What Is GIS?

What are the applications of GIS?

How is the real world represented in a GIS?

What kinds of analyses can be performed with a GIS?
This Is A Class About Maps

What do Maps Provide?

- Where (absolute, relative)
  - Navigation, Location, etc.

- What (absolute, relative)
  - I.e. Map legend information – codification of objects, properties and fields of information

- Spatial relationships, arrangements – combinations of where and what, networks of interconnections (e.g. rivers, routes)
GIS = Geographic Information System(s)

- Computerized management & analysis of geographic information
- Group of tools (and people) for collection, management, storage, analysis, display and distribution of spatial data & information
- Computer-based tool for mapping and analyzing things that exist and events that happen
GIS is to Geographic Analysis as:

- Typewriter → Word Processor
  Automation, Editing
- Pen & Ink Drafting → Computer Automated Drafting (CAD)
  Storage, Editing
- Almanacs → Climate Models
  Prediction, Analysis
- Light Table → G.I.S.
  Map Overlay Analysis, Pattern Recognition
Historical Development – GIS timeline

- **1963-1977 Innovation**

- **1981-1999 Commercialization**
  - ESRI/ArcInfo, GPS, MapInfo, TIGER, NSDI, MapQuest

- **2000-present Exploitation**
  - >$10 billion industry, >10 million users
Components of a GIS

- Network
- People
  - ~250,000 professionals in US, 2010
- Hardware
- Software
  - ~ $1 billion annual sales in 2000
- Data
  - >$4 billion/yr by gov. agencies
Demand for GIS Professionals

- In the U.S. in 2014:
  - ~500,000 using GIS as part of job; growing at 15% each year.
  - Job market demand is ~75,000/year
  - ~50,000 US students/year take a GIS class
  - 4000 “certified” graduates/year

GIS for Austin Geology – ArcGIS software
A GIS is Composed of Layers

Geology  D.E.M.  Hydro.  Roads
Layers contain Features or Surfaces

Features are geographic objects represented by a point, line or polygon

- Polygons (filled or unfilled) for things large enough to have boundaries
- Lines for things too narrow to be polygons
- Points for things too small to be polygons
Layers contain Features or Surfaces

- Surface composed of matrix of square cells, each containing a value for its location, e.g. elevation.
Features Have Locations

- Coordinate Systems can be orthogonal or “warped” (projected)
- GIS software transforms coordinates from one projection to another

Austin

Origin (0, 0)

X axis

Y axis

X = -5,551,222 m
Y = 3,300,200 m
Features can be displayed at different scales

Zooming, scaling, variable detail rendering
Features are linked to information

- Every Feature (e.g. road) has several Attributes (e.g. name, length) in an Attribute Table.
Spatial relationships can be queried

- What crosses what?
- Proximity – What is within a certain distance of what?
- Containment - What’s inside of what?
- Which features share common attributes?
- Many others
Applications – a short list

- What is where?
  - Query and info. retrieval – e.g. MapQuest, Google Maps
- What geographic patterns exist?
  - E.g. Geostatistics; e.g. prediction of ore grades from limited data
- Where have temporal changes occurred?
  - E.g. LULC change, water table levels, morphologic studies
- Where do certain conditions apply?
  - E.g. suitability analyses – “where is the best place for...”
- “What if” forward modeling; what are spatial implications for certain actions?
  - E.g. strip mining reclamation
The Five M’s

- Mapping
  - Accuracy, Reproducibility, Portability, Customization
- Measuring
  - Automation, Accuracy
- Modeling
  - Scaling, Verifiability, Analytical Tools
- Monitoring
  - Automation, Flexibility
- Management
  - Storage, Updating, Data Integrity, Security
GIS Advantages:

- Manage & organize vast amounts of geospatial data
  - Rapid updating, info. dispersal
- VERIFIABLE methods
- Modeling, hypothesis-testing, PREDICTION
- Automate & customize map production
GIS Drawbacks

- Errors play significant role in queried results – not always apparent
- Abstract concepts difficult to implement – different approaches may yield different answers
- Pretty pictures can obscure uncertainties – promotes uncritical thinking, black-box approach
ESRI - Scalable Product Lines

"Personal" GIS

"Departmental GIS"

"Enterprise" GIS

Desktop Software

ArcInfo

ArcEditor

ArcView

ArcSDE

ArcGIS Server

Server Software

ArcPad

ArcExplorer

Java Viewer

HTML Viewer

Data storage

Multi-user

Single user

Data files

Personal GIS

"Personal" GIS

Workgroup and "Departmental GIS"

Enterprise GIS

"Enterprise" GIS
ArcGIS Desktop

PRODUCTS (Licensing Levels)

ArcView

ArcEditor

ArcInfo

DATA SOURCES

Files

Databases

ArcIMS Services
ArcGIS Licensing Levels

- ArcView – Make maps, do queries, some spatial analysis, some editing (shapefiles, personal geodatabases) – included with GTK ArcGIS Desktop
- ArcEditor – plus edit multi-user geodatabases; more tools in toolbox
- ArcInfo – full functionality; comes with ArcInfo Workstation (i.e. legacy version ArcInfo v. 7). UT D.G.S. licenses.
- Current ArcGIS = v. 10.5
Licensing and “Floating Seats”

This Lab (30+ floating seats)

Limits use to number of floating licenses

License Manager

License file with keycodes

(CNS Server)
# ArcGIS Extensions

<table>
<thead>
<tr>
<th>ArcGIS Extension</th>
<th>ArcView, ArcEditor, and ArcInfo</th>
<th>ArcInfo only</th>
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<tbody>
<tr>
<td>ArcGIS Spatial Analyst</td>
<td>• Advanced raster modeling&lt;br&gt;• ARC GRID calculator with ARC GRID algebra&lt;br&gt;• VBA for raster analysis</td>
<td>• ARC GRID program in ArcInfo Workstation&lt;br&gt;• ARC GRID commands in Arc program</td>
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<tr>
<td>ArcGIS 3D Analyst</td>
<td>• ArcScene™—real-time interactive three-dimensional scenes&lt;br&gt;• Scene views in ArcCatalog&lt;br&gt;• Three-dimensional modeling tools&lt;br&gt;• ARC TIN tools</td>
<td>• ARC TIN™ commands in Arc program&lt;br&gt;• Surfacescene command</td>
</tr>
<tr>
<td>Geostatistical Analyst</td>
<td>• Advanced kriging and surface modeling&lt;br&gt;• Exploratory spatial data analysis tools&lt;br&gt;• Probability, threshold, and error mapping</td>
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Online GIS – e.g. Google Earth
Online GIS – Google Maps