



**University of North Carolina at Chapel Hill  
Department of City and Regional Planning  
PLAN 591 Advanced GIS for Urban Planners**

Fall 2019  
T 3:30 – 6:00 pm, 302 Murphey Hall

Professor: Yan Song

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No matter how large or small your community, planners, environmental scientists, public health officers, and other local analysts must deal with spatial information: addresses, land parcels and land cover, zoning, transportation networks, housing stock, neighborhoods, streams, and natural hazards. Federal, regional, state, county, and local planning agencies and private enterprises have realized the power of Geographic Information System (GIS) to identify problems, respond to them efficiently, and share the results with a variety of audience. GIS techniques provide tools to help you present and analyze spatial information.

This class covers a range of intermediate to advanced concepts of GIS and spatial analysis. The course intends to provide broad coverage of GIS topics so that students will feel comfortable with the most common functions of GIS and spatial analysis, and will also be competent in using GIS software. The class is not intended to make students into GIS coding, spatial modeling or spatial statistics experts – those interested in a GIS-based career path should continue to take a programming course in Computer Science (C++ or Java), a database course in Computer Science, and one of Geography's advanced GIS offerings.

The class time will be divided into lecture and laboratory sessions which cover both theory and practice of topics of interest. By the end of the class all students should be *very familiar* with almost all of ArcGIS's core functionalities. We will use ArcGIS 10.X, various extensions including Spatial Analyst, 3D Analyst, Geostatistical Analyst, Network Analyst, and a variety of smaller 3rd party extensions. This course also looks at how to make GIS useful to urban planners - this means that a large part of the class focuses on the tasks that urban planners will face in general.

The course is structured around a series of small assignments and two related larger projects. Attendance as well as active class discussions are required and count in the final grade.

**Grades:** Preparation of lab reflection notes for each week (8%); Project 1 (11%); Project 2 (25%); Seven Individual Assignments (each 8%) due by the beginning of next class.

**The textbook with lab instructions and additional readings are provided on Sakai every week. Lab instructions will be provided throughout the semester.** The textbook is: Y. Song, Y. Yang, and Y. Chen (forthcoming). GIS for Planners.

**Topics and Reference Readings:**

## **Week 1 (Aug 20) - Course Overview, Get Prepared and Introduction to GIS**

### Lecture:

- Course overview
- How to obtain and install ArcGIS
- Application of GIS in urban planning
- Installation of ArcGIS Desktop and Pro
- Defining GIS

### Reference Readings on GIS and Applications:

- *Chapter 1.*

*Esri. GIS Best Practices: GIS for Urban and Regional Planning.*

<https://www.esri.com/library/brochures/pdfs/gis-sols-for-urban-planning.pdf>

## **Week 2 (Aug 27) - Mapping**

### Lecture:

- Map design - Making effective thematic maps; Presenting data

### Reference Reading on Map Design:

*Esri. Introduction to Map Design.*

<https://www.esri.com/arcgis-blog/products/product/uncategorized/map-design-101/>

### Lab Session:

- Lab 1: Mapping single-family parcels in Washington County, Oregon. *Chapter 2.*
- Lab 2 (after class exercise): Online mapping. Instructions will be provided.

## **Week 3 (Sep 3) - Introduction to ArcGIS**

### Lecture:

- The basics of applied GIS – Using ArcMap, ArcCatalog and ArcToolBox
- More discussion on Map design - Map scale, Projections, Coordinate systems, and Symbols
- Making sense of Census data

### Reference Reading on GIS data:

*For more on downloading GIS data from Census, USGS, Google Earth and other sources, please see*

<https://gisgeography.com/best-free-gis-data-sources-raster-vector/>

[https://www.socialexplorer.com/product-](https://www.socialexplorer.com/product-data?gclid=EAIaIQobChMIiruBqoeO5AIVFJSzCh21YQzEEAAYASAAEgIg0vD_BwE)

[data?gclid=EAIaIQobChMIiruBqoeO5AIVFJSzCh21YQzEEAAYASAAEgIg0vD\\_BwE](https://www.usgs.gov/core-science-systems/ngp/tnm-delivery/gis-data-download)

<https://www.usgs.gov/core-science-systems/ngp/tnm-delivery/gis-data-download>

[https://github.com/CenterForSpatialResearch/gis\\_tutorials/blob/master/19\\_Importing\\_and\\_Exporting\\_GIS\\_Data\\_from\\_Google\\_Earth\\_and\\_Google\\_Maps.md](https://github.com/CenterForSpatialResearch/gis_tutorials/blob/master/19_Importing_and_Exporting_GIS_Data_from_Google_Earth_and_Google_Maps.md)

