University of Maryland, College Park
EDMS 738R: Diagnostics for Item Response Models
Fall 2019
Class location: EDU (Benjamin Bldg) 3233
Class meeting time: Monday 4:15–7:00pm

Instructor
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Office Hours: Monday 1:30–3:30pm, or by appointment

Course description
Item response theory (IRT) concerns fitting latent variables measurement models to categorical response data and has become a standard tool for analyzing survey and testing data in educational and psychological research. Before inferences are made based on the fitted IRT model, it is often recommended to run various diagnostic procedures to assess the global and local goodness-of-fit. EDMS 738R is an advanced seminar course focusing on statistical inference and model-fit diagnostics in IRT. Two basic techniques, namely Monte Carlo method and (first-order) asymptotic theory, are introduced and applied to design formal tests of model assumptions. Special topics such as differential item functioning (DIF), person fit assessment, Bayesian methods, and model error are also discussed. It is also remarked that methods introduced in this course can be extended to the goodness-of-fit assessment for more general statistical models.

Prerequisites
The prerequisites are EDMS 724 (Modern Measurement Theory) and 779 (Mathematical Foundations and Simulation Techniques). Proficiency in R programming and background knowledge in probability theory, mathematical statistics, and calculus are required.

Objectives
Students who attend this course have already been familiar with IRT models. The course mainly focuses on the statistical theory of model-fit testing and its applications to IRT. The expectations are

- to improve the skills in Monte Carlo methods and R programming
- to grasp the essentials in asymptotic statistics
- to design theoretically justified procedures to assess IRT model assumptions
- to review the literature and present statistical ideas

References
There is no required textbook for this course. Extra reading materials will be posted on ELMS. The following are advanced references for Monte Carlo methods and statistical theory:

- Bickel, P. J., & Doksum, K. A. (2015). *Mathematical Statistics: Basic Ideas and Selected Topics, Volumes I.* Chapman and Hall/CRC.
- Bishop, Y. M., Fienberg, S. E., & Holland, P. W. (2007). *Discrete Multivariate Analysis: Theory and Practice.* Springer.
- Boos, D. D., & Stefanski, L. A. (2013). *Essential Statistical Inference.* Springer.
- Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B. (2013). *Bayesian Data Analysis.* CRC Press.
- Lehmann, E. L. (2004). *Elements of Large-Sample Theory.* Springer.
- Lehmann, E. L., & Romano, J. P. (2006). *Testing Statistical Hypotheses.*
- Robert, C., & Casella, G. (2013). *Monte Carlo Statistical Methods.* Springer.

Course delivery
Course slides and supplemental materials will be made available by 10am every Monday on the ELMS Canvas system (https://elms.umd.edu). An email notification will be sent out when new materials are posted. Derivations of theoretical results will be presented on the board. It is your responsibility to take notes: Taking photos of instructor's writing on the board is not recommended. You may bring your own laptop to the class, as software demonstration is a component of the lecture.

Statistical software
R will be used in this course. There will not be lab sessions on statistical software; however, annotated code/output will be distributed. R is free and easy to install on your own computer. It is currently maintained by the R Core development team. Students can download R at the home page of the R project (http://www.r-project.org). It is a flexible statistical computing environment that contains a wide variety of packages that allow students to do numerous mathematical and statistical operations ranging from data simulation to data analysis.

Course assignment
Homework There will be **two homework assignments** throughout the semester, each of which is worth **10% of the final grade** and contains problems related to the theory and techniques learned in class. Students are expected to refer to materials from lecture slides and supplementary notes.

Students are encouraged to work in groups on homework but the **writing must reflect individual work**. Copying other students writing is considered plagiarism, even among students who form a study group to complete the assignment collaboratively. Formatting should conform as closely as possible to the **APA style presentation** of tables, graphics, and references. Students are expected to report statistical results as if it were going into a

journal article or a thesis, and include the original software output as an appendix to show how they arrive at the solution. Please **do not just cut and paste all the software output** into the writing without necessary interpretation and formatting.

Please note that **late homework will not be accepted** unless pre-approval is given for exceptional circumstances. The homework **must be typed**: Students are required to hand in a **printed copy** at the beginning of the 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 typically be returned during the next lecture. Homework will be graded on a scale of **P (pass) or L (low pass)**. Getting a P means receiving a full credit for the particular assignment. In case of an L grade, partial credit will be assigned depending on the level of completion.

Special topic presentation and discussion Each student will lead the discussion of a special topic of choice. The tasks involve a **one-hour presentation (20%)** on the topic and **facilitation of discussions (20%)** among participants. The student in charge is expected to meet with the instructor one week ahead of time to discuss the readings and materials.

Final project The final project consists of an **in-class presentation (20%) and a paper submission (20%)**. The project **must focus on methodology** related to goodness-of-fit assessment of IRT models. A short description of the project should be submitted by the due date (see the tentative schedule for more information), and **the topic must be approved by the instructor**. Students are welcome to discuss the project with the instructor during office hours or by appointment. Students are required to **work individually** on the final project.

The final paper must be **typed** and follow as closely as possible to the **APA format**. The length of the paper must be **no more than 15 pages (double-spaced, excluding figures, tables, and references)**. Detailed grading rubric regarding the in-class presentation and paper will be provided later.

Grades
The final grade is calculated based on the **homework assignments (20%), Special topics presentation (40%), and final project (40%)**. The grading scale is tabulated as follows:

Letter grade	Percentage	Letter grade	Percentage
A+	98.00–100.00%	C+	75.00–77.99%
A	92.00–97.99%	C	72.00–74.99%
A−	88.00–91.99%	C−	68.00–71.99%
B+	85.00–87.99%	D+	65.00–67.99%
B	82.00–84.99%	D	62.00–64.99%
B−	**78.00–81.99%**	D−	58.00–61.99%
		F	≤57.99%

With exceptions of computational error, grades will not be changed once they are

posted. **The incomplete grade is not an option for poor performance** in the course. Unless the student can provide very compelling reasons with proof documents, incomplete will not be given.

Tentative schedule
Note: This schedule is subject to change.

Week	Date	Lecture	Assignment
1	8/26	IRT and statistical inference	
2	**9/2**	**Labor day, no class**	
3	9/9	Monte Carlo methods	
4	9/16	Asymptotic theory I	Homework 1
5	9/23	Asymptotic theory II	
6	9/30	Residuals	
7	10/7	Asymptotic tests	
8	10/14	Cross-validation and information criteria	Homework 2
9	10/21	Special topic: Power	Project description
10	10/28	Special topic: Approximate fit and model error	
11	11/4	Special topic: Source of misfit	
12	11/11	Special topic: Person fit	
13	11/18	Special topic: Differential item functioning	
14	**11/25**	**Thanksgiving week, no class**	
15	12/2	Special topic: Bayesian method	
16	12/9	Final project presentations	
17	12/16		Final paper

Course procedures and policies
Please visit http://www.ugst.umd.edu/courserelatedpolicies.html for a summary of course-related policies. Here are some that I want to emphasize.

Accommodations for emergencies and 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 see http://www.president.umd.edu/policies/docs/III-100A.pdf. 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, they 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 the 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.**