

# GIS @ DUSP

INTRODUCTIONS

WHAT IS GIS?

REQUIREMENTS AND TESTOUT

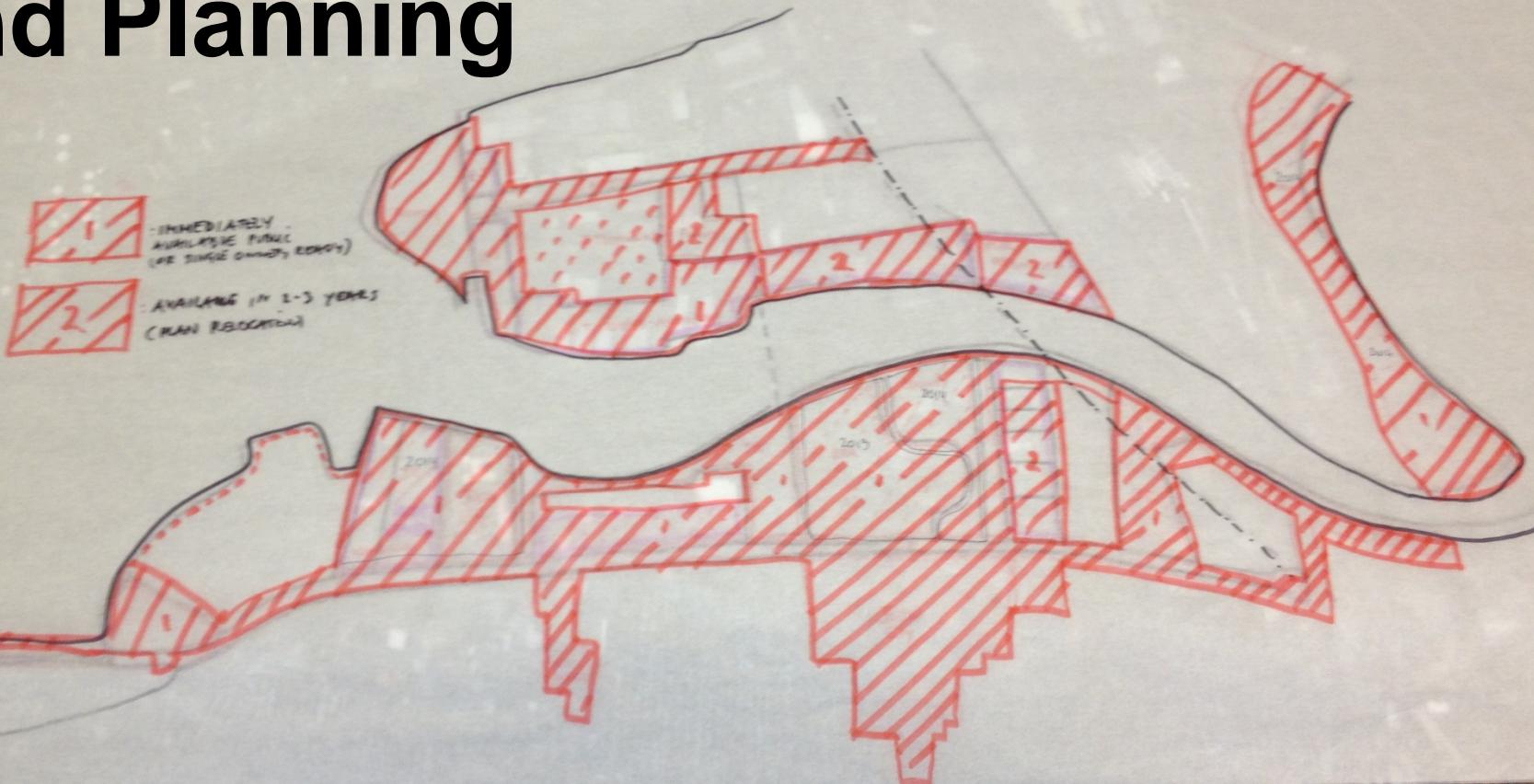
GIS TESTOUT REVIEW

FALL 2015

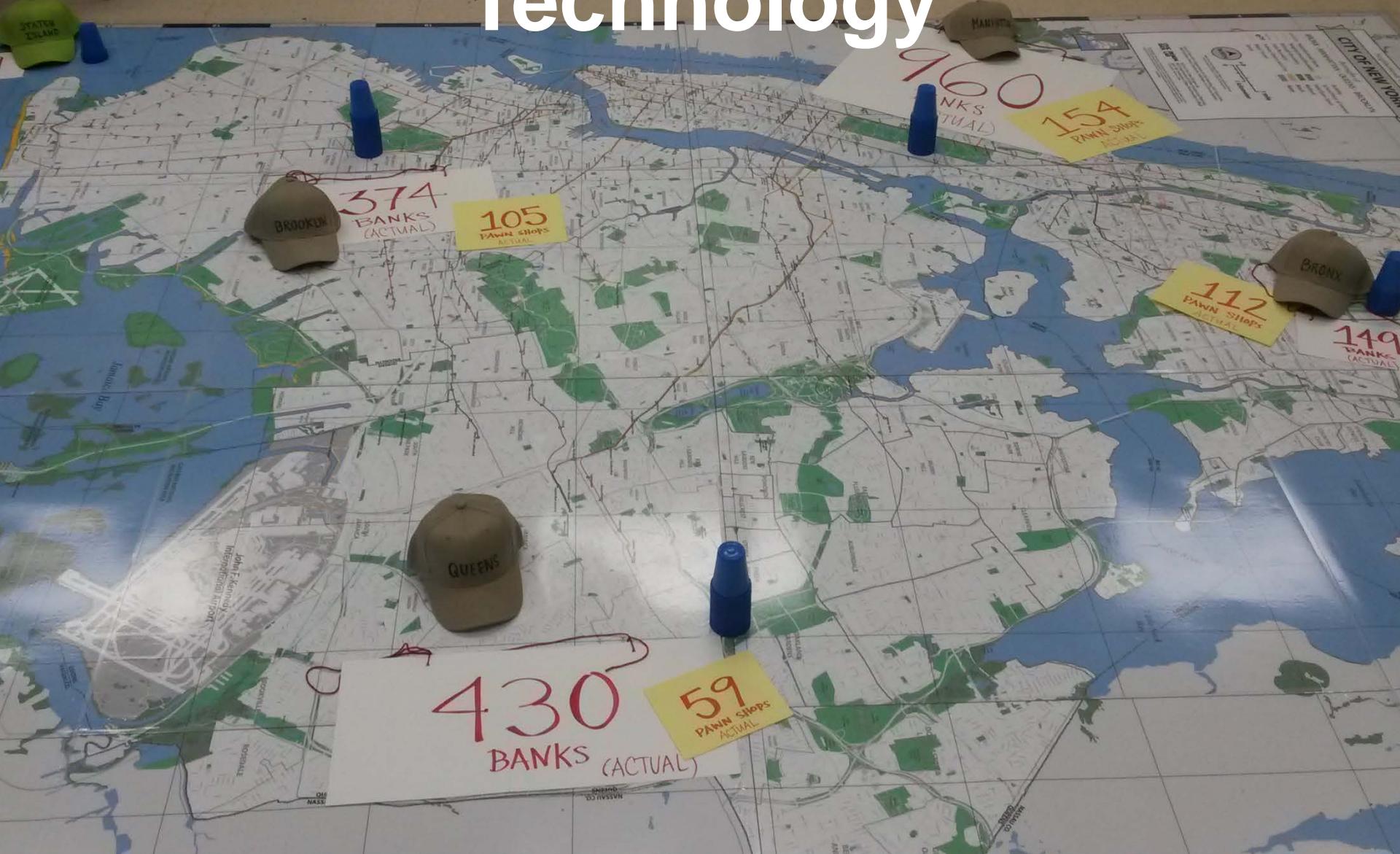
SEPTEMBER 3, 2015

ROOM 4-237 - 3:00-5:00PM

# Merge Geography, Data, and Planning



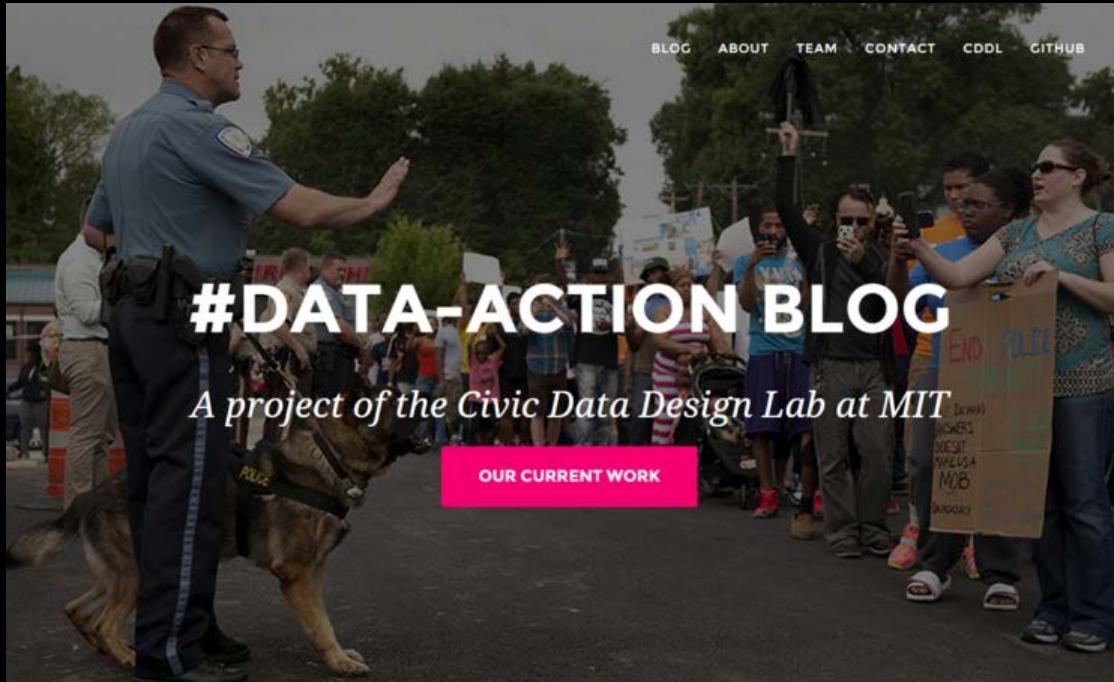
# Promote Literacy in Spatial Technology



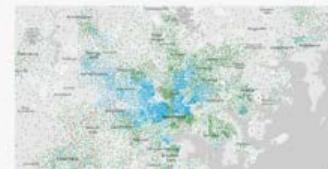
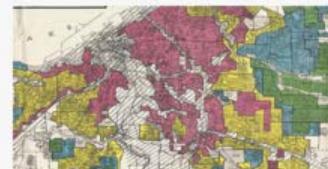
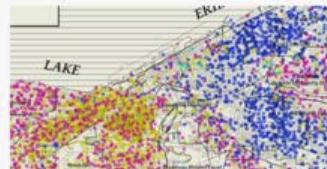
# Research latest mapping technologies



# Support Lab Projects and Initiatives



BLOG





**Support  
Students,  
Faculty, and  
Research Staff**

# Today's Outline

- Introductions
- What is GIS?
- How is GIS used in Planning?
- DUSP GIS Requirements
- DUSP GIS Resources
- Testout Review
  - Making Maps
  - Relational Databases
  - Descriptive Stats
  - Geoprocessing
  - Data Extraction
- Open Lab Session (Room 9-251)

# Merge Geography, Data, and Planning

How do planners use GIS?



