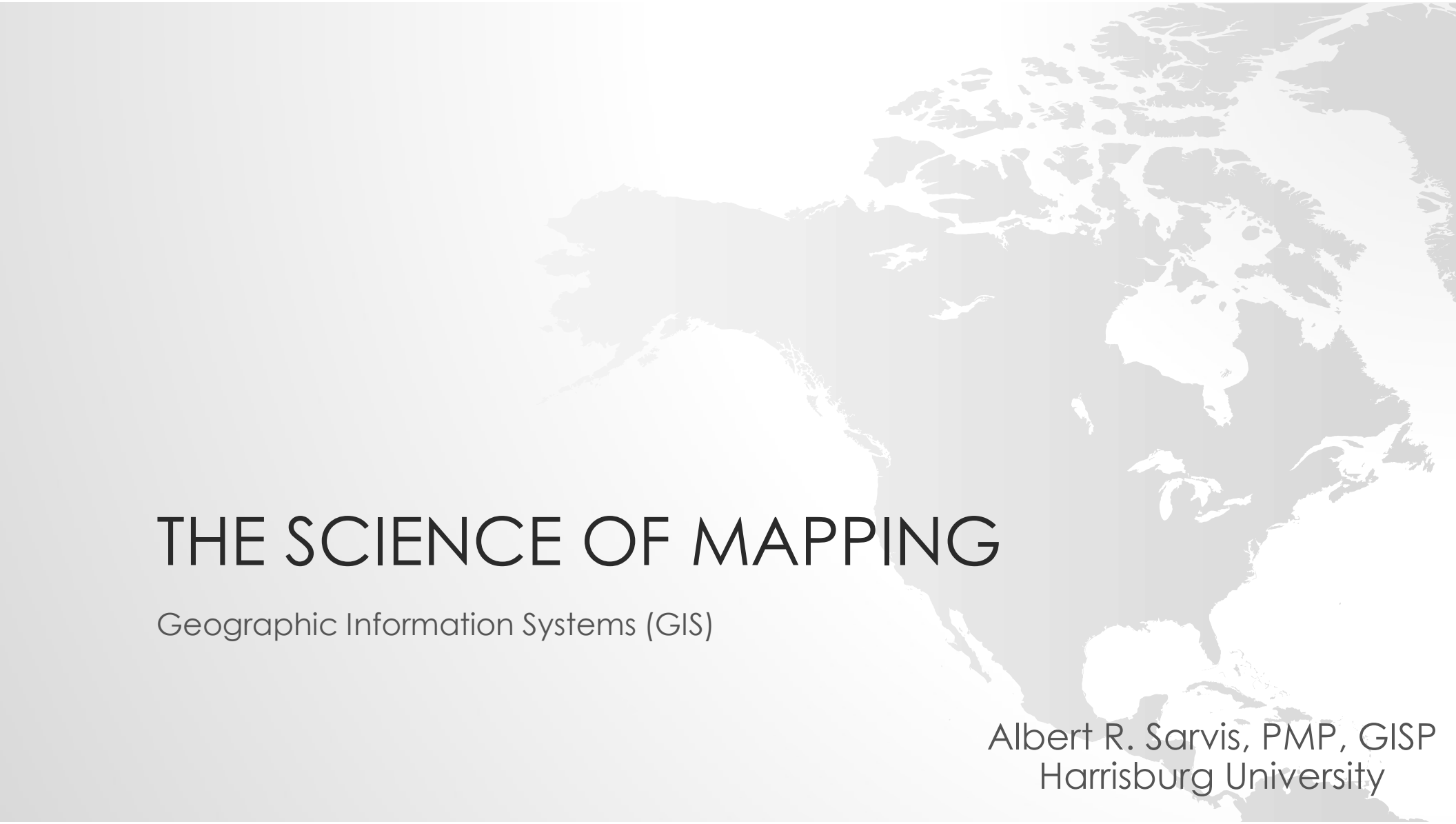


THE SCIENCE OF MAPPING

Geographic Information Systems (GIS)

