Term Information

Effective Term	Autumn 2014
Previous Value	*Summer 2012*

Course Change Information

What change is being proposed? (If more than one, what changes are being proposed?)

Adding GE status, in Data Analysis category

What is the rationale for the proposed change(s)?

Geography 2200 addresses the data analysis ELOs by exposing students to the problems of gathering, storage, manipulation, analysis, presentation, and interpretation of geographic data, specifically as it relates to mapping.

What are the programmatic implications of the proposed change(s)?

(e.g. program requirements to be added or removed, changes to be made in available resources, effect on other programs that use the course)?

None

Is approval of the requrest contingent upon the approval of other course or curricular program request? No

Is this a request to withdraw the course? No

General Information

Course Bulletin Listing/Subject Area	Geography
Fiscal Unit/Academic Org	Geography - D0733
College/Academic Group	Arts and Sciences
Level/Career	Undergraduate
Course Number/Catalog	2200
Course Title	Mapping Our World
Transcript Abbreviation	Mapping Our World
Course Description	Introduction to the power of maps, covering spatial representation, visual literacy, and geographic information technology in a global society.
Semester Credit Hours/Units	Fixed: 3

Offering Information

Length Of Course	14 Week, 7 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus, Lima, Mansfield, Marion, Newark

Prerequisites and Exclusions

Prerequisites/Corequisites	
Exclusions	Not open to students with credit for 480.

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	45.0701
Subsidy Level	Baccalaureate Course
Intended Rank	Freshman, Sophomore, Junior, Senior

Quarters to Semesters

Quarters to Semesters	Semester equivalent of a quarter course (e.g., a 5 credit hour course under quarters which becomes a 3 credit hour course under semesters)
List the number and title of current course being converted	480 Map Reading and Interpretation

Requirement/Elective Designation

General Education course:

Data Analysis

The course is an elective (for this or other units) or is a service course for other units

Previous Value

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Students will employ basic methods of spatial data-gathering, presentation, and interpretation
- Students will interpret map symbology in order to analyze and critically evaluate the spatial structure of and relationships among spatial phenomena
- Students will demonstrate familiarity with some basic concepts of descriptive and inferential statistics and understand some unique properties of spatial statistics
- Students will apply statistical ideas to seek explanations for unusual or interesting patterns on maps
- Students will evaluate the impact of spatial data sampling and uncertainty on map use

Previous Value

Content Topic List

- Introduction to geographic data
- Geovisual literacy
- The mapping process
- methods of spatial data gathering, presentation, and interpretation
- interpretation of map symbology
- mapping with descriptive, inferential, and spatial statistics
- application of statistical ideas for map analysis and evaluation

Previous Value

- *Introduction to geographic information*
- *The mapping process*
- *Mapping the ages*
- *Mapping physical processes*
- *Mapping social processes*
- *Atlases*
- *Wiki cartography*

Attachments

- Geog-2200-GEC-proposal-revisedOA.doc: GE proposal and syllabus

  (GEC Model Curriculum Compliance Stmt. Owner: Mansfield,Becky Kate)
- Assignment - PE5 - Exploratory data and autocorrelation.docx: Exercise 5

  (Other Supporting Documentation. Owner: Mansfield,Becky Kate)
- Assignment- PE6 – Point pattern analysis.docx: Exercise 6

  (Other Supporting Documentation. Owner: Mansfield,Becky Kate)
- Assignment - Term Paper.docx: Term Paper assignment

  (Other Supporting Documentation. Owner: Mansfield,Becky Kate)

Comments

- The revised version of this proposal was developed in consultation with Peter Craigmile, from Statistics. We include 3 sample assignments, including exercises 5 and 6 and the term paper (former exercise 7) which were explicitly mentioned by the committee in the request for revision. *(by Mansfield,Becky Kate on 12/04/2013 11:33 AM)*
- See 4-5-13 e-mail to B. Mansfield.bv *(by Vankeerbergen,Bernadette Chantal on 04/05/2013 01:20 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Mansfield,Becky Kate	03/26/2013 10:57 AM	Submitted for Approval
Approved	Mansfield,Becky Kate	03/26/2013 10:58 AM	Unit Approval
Approved	Haddad,Deborah Moore	03/26/2013 12:20 PM	College Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	04/05/2013 01:20 PM	ASCCAO Approval
Submitted	Mansfield,Becky Kate	12/04/2013 11:33 AM	Submitted for Approval
Approved	Mansfield,Becky Kate	12/04/2013 11:34 AM	Unit Approval
Approved	Haddad,Deborah Moore	12/04/2013 11:41 AM	College Approval
Pending Approval	Vankeerbergen,Bernadette Chantal Nolen,Dawn Jenkins,Mary Ellen Bigler Hogle,Danielle Nicole Hanlin,Deborah Kay	12/04/2013 11:41 AM	ASCCAO Approval

GEOGRAPHY 2200: MAPPING OUR WORLD

Adherence to Data Analysis General Education Expected Learning Outcomes

According to the 2012 Revised GE Goals & Expected Learning Outcomes, approved 6/8/2012, the expected learning outcomes for "Data Analysis" are:

> *"Students understand basic concepts of statistics and probability, comprehend methods needed to analyze and critically evaluate statistical arguments, and recognize the importance of statistical ideas."*

In line with the intent of this category, Geography 2200 will address this by exposing students to the problems of data gathering, storage, manipulation, analysis, presentation, and interpretation of geographic data, specifically as it relates to mapping. The main goal is to equip students with a geovisual literacy foundation (including spatial quantitative reasoning methodologies) so students can realize the value of geographic knowledge and develop their ability to analyze real-world, critical problems such as understanding international markets, demographic patterns, business locations, natural disaster recovery and responses, watershed preservation, and much more. Specifically, the following course objectives have been identified:

After completing this course, students should be able to:

- employ basic methods of spatial data-gathering, presentation, and interpretation
- interpret map symbology in order to analyze and critically evaluate the spatial structure of and relationships among spatial phenomena
- demonstrate familiarity with some basic concepts of descriptive and inferential statistics and understand some unique properties of spatial statistics
- apply statistical ideas to seek explanations for unusual or interesting patterns on maps
- evaluate the impact of spatial data sampling and uncertainty on map use

This course not only emphasizes geographical science but also embraces other disciplines that require the analysis of spatial data (including, but not limited to, geology, political science, criminology, philosophy, biology, anthropology, business, law, history, and environmental science). Thus, the course will bridge between qualitative social science and quantitative natural science data analysis and reasoning while connecting fundamental concepts and theory to real-world experiences and scenarios.