### Lab Session:

- Lab 1: Preparing GIS Data – Projection. *Chapter 2\_supplementary.*
- Lab 2: Preparing GIS Data –
  - 2-1 Creating Spatial Vector Data from Other Sources, *Chapter 3;*
  - 2-2 Georeferencing Aerial Photos, *Chapter 4;*
  - 2-3 Geocoding, *Chapter 6.*
- *Assignment 1 – Making sense of Census* assigned. *Chapter 7.*

## Week 4 (Sep 10) – Spatial Data Representation

\*\*\* *Project 1 Discussed* \*\*\*

### Lecture:

- Spatial data representations: vector, raster, and surface
- Spatial data models: shapes, coverages, geodatabases, and grids

### Lab Session:

- Lab 1: Geoprocessing, Dissolve and Buffer (Census and TAZ overlaying). *Chapter 5.*
- Lab 2: Application of Geoprocessing: Mapping job and housing balance. *Chapter 8.*

### Reference Reading on Job-housing Balance:

*Esri.* [http://proceedings.esri.com/library/userconf/proc16/papers/221\\_246.pdf](http://proceedings.esri.com/library/userconf/proc16/papers/221_246.pdf)

## Week 5 (Sep 17) – Raster and TIN models

### Lecture:

- Types of raster data; Raster data model; Raster analysis; Raster formats and Internet resources
- Application and examples of raster data model
- Surface modeling; Structure of TIN; Modeling surface feature; Surface analysis; TIN Internet resources
- Applications and examples of surface model

### Lab Session:

- Lab 1: Working with DEM data – Construction topography information. *Chapter 13.*
- Lab 2: Working with DEM data – Hydrological analysis. *Chapter 14.*
- **Assignment 2 – Computing the NDVI** assigned. *Chapter 15.*

### Reference Reading on NDVI:

- Mahesh Rao, Guoliang Fan, Johnson Thomas, Ginto Cherian, Varun Chudiwale, Muheeb Awawdeh, A web-based GIS Decision Support System for managing and planning USDA's Conservation Reserve Program (CRP), *Environmental Modelling & Software*, Volume 22, Issue 9, September 2007, Pages 1270-1280, (<http://www.sciencedirect.com/science/article/pii/S1364815206001988>)

## Week 6 (Sep 24) – ArcGIS Extensions (1) – 3D Analysis

### Lecture:

- More on Data preparation and integration; Data media conversion – digitizing; Data format conversion
- Global positioning system

### Lab Session:

- **Assignment 3 – Managing 3D data** assigned. *Chapter 12.*

### Reference Reading on 3D GIS and Planning:

- Bhattarai, Keshav, and Dennis Conway. "Urban Vulnerabilities in the Kathmandu Valley, Nepal: Visualizations of Human/Hazard Interactions." *J. Geographic Information System* 2.2 (2010): 63-84.
- Preparation of Project 1

## Week 7 (Oct 1) – ArcGIS Extensions (2) – Networks in GIS

Lecture:

- Concept of networks, Network models; Network analysis
- Important applications, utilities and transportation, using network model in GIS

Lab Session:

- **Assignment 4 – Network analysis** assigned. *Chapter 9.*

Reference Readings on Network Analyst and Applications:

- Greg Rybarczyk, Changshan Wu, Bicycle facility planning using GIS and multi-criteria decision analysis, *Applied Geography*, Volume 30, Issue 2, April 2010, Pages 282-293, (<http://www.sciencedirect.com/science/article/pii/S0143622809000502>)
- Belinda Gallardo, M. Paz Errea, and David C. Aldridge. Application of bioclimatic models coupled with network analysis for risk assessment of the killer shrimp, *Dikerogammarus villosus*, in Great Britain. *Biological Invasions*, June 2012, Volume 14, Issue 6, pp 1265-1278. (<http://link.springer.com/article/10.1007/s10530-011-0154-0#>)

**Week 8 (Oct 8) – ArcGIS Extensions (3) – Spatial Analyst**

Lecture:

- Spatial analysis

Lab Session:

- Lab 1: Spatial Analyst – Viewshed analysis. *Chapter 16.*

Reference Reading on Spatial Analyst and Applications:

- Susanna T.Y. Tong, Wenli Chen, Modeling the relationship between land use and surface water quality, *Journal of Environmental Management*, Volume 66, Issue 4, December 2002, Pages 377-393, ISSN 0301-4797, (<http://www.sciencedirect.com/science/article/pii/S0301479702905931>)

