Spatial Sciences Institute
University of Southern California

SSCI 135Lg Maps in the Digital World

Fall 2015 — MWF 11:00–11:50 A.M.

Location: Taper Hall of Humanities (THH) 114

Instructor: Travis Longcore, Ph.D.

Office: Watt Hall 331

Map of California shown as an island, circa 1650, by Joan Vinckeboons

Office Hours: Fridays, 12–1 P.M. and Thursdays 2–6 P.M. (Thursdays by appointment)

Website: blackboard.usc.edu

Contact Info: longcore@usc.edu, (310) 247-9719 (mobile), travislongcore (Skype)

1 Catalogue Description

SSCI 135Lg Maps in the Digital World
The role of formal reasoning, abstract representation, and empirical analysis in building maps for sharing knowledge across the physical, life and social sciences and the humanities.

2 Introduction

This course explores all the ways in which maps are been used to compile, build and share knowledge of the world around us. The first maps appeared long ago and today maps are used extensively across the physical, life and social sciences as well as the humanities. Numbers and quantitative data feature prominently in the preparation of most maps and the overarching intent is to examine some of the ways in which formal reasoning, abstract representation, and empirical analysis are used to construct the maps that you see and use in a given field of study and in everyday life. The topics covered in this course will range from geodetic principles (the ways things are located and measured on the Earth's surface) to the various ways in which information is captured and represented on maps, the role of scale and map projections, and the ways in which various hierarchies and classifications can be combined and used with empirical analysis to add meaning to maps.

This course is a Quantitative Reasoning General Education course. Maps are used to engage you in the analysis and manipulation of data and information related to quantifiable objects, symbolic elements, and logic to help navigate the complexity and sophistication of the modern world. The lectures and accompanying assignments will focus on the role of maps in modern life and how numbers are used to construct maps of the world around us. The assignments and final project will increase your capacity to evaluate chains of formal reasoning (the use of formal logic and mathematics), abstract representation (the use of symbolic and diagrammatic representations), and empirical analysis (the use of statistical inference) in building and interpreting various kinds of maps.

3 Learning Objectives

The central learning objective of this course is to use maps to increase the capacity of students to use numbers in all their various guises to describe and interpret the complexity and sophistication of the modern world. Students will learn how to use a set of formal tools, including logical and statistical inference, probability and mathematical analysis, to pose and evaluate hypotheses, claims, questions, or problems with a variety of maps. Students will also explore the logical structures embedded in various kinds of maps and learn how distinguish between their assumptions and implications. Maps are now a pervasive part of our everyday lives and by the end of the course, students will be able to identify both useful and specific applications of the various kinds of maps they study.

4 Course Outline

The course will be organized around the following lecture and exercise topics.

Week	**Topic**	**Readings**
Week 1: 8/22	Guiding Principles, Special Properties of Maps/Exercise 0	Arlinghaus & Kerski, Chapter 1
Week 2: 8/29	Geometry of the Sphere/Exercise 1	Arlinghaus & Kerski, Chapter 1
Week 3: 9/5 (2 lectures)	Location, Trigonometry and Measurement of the Sphere/Exercise 2	Arlinghaus & Kerski, Chapter 2
Week 4: 9/12	Location, Trigonometry and Measurement of the Sphere/Exercise 3	Arlinghaus & Kerski, Chapter 2
Week 5: 9/19	Transformations: Analysis and Raster/Vector Formats/Exercise 4	Arlinghaus & Kerski, Chapter 3
Week 6: 9/26	Replication of Results: Color and Number/Exercise 5	Arlinghaus & Kerski, Chapter 4
Week 7: 10/3	Mid Term Exam; Scale/Exercise 6	Arlinghaus & Kerski, Chapter 5
Week 8: 10/10	Scale; Partitioning Data/Exercise 7	Arlinghaus & Kerski, Chapter 5
Week 9: 10/17	Partitioning of Data: Classification and Analysis/Exercise 8	Arlinghaus & Kerski, Chapter 6
Week 10: 10/24	Partitioning of Data: Classification and Analysis	Arlinghaus & Kerski, Chapter 6
Week 11: 10/31	Visualizing Hierarchies/Exercise 9	Arlinghaus & Kerski, Chapter 7
Week 12: 11/7	Distribution of Data/Exercise 10	Arlinghaus & Kerski, Chapter 8
Week 13: 11/14	Map Projections/Exercise 11	Arlinghaus & Kerski, Chapter 9
Week 14: 11/21 (1 lecture)	Map Projections	Arlinghaus & Kerski, Chapter 9
Week 15: 11/28	Integrating Past, Present, and Future Approaches/Exercise 12	Arlinghaus & Kerski, Chapter 10
Finals: 12/7	Final Exam (11:00 A.M.–1:00 P.M.)	

