Harvard University PhD Program in Health Policy
Methods for Policy Research Concentration
2018-2019

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INTRODUCTION
General description of the Methods for Policy Research (MPR) concentration:
Training in the MPR concentration will position students to conduct rigorous, policy-relevant research. The concentration includes intensive methodological training that draws from several quantitative fields, including statistics, econometrics, and epidemiology, and also offers opportunities to learn qualitative methods. Students in the MPR concentration will also develop proficiency in experimental and quasi-experimental research designs. The MPR concentration does not require training in a specific discipline of social science, but students are allowed to use two of their distributional requirements to acquire some disciplinary training (e.g., in economics or sociology), and many students pursue additional coursework in a substantive area of interest or advanced levels of statistics. By virtue of this training, MPR students develop a multi-disciplinary toolkit that borrows from the strengths of different quantitative sciences and supports novel applications to health-related questions. Graduates are able to communicate and collaborate effectively with statisticians, economists, epidemiologists, and clinician-investigators, as they lead their independent work. The concentration’s broad methodological training flexibly supports scholarship on a wide range of topics, including common areas of interest in health services research related to health care access, quality, costs, and disparities, but also questions focused on clinical decision-making, behavior (e.g., of patients, physicians, or organizations), social determinants of health, and social programs with implications for health. Graduates of the MPR concentration have used their training to study, for example:

POLICY EVALUATION
- Impact of acquiring Medicare coverage on the health of previously uninsured adults
- Effects on health behavior of insurance restrictions on maternity lengths of stay
- Effects of drug coverage on access to essential medications in Medicare
- Effects of regulatory changes in legal drinking ages on health and mortality

QUALITY OF CARE AND CLINICAL DECISION-MAKING
- Effects of physician experiences with adverse medical events on under-prescribing of essential medicines
- A controlled natural experiment on the effectiveness of direct to consumer drug advertising

DISPARITIES
- Effects of near-universal Medicare coverage on disparities in cardiovascular disease and diabetes control
- Methods to estimate racial/ethnic health care disparities and their effects on health

COMPARATIVE HEALTH POLICY
- International differences in health outcomes following medical care for acute myocardial infarction

POPULATION HEALTH
- Effects of unemployment on mortality

METHODS
- Potential bias of instrumental variable analyses for observational comparative effectiveness research

last updated: 8/31/2018
Courses for students in the methods for policy research concentration:
The course requirements for the Methods for Policy Research concentration were selected to provide students with
important skills needed for conducting original health policy research; at the completion of coursework, students should
be able to propose feasible study designs to answer health policy questions, as well as identify the strengths and
limitations of the various designs in their proposed work and in other published studies. They also will develop strong
analytical skills, including the technical expertise required to analyze data as well as interpret results, identify the
strengths and limitations of analyses, and the broader implications of results for future health policy.

The following course requirements encompass both methods and research design. Students are required to take at least 9
credits of methods. The 9 credits include required coursework in research design, probability, inference, and regression,
and additional coursework in other specific areas from which students can choose (e.g., program evaluation, hierarchical
modeling, causal inference, machine learning, analysis of survey data, or qualitative methods). **Incoming students
should also be aware that many of the intermediate and advanced courses have prerequisites. In addition, some
courses are offered only in alternative academic years, and scheduling conflicts do occur. Due to these issues,
incoming students should plan a tentative two-year course program early in the first year. They should also
consult with more senior students about their tentative program for additional feedback and suggestions.** In
planning their required coursework in probability, inference, and regression, students are encouraged to follow a basic
sequence of courses **within a particular school or department** (i.e., Biostatistics, Statistics, Economics, or HKS) as
opposed to selecting from multiple schools/departments. This is recommended in order to facilitate a more coherent
presentation of the fundamentals. Subsequently, students are encouraged to choose courses based on interests and career
objectives from among all schools/departments and to expose themselves to the diversity languages, emphases, and
approaches.

**OVERVIEW OF MPR AND PROGRAM COURSE REQUIREMENTS**

<table>
<thead>
<tr>
<th>MPR Requirements (9 credits)</th>
<th>Program and Distribution Requirements (6 credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Probability Theory (1 credit)</td>
<td>• Health Policy Core Course (2 credits)</td>
</tr>
<tr>
<td>• Statistical Inference (1 credit)</td>
<td>• Health Policy Research Seminar (1 credit)</td>
</tr>
<tr>
<td>• Regression (1 credit)</td>
<td>• Distribution requirements (3 credits, spanning at least 2 of the following areas)</td>
</tr>
<tr>
<td>• Impact Evaluation (1 credit)</td>
<td>o Decision Sciences</td>
</tr>
<tr>
<td>• MPR Reading Course (1 credit)</td>
<td>o Economics</td>
</tr>
<tr>
<td>• Other Data Analyses (2 credits)</td>
<td>o Ethics</td>
</tr>
<tr>
<td>• Specific Methodological Approaches (2 credits)</td>
<td>o Management</td>
</tr>
<tr>
<td>o Survey Research Methods</td>
<td>o Political Analysis</td>
</tr>
<tr>
<td>o Causal Inference</td>
<td>o Social Policy</td>
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<tr>
<td>o Decision Sciences</td>
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<tr>
<td>o Epidemiology</td>
<td></td>
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<tr>
<td>o Program Evaluation</td>
<td></td>
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<tr>
<td>o Qualitative Research</td>
<td></td>
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<tr>
<td>o Network Analysis</td>
<td></td>
</tr>
</tbody>
</table>

1 credit = 4 units at FAS/HKS/GSE = 5 units at HSPH

Notes:
1) Students in the MPR track are strongly encouraged to take courses in Survey Research Methods and Causal Inference. Students are also encouraged to supplement their curriculum with social sciences classes to gain a well-rounded understanding of the health care system. Finally, students should make an effort to regularly attend research design seminars that are held around the university.

2) MPR students may count decision sciences courses towards the PhD distribution requirements as well as towards the Specific Methodological Approaches requirement.

3) Certain courses are listed twice under different requirements, but they CANNOT count toward more than one requirement (e.g., BST 222 can count towards either Probability Theory or Statistical Inference, but not both). The classes that are listed under two requirements but that only count toward one requirement are:
   - BST 222 and Econ 2110 count as a Probability Theory or Statistical Inference course
   - Econ 2115 counts as a Statistical Inference or Regression course
   - Gov 2001 counts as a Statistical Inference or Other Data Analysis course
   - BST 232 counts as a Regression or Other Data Analysis course
   - Statistics 160 counts as an Other Data Analysis or Survey Research Methods course
   - Statistics 186 / Government 2002 counts as a Statistical Inference or Causal Inference course

4) To satisfy all MPR, program, and distribution requirements, MPR students should plan on taking 3–4 credits each semester in their first and second years. Many students TF in their second/third years, and some students take courses in their third year.

5) Students may petition the MPR concentration chairs for credit if they have previously taken one of the courses listed in this packet.

6) Students who have taken a class similar to Statistics 110 should contact Mary Beth Landrum. These students may take a more advanced probability course to satisfy the Probability Theory requirement. Alternatively, they may take an additional statistics course instead of another probability course to satisfy the Probability Theory requirement.

7) Students may petition the MPR concentration chairs if they would like a non-listed course to count towards a requirement. They may petition the DGS if they would like a non-listed course to count towards a distribution requirement.
## METHODS COURSE REQUIREMENTS IN DETAIL