**Week 9 (Oct 15) - Presentations on Examples of GIS Planning Supporting Systems (PSS) in City Planning**

Recommended Readings:

- Brail, Richard K., & Richard E. Klosterman (Eds.). 2000. *Planning Support Systems – Integrating Geographic Information Systems, Models, and Visualization Tools*. Redlands, CA: ESRI Press.
- Lewis D. Hopkins. Planning support systems for cities and regions. *International Journal of Geographical Information Science*, Vol. 25, 2011, Issue 2. ([http://www.tandfonline.com/doi/abs/10.1080/13658810903569606?journalCode=tgis20#.Uhd\\_2STD-AV](http://www.tandfonline.com/doi/abs/10.1080/13658810903569606?journalCode=tgis20#.Uhd_2STD-AV))
- Christopher J. Pettit, Richard E. Klosterman, Marcos Nino-Ruiz, Ivo Widjaja, Patrizia Russo, Martin Tomko, Richard Sinnott, and Robert Stimson. The Online What if? Planning Support System. *Lecture Notes in Geoinformation and Cartography*, Volume 195, 2013, pp 349-362. ([http://link.springer.com/chapter/10.1007/978-3-642-37533-0\\_20](http://link.springer.com/chapter/10.1007/978-3-642-37533-0_20))

We will have four presentations. Each team will have 25 minutes (20 minutes for presentation and 5 minutes for questions and discussions).

**Week 10 (Oct 22) – Spatial Statistics**

Lecture:

- Spatial statistics

- Spatial autocorrelation; Spatial error
- Exploratory spatial data analysis

Lab Session:

- Lab 1: ArcGIS Extension Geostatistical Analyst – Air quality surface.
- **Assignment 5: Geostatistical Analyst – Temperature surface** assigned. *Chapter 17.*

Reference Reading on Spatial Statistics:

- Luc Anselin, From SpaceStat to CyberGIS: Twenty Years of Spatial Data Analysis Software. *International Regional Science Review*, April 2012, Issue 35, pp. 131-157. (<http://irx.sagepub.com/content/35/2/131.short>)
- Yan Song, Louis Merlin and Daniel Rodriguez, The Measurement of Land Use Mix: A Review and Simulation. *Computers, Environment and Urban Systems*.

**Week 11 (Oct 29) – Advanced Data Modeling, Feature and Feature Cataloguing**

Lecture:

- Progress of spatial data models
  - CAD (Computer Aided Design) data model; Georelational data model; Object-oriented data model
- Features in an object-oriented data model
- Building data models
  - Logical data model; Physical data model
- The characteristics of features; Geometry and features
- The structure of features and objects in ArcInfo 9: Subtype; Validation and domain; Relationships
- Testing spatial relationship; Topological operators
- Needs for feature cataloguing
- Understanding feature cataloguing methodology

Lab Session:

- Lab 1: Creating a geodatabase based on a logical model

Reference Reading on Geodatabase:

- Stefano Morelli, Samuele Segoni, Goffredo Manzo, Leonardo Ermini, Filippo Catani, Urban planning, flood risk and public policy: The case of the Arno River, Firenze, Italy, *Applied Geography*, Volume 34, May 2012, Pages 205-218, (<http://www.sciencedirect.com/science/article/pii/S0143622811002232>)

**Week 12 (Nov 5) – ArcGIS Pro and Applications of Big Data in Urban Analysis**

Lecture:

- Introduction of ArcGIS Pro
- Big data and applications

Lab Session:

- Lab 1: Point pattern analysis of social network data in ArcGIS Pro
- **Assignment 6 – Scraping and analyzing spatial data via APIs in R** assigned.

**Week 13 (Nov 12) – Remote Sensing**

Lecture:

- Application of remote sensing in planning, for example, land use and land cover analysis, and urban sprawl studies
- Basic concepts in satellite remote sensing

Lab Session:

- Lab 1: Working with Remote Sensing Imagery. *Chapter 11.*
- Lab 2: Estimating urban economic activities with Nighttime Images. *Chapter 10.*

Reference Reading on Remote Sensing and Applications:

- Qihao Weng, Remote sensing of impervious surfaces in the urban areas: Requirements, methods, and trends, *Remote Sensing of Environment*, Volume 117, 15 February 2012, Pages 34-49, (<http://www.sciencedirect.com/science/article/pii/S0034425711002811>)

**Week 14 (Nov 19) – Programming in GIS**

Lecture:

- ArcGIS customization
- Introducing VBA; Programming VBA in ArcGIS; VBA vs. VB
- UI Control and Macros
- Introducing ArcObjects; ArcObjects:
  - Map Components; Map Object; ArcMap Object; Map Layer; Layer Type; Layer
- Application Extension
- Review: Problem solving with ArcObjects

Lab Session:

- Lab and *Assignment 7 Model Builder and Scripting* assigned. Chapter 20.

