Statistics Seminar

Department of Mathematical Sciences

DATE:	Thursday, March 5, 2015
TIME:	1:15pm to 2:15pm
LOCATION:	WH 100E
SPEAKER:	Wenyu Du (Binghamton University)
TITLE:	Accurate and efficient numerical performance evaluation of the Generalized Shiryaev-Roberts procedure for quickest change-point detection

Abstract

Quickest change-point detection is a branch of Statistics concerned with the development and evaluation of procedures for early but reliable detection of unanticipated changes that may occur in the statistical behavior of a series of sequentially made observations. A problem particularly persistent in applied change-point detection is that of accurate and efficient performance evaluation of change-point detection procedures. We consider this problem for the Generalized Shiryaev-Roberts (GSR) detection procedure. The latter is a recently proposed headstarted extension of the classical Shiryaev-Roberts (SR) procedure with strong optimality properties not exhibited by such mainstream detection procedures as the Cumulative Sum (CUSUM) “inspection scheme” or the Exponentially Weighted Moving Average (EWMA) control chart. We approach the performance evaluation problem numerically and propose an integral-equations-based numerical method wherewith one can compute all major performance metrics for the GSR procedure. The proposed method utilizes the collocation framework and its key feature is that the collocation functional basis is chosen so as to take advantage of a certain change-of-measure identity and a unique martingale property of the GSR procedure’s statistic. This substantially improves the method’s accuracy and robustness, although the method’s theoretical convergence rate is shown to be merely quadratic. A tight upperbound on the method’s error is supplied as well. Moreover, the use of the change-of-measure identity also lends the method greater efficiency, for the Average Run Length (ARL) to false alarm and Shiryaev’s Stationary Average Detection Delay delivered by the GSR procedure can both be computed *simultaneously*. The method’s theoretically expected high accuracy, efficiency and robustness are confirmed experimentally in a comprehensive numerical study. Furthermore, we also offer a scenario where the method exhibits no error whatsoever, and yields the GSR procedure’s ARL to false alarm exactly. Exact results are extremely rare in change-point detection.

As a practically important application of the proposed method, we devise the latter in a particular scenario and assess the sensitivity of the classical SR procedure with respect to a possible misspecification of the parameter in the observations’ post-change distribution.

The proposed numerical method might help foster and facilitate further research on the theory and application of the GSR procedure and thereby pave the way for the latter to become the top tool for quickest change-point detection.

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