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Plenary: Nonparametric hypothesis testing for a spatial signal

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Abstract

Summary form only given. Nonparametric hypothesis testing for a spatial signal can involve a large number of hypotheses. For instance, two satellite images of the same scene, taken before and after an event, could be used to test a hypothesis that the event has no environmental impact. This is equivalent to testing that the mean difference of "after-before" is zero at each of the (typically thousands of) pixels that make up the scene. In such a situation, conventional testing procedures that control the overall Type I error deteriorate as the number of hypotheses increase. Powerful testing procedures are needed for this problem of testing for the presence of a spatial signal. In this talk, we propose a procedure called enhanced FDR (EFDR), which is based on controlling the false discovery rate (FDR) and a concept known as generalized degrees of freedom (GDF). EFDR differs from the standard FDR procedure through its reducing of the number of hypotheses tested. This is done in two ways: first, the model is represented more parsimoniously in the wavelet domain, and second, an optimal selection of hypotheses is made using a criterion based on generalized degrees of freedom. Not only does the EFDR procedure tell us whether a spatial signal is present or not, it has an added bonus that, if a signal is deemed present, it can indicate its location and magnitude. The EFDR procedure is applied to an air-temperature data set generated from the climate system model (CSM) of the National Center for Atmospheric Research (NCAR) and to brain-imaging data from fMRI experiments.

Keywords

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Abstract

Nonparametric hypothesis testing for a spatial signal can involve a large number of hypotheses. For instance, two satellite images of the same scene, taken before and after an event, could be used to test a hypothesis that the event has no environmental impact. This is equivalent to testing that the mean difference of "after - before" is zero at each of the (typically thousands of) pixels that make up the scene. In such a situation, conventional testing procedures that control the overall Type I error deteriorate as the number of hypotheses increase. Powerful testing procedures are needed for this problem of testing for the presence of a spatial signal. In this talk, we propose a procedure called Enhanced FDR (EFDR), which is based on controlling the false discovery rate (FDR) and a concept known as generalized degrees of freedom (GDF). EFDR differs from the standard FDR procedure through its reducing of the number of hypotheses tested. This is done in two ways: first, the model is represented more parsimoniously in the wavelet domain, and second, an optimal selection of hypotheses is made using a criterion based on generalized degrees of freedom. Not only does the EFDR procedure tell us whether a spatial signal is present or not, it has an added bonus that, if a signal is deemed present, it can indicate its location and magnitude. The EFDR procedure is applied to an air-temperature data set generated from the Climate System Model (CSM) of the National Center for Atmospheric Research (NCAR) and to brain-imaging data from fMRI experiments.

Biosketch

Noel Cressie was born in Fremantle, Western Australia. He received the Bachelor of Science degree with first class honours in Mathematics from the University of Western Australia. He received the M.A. and Ph.D. degrees in Statistics from Princeton University in 1973 and 1975, respectively. Since 1998 he has been Professor of Statistics at The Ohio State University and Director of the Program in Spatial Statistics and Environmental Sciences (SSES). He is the author of around 200 refereed articles and of two books, the most recent being, "Statistics for Spatial Data, rev. edn", published by John Wiley and Sons in 1993. His research interests are in the statistical modeling and analysis of spatio-temporal data, and in Bayesian and empirical Bayesian methods. Dr Cressie is a Fellow of the American Statistical Association and The Institute of Mathematical Statistics.