Florida International University, Department of Earth and Environment

Advanced Spatial Analysis of Earth and Environmental Data
GIS 4390, Spring Term 2020
Tu/Th 2:00 – 3:15 GIS Center Lab, GL 274

Course Syllabus

Instructor
Dr. Dean Whitman
Office: AHC5-396; Tel: 348-3089; email: whitmand@fiu.edu
Office Hours: Wednesday 1:30-3:30, Thursday 10-12, or by appointment

Course Description:
Spatial analysis is a set of techniques for analyzing patterns of and interrelationships between map data. The field of spatial analysis has seen much growth in recent years with the introduction of inexpensive and easy to use Geographic Information Systems (GIS). While many users employ GIS only for building spatial databases and displaying maps, GIS are powerful tools for performing spatial analysis. This course will introduce advanced undergraduates to techniques for using GIS technology to solve spatial problems. Emphasis in this course will be on applying raster analysis techniques.

The course will be comprised of lectures and computer exercises. Computer instruction will utilize the ESRI ArcGIS suite of software. Course will be composed of 1) Review of GIS concepts and data models; 2) concepts of point and line pattern statistics; 3) methods of spatial analysis including density mapping, buffer zone analysis, 4) deterministic and geo-statistical surface estimation methods, 5) multi-layer map comparison, map algebra, and suitability modeling.

Course Objectives
Students completing this course will have a strong understanding of the theory of and the basic functions used in GIS spatial analysis and modeling. Students will have a functional understanding of the Spatial Analyst and Geostatistical Analyst extensions for ArcGIS 10.

Learning Outcomes
Students completing this course will be able to perform the following:
1. Describe the elements of and the differences between the vector and raster data models.
2. List and describe the various tools used in the analysis of GIS data.
3. Perform distance, density, and pattern analysis on vector and raster data.
4. Estimate and interpolate surfaces.
5. Analyze, compare and model univariate, bivariate and multivariate geospatial data.
6. Apply methods of map algebra to model spatial processes and problems.

Prerequisites and Recommended Background:
This is an advanced course and assumes proficiency with the ESRI ArcGIS suite of software. An introductory GIS course that uses ESRI ArcGIS (GIS 3043, GIS 3048, CGN 4321 or equivalent) or demonstrated competence with Desktop ArcGIS software is required. Basic knowledge of map projections, analytic geometry, trigonometry, and statistics are recommended.
Required Reading:
   - Available free online at [www.spatialanalysisonline.com](http://www.spatialanalysisonline.com). Pdf, Kindle, and hardcopy versions may also be purchased from the publisher (students can receive a discount)
   - Note: Author M. J. de Smith also has a free online *Statistical Analysis Handbook* available at [http://www.statsref.com/](http://www.statsref.com/) which may be referenced in the course.
2. ArcGIS manuals:
   - ESRI provides an excellent set of documentation. It can be accessed via the following:
     - From the Help menu in ArcGIS (select ArcGIS Desktop Help)
     - From the Windows All Programs Menu (ArcGIS → ArcGIS for Desktop 10.5 Help)
       - Under ArcMap, select the Previous Version 10.5x

Recommended Reading:

Software:
Most examples and exercises will utilize ESRI’s ArcGIS V.10.5 with the Spatial Analyst, Geostatistical Analyst and 3-D Analyst extensions. ArcGIS must have these extensions installed in order for you to do the exercises in this course.
- GIS Lab Accounts (GL 274)
  - *Username*—panther\username (where username is your email address without the “@fiu.edu” extension
  - *Password*—your universal "My Accounts" password
- At Home Student Copy
  - Students may obtain 1-year ArcGIS licenses free of charge.
    - Go to [http://maps.fiu.edu/gis/services/software-licenses/software-licenses-students](http://maps.fiu.edu/gis/services/software-licenses/software-licenses-students) and follow the instructions.

Additional numerical analysis will use *Microsoft Excel* and perhaps *R*.

Internet Resources
This is a web assisted course. A course webpage will be maintained with *Canvas*. This page will contain this syllabus, lectures notes, reading materials, exercises, data sets and links.

To access this resource, go to [https://canvas.fiu.edu/](https://canvas.fiu.edu/) and LOGIN menu. Login with your FIU MyAccounts User Name and Password. Select GIS44390 U01 1201
**Grading:**
Course grade will be based on attendance and class participation (10%), exercises (60%), a Midterm Exam (15%), and a Final Exam (15%).

- Homework will be assigned approximately every two weeks. Assignments will be distributed through Canvas with associated data. Normally you will have 1-2 weeks to complete the assignment. Late assignments by be downgraded. All assignments must be typed and **submitted through Canvas**, as a Microsoft Word document unless otherwise indicated.

