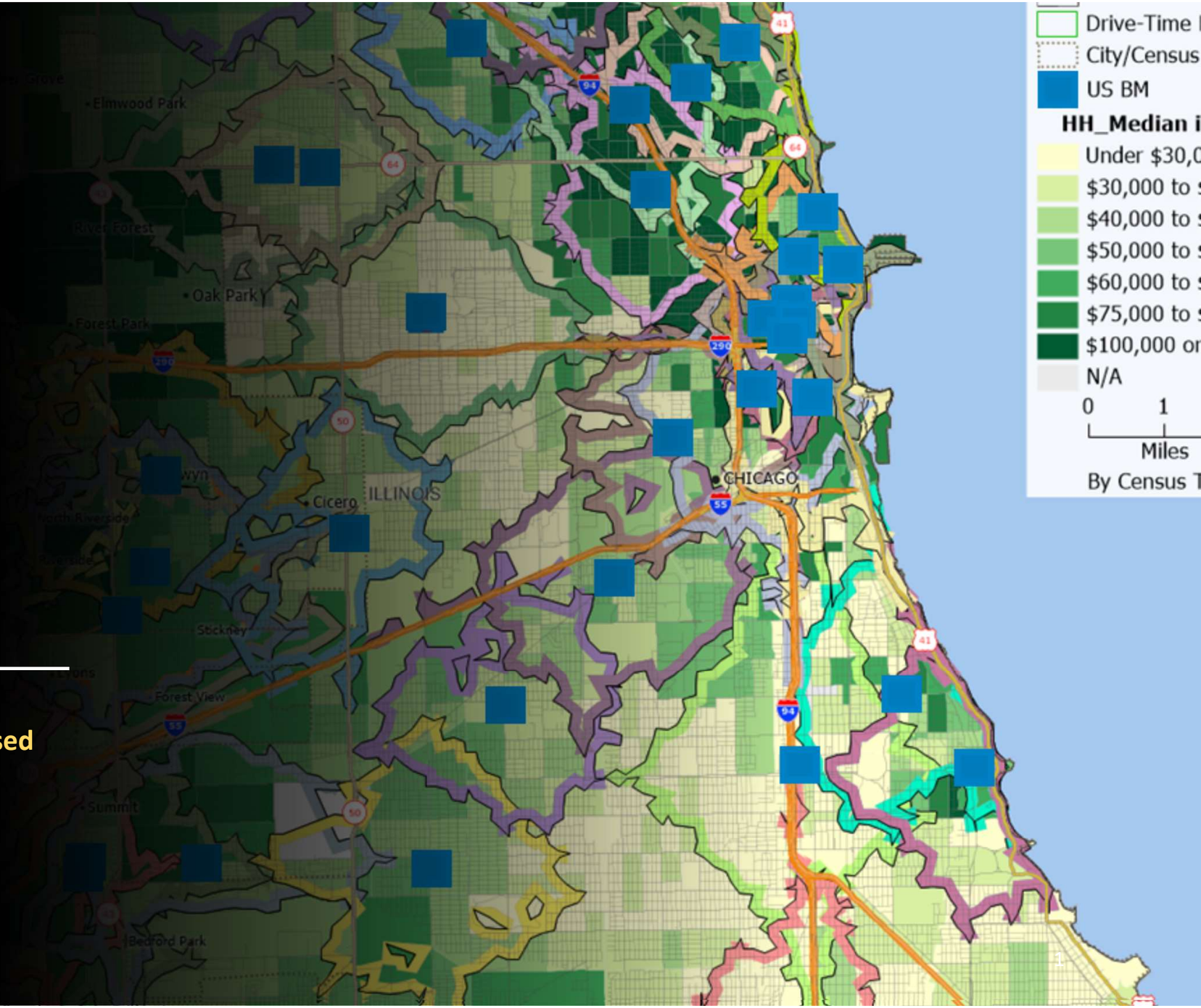
Pathways to Actionable Results with Business GIS



An Applied Handbook for Problem-Focused Research in Retail & Business Geography

By Murray D. Rice

Pathways to Actionable Results with Business GIS: An Applied Handbook for Problem-Focused Research in Retail & Business Geography

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Introduction

The Emergence of Business GIS

Until recently, Business GIS has been a well-kept secret. Mind you, its practitioners and teachers haven't meant it to be a secret at all. But the truth is that for many years the application of geographic information systems technology to everyday problem-solving and decision-making in the business realm has been largely the domain of specialists who work well outside of public view, and outside of general understanding and appreciation even within their own organizations.

