



GIS WEEK

MS CSS Summer Boot Camp
August 8-12, 2022



INTRODUCTIONS

- Instructors
 - Julie Wartell, MPA, PGDip (jwartell@ucsd.edu)
 - Sarah McTague, MS (smctague@ucsd.edu)
- Students
 - Name
 - Educational focus/topic of interest
 - Experience with GIS (beyond getting directions on your phone!)
 - What you hope to get out of this week's classes

Class Overview

Day 1:

- LECTURE: Introduction to GIS & Geographic Analysis
- LAB: Getting started with ArcGIS Online

Day 2:

- LECTURE: GIS and Transportation Planning
- LAB: Viewing and analyzing transportation and demographics

Day 3:

- LECTURE: GIS and Public Health
- LAB: COVID dashboards and other health trend maps and analysis

Day 4:

- LECTURE: GIS and Affordable Housing
- LAB: Getting started on your own maps/analysis

Day 5:

- LECTURE: GIS and Crime
- LAB: Creating a storymap



INTRODUCTION TO GIS & GEOGRAPHIC ANALYSIS

History of GIS



1854 – Dr. John Snow mapped a cholera outbreak in London; analysis of the distribution led to the source of the disease, a contaminated water pump; was the first to analyze clusters of geographically-dependent phenomena.

1960 - Development of the world's first true operational GIS in Ottawa, Ontario, Canada by the federal Department of Forestry and Rural Development.

Late 1970s/Early 80s - Emerging commercial vendors of GIS software, successfully incorporating many of the CGIS features, combining 1st gen approach to separation of spatial & attribute information with 2nd gen approach to organizing attribute data into database structures.

1990s – Growing industry and introduction of GIS to personal computers via desktop software.

2000s – Introduction of Dynamic Data, Real-time updates and Web-based GIS

In What Fields are GIS Used?

Business

- Insurance
- Retail
- Manufacturing
- Real Estate
- Banking
- Marketing
- Media and Entertainment

Government

- Federal, State, Local
- Defense
- Intelligence
- Resilient Communities
- Architecture, Engineering, and Construction (AEC)
- Economic Development
- Elections and Redistricting
- Facilities
- Land Administration
- Public Works
- Surveying
- Urban and Regional Planning

Health and Human Services

- Public Health
- Human Services
- Hospital and Health Systems
- Geomedicine

Natural Resources

- Agriculture
- Climate Change
- Conservation
- Environmental Management
- Forestry
- Mining
- Oceans
- Petroleum
- Water Resources

Public Safety

- Emergency Call Taking and Dispatch
- Emergency/Disaster Management
- Fire, Rescue, and EMS
- Homeland/National Security
- Law Enforcement
- Wildland Fire Management

Transportation

- Airports and Aviation
- Highways
- Logistics
- Railways
- Ports and Maritime
- Public Transit

Utilities and Communications

- Electric
- Gas
- Pipeline
- Telecommunications
- Water/Wastewater

Additional Industries

- Aid and Development
- Education
- Map, Chart, and Data Production



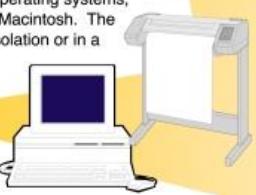
GIS Components

A Geographic Information System (GIS) links locational (spatial) and database (tabular) information and enables a person to visualize patterns, relationships, and trends. This process gives an entirely new perspective to data analysis that cannot be seen in a table or list format. The five components of a GIS are listed below.

HARDWARE

The hardware is the computer and peripherals on which the GIS operates. Today, this could be a centralized computer server running the UNIX or Windows NT operating systems, a desktop PC, or an Apple Macintosh. The computer may operate in isolation or in a networked configuration.

- Computers
- Networks
- Peripheral Devices
 - Printers
 - Plotters
 - Digitizers



SOFTWARE

GIS software provides the functions and tools users need to store, analyze, and display geographical information. The key software components are

- GIS Software
- Database Software
- OS Software
- Network Software



GIS

PEOPLE

GIS technology is clearly of limited value without people to manage the system and to develop plans for applying it. Users of GIS range from highly qualified technical specialists to planners, foresters, and market analysts who use GIS to help with their everyday work.

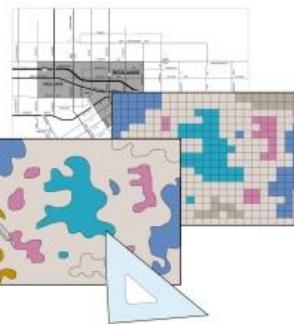
- Administrators
- Managers
- GIS Technicians
- Application Experts
- End Users
- Consumers



DATA

One of the most important component of GIS is the data. It is absolutely essential that data be accurate. The following are different data types:

- Vector Data
- Raster Data
- Image Data
- Attribute Data



METHODS

Methods are well designed plans and application-specific business rules describing how technology is applied. This includes the following:

- Guidelines
- Specifications
- Standards
- Procedures

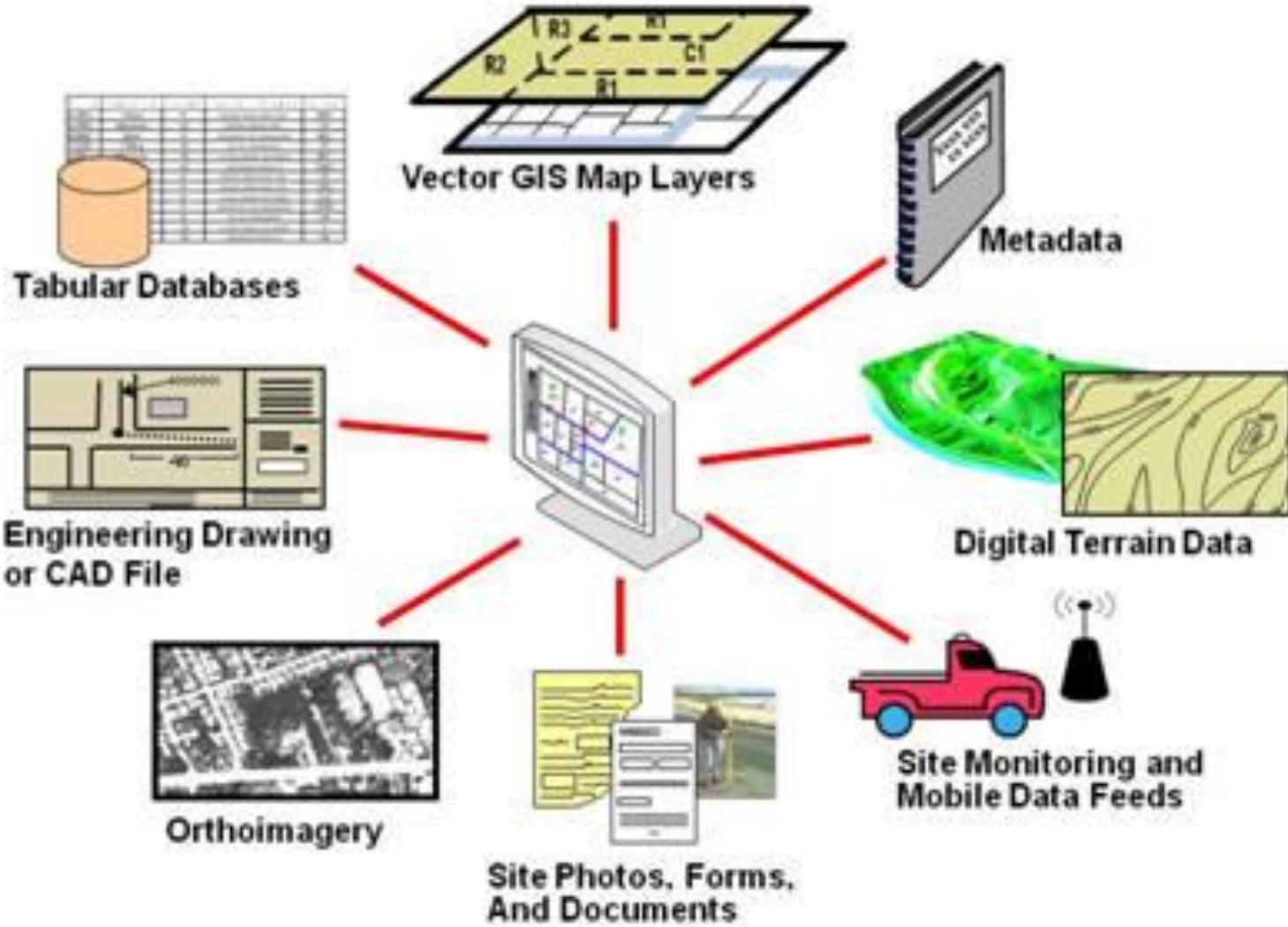


GIS doesn't work without data

- What is it (data) that you want to study?
 - EX: disease trends, transportation options, equity
 - What is the spatial element/geographic unit? As in, how will it be represented on a map?
- What data will put your data in context? In other words, what other data might be on the base map?
 - EX: city boundaries, ZIP codes, freeways



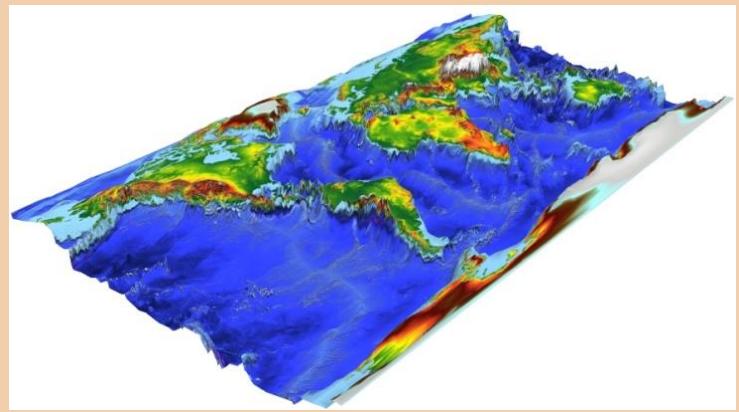
GIS Data Input Types



GIS Data Representation

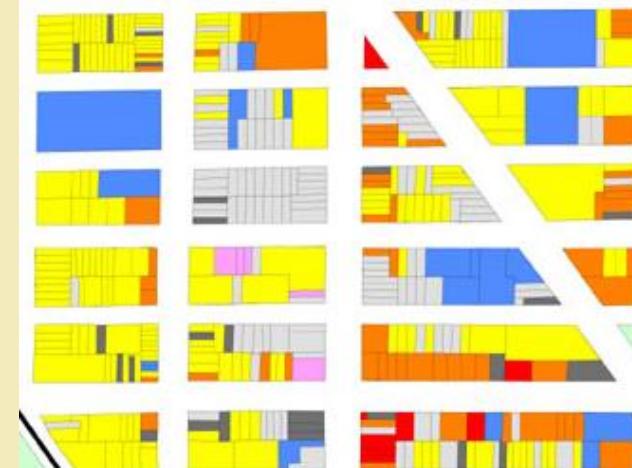
Raster

Digital image represented by reducible and enlargeable grids. Consists of rows and columns of equal-sized grid cells, with each cell storing a single value. Raster data images include each pixel (or cell) containing a color or height value.



