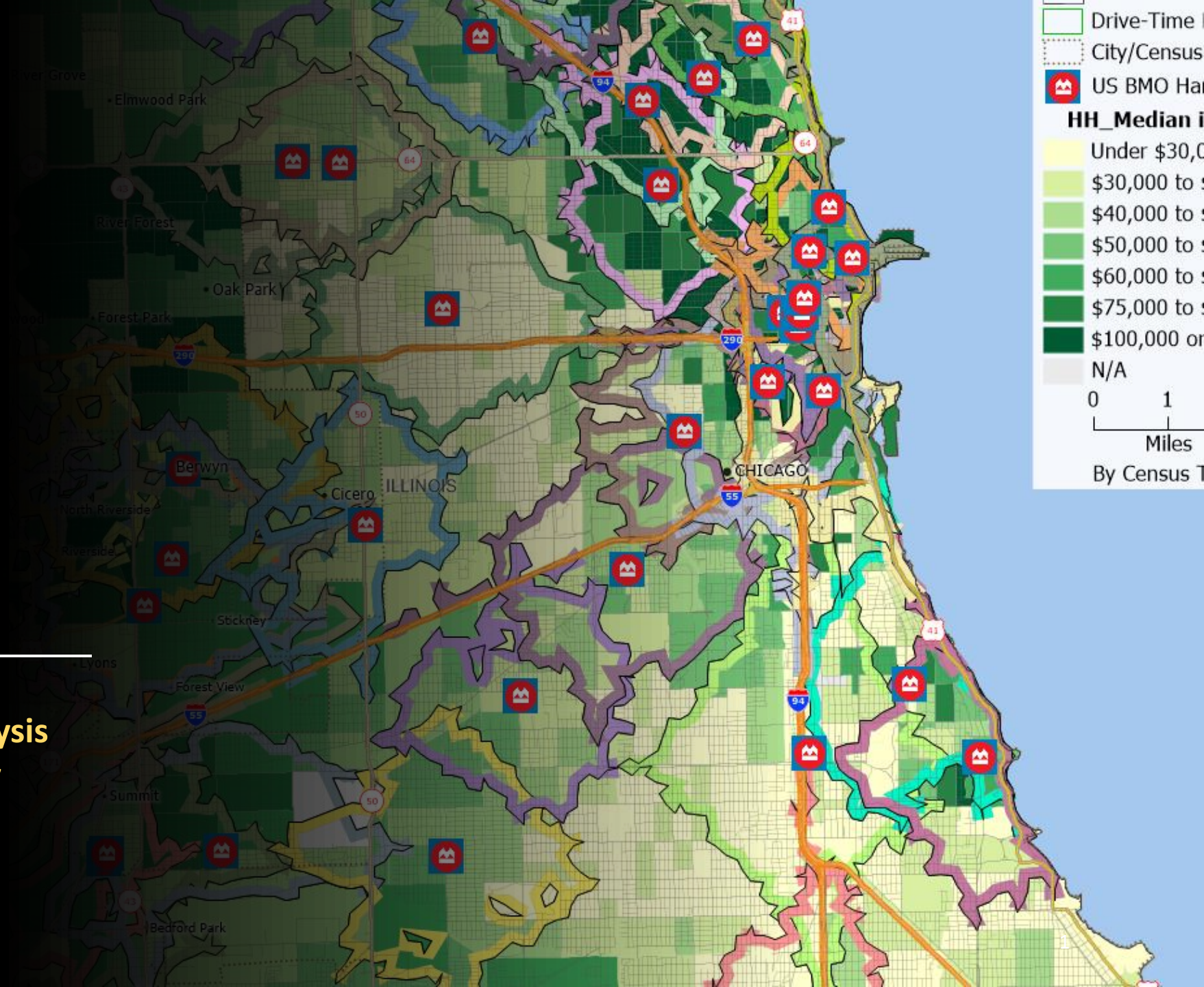
Business GIS Methods & Applications

An Applied Handbook for Analysis in Retail & Business Geography

By Murray D. Rice



Business GIS Methods & Applications: An Applied Handbook for Analysis in Retail & Business Geography

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Introduction

Why This Handbook?

There are many GIS textbooks and other technical and reference publications. Why is it important to add this one to the mix?

The short answer is that it is needed. Since I started teaching retail and business geography in the 1990s, my courses have always included a major semester project that is designed to challenge the class to produce an innovative GIS solution to a real-world business problem. Every year I've seen students struggling to incorporate in their analysis a suitable range of GIS capabilities that bear on the problem at hand. Typically, many past projects have focused on a single major method and have gone no further, even though a multi-method approach is actually what is needed. I used to think that students simply weren't paying attention the whole way through the course, and that they simply missed or perhaps forgot some of the methods and applications we covered in class.*

However, over time I've come to appreciate that my students are truly working hard to understand and use the GIS options they have. Rather than being a matter of work or study shortfall, I have come to believe the problem is more an indicator of a need for improved identification of core business GIS methods (focus) and better demonstration of how methods can be combined (versatility of use). Expanding on these two themes:

> **1. Focus:** there are many methods and features available in modern GIS packages, but I've found even I as a professor find it challenging to answer the question as to which methods are most central to retail and business geographic analysis. I can imagine how challenging it would be for students entering the field. Some clarity is needed.

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* Of course, it hasn't helped that the GIS packages we have are always increasing the range and depth of analytical options to choose from (a good problem to have, indeed).

2. Versatility of use: even once a focused set of methods and applications has emerged, I've seen there is still some level of confusion as to how the methods can build on each other to create a solution to a more complex problem. Use of a single method: no problem. Combining multiple methods in sequence to address a more complex situation: now we have difficulty. This issue relates to the growth of a problem-solving mindset. While some of this can be best learned with experience, attention to this need (with examples) in the course experience can help to ease the transition into this desired mindset.

This handbook aims to address both issues. **Part A** of the reference, "Foundational Methods", lists a brief but powerful set of basic methods that provide a multifunctional toolkit for retail and business geography. **Part B**, "Application Areas", addresses a small sampling of common but more advanced applications that mostly use the foundational methods as building blocks in creating something more.**

This book is not intended to be the ultimate authority on business GIS methods and applications, nor is it exhaustive in its coverage of either methods or applications. Neither does this volume examine the crucial issue of data quality and reliability. Other books are more expansive in their discussion of business GIS and geospatial analytics and their context in geography and business (Pick 2008; Church and Murray 2009). What this book aims to do is summarize some basic methodological considerations for business GIS practice, while providing some modest direction toward analytical extensions. My hope is that this short handbook will provide a measure of clarity on basic tools and ideas that retail and business geography students can use to produce appropriate geospatial analytical results in a truly rigorous manner.

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** Recognizing that Part B only begins to survey the spectrum of advanced, multi-method applications, this book also includes an appendix that briefly lists and provides suggestions for a few more application scenarios (see Appendix B, pages 159-160).

GIS Software Used in this Handbook

A number of GIS packages make it possible to implement the addition of a location component to an existing business database. To provide some depth of coverage while also portraying some diversity in approach, this handbook makes direct reference to implementation of methods in two GIS packages in particular:

1. Caliper's desktop-based **Maptitude** https://www.caliper.com/maptovu.htm
2. Esri's cloud-based **Business Analyst Web App** ("BA Web App") https://www.esri.com/en-us/arcgis/products/arcgis-business-analyst/overview

I chose each of these two packages for inclusion here (and in my business and retail geography classes) because both are highly capable and user-friendly. Yet both platforms also have unique strengths and weaknesses that to a degree complement each other. There are other software platforms that are more widespread in use, but the two used here have been designed for application specifically in the retail and business realm. These two packages and their distinctive strengths and weaknesses are intended to provide some helpful perspective on the actual implementation side of the ideas covered here. The applications here are real. ***However, the aim here is not to limit application to the two featured GIS packages, but to provide inspiration that can apply to use of many different GIS platforms.***

This handbook provides some implementation suggestions for each method covered, but it is not in any way a training manual for either Maptitude or BA Web. The aim of the basic usage suggestions is to point the reader in the right direction to start your analysis involving any of the methods and applications highlighted here. To this end, each method discussion includes some advice related to the application of both Maptitude and BA Web (including a clear indication of whether each platform has the appropriate analytical capabilities). More complete resources to support implementation are available on the websites of the respective software publishers.

Summary Table: Methods and Applications Covered

Major Category	Method/Application	Summary
Foundational Methods	**1. Adding a Location Component to an Existing Database**	Merging location variables into a standard business database that did not originally include a location element.
	2. Buffer/Drive-Zone Analysis	Setting up one of two types of zones around a defined location.
	3. Choropleth Mapping	Mapping a statistic across a region using shaded areas to communicate the map pattern.
	4. Target Zone Identification	Identifying census areas that fit a specific characteristic, such as having a specific income or education level.
	5. Geodemographic Segmentation	A neighborhood classification system that rigorously identifies similar communities by type. National-level geodemographic systems are available for many countries.
	6. Areas of Influence	An automated means of defining service zones around each facility in a network of service-providing facilities covering a region (such as schools serving a city).
	7. Density Grid Analysis	Conversion of a complex point-based map into a color-coded density display by area.
	8. Network Analysis	Methods that produce optimal routing solutions, for example to guide a delivery vehicle making multiple stops.
Application Areas	**1. Business Data Enhancement**	Using a location field in a database to add further data based on proximity.
	2. Customer Analytics by Market Area	Using a combination of geocoding and buffer/drive-zone analysis to profile the customers for a given business in a given market zone.
	3. Site Selection	Use of a variety of approaches to identify the best location(s) for new facilities.
	4. Market Area Analysis	Means of defining a market and developing a profile of the customers in that market.

Part A: Foundational Methods

Building blocks for business GIS application

Foundational Methods: The Basic Idea

This section of the handbook explores a short list of routine methods that are available in most GIS packages that retail and business geographers might conceivably use. The common tie that binds the methods included here is this: *each one is so basic and foundational that it probably would not be used on its own*.

For example, the addition of a location component to an existing business database is without doubt a useful process to complete. However, it would be a rare project indeed that would end with simply having location coordinates. Instead, geocoding is much more likely to be used as a step along the way to a bigger goal.* Thus, geocoding might be a first stage in locating customers so further geospatial analysis can be completed using other methods, such as those also discussed in the "Foundational Methods" discussion. For example:

- After geocoding a customer data file for a chain retailer, a set of drive-time zones could be created around the locations in the chain
- With customer locations and drive-time zones around all stores in the chain in place, each customer record could be classified by the specific drive-time zone each is located within (and tagged with the store serving that zone)
- This would be an input to targeted marketing and further analysis geared to merchandising decisions for each store

This section is thus intended to provide some definition of a basic toolkit that can then be combined and extended in an infinite number of ways to solve a wide spectrum of business problems.

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* These bigger goals are of course the point of doing this kind of work. For more ideas related to the process of combining foundational methods into solutions for bigger problems, please see Part B ("Application Areas", pages 97-152) and the two Appendices (Appendix A: "How to Problem-Solve", pages 156-158; and Appendix B: "Matching Problem and Method", pages 159-160).

Format for Methods Discussion

To help make this complex content as user-friendly as possible, the following foundational methods sections each follow a consistent format of presentation. For each method these are the key topics covered:

- **Overview of the Method:** a general discussion of the context for the method's contribution
- **Detailed Discussion:** consideration of the options available for use of the method
- **Resources and Processes:** a brief and practical "first step" primer to using ***Maptitude*** and ***Business Analyst Web App*** to implement the method
- **What Next:** potential follow up steps to gain further useful results and interpretations from the method

Method 1: Adding a Location Component to a Database

Overview of Adding a Location Component to a Database

Many business databases have an implicit location element to them, even if location coordinates are not explicitly embedded in the variables of the database. For example, many businesses capture address data for their customers, which can be converted into latitude and longitude coordinates. Businesses that ship or deliver their products to their customers are especially likely to fall in this category.

However, even businesses that do not collect customer addresses for shipping still retain customer address or contact data in some form. For example, they might not ship a product, but they might send an invoice, or they might send follow up material, questionnaires, or sales material to their customers. Yet other businesses might not do any of this, but they still collect address information for their records.

For example, customer location data sometimes comes in forms other than addresses. For example, a zip or postal code might be requested and retained even if full address data is never collected. Zip or postal codes likely won't trace back to an exact location, but they do give an indication of the geographic area the customer comes from. Another example is telephone number data. Such numbers might be cross-referenced with information from other databases to fully extract a complete customer address, which can then be converted to location coordinates (Dramowicz 2004).

In any event, addition of a location component to existing databases is one of the most powerful and common processes we can complete with GIS technology. The following outlines the basics of this method.

Detailed Discussion: Geocoding

Point-Based Geocoding

In its most straightforward form, geocoding is the determination of the latitude and longitude coordinates associated with each address in a business address database. This establishes the basis for further geographic analysis.

Business Address Database

Dataview1 - US JCPenney

Name	Type	State	Postal	City	Address
JCPenney	Department Store	TX	77449	Houston	23523 Grand Circle Blvd
JCPenney-First Colony Mall	Department Store	TX	77479	Sugar Land	16529 SouthWest Fwy
JCPenney	Department Store	TX	77096	Houston	730 Meyerland Plaza Mall
JCPenney	Department Store	TX	77024	Houston	300 Memorial City Way
JCPenney-Cypress Towne Ctr	Department Store	TX	77429	Harris	25646 Northwest Fwy
JCPenney-Willowbrook Mall	Department Store	TX	77070	Houston	7925 FM 1960 Rd W
JCPenney	Department Store	TX	77584	Pearland	2500 Smith Ranch Rd
JCPenney	Department Store	TX	77505	Pasadena	5120 Fairmont Pkwy
JCPenney	Department Store	TX	77049	Harris	5858 E Sam Houston Pkwy N
JCPenney-Friendswood	Department Store	TX	77546	Houston	100 Baybrook Mall
JCPenney	Department Store	TX	77521	Baytown	2000 San Jacinto Mall
JCPenney	Department Store	TX	77338	Humble	20131 Highway 59 N

Address Database with Geographic Coordinates

Dataview1 - US JCPenney

LONGITUDE	LATITUDE	Name	Type	State	Postal	City
-95773910	29790290	JCPenney	Department Store	TX	77449	Houston
-95626620	29591690	JCPenney-First Colony Mall	Department Store	TX	77479	Sugar Land
-95463140	29686760	JCPenney	Department Store	TX	77096	Houston
-95539410	29779540	JCPenney	Department Store	TX	77024	Houston
-95688490	29968270	JCPenney-Cypress Towne Ctr	Department Store	TX	77429	Harris
-95537000	29959010	JCPenney-Willowbrook Mall	Department Store	TX	77070	Houston
-95385520	29560980	JCPenney	Department Store	TX	77584	Pearland
-95164470	29647640	JCPenney	Department Store	TX	77505	Pasadena
-95161120	29810660	JCPenney	Department Store	TX	77049	Harris
-95150220	29541500	JCPenney-Friendswood	Department Store	TX	77546	Houston
-94983120	29800650	JCPenney	Department Store	TX	77521	Baytown
-95271930	30009100	JCPenney	Department Store	TX	77338	Humble

Databases from Maptitude

Detailed Discussion

Point-Based Geocoding Result: Visualization of the location dimension that was implicit in the original database because of the inclusion of some form of address or place information, but not obvious.

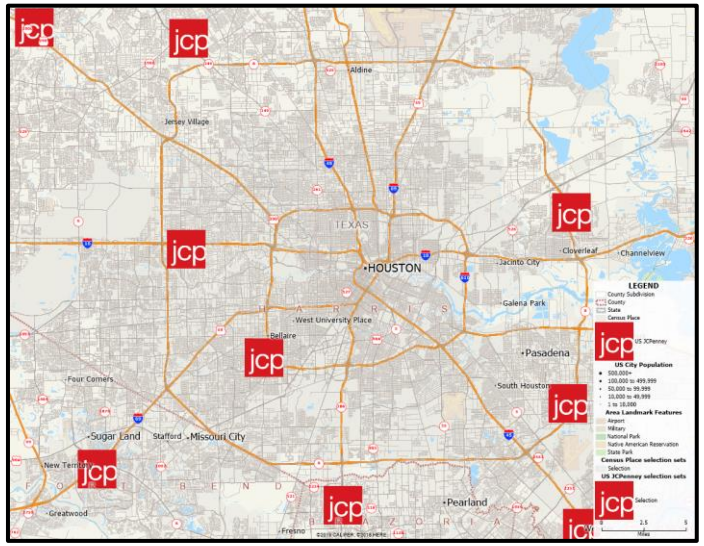
Business Address Database with Geographic Coordinates

Dataview1 - US JCPenney

LONGITUDE	LATITUDE	Name	Type	State	Postal	City
-95773910	29790290	JCPenney	Department Store	TX	77449	Houston
-95626620	29591690	JCPenney-First Colony Mall	Department Store	TX	77479	Sugar Land
-95463140	29686760	JCPenney	Department Store	TX	77096	Houston
-95539410	29779540	JCPenney	Department Store	TX	77024	Houston
-95688490	29968270	JCPenney-Cypress Towne Ctr	Department Store	TX	77429	Harris
-95537000	29959010	JCPenney-Willowbrook Mall	Department Store	TX	77070	Houston
-95385520	29560980	JCPenney	Department Store	TX	77584	Pearland
-95164470	29647640	JCPenney	Department Store	TX	77505	Pasadena
-95161120	29810660	JCPenney	Department Store	TX	77049	Harris
-95150220	29541500	JCPenney-Friendswood	Department Store	TX	77546	Houston
-94983120	29800650	JCPenney	Department Store	TX	77521	Baytown
-95271930	30009100	JCPenney	Department Store	TX	77338	Humble

Databases from Maptitude

Map of Address Locations



Area-Based Geocoding

Sometimes, point-based geocoding is not possible because the business does not possess a full address database. However, they may have partial address information, such as postal (Zip) codes or telephone numbers. Geocoding coming from this area foundation can also establish a basis for further geographic analysis.

Business Customer Postal Code Database

Dataview1 - Basic Customer Data Table

Customer ID	ZIP Code	QTR1 Sales	QTR2 Sales
1001	80510	2010	2379
1002	80510	1024	909
1003	80420	3928	4586
1004	80420	1032	1046
1005	80002	9757	10475
1006	80002	4028	4462
1007	80002	4145	4942
1008	80002	959	1289
1009	80002	18670	23067
1010	80002	2069	2490

Databases from Maptitude

Business Customer Database by Postal Code

Dataview1 - Overlay

[5-Digit ZIP Code].I	ZIP	State	N Customers	QTR1 Sales	Avg QTR1 Sales	QTR2 Sales	Avg QTR2 Sale
1105434	80302	CO	56	780299.00	13933.91	853275.00	15237.0
1094613	80112	CO	49	645589.00	13175.29	734240.00	14984.4
1093263	80401	CO	49	792781.00	16179.20	825761.00	16852.2
1142878	80012	CO	48	1019650.00	21242.71	1113687.00	23201.8
1107973	80501	CO	47	625476.00	13308.00	684266.00	14558.8
1094666	80210	CO	47	362948.00	7722.30	395931.00	8424.0
1094631	80219	CO	44	486408.00	11054.73	522310.00	11870.6
1094633	80223	CO	42	357220.00	8505.24	423773.00	10089.8
1099024	80206	CO	41	685024.00	16707.90	719045.00	17537.6
1094645	80204	CO	41	368140.00	8979.02	415581.00	10136.1
1094622	80226	CO	40	507226.00	12680.65	619941.00	15498.5
1142880	80015	CO	37	188329.00	5089.97	203365.00	5496.3

Data aggregated by Postal Code

Detailed Discussion

Area-Based Geocoding Result: Even with only postal codes available, we have set up a powerful visualization of the location dimension present in the original database that was implicit but not obvious.

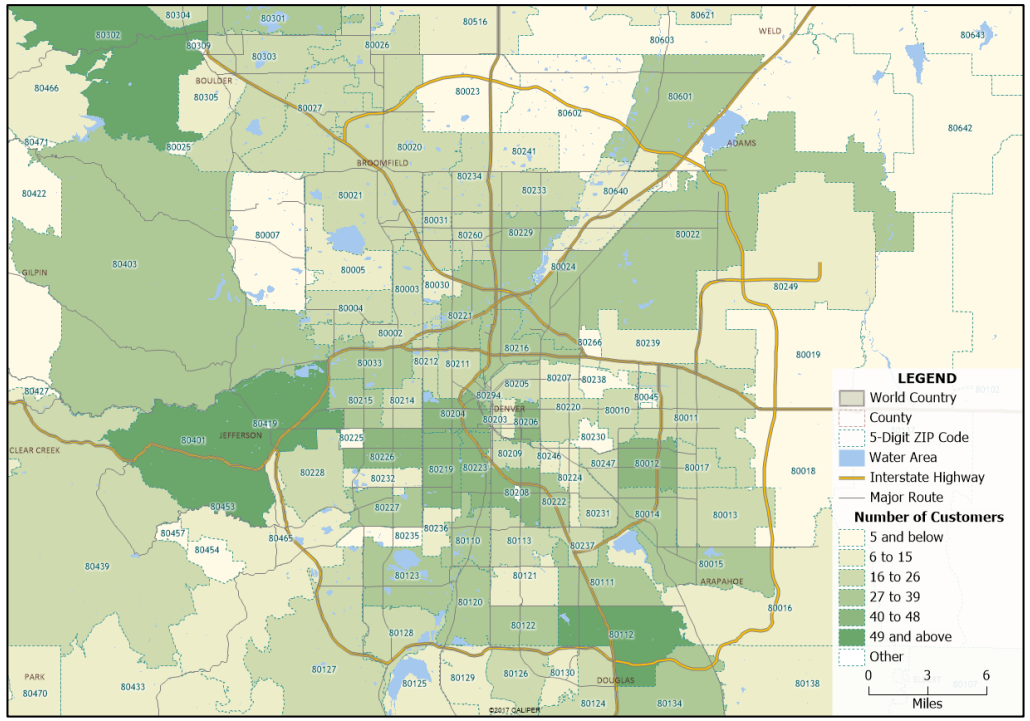
Business Customer Database by Postal Code

Dataview1 - Overlay

[5-Digit ZIP Code].U	ZIP	State	N Customers	QTR1 Sales	Avg QTR1 Sales	QTR2 Sales	Avg QTR2 Sale
110543	80302	CO	56	780299.00	13933.91	853275.00	15237.0
109461	80112	CO	49	645589.00	13175.29	734240.00	14984.4
109326	80401	CO	49	792781.00	16179.20	825761.00	16852.2
114287	80012	CO	48	1019650.00	21242.71	1113687.00	23201.8
110797	80501	CO	47	625476.00	13308.00	684266.00	14558.8
109466	80210	CO	47	362948.00	7722.30	395931.00	8424.0
109463	80219	CO	44	486408.00	11054.73	522310.00	11870.6
109463	80223	CO	42	357220.00	8505.24	423773.00	10089.8
109902	80206	CO	41	685024.00	16707.90	719045.00	17537.6
109464	80204	CO	41	368140.00	8979.02	415581.00	10136.1
109462	80226	CO	40	507226.00	12680.65	619941.00	15498.5
114288	80015	CO	37	188329.00	5089.97	203365.00	5496.3

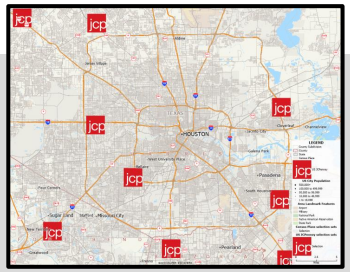
Map aggregated customer figures by Postal Code

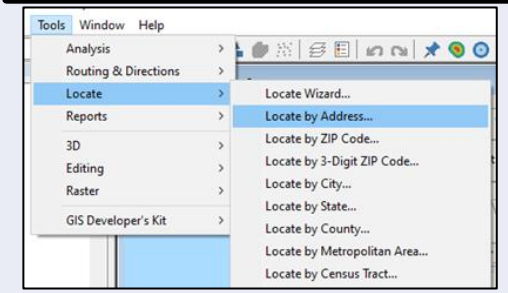
Customers by Postal Code



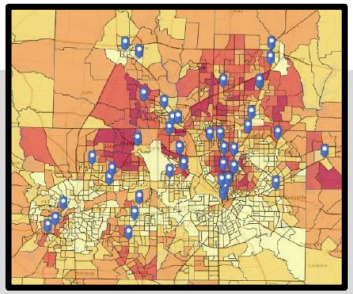
Resources and Processes to Add a Location Component to a Database

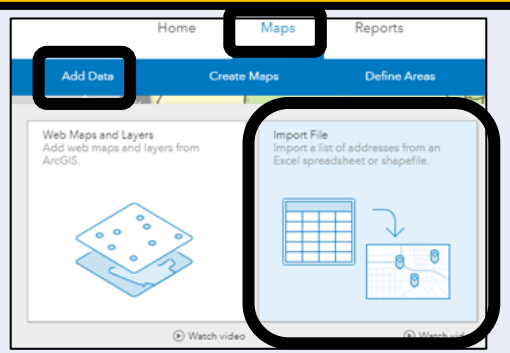
In Caliper Maptitude:



Adding a Location Component…	
Supported by Maptitude	Yes
Starting the Analysis	Tools > Locate > Locate by Address… 
More guidance from Caliper	https://www.caliper.com/video/maptitude/maptitude-locating-video/maptitude-locating-video.html

In Esri BA Web App:



Adding a Location Component…	
Supported by BA Web App	Yes
Starting the Analysis	Maps > Add Data > Import File 
More guidance from Esri	https://doc.arcgis.com/en/business-analyst/web/import-file.htm

Next Steps After Adding a Location Component to a Database

Now that you have a location component in your database, what is possible now?

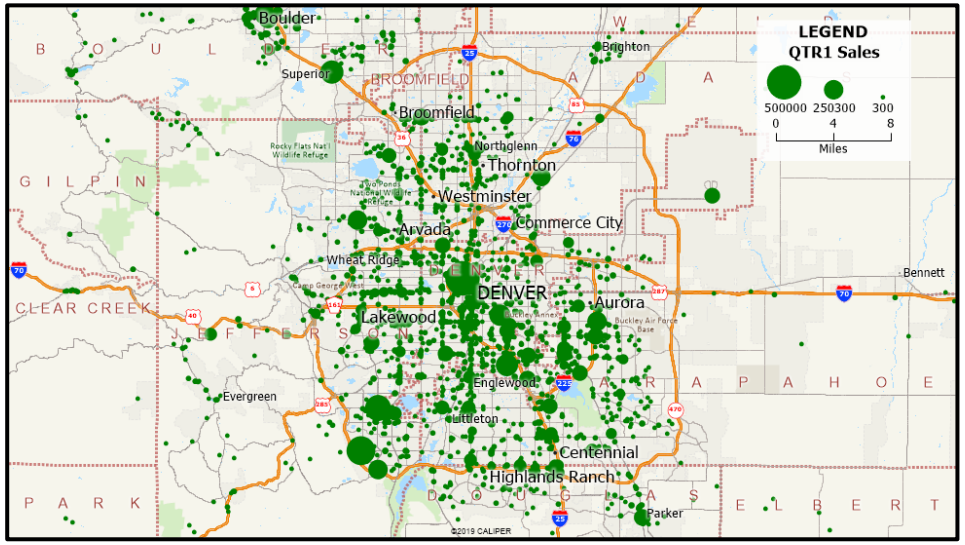
For a database representing individual places (point locations), such as residential or work addresses for individual people or business locations for stores, restaurants, or offices, you have a foundation for a variety of analytical extensions that depict point patterns.

- For example, by adding residential location coordinates to a customer purchase database, you now have the ability to map purchases and represent spatial patterns that could have never been visualized in the original, location-free database

Dataview1 - Customers

Customer Name	Street Address	City	State	ZIP Code	QTR1 Sales	QTR2 Sales
Customer #1005	11700 W 58th Ave	Arvada	CO	80002	9757	10475
Customer #1007	5225 Gladiola St	Arvada	CO	80002	4145	4942
Customer #1009	5285 Wadsworth Byp	Arvada	CO	80002	18670	23067
Customer #1010	5300 Sheridan Blvd	Arvada	CO	80002	2069	2490
Customer #1011	5308 Flower Cir	Arvada	CO	80002	1996	2528
Customer #1013	5330 Sheridan Blvd	Arvada	CO	80002	20884	18983
Customer #1015	5400 Sheridan Blvd	Arvada	CO	80002	969	1328
Customer #1017	5410 Nolan St	Arvada	CO	80002	962	1288
Customer #1019	5460 Carr St	Arvada	CO	80002	11774	15371
Customer #1020	5465 Wadsworth Byp	Arvada	CO	80002	8302	8697
Customer #1021	5490 Wadsworth Byp	Arvada	CO	80002	3050	3285
Customer #1023	5675 Olde Wadsworth Blvd	Arvada	CO	80002	3019	3599
Customer #1025	5755 Everett St	Arvada	CO	80002	985	931
Customer #1027	5778 Lamar St	Arvada	CO	80002	2918	3759
Customer #1029	6291 W 58th Ave	Arvada	CO	80002	4133	4238
Customer #1030	7405 Grandview Ave	Arvada	CO	80002	2909	4008
Customer #1031	7430 W 52nd Ave	Arvada	CO	80002	6126	6653

Original, Location-Free Database

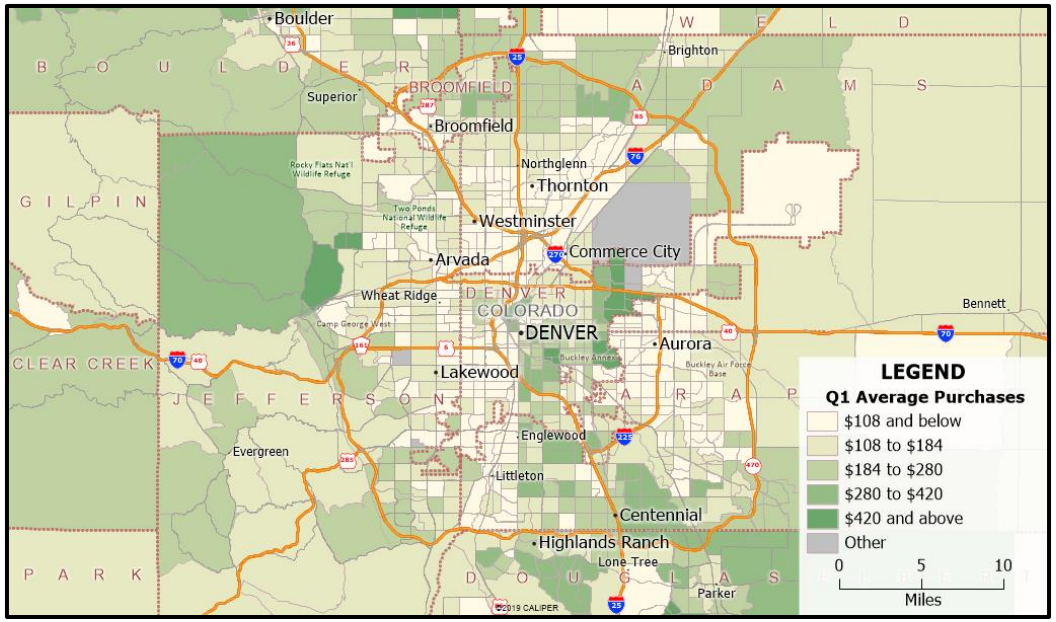


Mapping Now Possible with Location Coordinates

What Next

Taking the customer point location database analysis a step further,

- Customer records can be aggregated by census tract to emphasize the best neighborhood markets
- Starting with point locations means that you can aggregate at any geographic level that you wish
- Starting with postal codes means that you can only aggregate at the postal code level, and not go with any smaller areas such as census tracts, block groups, or blocks



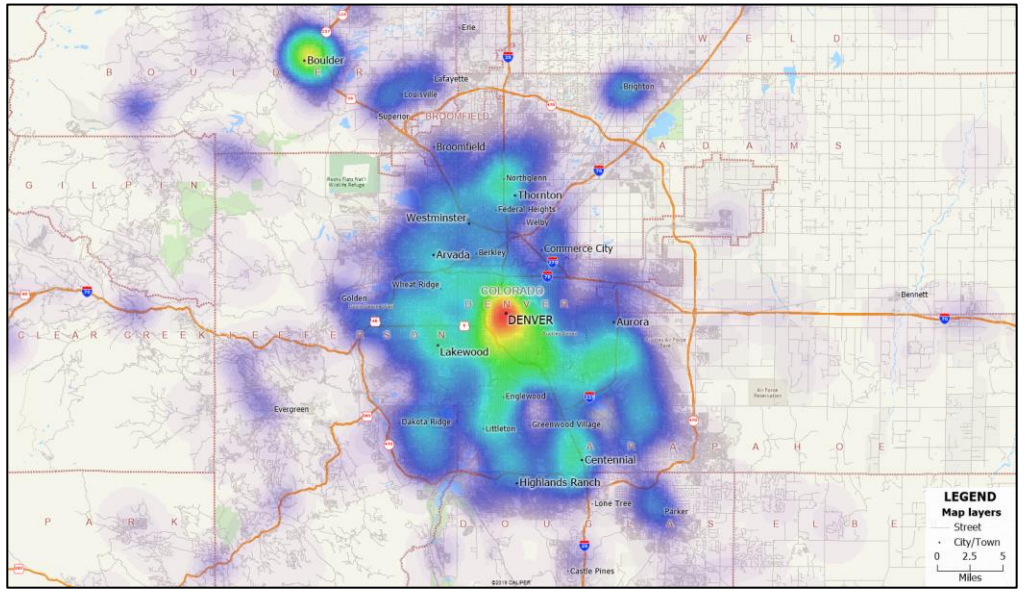
Maptitude

Aggregating and Averaging Customer Purchase Records by Census Tract

What Next

Another available option when starting with a customer point location database analysis is conversion to an areal theme using a density grid analysis (see page 79)

- Aggregation using census tracts imposes a boundary system on the data that may distort the actual spatial patterns in the dataset
- Use of the density grid analysis avoids this problem and provides a simplified (but not simple) map pattern to interpret



Maptitude

Density Grid Analysis of a Customer Database

Method 2: Buffer/Drive-Zone Analysis

Overview of Buffer/Drive-Zone Analysis

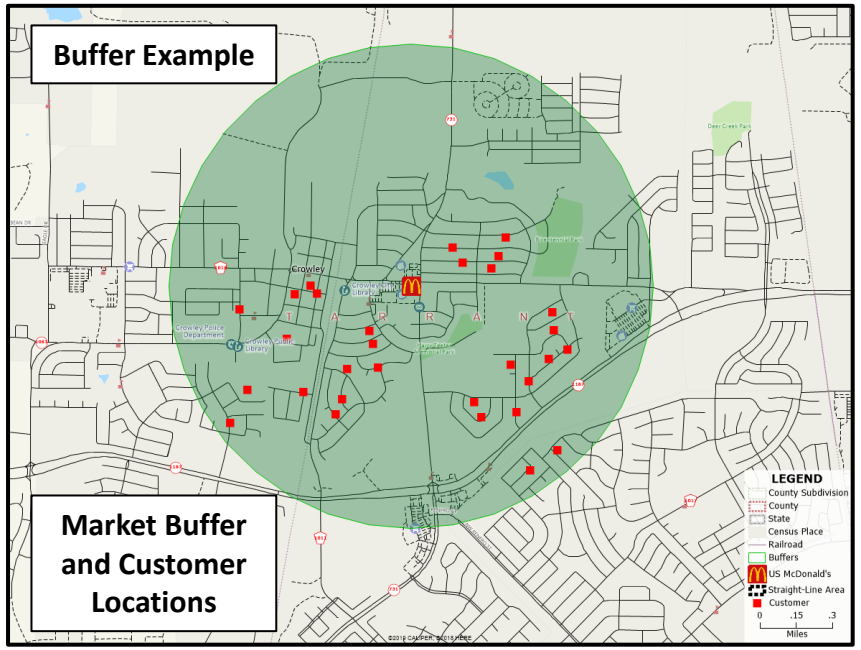
Method 2, buffers and drive-time zones, is a useful analytical framework in at least two ways.

1. First, use of either option provides a **graphic representation of the core service area** served by a given service-providing facility (store, restaurant, hotel, or warehouse).
2. Second, use of either option also provides a **foundation for further research** that can help the business understand the markets and customers located in the geographically-proximate zone next to them.

Buffers and drive-time zones are also useful because they work with method 1 (adding a geographic component to a database) to provide a "bridge" that businesses can use to start using geographic analysis in more complex ways.

- Method 1 assembles a database of point location data.
- Method 2 (buffers/drive-time zones) defines areas that can be used to aggregate the records from method 1.

For example, if the point-based data from method 1 are customer records, a buffer created by method 2 could define the market area for a facility (see example at right) and identify the specific customers who live within that market area.

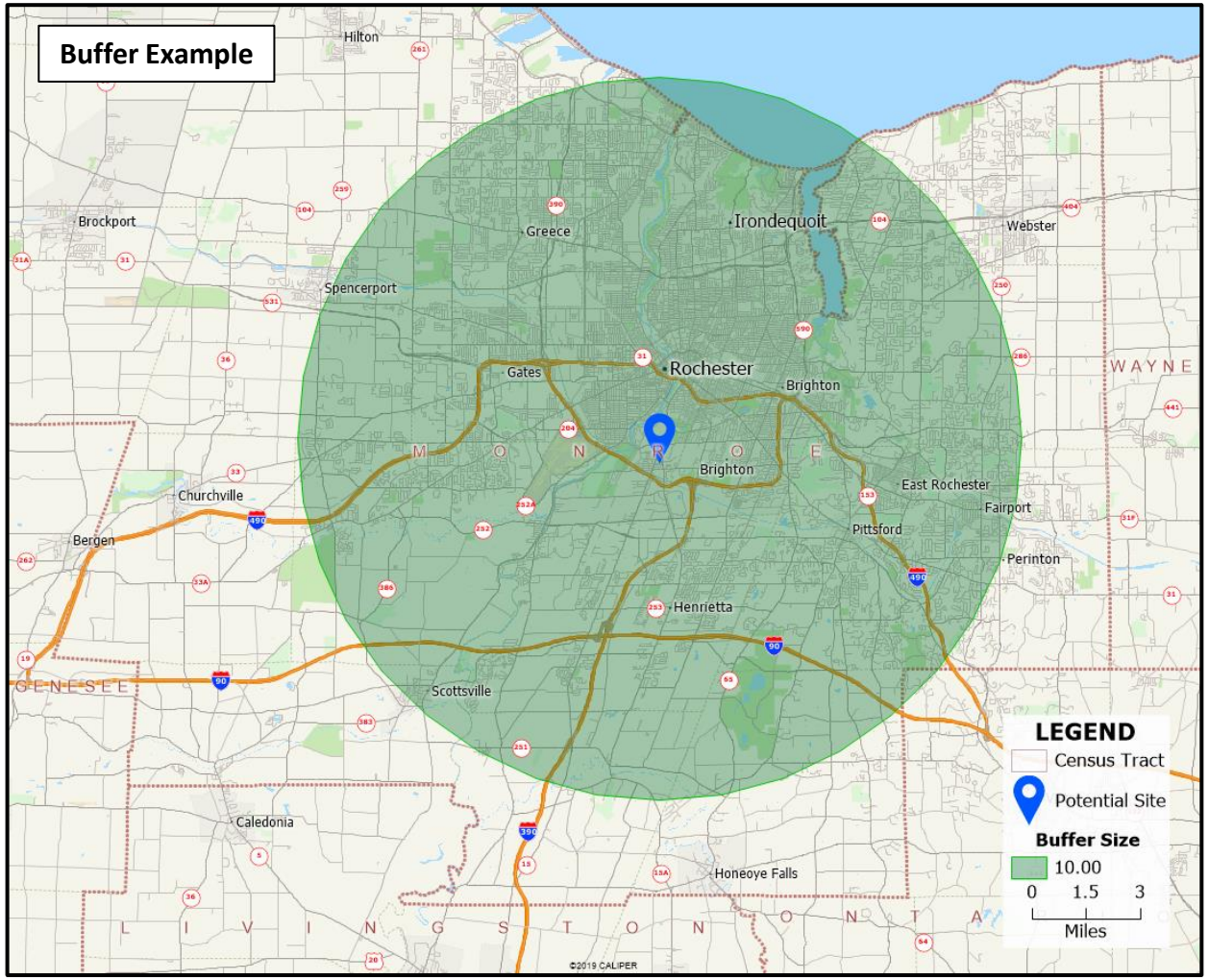


Maptitude

A. Buffer: Straight-Line Distance

Focus: a single, critical distance (radius) that defines a circular zone around a location

Rochester Example: zone based on a 10-mile buffer around a specific location



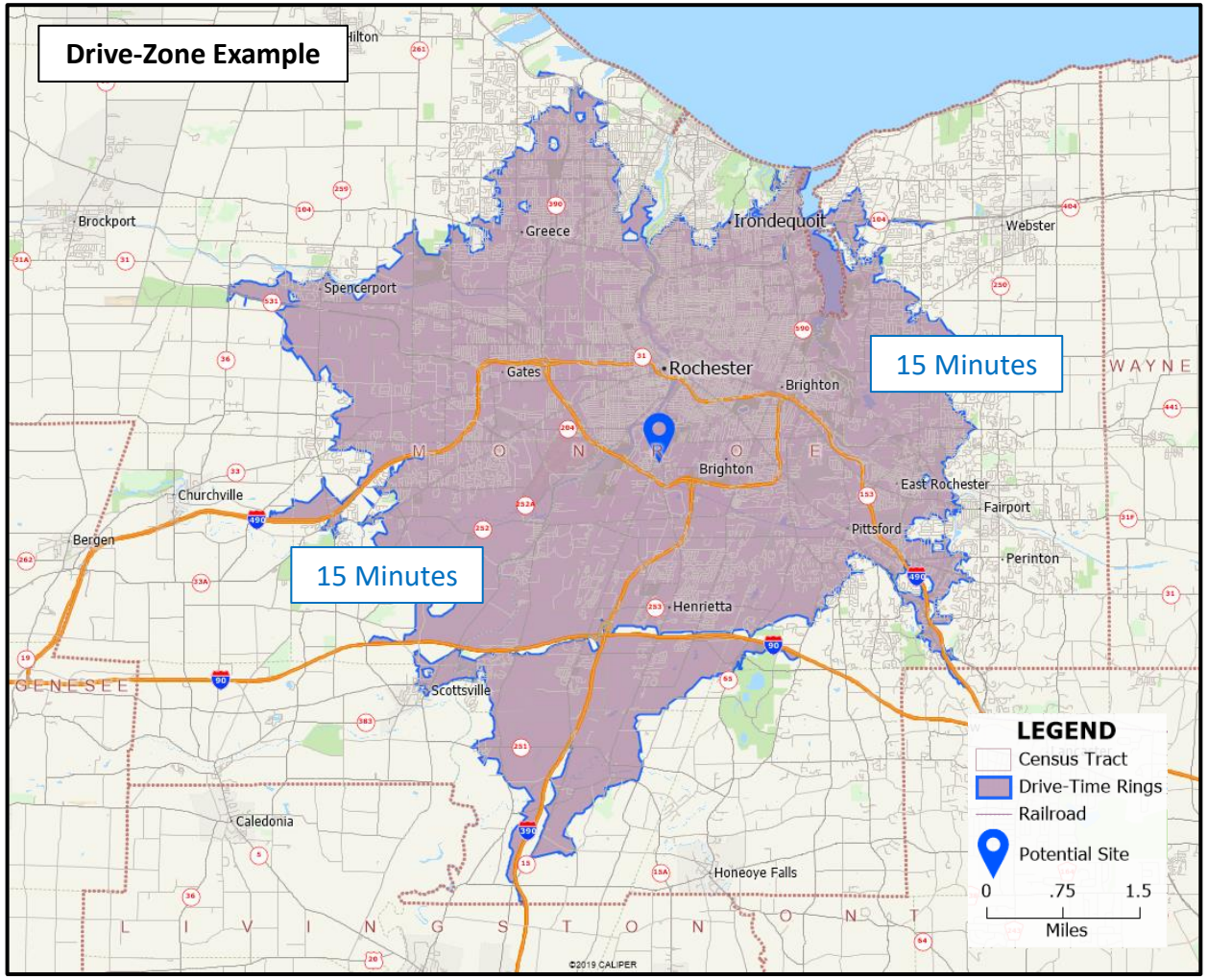
Maptitude

B. Drive-Zone Analysis

Drive-Zone: considered in terms of distance driven (zone located within a given drive distance) or drive times (zone located within a given drive time)

