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Title: An extreme value approach to estimating bivariate limit sets and new environmental contours

Abstract:
An integral part of carrying out statistical analysis for bivariate extreme events is characterising the tail dependence relationship between the two variables. In the extreme value theory literature, various techniques are available to assess or model different aspects of tail dependence, but currently, inference must be carried out separately for each of these, with the possibility of contradictory conclusions. Theoretical developments by Nolde and Wadsworth (2022) have established links between different characterisations of extremal dependence, through studying the limiting shape of an appropriately-scaled sample cloud. We exploit these results for inferential purposes, by first developing an estimator for the sample limit set and then using this to deduce self-consistent estimates for the extremal dependence properties of interest. Through simulations, we show that the limit set estimates are successful across a range of distributions, and the estimates of dependence features are individually competitive with existing estimation techniques, and jointly provide a major improvement. We also extend this approach to define and estimate contours at non-limiting (but still extreme) levels; this links to the idea of "environmental contours", which are used to describe risky combinations of variables according to some definition of an exceedance probability.