5 Important Dates

8/19:	Last day to register and settle without a late fee
8/22:	Fall semester classes begin
9/5:	Labor Day, university holiday
9/9:	Last day to register and add classes; last day to change enrollment option to Pass/No Pass or Audit; and last day to drop a class without a mark of "W", except for Monday-only classes, and receive a 100% refund
10/3:	Mid-term Examination
11/13:	Last day to drop a class with a mark of W
11/23–27:	Thanksgiving recess
12/2:	Fall semester classes end
12/3-12/6:	Study days
12/7:	Final Examination (11:00 A.M.–1:00 P.M.)

In addition to the lectures and in-class discussions, there are a series of assignments that are designed to introduce the tools of quantitative reasoning and provide practical experience in implementing these tools to explore various problems within the framework of the scientific method. These assignments are linked to the lectures and class discussions, but do not duplicate the classroom experience. Weekly assignments will be graded and returned, and the mid-term and final exams will draw from these assignments. In other words, the assignments are an important and integral part of the course as a whole.

No make-up opportunities will be offered for missed exams, so mark the appropriate dates on your calendars! If you have a legitimate conflict, speak with one of the course instructors as soon as possible so we can make alternative arrangements.

6 Grading Scheme

Exercises (12 x 4 points per assignment)	48%
Midterm Examination (in class)	12%
Final Project (1 with multiple components)	10%
Final Examination (12/14/15)	30%

7 Textbooks

7.1 Required Text

Arlinghaus S L and Kerski J J (2014) *Spatial Mathematics: Theory and Practice through Mapping*. Boca Raton, FL, CRC Press

7.2 Recommended Texts

de Smith M, Longley P A, and Goodchild M F (2006) *Geospatial Analysis: A Comprehensive Guide.* Available at http://www.spatial analysisonline.com/

MacEachern A M (1995) *How Maps Work.* New York, Guilford Press

Monmonier M and de Blij H (2010) *How to Lie with Maps* (Second Edition). Chicago, IL, University of Chicago Press

Unwin D J (2010) *Numbers Aren't Nasty: A Workbook of Spatial Concepts.* Available at http://www.teachspatial.org/sites/teachspatial.org/files/Unwin_WorkbookOfSpatialConcepts.pdf

8 Exercise Topics and Protocols

The experiences will be organized around the topics listed below. The letter 'P' listed at the end of selected topics indicates assignments that include components that will contribute towards your final projects:

Exercise #0: Mental Maps

Exercise #1: Routes, Coordinates, Precision and Accuracy

Exercise #2: Measuring the Circumference of the Earth

Exercise #3: Measuring Positions on the Earth's Surface

Exercise #4: Transformations and Raster/Vector Analysis (P)

Exercise #5: Role of Color and Image Interpretation

Exercise #6: Role of Scale and Dot Density Maps

Exercise #7: Classification and Normalization of Data (P)

Exercise #8: Role of Traditional and Hexagonal Hierarchies (P)

Exercise #9: Examining the Distribution of Tornado Data

Exercise #10: Calculating Mean Centers and Standard Derivational Ellipses

Exercise #11: Comparing Map Projections (P)

Exercise #12: Network Analysis (P)

Last but not least, I wanted to use a series of examples to describe something more about the character and flow of the course as a whole and the exercises in particular. We will make extensive use of a series of cloud-based solutions that require no software so that students can learn key skills and use maps-with-numbers throughout the course and not get bogged down learning all of the functions in, say, a standalone GIS package.