This undercover status effectively parallels the public trajectory of awareness for geography, the "parent" field for business GIS. Geography has a long (and unwanted) tradition of being misunderstood and under-appreciated (Rice and Hernandez 2017). Dobson (2014), for example, points out that few job listings include the term "geographer", even though the research, interpretation, and communication skills gained in any geography degree program are widely demanded. Indeed, Murphy (2018) provides a masterful depiction of the broad scope of geographic thinking and analysis that applies to both basic and advanced challenges organizations of all kinds need to solve today. Geography has always been much more than a category in trivia games ("What's the capital of North Dakota?"), and geographers are doing more than ever before to dispel the notion that geographic knowledge and expertise are not that important. One of the great proponents of Applied Geography, the AGX Conference organization, is a primary example of this growing movement to demonstrate geography's relevance.

So, while there has been an extended period of challenge for geography in gaining a foothold in public perception, business GIS is one component of the overall field that is leading a potential renaissance. GIS is providing new, clear, and powerful applications that demonstrate the relevance of space and place in everyday life. This handbook is a practical guide that aims to provide in no-nonsense terms a bridge between the technical capabilities of GIS and the outcomes such methodologies can produce that contribute specific value to the improvement of a wide range of business decisions.

Why This Handbook?

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

The short answer is that both geography and business need the kind of bridge-building effort represented here. 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 to all that we covered, 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 better education on research planning and problem-solving skills (ability to comprehend, plan, and take action), improved identification of core business GIS methods (a straightforward inventory need) and better demonstration of how methods can be combined (relating to versatility of use).

* 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. But this is a great problem to have, indeed.

Introduction

Expanding on these three themes:

Theme 1. Comprehension, planning, and taking action As a field of practice, research and its close cousin, problem-solving, have many barriers to entry. Students enter classrooms across the country with little experience in gathering factual evidence and making sense of it, and little comprehension of what "research" actually is or how to do it well. This is more the fault of our school systems than the students themselves, but it is the students themselves that need to close this gap (or pay the career consequences). Beginning researchers and problem-solvers need clarity on what they need to learn and how to start learning it so they can move beyond a student role and get started as effective practitioners.

Theme 2. Inventory 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 identifying a good roster of existing GIS methods, and which GIS methods are most central to retail and business geographic analysis. I can imagine how challenging it is for students entering the field. Again, clarity is needed.

Theme 3. 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 inventory issues and versatility of us from the specific perspective of application of business GIS methods to the suite of issues that businesses face every day. However, there is one other area of concern that must be addressed is even more foundational than the other two concerns: the ability to **situate a real-world problem in a practical research context.** In other words, a central concern for practice in the business GIS area relates to the passing along of a solid ability to create a logical and rigorous research plan that directly and comprehensively addresses the business problems being faced.

Introduction

This handbook is organized to address all three issues through the book organization outlined below.

Part A , "Planning for Effective, Problem-Focused Research", explores the issue of doing research that effectively meets a targeted set of business needs in a concise but helpful manner. What does a student studying geography need to know about how they can position their unique and powerful skills to focus attention on this challenge? **Theme 1** is addressed here.

Part B of this handbook, "Data Quality Considerations", acknowledges the vast importance of understanding the data needed for a project, versus the data available. This section develops the basic rationale for data assessment and provides a brief overview of potential data issues. **Theme 1** is addressed here as well.

Part C, "Foundational Methods", lists a brief but powerful roster of basic methods that provide a multifunctional toolkit for retail and business geography. Is there room for debate as to whether all methods cited are the most central to business geography application? Absolutely. Are there methods excluded from this section that are worthy of additional attention? No doubt. But this roster of methods provides a starting point for discussion, not an end point. **Theme 2** is addressed here.

Part D, "Application Areas", addresses a small sampling of common but more advanced applications that mostly use the foundational methods of Part B as building blocks in creating something more.** In other words, this discussion explores a range of applications that explicitly require use of multiple methods from Part C to generate solutions. As with the other parts of this volume, more and perhaps even more powerful multi-method applications can be identified by the reader. Exhaustive

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** Recognizing that Part D 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 A, pages 208-209).

listing of such applications is not the point, and I would argue such a roster would be impossible to delineate. The idea here is not to create a complex applications roster to be memorized, but to provide a small number of sample scenarios that might be used for inspiration as the reader pursues a career of building more and better creative solutions to practical business problems. Theme 3 is addressed here.