Rochester Example: zone based on a 15-minute drive time around a given location

This analysis can also be completed with a single zone or multiple (nested) zones

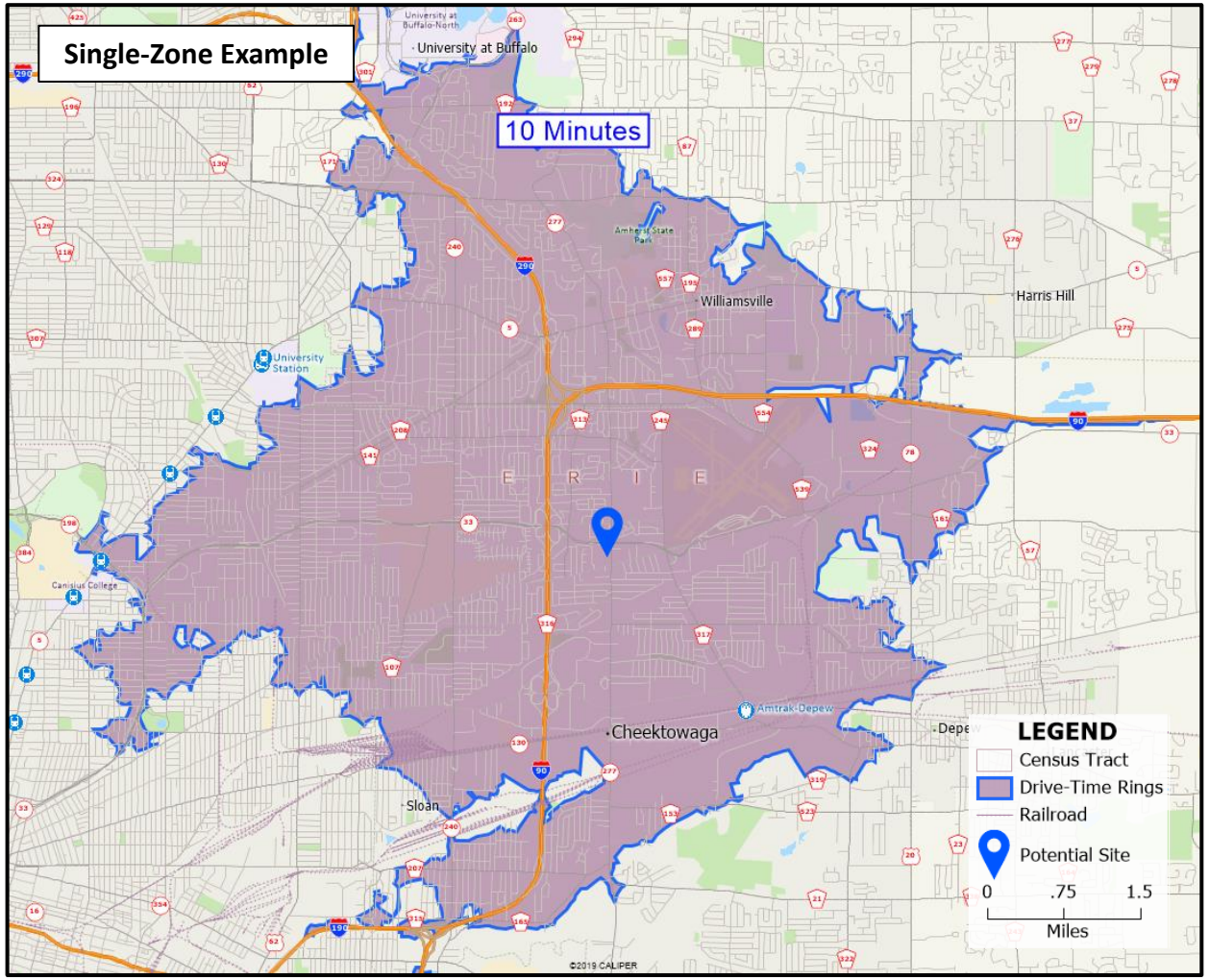


Maptitude

Detailed Discussion

Single-Zone: one value to consider

Buffalo Example: one zone definition based on a single 10-minute drive time around a retail location

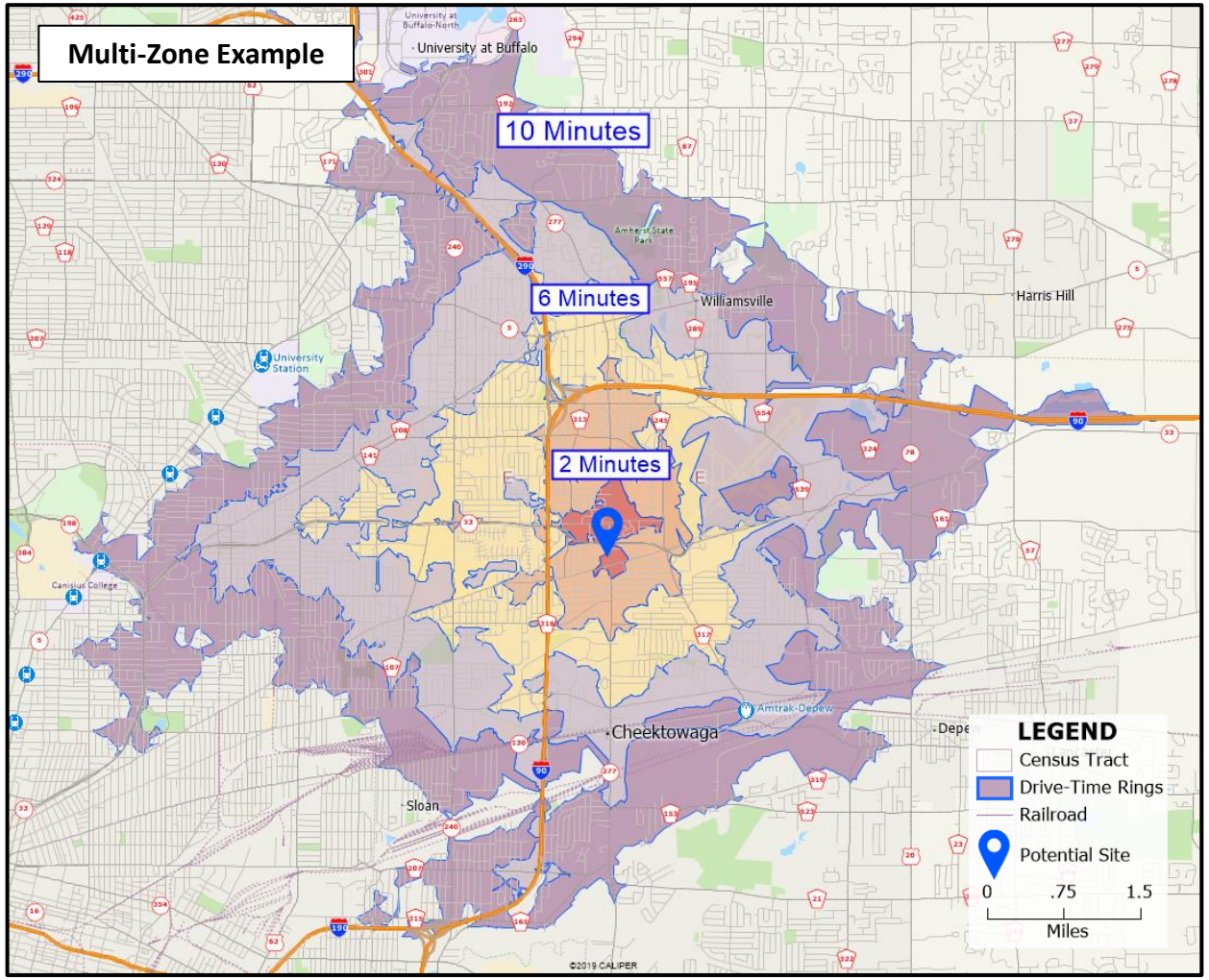


Maptitude

Detailed Discussion

Multi-Zone: nested analyses incorporating a range of drive values

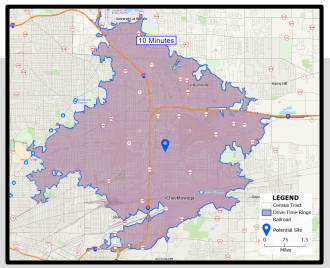
Buffalo Example: nested zones based on a series of drive time around the same retail location, building from 2 minutes to 10 minutes



Maptitude

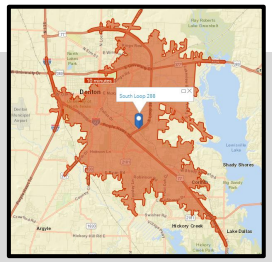
Resources and Processes to do a Buffer/Drive-Zone Analysis

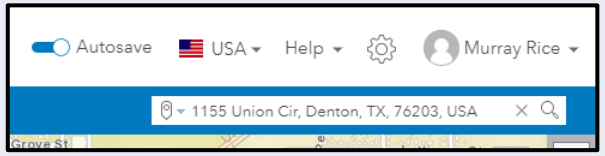
In Caliper Maptitude:



Buffer/Drive Zone Analysis…	
Supported by Maptitude	Yes
Starting the Analysis	Top Toolbar > Create Buffers Button  Top Toolbar > Create Drive-Time Rings 
More guidance from Caliper	https://www.caliper.com/video/maptitude/maptitude-overlays-and-buffers-video/maptitude-overlays-and-buffers-video.html

In Esri BA Web App:



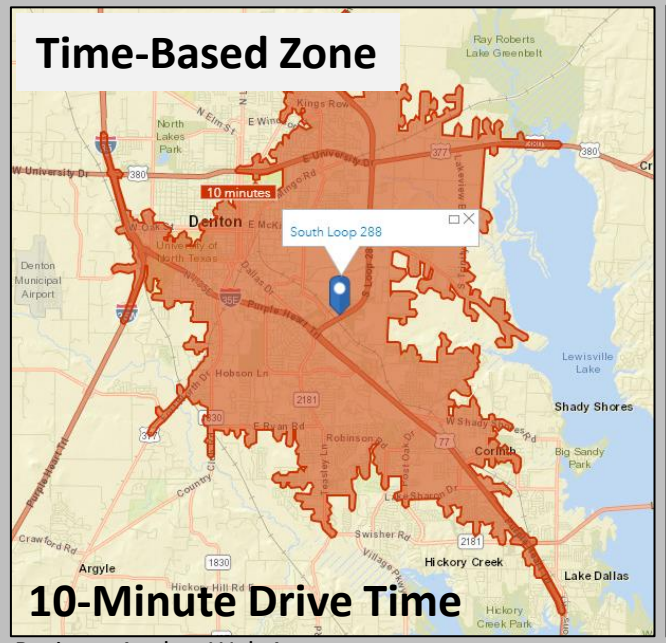
Buffer/Drive Zone Analysis…	
Supported by BA Web App	Yes
Starting the Analysis	"Address locate" tool on main screen 
More guidance from Esri	https://doc.arcgis.com/en/business-analyst/web/find-location.htm

In Esri BA Web App (Special Note):

Buffers/Drive-Zone Results with BA Web App

BA Web provides some intriguing output options in the buffers/drive-zone analysis area. As represented at right, BA Web offers both time-based and distance-base zone calculations. The examples show that use of the two options leads to meaningful differences.

Additionally, note that BA Web App also provides a walk-time option not shown here.



Business Analyst Web App

Business Analyst Web App

Note the differences in zone geometry when choosing <u>time-based</u> versus <u>distance-based</u> calculation. Time-based geometries are more "spiky" due to the operation of different speed limits on different roads.

Next Steps After Creating a Buffer/Drive-Zone

Now that you have created a buffer/drive-zone analysis, what is possible now?

On a map showing locations both customers (people or businesses) and facilities that provide service (stores), you have a foundation to:

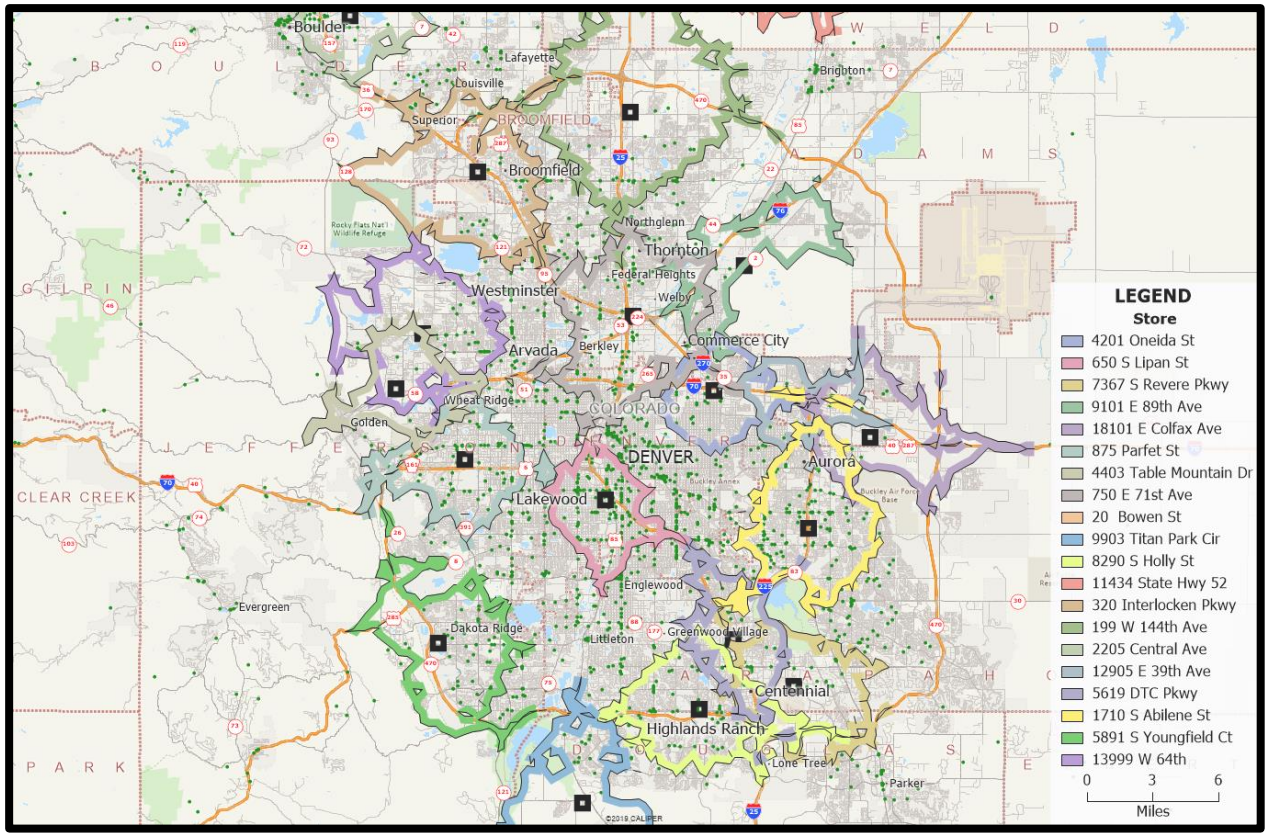
- Develop targeted databases that list the group of customers that reside closest to each store

A	B	C	D	E	F	G	H	I
Store	Customer ID	Customer Name	Street Address	City	State	ZIP Code	QTR1 Sales	QTR2 Sales
1021	1005	Customer #1005	11700 W 58th Ave	Arvada	CO	80002	9757	10475
1021	1006	Customer #1006	5220 Wadsworth Byp	Arvada	CO	80002	4028	4462
1021	1007	Customer #1007	5225 Gladiola St	Arvada	CO	80002	4145	4942
1021	1008	Customer #1008	5234 Braun St	Arvada	CO	80002	959	1289
1021	1009	Customer #1009	5285 Wadsworth Byp	Arvada	CO	80002	18670	23067
1021	1010	Customer #1010	5300 Sheridan Blvd	Arvada	CO	80002	2069	2490
1021	1011	Customer #1011	5308 Flower Cir	Arvada	CO	80002	1996	2528
1021	1012	Customer #1012	5315 Marshall St	Arvada	CO	80002	5858	5916
1021	1013	Customer #1013	5330 Sheridan Blvd	Arvada	CO	80002	20884	18983
1021	1014	Customer #1014	5398 Sheridan Blvd	Arvada	CO	80002	5228	4885
1021	1015	Customer #1015	5400 Sheridan Blvd	Arvada	CO	80002	969	1328
1021	1016	Customer #1016	5405 Wadsworth Byp	Arvada	CO	80002	121291	153393
1021	1017	Customer #1017	5410 Nolan St	Arvada	CO	80002	962	1288
1021	1018	Customer #1018	5440 Marshall St	Arvada	CO	80002	1049	1284
1021	1019	Customer #1019	5460 Carr St	Arvada	CO	80002	11774	15371
1021	1020	Customer #1020	5465 Wadsworth Byp	Arvada	CO	80002	8302	8697
1021	1021	Customer #1021	5490 Wadsworth Byp	Arvada	CO	80002	3050	3285

Customer Database Segmented by Closest Store

What Next

This analysis also provides a foundation to visualize the customer coverage provided by each store, and by multiple stores working collectively. To interpret these results well, a combination of GIS-based evidence and business and market knowledge will be necessary. Examining this sample map in detail, we can see some areas of concern along with some positive features.

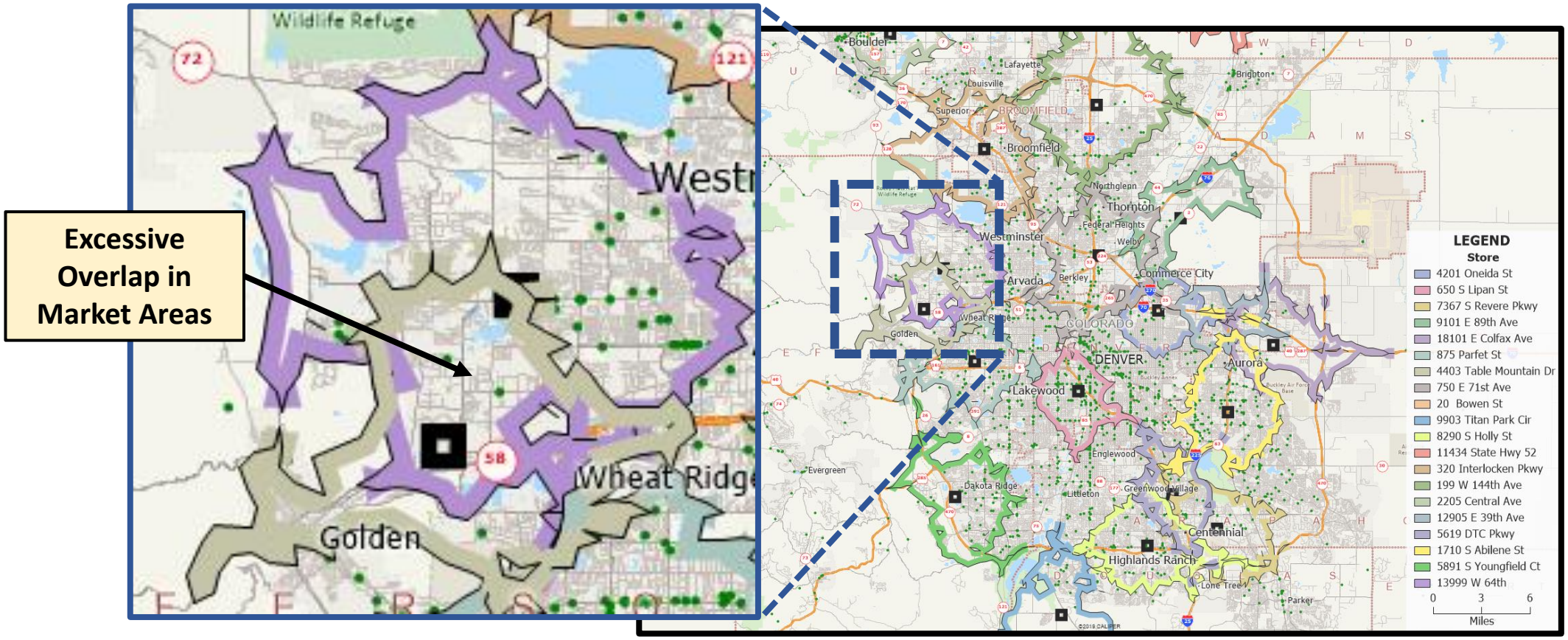


Denver-Area Customers and Store-Based Drive-Zones

Maptitude

What Next

1 Here, we see a first concern: an <u>excessive market area overlap</u> in one portion of the map.

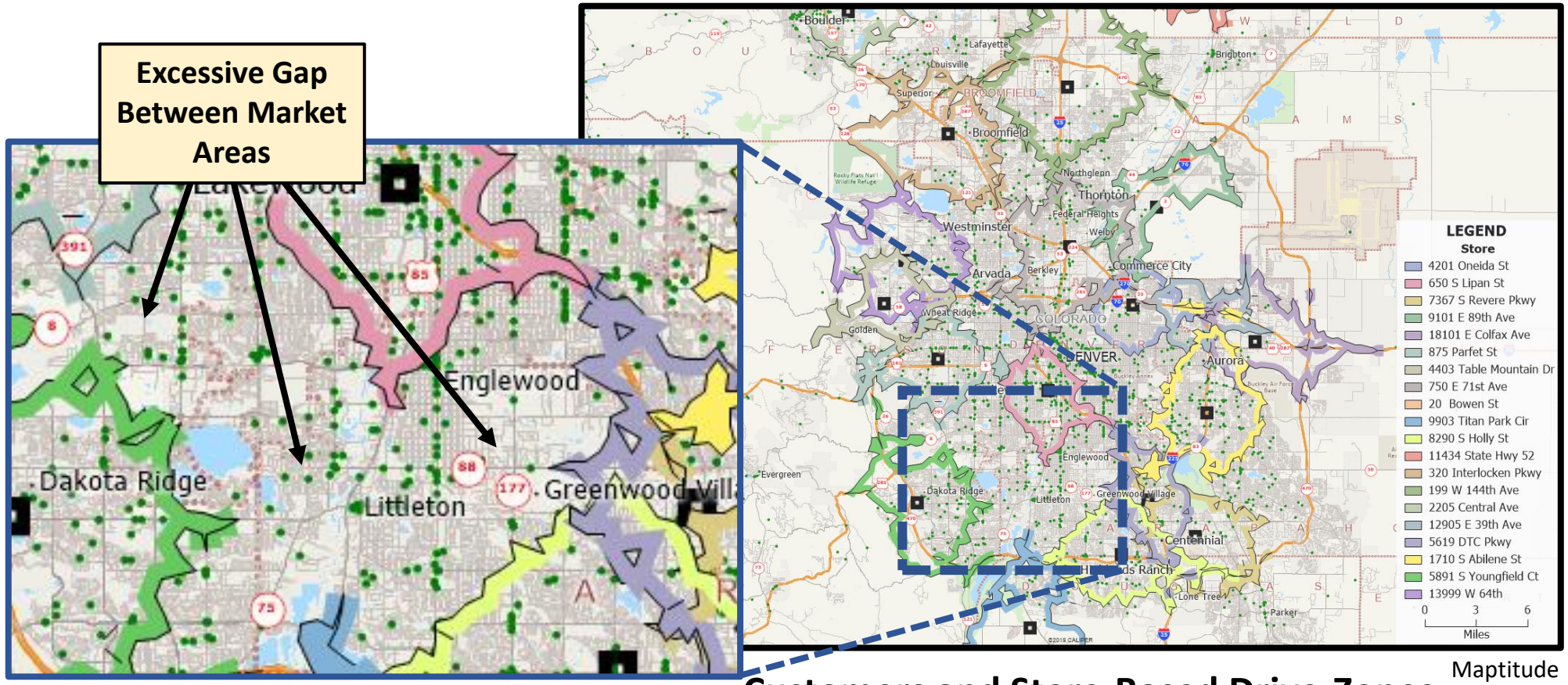


Maptitude

Customers and Store-Based Drive-Zones

What Next

2 Here is a second concern: an <u>excessive gap in coverage</u>, leaving a portion of the market under-served.

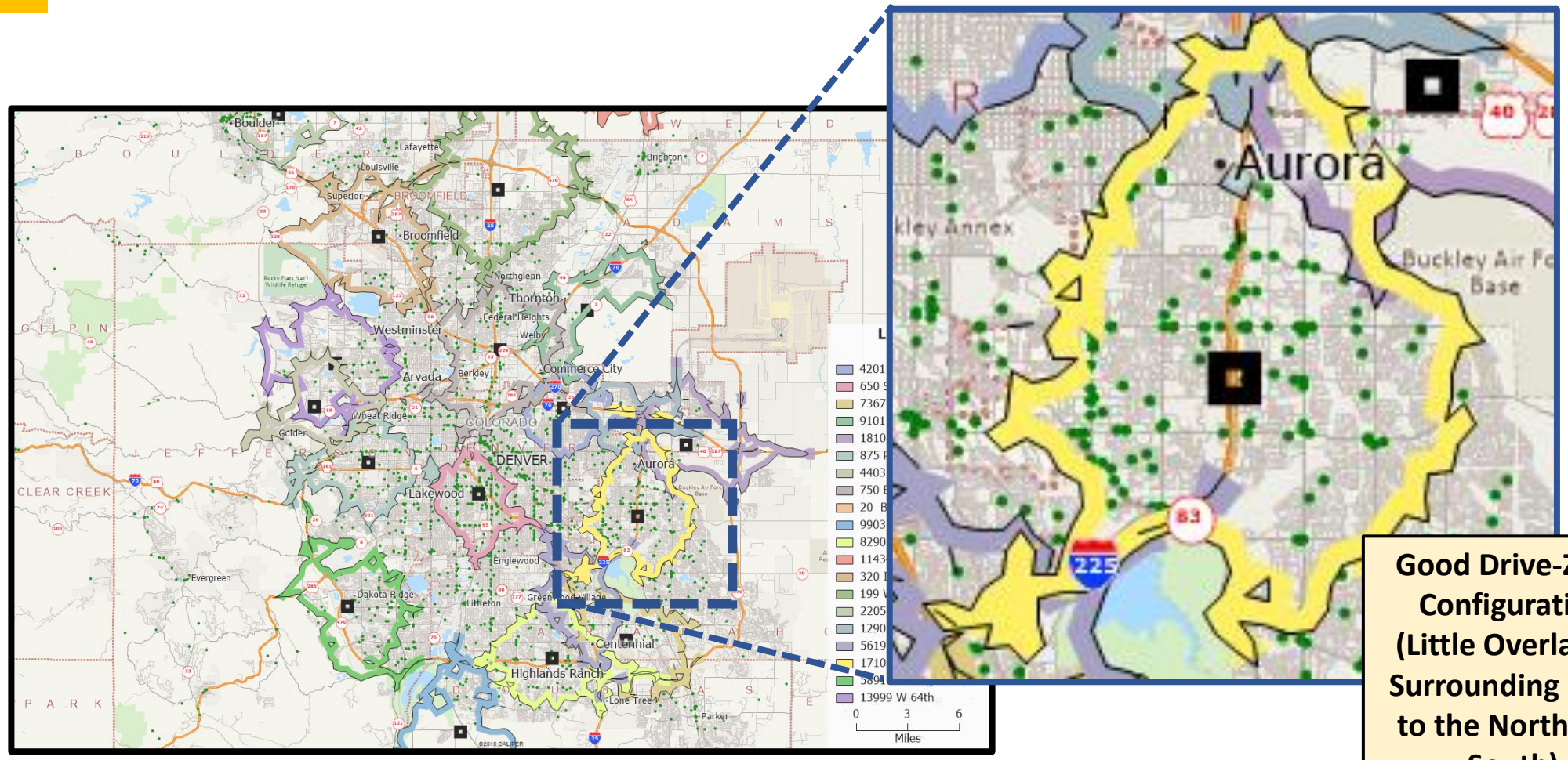


Maptitude

Customers and Store-Based Drive-Zones

3

Finally, here is a portion of the Denver market area where things appear to be working well.



Maptitude

Customers and Store-Based Drive-Zones

Good Drive-Zone Configuration (Little Overlap or Surrounding Gaps to the North and South)

Method 3: Choropleth Mapping

Overview of Choropleth Mapping

One issue we cannot overlook is the identification and use of basic mapping types that are suited to effective communication of spatial patterns for a variety of geographic data types.

We have already encountered point mapping directly, through our point-based geocoding discussion (page 15). Along the way, we have also discussed a couple of major point data mapping options:

- Use of a single symbol to simply reflect the distribution of a point phenomenon that focuses on an item where every occurrence is relatively similar to each other (e.g. the JCPenney department store chain on page 16).
- Use of a scaled symbol, which is appropriate in situations where we can focus on a key characteristic of the point, and this characteristic varies in some systematic manner (e.g. the customer sales map on page 20).

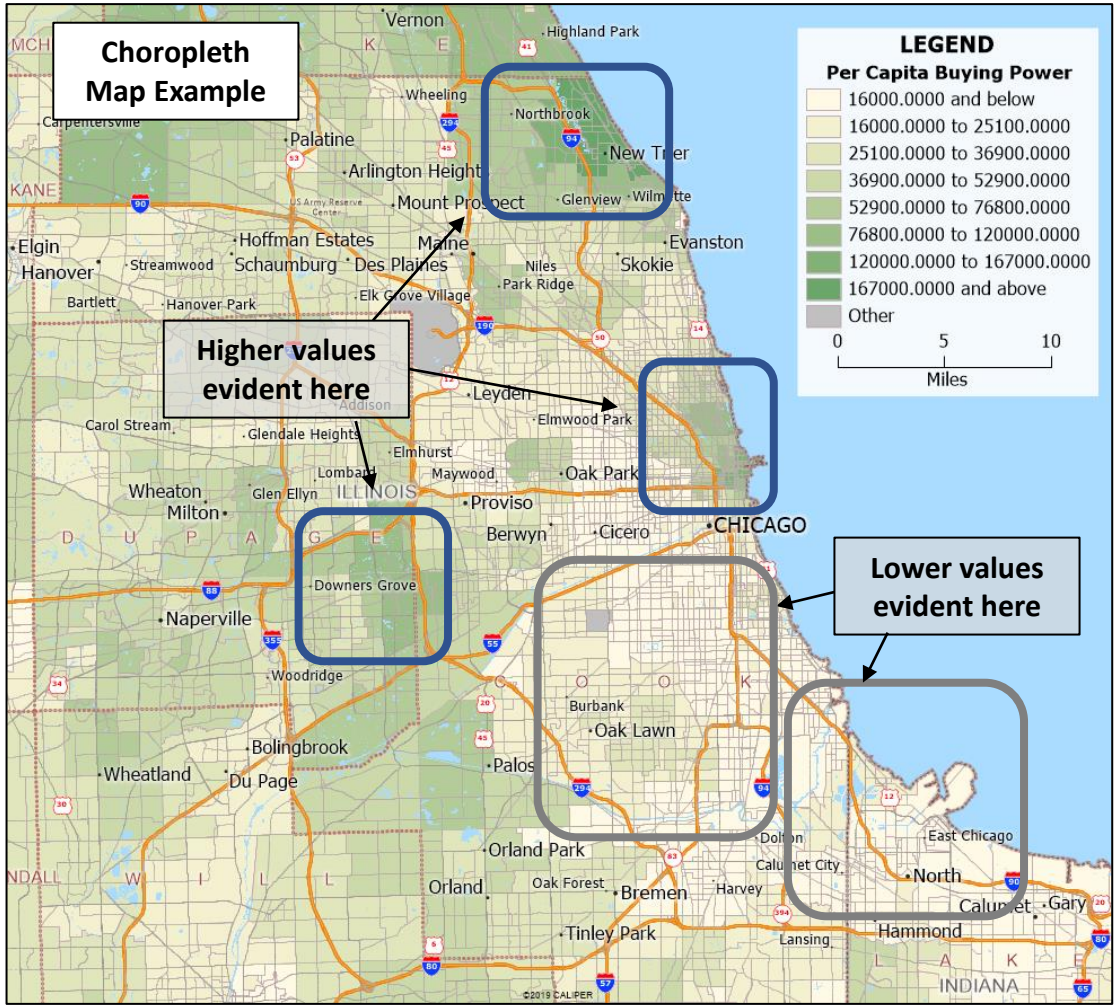
For completeness, we need to deal with another major map type: the choropleth map. By contrast with the above, choropleth maps are area-based, and the use variation in map color or shade to detect variation in a key characteristic of the area of being represented.

The following provides a brief survey of considerations that relate to effective choropleth mapping.

Detailed Discussion: Choropleth Mapping

Focus: representing what is happening with an area-based phenomenon that extends across a region of mapping interest

Chicago Example: map representing the variation across the Chicago metropolitan area of something called per capita buying power. This is a measure of the economic impact potential of a person or household rooted in their financial resources. This map helps us understand that high buying power is clustered in certain places across the Chicago area.

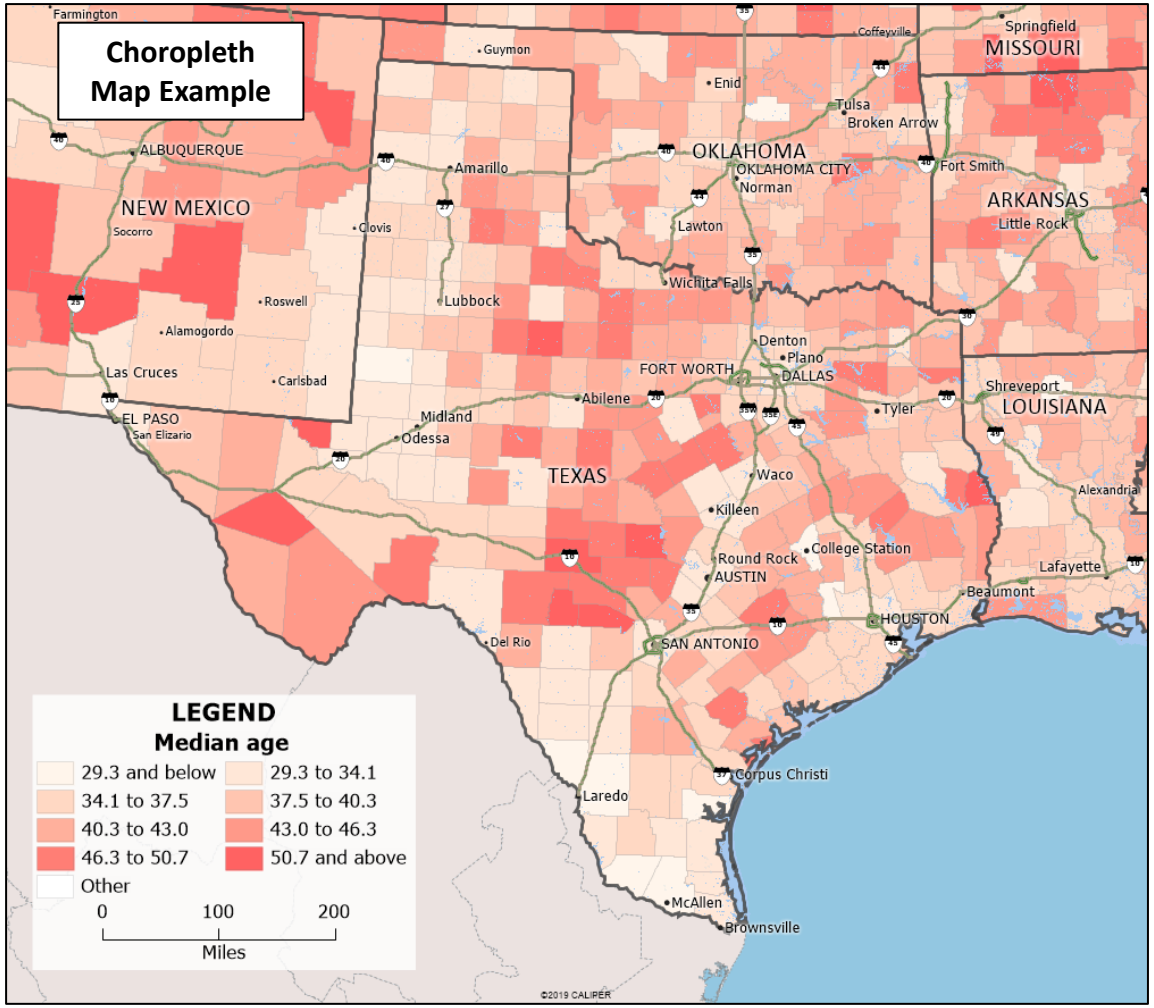


Maptitude

Detailed Discussion

Choropleth maps can focus on a relatively small area, such as the census tracts represented in the Chicago buying power example. However, they can also focus on and provide good insight into relatively large areas such as counties or states.

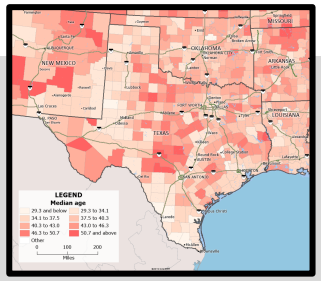
Texas Example: map representing the county-by-county variation across Texas in the population's median age. The map demonstrates the variation among the counties is substantial and that there is a complex map pattern characterizing this age variable.

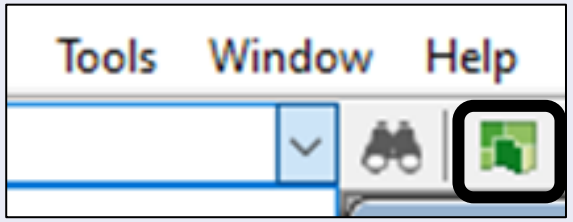


Maptitude

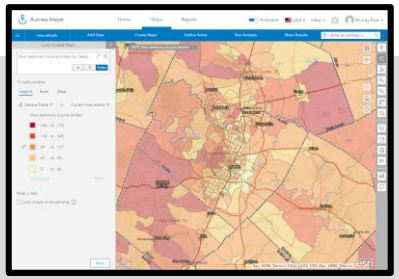
Resources and Processes to Complete a Choropleth Map

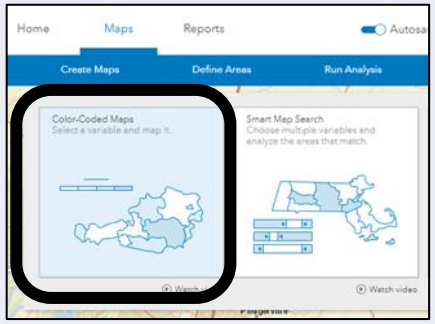
In Caliper Maptitude:



Choropleth mapping…	
Supported by Maptitude	Yes
Starting the Analysis	Top Toolbar > Color Theme MapWizard 
More guidance from Caliper	https://www.caliper.com/video/maptitude/maptitude-thematic-mapping-video/maptitude-thematic-mapping-video.html

In Esri BA Web App:



Choropleth mapping…	
Supported by BA Web App	Yes
Starting the Analysis	Create Maps > Color Coded Maps 
More guidance from Esri	https://doc.arcgis.com/en/business-analyst/web/color-coded-maps.htm

Next Steps After Creating a Choropleth Map

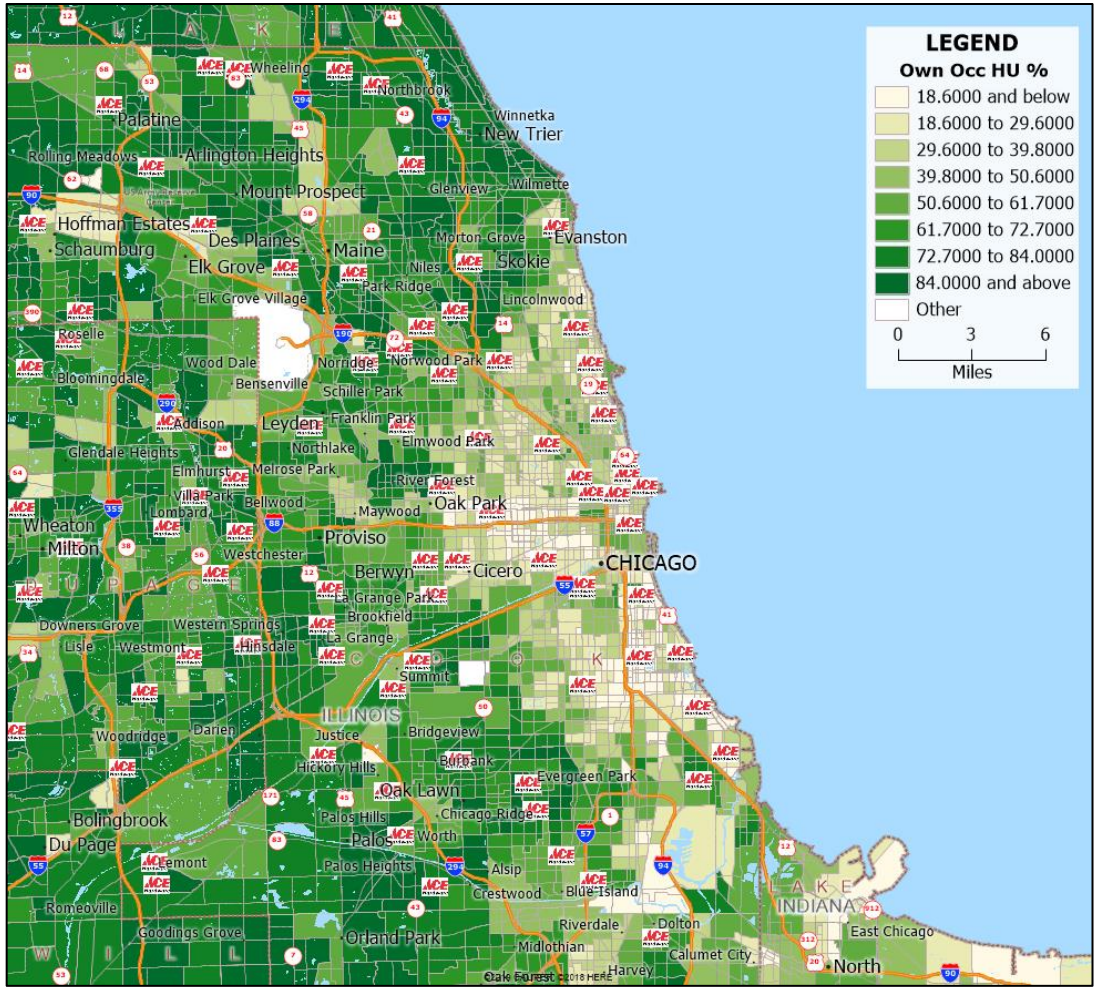
Now that you have created a choropleth map, what is possible now?

One idea would be to combine a choropleth (area) theme with a business or customer (point) theme to provide insight due to the interaction of the two layers.

Chicago Example: map representing two themes:

1. Location of Ace Hardware stores across the metropolitan area (point layer).
2. Choropleth theme indicating the distribution of owner-occupied housing, again across the metropolitan area.

The relationship of these two map themes can produce insights in terms of merchandising each store. Hardware stores in high owner-occupied communities might be expected to have different sales profiles compared to stores in rental communities.



Ace Hardware Locations versus Owner-Occupied Housing Units Choropleth Theme

Method 4: Target Zone Identification

Overview of Target Zone Identification

While some businesses, such as Walmart or Target, serve a reasonably broad cross section of American society, many businesses focus their business activities on serving a specific target market that represents only a fraction of the nation. Target zone identification methods recognize the ability of a combination of GIS technology and nationwide community data to precisely identify neighborhoods that have a specific characteristic, or bundle of characteristics. These characteristics can be subdivided into two distinctive forms of target zone selection: *select by attribute*, and *select by location*.

Select by Attribute Target zone identification can proceed using any of a wide range of community characteristics, with the limitation being only what data types can be accessed. Both Maptitude and BA Web provide included access to a wide range of community data, including:

- Census demographics, such as age groups, ethnicities, income and education levels
- Expenditure profiles by product and service categories
- Financial profiles, including household total asset levels and financial services purchased
- Behavioral profiles, such as recreation, sports, and entertainment activities participated in
- A wide range of other household and community information

Using a range of such variables, the business geographer has much power to define a very specific kind of target market zone. However, there is one additional selection type to consider.

