

Syllabus

MAT752: Statistical Ranking, Selection, and Multiple Comparisons

Class Time: Spring 2019, MW 2:15 pm -3:35 pm, Carnegie Building 219.

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

Office Hours: Mondays, Tuesdays, Wednesdays 1 pm – 2 pm.

Objectives: Ranking and Selection theory was developed in 1950's to provide experimenters with statistical formulations for solving real world problems that had been previously inappropriately handled by methods in hypothesis testing (of homogeneity.) It rapidly gained recognition as an alternative approach to multiple hypotheses testing. In the last two decades, 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 used in ranking and selection theory and (2) be ready 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: (4 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 Presentations by Students (4-5 weeks): Each student chooses an article from the list below or an article related to selection theory, study it, discuss the article with the instructor, and present it to the class.

Selection problems for Normal Populations:

1. Bechhofer, R. E. (1954) A Single-sample multiple decision procedure for ranking means of normal populations with known variances, *Annals of Mathematical Statistics*, 25, 16-39.
2. 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.
3. Mahamunulu, D. M. (1967) Some fixed-sample ranking and selection problems, *The Annals of Mathematical Statistics*, 38, 1079-1091.
4. 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.
5. Carroll, R. J., Gupta, S. S., and Huang, D. Y. (1975) Selection Procedures for the t best populations, *Communications in Statistics*, 4 (11), 987-1008.
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. 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.
8. Buzaianu, E. and Chen, P. (2015) Selection of the Best Experimental Treatment in Comparison with a Control: the Heteroscedastic Case, *Sequential Analysis*, Vol. 34, Issue 4, 441-460.

Selection problems for binomial and multinomial populations:

9. Sobel, M. and Huyett, M. (1957) Selecting the Best One of Several Binomial Populations, *The Bell System Technical Journal*, March 1957, 537-576.
10. Wilcox, R. R. (1981) Selecting the t best of k Examinees Whose True Score is Better Than a Standard, *Educational and Psychological Measurement*, 41, 709-716.
11. Eaton, M. and Gleser, L. (1989) Some Results on Convolutions and a Statistical Application, in *Contributions to Probability and Statistics, Essays in honor of Ingram Olkin*, Springer, 75-90.
12. 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.

13. 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.
14. 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.
15. 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.
16. Chi Y. and Chen, C. M. (2008). Curtailed Two-Stage Designs in Phase II Clinical Trials, *Statistics in Medicine*, 27, 6175-6189.
17. Buzaianu, E. and Chen, P. (2005). On Selecting Among Treatments with Bernoulli Outcomes, *Communications in Statistics – Theory and Methods*, 34, 1247-1264.
18. Buzaianu, E. and Chen, P. (2008) Curtailment Procedure for Selecting Among Bernoulli Populations, *Communications in Statistics – Theory and Methods*, 37, 1085-1102.
19. Buzaianu, E. and Chen, P. (2009) A Hybrid Selection and Testing Procedure with Curtailment for Comparative Clinical Trials, *Sequential Analysis*, 28, 1, 2-20.
20. Carsten, C. and Chen, P. (2016) Curtailed two-stage designs in double-arm phase II Clinical Trials, *Journal of Biopharmaceutical Statistics*. 26, No. 5, 816-822.
21. 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.
22. 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.
23. 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.
24. Alam, K. and Thompson, J. R. (1972). On Selecting the Least Probable Multinomial Event, *The Annals of Mathematical Statistics*, v. 43, 8, 1981-1990.
25. Chen, P. and Hsu, L. (1991) A Composite Stopping Rule for Multinomial Subset Selection, *British Journal of Mathematical and Statistical Psychology*, 44, 403-411.
26. 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.

Nonparametric Selection:

27. Sobel, M. (1967) Nonparametric Procedures for Selection the t best Populations with the Largest α - Quantiles, *Annals of Mathematical Statistics*, 37, 6, 1804 – 1816.
28. Rizvi, MH and Sobel, M. (1967) Nonparametric Procedures for Selecting a Subset Containing the Population with the Largest α - Quantiles, *Annals of Mathematical Statistics*, 37, 6, 1788 - 1803.
29. Sobel, M. (1985) Nonparametric Selection of the Smallest-Dispersion Population, *American Journal of Mathematical and Management Sciences*, V. 5, # 3 & 4, 313-329.

Selection Problems for Multivariate Populations:

30. Alam, K. and Rizvi, M. H. (1966). Selection from Multivariate Populations, *Annals of Institute of Statistical Mathematics*, 18, 307-318.
31. Chen, P., Melvin, W. and Wicks, M. (1999) Screening Among Multivariate Normal Data, *Journal of Multivariate Analysis*, 69, 10-29.
32. Chen, P. and Wicks, M. (2003) Development of a Lower Confidence Limit for the Number of Signals, *IEEE Transactions of Signal Processing*, Vol 51, 6, 1449-1456.

III. Applications to clinical trials: (1-2 weeks)

1. Two-Stage Selection/Testing procedures.
 - a. Carsten, C. and Chen, P. (2016) Curtailed two-stage designs in double-arm phase II Clinical Trials, *Journal of Biopharmaceutical Statistics*. DOI:10.1080/10543406.2015.1074921.
 - b. Buzaianu, E. and Chen, P. (2015) Selection of the Best Experimental Treatment in Comparison with a Control: the Heteroscedastic Case, *Sequential Analysis*, Vol. 34, Issue 4, 441-460.
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: (1-2 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: (4-5 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.

Students with disabilities. If you believe that you need academic adjustments (accommodations) for a disability, please contact the Office of Disability Services (ODS), <http://disabilityservices.syr.edu>, located in Room 309 of 804 University Avenue, or call (315) 443-4498 or TDD: (315) 443-1371 for an appointment to discuss your needs and the process for requesting academic adjustments. ODS is responsible for coordinating disability-related academic adjustments and will issue students with documented Disabilities Accommodation

Authorization Letters, as appropriate. Since academic adjustments may require early planning and generally are not provided retroactively, please contact ODS as soon as possible.

Related link: <http://disabilityservices.syr.edu/faculty-staff/syllabus-statement/>

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The Violation and Sanction Classification Rubric establishes recommended guidelines for the determination of grade penalties by faculty and instructors, while also giving them discretion to select the grade penalty they believe most suitable, including course failure, regardless of violation level. Any established violation in this course may result in course failure regardless of violation level.

For more information and the complete policy, see <http://class.syr.edu/academic-integrity/>

Religious observances policy. Syracuse University's Religious Observances Policy recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holy days according to their tradition. Under the policy, students are provided an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance provided they notify their instructors no later than the end of the second week of classes. For fall and spring semesters, an online notification process is available through MySlice (Student Services -> Enrollment -> My Religious Observances) from the first day of class until the end of the second week of class.

Related link: http://supolicies.syr.edu/studs/religious_observance.htm

Cell Phones. Cell phones should be turned off and put away during class.