Base Map    2010 Photo

Help    Mobile    Scale 1" = 385 ft

Selection    Legend    Location

1 selected    To Mailing Labels    To Spreadsheet

Property Info    Sales History    Property Images    Print

Mass Land Records Website

**Sale Date: 05/19/2010**  
Sale Price \$235,429,000.00  
Sold to NOVARTIS INSTITUTES FOR  
Book / Page 1384/ 50

**Sale Date: 01/19/2005**  
Sale Price \$143,330,211.00  
Sold to NOVARTIS SERVICES, INC.,  
Book / Page 44498/ 81

**Sale Date: 01/09/2003**  
Sale Price \$76,750,000.00  
Sold to DSF CAMBRIDGE LLC,  
Book / Page 1263/ 29

**Sale Date: 01/01/1900**  
Sale Price \$0.00  
Sold to NEW ENGLAND  
CONFECTIONERY CO  
Book / Page 27/ 293

Tax Assessing  
City of Cambridge Assessors Office

Save Map as Image

Google Maps    Go

4.0.7 (production) AppGeo

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# MetroFuture Growth and Preservation Areas

## Targeted Growth Areas

Higher Priority      Lower Priority

MAPC Boundary

### Metropolitan Core



Job growth built around medical and educational institutions, and other major industries

Improved schools, safety, parks attract families and retirees

Build on role as the "hub" of the regional transportation network

### Regional Hubs



Rebirth of industrial cities and downtowns

Focused growth in major suburban economic centers

Best prospects for new transit outside of Metro Core

### Suburban Centers



Maximize potential of major town centers and existing transit

Mixed-use growth expands housing choice and tax revenue

New local bus connections and bike/pedestrian paths

### Priority Conservation Areas



Areas with significant natural, scenic, agricultural, and historical value



# Power and Energy

Platts Oil and Gas Data



Primary Fuel	Capacity (MW) & Operating Status	
	Existing	Planned or Under Construction
Natural Gas	2,401-10,000	
Coal	1,601-2,400	
Hydro	901-1,600	
Uranium	401-900	
Oil	100-400	
Wind		
Solar		
Other		

**Other Infrastructure**  
Major Substations  
Max Voltage 1735 kV or 210 circuits  
Labeled with Substation Name

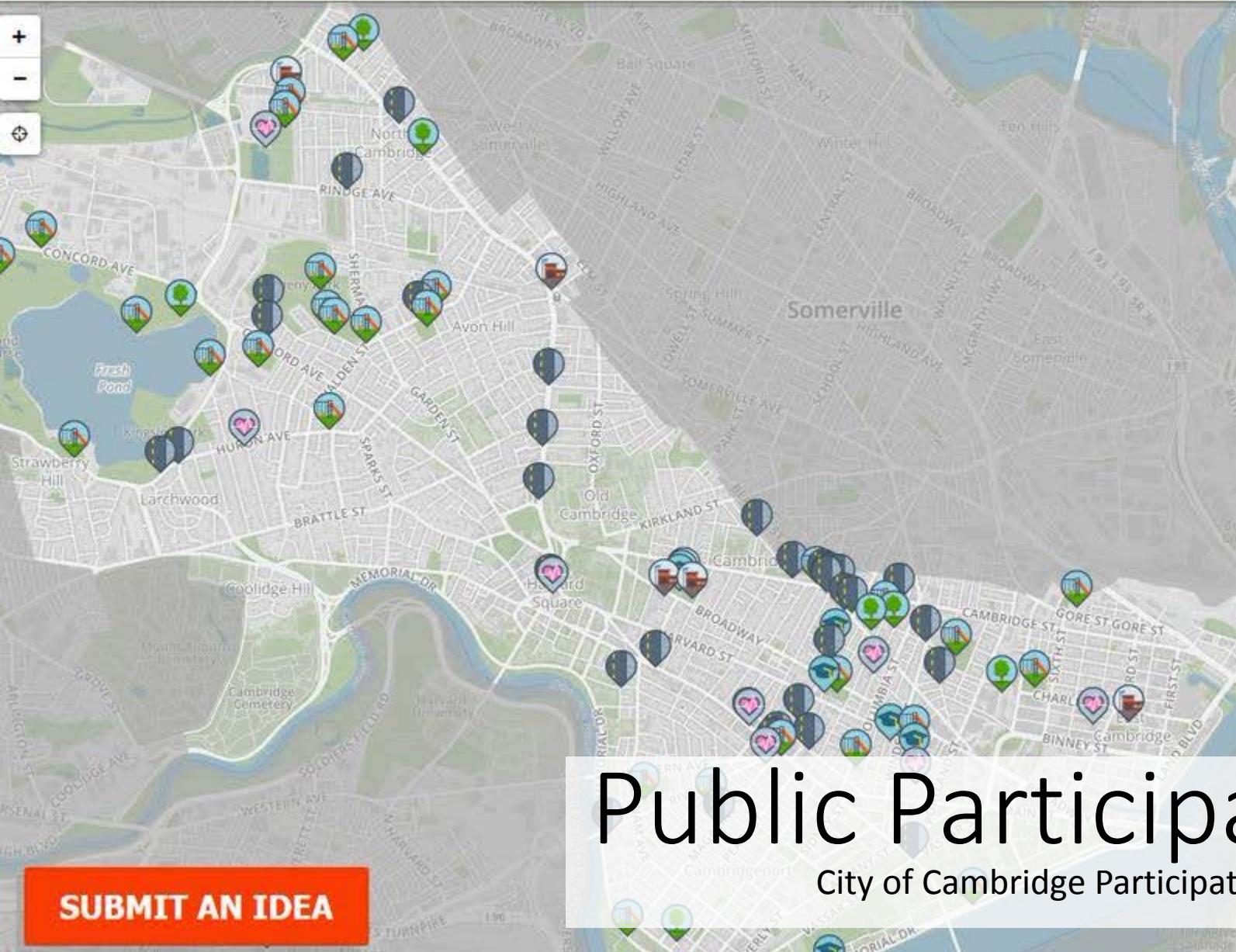
**Utility Service Territories**  
Investor-Owned Utilities & Major Canadian Utilities  
Labeled with Operator Name

## Major Cities

Transmission Line ( $\geq 161$ kV)	Voltage & Status	
	Existing	Planned or Under Construction
DC Line	735-765 kV	
	450-525 kV	
	315-400 kV	
	220-287 kV	
	161 kV*	

\*Some major transmission lines under 161kV are also displayed to show connectivity

Enter an address...



Culture and Comm Facilities

Education

Environment

Parks and Recreati

Public Health and S

Streets and Sidewa

Thelo commented on Fi Square crosswalk lights & seating

Sarah D suggested a St Sidewalks idea: Make Ha Cambridge Streets into C Boulevard w bike lanes a sidewalks

Sarah D suggested a St Sidewalks idea: Make Ca & Hampshire st. into Gra Boulevards w bike lanes sidewalk

John S. commented on sidewalks at this busy lo

John S. commented on equipment

John S. commented on an Renovate Playgroun slackers field

Thelo commented on Bi Prospect Street

# Public Participation

City of Cambridge Participatory Budgeting

SUBMIT AN IDEA

[Sign up for crime alerts](#)[iPhone](#)

0 Clear Filters

Menu

## Search Address

ADDRESS

Cambridge, MA

1600 Pennsylvania Ave, Washington, DC 20500

[Go to Address](#)

JUMP TO CITY

Start typing or click the arrow...

BUFFER

 Off    0.5 miles Only display crimes within buffer

## Event

## Offenders

## Date Range

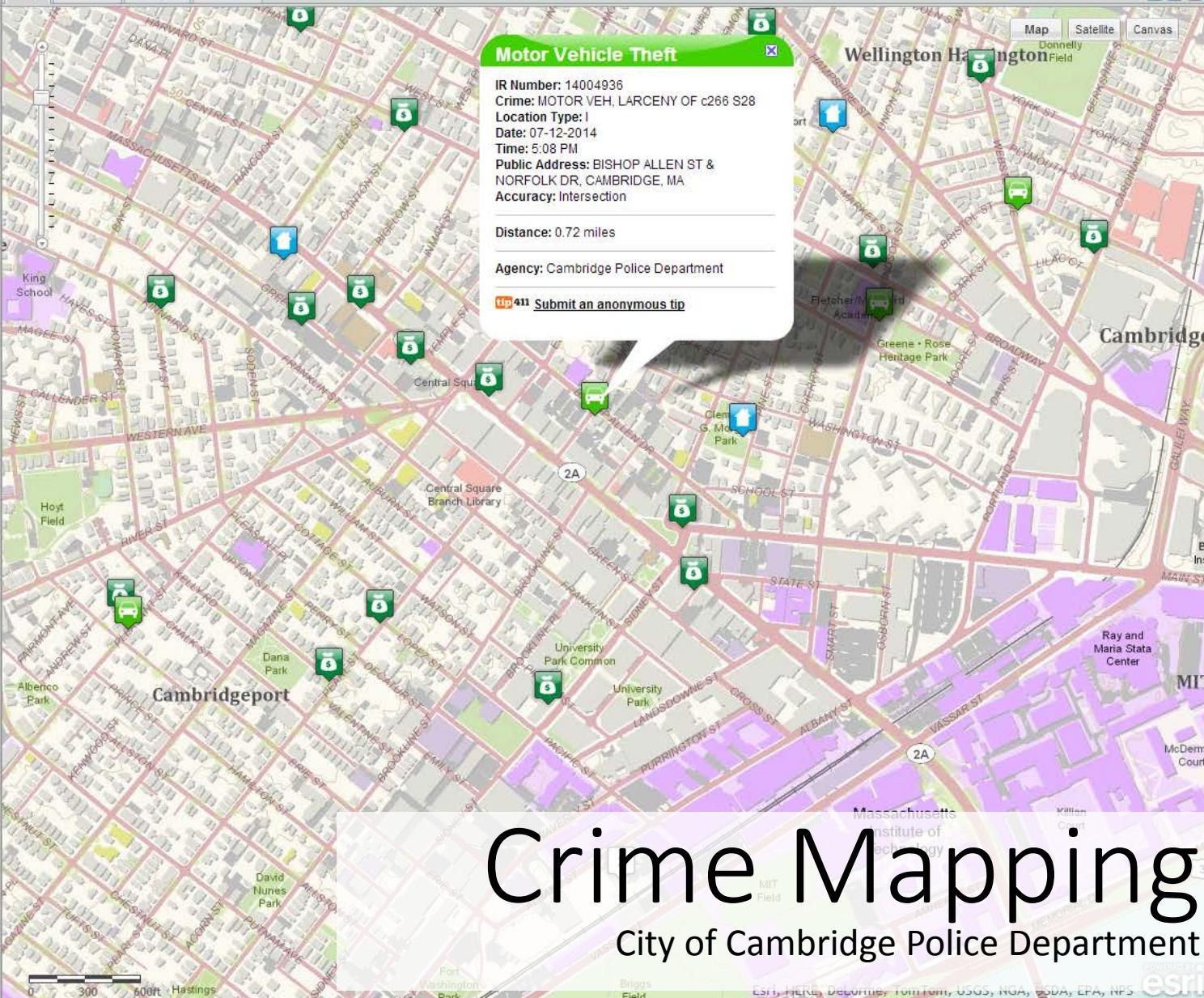
## Analytic Layers

## Data Layers

## Agency Layers

## About RAIDS Online

Map Data Grid Analytics Metadata



# Crime Mapping

## City of Cambridge Police Department



## Table of Contents



## Layers

- Manholes
  - 
  - Discharge
    - 
    -
  - Manholes
    - 
    - Ratings
      - <all other values>
      - Rated
        - Emergency Repair
        - Excellent
        - Fair
        - Good
        - N/A
        - Poor
        - xxx

