

## NUTR 231

## FUNDAMENTALS OF GEOGRAPHIC INFORMATION SYSTEMS

### Syllabus for Spring 2018

This syllabus is subject to change. Check the course Canvas site for latest version.

**Graduate course:** 1 credit

**Class Time:** Wednesdays, 9:00–12:00 pm

**Location:** Sackler Hall, Room S514 (Big Lab) Hirsh Library 5<sup>th</sup> floor

**Enrollment Limit:** 20

**Instructor:** [Paul Cote CV](#)

**Email:** paulbcote@gmail.com

**Office Hours:** Email for Appointment

**Assistant Instructor:** Yvonne Socolar

**Email:** Yvonne.socolar@tufts.edu

**Office Hours:** Check Canvas site for most up-to-date schedule.

**Tufts Credit:** 1 credit (3 classroom hours per week over 15 weeks)

**Prerequisites:** Graduate standing, or permission of the instructor.

### Course Description:

Many problems in agriculture, food, and nutrition are geographic in nature. For example, livestock production is increasingly concentrated in large feeding operations, leading to new spatial patterns of water and air pollution or foodborne illness. Spatial clustering is equally important for food consumption, nutrition, and public health, as in hunger hotspots, food deserts, and disease corridors. This course will equip students with a mindset and skills needed to produce and use geographic data and maps in decision-making situations using a variety of examples from agriculture, food, and nutrition.

### Course Objectives:

This course will provide opportunities for students to acquire the following capabilities:

1. Design and evaluate research projects involving geospatial processes and data.
2. Organize and manage data and research products for collaborative and on-going projects.
3. Create and evaluate maps involving categorical, quantitative, and topographic data.
4. Develop credible arguments using Vector and Raster data models.

### Background and Context:

Improvements in quality and accessibility of geographically referenced data present new opportunities and expectations for management and communication concerning landscapes and their influence on food systems and health. Students in NUTR 231 will learn to create, organize and evaluate geographic data; to develop credible arguments using maps and analytical models; and to think strategically about how organizations manage and share information.

NUTR 231 provides students with a conceptual framework and technical skills for using geographic data, maps, and geographical models in research and decision-making contexts. Each week we will meet for three hours for a presentation and technical demonstrations that weave together several threads:

**Exposing the historical context of GIS and information infrastructure** provides an understanding of the problems that geographic information systems have evolved to address, and the direction that these technologies are headed; particularly in terms of research, planning and administration. At a more technical level, the historic viewpoint on GIS reveals how the two primary tool-kits for spatial analysis: Vector/Relational; and Raster/Map Algebra have evolved to simulate particular sorts of spatial processes and relationships.

**A model-based approach to describing situations** considers the ways that problems and concerns may be boiled down to conceptual models that may be partially represented with data and computing procedures. How can data be used represent things and conditions that play a role in our conceptual model? How can we simulate and explore real-world relationships and future scenarios by transforming data with GIS? The model-based viewpoint on GIS reminds us that the representing aspects of the world with data requires choosing one type of error over others within a purpose-specific assessment of accuracy and confidence. This frame of mind provides the analyst with an operational sense of the utility of a dataset or analysis and a feel for how models and simulations may most effectively be improved.

Workshops will explore the problem of geographical problem-solving from the perspective of information management. **Technical aspects of information encoding, exchange, and organization** have been the backbone of geography since its inception in 500 BCE and into the age of the World Wide Web. Students will develop and demonstrate their capacity to participate in the culture of geography as each exercise extends their well-documented, re-usable and transferrable collection of data, map documents and models.

**Weekly Exercises:** Each course meeting will feature technical demonstrations that begin with a specific question and intention, develop a conceptual model, evaluate data-sets as proxies for elements of the model, and apply procedures to create a map or analytic model. This aspect of the course will provide students with a “How to do it” capability and a credible analytic mindset that will be practiced each week as each student investigates questions that they choose for themselves.

In keeping with the Tufts standard for weekly time-commitment per credit, students should plan on spending six hours each week working on their projects for this course. Half of each exercise is about learning how to learn software. We will practice techniques in class. Tutorials provide a narrative discussion of the methods performed in the workshop and the conceptual discussion of the interpretation of your results. Tutorials mention each step that was performed in the workshop and provide links to the ArcMap on-line help for each of the operations. Our course tutorials are not the sort that describe every single button and menu that must be tweaked. To use GIS productively in the field, this way of learning from documentation is a necessary skill.