Overview

Select by Location As well as selecting by data values, it is also important for the business geographer to consider selection by location. Proximity in many different forms can be incorporated in a target zone analysis. For example, target markets or zones of interest can be identified by location relative to a key location, such as:

- Census tracts that are within a 15 minute drive of a specific shopping mall
- Block groups that are more than a 5 minute drive from their closest fire station
- Stores that are between 1 and 2 hours from their closest distribution center when the chain target is for this number to be less than 1 hour

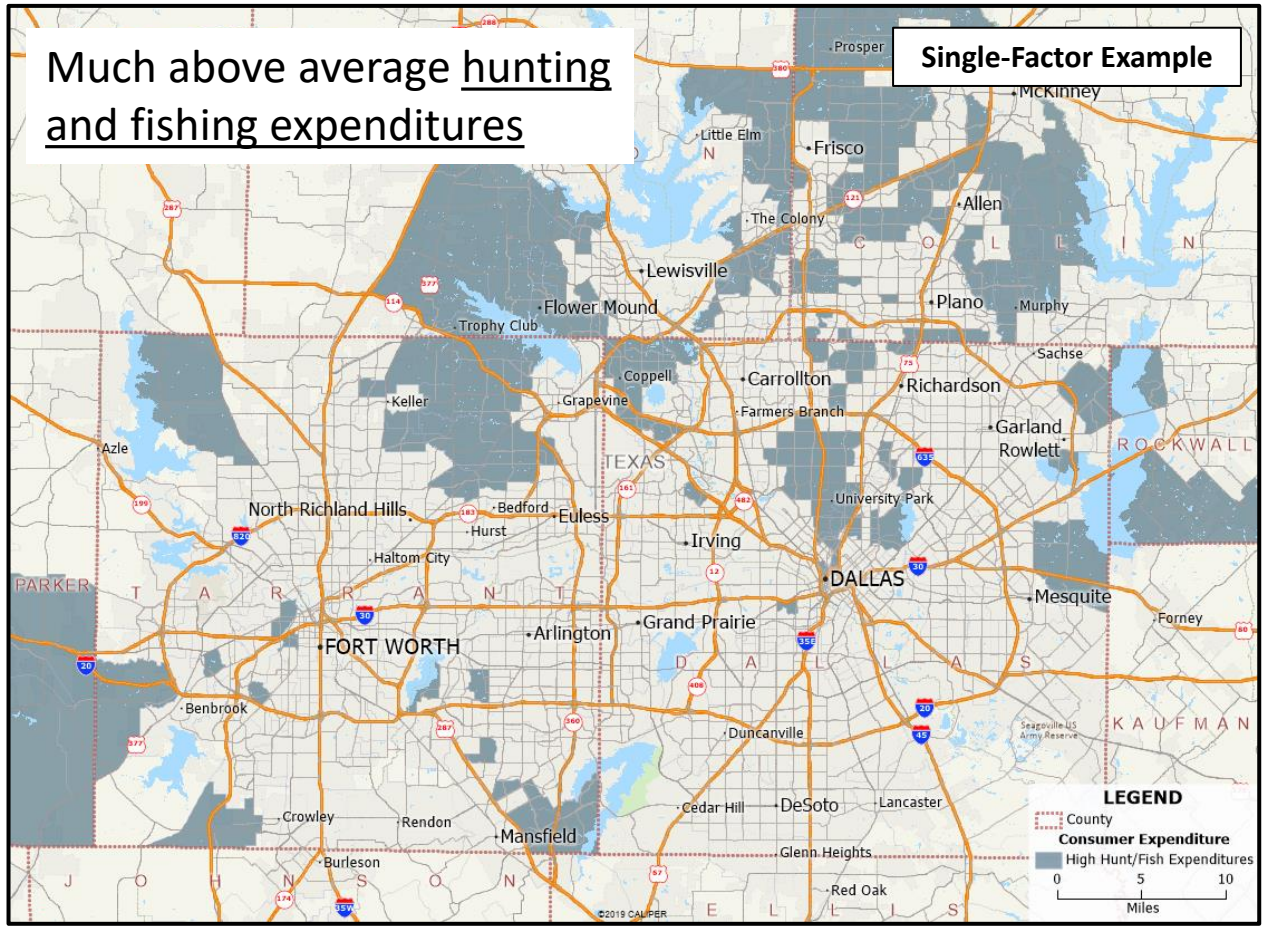
Of course, select by attribute and select by location can be combined in many creative ways to define a very specific market or business location type. The following provides more examples to explain what is possible in this area of geospatial practice.

A. Target Zone: Single Factor

Basic Idea: identify census or postal zones that meet a specific condition

- Census-based statistics, such as
  - Age groups
  - Mobility category
  - Education level
- Other zone measures, such as
  - Consumer expenditures
  - Health statistics
- Or location types, such as
  - Within a given distance of a store

Dallas-Fort Worth Example: identification of census tracts hosting households with <u>much above average hunting and fishing expenditures</u>

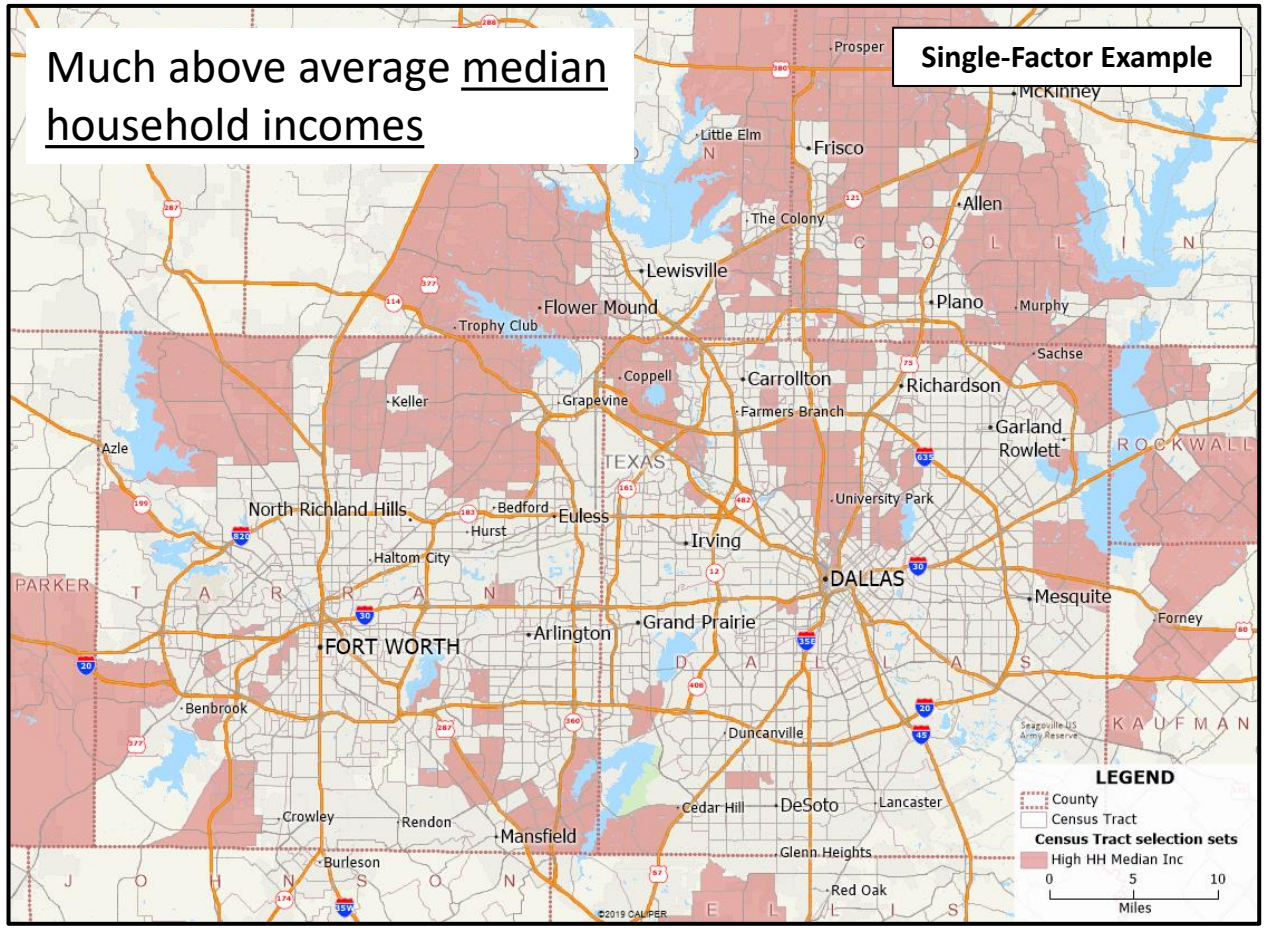


Maptitude

Detailed Discussion

Single-Factor: analysis focused on identifying target zones based on a single, important variable

Dallas-Fort Worth Example: map indicating the census tracts with households that with much above average median household incomes

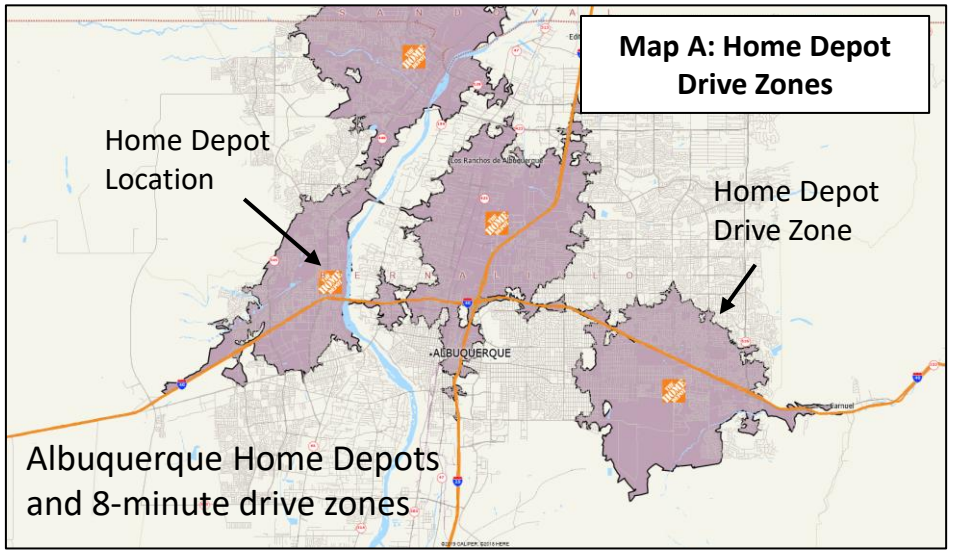


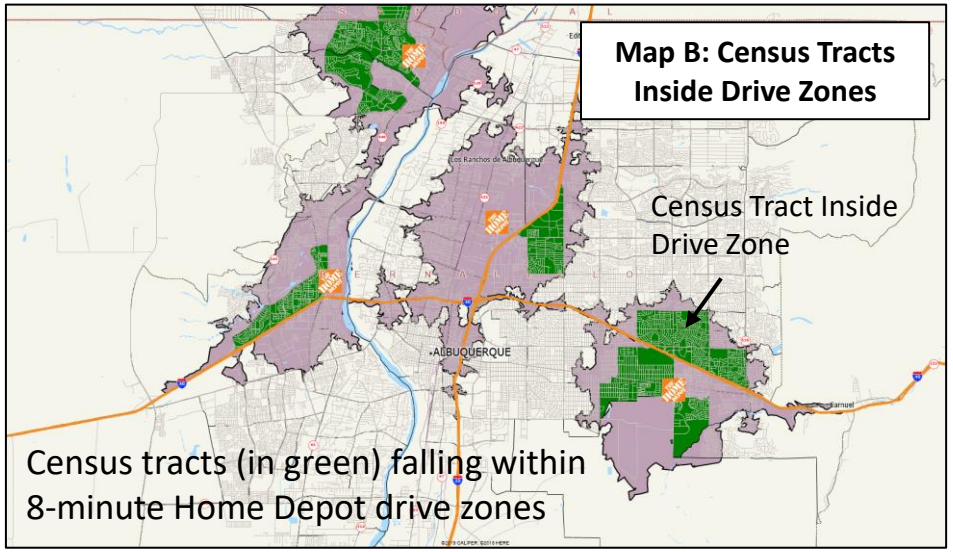
Maptitude

Detailed Discussion

Albuquerque Example: based on location, here is a sequential development of

- The 8-minute drive time zones around the four Home Depot locations in Albuquerque (top map, purple zones), leading to
- The identification of the census tracts (in green) that fall within these 8-minute zones (bottom map).



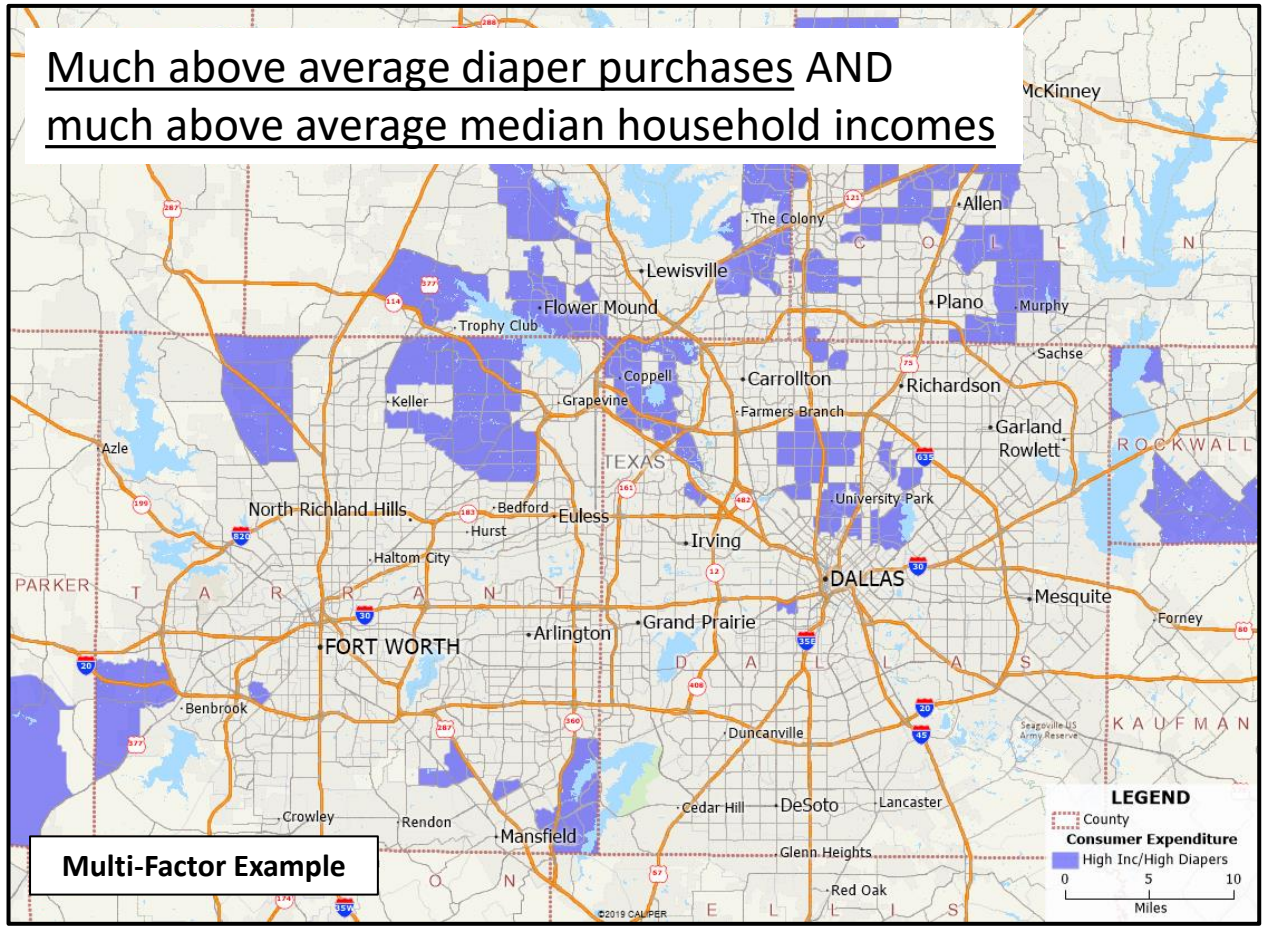


Maptitude

B. Target Zone: Multi-Factor

Multi-Factor: analysis focused on identifying target zones based on a combination of two or more variables that are both important

Dallas-Fort Worth Example: map indicating the census tracts with households with much above average diaper purchases and much above average median household incomes



Maptitude

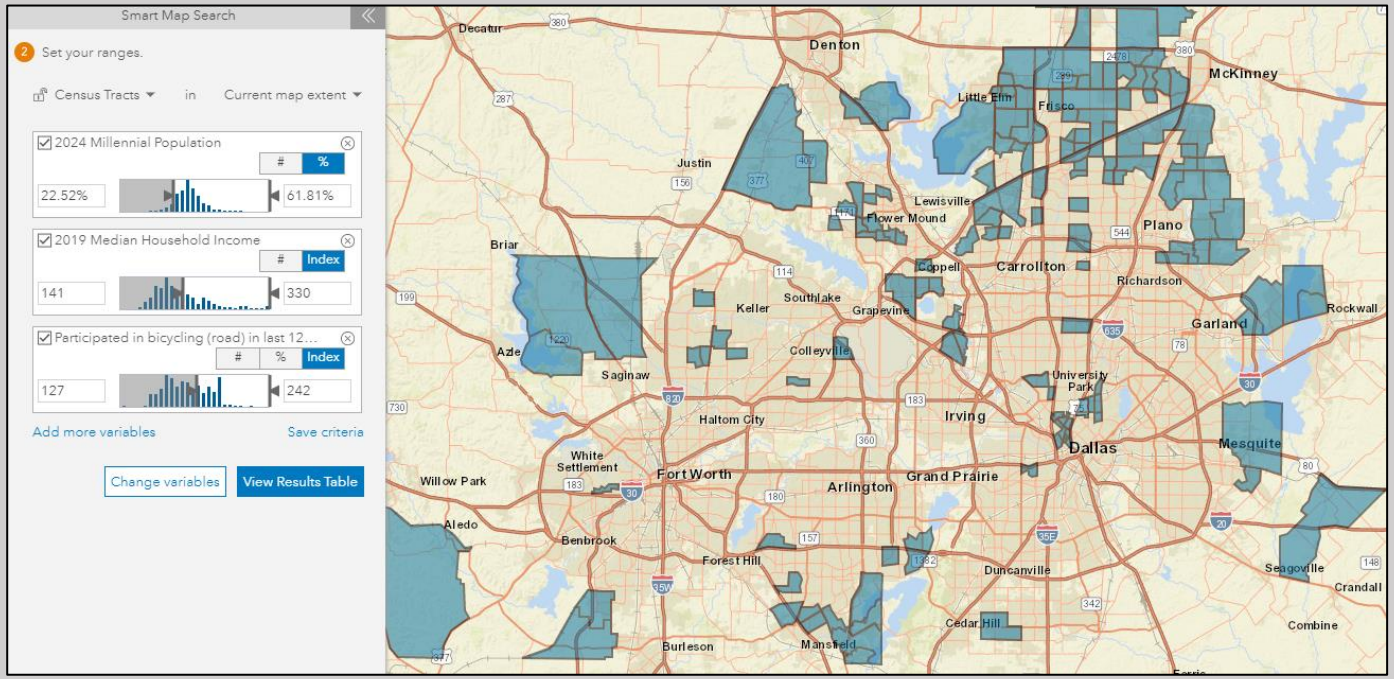
Detailed Discussion

Note: multi-factor target zone development necessarily involves the use of operators that work to <u>combine variables</u>

A simple but powerful set of combination operators are Boolean functions, including AND, OR, and NOT:

- Condition 1 **AND** Condition 2
- Condition 2 **OR** Condition 4
- Condition 5 **NOT** Condition 6

Example of the Boolean Operator **AND**



Business Analyst Web App

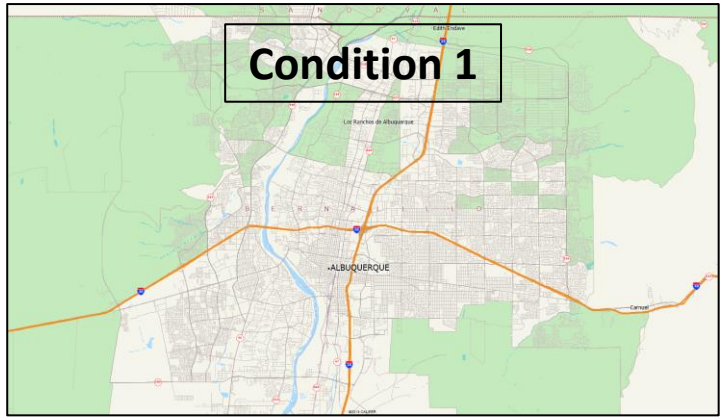
Dallas-Fort Worth Example: map indicating the census tracts with high levels of

- Millennial Generation Population AND
- Median Household Income AND
- Participation on Road Bicycling

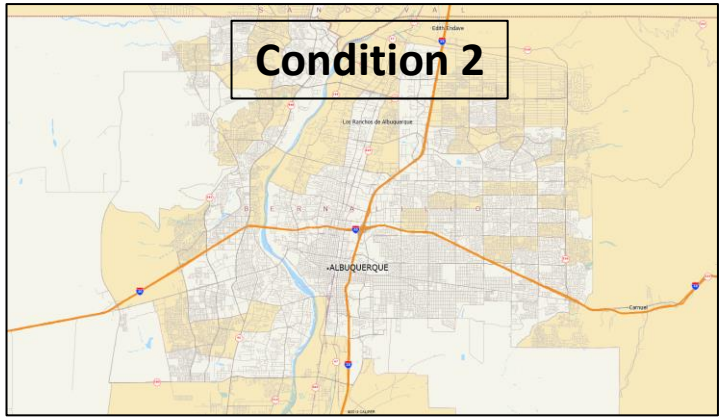
Detailed Discussion

Albuquerque Example:

Example of the Boolean Operator **OR**



Green Census Tracts: Median Household Income > $65,000 Annually

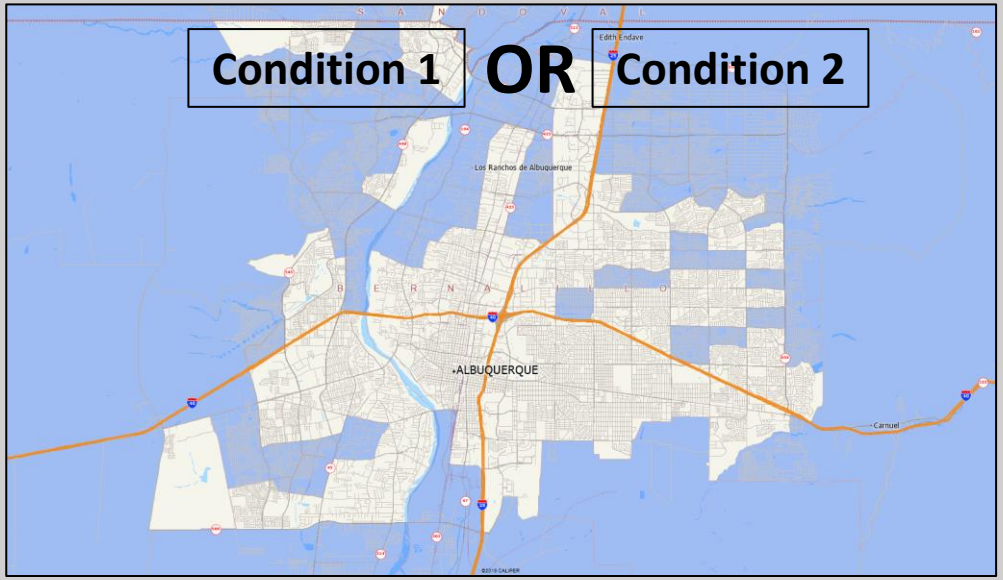


Tan Census Tracts: Owner-Occupied Housing > 75% of all Housing Units

Map indicating the census tracts (in light blue) that

- Condition 1: Have high median household incomes **OR**
- Condition 2: Have high home ownership rates

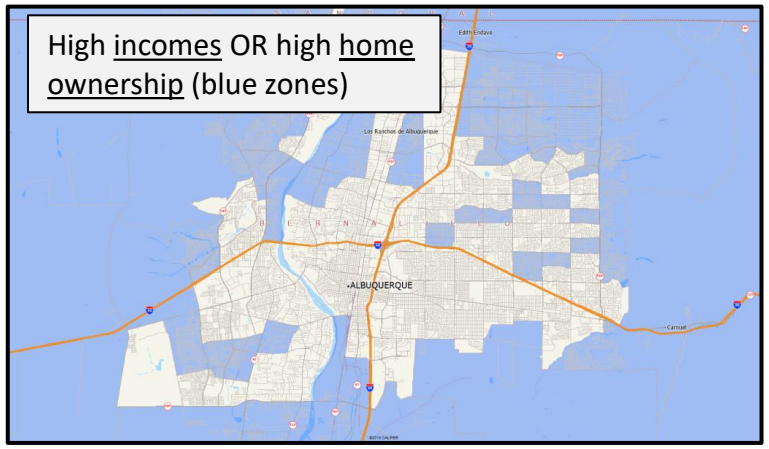
In this particular case, the business needing this market analysis needs <u>either</u> one (<u>or both</u>) of these criteria filled, but <u>not necessarily both</u>



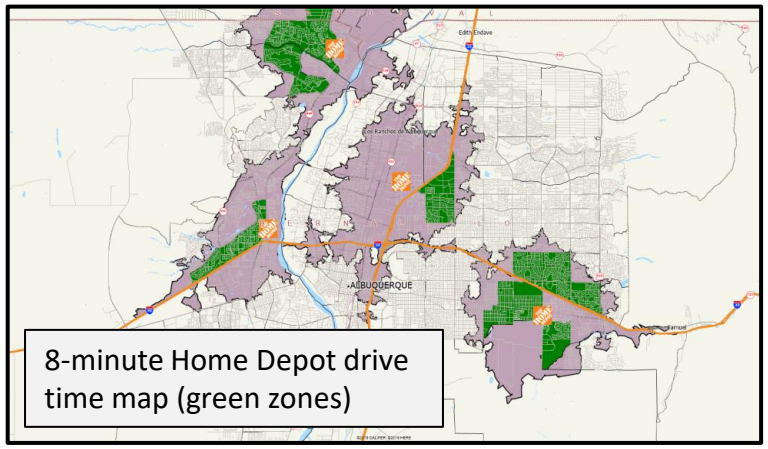
Detailed Discussion

Combining our Albuquerque examples from the last few pages:

- **Map A:** our conditional map (high incomes OR high home ownership)
- **Map B:** our 8-minute drive time Home Depot proximity map
- **Final map:** representing a combined attribute and location based selection target zone map



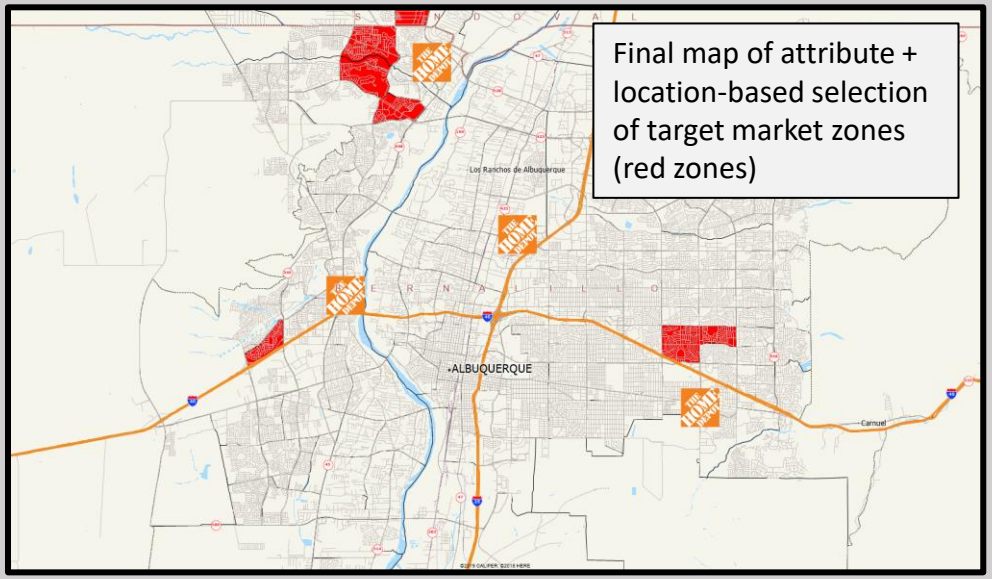
Map A



Map B

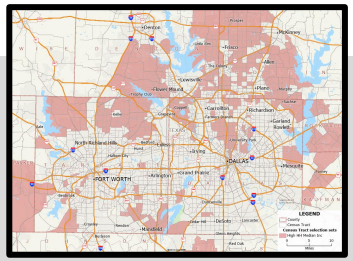
Map A + Map B =

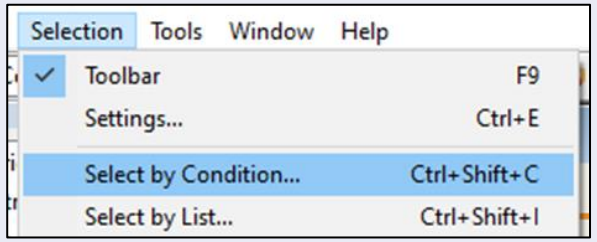
Which census tracts are identified in both?



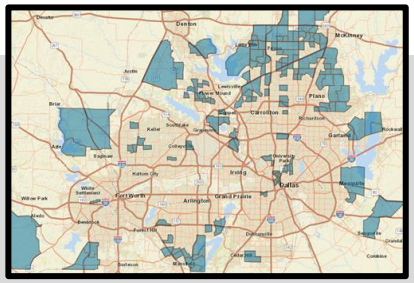
Resources and Processes to Do a Target Zone Analysis

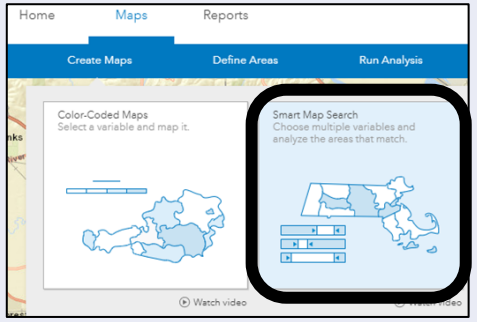
In Caliper Maptitude:



Target Zone Analysis…	
Supported by Maptitude	Yes
Starting the Analysis	Selection Menu > Select by Condition 
More guidance from Caliper	https://www.caliper.com/video/maptitude/maptitude-selections-and-filters-video/maptitude-selections-and-filters-video.html

In Esri BA Web App:



Target Zone Analysis…	
Supported by BA Web App	Yes
Starting the Analysis	Maps > Create Maps > Smart Map Search 
More guidance from Esri	https://doc.arcgis.com/en/business-analyst/web/color-coded-maps.htm

Next Steps After Completing a Target Zone Analysis

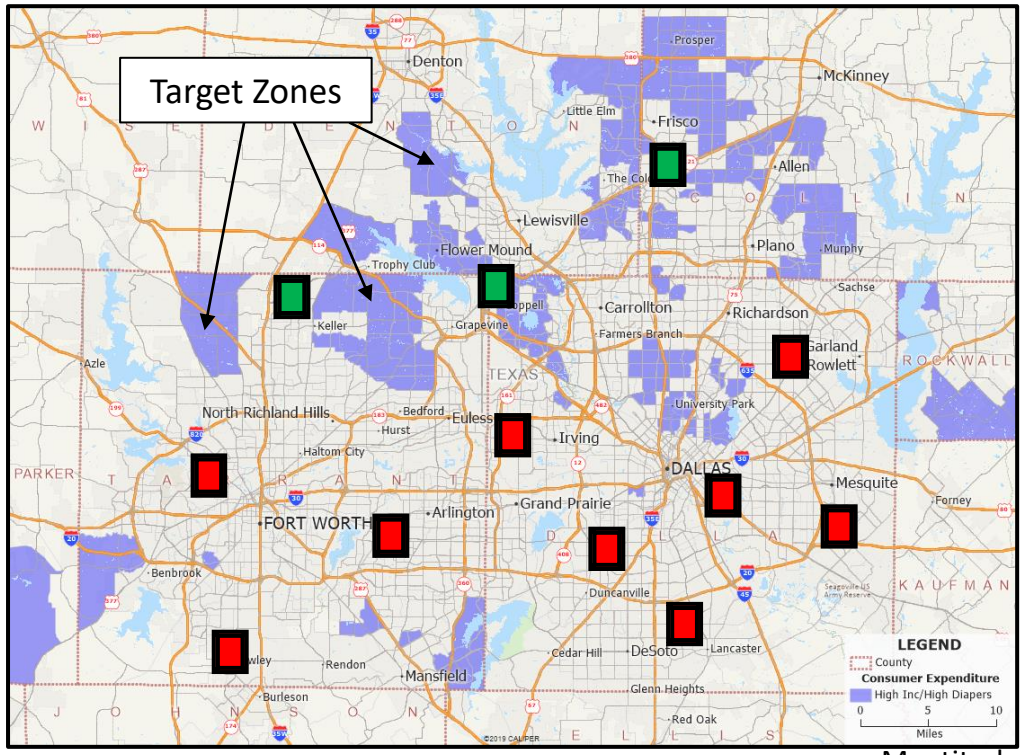
Now that you have located your target zone, what is possible now?

On a map showing your target zone, you have a foundation to interpret your analysis to:

- Support selection of store locations that prioritize accessibility to your target zones

Potential Site Chosen for Development

Potential Site Not Chosen for Development



Maptitude

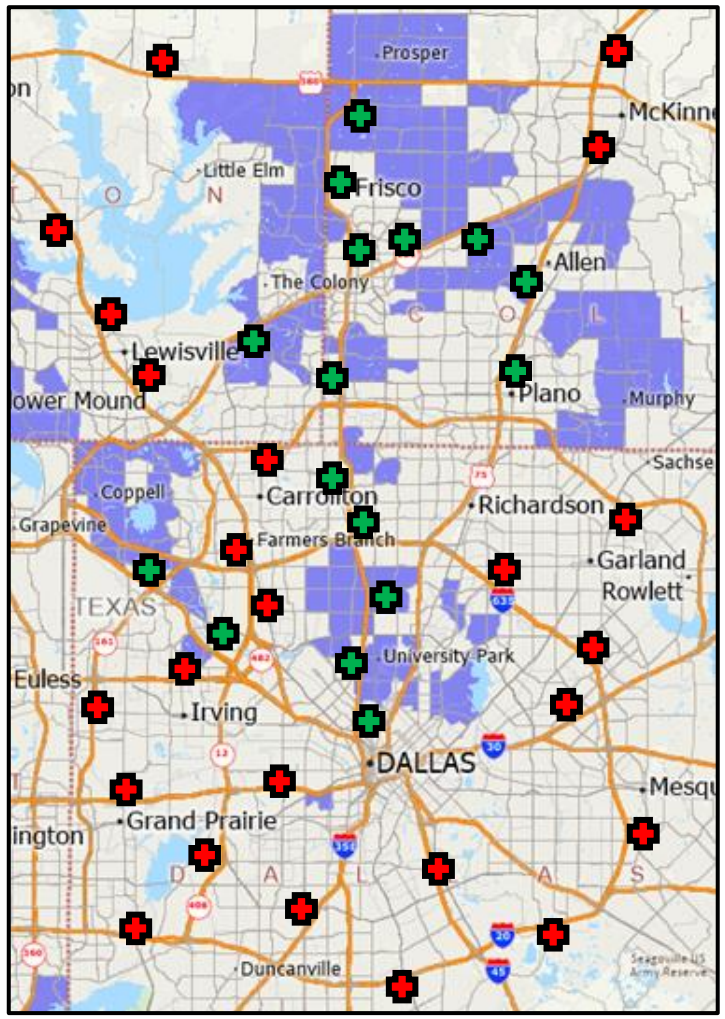
Map of Target Zones and Potential Store Locations

What Next

Target zone analysis also provides a foundation to visualize the use of physical advertising opportunities (such as billboard placement) for reaching households in the target zone

- Potential Billboard Site Chosen for Use
- Potential Billboard Site Not Chosen for Use

Choices based on location and proximity of target zone, and location of major highways in and out of target zone



Maptitude

Identify the Best Billboard Opportunities for Effective Communication with Target Market

Method 5: Geodemographic Segmentation

Overview of Geodemographic Segmentation

One primary need for businesses is to improve their understanding of markets and customers. Comprehensive and solid market understanding is central to the development of excellent plans to survive and thrive in a highly competitive business landscape. The complexity of modern markets is great, so breaking down the characteristics of markets in ways that can facilitate high-quality decisions is not a trivial task.

One path to substantial contribution for geospatial analysis lies in its ability to combine data and technology to expose market structures that are not immediately apparent. One prominent means geographers have to do this is through the use of geodemographic segmentation to classify the thousands of communities across the country and their many variations into a small number of groups that are statistically robust and understandable to informed business and community leaders (Major et al. 2018).

Geodemographic segmentation classifies communities by involving dozens of variables, representing a spectrum of human activities and characteristics (Troy 2008). Such analysis identifies the groupings of communities that simultaneously represent the range of community orientations that exist. Geodemographic segmentation also recognizes the similarities that link specific neighborhoods that, in many cases, are scattered broadly across the country but share certain identifying characteristics.

Detailed Discussion: Geodemographic Segmentation

Three examples can help to clarify the existence of neighborhood types across the country.

1

"Chinatowns" represent one distinctive neighborhood type present in some North American cities. While the number of Chinatowns across the continent is not large, such neighborhoods are clearly recognizable and can be well identified by their unique immigration and travel profiles. Similarly, other dense, downtown neighborhoods with names such as "Koreatown" or "Little Italy" can be recognized not only as distinctive communities in a city but as a neighborhood type that might be identified as a relatively rare neighborhood in the United States and Canada.

San Francisco's Chinatown

2

At the other end of the prevalence spectrum might be communities like this, representing a **suburban, middle-class** population. While a detailed analysis can reveal sub-types of suburban, middle class neighborhoods, in a broad sense the number of neighborhoods like the community pictured at right is large, numbering in the thousands nationally. In every metropolitan area many examples can be found of neighborhoods that host a mix of middle-income, moderately-educated, SUV-owning households.

Suburban Denton, Texas

3

A third community class we could call the **"Inner City Elite"** represents a neighborhood type that is between the first two in absolute community numbers across the country. Like the first, ethnic neighborhood type discussed, this third type is a high-density, inner city community. Many adult residents in these neighborhoods have a university degree and a high net worth. Broadly speaking, residents here are also health-conscious consumers, who exercise regularly and pay attention to the nutritional value of the food they purchase. Such purchase and behavioral patterns make identification of communities such as these a sound part of retail business practice.

Boston's Beacon Hill

Example Neighborhood Number	Example Name	Representative Segment Type (Esri Tapestry System)	Number of Households Nationally
1	Chinatown	Downtown Melting Pot	0.8 Million
2	Suburban, Middle-class	Up and Coming Families	2.9 Million
3	Inner City Elite	Laptops and Lattes	1.3 Million

(Source: Esri Tapestry)

Detailed Discussion

The geodemographic segmentation concept formalizes this general idea, statistically identifying the categories of communities that exist across the country and specifying the category identity of each neighborhood.

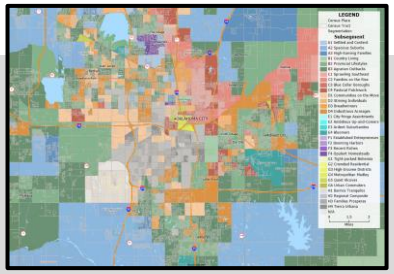
Because such segmentation systems are complex and expensive to build and update in an ongoing basis, generally geospatial analysts rely on segmentation schemes that are created by major GIS and geospatial analytics firms.

The “Resources and Processes” pages of this geodemographic segmentation discussion describe in general terms the geodemographic segmentation systems available through Maptitude and BA Web.*

* One related point is worth making here. While not strictly a “method”, detailed consumer expenditure databases are a powerful counterpart to geodemographic segmentation. When employed in tandem, a combination of consumer expenditure analysis and geodemographic segmentation profiling can provide a powerful picture of the market structure of a city.

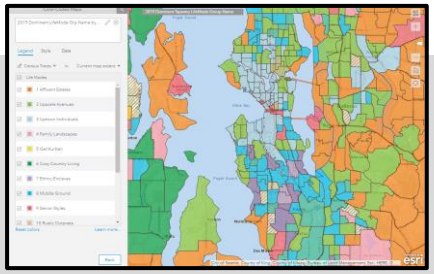
Resources and Processes to do a Geodemographic Segmentation Analysis

In Caliper Maptitude:



Geodemographic Segmentation…	
Supported by Maptitude	Yes
Starting the Analysis	Maptitude's system is delivered as a separate census tract-level data file that can be incorporated in any Maptitude workspace as a map layer.
More guidance from Caliper	https://www.caliper.com/featured-maps/maptitude-geodemographic-segmentation.html

In Esri BA Web App:



Geodemographic Segmentation…	
Supported by BA Web App	Yes
Starting the Analysis	Maps > Create Maps > Color-Coded Maps Tapestry can be accessed in BA Web via the Color-Coded Maps menu (search for Tapestry among the available data sets).
More guidance from Esri	https://doc.arcgis.com/en/business-analyst/web/color-coded-maps.htm

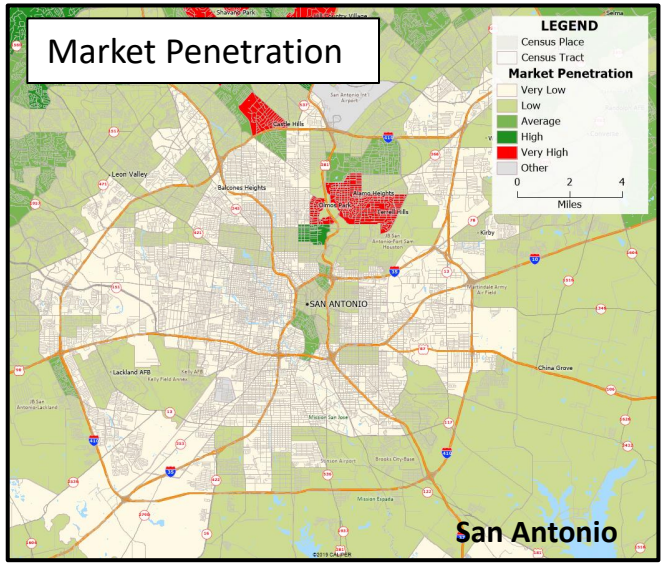
Next Steps After Completing a Geodemographic Segmentation Analysis

Now that you have created your geodemographic segmentation map, what is possible now?
<u>One extension</u>: deriving further value from the output by peak market segment identification

Step 1: on an ordinary customer map, calculate the percentage of households accounted for by your customers in each census tract

- This is a simple representation of your business' market penetration across the region

On this map, the red shaded zones are the "very high" market penetration areas for our sample business: the places where your business is doing the best in attracting customers



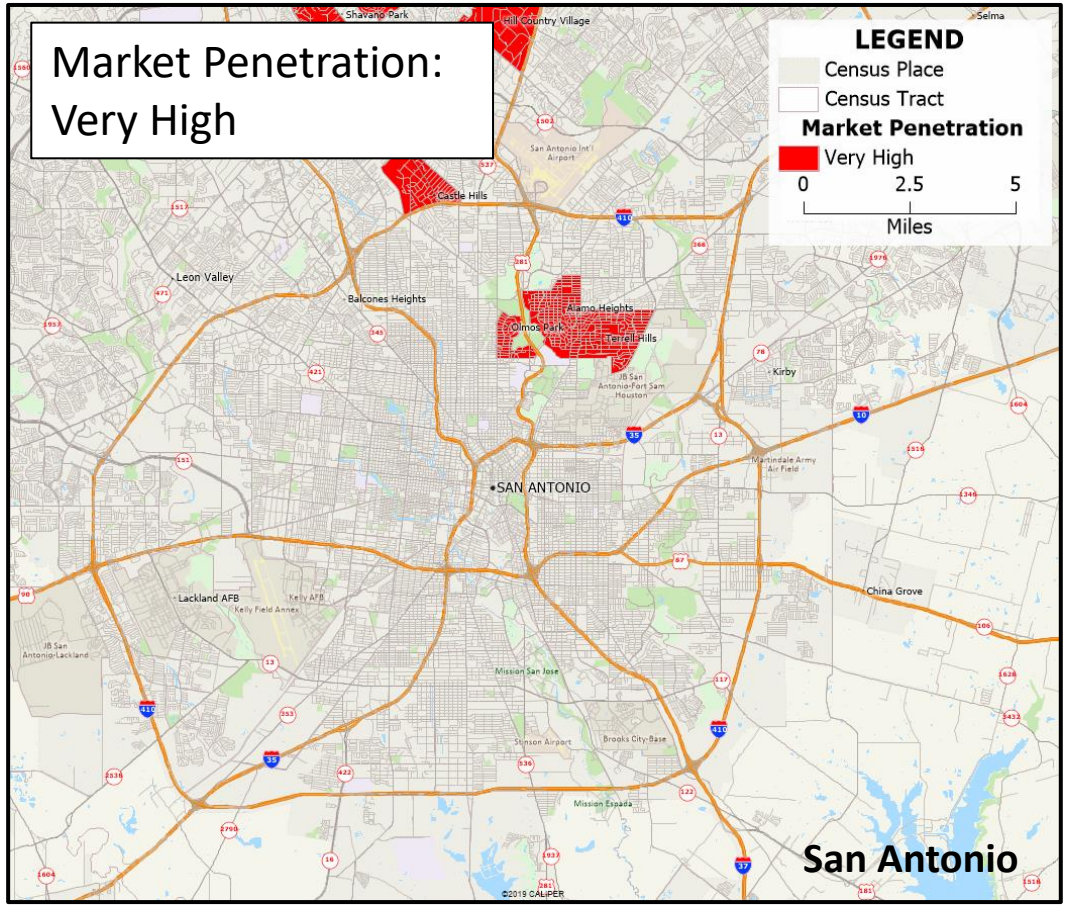
Maptitude

What Next

Step 2: on this same map, eliminate all census tracts except those falling in the “very high” category

- These are your best market zones in the map region

Focus on only the “very high” market penetration areas



Maptitude

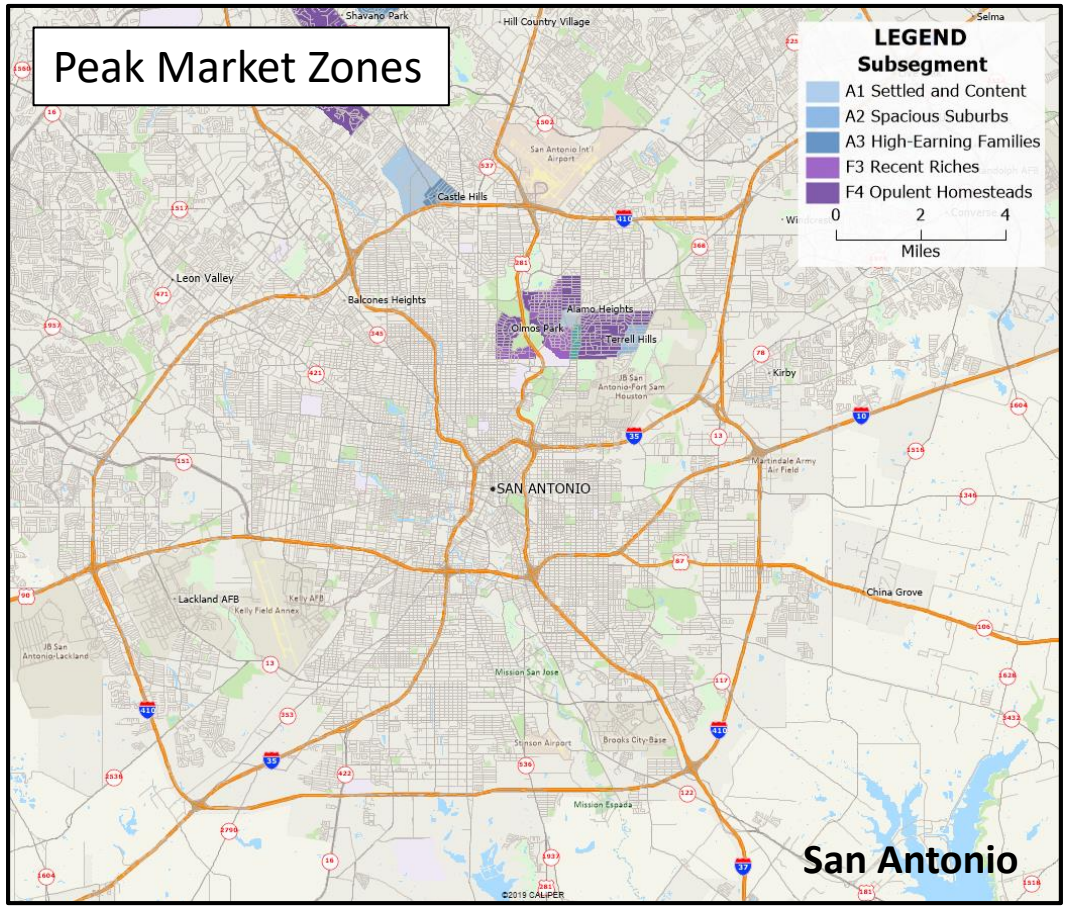
What Next

Step 3: again on this same map, reveal only the segments that exist in the very high market penetration zones

- These are your peak market segments that you should be focused on serving both here and in other cities where you want to develop locations

Identify the segments that exist in your "very high" market penetration areas

A1 Settled and Content
A2 Spacious Suburbs
A3 High-Earning Families
F3 Recent Riches
F4 Opulent Homesteads



Maptitude

What Next

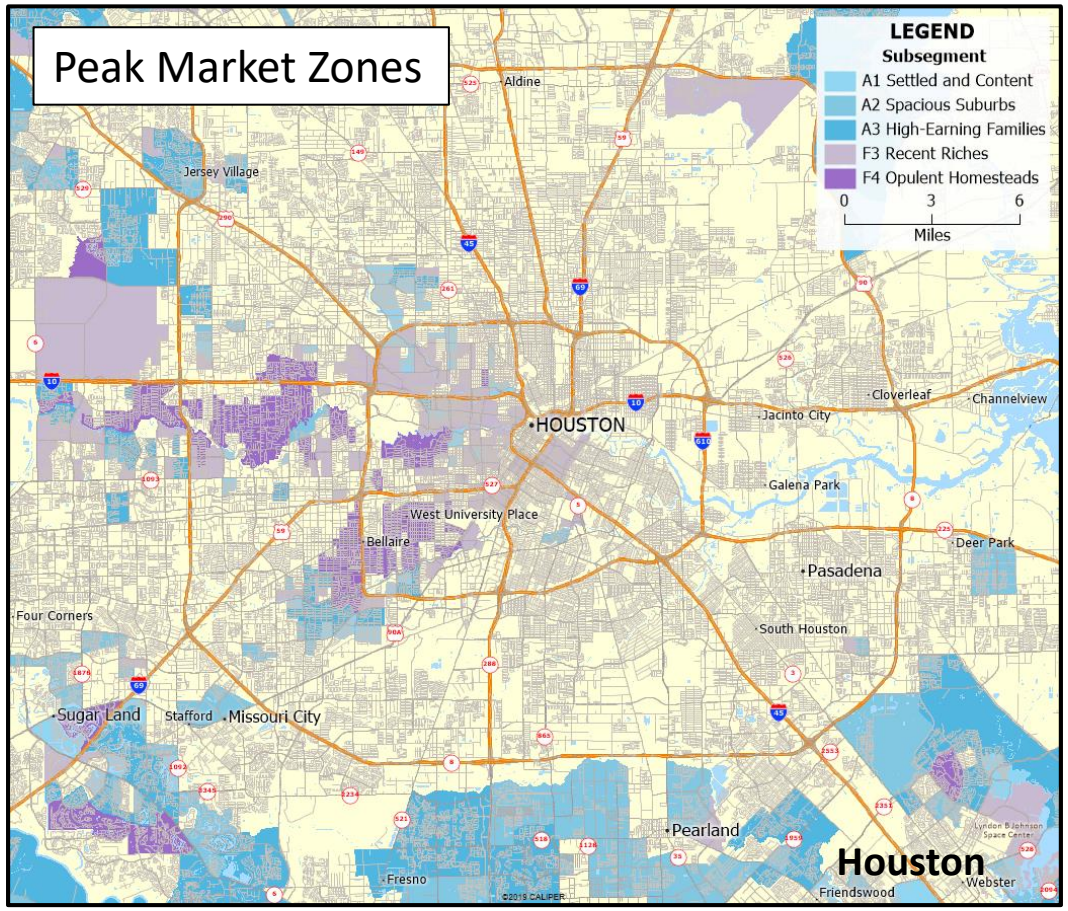
Step 4: last, keep only these peak segments and transfer this map theme to a new urban region you are interested in exploring as a potential expansion region

- These peak segment locations will guide you on which parts of the city you should consider for store locations/targeted marketing

Again, only the segments that exist in your "very high" market penetration areas from your existing operations

A1 Settled and Content
A2 Spacious Suburbs
A3 High-Earning Families
F3 Recent Riches
F4 Opulent Homesteads

Market size numbers can also be extracted at this stage, providing one indication of potential viability for a possible expansion



Maptitude

Method 6: Areas of Influence

Overview of Areas of Influence

Many businesses operate in a multiple-location mode, where they operate several facilities or stores that need to be coordinated with each other. Coordination is necessary to avoid two problems:

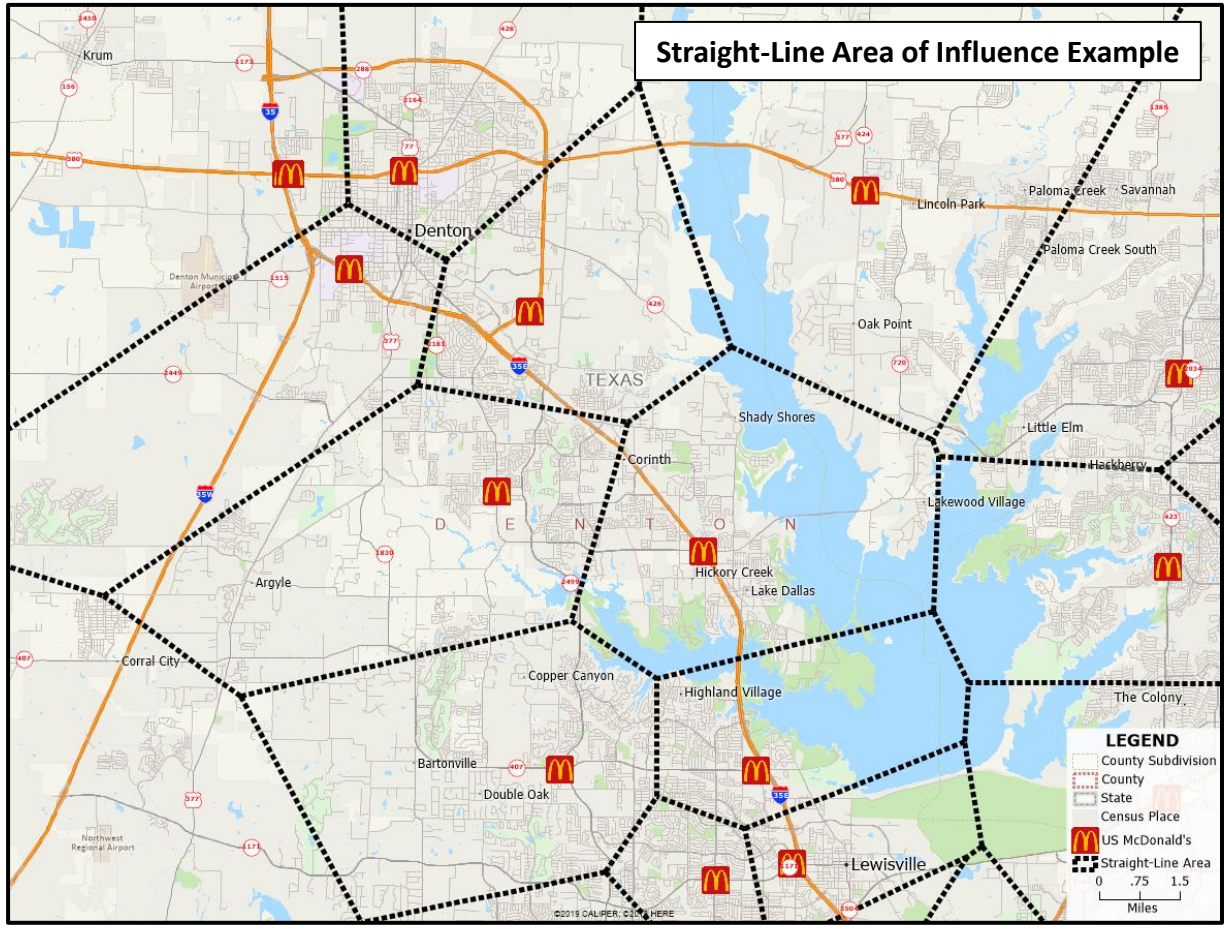
1. **Self-competition (also known as "cannibalization"):** The business locates two or more facilities too close to each other, leading to each of the facilities eating into what should be their core market areas.
2. **Unintended service gaps:** If it is possible for a retailer to locate its stores too close together, it is also possible to plan store locations that are too widely separated. Here, broad separations between stores in the same chain leaves coverage gaps that provide an opening for a competitor to enter the area and have a part of the regional market all to themselves.

Area of influence mapping provides a visual representation of the territory served by each facility, enabling the management of the business to quickly identify variation in the size of its service zones. If a business has complete data for its customers (where they come from, which store(s) they shop at) then the best area of influence determination would follow from mapping these customer data. However, often businesses do not have such data, and in that case the following two area of influence modeling options provide excellent alternatives.

A. Straight-Line Area of Influence

This analysis is focused on dividing the map into zones, with each zone including all of the territory that is geographically closest to any one in a series of service providing facilities. The only considerations here are the service facility locations and straight-line distances. Thus, this is a good option for service zone delimitation in a situation with little data. “Straight-Line Areas of Influence” (also known as “Thiessen Polygons”) can be useful in areas where the road network is not well developed.

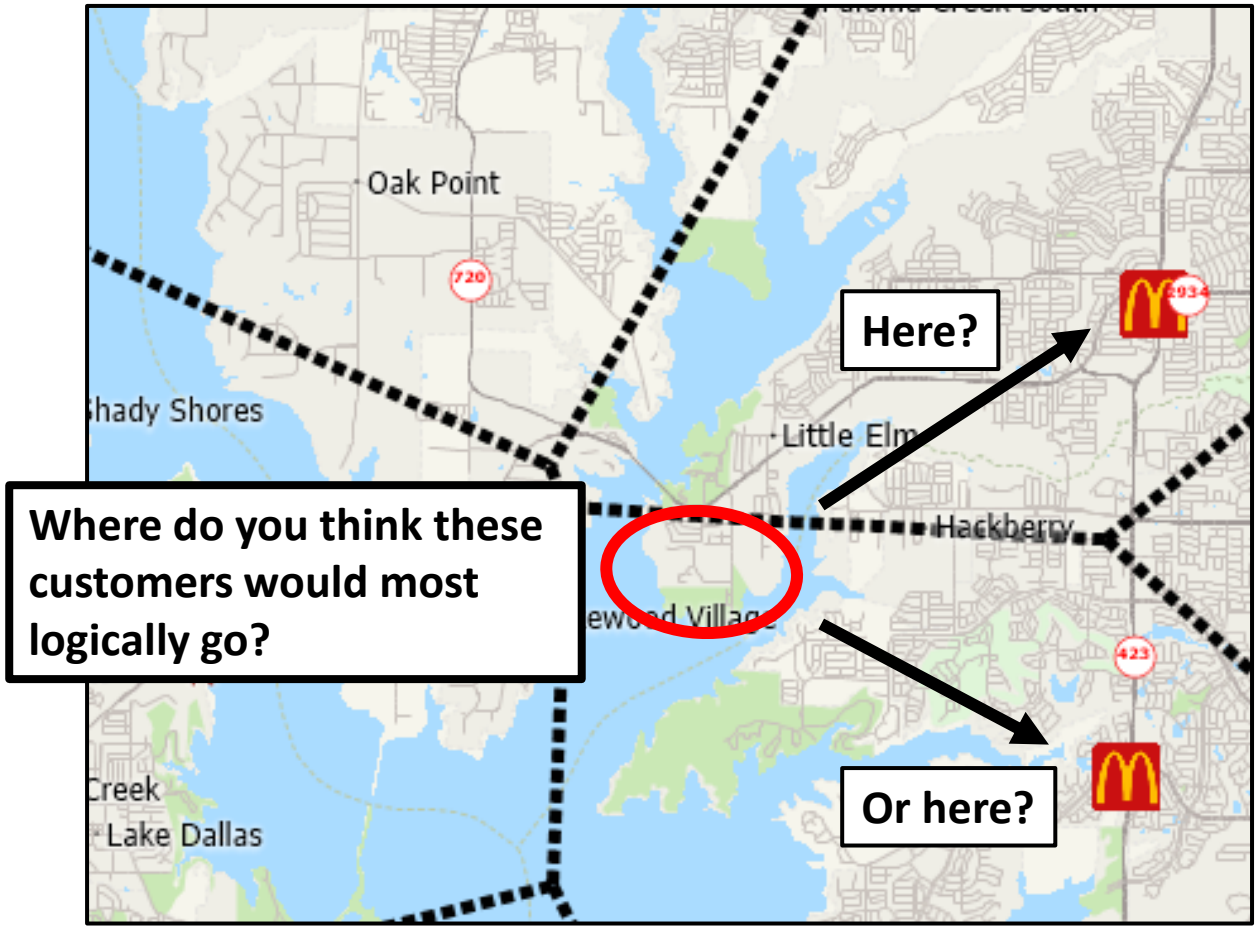
Denton Example: map representing the geographically-proximate zones for each of the McDonald’s restaurants in and around the city. Each point falling within a given polygon is closest to the one facility contained in the polygon.



Maptitude

Note: these areas of influence are only simple approximations. For example, see the way that the zones on the map to the right do not truly account for water boundaries:

- Given the shape and location of this lake, it is unlikely that the true market boundaries see customers on one side of the lake actually being served by a restaurant on the other side.

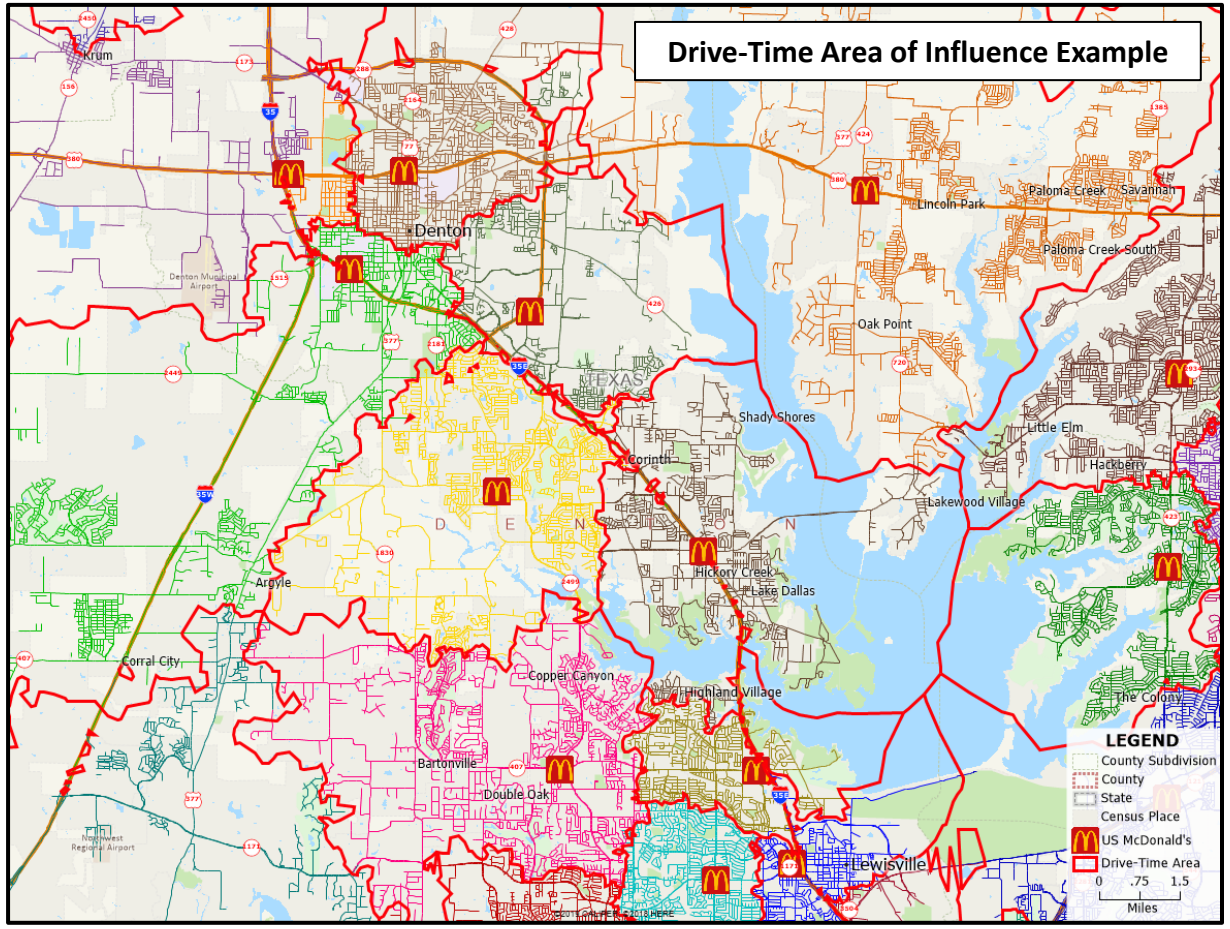


Maptitude

B. Drive-Time Area of Influence

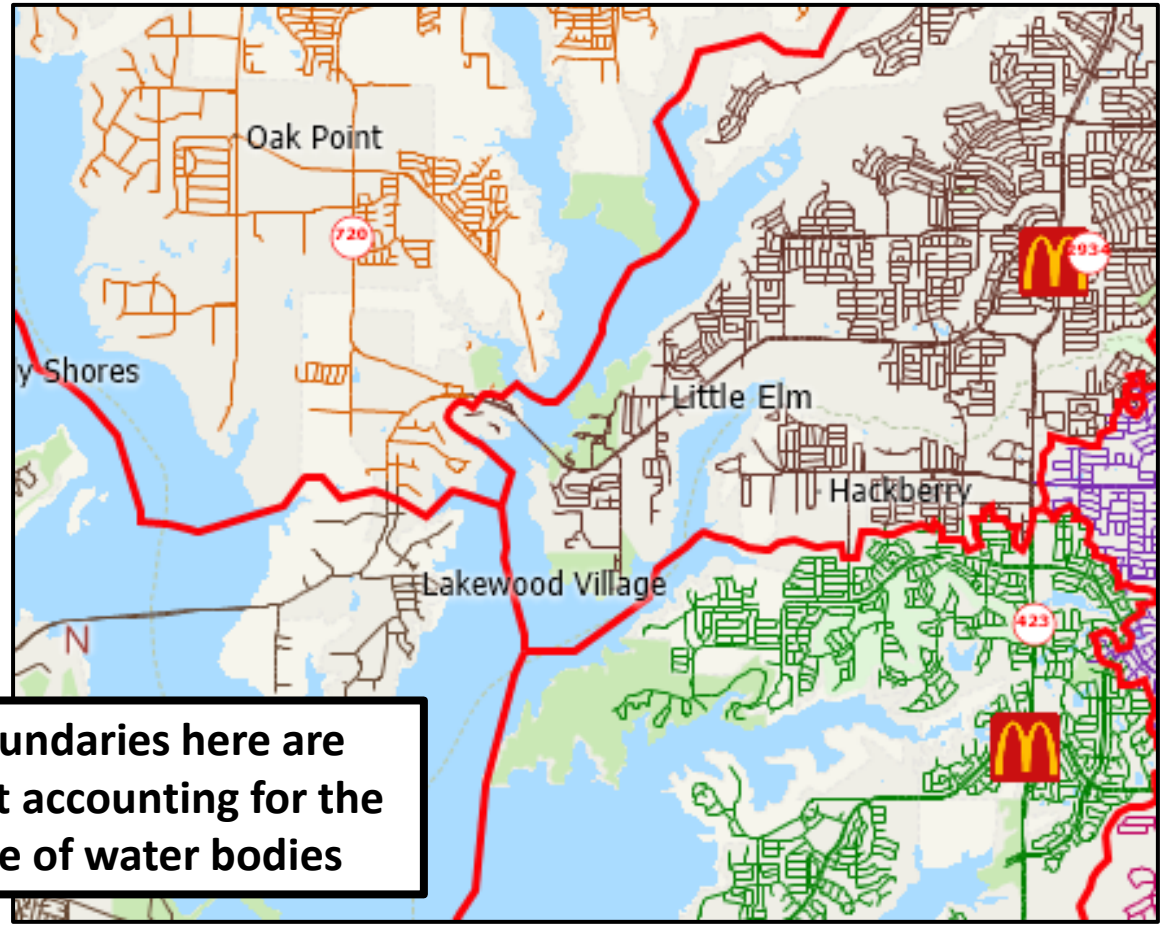
This is analysis again focused on dividing the map into zones, with each zone including all of the territory that is geographically closest to any one in a series of service providing facilities. The difference here is that instead of taking a straight-line "as the crow flies" approach, distances are measured via the local road network. Thus, the zone definitions are more realistic than those derived from a straight-line approach.

Denton Example: map representing the geographically-proximate drive-time zones for each of the McDonald's restaurants in and around the city.



Maptitude

To the Previous Point on Approximations: again, this drive-time representation is only an approximation, but inclusion of the street network in the analysis leads this method to account much better for the impacts of water bodies on market areas.



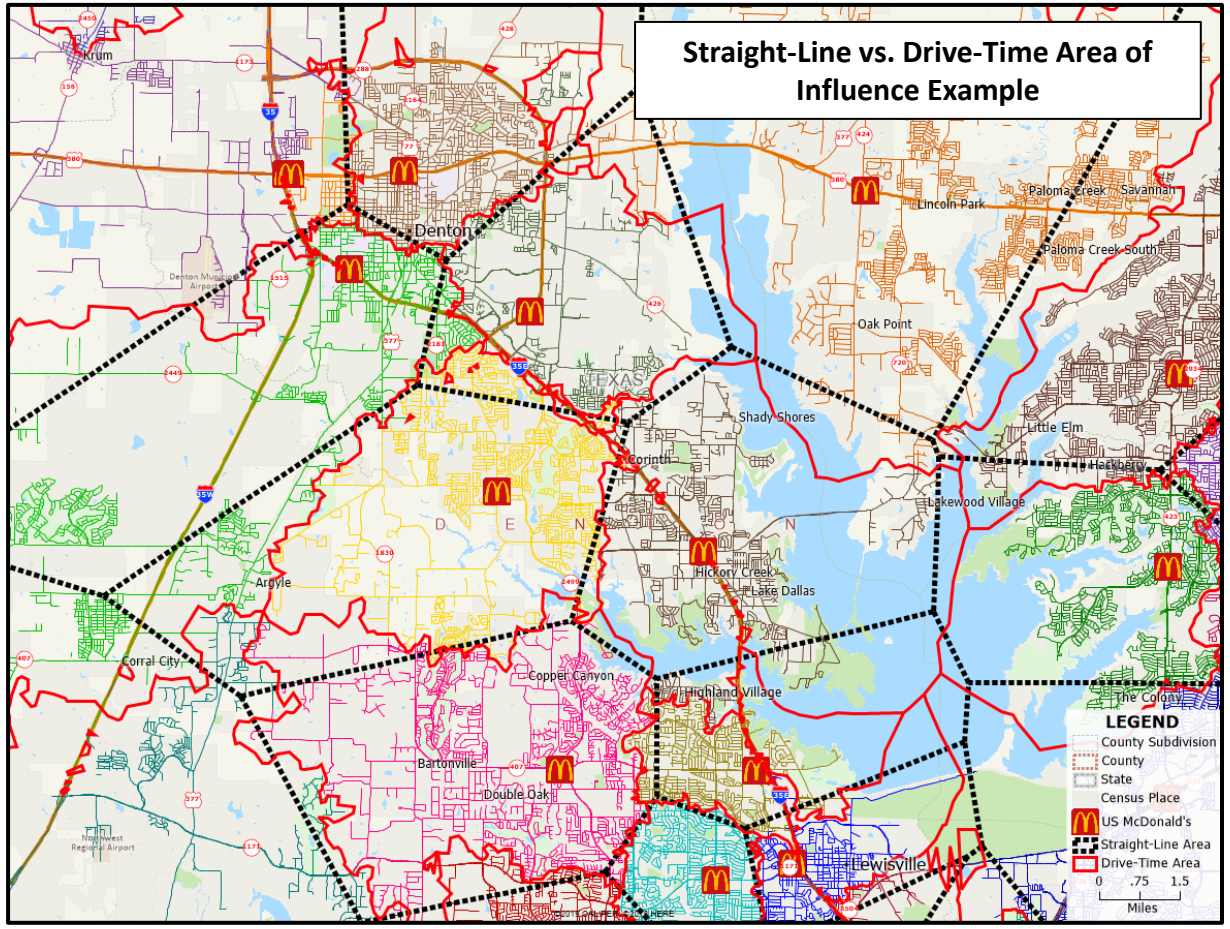
Zone boundaries here are better at accounting for the influence of water bodies

Maptitude

C. Comparing the Two Area of Influence Methods

Head to Head: how do the two methods compare? The map at right shows a combined view of the two methods being applied to the Denton McDonald's scenario.

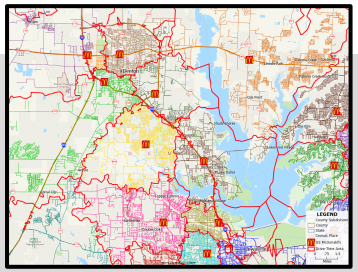
The map indicates that the overall extent of the zones in the two methods is very similar, but the drive-time method produces a boundary set that better reflects the reality of the local road network.



Maptitude

Resources and Processes to do an Area of Influence Analysis

In Caliper Maptitude:



Area of Influence Analysis…	
Supported by Maptitude	Yes
Starting the Analysis	Tools > Straight Line Influence Areas… Tools > Routing & Directions > Drive-Time Influence Areas
More guidance from Caliper	https://www.caliper.com/video/maptitude/maptitude-areas-of-influence-video/maptitude-areas-of-influence-video.html

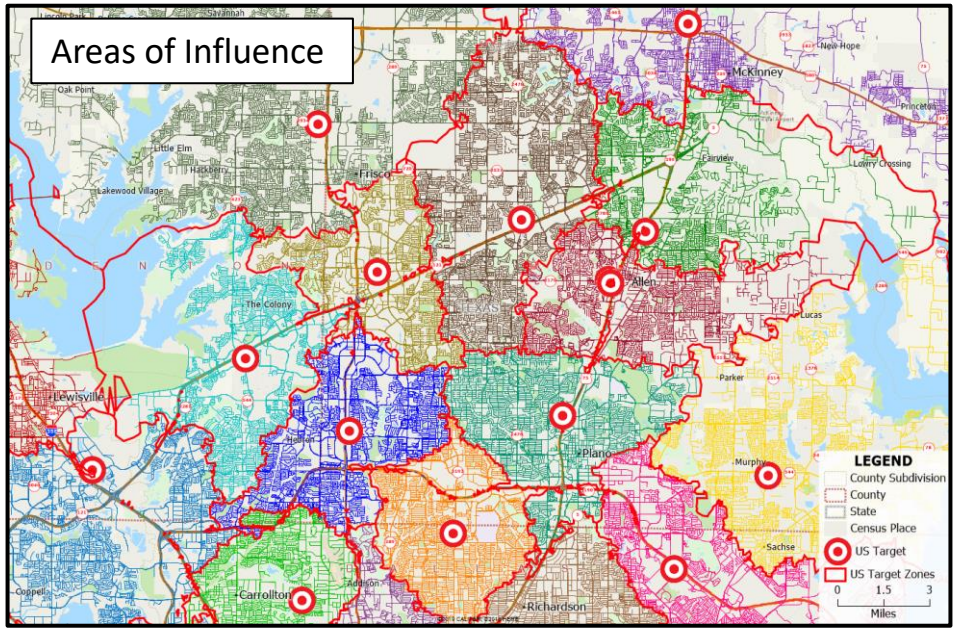
In Esri BA Web App:

Area of Influence Analysis…	
Supported by BA Web App	No
Starting the Analysis	N/A
More guidance from Esri	N/A

Next Steps After Completing an Area of Influence Analysis

Now that you have created your area of influence map, what is possible now?
<u>One powerful extension</u>: market size comparison using the calculated Area of Influence zones

Step 1: on a store location map for a given business of interest, complete an area of influence analysis using the method of your choice (straight-line or drive-time)



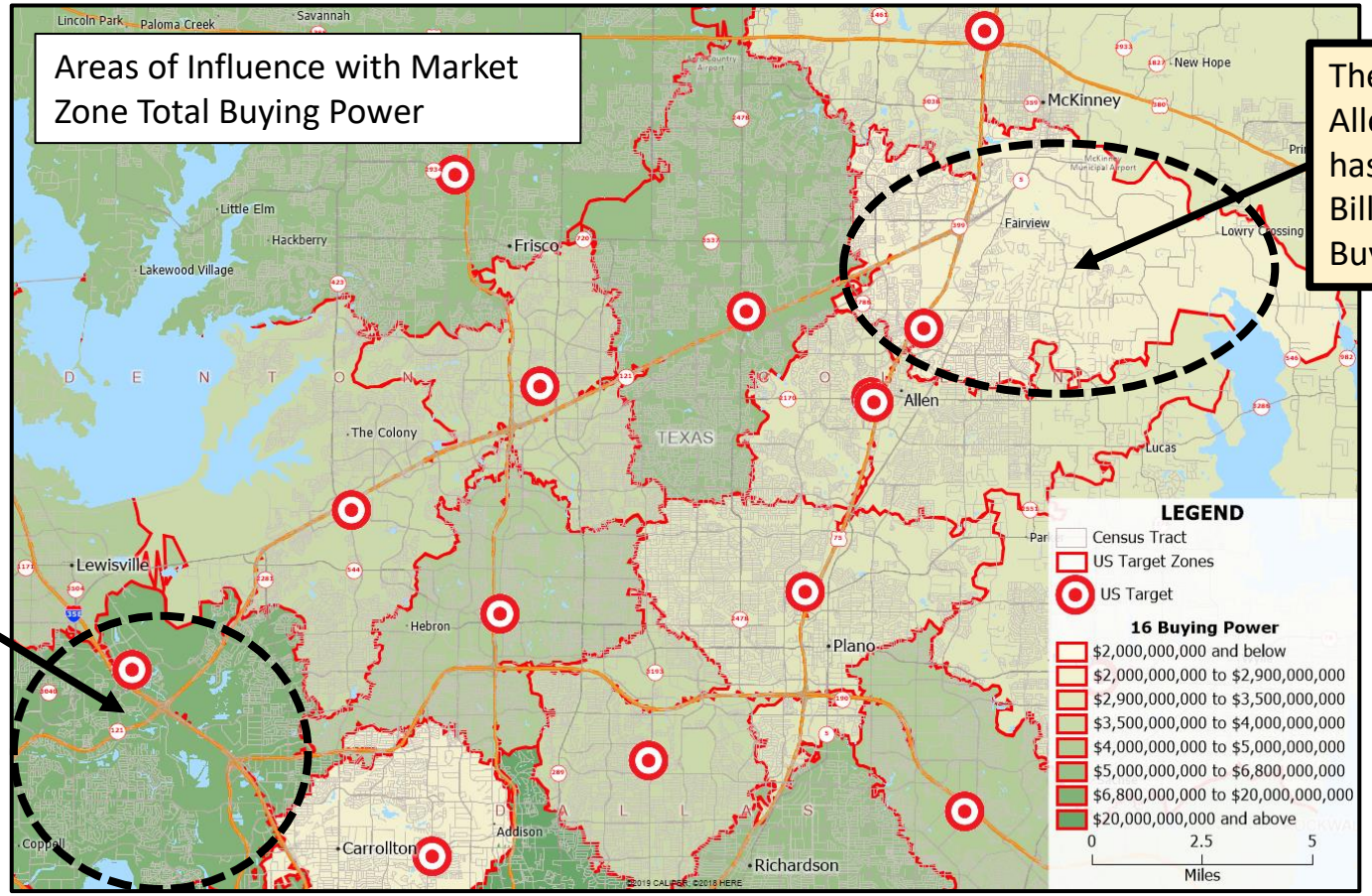
Maptitude

What Next

Step 2: on your area of influence map, overlay* the store zones with a census layer. This will enable you to append census data, such as population or purchase data to your store zones. Using this capability, the map here illustrates the variation that exists in market size by store zone.

The color theme scale indicates the great variation that exists in total store zone buying power

The Lewisville Market Zone has more than $6.8 Billion in Total Buying Power



The Fairview/North Allen Market Zone has less than $2 Billion in Total Buying Power

Maptitude

* See page 110 for another reference to the overlay tool.

What Next

Step 3: now is the time for evidence-based interpretation of your result. Is there an avoidable problem at the root of the market size imbalance you are observing? What options are available to address the imbalance? Would addressing the imbalance be likely to improve the operating performance of the facility network in a tangible way?

Answers in this third step are likely to come from combined application of existing evidence, results from targeted further investigation (as needed), and personal judgment coming from experience and education.

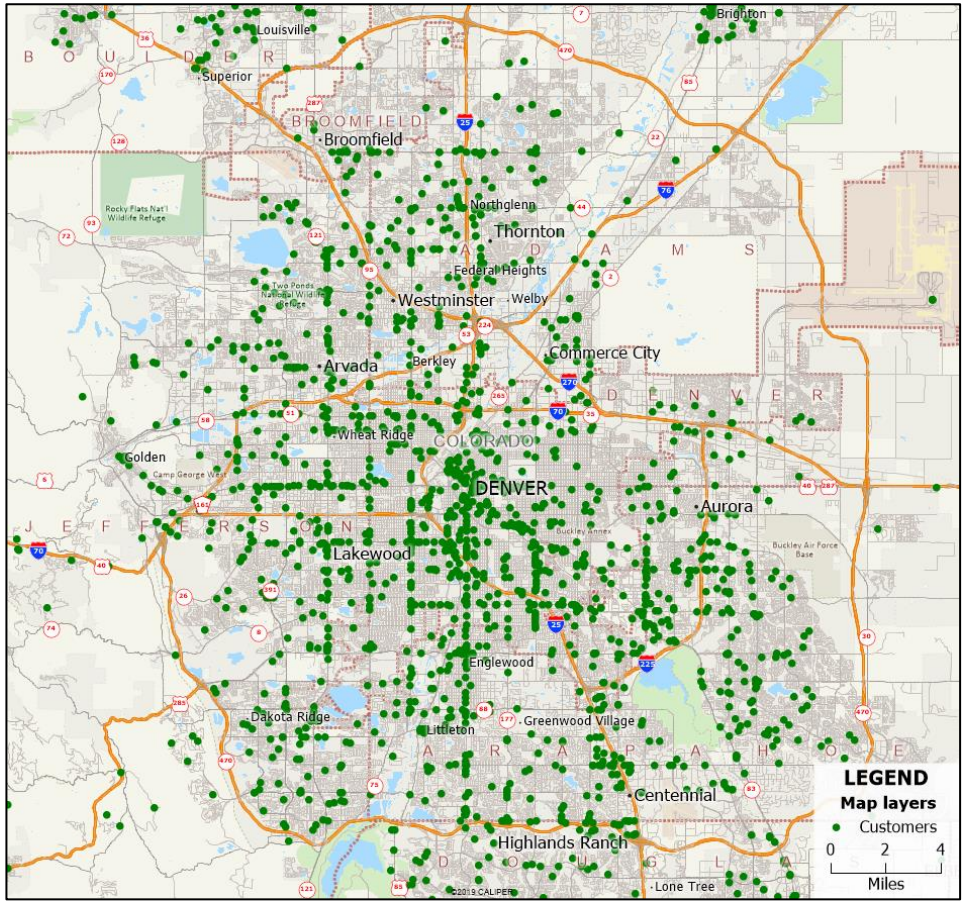
Method 7: Density Grid Analysis

Overview of Density Grid Analysis

In adding a location component to an existing database (method 1, page 13), we often end up with a map of point locations. Making sense of point distributions is often a challenging task.

For example, at right is a map of customers for a business in Denver, Colorado. It is clear that there is some pattern to the distribution of customers across the map: this is not a random spread of customer locations. Yet, coming up with a concise summary that gets at the basic patterns evident on the map would be challenging. It would be next to impossible to provide a word description of this map pattern that would allow a reader to duplicate the map pattern on their own in an even approximate sense.

Density grid analysis is highly useful in situations like this. Density grid analysis provides a simplified graphical display that captures the essential features of a point distribution without going into excessive detail.



Maptitude

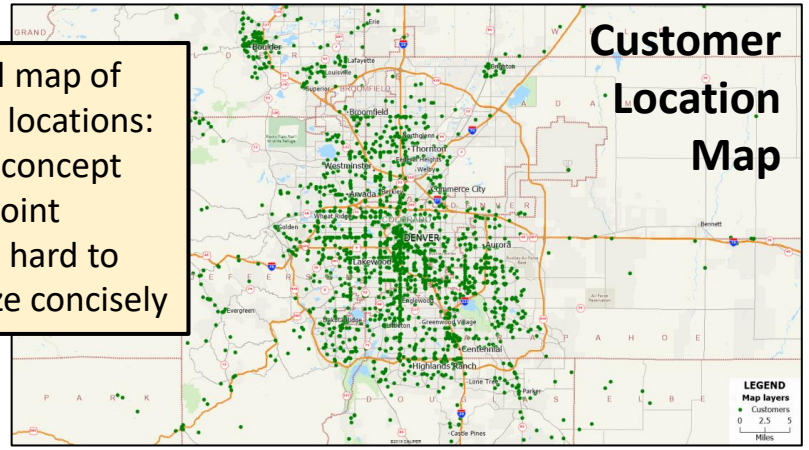
Detailed Discussion: Density Grid Analysis

The starting point: a complex map of point locations, such as our customer location theme, that defies simple description.

The solution: use the concept of density (number of points per unit area) to calculate a local point density value for every location across the map region. The key to a solution here is "local": the density map is generated by considering only the immediate, local surroundings of each location on the map. Duplicating this density calculation systematically across the map provides the result.

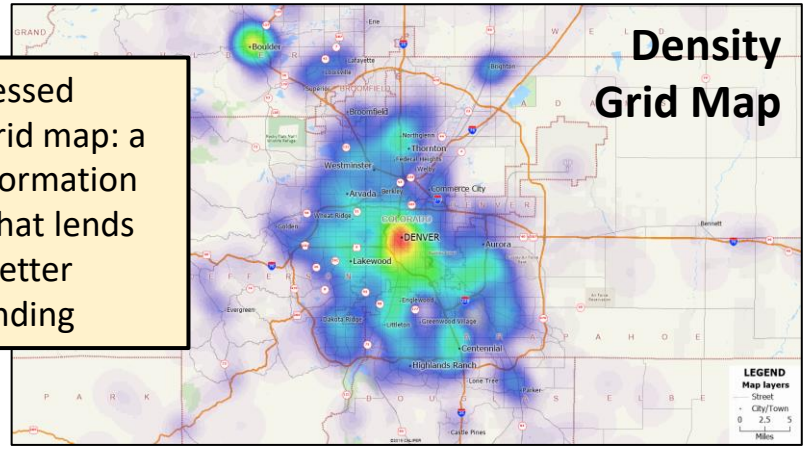
The result: the color-coded map at right. But before we unpack that result further, how do we actually get there?

The initial map of customer locations: simple in concept but this point pattern is hard to summarize concisely



Maptitude

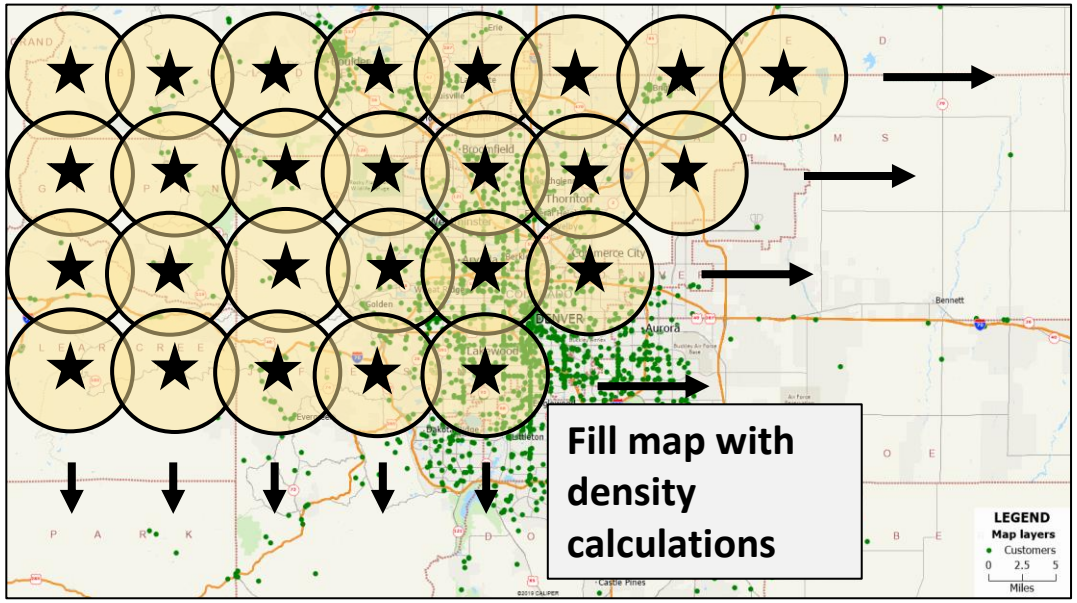
The processed density grid map: a better information balance that lends itself to better understanding



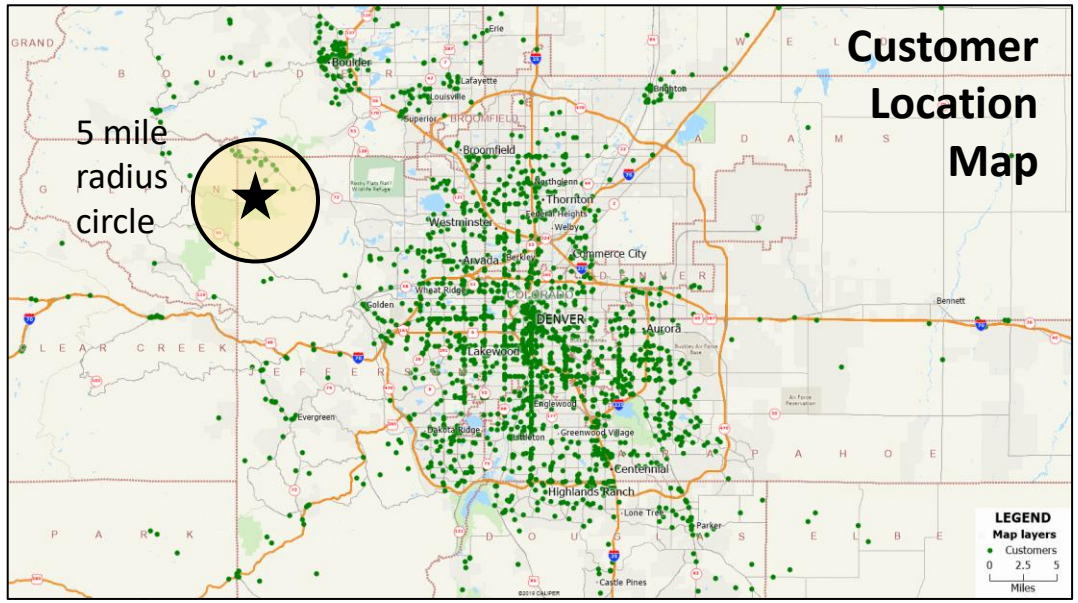
Maptitude

Detailed Discussion

The density calculation, explained: on our customer map (at right), let's take a sample location to illustrate the process. We need to calculate the local point density at the star location, which means we need to define what we mean by "local". We do this by defining a radius for our local circle (in this case, 5 miles). With this value defined, we simply need to calculate the area of the circle and calculate the number of customers located within that circle. With that, density = # customers / area.



Maptitude



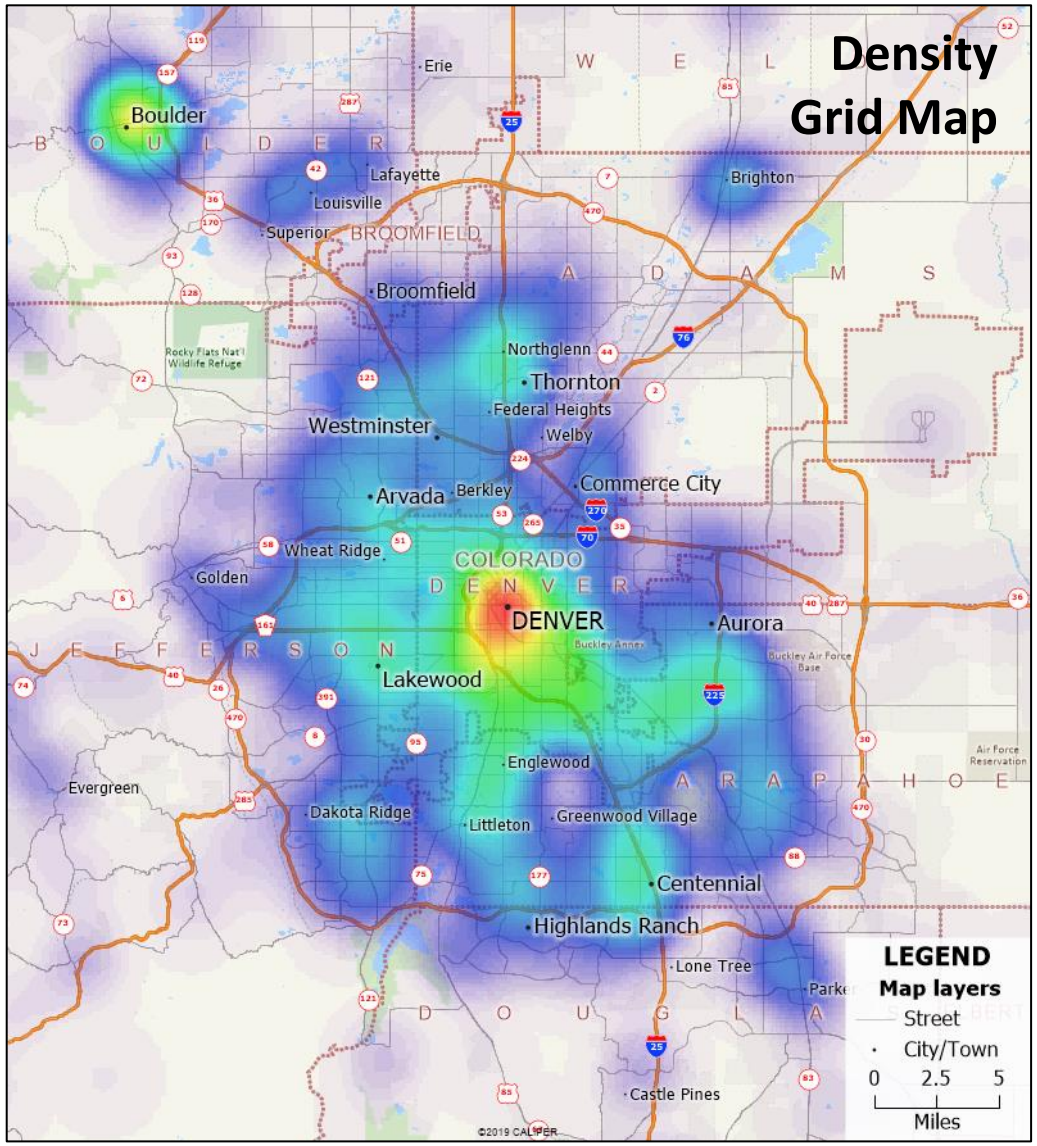
Maptitude

So how do we get from that calculation to our density grid map? The key here is that our software replicates that simple calculation across every part of our map area. The map at left provides a partial indication of what our software does, systematically calculating density values across the map. The difference, of course, is that our GIS software performs this calculation on a much denser basis than our example map to the left shows.

Detailed Discussion

The final result: a color-coded map that represents the regions of high and lower density of dot locations in a clear and easy to interpret manner, without troubling the reader with unnecessary detail. On this map, the highest local customer densities are signified by red and yellow shades, while lower densities are indicated by green, blue, and purple.

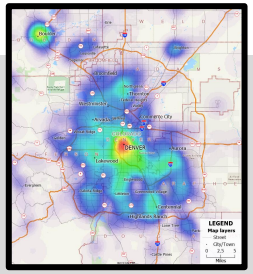
Compared with the original dot map and all of its detail, this map reduces detail in a way that provides a better information balance. The level of insight here allows for a word description that provides useful detail that can be used for further planning purposes.

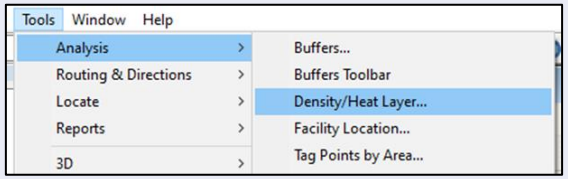


Maptitude

Resources and Processes to do a Density Grid Analysis

In Caliper Maptitude:



Density Grid Analysis…	
Supported by Maptitude	Yes
Starting the Analysis	Tools > Analysis > Density/Heat Layer… 
More guidance from Caliper	https://www.caliper.com/video/maptitude/maptitude-density-grid-hot-spot-video/maptitude-density-grid-hot-spot-video.html

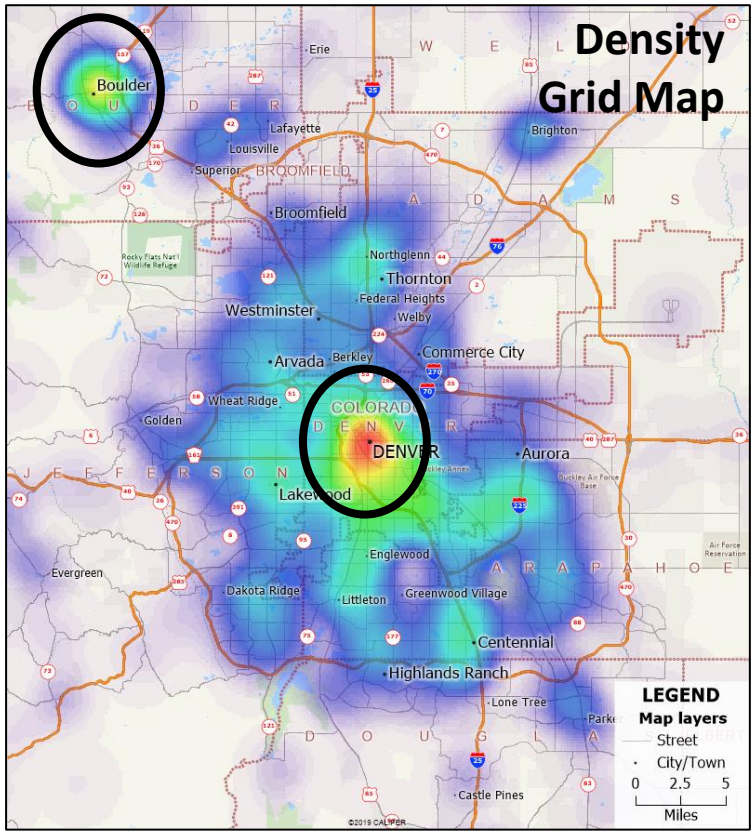
In Esri BA Web App:

Density Grid Analysis…	
Supported by BA Web App	No
Starting the Analysis	N/A
More guidance from Esri	N/A

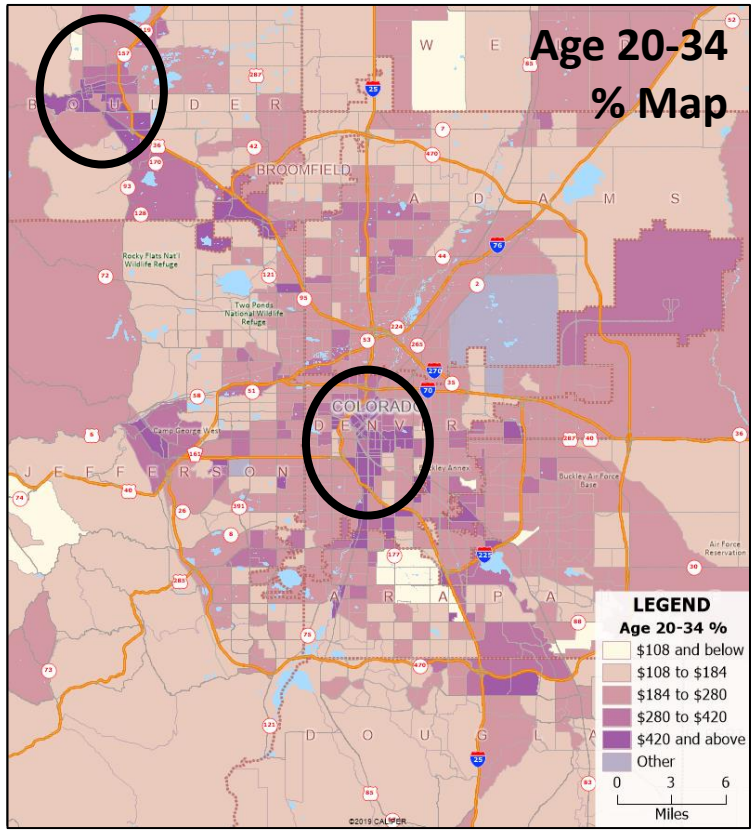
Next Steps After Completing a Density Grid Analysis

Now that you have created your density grid map, what is possible now?

<u>One possible extension</u>: relate the general features of the density grid to other underlying variables of interest. This opens up many possibilities for creative interpretation of the density pattern and its relation to other factors in the study area.



Maptitude



Maptitude

There may be some relationship between the customer point layer and the age 20 to 34 data theme. But what is the precise nature of this relationship?

Method 8: Network Analysis

Overview of Network Analysis

Transportation planning is a key issue for businesses in many parts of the economy. Active and effective management of transport activities is crucial for companies where deliveries or service calls are central to their business model.

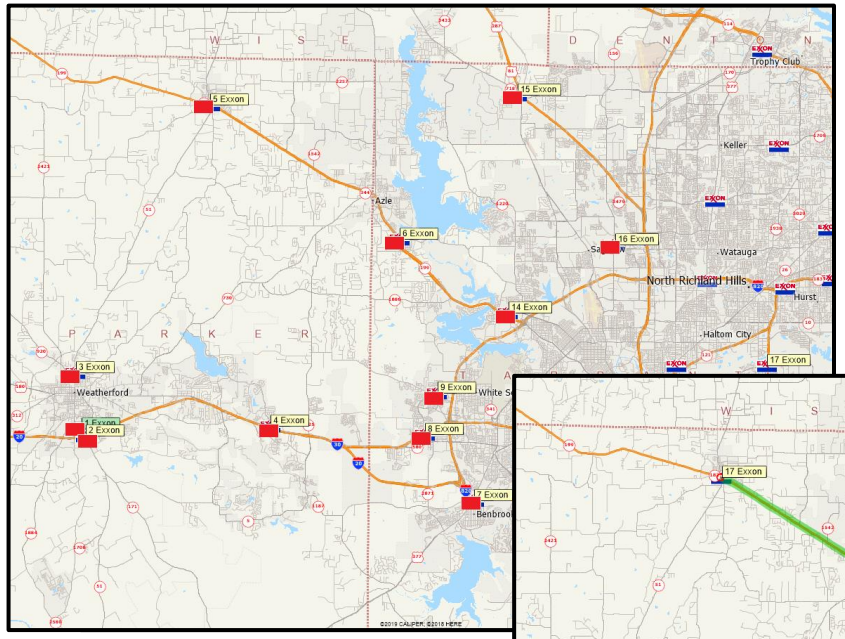
GIS plays an important role in transportation planning by enabling transport-dependent businesses to establish efficient routing and schedule plans. Such contributions are especially important when a business dispatches vehicles to complete a series of stops on a trip. In this case, planning of the most efficient route to minimize travel cost or time is a substantial contribution to the business' bottom line.

The following covers two different but related services that GIS can provide to businesses in need of efficient transportation planning.

A. Multiple Stop Delivery: Routing Analytics

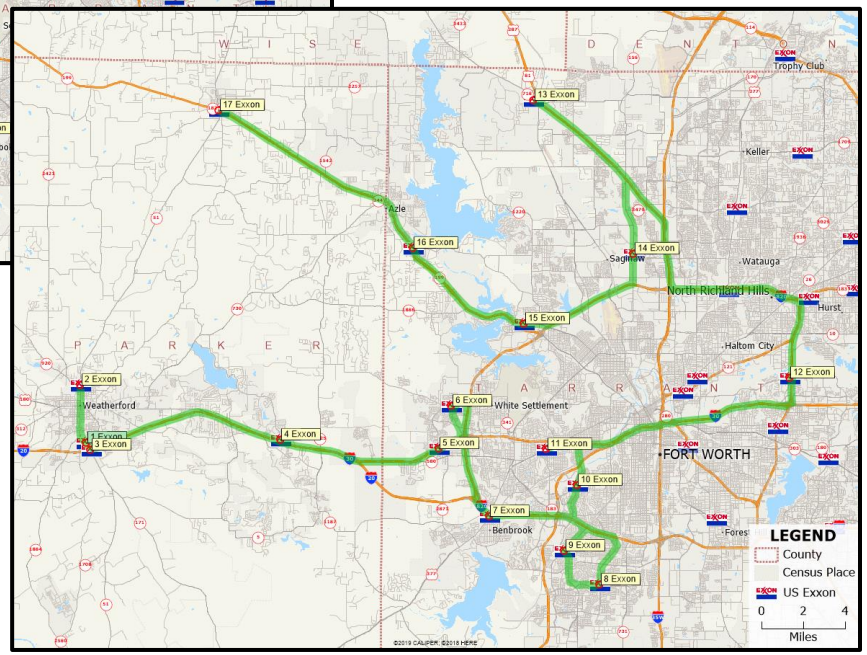
Delivery problem: one basic business problem is how to plan efficient routing given an unordered list of delivery stops. What stop order and routing will minimize the total travel time, distance, or cost of the trip?

Example here: to the upper right is a map of gas stations that a delivery truck needs to service in a single trip. How can this be done to minimize the travel time necessary? In the lower right is a map that provides the optimal solution, taking into account the street network and typical speeds and speed limits along the way.



Maptitude

Map of stops needed for a given delivery trip

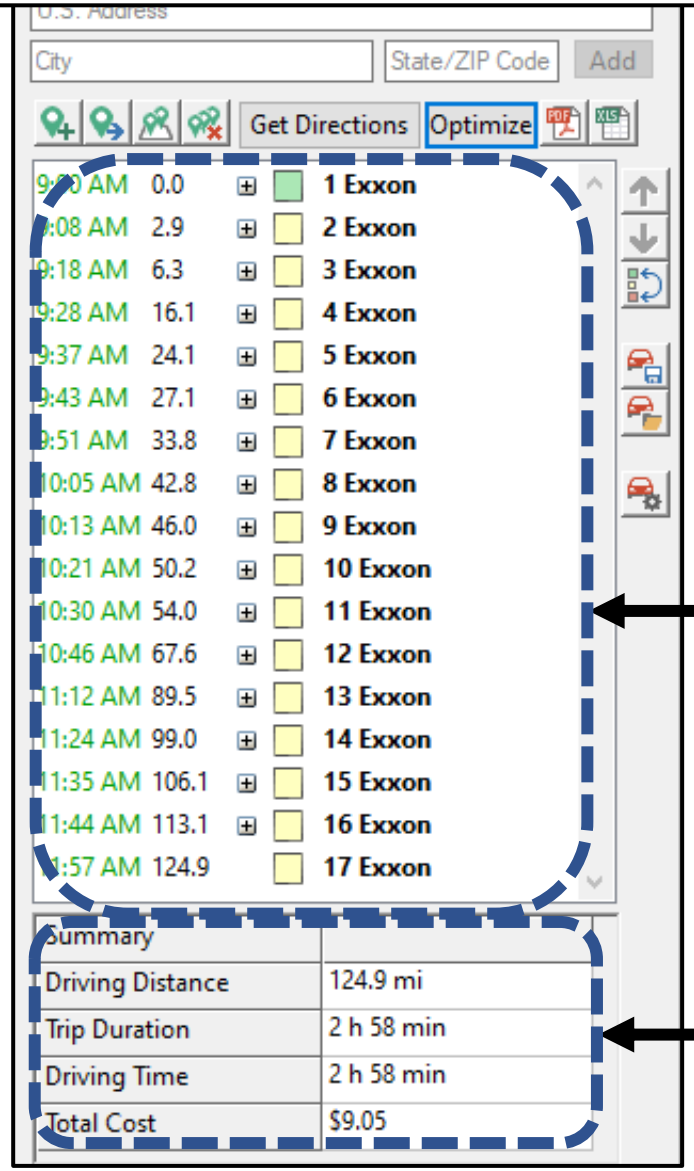


Maptitude

Map of optimized stop order and routing

Detailed Discussion

Example, continued: Additionally, for the same routing we can generate a schedule, mileage tracker, and overall trip summary to track predicted travel times and costs.*



Maptitude

Predicted stop times and trip distances

Overall trip summary

* Of course, one key factor that impacts travel times is traffic levels tracked by roadway segment. In addition to this role in routing, traffic volume data are also factors in site selection and are available as separate national data sets from both Caliper and Esri.

B. System-Wide Distance and Travel Time Modeling

Planning need: Sometimes a trip is necessary between individual locations in a larger business with many facilities. Given the location of facilities in a network (such as all of the stores in a retail chain), what is the travel time or distance between each facility pair?

Example here: using the same roster of 17 stops from the previous page, we can use GIS to generate a set of reference matrices and tables reflecting travel times and distances between any given facility pair.

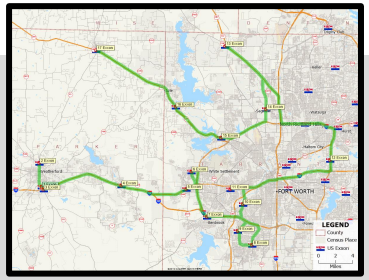
Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	--	2.35	8.21	12.04	24.11	33.15	21.75	19.00	23.67	29.82	26.24	29.61	34.46	29.81	47.19	35.09	39.26
2	2.21	--	9.54	10.62	25.44	32.61	20.33	17.58	22.26	28.40	24.82	28.19	33.04	28.39	45.78	33.68	37.84
3	8.39	9.59	--	17.06	15.90	29.89	26.77	24.02	28.69	34.83	31.25	34.63	39.48	34.82	42.90	40.11	44.28
4	11.28	10.77	16.85	--	31.26	23.79	11.51	8.76	13.43	19.58	16.00	19.37	24.22	19.57	36.95	24.85	29.02
5	24.55	25.74	16.15	30.66	--	14.24	33.86	31.86	30.86	42.09	36.32	41.50	46.74	22.04	27.05	33.32	42.37
6	32.24	32.01	29.39	24.94	13.29	--	23.73	21.73	20.73	31.96	26.19	31.37	36.60	11.91	28.29	23.19	32.24
7	22.24	21.73	27.81	12.33	34.72	21.87	--	7.68	10.43	9.52	9.67	9.32	14.17	14.55	31.94	19.84	22.30
8	20.55	20.03	26.12	10.63	31.57	18.72	6.55	--	5.59	14.78	7.84	13.02	19.43	11.41	28.79	16.70	20.86
9	22.67	22.16	28.24	12.75	31.33	18.47	8.66	6.20	--	16.89	11.12	16.30	21.54	11.16	28.55	16.45	24.15
10	28.91	28.40	34.48	19.00	41.62	28.76	9.40	14.58	17.33	--	12.42	8.19	7.90	21.45	35.68	26.74	21.98
11	24.85	24.33	30.42	14.93	35.63	22.77	10.01	8.38	11.34	12.32	--	8.22	17.23	15.46	30.42	20.75	16.06
12	29.06	28.55	34.63	19.15	41.00	28.14	9.54	13.75	16.71	9.56	9.18	--	14.26	20.83	33.50	25.01	19.15
13	33.93	33.42	39.50	24.01	46.63	33.78	14.41	19.59	22.35	7.41	17.68	13.21	--	26.47	36.69	28.20	23.02
14	28.53	28.02	34.10	18.61	21.51	8.65	14.06	12.06	11.06	22.29	16.52	21.70	26.94	--	23.71	12.18	21.24
15	45.43	44.92	43.91	35.51	27.80	27.73	30.96	28.96	27.96	33.65	30.86	33.44	35.16	22.73	--	12.79	23.48
16	33.58	33.06	39.15	23.66	32.39	19.53	19.11	17.11	16.11	27.34	21.57	26.75	29.41	10.88	13.97	--	16.94
17	37.47	36.95	43.04	27.55	42.33	29.48	21.91	21.00	23.96	21.76	16.43	19.01	23.27	20.83	25.52	16.55	--

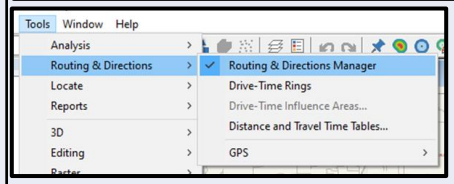
Travel Time (Minutes) | Distance (Miles)

Maptitude

Resources and Processes to do a Network Analysis

In Caliper Maptitude:



Network Analysis…	
Supported by Maptitude	Yes
Starting the Analysis	Tools > Routing & Directions > Routing & Directions Manager 
More guidance from Caliper	https://www.caliper.com/video/maptitude/maptitude-routing-video/maptitude-routing-video.html https://www.caliper.com/video/maptitude/maptitude-time-table-video/maptitude-time-table-video.html

In Esri BA Web App:

Network Analysis…	
Supported by BA Web App	No
Starting the Analysis	N/A
More guidance from Esri	N/A

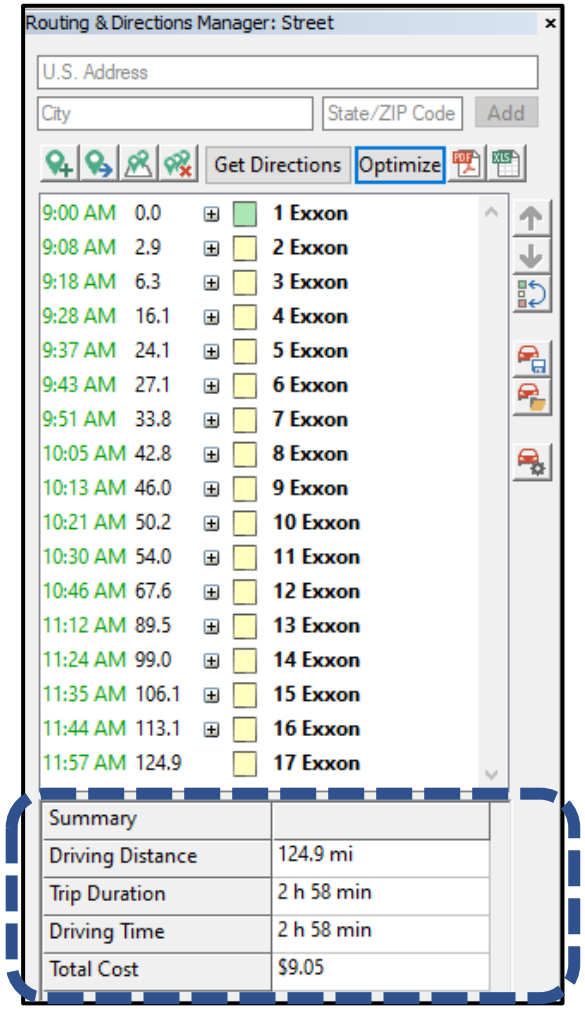
Next Steps After Completing a Network Analysis

Now that you have created an initial network analysis, what is possible now?

<u>One option</u>: expansion of the analysis via incorporation of multiple delivery vehicles

The earlier, one-vehicle routing analysis demonstrated the basic power of network tools, including generation of summary figures

Overall trip summary



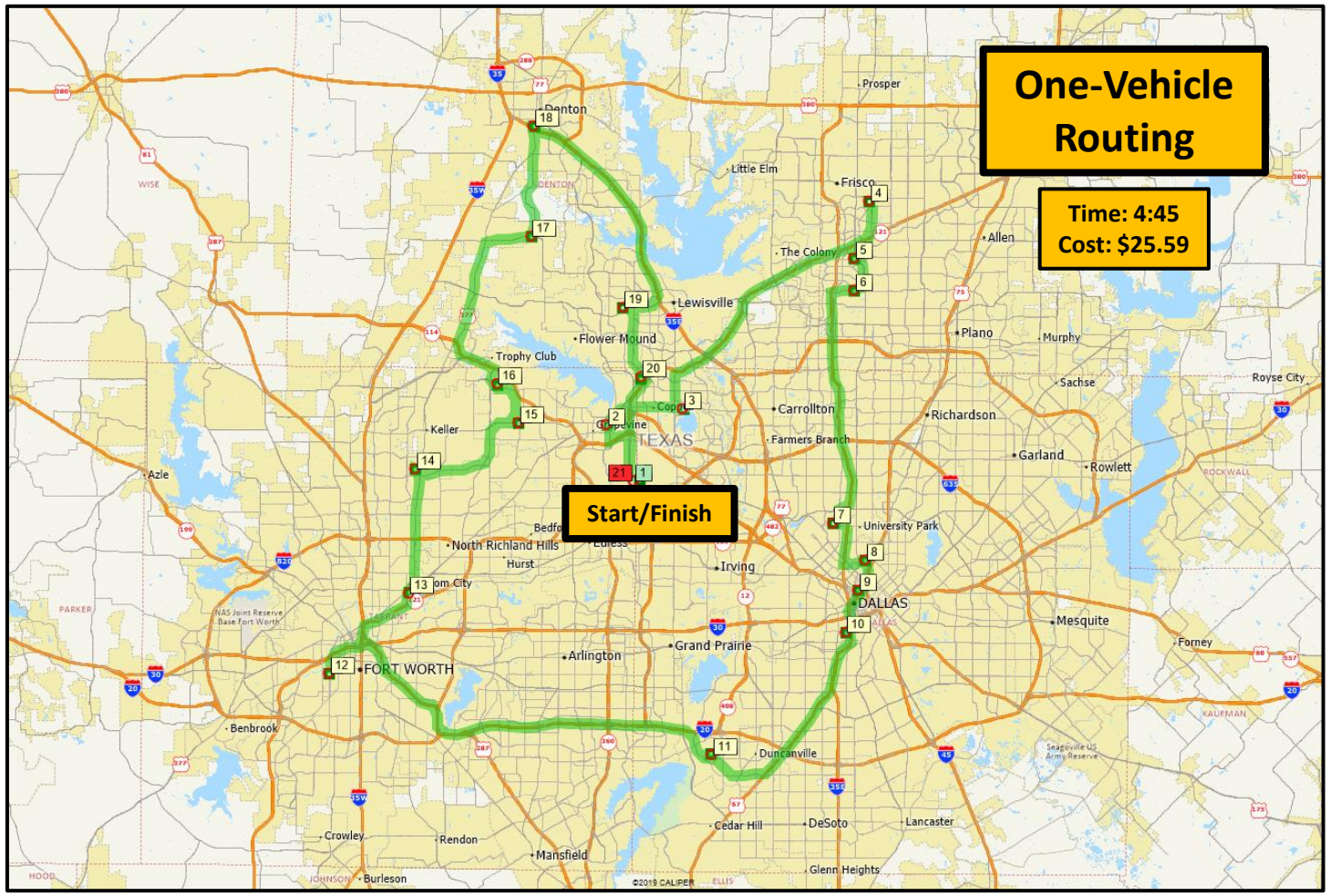
Maptitude

What Next

We can determine the optimal route for one delivery vehicle to cover all stops, and calculate total driving distance, trip duration, and total cost

Summary	
Driving Distance	161.5 mi
Trip Duration	4 h 45 min
Driving Time	4 h 45 min
Total Cost	$25.59

However, after thoughtful interpretation of the results, we might come to a conclusion that single-vehicle routing is yielding a delivery cycle that is too lengthy



Maptitude

What Next

We can divide the stops into groups to determine the impact of using two delivery vehicles to shorten the delivery cycle duration

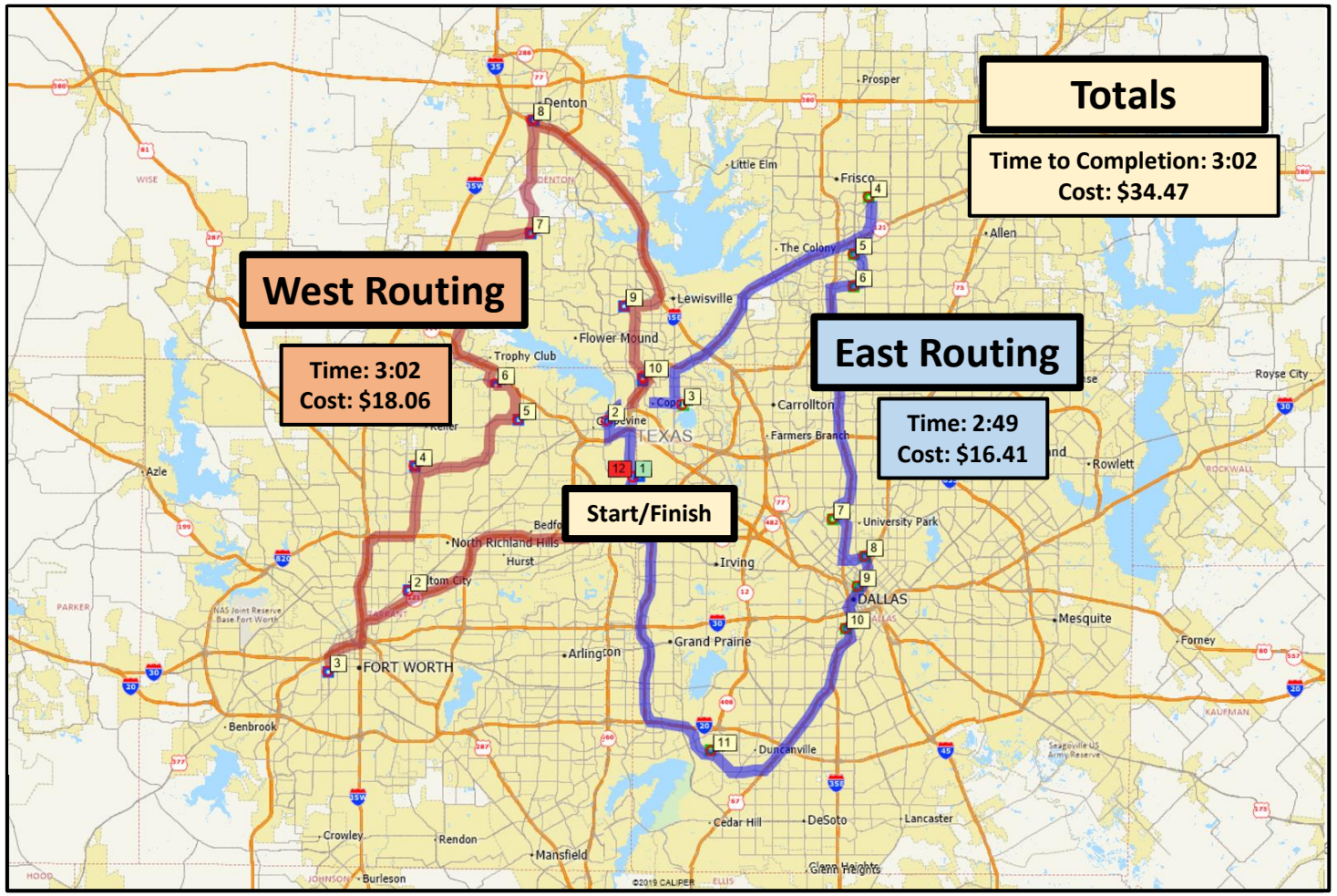
East Routing

Summary	
Driving Distance	107.6 mi
Trip Duration	2 h 49 min
Driving Time	2 h 49 min
Total Cost	$16.41

West Routing

Summary	
Driving Distance	114.6 mi
Trip Duration	3 h 2 min
Driving Time	3 h 2 min
Total Cost	$18.06

Delivery vehicles driven concurrently



Maptitude

End of Part A

Part B: Application Areas

Advanced Business GIS Uses

Application Areas: The Basic Idea

This second section of the handbook explores a roster of applications that are possible to implement in many GIS packages. Going beyond the foundational methods defined in the first section of this handbook, the basic idea in this second section is that each of the applications explored are:

- The result of a combination of more basic GIS processes, and
- They are of a sufficiently high level of contribution that completion of the described process leads to a result that is useful on its own terms.

For example the first application discussed in this section, business data enhancement, is the result of combining geocoding and buffer or drive-time analysis together with addition of further business datasets to create a new, more useful database suited for even higher-level analysis. Likewise, the other applications discussed here (customer analytics by market area, site selection, and market analysis) each combine more foundational methods and ultimately produce high-level, actionable results.

The applications covered here are not exhaustive. However, they do provide some insight into the way that GIS processes can be used and combined in creative ways to solve an infinite number of problems that range from the very simple to the highly complex.

Application 1: Business Data Enhancement

Application Overview: Business Data Enhancement

Business data enhancement is an extension of geocoding. If you recall, geocoding adds geographic data (latitude and longitude) to a business database that started with no explicit spatial component, but did have some fields that could be processed to reveal some location insight. So the result of geocoding on its own is a geographically-enabled database that can be used in a GIS.

Business data enhancement uses the new geographic fields in the database to add more data yet. For example:

1. A database of a chain of store locations can have latitude and longitude data appended (a geocoding step).
2. Then, using the location data added through geocoding, a market area can be modeled for each store, and purchase data for each market zone can be pulled in for analysis (a business data enhancement step).
3. Result: a database that started with just internal data for the car repair chain can be extended to incorporate highly useful market data referenced to each location in the chain.

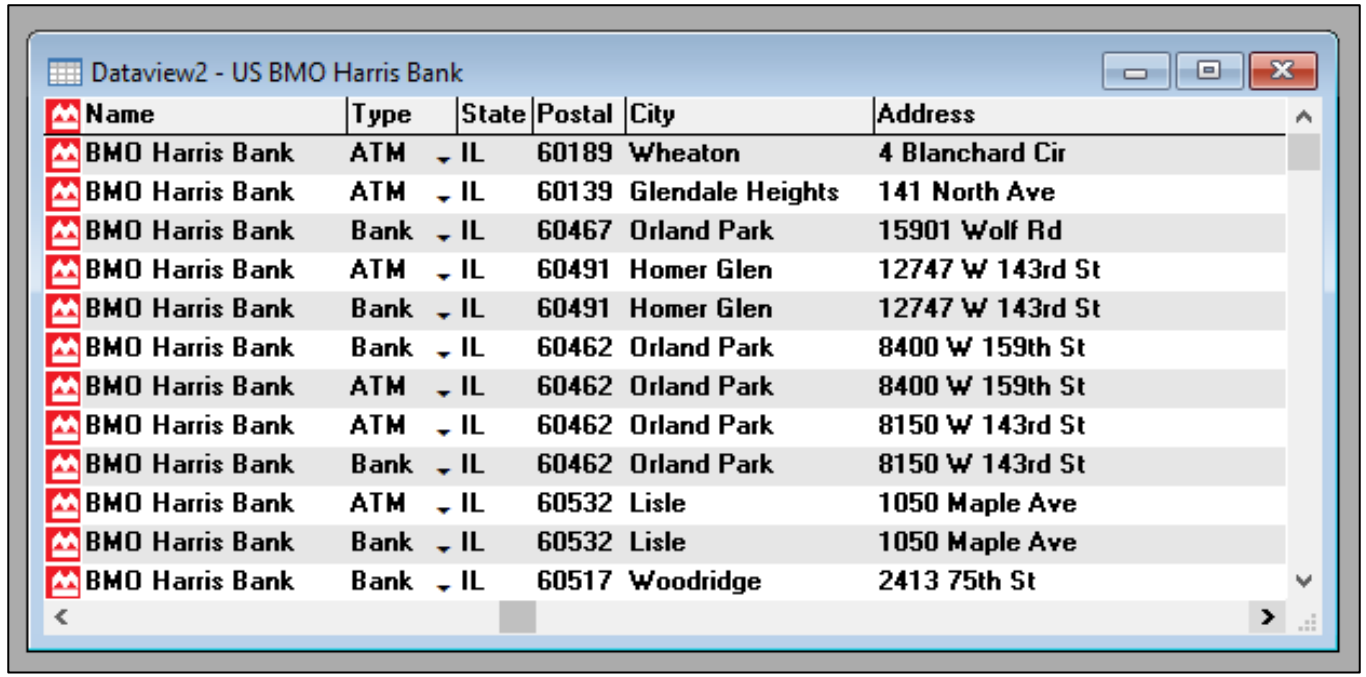
The following develops this basic thinking in an illustrative extended example of use.

Step-by-Step: Business Data Enhancement

Step 1

We start with a database containing address information, but no explicitly geographic fields.

In this case, the database refers to a bank with branches across the Chicago area.



Dataview2 - US BMO Harris Bank

Name	Type	State	Postal	City	Address
BMO Harris Bank	ATM	IL	60189	Wheaton	4 Blanchard Cir
BMO Harris Bank	ATM	IL	60139	Glendale Heights	141 North Ave
BMO Harris Bank	Bank	IL	60467	Orland Park	15901 Wolf Rd
BMO Harris Bank	ATM	IL	60491	Homer Glen	12747 W 143rd St
BMO Harris Bank	Bank	IL	60491	Homer Glen	12747 W 143rd St
BMO Harris Bank	Bank	IL	60462	Orland Park	8400 W 159th St
BMO Harris Bank	ATM	IL	60462	Orland Park	8400 W 159th St
BMO Harris Bank	ATM	IL	60462	Orland Park	8150 W 143rd St
BMO Harris Bank	Bank	IL	60462	Orland Park	8150 W 143rd St
BMO Harris Bank	ATM	IL	60532	Lisle	1050 Maple Ave
BMO Harris Bank	Bank	IL	60532	Lisle	1050 Maple Ave
BMO Harris Bank	Bank	IL	60517	Woodridge	2413 75th St

Maptitude

Original Database

Step 1 (continued)

In an initial geocoding step, data enhancement here involves appending latitude and longitude information to each bank branch address.

