Attention!

This is a *representative* syllabus.

The syllabus for the course when you enroll may be **different**.

Use the syllabus provided **by your instructor** for the most up-to-date information. Please refer to your instructor for more information for the specific requirements for a given quarter.

Psychology 608
Introduction to Mathematical Psychology
Spring Semester 2013

Credit units: 3 units
Lecture: Tuesday and Thursday 1:30 -3:00 pm
Web site: https://carmen,osu.edu

Students with Disabilities

Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/.

Academic Misconduct

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term academic misconduct includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct (http://oaa.ohio-state.edu/coam/code.html).

Having Problems?

Sometimes personal issues will get in the way of a student's abilities to complete their coursework. If you are in trouble, you will need to tell me about it as soon as possible if you want my help in managing your course responsibilities. If you wait until the end of the quarter hoping that things will just work out somehow, then I will not be able to do anything for you. Also keep in mind that the Student Advocacy Center can help you choose a course of action and will serve as a mediator between you and your instructors.

Course Objectives

This course will give students familiarity with mathematical reasoning and modeling in psychology. We will focus on some of the best applications of mathematics to psychology and discuss what made them successful. We will also cover issues of measurement (which go hand-in-hand with models). Topics will include scaling, psychophysics, signal detection, probabilistic choice, decision making, response selection, and model comparison. The last four weeks of this class (Weeks 11-14) will be spent on building and testing Bayesian versions of various mathematical models of cognition using computing software packages R and WinBUGS.

Readings

Though many people have promised that they will write a decent textbook on mathematical psychology, so far no such book is forthcoming. There are several texts that people use, including the classic by Coombs, Dawes and Tversky (1970), Mathematical Psychology: An Introduction, and Townsend and Ashby's (1983) Stochastic Modeling of Elementary Psychological Processes. These books are both very old, however, and do not reflect the current thinking in mathematical psychology. On the other hand, because mathematical psychology has a firm grounding in mathematics and statistics, these books are important because they contain the foundations of the discipline. So don't feel too badly that many readings are old. For this course, I will draw on readings from these classics and from newer works in an attempt to provide both a firm historical background and an accurate picture of the issues that mathematical psychology addresses today.

For the Bayesian modeling portion of the course, we will be using a soon-to-be-published (work-in-progress) book entitled A Course in Bayesian Graphical Modeling for Cognitive Science by Michael Lee and Eric-Jan Wagenmakers (free download from http://users.fmg.uva.nl/ewagenmakers/BayesCourse/BayesBook.pdf).

Each day's reading assignments are provided on the class schedule. I expect you to come to class already having read them.

Examinations and Homework

There will be three examinations in the course and homework assigned approximately bi-weekly. Exam I, II and II are worth 25%, 25%and 20% of the total points available in the course, respectively, and homework is worth 30%.

Policy on missing exams and late homeworks

Please note carefully:

1. If, because of an emergency, you cannot take an exam at the scheduled time, you must contact the instructor BEFORE the exam.

2. There will be NO EXCEPTIONS to (1.) above.

3. You must provide DOCUMENTATION that verifies the emergency that prevented you from taking an exam or quiz at the scheduled time. No documentation, no makeup.

Homeworks that are late for un-excused reasons will be marked down by 10% for each day past the due date.

Grading

For a variety of reasons, I do not grade on a curve. For example, when a curve is used, no matter how well everyone in the class does on an exam, only a small percentage of students can receive an A. Instead, I prefer to give everyone a chance to get an A. Therefore, I apply the following preset cutpoints:

A (93%) A- (90%) B+ (87%) B (83%) B- (80%) C+ (77%) C (73%) C- (70%) D+ (67%) D (60%)

Exams are designed to reflect what I think is an appropriate level of mastery of the material covered. So if everyone gets an A, that's great! I'll assume such performance reflects your hard work and intelligence (and, of course, my excellent teaching). If everyone does poorly, I'll assume it was my fault, and define an A by the top scores on the test: 100% will be given as the second highest test score. So, if the top two scores were 67% and 62%, and you scored 54%, your test grade would be 54 points out of 62, or 87%.

Tentative Class Schedule and Reading Assignments

Week 1: Introduction and History of Mathematical Psychology

Coombs, C. H., Dawes, R. M., & Tversky, A (1970). Mathematical Psychology: An Elementary Introduction, Chapter 1. Englewood Cliffs, NJ: Prentice-Hall.

Estes, W. K. (2002). History of the Society. Online Document: http://www.cogs.indiana.edu/socmathpsych/history.html

Thurstone, L. L. (1959). The Measurement of Values, Introduction. Chicago, IL: The University of Chicago Press.

