Syllabus: GEOG606 - Quantitative Spatial Analysis - Spring 2016

Instructor
Dr. Jonathan P. Resop (resop@umd.edu)
Office Hours: On-campus: Mondays 3 to 5 pm (Also available most days by appointment)
Location: 1111 LeFrak Hall

About the Course
Time: 1:30 to 4 pm Wednesdays (Lectures)
Location: Campus Location: 1171 LeFrak Hall; Online: http://elms.umd.edu

Course Schedule
This is a tentative schedule and may be adjusted. Changes will be announced and posted on ELMS.

Week	Date	Lecture Topics	R Group
1	01/27	Introduction to Quantitative Spatial Analysis	
2	02/03	Review of Basic Statistics and Matrix Operations	
3	02/10	Hypothesis Testing I	Stats (Basic)
4	02/17	Hypothesis Testing II ***Assignment 1 Due (Stats and Matrix)***	Matrix (Basic)
5	02/24	Exploration of Data Structure through PCA and Factor Analysis ***Project Topic and Initial Proposal Due***	Stats (H Tests)
6	03/02	Correlation and Linear Regression Analysis ***Assignment 2 Due (Hypothesis Testing)***	Matrix (PCA)
7	03/09	Advanced Regression - Polynomial and Nonlinear Regression ***Assignment 3 Due (PCA and Factor Analysis)***	Stats (Linear)
	03/16	Spring Break	
8	03/23	Advanced Regression - Logistic Regression and Regression Trees ***Final Project Proposal Due***	Matrix (Nonlinear)
9	03/30	Spatial Prediction Methods - Classification and Learning Algorithms ***Assignment 4 Due (Correlation and Linear Regression)***	Stats (Cubist)
10	04/06	Spatial Pattern Analysis - Randomness and Clustering ***Assignment 5 Due (Polynomial and Nonlinear Regression)***	Matrix (SVM)
11	04/13	Spatial Prediction Methods - Autocorrelation and Kriging ***Assignment 6 Due (Random Forests)***	Stats (PPA)
12	04/20	Validity of Spatial Inferences - Sampling Design and Data Quality ***Progress Report on Project Due*** **(AAG Meeting, NASA CC&E Meeting)**	Matrix (Auto)
13	04/27	Uncertainty Analysis - Estimations in Spatial Prediction ***Assignment 7 Due (Kriging)***	
14	05/04	**Final Project Presentations I**	
15	05/11	**Final Project Presentations II**	
	05/15	**Final Project Report Due**	

Course Prerequisites
An introductory course in statistics (GEOG 306 or equivalent) is required. Knowledge of linear algebra is a must. A basic proficiency in programming is assumed as assignments are computer-based.

Course Description

This course introduces advanced quantitative methods for studies in geographical sciences and other related fields, including (1) multivariate methods, (2) spatial pattern analysis methods, and (3) spatial prediction and uncertainty estimation methods. Through this course, students will develop their technical foundations for geographical analysis. They are expected to understand the **mathematical and statistical principles** of the methods covered, understand the **types of science problems** that can be addressed using these methods as well as their **strengths and weaknesses**, and to demonstrate their ability to apply these methods to address their own research questions **using R and related tools**. Students should gain a thorough understanding of the impacts on spatial and statistical inferences of many issues associated with these methods, including data sampling methods, sample size, data distribution, etc.

Assignments

Students are expected to play a role in the teaching of this course. For each method covered in the course, the instructor will give a lecture on the mathematical and statistical theory. The students will demonstrate its usage using R and lead discussions on the science questions that can be or have been addressed using that method. To make this task more manageable for the students, they will be divided into two groups (Stats Group and Matrix Group), which will take turns in leading class discussion.

Other assignments include homework and a final project. Homework reports are due one week after the homework is assigned unless specified differently. Submission should be made via ELMS.

Final Project

For the final project, students will conduct a research using methods covered in this course and report the outcome of the research. The final project report should be about 10 pages (double spaced) of text plus additional pages for bibliography and figures. At the end of the semester, each student will have 20 minutes to present his/her project, including 10 minutes for the presentation and 10 minutes for questions and discussion. Students are to provide (1) an initial project topic, (2) a short proposal (1 page), (3) a progress report (1 page), and (4) a final report following the dates on the course schedule above.

The short proposal should include the following:

- Significance of the science question to be address
- Objectives that are clearly defined and succinct; Hypothesis to be tested, if any
- Data and methods to be used
- Expected outcome and significance of the project

The final report should be prepared following conference or journal paper standards (in terms of both format and scientific contents). A typical paper structure should include the following:

- Introduction (Background and Context, Objective, and Significance)
- Data and Methods (Study Area, Data Sets, and Methods)
- Results and Discussion
- Conclusions

Students are encouraged to develop their final project into a conference proceeding or journal paper.

Grading

Final grades will be based on the following:

- Homework Assignments (7) (40%)
- Group Presentations (5) (10%)
- Class Discussions and Participation (10%)
- Final Project (40%)

Readings

The required textbooks for this class are:

1. *Using Multivariate Statistics, by Barbara G. Tabachnick and Linda S. Fidell, 2012.*
2. *An Introduction to Applied Multivariate Analysis with R, by Brian Everitt and Torsten Hothorn, 2011. Free E-book available via UMD library.*
3. *Applied Spatial Data Analysis with R, by Bivand, Pebesma, and Gómez-Rubio, 2008. Free E-book available via UMD library.*

Additional reading materials to be provided throughout the class:

4. *Sheskin, D. J. 2004. Handbook of parametric and nonparametric statistical procedures. CRC Press.*
5. *Fischer, M. M., Getis, A. 2010. Handbook of Applied Spatial Analysis. Springer.*
6. *Montgomery, D. C., Peck, E. A., Vining, G. G. 2001. Introduction to Linear Regression Analysis. 3rd Ed. Wiley.*
7. *Plant, R. E. 2012. Spatial Data Analysis in Ecology and Agriculture Using R. CRC.*
8. *Schabenberger, O. and Gotway C. A. Statistical Methods for Spatial Data Analysis. Chapman & Hall.*

Software

The software for our statistics analyses is R. An online tutorial of basic functions and syntax: http://www.ats.ucla.edu/stat/r/

All students are REQUIRED to have a UMD GLUE account and a UMD email address. We will frequently use email for communication of class related matters. In addition all students must get access to the Geography Open Lab PC. If your current email address is not the one listed by the UMD Registrar, please update that address immediately. The instructors will ONLY mail to a UMD email address.

Late Assignment Policies

No late assignments will be accepted without prior arrangement. For any case, please talk with the instructor in advance. *No late final project report will be accepted without a very strong reason.*

Academic Misconduct

The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. All students are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.shc.umd.edu.

Within our class, students may discuss together. Exchanging questions and suggestions on ELMS discussion board are highly encouraged. However, once the discussion is close to the solution, students should not exchange written code or solution steps with each other. In short, discussion among students should be in the form of "why don't you try ...", but not in the form of "the solution is …"

Disability Statement

Any student who feels he or she may need an accommodation based on the impact of a disability should contact the instructor privately to discuss his or her specific needs. Please contact the Office of Disability Support Services (http://www.counseling.umd.edu/DSS/) at 301.314.7682 in Counseling Center, 0126 Shoemaker Building to coordinate reasonable accommodations in case of documented disabilities.