Dataview2 - US BMO Harris Bank

LONGITUDE	LATITUDE	Name	Type	State	Postal	City	Address
-88102810	41836470	MO Harris Bank	ATM	IL	60189	Wheaton	4 Blanchard Cir
-88083760	41902650	MO Harris Bank	ATM	IL	60139	Glendale Heights	141 North Ave
-87891360	41600130	MO Harris Bank	Bank	IL	60467	Orland Park	15901 Wolf Rd
-87930820	41629090	MO Harris Bank	ATM	IL	60491	Homer Glen	12747 W 143rd St
-87930820	41629090	MO Harris Bank	Bank	IL	60491	Homer Glen	12747 W 143rd St
-87823930	41601830	MO Harris Bank	Bank	IL	60462	Orland Park	8400 W 159th St
-87823930	41601830	MO Harris Bank	ATM	IL	60462	Orland Park	8400 W 159th St
-87819150	41631140	MO Harris Bank	ATM	IL	60462	Orland Park	8150 W 143rd St
-87819150	41631140	MO Harris Bank	Bank	IL	60462	Orland Park	8150 W 143rd St
-88073810	41787070	MO Harris Bank	ATM	IL	60532	Lisle	1050 Maple Ave
-88073810	41787070	MO Harris Bank	Bank	IL	60532	Lisle	1050 Maple Ave
-88041500	41749870	MO Harris Bank	Bank	IL	60517	Woodridge	2413 75th St

Maptitude

Appended Location Data

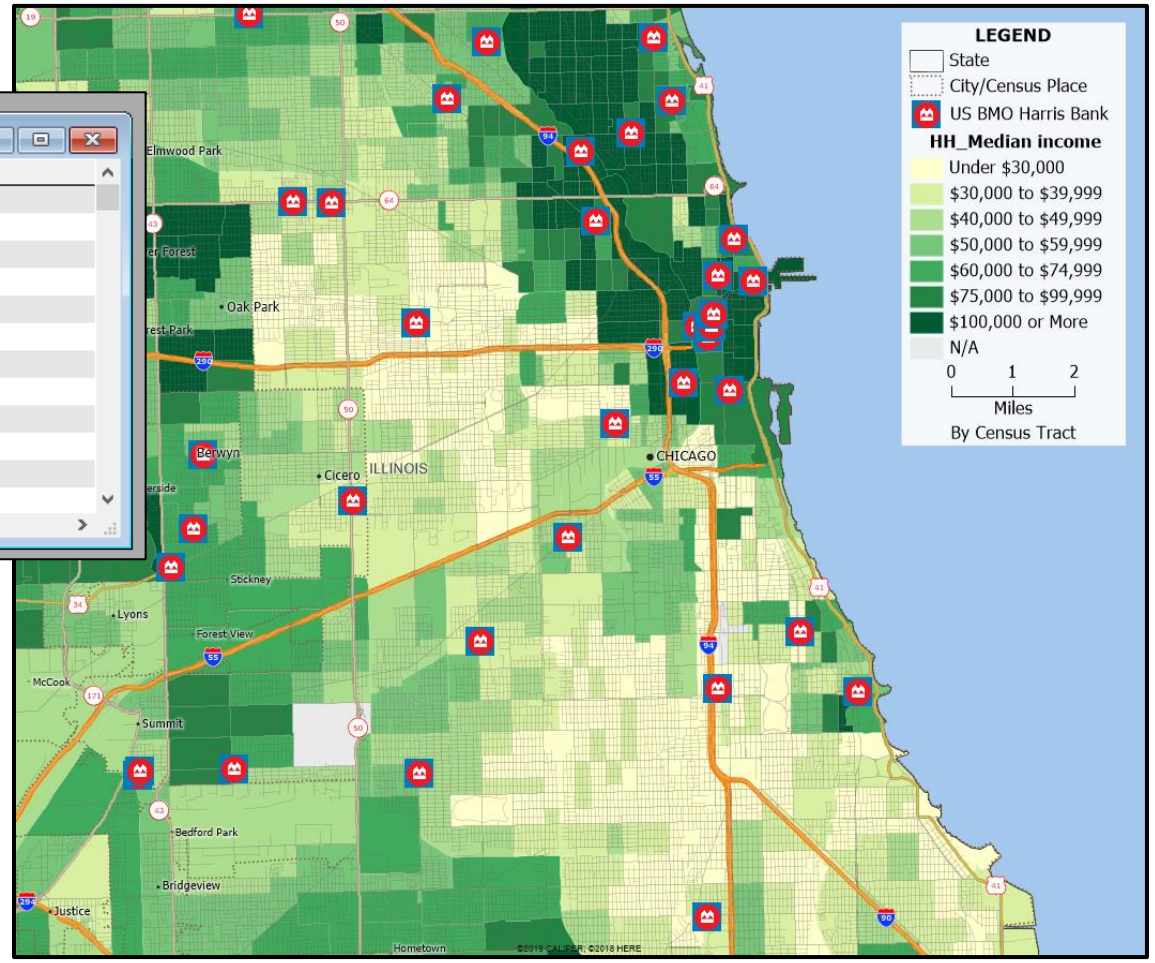
Original Database

Detailed Discussion

Step 2

Dataview2 - US BMO Harris Bank

LONGITUDE	LATITUDE	Name	Type	State	Postal	City	Address
-88102810	41836470	BMO Harris Bank	ATM	IL	60189	Wheaton	4 Blanchard Cir
-88083760	41902650	BMO Harris Bank	ATM	IL	60139	Glendale Heights	141 North Ave
-87891360	41600130	BMO Harris Bank	Bank	IL	60467	Orland Park	15901 Wolf Rd
-87930820	41629090	BMO Harris Bank	ATM	IL	60491	Homer Glen	12747 W 143rd St
-87930820	41629090	BMO Harris Bank	Bank	IL	60491	Homer Glen	12747 W 143rd St
-87823930	41601830	BMO Harris Bank	Bank	IL	60462	Orland Park	8400 W 159th St
-87823930	41601830	BMO Harris Bank	ATM	IL	60462	Orland Park	8400 W 159th St
-87819150	41631140	BMO Harris Bank	ATM	IL	60462	Orland Park	8150 W 143rd St
-87819150	41631140	BMO Harris Bank	Bank	IL	60462	Orland Park	8150 W 143rd St
-88073810	41787070	BMO Harris Bank	ATM	IL	60532	Lisle	1050 Maple Ave
-88073810	41787070	BMO Harris Bank	Bank	IL	60532	Lisle	1050 Maple Ave
-88041500	41749870	BMO Harris Bank	Bank	IL	60517	Woodridge	2413 75th St



Maptitude

Taking a simple next step: map the bank branches with a census tract theme of financial information (in this case, median incomes). Even with just this simple step complete, it is apparent that the bank branches have vastly differing markets to serve.

Detailed Discussion

Step 3

Dataview2 - US BMO Harris Bank

LONGITUDE	LATITUDE	Name	Type	State	Postal	City	Address
-88102810	41836470	BMO Harris Bank	ATM	IL	60189	Wheaton	4 Blanchard Cir
-88083760	41902650	BMO Harris Bank	ATM	IL	60139	Glendale Heights	141 North Ave
-87891360	41600130	BMO Harris Bank	Bank	IL	60467	Orland Park	15901 Wolf Rd
-87930820	41629090	BMO Harris Bank	ATM	IL	60491	Homer Glen	12747 W 143rd St
-87930820	41629090	BMO Harris Bank	Bank	IL	60491	Homer Glen	12747 W 143rd St
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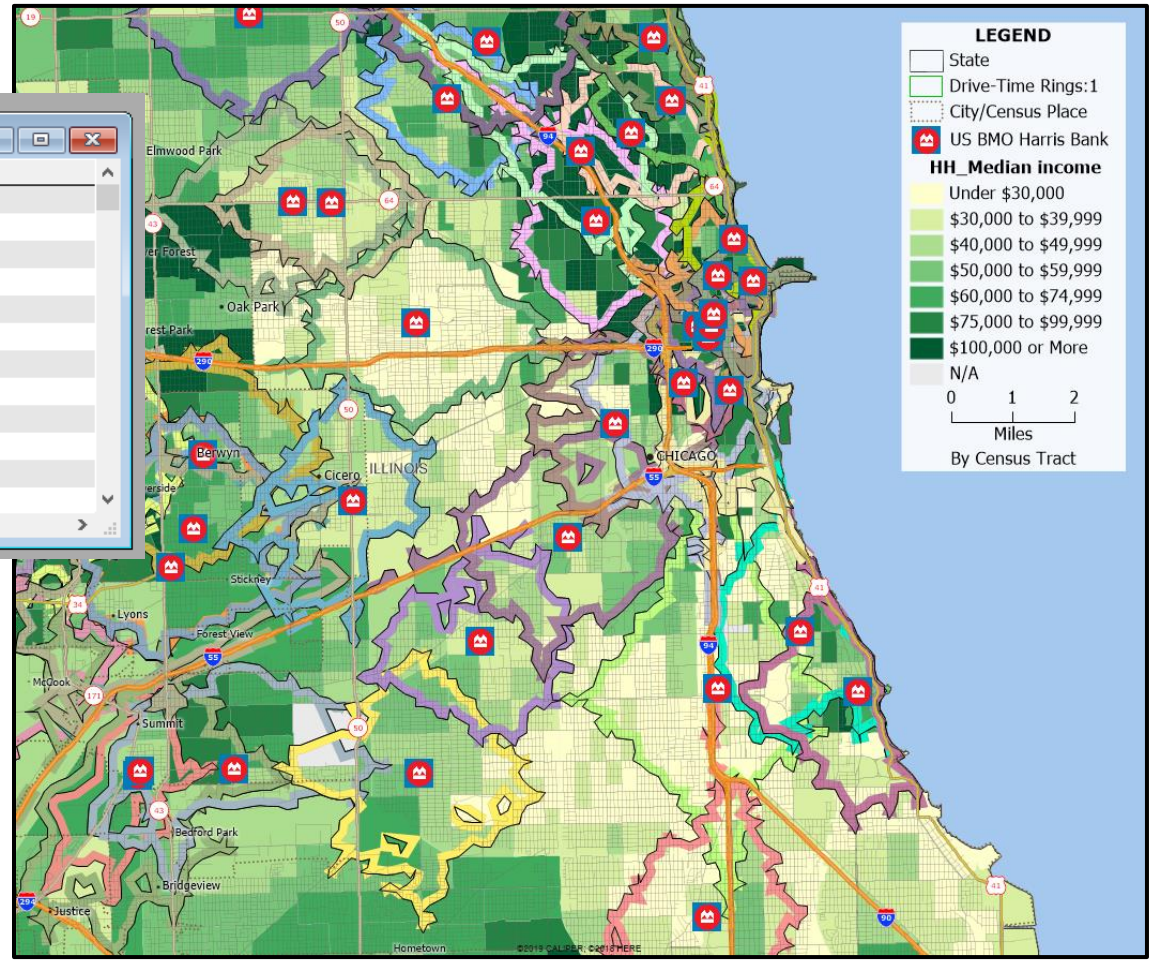
-88073810	41787070	BMO Harris Bank	ATM	IL	60532	Lisle	1050 Maple Ave
-88073810	41787070	BMO Harris Bank	Bank	IL	60532	Lisle	1050 Maple Ave
-88041500	41749870	BMO Harris Bank	Bank	IL	60517	Woodridge	2413 75th St



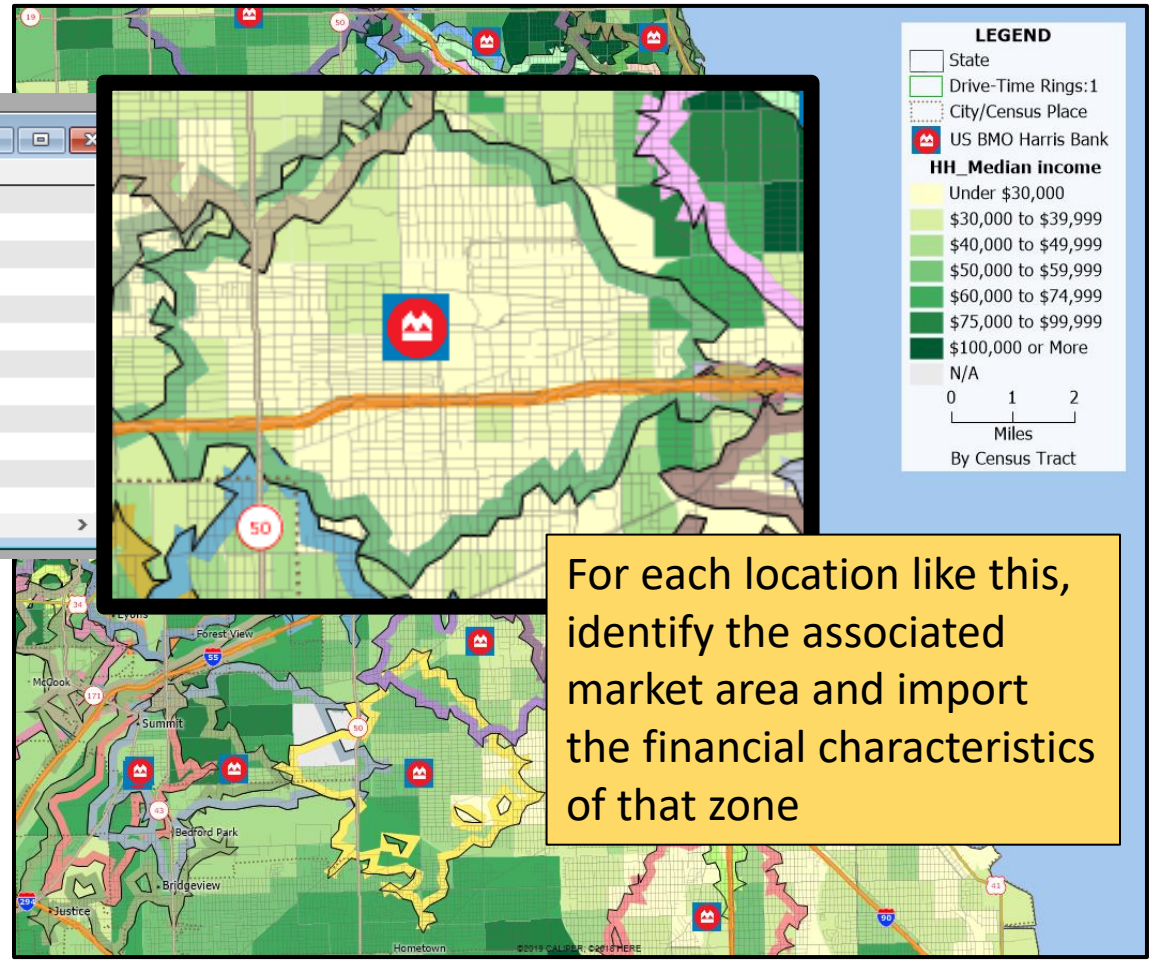
Maptitude

Now take a step further: connect each bank branch record with financial information for the market area surrounding it. Just as we appended location data to the bank database, we can now append further market data to each bank branch record.

Step 3 (continued)

Dataview2 - US BMO Harris Bank

LONGITUDE	LATITUDE	Name	Type	State	Postal	City	Address
-88102810	41836470	BMO Harris Bank	ATM	IL	60189	Wheaton	4 Blanchard Cir
-88083760	41902650	BMO Harris Bank	ATM	IL	60139	Glendale Heights	141 North Ave
-87891360	41600130	BMO Harris Bank	Bank	IL	60467	Orland Park	15901 Wolf Rd
-87930820	41629090	BMO Harris Bank	ATM	IL	60491	Homer Glen	12747 W 143rd St
-87930820	41629090	BMO Harris Bank	Bank	IL	60491	Homer Glen	12747 W 143rd St
-87823930	41601830	BMO Harris Bank	Bank	IL	60462	Orland Park	8400 W 159th St
-87823930	41601830	BMO Harris Bank	ATM	IL	60462	Orland Park	8400 W 159th St
-87819150	41631140	BMO Harris Bank	ATM	IL	60462	Orland Park	8150 W 143rd St
-87819150	41631140	BMO Harris Bank	Bank	IL	60462	Orland Park	8150 W 143rd St
-88073810	41787070	BMO Harris Bank	ATM	IL	60532	Lisle	1050 Maple Ave
-88073810	41787070	BMO Harris Bank	Bank	IL	60532	Lisle	1050 Maple Ave
-88041500	41749870	BMO Harris Bank	Bank	IL	60517	Woodridge	2413 75th St



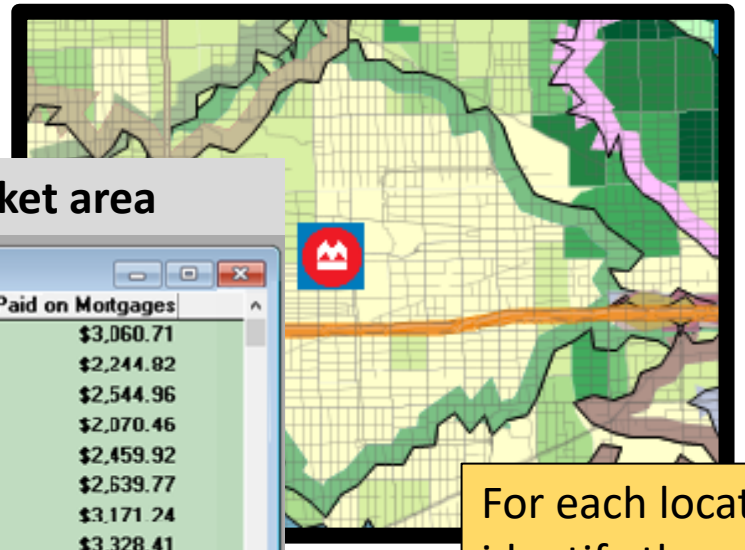
For each location like this, identify the associated market area and import the financial characteristics of that zone

Maptitude

In this way, we can start with a fairly simple geographic technique (appending geographic data to an existing business database) and build something extremely useful.

Detailed Discussion

Step 3 (continued)



Sample financial data to append for each bank branch market area

Dataview2 - US BMO Harris Bank

LONGITUDE	LATITUDE	Name	State	Postal	City	Princ. Paid on Lump Sum/Home Eqty Loans	Princ. Paid on Mortgages
-88102810	41836470	BMO Harris Bank	IL	60189	Wheaton	$67.70	$3,060.71
-88083760	41902650	BMO Harris Bank	IL	60139	Glendale Heights	$53.21	$2,244.82
-87891360	41600130	BMO Harris Bank	IL	60467	Orland Park	$56.03	$2,544.96
-87930820	41629090	BMO Harris Bank	IL	60491	Homer Glen	$46.75	$2,070.46
-87930820	41629090	BMO Harris Bank	IL	60491	Homer Glen	$58.08	$2,459.92
-87823930	41601830	BMO Harris Bank	IL	60462	Orland Park	$52.67	$2,639.77
-87823930	41601830	BMO Harris Bank	IL	60462	Orland Park	$70.27	$3,171.24
-87819150	41631140	BMO Harris Bank	IL	60462	Orland Park	$71.53	$3,328.41
-87819150	41631140	BMO Harris Bank	IL	60462	Orland Park	$78.32	$3,749.47
-88073810	41787070	BMO Harris Bank	IL	60532	Lisle	$72.52	$3,701.89
-88073810	41787070	BMO Harris Bank	IL	60532	Lisle	$55.41	$2,887.94
-88041500	41749870	BMO Harris Bank	IL	60517	Woodridge		

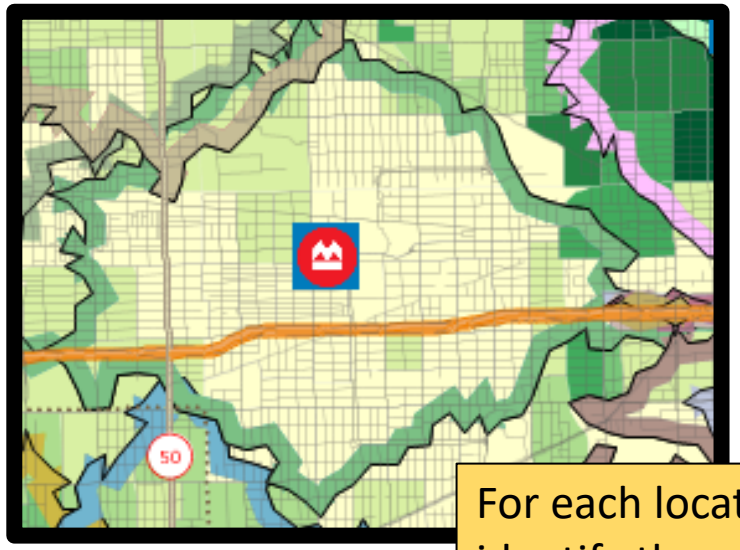
Maptitude

For each location like this, identify the associated market area and import the financial characteristics of that zone

Step 3 (continued)

Note:

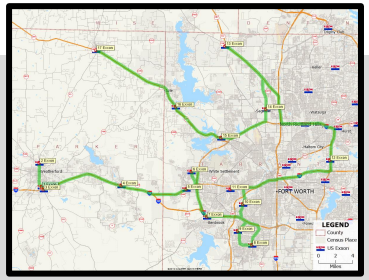
- This example focuses on a bank and its own internal operations planning
- The same methods could equally well be used to append geographic data to a customer or prospect database (an external focus)



Maptitude

For each location like this, identify the associated market area and import the financial characteristics of that zone

In Caliper Maptitude:



Business Data Enhancement…	
Supported by Maptitude	Yes
Starting the Analysis	Tools > Analysis > Overlay… Transfers data values from one geographic layer to another
More guidance from Caliper	https://www.caliper.com/video/maptitude/maptitude-overlays-and-buffers-video/maptitude-overlays-and-buffers-video.html

In Esri BA Web App:

Business Data Enhancement…	
Supported by BA Web App	Not as discussed here
Starting the Analysis	N/A
More guidance from Esri	N/A

Application 2: Customer Analytics by Market Area

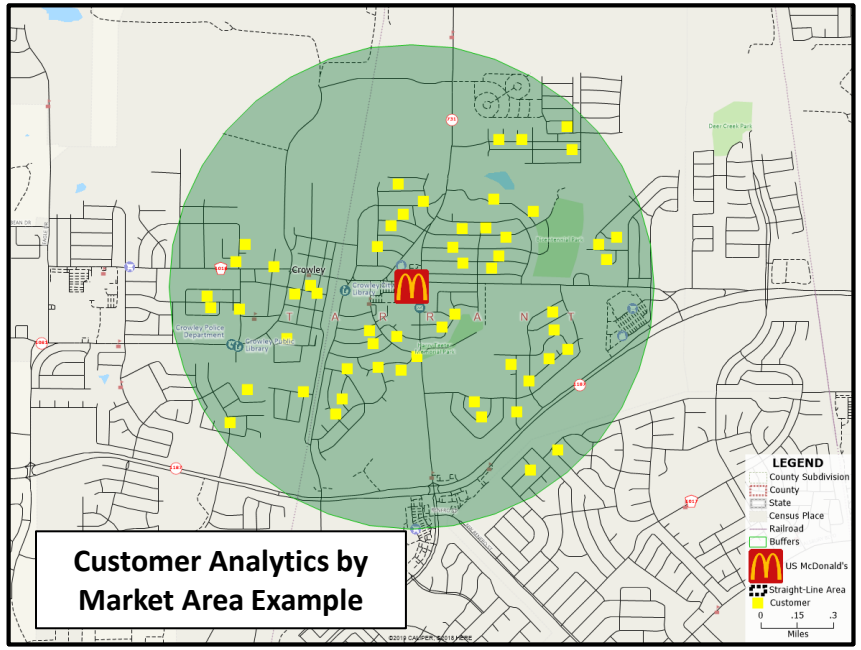
Application Overview: Customer Analytics by Market Area

One of the applications made possible by tools covered in the foundational methods section is the idea of helping a business understand the customers located in a specific local market area. This analytical power is multiplied further if the business is a chain business with multiple locations, and thus multiple market areas. GIS can cut through the complexity of this situation and provide insights into the customers located in each market area served by each location in the chain.

One way of doing this involves a three-step process.

1. Your customer data will likely not come with ready-to-go geographic coordinate data. So before going any further, you need to geocode whatever customer data you have. Geocoding (method 1 from earlier in this reference) assembles a database of point location data, with the points being your customers (in the sample map shown here, these are the yellow dots).

2. With customer point data in place, now you can generate a representation of your market area or areas using your buffers/drive-time zones tools (method 2 from earlier). The sample map to the right uses a buffer (green circular zone around the McDonald's, with geocoded customers in yellow).



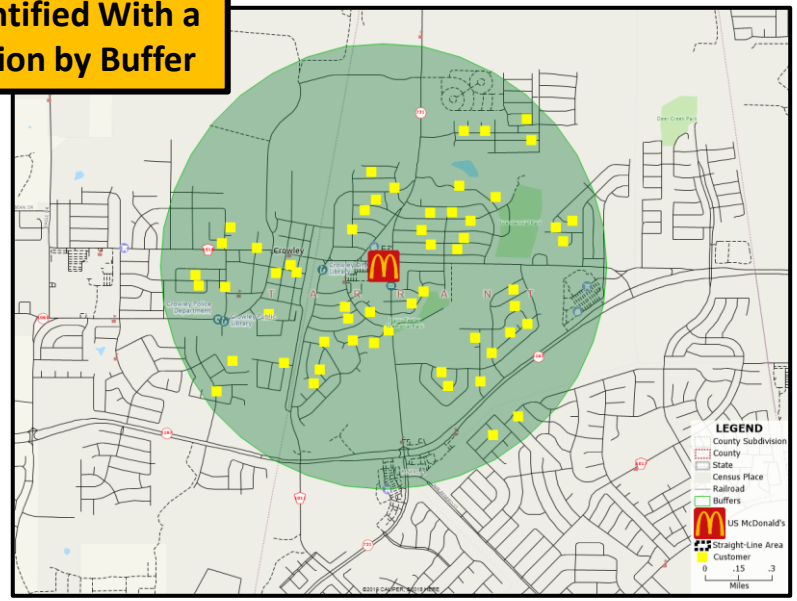
Customer Analytics by Market Area Example

Maptitude

Overview

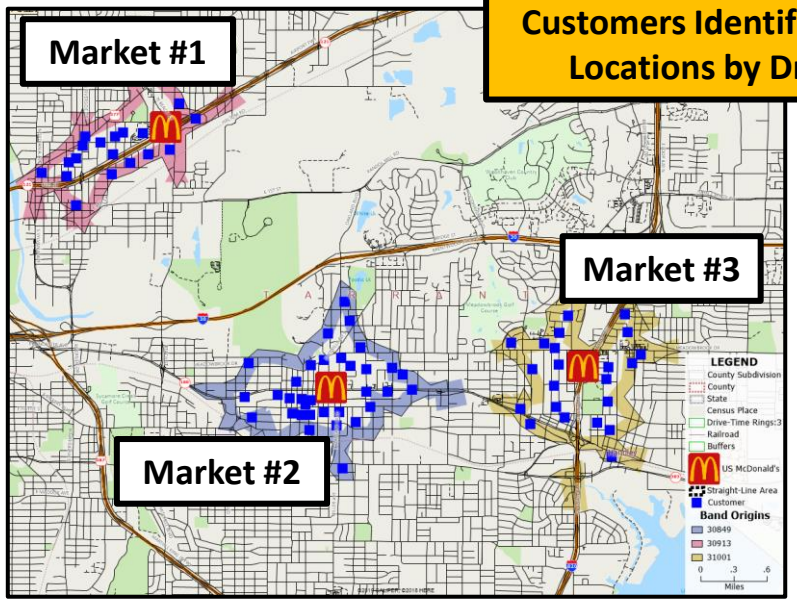
3. With these resources in place, the basic idea is to identify which customer records fall within which market area. If you are analyzing customers for only one location, your task is more simple (as in the buffer market example on the left). However, if you have multiple locations (and thus multiple markets), your task is more complicated (as in the drive-time example on the right). However, application of geocoding and buffer/drive-time zones together gives you great insight into the customers you serve in your immediate local market.*

Customers Identified With a Business Location by Buffer



Maptitude

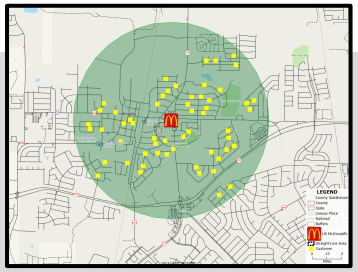
Customers Identified With Business Locations by Drive-Time Zone



* Another means of assigning customers to a store, similar to this, is by use of Maptitude's Dataview and Tagging tools.

Resources and Processes to do Customer Analytics by Market Area

In Caliper Maptitude:



Customer Analytics by Market…	
Supported by Maptitude	Yes
Starting the Analysis: A Combined Approach	**Geocoding (to locate each customer record on a map) – pages 13 to 20** • Result: customer records can be mapped **Buffers/drive-time (define the market area connected to each location) – pages 23 to 35** • Result: identify customers living in an area **Overlays (to total the customer data for each market area) – page 110** • Result: collect and analyze business data by market area
More guidance from Caliper	See individual video tutorials for the three methods listed above

In Esri BA Web App:

Customer Analytics by Market…	
Supported by BA Web App	Not as discussed here
Starting the Analysis	N/A
More guidance from Esri	N/A

Application 3: Site Selection

Overview of Site Selection

Site selection is one of the most basic and longstanding applications of geographic knowledge, thinking, and analytical skill. Site selection involves a choice among a set of potential locations. Because of its enduring and need and practice, site selection has evolved to include several different approaches.

To give some insight into the varied contributions that GIS can make to site selection, the following discussion addresses five approaches to the site selection problem (Jones and Simmons 1990).

A. **Rules of Thumb:** simple yes/no questions that collectively form a profile for business success at a given location. If these questions can be answered affirmatively for a given location, the property could be viewed as having high potential for business success.
B. **Ranking:** transferring the site selection parameters from a yes/no format to a multi-point scale. This approach allows for a higher degree of nuance (better reflective of real-world conditions) than the rule of thumb approach.
C. **Analogs:** comparison of potential new sites with the most similar existing business locations.
D. **Regression Modeling:** capturing the key site factors in a quantitative model which provides a direct prediction of financial results associated with a specific location. These site-based numeric results can be then compared for a series of locations, thus providing a basis for comparison and selection.
E. **Location-Allocation:** use of models that directly determine both facility locations and the service zones associated with the entire set of facilities.

The approaches mentioned here are diverse in nature, but there is one key element that all share: the role played by *sound judgment*. Care needs to be exhibited in choices involved with each method, and often such care comes from *experience* in addressing a variety of similar problems.

Overview

In this way, the field of business geography exhibits what to some might be some unexpected nuance:

- The field has a solid base in **science** that relates to the collection of *objective evidence* and the performance of the range of well-defined preliminary analyses that this handbook addresses.
- This being said, there is also an element of **art** in business geography that goes beyond the objective results to be gained from market and site analyses and moves into an area where the business geographer's role is not only defined by established equations and GIS methods, but includes the benefit of experience.

A skillful business geographer brings *both* to bear on every problem they address. Indeed, Aversa et al. (2018) found experience to be as important as any other asset in their research on corporate location decisions.

At this point, a student interested in perhaps becoming a business geographer might sense a problem: the science side might not be easy to pick up, but it can be done through attentive study and hard work on well-defined subjects like GIS. But the art side: how do you become proficient at assessing a situation and coming to a judgment when you have no experience? There is only one good solution: find a mentor with experience, and spend time with them. The best kind of time to spend with such a mentor is a mix of two kinds of experience: (1) time in informal conversation, listening to them talking about the work they have done, and (2) time out in the field, seeing stores, retail complexes, markets, and cities with them. If you can gain such a mentor, you will be on a solid path to gaining the base level of insight you will need to enter the field successfully.

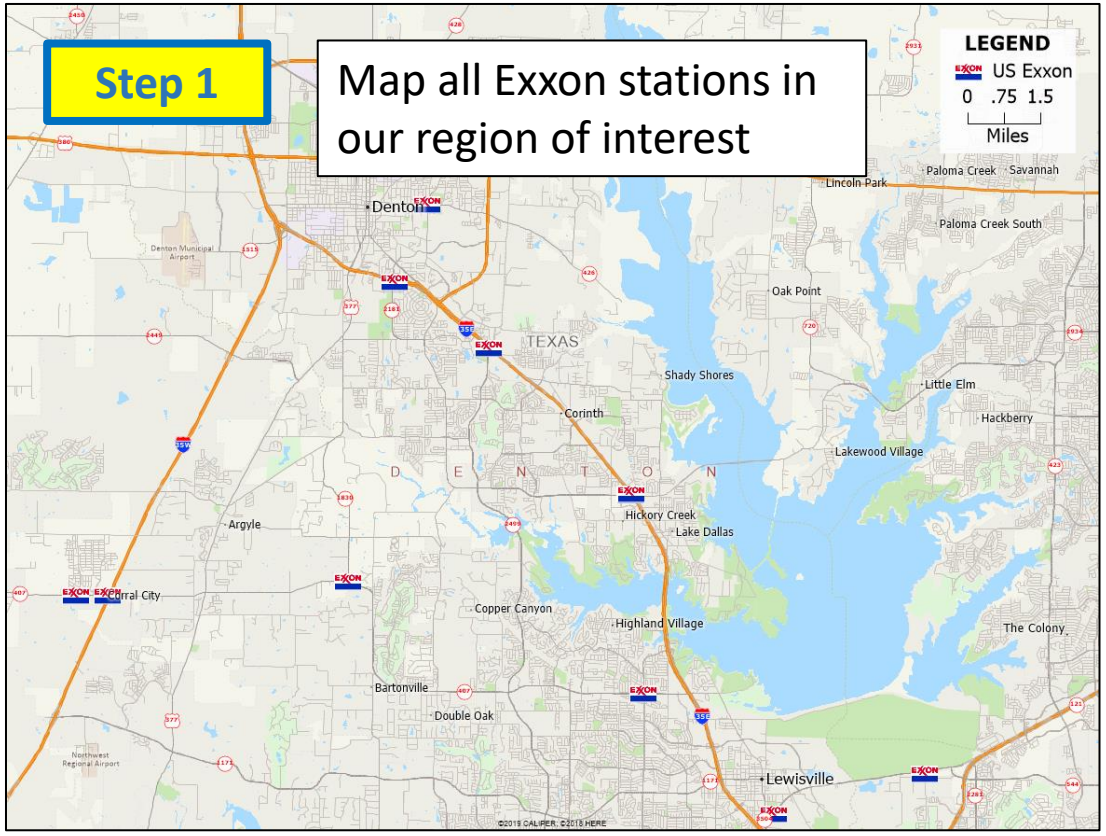
This book can't help you with the art side (much), but there are specifics to discuss on the approaches already mentioned. The following provides some basic ideas relating the strengths of the analytical applications of each approach.

A. Rules of Thumb

- Formulation of a simple rule (or rules) that can be equated with business success (Jones and Simmons 1993)

Example: a business has identified that its locations close to both an Exxon station and a McDonald's are superior sales performers. The business would like to identify further locations with this business mix for expansion.

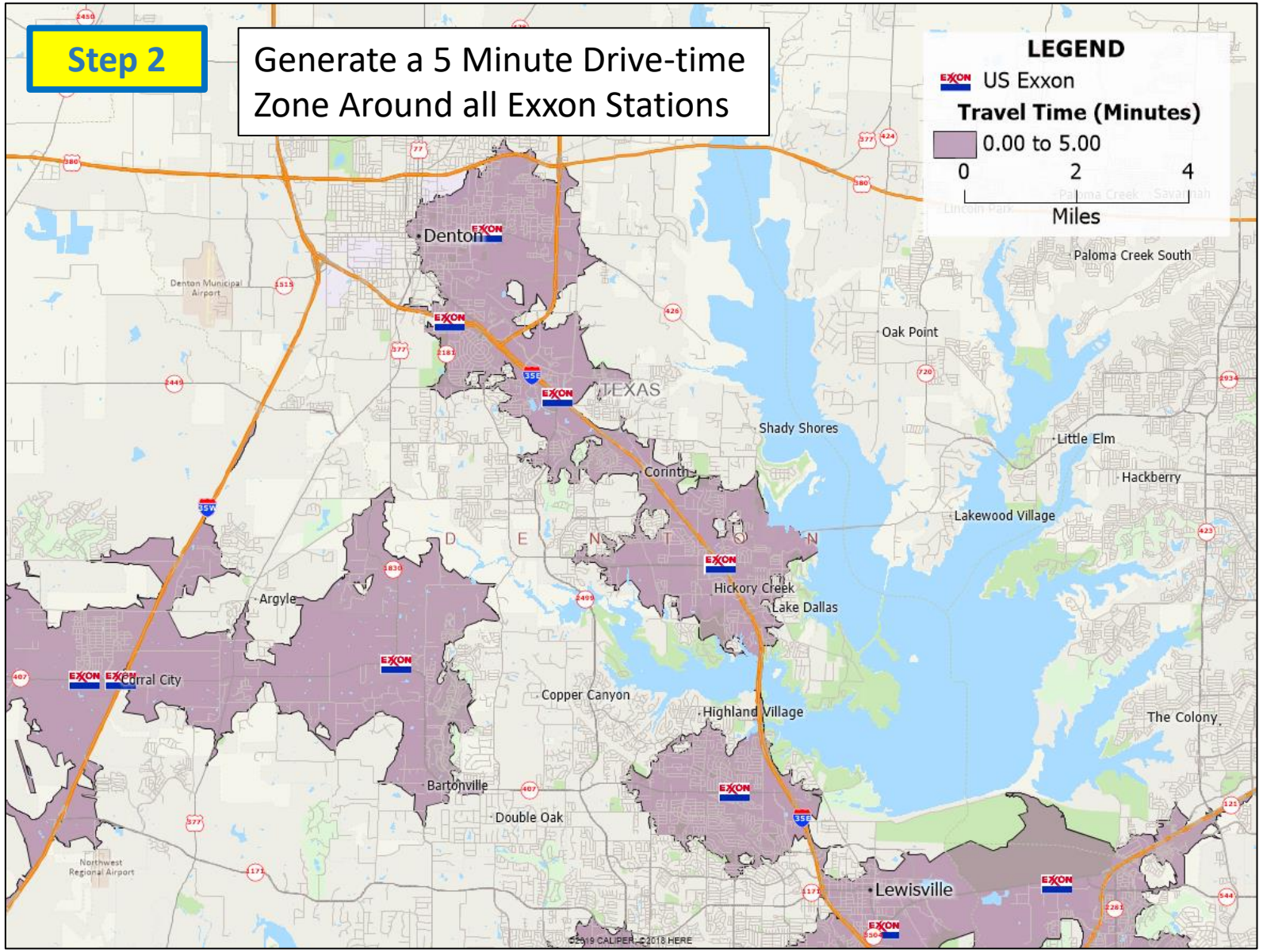
Sample GIS Response: Identify locations where there is an Exxon and a McDonald's within a half mile of each other



Maptitude

Detailed Discussion

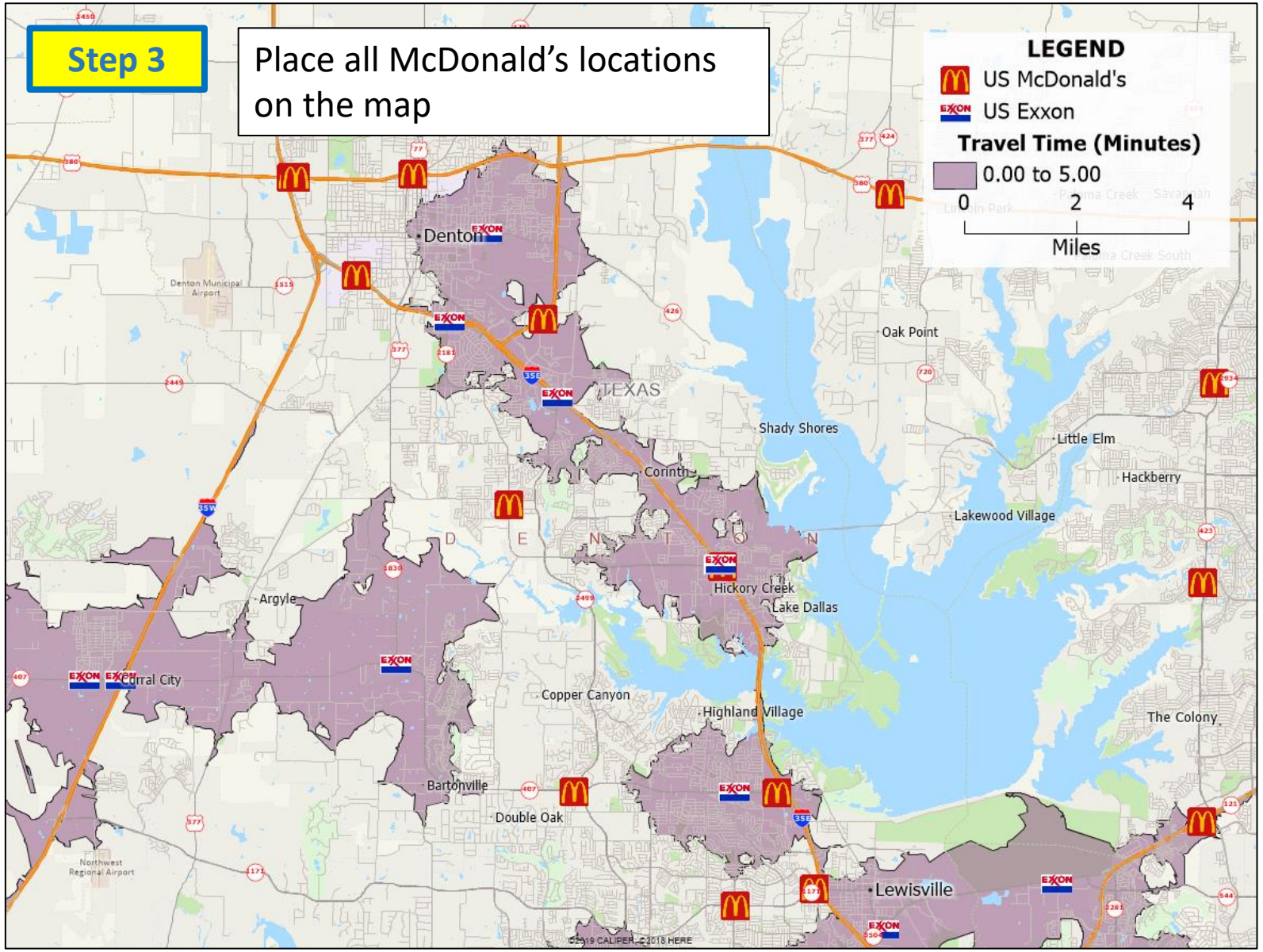
The 5 minute zone figure in this case is the result of a judgment call. If the business has any reason to use a different zone size, they should do it.



Maptitude

Detailed Discussion

We now have all of the elements on the map that we need to achieve our ultimate purpose

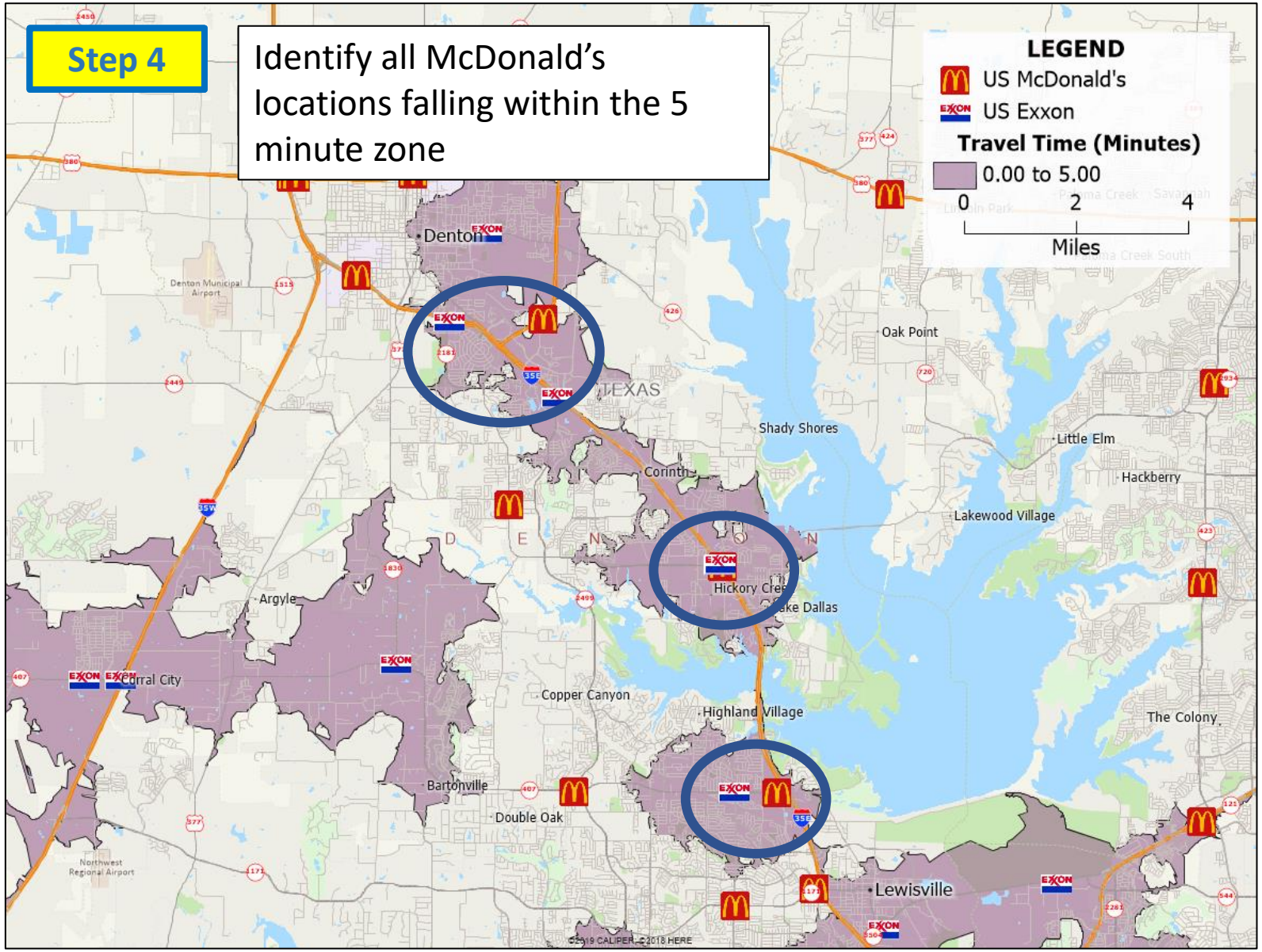


Maptitude

Detailed Discussion

With the map complete, all that remains is to identify the locations that meet the given rule of thumb

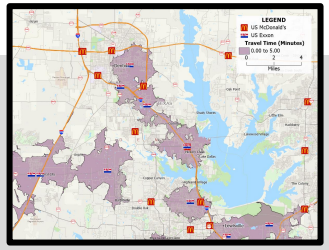
In this case, this simple rule of thumb-based analysis revealed <u>three potential location options</u> for the business to consider in Denton County



Maptitude

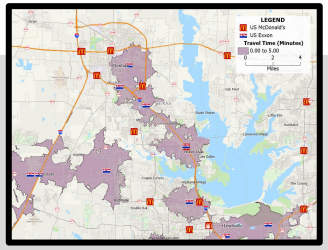
Resources and Processes to Support Rule of Thumb Decisions

In Caliper Maptitude:



Rule of Thumb Decisions…	
Supported by Maptitude	Yes
Starting the Analysis: A Combined Approach	**Geocoding (to locate each customer record on a map) – pages 13 to 20** • Result: customer records can be mapped **Buffers/drive-time (define the market area connected to each location) – pages 23 to 35** • Result: identify customers living in an area
More guidance from Caliper	See individual video tutorials for the two methods listed above

In Esri BA Web App:



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B. Ranking

- A simple rating system that assesses locations on a scale for several dimensions (Clarke 1998; Swales 2018)

For example:

Assessing locations for a new bank in Cedar Park, TX

Dimension	Scale
Mean Household Income	0 (low) to 10 (high)
Median Age of Homes in Area	0 (pre-1920s) to 10 (post-2010)
Mean Retirement Account Balance	0 (low) to 10 (high)
Level of Competition	0 (low) to 10 (high)
Total Score	**0 (least suitable) to 40 (most suitable)**

Detailed Discussion

- The basic idea here is to complete one sub-analysis for each dimension identified. In the case of this example,
  - Four dimensions lead to four maps of the city with the potential bank locations identified
  - Aim of each map: harvest scores from the local zone around each potential location
  - When all four maps are complete, create a composite map that combines the scores for all four dimensions

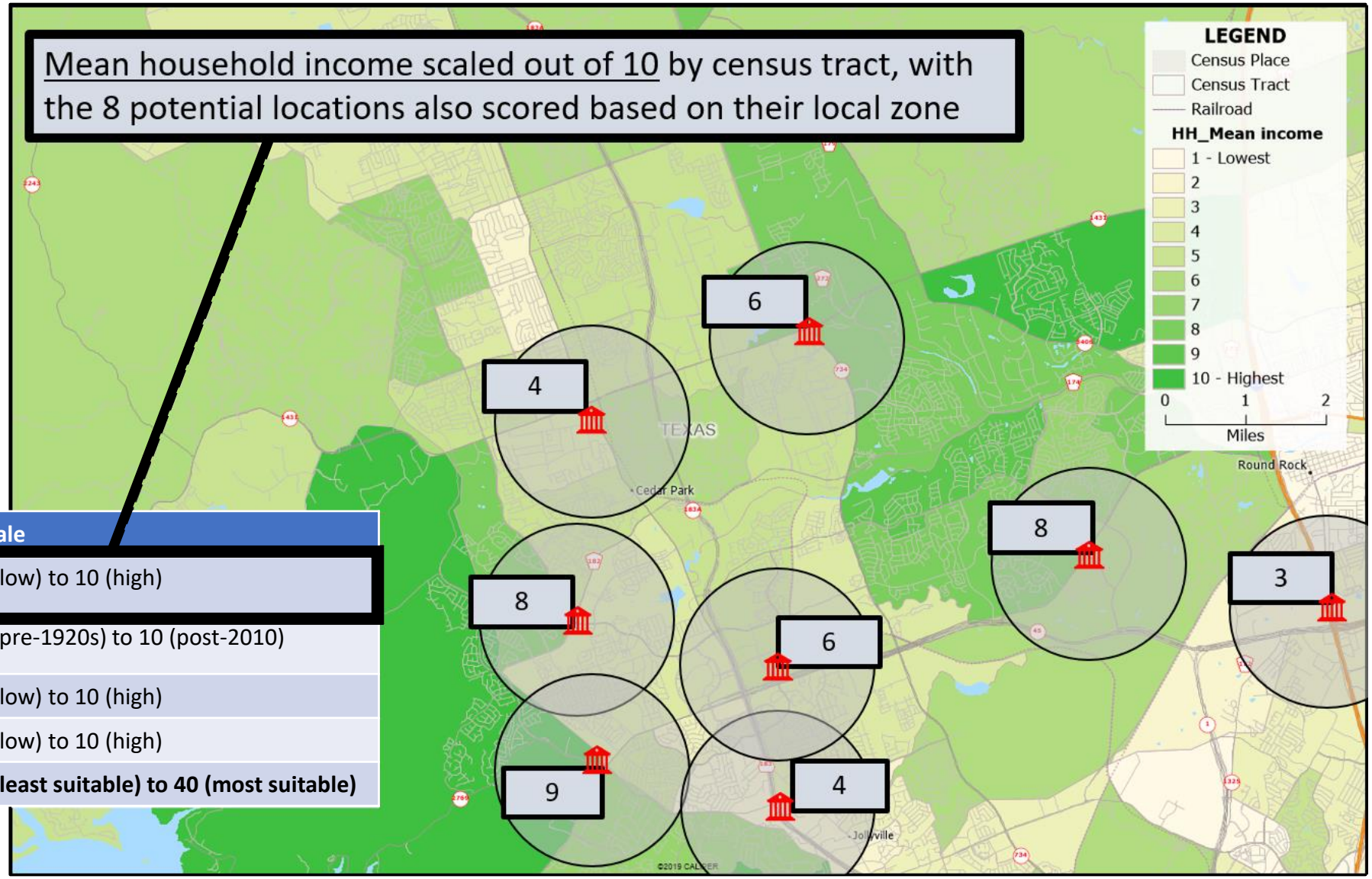
Dimension	Scale
Mean Household Income	0 (low) to 10 (high)
Median Age of Homes in Area	0 (pre-1920s) to 10 (post-2010)
Mean Retirement Account Balance	0 (low) to 10 (high)
Level of Competition	0 (low) to 10 (high)
Total Score	**0 (least suitable) to 40 (most suitable)**

Detailed Discussion

1

The first map in the four-part series represents the variation of household incomes.

The analysis extracts income scores from the zone around each potential bank location (in this case, using a buffer).



Dimension	Scale
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Median Age of Homes in Area	0 (pre-1920s) to 10 (post-2010)
Mean Retirement Account Balance	0 (low) to 10 (high)
Level of Competition	0 (low) to 10 (high)
Total Score	**0 (least suitable) to 40 (most suitable)**

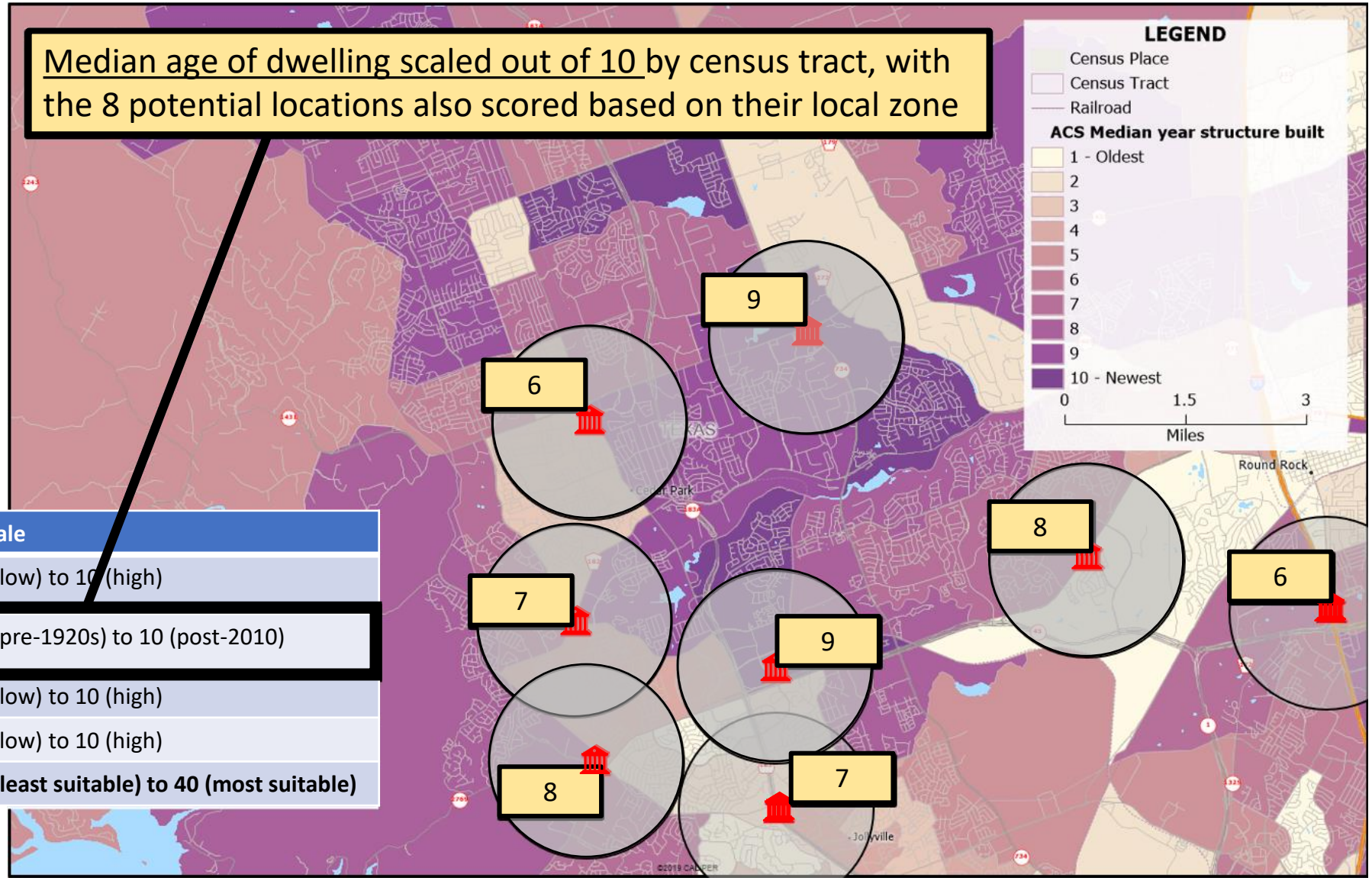
Maptitude

Detailed Discussion

2

Similarly, the second map represents dwelling age, and extracts scores again for each potential location.

This continues until we are ready to produce the composite map…



Dimension	Scale
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Total Score	**0 (least suitable) to 40 (most suitable)**

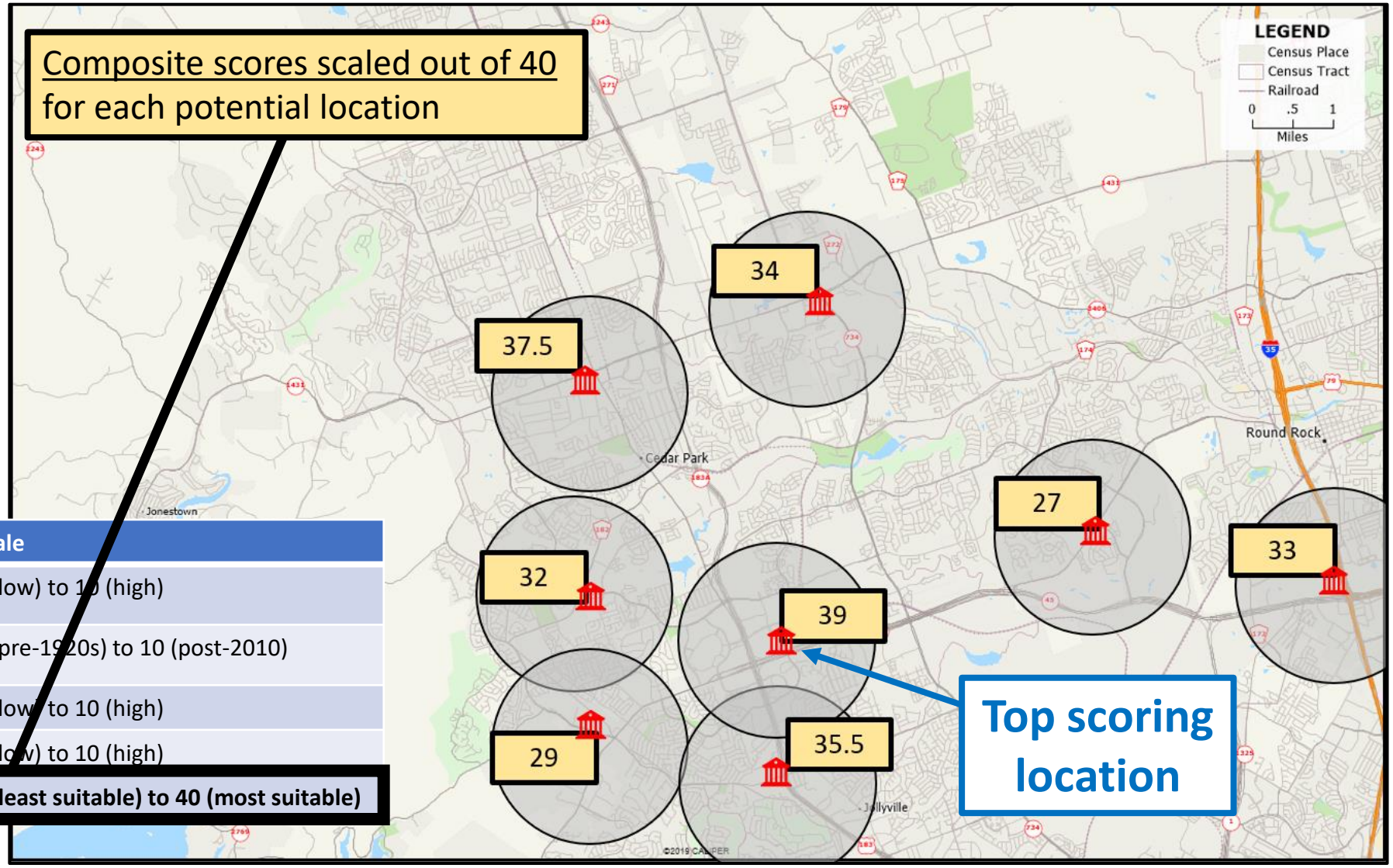
Maptitude

Detailed Discussion

3

Skipping maps 3 and 4 here (retirement accounts and competition), we end with the final, composite score map.

This map leads us to our ultimate analytical conclusion: the composite site score.



Dimension	Scale
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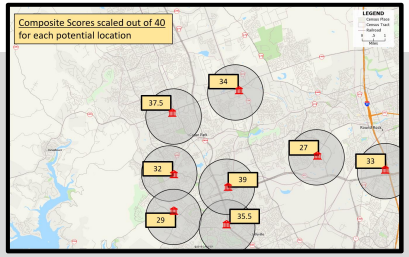
Maptitude

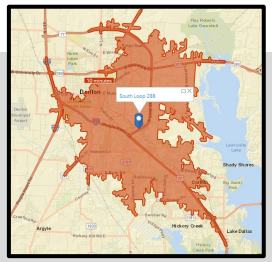
Resources and Processes to Support Site Ranking

In Caliper Maptitude:



Site Ranking…	
Supported by Maptitude	Yes
Starting the Analysis: A Combined Approach	**Choropleth mapping – pages 21 to 30** • Result: evidence base, each dimension **Buffers/drive-time zones – pages 23 to 35** • Result: identify customers in a specific area **Overlays – page 110** • Result: total customer data for each area
More guidance from Caliper	See individual video tutorials for the methods listed above

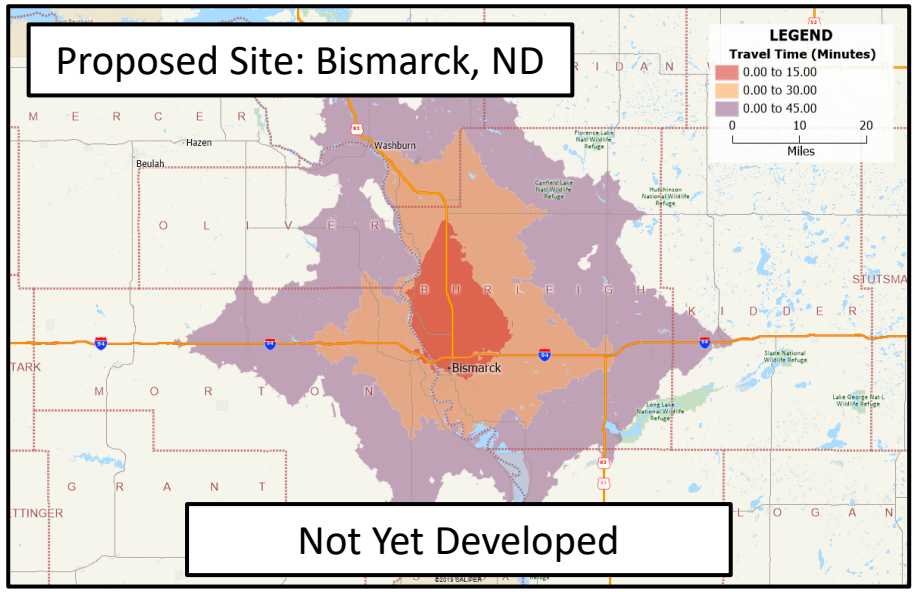
In Esri BA Web App:



Site Ranking…	
Supported by BA Web App	Partially
Starting the Analysis	**Choropleth mapping – pages 21 to 30** • Result: evidence base, each dimension **Buffers/drive-time zones – pages 23 to 35** • Result: identify customers in a specific area
More guidance from Esri	See individual help sections for the methods listed above

C. Analogs

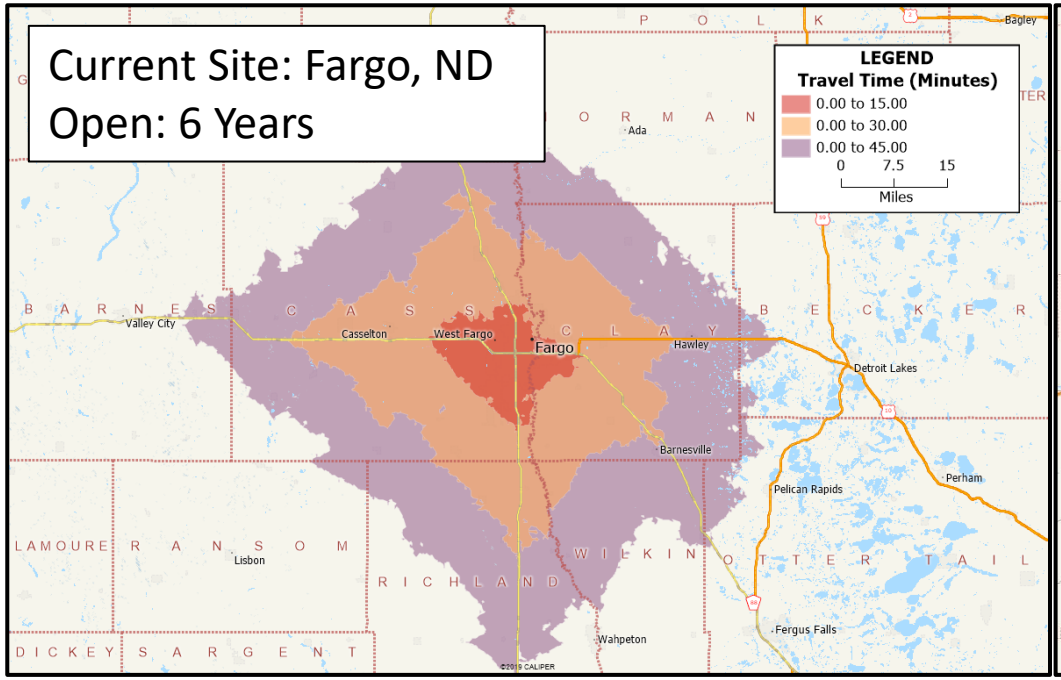
- Use of massive datasets to provide a foundation for comparison between potential new business sites under consideration for development and existing sites that have an established track record with the business (Buckner 1982; Ghosh and McLafferty 1987; Clarke 1998)
- **The central idea:** a new site that is similar to an existing business location can be expected to perform financially in a similar manner to the track record established by the current site

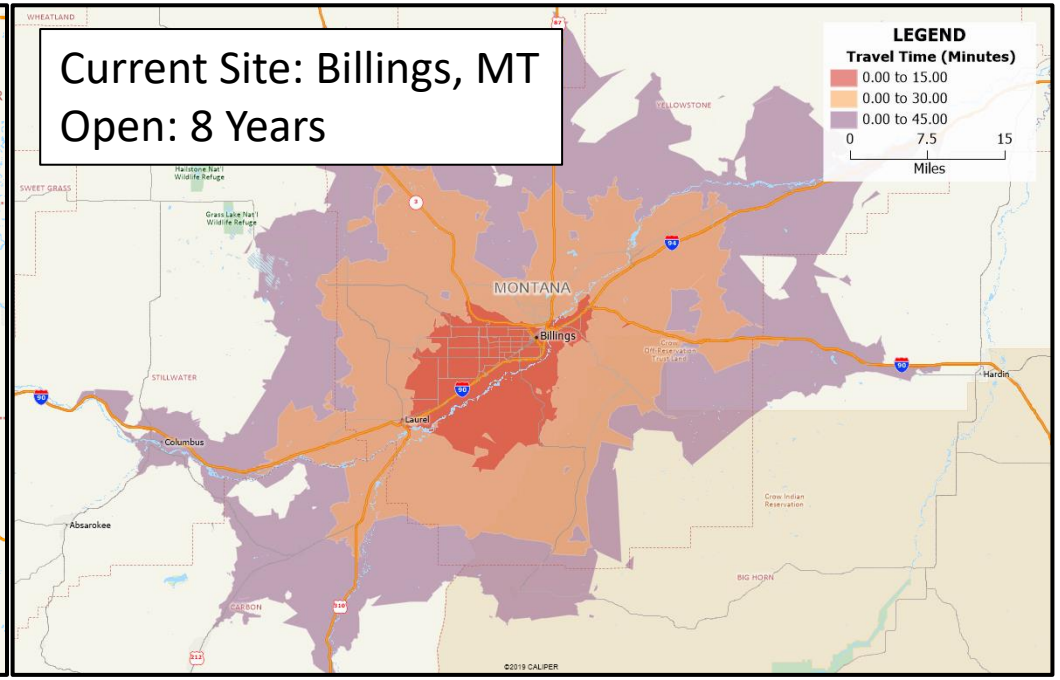


Maptitude

Detailed Discussion

- The key here is ability to identify existing sites that are highly similar to each new location under consideration.



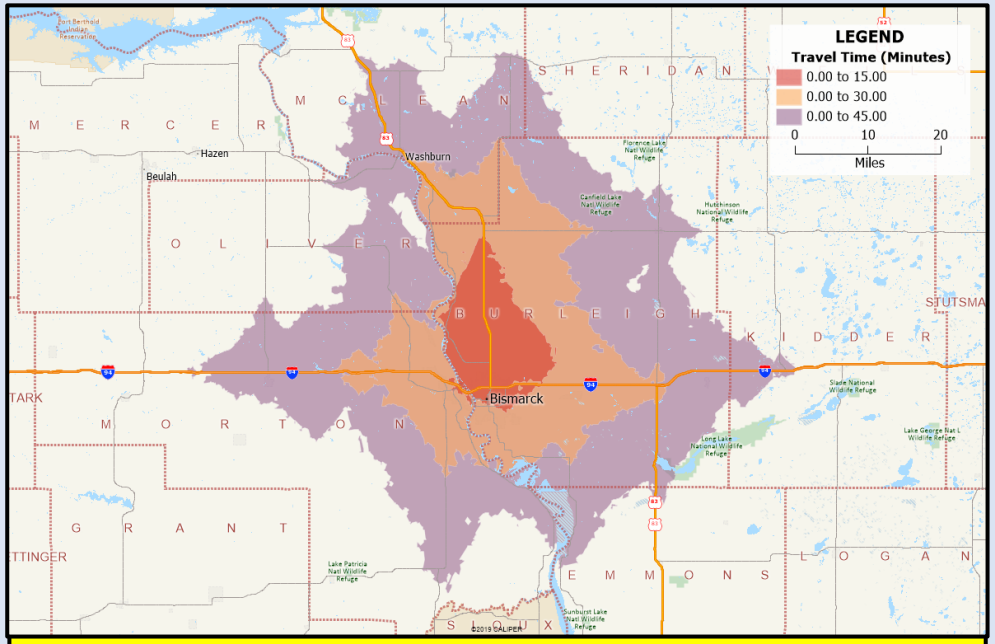


Maptitude

Example:

Step 1

Assemble demographic and financial statistics for a proposed new store and market (in this case, a potential new retail location in Bismarck, ND)



Proposed Site: Bismarck, ND

Maptitude

Drive-Time Rings Report

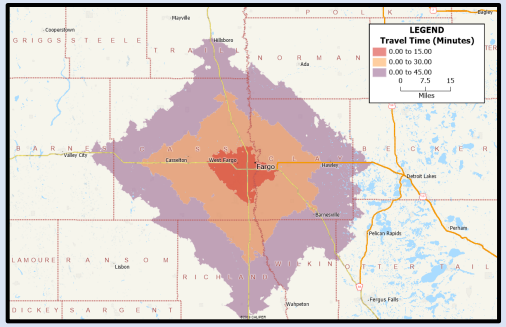
Attribute	0 To 15 Min	0 To 30 Min	0 To 45 Min
Drive-Time Rings:2.ID	1	2	3
Estimated Median HH_Income	$69,271	$69,234	$69,478
Estimated % Change in Median HH_Income	1.50%	2.63%	2.81%
Average HH_Income	$83,699	$86,338	$8[illegible],655
% Change in Average HH_Income	0.31%	1.94%	2.[illegible]0%
HH_Income <$[illegible]K	1,407	2,392	2,[illegible]52
HH_Income $10[illegible]-14,999	953	1,727	1,[illegible]24
HH_Income $15[illegible]-24,999	2,482	3,830	[illegible],042
HH_Income $25[illegible]-34,999	2,654	3,881	[illegible],092
HH_Income $35K-[illegible],999	4,027	6,395	[illegible]6,700
HH_Income $50K-74[illegible]99	5,124	8,557	9,115
HH_Income $75K-99,99[illegible]	4,229	7,202	7,667
HH_Income $100K-149[illegible]99	5,279	8,699	9,296
HH_Income $150K-19[illegible]999	1,766	2,[illegible]	3,160
[illegible]	1,715	2,694	2,860
[illegible]	68,896	113,321	120,461
[illegible]	2.99%	2.28%	2.11%

Mix of <u>demographic</u> (demand) and <u>competitive</u> (supply) variables need to be included here

Detailed Discussion

Step 2

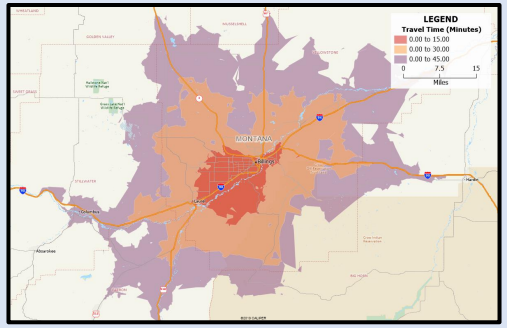
Assemble demographic and financial profile statistics for current stores and markets (in this case: showing Fargo, ND and Billings, MT)



Current Site: Fargo, ND

Drive-Time Rings Report

Attribute	0 To 15 Min	0 To 30 Min	0 To 45 Min
Drive-Time Rings.ID	1	2	3
Estimated Median HH_Income	$57,439	$59,738	$60,693
Estimated % Change in Median HH_Income	2.31%	2.80%	3.14%
Average HH_Income	$75,804	$77,449	$78,027
% Change in Average HH_Income	4.40%	4.21%	4.21%
HH_Income <$10K	3,820	4,921	5,125
HH_Income $10K-14,999	3,350	4,373	4,618
HH_Income $15K-24,999	7,302	8,812	9,338
HH_Income $25K-34,999	7,448	9,049	9,635
HH_Income $35K-49,999	9,640	12,214	13,158
HH_Income $50K-74,999	13,001	16,948	18,500
HH_Income $75K-99,999	10,158	13,060	14,378
HH_Income $100K-149,999	9,051	12,706	14,186
HH_Income $150K-199,999	2,897	4,086	4,535
HH_Income $200K+	3,685	4,789	5,136
Population	166,321	218,368	237,849
% Change in Population	2.43%	2.45%	2.32%



Current Site: Billings, MT

Drive-Time Rings Report

Attribute	0 To 15 Min	0 To 30 Min	0 To 45 Min
Drive-Time Rings:1.ID	1	2	3
Estimated Median HH_Income	$54,470	$58,286	$59,192
Estimated % Change in Median HH_Income	5.47%	5.26%	5.34%
Average HH_Income	$72,316	$76,581	$77,680
% Change in Average HH_Income	5.01%	5.41%	5.39%
HH_Income < $10K	2,534	3,158	3,309
HH_Income $10K-14,999	1,853	2,503	2,622
HH_Income $15K-24,999	4,693	6,462	6,764
HH_Income $25K-34,999	4,153	5,769	6,188
HH_Income $35K-49,999	5,524	8,136	8,669
HH_Income $50K-74,999	8,391	12,381	13,191
HH_Income $75K-99,999	4,637	7,627	8,340
HH_Income $100K-149,999	4,678	7,815	8,654
HH_Income $150K-199,999	1,613	2,794	3,075
HH_Income $200K+	1,725	2,808	3,121
Population	94,273	144,638	156,309
% Change in Population	0.09%	0.85%	0.87%

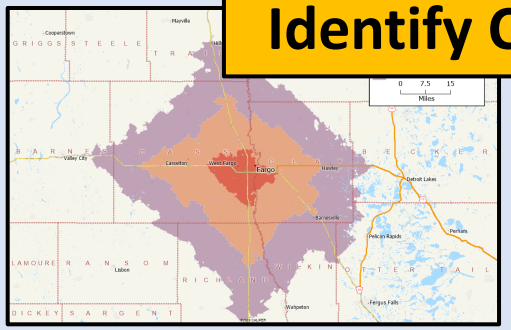
Along with other current operations in the northern plains

Detailed Discussion

Step 3

From these comparative sites, identify the one(s) that represent the closest analog match for the proposed site in question

Identify Closest Match



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Current Site: Billings, MT

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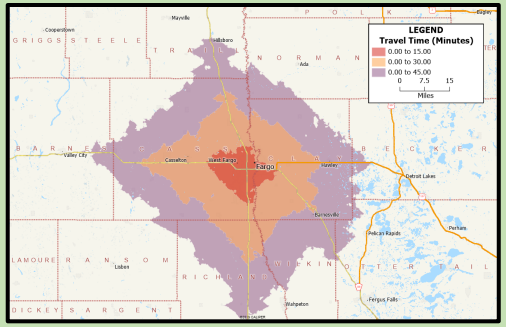
Detailed Discussion

Step 4

With the closest analog matches identified, we can now use the demographic and competitive status of the current location(s) to calculate projections for the proposed site



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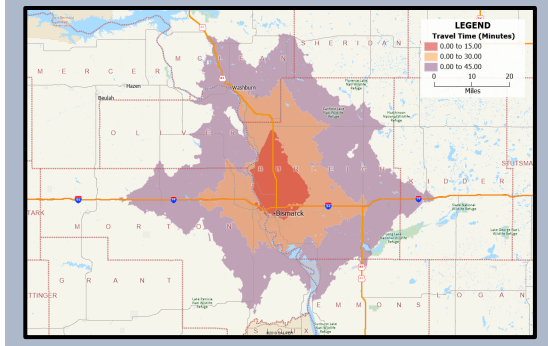
Current Site: Fargo, ND (Open 6 Years)



Drive-Time Rings Report

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HH_Income $50K-74,999	5,124	8,557	9,115
HH_Income $75K-99,999	4,229	7,202	7,667
HH_Income $100K-149,999	5,279	8,699	9,296
HH_Income $150K-199,999	1,766	2,962	3,160
HH_Income $200K+	1,715	2,694	2,860
Population	68,896	113,321	120,461
% Change in Population	2.99%	2.28%	2.11%

Proposed Site: Bismarck, ND

Actual Sales: $148 Million in Year 6

Projected Sales: $136 Million in Year 1

Resources and Processes to Engage in Analog Modeling

In Caliper Maptitude:

Further tools to learn and use to complete an analog model:

Buffer and/or Drive-time zone calculation tools (see pages 23 to 35 of this handbook)

- Calculate: same zone definition for every current and potential business location
- Key: enable demographic reports for the created buffers/zones so you have a comprehensive roster of demographic and financial figures for comparison (Maptitude has a standard report format produced in conjunction with zone creation, but you need to take an extra step after creating your zones to access this); Maptitude also offers access to separate business databases for the necessary competitive figures to complete the analog analysis)

In Esri BA Web App:

Further tools to learn and use to complete an analog model:

Rings or Drive-time zone dialogues (again, see pages 23 to 35 of this handbook)

- Calculate: same zone definition for every current and potential business location
- Key: once rings/drive-times are determined, go to the separate reports dialogue and select from a wide range of demographic and competitive reports available for creation and comparison (the specialized datasets available here are a strong feature of BA Web)

D. Regression Modeling

- Placing the key site factors in a quantitative model which provides a direct prediction of financial results associated with a specific site (Taylor 2015)

For example: regression modeling for a restaurant chain

Step 1 Identify variables for analysis

Again, a mix of <u>demographic</u> (demand) and <u>competitive</u> (supply) variables need to be included here

Site-Specific Sales Model: Variables Included
Apartments % within 0.5 Miles
Pedestrians % of Customers
Competitive Restaurants Within 1.0 Miles
Office Workers Within 1000 Feet
Modeled Sales at a Particular Site

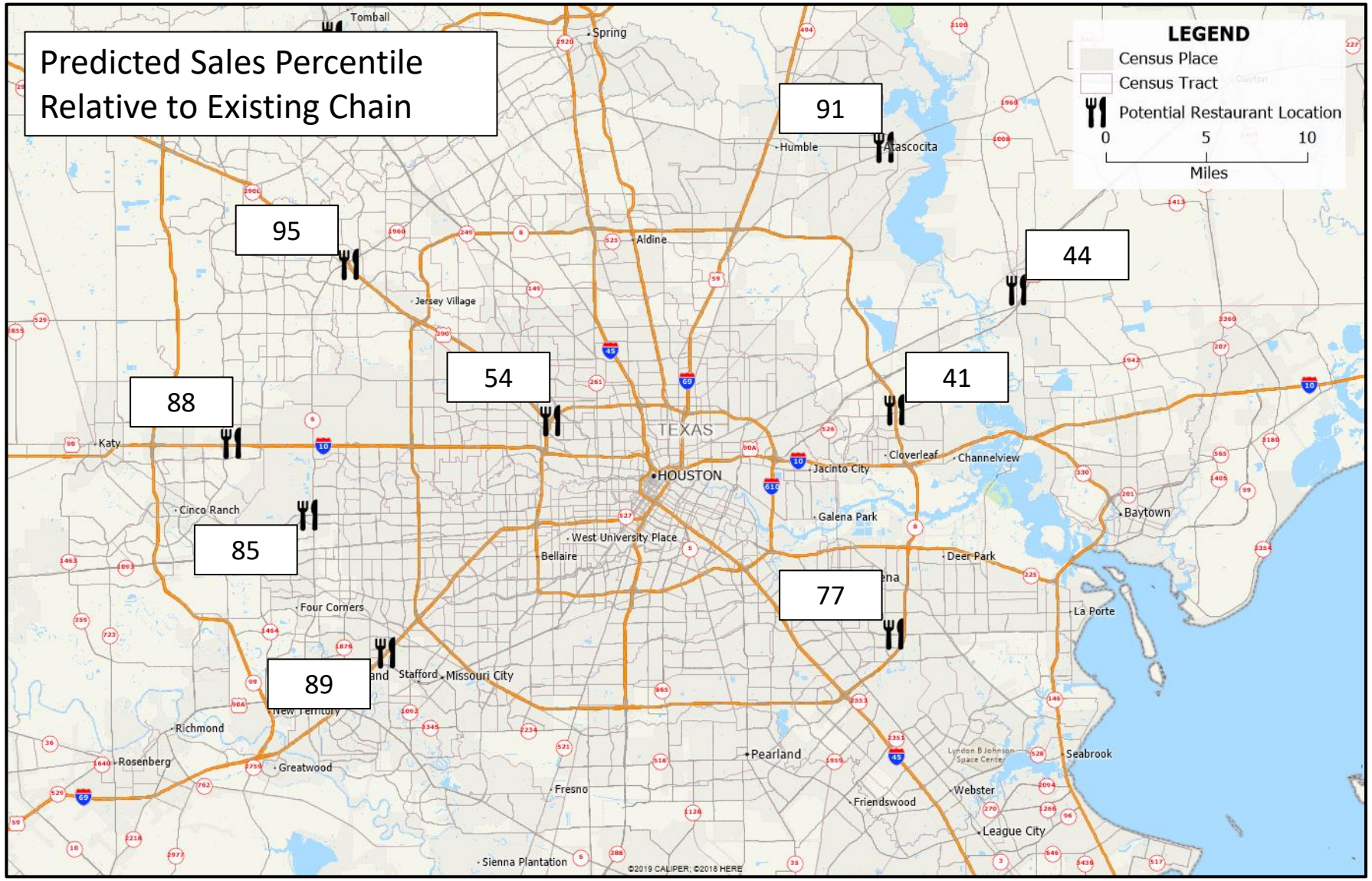
Detailed Discussion

Step 2

Build and apply the regression model.*

Step 3

At the end, use the model to generate a predicted sales value (in this case, relative to the entire chain)



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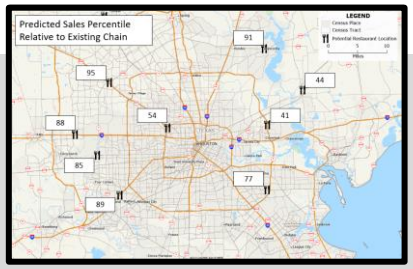
* Please consult any of a wide range of multivariate analysis reference resources. The construction of regression models goes well beyond the scope of this handbook.

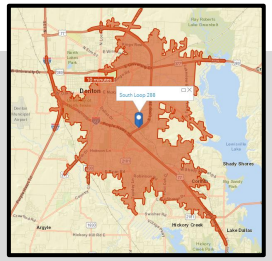
Resources and Processes to Support Regression Modeling

In Caliper Maptitude:



Regression Modeling…	
Supported by Maptitude	Yes
Starting the Analysis: A Combined Approach	Dataview > Statistics > Model Estimation… • Result: calculates a model that can be used for a regression approach to site selection Dataview > Statistics > Model Evaluation • Result: evaluates the quality of the model you have generated
More guidance from Caliper	See Maptitude help files for the information they provide

In Esri BA Web App:



Regression Modeling…	
Supported by BA Web App	No
Starting the Analysis	N/A
More guidance from Esri	N/A

E. Location-Allocation Modeling

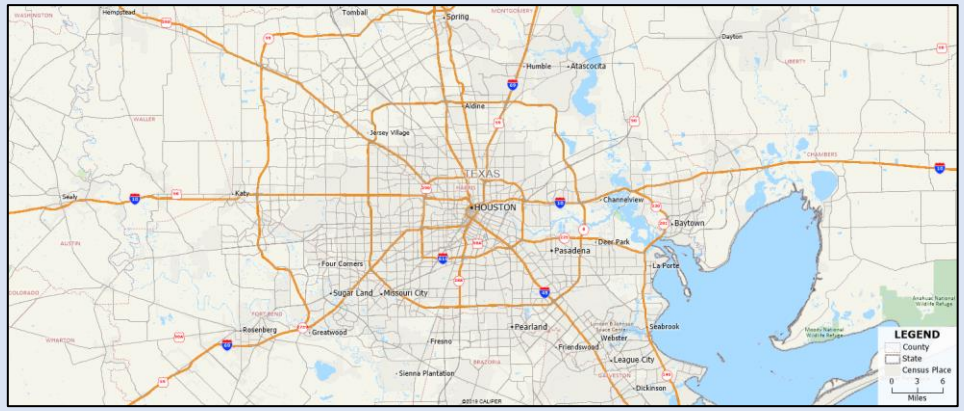
- Use of models that directly determine both facility locations and the service zones associated with the entire set of facilities (Ghosh and Rushton 1987; Church and Murray 2009)
- This is a powerful location modeling environment, but it is most applicable when a business has an entire network of facilities to locate across an extended region
- **Example:** a retail chain decides to enter a large metropolitan region with 38 stores, where previously the chain had no presence whatsoever

Business Scenario

This Year: 0 QuikTrip Gas Stations in Houston

In Five Years: 38 QuikTrip Gas Station Locations

But where should the 38 stations go?



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Detailed Discussion

- There are three principal approaches to be aware of in solving the basic location-allocation problem

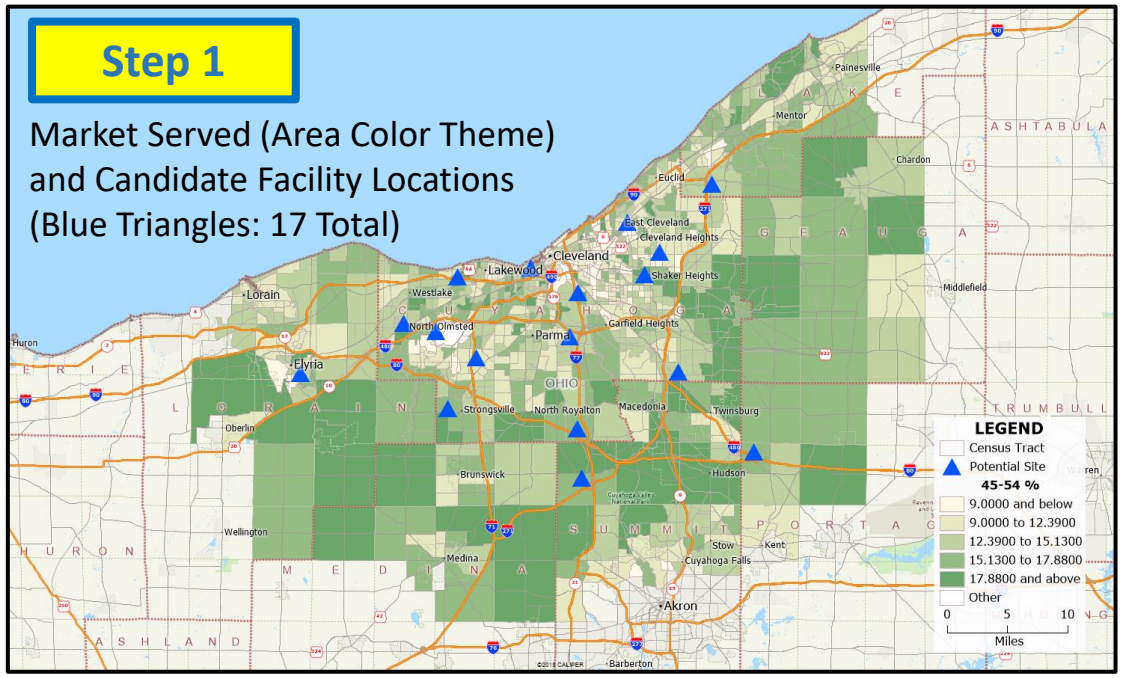
  - **1. P-median problem (PMP):** locate a fixed number (p) of service-providing facilities to provide the most efficient coverage of client demand across a given region
    - **Note:** efficient coverage of all client demand may entail leaving a select few clients with very poor service coverage.
    - **In the Houston QuikTrip example:** management has decided 38 locations is the right number (for whatever reason). Now the location challenge is deciding where the stations ought to be located.

