EWCE 206

GIS in Environmental and Water Resources Engineering

1.5 Cr, 3 hrs/wk

Overview of GIS and ArcGIS Software

Lecture Outline

- ❑ What is GIS?
- ❑ Types of Data
- ❑ ArcGIS Software
- ❑ What Can We Do With ArcGIS Software?
- ❑ Where can we find GIS data?
- ❑ ArcGIS for Beginners course contents

What is GIS?

- Geographic Information System (GIS) is a system that is designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.

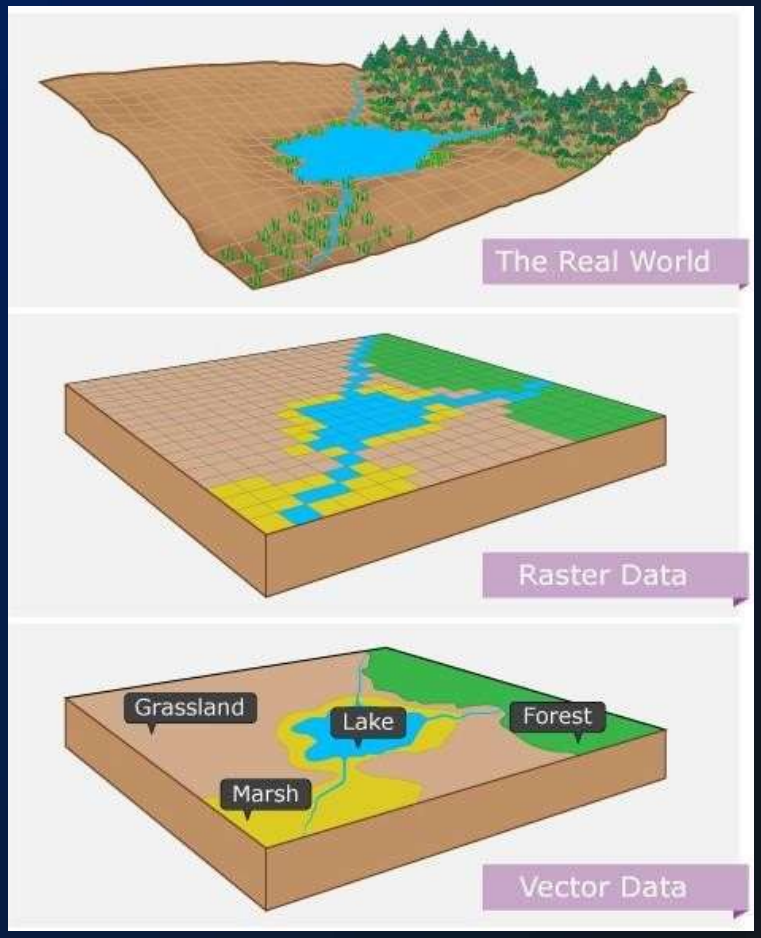
- GIS applications allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations.

Types of Data

The basic data types in GIS-

- Spatial data
- Tabular data

Spatial Data



Spatial data refers to the geographic location, shape, length, and boundaries of features on Earth.

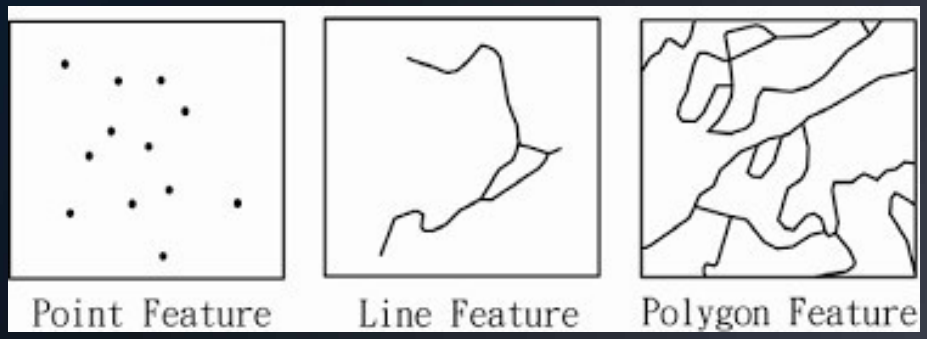
- Vector data: Points, lines, and polygons
- Raster data: Cells, Grids, Rows and column matrix

Vector Data

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

- Polygons
- Lines
- Points

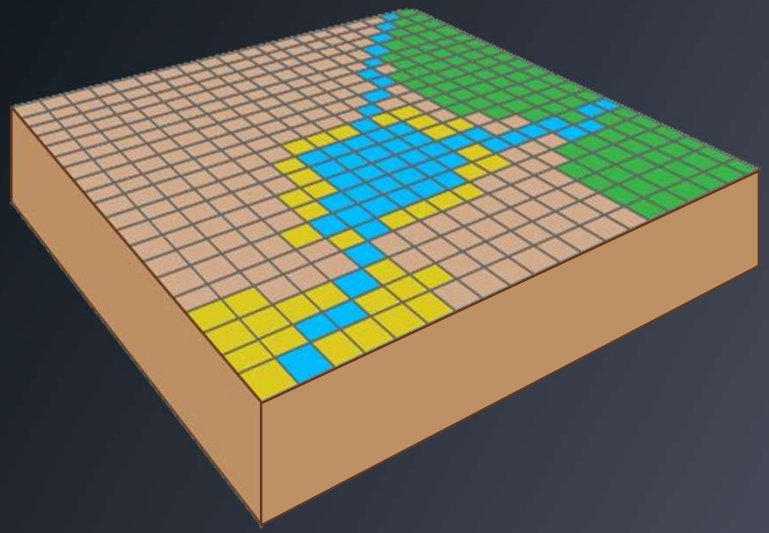
These features are also called feature data/theme/shapefile/feature class/feature Layer.