- Manhole Details
- HyperLinks

- Storm



- Sanitary



- Storm



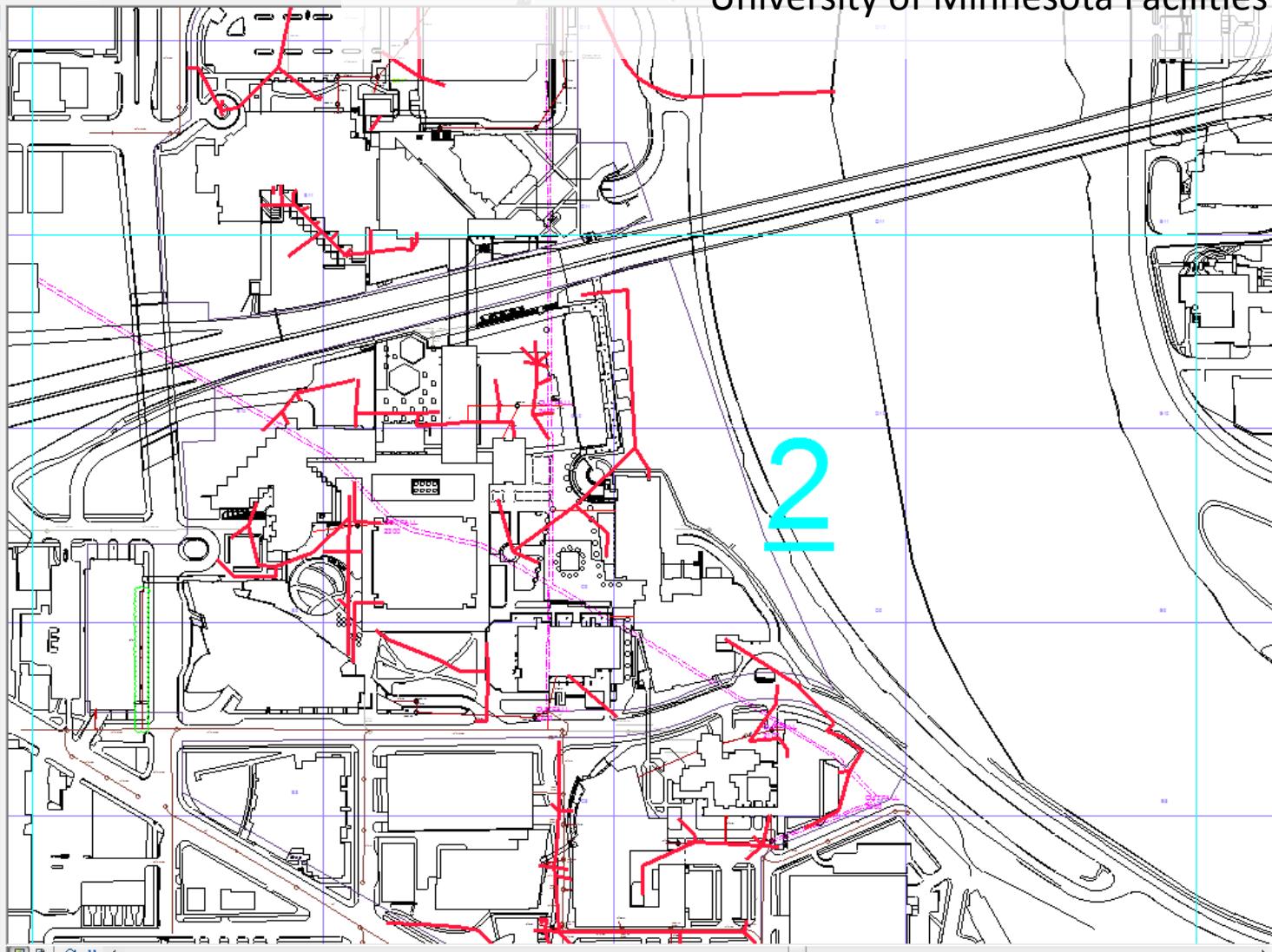
- Water



- MLPS EAST SAN.dwg Group Layer
- MLPS EAST STORM.dwg Group Layer
- MLPS EAST WATER.dwg Group Layer
- MLPS WEST SAN.dwg Group Layer
- MLPS WEST STORM.dwg Group Layer
- MLPS WEST WATER.dwg Group Layer
- STPL SAN.dwg Group Layer
- STPL STORM.dwg Group Layer
- STPL WATER.dwg Group Layer
- Imagery-Pictometry
- Imagery-RNC
- USGS\_200804

# Sewer and Water

## University of Minnesota Facilities





## Sea Level Rise and Coastal Flooding Impacts

Sea Level Rise Confidence Marsh

Vulnerability Flood Frequency

Sea Level Rise ?

5 ft SLR

Legend

Water Depth

Low-lying Areas

Area Not Mapped

Visualization Location

[View Levees](#)

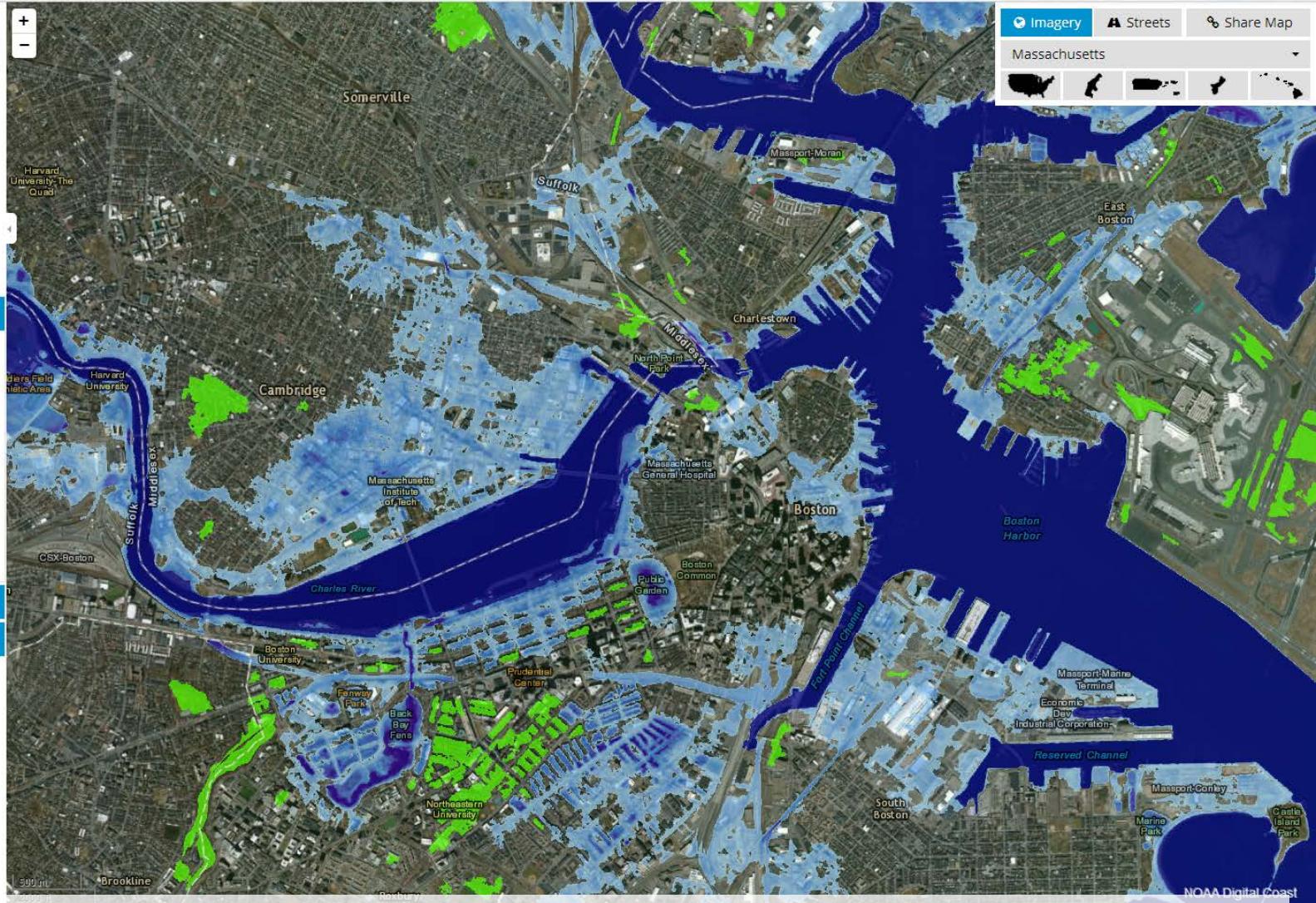
**i Overview**

Use the slider bar above to see how various levels of sea level rise will impact this area. Levels represent inundation at high tide. Areas that are hydrologically connected are shown in shades of blue (darker blue = greater depth).

Levels represent inundation at high tide. Areas that are hydrologically connected are shown in shades of blue (darker blue = greater depth). Low-lying areas, displayed in green, are hydrologically "unconnected" areas that may flood. They are determined solely by how well the elevation data captures the area's hydraulics. A more detailed analysis of these areas is required to determine the susceptibility to flooding.

