Determining the dependence structure of multivariate extremes

Simpson, Wadsworth and Tawn (2020)

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Introduction

- When modelling in multivariate extreme value analysis, one often needs to exploit extremal dependence features.
- Consider the random vector $X = (X_1, \ldots, X_d)$, with $X_i \sim F_i$.
- Consider a subset of these variables $X_C = \{X_i : i \in C\}$, C lies in the power set of $D = \{1, \ldots, d\}$.
- For any C with $|C| \geq 2$, extremal dependence with X_C can be summarized by

$$\chi_C = \lim_{u \to 1} pr \left\{ F_i(X_i) > u : i \in C \right\} / (1 - u)$$

if the limit exists.

Introduction

- If $\chi_C > 0$, the variables in X_C are asymptotically dependent (they can take their largest values simultaneously).

- If $\chi_C = 0$, the variables in X_C cannot all take their largest values simultaneously.

- However, it is possible that for some $\underline{C} \subset C, \chi_{\underline{C}} > 0$.

Introduction

Many models for multivariate extremes are applicable only when

- data exhibit either full asymptotical dependence, entailing $\chi_C > 0$ for all $C \in z^D \backslash \emptyset$ with $|C| \geq 2$.
- or full asymptotical independence $\chi_{i,j} = 0$ for all $i < j$.

However, it is often the case that some χ_C are positive while others are zero.

The extremal dependence between variables can thus have a complicated structure.