Hence, this course will use ArcGIS Online (http://www.esri.com/software/arcgis/arcgisonline), GapMinder (http://www.gapminder.org/), Worldmapper (http://www.worldmapper.org/) and other tools to explore a variety of maps and quantitative reasoning skills, all of which are showcased in the *Spatial Mathematics* book.

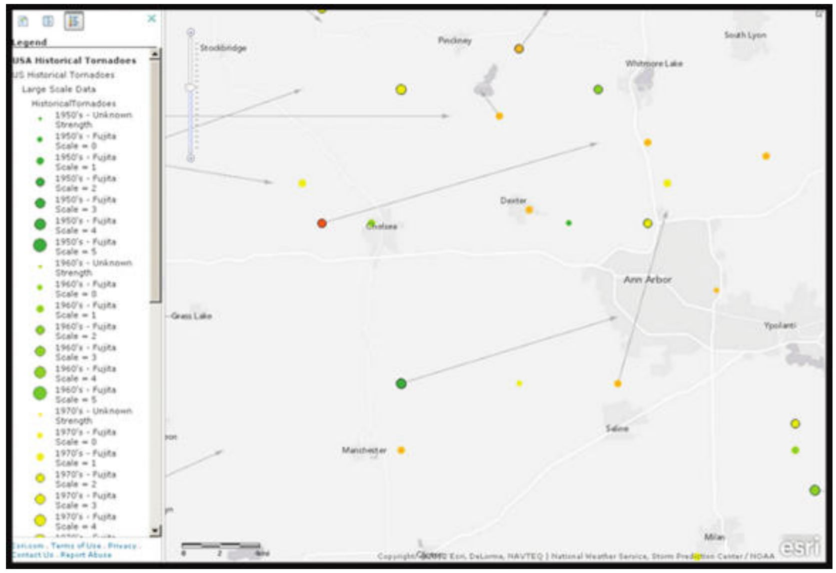
One example focuses on modeling the geometry of a sphere, doing simple but with-a-purpose measurement distance of 1 degree of longitude along the Equator vs at 30 degrees north, 45 degrees north, and so on. This can be easily accomplished by comparing the UTM reading in meters with the latitude-longitude reading in degrees-minutes-seconds.

Another easy but powerful lesson is to enter latitude-longitude values in ArcGIS Online and then successively remove one significant digit, analyzing the positional result, and then measuring the distances between the point with five significant digits vs. four, three, two and one significant digit.

Another activity involves measuring the distance of one second of latitude with a GPS or smartphone in the field (i.e. just outside the classroom, on campus) and then computing the Earth's circumference from that. A user can usually get within 1 or 2% of the true polar circumference! We can then give you a few formulas and have you compute the Earth's mass and volume.

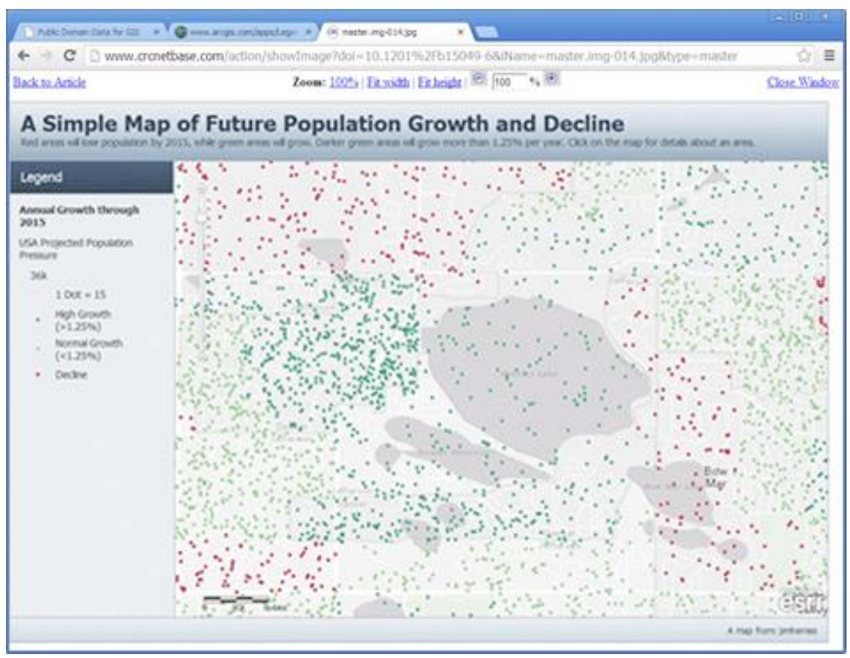
This may sound like pretty basic stuff but the idea here is to get you all involved in calculating numbers that are normally meaninglessly taken for granted and memorized for exams. I believe the retention rate for these hands-on ways of learning is much higher. And you are doing real science and inquiry just like Eratosthenes did 2,200 years ago! You can also calculate the circumference based on Sun angles just like Eratosthenes did.

