Applied Spatial Statistics —

Stat 5410, Section 001 & Stat 6410, Section 001

Spring 2020 (2 Credits)

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Office Hours: Tuesday (T) 10:00am – 11:00am, Thursday (H) 4:30pm – 5:30pm, and by appointment. I may also be available Thursday (H) 3:30pm – 4:30pm.

Classes & Rooms:
TH 1:30pm – 2:45pm, T 1/21/20 – H 4/9/20 or H 4/16/20 (tentatively): AnSc 320.

Please visit the course Web page listed above and/or Canvas frequently for lecture notes, recordings of lectures, data sets, graphical examples, R code, etc. — in particular if you miss class for any reason.

Detailed Class Schedule:
For a 2–credit course, we need 20 lectures/lecture days (in contrast to 29 or 30 lectures/lecture days for a 3–credit course). Those days are marked as "Lecture 01" to "Lecture 20" in the overview below:

Week	Tuesday	Thursday
1	1/7: No class	1/9: No class
2	1/14: No class	1/16: No class
3	1/21: Lecture 01	1/23: Lecture 02
4	1/28: Lecture 03	1/30: Lecture 04
5	2/4: Maybe	2/6: Maybe
6	2/11: Lecture 05	2/13: Lecture 06
7	2/18: Lecture 07	2/20: Lecture 08
8	2/25: Lecture 09	2/27: Lecture 10
9	3/3: No class	3/5: No class
10	3/10: No class	3/12: No class
11	3/17: Lecture 11	3/19: Lecture 12
12	3/24: Lecture 13	3/26: Lecture 14
13	3/31: Lecture 15	4/2: Lecture 16
14	4/7: Lecture 17	4/9: Lecture 18
15	4/14: Lecture 19/Backup	4/16: Lecture 20/Backup
16	4/21: Backup	

Note: "No class" means guaranteed no class that day. I have marked a few days as "Backup", e.g., in case we miss lectures because of snow days, I am sick, or I have to travel. But, hopefully,

this won't happen. If nothing goes wrong, our tentative last lecture date will be on H 4/9/20 or H 4/16/20, depending on whether I will have to travel on T 2/4/20 and H 2/6/20.

Course Objectives:

This class will provide a first insight into applied spatial statistics. We will use a lot of computer software (primarily R and R packages for spatial statistics) and practical examples to provide a basic understanding of existing tools and solutions for spatial statistics.

Prerequisites:

I expect basic knowledge of R as taught in the "Introduction to R" course. Moreover, you should be familiar with a tool such as R Markdown, knitr, or sweave that allows you to combine text, R code, graphics, and numerical results in high-quality documents. LaTeX is a plus but is not formally required at the 5000 level, but it will be required at the 6000 level of this course.

Moreover, I expect basic "operational" knowledge from an introductory stats course such as Stat 2000, Stat 3000, or higher. "Operational" means that you still recall sufficient details from regression, ANOVA, hypothesis tests, etc. (it is not sufficient that you have taken such a course several years ago and have forgotten almost all details).

Spatial statistics obviously requires working with maps. You must be able to draw basic maps and create map overlays using a Geographic Information System (GIS) or you should attend/work through the map–related course materials of my "Statistical Visualization II" course to acquire similar map production skills in R. This course is taught on TH 12:00noon – 1:15pm on the same dates and in the same classroom as our course. All course materials will be available in Canvas.

IDEA Center Learning Objectives:

Objective 1) Gaining factual knowledge (terminology, classifications, methods, trends).

Objective 2) Learning fundamental principles, generalizations, or theories.

Objective 3) Learning to apply course material (to improve thinking, problem solving, and decisions).

Topics: (subject to change)

1. Handling spatial data in R (data structures, data import and export).
2. Basic exploration and visualization of spatial data (ESDA).
3. Analysis of spatial data (point patterns, geostatistics, areal data).
4. Others (as time permits).

We will work with some data sets suitable for particular concepts introduced in class. These data sets will contain surprises — for you and for me. Do not expect that someone is going to give you the final answer or model. We jointly will have to work towards such an answer or model.

For MS and PhD students majoring in Statistics, it is important to learn LaTeX — from basic document preparation, over the inclusion of R graphics into your LaTeX documents to advanced topics such as Sweave (`https://leisch.userweb.mwn.de/Sweave/`) and the LaTeX bibliography BibTeX (`http://www.bibtex.org/`). LaTeX is essential for graduate work (at the MS and PhD level) and will be used for many theses, dissertations, and scientific publications. Therefore, LaTeX will have to be used for all homeworks, projects, presentations, etc. at the 6000 level of this course.