1. How does Geography 2200 course objectives address the GE learning outcomes above?

The overarching goal of this course is to promote spatial data literacy. The course approaches this through a critical examination of maps as one of society's most sophisticated conceptual creations, serving increasingly many interests in modern society, seemingly intuitive, yet fraught with issues related to abstraction, data collection, sampling, classification, processing, and symbolization. Students will actively engage in how to examine, analyze and explain natural and social phenomena through maps and other statistical graphics aided by geospatial technologies such as virtual globes, geographic information systems, and location aware devices (GPS, smart phones, etc.)

Descriptive statistics, such as measurement scale, measures of dispersion and central tendency, are fundamental to the proper use of maps, and will be treated by careful examination of various spatial data displays. Students will be exposed to numerical attribute summaries, tables and graphical

summaries in maps and charts to become well versed in numerical and graphical arguments, and subsequently students will explore correlations between spatial attributes. Here, multiple and multi-variate thematic maps as statistical surfaces will serve as a theoretical foundation for discussions on the uses vs. misuses of statistics and quantitative vs. qualitative arguments.

Through readings and ~~labs~~practical exercises the students will learn about fundamental issues related to the acquisition, manipulation, analysis, display, and interpretation of spatially referenced data. Data gathering exercises range from primary field observations to secondary use of existing data bases where students will develop a contextualized understanding of problems related to the measurement of space, spatial observations and gathering of data as attributes of space. Key ideas such as sampling, measurement, central tendency, and probability are naturally integrated with the mapping of summary demographics, spatial hot-spots, and interpolation of data from weather stations. Here, students will become aware of the problematic nature of spatial data for statistical analysis. Specifically, the Modifiable Areal Unit Problem (MAUP) and spatial autocorrelation will allow students to realize why simple correlation and regression are particularly challenging to employ on spatial data sets and maps.

Through a series of thematic application areas – history, geology, climate, population, politics, economy, weather, and cyberspace – students will recognize and gain a hands-on understanding of the impact of basic statistical ideas in contexts that are relevant to daily life and specific areas of study. The use of geographic information systems software in ~~laboratory~~ computer exercises present students with opportunities to apply concepts they learn in class to practical problems of data analysis. As such it provides students with the necessary foundation for interpreting maps, geovisual displays, and to recognize the importance of spatial statistical thinking in the natural, social, and behavioral sciences.

2. How do the readings assigned in Geography 2200 address the GE Expected Learning Outcomes above?

The text book for this course – by Kimerling, Buckley, Muehrcke and Muehrcke – is now in it's 7th edition and is written as a thorough introduction to map use and spatial understanding of the world. In two sections it covers the basics of “Map reading” – the map maker's process from reality to symbolic representation – and the reverse process “Map analysis”– the extraction of information from the map. In it~~'~~s latest edition (2011) it provides up-to-date coverage and places maps in the context of other representational systems such as natural language, mathematics, and art. It also recognizes and allows for a critical examination of the current shift from authoritative, government-agency-produced maps to commercially or crowd-sourced map products. As such, the book provides a solid foundation for understanding the particular problems related to geographic data gathering, storage, manipulation, and interpretation of the natural and human landscape. The large map analysis section provides dedicated chapters on methods and examples of area and volume measures, surface analysis, spatial patterns, and spatial associations. Those sections use foundations from the first part of the book to bear on a few inferential statistical techniques important to spatial data analysis.

The book is designed primarily for college-level students that seek to unlock the codes used by map makers to visually represent quantitative and qualitative information about the world. The companion web-site also has chapter specific resources and student exercises.

3. How do the topics covered in Geography 2200 address the GE Expected Learning Outcomes above?

The course is centered around problems related to data-gathering, presentation and interpretation of data. Students will have weekly practical exercises ~~labs~~ where they gain first-hand experience of data gathering in the field through observations, recording data, as well as using existing databases. As part of these practical exercises ~~labs~~ they will present their results in written reports where maps are an integral component. The practical exercises ~~labs~~ are also designed to give students significant practice in map data interpretation and analysis. Several shorter in-class exercises also help reinforce the concepts covered by the lectures.

Significant class time is devoted to map presentations where students learn to critically examine how maps are used in media (newspaper, internet, TV) reports to inform about current events. These presentations help to get students exposed to many different types of maps on a variety of subjects and they connect class material to relevant, real-world examples that makes for a more engaging and personalized learning experience.

Maps are mostly about descriptive statistics and therefore deal most commonly with data summaries in the form of average, median, standard deviation and quantiles. Many of the worst examples of 'how to lie with maps' are related to the use of inappropriate map types for particular types of data. Therefore the course will thoroughly examine the do's and don'ts of statistical mapping. In addition, a significant portion of the course is devoted to map analysis, e.g. spatial arrangement and association, and therefore involve concepts of spatial correlation, expected vs. predicted frequencies, and cluster detection. While many details and complexities of these topics are beyond the scope of this course, the maps that students confront will naturally reveal the importance of a deeper assessment than just judging a map by the looks of it.

In most of the ~~laboratory~~ practical exercises students will use geographic information system software to perform basic computational analysis and statistical map design. By using computers and mathematical algorithms, students learn both the concepts of spatial reasoning and the techniques of quantitative geocomputation. For example, students can utilize online mapping tools to explore the socioeconomic impact of recurring wildfires, calculate the size of the impact area, and contrast these with socio-economic data on e.g population and transportation through basic map algebra operations such as intersection, union, and spatial summary operations.

4. How do the written assignments completed in Geography 2200 address the GE Expected Learning Outcomes above?

Each week students work on a practical ~~lab~~ assignment that requires a written ~~lab~~ report. The practical exercises ~~labs~~ progressively build skills in how to collect, enter, analyze, and visualize spatial data.

The following table outlines the alignment of course objectives and GE ELOs with ~~Homework~~ practical ~~assignments~~exercises. While most assignments align to some extent with most of the course objectives and ELOs, the table focus on the most substantial alignments.