To learn more about map projections, we can compare Geodesic vs. Euclidean buffering using tools like those at: https://developers.arcgis.com/flex/sample-code/buffer-using-geometry-service.htm



On set theory, you will do some simple map overlay operations in ArcGIS Online and a simple activity like the one my colleague, Joseph Kerski, describes in this video so you can all see, first-hand, the vast differences between AND, OR, and XOR: http://www.youtube.com/watch?v=B_0Dc3-Q_xM

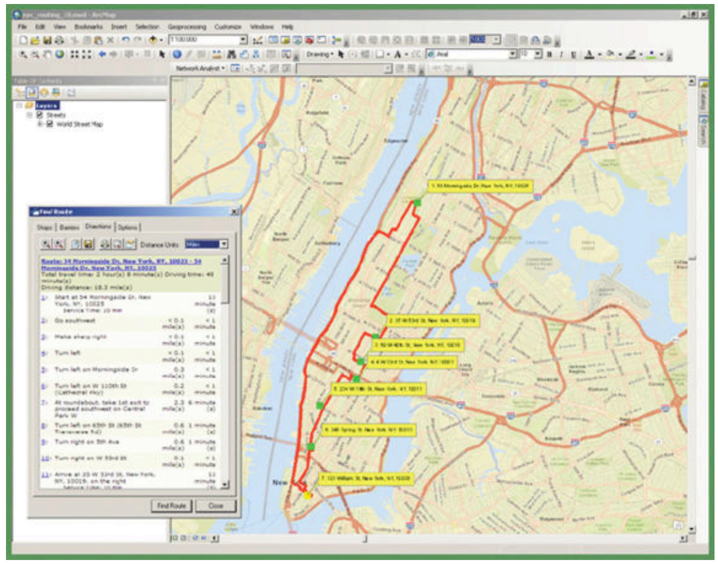
Regarding scale, you will examine tornado "touchdown points" at Scale A and then zoom in to Scale B and see them as vectors, and ponder why the measurements differ. We will then consider their accuracy and whether or not they really are all straight lines as shown in the map here. And what about the 1950s-1960s tornado vectors before Doppler radar existed vs. 1990s–2000s-era tornadoes?



Regarding the advantages and disadvantages of different ways of representing data, there are a variety of things we can do – for example, we can examine choropleth vs. density maps or study the map of population below. Are people really living on the lakes? Why or why not?

On normalizing data, we will spend some time exploring classification methods with natural breaks vs. standard deviations vs. quantiles, and so on. We will also examine hierarchies by looking at Census demographic variables from the state to the county to the census tract to the block group level. Again, we can accomplish all of these tasks with no software to install and no steep learning curve.

And we will explore measures of centrality such as mean center and standard deviational ellipse. We will discuss some interesting out-of-the-box examples in class like the mean center of the 10 largest cities of the past 2,000 years and how it changes.



Finally, the assignments will inevitably include a few exercises about routing that are numbers-heavy – calculating times and distances, for example, in running a tour bus around Manhattan or a trucking company around the U.S. with scheduled pickups and drop offs of freight. The goal throughout is to show how maps and numbers work hand-in-hand and how they can be used to support quantitative reasoning about the world around us.

9 Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions can be found at: https://scampus.usc.edu/b/11-00-behavior-violating-university-standards-and-appropriate-sanctions/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/.

10 Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. More information about academic accommodations based on a disability can be found at: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to an instructor as early in the semester as possible. DSP is located in STU 301 and is open 8:30 A.M.–5:00 P.M., Monday through Friday. The phone number for DSP is (213) 740-0776.