Cognitive Diagnosis Modeling
16:300:696
Spring 2013

Course Syllabus

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Time:	Monday, 1:10 – 3:50 PM
Place:	Room 347, Graduate School of Education

Course Description
The course provides in-depth overview of cognitive diagnosis modeling, a novel psychometric framework for developing assessments and analyzing item-response data. In addition to the rationale, bases and frameworks for cognitive diagnosis modeling, the course covers some of the most recent developments in the area. These developments include models for cognitive diagnosis, model estimation and comparison, attribute and Q-matrix validation, computerized adaptive testing, and differential item functioning.

Course Objectives
At the end of the course, students are expected to

1) be acquainted with the major approaches to diagnostic modeling;

2) understand the issues involved in constructing and analyzing cognitively diagnostic assessments; and

3) have a deep familiarity with the major areas of research in cognitive diagnosis modeling.

Course Requirements

1) **Class Participation (30% of the Final Grade)**
Students are expected to actively contribute to the class discussion, and will be graded based on their participation. Comments and questions in the class discussion should be based on the assigned reading materials. In-class and homework exercises will also be discussed. Finally, students are also expected to participate in the class discussion by reporting on assigned topics.

2) **Project (40% of the Final Grade)**
An individual class project that illustrates the principles and applications of cognitive diagnosis modeling will be required. The project should be written up, and should be of conference or

journal quality. In this project, students can choose to (1) do purely theoretical work, (2) develop and document his/her own computer code, (3) conduct a simulation study, or (4) analyze real data. The project is due on the last day of the class.

3) **Project Presentation (30% of the Final Grade)**
The last two meetings will be devoted to project presentation. Students will be given approximately 30-40 minutes to give a presentation based on their project. The presentation will be graded based on its clarity, and the student's ability to respond to project-related questions.

The final letter grade will be assigned as follows:

Final Score	Letter Grade
90% and Above	A
80%-89%	B+
75%-79%	B
65%-74%	C+
60%-64%	C
Below 60%	F

Class Schedule
The class schedule below is subject to change if necessary. Following the topic/s to be covered each week are the reading assignments. Different topics are separated by 1, 2 and so forth. Required readings are marked by †. Reading assignments must be completed prior to each lecture.

1/28 Introduction to Diagnostic Modeling Framework in Educational Assessment
†Mislevy, R. J., Almond, R. G., & Lukas, J. F. (2004)
†NRC (2001) - Chapter 2

2/4 Defining and Validating Attributes
†Leighton, J. P. & Gierl. M. J. (2007)
†NRC (2001) - Chapter 3
Pellegrino, J. W., Baxter, G. P., & Glaser, R. (1999)

2/11 Models and Approaches to Diagnostic Modeling (Reports on Rule Space Methodology[1], Attribute Hierarchy Method[2], Bayesian Inference Network[3], Knowledge Space Theory[4], Nonparametric Approaches[5])
[3†]Almond, R. G., DiBello, L.V., Moulder, B., & Zapata-Rivera, J. D. (2007)
[5†]Chiu, C., Douglas, J. A., & Li, X. (2009)
[4†]Falmagne, J. C., Doignon, J. P., Koppen, M., Villano, M., & Johannesen, L. (1990)
[1†]Gierl, M. J., Leighton, J. P., & Hunka, S.M. (2000)
[2†]Leighton, J. P., Gierl, M. J., & Hunka, S.M. (2004)

2/18 IRT-Based CDMs
†DiBello, L. V., & Stout, W. (2007)
Haertel, E. H. (1984)
†Rupp. A. A., & Templin, J. L. (2008)
Junker, B. W., & Sijtsma, K. (2001)

2/25 CDM Estimation: Specific Algorithms (Expectation-Maximization[1] and Markov Chain Monte Carlo[2]) & General Software Packages (Latent Gold[3] & Mplus[4])

[1†]de la Torre, J. (2009)
[2†]de la Torre, J., Douglas, J. A. (2004)
[3]DeCarlo (2011; Appendix A)
[4]Rupp, A. A., Templin, J., & Henson, R. A. (2010; Chapter 9)

3/4 General CDMs[1] & Model Comparison[2]

[1†]de la Torre, J. (2011)
[2†]de la Torre, J., Lee, Y. S. (2010)
[1]Henson et al. (2009)
[1]von Davier, M. (2005)

3/11 Q-Matrix Validation

de la Torre, J. (2008)
[†]de la Torre, J., & Chiu, C. Y. (2010)
Liu, J., Xu, G., Ying, Z. (2012)

3/18 Spring Break

3/25 Ox Codes (DINA, HO-DINA, Q-matrix Validation)[1] & PR Item Construction and Validation[2]

