The Biomedical Data Science and Informatics Joint Ph.D. Program

Clemson University and the Medical University of South Carolina

2021-22 Graduate Handbook

June 19, 2021

I. PROGRAM OVERVIEW

Introduction

The Biomedical Data Science and Informatics (BDSI) Ph.D. program is a joint Ph.D. program offered by Clemson University and the Medical University of South Carolina. The program brings together Clemson's strengths in computing, engineering, and public health and MUSC's expertise in biomedical sciences. Graduates will be prepared to manage and analyze large-scale data from a variety of sources such as electronic health records, biomedical texts, bio-sensor and imaging data, and omics data, and will possess the necessary skills for informatics careers in biology, medicine and public health, and research in prescriptive analytics. This interdisciplinary program is designed for full-time students with undergraduate or graduate computer science, math, engineering, or biomedical sciences backgrounds who wish to make a contribution to biomedical sciences and individual and societal health.

Specialized tracks will initially include precision medicine, population health, and clinical and translational informatics.

Precision medicine focuses on disease treatment and prevention and takes into account individual variability in genes, environment and lifestyle.

Population health addresses the health outcomes of a group of individuals, including the distribution of such outcomes within the group.

Clinical and translational informatics focuses on delivery of healthcare services and the translation of scientific discoveries from the bench to medical care at the bedside.

Additional tracks may be developed to meet developing research interests and health needs.

The Ph.D. in Biomedical Data Science and Informatics is a research degree. Students will have the opportunity to work directly with faculty on research related to data science and informatics, and to actively engage in developing research proposals, conducting research, writing abstracts and manuscripts, and presenting findings.

II. GENERAL INFORMATION

University Policy

The information in this handbook is specific to the Biomedical Data Science and Informatics joint Ph.D. program. For university policy related to continuous enrollment and time to degree, along with academic grievances, integrity, and standards, and other university- and college-level policies, please visit the handbooks and bulletins for your home institution.

For BDSI students having MUSC as their home institution, please see the policies and guidelines posted to https://education. musc.edu/students/enrollment/bulletin/policies-and-guidelines.

For BDSI students having Clemson as their home institution, please see the Graduate School Handbook at https://www. clemson.edu/graduate/students/policies-procedures/index.html.

Contacts

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The Application Process

Applicants must possess a Bachelor's or Master's degree from an accredited institution, with backgrounds in biomedical or health sciences, computing, mathematics, statistics, engineering, or related disciplines. Coursework requirements include:

◦ One year of calculus
◦ One year of college biology
◦ Computer programming coursework or substantial industry experience

Courses in multivariate calculus, linear algebra, probability and statistics, and biostatistics are also recommended, as is relevant research experience.

Additional application requirements can be found at https://www.clemson.edu/ graduate// admissions/preparing-to-apply/supporting-materials.html. Along with the material listed here, the program also requires the general GRE, and either TOEFL or IELTS scores for international applicants without a US degree. These scores should be sent directly from the ETS and IELTS offices. For detail on how to request official GRE and TOEFLS scores, please see https://www.ets.org/gre/revised_general/scores/send/. Our institutional ETS code is 5111. No department code is necessary. For detail on how to request IELTS scores, see https://www.ielts.org/en-us/usa/ielts-for-test-takers/results.

Students selected from the initial review may be asked to interview with members of the admissions committee. These interviews may take place in person, or via synchronous video technology.

Students will have a designated "home institution"—either Clemson or MUSC—at which they will be physically located. Applicants should indicate a preference for primary institution at the time of application. The admissions committee decides the home institution for each admitted student, taking this preference into consideration

Admissions recommendations for the Ph.D. program are made by the Joint BDSI Admissions Committee. Final admissions decisions rest with the Graduate Schools of Clemson University and the Medical University of South Carolina.

The deadline to apply to the BDSI Ph.D. program is January 15, although applicants are encouraged to submit early. The program admits during the Fall semester only.

Transfer Credits/Exemptions

With the approval of their Major Advisor and the BDSI Graduate Program Coordinator, students may transfer or exempt credits for recent graduate-level course work taken at other accredited institutions prior to admission into the BDSI Ph.D. program. Only those courses assessed to be equivalent (none from correspondence or research courses) and in which a grade of 3.0 or above was received will be acceptable for transfer or exemption to the program of study.

Financial Assistance

Full-time PhD students on assistantships receive both a stipend and tuition support. Assistantships are awarded on a competitive basis to qualified students, both domestic and international. All qualified students are considered for assistantships when applications are processed.

Graduate students are eligible for an assistantship if they are enrolled in full-time graduate study, in good academic standing, and making satisfactory progress toward their degree. Full-time study during the Fall and Spring semester is 9 credit hours. Assistantships that occur over the summer also require summer enrollment. Full-time study during the summer semester is 6 credit hours.