Students should expect to have problems and plan to get started early so that you have time to ask questions and overcome obstacles. Each exercise builds on the techniques, concepts and data that has been covered and collected in previous weeks. Falling behind with projects is problematic. Each student is given leeway to be up to one week late with one assignment. After this, a half-point may be deducted for the second late assignment (one week) and a full point deducted per week for subsequent late exercises.

For the first six weekly exercises, students will develop a well-organized collection of data, metadata, and map documents designed to represent many aspects of place of their choosing anywhere within the state of Massachusetts. Each week will extend the collection to cover a specific aspect of geography, data, and cartography. Students will be challenged to frame their own questions about changes that might affect the people, things or conditions in the place of their choosing.

Each weekly exercise includes the following learning objectives:

1. Frame a decision-making question in terms that may be approached with the data-set of the week.
2. Gather data and organize it in your re-useable collection of data, metadata and map documents.
3. Understand data in terms of fitness for use in a specific decision-making context.
4. Apply principles of cartography to represent digest different sorts of data into graphical representations that will be interpreted in a predictable way by an audience.
5. Communicate your understanding of data and common pitfalls of map interpretation clearly and with credibility.

Our exclusive focus on Massachusetts in the first six weeks of the course will allow a high degree of freedom to explore different sorts of geographic phenomena and decision-making situations using the very consistent and well-documented data sources provided by the [Massachusetts Geographic Information System](#) (MassGIS).

The last three or four weeks of the course will explore how GIS is used to simulate decision-making situations. By developing concise conceptual models, aspects of a situation may be represented with data and procedures. The resulting data models may then be used to explore experimental “what-if” scenarios. We will demonstrate a few of these in class, featuring some rural, agriculturally themed situations and some urban food policy scenarios.

**Term Project:** During the first six or seven weeks of the class, students will develop a research question of their own through a literature review and search for data. If students have an interest and motivation to apply GIS in any part of the world. This term research project is their opportunity to look more deeply into how GIS has been applied in their own area of interest, and to get some first-hand experience collecting and evaluating data outside of Massachusetts. Each week we will take a little class time to discuss these broader research issues. Around week seven, students will prepare a brief review of an interesting GIS project that they have found.

Based on their independent research, students will propose a final independent project. Students are encouraged to keep these very simple and to use Massachusetts data for these projects. For the final project for the course, each student will prepare a poster for the [Tufts GIS Expo](#).

**Prerequisites:** Students must be familiar the basics of file management using the Microsoft Windows operating system and comfortable learning and using software with on-line documentation. Students will need to be able to create multiple page documents with illustrations in PDF format.

**Assignments and Submission Instructions:** A ten-point exercise is assigned each week and will be due before the next class meeting.

**Software:** Assignments will require the use of ArcGIS desktop version 10.5. This software runs on MS Windows version 7 or beyond. Students may use lab computers and may obtain a free one-year license to ArcGIS to install on their own computers.

**Backups and Lost Data:** Students are responsible for keeping their work backed up on two different pieces of media that they control. Students must be capable of restoring and revising any project document at any time before final grades have been distributed.

**Writing and Graphic Standards:** To be worthy of an excellent mark, a project should be nearly presentable in a professional setting. Clear layout and legibility are important.

**Accommodation of Disabilities:** Students with disabilities are entitled to academic accommodation appropriate to their needs within the limits of the contractual requirements for course instructors. If you require accommodations, please arrange for instructions to be sent by the Friedman School Assistant Dean for Student Affairs.

**Academic Conduct:** Each student is responsible for upholding the highest standards of academic integrity, as specified in the [Friedman School's Student Policies and Procedures Manual](#) and [Tufts University policies](#). It is the responsibility of each student to understand and comply with these standards, as violations will be sanctioned by penalties ranging from failure on an assignment and the course to dismissal from the school.

**Individual Work:** There are no group projects in this class. Each exercise and project should be the student's own work. Proper attribution is required for all data, figures and ideas used in each project.

**Office Hours and Lab Assistants:** A weekly help session will be scheduled at a time that suits the schedules of as many students as possible. Please use help sessions as a means of getting clarification on assignments and specific tasks. Students are encouraged to visit the Tufts GIS Center for help finding data. The purpose of the assignments in this course is to assess your ability to solve problems independently. Therefore, the teaching assistant and the data center personnel should not be relied on to design or perform extended analyses. One-on-one meetings with the instructor may be arranged when necessary.

**Assessment and Grading:**

All assignments will be assessed according to guidelines that are posted for each exercise. Weekly exercises are due the night before the next class date.