<table>
<thead>
<tr>
<th>Class</th>
<th>Instructor</th>
<th>Semester</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Probability Theory (1 credit)</strong></td>
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</tr>
<tr>
<td>Statistics 110: Introduction to Probability</td>
<td>Blitzstein</td>
<td>Fall</td>
<td>MW 1:30–2:45</td>
</tr>
<tr>
<td>Statistics 171(^1): Introduction to Stochastic Processes</td>
<td>Pillai</td>
<td>Spring</td>
<td>MW 1:30–2:45</td>
</tr>
<tr>
<td>Statistics 210(^2): Probability I</td>
<td>Blitzstein</td>
<td>Fall</td>
<td>TuTh 1:30–2:45</td>
</tr>
<tr>
<td>Economics 2110: Econometrics I</td>
<td>Avery</td>
<td>Fall</td>
<td>MW 11:30–12:45</td>
</tr>
<tr>
<td>BST 222: Basics of Statistical Inference</td>
<td>Wypij</td>
<td>Fall</td>
<td>TuTh 8–9:30</td>
</tr>
<tr>
<td>Biostatistics 230 / BST 230: Probability I</td>
<td>Pagano</td>
<td>Fall</td>
<td>MW 2–3:30</td>
</tr>
<tr>
<td><strong>Statistical Inference (1 credit)</strong></td>
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<tr>
<td>Statistics 111: Introduction to Statistical Inference</td>
<td>Murphy</td>
<td>Spring</td>
<td>TuTh 1:30–2:45</td>
</tr>
<tr>
<td>Statistics 186 / Government 2002: Causal Inference</td>
<td>Imai</td>
<td>Fall</td>
<td>TuTh 1:30–2:45</td>
</tr>
<tr>
<td>Statistics 211: Statistical Inference I</td>
<td>Janson</td>
<td>Fall</td>
<td>MW 3–4:15</td>
</tr>
<tr>
<td>Economics 2110: Econometrics I</td>
<td>Avery</td>
<td>Fall</td>
<td>MW 11:30–12:45</td>
</tr>
<tr>
<td>Economics 2115: Econometric Methods II</td>
<td>Goodman</td>
<td>Spring</td>
<td>MW 1:15–2:30</td>
</tr>
<tr>
<td>Government 2001: Advanced Quantitative Research Methodology</td>
<td>King</td>
<td>Spring</td>
<td>M 3–5:45</td>
</tr>
<tr>
<td>BST 222: Basics of Statistical Inference</td>
<td>Wypij</td>
<td>Fall</td>
<td>TuTh 8–9:30</td>
</tr>
<tr>
<td>Biostatistics 231 / BST 231(^1): Statistical Inference I</td>
<td>Gray</td>
<td>Spring</td>
<td>MW 9:45–11:15</td>
</tr>
<tr>
<td>API 209: Advanced Quantitative Methods I: Statistics</td>
<td>Levy</td>
<td>Fall</td>
<td>TuTh 1:15–2:30</td>
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<tr>
<td><strong>Regression (1 credit)</strong></td>
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<tr>
<td>Statistics 139: Linear Models</td>
<td>Rader</td>
<td>Fall</td>
<td>MW 9–10:15</td>
</tr>
<tr>
<td>Statistics 244(^2): Linear and Generalized Linear Models</td>
<td>Glickman</td>
<td>Fall</td>
<td>TuTh 12–1:15</td>
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<tr>
<td>Economics 1123: Introduction to Econometrics</td>
<td>Stock (F)</td>
<td>Fall/Spring</td>
<td>(F) MW 9–10:15; (S) TuTh 1:30–2:45</td>
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<td>Economics 2115: Econometric Methods II</td>
<td>Goodman</td>
<td>Spring</td>
<td>MW 1:15–2:30</td>
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<tr>
<td>Government 2000: Introduction to Quantitative Methods I</td>
<td>Zhou</td>
<td>Fall</td>
<td>M 9–11:45</td>
</tr>
<tr>
<td>BST 211: Regression &amp; Analysis of Variance in Experimental Research</td>
<td>TBA</td>
<td>NA</td>
<td>Not offered 2018-19</td>
</tr>
<tr>
<td>BST 213: Applied Regression for Clinical Research</td>
<td>Orav</td>
<td>Fall</td>
<td>MW 8–9:30</td>
</tr>
<tr>
<td>Biostatistics 232 / BST 232: Methods I</td>
<td>Coull</td>
<td>Fall</td>
<td>MW 8–9:30</td>
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<tr>
<td>Biostatistics 235 / BST 235(^1): Advanced Regression and Statistical Learning</td>
<td>Mukherjee</td>
<td>Fall</td>
<td>MW 9:45–11:15</td>
</tr>
<tr>
<td>GHP 525: Econometrics for Health Policy</td>
<td>Canning</td>
<td>Fall</td>
<td>TuTh 8–9:30</td>
</tr>
<tr>
<td>API 210: Advanced Quantitative Methods II: Econometric Methods</td>
<td>Svoronos</td>
<td>Spring</td>
<td>TuTh 10:15–11:30</td>
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<tr>
<td><strong>Impact Evaluation (1 credit)</strong></td>
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<td>GHP 228: Econometric Methods in Impact Evaluation</td>
<td>Cohen</td>
<td>Spring</td>
<td>F 8–11:15</td>
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<tr>
<td><strong>MPR Reading Course (1 credit)</strong></td>
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<tr>
<td>Health Policy 3080A/B : Graduate Reading Course: Methods for Policy Research</td>
<td>Landrum</td>
<td>Fall/Spring</td>
<td>TBA</td>
</tr>
<tr>
<td><strong>Other Data Analyses (2 credits)</strong></td>
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<tr>
<td>Statistics 120: Introduction to Bayesian Inference and Applications</td>
<td>Ning</td>
<td>Fall</td>
<td>MW 3–4:15</td>
</tr>
<tr>
<td>Statistics 131: Time Series and Prediction</td>
<td>Jacob</td>
<td>Fall</td>
<td>TuTh 9–10:15</td>
</tr>
<tr>
<td>Statistics 149: Generalized Linear Models</td>
<td>Glickman</td>
<td>Spring</td>
<td>MW 9–10:15</td>
</tr>
<tr>
<td>Statistics 151 /EDU 5043: Multilevel and Longitudinal Models</td>
<td>TBA</td>
<td>NA</td>
<td>Not offered 2018-19</td>
</tr>
<tr>
<td>Statistics 220(^2): Bayesian Data Analysis</td>
<td>Liu</td>
<td>Spring</td>
<td>MW 1:30–2:45</td>
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<tr>
<td>Statistics 232R: Topics in Missing Data</td>
<td>TBA</td>
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<td>Not offered 2018-19</td>
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<tr>
<td>Economics 2140(^2): Econometric Methods</td>
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<td>NA</td>
<td>Not offered 2018-19</td>
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<tr>
<td>ECON 2150: Machine Learning in Econometrics</td>
<td>TBA</td>
<td>NA</td>
<td>Not offered 2018-19</td>
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<td>Government 2001: Advanced Quantitative Research Methodology</td>
<td>King</td>
<td>Spring</td>
<td>M 3–5:45</td>
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<tr>
<td>Government 2735: Empirical Models in International Relations</td>
<td>TBA</td>
<td>NA</td>
<td>Not offered 2018-19</td>
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<tr>
<td>Sociology 2211 (formerly 211 and 203b): Analysis of Longitudinal Data</td>
<td>Killewald</td>
<td>Fall</td>
<td>F 9:45–11:45</td>
</tr>
<tr>
<td>BST 210: Applied Regression Analysis</td>
<td>Lutz (F)</td>
<td>Fall/Spring</td>
<td>(F) MW 8–9:30; (S) TuTh 8–9:30;</td>
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<tr>
<td>BST 223: Applied Survival Analysis</td>
<td>Bellavia</td>
<td>Spring</td>
<td>TuTh 9:45–11:15</td>
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<tr>
<td>BST 226: Applied Longitudinal Analysis</td>
<td>Fitzmaurice</td>
<td>Spring</td>
<td>TuTh 2–3:30</td>
</tr>
<tr>
<td>BST 228: Applied Bayesian Analysis</td>
<td>Trippa</td>
<td>Fall</td>
<td>TuTh 9:45–11:15</td>
</tr>
<tr>
<td>Biostatistics 232 / BST 232: Methods I</td>
<td>Coull</td>
<td>Fall</td>
<td>MW 8–9:30</td>
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<tr>
<td>Biostatistics 233 / BST 233: Methods II</td>
<td>TBA</td>
<td>NA</td>
<td>Not offered 2018-19</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Instructor</td>
<td>Term</td>
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<tr>
<td>Biostatistics 245 / BST 245¹</td>
<td>Analysis of Multivariate and Longitudinal Data</td>
<td>Haneuse</td>
<td>Spring</td>
</tr>
<tr>
<td>Biostatistics 249 / BST 249¹</td>
<td>Bayesian Methodology in Biostatistics</td>
<td>TBA</td>
<td>NA</td>
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<tr>
<td>BST 263</td>
<td>Statistical Learning</td>
<td>Miller</td>
<td>Spring</td>
</tr>
<tr>
<td>BST 515</td>
<td>Measurement Error and Misclassification</td>
<td>TBA</td>
<td>NA</td>
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<tr>
<td>SBS 263</td>
<td>Multilevel Statistical Methods: Concept and Application</td>
<td>Subramanian</td>
<td>Spring</td>
</tr>
<tr>
<td>API 222</td>
<td>Machine Learning and Big Data Analytics</td>
<td>Saghaian</td>
<td>Fall</td>
</tr>
<tr>
<td>EDU S052</td>
<td>Applied Data Analysis</td>
<td>Ho</td>
<td>Spring</td>
</tr>
<tr>
<td>EDU S077</td>
<td>Applied Longitudinal Data Analysis</td>
<td>TBA</td>
<td>NA</td>
</tr>
<tr>
<td>MIT 6.860/9.520</td>
<td>Statistical Learning and Applications</td>
<td>Poggio Rosasco</td>
<td>Fall</td>
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</tbody>
</table>

**Specific Methodological Approaches**

*Take 2 credits from courses in any of the eight categories below*

### Survey Research Methods (recommended)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Term</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>BST 212</td>
<td>Survey Research Methods in Community Health</td>
<td>Mangione</td>
<td>Spring</td>
<td>W 3:45–5:15</td>
</tr>
</tbody>
</table>

### Causal Inference (highly recommended)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Term</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td>Statistics 186 / Government 2002</td>
<td>Causal Inference</td>
<td>Imai</td>
<td>Fall</td>
<td>TuTh 1:30–2:45</td>
</tr>
<tr>
<td>Statistics 240</td>
<td>Matched Sampling and Study Design</td>
<td>TBA</td>
<td>NA</td>
<td>Not offered 2018-19</td>
</tr>
<tr>
<td>EPI 201</td>
<td>Introduction to Epidemiology: Methods 1</td>
<td>Mittleman</td>
<td>Fall 1</td>
<td>TuTh 9:45–11:15 or TuTh 11:30–1</td>
</tr>
<tr>
<td>EPI 289</td>
<td>Epidemiologic Methods III: Models for Causal Inference</td>
<td>Hernan</td>
<td>Spring 1</td>
<td>MW 9:45–11:15</td>
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### Decision Sciences

