EPSY 8269: Matrix Algebra for Statistical Modeling
Spring 2014

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Class Website: www.edmeasurement.net/matrix

Text
The course is primarily based on course notes; however, several resources are available at the class website for additional background readings – NOT REQUIRED READING – including:

Kaw, A.K. (2008). *Introduction to Matrix Algebra*.
http://autarkaw.com/books/matrixalgebra

Interactive Web Based Tools
Several online resources are available at the class website, including:

Bogacki, P. (2000). *Linear algebra toolkit*.
http://www.math.odu.edu/~bogacki/lat/

Waner, S., & Costenoble, S.R. (1998). *Matrix Algebra Tool*.
http://people.hofstra.edu/faculty/Stefan_Waner/RealWorld/fancymatrixalg.html

Math Medics (1999). *S.O.S. Mathematics: Matrix Algebra*.
http://www.sosmath.com/matrix/matrix.html

Course Description:
Statistics in the behavioral sciences and education is a practice-oriented field that provides a set of tools for the summary and interpretation of quantitative and qualitative data. Our study of linear and matrix algebra is primarily to provide a foundation for the understanding and use of basic statistical techniques. We will investigate the matrix algebra behind several common statistical techniques. Application is the focus; however, conceptual understanding of the problem solving process used in linear and matrix algebra will be emphasized.

This course will cover basic concepts of linear and matrix algebra, including examples and applications familiar to students in education and social science research, and also include more formal definitions. Topics will include vectors and vector operations with applications to statistics, matrices and matrix operations and applications to statistics, and the representation of multivariate statistical models.

The course will also include analyses requiring the use of software that supports Matrix language and operations. The course will introduce the MATRIX command language available in SPSS,

but students can elect to use whatever software they prefer, including R, Stata, or others. Weekly exercises will be provided to exemplify each topic and operation covered in the course.

Primary Course Objectives:

Students will become familiar with basic notation, representations of systems of equations, and learn to manipulate vectors and matrices through investigating applications of the operations covered in the course. Students will also learn to use the MATRIX command language in SPSS that will allow them to compute statistics as they prefer employing formulas directly rather than using the canned formulas employed by SPSS drop-down menus. This will allow students to see directly how common statistics are computed and provide greater understanding of the requirements for computation and address complex computation issues (e.g., when factor analysis fails due to matrix dependency or matrices that cannot be inverted).

- conduct basic statistical analyses including descriptive statistics and the evaluation of bivariate relationships,

- employ matrix notation to represent multivariate systems of linear equations,

- compute statistical tests and evaluate multiple systems of equations,

- employ SPSS to compute matrix algebra problems and use matrix syntax to conduct common statistical tests, and

- solidify understanding of the mechanics of regression and regression diagnostics.

Requirements:

Students will be expected to read the class notes provided online to complete assignments, labs, and quizzes. Problem sets are integrated in class notes for practice and to gain experience using the matrix algebra techniques covered during the course. The KEY to these practice exercises in the class notes will be posted when the notes are assigned. Each week, assignments will be required for course credit. In total, assigned problems will be weighted to equal 50% of the total grade.

There will be six quizzes. Each quiz will contain brief computational items and/or short-answer items requiring explanation of key concepts. The total sum of quizzes will be weighted to equal 25% of the total grade. The problem sets assigned for homework are representative of the problems you will encounter on the quizzes.

There will also be three computer lab activities assigned during the course. The total sum of labs will be weighted to equal 25% of the total grade.

The material is cumulative to a certain extent so it is imperative that you keep up with the workload. You are encouraged to utilize office hours to complete your understanding of the material from the moment you begin to feel uncertain.

*Class Procedures***:**

These are the recommended procedures and guidelines to complete the work of the course:

1. Each week course notes on key points of the week's topics. At the beginning of each week, course notes will be posted with interactive sections to check understanding. Keys to these interactive sections will be provided separately to allow students to self-check their work.

2. Each week, an assignment will be provided to check understanding of week's topic. Students will complete the assignment and submit it to the instructor before the following Monday. The assignments will be graded and returned to students. Assignments can be submitted twice for full credit.

3. Quizzes will be provided occasionally for further evaluation of key ideas. Quizzes will be assigned on Mondays and must be returned within two days – by the end of the day Wednesday. The days when quizzes will be assigned are provided in the syllabus. Quizzes cannot be resubmitted.

4. Three labs will be assigned, to allow students to complete data analyses through matrix notation in the software program of the student's choice. Course notes and instructions will be provided to complete labs in SPSS using Matrix language in a syntax window, but labs can be completed with other software. Labs will be due within one week following their assignment. Labs can be submitted twice for full credit.

5. Questions about the assignments and the labs can be submitted to the instructor by email at any time during the course. Responses to questions of general interest will be provided to the entire class.

6. Assignments and quizzes may be completed by hand, scanned, and returned via email. Alternatively, coursework may be word processed using correct matrix notation – for example, by using the equation editor of a word processing software program. Course notes, assignments, and quizzes were written using Microsoft Word, with the support of the Word equation editor.

