Geography 409/849

Fall 2019

Advanced Spatial Analysis & Modelling

Instructor:	**Joe Piwowar** email: joe.piwowar@uregina.ca
Office Hours:	CL 411 – Arts Student Services Office I am around a lot – just drop in or email me to make a specific appointment.
Meeting Times:	17:30 – 18:45 TR CL 305

Introduction

A geographic information system (GIS) is a tool for automating geographic concepts. At its most basic level it can help us to explain distributions and make decisions. At an advanced level it can help us understand complex spatial processes. Geographers (and others) use GISs to help them understand, describe, and predict how things are arranged in the real world.

All too often we produce a map from a GIS and conclude, "Gee, it looks like there is a pattern in the data," but we struggle to attach any certainty to our analysis. The real question we want answered is most likely, "Is there a significant pattern?" The methods developed in this course will help you answer this question. The aim of this course is to enable you to build your own toolbox of spatial analysis techniques to investigate spatial processes. By the end of this course, you will feel comfortable at tackling a wide-range of spatial analyses using GIS and remote sensing.

Pre-Requisite Knowledge

This is an **advanced** course in spatial analysis. I assume that you know the basics of GIS (e.g. buffering, overlay, attribute analysis), Remote Sensing (e.g. interpreting colour composite images, multispectral classification, raster data manipulation), and Cartography (e.g. effective map layout, proper use of colours and fonts). Knowledge of basic statistics (e.g. the Normal distribution and its derived statistics) and ArcGIS is also required. Instruction in these topics is beyond the scope of this course and will not be provided.

Reference Text

de Smith, M.J., Goodchild, M.F., and Longley, P.A. *Geospatial Analysis - A Comprehensive Guide to Principles, Techniques and Software Tools*. Winchelsea: The Winchelsea Press.

Available online at www.spatialanalysisonline.com.

Coursework & Grading

Lab Assignments There are 10 lab assignments; each assignment contributes 5% to your course grade.	50% (10 x 5%)
GIS Software/Tool Presentation	5%
Research Proposal	5%
Research Paper* A research paper demonstrating the development and application of advanced spatial analysis techniques to address a geographic problem. *This is a core course activity: your research paper must receive a passing grade for you to receive a passing grade for the course.	40%

Lab Assignments

There are 10 lab assignments. Some labs are long (10 hours); others are much shorter (2-3 hours). You will have 2 weeks to complete each lab. However, since new labs are distributed each week, you will always have 2 labs to work on.

Labs will have their due date clearly printed at the top of page 1. They are due at the start of the class on that day. Be sure to budget your work time accordingly.

Unless otherwise specified, all labs must be completed using the software ArcGIS Pro.

You are encouraged to work together to solve course related problems and issues. All submitted work, however, must be original (i.e. using your own words and map designs) unless otherwise specified.

GIS Software/Tool Presentation

Although ArcGIS is arguably the dominant GIS in the world, it is not the only spatial analysis system out there. I would like you to learn about another spatial analysis system or toolbox and demonstrate its capabilities to the class. Your demonstration should be between 15-30 minutes in length and cover (at least) the following topics:
- Purpose of the software/toolbox
- Cost (Many developers of commercial packages do not publish pricelists, so if the price of the system is not online at least note if it is completely free, has a free trial version, or only available for purchase.)
- Currency (i.e. Date of last release)
- System requirements (e.g. What platform does it run on? Does it require other software to run?)
- Your thoughts about using this software (e.g. How easy was it to learn/use? How good is its documentation? How robust is its functionality? Would you recommend it to others?)

Prepare a 1-page summary of the above points and hand it in to me at the start of your demonstration. Check **UR Courses** for your presentation date.

Tips:
- The course textbook has good list of GIS software at https://www.spatialanalysisonline.com/software.html.
- Don't just focus on the free software in this list; many commercial packages have demo versions that you can try for free.
- Some software comes as fully-functional systems; other are software tools that you need to link with other software to use them.
- You will need to install this software on your own computer in order to try it out. Preferably, your own computer will be a laptop that you can bring to class for your demonstration. If you don't have a capable laptop, you may create a PowerPoint presentation showing how you used the program.
- You do not need to provide an extensive review; You only need to explore/demonstrate some basic functionality (e.g. display some data and perform a simple task like creating a buffer).
- You may present GIS software that someone else has already presented, however, your presentation must be original.

Research Paper

You are to complete research on a topic, selected from the lists below, and write a research paper describing your work. You may choose a different topic, but you must get my approval first.

