residency requirement for the program by completing 18 hours, either coursework or research credits, by study-in-residence during the academic year and during the summer terms, as long as the study is continuous. Study-in-residence is deemed to be continuous if the student is enrolled in one or more courses (including research/dissertation credit) in successive semesters until eighteen hours of credit are earned.

Following the UNC Charlotte Graduate School policies, in addition to demonstrating a high level of competence in coursework, the student must pass the Ph.D. qualifying examination. The qualifying examination should be taken no later than one semester after completion of required core courses of the program. The qualifying exams will consist of three parts: a written research prospectus (draft proposal), oral defense of the draft proposal, and a written response to a data science problem presented by an ad hoc committee. Failure to pass the qualifying examination in two tries will result in the termination of the student's enrollment in the Ph.D. program.

After passing the qualifying examination, a student must propose a dissertation topic, prepare a written proposal, and submit it to the doctoral committee for review at least two weeks before the oral exam date. The oral exam, administered by the student's doctoral research advisor and doctoral committee, will include a presentation and defense by the student of his or her proposed research topic in accordance with rules and policies of the UNC Charlotte Graduate School. The doctoral student advances to candidacy after the dissertation topic and proposal has been approved by the student's doctoral committee and the Graduate School. The candidacy must be achieved at least 6 months before the doctoral degree is conferred.

The DTSC program will allow the student's dissertation to take either of two forms: a traditional monograph or a collection of three or more articles structured coherently around a common theme. For the latter option, the student will be expected to follow the protocols laid out by the UNC Charlotte Graduate School.

To earn the degree, a student is expected to satisfactorily complete all credit hours of required courses with an overall GPA of 3.0. Students who fail to maintain satisfactory progress toward their program or who do not achieve commendable or satisfactory grades in all their graduate coursework are subject to suspension and/or termination from their program of study and/or the Graduate School. Per the policy of the Graduate School, no course older than six years may be applied towards a master's degree

Program evaluation at year 4

The UNC Charlotte Ph.D. in Data Science will provide research intensive doctoral-level education for students seeking Data Science careers in practice, research and teaching/academia. Our evaluation plans for the proposed Ph.D. in Data Science encompass the criteria to evaluate the quality and effectiveness of the program, as well as the Student Learning Outcomes (SLO), Measures (Metrics), and Plan/Schedule.

The program evaluation will be focused on the program objectives (restated below) and the SLOs. The program evaluation will be conducted through internal assessments and an external reviews process.

The objectives of the Data Science Ph.D. program include:

- Preparing research data scientists, professional data scientists, and scholars/academicians who will be leaders in developing, maintaining, and managing data ethically and effectually to sustain the economic and social vibrancy of North Carolina and the United States;
- Training research data scientists who have deep understanding of data, of knowledge production based on data and of subject matters that thrive on evidence-based research and practice;
- Providing a range of educational and research experiences for a diverse group of students to participate in research initiatives at UNC Charlotte, Private, Public, and International institutions; and,
- Preparing future data science educators, scholars, and professionals who are at the frontiers of understanding and leveraging the evolving data landscape.

To measure these objectives, the following criteria will be used to evaluate the planned Data Science Ph.D. program.

- Criterion 1: Number of students who demonstrate mastery of the fundamental concepts, models, advanced research skills of Data Science.
- Criterion 2: Number of UNC Charlotte graduates recruited, retained, and graduated; number of non-UNC Charlotte graduates recruited, retained, and graduated; diversity of recruited Ph.D. students and local versus international institutions where they gained their B.S. and M.S. degrees; time to graduation.
- Criterion 3: Number of research articles published in peer-reviewed and indexed outlets by doctoral students and their advisers on average; number of projects that were affected in North Carolina and elsewhere through research conducted by program students and their advisers; number of presentations and short courses taught by doctoral degree candidates.
- Criterion 4: Number of program graduates who are gainfully employed in their field of study; number of program graduates who serve in leadership positions and/or win professional awards.

