An Introduction to GIS using ArcGIS
Spring Lab Workshop
5 March 2013

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Agenda

- What is GIS?
- Basic GIS Concepts
- Introduction to ArcGIS
- Coordinates & Projections

- GIS Analysis
- Thematic maps
- Exporting GIS data/analysis to a dataset

- Back and forth between GIS concepts and ArcGIS
Data

• Login to the lab computer
• Navigate to the I: drive
• **Copy** the folder titled ‘ArcGIS_Workshop_sp13’ to your Desktop

• *Please do not use the files in the I: drive*
What is GIS?

- Geographic Information System
- Goal: Display geographic information on a map

Example: Population of continental United States (between the ages 30-34)
Information - Features

- Real world objects on a map
- Airports
- Railroads
- Counties
Information - Attributes

- Describe the features in a GIS
- County name
- County size
- County vote share
System

- Database that links features & attributes
- Draw (pretty!) maps
- Edit & analyze geographic data
GIS Functions

- Visualization
  - Display maps (paper & computer)
  - Color or grey-scale
- Database
  - Import geographic data
  - Convert data to information
- Analyze
  - Find areas of the map based on different criterion
GIS Concepts

- Features
- Layers
- Scales
Features

- Shape
- Location
- Symbol
- Attribute

Information to describe features:

- Shape
- Color
- Name
- Latitude
- Capital
- Pattern
- Longitude
- Polygon
- All of the above
Layers

- Collection of features
- Features have
  - Same shape
  - Same attributes
- Example
  - US Population
  - Airports
- View different layers in a single map
Scale

- Size of feature vs Size in the real world
  - 1 : 12,000
  - 1 inch : 5 miles

- Zoom in/out to see more/less information
Data Storage Types

- Vector
- Raster
Vector Data

- Shapes & Coordinates
  - Points
    - One pair of coordinates (e.g., cities, airports)
  - Lines
    - Two or more coordinates (e.g., rivers, roads)
  - Polygons
    - Three or more coordinates & closed (e.g., states)
Raster Data

- Continuous Data
- Cells to store data
  - Cells have same size
  - Measurement like quantity
  - Code for category

- Every raster has an origin
- All cells have a unique position wrt to this origin
GeoDatabase

- GIS data stored in a database
  - “Collection of geographic data sets, real-world object definitions, and relationships”
  - Feature class – digital collection of features with the same shape & attributes

- Layers are the visual representation of a feature class

- Table to store feature geometry
  - Row – feature
  - Column – attribute

- Can be used to store both vector and raster data
Illustration:

- Point (landmark, tree, etc.)
- Line (street, river, stream, etc.)
- Polygon (land parcels, buildings, etc.)
- Topography (terrain, contours, etc.)
- Raster Image (satellite imagery, historic photos, etc.)
- Integrated representation and management of data
ArcGIS Introduction
ArcGIS Desktop

- **ArcMap** - Integrated map display, editing, and production environment. ArcMap is used to display, query, edit, create, and analyze your geographically referenced data.

- **ArcCatalog** - Data management application. ArcCatalog helps users to browse, search, explore, view, and manage data (with metadata creation and editing capabilities) and maps. It also helps GIS database administrators maintain spatial and tabular GIS data for use by others in their organization.
ArcDesktop

- **ArcToolbox**: Geoprocessing tool. ArcToolbox helps users to perform geoprocessing operations such as data conversion, overlay processing, buffering, proximity analysis and map transformation. Each tool has a menu-driven interface with wizards or dialogs.

- **Search**: Allows to find data, maps and tools by keywords or data types.
In ArcMap

- Create Folder Connections
- Click on Add Data
- Create a Folder Connection to ‘H:\ArcGIS_Workshop_sp13’

- The maps are stored as shapefiles
- “simple, nontopological format for storing the geometric location and attribute information of geographic features”
- Used for points, lines, or polygons
In ArcMap

- **Adding Data to a Map**
  - Click on the Add Data button
  - Navigate to where you stored the files
  - Choose US2010_Census_by_State.shp
  - Click on the Add Data button again
  - Choose US_Airports.shp

- **Navigating and finding Information**
  - Zoom in/out
  - Identify some ‘states’ and ‘airports’
  - Find the location of the John F. Kennedy airport

- **Open the Attribute table and look at the different attributes**
Coordinates & Projections
Coordinates

- **Shape of the Earth: Ellipsoid**
  
  “A three-dimensional, closed geometric shape, all planar sections of which are ellipses or circles.”

