Welcome to GEOG 176A:
Introduction to Geographic Information Systems
Instructor and TA

- **Instructor: Rui Zhu**
  - Email: ruizhu@geog.ucsb.edu
  - Office hours: Wednesday 1:40 pm – 3:40 pm @ Ellison 4839

- **TA: Behzad Vahedi**
  - Email: behzad@geog.ucsb.edu
  - Office hours: Tuesday 5:00 pm – 7:00 pm @ Ellison 5704
Who am I?  http://www.geog.ucsb.edu/~zhu/

Education:

2014-Now: Ph.D. Candidate in GIScience, Department of Geography, UC Santa Barbara, USA

2012-2014: M.S. in Information Science, School of Information Sciences, University of Pittsburgh, USA

2008-2012: B.A. in Information Systems and Management, Shanxi University of Finance and Economics, China

Research Interests:

Spatial Statistics / Geostatistics, Geospatial Semantics, Machine Learning, Navigation Services...
Course information:

- **Textbook:**

- **Lectures:**
  - MTWR: 12:30 pm - 1:35 pm, Ellison 3621

- **Labs:**
  - T: 2:00 pm - 4:50 pm, Ellison: 3620

- **Course Material:**
  - Gauchospace https://gauchospace.ucsb.edu
Textbooks reserved at the library

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Grades:

- Your total score will be weighted as:
  - Mid-term Examination: 25% (08/21)
  - Final Examination: 30% (09/13)
  - Lab Assignments: 40% (7% for lab1-lab5, 5% for lab6)
  - In-class activities, participations, and attendance: 5%

- Zero tolerance on copy or plagiarism! We take serious about this!
Overview of GEOG 176 series

- **GEOG 176A - Introduction to Geographic Information Systems**
  - An introductory level GIS course; provide an overview of GIS concepts and hands-on experience on basic GIS functions.

- **GEOG 176B - Technical Issues in GIS**
  - Discusses more advanced topics in GIS, such as spatial modeling, spatial simulation and spatial analysis.

- **GEOG 176C - GIS Design and Applications**
  - A capstone course for GEOG 176. Students are required to apply what they have learned in A and B to solve practical geospatial problems in the real world.
What you will learn in this 176A class?

- An overview of GIS
- Be comfortable working with ArcGIS and Google Earth softwares
- Understand fundamental concepts and data models about GIS
- Know where and how to find/obtain GIS data
- Gain the abilities to process, store, analyze and visualize GIS data
- Be able to evaluate the pros and cons of GIS
- Have experience of solving practical GIS problems
Components of this class

- Introduction: What is GIS (2 lectures)
- GIS Roots in Cartography (2 lectures)
- Geographic Data Models (4 lectures)
- Geographic Database Management (1 lecture)
- Spatial Analysis (6 lectures)
- GIS Systems (2 lectures)
- GIS Application and the Future (3 lectures)
How to learn?

● Attend lectures and lab sessions
● Read textbooks and related materials
● Conduct lab assignments
Access to ArcGIS software:

● Lab computers
  ○ ArcGIS, and other relevant softwares, are already installed in the lab (Ellison 3620). So please attend the lab sessions!

● On your own machine
  ○ All ucsb students are eligible for a free one year trial version of ArcGIS.
  ○ You have to have a windows PC, with at least 4GB RAM.
  ○ Check http://www.library.ucsb.edu/mil/esri for details

● Other resource
  ○ Labs at Ellison Hall
  ○ UCSB Collaborate Labs (http://labschedule.collaborate.ucsb.edu/)
  ○ The Collaborate (Library) has several Windows PCs with ArcGIS and Google Earth installed
GEOG 176A: Introduction to Geographic Information Systems

Lecture 01: What is GIS?

Rui Zhu
What is a GIS?

Geographic Information Systems (GIS)

GISs are simultaneously the telescope, the microscope, the computer, and the Xerox machine of **regional analysis and synthesis** of spatial data. (Ron Abler, 1988)

- Acquisition
- Management
- Retrieval
- Analysis
- Visualization
Where did GIS come from?

- Backgrounds in Geography, Cartography, Computer Science, Statistics, and Mathematics
- Fusion of information systems and imaging/positioning technologies
- Geographic Information Science is a new interdisciplinary field built out of the use and theory of GIS → SpatialCenter @ UCSB
Defining GIS

- Different definitions of a GIS have evolved in different areas and disciplines.
- All GIS definitions recognize that spatial data are unique because they are linked to maps; and the way of dealing with spatial data is special!
- A GIS at least consists of a database, map information, and a computer-based link between them.

What is the "link" here?
Spatial data -- Geographic Primitive

\[ G = f(x, y, z, t, F) \]
## Spatial vs Non-Spatial Data

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<th>Quantity</th>
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<td>Tire</td>
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### Crimes during 2003

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<tr>
<td>22-Jan</td>
<td>123 James St.</td>
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<tr>
<td>24-Jan</td>
<td>22 Smith St.</td>
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<tr>
<td>10-Feb</td>
<td>9 Elm St. #4A</td>
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<tr>
<td>13-Feb</td>
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<td>Breaking and Entering</td>
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<tr>
<td>14-Feb</td>
<td>17 Del Playa</td>
<td>Drunk and Disorderly</td>
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Definition 1: A GIS is a toolbox

"a powerful set of tools for storing and retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes"

-------- Burrough, 1986, p.6 (from functional perspective)

"automated systems for the capture, storage, retrieval, analysis, and display of spatial data"

-------- Clark, 1995, p.13 (from process perspective)
GIS as toolbox

- General or Specific
- Cutting or Joining
- Complex or Simple
- Cheap or Expensive

Input  ➔  Output

Transformation
Definition 2: A GIS is an information system

"An information system that is designed to work with data referenced by spatial or geographic coordinates. In other words, a GIS is both a database system with specific capabilities for spatially-referenced data, as well as a set of operations for working with the data"

-------- Star and Estes, 1990, p.2
GIS as information system
Map storage: Layers and themes
Dueker's 1979 definition (p.106)

"A geographic information system is a special case of information systems where the database consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines, or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data for ad hoc queries and analysis."

