18a4-1   **Likelihood Ratio Test for Exploratory Factor Analysis Model**

Yoshiyuki Ninomiya  
*Kyushu University, Japan*

To select the number of factors in the factor analysis, we consider the following testing procedure: (i) Testing $m$ against $m + 1$ for the number of factors by the likelihood ratio test statistic is conducted from $m = 1$ as long as the last testing is rejected (ii) When the testing is not rejected, the number of factors in the null hypothesis is selected as the true number. But this procedure needed a Monte Carlo simulation to evaluate its $p$-value, because the likelihood ratio test statistic does not follow the chi-square distribution asymptotically. To avoid the simulation, we generalize the locally conic parameterization introduced by Dacunha-Castelle and Gassiat [Ann. Statist. 27(1999):1178-1209] to evaluate the asymptotic distribution of the likelihood ratio test statistic.

[Yoshiyuki Ninomiya, Kyushu University, Japan; nino@math.kyushu-u.ac.jp]

18a4-2   **Likelihood Ratio Tests for Positivity in Polynomial Regressions**

Naohiro Kato  
*The Graduate University for Advanced Studies, Tokyo, Japan*

Satoshi Kuriki  
*The Institute of Statistical Mathematics, Tokyo, Japan*

A polynomial that is nonnegative over a given interval is called a positive polynomial. The set of such positive polynomials forms a closed convex cone $K$. In this paper, we consider the likelihood ratio test for the hypothesis of positivity that the estimand polynomial regression is a positive polynomial. By considering hierarchical hypotheses including the hypothesis of positivity, we define nested likelihood ratio tests, and derive their null distributions as mixtures of chi-square distributions by using the volume-of-tube method. The mixing probabilities are obtained by utilizing the parameterizations for the cone $K$ and its dual provided in the framework of the Tchebycheff systems when the degree of polynomials is up to 4. Moreover, we propose the associated simultaneous confidence bound for polynomial regression curves. Regarding computation, we demonstrate that symmetric cone programming is useful to obtain the test statistics.
18a4-3 **Ordinal Data Analysis Based on Kullback-Leibler Distance**

Wei Gao
Ning-Zhong Shi
*School of Math and Statistics, Northeast Normal University, People’s Republic of China*

Ordinal data often appear in clinic studies, econometrics and social science data analysis. It can improve statistical inference if “ordinal” information properly incorporate into data analysis. Base on the Kullback-Liebler information, we will propose statistics for ordinal data and present unified generalized iterative scaling (UGIS) to estimate the related parameters, which is a powerful method to deal with ordinal data analysis.

[Wei Gao, School of Math and Statistics, Northeast Normal University, Changchun, Jilin 130024, China; tgaow@nenu.edu.cn]