Albert R. Sarvis, PMP, GISP
Harrisburg University

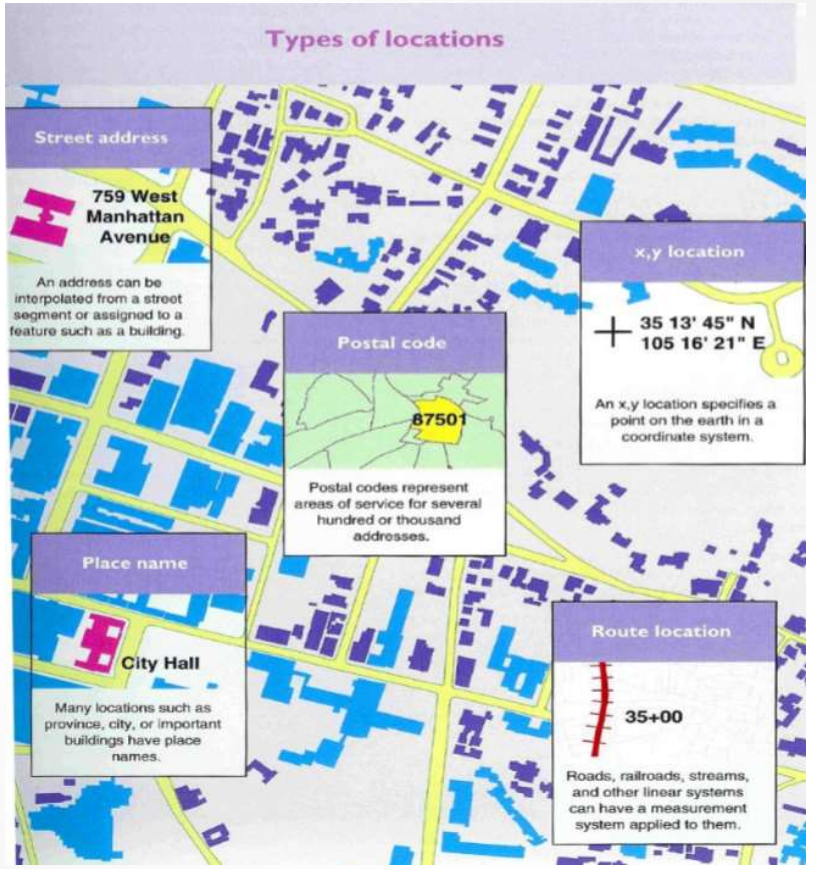
GEOGRAPHIC INFORMATION SYSTEMS

- Geographic Information Systems (GIS) is a collection of:
  - hardware, software, data and trained personnel
- Used to:
  - Store, manipulate, analyze and present information

GIS is the "Science of Where"

<u>The key is linking data to location</u>

Estimated that 80% of all data has a spatial component



THE SCIENCE OF MAPPING REQUIRES CRITICAL SPATIAL THINKING

Critical Spatial Thinking:

"…using spatial data to understand problems, derive solutions and communicate effectively…"

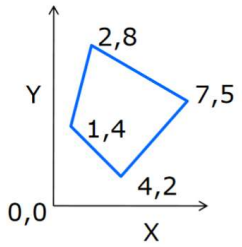
"Many of the issues and situations addressed with a GIS do not have one single correct solution but may have explanations and better choices that can be informed by critical spatial thinking and abductive reasoning."

- Merely displaying spatially coincident datasets may yield incorrect assumptions regarding relationships. Most maps require some explanation.

(Source: Stinton et al. 2013)

ESSENTIALLY ALL MAPS ARE JUST:

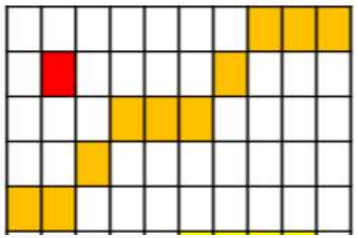
Points, **Lines** and **Polygons** stored and represented by coordinates



Coordinates
4,2
1,4
2,8
7,5
4,2

- **Points** are single coordinate pairs,
- **Lines** are ordered sets of coordinate Pairs
- **Polygons** are closed sets of lines (areas) that have interiors and share edges (adjacency) with other polygons.