Since the proposed Ph.D. program is expected to take about 6 – 7 years to mature and achieve steady state, several of the measures for evaluating program success, listed above, will not be realized in four years. Therefore, evaluation of the program will assess progress towards the steady-state goals. The program will be evaluated internally at the end of each academic year for the first four years. SLOs will be assessed and reports will be submitted to the SDS Executive Director and to the Graduate School every year.

By the end of the fourth year, an evaluation report will be submitted to the SDS Executive Director and the UNC Charlotte Office of Academic Affairs. The report will include information on the extent to which UNC Charlotte has met projected enrollments and degrees conferred, and the readiness of the university to continue funding the program on the level provided at the end of the fourth year. This report will be submitted as a part of UNC Charlotte's long-range planning submission. Every two years of operation, an internal evaluation will be conducted by the Ph.D. Program Director. At the end of the second year, the evaluation report including all the components mentioned above will be submitted to the SDS Executive Director for their review. Based on the results of these reviews, deficiencies, structural and programmatic inconsistencies in the program will be addressed. The Graduate School and the Office of Academic Affairs at UNC Charlotte also have mechanisms and processes in place for providing oversight

on all graduate programs. The proposed program will be assessed to determine if it is meeting the four-year milestones described below.

Program enrollment in the fourth year should approach 30 students.

- During the fourth year of the proposed program, scholarly activities including presentations, journal publications, and grant activity by the SDS Faculty will be assessed. New external funding generated annually by the SDS affiliated faculty should exceed $2.0M. External funding should be supporting a minimum of 10 RAs.
- The program should have produced its first graduates by the fourth year of operation.
- Changes in the proposed program will be implemented as necessary to allow achievement of program goals.

Definition of a Credit Hour

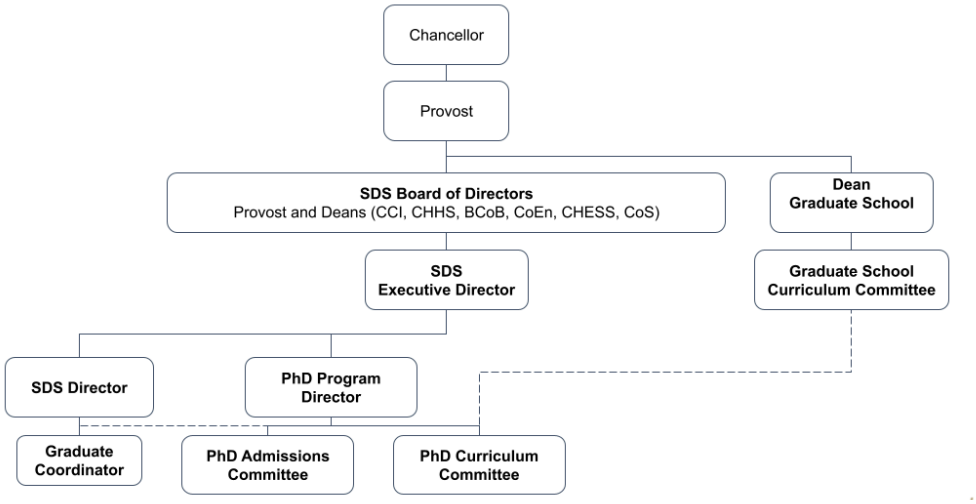
The course and curriculum development process are governed by the Standing Rules of the Faculty Council. Faculty members in academic departments develop and complete the required steps in Curriculog, the University's online course and curriculum change system, for new courses and revisions to courses. As part of the proposal, faculty are asked to provide a draft catalog copy for the course which includes the amount of credit to be awarded. Undergraduate faculty must also submit a draft course syllabus that includes the number of credits. The departmental and collegiate curriculum committees are responsible for verifying the credit hours for new courses and revisions to courses based on documentation of the amount of work expected by faculty in the class.

Existing and new courses represent best practices of credit calculations nationwide by following the federal definition of Carnegie Units. It is recommended that faculty members include the Suggested Standard Syllabus Policies (p. 2). All departments are required to verify that the credit awarded for new courses conform to federal and Commission policy and will indicate such through required steps and documentation submitted during the Curriculog course proposal process.