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Term</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDS 280</td>
<td>Decision Analysis for Health and Medical Practices</td>
<td>Pandya</td>
<td>Fall 2</td>
<td>TuTh 2–3:30</td>
</tr>
<tr>
<td>RDS 282</td>
<td>Economic Evaluation of Health Policy and Program Management</td>
<td>Resch</td>
<td>Spring 2</td>
<td>MW 2–3:30</td>
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<tr>
<td>RDS 284</td>
<td>Decision Theory</td>
<td>Hammitt</td>
<td>Fall</td>
<td>MW 11:30–1</td>
</tr>
<tr>
<td>RDS 285</td>
<td>Decision Analysis Methods in Public Health and Medicine</td>
<td>Menzies</td>
<td>Spring 1</td>
<td>MW 2–3:30</td>
</tr>
<tr>
<td>API 302 / ECON 1415</td>
<td>Analytic Frameworks for Policy</td>
<td>Zeckhauser</td>
<td>Fall</td>
<td>TMW 10:15–11:30</td>
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### Epidemiology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Term</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPI 202</td>
<td>Epidemiologic Methods II: Elements of Epidemiologic Research</td>
<td>Mittleman</td>
<td>Fall 2</td>
<td>TuTh 9:45–11:15 or TuTh 11:30–1</td>
</tr>
<tr>
<td>EPI 203</td>
<td>Study Design in Epidemiologic Research</td>
<td>Hernandez-Diaz</td>
<td>Spring 2</td>
<td>TuTh 3:45–5:15</td>
</tr>
<tr>
<td>EPI 204</td>
<td>Analysis of Case-Control, Cohort, and Other Epidemiological Data</td>
<td>Chibnik</td>
<td>Spring 2</td>
<td>MW 9:45-11:15</td>
</tr>
<tr>
<td>EPI 207</td>
<td>Advanced Epidemiologic Methods</td>
<td>Robins Hernan</td>
<td>Fall 1</td>
<td>MW 3:45–5:15</td>
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### Program Evaluation

<table>
<thead>
<tr>
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<th>Course Title</th>
<th>Instructor</th>
<th>Term</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td>API 211 / EDU A164</td>
<td>Program Evaluation</td>
<td>Kane</td>
<td>Spring</td>
<td>M 4–7</td>
</tr>
<tr>
<td>HPM 543</td>
<td>Quantitative Methods in Program Evaluation</td>
<td>Curto</td>
<td>Spring 2</td>
<td>MW 2–3:30</td>
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### Qualitative Research

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<thead>
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<th>Instructor</th>
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<th>Time</th>
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</thead>
<tbody>
<tr>
<td>GHP 504</td>
<td>Introduction to Qualitative Research for Global Health</td>
<td>Yousafzai</td>
<td>Spring 1</td>
<td>MW 3:45–5:15</td>
</tr>
<tr>
<td>SBS 288</td>
<td>Qualitative Research Methods in Public Health</td>
<td>Goldman</td>
<td>Fall 1</td>
<td>F 9:45–12:45</td>
</tr>
<tr>
<td>EDU S504</td>
<td>Introduction to Qualitative Research</td>
<td>TBA</td>
<td>Fall</td>
<td>W 1–4</td>
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### Network Analysis

<table>
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<th>Course Title</th>
<th>Instructor</th>
<th>Term</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>BST 267</td>
<td>Introduction to Social and Biological Networks</td>
<td>Onnela</td>
<td>Fall 2</td>
<td>MW 3:45–5:15</td>
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### Other

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Term</th>
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<tr>
<td>Statistics 140</td>
<td>Design of Experiments</td>
<td>TBA</td>
<td>NA</td>
<td>Not offered 2018-19</td>
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<tr>
<td>Government 2010</td>
<td>Strategies of Political Inquiry</td>
<td>TBA</td>
<td>NA</td>
<td>Not offered 2018-19</td>
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<tr>
<td>SBS 245</td>
<td>Social and Behavioral Research Methods</td>
<td>Gortmaker Kenney</td>
<td>Fall</td>
<td>TuTh 8–9:30</td>
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<td>HBSDOC 4070</td>
<td>Design of Field Research Methods</td>
<td>Ely</td>
<td>Spring</td>
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¹ Advanced or very challenging course; please check prerequisites
## SUGGESTED SEQUENCE OF STATISTICS COURSES

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<tr>
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<th>Fall 1st year</th>
<th>Spring 1st year</th>
<th>Fall 2nd year</th>
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<tr>
<td>Biostatistics (Level 1)</td>
<td>1) BST 213 or BST 211</td>
<td>1) BST 223 or BST 226</td>
<td>1) BST 210</td>
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<td>Biostatistics (Level 2)</td>
<td>1) BST 230</td>
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<td>Statistics (Level 2)</td>
<td>1) STAT 110</td>
<td>1) STAT 111</td>
<td>1) STAT 139</td>
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<td>Statistics (Level 3)</td>
<td>1) STAT 210</td>
<td>1) STAT 211</td>
<td>1) STAT 220</td>
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<td>Econometrics (Level 1)</td>
<td>1) API-209 or GHP 525</td>
<td>1) API-210</td>
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<td>1) ECON 2115</td>
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<td>Econometrics (Level 2)</td>
<td>1) ECON 2110</td>
<td>1) ECON 2115</td>
<td>1) ECON 2140</td>
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FACULTY MEMBERS ASSOCIATED WITH THE MPR CONCENTRATION

Concentration Chairs
Mary Beth Landrum
    Professor of Health Policy (Biostatistics), Harvard Medical School
J. Michael McWilliams
    Warren Alpert Foundation Professor of Health Care Policy and Professor of Medicine, Harvard Medical School

Associated Faculty
Michael Barnett
    Assistant Professor of Health Policy and Management, Harvard T.H. Chan School of Public Health
Niteesh Choudhry
    Professor of Medicine, Harvard Medical School
Jessica Cohen
    Associate Professor of Global Health, Harvard T. H. Chan School of Public Health
Benjamin Le Cook
    Assistant Professor of Psychiatry, Harvard Medical School
Arnold M. Epstein
    John H. Foster Professor of Health Policy and Management, Harvard T.H. Chan School of Public Health
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Laura Garabedian
    Assistant Professor of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute
Laura Hatfield
    Associate Professor of Health Care Policy (Biostatistics), Harvard Medical School
David Hemenway
    Professor of Health Policy, Harvard T.H. Chan School of Public Health
John Hsu
    Associate Professor of Medicine, Harvard Medical School
Gary King
    Albert J. Weatherhead III University Professor
Dan Levy
    Senior Lecturer in Public Policy, Harvard Kennedy School
Christine Lu
    Associate Professor of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute
Barbara J. McNeil
    Ridley Watts Professor of Health Care Policy, Harvard Medical School
    Professor of Radiology, Harvard Medical School
Ateev Mehrotra
    Associate Professor of Health Care Policy and of Medicine, Harvard Medical School
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    Professor of Statistics Emeritus, Faculty of Arts and Sciences
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    Professor of Health Care Policy (Biostatistics), Harvard Medical School
    Professor in the Department of Biostatistics, Harvard T.H. Chan School of Public Health
Sherri Rose
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    Associate Professor of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute
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Stephen Soumerai
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Theodore Svoronos
    Lecturer in Public Policy, Harvard Kennedy School
Katherine Swartz
    Professor of Health Policy and Economics, Harvard T.H. Chan School of Public Health
James Frank Wharam
    Associate Professor of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute
### Methods Course Descriptions

**Probability Theory (1 credit)**

**Statistics 110. Introduction to Probability**

*Prerequisite:* Mathematics 1b or equivalent or above.

**Statistics 171. Introduction to Stochastic Processes**
An introductory course in stochastic processes. Topics include Markov chains, branching processes, Poisson processes, birth and death processes, Brownian motion, martingales, introduction to stochastic integrals, and their applications.

*Prerequisite:* Statistics 110 and Mathematics 21a and 21b, or equivalent.

**Statistics 210. Probability I**

*Prerequisite:* Statistics 110 or equivalent required.

**Economics 2110. Econometrics I**
Economics 2110 and 2115 comprise a two-course sequence for first-year graduate students seeking training in econometric methods at a level that prepares them to conduct professional empirical research. Economics 2110 (fall) reviews probability and statistics, then covers the fundamentals of modern econometrics, with a focus on regression methods for causal inference in observational and experimental data. Prerequisites: undergraduate courses in probability and statistics, regression analysis, linear algebra, and multivariate calculus.

**BST 222. Basics of Statistical Inference**
This course will provide a basic, yet thorough introduction to the probability theory and mathematical statistics that underlie many of the commonly used techniques in public health research. Topics to be covered include probability distributions (normal, binomial, Poisson), means, variances and expected values, finite sampling distributions, parameter estimation (method of moments, maximum likelihood), confidence intervals, hypothesis testing (likelihood ratio, Wald and score tests). All theoretical material will be motivated with problems from epidemiology, biostatistics, environmental health and other public health areas. This course is aimed towards second year doctoral students in fields other than Biostatistics. Background in algebra and calculus required.

