Areas of Study

BIOSTATISTICS

(MA, PhD)

BIOSTATISTICS

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I. Biostatistics Programs

INTRODUCTION

Since its inception in 1955, the Graduate Group in Biostatistics has offered academic degree programs leading to the Master of Arts (MA) and Doctor of Philosophy (PhD) degrees. The curriculum offers instruction in statistical theory and computing, as well as opportunities to rigorously apply this knowledge in biological and medical research.

MISSION

The mission of the Graduate Group in Biostatistics is to train students to collect and explore relevant data that address issues in the biological, health, and medical sciences; acquire techniques to better understand such data; develop core methodological research skills including loss-based estimation (e.g., classification, estimation, model selection), semi-parametric estimation, cross-validation, multiple hypothesis testing, survival analysis, clinical trials, adaptive designs, causal inference, and statistical computing; and apply research skills to areas including epidemiology, genetics, medicine , and molecular biology.

II. Biostatistics MA Requirements

PROGRAM OVERVIEW

The MA degree in Biostatistics is completed in four semesters. Candidates for this degree are expected to earn 48 units with courses in biostatistics, statistics, public health, and biology, with a 12-unit per semester minimum enrollment. The program is completed by writing a thesis (Plan I) or taking a comprehensive oral exam (Plan II). Students are expected to enroll for all four semesters of the program; therefore, use of the filing fee in the final semester is not an option.

COMPETENCIES

- Understand foundations of statistical inference, e.g., maximum likelihood estimation, regression.
- Understand the theoretical framework, scope, and assumptions of methods in the following areas:
  - Multivariate analysis
  - Computational statistics
  - Categorical data analysis
  - Survival analysis
  - Longitudinal data analysis
  - Causal inference
  - Clinical trials
  - Statistical genomics
  - Statistical computing
- Have the ability to soundly apply methods in the aforementioned areas.
- Have the ability to translate subject-matter questions into precise statistical questions and to identify and apply pertinent methods to address these questions.
- Have fluency in statistical programming languages for both analysis using classic methods and implementation of novel methods.

» Effectively communicate research findings, orally and in writing.

CURRICULUM

The curriculum in Biostatistics involves courses from a wide variety of areas spanning the mathematical and biological sciences. The core to this curriculum includes: loss-based estimation (e.g., classification, regression, density estimation, model selection), semi-parametric estimation, cross-validation, multiple hypothesis testing, survival analysis, clinical trials, adaptive designs, causal inference, and statistical computing. Courses in the biomedical sciences, such as epidemiology, genetics, and microbiology, are also part of the curriculum and are fundamental for an understanding of subject-matter issues.

Students are expected to take STAT 201A and 201B and at least four courses from the core PB HLTH C240 (A, B, C, D, E, and F) and PB HLTH 252D-E. This requirement may be waived for students who have had coursework in these subject areas before entering the program and who will want to take advantage of more advanced course offerings (e.g., STAT 215A, B and STAT 210 A, B). The 12-unit per semester minimum enrollment requirement may be met with independent research or seminar courses. A program of courses tailored to suit each student's background and interests may be arranged with a graduate adviser.

Courses in the Biostatistical Methods PB HLTH C240 series (A, B, C, D, E, and F) are designed to introduce students to basic concepts as well as cutting-edge topics. These courses are cross-listed in the STAT C245 series. Part A concerns fundamentals of biostatistical theory and practice; Part B survival analysis; Parts C and D computational statistics with applications in biology and medicine; Parts E and F statistical genomics. Courses in the Special Topics in Biostatistics PB HLTH 243 series cover a wide range of more specialized topics corresponding to specific faculty interests and expertise. One goal of these courses is to introduce students to current issues that might potentially lead to dissertation projects. Topics presented and course format will depend on instructor preference.

Biostatistics Core Courses

PB HLTH C240A	Introduction to Modern Biostatistical Theory and Practice
PB HLTH C240B	Survival Analysis and Causality
PB HLTH C240C-D	Computational Statistics with Applications in Biology and Medicine I and II
PB HLTH C240E-F	Statistical Genomic I and II
PB HLTH 252D-E	Causal Inference I and II

In addition to the core Biostatistical Methods PB HLTH C240 series, the following is a non-exhaustive selection of courses of interest to Biostatistics students.

