Course Description

A central theme in psychological and educational measurement is the establishment of the technical criteria and statistical models for ensuring the reliability, fairness, and validity of the measurement instruments. Whether it is an aptitude test for admissions (e.g., the Graduate Record Examinations; GRE), a large-scale educational survey (e.g., National Assessment of Educational Progress; NAEP), or an assessment of physical, mental, and social well-being for patients (e.g., Patient Reported Outcomes Measurement Information System; PROMIS), the underlying measurement models and methods are similar. One particular set of measurement theory, models, and techniques that is of foundational importance in modern psychometrics is Item Response Theory (IRT).

This course is a graduate level course about IRT, covering the basics of IRT models, their estimation, model fit assessment, and applications. The course materials are developed in collaboration with my colleague Dr. Yang Liu who is also an assistant professor at EDMS. The course starts with a brief review of the history of IRT. Then IRT models for various item responses (e.g., dichotomously and polytomously scored item responses) are introduced with empirical/simulated data examples. Estimation of the model parameters and related issues are discussed from both Likelihood-based and Bayesian approaches. Various approaches to assess model fit are addressed before moving into more applied topics that include local dependence detection, differential item functioning, score combination, and computerized-adaptive testing. Overall this course focuses on the statistical theory underlying IRT models as well on their application to real and simulated data sets using computer softwares.

Prerequisites

This is a graduate-level measurement course. The prerequisites of this course include classical test theory (e.g., EDMS623) and statistical models up to logistic regression (e.g., EDMS651). Please contact the instructor as soon as possible if you do not think you meet these prerequisites.
Objectives

It is my hope that students will be able to have a solid understanding of item response theory so that students become a capable researcher, an informed consumer, and a clear communicator. Students should be able to use IRT methods correctly and in a constructive manner in their own research. Students should also be able to interpret the results from item analysis and communicate the results effectively, whether for students' own work or for evaluating the adequacy of other researchers' work. Students should also be able to demonstrate their ability to run an IRT software program for data analysis. For statistics/quantitative psychology/advanced quantitative methodology students, an additional objective is to become familiar with a general IRT framework, so that students may contribute to the educational and psychological measurement literature in the future.

Reading Materials

There is no required textbook for this course. We will be reading book chapters and journal articles each week that will be posted on the course website. In addition, the following books may be useful throughout the course (wait for the instructor's explanation before purchasing):

Recommended Books


Course Delivery

Course slides and supplemental materials (if there are any) will be made available by 9AM of Mondays on ELMS CANVAS course delivery system (https://elms.umd.edu). An email notification will be sent out when new materials are posted on the board. It is your responsibility to print them or bring them to class.
Software

You may use any competent software program of your choice (e.g., IRTPRO, IRT in R, mvIRT from Multivariate Software, Mplus, and occasionally SAS). For the most part I will use R packages and flexMIRT.


3-month workshop version of flexMIRT will be made freely available. Installation instructions will be provided separately.

Formal Course Assessment

Homework Assignments: There will be THREE assignments (45%) throughout the semester, each of them designed to give students an opportunity to apply concepts and techniques learned in class.

I do expect that students’ word-processed homework will conform as closely as possible to APA style presentation of tables, graphics, and references. Therefore, students should cut and paste relevant portions of the computer output into the appropriate places in your homework to show how you arrived at your solution. One of the goals of this class is to be able to write-up statistical results as if it were going into a journal article or a thesis. There will be an exemplary writing to show how to write-up statistical results at the beginning of the semester. For APA style reference, go to the website of Douglas Degelman for manuscripts following APA style.

Please note that late homework assignments will not be accepted unless pre-approval is given for exceptional circumstances. Only a hard copy of the homework assignment is accepted at the beginning of class on the specified due date. It might be wise to keep a photocopy or at the very least save assignments electronically for your own protection. Graded assignments will generally be returned during the next class.

Homeworks will be graded on a scale of H (high pass), P (pass), or L (low pass). Getting either H or P means receiving full credit for the particular assignment (15% of the total grade), and getting L means receiving only partial credit for the assignment depending on the level of completion.

Midterm Exam: There will be an in-class midterm exam (20%). The midterm exam will be closed book and closed class note. The purpose of the in-class midterm is to check students’ understanding of the content of IRT, their ability to apply appropriate IRT techniques to address real data problems, and their familiarity with the software output. More information about the question formats and expectations are to be announced.

The final project: Presentation and paper Toward the end of the semester, you will need to conduct a small project involving some aspect of item response theory, do a 20-minute oral presentation (10%), and produce a short written report summarizing your findings (20%). The remaining 5% is based on your participation in class.

