# On Probabilistic Group Testing Designs: Prevalence Estimation, Cost Considerations, and Dilution Effects

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## Abstract

Group testing has been widely used in many areas such as disease testing, fault detection, genetics, and food safety. Group testing can only be applied when samples from multiple subjects can be pooled and tested as a group. A group testing design is specified by distinct group sizes and their corresponding frequencies. In this series of works, we first construct locally optimal approximate designs for group testing with uncertain error rates, where the goal is to maximize the precision of the prevalence estimate. We then extend the framework to accommodate two features likely to be encountered in real-world studies: 1) both subjects and assays incur costs, and 2) the error rates of the test are linked to the group sizes, allowing dilution effects to reduce the test performance.

Our results show that an optimal design must have at least three group sizes, where the intermediate size is important for estimating prevalence, and extreme sizes are important for error rate parameters. Moreover, as the ratio of subject to test costs increases even moderately, the larger group sizes and their proportions of trials drop rapidly, but their proportions of budget still increase. Several simulated examples show that the locally optimal designs are quite stable to the working parameters prespecified using domain knowledge.

Keywords: Budget-constrained design, dilution effect, Ds-optimality, group testing, misclassification

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