Program Oversight

The proposed Ph.D. in Data Science program will be administered within the School of Data Science as illustrated by the organizational chart below. The School of Data Science will name a Ph.D. Program Director who will be responsible for recruiting, admissions, advising, and oversight of graduate students within the Ph.D. in Data Science program. A professional Graduate Coordinator, who works for the SDS Director, will assist the Ph.D. Program Director in advising and recruiting. Faculty committees (Ph.D. curriculum committee and Ph.D. admissions committee) will assist with curriculum, recruiting, admissions, and student advising. Both the SDS Director and the Ph.D. Program Director will report to the SDS Executive Director, who has ultimate responsibility for all programs within the School. The SDS Executive Director reports to a Board of Directors that includes Deans and the Provost. Overall administration of all university graduate programs is provided by the Dean of the Graduate School. Oversight of the graduate curriculum is provided by the Graduate School's curriculum committee. The Provost reports to the Chancellor of UNC Charlotte.

Figure 1. Organizational Chart for the School of Data Science



The following describes a governance structure and processes of the Data Science program:

- *Graduate School*: The Graduate School is responsible for setting policy regarding the operation of all graduate programs of the University of North Carolina at Charlotte. These policies cover minimum admission standards and performance requirements for successful completion of graduate degree programs. The Ph.D. in the Data Science program will be subject to the rules and policies of the Graduate School. The Graduate School is responsible for collecting the material for applicants to the program and forwarding completed application packets to the Ph.D. Program Director.

- *Dean of the Graduate School*: At UNC Charlotte, the Dean of the Graduate School is the administrative officer with primary responsibility for the supervision of graduate programs. The Dean is responsible for the executive and administrative affairs of the Graduate School in accordance with policies determined by the UNC Charlotte Graduate Council, the Graduate Faculty, and the Faculty Council. It is anticipated that the Dean of the Graduate School will communicate with Deans of all colleges on important programmatic issues. The Graduate Dean's primary duties include the following:

    - Final admission of students;
    - Approval of programs of study; and
    - Admission of students to candidacy.

- *SDS Board of Directions including College Deans*: The College Deans have the administrative responsibility for supervision of all departments and programs housed within the College and have joint responsibility for SDS.

- *Ph.D. Program Director*
    - Recommends operating budgets to the SDS Executive Director and supervises expenditures;
    - Communicates assessment of the program and personnel to the chairs of participating departments, the SDS Executive Director, the SDS Board and the Graduate School;

- Manages the Ph.D. Admissions Committee and the Ph.D. Curriculum Committee
- Oversees recruitment efforts for the program;
- Coordinates the scheduling of courses;
- Assures proper maintenance of graduate student records;
- Represents the program to external constituencies.

- *SDS Executive Director*
  - Overall responsibility for programs and operations of SDS
  - Reviews faculty and staff within SDS
  - Manages the funding and budget for all of SDS

- SDS Director
  - Supervises the majority of staff within SDS
  - Manages the overall operations of SDS

- *Data Science Faculty*: The Ph.D. in Data Science Faculty will be composed of those members of the Graduate Faculty at UNC Charlotte who will participate in the program as advisors and instructors in component courses. It is expected that the credentials presented by a data science program graduate faculty member will include a list of journal publications, externally funded research grants and prior experience in supervising master's theses and/or doctoral dissertations, as well as a research program relevant to the goals of the program.

- *Graduate Coordinator:*
  - Assists the Ph.D. Program Director with advising and recruitment.
  - Works with graduate students to evaluate and track their progress toward graduation.
  - Collaborates with faculty members in SDS
  - Department to provide additional information/services/programming to graduate students.

Faculty Qualifications

All School of Data Science faculty members that are also Graduate Faculty at UNC Charlotte are qualified to teach, chair and serve on graduate student committees, and fully engage in all graduate matters within their colleges and the University as appointed regular graduate faculty following the procedures for appointment as stated by the Graduate Council. Three full time equivalents of graduate faculty are required to launch this program and have been funded by the Provost for this program. The program would facilitate increased research productivity and external funding acquisition with the present faculty workforce.

