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Regression Models for Extremes

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Abstract: When the severity or frequency of extremes varies over time and space, standard stationary models fall short. We present a practical framework for regression models for extremes, focusing on conditional GEV specifications whose parameters are functions of a covariate vector \mathbf{x} . We also cover regression for Pareto-based responses—e.g., peaks-over-threshold models with a generalized Pareto (Pareto-type) tail—in which tail parameters are linked to covariates. Estimation is carried out via maximum likelihood and a complementary Bayesian approach, with uncertainty quantified through the observed Fisher information and posterior draws. Model adequacy is assessed using quantile–quantile plots of transformed residuals, which provide clear visual diagnostics of systematic departures from the assumed distribution. The proposed methodologies are applied to real data to illustrate practical implementation and interpretability.

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Keywords: Extreme value theory, Non-stationarity, Regression for extremes, Conditional GEV, Condition GP, Inference, Residual diagnostics

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