**Understanding The Map**

**Additional Information**

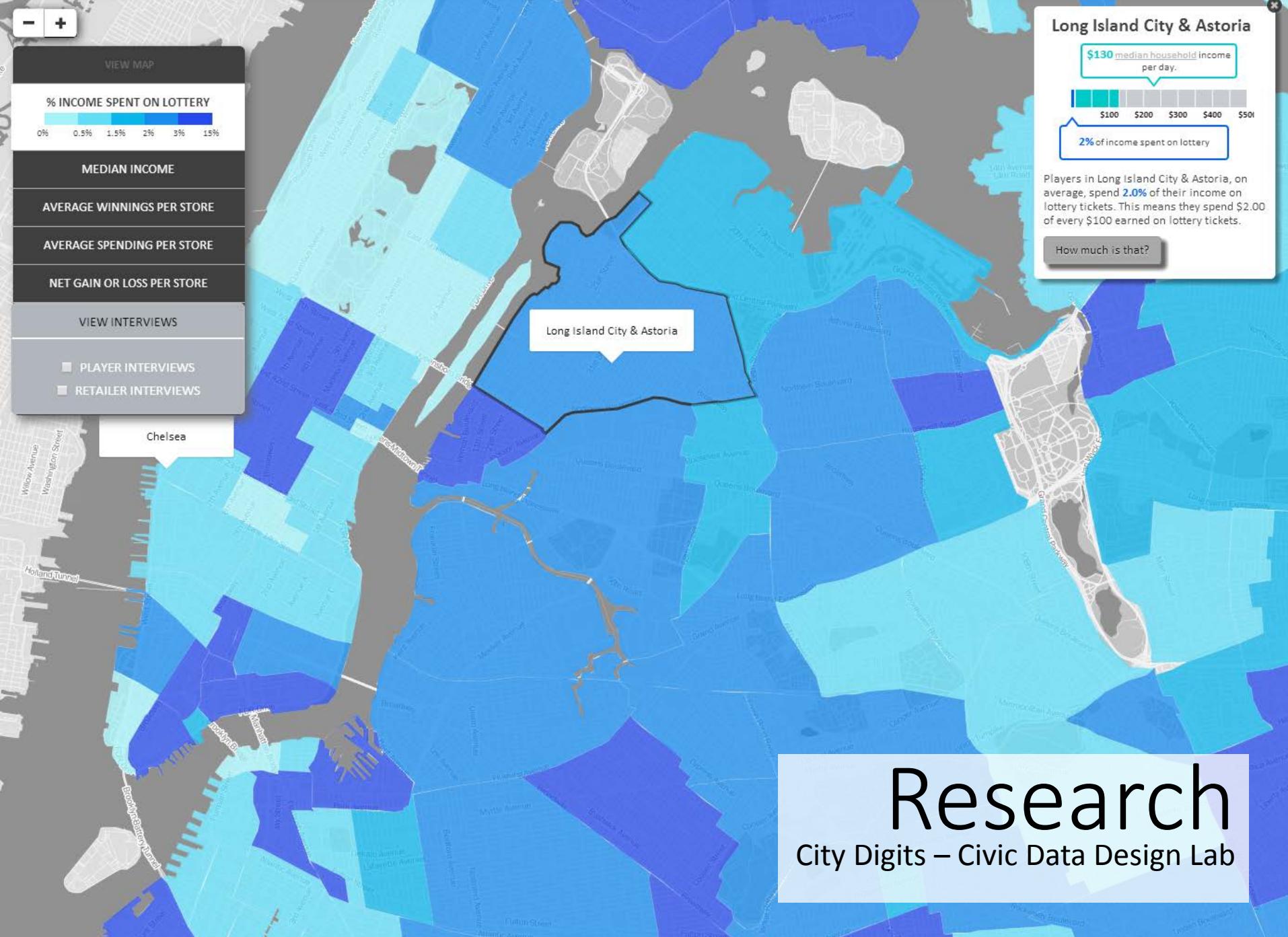


United States Department of Commerce | National Oceanic and Atmospheric Administration | National Ocean Service

Contact Us | Privacy Policy | Link Disclaimer | USA.gov

# Environmental Management

NOAA Sea Level Rise Viewer



# GIS@DUSP

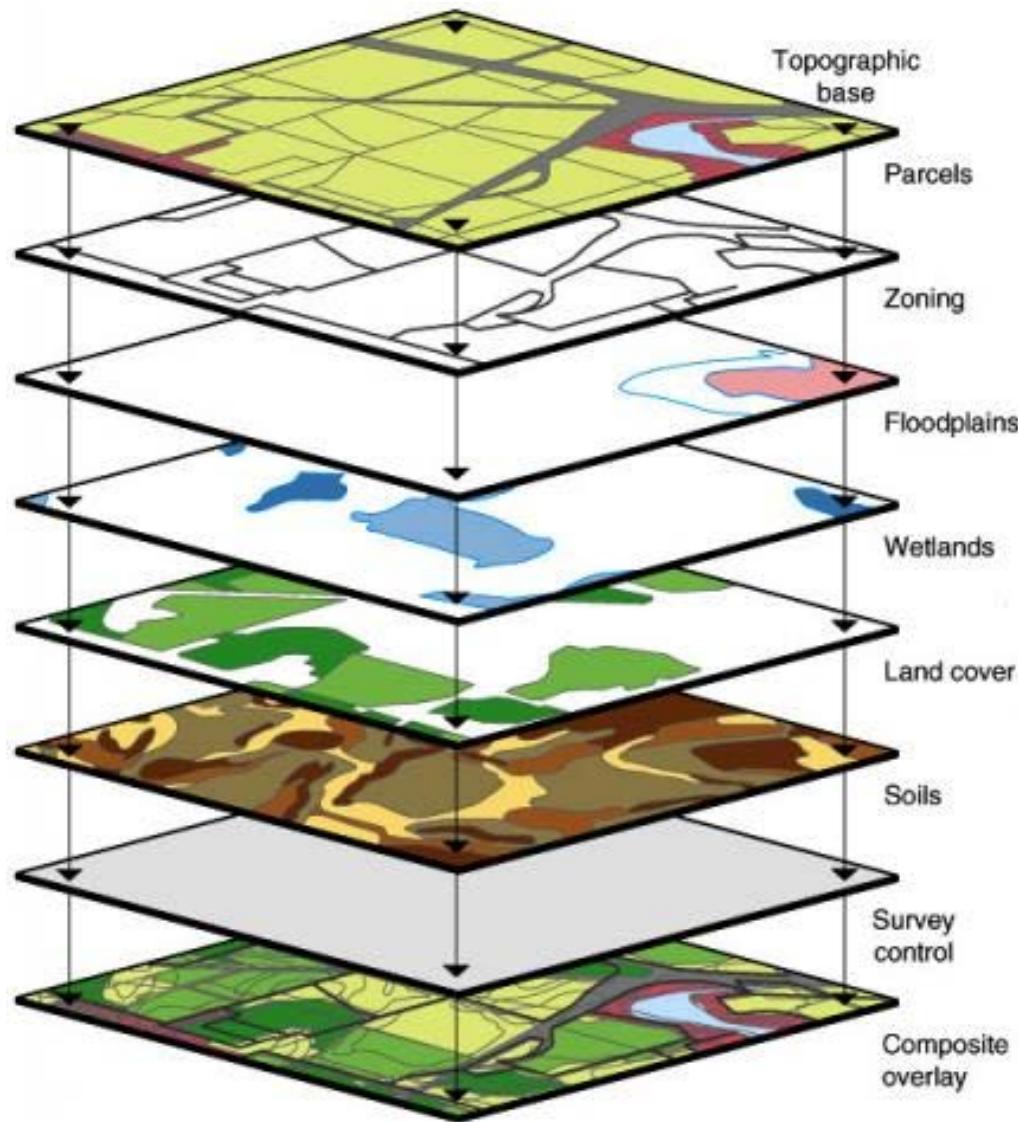
Geographic Information Systems (GIS) have become an essential tool for understanding the urban and built environment.

# What is GIS?

- **Geographic Information System**
  - A system designed to capture, store, manipulate, analyze, manage, and present all types of spatial data
- **What is spatial data?**
  - Any data that sits somewhere in space!
- **But, it's not just a system...**  
... it is also a science.

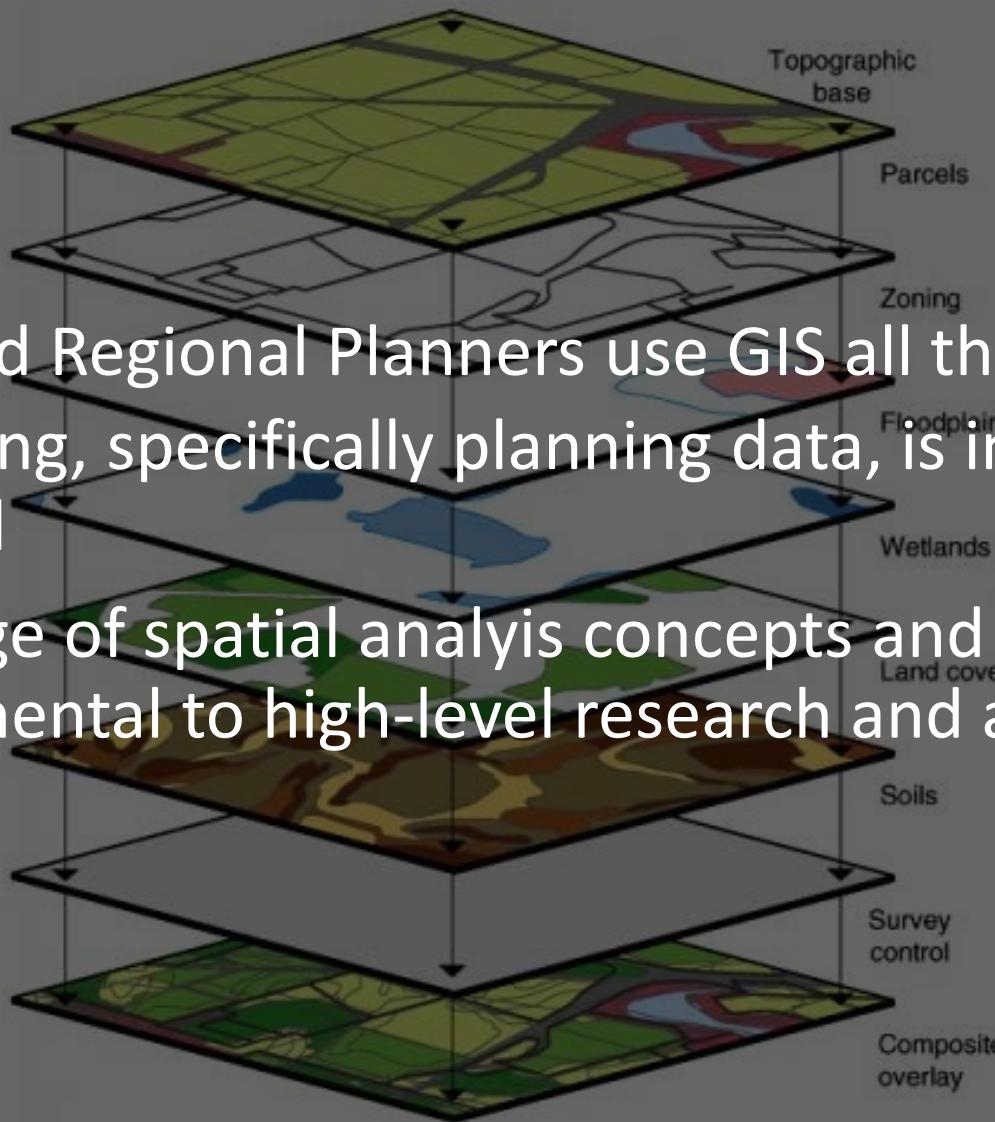
GIS is a discipline consisting of complex analytical methods, concepts, and technology that seek to answer spatial questions.

# What is GIS?

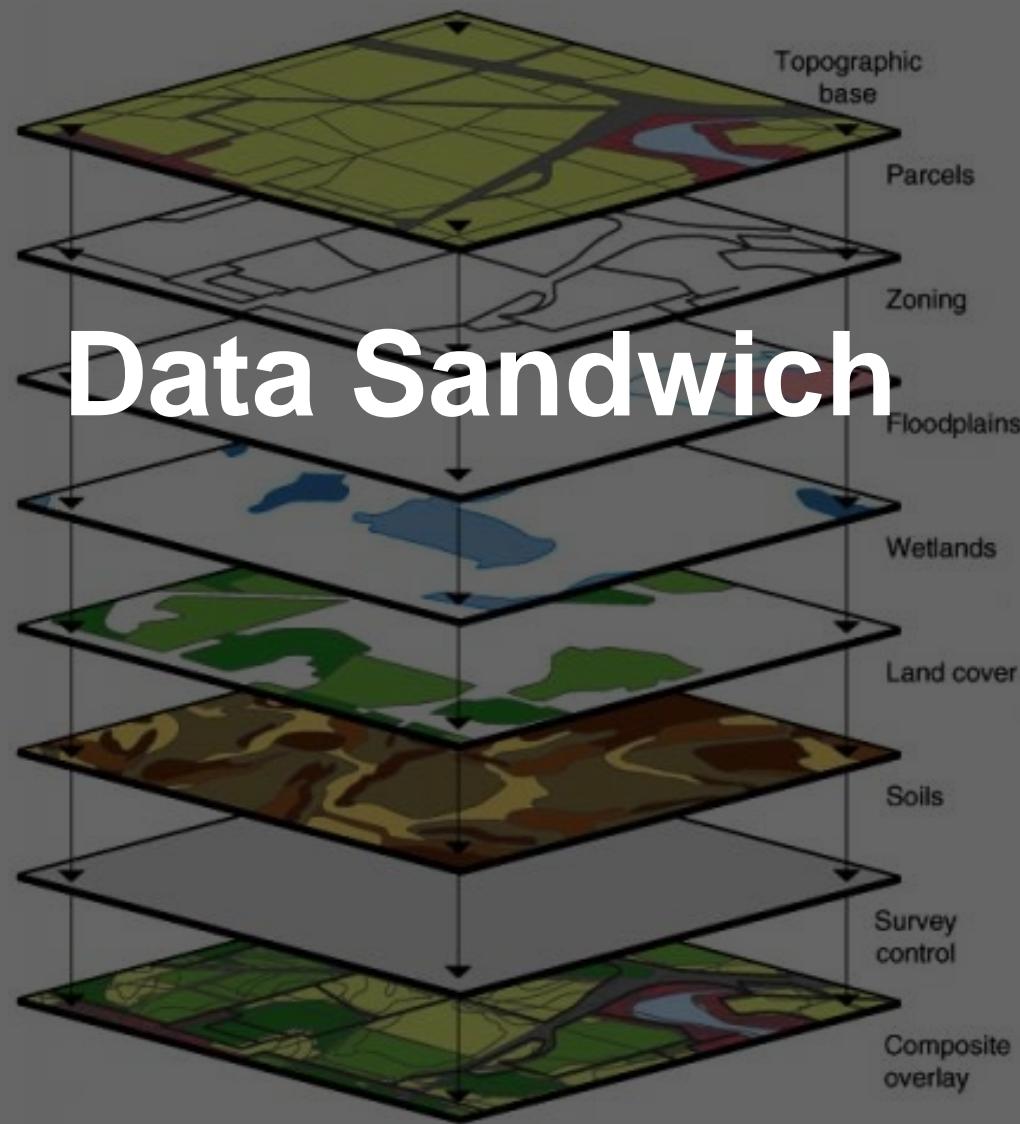


# What is GIS?

- Urban and Regional Planners use GIS all the time!
  - Planning, specifically planning data, is inherently spatial
- Knowledge of spatial analysis concepts and methods is fundamental to high-level research and analysis



# What is GIS?



# GIS@DUSP

GIS at DUSP is not just learning software, it is training your mind to utilize spatial problem solving methods.

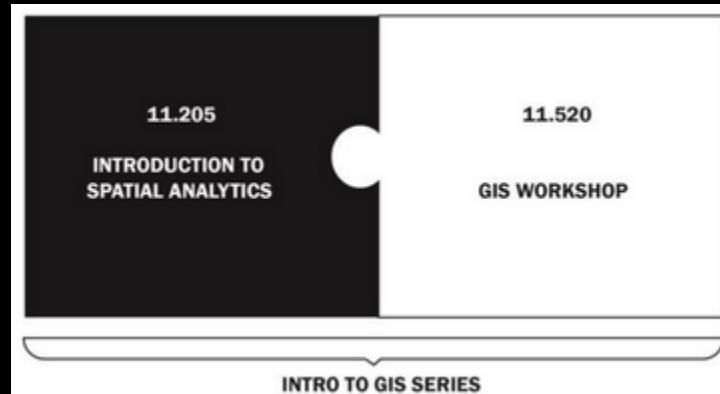
*“The art and science of asking spatial questions and arriving at solutions to problems using spatial methods.”*

# DUSP GIS Requirements

DUSP Intro to GIS series consists of two modular courses, 11.205 and 11.520.

11.205 Intro to GIS (first half) introduces basic spatial analysis and is required by all MCP students.

11.520 GIS Workshop (second half) focuses on developing a GIS research project and further develops skills.



# DUSP GIS Requirements

**11.205**

INTRODUCTION TO  
SPATIAL ANALYTICS

**11.520**

GIS WORKSHOP

INTRO TO GIS SERIES

# GIS Test Out

Introduction to Spatial Analysis (11.205) is required by the MCP Degree. It introduces basic concepts, terminology, and technology of GIS, spatial analysis, and mapping.

Students who have a previous background in GIS can test-out of this course.

## **Test Out Examination**

Tomorrow, September 4, 2015  
2:30-5:00pm, Room 9-251

# GIS Test Out

We will cover and review GIS topics the second half of this session.

## **Test Out Examination**

Tomorrow, September 4, 2015

2:30-5:00pm, Room 9-251

# Handouts

## COMPUTING ENVIRONMENT

Don't run over the network!

Set all folders folders and files you are working in to local or USB locations (i.e. external hard drive).

See instructions for that here:

[GIS@DUSP Computing Environment](#)

# Get an External Hard Drive

You will acquire and use lots of data, and you will move from computer to computer.

We highly recommend acquiring an external hard drive.

1 Terabyte Hard Drives are available on Amazon for approximately \$60, which is an amazing amount of data for a good price!

# Handouts

## DUSP DATA DRIVE

There are a lot of places to find data. Some datasets exclusive to DUSP can be found on the DUSP GIS Data Drive.

See instructions for that here:

<http://duspviz.mit.edu/data>

# Installing GIS on your Machine

GIS is **NOT** required on your own machine or laptop.

You can do everything in labs and on CRON workstations.

However...

It is recommended if you want to work outside class or from home, CRON site has software with patches.

CRON ArcGIS Install Site:

<http://cronlasso.mit.edu/cron/p.lasso?t=8:5:5>

# So I have a Mac...

ArcGIS **ONLY** runs on Windows

To run Windows on a Mac, you have two options:

- Install Bootcamp (dual boot)
- Install a Virtual Machine (windows runs in a “window”)

We recommend for those with sufficient hardware  
that you run a Virtual Machine.

Message cron for more information or come to the  
GIS installation sessions for more information.

# ARCGIS INSTALLATION SESSIONS

LUNCH TIME ARCGIS INSTALLATIONS

12:00-1:00PM

MONDAY, SEPT 14 – FRIDAY, SEPT 18

SECOND WEEK OF CLASS

ROOM 9-524 (LAB NEAR CRON)



CRON

## Software

[Operating Systems](#) | [Adobe](#) | [CAD-related](#) | [GIS-related](#) | [Microsoft](#) | [Other](#) | [VMWare](#) | [Boot Camp](#) | [MATLAB](#) | [STATA](#) | [MIT Email](#)

### QGIS : Open Source GIS

Macintosh: Please run the maintenance script found [here](#). This script includes the several pieces needed for the complete QGIS install. (It also performs cron's recommended laptop maintenance.)

Windows: Download latest version here: <http://qgis.org/en/site/forusers/download.html>

### ESRI ArcGIS Terms

1. You agree not to share this software with anyone.
2. You agree to all other specific terms in the license agreement.
3. You must run this software whilst on MIT campus or [connected to MIT network via VPN](#).

### ESRI ArcGIS Software

Note: ESRI products are Windows only. If a Macintosh user, you can run them either under BootCamp or VMWare, or over a [Citrix connection](#). If a Macintosh user, and you would like a Windows Virtual Machine (VM) with ArcGIS already installed, please email cron requesting same.

We have an installer that is patched and configured for MIT.

1. Navigate to [lwin.mit.edu/dfs/Departmental/uds/Software/ESRI](http://lwin.mit.edu/dfs/Departmental/uds/Software/ESRI) in Windows Explorer (not Internet Explorer).
2. After a long wait, you will be prompted to enter your username in the form **yourname@mit.edu** and your Athena password. The "Remember my credentials" checkbox should be checked. The dialog box should look like



3. It's normal for the installer to run for a long time (> 30 minutes). Please do not move your computer while the installer is running to minimize the risk of network interruptions.
4. Run **setup-cron.bat**

The old and traditional method with installation instructions:

[http://libraries.mit.edu/gis/software/arcgis\\_install10/](http://libraries.mit.edu/gis/software/arcgis_install10/)

1. Request a copyof ESRI ArcGIS from MITVSLs at: <http://ist.mit.edu/arcgis/10/win>
2. Download service packs and updates from [support.esri.com](http://support.esri.com)
3. Apply updates.

Troubleshooting:

<http://cron.mit.edu/p.lasso?t=6:4:5>



# DESKTOP GIS SOFTWARE

# Esri ArcGIS

- **RECOMMENDED SOFTWARE**
- Desktop GIS Software developed by Esri
- Software suite, many components
  - ArcMap – mapping and analysis
  - ArcCatalog – data cataloging
  - ArcScene – 3D visualization
  - etc.
- Many extensions
  - Network Analyst, 3D Analyst, Spatial Analyst, etc.
- Supports data, analysis, and map production

**PRIMARY SOFTWARE IN 11.205,  
REQUIRES MIT SITE LICENSE**



# DESKTOP GIS SOFTWARE

## QGIS

- Free and Open Source Desktop GIS Software
  - Built and maintained by large open source community
- Runs on Mac and Windows
- Not as robust, well supported, or full featured, but very capable desktop GIS for data management, spatial analysis, and map creation
  - Especially good for data conversion
- **Good alternative if ArcGIS is not available**
- NOT USED IN 11.205 EXERCISES, BUT CONCEPTS THE SAME

# Need help?

- DUSP GIS Specialist - Mike Foster
  - email – [\*\*mjfoster@mit.edu\*\*](mailto:mjfoster@mit.edu)
  - office - Building 9-528 (right near CRON)
  - Office Hours – Tuesdays, 2:00-4:30pm
- Any of your GIS instructors and TAs!
- Office Hours – will be announced next week
- [\*\*\*gishelp@mit.edu\*\*\*](mailto:gishelp@mit.edu) (MIT Libraries GIS)
- GIS Lab – Mon-Thurs 1-5pm, Fri 2-4pm
  - Rotch Library, Building 7 Floor 2

# DUSPVIZ

A DUSP initiative to improve departmental capacity  
in data analysis, visual representation, and  
technological communication tools.

Workshops and sessions are lead by students, staff,  
and faculty.

Goal is to share knowledge on GIS, Design, and other  
tech specific topics.

<http://duspviz.mit.edu>

# DUSPVIZ SESSIONS

Adobe Illustrator, Photoshop, InDesign

ArcGIS Tools

Design Tools (Rhino, etc.)

Web Maps and Websites

Poster Design

QGIS

... and more.

# GIS Testout Review

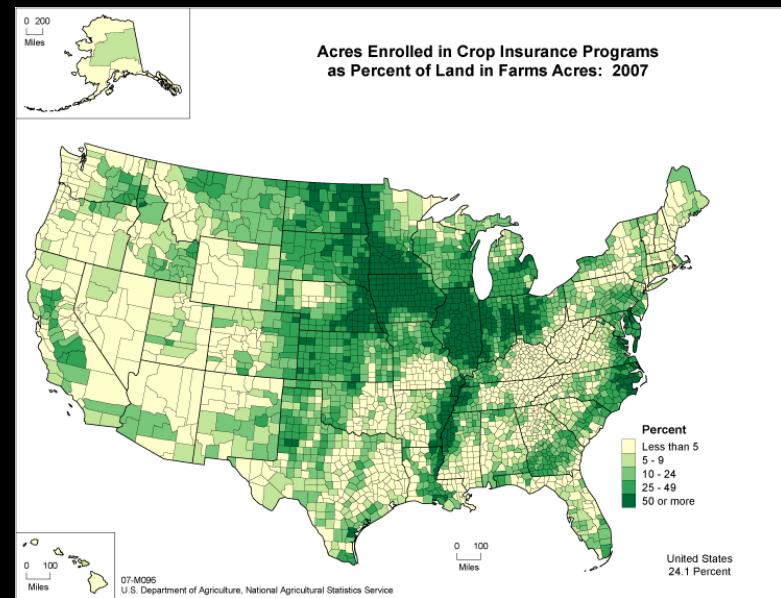
- Making Maps
- Relational Databases
- Descriptive Statistics
- Geoprocessing
- Data Extraction

# Part 1 – Making Maps

- GIS is not only making maps, but spatial data is often most easily consumed through a map.
- A good map is a communication piece and tells a story.
- The way you classify, normalize, symbolize, and present your data can completely change your story.

# Basic Map Elements

1. *Informative Title*
2. *Legend*
3. *Data Source*
4. *Scale Bar*
5. *Date*
6. *North Arrow*
7. *Author*



# Different Types of Maps

- Reference Map
  - General Reference
    - Portray the earth's surface with as much accuracy as possible.
- Thematic Map
  - Designed to show a particular theme or communicate a particular message
  - *Choropleth*
  - *Proportional Symbol*
  - *Isarithmic or Isopleth (contour)*
  - *Dot*
  - *Dasymetric*
- ***Know what to use to best show your data!***
  - *Each has its positives and negatives*

# When you map your data...

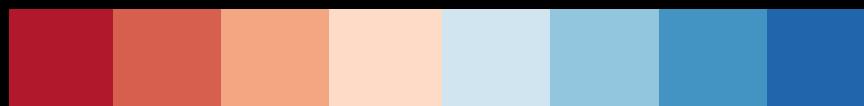
- Remember, your map is a communication tool, it is your goal to tell a story, as simple as it may sound.
- Consider the best methods, and read each and every map with an intelligent eye.
- The way you classify, normalize, and symbolize your data can completely change your message.
  - How to Lie with Maps
    - Mark Monmonier, 2<sup>nd</sup> Ed. (1996)
- Maps are powerful tools, treat them as such!

# Symbology

- The quality of a map's design affects its readers ability to extract information and to learn from the map.
- Symbology has been developed to portray the world accurately and effectively convey information to the map reader.
- The symbols should be intuitive, easy-to-understand, and follow standards whenever possible.
  - i.e. don't use a picture of ship to show a train station, and make water blue!

# Color on your Maps

- Color is important on your maps.
- Choose an appropriate scheme based on your data.



Divergent

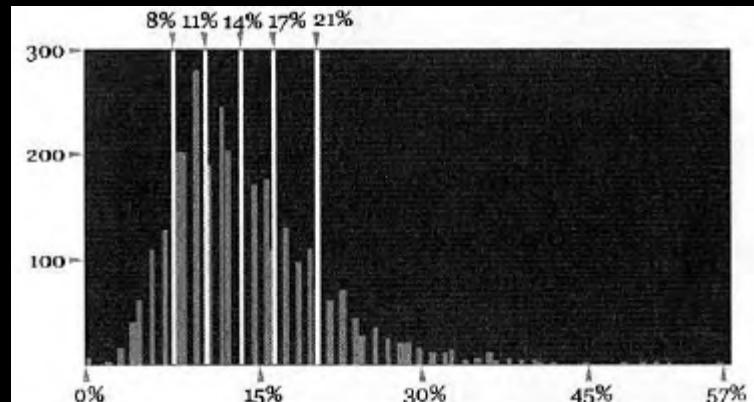


Sequential

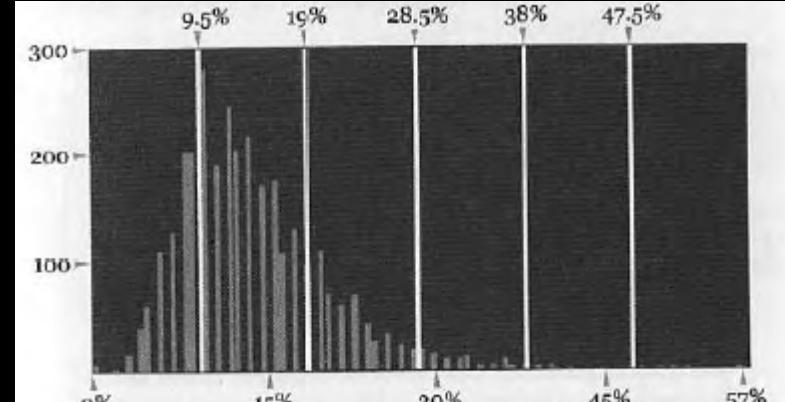


Qualitative/Categorical

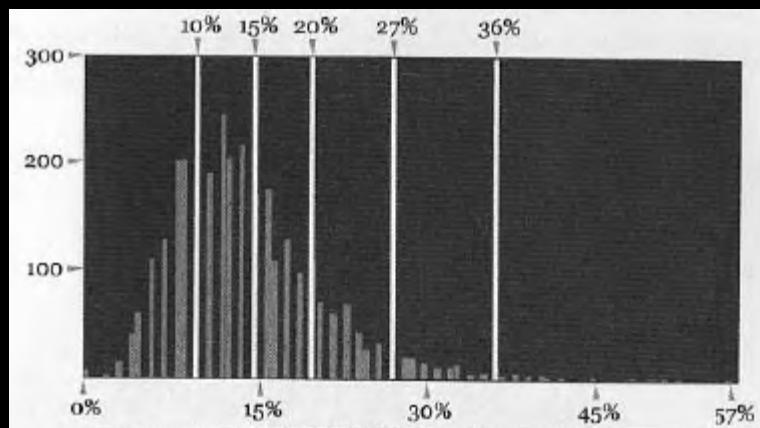
# Data Classification



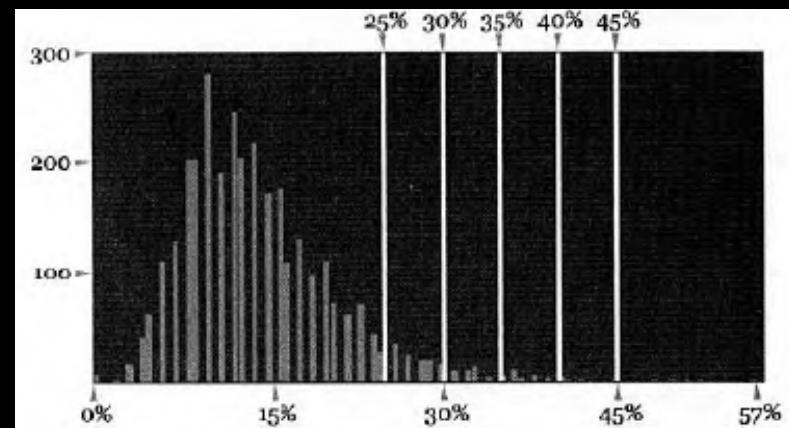
Quantile



Equal Interval



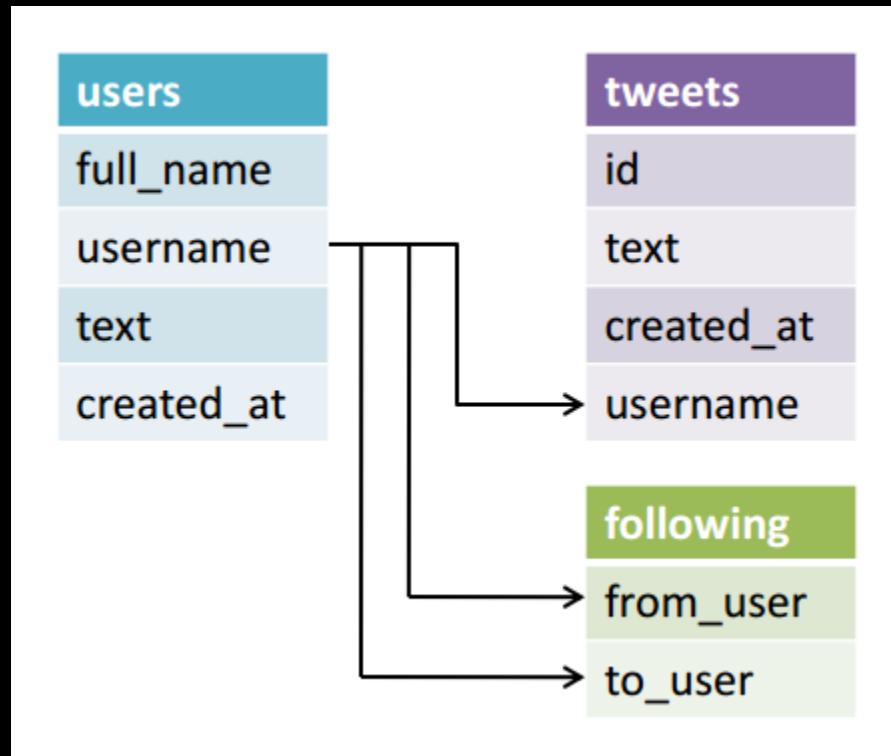
Natural Breaks



Unique

# Part 2 - Relational Databases

- A database of multiple tables that can be joined on unique IDs



# Joining and Relational Databases

Consists of a collection of tables. Each table contains a **heading** defining the columns, and a **body** containing the rows of the table. Each **row** in the table has one or more **columns** that are unique to that specific row.

These '**Unique IDs**' exist in multiple tables, matching values represent a relationship between the two tables.

Tables can be combined and **joined** on these Unique IDs.

Joining tables is fundamental to GIS.

QGIS 2.2.0-Valmiera

Project Edit View Layer Settings Plugins Vector Raster Database Processing Help

Attribute table - OGRGeoJSON Features total: 20859, filtered: 20859, selected: 1

	address_id	ml	StName	StNm	BldgID	Full_Addr	Entry
3980	460	246A-42	Brattle St	224	316-1	224 Brattle St	Primary BU
3981	475	246A-46	Brattle St	220	316-2	220 Brattle St	Primary BU
3991	424	246-1021	Brattle St	200	306-13	200 Brattle St	Primary BU
3992	427	246-1019	Brattle St	202	306-8	202 Brattle St	Primary BU
3993	392	246-28	Brattle St	194	306-4	194 Brattle St	Primary BU
3994	388	246-30	Brattle St	190	306-3	190 Brattle St	Primary BU
3995	390	246-24	Brattle St	192	306-11	192 Brattle St	Primary BU
4008	363	240-36	Brattle St	180	301-1	180 Brattle St	Primary BU
4009	340	240-51	Brattle St	174	301-2	174 Brattle St	Primary BU
4084	338	239-60	Brattle St	170	297-5	170 Brattle St	Primary BU
4101	282	239-67	Brattle St	158	297-1	158 Brattle St	Primary BU
4160	538	250-209	Brattle St	251	270-83	251 Brattle St	Primary BU
4537	275	222-2	Brattle St	154	294-3	154 Brattle St	Primary BU

Attribute table - OGRGeoJSON :: Features total: 13116, filtered: 13116, selected: 1

	MAP	UYEAR	LOC_ID	LOT	ML	EditDate
5114	246	0	F_753799_2962362	27	246-27	NULL NULL
5098	246	0	F_753887_2962393	28	246-28	NULL NULL
5056	246	0	F_754098_2962447	29	246-29	NULL NULL
7968	24	0	F_769358_2959870	63	246-63	NULL NULL
5081	246	0	F_753985_2962415	30	246-30	NULL NULL
7961	24	0	F_769334_2959874	64	246-64	NULL NULL
7956	24	0	F_769306_2959879	65	246-65	NULL NULL
5130	246	0	F_754075_2962359	7	246-7	NULL NULL
7683	24	0	F_769220_2960124	68	246-68	NULL NULL
5216	246	0	F_753877_2962088	9	246-9	NULL NULL

1 feature(s) selected on layer OGRGeoJSON.

