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
- 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 performed?
**What is GIS?**

**Historical Development – GIS timeline**

- **1963-1977 Innovation**
  - Canadian Land Inventory system, Harvard Graphics & S.A. Lab, US Census Bureau, ERTS-1 (Landsat 1)

- **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**
What is GIS?

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

Features have locations

- Origin (0, 0)

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

- X axis
- Y axis
Features can be displayed at different scales

1: 40,000
1: 150,000

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?

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
What is GIS?

ArcGIS Desktop 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 Licensing Levels

- Licensing and “Floating Seats”
  - This Lab (20 floating seats)
  - License Manager (CNS Server)
  - Limits use to number of floating licenses

ArcGIS Extensions

- **ArcView, ArcEditor, and ArcInfo**
  - Advanced raster modeling
  - Arc GRD calculator with ARC GRD algebra
  - VBA for raster analysis
- **ArcGIS Spatial Analyst**
  - ArcScene™ real-time interactive three-dimensional scenes
  - Scene views in ArcCatalog
  - Three-dimensional modeling tools
  - ARC TIN tools
- **ArcGIS 3D Analyst**
  - ArcScene™ real-time interactive three-dimensional scenes
  - Scene views in ArcCatalog
  - Three-dimensional modeling tools
  - ARC TIN tools
- **Geostatistical Analyst**
  - Advanced kriging and surface modeling
  - Exploratory spatial data analysis tools
  - Probability, kriging, and error mapping

- **ArcInfo only**
  - ARC GRID program in ArcInfo Workstation
  - ARC GRID commands in Arc program
  - ARC TIN™ commands in Arc program
  - Surfer commands
What is GIS?

Online GIS – e.g. Google Earth

Online GIS – Google Maps