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Testing Independence Between Two Spatial Random Fields

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Abstract

We consider testing independence between two spatial Gaussian random fields evaluated respectively at p and q locations with sample size n, where p and q are allowed to be larger than n. Our approach is based on canonical correlation analysis (CCA), without imposing any spatial stationarity and parametric structure for the two random fields. Instead of applying CCA directly to the two random fields, which is not feasible for high-dimensional testing considered, we adopt a dimension-reduction approach using a special class of multiresolution spline basis functions. These functions are ordered in terms of their degrees of smoothness. By projecting the data to the function space spanned by a few leading basis functions, the spatial variation of the data can be effectively preserved. The test statistic is constructed from the first sample canonical correlation coefficient in the projected space and is shown to have an asymptotic Tracy-Widom distribution under the null hypothesis. Our proposed method automatically detects the signal between the two random fields and is designed to handle irregularly spaced data directly. In addition, we show that our test is consistent under mild conditions and provide simulation experiments to demonstrate its powers. Moreover, we apply our method to investigate whether the precipitation in continental east Africa is related to the sea surface temperature (SST) in the Indian Ocean, and whether the precipitation in west Australia is related to the SST in the North Atlantic Ocean. (Work done jointly with H.-C. Huang, R. S. Tsay, and G. Pan.)

Keyword: canonical correlation analysis, high-dimensional test, irregularly spaced data, teleconnection, Tracy-Widom distribution