There is a plugin update available

Coordinate: 753613, 2962360

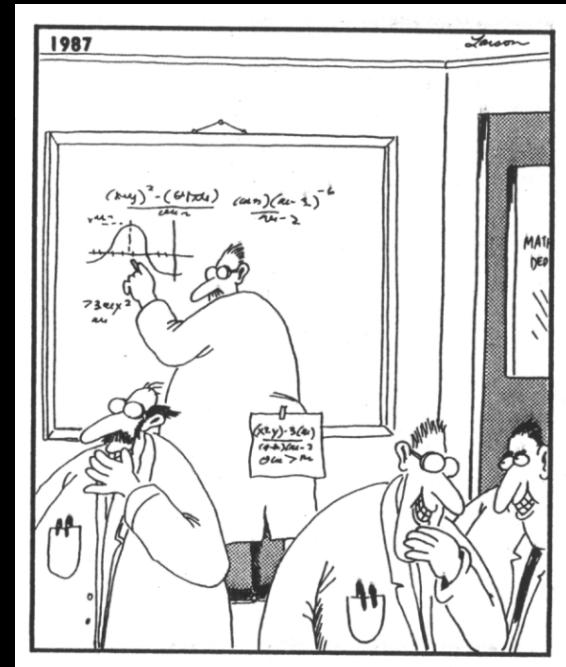
Scale: 1:2,746

Render

EPSG:3586

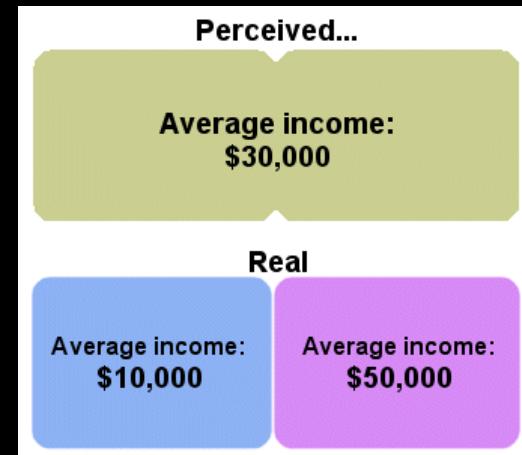
# Part 3 – Descriptive Statistics

- The first step in any analysis, including spatial analysis, is to look at the distribution of the data.
- Definition: The arrangement of values that one or more variables take in a dataset. Data is ‘binned’
- Describing the distribution:
  - For interval data, a *histogram* is a good way to do this
  - For ordinal and nominal data, *frequency tables* or *bar charts* are appropriate
- Mean, Median, and Mode
- Range and Standard Deviation



# Descriptive Statistics...

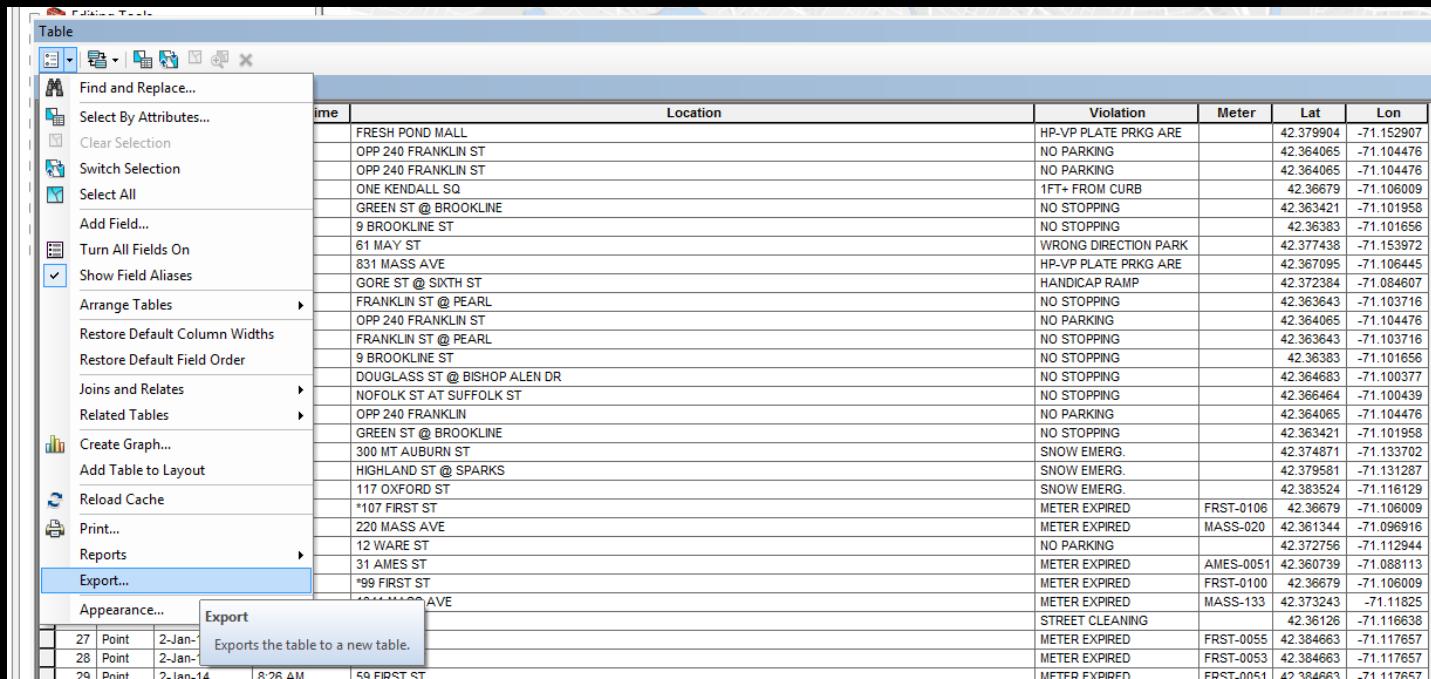
- Using GIS in an Urban Planning setting, you are going to use descriptive summary stats all the time, and there are important things to remember... data is just a part of the puzzle, focusing on trends and averages, not the individual.
- **Ecological Fallacy**
  - While working with spatial data, remember to be careful to not simply ascribe an attribute of the group to the individual
- You will get **plenty** more of this in your courses...



# Export to Excel

- Exporting attribute tables to Excel is one way to access, summarize, and manipulate datasets.
- Do this from

Table Options -> Export

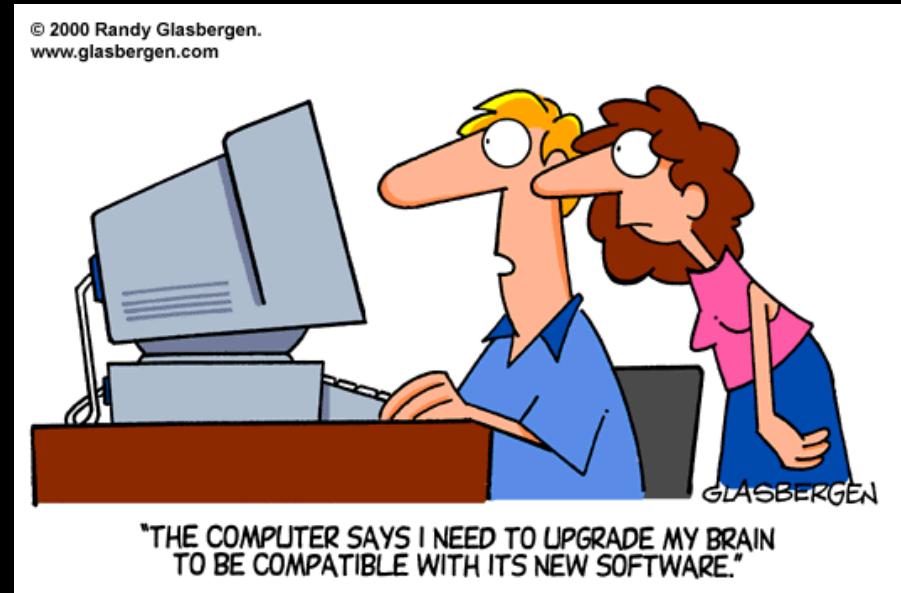


# Part 4 – Geoprocessing

- Geoprocessing is a general term given to a variety of operations on spatial data in which data layers are combined or transformed in different ways to yield new geometric or attribute information.
- Typical geoprocessing tasks produce new datasets based on set criteria.

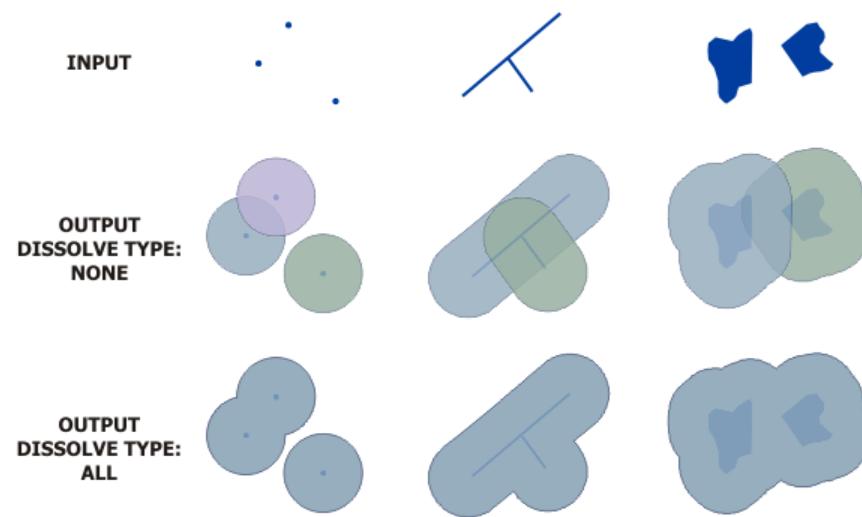
# Geoprocessing

- So, this begs the question, what is a “GIS Operation”?
- GIS Operations are closely related to the database operations we discussed earlier in this lecture.
- **Common Geoprocessing Operations**
  - Buffer
  - Clip
  - Intersect
  - Spatial Join
  - Union
  - Merge
  - Calculate Geometry
  - Field Calculator
  - Table Join



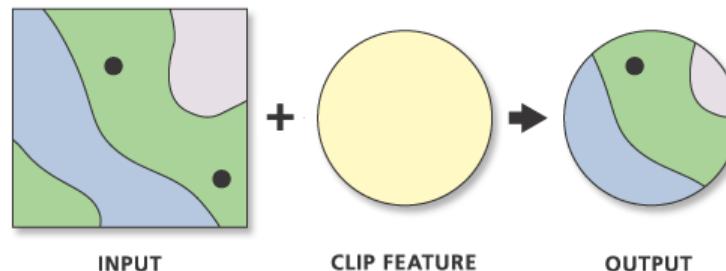
# Buffer

- Used for proximity analysis.
- Creates polygon covering area within a specific distance of a feature.
- Example case use –
  - Locating all features near or within a certain distance of a feature.



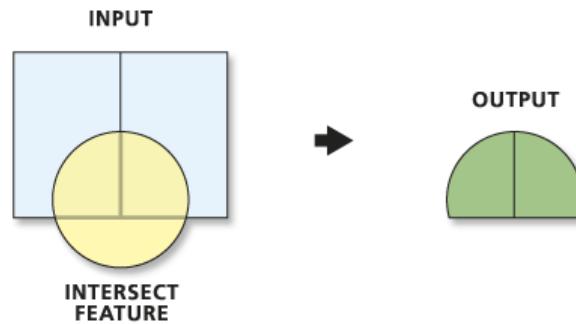
# Clip

- Clips features from one dataset to the extent of another dataset.
- Example case use –
  - Trimming a road dataset down to contain only the roads within a certain city.
- Clip does not change underlying data. You will need to double check and likely recalculate areas and other attributes after clipping.