Faculty Credential Guidelines for School of Data Science courses, including DTSC courses are as follows: The School of Data Science offers interdisciplinary courses that draw on faculty members' academic, research and professional expertise. Courses typically apply the faculty members' primary academic or professional discipline and utilize data science techniques. They also support students' inquiry of the intersections between disciplines with the goal of creating new knowledge. Faculty teaching these courses are expected to have a graduate degree and experience with issues and problems in data science.

The faculty members expected to teach in the Ph.D. in Data Science program are identified in the faculty roster. This demonstrates that faculty possess the required credentials or demonstrated competencies and achievements to teach in the program.

Overall, the percentage taught by part-time faculty and graduate teaching assistants is expected to be 0%. This demonstrates that both the number and percentage of full-time faculty is adequate to perform the basic functions of the academic programs.

During the academic year, faculty assignments will be made within their normal course load and there will be no increased workload on current faculty. Thus, the new program will not impact faculty activity, including course load, public service activity, and scholarly research. The Provost has provided $1M in recurring funding to expand the faculty within the School of Data Science. This includes funding for three FTE of full time faculty, the graduate coordinator, and eight teaching assistantships for Ph.D. students. The new faculty will have teaching loads of at least nine sections of courses. We will balance the teaching of the new 8000 level courses between current and new faculty with new faculty replacing capacity in current programs as required to be net neutral to these programs.

Library and Learning Resources

The J. Murrey Atkins Library at UNC Charlotte contains approximately 285,000 square feet, which is devoted to the library's collections and a variety of study spaces with seating for about 1,900. The Atkins Library provides 292 desktop computers available 24 hours, five days a week during the semester. There are currently 48 group study rooms available to students by reservation, and three classrooms with laptops used for instruction by librarians and others. For the convenience of our students, the Atkins Library also provides 700 laptops available for check out from Atkins Library or from a vending machine in an academic building.

Graduate students will have off-campus access to all of the resources provided on-campus through the Atkins Library website homepage. These resources include journal articles, workbooks, e-books, print books and videos. They can request research assistance either in person, or by phone, chat, text or email from the Library's homepage. Students may contact a research librarian who has specialty knowledge of their discipline area(s) for assistance with research or for help identifying and using the many electronic databases available. Research Guides are available electronically 24/7 for assistance with a specific course or particular subject area.

The Atkins Library also provides interlibrary loan service to all students and faculty. If students are unable to find a particular journal article or book within the library's own collection, they may request to have the item delivered from another library, either electronically or by mail. Articles take 24-48 hours to arrive and books take 5-7 business days. There is no charge for this service.

The library provides a large array of materials to aid students and faculty in their research, learning, and teaching. The present library holdings for the proposed program are adequate to begin the instructional and research needs of this program.

The collection currently includes:

- Books: 4,506
- Journals: 258
- Ebooks: 19,473

- eJournals: 539
- Electronic Database Subscriptions: 19
- Microform: 4
- Audiovisual/media materials: 6
- Media (streaming curricular) titles: 416

Databases of journal articles that Atkins Library currently subscribes to are below.

- For Engineering/Statistics/Mathematics: Web of Science, ScienceDirect, ACM Digital Library, Compendex, INSPEC, IEEE Xplore, MathSciNet
- For Business: ABI-INFORM, Business Source Complete, Mergent Online, Mintel Academic Reports
- For Health: PubMed, Cochrane Library, CINAHL Complete, Liebert Online
- For Social Science, Humanities, and General Data/Statistics/Demographics: SimplyAnalytics, Data Axle, Proquest Statistical Abstract, Statista, Data Citation Index, Policy Map

In order to offer resources in line with other comparable programs, J. Murrey Atkins Library will need to acquire subscriptions to research databases and datasets that the library currently does not provide access to. A new permanent allocation of $20k/yr will be provided to the Library for additional purchases to support the Ph.D. in Data Science. Additional collections being considered are

