THE UNIVERSITY OF GEORGIA
DEPARTMENT OF STATISTICS

Colloquium Series

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3:30pm in room 102, Caldwell Hall

Neyman-Pearson Classification Algorithms and NP Receiver Operating Characteristics

In many binary classification applications, such as disease diagnosis and spam detection, practitioners commonly face the need to limit type I error (i.e., the conditional probability of misclassifying a class 0 observation as class 1) so that it remains below a desired threshold. To address this need, the Neyman-Pearson (NP) classification paradigm is a natural choice; it minimizes type II error (i.e., the conditional probability of misclassifying a class 1 observation as class 0) while enforcing an upper bound, α, on the type I error. Although the NP paradigm has a century-long history in hypothesis testing, it has not been well recognized and implemented in classification schemes. Common practices that directly limit the empirical type I error to no more than α do not satisfy the type I error control objective because the resulting classifiers are still likely to have type I errors much larger than α. As a result, the NP paradigm has not been properly implemented for many classification scenarios in practice. In this work, we develop the first umbrella algorithm that implements the NP paradigm for all scoring-type classification methods, including popular methods such as logistic regression, support vector machines and random forests. Powered by this umbrella algorithm, we propose a novel graphical tool for NP classification methods: NP receiver operating characteristic (NP-ROC) bands, motivated by the popular receiver operating characteristic (ROC) curves. NP-ROC bands will help choose α in a data adaptive way and compare different NP classifiers. We demonstrate the use and properties of the NP umbrella algorithm and NP-ROC bands, available in the R package nproc, through simulation and real data case studies.