EEB1250H Spatial Statistics
Department of Ecology & Evolutionary Biology
Course Outline

Course Instructor

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Location and Time

Lecture: Thursdays from 10:00 (sharp) to 12:00 via ZOOM meeting.

Course Description

Ecological processes are inherently spatially structured due to spatial dependence to environmental conditions and spatial autocorrelation of species behaviors. The goal of this course is to provide a broad overview of the various spatial analytical methods available to quantify (geostatistics, network theory, boundary detection), test (restricted randomization) and model (spatial regressions) spatially autocorrelated ecological data. Students will be introduced to concepts of spatial scales and how multiscale analysis can be performed with census and sampled data. Furthermore, specific spatial methods to deal with point pattern data and surface pattern data will be reviewed. A combination of lectures and computer laboratory sessions will be used.

Course Objectives

By the end of the course, graduate students should be able to:

- understand the utility and pitfalls of statistics and their appropriate application to spatially structure data;
- analyse their data with the appropriate statistics and interpret the results adequately;
- read, understand, and critically evaluate paper and their use of spatial statistics.

Topics and Timetable

2021	TOPICS	LAB
Jan 21–Wk1	• Space: scales, sampling, randomization tests • Spatial autocorrelation for population data • Join count statistics	Homework: Questions, data, analyses
Jan 28–Wk2	• Spatial autocorrelation for sample data • Interpolation • Sampling	**Homework DUE** Lab 1: Spatial aggregation and spatial autocorrelation
Feb 4–Wk3	• Relationship between spatially autocorrelated variables • Mantel test • GLMM; Spatial regression (CAR/SAR, GWR, CART)	Lab 2: Spatial relationships
Feb 11–Wk4	• Ordinations • Multiscale analysis (MEM, wavelet)	**Lab 1 report DUE**
Feb 25–Wk5	• Network theory; Connectivity • Spatio-temporal analysis	
March 4–Wk6	• Species Distribution Models • Landscape Metrics	**Lab 2 report DUE**
March 11–Wk7	• Boundary detection • Spatial Diversity	
March 25-Wk8	• Student presentations (5 to 10 minutes MAXIMUM)	**Term-paper DUE**

Evaluation

1. Assignment using R using spatial exploratory data analysis methods (15%)

→ Do not want printout of the figures BUT the statistical and biological interpretations of the results obtained.

2. Assignment using R using spatial regression methods (15%)

→ Do not want printout of the figures BUT the statistical and biological interpretations of the results obtained.

3. Term project = Report (50%): Write the "methods section" of your potential data analysis explaining which statistics you should use to answer your hypotheses/objectives: Compare at least two different statistical methods stressing the assumptions of each selected statistical methods as well as their pros and their cons from a statistical/methodological perspective and from an ecological/evolutionary/biological perspective.

- Maximum 6 pages single-spaced (half-page presenting the objectives of the study; half-page presenting the data; 4 pages explaining and comparing the statistical methods; 1 page for the references)

4. Term project = Presentation (20%): Each student will present a 10-minute talk summarizing: The objective(s) of their project; The (potential) data to be analysed; The selected methods that should be used to assess/test your hypotheses.

Useful References

→ Dale MRT, M-J Fortin. 2014. *Spatial Analysis: A Guide for Ecologists*. 2nd edition. Cambridge University Press.
→ Fletcher R, M-J Fortin. 2019. *Spatial Ecology and Conservation: Concepts and Modeling with R*. Springer.
→ Borcard D, F Gillet, P Legendre. 2018. *Numerical Ecology with R*. 2nd edition. Springer.

Dale MRT, M-J Fortin. 2010. From graphs to spatial graphs. *Ann. Review of Ecology, Evolution, and Systematics*. 41.
Dale MRT et al. 2002. The conceptual and mathematical relationships among methods for spatial analysis. Ecography, 25: 558-577.
Dray et al. 2012. Community ecology in the age of multivariate multiscale spatial analysis. *Ecol. Monog.* 82:257-275.
Fortin et al. 2012. Spatial statistics, spatial regression, and graph theory in ecology. *Spatial Statistics*, 1:100-109.
Melles et al. 2009. Disentangling habitat and social drivers of nesting patterns in songbirds. *Land. Ecol.* 24:519-531.
Rayfield B, A Fall, M-J Fortin. 2010. The sensitivity of least-cost habitat graphs to relative cost surface values. *Landscape Ecology*, 25: 519-532.
Remmel TK, M-J Fortin. 2013. Categorical, class-focused map patterns: Characterization and comparison. *Landscape Ecology*, 28: 1587-1599.
Ruppert et al. 2010. Environmental mediation of Atlantic cod on fish community composition: an application of multivariate regression tree analysis to exploited marine ecosystems. *Mar. Ecol. Progress Series*, 411:189-201.
Ruppert et al. 2018. Human activities as a driver of spatial variation in the trophic structure of fish communities on Pacific coral reefs. *Global Change Biology*, 24: e67-e76.