- For Engineering, Mathematics, and Health: Scopus which is the largest abstract and citation database of peer-reviewed literature.
- For Social Science, Humanities, and General Data/Statistics/Demographics: Data Planet/SAGEData (Access data on economics, crime, health, population, energy, the environment, and more in a single interface), Social Explorer (contains access to U.S. Census data dating back to 1790. Users can create maps and embed them as objects or download static images), Proquest Historical Statistical Abstract Add-on (back to 1878) and Abstracts of the World (50 countries worth of data).

The Atkins Library will analyze the collection on a three-year cycle, including individual electronic serials, print serials, standing orders, and electronic databases. It will continue to provide access to updated readings which will include mostly journal articles.

There are currently no plans to formally partner with other libraries to provide services for the students in the program.

Use of Technology

Multiple UNC Charlotte departments are involved in fostering, training, and supporting the use of technology to enhance student learning. The primary mission of the Center for Teaching and Learning (CTL) is to help faculty develop meaningful and pedagogically sound approaches to their teaching. CTL provides professional development workshops, software, and support to allow faculty to teach effectively with technology. Working in conjunction with CTL are the Office of OneIT (OneIT), and the Atkins Library.

The Center for Teaching and Learning (CTL) hosts the platform for the University's Learning Management System (LMS). Canvas is the center point for the delivery of technology in support of teaching. Every student enrolled at the University automatically has access to Canvas, which has online, chat, and telephone support systems available twenty-four hours a day. In addition, Canvas is the single point of entry for other important learning tools such as Video Content Management, Document Collaboration,

Secure Testing, Synchronous Learning, Integrated Response Systems (clickers), and plagiarism detection. The Center for Teaching and Learning provides training to faculty who teach online and blended courses. The Center offers courses on Canvas, course design, Quality Matters, etc.

The Media Production Team which is part of CTL provides support for the video conferencing and teleclass facilities that support both traditional educational programs and distance learning programs. The state-of-the-art technology for the classrooms on campus ensures that faculty have access to modern tools such as smartboards and video capture. The Media Production Team works with individual faculty to create custom, high quality, and engaging digital media elements for academic courses.

Working in conjunction with CTL is the OneIT. OneIT provides both the software and the training for students to make the best use of the technology resources available on campus. In addition, a wide variety of professionally developed training courses are available through Percipio.

The Atkins Library Information Commons (IC) staff provides online resources and classes for students in the Library. The curriculum ranges from foundational instruction for the first-year writing program to differentiated instruction for upper-level courses in the Writing, Rhetoric, and Digital Studies major.

Additionally, faculty are provided with training through a full range of workshops on the utilization of electronic tools such as Respondus, e-portfolios, and Zoom. Students that work full or part-time and may be geographically removed from the Charlotte area; therefore, they will have access to faculty by phone and Zoom conferencing tools. Assistance is also provided by the Media Production Team which designs and installs the technology located in the learning and common spaces.

The Data Science Ph.D. Program will utilize the University Research Computing (URC) infrastructure. This provides high-performance computing and analytics capabilities to support the research and teaching missions at UNC Charlotte. URC resources include clusters of powerful computers and storage tailored to data science needs. Many applications are pre-installed and ready for use. These resources are provided “as a service” to registered users including faculty and students.

The URC team provides consulting and assistance with experimental software and hardware needs. Together, URC supports, configures and ports applications to University resources and liaises between those engaged in research. Additionally, URC offers training and administration of these local high-performance systems. For a more detailed overview of the types of systems that make up each cluster, please check out our Research Clusters and Educational Cluster pages. Research Computing provides an extensive set of applications and codes for use by our researchers on the cluster. More information can be found here.

SDS works closely with the URC group to project and manage capacity needs. In the Spring of 2024, SDS and the URC collaborated to increase the capacity to be capable of training select large language models (LLM such as ChatGPT 3.0). In addition, the URC is developing methods and tools to utilize cloud based computing resources for cases where this may be more cost effective and timely for specific types of data science research needs. The SDS Executive Director works with the faculty and URC to ensure equipment and technology is present for training and experimentation of machine learning and artificial intelligence models.