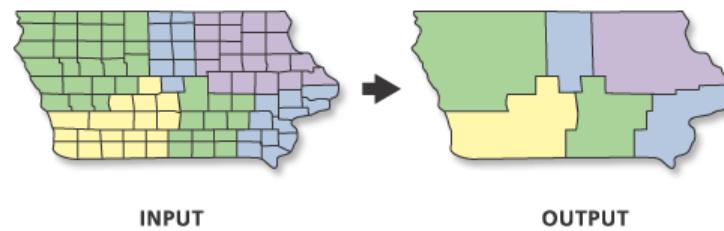
# Intersect

- Finds common areas between two datasets.
- Example case use –
  - You have a dataset showing income and a dataset showing land uses. You want to find all areas where the two datasets cover the same geographical area.
- Intersect does not change underlying data but does apply attributes from the intersecting dataset to the input dataset.



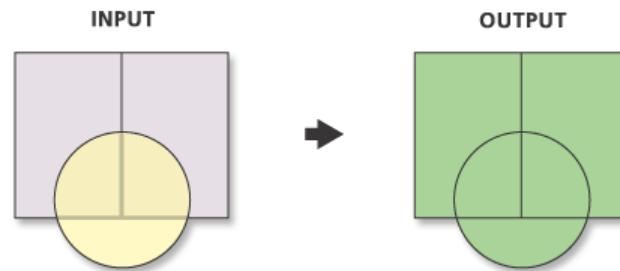
# Dissolve

- Creates new dataset with new polygons based on common attributes in original dataset.
- Example case use –
  - You have a parcel dataset, you want to create a new dataset of land use based on an attribute associated with the parcels. You run dissolve and get new polygons based on the parcels.
- **IMPORTANT** – Dissolve runs to the least common denominator, and gets rid of all attributes not common to original polygons.

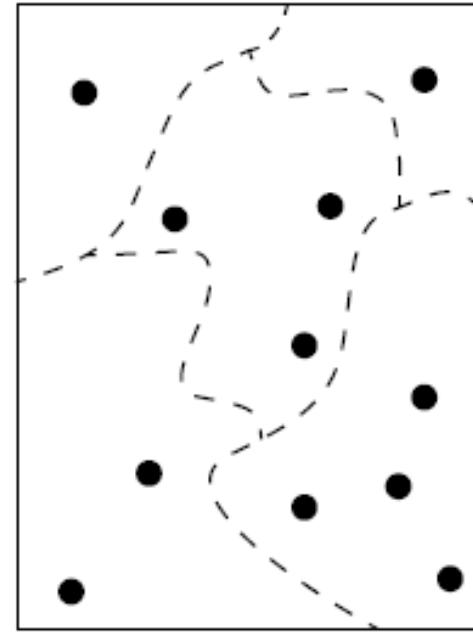
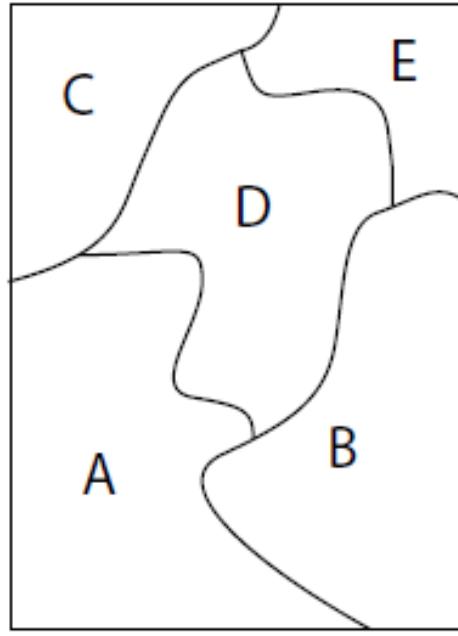
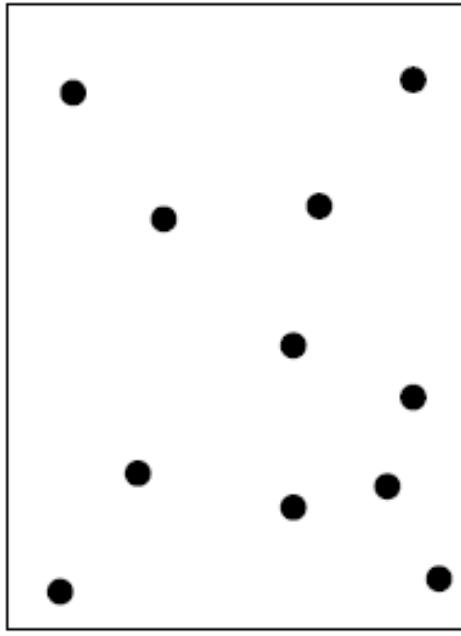


# Union

- Uses to create a union of two datasets.
- Example case use –
  - You have a data showing landcover types from two sources, you want the two datasets in one all encompassing dataset.



# Spatial Join



## Spatial Join

Table join of features based on spatial location. Output features contain column with sum of joined features. i.e. points in a polygon.

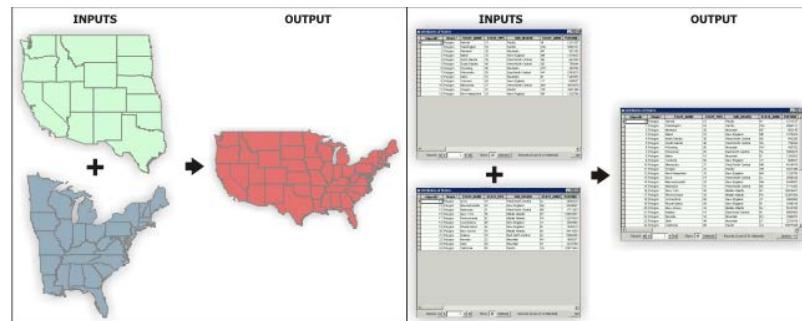
A	2
B	4
C	1
D	3
E	1

# Merge

Used to merge two adjacent datasets into one.

Example case use –

- You have two area datasets, adjacent to one another, you want to create a completely new dataset with both of them.



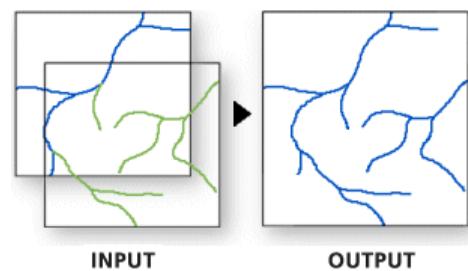
# Append

Used to append one dataset on to another.

Schemas should match.

Example case use –

- You have two line files, adjacent to one another, you want to add one of the line files to the other.



# Part 5 – Data Extraction Methods

Data extraction, or spatial extraction, makes it possible to look at rich disaggregated datasets, such as census data, and extract data and information.

Methods of extraction, for example, involve taking census unit level data, which has been aggregated by tract, block, or other, and combining it or modifying it systematically to derive new information and data.

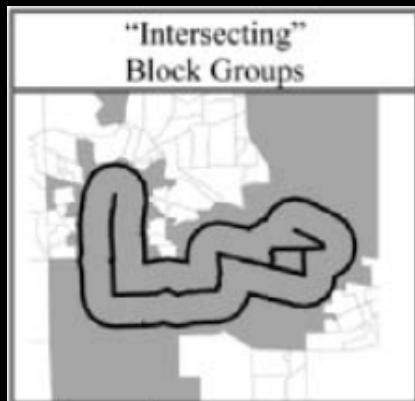
(Schlossberg, 2003)

# Extraction Methods

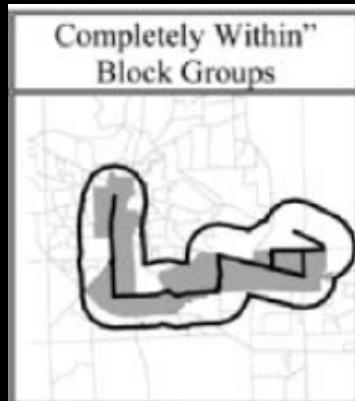
Methods used to extract data when you have multiple varying sources and geographies

- These are the most common, many exist...

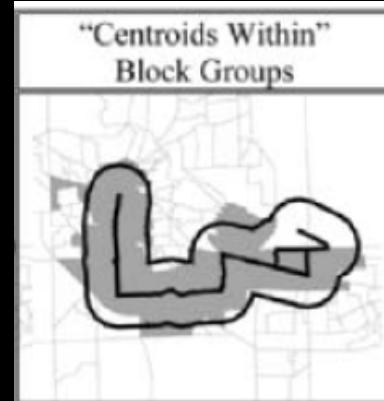
Intersecting



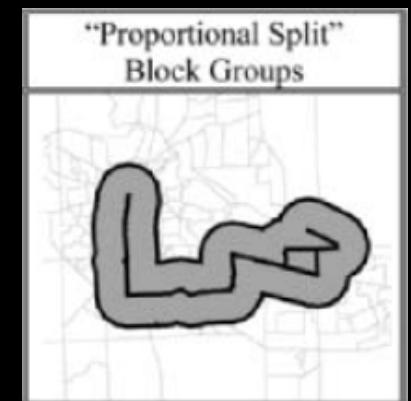
Completely Within



Centroids Within



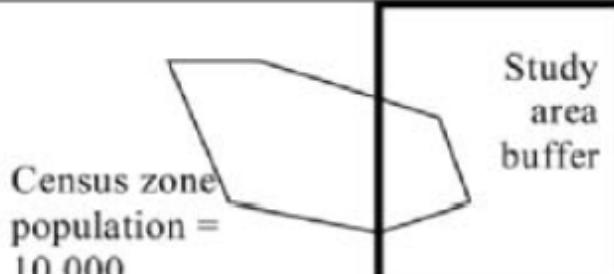
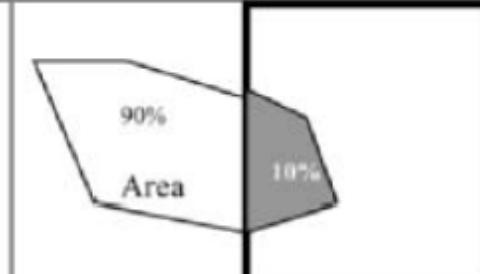
Proportional Split



# Proportional Split

Splits polygons to fit shapes or within buffers.

- Example: Study area splits census block groups, but you still need estimated numbers.

 <p>Census zone population = 10,000</p>	 <p>Study area buffer</p> <p>90% Area</p> <p>10%</p>	<p>Population within buffer: 1,000</p> <p>Population outside buffer: 9,000</p>
<p>Suppose a census zone of 10,000 people was overlaid by a buffer (e.g. area around a bus line).</p>	<p>With "Proportional Split", the GIS calculates that 90% of the census zone is outside the buffer and 10% is inside.</p>	<p>These proportions are then applied to the data to estimate numbers inside the buffer area.</p>

# Data Extraction Methods

## Pros and Cons

- Intersecting
  - Pro – Exhaustive / Con – Too inclusive
- Completely within
  - Pro – Good targeting / Con – Too exclusive
- Centroids within
  - Pro – Good compromise / Con – imprecise, adds error
- Proportional Split
  - Pro – forces polygons to mirror study area / Con – assumes uniform distribution

# GIS Open Lab

Immediately following this session in  
Room 9-251 until 7pm.

Set up your environment, test your  
skills, play with data.