Course objective	GE ELO	~~Homework Assignment~~Practical Exercise
employ basic methods of spatial data-gathering, presentation, and interpretation	"comprehend methods needed to analyze and critically evaluate statistical arguments"	PE 1, PE 2, PE 3
interpret map symbology in order to analyze and critically evaluate the spatial structure of and relationships among spatial phenomena	"comprehend methods needed to analyze and critically evaluate statistical arguments"	PE 3, PE 5, ~~HA 6,~~ ~~PE 7~~Term Paper
demonstrate familiarity with some basic concepts of descriptive and inferential statistics and understand some unique properties of spatial statistics	"Students understand basic concepts of statistics and probability"	PE 2, PE 3, PE 4, PE5, PE 6
apply statistical ideas to seek explanations for unusual or interesting patterns on maps	"Students develop skills in drawing conclusions and critically evaluating results based on data."	PE5, PE 6, ~~PE 7~~Term Paper
evaluate the impact of spatial data sampling and uncertainty on map use	"recognize the importance of statistical ideas"	PE 3, PE 4, PE 6, ~~PE 7~~Term Paper

GEOG 2200 Course Assessment Plan

As developed in consultation with the Undergraduate Studies Committee in the Department of Geography, Geography 2200 will be reviewed and assessed through the following mechanisms:

1. Quantitative student SEI evaluation
2. Embedded testing in ~~both~~ the midterm ~~and final~~ exam~~.s~~
3. ~~Embedded testing~~ Use of a rubric to assess the course goals in ~~Homework~~ the term paper ~~A~~assignment~~. 7~~

Item 2 will consist of standardized questions on the midterm ~~and final~~ exam~~s~~ which will allow for comparisons in GE learning outcomes listed above.

Item 3 is an end-of-course term paper ~~assignment~~ that offers the opportunity to do a final assessment of learning outcomes. The ~~final report~~ term paper assignment ~~template~~ asks each student to present an argument and justification using maps and geographic data in an area they are interested in (e.g. international relations, politics, biodiversity, crime prevention, social networks). A central section of the report is to provide a description of how the geographic situation or phenomenon has been conceptualized, a data description (using appropriate terminology), and a discussion of how any data analysis support their argument.

Items 1-3 will be maintained on file in the department so that the progress of the course can be monitored and evaluated across time as the course evolves and to enable the department to address any major concerns or drift from the established goals and standards. The embedded questions will be critically reviewed by the Undergraduate Studies Committee every third time the course is taught.

This review will provide an assessment of how well the GE goals of the course are being met through time, and if the results are consistent independent of specific instructors. If the results suggest that the GE learning objectives are not being clearly communicated through course content, the instructor will undertake substantial revision of readings, lecture content, and discussion in class. If the data primarily indicate neutrality or that GE material is being adequately covered in class, the instructor will still make minor adjustments to readings and lecture content.

Geography 2200
Mapping our World

Spring 2012
3 credit (semester) hours

Time: TBD
Location: Derby Hall 0140

Instructor: TBD

Office phone: xxx-xxxx

Office address: xxxx Derby Hall, 154 N Oval Mall

Office hours: TBD

GTA: TBD

Office phone: xxx-xxxx

Office address: xxxx Derby Hall, 154 N Oval Mall

Office hours: TBD

Course Description

The powerful language of maps visually shows trends, and patterns that are not apparent in other data presentations; Corporations, government, media, and researchers use maps and geographic information technology to understand and visualize data on for example natural resources, flows of trade, historical events, property management, and diseases. In this course we will explore what makes spatial information special, how and why maps ~~is~~ are such a powerful tool to understand an increasingly complex world, and how modern technology is currently transforming the art and science of map making. In hands-on field work, ~~laboratory~~ practical exercises and discussions students will develop the knowledge, skills, and dispositions that constitute geographic information literacy.

The main goal is to give students a geovisual literacy foundation (including spatial quantitative reasoning methodologies) so students can realize the value of geographic knowledge and develop their ability to analyze real-world, critical problems such as understanding international markets, demographic patterns, business locations, natural

disaster recovery and responses, watershed preservation, and much more. Specifically, the following course objectives have been identified:

After completing this course, students should be able to:

- employ basic methods of spatial data-gathering, presentation, and interpretation
- interpret map symbology in order to analyze and critically evaluate the spatial structure of and relationships among spatial phenomena
- demonstrate familiarity with some basic concepts of descriptive and inferential statistics and understand some unique properties of spatial statistics
- apply statistical ideas to seek explanations for unusual or interesting patterns on maps
- evaluate the impact of spatial data sampling and uncertainty on map use

GE Data Analysis

This course meets the requirements of the General Education category Data Analysis. The intent of the Data Analysis GE is to enable students to deal with problems of data-gathering, presentation, and interpretation. Students should develop an understanding of problems of measurement, be able to deal critically with numerical and graphical arguments, gain an understanding of the impact of statistical ideas in daily life and specific areas of study, and recognize the uses and misuses of statistics and related quantitative arguments.

The GE goals for Data Analysis are: Students develop skills in drawing conclusions and critically evaluating results based on data.

Expected Learning Outcomes: Students understand basic concepts of statistics and probability, comprehend methods needed to analyze and critically evaluate statistical arguments, and recognize the importance of statistical ideas.

This course meets these goals and objectives by exposing students to the problems of data gathering, presentation, and interpretation, in the context of spatial, statistical maps.

Texts

Required:

Kimerling, A. J., Buckley, A. R., Muehrcke, P. C., & Muehrcke, J. O. (2011). *Map Use: Reading and Analysis*. 7th Ed., Esri Press.

How to Lie With Maps, 2nd Edition. Mark Monmonier, 1996.

The New York Times, or other newspaper with good maps and graphics in their coverage of current events.

You will be asked to present to the class and discuss the design of maps on current events. This activity will be ongoing throughout the quarter. Free copies of NYT are available to students in the residence halls and student discounted personal subscriptions run ~$20 for the quarter.

Additional required readings will be provided in Carmen

Schedule

Week #	Topic	~~Homework Assignment (HA)~~Practical Exercise (PE)
1	Why is spatial special? Introduction to geographic information	1. Spatial observations
2	Spatial observations	
3	Visual Variables	2. Drawing a map
4	Map coordinates and projections	
5	Hot and cold: weather patterns and what makes a climate	3. Isoline climate maps
6	Isoline maps and analysis	
7	Crossing the line: the nature and significance of political boundaries	4. Map accuracy and uncertainty
8	Remote sensing and image maps	
9	Where's Wall Street? The wealth of nations and their connections	5. ~~Multivariate data & exploratory map analysis~~Spatial data exploration and autocorrelation

10	Multi-variate data and visualization	
11	Spatial pattern analysis	6. Spatial pattern analysis
12	Spatial association analysis	
13	Volunteered geographic information and the new Wiki cartography	~~7. Individual~~ Term Paper ~~project~~
14	What can maps do for us? Personally selected topic related to the course material	
15	What can maps do for us? Cont.	

