levels by a nonparametric smoother. Finally, quantile coherence is computed from the smoothed QPACF. Numerical results show that the proposed estimation method outperforms other conventional nonparametric methods.

E2031: **Modeling and simulating dependence in networks using topological data analysis**
Presenter: **Anass El Yaagoubi Bourakna**, King Abdullah University of Science and Technology, Saudi Arabia
Co-authors: Moo K Chung, Hernando Ombao

Topological data analysis (TDA) approaches are becoming increasingly popular for studying the dependence patterns in multivariate time series data. In particular, various dependence patterns in brain networks may be linked to specific tasks and cognitive processes, which can be altered by various neurological and cognitive impairments such as Alzheimer's and Parkinson's diseases, as well as attention deficit hyperactivity disorder (ADHD). Because there is no ground-truth with known dependence patterns in real brain signals, testing new TDA methods on multivariate time series is still a challenge. Simulations are crucial for evaluating the performance of proposed TDA methods and testing procedures, as well as for creating computation-based confidence intervals. To our knowledge, there are no methods that simulate multivariate time series data with specific and manually imposed connectivity patterns. We present a novel approach to simulate multivariate time series with a specific number of cycles/holes in its dependence network. Furthermore, we also provide a procedure for generating higher dimensional topological features.

EC809 Room S0.03 SPATIAL STATISTICS **Chair: Christopher Hans**

E1689: **Spatial clustering of time series using Bayesian quantile regression**
Presenter: **Paolo Girardi**, Ca' Foscari University, Italy
Co-authors: Victor Muthama Musau, Carlo Gaetan

A large research literature has developed methodologies for identifying clusters of units in a spatial setting. When we deal with longitudinal or temporal data, the proposed methods are mainly based on mean regression. However, the resulting classification could not be robust in presence of outliers, skewed distributions and/or heteroscedasticity. Furthermore, the researcher might be interested in classifying units according to whether certain thresholds are exceeded. We propose a model-based approach for clustering spatial units, that is based on median or, more in general, quantile regression. In this way, we want to cope better with the aforementioned issues. The spatial units are supposed to belong to a network. The model specification is hierarchical that allows a Bayesian inference based on Markov chain Monte Carlo methods. As an illustration and motivating example, we consider data on the sea surface temperature (SST) of the Mediterranean Sea. The dataset is a result of a model re-analysis that provides 251 time series of temperature in 1-degree gridded data covering the temporal window from 1982 to 2012. Specifying a quantile of interest (e.g. in ecology, is 0.9), we aim to identify areas with similar trends and cyclic patterns.

E1716: **Spatio-temporal Bayesian methods for historical data**
Presenter: **Tiia-Maria Pasanen**, University of Jyvaskyla, Finland

A Bayesian spatio-temporal model is developed to study pre-industrial grain market integration during the Finnish famine of the 1860s. The data consists of 80 regional time series covering nine years of monthly grain prices. The model takes into account several problematic features often present when analysing such spatially interdependent time series. For example, compared with the error correction methodology commonly applied in econometrics, this approach allows simultaneous modelling of multiple interdependent time series, avoiding cumbersome statistical testing needed to predetermine the (often artificial) market leader as a point of reference. Furthermore, introducing a flexible spatio-temporal structure enables analysing of detailed regional and temporal dynamics of the market mechanisms, for example, the asymmetric neighbour dependencies. The whole process, from deriving the model to interpreting the results, is covered with the famine application from the point of view of a statistician.

E1841: **Robust spatial blind source separation**
Presenter: **Sara Taskinen**, University of Jyvaskyla, Finland
Co-authors: Mika Sipila, Klaus Nordhausen

Assume a spatial blind source separation model in which the observed multivariate spatial data is assumed to be a linear mixture of latent stationary spatially uncorrelated random fields. The goal is then to recover an unknown mixing procedure as well as latent uncorrelated random fields. Recently, spatial blind source separation methods that are based on simultaneous diagonalization of two or more scatter matrices were proposed. In case of uncontaminated data such methods are capable of solving the blind source separation problem, but in presence of outlying observations the methods perform poorly. We propose a robust blind source separation method which uses robust global and local scatter matrices based on generalized spatial signs in simultaneous diagonalization. Simulation studies are used to illustrate robustness and efficiency properties of proposed methods in various scenarios.

E1776: **A multi-resolution approximation by linear projection and covariance tapering for large spatial datasets**
Presenter: **Toshihiro Hirano**, Kanto Gakuin University, Japan

Estimation and prediction for large spatial datasets, such as maximum likelihood estimation and kriging, are impractically time-consuming. A multi-resolution approximation via linear projection has been developed to deal with this computational burden. However, this method can cause the partly mismatched fitting around the origin for the covariance function if the two locations are not in the same subregion at the low resolution. Additionally, in this case, there is a possibility of producing artificiality in the predictive surface. To solve this problem, we propose an algorithm that approximates the covariance function by iteratively applying the covariance tapering instead of dividing the region at each resolution. We also elicit fast computation algorithms for estimation and prediction by using the approximated covariance function. A real data analysis for air dose rates demonstrates that our proposed method works well and avoids artificiality in the predictive surface.

E1996: **Non-normal estimation of multiple spatial data using multivariate skews normal process**
Presenter: **Kassahun Abere Ayalew**, Centers for Disease Control and Preventions, South Africa
Co-authors: Samuel Manda, Bo Cai

A Multivariate Gaussian Intrinsic Conditional Autoregressive (MICAR-normal) model is used in joint spatial modeling. However, the modelled multivariate data could be highly tailed and skewed. We present a multivariate skew-normal Intrinsic Conditional Autoregressive model (MICAR-skew-normal) to capture the non-normal distribution of the spatial data. We show how to obtain estimates of the model parameters using a fully Bayesian analysis using a stochastic approximation of the EM algorithm (SAEM). Using extensive simulation studies, we demonstrate the capabilities of the proposed model and its usefulness with an analysis of HIV data from South Africa.

EC822 Room S0.12 MULTIVARIATE STATISTICS AND COMPLEX DATA **Chair: Michelle Carey**

E0262: **Geometric goodness of fit measure to detect patterns in data point clouds**
Presenter: **Maikol Solis**, Universidad de Costa Rica, Costa Rica
Co-authors: Alberto Hernandez

A geometric goodness-of-fit index similar to R^2 is derived using geometric data analysis techniques. We build the alpha shape complex from the data-cloud projected onto each variable and estimate the area of the complex and its domain. We create an index that measures the difference in area between the alpha shape and the smallest squared window of observation containing the data. By applying ideas similar to those found in the closest neighbor distribution and empty space distribution functions, we can establish when the characterizing geometric features of the point set