There are two options for the project: (a) it can be a more methodologically focused project (studying and extending the current methodology), or (b) it can be more applied (using the existing methodology in an innovative way).
Course Grades

Overall Course Percent Grade:
98.00% ~ 100.00%: A+
92.00% ~ 97.99% : A
88.00% ~ 91.99% : A-
85.00% ~ 87.99% : B+
82.00% ~ 84.99% : B
78.00% ~ 81.99% : B-
75.00% ~ 77.99% : C+
72.00% ~ 74.99% : C
68.00% ~ 71.99% : C-
65.00% ~ 67.99% : D+
62.00% ~ 64.99% : D
58.00% ~ 61.99% : D-
≤ 57.99% : F

Notes: With exceptions of computational error or human mistakes, grades will not be changed once they are posted. There will be no extra credit opportunities. Incomplete option is not for poor performance in the course. Incomplete for this course will be given on a case-by-case basis. However, unless the student can provide very compelling reasons with proof documents, incomplete will not be given.

Tentative Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topics</th>
<th>Due</th>
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<td>1</td>
<td>Jan 24</td>
<td>Introduction and overview</td>
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<tr>
<td>2</td>
<td>Jan 31</td>
<td>Models for dichotomous responses</td>
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<td>3</td>
<td>Feb 7</td>
<td>Models for ordinal responses</td>
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<td>4</td>
<td>Feb 14</td>
<td>IES review panel service (No class)</td>
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<td>5</td>
<td>Feb 21</td>
<td>Nominal response model and variations</td>
<td>HW1</td>
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<td>6</td>
<td>Feb 28</td>
<td>IRT Scoring</td>
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<td>7</td>
<td>Mar 7</td>
<td>Maximum likelihood estimation</td>
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<td>8</td>
<td>Mar 14</td>
<td>Bayesian estimation</td>
<td>HW2</td>
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<td>Mar 21</td>
<td>Spring Break (No Class)</td>
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<td>9</td>
<td>Mar 28</td>
<td>In-class midterm exam</td>
<td>Project description</td>
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<td>10</td>
<td>Apr 4</td>
<td>Goodness of fit assessment</td>
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<td>11</td>
<td>Apr 11</td>
<td>Multiple group IRT I: Differential item functioning</td>
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<td>12</td>
<td>Apr 18</td>
<td>Multiple group IRT II: Scaling</td>
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<td>13</td>
<td>Apr 25</td>
<td>Sources of IRT model misfit</td>
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<td>14</td>
<td>May 2</td>
<td>Review/Project Presentations</td>
<td>HW3</td>
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<td>15</td>
<td>May 9</td>
<td>Project Presentations</td>
<td>Project Paper</td>
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Course Procedures and Policies

Please visit http://www.ugst.umd.edu/courserelatedpolicies.html for full course-related policies. Here are some of them that the instructor wants to emphasize.

Accommodations for Emergencies & Email Communication:
When the University closes on the day of class, we will have no class. Otherwise, I strongly urge you to be vigilant about your email and/or the course website on CANVAS if there are any threats (e.g. extreme weather) that could potentially prohibit having class at our regular time.

If you need to be absent from class or late for the class significantly (or leaving early), letting me know about it ahead of the time would be much appreciated. All students are expected to take the exams and/or submit assignments on the specified dates and no make-up exams are given. You must contact me before an exam if you are going to be absent or you will receive a zero for that assessment.

The primary communication tool will be emails. However, I would like to remind you that you should allow me at least 24 hours to take care of emails due to my other duties as a faculty member. Emergencies deserve prompt replies, but last minute questions with respect to assignments might not be well taken. I strongly recommend that you should plan ahead to meet the deadlines properly.

Academic Accommodations:
In compliance with and in the spirit of the Americans with Disabilities Act (ADA), I would love to work with you if you have a documented disability that is relevant to successfully completing your work in this course. If you need academic accommodation by virtue of a documented disability, please contact me as soon as possible to discuss your needs.

Academic Integrity:
The University of Maryland, College Park, has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible to uphold these standards for this course. It is imperative that you are aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the code of Academic Integrity or the Student Honor Council, please visit https://www.president.umd.edu/administration/policies/section-iii-academic-affairs/iii-100a for details. Plagiarism and other forms of academic fraud are a violation of university regulations and unacceptable under any circumstance. These instances have to be and will be reported to the Honor Council in writing. Notes on plagiarism in this class: Due to the nature of reporting statistical results, some expressions are commonly used and should be phrased in the same/similar ways. However, how to approach a problem and end up with the solution is definitely a result of logic process, and this should not be stolen and used with proper citations.

Religious observances:
The University of Maryland policy on religious observances states that students not be penalized in any way for participation in religious observances. Students shall be allowed, whenever possible, to make up academic assignments that are missed due to such absences. However, the must contact the instructor before the absence with a written notification of the projected absence, and arrangements will be made for make-up work or examinations.

Student Participation:
The classes will be composed of lectures and small group/class discussions. Each student’s meaningful participation is very appreciated and will contribute to entire learning process, promoting critical thinking skills. Throwing questions and bringing in topic-related problems to class are always welcomed. Unexcused absences from more than one third of the lectures (5 times) will result in an F.