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 Largely 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

- Growing Field With Strong Prospects

In the US:

- ~500,000 using GIS as part of job; growing at 15% each year
- ~50,000 US students/year take a GIS class
- 2017 average salary $71K; range $54-138K
- Global market worth $17.5B by 2023?

“There will always be a high demand for those with critical and spatial thinking skills”
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 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, slope, aspect, em. spectral proxy

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Features Have Locations

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

Origin (0, 0)

Austin

X = -5,551,222 m
Y = 3,300,200 m

X axis

Y axis
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. Bing, Google Maps

- What geographic patterns exist?
  - E.g. Geostatistics; e.g. prediction of ore grades, groundwater depth from limited data

- Where have temporal changes occurred?
  - E.g. Land use, land cover 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, retrieval
- VERIFIABLE methods
- Modeling, hypothesis-testing, PREDICTION
- Automate & customize map production
GIS Drawbacks

- Errors play significant role in queried results – not always apparent – uncertainties not commonly specified
- 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

Server Software
ArcInfo
ArcEditor
ArcView
ArcSDE
ArcIMS

Data storage
Multiuser geodatabase

J.S.G.
ArcGIS Desktop Licensing Levels

- ArcView ("Basic") – Make maps, do queries, some spatial analysis, some editing (shapefiles, personal geodatabases) – included with GTK ArcGIS Desktop

- ArcEditor ("Standard") – plus edit multi-user geodatabases; more tools in toolbox

- ArcInfo ("Advanced") – full functionality; comes with ArcInfo Workstation (i.e. legacy version ArcInfo v. 7). UT D.G.S. licenses.

- Current ArcGIS Desktop = v. 10.7 (April 2019)
  - ArcGIS Pro: Separate, latest, parallel package, c. 2015, to replace Desktop by ??
Licensing and “Floating Seats”

This Lab (30+ floating seats)

Limits use to number of floating licenses

ArcView (single-use) seat
Floating seat
Floating seat
ArcView (single-use) seat
Floating seat

Network

License Manager

License file with keycodes

(CNS Server)
## ArcGIS Extensions

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