Raster Data

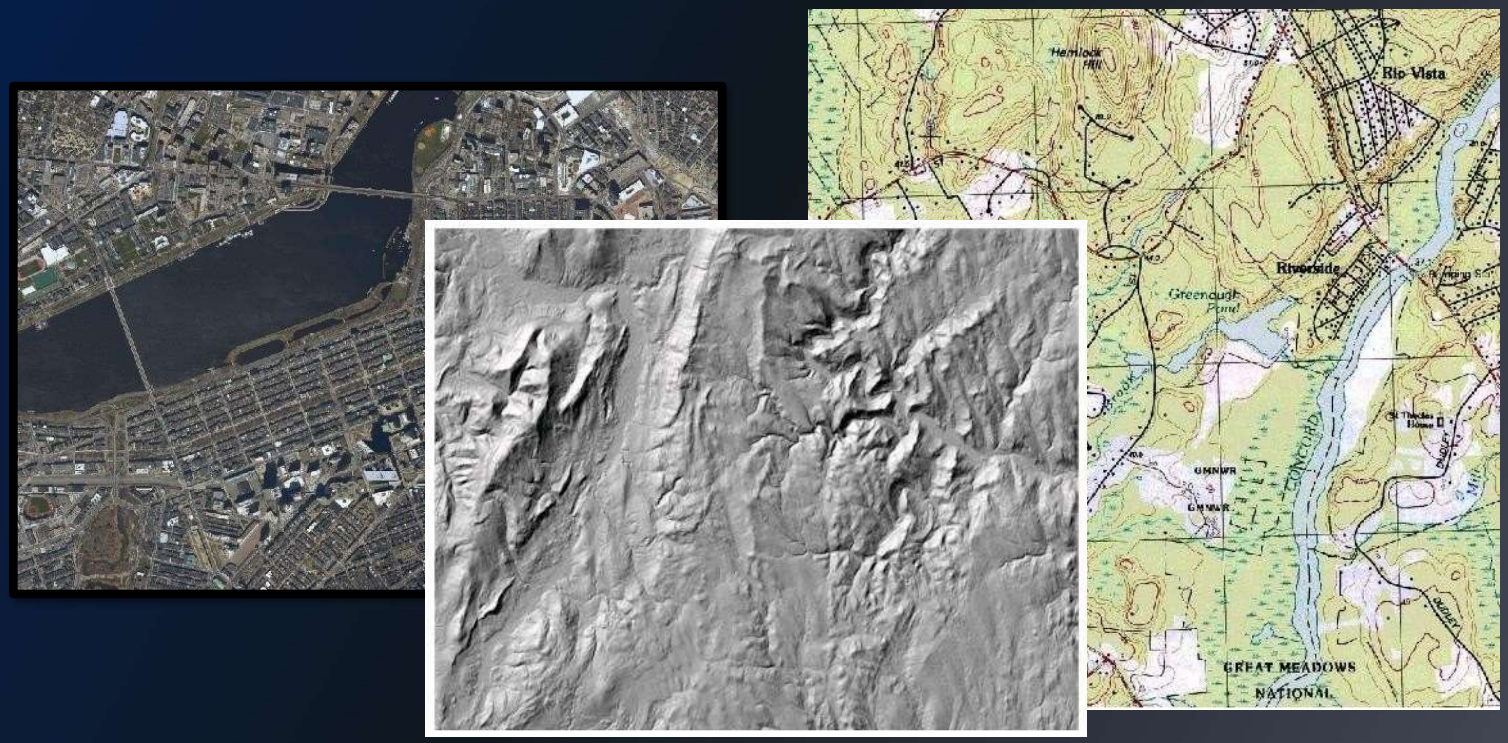
A model of the world as a surface that is divided into a regular grid of cells, arranged into rows and columns.

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



Raster Data

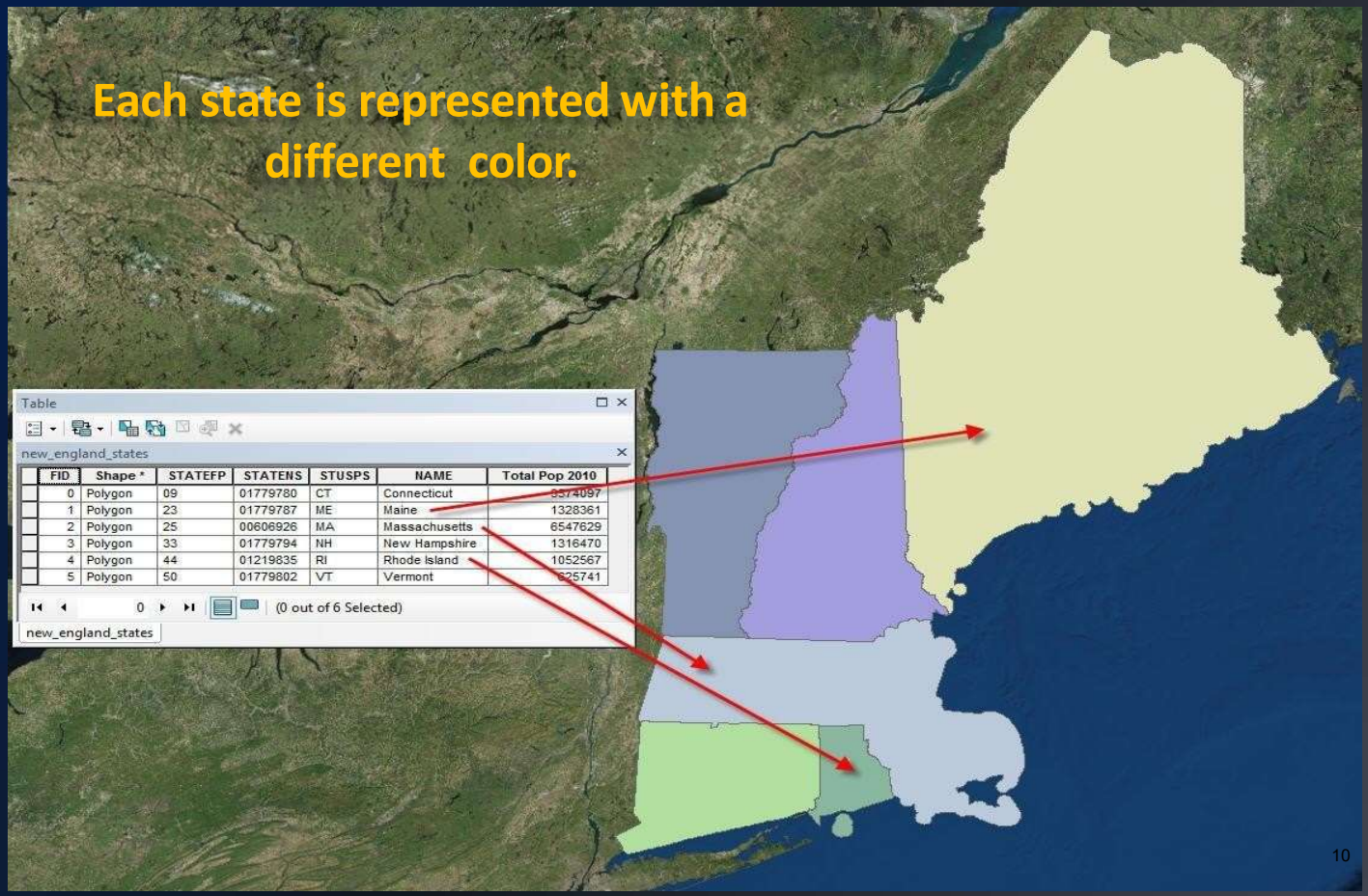
Raster data include images, elevation models, and scanned maps.



Attribute Data

- Spatial data have a backend database called an attribute data/table.
- It can be used for querying and analysis.
- All attributes can be mapped.

Data Attribute Table



Data Attribute Table

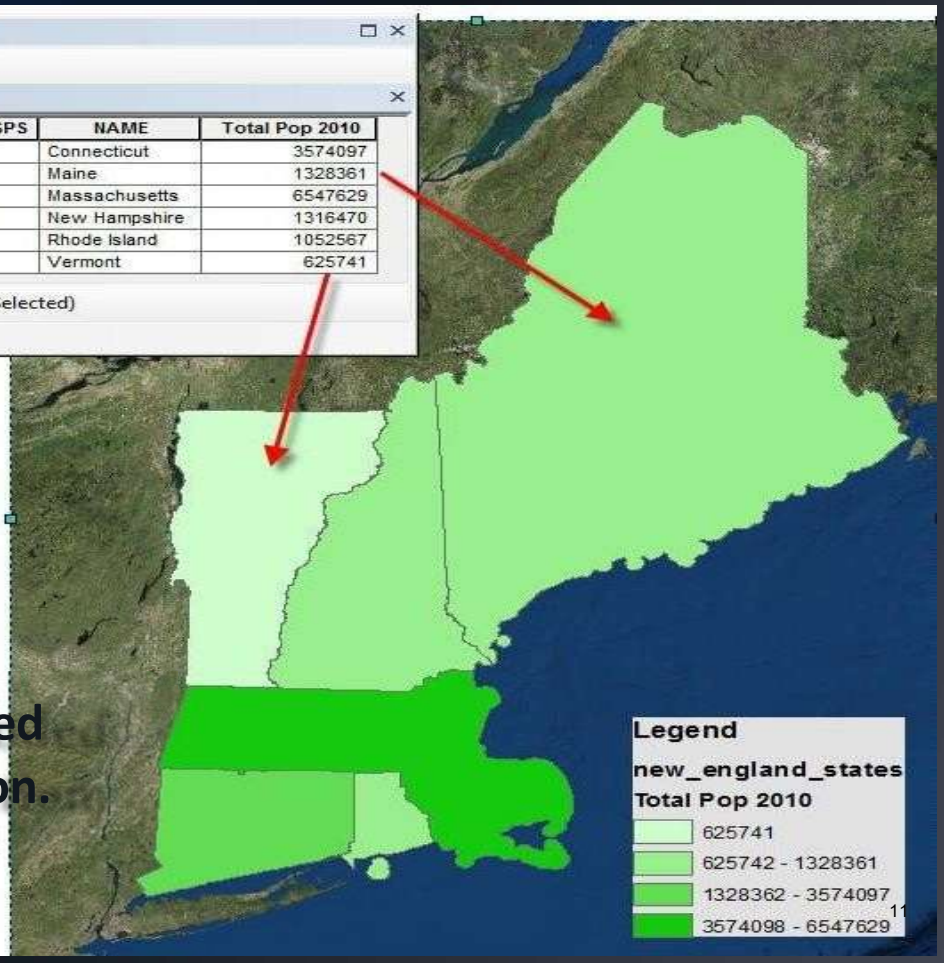
Table

new_england_states

FID	Shape *	STATEFP	STATENS	STUSPS	NAME	Total Pop 2010
0	Polygon	09	01779780	CT	Connecticut	3574097
1	Polygon	23	01779787	ME	Maine	1328361
2	Polygon	25	00606926	MA	Massachusetts	6547629
3	Polygon	33	01779794	NH	New Hampshire	1316470
4	Polygon	44	01219835	RI	Rhode Island	1052567
5	Polygon	50	01779802	VT	Vermont	625741

0 (0 out of 6 Selected)

new_england_states



Each state is color coded based on its population.

Metadata

- Information about the data layer
- Read the metadata to determine who created the data, when it was created, what the codes in the table mean, if there are constraints on how it can be used, etc.
- You can find metadata:
  - Downloaded with your data layers
  - On the website where you got your data
  - Sometimes you may need to contact the data provider to get metadata
- Metadata is most commonly in html/xml format, text files, or in a table format, such as excel or csv.

Metadata

World (Countries, 2005)

Institution
MIT

Data Type
Polygon

Theme Keywords
polygon countries international boundaries coastlines area international codes status population boundaries society

Place Keywords
World



Download FGDC Metadata

- Identification Information
- Metadata Reference Information
- Spatial Data Organization Information
- Spatial Reference Information
- Entity and Attribute Information
- Distribution Information

In GeoWeb, expand each category to read the metadata.

Metadata

Entity and Attribute Information

SDE_DATA.INT_A1CNTRY_2005

ObjectID

Attribute Definition	Internal feature number.
Attribute Definition Source	ESRI

FIPS_CNTRY

Attribute Definition	The FIPS code (two-letter) for the country.
Attribute Definition Source	Department of Commerce, National Institute of Standards and Technology

GMI_CNTRY

Attribute Definition	The country code (three-letter) for the country from Global Mapping International.
Attribute Definition Source	Global Mapping International

ISO_2DIGIT

Attribute Definition	The country code (two-letter) for the country from the International Organization for Standardization.
Attribute Definition Source	International Organization for Standardization

ISO_3DIGIT

Data Types: Tabular

- Table (CSV, Excel) or database (Access, Oracle, PostgreSQL)

- Can be transformed into spatial data and mapped:
  - 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

ArcGIS Software

About ESRI

- ESRI: Environmental Systems Research Institute
- Founded : 1969 in Redlands, California
- Founder: Jack Dangermond
- Headquarters: Redlands, California, United States
- ESRI is an international supplier of geographic information system software, web GIS and geodatabase management applications.



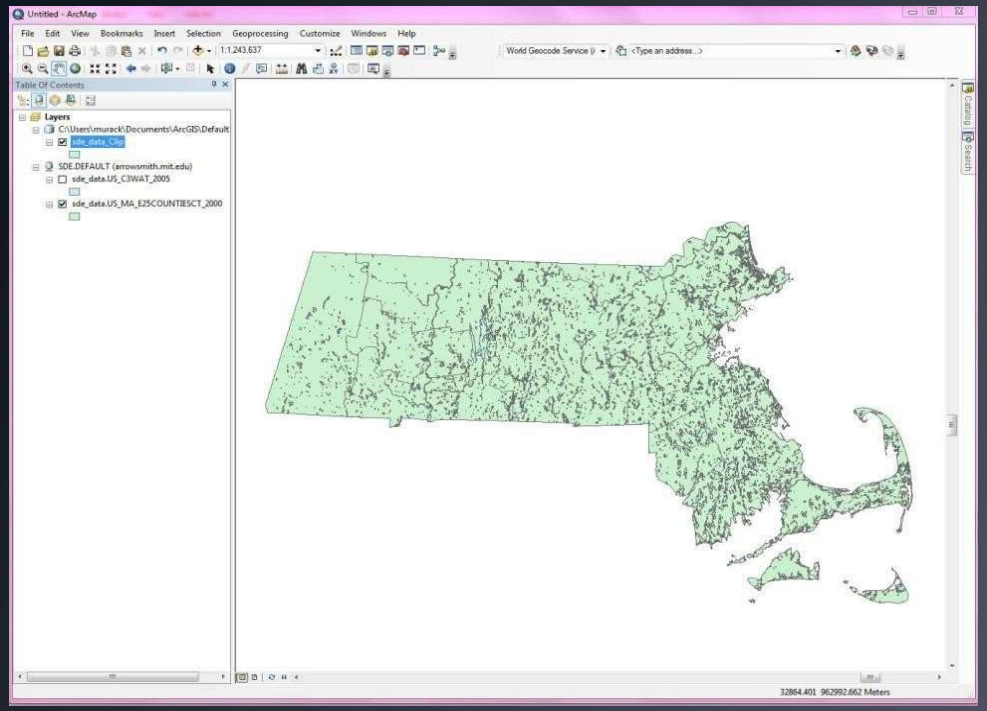
GIS and Mapping Products

- ArcGIS
- ArcGIS Online
- ArcGIS Enterprise
- ArcGIS Developers
- ArcGIS Platform

Website: *esri.com*

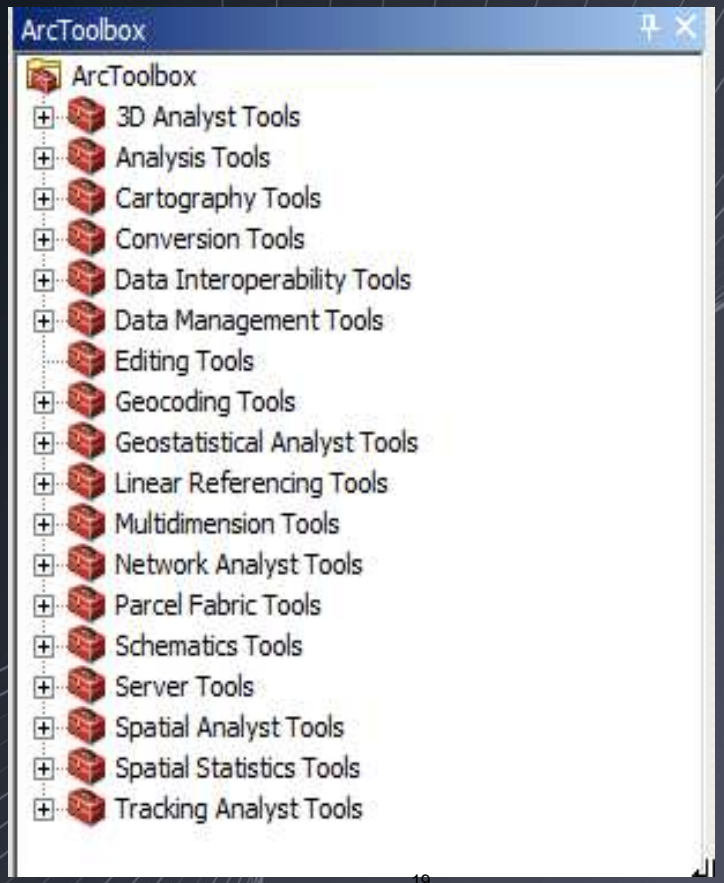
ESRI ArcGIS: ArcMap

- Provides the most tools for processing data, analysis, and creating maps
- Comprehensive support through our academic license



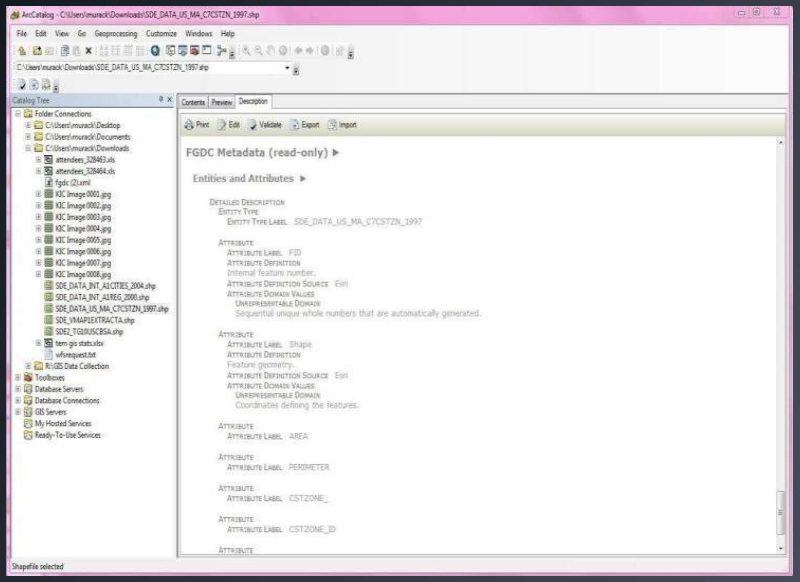
ArcToolbox

- **ArcToolbox** is an integrated application developed by Environmental Systems Research Institute (Esri).
- It provides a reference to the toolboxes to facilitate user interface in ArcGIS for accessing and organizing a collection of geoprocessing tools, models and scripts.



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



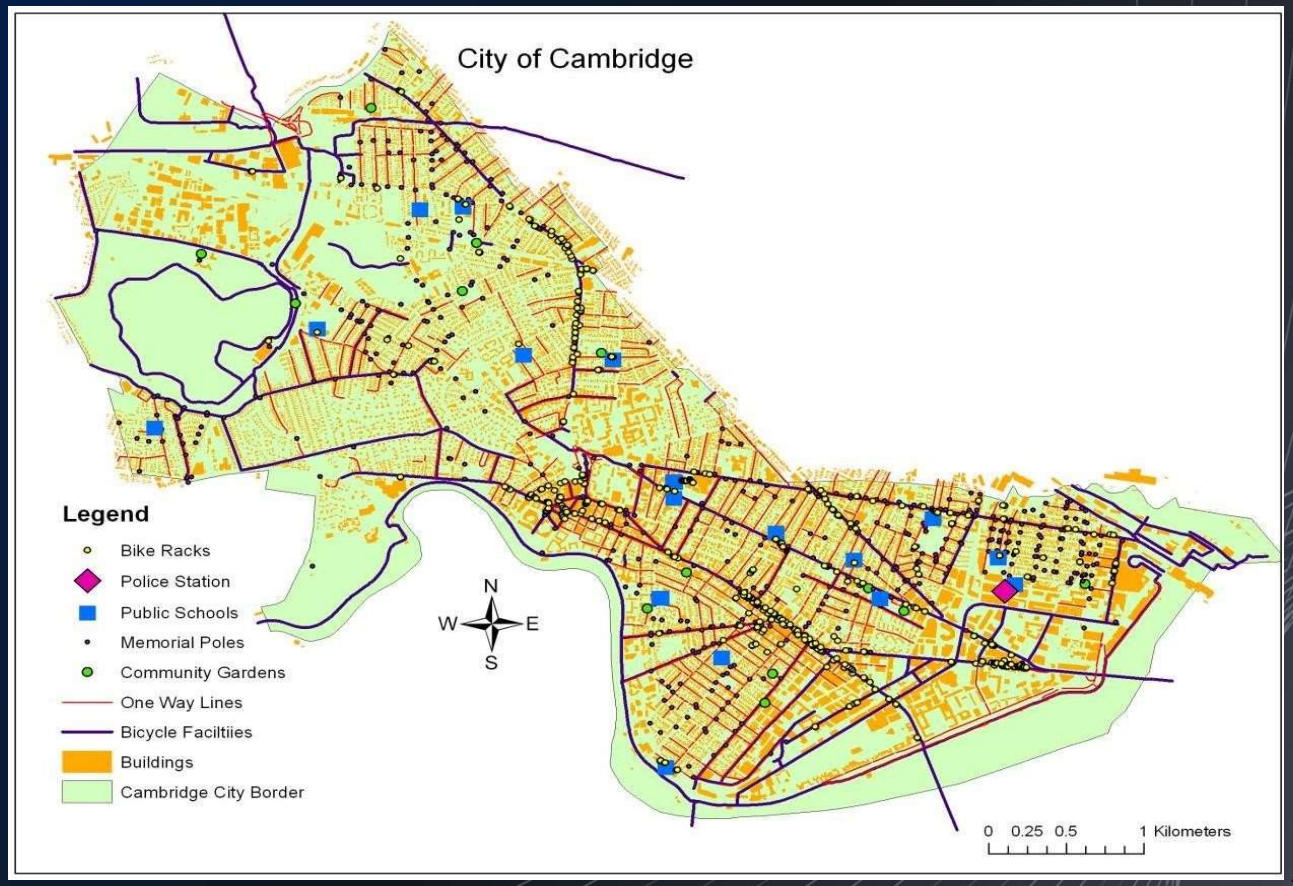
What can we do with ArcGIS Software?

View Data and Create Maps

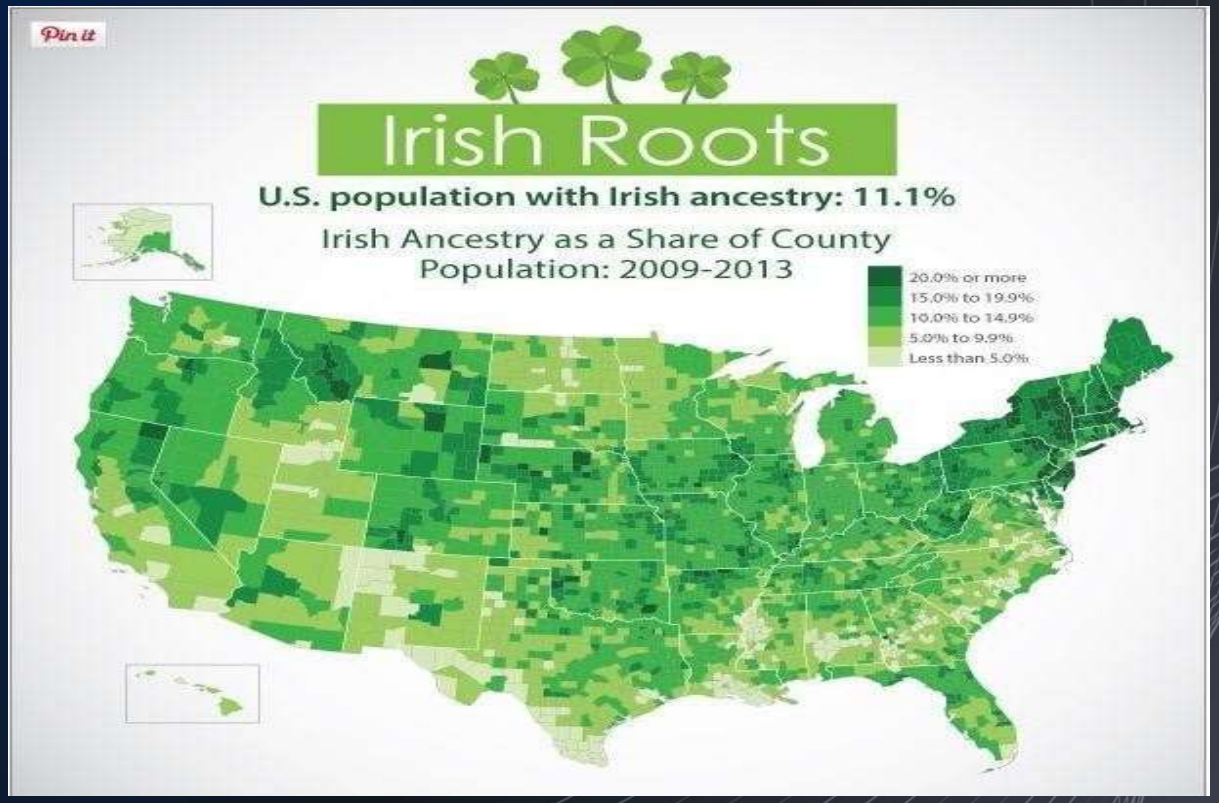
View Imagery



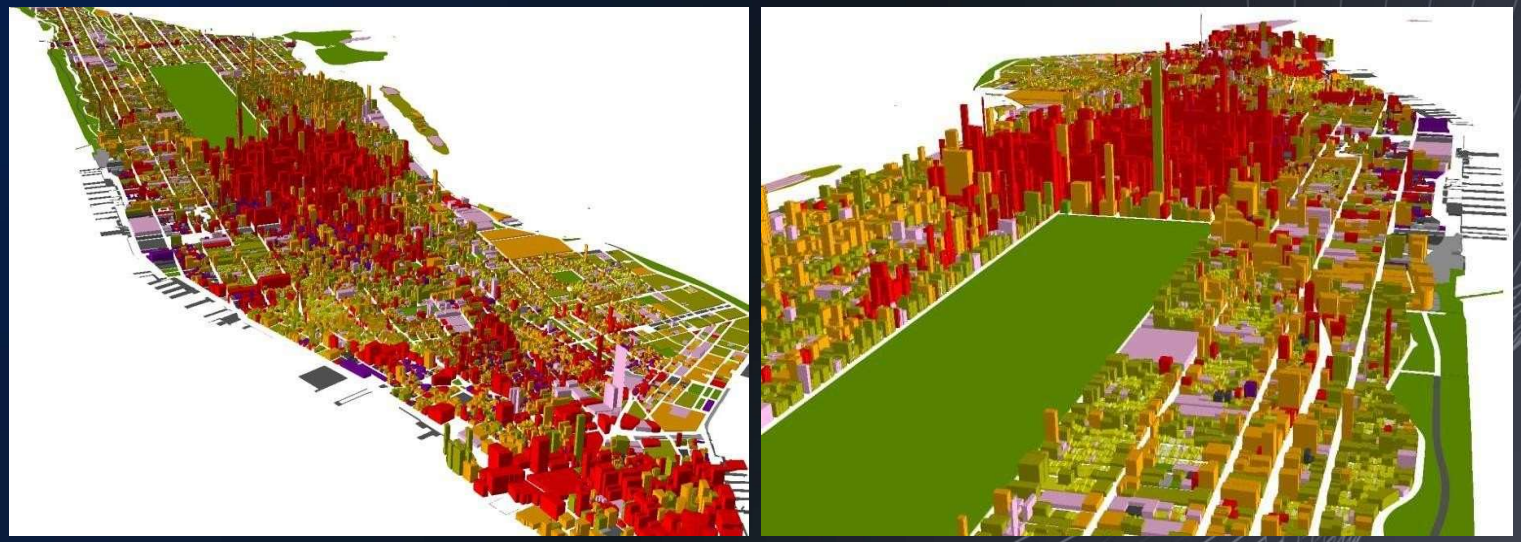
Create Maps


City of Cambridge
Legend
Bike Racks
Police Station
Public Schools
Memorial Poles
Community Gardens
One Way Lines
Bicycle Facilitiies
Buildings
Cambridge City Border
N
W
E
S
0 0.25 0.5 1 Kilometers

Create Maps


Pin it
Irish Roots
U.S. population with Irish ancestry: 11.1%
Irish Ancestry as a Share of County Population: 2009-2013
20.0% or more
15.0% to 19.9%
10.0% to 14.9%
5.0% to 9.9%
Less than 5.0%

Create 3D Models



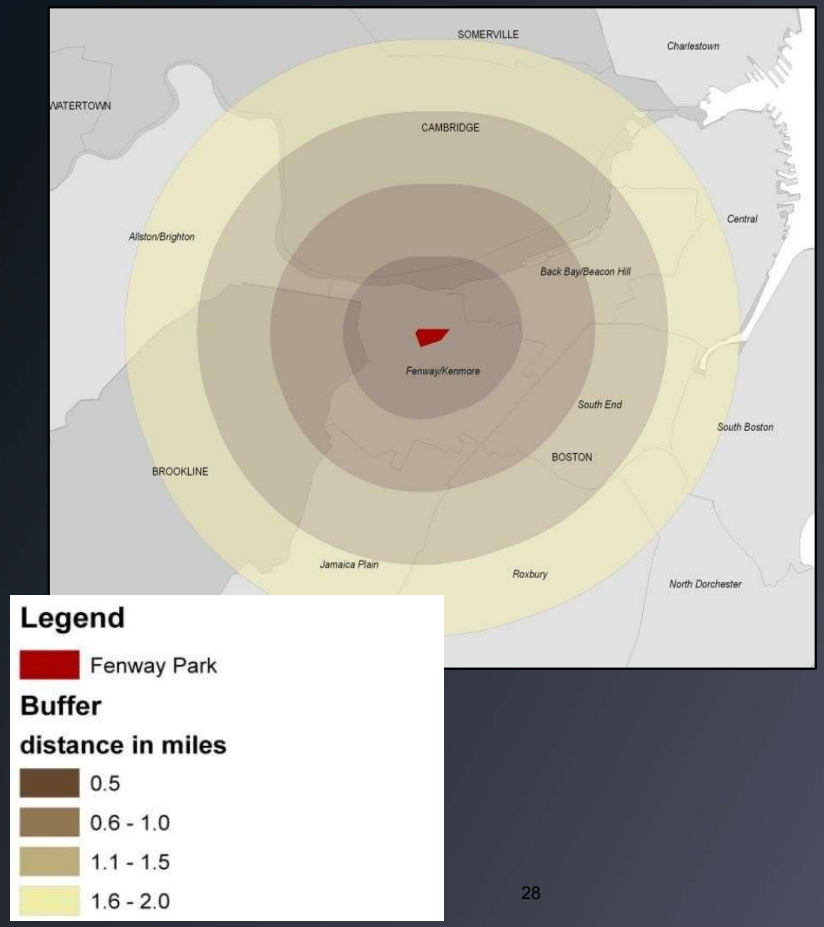
Perform Analysis

Create Buffers

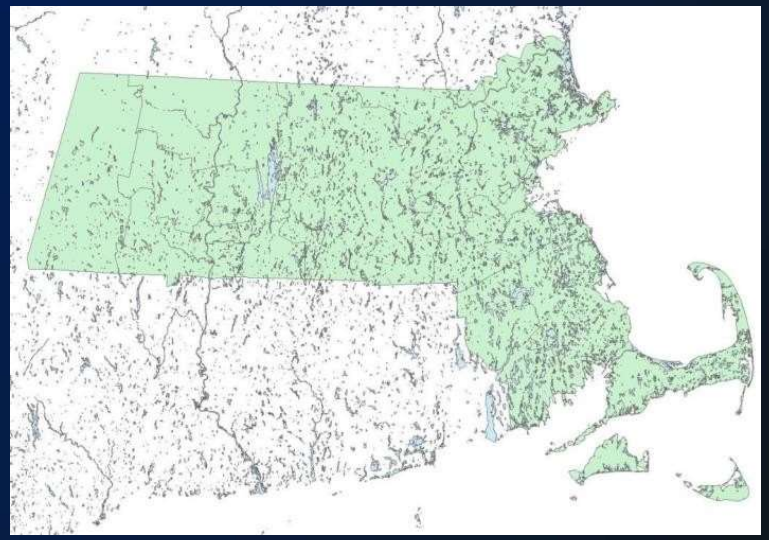
Calculate what is

- ❑ Inside
- ❑ Outside
- ❑ Within a certain distance

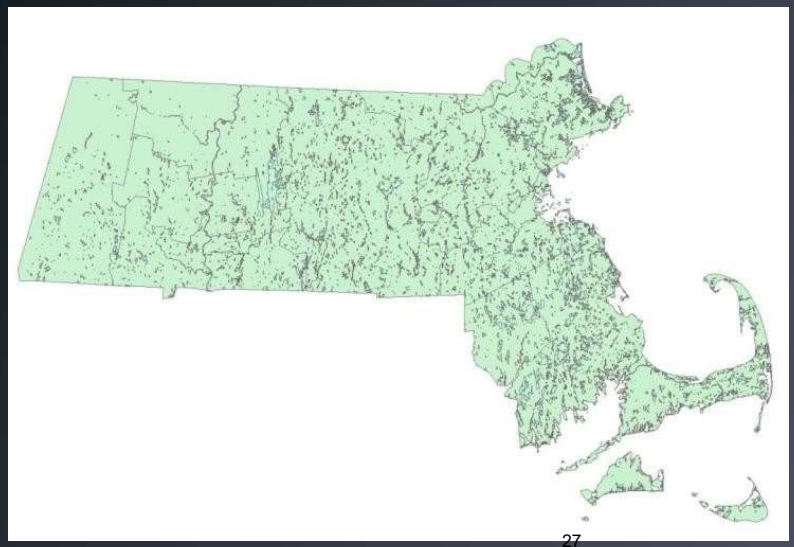
Buffers in ½-mile increments around Fenway Park



Clip Features

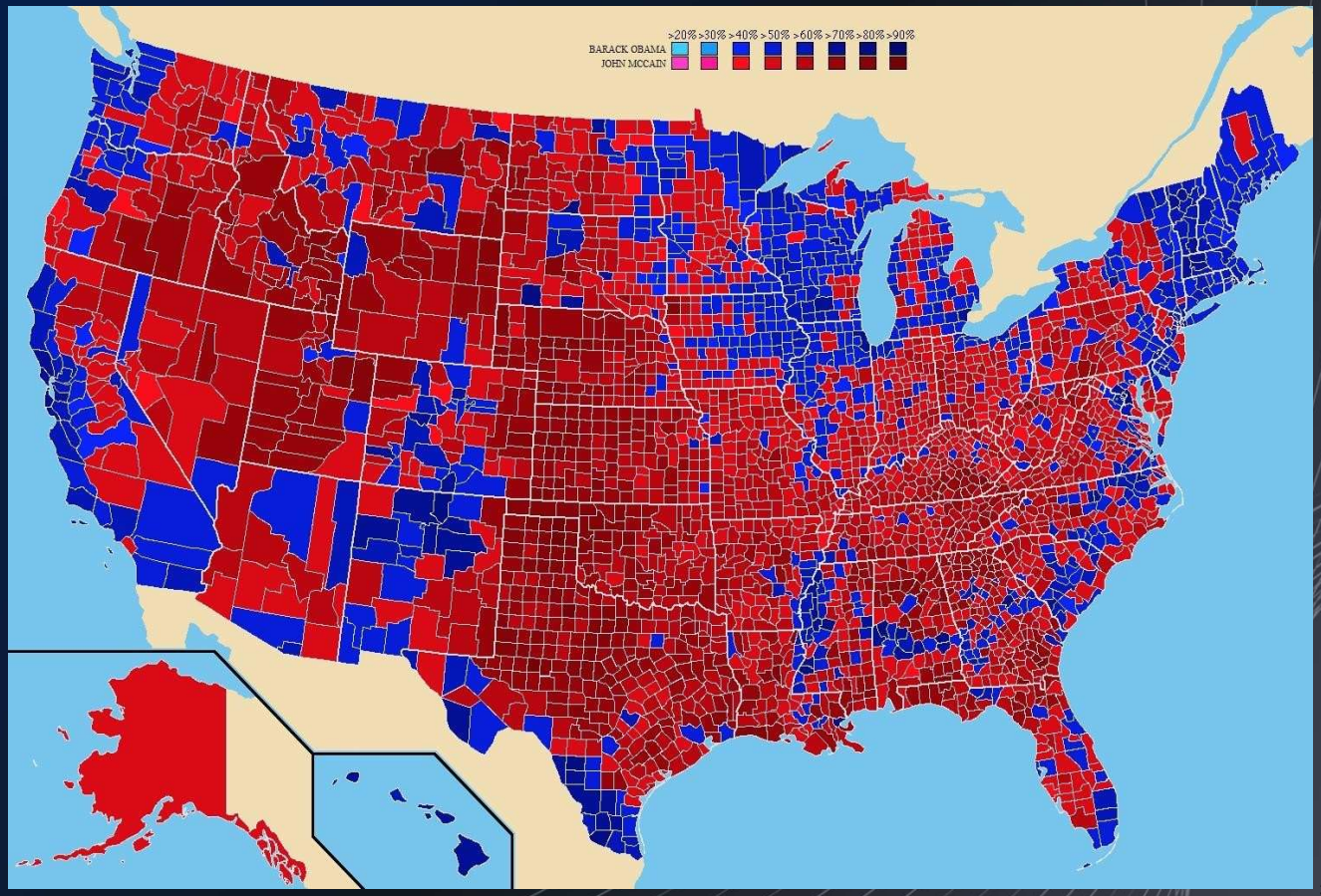


All the water bodies in the US have been clipped using the Massachusetts state boundary.



Now only the water in Massachusetts is visible.

Spatial Statistics



Analyze Raster Data



Digital Elevation Model (DEM): A sampled array of elevations for a number of ground positions at regularly spaced intervals

Use it to:

- Calculate rivers and watersheds,
- Create contour lines
- Determine viewsheds

. . . and More!

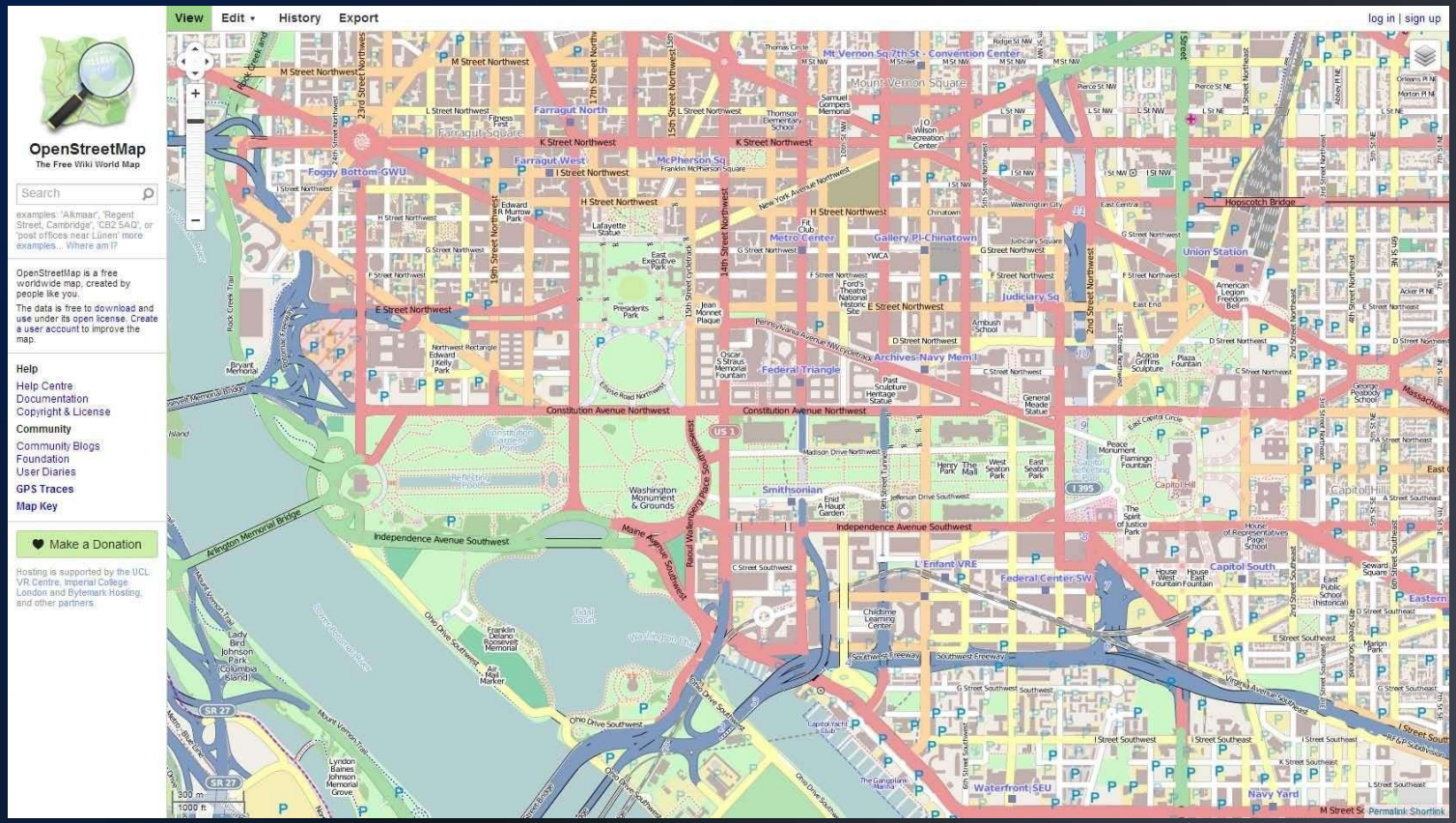
- Calculate area and volume
- Join data based on a common attribute (ID, name, etc.) or its spatial location
- Find where data layers intersect
- Find the nearest features
- Perform surface analysis
  - Contour
  - Slope
  - Hillshade
  - Viewshed
  - Hydrology

Where can we find GIS data?

Data Sources

- MIT sources
  - GeoWeb: use any web browser (includes data downloads as well as DVDs and Maps in the library)
- ESRI
- Internet
  - http://libguides.mit.edu/gis (Links to data sources)
- Create your own
  - GPS, digitizing, etc.
- Not finding what you want? GIS data purchase requests? Contact GIS Help.

OpenStreetMap.org



Open data! Anyone can contribute and download

Data Formats

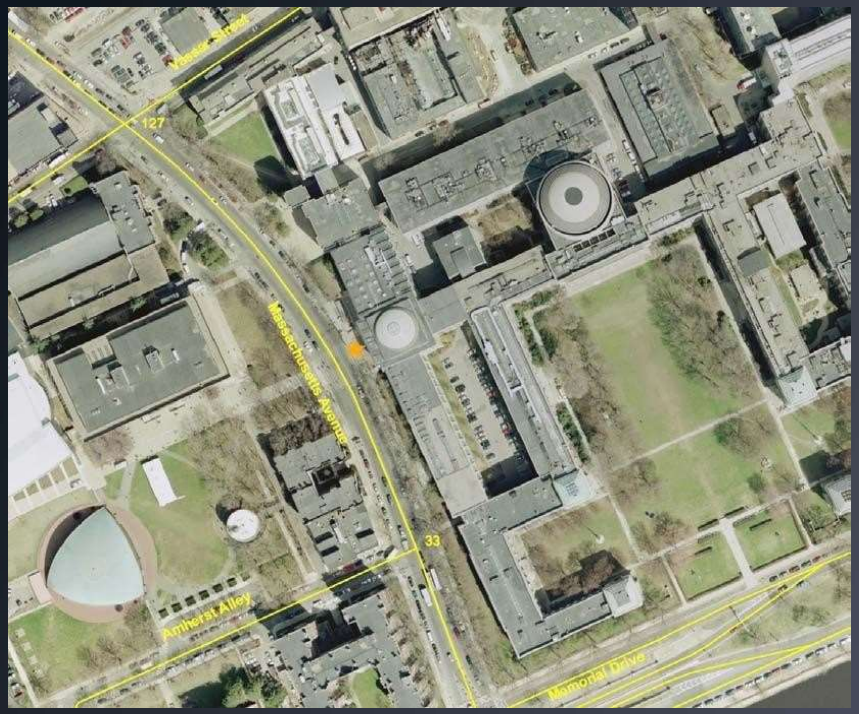
- ArcGIS can read many formats, including:
  - Shapefile, personal geodatabase (Access), file geodatabase (ESRI)
  - Image formats (JPG, TIF, GEOTIF, etc.)
  - CAD (DXF and DWG)
  - KML/KMZ files (from Google Earth)

- Data can be exported from ArcGIS to a variety of formats, including:
  - KML
  - CAD
  - Adobe Illustrator
  - TIF
  - JPG

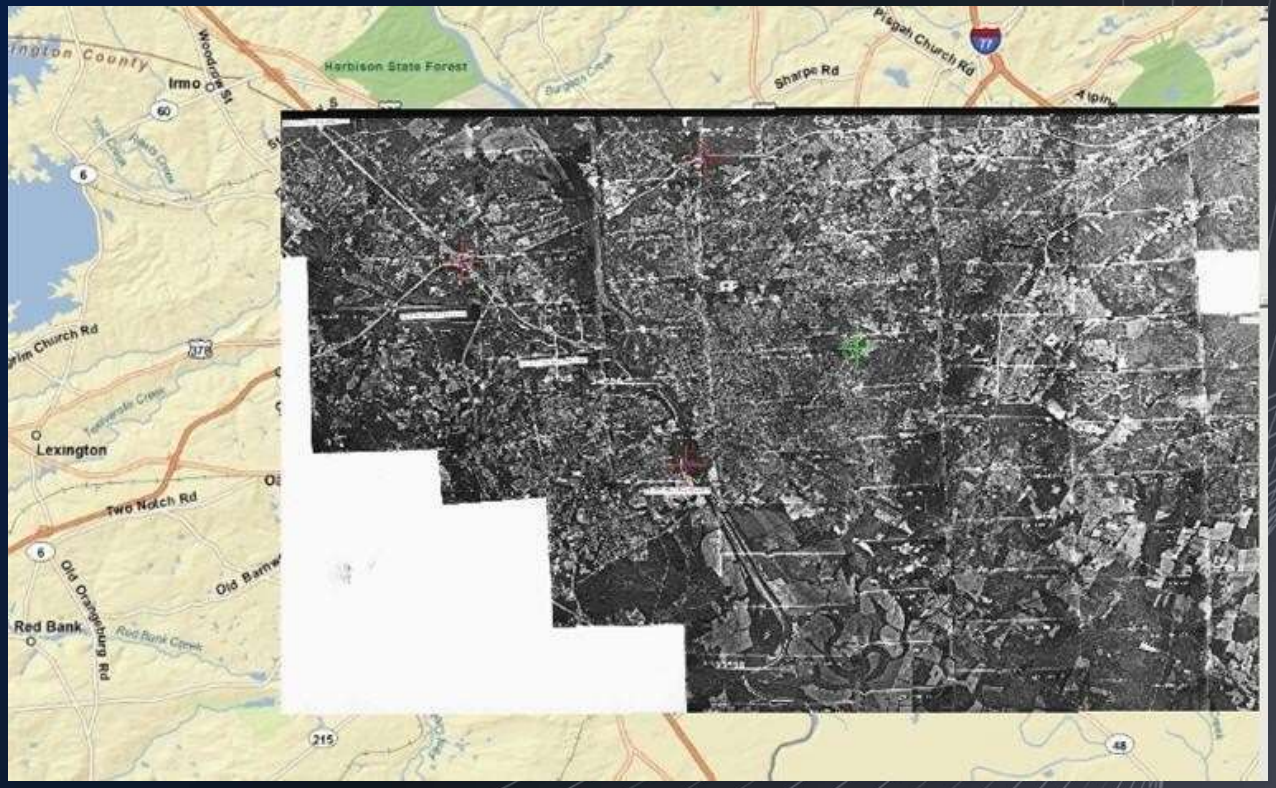
Create your own Data: Map Coordinates or Addresses

Geocode Addresses:
77 Massachusetts Ave. **Cambridge, MA 02139**

Add XY data: **71.093458 W**
42.359097 N



Create your Data:
Georeferenced maps and images



Collect Your Own Data

Global positioning system (GPS)



Lecture Plan
Room- 402

WEEK	DATE	TOPICS
1.	04.12.2024	Introduction to ArcGIS, ArcGIS Basics
2.	11.12.2024	Introduction to ArcGIS, ArcGIS Basics
3.	18.12.2024	Introduction to Map, Map Projections and Co-ordinate Systems, Map Design
4.	25.12.2024	Govt Holiday
5.	01.01.2025	GIS Output
6.	08.01.2025	QUIZ 1
7.	15.01.2025	Table Operation
8.	29.01.2025	Geoprocessing
9.	05.02.2025	File Geodatabase
10.	12.02.2025	Spatial Analysis
11.	19.02.2025	QUIZ 2
12.	26.02.2025	Georeferencing
13.	05.03.2025	Digitizing and Editing
14.	12.03.2025	FINAL QUIZ

Lecture Plan
Room- 404

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12.	26.02.2025	Georeferencing
13.	05.03.2025	Digitizing and Editing
14.	12.03.2025	FINAL QUIZ

Tentative Marks Distribution:

- Class Assessment: 20%
- Home Assignment: 15%
- Quizzes: 65%

Reference Books/Materials

- ArcGIS Workbook by ESRI
- Lab Manuals

Thank you!