III. Degree Requirements

Prerequisite Coursework

Given that students will enter the program from a variety of disciplines, a student may already be well prepared in some of the topical areas and at the same time may lack recommended preparation in other areas. Accordingly, the graduate coordinator may waive or substitute a course to avoid duplication in an area in which a student has already demonstrated mastery, or may require remedial work in areas in which the student's preparation is lacking. Such remedial work will be in addition to the degree requirements of the program. Each student's program of study will be crafted in consultation with the

graduate coordinator and the student's advisory committee to address the individual student's background and goals.

In cases where a student lacks pre-requisites for a required course, the student will be asked to complete both the pre-requisite coursework and the required course.

Required Coursework

Ph.D. students are required to take a minimum of 65 credit hours to complete the program. These hours are divided into 5 areas:

- Area I: Biomedical Informatics Foundations and Applications (15-16 hours)
- Area II: Computing/Math/Stats/Engineering (18 hours)
- Area III: Population Health, Health Systems, and Policy (5-6 hours)
- Area IV: Domain Biology/Medicine (3-4 hours)
- Area V: Lab rotations, seminars, doctoral research (24 hours)

A detailed map of the program's curriculum can be found at
https://www.cs.clemson.edu/bdsi/images/phdfall2020curriculum.pdf.

All BDSI Ph.D. students will take graduate courses from both institutions. Students will not be required to travel between campuses as courses will be made available to students both on-campus and via synchronous remote technology, although certain courses may require short 3-5 day in-person sessions to open the semester. Courses are offered at the Clemson main campus, MUSC main campus, the University Center at Greenville, and the Zucker Family Graduate Education Center on CURI campus, North Charleston. Requests to take non-required courses at a student's non-home institution will be considered on a case-by-case basis.

For MUSC course descriptions, please visit https://gradstudies.musc.edu/current-students/course-descriptions.

For Clemson course descriptions, please visit http://catalog.clemson.edu/content.php?catoid=26&navoid=781.

Once coursework is completed, students may maintain enrollment by registering for at least 1 credit hour of dissertation research. At MUSC, a student may register for 1 credit hour only once.

Orientation

In addition to the New Graduate Student and International Student orientations offered by the student's home institution, a program orientation for new students is held before Fall classes begin. During the program orientation, students are introduced to faculty and staff, and given detail about the program, its degree requirements, and current research projects. An orientation schedule will be shared with newly admitted students the summer before they matriculate into the program.

Advising

Upon entering the program, students without a research advisor will be advised by the BDSI Graduate Program Coordinator for their home institution. During this period, the Graduate Program Coordinator will provide guidance regarding coursework and carry out selected academic functions related to program requirements. There is no relationship of funding between the student and the Graduate Program Coordinator during this time.

Students without a research advisor are encouraged to confer with their Graduate Program Coordinator before registering, as well as when adding or dropping courses.

Plan of Study

Students will work with their Graduate Program Coordinator, Advisor, and Dissertation Committee to construct a plan of study that conforms to course requirements, and takes into account both the student's prior preparation and intended area of research. Because the curriculum will be tailored to each student, the time needed to complete the degree will vary, but it is generally expected that students can complete the degree in five years or less.

For Clemson students, the plan of study is documented by filing a GS2-Plan of Study. Both the student's curriculum and dissertation committee may be revised as necessary by submitting a new GS2. Directions and filing deadlines for the GS2 can be found at https://www.clemson.edu/graduate/students/plan-of-study/index.html.

At Clemson, a plan of study must be on file and signed by the student's dissertation committee prior to sitting for the qualifying exam.

Ph.D. Advanced Qualifying Exam

After completing the majority of required coursework, and under the advice of the student's Advisor, the student should prepare for the Advanced Qualifying Examination. The examination is offered once per year on a determined date and is prepared by the BDSI Student Progress Committee. The examination assesses competency in each of Areas I-IV as outlined in the BDSI curriculum. Students who pass all four areas pass the examination. Students who pass three of the four areas are allowed to retake the area they failed the following year. Students who pass two or fewer areas do not pass the examination.

Students who do not pass the examination will be asked to retake the entire examination the following year. Students who fail to pass the examination more than once may be recommended for dismissal.

Dissertation Advisory Committee

Students should select a Dissertation Advisor once they have selected an area of research, preferably by the end of the student's first year. All Dissertation Advisors must have their primary appointment in the student's home institution. Additionally, the Dissertation Advisor must be a full member of either MUSC's Graduate Faculty of the College of Graduate Studies or Clemson's Graduate Faculty. Once the Dissertation Advisor is selected, the student should meet with the Advisor as often as needed to discuss course selection and research.

It is the responsibility of the Dissertation Advisor, in consultation with the student, to select a Dissertation Advisory Committee. The Dissertation Advisory Committee will guide the student's research, and assume responsibility for the student's progress toward the degree. Prior to the first meeting of the Dissertation Committee, the student must present the Committee with a plan of study, with grades received in all courses completed. The Dissertation Committee, after review of the plan of study and in consultation with the Graduate Program Coordinator, may suggest further coursework deemed beneficial.