Student Support Services

The Graduate School's role is to foster excellence in all dimensions of post-baccalaureate studies as the primary advocate for graduate education and for graduate students at the University. It administers student admissions, financial aid, orientation, professional development, student mentoring, peer advising, funding support, and training for Teaching Assistants.

- The Graduate School strategically plans, implements, and evaluates services and programs to facilitate student enrollment and success. This unit collaborates with many offices in Academic Affairs, such as Financial Aid, Residency Determination, and Registrar, to facilitate seamless services for graduate students. The Graduate School also coordinates with graduate program directors in each program to ensure that admitted students receive the faculty support needed to be successful.

- The Center for Graduate Life provides graduate students with centralized space dedicated to their needs and creates a stronger graduate community by promoting shared experiences, discourse, and activities designed to support interdisciplinary learning. Professional development courses and workshops which are provided support the development of "core competencies" in teaching, research, writing, leadership and ethics of graduate students. Mentoring support, teaching assistant training, and personal development programs are also offered through the Center.

- Consistent with the institution's mission of promoting student learning and development of its students, the Graduate and Professional Student Government works closely with the Assistant Dean for Student Affairs in the Graduate School to promote student self-governance and student leadership.

The Graduate School partners with many units on campus to offer services that enrich and support the graduate student community. Working with offices in the divisions of Academic Affairs and Student Affairs, students have access to a broad range of services that support their educational experience and success. Examples of university level student support programs, services, and activities that support student learning and success include, but are not limited to:

- Dean of Students Office manages a variety of activities such as women's programs, new student programs, volunteer outreach, student conduct, off-campus student services, SAFE mentoring program, sorority and fraternity life, Niner Nation Family program, and veteran student outreach.

- Disability Services ensures access to academic programs and campus facilities by providing verification of medical documentation, academic accommodations, counseling, testing, note-taking, and scholarships.

- Office of International Programs works with international students and scholars, and organizes activities related to acclimating to an American model of higher education. International graduate students benefit from specialized orientations and trainings, coordinated through this office.

- University Career Center offers career assessment, internships, co-ops, service-learning, job preparation, and job interview opportunities. This center connects industry and community partners with graduate students in a variety of ways.

- Writing Resources Center offers one-to-one writing instruction in writing across the disciplines from first-year to graduate, presentations, and workshops. Consultations, on-line services, and a library of writing-related instructional materials are also available. The Writing Resources Center hires graduate students as tutors, helping to meet the need for advanced writing assistance.

Physical Resources

The proposed program will not have an impact on current physical facilities or equipment. The primary infrastructure (i.e. computing resources and software, classrooms, and office space) currently exists to implement the Ph.D. in Data Science program.

Facilities are available for the Data Science program staff in the Colvard Building. All faculty have private offices, conference rooms, and workspaces. Space for new faculty, research labs, and classroom facilities is being accounted for in a current renovation and expansion of the Burson building. In the renewed Burson, SDS will have dedicated space for faculty and staff as well as interdisciplinary research space (Engineering, Computing, and Data Science). Funding for the Burson expansion has already been allocated through the state budget and System allocations. Tentative groundbreaking for the expansion is in 2024 with expected completion in 2027. Finally, the Colvard Building has $4.5M in planning funds and a $45M budget for refurbishment within the next 10 years.

Financial Support

The North Carolina Legislature, as part of the overall State budget, allocates funding for the University of North Carolina System, including UNC Charlotte. Within the UNC Charlotte budget, the State allocates a building reserve fund to cover maintenance and operation of existing facilities (housekeeping, maintenance, information technology, utilities, security, etc.), administered by UNC Charlotte's division of Business Affairs. Day-to-day operating costs (office supplies, phone service, student workers, etc.) are funded through the division of Academic Affairs, under the direction of the Provost. The year one budget for the Ph.D. in Data Science is included as **Table 1**.

