Syllabus
MAT752: Statistical Ranking, Selection, and Multiple Comparisons

Class Time: Spring Semester 2015, MW 3:45 pm -5:05 pm.

Instructor: Professor Pinyuen Chen, pinchen@syr.edu, x-1577.

Office Hours: Mondays and Wednesdays 11 am – 12 noon.

Objectives: Ranking and Selection theory was developed in 1950's to provide experimenters with statistical formulations for real world problems that had been previously inappropriately handled as test of homogeneity. It rapidly gained recognition as an alternative of multiple hypotheses testing. In the last 20 years, we observed the successes of applications of ranking and selection procedures to signal processing, pharmaceutical sciences, clinical trials, quality control, biology, environmental science and forestry, educational and psychological measurements, etc. In the first half of the course, we will review the fundamental approaches of ranking and selection theory. In the second half, we study several recent modifications of the traditional ranking and selection approaches that were made to fit respective applications. By the end of the semester, students will (1) be familiar with the basic tools in ranking and selection theory and (2) be able to apply selection theory to practical problems as well as to the research in their own disciplines.

Prerequisites: A mathematical statistics course and two semesters of calculus.

Textbooks: Both books can be read online at books.google.com:

1. Selecting and Ordering Populations: A New Statistical Methodology, written by Jean Dickinson Gibbons, Ingram Olkin, Milton Sobel, published by *Society for Industrial and Applied Mathematics*,1999.
2. Multiple Decision Procedures: Theory and Methodology of Selecting and Ranking Populations, written by Shanti S. Gupta, S. Panchapakesan, published by *Society for Industrial and Applied Mathematics*, 2002.

Grade: Midterm Presentation 40% + Final Project Presentation 60%.

Course Outline:

I. Fundamentals: (5 weeks)

1. Philosophy of Ranking and Selection: Chapter 1 of GOS (Gibbons, Olkin, and Sobel (1999)).
2. Selecting the Best Normal Population with Indifference Zone Approach: Chapters 2 & 5 of GOS + Chapter 2 of GP (Gupta and Panchapakesan (2002)).
3. Subset Selection Approach and an Alternative Definition of A Correct Selection: Chapter 1 of GOS + Chapter 11 of GP.
4. Selecting the best Bernoulli population: Chapter 4 of GOS + Chapter 4 of GP.

5. Selecting among multinomial cells: Chapter 6 of GOS + Section 4.9 and Section 13.6 of GP.
6. Nonparametric Selection: Chapter 7 of GOS.

II. Midterm Presentation by Students (2-4 weeks): Each student chooses an article from the list below, study it, discuss the article with the instructor, and present it to the class.

1. Bechhofer, R. E., Dunnett, C. W., and Sobel, M. (1954). A Two-Sample Multiple Decision Procedure for Ranking Means of Normal Populations with Unknown Variances, *Biometrika*, 41, 170-176.
2. Bechhofer, R. E. and Turnbull, B. W. (1978). Two (k+1)-Decision Selection Procedures for Comparing k Normal Means with a Specified Standard, *Journal of the American Statistical Association,* 73, 385-392.
3. Dunnett, C. W. (1984). Selection of the Best Treatment in Comparison to a Control with an Application to a Medical Trial, in *Design of Experiments, Ranking, and Selection* (Edited by T. J. Santner and A. C. Tamhane) Marcel Dekker, Inc., New York, 47-66.
4. Thall, P. F., Simon, R. and Ellenberg, S. S. (1988). Two-Stage Selection and Testing Designs for Comparative Clinical Trials, *Biometrika*, 75, 2, 303-310.
5. Thall, P. F., Simon, R. and Ellenberg, S. S. (1989). A Two-Stage Design for Choosing Among Several Experimental Treatments and a Control in Clinical Trials. *Biometrics*, 45, 537-547.
6. Dudewicz, E. J. and Dadal, S. R. (1975). Allocation of Observations in Ranking and Selection with Unequal Variances, *Sankhya Ser B* 37, 28-78.
7. Tong, Y. L. (1969). On Partitioning a Set of Normal Populations by their Locations with Respect to a Control, *The Annals of Mathematical Statistics*, 40, 4, 1300-1324.
8. Gupta, S. S. and Sobel, M (1960). Selecting a subset containing the best of several binomial populations. *Contributions to Probability and Statistics* (Eds. I. Olkin et al.) Stanford University Press, Stanford, California, pp. 224-248.
9. Mahamunulu, D. M. (1967) Some fixed-sample ranking and selection problems, *The Annals of Mathematical Statistics*, 38, 1079-1091.
10. Alam, K. and and Rizvi, M. H. (1966). Selection from Multivariate Populations, *Annals of Institute of Statistical Mathematics*, 18, 307-318.
11. Chi Y. and Chen, C. M. (2008). Curtailed Two-Stage Designs in Phase II Clinical Trials, *Statistics in Medicine*, 27, 6175-6189.
12. Bechhofer, R. E., Elmarghraby, S., and Morse, N. (1959) A Single-Sample Multiple Decision Procedure for Selecting the Multinomial Event Which Has the Highest Probability, *The Annals of Mathematical Statistics*, 30, Issue 1, 102-119.
13. Bechhofer, R. E. and Chen, P. (1991). A Note on a Curtailed Sequential Procedure for Subset Selection of Multinomial Cells, *American Journal of Mathematical and Management Sciences,* Volume 11, Numbers 3 & 4, 309-324.
14. Gupta, S. S. and Nagel, K. (1967). On Selection and Ranking Procedures and Order Statistics from the Multinomial Distribution*, Sankhya Ser. B* 29, 1-34.
15. Sobel, M. (1985). Nonparametric Selection of the Smallest-Dispersion Population, *American Journal of Mathematical and Management Sciences*, V. 5, # 3 & 4, 313-329.