The most up to date schedule will always be posted on Carmen under Course info. Any significant changes to the schedule will be announced well in advance.

Lectures

xxxdays and yyydays hh:mm — hh:mm in [location].

Class material such as lecture notes, worksheets, handouts will be made available through Carmen under the heading Lectures.

During lectures we will often spend some time to work with sample problems and discuss practical applications. These activities are meant to build a deeper understanding of the subject matter but ~~it~~ they also rely~~ies~~ heavily on your active participation. There will also be seven ~~homework~~ practical exercises ~~assignments~~ that will be introduced during class time but will have to be completed outside of scheduled class time.

Grading Policy

Overall credits for the course are given approximately as follows:

In-Class Participation: 10%

This includes a short in-class presentation on one of the chapters in How to Lie with Maps (5%), and the remaining 5% will come from your attendance and active participation in class.

Map Review: 5%

You will review one published map from a reputable news source in a five-minute presentation once during the quarter.

~~Homework Assignments~~Practical Exercises: ~~50~~45%

There will be weekly practical exercises where you gain first-hand experience of data gathering in the field through observations, recording data, as well as using existing databases. As part of each practical exercise you will present your results in a written report where maps are an integral component.

Formatted: Indent: Left: 1", First line: 0"

~~There will be seven assignments, one of which will be a longer 3-5-page report on a subject of your choice.~~

Exams: ~~35~~40%

There will be one midterm and one final ~~exam~~project, a term paper. The Term Paper is a major deliverable that helps you develop/demonstrate your understanding of basic methods of spatial data-gathering, presentation, and interpretation. It also asks you to demonstrate the value of geographic knowledge and how it can be used to analyze real-world, critical problems.

Final letter grades will be assigned based on how many percent of total points available you have earned.

92.5 <= A
90.0 <= A- < 92.5
87.5 <= B+ < 90.0
82.5 <= B < 87.5
80.0 <= B- < 82.5
77.5 <= C+ < 80.0
70.0 <= C < 77.5
60.0 <= D < 70.0
~~F~~ E < 60.0

Attendance, Timeliness & Examination Policy

All course work are expected by the due date. A late penalty of at least 10 percentage units will be taken off each day after the due date.

If you have a genuine reason (known medical condition, a pile-up of due assignments on other courses, ROTC, athletics teams, job interview, religious obligations etc.) for being unable to complete work on time, then some flexibility is possible. However, if in my judgment you could reasonably have let me know *beforehand* that there would likely be a delay, then a late penalty will still be imposed if I don't hear from you until *after* the deadline has passed. For unforeseeable problems, I can be more flexible. This applies to my ability to offer make-up exams as well.

If there are ongoing medical, personal, or other issues that are likely to affect your work all semester, then please arrange to see me to discuss the situation.

Most classes have time allotted for discussions, in-class work and other activities. Your contribution in these and in class generally, will be noted, and used to determine part of your final grade, just showing up is not enough! Obviously, you will receive no credit for in-class work if you are not present.

Academic Integrity Policy

You are welcome to discuss the assignments amongst yourselves, in fact this is encouraged, but the final product you hand in must be your own work.

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the University's *Code of Student Conduct*, and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the University's Code of Student Conduct and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the University, or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the University's *Code of Student Conduct* is never considered an "excuse" for academic misconduct, so I recommend that you review the Code of Student Conduct and, specifically, the sections dealing with academic misconduct.

What this really means is: If I suspect that a student has committed academic misconduct in this course, *I am obligated* by University Rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the University's *Code of Student Conduct* (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the University. Please do not put yourself in that situation.

If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

Other sources of information on academic misconduct (integrity) can be found on the Committee on Academic Misconduct web pages (oaa.osu.edu/coam/home.html)

Disability Services

Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901;

http://www.ods.ohio-state.edu/**.**

Practical Exercise 5 – Spatial data exploration and autocorrelation

Assigned date: Month dd, yyyy | **Due date**: Month dd, yyyy
Total points: 25p

Objectives

- Practice interpretation of maps and graphs in order to analyze and critically evaluate the spatial structure of spatial data (CO2)
- Become familiar with some basic concepts of descriptive and inferential statistics and understand some unique properties of spatial statistics (CO3)
- Practice applying statistical ideas to investigate unusual or interesting spatial patterns (CO4)

Background

For the last century or so, scholars and decision makers have tried to characterize the spatial footprints of social, economic, and demographic characteristic. The basic principle of a method called Social Area Analysis developed in the 1950's and 60's is basically an exploratory multi-variate technique. The method is still in use, albeit in a more theoretically and methodologically advanced form.

In this lab we will get familiar with some visual, multi-variate techniques using the framework of Social Area Analysis applied to block group Census data of Franklin County.

Setting up the lab

A cleaned-up version of some census data similar to what you downloaded and prepared for the previous lab is provided for you in Carmen.

- Download lab5_data.zip and extract all the files to your workspace folder.
- Start GeoDa (on lab PCs you can find "Geoda095i" shortcut icon on the desktop).
- Load the FranlkinMultiv.shp Shape file (*File > Open Project*), key Variable can be ID.

This should bring up a map of Franklin County with outlines of Census block groups.

- Then bring up the data table by clicking the table button in the toolbar 

You should get a display of the attribute table that is related to the map. Apart from the identifier attributes in the first 9 columns there are some socio-economic attributes for each unit as well;

PCTWHT	% of white population
HOURS	mean travel time to work
HIGHED	% of population with higher education degrees
FEMALE	% of female population that is part of the workforce (whatever that means)
INCOME	median annual household income
RENT	median contract rent

These summary statistics were all compiled from data similar to what you downloaded in the previous lab, more specifically the following attributes:

P6 Race
P31 Travel Time to Work for Workers 16+ Years
P37 Sex by Educational Attainment for the Population 25+ Years
P43 Sex by Employment Status for the Population 16+ Years
P53 Median Household Income in 1999 (Dollars)
H56 Median Rent Asked (Dollars)

Now it's time to explore!

1. Histogram

It is often a good idea to look at an attribute's distribution through a histogram:

- From the menu, click on *Explore > Histogram*
- Choose INCOME from the list of variables and click OK

This should bring up a small histogram showing the distribution of income values throughout the data set. It should look more or less like a skewed normal distribution. By default it comes up with 100 bins, but you can easily change that and some other histogram attributes by *right-clicking in the histogram window.* Now change the number of bins (intervals) to 20:

- Right-click the histogram window
- Click Intervals type in 20 and click OK

2. Linking

The histogram and the map (and any other exploratory tool) is automatically linked, so anything that you select in the map or the histogram gets automatically selected in the other display(s).