Table 1. Summary of Estimated Additional Costs and Revenue for Proposed Program (Year 1)

COSTS	**1st Year**
Current	
Tenure/Tenure-Track Faculty	$ 373,524
Graduate Student Support	73,480
EHRA Non-Faculty Positions	86,198
Total Current	**$ 533,202**
New	
Tenure/Tenure-Track Faculty*	330,425
Graduate Student Support*	73,480
EHRA Non-Faculty Positions*	86,198

Libraries	20,000
Supplies and Materials	5,000
Travel, Communications, and Fixed Charges	5,000
Equipment and Technology	40,000
Other (Identify)	15,000
Total New	**$ 575,103**
Total Proposed	**$ 1,108,304**

Proposed New Revenue		
Resident Enrollment (FTE)		2
Regular Resident Tuition (Annual Rate)	$ 4,337	$ 8,674
Nonresident Enrollment (FTE)		6
Regular Nonresident Tuition (Annual Rate)	$ 18,482	$ 110,892
Tuition Differential (Annual Rate)	$ 7,000	$ 56,000
External Funding from Provost		1,000,000
Total New Sources		**$ 1,175,566**

Year 1, Budget Narrative

Year 1: Total costs $1.1M.
Of the $1.1M in annual cost to run the program, roughly 50% ($533k, see above) are reallocations from current programs where the Data Science Ph.D. program can add seats to currently taught courses. We will also receive some efficiency from utilizing SDS funds that currently support two TA positions in the MS to TAs within the Ph.D. program. We would reassign a portion of current SDS staff to the Ph.D. program.

New costs ($575k) come from two new tenure track faculty to teach the core DTSC Ph.D. cores. New costs to support two additional graduate assistantships, one EHRA staff for operations, and other misc support (library, travel, student computing).

Year 1: Revenue $1.2M
In Spring of 2024, the UNC Charlotte Provost allocated $1M in recurring funding to SDS to launch the Ph.D. program in Data Science. This is sufficient to support the launch and continuous operation of the program for at least 5 years. In addition, the tuition and State appropriation for student credit hours results in additional revenue of $176k. These combined funds will cover the new faculty, staff, library, and Teaching Assistantships for eight new Ph.D. students.

Contingency Plan

While the primary risk due to funding has been mitigated through the Spring 2024 allocation of $1M of recurring funding through the Legislative program for Engineering North Carolina's Future, should the expected revenue not materialize, or costs greatly exceed expectations, the program will manage the costs by reducing supported teaching assistantships and cross listing more courses than is currently expected. As the primary drivers of our cost are faculty and teaching assistantships, this should suffice to balance our costs and revenue.

Evaluation and Assessment

Student Learning Outcomes

As part of the Annual Report, departments must submit an annual Student Learning Outcomes Assessment Plan and Report. For each program this report documents student learning outcome assessment plans (which consist of student learning outcomes, effectiveness measures, assessment methodology, and performance outcomes), assessment data, changes made based on assessment data, and the impact of changes on student learning. Student learning outcomes for programs offered through the online delivery mode are the same as for programs offered face-to-face. Student Learning Outcomes Assessment Plans and Reports from all colleges at both the undergraduate and graduate levels, and from online and face-to-face delivery modes, are required to be completed.

College Assessment Directors (CADs) are appointed to oversee the student learning outcomes assessment process in their respective Colleges. CADs work with department chairs and program coordinators on developing Student Learning Outcomes Assessment Plans and Reports, and documenting assessment data and the impact of changes on student learning. Also, CADs act as liaisons with faculty and Office of Assessment and Accreditation (OAA) team members to improve the quality and completion of reports. OAA reviews and provides feedback on the evaluation and improvement of program student learning outcomes; the Office also conducts faculty and staff professional development workshops.

Planning

All colleges and departments within Academic Affairs periodically complete strategic plans. In addition, colleges and departments submit Annual Reports which address results for the past year and plans for the next year which are aligned to strategic plans.