

Gaussian Copulas for Large Spatial Fields

Modeling Data-Level Spatial Dependence in Multivariate Generalized Extreme Value Distributions

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Introduction

- ▶ Importance of modeling spatial dependence in extreme values
- ▶ Brief overview of traditional approaches (BYM model)
- ▶ Challenges in large-scale spatial modeling

Background: Spatial Models in Disease Mapping

- ▶ The Besag-York-Mollié (BYM) model
 - ▶ Structure and benefits
 - ▶ Computational advantages (sparse precision matrices)
- ▶ Limitations of BYM, particularly in scaling and interpretation

The BYM2 Model: Addressing Scaling Issues

- ▶ Introduction to BYM2 (Riebler et al., 2016)
- ▶ Importance of proper scaling in spatial models
- ▶ Interpretable parameterization in BYM2

The Need for Copulas in Spatial Extreme Value Modeling

- ▶ Limitations of traditional approaches for extreme values
- ▶ Why extreme values require special treatment
- ▶ Benefits of copulas for modeling dependencies in extremes
 - ▶ Flexibility in capturing complex dependence structures
 - ▶ Ability to separate marginal distributions from dependence structure
- ▶ Specific advantages for spatially distributed extreme values

Our Approach: GMRF Copulas for GEV Distributions

- ▶ Combining GEV distributions with GMRF copulas
- ▶ Ensuring unit marginal variance: challenges and solutions
- ▶ Why unit marginal variance is crucial for copula modeling
- ▶ How this approach addresses the specific needs of spatial extreme value modeling

Computational Methods

- ▶ Eigendecomposition techniques
- ▶ Circulant and folded circulant approximations
- ▶ Comparison with computational aspects of BYM/BYM2
- ▶ Efficiency gains in handling large-scale spatial data

Results and Discussion

- ▶ Performance on simulated and real datasets
- ▶ Comparison with traditional methods (including BYM2)
- ▶ Advantages in interpretability and scalability
- ▶ Improved modeling of spatial dependencies in extreme values

Conclusion and Future Work

- ▶ Key contributions of our approach
- ▶ Potential applications in various fields (e.g., climate science, hydrology)
- ▶ Future research directions

Thank You

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- ▶ Q&A