- **Approximated by a Spheroid**
  
  “A three-dimensional shape obtained by rotating an ellipse about its (major or minor) axis”

- **Sphere:** used for mathematical calculations such that it has the same surface area as a spheroid (authalic sphere)
Latitude/Longitude

- Parallels & Medians
- Based on 360 degrees where
  - 1 degree = 60 minutes
  - 1 minute = 60 seconds
- Latitude – locate features from North to South
  - Zero is at the Equator
  - Northern hemisphere – 0 to 90N
  - Southern hemisphere – 0 to 90S
- Longitude – locate features East to West
  - Zero at the Prime Meridian (in Greenwich, GB)
  - Eastern hemisphere – 0 to 180E
  - Western hemisphere – 0 to 180W
Decimal Degrees

• Another way to denote coordinates
• Latitude for Broadway & 42\textsuperscript{nd} Street: 40° 45' 21"
  • 45 minutes = .75 degrees (45/60)
  • 21 seconds = .00583 degrees (21/3600)

• Add up the degrees:
  • $40° + .75° + .00583° = 40.75583$ DD

• Note: Southern and Western hemispheres have negative values
Projections

- Process of converting points on a globe to a flat map surface
- Distortion always occurs
  - Shape
  - Area
  - Direction
  - Distance
Which projection to use?

Which spatial property (shape, area, direction, distance) of objects on the globe do you want to preserve in the flat map?
Examples

• **Mercator** – preserves shape
• **Sinusoidal** – preserves area
• **Equal-area Cylindrical** – preserves area, but shapes are distorted
• **Azimuthal Equidistant** – preserves distance and direction, but shapes/sizes distorted at outside edges
• **Robinson** – middle ground
More on Projections

- **Types of Projections**
  - Planar (useful for polar maps)
  - Cylindrical (useful for equatorial maps)
  - Conic

- **Light Source**
  - Gnomonic – center of the Earth
  - Stereoscopic – viewed from one pole to another
  - Orthoscopic – viewed from space

- **Aspect**
  - Orientation of the globe to the projection surface
World Geodetic System 1984

- The most widely used geocentric datum and geographic coordinate system today (designed by the U.S. Department of Defense)
- Used by GPS
- Typically referred to as WGS84

- Starting point for the calculation of shape is the Earth’s center
- Projections based on this have uniform accuracy across the globe
- Very useful for world maps
Universal Transverse Mercator

- A projected coordinate system that divides the world between 80°S and 84°N latitude into 60 zones, each 6° of longitude in width
- Zone 1 covers longitude 180° to 174° W
- Numbering increases as we move East
- Zone 60 that covers longitude 174 to 180 East
- Very useful for finer scale mapping
10 minute break!
Basic GIS Analysis

- Buffer Tool
- Select by Location
- Calculation of Area (if time permits)
- Calculation of Perimeter (if time permits)
Buffer Tool

- Right click on the Data Frame
- Choose Data Frame Properties
- Navigate to the General Tab
- Select Map and Display Units as ‘Miles’

- Click on Add Data
  - Choose US2010_Census_by_State.shp
  - Click on the Add Data button again
  - Choose US_Airports.shp
  - Click on the Add Data button again
  - Choose JFK.shp

- Click on the Geoprocessing Menu
- Choose the Buffer Tool
Buffer Tool … (cont'd)

- Choose the Input feature as the JFK Layer
- Leave the Output as the Default
- Let the Distance be a Linear Unit with a radius of 100 miles
- Click Ok

- Zoom to new Buffered layer

- Right-click on the US Airports layer
- Choose Properties
- Navigate to the Labels tab
- Select ‘Label features in this layer’ with AIRPT_NAME
- Click Ok

- See the different airports in the vicinity of JFK
Select by Location

- Right click on the Data Frame
- Choose Data Frame Properties
- Navigate to the General Tab
- Select Map and Display Units as ‘Miles’

- Click on Add Data
- Choose US2010_Census_by_State.shp
- Click on the Add Data button again
- Choose US_Airports.shp
- Click on the Add Data button again
- Choose JFK.shp
Select by Location … (contd)

- Click on Selection
- Choose Select by Location
- Leave the selection method as ‘select features from’
- Let the target layer as ‘US_Airports’
- Let the source layer be ‘JFK’
- Apply a search distance of 200 miles
- Click Ok

- You should see other airports selected within the vicinity of JFK

- Open the Attribute table of the layer ‘US_Airports’
- Export Selected Records
Thematic Maps

- Maps based on attributes

- Typical elements of a map
  - Title
  - Actual map!
  - Legend
  - Scale
  - North Arrow
  - Author, Organization, Data Source, Date, Projection, Disclosure

- *Always* use a template
Thematic Maps … (contd)

- Click Add Data and choose the ‘PE2008_by_County’ layer file
- Verify that the projected coordinate system is US_National_Atlas_Equal_Area’
- Right-click on the attribute table and verify PER_DEM variable

- Right click on the ‘PE2008_by_County’ layer file
- Choose Properties
- Navigate to the Symbology tab
- Choose either Categories or Quantities
- Choose desired Symbology
Thematic Maps … (contd)

• Switch to Layout View
• Add the following:
  • Legend
  • Scale
  • North Arrow
  • Title
• Move objects in the Layout view until you have the desired map

• Export map
Resources

NYU Data Services
5th floor, Elmer Holmes Bobst Library
70 Washington Square South
http://nyu.libguides.com/dataservices
Data.service@nyu.edu
1-212-998-3434
For Purchase GIS Software