*Prerequisite:* BST210 or BST213 or PHS 2000A&B.

**Biostatistics 230 / BST 230. Probability I**
Axiomatic foundations of probability, independence, conditional probability, joint distributions, transformations, moment generating functions, characteristic functions, moment inequalities, sampling distributions, modes of convergence and their interrelationships, laws of large numbers, central limit theorem, and stochastic processes.

*Prerequisite:* You must be a Biostatistics student or have taken BST222 to register for this course. If you have taken BST222 and are not a Biostatistics student, please ask the instructor for an instructor override.

**Statistical Inference (1 credit)**

**Statistics 111. Introduction to Statistical Inference**
The course is designed for undergraduates as their first introduction to rigorous statistical inference. Understanding the foundations will allow you to see more deeply into individual methods and applications, placing them in context and able to learn new ones (and invent new ones!) much faster having understood broad principles of inference.

*Prerequisite:* Mathematics 19a and 19b or equivalent and Statistics 110.
Substantive questions in empirical scientific and policy research are often causal. Does voter outreach increase turnout? Are job training programs effective? Can a universal health insurance program improve people's health? This class will introduce students to both statistical theory and practice of causal inference. As theoretical frameworks, we will discuss potential outcomes, causal graphs, randomization and model-based inference, sensitivity analysis, and partial identification. We will also cover various methodological tools including randomized experiments, regression discontinuity designs, matching, regression, instrumental variables, difference-in-differences, and dynamic causal models. The course will draw upon examples from political science, economics, education, public health, and other disciplines.
Prerequisite: (1) Stat 110 AND Stat 111 or (2) Gov 2000 AND Gov 2001.

Statistics 211. Statistical Inference I
Prerequisite: Statistics 111 and 210a or equivalent.

Economics 2110. Econometrics I
(listed above under Probability Theory)

Economics 2115. Econometric Methods II
Economics 2110 and 2115 comprise a two-course sequence for first-year graduate students seeking training in econometric methods at a level that prepares them to conduct professional empirical research. Economics 2115 (spring) covers topics (different methods) in current empirical research. Faculty members from across the university will teach modules each covering a different method of causal inference, including but not limited to instrumental variables, panel data methods, and regression discontinuity and kink designs. The course will emphasize a mixture of theory and application, with problem sets focused on the replication or extension of recent papers utilizing these methods.
Prerequisite: Economics 2110 or equivalent.

Graduate-level version of Gov. 1002. Meets with Gov. 1002, introduces theories of inference underlying most statistical methods and how new approaches are developed. Examples include discrete choice, event counts, durations, missing data, ecological inference, time-series cross sectional analysis, compositional data, causal inference, and others. Will require extra homework and examination problems in addition to those for Gov. 1002.
Prerequisite: Government 2000 or the equivalent.

BST 222. Basics of Statistical Inference
(listed above under Probability Theory)

Biostatistics 231 / BST 231. Statistical Inference I
Exponential families, sufficiency, ancillarity, completeness, method of moments, maximum likelihood, unbiased estimation, Rao-Blackwell and Lehmann-Scheffe theorems, information inequality, Neyman-Pearson theory, likelihood ratio, score and Wald tests, uniformly and locally most powerful tests, asymptotic relative efficiency.
Prerequisite: Biostatistics 230 or signature of instructor required.

API 209. Advanced Quantitative Methods I: Statistics
The goal of this course is to prepare students to analyze public policy issues using statistics. Topics included fall in the areas of probability theory, sampling, estimation, hypothesis testing, and regression analysis. While many students taking this class will have already taken courses in statistics and regression analysis, this course will probably place a much stronger emphasis than typical courses on conceptually understanding the statistical methods. Since the course is targeted to first-year students in the MPA/ID program, we will not shy away from using the mathematical tools needed to develop the conceptual understanding. But the emphasis of the course will be on the conceptual understanding and application of the tools rather than on the math or the mechanics behind the tools.
Note: This course is open to non-MPA/ID students only by permission of the instructor. May not be taken for credit with API-201.
Prerequisite: Multivariate calculus or linear algebra.
Regression (1 credit)

Statistics 139. Linear Models
An in-depth introduction to statistical methods with linear models and related methods. Topics include group comparisons (t-based methods, non-parametric methods, bootstrapping, analysis of variance), linear regression models and their extensions (ordinary least squares, ridge, LASSO, weighted least squares, multi-level models), model checking and refinement, model selection, cross-validation. The probabilistic basis of all methods will be emphasized.
Prerequisite: Statistics 110 and Math 21a and 21b or equivalent.

Statistics 244. Linear and Generalized Linear Models
The theory and application of linear and generalized linear models, including linear models for normal responses, logistic models for binary and multinomial data, loglinear models for count data, overdispersion and quasi likelihood methods, and models and methods for clustered (e.g., repeated measurement) correlated data.
Prerequisite: Strong statistics background required (at the second-year graduate level), Statistics 210a may be taken concurrently, Statistics 211a desirable.

Economics 1123. Introduction to Econometrics
An introduction to multiple regression techniques with focus on economic applications. Discusses extensions to discrete response, panel data, and time series models, as well as issues such as omitted variables, missing data, sample selection, randomized and quasi-experiments, and instrumental variables. Also develops the ability to apply econometric and statistical methods using computer packages.
Prerequisite: Statistics 100 or 104.

Economics 2115. Econometric Methods II
(listed above under Statistical Inference)

Government 2000. Introduction to Quantitative Methods I
Graduate-level version of Government 1000. Meets with Government 1000, an introduction to statistical research in political science with a focus on applied linear regression. Will require extra homework and examination problems in addition to those for Government 1000.
Prerequisite: Permission of the instructor for anyone other than Government Department graduate students.

BST 211. Regression and Analysis of Variance in Experimental Research
Covers analysis of variance and regression, including details of data-analytic techniques and implications for study design. Also included are probability models and computing. Students learn to formulate a scientific question in terms of a statistical model, leading to objective and quantitative answers.
Course Note: Lab or section times to be announced at first meeting.
Prerequisite: ID201 or BST201 or (BST202 & BST203) or [BST206 & (BST207 or BST208)]. Concurrent enrollment allowed.

BST 213. Applied Regression for Clinical Research
This course will introduce students involved with clinical research to the practical application of multiple regression analysis. Linear regression, logistic regression and proportional hazards survival models will be covered, as well as general concepts in model selection, goodness-of-fit, and testing procedures. Each lecture will be accompanied by a data analysis using SAS and a classroom discussion of the results. The course will introduce, but will not attempt to develop the underlying likelihood theory. Background in SAS programming ability required.
Note: Lab or section times to be announced at first meeting.
Prerequisite: ID201 or BST201 or (BST202 & BST203) or [BST206 & (BST207 or BST208)]. Concurrent enrollment allowed.

Biostatistics 232 / BST 232. Methods I
Introductory course in the analysis of Gaussian and categorical data. The general linear regression model, ANOVA, robust alternatives based on permutations, model building, resampling methods (bootstrap and jackknife), contingency tables, exact methods, logistic regression.

Biostatistics 235 / BST 235. Advanced Regression and Statistical Learning
An advanced course in linear models, including both classical theory and methods for high dimensional data. Topics include theory of estimation and hypothesis testing, multiple testing problems and false discovery rates, cross validation and model selection, regularization and the LASSO, principal components and dimension reduction, and classification methods.
**Prerequisite:** BST 231 and (BST 232 or BST 233). Background in matrix algebra and linear regression required.

**GHP 525. Econometrics for Health Policy**
This is a course in applied econometrics for doctoral and advanced master level students. The course has two primary objectives: (1) to develop skills in linking economic behavioral models and quantitative analysis, in a way that students can use in their own research; (2) to develop students' abilities to understand and evaluate critically other peoples' econometric studies. The course focuses on developing the theoretical basis and practical application of the most common empirical models used in health policy research. In particular, it pays special attention to a class of models identifying causal effects in observational data, including instrumental variable estimation, simultaneous equations and two-stage-least-squares, quasi-experiments and difference-in-difference method, sample selection, treatment effect models and propensity score methods. Lectures will be complemented with computer exercises building on public domain data sets commonly used in health research. The statistical package recommended for the exercises is Stata.

**Course Activities:** Optional review and computer lab sessions will be held.

**Note:** Students are expected to be familiar with probability theory (density and distribution functions) as well as the concepts underlying basic ordinary least square (OLS) estimation.

**Prerequisites:** BST210 or BST213; or equivalent course taken at Harvard Chan or HGSE with instructor permission.

**API 210. Advanced Quantitative Methods II: Econometric Methods**
Intended as a continuation of API-209, Advanced Quantitative Methods I, this course focuses on developing the theoretical basis and practical application of the most common tools of empirical analysis including non-linear models, instrumental variables, and panel data. Foundations of analysis will be coupled with hands-on examples and assignments involving the analysis of data sets.

**Note:** This course is open to non-MPA/ID students only by permission of the instructor. May not be taken for credit with API-202.