The book you are reading now contributes to business GIS education and practice by providing an accessible, one-stop source of basic problem-solving strategies, data insights, methodological knowledge, and inspiration on how these various elements can be linked. Given this introductory and summary-focused orientation, this book is not intended to be exhaustive in its coverage of the formulation of complete problem-solving plans or of business GIS methods and applications. For example, this volume only briefly examines the crucial issue of data quality, and it intentionally limits its software considerations to two specific GIS platforms. To supplement the guidance provided here, please review other books that are intended to be more much expansive in their discussion of business GIS and geospatial analytics (Castle III 1993; Pick 2008; Church and Murray 2009; Longley et al. 2015) and in general issues related to research planning (Booth et al. 2016; Montello and Sutton 2012).

In summary, my hope is that this handbook can provide a measure of clarity on basic research planning approaches, tools, ideas, and applications that retail and business geography students can use to produce useful geospatial analytical results in a truly rigorous manner.

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May 23, 2022

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 **ArcGIS Business Analyst Web App** ("ArcGIS BA Web") https://www.esri.com/en-us/arcgis/products/arcgis-business-analyst/overview

I chose these two packages for inclusion here (and in my business GIS 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 intended to be a training manual for either Maptitude or BA Web. The aim of the basic usage suggestions (see Table Intro-1 to start) is to point the reader in the right direction to start your analysis involving any of the methods and applications highlighted. 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 resources to support implementation are available on the websites of the respective software publishers.

Table Intro-1: Inventory of Methods and Applications Covered in this Handbook

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. Consumer Choice Modeling (Huff Modeling)	Geospatial analysis that defines the probabilistic landscape reflecting the likelihood that consumers located across a region will choose to shop at a given retail store, complex, or district.
	8. Density Grid Analysis	Conversion of a complex point-based map into a color-coded density display by area.
	9. 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	Advanced market area definition options, with additional consideration of customer profiling.

Part A: Planning for Effective, Problem-Focused Research

A Basic Planning Framework for Problem-Solving at the Intersection of Business and Location

Planning for Effective, Problem-Focused Research: The Basic Idea

Over the years, I have seen many students go through my retail and business geography classes. These classes almost always feature a semester-long research project focused on the needs of a real-world firm. These projects require skills oriented around understanding the problem given by the industry partner (or "client"), together with skills related to assessment of the problem, identification and collection of data related to the problem, and application of analytical methodologies to produce the insights needed to resolve the problem.

While most students have exhibited some dexterity in parts of these projects, their overall project responses often provide evidence, analysis, and insight that address only a portion of client concerns. For example, a recent semester project location analysis came with a primary request that students identify the best new locations for an expanding car wash chain. The project included a secondary request, that the students also identify potential tenants for co-location with the primary car wash facility. Although both requests were outlined and discussed clearly, only about 30% of final reports addressed the tenant colocation issue in a substantive manner. For the client business, this was a rather shocking omission.

Why did so few of the student reports include a full response to the client's requests? Like other similar missed opportunities over the years, I believe that the content omitted here was not an intentional disregard for client needs, but the result of a flawed approach to research planning. Indeed, experience indicates that, for most people, research is not a native skill but an acquired competency. It is easy to miss a step in planning a research project because it represents unfamiliar territory for new researchers. However, once some fundamental ideas are established, it is also often possible to foresee and avoid research planning mistakes. This first part of this handbook aims to provide some insight to guide new researchers as they seek to provide results of value for their research efforts in business geography and GIS.

1. Key Terms and Considerations

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Problem Solving versus Exercise Completion 16

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Basic Ideas for Shaping Your Research

Doing research in business geography or any other branch of geography requires a unique set of skills. These skills, in turn, rely on an understanding of a set of rather specialized ideas. This section of the handbook briefly discusses terms related to research.

Research, and How it Differs from Problem-Solving

Before we go further, an essential starting point is to lay out what we mean when we use the term "research". Research is a common term that might be logical to assume has a well agreed upon meaning. However, having taught classes that involve "research" for over 25 years, I can say with confidence that "research" means different things to different people.

