

# A Shrinkage Likelihood Ratio Test for High-Dimensional Subgroup Analysis with a Logistic-Normal Mixture Model

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## Abstract

In subgroup analysis, testing the existence of a subgroup with a differential treatment effect serves as protection against spurious subgroup discovery. Despite its importance, this hypothesis testing possesses a complicated nature: parameter characterizing subgroup classification is not identified under the null hypothesis of no subgroup. Due to this irregularity, the existing methods have the following two limitations. First, the asymptotic null distribution of test statistics often takes an intractable form, which necessitates computationally demanding resampling methods to calculate the critical value. Second, the dimension of personal attributes characterizing subgroup membership is not allowed to be of high dimension. To solve these two problems simultaneously, this study develops a novel shrinkage likelihood ratio test for the existence of a subgroup using a logistic-normal mixture model. The proposed test statistics are built on a modified likelihood function that shrinks possibly high-dimensional unidentified parameters toward zero under the null hypothesis while retaining power under the alternative. This shrinkage helps handle the irregularity and restore the simple chi-square-type asymptotics even under the high-dimensional regime.