[2†]de la Torre et al. (AERA Paper on Proportional Reasoning)

4/1 Model Fit Evaluation

[†]de la Torre, J., & Douglas, J. A. (2008)
[†]Chen,. J., de la Torre, J., Zhang, Z. (2013)

4/8 Attribute Estimation/Classification[1] & Person Fit Evaluation[2]

[1†]Huebner, A., & Wang, C. (2011)
[2†]Liu, Y., Douglas, J. A., & Henson, R. A. (2009)

4/15 Optimal Test Design[1] & Computerized Adaptive Testing[2]

[2]Cheng, Y. (2009)
[1]Finkelman, M., Kim, W., & Roussos, L.(2009)
[1†]Henson, R. A., & Douglas, J. A. (2005)
[2]Wang, C., Chang, H., & Douglas, J. (2011)
[2†]Wang, C., Chang, H., & Huebner, A. (2011)

4/22 DIF[1] & Small Sample Estimation[2]

[1†]Hou, L., & de la Torre, J. (2012)
[2†]Rojas, G., de la Torre, J., & Olea, J. (2012)

4/29 AERA/NCME (No Class)

5/6 Report 1

5/13 Report 2

COMPLETE REFERENCES

1. Almond, R. G., DiBello, L.V., Moulder, B., & Zapata-Rivera, J. D. (2007*)*. Modeling diagnostic assessments with Bayesian networks. *Journal of Educational Measurement, 44*, 341–359.

2. Chen, J., de la Torre, J., & Zhang, Z. (2013). Relative and absolute fit evaluation in cognitive diagnosis modeling. *Journal of Educational Measurement*.

3. Cheng, Y. (2009). When cognitive diagnosis meet computerized adaptive testing: CD-CAT. *Psychometrika*, *74*, 619-632.

4. Chiu, C., Douglas, J. A., & Li, X. (2009). Cluster analysis for cognitive diagnosis: Theory and applications. *Psychometrika, 74*, 633–665.

5. de la Torre, J. (2008). An empirically-based method of Q-matrix validation for the DINA model: Development and applications. *Journal of Educational Measurement*, *45*, 343-362.

6. de la Torre, J. (2009). DINA model and parameter estimation: A didactic. *Journal of Educational and Behavioral Statistics, 34,*115-130.

7. de la Torre, J. (2011). The generalized DINA model framework. *Psychometrika, 76,* 179-199.

8. de la Torre, J., & Chiu, C. Y. (2010, April). *General empirical method of Q-Matrix validation*. Paper presented at the Annual Meeting of the National Council on Measurement in Education, Denver, CO.

9. de la Torre, J., & Douglas, J. (2004). Higher-order latent trait models for cognitive diagnosis. *Psychometrika, 69,* 333-353.

10. de la Torre, J., & Douglas, J. (2008). Model evaluation and selection in cognitive diagnosis: An analysis of fraction subtraction data. *Psychometrika, 73,* 595-624.

11. de la Torre, J., Tjoe, H., Rhoads, K., & Lam, T. C. (2010, April). Conceptual and Theoretical Issues in Proportional Reasoning. Paper presented at Annual Meeting of American Educational Research Association, Denver, CO.

12. de la Torre, J., & Lee, Y. S. (2010, April). *Item-level comparison of saturated and reduced cognitive diagnosis models*. Paper presented at the Annual Meeting of the National Council on Measurement in Education, Denver, CO.

13. DeCarlo, L. T. (2011). On the analysis of fraction subtraction data: The DINA model, classification, latent class sizes, and the Q-matrix. *Applied Psychological Measurement, 35*, 8-26.

14. DiBello, L. V., & Stout, W. (2007). IRT-cased cognitive diagnostic models and related methods. *Journal of Educational Measurement, 44*, 285–291.

15. Falmagne, J. C., Doignon, J. P., Koppen, M., Villano, M., & Johannesen, L. (1990). Introduction to knowledge spaces: How to build, test, and search them. *Psychological Review, 97*, 201-224.

16. Finkelman, M., Kim, W., Roussos, L., Verschoor, A. J. (2010). A Binary Programming Approach to Atuomated Test Assembly for Cognitive Diagnosis Models. *Applied Psychological Measurement, 34*, 310-326.

17. Gierl, M. J., Leighton, J. P., & Hunka, S. (2000). Exploring the logic of Tatsuoka's rule-space model for test development and analysis. *Educational Measurement: Issues and Practice, 19,* 34-44.

18. Haertel, E. H. (1989). Using restricted latent class models to map the skill structure of achievement items. *Journal of Educational Measurement, 26,* 333-352.

19. Henson, R., & Douglas, J. (2005). Test construction for cognitive diagnosis. *Applied Psychological Measurement, 29,* 262-277.