- Nine weekly exercises: 90 points
- Term project in 4 installments: 50 points
- Class participation: +/- 10 points

**Attendance and Participation:** Ten of the 150 total points possible in the course are for attendance and participation. Points can be gained by paying attention, asking thoughtful questions and by answering questions posed to the class. Being repeatedly absent or late, sleeping in class, or pre-occupation with your mobile phone can be a cause for losing participation points. Students are responsible for making up missed lectures and workshops by consulting with the on-line notes and instructions.

**Grading Rubric**

In keeping with the Tufts standard rubric letter grades will be assigned as follows

**Percentage Expectation**

100 – 95	Work that shows exceptional merit.
90 – 95	Work that is worthy of presentation in public, from the standpoint of credibility and graphical sophistication. Demonstrates a mastery of each critical concept and software techniques called for in the exercise check-list and readings.
85 – 90	Demonstrates the critical and technical requirements; but has problems in terms of graphical and or use of language.
80 – 85	Demonstrates most of the technical and critical requirements, but is not explained well or misses one or two elements. Constitutes a good try. Is not embarrassing.
60 – 80	Deficient. Indicates a lack of attention to the instructions, and the conceptual content covered in class or the readings. May also indicate that not enough time or advance planning was dedicated to the project.

**Spring 2018 DRAFT Course Schedule:**

**Meetings are on Wednesday Mornings in Sackler Big Lab S514 (subject to change)**

<b>Date</b>	<b>Weekly Topic</b>	<b>Exercise Due</b>	<b>Exercise Assigned</b>	<b>Term Project Topic</b>
January 24	Geography in Decision-making	Nothing Due	Evaluate Data	Introduce Term Project
January 31	Organizing Data	Evaluate Data	Organize Data <b>Research Review</b> <b>Term Project Proposal</b>	Research Review
February 7	Nuts and Bolts of Mapping	Organize Data	Nuts and Bolts of Mapping	Managing Metadata
February 14	Data Formats, RDBMS	Nuts and Bolts of Mapping	Mapping Categorical Data	Gathering base data.
February 21	Making Sense of the Census	Mapping Categorical Data	Mapping Intensive Statistics	
February 28	Introduction to Geoprocessing	Mapping Census Data	Buffer, Selection, Summary	Reproducible analytics
March 7	Raster Data & Elevation	Buffer, Selection, Summary	Mapping Terrain	Regarding context.
March 14	Mid-Term Stretch Geoprocessing Demos	Mapping Terrain	<b>Research Review (*Reminder)</b>	The Wisdom of Pilot Proposals
Spring Break				
March 28	Simple Vector Facility Allocation Demo	Nothing Due	Simple Vector Model (Facility Allocation)	
April 4	Raster Overlay Models	Simple Facility Allocation	Raster Overlay Model	
April 11	<b>Research Review Presentation</b>	<b>Research Review Document</b> Raster Overlay Model	<b>Term Project Proposal</b>	
April 18	Advanced Vector & Raster Models Demonstration	2 <sup>nd</sup> Draft Proposal	Term Project Models	
April 25	Conclusion & Poster Design	Term Project Models	Poster	
May 2	Model Hospital (by appt.)	Nothing Due	Reading Week	
May 14	No Meeting	Poster Due (25 Pts)	No Assignment	

**Text:** Lectures, workshops and exercises will be taken from the instructor's website: [www.gismanual.com](http://www.gismanual.com) . These pages are continually updated.

## Course Topics, Learning Objectives and Assignments

**Part 1:** The first half of the course focuses on organizing, mapping and evaluating typical GIS datasets. These exercises will be carried out using specific datasets chosen from MassGIS. Students will choose their own area of interest within the state to study in terms of cultural and physical context, demographics, land use and terrain.

### 1. Geography in the 21<sup>st</sup> Century: Infrastructure for Spatial Data and Metadata

- Describe a question in terms of concepts and relationships that can be instantiated with data.
- Use metadata to evaluate available datasets in terms of utility for specific purposes.
- Cite originating and issuing sources appropriately.

Exercise: Introduce yourself. Include a photo. Describe a research question. Describe a dataset that may be of interest with regard to your question. Identify a two square kilometer place in Massachusetts in which the issue you are describing makes a difference. Upload a single, multi-page PDF document to the course web site on the Tufts Canvas web platform.

Readings:

- [Spatial Models for Research and Decision Support](#)
- [Sources of Geographic Data](#)
- [Understanding Geographic Data](#)
- [MassGIS Web Site](#)

### 2. Begin a Data Collection for On-Going Geographic Research

- Plan a File System for Ongoing Research and Archiving.
- Obtain base map data.
- Create an ArcMap document.
- Back-up and restore a research archive collection of data.