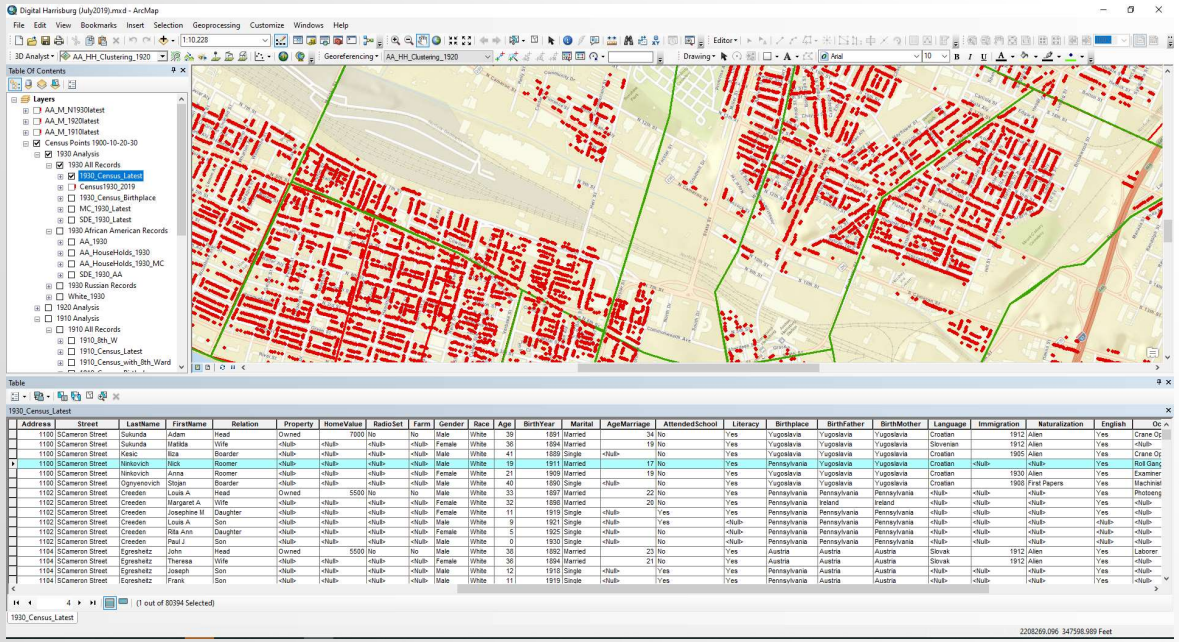
Maps also employ backgrounds "cells" (such as pixels in an aerial photo) stored and represented by a grid.