Townsend, J.T. & Ashby, F.G. (1983). Stochastic Modeling of Elementary Psychological Processes, Chapter 1. New York: Cambridge University Press.

Week 2: Random Variables and Probability Distributions

Discrete and continuous random variables: pp. 18-40, pp. 55-74

Conditional probabilities: pp. 133-136, 139-147, 162-168

Expected value and variance: pp. 225-284

Distributions : pp. 183-224

Functions of random variables: pp. 210-211

Convolutions: pp. 285-304

Generating functions: pp. 365-377, pp. 394-404

Week 3: Psychophysical Scaling

Falmagne, J. C. (1986). Psychophysical measurement and theory. In K. R. Boff, L. Kaufman, & J. P. Thomas (Eds.). Handbook of perception and performance: Volume 1 (pp. 1-1 to 1-22).

Goldstein, E. B. (1989). Sensation and Perception, 3rd Edition, Appendix A. Belmont, CA: Wadsworth.

Link, S. W. (1992). The Wave Theory of Difference and Similarity, Introduction and Chapter 1. Hillsdale, NJ: Lawrence Erlbaum, Associates.

Stevens, S. S. (1957). On the Psychophysical Law. Psychological Review, 64, 153-181.

Marks, L. E. & Gescheider, G. A. (2002). Psychophysical scaling. In J. Wixted and H. Pashler (Eds.), Stevens' Handbook of Experimental Psychology (3rd Edition): Methodology in Experimental Psychology (pp. 91-138).

Todd, J.T., Oomes, A.H.J., Koenderink, J.J., & Kappers, A.M.L. (2001). On the affine structure of perceptual space. Psychological Science, 12, 191-196.

Week 4: Probablistic Choice

Coombs, C. H., Dawes, R. M., & Tversky, A (1970). Mathematical Psychology: An Elementary Introduction, Chapter 5, pp. 148-164. Englewood Cliffs, NJ: Prentice-Hall.

Luce, R.D. (1977). Thurstone's Discriminal Processes Fifty Years Later. Psychometrika, 42, 461-489.

Thurstone, L. L. (1927). A Law of Comparative Judgment. Psychological Review, 34, 273-286.

Week 5-6: Signal Detection Theory

Balakrishnan, J. D. (1999). Decision Processes in Discrimination: Fundamental Misrepresentations of Signal Detection Theory. Journal of Experimental Psychology: Human Perception and Performance, 25, 1189-1206.

Kadlec, H. (1999). Statistical Properties of $d_{\neg}$ and β Estimates of Signal Detection Theory. Psychological Methods, 4, 22-43.

Macmillan, N. A. (2002). Signal Detection Theory. In H. Pashler (Series Ed.) and J. Wixted (Volume Ed.) Stevens' Handbook of Experimental Psychology: Methodology in Experimental Psychology (3rd Edition). New York: Wiley Press.

Van Zandt, T. (2000). ROC Curves and Confidence Judgments in Recognition Memory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 26, 582-600.

Exam I (during Week 6)

Week 7: Risky Choice

Coombs, C. H., Dawes, R. M., & Tversky, A (1970). Mathematical Psychology: An Elementary Introduction, Chapter 5, pp. 113-147. Englewood Cliffs, NJ: Prentice-Hall.

Luce, R.D. & Raiffa, H. (1958). Games and Decisions, Chapter 2. New York: Wiley Press.

Week 8: Cognitive Architecture

Logan, G.D. (2002). Parallel and Serial Processing. In H. Pashler (Series Ed.) and J. Wixted (Volume Ed.) Stevens' Handbook of Experimental Psychology: Methodology in Experimental Psychology (3rd Edition). New York: Wiley Press.

Sternberg, S. (1966). High-speed scanning in human memory. Science, 153, 652-654.

Schweickert, R. (1993). Information, Time, and the Structure of Mental Events: A Twenty-Five Year Review. In D.E. Meyer and S. Kornblum (Eds.), Attention and Performance XIV: Synergies in Experimental Psychology, Artificial Intelligence, and Cognitive Neuroscience (pp. 535-566). Cambridge, MA: MIT Press.

Townsend, J. T. & Ashby, F. G. (1983). Stochastic Modeling of Elementary Psychological Processes, Chapter 4. New York: Cambridge University Press.

Van Zandt, T. (2002). Analysis of response time distributions. In H. Pashler (Series Ed.) and J. Wixted (Volume Ed.) Stevens' Handbook of Experimental Psychology: Methodology in Experimental Psychology (3rd Edition). New York: Wiley Press.

