SPRING 2018 COURSE ANNOUNCEMENT

STATISTICS 542

MULTIVARIATE STATISTICAL ANALYSIS: CLASSICAL THEORY AND RECENT DEVELOPMENTS

Time: MWF 2:30-3:20pm
Place: C301 Padelford Hall
Instructor: Michael Perlman, Statistics Dept, B310 Padelford
michael@stat.washington.edu
Prereq: STAT 581-582 plus linear algebra and matrix theory. In particular, familiarity with hypothesis testing, decision theory, and invariance. BIOSTAT/STAT 533 (univariate linear models) is also helpful.

The first 3/4 of the course will concentrate on "classical" multivariate analysis, i.e, distribution theory and statistical inference based on the multivariate normal distribution. The last 1/4 will cover special topics of interest to the instructor and/or requested by the class. There will be several homework assignments. Time permitting, each registered student will report on a topic of interest to her/him.

Topics include (as time permits):

0. Brief review of matrix algebra and the multivariate normal distribution: pdf, marginal and conditional distributions, covariance matrix, correlations and partial correlations.

1. The Wishart distribution: definition and properties, distribution of the sample covariance matrix, marginal and conditional distributions.

2. Estimation and testing: likelihood inference and invariance. Hotelling's T^2 test, multivariate linear models and MANOVA, testing independence, Bartlett's tests for equality of covariance matrices. The James-Stein estimator for the mean vector, the Stein estimator for the covariance matrix.

3. Distributions derived from the Wishart distribution and their role in hypothesis testing: eigenvalues, principle components, canonical correlations. Jacobians of multivariate distributions. Stein’s integral representation of the density of a maximal invariant statistic.

4. Group symmetry in estimation and testing (the Copenhagen theory.)

5. Multivariate probability inequalities and their applications to the power of multivariate tests and multiparameter confidence intervals.

6. Lattice conditional independence models and their applications to missing data problems and "seemingly unrelated regression" models.

REFERENCES

Books/Notes:

Anderson, T. W. (2003). *An Introduction to Multivariate Statistical Analysis (3rd ed).* Wiley, New York.

Andersson, S. A. (1999). *An Introduction to Multivariate Statistical Analysis,* Lecture Notes, Indiana University.

Bilodeau, M. and Brenner, D. (1999). *Theory of Multivariate Statistics*. Springer, New York.

Eaton, M. L. (1983). *Multivariate Statistics.* Wiley, New York.

Eaton, M. L. (1989). *Group Invariance Applications in Statistics*. IMS-ASA.

Lehmann, E. L. and Romano, J. P. (2005). *Testing Statistical Hypotheses, 3nd ed.* Wiley, New York.

Muirhead, R. J. (1982). *Aspects of Multivariate Statistical Theory.* Wiley, New York.

Seber, G. A. F. (1984). *Multivariate Observations.* Wiley, New York.

Articles:

Anderson, T. W. and Perlman, M. D. (1993). Parameter consistency of invariant tests for MANOVA and related multivariate hypotheses. *Statistics and Probability: A Raghu Raj Bahadur Festschrift* (J.K. Ghosh, S.K. Mitra, K.R. Parthasarathy, B.L.S. Prakasa Rao, eds.), 37-62. Wiley Eastern Ltd.

Andersson, S. A. (1990). The lattice structure of orthogonal linear models and orthogonal variance component models. *Scand. J. Statist*. **17** 287-319.

Andersson, S. A., Brons, H. K., and Tolver Jensen, S. (1983). Distribution of eigenvalues in multivariate statistical analysis. *Ann. Statist.* **11** 392-415.

Andersson, S. A. and Klein, T. (2010) On Riesz and Wishart distributions associated with decomposable undirected graphs. *J. Multivariate Analysis* **101** 789-810.

Andersson, S. A. and Madsen, J. (1998). Symmetry and lattice conditional independence in a multivariate normal distribution. *Ann. Statist.* **26** 525-572.

Andersson, S. A. and Perlman, M. D. (1991). Lattice-ordered conditional independence models for missing data. *Statistics and Probability Letters* **12** 465-486.