- Click the interval with the most observations in the histogram

This should change the color of that bin to yellow (selected) and also in the map you should notice that a lot of the block group units shows a yellow hatch pattern (selected).

You can select several units/bins by holding *Shift key and click* each unit or by clicking-*dragging over multiple units-releasing your mouse button*. The effect varies a bit depending

on the tool. It is also possible to do the selection in any display window. Experiment a bit until you get the hang of this.

Question 1. Select the NW map quadrant and look at the income distribution for that selected area. Make a screen capture of the map and diagram and put in your report together with a short comment about the income distribution in that area based on the histogram. (2 point)

3. Box Plot

The Box Plot tool is a more compact version of a histogram showing only the median, first and third quartile of a distribution together with symbols for outliers. The definition of an outlier varies but can be set to 1.5 or 3 times the interquartile range above and below the first and third quartile.

To add a Box Plot to your display:

- Select *Explore* > *Boxplot* from the menu
- Pick the same attribute as for the histogram (INCOME)
- Click OK

The rectangle represents the cumulative distribution of the variable, sorted by value. The value in parentheses on the upper right corner is the number of observations. The red bar in the middle corresponds to the median; the dark part shows the interquartile range (going from the 25^{th} percentile to the 75^{th} percentile). The individual observations in the first and fourth quartile are shown as blue dots. The thin line is the hinge set to the default criterion of 1.5. Again, right clicking the display window lets you change some display preferences.

Observations can be selected in a similar fashion as with the previous displays and active links are maintained between all display windows.

Question 2. Compare the spatial distribution of the upper quartile vs. the lower quartile. What kind of spatial pattern do you find? (2 point)

4. Brushing

Another mode of selection is called brushing.

- While pressing the Ctrl key, make a small selection rectangle (click-drag-release) in the Box Plot.
- The selection rectangle will blink.
- Move the 'brush' slowly over the observations.
- Note how the selection on the box plot and the map follows your *'brushing'*.
- To cancel brushing, click on the box plot once.

The brushing feature is available in most of the exploratory tools in GeoDa.

Question 3. If you brush back and forth, from high to low income with a brush as wide as about 0.5 IQR. What spatial pattern can you see? (2p)

5. Scatter Plot

First investigations into multi-variate relationships between variables can be made with the 2D Scatter Plot tool. This plots individual observations as points located in a 2-dimensional area defined by the x and y axis values corresponding to two selected data attributes.

- Select *Explore* > *Scatter Plot* from the menu
- From the Variable Settings dialog select INCOME as Y and HIGHED as X
- Click OK

This brings up a scatterplot of all the census tracts and a blue line that is a least squares regression fit on those data. As we would suspect, there seems to be a positive relationship between the percent of people with a higher education degree and the median income in that area.

A useful option in this tool is to display standardized values (Z-scores) in the plot. As usual you can adjust display settings by right clicking on the display. To show standardized data you

- Right-click the display area
- Select *Scatterplot* > *Standardized data*

Question 4. What does it mean when an area has a z-score of 0 for the median income variable? (2p)

Question 5. Name at least two reasons why you should be careful about taking the blue line too seriously. (2p)

Question 6. There is a very particular spatial pattern to the combination of these two variables. Try to characterize (where) the spatial distribution of the four combinations of above/below average median income and above/below average proportion of people with a higher education. Also try to speculate about reasons for this distribution. Use a table similar to the one below (4 p)

Where are they? (why?)	Below average proportion higher educated	Above average proportion higher educated
Above average median income		
Below average median income		

6. Spatial autocorrelation analysis

As you know by now, Tobler's "first law" of geography states that *"Everything is related to everything else, but near things are more related than distant things"*.
The GeoDA software actually contains a few useful ways to investigate and illustrate that concept using some of descriptive and inferential techniques we have talked about in class.

As you know, the idea of autocorrelation requires some measure of interaction, adjacency, or distance. In GeoDa this is called spatial weights and for this exercise we will settle for simple adjacency.

- Select *Weights > Create* from the tools menu
- From the Creating Weights dialog select FranlkinMultiv.shp as the input file
- Enter a name for the weights file, e.g. Lab6w
- Enter TractID as the ID variable and check Rook as the type of contiguity
- Finally click Create

A weights file (with extension .GAL) will now be created and appear in your workspace directory for your analysis.

Global Moran's I

Moran's I spatial autocorrelation statistic can now be calculated and visualized as a Moran Scatter Plot.

- Select *Explore > Univariate Moran* from the tools menu
- Select a variable of interest, e.g. median income
- Next select the weights file you created in the previous steps.

The scatter plot shows standardized values of the variable of interest on the x-axis and local averages of the variable of interest on the y-axis. The standardization facilitates interpretation and categorization of the type of spatial autocorrelation that each quadrant represents (cluster or outlier).

Let's examine a few quadrants of the plot. In the upper-right quadrant we have cases where both the median income and the local average of median income are higher than the overall average of median incomes. At the opposite end, in the lower-left quadrant, we have cases where both the median income and the local average of median income are lower than the overall average of median incomes.

Question 7. Do these cases represent areas of positive, negative or no auto-correlation? (2p)

Question 8. By selecting or brushing the scatterplot, can you see some places on the linked map that exemplify that pattern? Describe. (2p)

To see if the value of Moran's I is statistically significant, we can test the null hypothesis that there is no spatial autocorrelation. To do this, GeoDa uses a permutation or Monte Carlo procedure to produce an empirical distribution as we discussed in class.

- Select *Options* > *Randomization* from the tools menu
- Specify the number of permutations you want to use, 999 will give a good result.

After that you will see a histogram of the empirical distribution under the assumption that there is no spatial autocorrelation. Your actual Moran's I value will be highlighted and a p-value given as an estimation of the significance.

Question 9. What is the p-value after 999 permutations? (2p)

Question 10. What does that tell you about how median income is spatially distributed, is it spatially autocorrelated or not? (2p)

LISA maps

Your previous analysis can determine if autocorrelation exists at all in the entire dataset, but autocorrelation is likely to vary across the map and the significance of cluster will also vary. We can break down the overall Moran's I values into Local Indictors of Spatial Association, or LISA Maps.