**Prerequisite:** API-209 or permission of instructor.

**Impact Evaluation (1 credit)**

**GHP 228. Econometric Methods in Impact Evaluation**
The objective of this course is to provide students with a set of theoretical, econometric and reasoning skills to estimate the causal impact of one variable on another. Examples from the readings explore the causal effect of policies, laws, programs and natural experiments derived from pension programs to television shows to natural disasters. We will go beyond estimating causal effects to analyze the channels through which the causal impact was likely achieved. This will require that the students are familiar with microeconomic theories of incentives, institutions, social networks, etc.

The course will introduce students to a variety of econometric techniques in impact evaluation and a set of reasoning skills intended to help them become both a consumer and producer of applied empirical research. Students will learn to critically analyze evaluation research and to gauge how convincing the research is in identifying a causal impact. They will use these skills to develop an evaluation plan for a topic of their own, with the aim of stimulating ideas for dissertation research. This is a methods class that relies heavily on familiarity with econometrics and microeconomics. These are pre-requisites for the course without exception. The course is intended for doctoral students who are finishing their course work and aims to help them transition into independent research.

The aim of this course is to prepare doctoral students in the health systems track of the Global Health and Population department for the dissertation phase of their research and thus they will be given priority in enrollment. The course is also open to other GHP doctoral students, other GHP masters students and students from other departments, conditional on having adequate training in economics and the course having enough space.

**Prerequisites:** A course in econometrics and a course in intermediate microeconomics are required. While students can get by with just these two subjects, some previous experience with regression analysis and applied economic research will be a huge advantage. Students seeing applied regression analysis for the first time in this course will most likely struggle with the reading.

**Course Note:** Students interested in taking this course must email the course instructor (cohenj@hsp.harvard.edu) by January 4, 2019. Students will be notified of their status by January 18, 2019. This essay should include the following information: name, academic department, degree program and year, previous courses taken in economics (specify if these were beginner, intermediate or advanced) and econometrics, any previous experience with impact evaluation, and the reason you want to take the course.
**MPR Reading Course (1 credit)**

**Health Policy 3080A&B. Graduate Reading Course: Methods for Policy Research**
Graduate reading course covering major topics in study design and quantitative research methods for health policy research. This course is designed to help students in the Methods for Policy Research track of the Health Policy PhD program prepare for their concentration exam.

**Other Data Analysis (2 credits)**

**Statistics 120. Introduction to Bayesian Inference and Applications**
Provides students a comprehensive understanding to the questions as of what is, how and why Bayesian. Introduction to classic Bayesian models, basic computational algorithms/methods for Bayesian inference, as well as their applications in various domain fields, and comparisons with classic Frequentist methods. As Bayesian inference finds its roots and merits particularly in application, this course puts great emphasis on enhancing students' hands-on skills in statistical computation (mostly with R) and data analysis.  
*Prerequisite:* STAT110, STAT111 and basics of R programming are required.

**Statistics 131. Time Series and Prediction**
*Prerequisite:* Statistics 111 and 139 or equivalent.

**Statistics 149. Generalized Linear Models**
Sequel to Statistics 139, emphasizing common methods for analyzing continuous non-normal and categorical data. Topics include logistic regression, log-linear models, multinomial logit models, proportional odds models for ordinal data, Gamma and inverse-Gaussian models, over-dispersion, analysis of deviance, model selection and criticism, model diagnostics, and an introduction to non-parametric regression methods.  
*Note:* Examples will be drawn from several fields, particularly from biology and social sciences.  
*Prerequisite:* Statistics 139 or with permission of instructor.

**Statistics 151 / EDS S-043. Multilevel or Longitudinal Models**
Data often have structure that needs to be modeled explicitly. For example, when investigating students' outcomes we need to account for the fact that students are nested inside classes that are in turn nested inside schools. If we are watching students develop over time, we need to account for the dependence of measurements across time. If we do not, our inferences will tend to be overly optimistic and wrong. The course provides an overall framework, the multilevel and generalized multilevel (hierarchical) model, for thinking about and analyzing these forms of data. We will focus on specific versions of these tools for the most common forms of longitudinal and clustered data. This course will focus on applied work, using real data sets and the statistical software R. R will be specifically taught and supported. While the primary focus will be on the linear model with continuous outcomes (i.e., the classic regression framework) we will also discuss binary, categorical, and ordinal outcomes. We will emphasize how to think about the applicability of these methods, how they might fail, and what one might do to protect oneself in such circumstances. Applications of hierarchical (multi-level) models will include the canonical specific cases of random-slope, random-intercept, mixed effect, crossed effect, marginal, and growth-curve models.  
*Prerequisite:* Permission of instructor required. S-052, Stat 139, or an equivalent. Jointly-offered in the Graduate School of Education.

**Statistics 160/260. Design and Analysis of Sample Surveys**
Methods for design and analysis of sample surveys. The toolkit of sample design features and their use in optimal design strategies. Sampling weights and variance estimation methods, including resampling methods. Brief overview of nonstatistical aspects of survey methodology such as survey administration and questionnaire design and validation (quantitative and qualitative). Additional topics: calibration estimators, variance estimation for complex surveys and estimators, nonresponse, missing data, hierarchical models, and small-area estimation.  
*Prerequisite:* Statistics 111 or 139 or with permission of instructor.

**Statistics 220. Bayesian Data Analysis**
Basic Bayesian models, followed by more complicated hierarchical and mixture models with nonstandard solutions. Includes methods for monitoring adequacy of models and examining sensitivity of models.  
*Note:* Emphasis throughout term on drawing inferences via computer simulation rather than mathematical analysis.
Prerequisite: Statistics 110 and 111.

Statistics 232R. Topics in Missing Data
The modern era of work on missing data problems began in the 1970s and has seen an explosion of developments since then. Seminar will focus on an updated version of a classic text, supplemented with classic articles.

Economics 2140. Econometric Methods
The class continues the first year sequence in econometrics and covers various topics of relevance in particular in applied microeconomics. The first half of the class will be taught by Maximilian Kasy, the second half by Elie Tamer.

We start by discussing Identification. The focus will be on settings and assumptions that allow to recover causal relationships, including randomized experiments, conditional exogeneity, IV methods, difference in differences, and regression discontinuity. We then proceed to a discussion of Estimation. Statistical decision theory will be introduced as a general framework to think about estimation problems and the trade-off between bias and variance. Various examples of practical relevance will be covered, including experimental design, machine learning methods such as Lasso, and “value added” estimation as popular in education, labor and related fields.

Continuing in the same spirit, the second half of class will start by an overview of methods for nonparametric estimation of regression functions and probability densities. The class continues with a discussion of approaches to Inference, including standard errors for m-estimators, clustering, two step estimators, the bootstrap, and randomization inference. The class concludes with some topics in structural estimation, in particular moment inequalities, demand analysis, and other models.

Prerequisite: Economics 2120 or equivalent.

Econ 2150. Machine Learning in Econometrics: Prediction, Estimation, and Big Data
Innovations in machine learning (‘big data’) have created many engineering breakthroughs from real time voice recognition to automatic categorization (and in some cases production) of news stories. Since these techniques are at their essence novel ways to work with data, they should also have implications for social science. This course explores the intersection of machine learning and social science and aims to answer a few questions about these new techniques: (i) How do they work and what kinds of statistical guarantees can be made about their performance? (ii) How can they be used to answer questions that interest social science researchers, such as testing theories or improving social policy; and (iii) How might they open up new research questions? We will cover standard machine learning techniques such as supervised and unsupervised learning, statistical learning theory and nonparametric and Bayesian approaches. The goal is to create a working understanding of when and how they can be profitably applied. Students will be required to apply some of these techniques themselves, but we will not cover the computational aspects of the underlying methods. The course is aimed at PhD students with a solid background in statistical techniques, such as comes from the equivalent of a first year economics PhD econometrics sequence.

(listed above under Statistical Inference)

Government 2735. Empirical Models in International Relations
This course examines statistical issues relevant to the study of international politics. The purpose is to familiarize students with different models that have been employed in research on international conflict, IPE and international institutions.

Sociology 2211 (formerly Sociology 211 and 203a). Analysis of Longitudinal Data: Seminar
This course takes an applied approach to the analysis of longitudinal data. Lectures will provide an overview of a variety of techniques, including fixed effects models, multilevel models, and duration models. Students will develop their own empirical projects and receive support as they begin to work with longitudinal datasets.

Note: Primarily for graduate students in sociology.

BST 210. Applied Regression Analysis
Topics include model interpretation, model building, and model assessment for linear regression with continuous outcomes, logistic regression with binary outcomes, and proportional hazards regression with survival time outcomes. Specific topics include regression diagnostics, confounding and effect modification, goodness of fit, data transformations, splines and additive models, ordinal, multinomial, and conditional logistic regression, generalized linear models, overdispersion, Poisson regression for rate outcomes, hazard functions, and missing data.

The course will provide students with the skills necessary to perform regression analyses and to critically interpret statistical issues related to regression applications in the public health literature.

Prerequisite: ID201 or BST201 or (BST202 and BST203) or (BST206 and (BST207 or BST208)) or permission of instructor.
**BST 223. Applied Survival Analysis**
Topics will include types of censoring, hazard, survivor, and cumulative hazard functions, Kaplan-Meier and actuarial estimation of the survival distribution, comparison of survival using log rank and other tests, regression models including the Cox proportional hazards model and the accelerated failure time model, adjustment for time-varying covariates, and the use of parametric distributions (exponential, Weibull) in survival analysis. Methods for recurrent survival outcomes and competing risks will also be discussed, as well as design of studies with survival outcomes. Class material will include presentation of statistical methods for estimation and testing along with current software (SAS, Stata) for implementing analyses of survival data. Applications to real data will be emphasized.