Other Biostatistics Courses

PB HLTH 241	Statistical Analysis of Categorical Data
PB HLTH 242A	Biometrical Data Analysis: Pathological Incomplete Data and Pattern Recognition
PB HLTH 242B	Biometrical Data Analysis: Model Free Curve Estimation
PB HLTH C242C	Longitudinal Data Analysis
PB HLTH 243C	Information Systems in Public Health
PB HLTH 243D	Special Topics in Biostatistics: Adaptive Designs
PB HLTH 244	Big Data: A Public Health Perspective
PB HLTH 245	Introduction to Multivariate Statistics
PB HLTH C246A	Censored Longitudinal Data and Causality

Theoretical and Applied Statistics Courses

STAT 152	Sampling Surveys
STAT 201A, B	Introduction to Probability and Statistics at an Advanced Level
STAT 204	Probability for Applications
STAT C205A, B	Probability Theory
STAT 210A, B	Theoretical Statistics
STAT 215A, B	Statistical Models: Theory and Application
STAT 230A	Linear Models
STAT 232	Experimental Design
STAT 240	Nonparametric and Robust Methods STAT C241A Statistical Learning Theory
STAT 272	Statistical Consulting

Statistical Computing Courses

STAT 133	Concepts in Computing with Data
STAT 243	Introduction to Statistical Computing STAT 244 Statistical Computing
PB HLTH 144A	Introduction to SAS Programming
PB HLTH 144B	Intermediate SAS Programming

Epidemiology and Other Courses

PB HLTH 250A,B, C	Epidemiologic Methods
PB HLTH 252	Epidemiological Analysis
PB HLTH 254	Occupational and Environmental Epidemiology
PB HLTH 256	Molecular and Genetic Epidemiology and Human Health in the 21st Century
EDUC 275G	Hierarchical and Longitudinal Modeling

Seminars and Variable Unit Courses

PB HLTH 295	Statistics and Genomics Seminar
PB HLTH 296	Special Study
PB HLTH 299	Independent Research
PB HLTH 375B	Instructional Techniques in Biostatistics
STAT 278B	Statistics Research Seminar
STAT 298	Directed Study for Graduate Students
STAT 299	Individual Study Leading to Higher Degrees

NOTE: that enrollment in many seminars and variable unit courses requires approval of the faculty member in charge.

Other departments where biostatistics students find many relevant courses include: Mathematics (analysis, differential equations, and linear algebra), Molecular and Cell Biology (computational biology, genetics, molecular biology), and Computer Science (optimization, parallel computing).

A complete list of courses offered in Biostatistics, Statistics, and other fields of interest can be found in the Course Catalog.

THESIS (PLAN I)
The Master's Thesis is filed at the end of the two-year MA program. The decision to complete a thesis must be made and declared early in the semester the student plans to graduate. Students are encouraged to solicit committee membership from among the Biostatistics Graduate Group faculty. Requirements for the configuration of the MA thesis committee are as follows: Thesis Committee Membership consists of three faculty members, with two "inside" members from the Graduate Group in Biostatistics and one "outside" member not belonging to the Group (a.k.a. "Academic Senate Representative"). If an outside member cannot be identified, a third member from the Group in Biostatistics is permissible. The Committee Chair must be an inside member (from within the Group in Biostatistics).

COMPREHENSIVE EXAMINATION (PLAN II)
Students may take the oral comprehensive examination in lieu of writing an MA thesis at the end of the two-year MA program. The decision to take the comprehensive exam must be made and declared early in the semester the student plans to graduate. The comprehensive examination committee is appointed by the Head Graduate Adviser, and consists of two faculty members from the Group in Biostatistics. The MA comprehensive examination is designed to test a candidate's breadth and depth of knowledge and understanding of material from the curriculum, as well as ability to articulate and explain basic concepts. Each examiner negotiates with the candidate a topic to explore. Candidates are expected to write a short essay on each of these topics and provide the written materials to each examiner at least three weeks before the oral exam. During the oral exam, examiners are free to question the candidate for more background, methodological detail, or examples. The comprehensive examination lasts about 90 minutes.

APPLYING TO THE DOCTORAL PROGRAM
Some students pursuing the MA degree intend to continue directly into a PhD program, while others take research positions in federal agencies, state and local health departments, health care delivery organizations, and private industry. MA students interested in continuing into the UC Berkeley Biostatistics doctoral program immediately following their MA degree should petition to add the new degree program through the online application for admission during their second year of study during the normal admissions cycle.

III. Biostatistics PhD Requirements

PROGRAM OVERVIEW
A PhD degree in Biostatistics requires a program of courses selected from biostatistics, statistics, and at least one other subject area (such as biology, environmental health, or epidemiology), an oral qualifying examination, and the completion of a dissertation. Courses cover traditional topics as well as recent advances in biostatistics and statistics. Since graduates with doctorates often assume academic research and teaching careers, a high degree of mastery in research design, theory, methodology, and execution is expected, as well as the ability to communicate and present research findings in a clear, understandable manner.

