Discussion of Distance-Based Mixture Models for Prior Specification in Spatial Bayesian Analysis

King Abdullah University of Science and Technology

جامعة الملك عبدالله للعلوم والتقنية

June 2025

Areal clustering

Clustering of spatial (areal) data - on the response, a functional or spatial random effect

- Clustering/Grouping (Scan statistics or model-based clustering)
- Boundary detection or wobbling (like Lu and Carlin (2005) and Banerjee and Gelfand (2006))

Contiguity... very problem-specific

Areal clustering

Clustering of spatial (areal) data - on the response, a functional or spatial random effect

- Clustering/Grouping (Scan statistics or model-based clustering)
- Boundary detection or wobbling (like Lu and Carlin (2005) and Banerjee and Gelfand (2006))

Contiguity... very problem-specific

Areal clustering

Clustering of spatial (areal) data - on the response, a functional or spatial random effect

- Clustering/Grouping (Scan statistics or model-based clustering)
- Boundary detection or wobbling (like Lu and Carlin (2005) and Banerjee and Gelfand (2006))

Contiguity... very problem-specific

Areal clustering

Clustering of spatial (areal) data - on the response, a functional or spatial random effect

- Clustering/Grouping (Scan statistics or model-based clustering)
- Boundary detection or wobbling (like Lu and Carlin (2005) and Banerjee and Gelfand (2006))

Contiguity... very problem-specific

Areal clustering

Clustering of spatial (areal) data - on the response, a functional or spatial random effect

- Clustering/Grouping (Scan statistics or model-based clustering)
- Boundary detection or wobbling (like Lu and Carlin (2005) and Banerjee and Gelfand (2006))

Contiguity... very problem-specific

Areal clustering

Clustering of spatial (areal) data - on the response, a functional or spatial random effect

- Clustering/Grouping (Scan statistics or model-based clustering)
- Boundary detection or wobbling (like Lu and Carlin (2005) and Banerjee and Gelfand (2006))

Contiguity... very problem-specific

Areal clustering

Clustering of spatial (areal) data - on the response, a functional or spatial random effect

- Clustering/Grouping (Scan statistics or model-based clustering)
- Boundary detection or wobbling (like Lu and Carlin (2005) and Banerjee and Gelfand (2006))

Contiguity... very problem-specific

Areal clustering

Clustering of spatial (areal) data - on the response, a functional or spatial random effect

- Clustering/Grouping (Scan statistics or model-based clustering)
- Boundary detection or wobbling (like Lu and Carlin (2005) and Banerjee and Gelfand (2006))

Contiguity... very problem-specific

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21 Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21 Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Scan statistics - Circle or flexible scan statistics and extensions

- contiguous
- flexible convex shapes
- very conservative

Other methods

- Knorr-Held, L. and Raßer, G., 2000. Bayesian detection of clusters and discontinuities in disease maps. Biometrics, 56(1):13–21
  Bayesian Detection of Clusters and Discontinuities (BDCD).
- Hartigan (1990) Product partition model
- SKATER (Assunção et al. (2006)) $\rightarrow$ REDCAP, Bayesian space-time partitioning by sampling and pruning spanning trees of Teixeira et al. (2019)

Recent work using MST for spatial (spatio-temporal) clustering:

- Teixeira, L.V., Assunção, R.M. and Loschi, R.H., 2019. Bayesian space-time partitioning by sampling and pruning spanning trees. Journal of Machine Learning Research, 20(85), pp.1-35.
  Very similar priors for the number of clusters and partition, from a different viewpoint (Maybe some framework for extending to space-time)

Recent work using MST for spatial (spatio-temporal) clustering:

- Teixeira, L.V., Assunção, R.M. and Loschi, R.H., 2019. Bayesian space-time partitioning by sampling and pruning spanning trees. Journal of Machine Learning Research, 20(85), pp.1-35.
  Very similar priors for the number of clusters and partition, from a different viewpoint (Maybe some framework for extending to space-time)

Recent work using MST for spatial (spatio-temporal) clustering:

- Teixeira, L.V., Assunção, R.M. and Loschi, R.H., 2019. Bayesian space-time partitioning by sampling and pruning spanning trees. Journal of Machine Learning Research, 20(85), pp.1-35.
  Very similar priors for the number of clusters and partition, from a different viewpoint (Maybe some framework for extending to space-time)

Recent work using MST for spatial (spatio-temporal) clustering:

- Teixeira, L.V., Assunção, R.M. and Loschi, R.H., 2019. Bayesian space-time partitioning by sampling and pruning spanning trees. Journal of Machine Learning Research, 20(85), pp.1-35.
  Very similar priors for the number of clusters and partition, from a different viewpoint (Maybe some framework for extending to space-time)

Recent work using MST for spatial (spatio-temporal) clustering:

- Teixeira, L.V., Assunção, R.M. and Loschi, R.H., 2019. Bayesian space-time partitioning by sampling and pruning spanning trees. Journal of Machine Learning Research, 20(85), pp.1-35.
  Very similar priors for the number of clusters and partition, from a different viewpoint (Maybe some framework for extending to space-time)

- Zhong, R., Chacón-Montalván, E.A. and Moraga, P., 2024. Bayesian spatial functional data clustering: applications in disease surveillance. arXiv preprint arXiv:2407.12633.