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Indices are useful tools for summarizing the effects of several variables simultaneously. They are widely used in environmental, economic, and sociological analyses. You are to pick an index and compute its value over a defined region. You may choose any index you wish and specify the area over which you will analyze it. Some of the more popular indices are listed below, along with one or two resources to get you started. You will need to search out more information for your selected index. You will find that some indices already have calculated values online. For the purposes of this course, you must calculate your own index values and do your own GIS analysis. You are not restricted to using the indices in this list. If you know of another index you wish to use, please ask me. Also, you are not restricted to calculating the index the same way as someone else has (in particular, this might arise if you can't find all the data necessary). If your calculations do deviate	The goal of a GIS analysis is finding *where* something occurs. The goal of a regression analysis is understanding *why* something occurs. With both, you can determine factors that influence patterns and predict how the pattern will change in the future. Geographically Weighted Regression (GWR; also known as Spatial Regression) is a tool that can be used to explain why a particular spatial pattern exists or to model the distribution of a feature so that you can predict where it might be found. You are to complete a GWR for a variable of your choice. Its OK to select a variable that has already been analyzed by someone else, but you must choose a different geographic region for your research. You can learn the basics of GWR by reading some of the resources listed below. An online search will produce many other resources as well.

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from those in the published literature, be sure to explain how your results might be different.

- Natural Amenities Index
  - https://www.ers.usda.gov/data-products/natural-amenities-scale/
- Market Potential Analysis
  - http://www.directionsmag.com/entry/a-market-potential-gis-case-study-market-potential-analysis-for-check-cashi/122646
- Crime index
  - https://www.numbeo.com/crime/indices_explained.jsp
  - http://www.statcan.gc.ca/pub/85-561-m/85-561-m2008015-eng.htm
  - https://en.wikipedia.org/wiki/Crime_statistics
- Vulnerable Localities Index (crime analysis)
  - http://www.ucl.ac.uk/jdibrief/analysis/Vulnerable-Localities-Index
- Social Vulnerability Index
  - https://svi.cdc.gov/
- Natural Hazards Risk
  - http://preview.grid.unep.ch/index.php?preview=home&lang=eng
- Environmental Indicators
  - https://www.oecd.org/env/indicators-modelling-outlooks/37551205.pdf
- Park Score
  - http://parkscore.tpl.org/
- Urban Rank Mobility Index
  - https://en.wikipedia.org/wiki/Rank_mobility_index
  - https://www.hindawi.com/journals/usr/2012/162965/
- Opportunity Atlas
  - https://www.opportunityatlas.org/
- Global Peace Index
  - http://visionofhumanity.org/indexes/global-peace-index/
- Other Government of Canada indices:
  - https://open.canada.ca/data/en/dataset?portal_type=dataset&q=index&collection=geogratis&_organization_limit=0

- Regression Analysis Basics
- An introduction to using regression analysis with spatial data
- Tips and Tricks for Finding a Good Model using OLS and GWR
- Applying GWR in Real Estate Analysis
- Regression Analysis Using ArcGIS
- GWR Explained
- Software for geographically weighted regression modelling
- The geography of online lending
- Was geography a factor in the 2016 US election?

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Research Proposal – Due November 5	**Research Proposal – Due November 5**
Your proposal must include:	Your proposal must include:
1. A working title for your paper.	1. A working title for your paper.
2. A statement of the Objective(s) of your research (i.e. what are you going to try and show by applying your index).	2. A statement of the Objective(s) of your research (i.e. what are you going to try and show by modelling your variable).
3. A list of all the data you will need to compute your index. Your list should include: ○ Dataset name(s) ○ Source organization(s) (where did you get them from?) ○ URL or other locator for the data (e.g. DVD) ○ A statement affirming to me that you have downloaded, or otherwise obtained, these data and they are now on your computer.	3. A list of all the data you will need to complete the GWR. Your list should include: ○ Dataset name(s) ○ Source organization(s) (where did you get them from?) ○ URL or other locator for the data (e.g. DVD) ○ A statement affirming to me that you have downloaded, or otherwise obtained, these data and they are now on your computer.
4. A summary of at least 5 articles that describe your index and its application. Your reviews should include descriptions – in your own words - of the following (if applicable): ○ purpose of the study; ○ data used; ○ analysis methods; ○ results; and ○ conclusions. At least 3 of your articles must come from refereed journals. Each review must be at least 250 words long and be written in grammatically correct prose (i.e. do not use bullet points). Include a complete bibliographic reference for each article. I don't care what bibliographic style you use, if you use it correctly and consistently.	4. A summary of at least 10 articles that describe your index and its application. Your reviews should include descriptions – in your own words - of the following (if applicable): ○ purpose of the study; ○ data used; ○ analysis methods; ○ results; and ○ conclusions. At least 5 of your articles must come from refereed journals. Each review must be at least 250 words long and be written in grammatically correct prose (i.e. do not use bullet points). Include a complete bibliographic reference for each article. I don't care what bibliographic style you use, if you use it correctly and consistently.