Andersson, S. A. and Perlman, M. D. (1993). Lattice models for conditional independence in a multivariate normal distribution. *Ann. Statist.* **21** 1318-1358.

Andersson, S. A. and Perlman, M. D. (1994). Normal linear models with lattice conditional independence restrictions. In *Multivariate Analysis and its Applications* (T.W. Anderson, K.T. Fang, I. Olkin,eds.), *IMS Lecture Notes-Monograph Series* Vol. **24** 97-110.

Andersson, S. A. and Perlman, M. D. (1998). Normal linear regression models with recursive graphical Markov structure. *J. Multivariate Analysis* **6**6 133-187.

Andersson, S. A. and Wojnar, G. G. (2004). Wishart distributions on homogeneous cones. *J. Theoret. Prob.* **17** 781-818.
[Also see http://faculty.frostburg.edu/math/wojnar/Documents/wispub1.pdf]

Daniels, M. J. and Kass, R. E. (2001). Shrinkage estimators for covariance matrices. *Biometrics* **57** 1173-1184.

Das Gupta, S., Anderson, T. W., and Mudholkar, G. S. (1964). Monotonicity of the power functions of some tests of the multivariate linear hpothesis. *Ann. Math. Statist.* **35** 200-205.

Drton, M., Andersson, S. A., and Perlman, M. D. (2005). Lattice conditional independence models for seemingly unrelated regression models with missing data. *J. Multivariate Analysis* **97** 385-411.

Joe, H. (2006). Generating random correlation matrices based on partial correlations. *J. Multivariate Analysis* **97** 2177-2189.
Also see http://ms.mcmaster.ca/canty/seminars/Joe_vinecorr_print.pdf

Kiefer, J. and Schwartz, R. (1965). Admissible Bayes character of T^2-, R^2-, and other fully invariant tests for classical multivariate normal problems. *Ann. Math. Statist.* **36** 747-770.

Ledet-Jensen, J. (1991). A large deviation-type approximation for the “Box class” of likelihood ratio criteria. *J. Amer. Statist. Assoc.* **86** 437-440.

Madsen, J. (2000). Invariant normal models with recursive graphical Markov structure. *Ann. Statist.* **28**

Marden, J. I. and Perlman, M. D. (1980). Invariant tests for means with covariates. *Ann. Statist.* **8** 825-63.

Okamoto, M. (1973). Distinctiveness of the eigenvalues of a quadratic form in a multivariate sample. *Ann. Statist.* **1** 763-754.

Perlman, M. D. (1980a). Unbiasedness of the likelihood ratio tests for equality of several covariance matrices and equality of several multivariate normal populations. *Ann. Statist.* **8** 247-263.

Perlman, M. D. (1980b). Unbiasedness of multivariate tests: recent results. *Proceedings of the Fifth International Symposium on Multivariate Analysis* (P.R. Krishnaiah, ed.), 413-432. [Also see Anderson (2003) Section 8.10.2.]

Perlman, M. D. and Olkin, I. (1980). Unbiasedness of invariant tests for MANOVA and other multivariate problems. *Annals of Statistics* **8** 1326-1341.

Perlman, M. D. (1987). Group symmetry covariance models. (Discussion of "A Review of Multivariate Analysis" by Mark Schervish.) *Statistical Science* **2**, 421-425.

Perlman, M. D. (1990). T.W. Anderson's theorem on the integral of a symmetric unimodal function over a symmetric convex set and its applications in probability and statistics. *The Collected Papers of T.W. Anderson:* 1943-1985 (G. Styan, ed.), Vol. **2** 1627-1641. J. Wiley & Sons, New York.

Schwartz, R. (1967). Admissible tests in multivariate analysis of variance. *Ann. Statist.* **38**, 698-710. [Also see Anderson (2003) Section 8.10.1.]

Stein, C. (1956). The admissibility of Hotelling's T^2-test. *Ann. Math. Statist.* **27** 616-623.

Tolver Jensen, S. (1988). Covariance hypotheses which are linear in both the covariance and the inverse covariance. *Ann. Statist*. **16** 302-322.