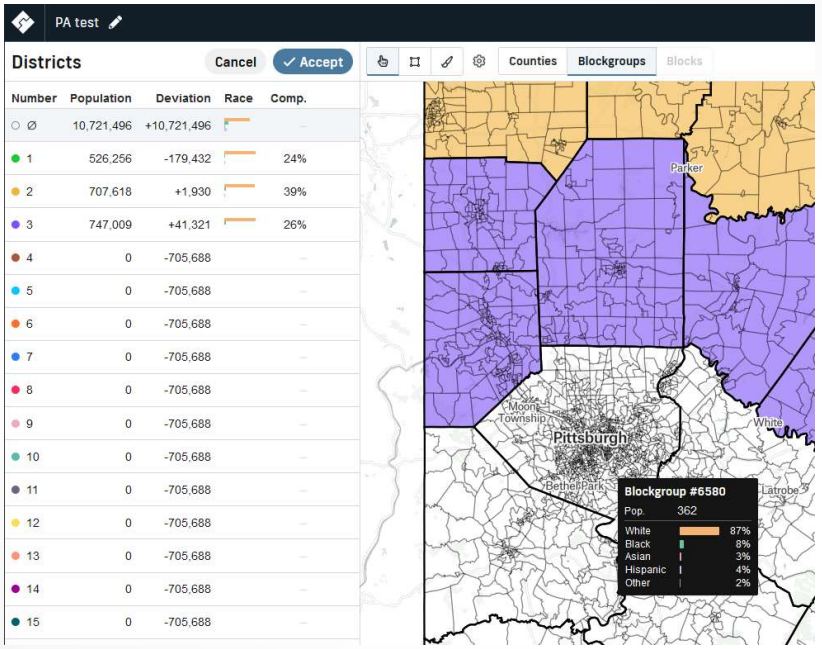
GIS FEATURES HAVE ATTRIBUTES

- Attributes are stored as rows and columns in a table
- They define/describe a spatial feature (qualitative or quantitative)
- Every row corresponds to a point, line or polygon feature

Point example: Census individuals



Polygon example: Census block groups



Source: https://app.districtbuilder.org

TYPES OF GIS SPATIAL ANALYSIS

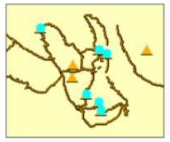
- **Understanding where** …boundaries between and/or around demographic groups
- **Measuring size, shape and distribution** …of population contained within polygons
- **Determining how places are related** …boundaries aligned with census demographic data
- **Finding the best locations and paths** …route to voting location
- **Detecting and quantifying patterns** …of voter turnout or population changes
- **Making Predictions** …based on past location data

A GIS works with thematic layers of spatial data

Answer questions by comparing different layers of data

Types of spatial questions:

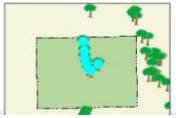
Which peaks are near trails?



Which counties are adjacent to Highlands County?

Which highways intersect Highlands County?

Which trees are inside the park?



BOUNDARY AND POLYGON OVERLAP

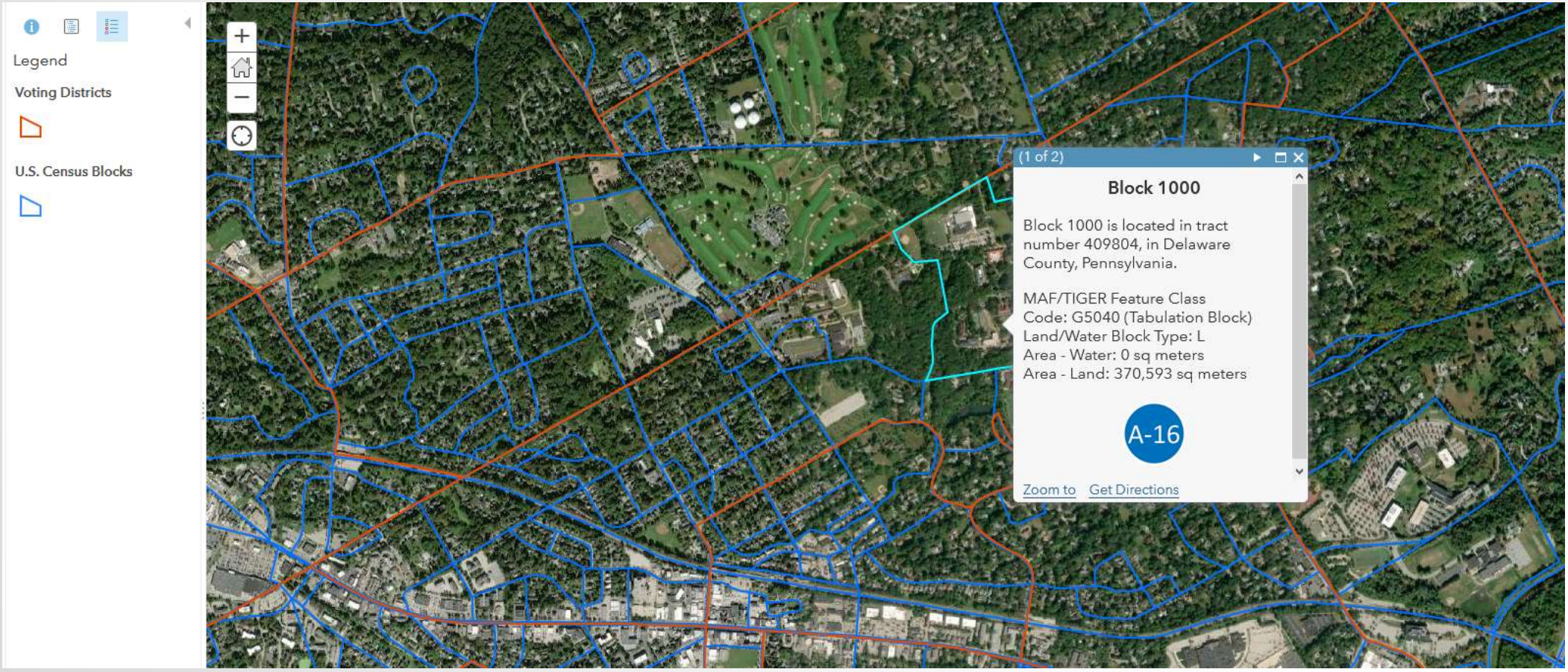
How many census block groups (blue), and their combined population are contained within a voting district (red)?