The Feature Model

<table>
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<tr>
<th>FEATURES</th>
<th>POINT</th>
<th>LINE</th>
<th>AREA</th>
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<tr>
<td></td>
<td>Goleta Point</td>
<td>CAMINO</td>
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- **Human’s role**: “activities” link to geographic patterns and distributions. Activities link to features. → e.g., migration
- **Time**: “event” part of GIS implies space and time. → e.g., car accident

*Figure 1.2 The Feature Model: Examples of a point feature (38 foot elevation bench mark), a line feature (road, contours) and area features (reservoir, vegetation).*
Definition 3: GIS is an approach to science

- Geographic Information Science is the research both on and with GIS.

“The generic issues that surround the use of GIS technology, impede its successful implementation, or emerge from an understanding of its potential capabilities.”

-------- Goodchild, 1992
Definition 4: GIS is a multi-billion dollar business

“The growth of GIS has been a marketing phenomenon of amazing breadth and depth and will remain so for many years to come. Clearly, GIS will integrate its way into our everyday life to such an extent that it will soon be impossible to imagine how we functioned before.”

Dangermond and Esri

- 10 regional offices;
- 80+ international distributors;
- A million users in 200 countries;
- 38000 employees globally;
- $1.1 Billion annual revenues in 2016
Other GIS related companies

MapBox

SuperMap

OpenStreetMap

QGIS

PostGIS

Google

Google Earth

Apple

here

lyft
Definition 5: GIS in society

“(GIS is an) organized activity by which people measure and represent geographic phenomena, and then transform these representations into other forms while interacting with social structures.”

-------- Nick Chrisman (1999)
A Brief History of GIS - BC (Before Computer)

- GIS’s origins lie in thematic cartography
- Many planners used the method of map overlay using manual techniques
- Manual map overlay described comprehensively by Tyrwhitt in a 1950 planning textbook
- McHarg used transparent overlays for site selection in Design with Nature
A Brief History of GIS - AT (After Tomlinson)

- Early systems (examples) were CGIS and MLMIS
- Early influential data sets were the World Data Bank and the GBF/DIME files
- The Harvard University ODYSSEY system was influential due to its topological arc-node (vector) data structure

Tomlinson 1967 Video about CGIS
Other key innovations to push GIS into the mainstream

IBM-PC 1982

ArcView 1.0 1994

Canada GIS 1967

SAGE 1963
GIS community - Journals

- International Journal of Geographic Information Science
- Cartography and Geographic Information Science
- Transactions in GIS
- Geoinformatica
- ...
GIS community - Conferences

- Esri’s User Conference
- International Conference on Geographic Information Science
- International Conference on Geo-information Science
- ACM International Conference on Advances in Geographic Information Systems
- International Conference on Spatial Information Theory
- Annual Meeting of American Association of Geography
- ....
GIS community - Organizations

- AAG: Association of American Geographers (www.aag.org)
- ACM: Association for Computing Machinery SIG-SPATIAL/GIS (www.sigspatial.org)
- CAGIS: Cartography and Geographic Information Society (www.cartogis.org)
- AGILE: Association of Geographic Information Laboratories in Europe (www.agile-online.org)
- CPGIS: Chinese Professionals in Geographic Information Sciences (www.cpgis.org)
- ASPRS: American Society for Photogrammetry and Remote Sensing (www.asprs.org)
- NACIS: North American Cartographic Information Society (www.nacis.org)
- ...
GIS community - Web resources

Data:
- OpenTopography ([www.opentopo.sdsc.edu](http://www.opentopo.sdsc.edu))
- US Census ([www.census.gov](http://www.census.gov))
- OpenStreetMap ([www.wiki.openstreetmap.org](http://www.wiki.openstreetmap.org))
- ...

GIS Blogs/Forums/Q&A
- StackExchange-GIS ([www.gis.stackexchange.com](http://www.gis.stackexchange.com))
- GISGeography ([www.gisgeography.com](http://www.gisgeography.com))
- GISLounge ([www.gislounge.com](http://www.gislounge.com))
- ...
GIS community - Job markets
GIS job category

www.directionsmag.com/article/1143

In an effort to understand distinctions and requirements of GIS jobs, Jung Eun (Jessie) Hong, an assistant professor in the Department of Geosciences at the University of West Georgia, recently completed a content analysis of GIS job advertisements. She compiled almost 1000 GIS job postings, spanning 2007 – 2014, from GIScareers.com, GISjobs.com and the GIS Jobs Clearinghouse. The titles of the jobs were used to sort the positions into five different job categories:

- Analysts (27.4% of job postings)
- Programmers/developers/engineers (29.8%)
- Specialists (14.0%)
- Technicians (11.2%)
- Other (17.7%).
GIS job skills

Then, individual skills specified in each ad — such as data mining, web mapping, programming or project management, for example — were all coded into four technical areas:

- Analysis/modeling
- Cartography/visualization
- Data processing/management
- Software/application development

and three general skill areas:

- Analytical
- Management
- Personal/social
Summary

GIS is an emerging technical and scientific filed. It changes people’s life everyday. GIS is everywhere!

A Map for every story. But GIS is even more beyond maps!