Course Outline

Advanced Spatial Analysis (G4071)

Quantitative Methods in the Social Sciences (QMSS)
Columbia University of the City of New York
Semester: Spring 2017

Dr. Jeremy R. Porter
Adjunct Professor
Department of Sociology (QMSS)

Office: 270c IAB (in the ISERP suite)
Phone: 212-854-9105 (QMSS Office)
E-mail: jp3323@columbia.edu (primary contact)
Office Hours: 10-12pm; 2-3pm Thurs (by appointment)
Class Meetings: 12:10-2pm Thursdays
Class Room:

Course Description:
(Prerequisites: (G4070) Introduction to GIS and Spatial Analysis) This course builds upon foundational spatial analysis concepts and skills through the application of advanced spatial statistical modeling tools. Topics covered include 1) Graphical and quantitative description of spatial data, 2) Kriging, block kriging and cokriging, 3) Common variogram models, 4) Point Pattern Analysis, 5) Spatial autoregressive models, estimation and testing, 6) Spatial non-stationarity and associated modeling procedures, and 7) Spatio-Temporal modeling procedures.

Use of open-source software (“R”) with emphasis on analysis of real data from the environmental, geological and social sciences. In addition, QGIS, GeoDa, and other GIS programs will be incorporated into the class where appropriate. Students will do a series of in-class labs and develop a final research project from these labs or an independent project.

Required Texts: [All books available in ebook format through Columbia Library System]

- LeSage and Pace. 2010. *Introduction to Spatial Econometrics*. CRC.
Required Software:
Prior to the Week 2 of class, you should acquire and install the following software packages for use in lab:

- R or R-Studio (r-project.org)
- GeoDa (spatial.uchicago.edu/)
- QGIS (qgis.org)

Grading Procedures. The requirements of the course include midterm and final exam, completion of all homework assignments in a timely manner, 4 short reports summarizing research articles (information to be provided), and a semester length research project. The midterm and final exam will be primarily application and interpretation-based and will be completed in a take-home exam format. The semester-length research project will result in a formal presentation using Microsoft Powerpoint (or equivalent) with an accompanying research paper. The topic and scope of the research project must be approved by the Instructor. This research project must use spatial data to address some theoretically-driven research problem/question. The topic, abstract, annotated bibliography, and proposal of methodology will all be due at various points throughout the semester (documented on the attached course schedule).

The final semester grade will be computed as:

- 40% for the midterm and final exams (20% each)
- 30% for final research project
- 30% of the grade will be made up of in-class lab/homework grades.

The course grades will be assigned letter grades using a conventional breakdown of final averages: A=90-100; B=80-89; C=70-79; D=60-69; F=below 60.
**COURSE TOPICS AND GENERAL SCHEDULE:**
(Note: this schedule is subject to change at the discretion of the Instructor. The projected timing for each topic is shown at left. The sequence will generally be followed verbatim. Key readings are shown bulleted below each entry. A reference list is included at the end of this course outline.)

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction and Organization</td>
</tr>
<tr>
<td><strong>Part I</strong></td>
<td><strong>Handling and Managing Spatial Data in R</strong></td>
</tr>
</tbody>
</table>
| 2    | Handling, Importing and Exporting Spatial Data in R  
  - Bivand CH1-3  
  - Gelfand CH1 |
| 3    | Handling, Importing and Exporting Spatial Data in R (Cont.)  
  - Bivand CH4-5 |
| **Part II** | **Continuous Spatial Variation** |
| 4    | Estimating Spatial Correlation  
  - Bivand CH8  
  - Gelfand CH2-3 |
| 5    | Spatial Prediction and Kriging  
  - Bivand CH8 |
| 6    | Spatial Point Pattern Theory and Processes  
  - Bivand CH7  
  - Gelfand CH16-17 |
| 7    | Spatial Point Pattern Models and Analysis  
  - Bivand CH7  
  - Gelfand 18-20 |
| 8    | Midterms |
| 9    | Spring Recess |
| **Part III** | **Discrete Spatial Variation** |
| 10   | Modeling Areal Data  
  - Bivand CH9  
  - Gelfand CH12, 15, 30 |
| 11   | Spatial Econometrics  
  - LeSage CH1-4, 5 |
| 12   | Spatial Econometrics (cont.)  
  - LeSage CH1-4, 5 |
| **Part IV** | **Spatio-Temporal Models** |
| 14   | Space-time Data and Processes  
  - Bivand CH6  
  - LeSage CH7  
  - Gelfand CH23-24 |
| 15   | Space-time Analysis  
  - Bivand CH6  
  - Gelfand 25-26 |
| Finals | Finals |
**Semester Length Research Project:**

There is a single semester length research project in which students are expected to engage in the spatial analysis of an instructor approved topic for presentation and submission of research paper at the end of the semester. There are a couple of important factors to consider when thinking about one’s project. 1) What am I interested in?, 2) Are there spatially referenced data available (or data that could be constructed from existing sources)?, and 3) What is the purpose of my proposed research?

In order to help along the way, the following due dates are related to the development of the semester length research project.

The final paper should include the following sections:

1) **Introduction:** Topic, why important, what do we know in summary.

2) **Review of Literature:** Review of most recent and most important research in the area (for the purpose of this paper citation count should be 15 at minimum). This section should ultimately culminate in a purpose statement with informal research hypotheses.

3) **Methodology:** What data are you using? How was it collected? Who collected? What variables are you interested in (and how are they measured)? What analytic approaches are you interested in applying? and.... why are those analytic approaches appropriate given your research questions/data/etc?

4) **Results:** Report results in relation to both statistical and spatial descriptive and inferential analyses.

5) **Discussion/Conclusion section:** Summarize your findings?, what are the implications as they relate to your research question?, what are limitations of your study?

--A page limit will not be set, but it is expected that the final research paper should meet the standards of what would be expected from a full semester project in an advanced methods course. One would expect that the final product would be a working draft of a thesis or publication quality research project.