Exercise: Begin your Data Collection; Create a Map; Back & Restore Up Your Collection. Turn in a zip file.

Readings:

- [Organizing Data for Re-Use](#)
- [ArcMap 101: Collecting GIS Data and Metadata](#)

### 3. Nuts and Bolts of Cartography: Geographic Referencing Systems

- Choose an appropriate map projection for a map.
- Create a three-layer graphical cartographic hierarchy.
- Create a map that frames a purposeful discussion of a place.

Exercise: Create a reference map portraying the immediate context of your study area.

Readings:

- [Fundamentals of Geographic Referencing](#)

- [Elements of Cartographic Style](#)
- [Nuts and Bolts of Mapping with ArcMap](#)

#### 4. Data Encoding and Exchange Formats, Mapping Categorical Data.

- Understand fundamental data formats.
- Use Structured Query Language (SQL) to filter tables based on complex relationships.
- Create layers and table views based on definition queries
- Use SQL to control labels

Exercise: Use queries to filter tables, create layers and control labels.

Readings:

- [Data Formats for Geography](#)
- [Relational Databases, Queries and Views](#)
- [Mapping Categorical Data](#)

#### 5. Demographic Surveys and Mapping with Quantitative Data

- Obtain census data for your study area
- Properly represent intensive and raw count statistics (parts and wholes)
- Develop credible discussions in light of the modifiable aerial unit problem

Exercise: Create demographic maps with choropleth and proportional symbol maps.

Readings:

- [About Census Data](#)
- [Mapping with Quantitative Data](#)
- [Mapping Census Data Tutorial](#)

#### 6. Intro to Geoprocessing: Scripting Relational Operations.

- Models are repeatable sequences of procedures
- [How to create models in ArcGIS](#)
- [Buffers and Spatial Selections](#)

**Exercise: Describe, and model a spatial mechanism using one or more of the techniques discussed in class.**

#### 7. Topographic Surveys & Mapping Terrain, Introduction to Rasters

- [Obtain elevation models for an area of interest.](#)
- Properly transform elevation data for graphical display
- Create maps with synthetic hill shading and contours.

Exercise: Add contours and hillshade to your area of interest map. Discuss precision of raster data.

Readings:

- [Obtaining and Transforming Elevation Data](#)
- [Topographical Surveys and Creating Elevation Data](#)

**Part 2: Modeling Spatial Mechanisms.** In this segment of the course you are welcome to define your own conceptual models and datasets. You may also choose a new study area at this time. One or more of these projects may become the subject of your term poster. Please read the brief for the term poster for guidelines.

### 8. Map Algebra & Weighted Overlay:

- Create and use raster models to represent conditions that vary as a spatially continuous function.
- Use Map Algebra to create new surfaces as functions of input surfaces.
- Appropriately apply weighted overlay techniques for site selection.

Readings:

- [Raster GIS Tutorial](#)
- [Geoprocessing in ArcGIS](#)

Exercise: Prepare a locational analysis with surfaces or weighted overlay.

Exercise: Propose model for Final Project

Readings:

- [Spatial Models for Research and Decision Support](#)
- [Sources of Geographic Data](#)
- [Understanding Geographic Data](#)
- [Tufts Data Center GIS Poster Collection](#)

Exercise: Develop a conceptual model involving spatial association (e.g. food deserts.) Instantiate your model using data of your choice. Use geoprocessing tools to create a reusable model to experiment with policy alternatives. Assess the degree of confidence in your model as a decision support tool.

Readings:

- [Evolution of Vector-Relational Database Management Systems and SQL.](#)
- [Vector-Relational Procedures in ArcMap](#)

### 9. Vector-Relational Modeling: Buffering and Overlay Techniques

- Spatial Associations
- Spatial Joins
- Overlay Techniques and Aerial Allocations
- Network Analysis

Exercise: Describe, and model a spatial mechanism using one or more of the techniques discussed in class. Use a bar chart or scatterplot to explore your model results

Readings:

- [Vector-Relational Procedures in ArcMap](#)

### 10. Raster Fundamentals: Focal, Zonal, and Interpolation Techniques

- Create Heat maps with interpolation and focal functions.
- Use zonal functions to model accessibility and exposure

Readings:

- [Raster GIS Tutorial](#) (continued)

Exercise: Raster interpolation and summary.

#### **11. Poster Design and Course conclusion**

- Organize ideas graphically using layout, fonts and color.
- Discuss the future of GIS in research and decisionmaking

Exercise: Create poster for final project and the [Tufts GIS Poster Expo](#).