False Discovery Control in Large-Scale Spatial Multiple Testing

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Abstract: This article develops a unified theoretical and computational framework for false discovery control in multiple testing of spatial signals. We consider both point-wise and cluster-wise spatial analyses, and derive oracle procedures which optimally control the false discovery rate, false discovery exceedance and false cluster rate, respectively. A data-driven finite approximation strategy is developed to mimic the oracle procedures on a continuous spatial domain. Our multiple testing procedures are asymptotically valid and can be effectively implemented using Bayesian computational algorithms for analysis of large spatial data sets. Numerical results show that the proposed procedures lead to more accurate error control and better power performance than conventional methods. We demonstrate our methods for analyzing the time trends in tropospheric ozone in eastern US.