  Contiguous clustering using MST and uniform partition prior with cluster-specific GLM - efficient implementation circumventing most MCMC steps.

- Zhong, R., Chacón-Montalván, E.A. and Moraga, P., 2024. Bayesian spatial functional data clustering: applications in disease surveillance. arXiv preprint arXiv:2407.12633.
  Contiguous clustering using MST and uniform partition prior with cluster-specific GLM - efficient implementation circumventing most MCMC steps.

- Zhong, R., Chacón-Montalván, E.A. and Moraga, P., 2024. Bayesian spatial functional data clustering: applications in disease surveillance. arXiv preprint arXiv:2407.12633.
  Contiguous clustering using MST and uniform partition prior with cluster-specific GLM - efficient implementation circumventing most MCMC steps.

- Zhong, R., Chacón-Montalván, E.A. and Moraga, P., 2024. Bayesian spatial functional data clustering: applications in disease surveillance. arXiv preprint arXiv:2407.12633.
  Contiguous clustering using MST and uniform partition prior with cluster-specific GLM - efficient implementation circumventing most MCMC steps.

- Zhong, R., Chacón-Montalván, E.A. and Moraga, P., 2024. Bayesian spatial functional data clustering: applications in disease surveillance. arXiv preprint arXiv:2407.12633.
  Contiguous clustering using MST and uniform partition prior with cluster-specific GLM - efficient implementation circumventing most MCMC steps.

- Yin, X., Anderson, C., Lee, D. and Napier, G., 2025. Risk estimation and boundary detection in Bayesian disease mapping. The International Journal of Biostatistics.

  Find the divisive boundaries in relative risk over space

- Yin, X., Anderson, C., Lee, D. and Napier, G., 2025. Risk estimation and boundary detection in Bayesian disease mapping. The International Journal of Biostatistics.

  Find the divisive boundaries in relative risk over space

- Yin, X., Anderson, C., Lee, D. and Napier, G., 2025. Risk estimation and boundary detection in Bayesian disease mapping. The International Journal of Biostatistics.
  Find the divisive boundaries in relative risk over space

Informative priors for MST

- Gangnon and Clayton (2000) - geometry-based
- Hegarty and Barry (2008) - PPM using cohesion functions
- Page and Quintana (2016) - PPM using spatial dependence in prior and likelihood, anisotropy

Informative priors for MST

- Gangnon and Clayton (2000) - geometry-based
- Hegarty and Barry (2008) - PPM using cohesion functions
- Page and Quintana (2016) - PPM using spatial dependence in prior and likelihood, anisotropy

Informative priors for MST

- Gangnon and Clayton (2000) - geometry-based
- Hegarty and Barry (2008) - PPM using cohesion functions
- Page and Quintana (2016) - PPM using spatial dependence in prior and likelihood, anisotropy

Questions

1. What can we learn form clustering the random effect as in this case, instead of the data or functionals?
2. In which cases is contiguity useful or necessary?
3. How does the method compare with others?

Questions

1. What can we learn form clustering the random effect as in this case, instead of the data or functionals?
2. In which cases is contiguity useful or necessary?
3. How does the method compare with others?

Questions

1. What can we learn form clustering the random effect as in this case, instead of the data or functionals?
2. In which cases is contiguity useful or necessary?
3. How does the method compare with others?

Questions

1. What can we learn form clustering the random effect as in this case, instead of the data or functionals?
2. In which cases is contiguity useful or necessary?
3. How does the method compare with others?

References

1. Assunção, R.M., Neves, M.C., Câmara, G. and da Costa Freitas, C., 2006. Efficient regionalization techniques for socio-economic geographical units using minimum spanning trees. International Journal of Geographical Information Science, 20(7), pp.797-811.
2. Sudipto Banerjee and Alan E. Gelfand. Bayesian wombling: Curvilinear gradient assessment under spatial process models. Journal of the American Statistical Association, 101(476): 1487–1501, 2006.
3. Haolan Lu and Bradley P. Carlin. Bayesian areal wombling for geographical boundary analysis. Geographical Analysis, 37(3):265–285, 2005.
4. John A. Hartigan. Partition models. Communications in Statistics-Theory and Methods, 19 (8):2745–2756, 1990.

References

5. Avril Hegarty and Daniel Barry. Bayesian disease mapping using product partition models. Statistics in Medicine, 27(19):3868–3893, 2008.
6. Ronald E. Gangnon and Murray K. Clayton. Bayesian detection and modeling of spatial disease clustering. Biometrics, 56(3):922–935, 2000.
7. Garritt L. Page and Fernando A. Quintana. Spatial product partition models. Bayesian Analysis, 11(1):265–298, 03 2016. doi: 10.1214/15-BA971.

Thank you • شكرا

جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology