Introduction to the 176A labs and ArcGIS

Purpose of the labs

• Hands-on experience with one software package
• Introduction to issues and problems of software use
• Reinforce lecture topics
• Learn more about theory by practice
• Means to assess student achievement
Introduction to ArcGIS

- *How data are stored in ArcGIS*
- Components of ArcGIS – ArcMap, ArcCatalog and ArcToolbox
- Extensions of ArcGIS – spatial analyst, geostatistical analyst and 3D analyst

ArcTools

ArcMap

ArcCatalog
Arc Map
- View and edit data
- Create maps
- Analyze data (Geoprocessing)

Arc Catalog
- View data (like Windows Explorer)
- Graphical previews
- Tables
- Metadata
Arc Toolbox

Arc Toolbox for ArcView and ArcEditor contains over 20 commonly used tools for data conversion and management.

Map Projections

Tools for commonly used tasks

Arc Globe

Arc Globe
Using ArcCatalog

ESRI GIS History

**Arc/Info** (coverage model)
- Versions 1-7 from 1980 – 1999
- Arc Macro Language (AML)

**ArcView** (shapefile model)
- Versions 1-3 from 1994 – 1999
- Avenue scripting language

**ArcGIS** (geodatabase model)
- Version 8.0, …, 9.1 from 2000 – Visual Basic for Applications

160,000 licenses
1,200,000 users as of 2004
Geographic Data Models

All geographic information systems are built using formal models that describe how things are located in space. A formal model is an abstract and well-defined system of concepts. A geographic data model defines the vocabulary for describing and reasoning about the things that are located on the earth. Geographic data models serve as the foundation on which all geographic information systems are built.

Scott Morehouse, Preface to “Modeling our World”

Data Models

• A geographic data model is a structure for organizing geospatial data so that it can be easily stored and retrieved.
File-based Data Models

- **Coverages**
  - Developed for workstation Arc/Info ~ 1980
  - Complex structure, proprietary format
  - Attributes in Info tables
  - .e00 export format still common

- **Shapefiles**
  - Developed for ArcView ~ 1993
  - Simpler structure in public domain
  - Attributes in dBase (.dbf) tables

Geographic coordinates and attributes are stored in separate but linked files

Storing Data

**Coverages**
- California
  - Counties
  - Census
  - Info

**Shapefiles**
- California
  - Counties.shp
  - Counties.shx
  - Counties.dbf
  - Tracts.shp
  - Tracts.shx
  - Tracts.dbf
Storing Data

- **Coverages and Shapefiles**
  - Coverages are stored partially in their own folder and partially in the common INFO folder. Shapefiles are stored in three to five files (with extensions .shp, .shx, .dbf, .sbx and .sbn).
  - Coverages store common boundaries between polygons only once, to avoid redundancy. Shapefiles store all the geometry of each polygon regardless of redundancy.
  - Coverage features are single lines or single polygons. Shapefiles allow features to have multiple, disconnected, intersecting and overlapping components.

Geodatabases and Feature Datasets

- A **geodatabase** is a relational database that stores geographic information.
- A **feature dataset** is a collection of feature classes that share the same spatial reference frame.
Geodatabase model

- Stores geographic coordinates as one attribute (shape) in a relational database table
- Uses MS Access for “Personal Geodatabase” (single user)
- Uses Oracle, SQL/Server, dB2 or other commercial relational databases for “Enterprise Geodatabases” (many simultaneous users)

ArcGIS Geodatabase
Object Class

• An **object class** is a collection of **objects** in **tabular format** that have the same behavior and the same attributes.

An object class is a table that has a unique identifier (ObjectID) for each record.

Feature Class

• A **feature class** is a collection of **geographic objects** in **tabular format** that have the same behavior and the same attributes.

Feature Class = Object class + spatial coordinates
Relationship

• A relationship is an association or link between two objects in a database.
• A relationship can exist between spatial objects (features in feature classes), non-spatial objects (objects in object classes), or between spatial and non-spatial objects.
Relationship

Relationship between spatial and non-spatial objects

Water quality data (non-spatial)

Measurement station (spatial)

Network

- A **network** is a set of edges (lines) and junctions (points) that are topologically connected to each other.
- Each **edge** knows which junctions are at its endpoints
- Each **junction** knows which edges it connects to
Licenses and Keycodes

License manager keeps track of number of simultaneous users and limits them to allowable number. Licenses are checked out on a first come-first-serve basis.

ArcGIS Extensions

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Spatial Analyst

- Analysis of land surface terrain as a grid
- Key means of defining drainage areas and connectivity to stream network

Grid Datasets

- Cellular-based data structure composed of *square cells of equal size* arranged in rows and columns.
- The grid cell size and extension (number of rows and columns), as well as the value at each cell have to be stored as part of the grid definition.
Grid Datasets

- Grid datasets

Geostatistical Analyst

- Interpolation of points to a grid using statistical correlation
- Produces a standard error of estimate of each map location

Biomass in the Arctic Ocean
Image Datasets

- Digital Orthophotos and satellite imagery

- Image datasets

3-D Analyst

- Analysis of land surface terrain as triangulated irregular network (TIN)
- Visualization in 3-D using Arc Scene

Stream channel of Pecan Bayou, TX
TIN Datasets

- TIN datasets

Points and breaklines from which a TIN is constructed

- Triangle sides are constructed by connecting adjacent points so that the minimum angle of each triangle is maximized. Triangle sides cannot cross breaklines.

- The TIN format is efficient to store data because the resolution adjusts to the parameter spatial variability.
Tracking Analyst

Produces animated maps and display files for space-time data

ESRI Software/Reference