16. Alam, K. and Thompson, J. R. (1972). On Selecting the Least Probable Multinomial Event, *The Annals of Mathematical Statistics*, v. 43, 8, 1981-1990.
17. Chen, P. and Hsu, L. (1991) A Composite Stopping Rule for Multinomial Subset Selection, *British Journal of Mathematical and Statistical Psychology*, 44, 403-411.
18. Cacoullos, T. and Sobel, M. (1966). An Inverse-Sampling Procedure for Selecting the Most Probable Event in a Multinomial Distribution, in *Multivariate Analysis (Edited by Paruchuri R. Krishnaiah),* Academic Press Inc., New York and London, 423-455.

III. Applications to clinical trials: (3 weeks)

1. Two-Stage Selection/Testing procedures.
   a. Carsten, C. and Chen, P. (2014) Curtailed two-stage designs in double-arm phase II Clinical Trials, Technical Report.
   b. Buzaianu, E. and Chen, P. (2014) A Stein-type Two-Sample Procedure for Comparing Normal Means, Technical Report.

2. Exact and curtailments for Bernoulli Selection/Testing.
   a. Buzaianu, E. and Chen, P. (2005). On Selecting Among Treatments with Bernoulli Outcomes, *Communications in Statistics – Theory and Methods,* 34, 1247-1264.
   b. Buzaianu, E. and Chen, P. (2008) Curtailment Procedure for Selecting Among Bernoulli Populations, *Communications in Statistics – Theory and Methods*, 37, 1085-1102.
   c. Buzaianu, E. and Chen, P. (2009) A Hybrid Selection and Testing Procedure with Curtailment for Comparative Clinical Trials, *Sequential Analysis*, 28, 1, 2-20.

IV. Applications to Signal Processing: (3 weeks)

1. Non-homogeneity Detection.
2. Number of Signals.
3. Selecting of the Principal Components.
4. Selecting the Best Log-Normal Populations in Electromagnetic Fields.

V. Final Project Presentation: (2-4 weeks)

Each student shall choose his/her own topic to work on and discuss the project with the instructor as frequently as possible. The project could be in theory or in application as long as it is related to ranking and selection theory. Each student shall present his/her project in class at the end of the semester.

Academic Integrity

The Syracuse University Academic Integrity Policy holds students accountable for the integrity of the work they submit. Students should be familiar with the Policy and know that it also governs the integrity of work submitted in exams and assignments as well as the veracity of signatures on attendance sheets and other verifications of participation in class activities. Serious sanctions can result from academic dishonesty of any sort. For more information and the complete policy, see **http://academicintegrity.syr.edu**

Disability

Students who may need academic accommodations due to a disability are encouraged to discuss their needs with the instructor at the beginning of the semester. In order to obtain authorized accommodations, students should be registered with the Office of Disability Services (ODS), 804 University Avenue, Room 309, 315-443-4498 and have an updated accommodation letter for the instructor. Accommodations and related support services such as exam administration are not provided retroactively and must be requested in advance."

For more information about services and policy, see Office of Disability Services

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