GIS for 11.027

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Overview

- What is GIS?
- Types of Data and Projections
- What can I do with GIS?
- Data Sources and Formats
- Software
- Data Management Tips
What is GIS?
Characteristics of GIS

• The data
  – Spatial
  – Tabular

• Methods
  – Data input
  – Data management
  – Data analysis: answer questions that may not be explicitly stated in the data
  – Data output: maps, new data

• Software and hardware
Characteristics of GIS

With software, you can digitally represent geographic objects with a variety of shapes and layer those shapes on top of one another to create maps and perform analysis.

- Polygons
Characteristics of GIS

With software, you can digitally represent geographic objects with a variety of shapes and layer those shapes on top of one another to create maps and perform analysis.

• Polygons
• Lines
Characteristics of GIS

With software, you can digitally represent geographic objects with a variety of shapes and layer those shapes on top of one another to create maps and perform analysis.

- Polygons
- Lines
- Points

geographic information systems services
Characteristics of GIS

With software, you can digitally represent geographic objects with a variety of shapes and layer those shapes on top of one another to create maps and perform analysis.

- Polygons
- Lines
- Points
- Images (pixels)
Data Types

- **Spatial**
  - Spatial or coordinate data represent features that have a known location on the earth.
  - **Vector**: Points, lines, and polygons
  - **Raster**: Row and column matrix
Data Types: Vector

Polygons
Data Types: Vector

Points

Lines
Data Types: Raster

A model of the world as a surface that is divided into a regular grid of cells, arranged into rows and columns.

• All cells (or pixels) must be the same size.
• All cells have a value.

0 : WATER
1 : HIGHLAND
2 : WETLAND
Data Types: Raster

Rasters include images, elevation models, and scanned maps.
Data Types

• Tabular
  – Table (CSV, Excel) or database (Access, Oracle, PostgreSQL)
  – Join with spatial data files by a common attribute (state name, unique ID, etc.)
  – Map as points using coordinates such as longitude and latitude gathered from a GPS device
  – Geocode: associate address fields with a street network
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Map Projections
Map Projections

- There are many different map projections. All map projections distort at least some of the following:
  - Shape
  - Area
  - Distance
  - Direction
Three Map Projections Centered at 39 N and 96 W

Mercator

Lambert Conformal Conic

Un-Projected Latitude and Longitude

Peter H. Dana 6/23/97

“Three Different Map Projections” from The Geographer’s Craft, Map Projections webpage:
http://www.colorado.edu/geography/gcraft/notes/mapproj/mapproj_f.html
What can I do with GIS?
Answer Spatial Questions

- Where are the most crimes in Baltimore?
- Where are the police stations?
- Where are crime hotspots?
- Where should I locate a new police station?
View Aerial Imagery

City of Cambridge Aerial Photograph, April 2010
View Aerial Imagery
View Aerial Imagery

City of Cambridge Aerial Photograph, April 2010
Digital Elevation Models (DEM)

A sampled array of elevations for a number of ground positions at regularly spaced intervals
View Aerial Imagery and DEM

Cape Town, South Africa Landsat Image over SRTM DEM (http://photojournal.jpl.nasa.gov/jpegMod/PIA04961_modest.jpg)
View and Analyze Land Cover Data

Westboro, Massachusetts

- Primary Roads
- Secondary Roads
- Ramp Access Roads

Legend:
- Green: Cropland
- Yellow: Pasture
- Blue: Forest
- Red: Open Undeveloped
- Orange: Open Developed
- Pink: Multi-Family Residential
- Brown: Small Lots Residential
- Reddish Brown: Med. Lots Residential
- Orange: Large Lots Residential
- Gray: Commercial
- Gray: Industrial
- Gray: Transportation
- Blue: Open Water

Map features include:
- Mill Pond
- Cedar Swamp
- Route 9
Create Maps
Create Maps

Legend
- Bike Racks
- Police Station
- Public Schools
- Memorial Poles
- Community Gardens
- One Way Lines
- Bicycle Facilities
- Buildings
- Cambridge City Border
Create Maps

POPULATION DENSITY OF MEXICO

People per sq. mi.
- 310+
- 186-310
- 124-186
- 31-124
- 0-31

Mexico City

Gulf of Mexico

Pacific Ocean

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What types of analysis can I do with GIS?
Create Buffers

Calculate what is
- Inside
- Outside
- Within a certain distance

Buffers in ½-mile increments around Fenway Park
Perform Spatial Statistics

- Analyze patterns
- Map clusters
- Measure geographic distributions
- Model spatial relationships
Map Coordinates or Addresses

• Geocode Addresses:
  – 77 Massachusetts Ave. Cambridge, MA 02139

• Add XY data:
  – 71.093458 W
  – 42.359097 N
Network Analysis
...and More!

• Georeference maps and images
• Calculate area and volume
• Perform surface analysis
  – Contour
  – Slope
  – Aspect
  – Hillshade
  – Viewshed
Where do I find GIS data?
Data Sources

• MIT sources
  – GeoWeb: use any web browser
  – MIT Geodata Repository Search Tool for ArcGIS
  – Barton catalog

• Internet

• Create your own
  – GPS, digitizing, etc.

Not finding what you want? GIS data purchase requests? Contact GIS Help (gishelp@mit.edu).
OpenStreetMap.org

Open data! Anyone can contribute and download.
Collect Your Own Data

Global positioning system (GPS) devices are available for checkout from the Rotch Library circulation desk.
Data Sources

- Data from different sources, covering the same area, can look very different. Evaluate scale, accuracy and file size when selecting data for a project.
Data Formats

• ArcGIS can read many formats, including:
  – Shapefile, personal geodatabase (Access), file geodatabase (ESRI)
  – Image formats (JPG, TIF, GEOTIF, etc.)
  – CAD (DXF and DWG)
  – KML/KMZ files (from Google Earth) can be read in ArcGlobe

• Data can be exported from ArcGIS to a variety of formats, including:
  – KML
  – CAD
  – Adobe Illustrator
  – TIF
  – JPG
What software can I use?
ESRI ArcGIS: ArcMap

- Provides the most tools for processing data, doing analysis, and creating maps
- Work in 2D
- Use the MIT-created toolbar for easily accessing the MIT Geodata Repository with a full GIS software package
ArcToolbox

- 3D Analyst Tools
- Analysis Tools
- Cartography Tools
- Conversion Tools
- Data Interoperability Tools
- Data Management Tools
- Editing Tools
- Geocoding Tools
- Geostatistical Analyst Tools
- Linear Referencing Tools
- Multidimension Tools
- Network Analyst Tools
- Parcel Fabric Tools
- Schematics Tools
- Server Tools
- Spatial Analyst Tools
- Spatial Statistics Tools
- Tracking Analyst Tools
ESRI ArcGIS: ArcScene

- Work in 3D
ESRI ArcGIS: ArcCatalog

- Manage files and folders
- Create new shapefiles and geodatabases
- Preview files
- View metadata in format of choice
- Create metadata so your data can be understood and shared with others
- Save metadata files as XML, TXT, HTML, or SGML
ESRI ArcGIS: ArcGlobe

- View the world as a globe
- 3D effects
- Fly-through animation on a globe surface
- Tools for recording movies
Open Source Software

The source code is made available under a license that allows the modification and redistribution of the software at will.

For a more in-depth definition, visit the Open Source Initiative: opensource.org/docs/definition.php
GIS Desktop Software

Open source: OSGeo projects
• GRASS GIS
• OSSIM
• Quantum GIS (QGIS)
• gvSIG

Proprietary
• ESRI ArcGIS Desktop
• MapInfo

www.osgeo.org

For a longer list, visit: en.wikipedia.org/wiki/List_of_GIS_software
Quantum GIS (QGIS)
Data Management Tips
Data Management Tips

GIS projects tend to generate **many files**, which are generally **large in size**. For file naming:

- Use file names that represent the file (default names like Export_Output are not helpful if you need to come back to your project later).
- Delete intermediate files
- Some software programs and tools may have file name constraints (e.g. an eight character limit without spaces). Watch out for this with ESRI ArcToolbox.
Data Management Tips

Keep detailed notes about:

• Data sources
• Licensing constraints
• Data processing steps (ModelBuilder creates visuals of your procedure)
• What is stored where
  – The GIS project maintains links to the individual data files (the data is not embedded in the map document itself)
  – GIS formats, like shapefile (SHP), have many files that are linked together and must stay together in order to function
• Descriptions of the files you create and use (ArcCatalog has built-in tools for creating and editing metadata)
Backup Your Data!
MIT GIS Services

- Individual and classroom GIS support
  - MIT GIS Lab located in Rotch Library
  - Walk-in help during lab hours: project and teaching space
  - Email support through gishelp@mit.edu

- General workshops

- Access to GIS data: MIT Geodata Repository
  - GeoWeb
  - ArcMap interface

- Loan GPS units to MIT community

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