I will be grading the assignments through Canvas so your submissions should be properly formatted. Submitted assignments should have the appearance of a professional technical report containing text, tables and maps. Text should contain a brief abstract of the assignment, answers to questions and discussions where indicated in the assignment. Do not include superfluous text from the assignment. Tables should include a caption (above the table) with numbers displayed to an appropriate number of significant figures. Maps should be Jpeg files produced with the *Export Map* command (no screen dumps please!) imbedded into the Word document. Maps should contain graticules, scales, legends and titles where appropriate. All maps should contain descriptive captions, numbered as Figure 1, Figure 2, etc.

- Exams will be closed book and will test your understanding of concepts covered in class. The Final Exam may include a Computer component where you demonstrate basic skills in applying the functions explored in the exercises.

**University Policy on Academic Dishonesty and Misconduct**

- All students are expected to adhere to a standard of academic conduct, which demonstrates respect for themselves, their fellow students, and the educational mission of Florida International University. Any act that violates the student/instructor trust will not be tolerated. Acts of cheating, plagiarism, or lying will result in an “F” grade for the class and the possibility of expulsion from FIU.

- All students are deemed by the University to understand that if they are found responsible for academic misconduct, they will be subject to the Academic Misconduct procedures and sanctions, as outlined in the *Student Handbook*. 
**GLY 4390/5758 Course Outline and Reading Assignments: (Tentative 11/25/19):**

| Week 1: | Organization. GIS Lab orientation. Maps as models. GIS data types, and structures. Vector and raster data models  
Reading: | de Smith et al.: Ch 1-2; Michell: Ch 1  
| Week 2 | What is spatial analysis? Modeling of spatial data. Review of raster analysis functions. Working with Raster Data Models; The ESRI Grid model  
Reading: | de Smith et al.: Ch 3; ArcGIS Help: Modeling and Solving Spatial Problems  
Exercise 1: | Getting Started with ArcGIS Spatial Analyst  
| Week 3 | Resampling, transforming, and registering Grids. Geometric Transformations of Grids  
Reading: | ArcGIS Help: Performing analysis in Spatial Analyst  
Exercise 2: | Grid Import, Resampling, and Registration, Using the Raster Calculator  
| Week 4: | Vector to raster; point and lines to areas.  
Reading: | ArcGIS Help: Fundamentals of raster data; To Raster toolset concepts  
Exercise 3: | Vector to raster transformations. Fractal dimension of a coastline.  
| Week 5 & 6: | Point and line distributions. Measurements of spatial form. Randomness, clustering, regularity and anisotropy.  
Reading: | de Smith et al.: Chs 4.34, 5.1-5.4; Mitchell, Ch 3 and 4  
Exercise 4: | Point Pattern Analysis: Measuring Geographic Point Distributions  
| Week 7: | Geoprocessing and Python Scripting  
Reading: | Zanderbergen (TBA)  
Week 8: | Spring Break  
| Week 9 & 10 | Estimating surfaces; the art of computer interpolation gridding, and interpolation. TIN, IDW, trend surfaces, kriging.  
Reading: | de Smith et al.: Ch 6.6; ArcGIS Help: Geostatistical Analyst  
Exercise 5: | Modeling of Surfaces I: Deterministic Methods-IDW, Splines, TIN  
| Week 11: | Optimal estimation of surfaces, geostatistics, kriging.  
Reading: | de Smith et al.: Ch 6.7; ArcGIS Help: Creating surfaces with geostatistical techniques  
Exercise 6: | Modeling of Surfaces II: Variograms, Geostatistics and Kriging  
| Week 12: | Univariate analysis of surfaces and raster maps. Reclassification, filtering and image processing. Local, zonal, and focal functions.  
Reading: | de Smith et al.: Ch 4.6; ArcGIS help: Performing analysis in Spatial Analyst  
Reading: | Michell: Ch 5  
Exercise 7: | Two map association with cross tabulation  
| Week 14: | Analysis of two or more coincident maps. Map algebra. Cluster analysis. Regression Modeling; Inter-map relationships.  
Reading: | de Smith et al.: Ch 5.6; Michell: Ch 5;  
Exercise 8: | Spatial regression models  
| Week 15 | Suitability modeling.  
Reading: | ArcGIS Help: Modeling and Solving Spatial Problems; Overlay toolset concepts  
Demo: | Suitability and Hazard Modeling  
Finals Week: | Final Exam, April 21, 2:00-3:15 (Tentative)