The PhD degree program requires a minimum of four semesters of registration. Since there are no formal course requirements for the PhD, other than the completion of the MA course requirements, a program of courses appropriate to a student's background and interests may be developed with a graduate adviser.

COMPETENCIES

- Understand foundations of statistical inference, e.g., maximum likelihood estimation, regression
- Understand the theoretical framework, scope, and assumptions of methods in the following areas:
  - Multivariate analysis
  - Computational statistics
  - Categorical data analysis
  - Survival analysis
  - Longitudinal data analysis
  - Causal inference
  - Clinical trials
  - Statistical computing
- Have the ability to soundly apply methods in the aforementioned areas.
- Have the ability to translate subject-matter questions into precise statistical questions and to identify and apply pertinent methods to address these questions.
- Have fluency in statistical programming languages for both analysis using classical methods and implementation of novel methods.
- Effectively communicate research findings, orally and in writing.
- Have the ability to develop novel methodology and validate the proposed methodology both theoretically and empirically.
- Have the ability to implement novel methodology in reliable software packages to be released to the scientific community.
- Have the ability to teach statistics at the university level.

CURRICULUM

PhD students are expected to have completed the MA course requirements, either as part of their prior MA degree or upon joining the PhD program at UC Berkeley. A program of courses appropriate to a student's background and interests may be developed in consultation with a faculty adviser.

Please refer to the "Biostatistics MA Requirements" section for details on curricular requirements and a list of suggested courses.

QUALIFYING EXAMINATION

The primary purpose of the oral qualifying examination is to test both a candidate's general competence in statistical theory and the ability to apply statistical methods to a subject-matter area. The exam is designed to measure breadth and depth of knowledge, as well as provide a determination of the candidate's readiness to enter the research phase of study. To assure the examining committee that the candidate has both a firm grasp of statistical foundations and familiarity with current problems in the field, the examination is conducted as follows:

1. The candidate is expected to begin with a 45-minute presentation of a dissertation topic, including a review of previous work and the proposal of a sound research strategy.
2. Following this presentation, the candidate is asked to demonstrate an ability to synthesize the methods learned through courses and to soundly apply this knowledge to areas and problems suggested by committee members. To achieve this goal, committee members

are likely to ask questions that delve into subjects that go beyond the chosen area of dissertation research.

3. The committee for the PhD Qualifying Examination consists of four faculty members: three "inside" members from the Graduate Group in Biostatistics and one "outside" member not belonging to the Group (a.k.a., "Academic Senate Representative"). At least two inside members must be core biostatistics faculty (from within the Division of Biostatistics) and one additional inside member must be faculty from another department but still a member of the Graduate Group in Biostatistics. The outside member must belong to the UC Berkeley Academic Senate (i.e., may not be an adjunct or clinical faculty or a lecturer) and may not be a member of the Group in Biostatistics. The chair of the qualifying examination committee must be a member of the Group in Biostatistics but may not serve as chair of the dissertation committee, though it is expected that the proposed chair of the dissertation committee will serve on the qualifying examination committee.

   The Graduate Division must approve this committee at least three weeks prior to the exam itself. The candidate should meet with the chair of the qualifying examination committee to discuss the structure of the exam and any other pertinent issues. To be eligible for the examination, a student must have a grade-point average of at least 3.0. The examination is scheduled for three hours.

DISSERTATION

The candidate's research is conducted under the guidance of a dissertation committee that consists of three faculty members, with two "inside" members from the Graduate Group in Biostatistics and one "outside" member not belonging to the Group. The committee chair, which must be a member of the Group in Biostatistics, is primarily responsible for supervising the student's research progress. The dissertation committee must be in place at the time the student submits the Application for Candidacy to the Graduate Division.

It is important for the student to meet regularly with the chair and other members of the dissertation committee. All members of the committee should approve the dissertation before it is put into final form. Instructions on the preparation and submission of the dissertation are available from the Graduate Division. The student is responsible for following these instructions, including obtaining all signatures of approval, and should allow ample time to complete all requirements well before the date when s/he plans to file the dissertation. A PDF file of the final version of the dissertation should be provided to the Group in Biostatistics.

DESIGNATED EMPHASIS

Students enrolled in the PhD program are eligible to apply for interdisciplinary study in a designated emphasis (DE). A designated emphasis for the PhD degree is the analogue of a minor in baccalaureate programs. Applications for a Designated Emphasis are reviewed on a rolling basis throughout the year; however students must apply prior to taking the qualifying exam and are strongly encouraged to begin the application process early in the third semester of graduate study. DE may place additional requirements on coursework and on the compositions of qualifying examination and dissertation committees. Please consult individual DE websites for details:

Computational and Genomic Biology (DE-CGB)

Computational and Data Science and Engineering (DE-CDSE)