

OPTIMAL TESTS SHRINKING BOTH MEANS AND VARIANCES
APPLICABLE TO MICROARRAY DATA ANALYSIS

by

J. T. Gene Hwang
Cornell University

and

Peng Liu
Iowa State University

April, 2007

ABSTRACT

As a consequence of “large p small n ” characteristic for microarray data, hypothesis tests based on individual genes often result in low average power. There are several proposed tests that attempt to improve power. Among these, F_S test developed using the concept of James-Stein shrinkage to estimate the variances, showed a striking average power improvement. In this paper, we derive the F_S test as an empirical Bayes likelihood ratio test, providing a theoretical justification. To shrink the means also, we modify the prior distributions leading to the optimal Bayes test which is called MAP test (where MAP stands for Maximum Average Power). Also an F_{SS} statistic is derived as an approximation to MAP and can be computed instantaneously. The F_{SS} shrinks both the means and the variances and has a numerically identical average power as MAP . Simulation studies show that the proposed test performs uniformly better in average power than the other tests in the literature including the classical F test, F_S test, the test of Wright and Simon, moderated t -test, SAM, Efron’s t test and B statistics. A theory is established which indicates that the proposed test is optimal in power when controlling the false discovery rate (FDR).