7. Students may work with partners (two or more) to complete assignments and labs. If you work with a partner, submit one assignment with all partners' names.

8. Quizzes must be completed **independently** by each student, without the assistance of another person. Since the course is managed online, quizzes can be completed with the aid of notes. Quizzes are provided to check individual understanding of key vector/matrix concepts.

As the instructor, I assume the following responsibilities: to provide material in a clear and contextualized format, to provide opportunity for students to pursue additional clarification through discussions via email and individual meetings, to develop and employ fair and meaningful assessment activities, to use results of evaluation activities for instructional feedback, and to provide opportunities for recourse if students believe they have been unfairly evaluated.

*Technology***:**
Technology is becoming increasingly important in education and we will pursue learning with the aid of technology in several ways. Students will receive and submit assignments and quizzes electronically. Students are encouraged to investigate matrix-related web sites to support their reading and coursework. Additional readings and resources are available at the class website.

*Diversity***:**
The College of Education and Human Development is committed to have every course contribute to our understanding of diversity, including but not limited to: age, creed, disability, ethnicity, gender, global perspectives, international background, language background, learning differences, marital status, multicultural perspectives, national origin, public assistance status, race, religion, sex, sexual orientation, and veteran status. Each of these characteristics plays a role in educational and social science research. They are factors that contribute to individual differences -- they (may) affect the challenges we set out to investigate and the way we interpret and report results.

Late Work and Incompletes:
Late work will be accepted only if I am previously notified – no points will be deducted for late work that was previously agreed upon. It is up to you to stay on track. An incomplete (I) will be assigned only if agreed to prior to the last week of class. If at the end of the semester course work is incomplete and no prior notification has been given, the grade based on points obtained at that time will be awarded. No options will be given at that point to submit incomplete work.

Makeup Work for Legitimate Absences:
Students will not be penalized for absence during the semester due to unavoidable or legitimate circumstances. Such circumstances include verified illness, participation in intercollegiate athletic events, subpoenas, jury duty, military service, bereavement, and religious observances. Such circumstances do not include voting in local, state, or national elections. For complete information, please see:
http://policy.umn.edu/Policies/Education/Education/MAKEUPWORK.html.

Returning Papers, Exams, and Projects
Given the nature of the class, the goal is to return work within one week of the due date. All exchanges of coursework will occur online through email.

University Senate Grading Policy
http://www.fpd.finop.umn.edu/groups/senate/documents/policy/gradingpolicy.html

For additional information, please refer to
http://policy.umn.edu/Policies/Education/Education/GRADINGTRANSCRIPTS.html.

A - achievement that is outstanding relative to the level necessary to meet course requirements.
B - achievement that is significantly above the level necessary to meet course requirements.
C - achievement that meets the course requirements in every respect.
D - achievement that is worthy of credit even though it fails to meet fully the course requirements.
I – (Incomplete) assigned at the discretion of the instructor when, due to extraordinary circumstances, e.g., hospitalization, a student is prevented from completing the work of the course on time. Requires a written agreement between instructor and student prior to the last day of class.

Academic dishonesty: academic dishonesty in any portion of the academic work for a course shall be grounds for awarding a grade of F or N for the entire course.

Letter Grade	Percentage
A	95-100%
A-	90-94.9%
B+	85-89.9%
B	80-84.9%
B-	75-79.9%
C+	70-74.9%
C	65-69.9%
C-	60-64.9%

How to Access Your Grades
Go to OneStop for Students (http://onestop.umn.edu/onestop/), click on Grades & Transcripts; on the right side under Quick Links, click on Grades/Unofficial transcript.

The Senate affirms the standard (first adopted by the University Senate on February 16, 1922, and reaffirmed 1993) that one semester credit is to represent, for the average University of Minnesota undergraduate student, three hours of academic work per week (including lectures, laboratories, recitations, discussion groups, field work, study, and so on), or approximately 45 hours of work over the course of an enrollment period. Expectations of faculty and students will be made clear. It is expected that the academic work required of graduate and professional students will exceed three hours per credit per week or 45 hours per semester.

Scholastic Dishonesty
You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. (Student Conduct Code: http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf) If it is determined that a student has cheated, he or she may be given an "F" or an "N" for the course, and may face additional sanctions from the University. For additional information, please see: http://policy.umn.edu/Policies/Education/Education/INSTRUCTORRESP.html.

The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: http://www1.umn.edu/oscai/integrity/student/index.html. If you have additional questions, please clarify with your instructor for the course. Your instructor can respond to your specific questions regarding what would constitute scholastic dishonesty in the context of a particular class-e.g., whether collaboration on assignments is permitted, requirements and methods for citing sources, if electronic aids are permitted or prohibited during an exam.

