What is GIS?

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
- Others, e.g. Bolstad

GIS is to geographic analysis as:

- Typewriter → Word Processor
  Automation, Editing
- Pen & Ink Drafting → C.A.D.
  Storage, Editing
- Almanacs → Climate Models
  Prediction, Analysis
- Light Table → G.I.S.
  Map Overlay Analysis, Pattern Recognition

Key Questions and Issues

- What is GIS?
- What are the applications of GIS?
- How is the real world represented in GIS?
- What analyses can GIS perform?
What is GIS?

Historical Development – GIS timeline

- **1963-1977 Innovation**

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

- **2000-present Exploitation**
  - >$7 billion industry, >1 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 2012:
  - ~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

Layers contain Features or Surfaces

Features have locations

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

Features have locations

Coordinate Systems can be orthogonal or "warped" (projected)

GIS software transforms coordinates from one projection to another

Layers contain Features or Surfaces

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

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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
- 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
What is GIS?

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

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
What is GIS?

ArcGIS Desktop Levels

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. 10.2

ArcGIS Extensions

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<td><strong>ArcGIS Spatial Analyst</strong></td>
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<tr>
<td>• Advanced raster modeling</td>
<td>• ArcGIS program in ArcInfo</td>
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<td>• ARC GRID calculator with ARC GRID algebra</td>
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Online GIS – e.g. Google Earth

Online GIS – Google Maps