**Week 15 (Nov 26) – Working Session on Project 2**

**Week 16 (Dec 3) –Project Presentation**

We will have four projects. Each team will have 20 minutes (15 minutes for presentation and 5 minutes for questions and discussions). Project papers are due in class (6:00 pm).

**Project Instructions:**

**Guidelines for Project 1: Planning Supporting System (PSS) or other GIS Applications in Urban Planning or related fields**

The purpose of this assignment is to discuss the application of a selected **Planning Supporting System (PSS)** in an area of interest to you (must be related to urban planning or your major academic field). You will present your findings and submit a report. Specific guideline is listed as follows.

- **Presentation:** Presentation should be prepared in a MS PowerPoint or similar format. Your discussion should at least include a general introduction of this PSS, a discussion of existing and potential applications, some screenshots (or a demo when available) of the program, and a critique of this PSS.

- **Written Report:** The format of this report is up to you - I welcome creativity. Grading will be based on the content. If you need a paper analogy to guide you, the report should be approximately equivalent to a 5-page (single space, 12 pt. font) paper.

Both the presentation and the written report should include discussion on the following points.

- General overview of one selected application/PSS
  - A Demo of general functions provided by the application/PSS: How it can be used to facilitate problem solving in urban planning or related fields
  - General data requirements
  - General outputs generated by the application/PSS
- One example of applying this PSS to perform a specific task
  - More information on the scope of the application
  - Data used
  - A discussion of contributions by the application
  - A discussion of the limitations of the application
  - Technical dimensions of this application/PSS, for example, ArcGIS functionalities involved
- A comparison of this PSS to the other ones in the field (if applicable)

### **Guidelines for Project 2: Applying GIS**

The purpose of Project 2 is for you to design a GIS project. The presentations should be prepared in MS PowerPoint or similar format. Presentations should briefly address several suggested points listed below.

- Title and objectives of the project
- Background – problem statement and justification
- Scope and characteristics of the study area
- Data acquisition and manipulation procedures: list or present as a diagram
- Methodology:
  - Describe which ArcGIS functionalities are applied to solve the problem
  - Describe what the advantages and limitations of those functionalities are
- Results and discussion:
  - Display your results in at least two cartographically pleasing maps
- Conclusions

Each team must also submit

- A PDF of a one page (you can go a little bigger than 8.5x11, but not poster sized; the absolute largest you should go is paper size A3, or about 16.5 x 11.7 in) layout to the Sakai folder under assignments called "Map Contest Submissions". Your layout should at least include the following elements:

1. Title
2. At least one map layout with accompanying legend
3. Brief explanation of the project or your research objective

4. Brief descriptions of tools/methods/techniques used
5. Brief explanation of your findings/major trends
6. Any supplemental information useful to the map reader

And of course, you should also include:

1. Compass rose
2. Scale information
3. Data Sources
4. Author/Date

### **Policy on Late or Incomplete Work**

Excessive absence from class and late assignments will not ordinarily be accepted. Grades of incomplete may be given in the event of a medical or other emergency. An application for an incomplete on any assignment, including the term project, must state the reasons for the request and propose a new deadline. A grade of F will be assigned for presentations and written assignments not completed on time.

The University's Honor Code is in effect. Please consult with the instructor if you are uncertain about your responsibilities under that code with respect to this course. It will apply particularly for written work.

### **OTHER INFORMATION: How to obtain ArcGIS for your personal computer**

You can obtain ArcGIS from UNC's Software Acquisition office.

Note that you are getting the ArcView version of the software rather than ArcInfo, which in a few cases does not include all of the tools you will need for the class (you can get around this by using lab computers for those exercises). You will, however, have access to all of the extensions. Also, the license file will expire after you are no longer a student at UNC.

1. Go to: <http://its.unc.edu/gis/arcgis/> and read the information
2. Email [software@unc.edu](mailto:software@unc.edu) and make your request for ArcGIS 10 on a CD-ROM, specify whether you need the on-campus or off-campus version.
3. Wait for their reply, then go to the Software Acquisition office to pick up the CD and installation instructions. The office is located in the basement of the Undergraduate Library (go to the end of the hall and turn right, it's a separate office from the rest of the IT department).

