14:50-15:40, Dec. 12th, 2015
Session (5)

Testing constancy of conditional co-variance matrix in high dimension

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Abstract

Testing constancy of conditional co-variance matrix is a crucial statistical problem especially in regression studies. It has many important applications and we shall introduce two major ones here. The first one lies in so-called inverse regression. Many sufficient dimension reduction (SDR) methods are based on the concept of inverse regression such as sliced inverse regression (SIR), sliced average variance estimation (SAVE), directional regression (DR) and so on. Two assumptions were typically imposed: the linearity for conditional expectation and constant conditional co-variance. The constant conditional variance assumption doesn't always hold in general, and it is a must to test the assumption before we apply most SDR methods. The other major application lies in multivariate linear regression (Aldrich, 2005), which assumes the response variables given the predictors follow a constant co-variance matrix. Apparently, deviation from constant conditional co-variance would result in severely inconsistent estimate. Thus, in reality, this assumption must be tested before we apply the parametric modeling. In this work, we propose a slice-based procedure to test constant conditional variance for high dimensional data which allows the number of dimensionality p grows with the sample size n, and under some mild and regular conditions, this consistency also holds when $p \gg n$. Both simulation and real data analysis favor our testing procedure. The computation is simple and fast, which can be easily implemented in several statistical software.