Every adjustment to a voting district boundary alters the demographic composition of the new **AND ADJACENT** voting district polygons.

Polygon shape and attribute accuracy is crucial! Job for GIS!

OVERLYING POLYGONS – AGGREGATED POPULATION

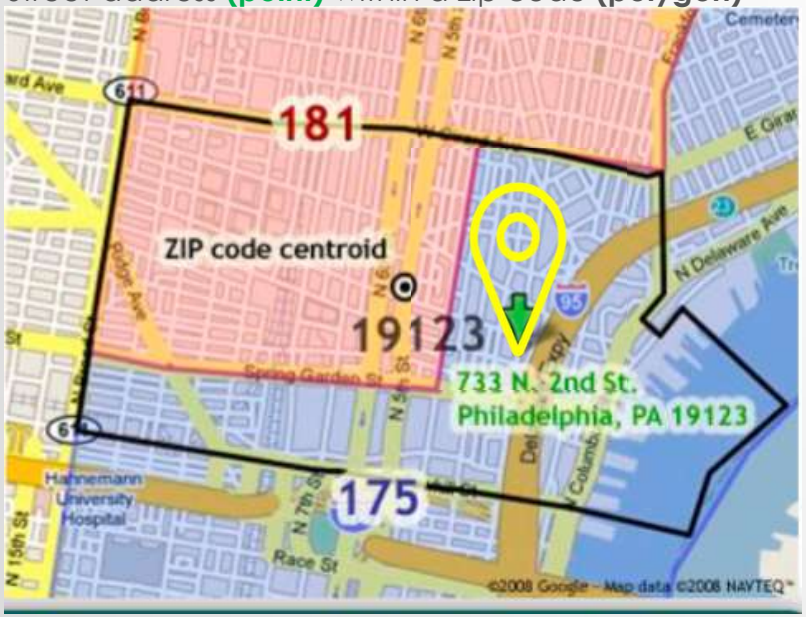
CHANGING AN OVERLYING POLYGON ALTERS THE NUMBER UNDERLYING POLYGONS



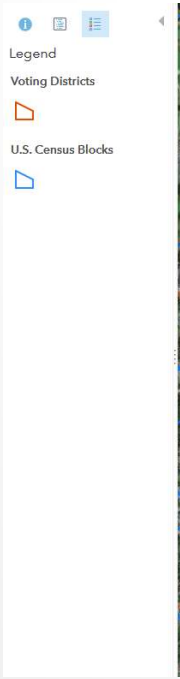
VOTER LOCATION ACCURACY (GEOCODING)