### **OTHER INFORMATION: Taking ESRI Virtual Campus Courses**

Virtual Campus is ESRI's on-line training center. Virtual Campus offers many training courses centered on learning GIS and using ESRI's GIS software packages, which you may want to take to supplement or expand on your GIS experience from this course. For more information, explore the Virtual Campus:



<http://campus.esri.com>

While the majority of the courses have an enrollment fee (typically \$100), creating a member account is free, and there are several intro modules that can be taken free of charge. As part of the University Site License program, ESRI allows UNC unlimited access to seats at the ESRI Virtual Campus. This does not, however, apply to every course offered at the virtual campus. To see which courses are available free and how you can take them, see:

[http://its.unc.edu/gis/virtual\\_campus/](http://its.unc.edu/gis/virtual_campus/)

## **OTHER INFORMATION: GIS LINKS**

- **National Spatial Data Infrastructure (NSDI)**

<http://www.fgdc.gov>

<http://nsdi.usgs.gov/>

<http://fgdclearhs.er.usgs.gov/> (FGDC Clearinghouse Referral Server)

<http://www.its.nbs.gov/nbs/meta/meta.html> (Metadata Standard)

<http://www.fgdc.gov/framework/overview.html> (NSDI Framework Initiative)

- **Databases - National**

<http://www.census.gov/geo/www/tiger/>

<ftp://ftp.census.gov/pub/tiger/boundary/>

<http://www.wessex.com/>

<http://www.etak.com/>

- **Digital Line Graph (DLG)**

<http://edcwww.cr.usgs.gov/nsdi/gendlg.htm>

- **Digital Elevation Model (DEM)**

<http://edcwww.cr.usgs.gov/nsdi/gendem.htm>

- **Digital Orthophoto Quads (DOQ); Digital aerial photography - rectified**

<http://nsdi.usgs.gov/nsdi/products/doq.html>

<http://mapping.usgs.gov/www/ti/DOQ/doqta.html>

<http://ortho.mit.edu>

- **Digital Raster Graphics (DRG); Digital 7.5 minute maps**

<http://mapping.usgs.gov/nsdi/html/drg.html>

- **Land Use/Land Cover - Bureau of Land Management**

<http://edcwww.cr.usgs.gov/nsdi/digital2.htm>

<http://www.coresw.com/Databases/> (ImageNet Remote Sensing Data Info)

<http://www.gislinx.com>

<http://www.esri.com/base/data/catalog/abk/abksam1.html> (New Hampshire)  
<http://plue.sedac.ciesin.org/plue/ddcarto> (Census data in ArcInfo, MapInfo and Atlas GIS format)  
<http://www.cast.uark.edu/local/hunt/index.html> (US Geospatial Data and Attributes)  
[http://www.epa.gov/docs/grd/forest\\_inventory/](http://www.epa.gov/docs/grd/forest_inventory/) (Forest Land Distribution Data from EPA)  
<http://www.lib.virginia.edu/socsci/collections.html> (University of Virginia Social Science Data Center)  
<http://www.ispa.fsu.edu/labins.html> (Land Boundary Information System)  
<http://nsdi.usgs.gov/nsdi/> (US government data)  
<http://edcwww.cr.usgs.gov/webglis> (USGS Global Land Information System)

- **Data - International**

<http://edcwww.cr.usgs.gov/webglis> (USGS Global Land Information System)  
<http://ilm425.nlh.no/gis/dcw/dcw.html> (Digital Chart of the World and Data Quality Project)  
<http://www.grida.no/prog/global/cgiar/htmls/data.htm> (UNEP/GRID - CGIAR Cooperation - Datasets)  
<http://www.gcdis.usgcrp.gov/> (Global Change Data and Information System)  
[http://res.agr.ca/CANSIS/\\_overview.html](http://res.agr.ca/CANSIS/_overview.html) (Canadian Soil Information System)  
<http://www.grida.no/prog/polar/aedea/> (Arctic Environmental Database for Europe and Asia)  
<http://ssda.anu.edu.au/ssda/about-ssda-holdings.html> (Social Science Data Archives - Australia)  
<http://www.lib.berkeley.edu/ENVI/cityintl.html#data> (International Data and Statistics Sources)  
<http://ellesmere.ccm.emr.ca/naismap/naismap.html> (National Map Atlas Information Service - Canada)