An Adaptive Decorrelation Procedure for Signal Detection

Mathieu Emily
Joint work with Florian Hebert and David Causeur

Handling dependence or not remains an open issue in signal detection, where a large number of pointwise test statistics are aggregated to simultaneously test for a collection of null hypotheses. In various fields such as genetic epidemiology or functional data analysis, many testing methods for signal detection have been proposed, some ignoring dependence across pointwise test statistics whereas others introduce a model for decorrelation, with unclear conclusions on their relative performance. Indeed, the benefit that can be expected from decorrelation highly depends on the interplay of the pattern of dependence across pointwise test statistics and of the location of the explanatory variables associated to the response. Within a large class of test statistics covering a continuum of decorrelation approaches, an optimal procedure is introduced. This procedure is based on the maximization of a Cumulant Generating Function based distance between the null and nonnull distributions of a global test statistic, in order to adapt the aggregation of the pointwise statistics to the pattern of the association signal. Using data-driven simulations, it is demonstrated that the ability of the present test to detect a signal is more robust to the dependence structure than existing methods. The present test is further applied to two Genome-Wide Association Studies, showing its ability to efficiently detect validated associations in various situations.