Week 9: Stochastic Latency Mechanisms

Audley, R.J. (1960). A stochastic model for individual choice behavior. Psychological Review, 67, 1-15.

Grice, G.R. (1972). Application of a variable criterion model to auditory reaction time as a function of the type of catch trial. Perception and Psychophysics, 12, 103-107.

Vickers, D. (1979). Decision Processes in Visual Perception, Chapter 3. New York, NY: Academic Press.

Ratcliff, R. (1977). A theory of memory retrieval. Psychological Review, 85, 59-108.

Ratcliff, R. & Smith, P. (2004). A comparison of sequential sampling models for two-choice reaction time. Psychological Review, 85, 59-108.

Schall, J.D. (2001). Neural basis of deciding, choosing and acting. Nature Reviews: Neuroscience, 2, 33-42.

Week 10: Model Comparison and Evaluation

Myung, I.J. & Pitt, M. A. (2002). Mathematical modeling. In H. Pashler (Series Ed.) and J. Wixted (Volume Ed.) Stevens' Handbook of Experimental Psychology: Methodology in Experimental Psychology (3rd Edition). New York: Wiley Press.

Pashler, H. & Roberts, S. (2000). How persuasive is a good fit? A comment on theory testing. Psychological Review, 107, 358-367.

Pitt, M A & Myung, I. J. (2002). When a good fit can be bad . Trends in Cognitive Sciences, 6, 421-425.

Shiffrin, R. M. & Nobel, P.A. (1997). The art of model development and testing. Behavior Research Methods, Instruments, and Computers, 29, 6-14.

Exam II

Week 11: Bayesian Modeling Basics

Gelman, A., Carlin, J. B., Stern, H. S. & Rubin, D. B. (2003). Bayesian Data Analysis (2nd edition), chapters 1-2. Chapman & Hall/CRC.

Wagenmakers, E.-J., Lee, M. D., Lodewyckx, T., & Iverson, G. (2008). Bayesian versus frequentist inference. In H. Hoijtink, I. Klugkist, & P. A. Boelen (Eds.), Bayesian

evaluation of informative hypotheses (pp. 181-207). New York: Springer Verlag.

Week 12: Bayesian Priors, Markov Chain Monte Carlo, and Bayesian software WinBUGS

Lee, M. D. & Wagenmakers, E.-J. (2009). A Course in Bayesian Graphical Modeling for Cognitive Science, chapters 2-4: Getting started.

Gill, J. (2008). Bayesian Methods : A Social and Behavioral Sciences Approach, chapter 5: The Bayesian prior. Chapman & Hall/CRC.

Gill, J. (2008). Bayesian Methods : A Social and Behavioral Sciences Approach, chapter 9: Basics of Markov chain Monte Carlo. Chapman & Hall/CRC.

Week 13: Bayesian Modeling of Signal Detection Theory and Decision Making

Lee, M. D. & Wagenmakers, E.-J. (2009). A Course in Bayesian Graphical Modeling for Cognitive Science, chapter 9: Signal detection theory.

Rouder J.N., Lu J. (2005). An introduction to Bayesian hierarchical models with an application in the theory of signal detection. Psychonomic Bulletin & Review. 12, 573-604

Lee, M. D. & Wagenmakers, E.-J. (2009). A Course in Bayesian Graphical Modeling for Cognitive Science, chapter 11: Take the best.

Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the fast and frugal way: Models of bounded rationality. Psychological Review, 103 (4), 650-669.

Week 14: Bayesian Modeling of Cognitive Development and Bayesian Hypothesis Testing

Lee, M. D. & Wagenmakers, E.-J. (2009). A Course in Bayesian Graphical Modeling for Cognitive Science, chapter 12: Number concepts.

Lee, M. D. & Wagenmakers, E.-J. (2009). A Course in Bayesian Graphical Modeling for Cognitive Science, chapters 14 & 15: Bayesian hypothesis testing; Bayesian t-tests.

Lee, M. D. & Sarnecka, B. W. (2009). A model of knower-level behavior in number concepts development. Cognitive Science, 34, 51-67.

Rouder, J. N., Speckman, P. L., Sun, D., Morey, R. D., & Iverson, G. (2009). Bayesian t-tests for accepting and rejecting the null hypothesis. Psychonomic Bulletin & Review, 16, 225-237.

Wetzels, R., Raaijmakers, J. G. W., Jakab, E., & Wagenmakers, E.-J. (2009). How to quantify support for and against the null hypothesis: A flexible WinBUGS implementation of a default Bayesian t-test. Psychonomic Bulletin & Review, 16, 752-760.

Finals Week: Exam III.