中央研究院統計科學研究所

學 術 演 講

講 題： Goodness-of-fit testing for the trend function of a Trend-Renewal Process (TRP)

演 講 人：Prof. Bo Henry Lindqvist
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時 間： 2024-11-18(Mon.) 10:30-12:00

地 點：Auditorium, B1F, Institute of Statistical Science；The tea reception will be held at 10:10.

備 註： Lecture in English. Online live streaming through Cisco Webex will be available.

Abstract

The use of nonhomogeneous Poisson processes (NHPP) to model the occurrence of successive failures T1, T2, . . . of a repairable system undergoing minimal repair is well known. Likewise, there has since the 1970s and 80s been devised various trend tests to decide whether the occurrence of failures is increasing or decreasing with time (Laplace test, Military Handbook test, etc.) These tests are typically for the null hypothesis of a homogeneous Poisson process (HPP). They are, however, generally sensitive to departures from the Poisson process assumption. This fact was the point of departure for the classical paper by Lewis and Robinson (1974), who had observed that the commonly used Laplace trend test often led to rejection of the null hypothesis of no trend, even in cases where a trend could not exist. More precisely, the authors observed that false rejections were particularly occurring in cases of overdispersion of the interevent times with respect to the exponential distribution. Their idea was to modify the Laplace test statistic to account for this overdispersion, which led to the test known under the name of Lewis–Robinson (LR) test. The LR test can be viewed as a test for the null hypothesis of a renewal process (RP). As was demonstrated by Kvaløy and Lindqvist (2020) (see also Lindqvist and Kvaløy 2024), this test is one member of a larger class of tests for the null hypothesis of RP that can be derived by adapting a functional central limit theorem for renewal process involving the Brownian Bridge. Likewise, an asymptotic version of the Military Handbook test as considered by Bhattacharjee et al. (2004) can be derived in this way. The above mentioned approach can essentially be described as extending models and results involving NHPP to the more general approach of trendrenewal processes (TRP). Informally, the concept of

TRP (Lindqvist et al. 2003) combines both renewal and trend dynamics of a recurrent event process. To be precise, the TRP shares with the NHPP a trend function $\lambda(t)$ (usually named intensity in the NHPP nomenclature), but involves in addition a distribution F (calle the renewal distribution) such that (by definition), $\Lambda(T1), \Lambda(T2), \ldots$ is an RP with interevent distribution F, where $\Lambda(t)$ = R t 0 $\lambda(u)$du. Hence a TRP is an NHPP if F is the standard exponential distribution, while a TRP is an RP if $\lambda(t)$ is constant in t. 1 Thus, by means of TRPs, one may reconsider classical analyses within the NHPP setting by instead doing inference on the trend function of the TRP, and thus in some sense robustify NHPP analyses. As noted above, the approach extends tests for the null hypothesis of HPP to the null hypothesis of RP. More generally, various goodness-of-fit tests for the intensity function of an NHPP can be extended to corresponding tests for the trend function of TRPs. As demonstrated by Kvaløy and Lindqvist (2020), the approach can also be used in the calculation of local power of trend tests versus given alternatives of the TRP type. For example, these results are in accordance with known results from the NHPP literature stating that the Military Handbook and Laplace tests are optimal for, respectively, alternatives of power and log-linear intensity functions. The main points as described above will be considered in the talk, including illustrating simulations and examples.

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