- Select *Explore* > *Univariate LISA* from the tools menu
- Next select the variable and spatial weights file in the usual way
- Finally select The Significance Map and The Cluster Map from the What windows to open-dialog box.

You should examine the correspondence between the cluster map and the Moran's I scatterplot.

Question 11. Are the intense blue and red areas examples of positive or negative autocorrelations? (1p)

Question 12. Do the areas in the North East parts of Franklin County show significant clustering (positive autocorrelation) of high median incomes? (2p)

Deliverable:

Type your answers to questions 1-12 in a separate document and submit a PDF version to the Carmen drop-box.

Practical Exercise 6 – Point pattern analysis

Assigned date: Month dd, yyyy | **Due date**: Month dd, yyyy
Total points: 22p

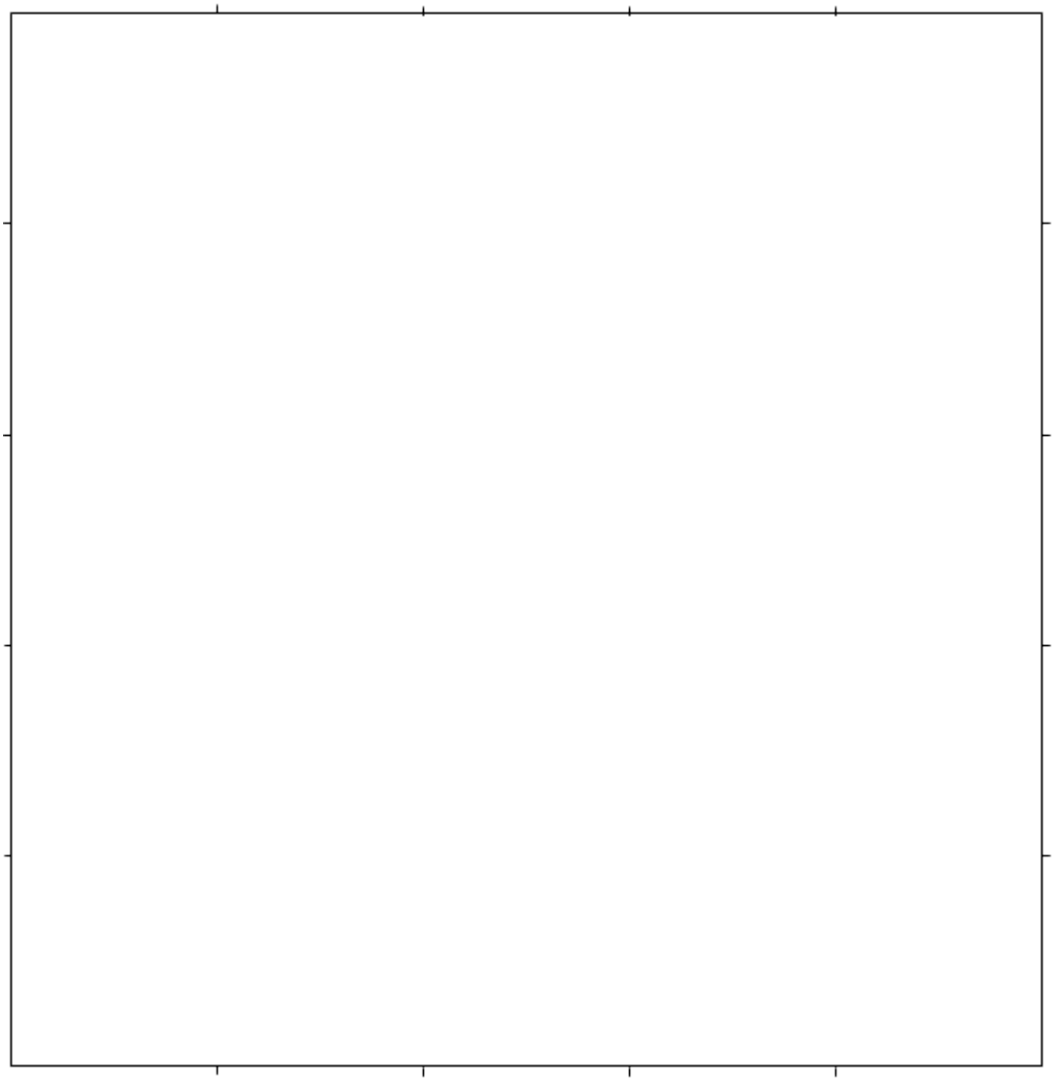
Objectives

- Become familiar with some basic concepts of descriptive and inferential statistics and demonstrate understanding of some properties of spatial statistics (CO3)
- Practice applying statistical ideas to investigate unusual or interesting spatial patterns (CO4)
- Reflect on the impact of spatial data sampling and uncertainty on map use (CO5)

Statistical testing of randomness for a point pattern

You are about to use your skills to first generate a random point pattern and then test if it is really random. Your first assignment will be to produce the point pattern.

Assuming that the rectangle below is a map of some place in the world, you should work manually using a pen/pencil and locate 50 dots ***in a random spatial pattern*** within the map. This means that each dot should be located independently of the other dots.



When you are done with your dot placement (make sure there are exactly 50 dots total) you should draw straight lines across the map, four horizontally and four vertically connecting the tick marks at the edge of the map. This will divide the map into 25 equally large quadrats or cells.

1. Quadrat counts

You will now perform a *quadrat count analysis*, a method developed primarily by ecologists in the first half of the twentieth century. In quadrat count analysis you first count the number of incidents in each cell (square) and then count the frequency of cells for each quadrat count. Complete the frequency table below. E.g. if you have 15 quadrats with 1 dot in each you enter 15 in the 'number of quadrats' column on the 1 'number of dots' row.

Fill out column A in Table 2

Most people would intuitively expect that most of the cells would have a number of dots close to an average expected outcome based on the total number of dots divided by the number of cells. In our example that would be 50 dots/25 cells = 2 dots/cell. But because of randomness there will be deviations, and many cells will have only one or no dots, and some may have 3, 4, or more dots. Those deviations can sometimes look "non random", so your job is to see if your point pattern is similar to a totally random point pattern.

To do this you will compare your pattern with an empirical distribution of several truly random patterns generated from drawing random coordinates for 50 points at a time, as demonstrated in class. This empirical distribution was used to fill in column B of the table. Those numbers then are what we would expect to see from a totally random point pattern. In reality, we could not have 6.8 cells with zero points in them since we don't count partial cells, but these numbers are averages so they will have decimals.