What is research? An accessible definition of research for a general audience comes from the American Heritage Dictionary:

"Research" as a noun:

"Careful study of a given subject, field, or problem, undertaken to discover facts or principles…"

"Research" as a verb:

"To study (something) thoroughly so as to present in a detailed, accurate manner…"

(American Heritage Dictionaries, 2015)

This definition covers what most people think of when they hear "research" in conversation : a fact collection exercise (as in "I did research on 2007 Toyota Camry used automobile values"). However, as with many terms, it is useful to see not just how some in the general public might view a term, but also the perspective of professionals who interact with the term on a more intimate basis. Given the diversity of definition argued above, how do specialists who *do* research see the term?

Planning for Effective, Problem-Focused Research

One of the most widely used textbooks about research of all time gives a definition of research that introduces a small but important nuance relative to the dictionary definition just discussed. In their book *The Craft of Research*, Booth et al. (2016) define research as happening "…whenever we gather information to answer a question that solves [a] problem". Considering research in this way makes the motivation for doing research clear: research is a crucial step in solving many of the problems we face each day. This element is clearly meaningful to people who actually do research.

Going forward, to emphasize this insight and clarify the perspective here, this handbook will use the terms "research" and "problem-solving" / "problem-focused research" in very specific ways.

- **"Research"** (a broad, umbrella term) involves inquiry into a defined area of interest, characterized by a drive to gain knowledge.
- **"Problem-solving"** and **"problem-focused research"** (narrow terms) concentrate on inquiry into a defined area of interest, characterized by a drive to gain knowledge, that is linked directly in turn to a specific problem that needs a solution (Archbald 2008).

Problem-solving is the primary focus of this book, but it is important to also remember problem-solving's home lies within the substantial, multidimensional world of research.

Text Box A-1: Research and Problem-Solving in a Nutshell

Before going further, let's make the point of this discussion clear:

- Research and problem-solving are **distinctive** activities, but they are also **related and not separate**
  - Research encompasses a **wide range** of inquiry-based activities
  - Problem-solving represents a **specific type of research**: the quest for knowledge linked to the solution of a specific question

To the "related but not separate point" consider the following example:

- A **good example of "research"** in medicine would be investigation into chemical processes taking place in the human brain (meets the criteria of taking place in a defined area of interest, and is characterized by a drive to gain knowledge)
- A **good, related example of "problem-solving"** in medicine would be research into the chemical processes in the human brain that relate to the development of a specific disfunction, such as Parkinson's disease, and its treatment

Although the two terms are related, neither research or problem-solving ought to be thought of as in any way superior or preferable to the other. Research (leading to greater understanding in a general sense) and problem-solving (with a specific, problem-oriented focus) both have their place, but those places also deserve to be recognized and understood separately.

Text Box A-2: What Research is Not

To further emphasize this focus on obtaining new knowledge, we can contrast the definition used here with a different idea that some students have used in completing their semester projects in my classes. Sometimes, a small number of students have:

- Quickly converged on an answer to a question posed in class,
- Located information that can support the answer that they have decided upon
- Discarded information that does not support their chosen answer.

Assembling information that supports a presupposed answer might be thought of as solving a communication or marketing challenge. However, it is most definitively not problem-solving as we define and use the term here, and it is not research in any use of the term as it relates to scientific investigation.

Problem-Solving versus Exercise Completion

However, even with agreement on an understanding of research and problem-solving, there are still some key challenges to confront. One of these challenges relates to the nature of research and problem-solving in a classroom versus in an applied setting. Many young researchers find the process of beginning to transition into an applied, real-world environment to be most frustrating. From my perspective, this difficulty is not at all surprising. The root of the problem is that the research environment in a classroom situation usually differs in a fundamental respect from research in the applied world. This difference can be readily understood by highlighting the distinction between yet another pair of terms.

Problem-solving is the usual mode of research that we encounter in the applied business workplace. Problem-solving is messy and ill-defined. This mode of research is characterized by incomplete definitions and much ambiguity. There is often a pressing problem and real needs to be addressed, but these problems and needs usually come to us in a format that lacks specifics. For example, the immediate problem for a business might be low sales at a particular store location. This is real and important. However, expressing the problem in this form does not provide a pathway for the researcher to follow to a solution. What needs to be done to identify potential causes of low store sales?

Also, problem-solving in a real-world context requires the researcher to understand that it is usually up to them to identify the resources that are available to solve the problem. It is at this point that "research" enters most directly into our problem-solving work, and at this point of entry the research process comes accompanied by a set of questions.

- What do we know? How certain is this knowledge? How quickly is it changing?
- What specifically does our research we need to determine?
- What methods are most appropriate to transform the data into forms that can be understood and interpreted?