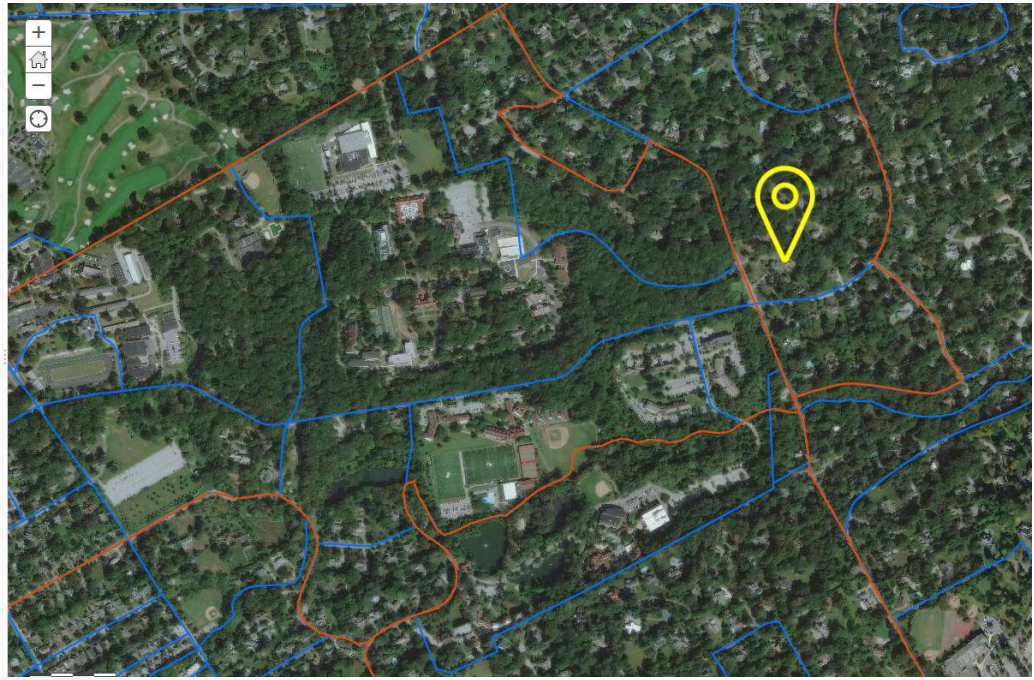
Geocoding in GIS is the process of associating an x,y coordinate to a geographic feature such as an address.

Street address **(point)** within a zip code **(polygon)**



Ensures accurate placement of voters within districts



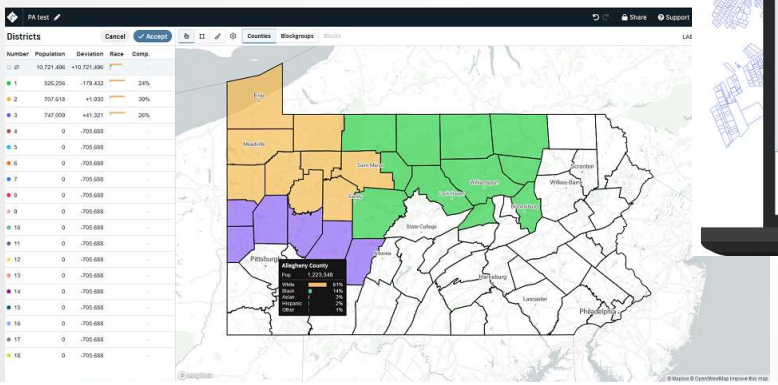


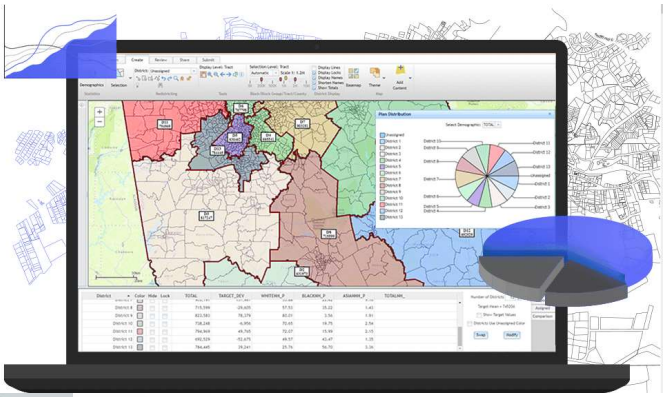
RESOURCES FOR GIS AND ELECTIONS

- National States Geographic Information Council
  - Best practices for **Geo-enabling elections**

- Federal Geographic Data Committee
  - Geospatial Data Act of 2018 – supports development of **consistent and authoritative** spatial data
  - National Spatial Data Infrastructure (NSDI)
    - **Define standards** for spatial data themes

- Software Tools
  - ArcGIS, ESRI Redistricting, District Builder, etc





GEO-ENABLED ELECTIONS

NATIONAL STATES GEOGRAPHIC INFORMATION COUNCIL (NSGIC)

GIS HELPS TO:

AVOID LOCATION ERRORS

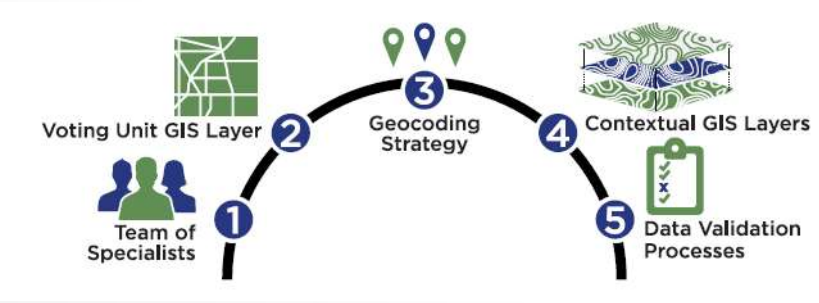
ELECTION ERRORS CAN LEAD TO LENGTHY LEGAL PROCESSES AND COSTLY DO-OVERS. MODERN GIS TECHNOLOGY TRANSFORMS VOTER LISTS INTO GEOSPATIAL PINPOINTS AND ENSURES THAT VOTERS AND CANDIDATES ARE PLACED IN THE RIGHT PRECINCT.

SAVE TIME AND WORK EFFORT

GEOSPATIAL DATA MADE VISUAL ON A MAP ARE MUCH EASIER TO CHECK FOR ACCURACY THAN LENGTHY VOTER ADDRESS LISTS. SIMILARLY, ASSIGNING VOTERS TO A NEW VOTING DISTRICT AND CREATING PRECINCT DEFINITIONS CAN BE DONE IN MINUTES WITH GIS.

BOOST VOTER CONFIDENCE

WHEN FEWER ERRORS ARE REPORTED AFTER AN ELECTION, VOTERS' CONFIDENCE THAT THEIR VOICES ARE BEING HEARD INCREASES, AND THEIR FAITH IN THE DEMOCRATIC SYSTEM IS STRENGTHENED.



Source: https://elections.nsgic.org/

NSGIC – GEO-ENABLED ELECTIONS

BEST PRACTICES

1. **Convene a team of specialists**
   - Collaboration between leaders, information technology, database administrators and GIS professionals
2. **Collect and sustain a statewide voting unit GIS Layer**
   - Comprehensive, authoritative, and accurate boundaries
3. **Implement a statewide geocoding strategy**
   - Assign accurate coordinates to each residential address
4. **Assemble best available contextual GIS layers**
   - Relevant, accurate, verified and accessible for boundary alignment
5. **Define and implement data validation processes**
   - Create spatial auditing processes for precinct creation and assignment

SUMMARY

- GIS is a powerful tool to help make **accurate maps** so that the best, spatially-based, decisions can be made.
- For GIS to be useful it requires **accurate and well-maintained data**.
- GIS requires **trained users** who use **critical spatial thinking** to evaluate implications of **mapping decisions**.
- Many **resources exist** to support the spatial element of elections.