Spatial Data Analysis in R

Course Syllabus

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Spring 2022

Meeting Times

- All course meetings are in Holdsworth Hall, room 211
- Lectures: Mondays and Wednesdays 11:15 – 12:05
- Lab: Wednesdays 12:20 – 2:15

Course Materials:

- Required texts
  - Spatial Ecology and Conservation Modeling, Robert Fletcher and Marie-Josée Fortin
  - Supplemental, topic-specific readings as needed throughout the course
- Software
  - R, RStudio

Course Objectives: In this course students will develop

- Proficiency working with spatial data concepts in R:
  - Projections, transformations, spatial data types (vector, raster)
  - Standard operations on spatial data: union, buffer, masks, etc.
  - Import, export, and display of spatial data
  - Important spatial packages and spatial data structures in R
- Basic theoretical understanding of core spatial statistical concepts such as:
  - Point patterns
  - Spatial autocorrelation/dependence
  - Spatial considerations for traditional statistical methods
  - Uncertainty, stochasticity and simulation
- Proficiency implementing core spatial analytical skills including:
  - Spatial summary statistics such as Moran's I, nearest-neighbor analysis, variograms, and others
  - Interpolation techniques, e.g. Kriging
  - Spatial regression techniques
  - Additional skills to be determined by students' interests
- Scientific communication skills:

- Interpretation of results of spatial analyses
- Effectively communicating with diverse audiences such as other scientists, lab groups, general public, and others.

Course Format

Lecture sessions consist of a mix of lecture, discussion of concepts/readings, group activities, and coding. We'll focus on peer-directed learning through a variety of whole-class and small-group directed activities designed to reinforce course concepts, encourage critical thinking, and practice effective communication of course topics. An important focus will be acknowledging, valuing, and learning from your peers' different backgrounds, perspectives, and ways of understanding the world! Lab sessions will mostly be spent working on example exercises, assignments, group projects, etc. in R.

Teaching philosophy

I firmly believe that optimal learning happens when students are active participants in my courses. This can take many forms including, but not limited to, student participation in whole-class and small group discussions and Q & A sessions, small group active learning activities, peer teaching and learning, and collaborative assignments. This is especially true at the graduate level, where you are preparing for a career in research, teaching, agency work, or other professional settings.

I also believe that courses should be dynamic. This means that I want to hear from you about what is working, and what could be improved. A key teaching objective is to be responsive to students' needs and to adjust course content and my teaching approach needed to optimize your learning.

It is important for you to learn specific details while taking my courses, however, no course can cover everything, and technical minutiae will fade after the semester ends. Therefore, it is critical for me to encourage you to develop the critical thinking skills and knowledge of the broad importance of the course content. In that way, you can recognize when a future situation might be addressed with what you learn in the course. I will be successful if you leave my course with a strong sense of the context of the materials. My goal is for you to be able to revisit and refresh your knowledge of the specific tools when you need them!

My Expectations

I expect you to take ownership of your learning in this course. This means that I expect you to be active contributors to lectures and class discussions. Although your coursework will be evaluated individually, I expect class to be collaborative. Peer learning and teaching are going to be key to everyone's success, especially in the applied portions of the course.

Course Overview

The course is divided into 2 parts. Part I covers important general concepts in spatial analysis. Part II content will be driven by student interests. The following is a listing of general concepts and an estimate of the time we will spend. The schedule is meant to be flexible and responsive to student needs, so these timelines are only approximate.

Part I: Spatial analysis core concepts

- Week 1: Course intro, intro/review of spatial concepts, spatial data in R, F&F ch 1
- Weeks 2 – 4: Scale, point patterns, stochasticity and distributions, land cover, F&F ch. 2 - 4,
- Weeks 5 – 7: Spatial dependence, inference, spatial statistics, interpolations, F&F ch 5, 6
- Weeks 8 – 9: Interpretation, communication, spatial simulation, recap of Part I topics

Part II: Student topics

We will customize the content for part II based on students' interests. Topics may include, but are not limited, to:

- Species distribution models
- Connectivity
- Species-area relationships
- Population dynamics

Labs

We will work through a series of lab assignments throughout the course. They are designed to help reinforce concepts from the lectures and readings and to improve students' proficiency with spatial data handling in R. Students will submit their unique work individually, but success will depend on collaboration during and outside of class.

Main Project

Students will complete an individual, main project for the course. The main project is meant to mirror the research process that leads to an article or dissertation/thesis chapter. Students will work on components of the main project throughout the course to produce a final document. Students will identify a spatial dataset that pertains to their research and interests during Part I. Students may choose to use their own data, or they can identify a spatial dataset of interest. They will create a proposal describing the research objectives and question(s) they wish to address, the data they will use to address their questions, and a proposed set of analyses. In part II, they will apply the techniques learned in part I, as well as other relevant methods covered in part II.

Grading

The main project will comprise 50% of the final grade, the labs will make up 40%. The remaining 10% will be allocated based on active participation in peer learning/teaching, contributions to Moodle discussions and the course Wiki, and contributions to lecture and class discussions.

Accommodation Statement

The University of Massachusetts Amherst is committed to providing an equal educational opportunity for all students. If you have a documented physical, psychological, or learning disability on file with Disability Services (DS), you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, please notify me within the

first two weeks of the semester so that we may make appropriate arrangements. Disability Services has additional information at: https://www.umass.edu/disability/students/accommodations-students

Academic Honesty Statement

Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst. Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent

For more information, please review the student code of conduct at: http://www.umass.edu/dean_students/codeofconduct/acadhonesty