*Prerequisite:* BST210 or BST213 or BST232 or BST260 or PHS2000A.

**BST 226. Applied Longitudinal Analysis**
This course covers modern methods for the analysis of repeated measures, correlated outcomes and longitudinal data, including the unbalanced and incomplete data sets characteristic of biomedical research. Topics include an introduction to the analysis of correlated data, analysis of response profiles, fitting parametric curves, covariance pattern models, random effects and growth curve models, and generalized linear models for longitudinal data, including generalized estimating equations (GEE) and generalized linear mixed effects models (GLMMs).

*Course Activities:* Homework assignments will focus on data analysis in SAS using PROC GLM, PROC MIXED, PROC GENMOD, and PROC GLIMMIX.

*Note:* Lab or section times will be announced at first meeting.

*Prerequisite:* BST210 or BST213 or BST232 or BST260 or PHS2000A.

**BST 228. Applied Bayesian Analysis**
This course is a practical introduction to the Bayesian analysis of biomedical data. It is an intermediate Master's level course in the philosophy, analytic strategies, implementation, and interpretation of Bayesian data analysis. Specific topics that will be covered include: the Bayesian paradigm; Bayesian analysis of basic models; Bayesian computing: Markov Chain Monte Carlo; STAN R software package for Bayesian data analysis; linear regression; hierarchical regression models; generalized linear models; meta-analysis; models for missing data.

Programming and case studies will be used throughout the course to provide hands-on training in these concepts.

*Prerequisite:* (BST210 or PHS 2000A&B) and BST222, or permission of the instructor.

**Biostatistics 232 / BST 232. Methods I**
*listed above under Regression*

**Biostatistics 233 / BST 233. Methods II**
Intermediate course in the analysis of Gaussian, categorical, and survival data. The generalized linear model, Poisson regression, random effects and mixed models, comparing survival distributions, proportional hazards regression, splines and smoothing, the generalized additive model.

*Prerequisite:* Biostatistics 232 or signature of instructor required.

**Biostatistics 245 / BST 245. Analysis of Multivariate and Longitudinal Data**
The multivariate normal distribution, Hotelling’s T2, MANOVA, repeated measures, the multivariate linear model, random effects and growth curve models, generalized estimating equations, multivariate categorical outcomes, missing data, computational issues for traditional and new methodologies.

*Prerequisite:* Biostatistics 231 and Biostatistics 235.

**Biostatistics 249 / BST 249. Bayesian Methodology in Biostatistics**
General principles of the Bayesian approach, prior distributions, hierarchical models and modeling techniques, approximate inference, Markov chain Monte Carlo methods, model assessment and comparison. Bayesian approaches to GLMMs, multiple testing, nonparametrics, clinical trials, survival analysis.

*Prerequisite:* Biostatistics 231 and Biostatistics 232, or signature of instructor required.

**BST 263: Statistical Learning**
Statistical learning is a collection of flexible tools and techniques for using data to construct prediction algorithms and perform exploratory analysis. This course will introduce students to the theory and application of methods for supervised learning (classification and regression) and unsupervised learning (dimension reduction and clustering). Students will learn the mathematical foundations underlying the methods, as well as how and when to apply different methods. Topics will include the bias-variance tradeoff, cross-validation, linear regression, logistic
regression, KNN, LDA/QDA, variable selection, penalized regression, generalized additive models, CART, random forests, gradient boosting, kernels, SVMs, PCA, and K-means. Homework will involve mathematical and programming exercises, and exams will contain conceptual and mathematical problems. Programming in R will be used throughout the course to provide hands-on training and practical examples.

Prerequisite: BST 260 or BST 210 or BST 232.

BST 515. Measurement Error and Misclassification
This course will cover theory for valid estimation and inference in statistical analysis when covariates are misclassified or measured with error. Methods for contingency tables, generalized linear models and for survival analysis will be addressed. Topics include likelihood-based methods, regression calibration, SIMEX, instrumental variables and optimal study design.

Course Prerequisite: BIO231 and BIO223 required.

Note: Course is mutually exclusive with EPI515. You may not take both this course and EPI515.

SBS 263. Multilevel Statistical Methods: Concept and Application
This course is designed to provide doctoral students with a training experience in the concept and application of multilevel statistical modeling. Students will be motivated to think about correlated and dependent data structures that arise due to sampling design and/or are inherent in the population (such as pupils nested within schools; patients nested within clinics; individuals nested within neighborhoods and so on). The substantive motivation for analyzing such complex data structures would be to make quantitative assessments about the role of contexts (e.g., schools, clinics, neighborhoods) in predicting individual outcomes. In particular, the principles of recognizing and modeling the underlying heterogeneity in average relationships would be emphasized. Linear, non-linear, and multivariate multilevel models will be covered. Upon completion, students should be able to conceptualize multilevel modeling strategies and to undertake empirical, quantitative multilevel research. The course will be lecture-based with substantial hands-on component.

Course Activities: Data management, modeling and analysis; individual assignments; project submission and class participation.

Notes: This course is a requirement for all SBS doctoral students. Required lab.

API 222. Machine Learning and Big Data Analytics
In the last couple of decades, the amount of data available to organizations has significantly increased. Individuals who can use this data together with appropriate analytical techniques can discover new facts and provide new solutions to various existing problems. This course provides an introduction to the theory and applications of some of the most popular machine learning techniques. It is designed for students interested in using machine learning and related analytical techniques to make better decisions in order to solve policy and societal level problems. We will cover various recent techniques and their applications from both supervised and unsupervised learning. In addition, students will get the chance to work with some data sets using software and apply their knowledge to a variety of examples from a broad array of industries and policy domains. Some of the intended course topics (time permitting) include: K-Nearest Neighbors, Naive Bayes, Logistic Regression, Linear and Quadratic Discriminant Analysis, Model Selection (Cross Validation, Bootstrapping), Support Vector Machines, Smoothing Splines, Generalized Additive Models, Shrinkage Methods (Lasso, Ridge), Dimension Reduction Methods (Principal Component Regression, Partial Least Squares), Decision Trees, Bagging, Boosting, Random Forest, K-Means Clustering, Hierarchical Clustering, Neural Networks, Deep Learning, and Reinforcement Learning.

Prerequisite: An understanding of intermediate-level statistics and probability theory (e.g., API-201, API-202, or equivalent courses).

EDU S052. Applied Data Analysis
This course is designed for those who want to extend their data analytic skills beyond a basic knowledge of multiple regression analysis and who want to communicate their findings clearly to audiences of researchers, scholars, and policymakers. S-052 contributes directly to the diverse data analytic toolkit that the well-equipped empirical researcher must possess in order to perform sensible analyses of complex educational, psychological, and social data. The course begins with general linear models and continues with generalized linear models, survival analysis, multilevel models, multivariate methods, causal inference, and measurement. Specific methods exemplifying each of these topics include regression, discrete-time survival analysis, fixed- and random-effects models, principal components analysis, instrumental variables, and reliability, respectively. S-052 is an applied course. It offers conceptual explanations of statistical techniques and provides many opportunities to examine, implement, and practice these techniques using real data. Students will learn to produce readable and sensible code to enable others to replicate and extend their analyses. Attendance at weekly sections is required.

Prerequisite: Successful completion of S-040 or an equivalent course covering applied multiple regression.
EDU S077. Applied Longitudinal Data Analysis
Researchers in education and the social sciences often pose research questions about change and event occurrence over time. For instance, a researcher investigating the development of reading skills in young children might ask: How rapidly do children’s reading skills develop as they age, and do the skills of boys and girls develop at different rates? Alternatively, her questions could be framed in terms of whether and when children achieve particular developmental milestones. Then, she would ask: When does a child make the transition from "learning to read" to "reading to learn," and do children exposed to innovative reading programs make the transition at different ages? Answering these kinds of questions requires longitudinal (panel) data and the application of innovative statistical methods. The goal of S-077 is to introduce two of these methods: individual growth modeling and survival analysis. The course is a seminar in which class members must take individual responsibility for reading new material, preparing written answers to discussion questions, and providing feedback to peers. Class members will also conduct an original research project of their own devising, using the new methods; make a public presentation of their findings; and submit a final paper of their original research. The nature of the research projects is negotiable, but must directly advance class members’ professional and scholarly agenda. Enrollment is limited to advanced students who have completed the S-052 course, have arranged access to appropriate longitudinal data, and have proposed a suitable research project.

MIT 6.860/9.520. Statistical Learning and Applications
Provides students with the knowledge needed to use and develop advanced machine learning solutions to challenging problems. Covers foundations and recent advances of machine learning in the framework of statistical learning theory. Focuses on regularization techniques key to high-dimensional supervised learning. Starting from classical methods such as regularization networks and support vector machines, addresses state-of-the-art techniques based on principles such as geometry or sparsity, and discusses a variety of algorithms for supervised learning, feature selection, structured prediction, and multitask learning. Also focuses on unsupervised learning of data representations, with an emphasis on hierarchical (deep) architectures.

