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

- 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
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, etc. spectral proxy
Features Have Locations

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

Austin

Origin (0, 0)

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. 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

Multi-user

Single user

J.G.S

Desktop Software

ArcInfo
ArcEditor
ArcView

Server Software

ArcInfo
ArcEditor
ArcView
ArcSDE
ArcIMS

Data storage

Multiuser geodatabase

Personal GIS
“Personal” GIS

Workgroup and
“Departmental GIS”

Enterprise GIS
“Enterprise” GIS

Data files
ArcGIS Desktop

DATA SOURCES
- Files
- Databases
- ArcIMS Services

PRODUCTS (Licensing Levels)
- ArcView
- ArcEditor
- ArcInfo
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)

Network

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

Limits use to number of floating licenses

License Manager

(CNS Server)

License file with keycodes
# ArcGIS Extensions

<table>
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<th>ArcGIS Spatial Analyst</th>
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Online GIS – e.g. Google Earth
Online GIS – Google Maps