

# Spatio-temporal statistics (MATH4341)

## Michaelmas term

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### Concepts

An introduction to spatial statistics:

- Regionalised statistical concepts
- Point pattern data analysis
- Aerial unit data analysis
- Computational statistics (INLA)
- Point referenced data analysis
- Implementation in R



## Handouts

1. Handout 1: Types of spatial data
2. Handout 2: Computational methods
3. Handout 3: Point referenced data modeling / Geostatistics
4. Handout 4: Aerial unit data / spatial data on lattices

## Reading list

These lecture Handouts have been derived based on the above reading list.

### Main texts:

- Cressie, N. (2015). Statistics for spatial data. John Wiley & Sons.
  - Our main reference book throughout the course. It covers all the three the spatial stats concepts we will introduce. Classic book in spatial statistics, but a bit outdated. Also very badly written.
- Gaetan, C., & Guyon, X. (2010). Spatial statistics and modeling (Vol. 90). New York: Springer.
  - Covers all the three the spatial stats concepts we will introduce but not all the details. Shorter and better written than than Cressie, N. (2015).

### Supplementary textbooks for various types of spatial data:

- Banerjee, S., Carlin, B. P., & Gelfand, A. E. (2014). Hierarchical modeling and analysis for spatial data. CRC press.
  - Covers all the three the spatial stats concepts we will introduce in a Bayesian manner. It requires some knowledge from multivariate statistics, e.g. multivariate Normal distribution.
- Ripley, B. D. (2005). Spatial statistics. John Wiley & Sons.
  - Covers all the three the spatial stats concepts we will introduce. Classic book in spatial statistics, and perhaps one of the first, if not the first, textbook in the area, so outdated. It shows a good intuition in the concepts.
- Schabenberger, O., & Gotway, C. A. (2005). Statistical methods for spatial data analysis. CRC press.
  - I have not checked it yet... but I have heard that it is OK. Sorry.

### Supplementary textbooks for Point reference data / Geostatistics:

- Wackernagel, H. (2003). Multivariate geostatistics: an introduction with applications. Springer Science & Business Media.
  - It covers the geostatistics /point referenced data part we will cover in advanced level, however it is easy to follow.

#### Supplementary textbooks for Areal data:

- TBD

#### Supplementary textbooks for Point pattern data:

- Diggle, P. J. (2013). Statistical analysis of spatial and spatio-temporal point patterns. CRC press.
  - Major focus on [S5] –Notice that this concept may not be introduced due to the time restrictions

#### Supplementary textbooks for Software:

- Bivand, R. S., Pebesma, E. J., Gómez-Rubio, V., & Pebesma, E. J. (2008). Applied spatial data analysis with R (Vol. 747248717, pp. 237-268). New York: Springer.
  - It describes R packages for presentation, and visualization of spatial data sets, as well as related basic statistical inference. It does not discuss INLA.
- Blangiardo, M., & Cameletti, M. (2015). Spatial and spatio-temporal Bayesian models with R-INLA. John Wiley & Sons.
  - It demonstrates how to implement Integrated Nested Laplace Approximation methods for the three types of spatial stat we will introduce. It is easy to read and it has a good intro in general INLA method.
- Gómez-Rubio, V. (2020). Bayesian inference with INLA. CRC Press.
  - It demonstrate how to implement Integrated Nested Laplace Approximation methods in statistics in general (eg, regression, glmm, spatial & spatio temporal models).

#### Supplementary textbooks for Theory:

- Kent, J. T., & Mardia, K. V. (2022). Spatial analysis (Vol. 72). John Wiley & Sons.
  - Covers theory / probabilities all the three the spatial stats concepts we will introduce.
- van Lieshout, M. N. M. (2019). Theory of spatial statistics: a concise introduction. CRC Press.
  - Covers theory / probabilities related all the three the spatial stats concepts we will introduce (however some theorems may not be included). It contains a subset of the material in Kent, J. T., & Mardia, K. V. (2022).