Specific Methodological Approaches (2 credits chosen from Survey Research Methods, Causal Inference, Decision Sciences, Epidemiology, Program Evaluation, Qualitative Research, Network Analysis, and Other)

- **Survey Research Methods**

  Statistics 160/260. Design and Analysis of Sample Surveys
  (listed above under Other Data Analyses)

  BST 212. Survey Research Methods In Community Health
  Covers research design, sample selection, questionnaire construction, interviewing techniques, the reduction and interpretation of data, and related facets of population survey investigations. Focuses primarily on the application of survey methods to problems of health program planning and evaluation. Treatment of methodology is sufficiently broad to be suitable for students who are concerned with epidemiological, nutritional, or other types of survey research.

- **Causal Inference**

  (listed above under Statistical Inference)

  Statistics 240. Matched Sampling and Study Design
  This course provides an accessible introduction to the study of matched sampling and other design techniques in any field (e.g., economics, education, epidemiology, medicine, political science, etc.) conducting empirical research to evaluate the causal effects of interventions.
  Prerequisite: Statistics 110, Statistics 111, and Statistics 139.

EPI 201. Introduction to Epidemiology: Methods I
EPI201 introduces the principles and methods used in epidemiologic research. The course discusses the conceptual and practical issues encountered in the design and analysis of epidemiologic studies for description and causal inference. The final exam requires the application of the learned skills to a real problem in epidemiology. EPI201 is the first course in the series of methods courses designed for students majoring in Epidemiology or Biostatistics, and
those interested in a detailed introduction to the design and conduct of epidemiologic studies. Students who take EPI201 are expected to take EPI202 (Methods II).

**Note:** Thursday or Friday lab required.

*Course is mutually exclusive* with EPI200, EPI208, EPI500, EPI505, ID200, and ID538. You may not take both this course and any of those courses.

**EPI 289. Epidemiologic Methods III: Models for Causal Inference**

Causal Inference is a fundamental component of epidemiologic research. EPI289 describes models for causal inference, their application to epidemiologic data, and the assumptions required to endow the parameter estimates with a causal interpretation. The course introduces outcome regression, propensity score methods, the parametric g-formula, inverse probability weighting of marginal structural models, g-estimation of nested structural models, and instrumental variable methods. Each week students are asked to analyze the same data using a different method. EPI289 is designed to be taken after EPI201/EPI202 and before EPI204 and EPI207. Epidemiologic concepts and methods studied in EPI201/202 will be reformulated within a modeling framework in EPI289. This is the first course in the sequence of EPI core courses on modeling (EPI289, EPI204, EPI207). EPI289 focuses on time-fixed dichotomous exposures and time-fixed dichotomous and continuous outcomes. Continuous exposures and failure time outcomes (survival analysis) will be discussed in EPI204, and time-varying exposures in EPI207. Familiarity with either SAS or R language is strongly recommended.

*Prerequisite:* EPI201 and EPI202; may not be taken concurrently.

### Decision Sciences

**RDS 280. Decision Analysis for Health and Medical Practices**

This course is designed to introduce the student to the methods and growing range of applications of decision analysis and cost-effectiveness analysis in health technology assessment, medical and public health decision making, and health resource allocation. The objectives of the course are: (1) to provide a basic technical understanding of the methods used, (2) to give the student an appreciation of the practical problems in applying these methods to the evaluation of clinical interventions and public health policies, and (3) to give the student an appreciation of the uses and limitations of these methods in decision making at the individual, organizational, and policy level both in developed and developing countries.

*Prerequisite:* BST201 or BST202&203 or BST206&207 or BST206&208 (all courses may be taken concurrently). Introductory economics is recommended but not required.

**RDS 282. Economic Evaluation of Health Policy and Program Management**

This course features case studies in the application of health decision science to policymaking and program management at various levels of the health system. Both developed and developing country contexts will be covered. Topics include: [1] theoretical foundations of cost-effectiveness analysis (CEA); [2] controversies and limitations of CEA in practice; [3] design and implementation of tools and protocols for measurement and valuation of cost and benefit of health programs; [4] integration of evidence of economic value into strategic planning and resource allocation decisions, performance monitoring and program evaluation; [5] the role of evidence of economic value in the context of other stakeholder criteria and political motivations.

*Prerequisite:* Students must have taken RDS280 or RDS286. Prior coursework in Microeconomics is recommended.

**RDS 284. Decision Theory**

Introduces the standard model of decision-making under uncertainty, its conceptual foundations, challenges, alternatives, and methodological issues arising from the application of these techniques to health issues. Topics include von Neumann-Morgenstern and multi-attribute utility theory, Bayesian statistical decision theory, stochastic dominance, the value of information, judgment under uncertainty and alternative models of probability and decision making (regret theory, prospect theory, generalized expected utility). Applications are to preferences for health and aggregation of preferences over time and across individuals.

**RDS 285. Decision Analysis Methods in Public Health and Medicine**

An intermediate-level course on methods and health applications of decision analysis modeling techniques. Topics include Markov models, microsimulation models, life expectancy estimation, deterministic and probabilistic sensitivity analysis, ROC analysis and diagnostic technology assessment, and cost-effectiveness analysis.

*Note:* Familiarity with matrix algebra and elementary calculus may be helpful but not required; lab or section times to be announced at first meeting.

*Prerequisite:* (BST201 or ID201) and (RDS280 or RDS286).
API 302 / ECON 1415. Analytic Frameworks for Policy
This course develops abilities in using analytic frameworks in the formulation and assessment of public policies. It considers a variety of analytic techniques, particularly those directed toward uncertainty and interactive decision problems. It emphasizes the application of techniques to policy analysis, not formal derivations. Students encounter case studies, methodological readings, modeling of current events, the computer, a final exam, and challenging problem sets.

Prerequisite: An understanding of intermediate-level microeconomic theory and introductory techniques of optimization and decision analysis; API-101, API-102, or equivalent.

Epidemiology

EPI 202. Epidemiologic Methods II: Elements of Epidemiologic Research
Introduces elements of study design, data analysis and inference in epidemiologic research. Principles and methods are illustrated with examples, and reviewed through homework and in-class exercises. May serve as an introduction to more advanced study or as a concluding course for those desiring a working knowledge of epidemiologic methods. EPI 202 extends the concepts of study design, data analysis, and inference introduced in the introductory epidemiology courses.

Prerequisite: EPI201 AND (BST201 or BST202&203 or BST206&207/8 or ID207 or PHS2000) (all courses may be taken concurrently).

EPI 203. Study Design in Epidemiologic Research
Beginning with the randomized clinical trial as a paradigm, this course examines common problems in the design, analysis, and interpretation of observational studies. Cohort and case-control studies are the focus of the discussion, but not to the exclusion of other designs. Problems of exposure and disease definitions, time-dependent effects, confounding, and misclassification are considered in the light of data sources typically available. Relevant statistical methods are introduced but not developed in detail.

Prerequisite: EPI202 and (BIO200 or ID200 or BST201 or BST202&203 or BST206&207/8/9 or PHS 2000A). All prerequisites may be taken concurrently.

EPI 204. Analysis of Case-Control, Cohort, and Other Epidemiologic Data
This course will examine, through practical examples, the use of regression methods for analyses of epidemiologic data, primarily case-control and cohort studies. Methods used will include linear, logistic, Poisson, conditional logistic and Cox regression models. The lectures will focus on the principle ideas and issues underlying the regression analyses, and the computer labs will provide practical experience applying those methods, using SAS software. Issues to be dealt with include dose-response, confounding, influence, and interaction. It will emphasize analysis and interpretation of results in the context of the study design. Familiarity with basic SAS is required, as this will be used in the labs. This can be met through BIO 113 (Introduction to Data Management and Programming in SAS) or other significant SAS experience.

Course Activities: Written group projects, class discussion, quizzes, homework.

Note: Computer lab is required, please sign up for one lab session when registering.

Prerequisite: (BST210 (concurrent enrollment allowed) or BST213 or PHS2000A/B) and (EPI200 or EPI201 or EPI208 or EPI505) and EPI202.

EPI 207. Advanced Epidemiologic Methods
Provides an in-depth investigation of statistical methods for drawing causal inferences from observational studies. Informal epidemiologic concepts such as confounding, selection bias, overall effects, direct effects, and intermediate variables will be formally defined within the context of a counterfactual causal model and with the help of causal diagrams. Methods for the analysis of the causal effects of time-varying exposures in the presence of time dependent covariates that are simultaneously confounders and intermediate variables will be emphasized. These methods include g-computation algorithm estimators, inverse probability weighted estimators of marginal structural models, g-estimation of structural nested models. As a practicum, students will reanalyze data sets using the above methods.

Course Activities: Class discussion, homework, practicum and final examination.

Note: Familiarity with logistic regression and survival analysis is expected; lab time will be announced at first meeting.

Prerequisite: EPI204 or (BST 210 and EPI289) or BIO233
Program Evaluation

Program evaluation comprises a set of statistical tools for assessing the impact of public interventions. This methodological course will develop students’ skills in quantitative program evaluation. Students will study a variety of evaluation designs (from random assignment to quasi-experimental evaluation methods) and analyze data from actual evaluations, such as the national Job Training Partnership Act Study. The course evaluates the strengths and weaknesses of alternative evaluation methods. This course meets the PhD requirement for empirical methods. **Prerequisite:** Familiarity with the basic concepts of statistical inference and regression analysis (such as API-202 or API-210).