University Policies
See http://onestop.umn.edu/onestop/faculty/Teaching/Policies.html for a list of policies related to teaching with links to those policies.
Also see http://policy.umn.edu/Policies/Education/Education/STUDENTRESP.html for University policies related to Teaching and Learning – Student Responsibilities.

Student Conduct Code
The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.
As a student at the University you are expected adhere to Board of Regents Policy: Student Conduct Code. To review the Student Conduct Code, please see: http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf.
Note that the conduct code specifically addresses disruptive classroom conduct, which means "engaging in behavior that substantially or repeatedly interrupts either the instructor's ability to teach or student learning. The classroom extends to any setting where a student is engaged in work toward academic credit or satisfaction of program-based requirements or related activities."

Appropriate Student Use of Class Notes and Course Materials
Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community. For additional information, please see: http://policy.umn.edu/Policies/Education/Education/CLASSNOTESSTUDENTS.html.

Sexual Harassment
"Sexual harassment" means unwelcome sexual advances, requests for sexual favors, and/or other verbal or physical conduct of a sexual nature. Such conduct has the purpose or effect of unreasonably interfering with an individual's work or academic performance or creating an intimidating, hostile, or offensive working or academic environment in any University activity or program. Such behavior is not acceptable in the University setting. For additional information, please consult Board of Regents Policy: http://www1.umn.edu/regents/policies/humanresources/SexHarassment.html

Equity, Diversity, Equal Opportunity, and Affirmative Action
The University will provide equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression. For more information, please consult Board of Regents Policy: http://www1.umn.edu/regents/policies/administrative/Equity_Diversity_EO_AA.html.

Disability Accommodations
The University is committed to providing quality education to all students regardless of ability. Determining appropriate disability accommodations is a collaborative process. You as a student must register with Disability Services and provide documentation of your disability. The course instructor must provide information regarding a course's content, methods, and essential components. The combination of this information will be used by Disability Services to determine appropriate accommodations for a particular student in a particular course. For more information, please reference Disability Services: https://diversity.umn.edu/disability/.

Mental Health Services
As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University of Minnesota services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website: http://www.mentalhealth.umn.edu.

Academic Freedom and Responsibility: for courses that do <u>not</u> involve students in research
Academic freedom is a cornerstone of the University. Within the scope and content of the course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.*

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Mission Statements

College of Education & Human Development

The new College of Education and Human Development is a world leader in discovering, creating, sharing, and applying principles and practices of multiculturalism and multidisciplinary scholarship to advance teaching and learning and to enhance the psychological, physical, and social development of children, youth, and adults across the lifespan in families, organizations, and communities.

Department of Educational Psychology

Educational psychology involves the study of cognitive, emotional, and social learning processes that underlie education and human development across the lifespan. Research in educational psychology advances scientific knowledge of those processes and their application in diverse educational and community settings. The department provides training in the psychological foundations of education, research methods, and the practice and science of counseling psychology, school psychology, and special education. Faculty and students provide leadership and consultation to the state, the nation, and the international community in each area of educational psychology. The department's scholarship and teaching enhance professional practice in schools and universities, community mental health agencies, business and industrial organizations, early childhood programs, and government agencies.

Quantitative Methods in Education

To prepare students to become cutting-edge professionals in educational measurement, evaluation, statistics, and statistics education, through excellence in teaching, research, and service; and through investigating and developing research methodology in education.

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Six Intellectual Principles of Ph.D./Ed.D./Master's Research Education
(Currently under review)

1. *Scholarly Formation*
2. *Communication*
3. *Leadership and Collaborative Skills*
4. *Global Context*
5. *Professional Responsibility*
6. *Personal and Professional Management Skills*

Matrix Algebra for Statistical Modeling
2014 Schedule

DATE	Assignments	READINGS
January 21 Kaw: 1-26	Vector 1	Intro & Review Vectors
January 27	Quiz V1 Vector 2, 3	Vector Geometry Vector Variance, Covariance, & Correlation Using SPSS Matrix Language
February 3 Kaw 41-50	Quiz V2, V3 Vector 4, Matrix 1	Intro to Matrices Matrix Statistics
February 10 Kaw 26-37, Chapter 4	Matrix 2	Linear Equations Matrix Characteristics Regression and Regression Diagnostics
February 17	Quiz M1 Matrix 3	Linear Dependence & Rank Linear Equations
February 24 Kaw Chapter 5	Matrix 4 Regression Lab	Solving Systems of Equations ANOVA Table Solving for SS in Regression
March 3	MV Regression Lab	Multivariate Regression More Regression Diagnostics
March 10 Kaw Chapter 10	Quiz MV1 Multivariate 1	Normalizing Vectors Eigenvalues & Eigenvectors Positive Definiteness Status Multivariate Techniques
March 17		*Spring Break*
March 24	Quiz MV2 Eigen Value Lab	Principal Components Design Models Transformations
March 31	Final Assignment	
April 7		Submit Final Assignments

The Kaw pages and chapters are suggested readings – not required. They are provided for additional background and examples of methods studied in class.