2. The Chi-squares test

Now we have a sample distribution – the frequency counts from your dot distribution – and an expected distribution – the empirical distribution from the random points generation. It is now time to do a hypothesis test, but to do so we first need to state:

Question 1. What is the null-hypothesis, and the alternate hypothesis?

The null-hypothesis: _____

The alternate hypothesis: _____

(4 points)

We start by looking at the differences between your results and the expected counts to get a sense of how different they are. You do this by completing column C in the table.

Question 2. Just by looking at your numbers, do you think that they are different or similar enough to the expected random counts to decide if you created a random pattern or not? (4 points)

Now use the provided Excel spreadsheet to re-enter your counts in column B. the spreadsheet will then complete column C and a few more for you automatically.

The table in this spreadsheet illustrates how a statistical assessment of your pattern can be done. The test uses the sum of differences from column C to see if your point counts are different enough to be considered *significantly different* from the expected random outcomes. The sum at the bottom of column D is the Chi-squares value.

Question 3. Investigate how column D is calculated and try to determine what a large vs. small sum would say about how different your dots are compared to a random dot pattern.

A ***small*** Chi-squares value would mean that my dots are _____ (random/not random)

A ***large*** Chi-squares value would mean that my dots are _____ (random/not random)
(4 points)

How large is large enough?
So, you have figured out what a really large or small would number would mean, but where is that critical value that separates a random from a not random pattern?

To answer this we use a Chi-squares distribution table or the Excel function CHIDIST(x, d.f.) to get a *p*-value. The *p*-value is the probability that your dot counts could have happened by chance and you will find this below the data table in the Excel spreadsheet. As we have learned, statistics usually considers outcomes that would only happen 5% of the time, very unusual calling them significant. If $p < 0.05$ you reject H_0.

Table 2 Quantitative analysis of a point pattern

Number of dots	*A) Number of quadrats*	*B) Expected number of quadrats*	*C) Difference (A – B)*	*D) Squared difference / expected (C / B)*
0		6.7		
1		13.5		
2		13.5		
3		9.0		
4		4.5		
5		1.8		
6		0.6		
7		0.2		
SUM		50		

Question 4. What is your *p*-value? (1p)

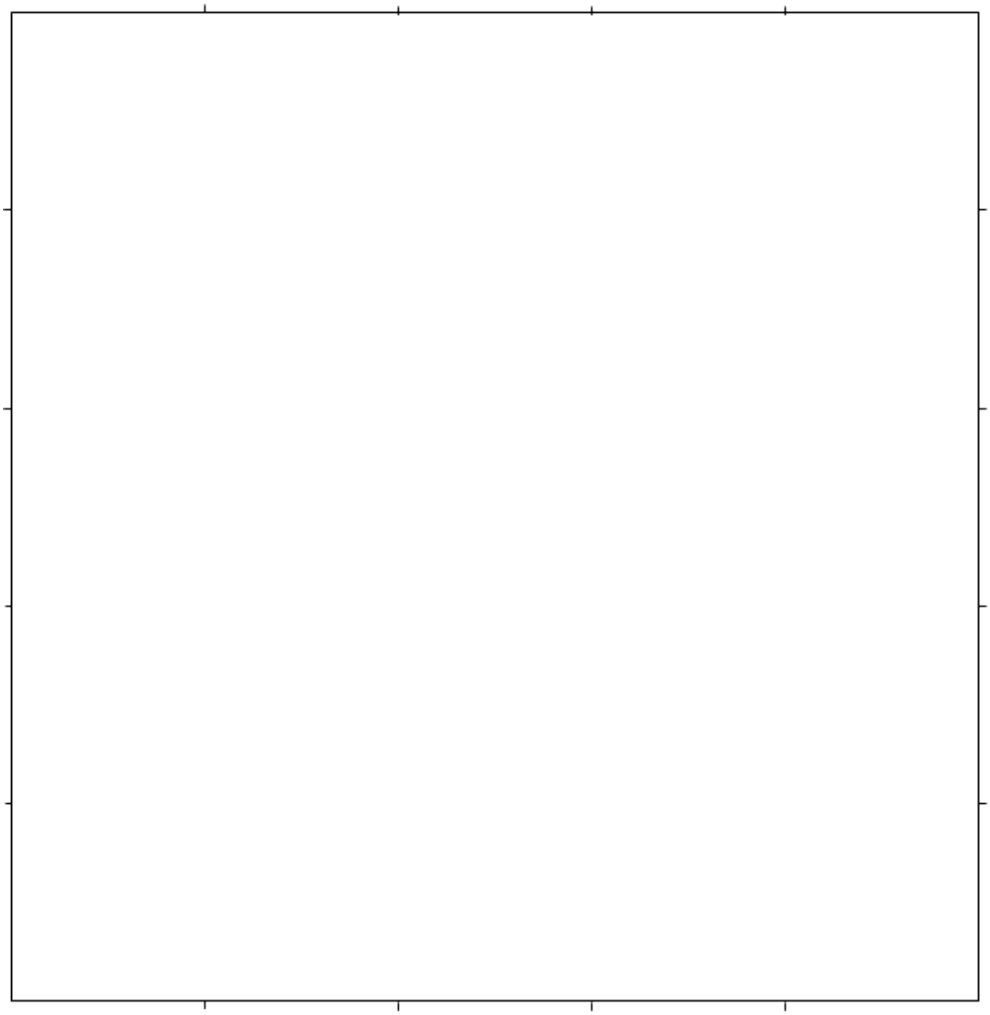
Question 5. Should you reject your Null hypothesis? (1p)

Question 6. Does your answer to question 5 mean that your dot pattern is random? Motivate why. (3p)

3. Point patterns and reality

The exercise so far has only been a very artificial way to explain the statistical principles behind analyzing a dot pattern. In reality there are often other considerations that will influence the viability of something like a quadrat counts analysis.

Assume for now that your dots on the map are the homes of people diagnosed with a particularly difficult strain of the flu and your map covers the area depicted below.



Question 7. Discuss how this would affect your analysis, if your data should be regarded as a sample or an entire census, and what you might do to adjust the analysis in order to account for the at-risk population. (5p)

Deliverable:

Type your answers to questions 1-7 in a separate document and submit a PDF version to the Carmen drop-box together with a copy of your dot pattern on page 2.

