Proximity based analyses
Learning objectives

• Explore proximity based tools in the GIS setting
• Explore the concepts of access
• Consider applying the proximity information to inform understanding of resources in space: geographic accessibility

GIS provides us with a number of tools to evaluate relationships between objects in our maps. Proximity relationships help us to measure, understand and relate spatial information with real world implications:
- Where are the closest resources of interest?
- What are the time and distance costs for reaching resources in space?
- Who can reasonably reach what?
Review: Geographic data?

Components

- Spatial (where?)
  - Geometry or shape of object
  - Where it is located

- Attributes (what?)
  - Tabular data
  - Describes an object

Review components of geographic data

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<th>LANDUSE_DE</th>
<th>PHYS_ADD</th>
<th>CONSTMTP</th>
<th>YEARBUILT</th>
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<td>RES/RURAL RES</td>
<td>1985</td>
</tr>
</tbody>
</table>
Understanding proximity

- The characteristics of spatial data help define connections among objects in coordinate space
- Allow us to determine the distance relationship between objects space: proximity

For the purposes of this discussion we will limit of definition of topology to: how points lines and polygons relate to each other.
Along with explicit spatial definition (i.e. coordinates) your geographic data includes topological information that helps define relationships to objects in space:
- How far is A from B?
- What is connected to what?
- What is within what?
- What is beside what?

GIS software keeps track of this information allowing you to use it for a number of spatial operations that are useful when you are interested in the relationships between these layers.
Where is the closest hospital with a primary stroke center classification?
Measuring proximity

• Options for measuring distances
  • Manhattan
  • Euclidian
  • Network based

• Best choice depends on
  • Available data and
  • Objectives

**Manhattan:** The distance between two points in a grid based on a strictly horizontal and/or vertical path (that is, along the grid lines).

**Euclidian** "as the crow flies" distance

Network distances measured via network of interconnected points (nodes) and lines (edges)

Let’s take a closer look at
  • Euclidean and
  • Network based methods

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Euclidian proximity

- Near
- Generate Near Table
- Buffer

Near:
Used to find the area within a given distance of a set of features
Near Calculates distance between the input features and the closest feature in another layer or feature class
Input and near features can be points, lines, or polygons
Adds information as new fields in input feature table

Generate Near table:
Calculates distances and other proximity information between features in one or more feature class or layer
Unlike the Near tool, which modifies the input, Generate Near Table writes results to a new stand-alone table and supports finding more than one near feature

Buffer:
Used to find the area within a given distance of a set of features
Input features can be points, lines, or polygons
Output feature will always be polygons
Network proximity

- Closest facility
- OD Cost Matrix
- Service Area

Closest facility:
Measures the cost of traveling between incidents and facilities and determines which are nearest to one another. When finding closest facilities, you can specify how many to find and whether the direction of travel is toward or away from them. The closest facility solver displays the best routes between incidents and facilities, reports their travel costs, and returns driving directions.

Optimized analysis

Origin Destination Cost Matrix:
Creates a cost matrix from multiple origins to multiple destinations
Good for calculating distance or time between multiple start and end points
Can find a desired number of destinations and or set distance threshold

Service Area:
Calculate an area based on time or distance from or to a point
Good for estimating populations
Different than a simple buffer since area represents the drive time/distance to or from a point of interest

Streets dataset: [https://rice.box.com/s/id2w5m68josfcgv5bas1uq320491xy81](https://rice.box.com/s/id2w5m68josfcgv5bas1uq320491xy81)
What about transit?

- The General Transit Feed Specification (GTFS) defines a common format for public transportation schedules and associated geographic information.

- Data are available: https://transit.land/feed-registry/

- Tools are in development: https://github.com/Esri/public-transit-tools

https://esri.github.io/public-transit-tools/resources.html
Key transit questions

• Who does the transit system serve? Where are the stops and lines?

• How well are the transit system’s constituents served?
  Frequency of service?

• To accurately estimate travel times by transit day of the week and time of day when important details occur.

**Question 1:**
Where are transit stops and lines?

**Question 2:**
Frequency of service is important; how often are stops visited?

**Question 3:**
How easily can people get to important destinations using transit options?
What is access?

• Multiple dimensions*:
  1. Availability
  2. Geographic accessibility
  3. Accommodation
  4. Affordability
  5. Acceptability

• Geographic accessibility
  • Cost for reaching resources, where cost is based on distance or travel time
  • Depends on the relative locations of population/individual and the resource(s) of interest

Related to health care, products and services…


Evaluating accessibility of resources for individuals and or populations in multiple contexts…

Assumption; In other words: the individual/population is a potential user of the facility/service

Even with these assumptions identification of areas/populations/individuals with low to high geographic accessibility provides useful and practical information
Measuring geographic accessibility

**Immediate proximity**
distance/time to closest resource

**Container approach**
number of resources w/in a given unit

**Immediate surroundings**
number of resources w/in a distance/time

**Average cost**
average distance/time b/t location and n resources

Near / Closest Facility

Spatial Join

Generate Near Table / OD Cost Matrix

OD Cost Matrix / Service Area

The highlighted methods require proximity based measurements
Operationalizing proximity analyses

- Define area of interest and appropriate scale
- Aggregate population
- Choose a measure of geographic accessibility
- Choose a distance type
Bringing it all together

Medication Therapy Management (MTM) Pharmacies within a 10 Minute Drive Time from High-Need Communities, Portsmouth Health District, 2016

Pharmacies

- MTM Confirmed
- Not MTM Confirmed

Census tracts with highest levels of both hypertension and poverty

Portsmouth Health District Outline