API 211 / EDU S164. Program Evaluation
As school districts and state agencies accumulate quantitative student outcome data, demand for evidence of impact will grow. All of us must learn to be critical consumers of quantitative evidence of impact. The key challenge when evaluating the impact of an education policy or program is to identify what would have happened if that policy or program had not been implemented. There are a number of different approaches to constructing a plausible estimate of what would have happened, using experimental or quasi-experimental techniques. In this course, we will have three goals: to gain insight into the strengths and weaknesses of different evaluation designs, including experimental and quasi-experimental techniques; to develop the skills required to be a critical reader of impact evaluations; and to develop the ability to more clearly recognize opportunities for impact evaluations in education and to implement policies in a manner that would be amenable to evaluation. During the course, we will read and critique a number of impact evaluations, replicate the results of several evaluations, and design evaluations of educational programs. The course will focus on quantitative impact evaluations, as opposed to qualitative or process evaluations. **Prerequisite:** Successful completion of S-030 or S-040, or prior equivalent training in multiple regression. Also offered by the Graduate School of Education as A-164. Permission of the instructor required. Enrollment procedure will be posted on the HGSE course website.

HPM 543. Quantitative Methods in Program Evaluation
This course will give students the tools that they need to evaluate policy interventions, social programs, and health initiatives. Did the program achieve its goals? Did it reach its target audience? Could it have been more effective? In order to answer these questions, students will develop a flexible set of analytical tools, including both the ability to design an evaluation study and the ability to evaluate existing studies critically.
By the end of the course students will be able to construct a well-designed study to answer well-posed questions, gauge the adequacy of available data, implement an econometric analysis, interpret the results of such studies, and draw policy implications. The course will focus on health policies and programs such as public insurance expansions and public health campaigns, but the techniques will be broadly applicable to other realms such as welfare or education. **Note:** The material in this course is inherently quantitative, and builds on a base of statistics fundamentals. The prerequisite is a course in basic statistics and probability, such as BIO 200, BIO 201, BIO 202/203, ID 538, ID201 or equivalent. This includes knowledge of confidence intervals and hypothesis testing. It also includes familiarity with the statistical package of your choice- ideally STATA, but SAS or SPSS are fine. During the course students will be given data sets to analyze, but there will be no instruction on the mechanics of opening and manipulating the data with a statistical software package. Students should contact instructor if they are uncertain about whether they have adequate preparation for the class. **Prerequisite:** BIO200 or BIO201 or BIO202&203, or BIO206 & (207 or 208 or 209) or ID538 or ID201 or equivalent.

Qualitative Research

GHP 504. Introduction to Qualitative Research for Global Health
This course introduces students to qualitative research design and methods applied in global health. Contrasts will be drawn with quantities and mixed-methods approaches in order to consider the place of qualitative research in global health. The course aims to provide students with an understanding of when to use qualitative research approaches, explores the philosophical debates around qualitative research and the theories that underpin qualitative research designs to consider which qualitative methodologies is appropriate for the research, and critically appraise the quality and credibility of qualitative research.
This practical-oriented course will equip students with the knowledge and skills to appropriately design, plan and appraise qualitative research. The course topics will include the application of qualitative research approaches in global health, qualitative research designs, qualitative methods, ethics and critical appraisal of qualitative research.
SBS 288. Qualitative Research Methods in Public Health

What students can expect from this course: Qualitative research can be used alone or in combination with quantitative research to investigate public health questions. This introductory course will provide students with an overview of the range of important conceptual and practical issues associated with qualitative research, including providing general familiarity with the design of qualitative studies and conduct of commonly-used qualitative methods. The course begins by examining the variety of potential uses of qualitative methods in public health research and diverse qualitative research approaches. The course then explores specific topics, including: developing research questions; ethics in qualitative research; “entering” the community to conduct qualitative research; role of theory; ensuring study rigor; selecting and implementing qualitative data collection methods (participant observation, semi-structured interviews and focus groups); writing open-ended questions; sampling; data management and analysis; publishing results; writing research proposals; and considerations for choosing qualitative methods for mixed-methods qualitative or mixed-methods qualitative/quantitative studies. Students should come to class prepared to apply concepts from readings and lectures through participation in class discussions and small group activities that will occur during every class period. In addition, students will demonstrate application of concepts through completion of written assignments.

What this course is not: As this is an introductory course on qualitative research that provides an overview of all pertinent topics to foster familiarity with this research approach as a whole, the course cannot dwell deeply on any one topic. Students who are looking for in-depth training on a particular step in qualitative research, such as how to analyze their own qualitative dataset, or how to use qualitative coding software, are advised to select a different course.

Registration by instructor permission only: By August 27, 2018, interested students must write a brief explanation of why they want to take this course, and send it to sbsacadaff@hsph.harvard.edu.

EDU S504. Introduction to Qualitative Research

This introductory methods course offers students a sense of the terrain of qualitative research, including some of the different tools and approaches available to researchers in the field of education. The assigned readings will include scholarship on the practice and philosophical underpinnings of qualitative research, varied examples of published qualitative research, and raw data. Class sessions will generally follow a workshop format with discussions and activities related to weekly readings. In addition, students will get a feel for the overall process of conducting qualitative research by developing an original research proposal that is informed by preliminary data gathering and analysis. Students will start to develop skills related to designing a study, collecting and analyzing data, making appropriate claims, positioning their work relative to existing literature, and appraising others' qualitative research. Students will also begin to think about their own identities and ethical responsibilities as educational researchers, and develop skills for further and ongoing reflection about their work and their relationship to it.

Note: Permission of instructor required. Enrollment is limited to doctoral students. Required for first-year Ph.D. students; other doctoral students may enroll with permission. Enrollment procedure will be posted on the course website.

Network Analysis

BST 267. Introduction to Social and Biological Networks

Many systems of scientific and societal interest consist of a large number of interacting components. The structure of these systems can be represented as networks where network nodes represent the components and network edges the interactions between the components. Network analysis can be used to study how pathogens, behaviors and information spread in social networks, having important implications for our understanding of epidemics and the planning of effective interventions. In a biological context, at a molecular level, network analysis can be applied to gene regulation networks, signal transduction networks, protein interaction networks, and more. This introductory course covers some basic network measures, models, and processes that unfold on networks. The covered material applies to a wide range of networks, but we will focus on social and biological networks. To analyze and model networks, we will learn the basics of the Python programming language and its NetworkX module.

Note: The course contains a number of hands-on computer lab sessions. There are five homework assignments and four reading assignments that will be discussed in class. In addition, each student will complete a final project that applies network analysis techniques to study a public health problem.

Prerequisite: BST201 or ID201 or (BST202 & 203) or [BST206 & (BST207 or 208)].
Other

Statistics 140. Design of Experiments
Statistical designs for efficient experimentation in the physical, life, social and management sciences and in engineering. A systematic approach to explore input-output relationships by deliberately manipulating input variables. Topics include completely randomized and randomized block designs, Latin square designs, balanced incomplete block designs, factorial designs, confounding in blocks, fractional replications, and re-randomization. Each topic motivated by real-life examples.
Prerequisite: Statistics 111 or 139.

Government 2010. Strategies for Political Inquiry
Research design for causal inference in qualitative and quantitative studies. Topics covered include measurement, conceptualization, case studies, the relationship between large-n and small-n studies, process-tracing, surveys, field experiments, and natural experiments, with examples of their use in political science.
Note: Primarily for graduate students; may also be taken by undergraduates preparing for senior thesis research.

SBS 245. Social and Behavioral Research Methods
Provides a broad overview of social and behavioral research methodology, including experimental, quasi-experimental and non-experimental research design, measurement, sampling, data collection, and testing causal theories. By case studies, methodological readings, discussion, written assignments, and data analytic homeworks students learn to conduct social and behavioral research and more applied program evaluations. Homework includes analytic work with observational and experimental studies and development of new measures.
Course Activities: Assigned readings, class participation, homeworks, reflections, two papers.
Note: A multivariate statistics course strongly recommended; course primarily for doctoral students.
Prerequisite: BST210 or BST211 or BST213.

HBSDOC 4070. Design of Field Research Methods
Field research involves collecting original data (qualitative or quantitative) in field sites. The course will combine informal lecture and discussion with practical sessions designed to build specific skills for conducting field research in organizations. Readings include books and papers about research methodology, as well as articles that provide exemplars of field research, including both theory driven and phenomenon driven work. Specific topics covered include variance versus process models, blending qualitative and quantitative data (in one paper, one study, or one career), collecting and analyzing different kinds of data (observation interview, survey, archival), levels of analysis, construct development, and writing up field research for publication. A core aim of the course is to help students understand the contingent relationship between the nature of the research question and the field research methods used to answer it, and to use this understanding to design and carry out original field research. Course requirements include several short assignments assessing readings and a final paper designed to help students' further their own field research goals. This seminar fulfills a requirement for HBS Organizational Behavior and Management students.
Prerequisite: Students are required to be in or beyond their second year of study.