20. Henson, R., Templin, J., & Willse, J. (2009). Defining a family of cognitive diagnosis models using log-linear models with latent variables. *Psychometrika, 74*, 191–210.

21. Hou, L., de la Torre, J., & Nandakumar, R. (2012, April). *Differential item functioning assessment in cognitive diagnosis modeling: Applying Wald Test to investigate DIF for DINA model*. Poster presented at the Annual Meeting of the National Council on Measurement in Education, Vancouver, Canada.

22. Huebner, A., & Wang, C. (2011). A note on comparing examinee classification methods for cognitive diagnosis models. *Educational and Psychological Measurement, 71*, 407-419.

23. Junker, B.W., & Sijtsma, K. (2001). Cognitive assessment models with few assumptions, and connections with nonparametric item response theory. *Applied Psychological Measurement, 25*, 258–272.

24. Leighton, J. P., & Gierl, M. J. (2007b). Defining and evaluating models of cognition used in educational measurement to make inferences about examinees' thinking processes. *Educational Measurement: Issues and Practice, 26,* 3-16.

25. Leighton, J. P., Gierl, M. J., & Hunka, S. (2004). The attribute hierarchy method for cognitive assessment: A variation on Tatsuoka's rule-space approach. *Journal of Educational Measurement, 41*, 205-237.

26. Liu, J., Xu, G., & Ying, Z. (2012). Data-driven learning of Q-matrix. *Applied Psychological Measurement. 36*, 609 - 618.

27. Liu, Y., Douglas, J. A., & Henson, R. A. (2009). Testing person fit in cognitive diagnosis. *Applied Psychological Measurement. 33,* 579-598

28. Mislevy, R. J., Almond, R. G., Lukas, J. F. (2004). *A brief introduction to Evidence-Centered Design*. CSE Technical Report 632, The National Center for Research on Evaluation,

Standards, and Student Testing (CRESST), Center for the Study of Evaluation (CSE), UCLA, Los Angeles, CA.

29. National Research Council (2001). *Knowing what students know: The science and design of educational assessment*. Committee on the Foundations of Assessment. In J. Pellegrino, N. Chudowsky, & R. Glaser (Eds.), *Board on Testing and Assessment, Center for Education*. Washington, DC: National Academy Press.

30. Pellegrino, J. W., Baxter, G. P., & Glaser, R. (1999). Addressing the "two disciplines" problem: Linking theories of cognition and learning with assessment and instructional practices. In A. Iran-Nejad & P. D. Pearson (Eds.), *Review of Research in Education* (pp. 307-353). Washington, DC: American Educational Research Association.

31. Rojas, G., de la Torre, J., & Olea, J. (2012, April). *Choosing between general and specific cognitive diagnosis models when the sample size is small*. Paper presented at the Annual Meeting of the National Council on Measurement in Education, Vancouver, Canada.

32. Rupp. A. A., & Templin, J. L. (2008). Unique characteristics of diagnostic classification models: A comprehensive review of the current state-of-the-art. *Measurement*, *6*, 219-262.

33. Rupp, A. A., Templin, J., & Henson, R. A. (2010*). Diagnostic measurement: Theory, methods, and applications*. New York: Guilford Press

34. Wang, C., Chang, H., & Huebner, A. (2011). Restrictive stochastic item selection methods in cognitive diagnostic CAT. *Journal of Educational Measurement, 48*, 255-273.

35. Wang, C., Chang, H., & Douglas, J. (2011). Combining CAT with cognitive diagnosis: A weighted item selection approach. *Behavior Research Methods, 44*, 95-109.

36. von Davier, M. (2005). *A general diagnostic model applied to language testing data* (ETS Research Report RR-05-16). Princeton: Educational Testing Service.

ACADEMIC INTEGRITY POLICY

Please comply with standards of academic integrity in this course. For the homework assignments, you are allowed to work with your classmates; however, submitted works should be of your own. For the exams, you are not allowed to work with or request help from anyone. The consequence for violating policies of academic integrity and other elements of the student code of conduct are serious and can have a tremendous negative impact on your academic progress and future career. Please familiarize yourself with the university policy on academic integrity: http://studentconduct.rutgers.edu/academic-integrity.

Policy on Academic Integrity

Please refer to the Policy on Academic Integrity for Undergraduate and Graduate Students at http://academicintegrity.rutgers.edu.

The University Code of Student Conduct can be accessed at: http://studentconduct.rutgers.edu/university-code-of-student-conduct

Related regulations may also be found in the Rutgers Graduate School of Education Catalog.

Clear evidence of violation of academic integrity policy may result in a grade of *F* for the assignment AND the course.