<table>
<thead>
<tr>
<th>Software</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maptitude</td>
<td><a href="http://www.caliper.com">http://www.caliper.com</a></td>
</tr>
<tr>
<td>GIS Design Server and Autodesk Map</td>
<td><a href="http://www.autodesk.com">http://www.autodesk.com</a></td>
</tr>
<tr>
<td>G/Technology and GeoMedia</td>
<td><a href="http://www.intergraph.com">http://www.intergraph.com</a></td>
</tr>
<tr>
<td>IDRISI Kilimanjaro</td>
<td><a href="http://www.clarklabs.org">http://www.clarklabs.org</a></td>
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<tr>
<td>Manifold Release GIS</td>
<td><a href="http://www.manifold.net">http://www.manifold.net</a></td>
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<tr>
<td>MapGraphix GIS</td>
<td><a href="http://www.comgrafix.com/mapgrafix_gis.html">http://www.comgrafix.com/mapgrafix_gis.html</a></td>
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<tr>
<td>MapInfo</td>
<td><a href="http://www.mapinfo.com">http://www.mapinfo.com</a></td>
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<td>MetaMap GIS</td>
<td><a href="http://www.metamap.com">http://www.metamap.com</a></td>
</tr>
<tr>
<td>MyWorld GIS</td>
<td><a href="http://www.myworldgis.org/myworld/">http://www.myworldgis.org/myworld/</a></td>
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<tr>
<td>Smallworld</td>
<td><a href="http://www.gsmallworld.com">http://www.gsmallworld.com</a></td>
</tr>
<tr>
<td>TNTmips</td>
<td><a href="http://www.microimages.com/product/tntmips.htm">http://www.microimages.com/product/tntmips.htm</a></td>
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<tr>
<td>XMap</td>
<td><a href="http://www.delorme.com/professional/xmap">http://www.delorme.com/professional/xmap</a></td>
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Source: Galati (2006)
Free GIS Software

<table>
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<tr>
<th>Software</th>
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<tr>
<td>AGISMap</td>
<td><a href="http://www.agismap.com">http://www.agismap.com</a></td>
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<tr>
<td>Chameleon</td>
<td><a href="http://chameleon.maptools.org">http://chameleon.maptools.org</a></td>
</tr>
<tr>
<td>degree</td>
<td><a href="http://degree.sourceforge.net">http://degree.sourceforge.net</a></td>
</tr>
<tr>
<td>DIVA-GIS</td>
<td><a href="http://www.diva-gis.org">http://www.diva-gis.org</a></td>
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<tr>
<td>Forestry GIS (fGIS)</td>
<td><a href="http://www.digitalgrove.net/fgis.htm">http://www.digitalgrove.net/fgis.htm</a></td>
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<tr>
<td>GeoMedia Viewer</td>
<td><a href="http://www.intergraph.com/gviewer">http://www.intergraph.com/gviewer</a></td>
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<tr>
<td>Geo/SQL</td>
<td><a href="http://www.geosql.com">http://www.geosql.com</a></td>
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<tr>
<td>GRASS</td>
<td><a href="http://www.baylor.edu/~grass">http://www.baylor.edu/~grass</a></td>
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<tr>
<td>MapWindow GIS</td>
<td><a href="http://www.mapwindow.com">http://www.mapwindow.com</a></td>
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<tr>
<td>idc1parmomoGIS</td>
<td><a href="http://www.monomgis.org">http://www.monomgis.org</a></td>
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Source: Galati (2006)
Geospatial Data

Table 15.4
Geospatial Data Clearinghouses

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<tr>
<th>Clearinghouse</th>
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<tr>
<td>The Data Store</td>
<td><a href="http://www.data-store.co.uk">http://www.data-store.co.uk</a></td>
</tr>
<tr>
<td>EROS Data Center</td>
<td><a href="http://edc.usgs.gov">http://edc.usgs.gov</a></td>
</tr>
<tr>
<td>Federal Geographic Data Committee Geospatial Clearinghouse</td>
<td><a href="http://www.fgdc.gov/clearinghouse/clearinghouse.html">http://www.fgdc.gov/clearinghouse/clearinghouse.html</a></td>
</tr>
<tr>
<td>GEO-DATA Explorer (GEODE)</td>
<td><a href="http://geode.usgs.gov">http://geode.usgs.gov</a></td>
</tr>
<tr>
<td>The Geography Network</td>
<td><a href="http://www.geographynetwork.com">http://www.geographynetwork.com</a></td>
</tr>
<tr>
<td>GIS Data Depot</td>
<td><a href="http://data.geocomm.com">http://data.geocomm.com</a></td>
</tr>
<tr>
<td>MapMart</td>
<td><a href="http://www.mapmart.com">http://www.mapmart.com</a></td>
</tr>
</tbody>
</table>

Source: Galati (2006)
Copyright

- *Not* mine!
- Everything based on my notes when I learnt GIS
- Various books, websites, & tutorials
- Other people could own the copyright
- Please use appropriately
Thank you!