Homework Assignments:

There will be a variety of assignments throughout the semester. Each assignment will include a value (typically 20–100 points) that it will be scored out of. Your final grade will be determined by the sum of your points in all assignments. Some assignments will include combinations of computer work in R (or others) and short oral presentations. The value of each assignment will be roughly proportional to its importance and the amount of work involved. Homework assignments will account for about 70% (Stat 5410) / 50% (Stat 6410) of your final grade.

Regular homework assignments will be done individually or in groups of 2 or 3 students. For individual assignments, you will be allowed to discuss general approaches to questions on the assignments with other students, but each student must write and submit their own code and comments. Any students caught sharing code will fail the class.

Unless otherwise stated on the assignment sheet, all homework assignments have to be submitted electronically via Canvas. **You will have 1 or 2 weeks after the last lecture to finalize and submit the last homework assignment.**

The following deductions will be applied to late homework submissions: 1 min – 24 hours late: 10% off; > 24 hours – 48 hours late: 25% off; > 48 hours – 72 hours late: 50% off. Homeworks won't be accepted later than 72 hours (i.e., 3 days) after the submission deadline.

This will be a very challenging course that requires a lot of individual time to work on the assignments (and projects). Just attending classes will not be enough to pass this course! In addition, you will have to do a lot of individual reading of textbooks, online documentation, and help pages, and search for available information on the web.

Quizzes:

There will be a series (4 ± 1) of short quizzes throughout the semester. The length of each quiz will be about 15 to 20min. These quizzes will determine whether you have understood the basic ideas discussed during the previous classes. You may have to interpret the output of some R code, spot the errors in the R code provided to you, or write short segments of R code (often just 1 or 2 lines) that accomplish a particular task. Some quizzes will be closed book/closed computer while in other quizzes, you will have access to R and/or your notes. Quizzes will be announced in class the lecture before an upcoming quiz and this information will also be posted in Canvas. Your lowest quiz score will be dropped. Thus, you can miss one quiz. There will be no makeup quizzes. Quizzes will account for about 30% (Stat 5410) / 20% (Stat 6410) of your final grade.

Projects (Stat 6410 only):

There will be one or two projects during the semester. This could be the presentation of an R package, a summary of a journal paper (related to spatial statistics), an extended open–ended analysis of a data set with a focus on spatial statistics, etc. Projects will require the preparation of a final project report and possibly a short presentation of your work for the other students in this course. The projects will account for about 30% of your final grade.

Textbooks:

Bivand, Roger S., Pebesma, Edzer, Gómez–Rubio, Virgilio (2013) *Applied Spatial Data Analysis with R (2nd Edition)* [ASDAR], New York, NY: Springer,
`http://www.springer.com/us/book/9781461476177` & `http://www.asdar-book.org/`.

Carr, Daniel B., and Pickle, Linda W. (2010) *Visualizing Data Patterns with Micromaps*, Boca Raton, FL: Chapman & Hall/CRC Press, `https://www.crcpress.com/Visualizing-Data-Patterns-with-Micromaps/Carr-Pickle/p/book/9781420075731` & `http://mason.gmu.edu/~dcarr/Micromaps/`.

Every student should have access to each of these books, but it is not necessary that every student buys all of these books. Perhaps you can make arrangements with some of the other students in class who purchases which book(s). If you plan to work in the area of spatial statistics for your MS or PhD degree, you should consider to purchase these books for an ongoing use beyond this course.

Credits:

This course uses some of the course materials provided by Dr. Roger Bivand that were prepared in support of his ASDAR textbook. We are likely to include parts from additional web sources that will be specified later on.

Software:

We will primarily be using R (`http://cran.r-project.org/`), a free software environment for statistical computing and graphics. Please install a recent version of R, i.e., 3.6.1 or 3.6.2, on your own computer so we can exchange code. Also install RStudio (`https://www.rstudio.com/`) as a front end to R and MiKTeX (`https://miktex.org/`) that will allow us to combine code and results from R into text documents.

Courtesy:

Please turn off cell phones and similar devices before class, and please keep conversations to a minimum during lectures. Please do not read/reply to your e–mails or browse other web pages than the ones discussed during class.

I will not keep track if you come to class or not. However, I would highly recommend to attend all lectures. If you have to miss a lecture, there will be a recording of the lecture available in Canvas (if the technology doesn't fail).

Americans with Disabilities Act:

If a student has a disability that will likely require some accommodation by the instructor, the student must contact the instructor and document the disability through the Disability Resource Center (DRC), during the first week of the course. Any requests for special considerations relating to attendance, pedagogy, taking of examination, etc. must be discussed with and approved by the instructor. In cooperation with the DRC, course materials can be provided in alternative formats — large print, audio, or Braille.

Note:

The above schedule and procedures in this course are subject to change in the event of extenuating circumstances.