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Research Paper – Due December 16

Prepare a research paper describing your analysis. In your paper you should:

•   Introduce what you were trying to accomplish.

•   Review of some previously published work on this topic.

•   Describe the data and study area.

•   Describe the analysis approach.

•   Present results of your analysis (maps, graphs, or tables where relevant).

•   Interpret your results.

•   Discuss the assumptions and limitations of your work.

•   Present a summary and conclusions.

•   Provide suggestions for future research.

A research paper that earns top marks will be one that has the potential to be submitted to a refereed journal for publication.

Tips:
  o   Use generic terms and concepts when you are discussing your methods. This means that you should avoid the use of ArcGIS-specific terminology and just describe the results of the process. For example, don't say: *The Majority Filter function of the ArcToolbox was used*. Rather, you should say something like: *To improve the accuracy and overall appearance of the results, small clusters of poorly classified pixels were removed*.
  o   Every table and figure in your report must be numbered and labeled (table captions are placed above the table; figure captions go below the figure). Further, each table and figure must be referenced in the text.
  o   Be sure to provide proper citations for all external information you use.
  o   Refer to the attached grading rubric to see how I will be evaluating your paper.

NAME: _____   **MARK:** _____ **/5**

RESEARCH PROPOSAL GRADING RUBRIC

Background **(1 marks)**	
• A working title for your paper. • A statement of the Objective(s) of your research (i.e. what are you going to try and show).	
Data Required **(1 marks)**	
• Dataset name(s) • Source organization(s) (where did you get them from?) • URL or other locator for the data (e.g. DVD) • A statement affirming to me that you have downloaded, or otherwise obtained, these data and they are now on your computer.	
Literature Review [GEOG 409:5 articles │ GEOG 849: 10 articles] **(3 marks)**	
• A full bibliographic reference • A summary of the paper, including (where applicable): o purpose of the study; o data used; o analysis methods; o results; and o conclusions. • At least half of your articles must come from refereed journals. • Each review must be at least 250 words long and be written in grammatically correct prose (i.e. do not use bullet points).	

NAME: _____   **MARK:** _____ **/40**

RESEARCH PAPER GRADING RUBRIC

A research paper that earns top marks will be one that has the potential to be submitted to a refereed journal for publication.

Introduction and Background **(5 marks)** • Introduction to what you were trying to accomplish. • What has been done by others? • Objectives • Description of the study area.	
Methods **(10 marks)** • Description of data used in the analysis. • Description of analysis approach.	
Results - Graphics **(10 marks)** • Results of analysis (images, maps, graphs, or tables where relevant).	
Results - Documentation **(10 marks)** • Interpretation of results. • Statement of limitations. • Suggestions for further research.	
General Presentation **(5 marks)** • Neat and concise reporting. • Free from spelling and grammar errors. • Organization – Paper is well laid-out using appropriate sections.	

Schedule
(subject to change)

Date		Topic	Assignments
September	5	Course Introduction. Getting Started with ArcPro.	
	10-12	Data resources. Lab 1: Effective Cartography	
	17-19	Marrying Raster and Vector Data Lab 2: To There and Back: Integrating RS and GIS	
	24-26	Ecological Fallacies Lab 3: The Modifiable Areal Unit Problem	Lab 1 due
October	1-3	Animation Lab 4: Visualizing Changes in Vegetation Phenology	Lab 2 due
	8-10	Network Analysis Lab 5: Where's the Best Place for a new Tim Horton's?	Lab 3 due
	15-17	Terrain Analysis Lab 6: Which Way Does that River Flow?	Lab 4 due
	22-24	Combining Data Lab 7: Weighted Overlay / Multi-Criteria Evaluation	Lab 5 due
	29-31	Tobler's First Law of Geography Lab 8: Spatial Autocorrelation	Lab 6 due
November	5-7	Fall Break: No Classes	Research Proposals Due
	12-14	Surface Analysis Lab 9: "Guestimating" What's Over There	Lab 7 due
	19-21	3D Analysis Lab 10: Into the Third Dimension	Lab 8 due
	26-28	Airphotos on Steroids: Pictometry	Lab 9 due
December	3-5	Research time	Lab 10 due
	16	Research Papers Due	Research Papers Due