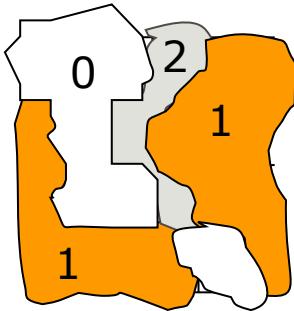
Vector

Features expressed as geometrical shapes. Different types of geometry are points, lines and polygons. Each feature is linked to a row in a database that describes its attributes



GIS Data Representation

vector



Attributes of Theme2.shp		
Shape	ID	LANDUSE
Polygon	0	WATER
Polygon	1	HIGHLAND
Polygon	2	WETLAND

*good for data that fits
into neat boundaries
(discrete data)*

raster

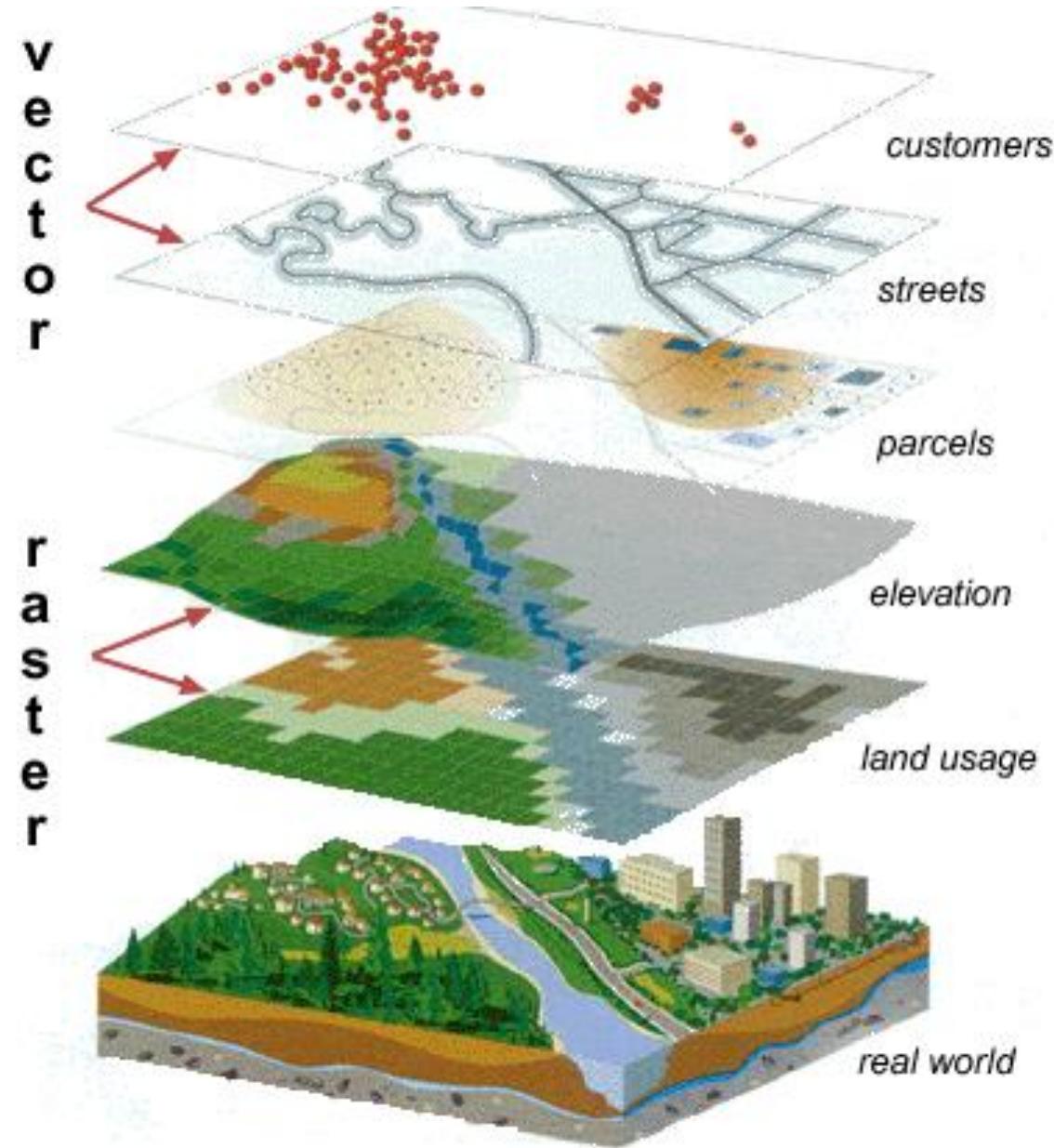
0	0	0	2	1	1
1	0	2	1	1	1
1	0	0	2	1	1
1	1	1	1	0	1

1 : HIGHLAND

*good for data that do
not have discrete
boundaries
(continuous surfaces)*



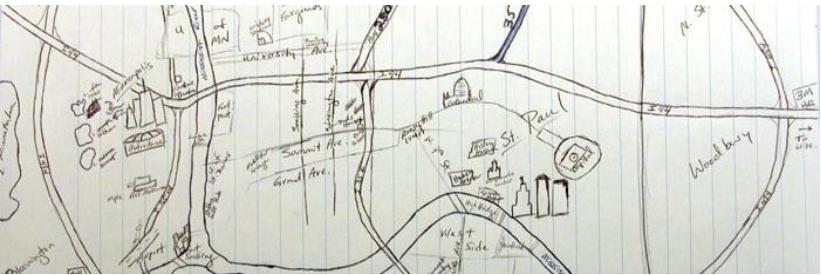
Layering Data



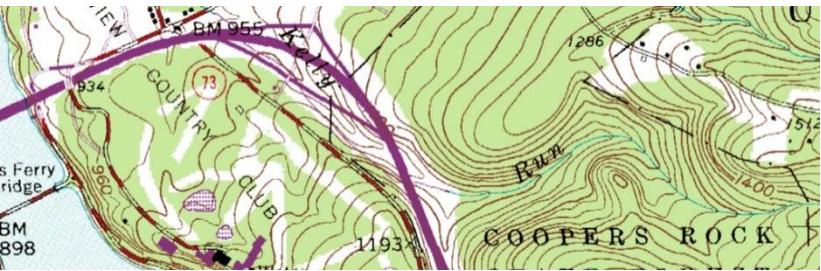
GIS Maps?



Map Types



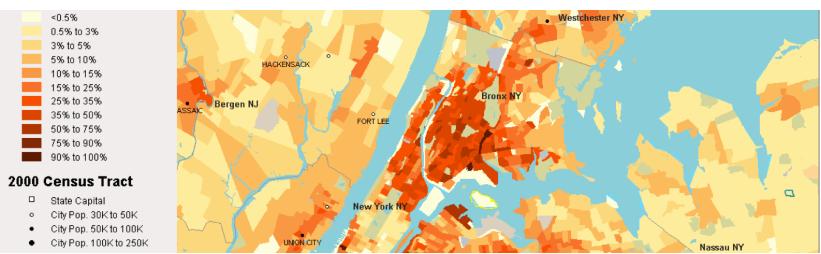
Cognitive



Reference



Thematic (Unique Values)

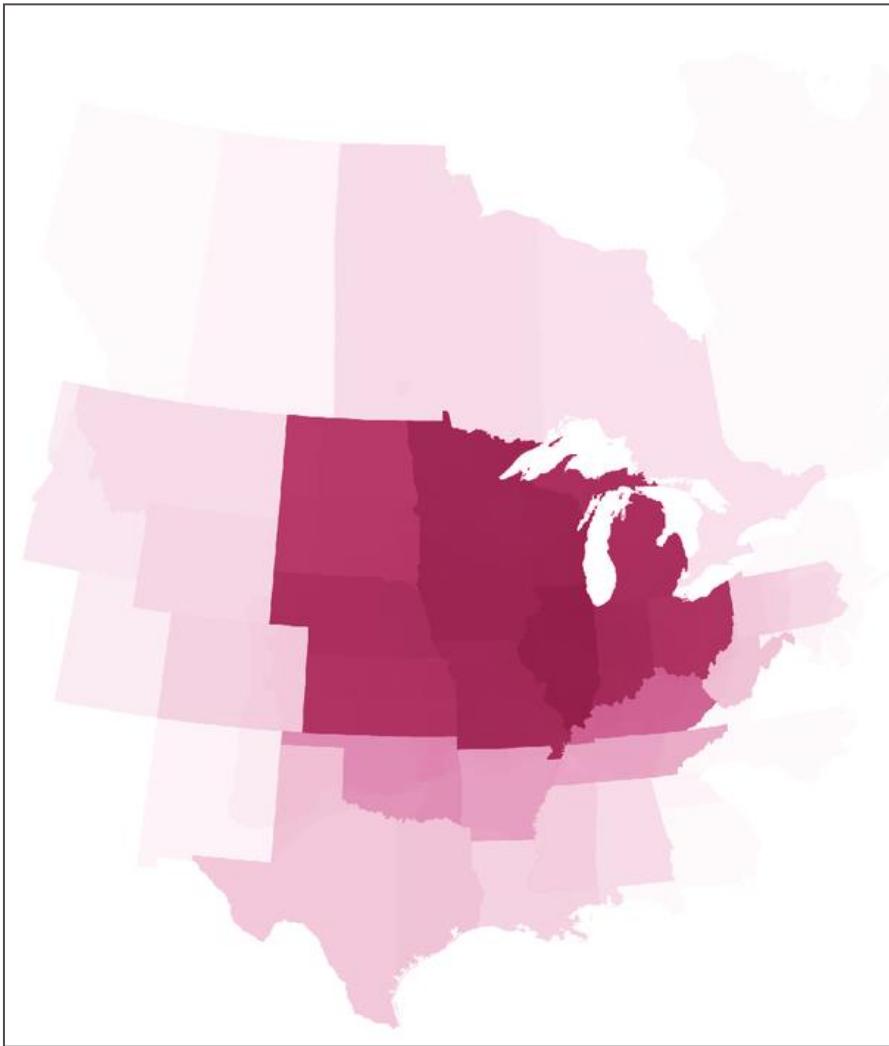


Thematic (Graduated Symbols / Choropleth)



Thematic (Heat Map)

Cognitive/Mental Maps



THE MIDWEST

according to 100 maps published by the following organizations

Alpha Chi Omega
American Association for Nude Recreation
American Chemical Society
American Eurocopter
American Orthopaedic Society for Sports Medicine
Apartment Therapy
Approach Systems, Inc.
Arts Midwest
Asian Pacific American Medical Student Association
Blaupunkt
Cat Fanciers Association
Cause Matters Corporation
Charles Schwab Investment Management
Chinese American Librarians Association
City-data.com
DudeRanch.com
FAICO Information Solutions
FilmInAmerica.com
Financial Industry Regulatory Authority
FMC Agricultural Products
Freemasonry
Gillaspay Associates
Guardian Water and Power
Haiku Society of America
Heartland Express
Home Depot
I-Con Systems, Inc.
Interior Design Educators Council
International Association of Voice Stress Analysts
Invesco
Kindermorgan Terminals
La Bloga
Learner.org

LifeDuringPregnancy.com
Lowrance
Maps.com (twice)
Marlen Textiles
Marten Transport
Megatrux Transportation
Midwest Dairy Association
Midwest Forensic Resource Center
Midwest Outdoors Television
Midwest Regional Rail System
Midwestern Magical Authority
MK Diamond Products
Moostash Joe Tours
Munich Re
National Association of Engineering Student Councils
National Coalition of Blacks for Reparations in America
National Council of Corvette Clubs
National Equity Fund
National Farm to School Network
National Model Railroad Association
National Precision Bearing
Northeast Biomanufacturing Center and Collaborative
Northwest Designs of Illinois
Northwood University
On Site Energy
Perkett PR
Phannenberg Signaling
Phi Delta Theta
Plunkett's Pest Control
Professional Trailbuilders Association
Project Lead The Way
Rails-to-Trails Conservancy
Rand McNally

Reliable Sprinkler
Siemer Enterprises
Single Action Shooting Club
Society for Photographic Education
Society of Quality Assurance
South African Consulate
Southern Fulfillment Services
Sportscar Club of America
Square 9
SVF Flow Controls, Inc.
Ulano Corporation
University of Michigan
University of Minnesota Duluth
U.S. Army Corps of Engineers
U.S. Bureau of Labor Statistics
U.S. Census Bureau
U.S. Centers for Disease Control
U.S. Department of Energy
U.S. Department of Labor
U.S. Environmental Protection Agency
U.S. Federal Energy Regulatory Commission
U.S. Geological Survey
U.S. Fish and Wildlife Service
U.S. Library of Congress
U.S. National Institute of Science and Technology
U.S. National Park Service
U.S. National Weather Service
U.S. Tennis Association
Verizon
Western Interstate Commission for Higher Education
Wikipedia
Wisconsin Milk Marketing Board
Women of Reform Judaism

<http://www.radicalcartography.net/index.html?midwest>

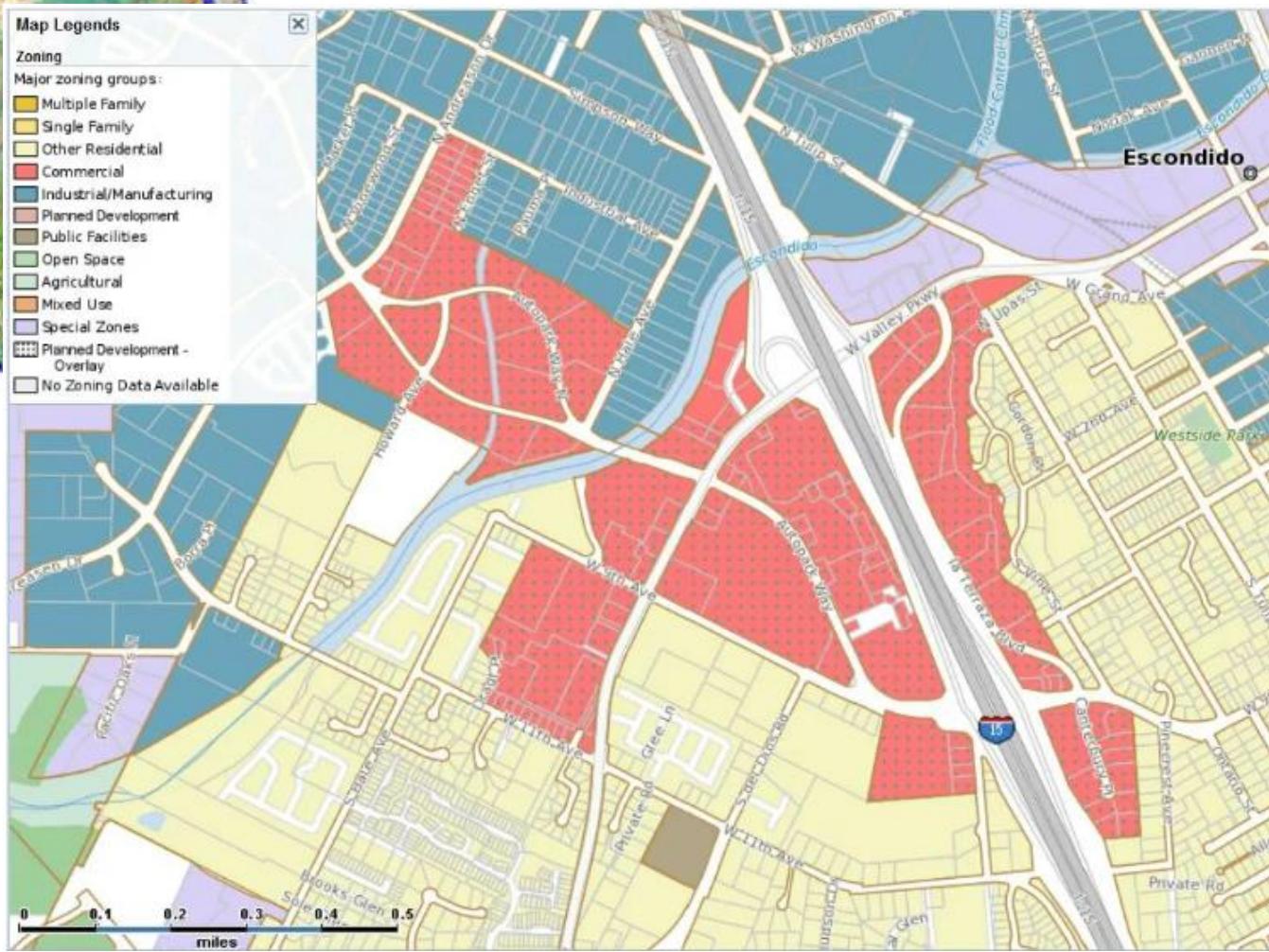
<https://www.citylab.com/design/2013/07/go-ahead-try-drawing-outline-midwest-map/6208/>





**Let's make
a mental
map**

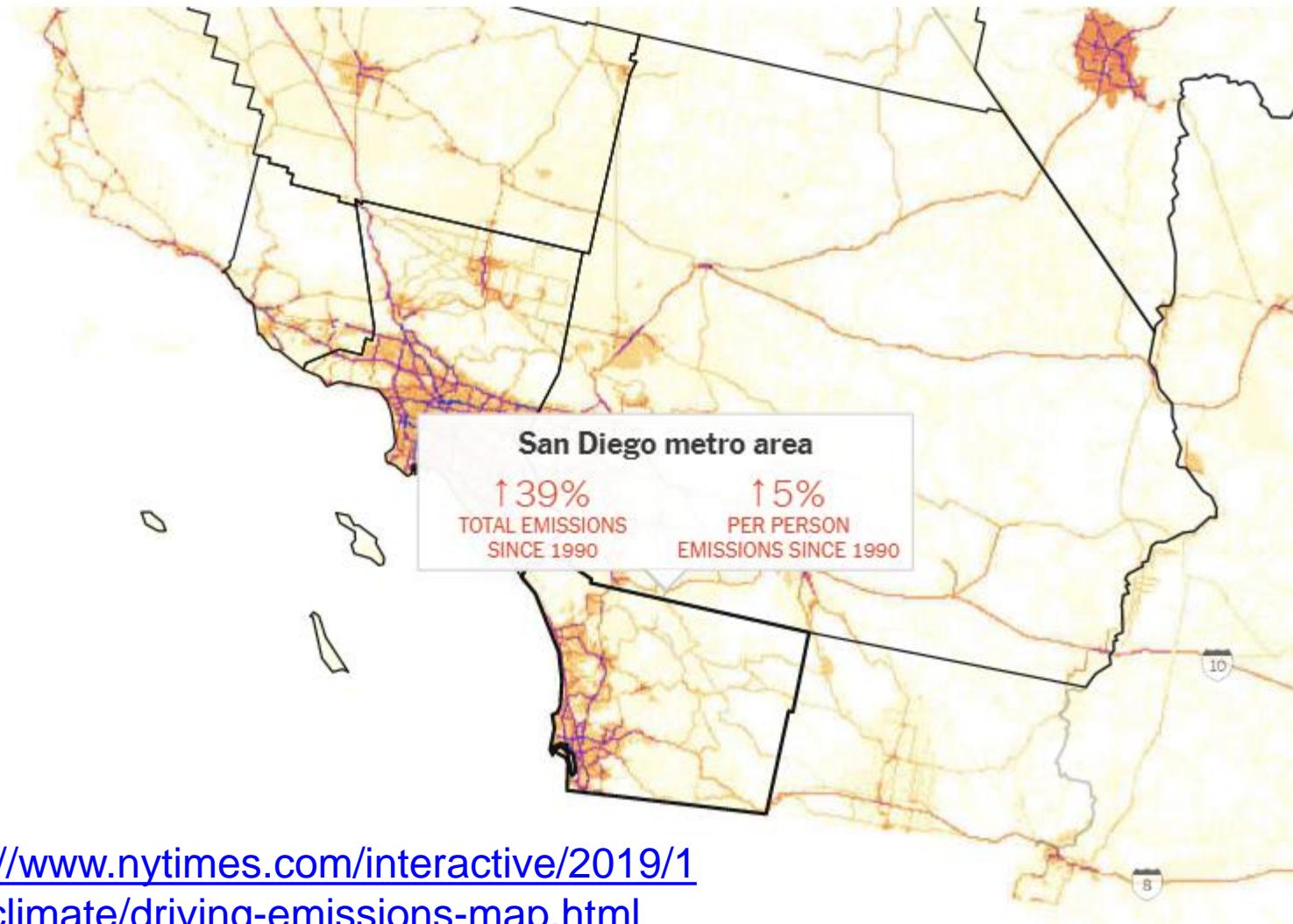
1. Take out a piece of paper
2. Draw your home neighborhood
 - Add in streets and landmarks
3. Compare it to a real map of the neighborhood that you find online



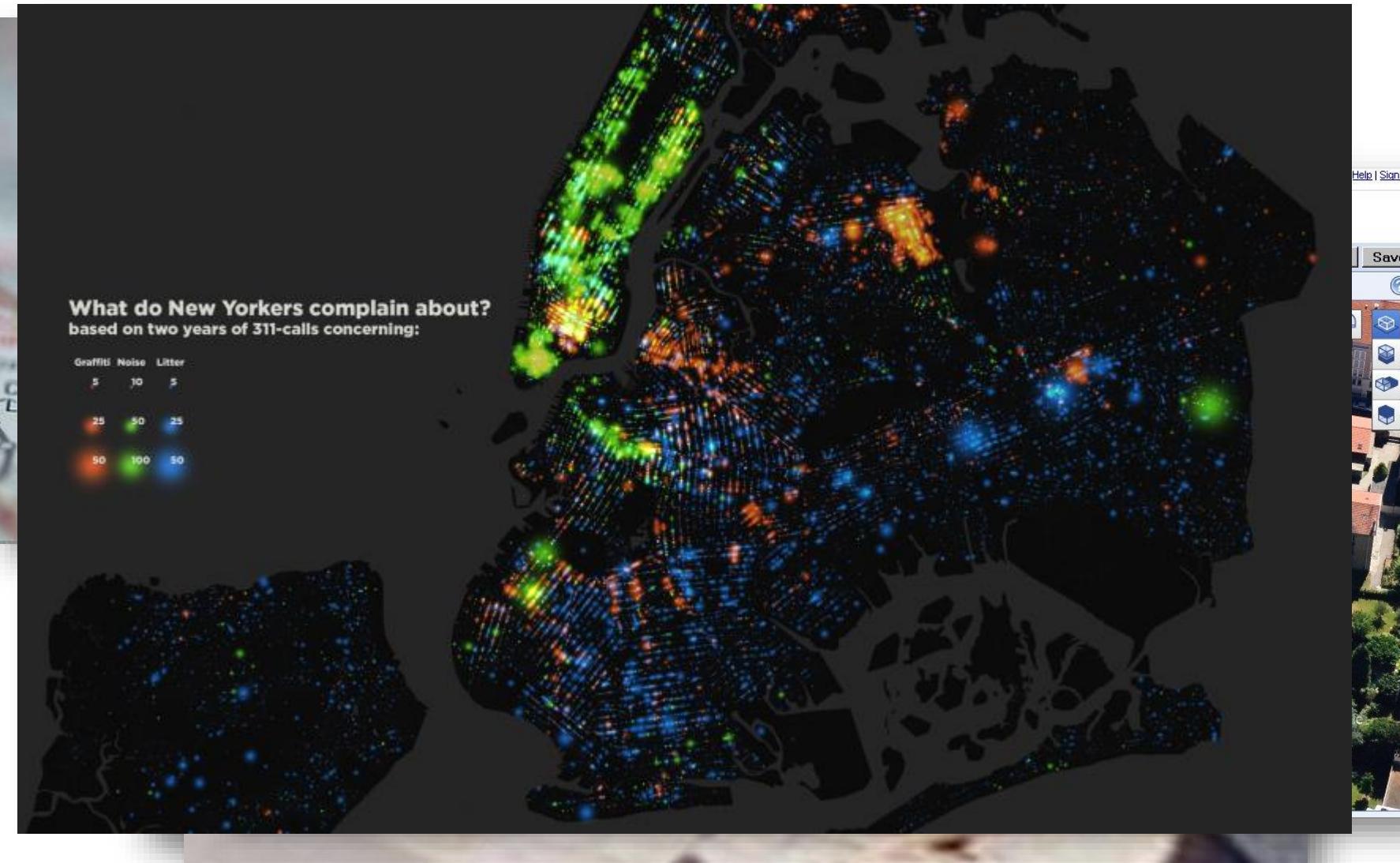
The New York Times

on every road in the **San Diego metro area** ▾

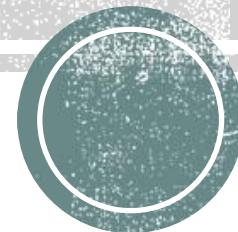
or choose another metro area.



Evolution of Web-based GIS / Geospatial Design



Understanding GIS Concepts



Key Terms

Points, Lines and Polygons

Attributes

Geodatabase, Shapefile, Layer

Spatial v Attribute/Tabular Queries

Geocoding

Metadata



GIS Tabular Data

- Spatial Elements
 - Lat/Long, Address, X/Y
- Attributes
 - What you want to symbolize, label, or analyze

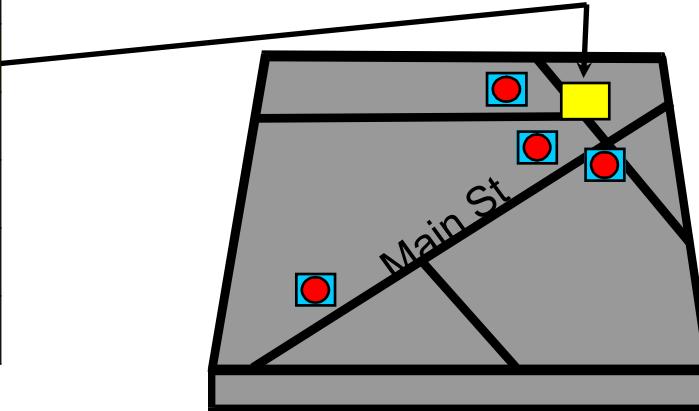


Incident Id	Removed	Removal Method	Surface Type	Latitude	Longitude
4846611	7/16/21	Paint	Wall	32.75132	-117.0938783
4846609	7/29/21	Paint	Wall	32.75132	-117.0938783
4816922	7/15/21	Paint	Garage Door	32.750944	-117.1118513
4810643	7/9/21	Paint	Wall	32.7546344	-117.0986685
4805879	7/8/21	Paint	Electric Box	32.7432331	-117.1009836

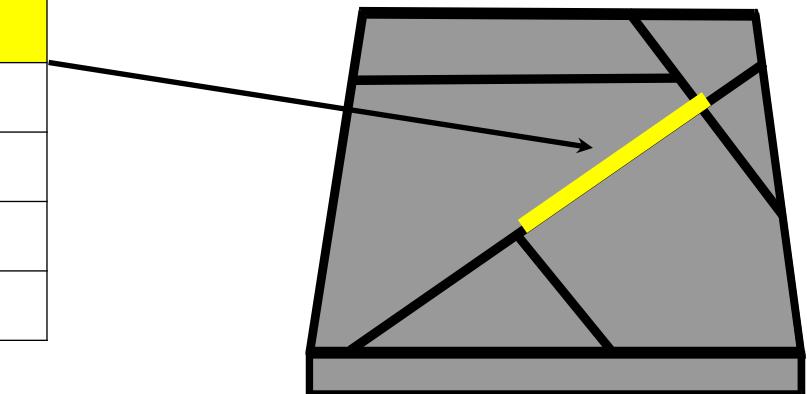


Selecting via Attribute Table or Map

COMPLAINT	ADDRESS	DATE	TIME
Graffiti	999 2nd St.	8/15/21	22:00
Graffiti	830 Main St.	8/22/21	20:30
Graffiti	100 Cross St.	8/27/21	15:00
Trash	1000 Main St.	9/4/21	22:35
Broken Window	997 Main St.	9/6/21	23:00



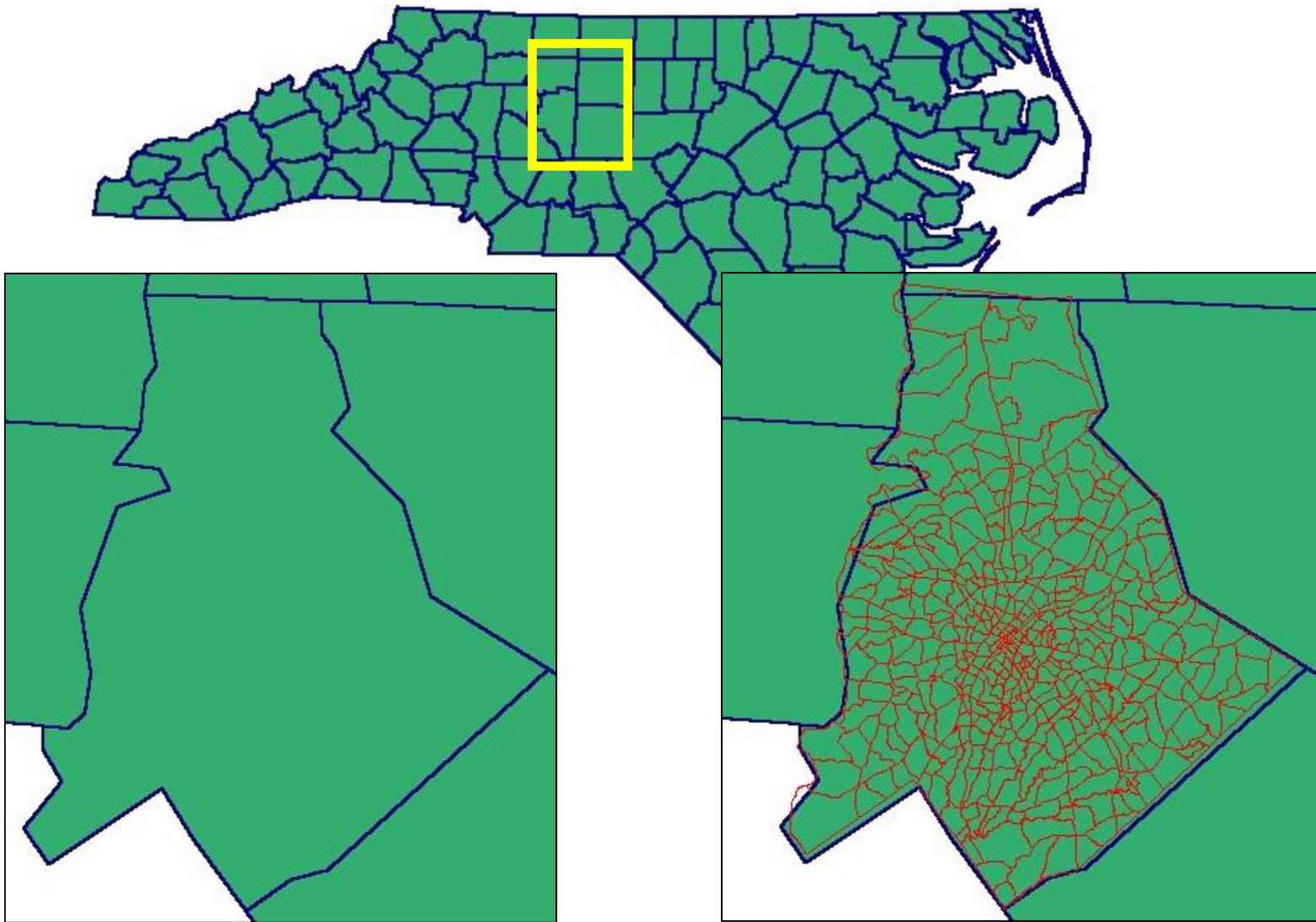
STREETNAME	STTYPE	STNUMLOW	STNUMHIGH	DIRWAYS	LANES
Main	St	801	900	Two Way	4
Main	St	901	1000	Two Way	4
Main	St	701	800	Two Way	4
Chester	Rd	101	200	One Way	2
1st	St	301	400	Two Way	2



The database could be queried to find out where a record is on the map... or vice versa.



Scale Matters: Data Collection





Data Collection Issues

- Importance of good data
“garbage in, garbage out”
- People tend to forget, ignore, lose sight of errors in data once it is in digital form
- GIS can map incorrect data as well as correct data



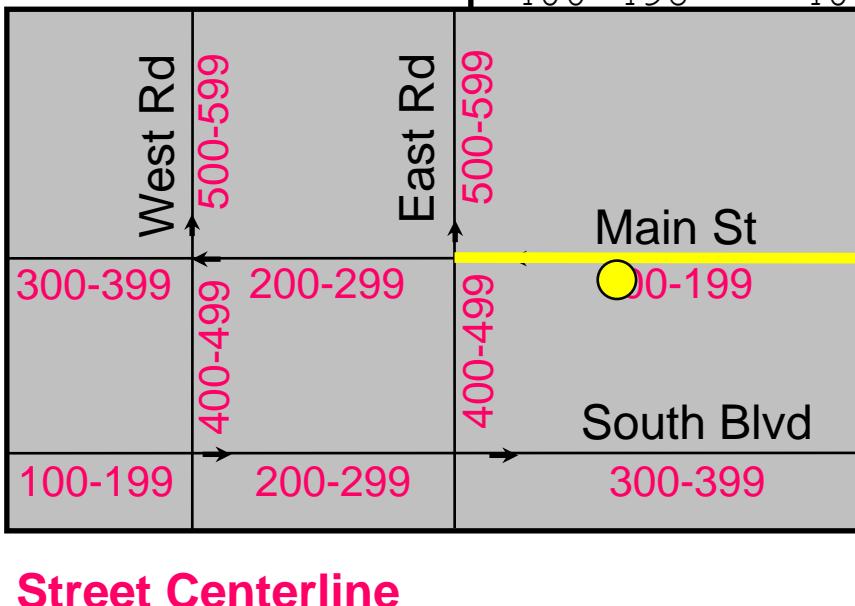
Metadata

- Metadata = data about the data
 - Who created the layer
 - When it was created
 - Spatial and attribute descriptions
 - Projections & Coordinate systems
 - Scale



Geocoding/Address Matching

- Assigning a location on the earth's surface
- Individual address or entire data file



LeftRange	RightRange	Street-Name
100-198	101-199	Main St
200-298	201-299	Main St
300-398	301-399	Main St
100-198	101-199	South Blvd
200-298	201-299	South Blvd
300-398	301-399	South Blvd
400-498	401-499	East Rd
	-599	East Rd
	-499	West Rd
	-599	West Rd

Street File

**Address to match:
160 Main St**





- **Queries**
 - Tabular/Attribute & Spatial
- **Overlays**
 - Visual & GIS
- **Buffers**
- **Hot spots**

GIS Analysis Tools: Tabular/Attribute Queries

Query:

Surface Type = Wall

Removed after July 15

Incident Id	Removed	Removal Method	Surface Type
4846611	7/16/21	Paint	Wall
4846609	7/29/21	Paint	Wall
4816922	7/15/21	Paint	Garage Door
4810643	7/9/21	Paint	Wall
4805879	7/8/21	Paint	Electric Box

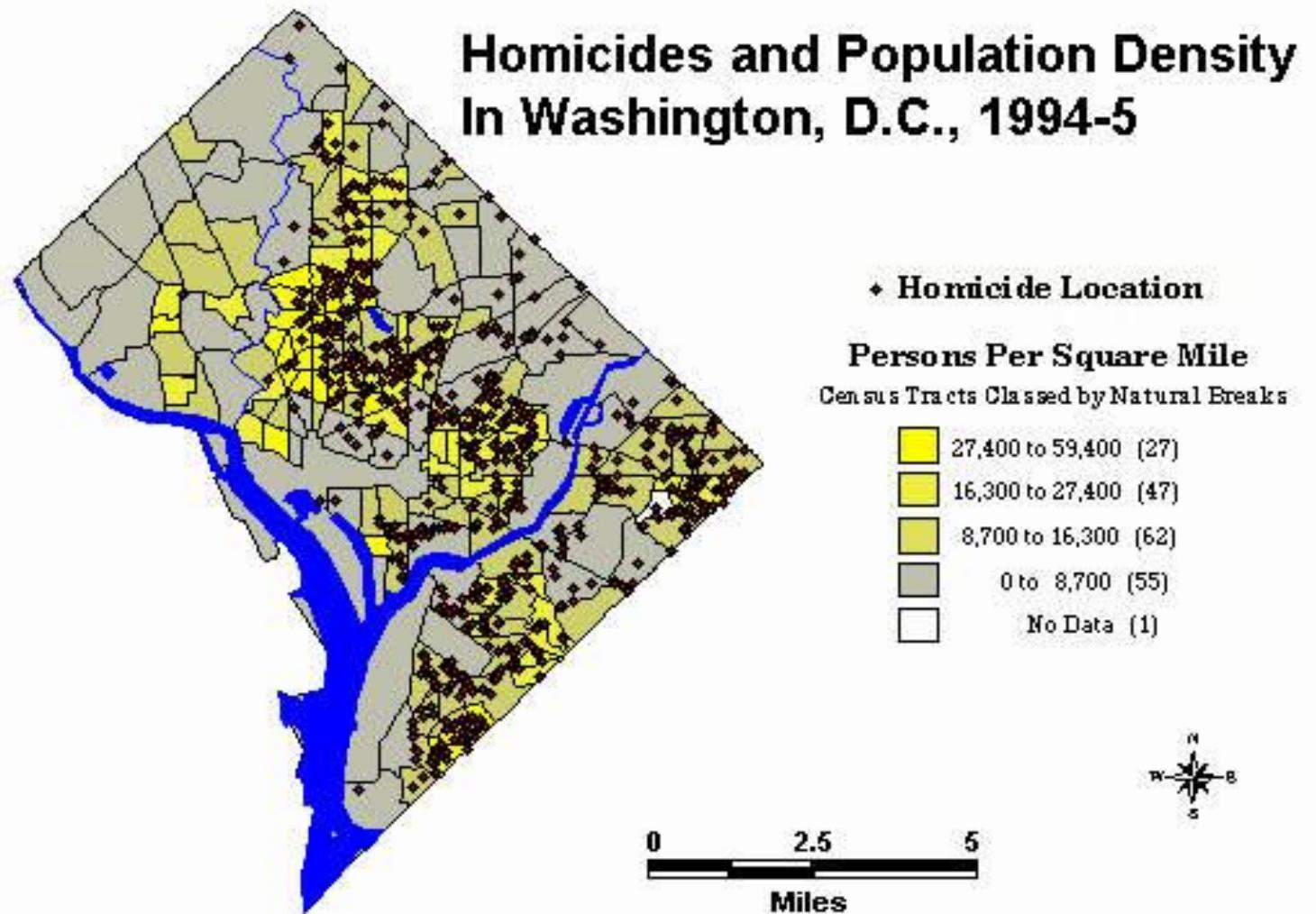


GIS Analysis Tools: Spatial Queries

- **Reporting:** Give me a report of property tax revenue by land use type in a proposed redevelopment area.
- **Profiling:** What is the demographic profile of two areas that the City is going to annex?
- **Notification:** Who is located within 500 feet of a proposed alcohol establishment?



Homicides and Population Density In Washington, D.C., 1994-5

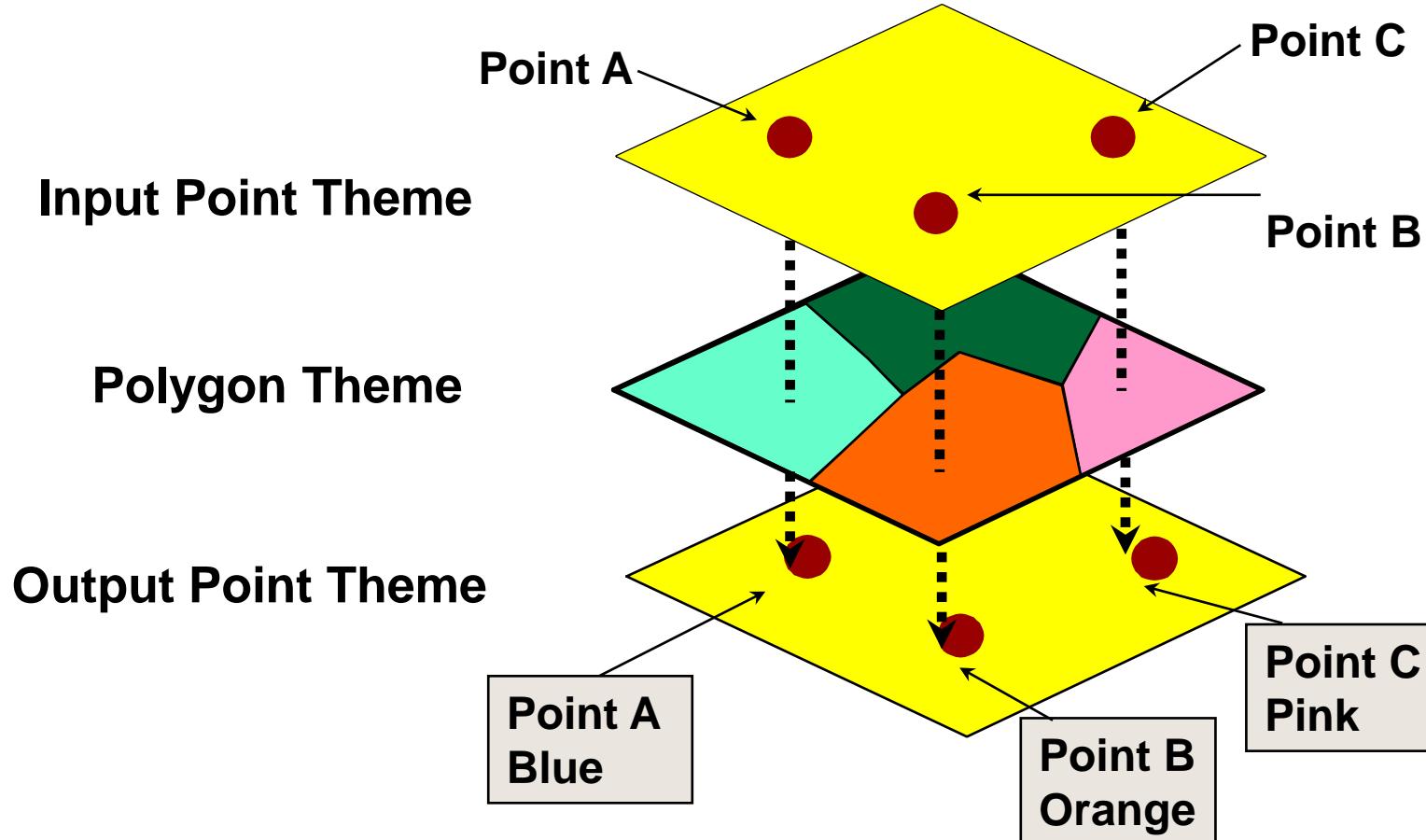


Sources: Washington Metropolitan Police Department; 1990 Census of Population and Housing / Author: Dan Sadler

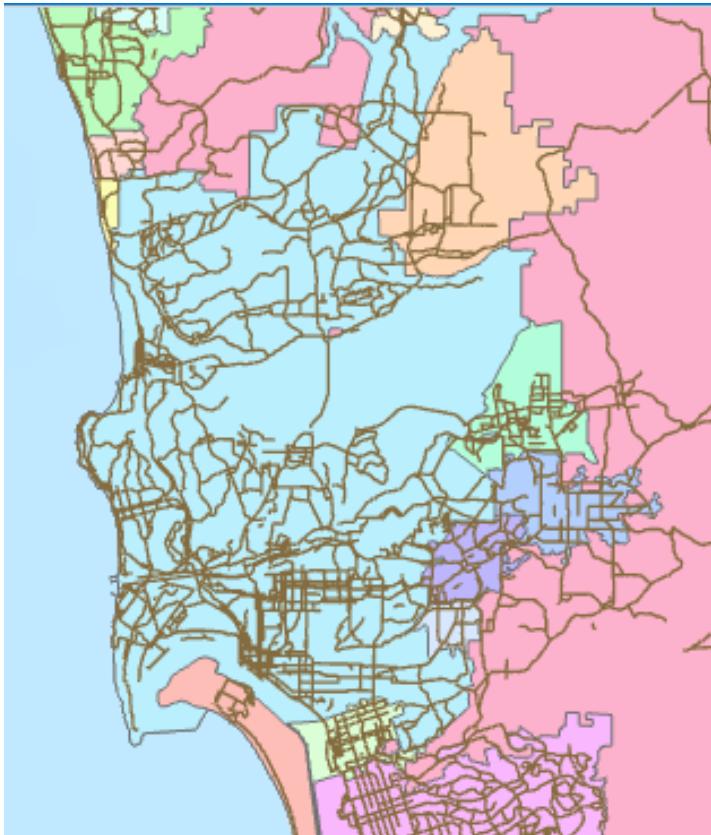
GIS Analysis Tools: Visual Overlay

Examine relationships
between two data sets

GIS Analysis Tools: GIS Overlay: Points and Polygons/Areas



GIS Analysis Tools: GIS Overlay: Points and Polygons/Areas



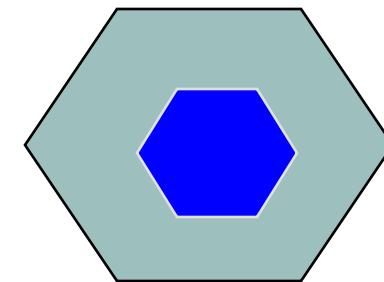
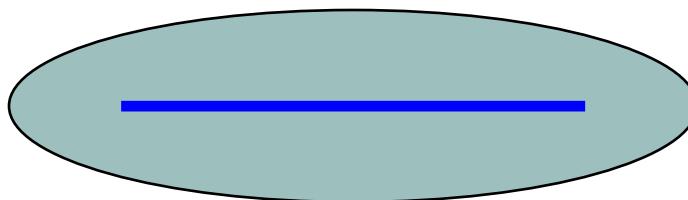
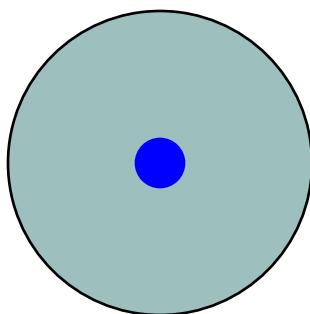
San Diego County
Municipalities & Bike Routes

BIKE_ROUTES_SpatialJoin X								
calculate		Selection: <input type="button" value="Select By Attributes"/> <input type="button" value="Zoom To"/> <input type="button" value="Switch"/> <input type="button" value="Clear"/> <input type="button" value="Delete"/> <input type="button" value="Copy"/>						
Shape *	Join_Count	TARGET_FID	RD20FULL	ROUTE	Route_Class	Shape_STLength	NAME	
polyline	1	9255	SR 52 Bike Path	1	Multi-Use Path	25154.415871	SAN DIEGO	
polyline	1	9926	PRIVATE RD	1	Multi-Use Path	14072.884526	SAN DIEGO	
polyline	1	866	I-5 NB	6	Freeway Shoulder Bicycle Acc...	11801.51106	S.D. COUNTY	
polyline	1	9922	PRIVATE RD	1	Multi-Use Path	11451.143541	SAN DIEGO	
polyline	1	7783	SAN LUIS REY BIKE PA...	1	Multi-Use Path	9408.681951	OCEANSIDE	
polyline	1	9902	PRIVATE RD	1	Multi-Use Path	9349.945207	SAN DIEGO	
polyline	2	2996	SCRIPPS POWAY PY	2	Bike Lane	9303.610288	S.D. COUNTY	
polyline	1	1726	PALM CANYON DR	2	Bike Lane	9235.582498	S.D. COUNTY	
polyline	1	0252	MISSION RAV BIKE DA	1	Multi-Use Path	0185.342470	SAN DIEGO	

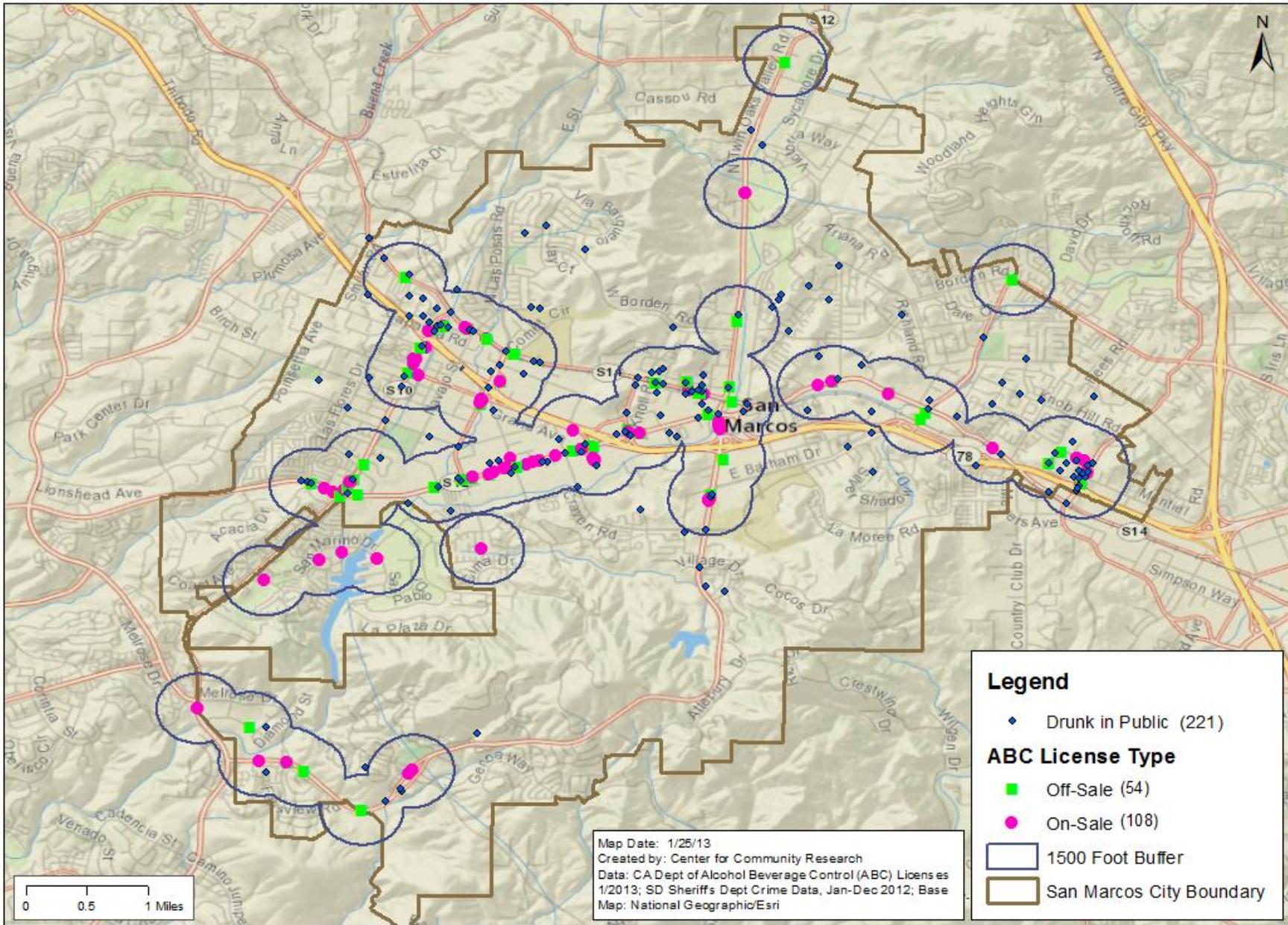


GIS Analysis Tools: Buffers

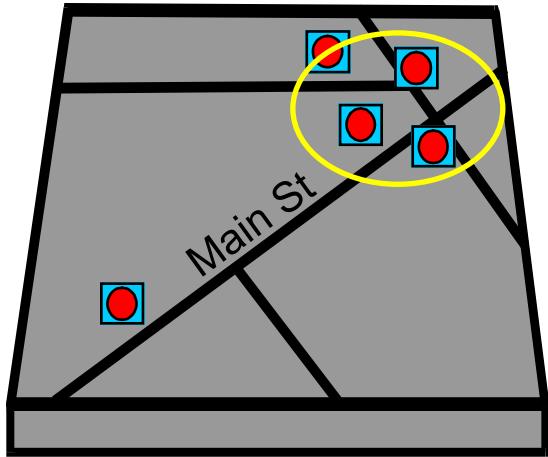
- All three feature types can be buffered - point, line, polygon
- Buffer is the area that is within a specified distance from a feature or features on a map



City of San Marcos - Alcohol Establishments & Drunk in Public Incidents, 2012



GIS Analysis Tools: Hot Spots: An Introduction

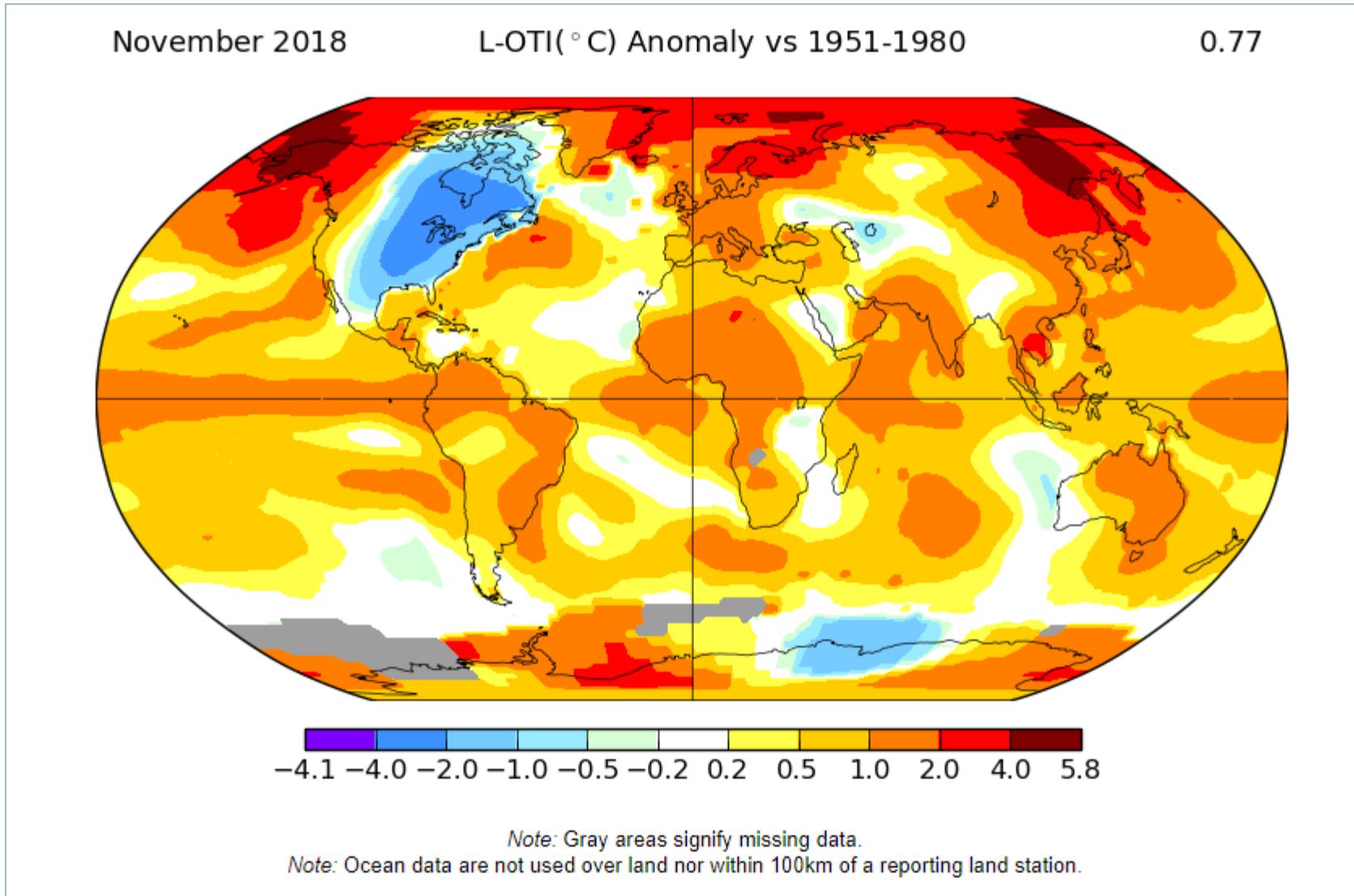


The data could be analyzed to look for clusters/hot spots of similar environmental hazard violations that occurred in a given month.

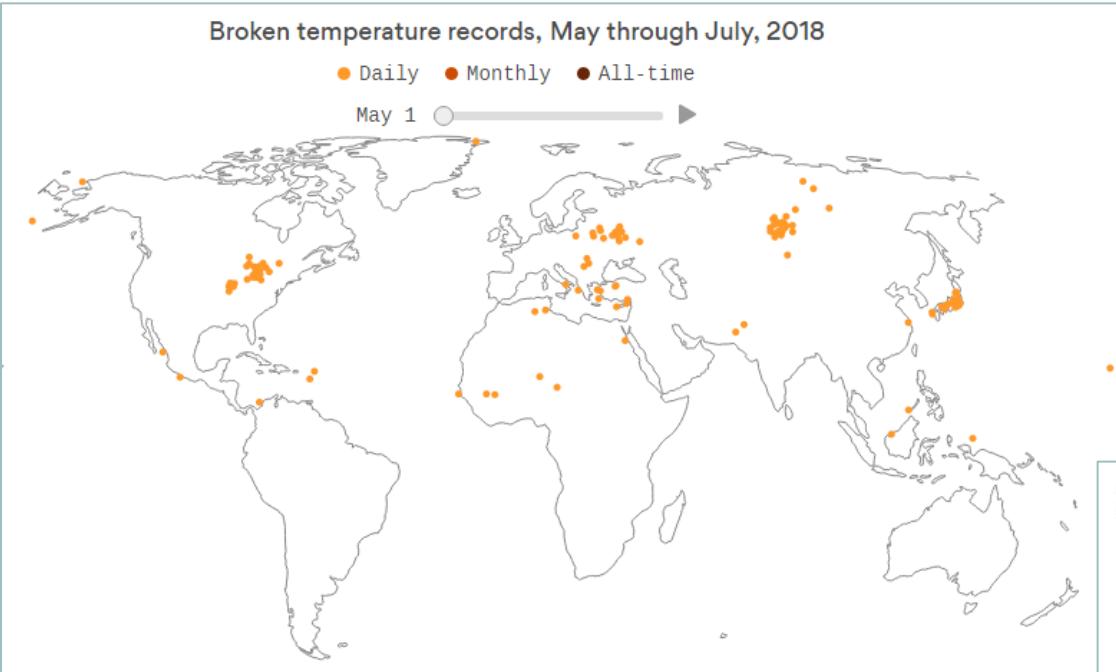
- Geography Matters
- Visualizing Persistence and Displacement



GIS Analysis Tools: Hot Spots

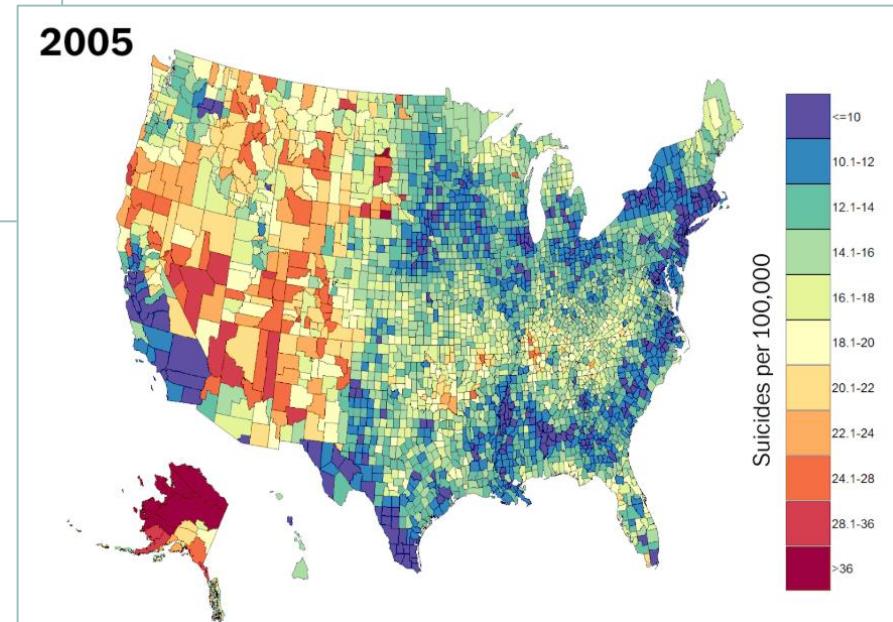


GIS Analysis Tools: Hot spots: Change over Time



<https://www.axios.com/heat-records-temperature-climate-change-map-f82a017b-4383-43d0-ae52-42517138b108.html>

<https://www.washingtonpost.com/news/wonk/wp/2018/05/24/mapping-the-rising-tide-of-suicide-deaths-across-the-united-states/>



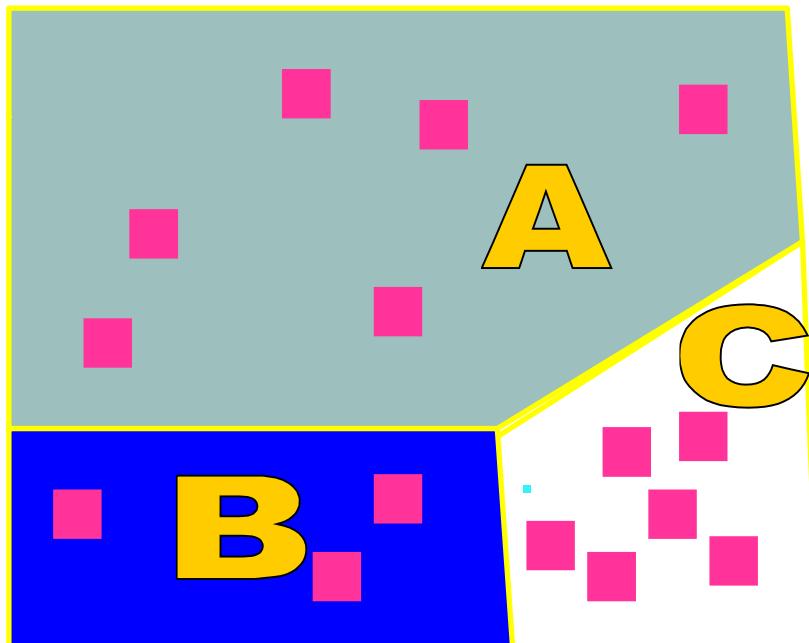
GIS Analysis Tools: Measuring

- Counting Events
- Calculating Rates
- Measuring area
- Measuring inclusion/overlap
- Measuring distance



GIS Analysis Tools: Measuring: Counting Events

Sum the number of events/records within each polygon/area

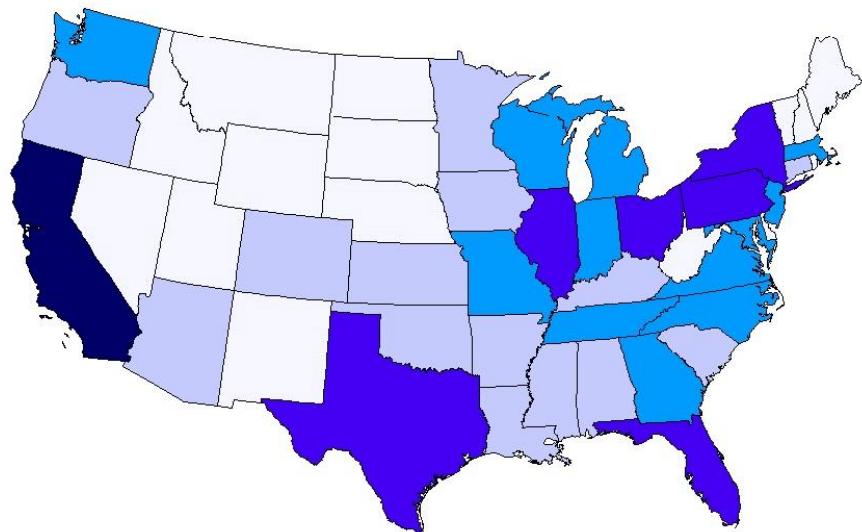


NAME	Shape_Length	Shape_Area	Sum route	Summarized Length in MILES	Count of Lines
SAN DIEGO	1194978.068805	9544911046.662451	37233	804.675817	8903
S.D. COUNTY	2506901.243521	97646721343.120544	7360	337.590519	2161
CHULA VISTA	325033.5354	1452900938.742253	3921	167.363615	1536
OCEANSIDE	248596.218946	1175733868.798229	4019	137.638282	1175
CARLSBAD	180343.880363	1090226292.542328	1561	119.008929	771
SAN MARCOS	219233.476	679796239.844849	1389	73.838456	622
ESCONDIDO	554350.53547	1043451403.312138	2413	70.06406	781
ENCINITAS	160832.550503	545861140.405242	1501	53.141602	505



GIS Analysis Tools: Measuring Area

Population



Population Density



Standardizing by Area: Accounts for the fact that in bigger areas, one would often expect greater raw numbers of people.



GIS Analysis Tools: Measuring Rates

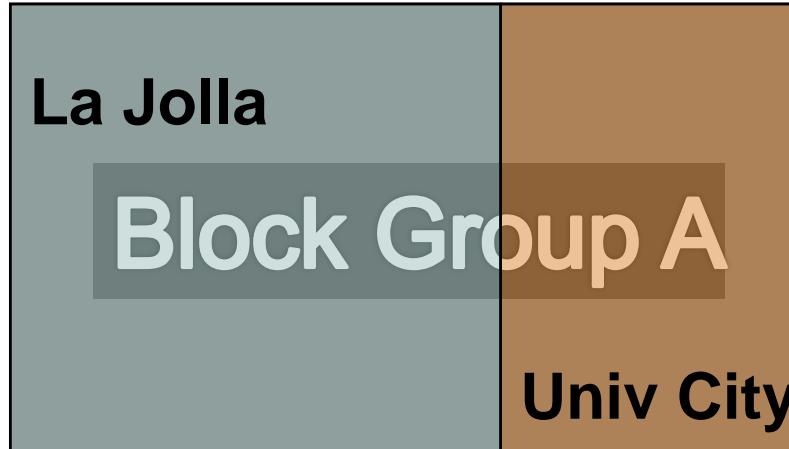
Standardizing Data

	NORTH	RATE	SOUTH	RATE
Population	15,000		26,000	
Housing Units	4,000		8,000	
SUVs	510	3.4	1200	4.6
Robberies	5	0.03	25	0.1
Fire Hydrants	475	11.9	555	6.9
Doctors	80	0.53	140	0.54



GIS Analysis Tools: Measuring: Inclusion/Overlap

Problem: What percentage of Census Block Group A is contained within La Jolla and within University City?



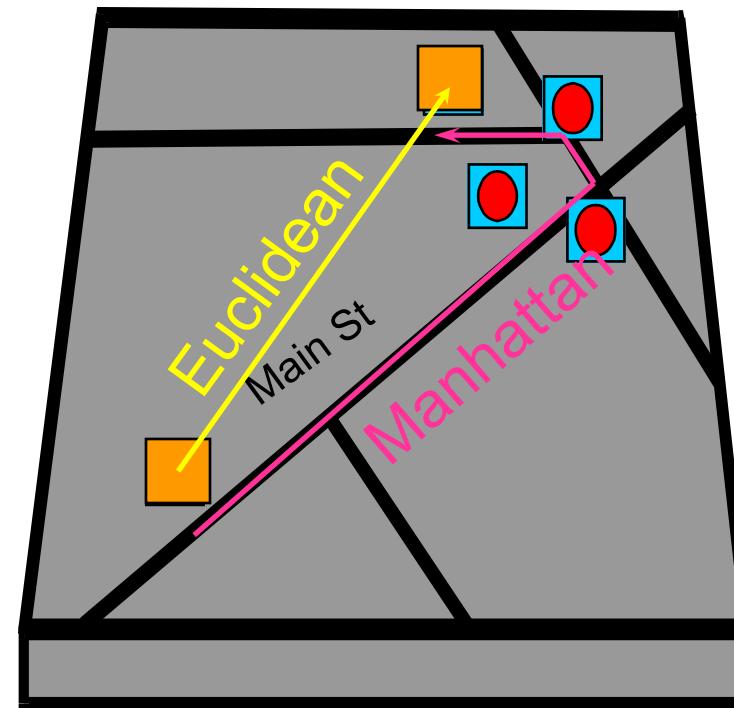
La Jolla = 35%

University City = 65%

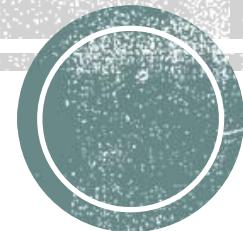


GIS Analysis Tools: Measuring Distance

- Euclidean
 - “as the crow flies”
- Manhattan
 - Street network distance



GIS Data Dissemination



GIS Data Dissemination: Outputs from a GIS

Maps, most common output from a GIS

Text in form of tables and reports

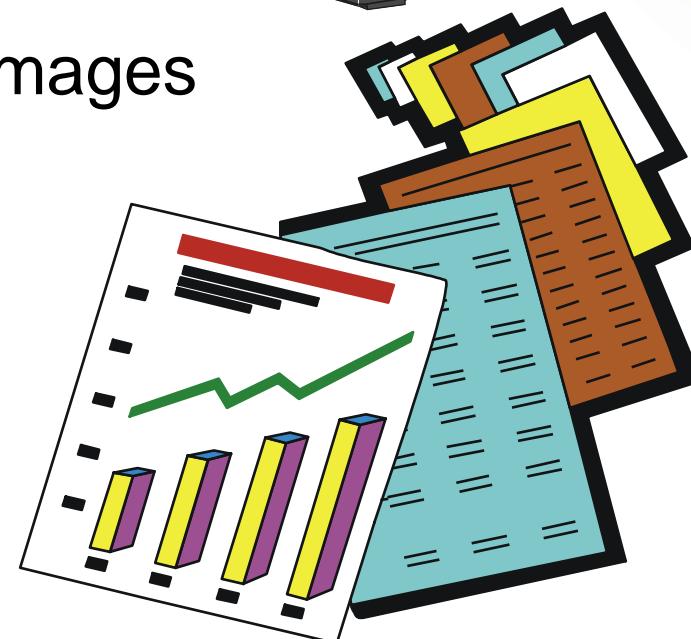
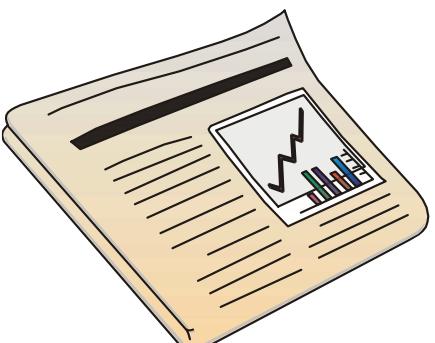
Graphs

Digital data



Images or 3-D images

Website



GIS Data Dissemination: Communicating via a Map

Often people will only see the output

“A map is worth a thousand words”

Know your audience!

Identify the main purpose or problem

Identify information that needs to be included

Decide what combination of maps, reports, graphs to use

Select the amount of detail needed



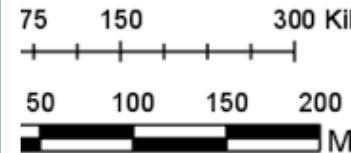
GIS Data Dissemination: Map/Cartographic Elements

MY
MAP

Title



Legend/Key



Scale Bar



North Arrow

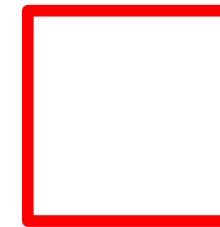
Map Date:
10/3/21

By J.Wartell

Map
Date/Maker

*Data from
SANDAG*

Sources/
Notes



Neat Lines



Local, National & Int'l Data Resources

- SANDAG (both GIS and demographic)
 - <https://www.sandag.org/index.asp?classid=21&fuseaction=home.classhome>
 - <https://www.sandag.org/index.asp?classid=26&fuseaction=home.classhome>
- SanGIS Data Warehouse
 - <https://gis-sangis1.hub.arcgis.com/pages/download-data>
- Los Angeles – <https://egis-lacounty.hub.arcgis.com/>
- California - <https://gis.data.ca.gov/>
- U.S. Census – <https://data.census.gov/cedsci/>
- U.S. Data.gov – <https://catalog.data.gov/>
- USGS Maps and Data
 - <https://www.usgs.gov/science/faqs/mapping-remote-sensing-and-geospatial-data>
- Latin America (statistical data)
 - https://guides.library.cornell.edu/latinamerica_statistics
- UCSD Geisel GIS Lab
 - <https://ucsd.libguides.com/c.php?g=90732&p=585762>