Students should attempt to meet formally with their entire committee at least once each semester. Selection of the student's committee members, including the Dissertation Advisor, requires the mutual consent of the student and the faculty selected. A student is free to dissolve an existing committee and form a new one at any time. Similarly, the Dissertation Advisor is free to step down, and committee members to leave the committee, if research interests change or relationships prove incompatible.

The selection of the Dissertation Committee
Students will be asked to select their dissertation committee prior to taking the advanced qualifying exam. At MUSC, both the Dissertation Advisor and the Dissertation Advisory Committee must be approved by the Graduate Training Director and the Department Chair.

The composition of the Committee is as follows:
1. The committee must be composed of at least 5 members.
2. The student's research advisor must serve as the committee chair and must come from the student's home institution.
3. At least 1 committee member must be from the student's non-home institution.
4. At least three committee members must be designated as BDSI core faculty.

At Clemson, the dissertation committee is selected and approved through the submission of the GS2-Committee Selection. Directions and filing deadlines for the GS2-Committee

Selection can be found at https://www.clemson.edu/ graduate/students/plan-of-study/index.html.

Plan of Research

After passing the advanced qualifying exam, students should prepare a Plan of Research, in consultation with their Dissertation Advisory Committee. At MUSC, the topic chosen for the thesis or dissertation must be approved by the Department Chair for Public Health Sciences, with regard to the scope of research and the availability and utilization of departmental resources, as well as by the Dean of the College of Graduate Studies.

The Plan of Research should identify either a methodological problem or a hypothesis to be tested, and describe the design and approach for addressing the proposed problem. This proposal should show evidence of creative integration of course material, as well as a sound understanding of the relevant literature, and should follow the format of a National Institute of Health (NIH) F31 grant proposal or National Science Foundation (NSF) grant application. An NIH-style proposal should include a specific aims page along with 6 pages explaining the proposal's significance, innovation, and approach, as well as an additional chapter of literature review of approximately 5,000 words. An NSF-style proposal should include a summary page along with 15 pages of project description. In the NSF-style proposal, the project description should include a thorough literature review. The list of references in the bibliography will not be included in any of the required page counts

Once completed, students should submit a written copy of their Plan of Research to each member of their Dissertation Committee and schedule a date for the proposal defense, allowing a minimum of two weeks prior to the proposal's presentation for review of the written document. At MUSC, the student also notifies the Public Health Sciences Department Chair and the Graduate Training Director of the date and submits a copy of the Plan of Research to both.

Students should consult the Graduate Services Coordinator at their home institution for detail regarding the scheduling protocol and approval process for their Plan of Research. On the date of the scheduled proposal, the student will present the Plan of Research publicly, then defend the plan to their dissertation committee during a closed-door session. The public presentation should begin with a formal 45–50 minute presentation that outlines the student's research questions, their significance, and the methods proposed for their solution. The presentation is then followed by a question-and-answer session with the audience before the student completes the closed-door session with their Dissertation Committee.

If the proposal is not approved, it may be repeated an indefinite number of times, subject to the consent of the Committee. Upon successful completion of both the qualifying examination and the proposal defense, the Dissertation Advisory Committee recommends that the student be admitted to candidacy by their signatures on the Admission to Candidacy form at MUSC, and on the Research Approval Form at Clemson. A successful proposal must occur at least one year prior to the date of the student's final defense.

Ph.D. Dissertation

A dissertation based on original investigation is required of all Ph.D. students. The dissertation must give evidence of mature scholarship and critical judgment, demonstrate methodologic rigor indicating knowledge of research methods and techniques, and demonstrate the student's ability to carry out independent investigation.

Students should strive to present the results of their research at a national or international meeting of a professional society and to publish their results in a peer-reviewed professional journal prior to graduation. A distinguished publication record is considered by the academic community as the primary indicator of professional qualification in the sciences.

For formatting guidelines and submission protocol, students should consult the Graduate Services Coordinator at their home institution.

Oral Defense of Doctoral Dissertation

Each Ph.D. candidate is required to pass a final oral examination directed primarily to the defense of the dissertation. The defense of the dissertation is a rigorous examination intended to test the student's knowledge of the research covered in the dissertation, as well as their general knowledge of the related fields of study. The dissertation defense begins with a formal 45-50 minute public presentation describing the research methods and results, which is followed by questions from the audience. The candidate's Dissertation Committee then conducts an oral examination in a closed-door session to test the candidate's understanding of the area of research. Performance on this examination must receive approval of the student's Dissertation Committee before the student will be recommended for the Ph.D. degree.

Students should consult the Graduate Services Coordinator at their home institution for detail regarding the scheduling protocol for their oral defense.