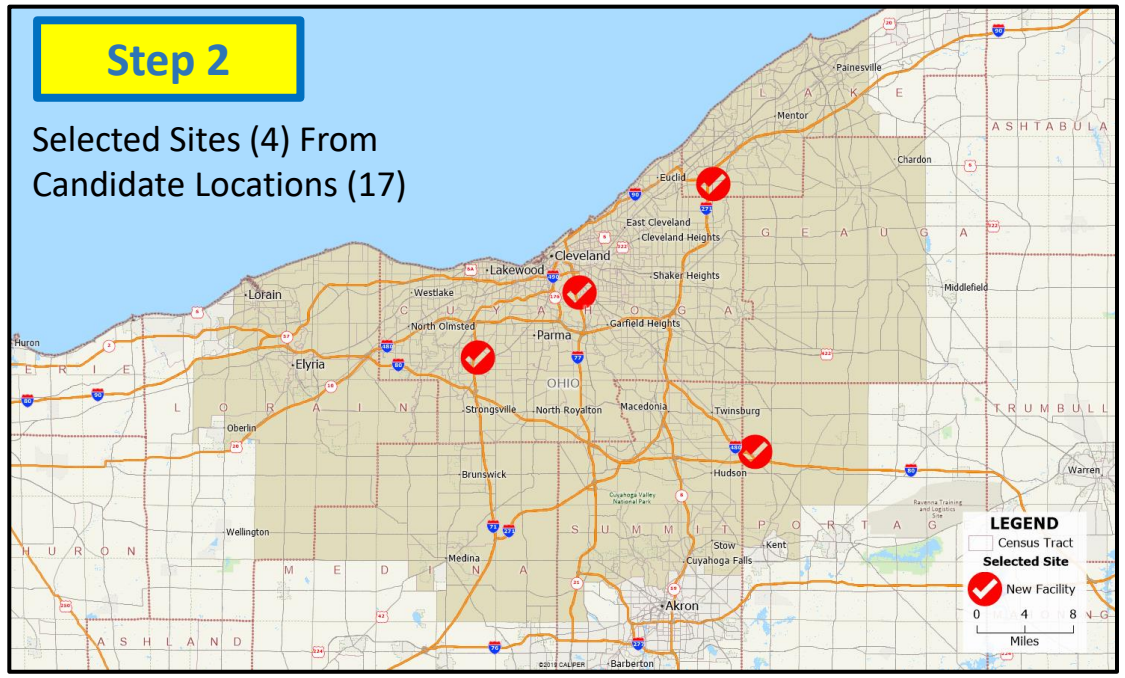
  - **2. Maximal covering location problem (MCLP):** locate a fixed number of facilities to maximize the percentage of clients who are served within a given service coverage standard
    - **What is a "service coverage standard"?** This could be defined as a maximum distance (as many children as possible to be located within 1 mile of a school) or a maximum travel time (as many houses as possible within 4 minutes of a fire station).
    - **Note:** this improves on the PMP, which has no service standard definition at all.
    - **In the Houston QuikTrip example:** still locating 38 gas stations, but the MCLP ensures that there is a relatively even distribution of QuikTrip locations across the region.

  - **3. Set covering location problem (SCLP):** define how many strategically-located facilities are needed to guarantee a given service coverage standard
    - **Note:** this goes a step further than the MCLP, as service coverage standards there are a goal but not a guarantee
    - **In the Houston QuikTrip example:** now the analysis determines the number and location of gas stations

A Complete Example:

- The problem: planning delivery depot locations in the Cleveland area
  - Best location for 4 delivery depots
  - Locations to be chosen out of a total of 17 candidate facilities distributed across the region
  - The target market for deliveries from these depots is well defined by census tract (in this case, the age 45-54 population)
  - Aim: looking for greatest system-wide efficiency, with no minimum service standard being considered





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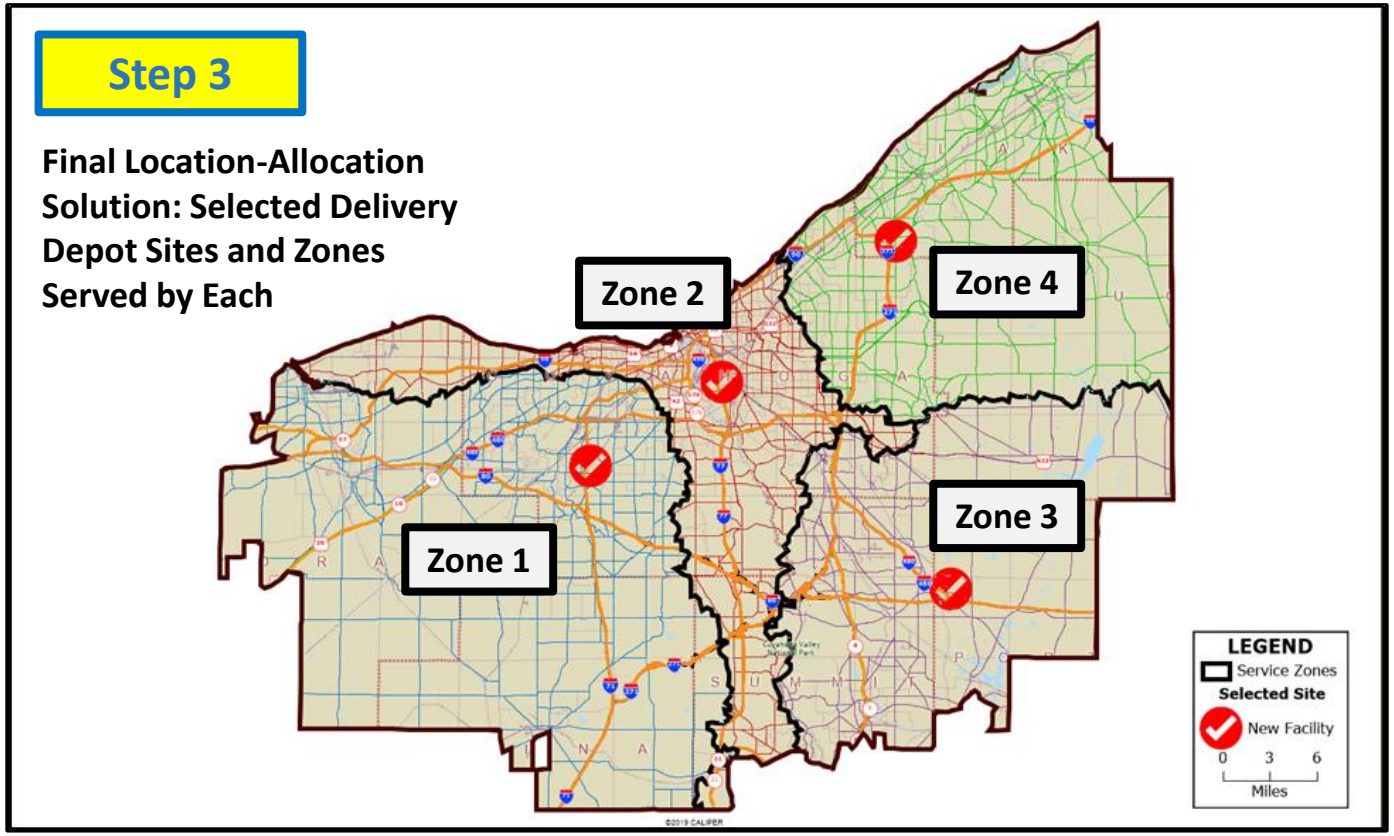
Detailed Discussion

- The complete location-allocation solution includes a definition not only the selected sites, but also of the zones each site serves



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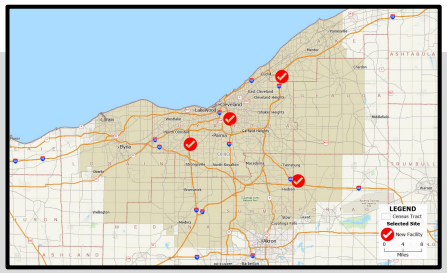
Resources and Processes to Support Location Allocation Modeling

In Caliper Maptitude:



Location Allocation Modeling…	
Supported by Maptitude	Yes
Starting the Analysis: A Combined Approach	Tools > Analysis > Facility Location… **Facility location tool** • Takes a client layer (customers to be served) and a potential site layer (locations to be considered) and selects the most strategic sites to fulfill the business' service goals
More guidance from Caliper	https://www.caliper.com/video/maptitude/maptitude-facility-location-video/maptitude-facility-location-video.html

In Esri BA Web App:

Location Allocation Modeling…	
Supported by BA Web App	No
Starting the Analysis	N/A
More guidance from Esri	N/A

Application 4: Market Area Delimitation & Analysis

Overview of Market Area Delimitation & Analysis

Market area delimitation and analysis gets most directly at the question of understanding the profile of the market served by a facility already sited at a given location (or hypothetically, what the market would look like if the facility were to be sited at a defined location).

To give some insight into the contributions that GIS can make to market area delimitation, the following examines three approaches to the market areas and their GIS implementation (Jones and Simmons 1990; Swales 2018). Put briefly, each can be summarized as:

A. **Spatial Monopoly:** focused purely on defining a zone that can be profiled. No attention paid to potential competitive aspects of the market area.
B. **Market Penetration:** flips the focus to examine the success of a business located in a given place as it competes, neighborhood by neighborhood, with firms in the same business.
C. **Dispersed Markets:** concentrates on the issue of market types, and implicitly assumes that certain market or neighborhood profiles form the core market for the specific business being analyzed.

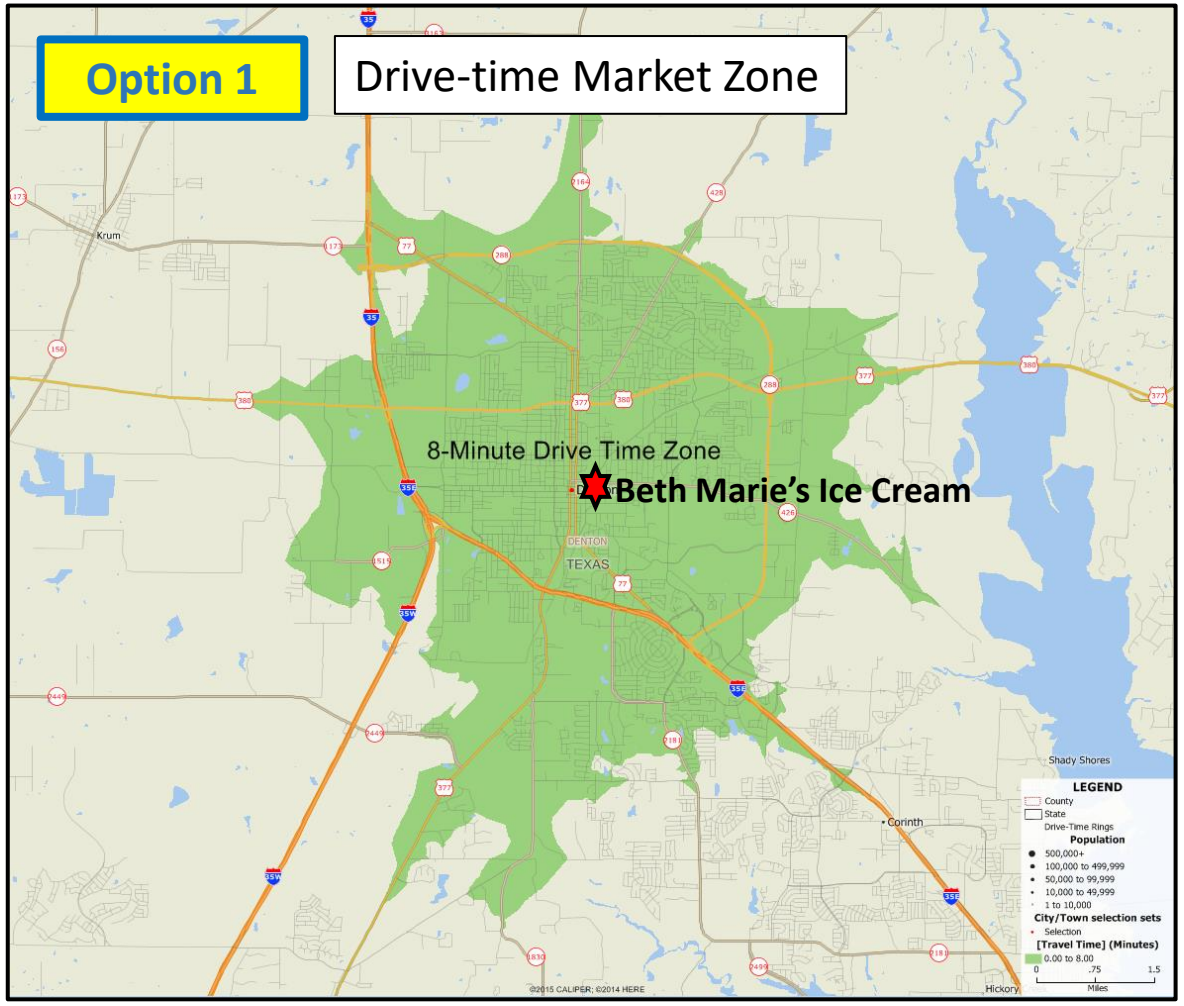
Each approach has its own characteristic strengths and weaknesses. The following provides some basic ideas that relate GIS applications to the analytical needs of each market area approach.

A. Spatial Monopoly

The spatial monopoly approach is to simply define some form of zone around a business and to treat it without any thought given to competition.

In doing this, the emphasis of any further analysis falls on profiling the market present in the zone, not on analysis of competitor strength or numbers.

From a spatial monopoly perspective, use whatever form of zone you can justify. A drive-time zone works well.



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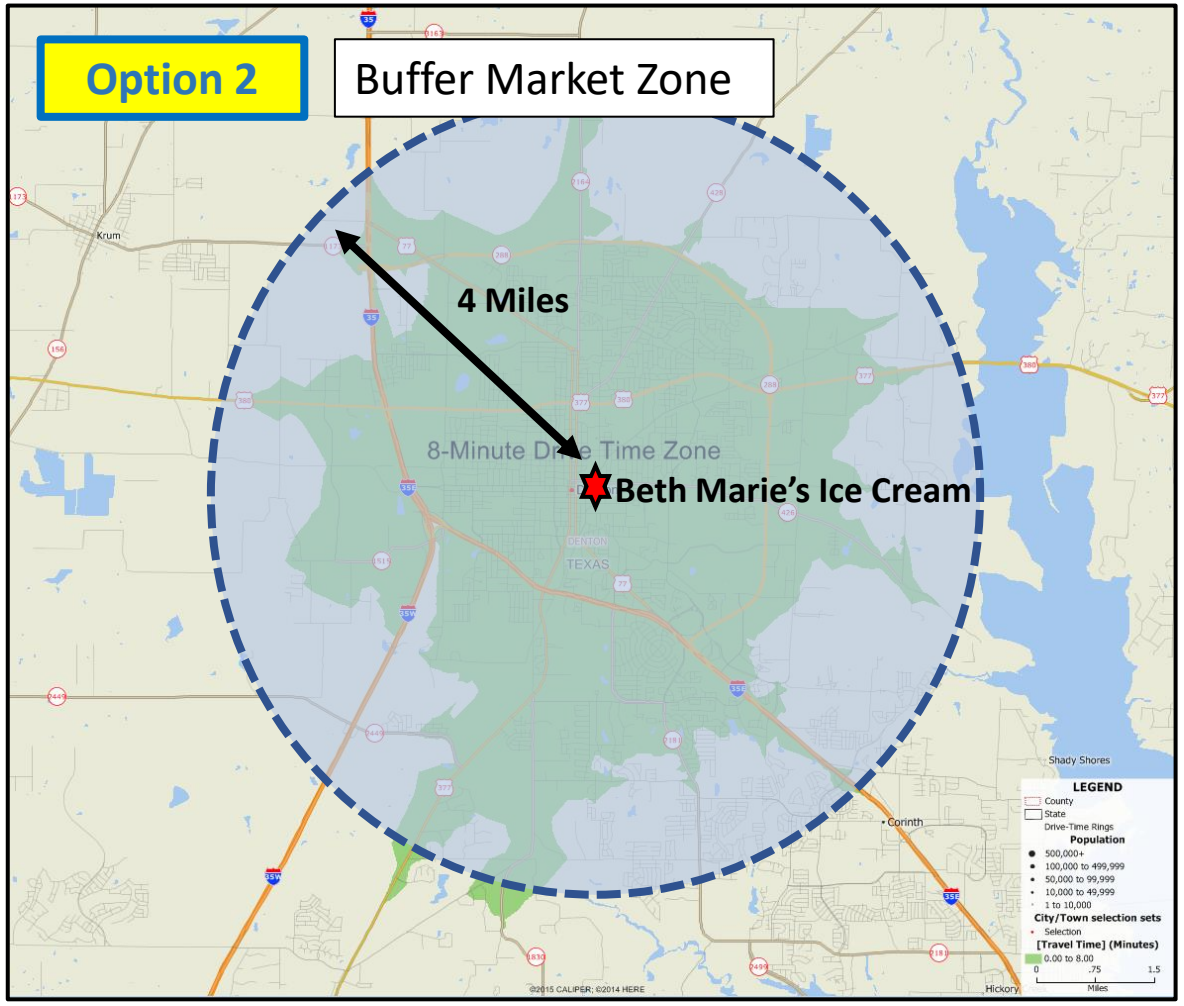
However, a buffer approach also works. The key is to select a market zone definition and then stay with it for any other market research.

See pages 21-30 for previous, related discussion.



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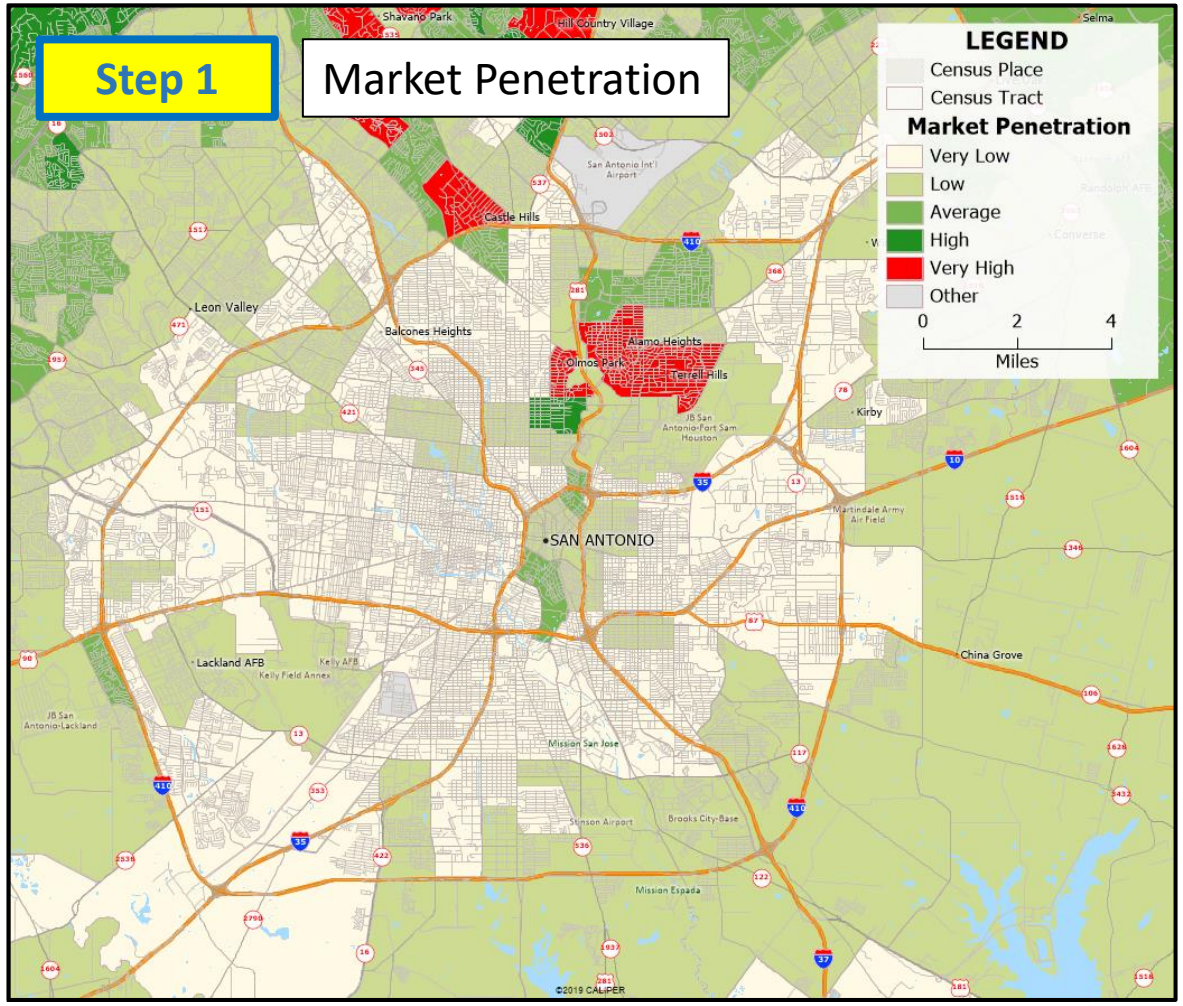
B. Market Penetration

Another approach we would use for different reasons is to define the market area of a business by the census tracts where business has highest market presence.

In this case, we measure market presence by the percentage of households that are customers. In the sample map at right, we might define the market area of the business as the “very high” census tracts that are colored in red.



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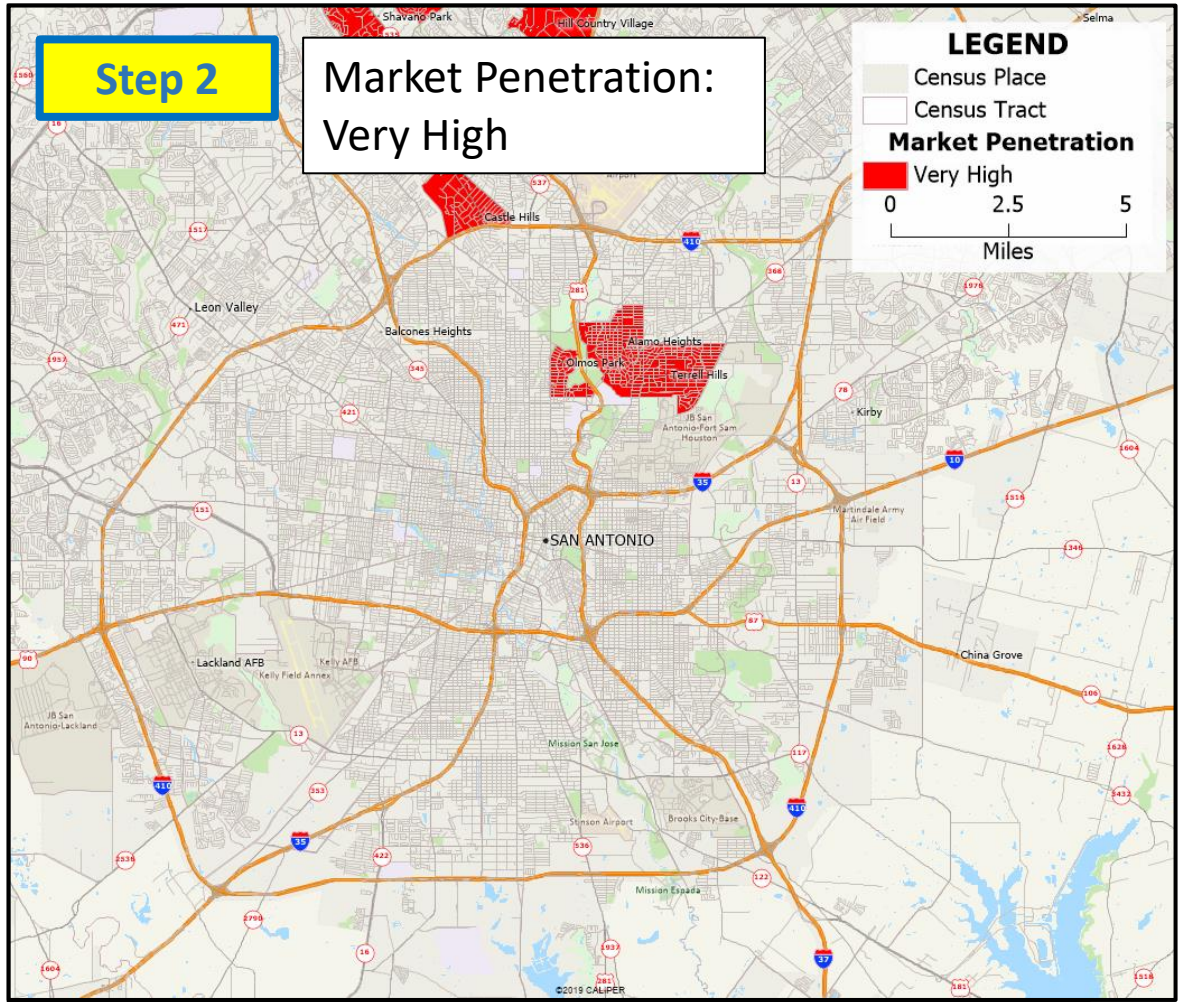
The market penetration approach also can be used to emphasize a market profile objective, but this profiling work comes from a slightly different perspective than the spatial monopoly approach.

Market penetration focuses on the neighborhoods in the region where the business performs the best against the competition (see focused map at right). Thus, a profile of these specific communities yields a picture of the population that might be considered as the business' core market types.



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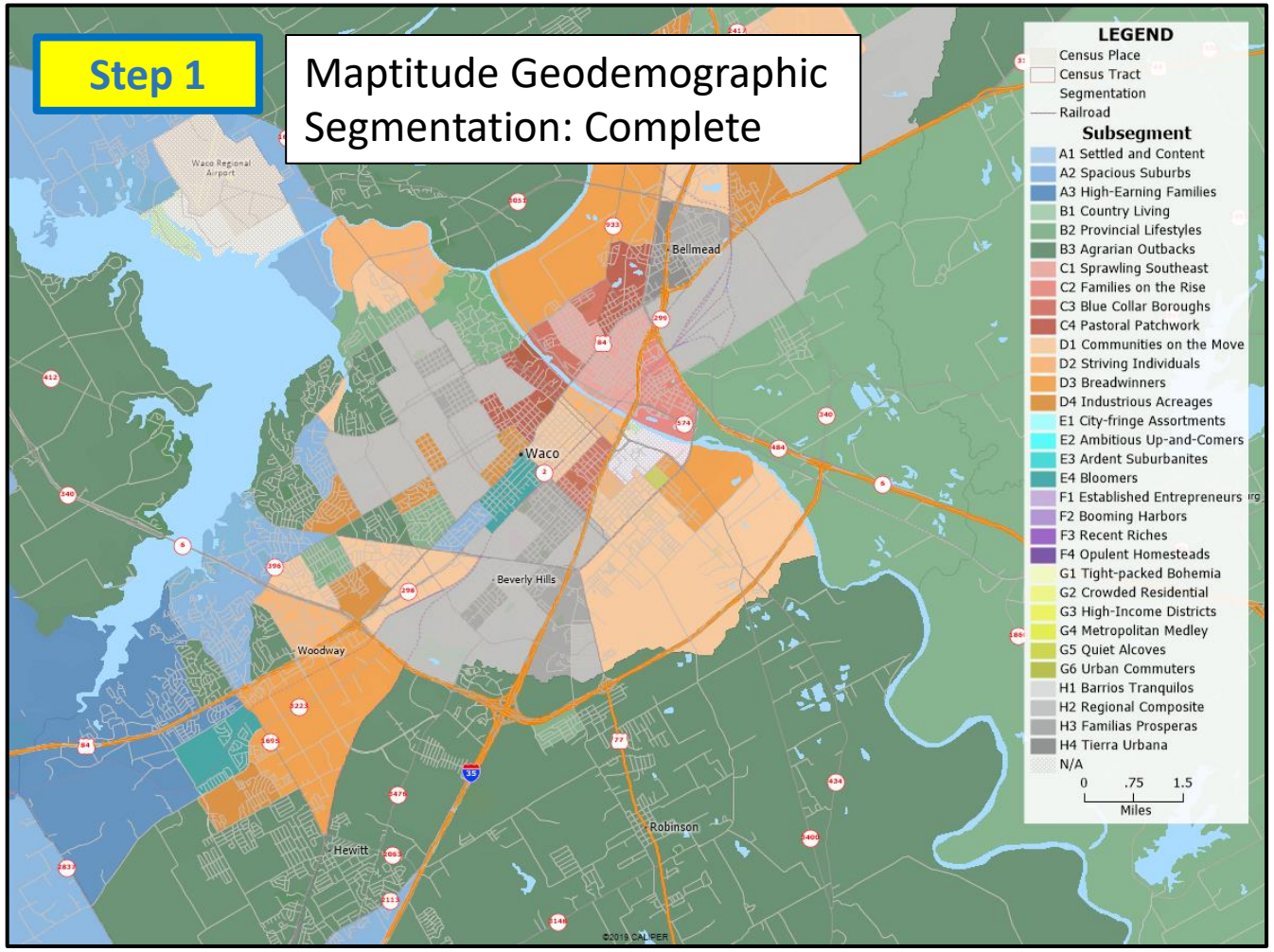
C. Dispersed Markets

The final approach, dispersed markets, focuses on the “market type” theme represented by geodemographic segmentation systems of all types. For example, the map at right provides an illustration of the neighborhood types that are found in Waco, Texas.

Each neighborhood type (or “subsegment”) is represented by a different color on the map, which makes for a complicated and potentially overwhelming map pattern. Some simplification would be helpful.



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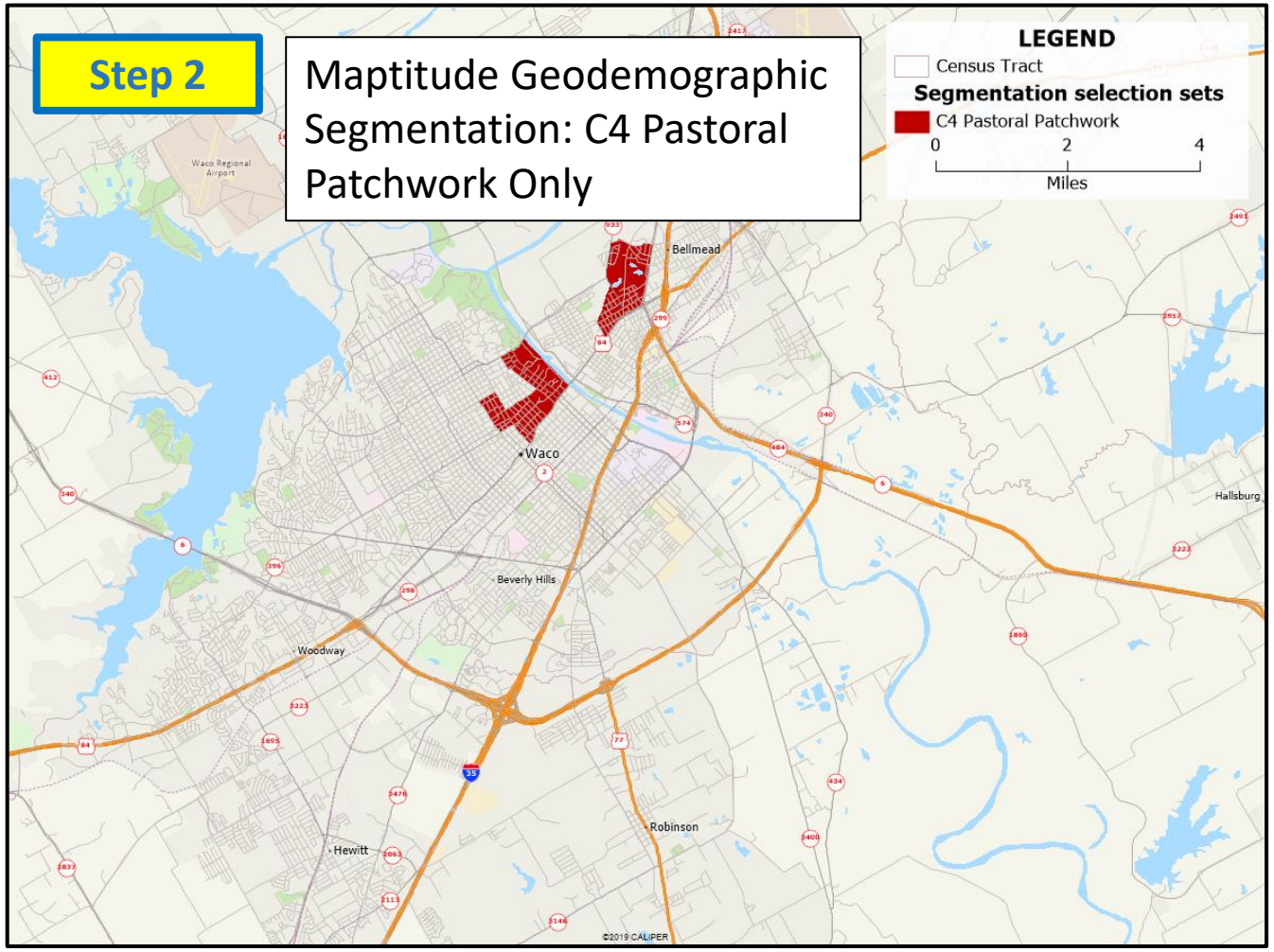
This next map represents one approach to simplification: depiction of a single subsegment, in this case subsegment C4 (Pastoral Patchwork). This format allows for more focus and a clearer representation of map patterns.

If C4 happens to be the primary and best market type for a specific business, this would then be the "dispersed markets" definition of that business' market area in Waco.

See pages 69-79 for previous, related discussion on the subject of geodemographic segmentation.



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A Closing Note

Retail & Business Geography in a New Era

Much of the methodological infrastructure summarized in this handbook was developed in the last half of the 20th Century, a time of great economic growth and prosperity. During this era, retailers in the United States and Canada were following the growth trends and patterns established by the major cities and expanding their own store and logistical networks. Almost all of the activity in the retail sector was centered on expansion.

The focus of the retail sector has changed dramatically since 2000. As of 2020, the need for analytics in support of growth might not be dead, but it is certainly dormant. Traditional brick-and-mortar retailers are faced by fierce competition from the Ecommerce realm, as evidenced by a long list of longstanding retailers already closed or in severe trouble (such as Pier 1 Imports, Radio Shack, Payless Shoes, Sears, JCPenney, Macy's, and countless others). Among other predictions, this has led to many proclaiming the "death of the shopping center" (Sanburn 2017). The economic realities of competition in the Ecommerce era, not to mention simply surviving in the face of the COVID-19 global pandemic, have shifted retail attention to store rationalization.

The methods outlined in this handbook are undoubtedly in need of reshaping and revisioning in consideration of this new era, but the basic thinking behind these technologies remains sound. Geography still matters. The challenge remains for the current and coming generations of retail and business geographers to adapt and create the methodologies needed to guide store closures and, eventually, the potential for renewed but continually evolving retail growth in the eras of business and technological development yet to come.

Appendices

Practical Thoughts on Problem Solving

Many real-world business problems are extremely complex. Between Part B and Appendix B, this book provides methodological recommendations for several specific application and problem types that go beyond a simple, one-step approach. Understanding higher-order (more complex) problems and solutions that involve multiple steps and methodologies is of great value for a business geographer. However, beyond understanding a roster of specific scenarios and application responses, a truly advanced business geographer needs to develop the ability to problem-solve on their own. That is, given a specific, real-world problem, a skilled business geographer should be able to understand the needed result and construct a customized path needed to get to an appropriate solution for that particular situation.

This scenario is analogous to the situation that engineers and data scientists face every day, where each bridge, electronic circuit, and database mining challenge is unique. In this problem-solving dimension it would be fair to assert that the job of the geographer follows the model of engineers and data scientists well. In engineering and data science there are well established problem-solving processes to follow, and these processes have such a broad similarity that we might think of these alternatives as a single process framework. There is value for us to review the broad outlines of what this process looks like here.

There are a number of contexts where what might be termed an “engineering approach to problem-solving” is deployed. Because of this, there are a variety of statements of what a problem solving approach and process in this broad area of practice entails (Sharp 1991; Ullman 2010). Of the spectrum of related statements, one that relates well to the data-focused problem solving done in business geography is the *Cross-Industry Standard Process for Data Mining* , alternatively known as “CRISP-DM” (IBM 2011).

Appendix A: How to Problem-Solve

CRISP-DM is an influential statement of stepwise structure that can be applied to many scenarios where data-oriented problem solving is needed. While a detailed statement of this stepwise structure goes beyond the bounds of this handbook, it is worthwhile to include a brief summary of CRISP-DM's six tasks. Beyond the specifics of the tasks represented, take note of the logical process constructed below: there is a logical progression throughout CRISP-DM that is worthy of emulation.

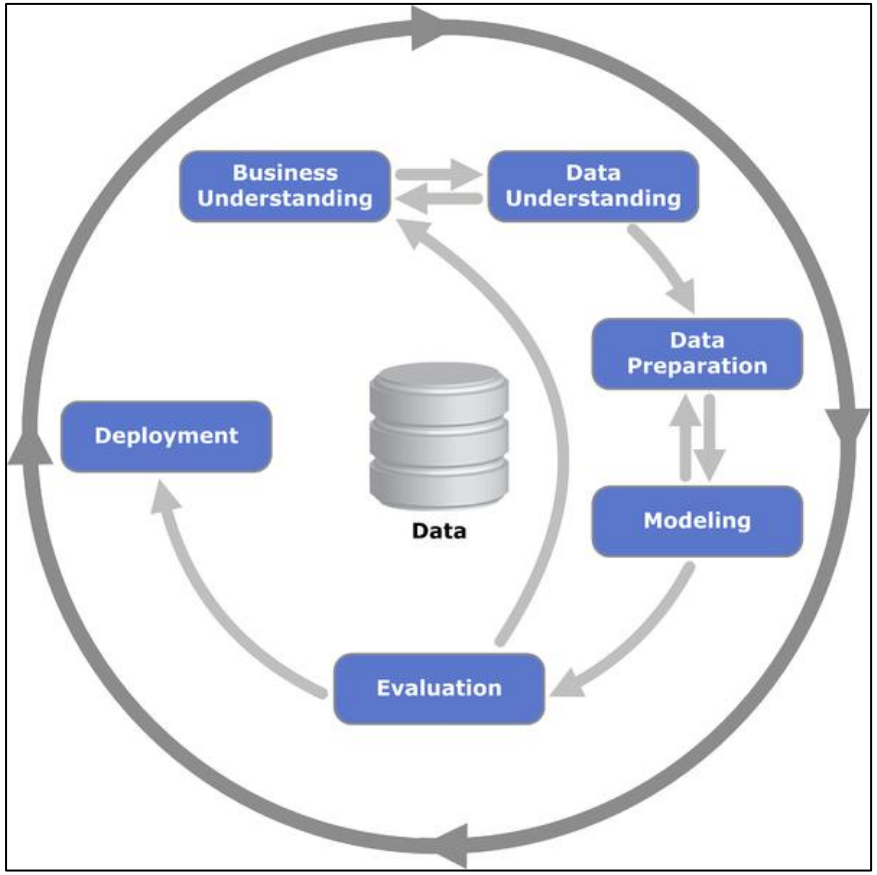
1. **Business or Situational Understanding**
   - Understanding the background, problem, and objectives to be achieved
   - Assess the situation, including an inventory of resources, assumptions, and constraints
2. **Data Understanding**
   - Identify, collect and inventory initial datasets that relate to the problem at hand
   - Describe the data, assess any data gaps that remain, and address those gaps
3. **Data Preparation**
   - Select, clean, construct, and integrate the data into a usable form
4. **Modeling**
   - Based on all of the above, select the analytical techniques to be used from available alternatives
   - Build, test, and assess the methods for congruence with initial objectives
5. **Evaluation**
   - Assess results, review entire process
   - Determine next steps (proceed to step 6, or loop back to step 1 and go through the cycle again)
6. **Deployment**
   - Produce final report, deploy results, continue to monitor and assess

This six-task structure can be alternatively represented as a diagram (see figure at right). Such a representation emphasizes the potential to include several iterations in a problem-solving effort, progressively improving the solution quality each time.

The point here is not to direct every reader to achieve mastery of CRISP-DM, or even that business geographers should learn to include each of its steps in every problem-solving scenario encountered. Rather, the most important point is this:

> *To encourage the reader to engage in a logical, step-by-step process of understanding, planning, preparation, and carrying out an analysis that is consciously designed to meet the needs of the situation at hand.*

CRISP-DM provides a helpful model to encourage that kind of thorough problem-solving approach.



The Cyclical Structure of the CRISP-DM Model

Additional Specific Problem and Method Suggestions

Here are a few more brief suggestions that relate some additional real-world problems to the methods highlighted in this handbook.

What's the Problem?	Method Suggestions
I need to profile a new market my business has not yet entered, but would like to.	Assuming you have no customer data for this market (which looks likely), try **geodemographic segmentation** (providing an overall profile by market type) and **choropleth mapping** (using your best judgment on selecting variables that relate to your business). If you have an advanced idea of your ideal target market profile, doing a combination of **geodemographic segmentation** and **target zone identification** should provide highly actionable results.
I need to define and profile market areas for an existing business that has never gathered customer data.	If you have multiple locations in one region for this existing business: try **areas of influence** (preferably network-based). If you have only one location, try **drive-zone analysis** (but you will need to have some basis for defining the outer boundary of your service zone). In either case, follow up on the initial market definition step with the suggestions provided above (e.g. geodemographic segmentation, etc.) for profiling a new market.
I need to use my business' existing database to understand our current customer base, with the ultimate aim of gaining insights on high priority customer service improvements.	If you have not mapped out your customers yet, start by **adding a location component** to your customer database. Then map the customers as an initial analytical step. After that, you could do a **density grid analysis** to highlight the major features (concentrations, holes) in your customer distribution. If you find some dominant customer clusters, going to a **geodemographic segmentation** and some targeted **choropleth mapping** (using sensible variables for your business) would be a good next step.
I need to define my business' market positioning relative to a well-defined set of major competitors.	Completing a **buffer/drive-zone analysis** for <u>your locations</u> and for <u>your competition</u> will give you an overall idea of the geography of your service zones, versus theirs. Then pull up some basic demographics (choropleth mapping) that relate to your business and **overlay** those demographic figures with your service zone polygons. From there you could produce a set of maps, tables, and charts that summarize the characteristics of each of your service zones individually in comparison with those of your competition.

What's the Problem?	Method Suggestions
I need to provide business expansion advice to one of the few businesses that is currently in a position to open new locations.	This fortunate circumstance leads of course to the suite of **site selection** and **market area analysis** applications outlined in part B of this handbook. But don't skip over the basic groundwork that you will need to do in preparation for whichever site selection and market analysis option you choose. If you read the three market area analysis options carefully, you will see that **adding a location component/geocoding** of an existing database, **choropleth mapping**, and **geodemographic segmentation** are initial ingredients for proceeding with further market area analysis. So the best plan in this area would involve (1) selecting which site and market area analysis option you ultimately wish to aim for, (2) identifying the various steps needed as you build toward a final solution, and (3) making sure you sequence your work well so you build from the first analyses to a final solution.
I need to assist a business that has to close some of their existing locations and wishes to take an evidence-based approach to their decisions.	This is all too necessary in today's economy. The basics of a rigorous approach to closure are contained in the analytical approaches summarized in the site selection and market area analysis discussions in part B. However, with location rationalizations comes the need to flip the previous site selection and market area analysis logic around. Rather than dealing with hypothetical locations that could be opened (and connected financial results), you are analyzing real locations that (hopefully) you have an abundance of real-world data for. A good plan here would include (1) selection of the most appropriate **market area analysis** approach, which would lead to assembly of evidence that could be used to rank and assess the business' current markets, and (2) consideration of the potential for a mix of **site methods** that could give you complementary analytical support for the necessary site rationalization decisions. For example, a location-allocation approach focused on optimal location with various facility numbers (starting with the current facility system and working down from there) could work with a regression modelling approach (yielding financial projections for each location) to give the management team a couple of different forms of input to assist with their site rationalization decisions. Other approaches could be considered as well, depending on the size and nature of the location exit situation the business is facing.

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Business GIS Methods & Applications

An Applied Handbook for Analysis in Retail & Business Geography

By Murray D. Rice

This book summarizes the basic building blocks of business GIS practice, while providing direction toward analytical extensions. This guide provides a measure of clarity on the basic tools and ideas that retail and business geography students can use to produce appropriate geospatial analytical results in a truly rigorous manner.

About the Author

Dr. Murray Rice is a professor specializing in business geography and location intelligence research and teaching at the University of North Texas, Department of Geography and the Environment.

In connection with these interests, Dr. Rice contributes to the applied geography community, where he is executive director of the Applied Geography Conferences, Inc.

The Business Geography Specialty Group (BGSG) of the American Association of Geographers presented Dr. Rice with their Distinguished Scholar Award in 2018. Dr. Rice is also a past chair of the BGSG and the Southwest Division of the American Association of Geographers.

Dr. Rice earned his B.E. (Engineering Physics), M.A. (Geography), and Ph.D. (Geography) at the University of Saskatchewan in Saskatoon, Canada.