"The use of maps in xxx" – Term Paper assignment

Total points available: 55 (~20% of course total)

DATES:	**Paper proposal** (5 points)	Month dd
	Peer-review (10 points)	Month dd
	Final Term Paper (40 points)	Month dd, yyyy, hh:mm

Objective

The Term Paper is a major deliverable that helps you develop/demonstrate your knowledge about map use and analysis. The Term Paper assesses your understanding of basic methods of spatial data-gathering, presentation, and interpretation. It also asks you to demonstrate the value of geographic knowledge and how it can be used to analyze real-world, critical problems.

What is a "White Paper"?

The term White Paper is often used to refer to government or corporate reports, usually indicating that the document is somehow authoritative and informative in nature. It is often used to argue a specific position or propose a solution to a problem with a fairly broad audience in mind. The language and terminology used may be somewhat technical, but in a way that most people can understand. Here are some examples of professional white papers, clearly above and beyond what I expect from you, but hopefully they can give some ideas.
http://download2.nemetschek.net/www_misc/2010/VW_GIS_Whitepaper.pdf
http://bit.ly/YLBFcT
http://www.esri.com/library/whitepapers/pdfs/esri-location-analytics-for-bi.pdf

The Assignment

The goals of this assignment are assess your ability to

- interpret map symbology in order to analyze and critically evaluate the spatial structure of and relationships among spatial phenomena
- apply statistical ideas to seek explanations for unusual or interesting patterns on maps
- evaluate the importance of spatial data sampling and uncertainty on map use

By completing this assignment you will 1) demonstrate your familiarity with basic methods of spatial data-gathering, presentation, and interpretation such that you can analyze and critically evaluate the spatial structure of and relationships among spatial phenomena in a selected area of interest; 2) gain some experience researching and extracting information to understand a topic in enough depth to be able to share your knowledge with others; and 3) gain some experience in writing for a professional audience. The white paper should not be too technical and should relate to several topics covered by the course.

The proposal

You should submit a short, one-paragraph proposal by [Month dd] where you outline: your paper topic and how it fulfills the criteria for the term paper as outlined in this document

The peer-review

This separate assignment consists of reviewing two Term Paper manuscripts. You will fill out a review form in class together with your peers, and turn this in after the class on [Month dd]. In return you will also get your own paper reviewed by two class peers.

The paper

In the paper you should present a map-centered argument in an area of your interest (e.g. international relations, politics, geology, criminology, philosophy, biology, anthropology, business, law, history, environmental science). Ideally this will be a topic you already know something about, so that you can contribute with your existing knowledge, but it can also be something you have to research from scratch. If you do not have a topic in mind, send me an email and I will help you decide on something relevant to the course. You could for example compare some existing examples of map use in the area of interest and make a recommendation based on some evidence. You should make a critical examination and analysis of any statistical arguments and, for example, compare and contrast relevant examples with not so useful ones. Make sure to acknowledge sources in your presentation.

Content Requirements

I. **Introduction**: What is the topic, subject area, or problem that you will address? Briefly summarize your proposition.
II. **Background, Examples, and Proposition**: Provide a summary of relevant and essential information that enables the audience to grasp the subject you are examining. This needs to include a description of a geographic situation or phenomenon has been mapped, a description of the map analysis including the use of any statistical concepts, and a discussion of what conclusions or arguments can be made based on the presented material including justification.
III. **Conclusion**: Speculate and make recommendations for future work and include any advice to the audience may seem relevant.

Paper Requirements:

Three to four double-spaced pages, (not to exceed 1000 -1200 words) with one inch margin all the way around with 12 point font. References, figures and tables are not included in that limit.

Submit all reports as MS-Word or PDF files to the appropriate dropbox in Carmen.

Grading

The grading will necessarily be somewhat subjective, but some of the things we will be looking for include 1)The final report fulfills requirements above; 2) The evaluation rubric on the next page; 3) Neat presentation, MS Word, OpenOffice or PDF documents only!

Ola Ahlqvist
Month dd, yyyy

Term paper grading rubric

	Exemplary	Accomplished	Developing	Beginning
1. Organization and Coherence (4 points)	Uses a logical structure appropriate to subject. Guides the reader through the chain of reasoning.	Shows a logical progression of ideas. Some logical links may be unclear.	May list or arrange ideas randomly. Logic is not always clear.	May have random organization, lacking internal paragraph coherence.
2. Method comprehension (8 points)	Clear and exemplary understanding of basic methods for spatial data gathering, presentation, and interpretation.	Accomplished but basic understanding of basic methods for spatial data gathering, presentation, and interpretation.	Developing but limited understanding of basic methods for spatial data gathering, presentation, and interpretation..	Lacking or beginning understanding of basic methods for spatial data gathering, presentation, and interpretation.
3. Data analysis (8 points)	Clear and exemplary analysis and critical evaluation of the spatial structure and/or relationships among spatial phenomena	Accomplished but basic analysis and critical evaluation of the spatial structure and/or relationships among spatial phenomena	Developing but limited analysis and critical evaluation of the spatial structure and/or relationships among spatial phenomena	Lacking or beginning analysis and critical evaluation of the spatial structure and/or relationships among spatial phenomena
4. Statistical concepts (4 points)	Clear and exemplary understanding of basic descriptive and inferential statistical concepts in a spatial data context	Accomplished but basic understanding of basic descriptive and inferential statistical concepts in a spatial data context	Developing but limited understanding of basic descriptive and inferential statistical concepts in a spatial data context	Lacking or beginning understanding of basic descriptive and inferential statistical concepts in a spatial data context
5. Support for conclusions (8 points)	Uses evidence appropriately and effectively, providing sufficient evidence and explanation to convince.	Begins to offer reasons to support points. Begins to interpret the evidence and explain connections between evidence and main ideas.	Often uses generalizations to support points. May use obvious or irrelevant examples, assumes that evidence speaks for itself, or has lapses in logic.	Depends on overgeneralizations for support, or offers little evidence of any kind. More personal narrative than essay, or summary rather than analysis.
6. Terminology (4 points)	Chooses words for their precise meaning and uses an appropriate level of specificity.	Generally uses words accurately and effectively, occasional use of incorrect terms.	Uses relatively vague and general words, include some incorrect terminology.	May be too vague and abstract, or too personal and specific, or incorrect.
7. Mechanics (4 points)	Almost entirely free of spelling, punctuation, and grammatical errors.	May contain a few errors, which may annoy the reader but not impede understanding.	Contains several mechanical errors, which may temporarily confuse the reader but not impede the overall understanding.	Plenty of spelling, punctuation, and grammatical errors that hamper the reader's understanding.

Modified from: Beth King, John A. Dutton e-Education Institute, The Pennsylvania State University