Answers to these basic questions are usually up to us as researchers, and again ambiguity plays a crucial role in answering these foundational questions.

For example, there may be more than one approach to research and analysis of a given problem that can provide a satisfactory result. Or, there may be multiple data sets available that relate to the problem, with each data set having a different set of strengths and weaknesses. In summary, real-world problem solving is usually anything but straightforward, and that is the center of the problem for new researchers.

All this begs a question: if "problem-solving" is a real-world, problem-focused, and messy activity, then how does "exercise completion" connect to this discussion?

Exercise completion contrasts with problem-solving across the complete range of arguments used to define problem solving above. Rather than being a real-world pursuit, exercise completion usually takes place in the classroom, and often comes in the form of a lab or exercise that has been planned carefully by the instructor. Careful planning is usually evident in an exercise completion context because instructors don't want their students to get lost and have unnecessary difficulties in finishing the lab or assignment. Key terms and methodologies that relate to the exercise needing to be completed are usually explicitly identified. Exercise completion usually starts with a well-defined set of resources: exercises usually state clearly what we know, and what we need to find. An exercise might even explicitly identify the methodology to be employed, perhaps in the exercise title, and crucial data sets may be provided as part of the exercise package (Brady et al. 2015).

This clarity fixes a crucial challenge faced by all problem-solvers. Problem-solving is complex, and therefore hard to learn. Exercise completion is straightforward, and inherently easier to follow. This makes exercise completion a helpful activity when the focus is learning a specific method or tool. A specific tool can be learned well from completing an exercise. But exercise solving also falls short. Exercise solving cannot address tool usage in a complex environment. For that, geographic education needs to engage in some way with problem solving as well as exercise completion. One does not substitute for the other.

Problem-solving and exercise completion are thus distinctive enterprises. Each represent a different context, and play different roles within the research realm. Both are needed, and both are practical, but their roles and expectations must be understood. Problem-solving focuses on the application of research skill and knowledge in a practical situation, where real and meaningful problems need to be overcome. Exercise solving focuses on helping students learn specific skills and ways of thinking in a controlled environment that has been planned to minimize or avoid the complexity of the real world.

So how is it helpful to recognize the distinctions between problem-solving and exercise completion? In my experience, many new researchers have been primarily exposed to the exercise completion model, and lack an understanding of the leap they must make as they transition from an educational mode to an application mode. And we should note that this challenge is not for new researchers alone. All members of the research community need to be aware of this challenge.

One outcome of such awareness would be to give intentional thought to how more realistic exercises can be adopted into the classroom and internship experiences. Another beneficial impact of this awareness would be attention to effective mentorship as a necessary resource that can help new researchers make the transition from classroom to real world problem solving.

Of course, leaving this bridge-building challenge to “the community at large” is not good enough. Educators in geography would serve their students well by incorporating this developmental need into their courses, both in courses that explicitly concentrate on problem solving (or more generally, “research”) as the central concern, and in courses that touch on problem-solving but focus more on understanding a topic area than on problem-solving as the central point. This handbook is intended to be of assistance in both situations, although the book has a primarily retail and business focus.

Let’s proceed with this basic understanding, as this provides a useful basis for the rest of this book. Of course, we can do this while still acknowledging there is more to say on these terms.

Topics versus Questions in Problem-Focused Research

Another area of confusion that has a real impact on the quality of research we can do relates to the distinction between our identification of a *topic* for analysis and our statement of a question for our analytical work to answer.

A **topic** for analysis lays out a general area of research interest. There may well be a specific issue that underlies the topic definition, but at the topic level we simply have an indication of an area to be studied. Topics are easily identified by analysts of all experience levels. Examples of topics would include:

- The evolution of retail cluster typologies,
- The impact of COVID-19 on local communities, and
- The relationship between changing climate patterns and extreme weather events.

By contrast, an analytical **question** defines a well-defined issue that lies within analytical topic area and provides a clear focus for the investigation to be completed. A good analytical question lays out in a specific and actionable manner the central problem to be addressed by the research. Also, good question framing accounts for the idea that worthwhile problems have costs that must be paid if they remain unsolved. Examples of research questions relating to the three topics above would include:

- What are the location factors associated with the development of big box retail centers in the United States?
- Which communities in Dallas have had their employment levels rebound most quickly from the COVID-19 pandemic?
- Is the occurrence of El Niño weather patterns in the Pacific ocean related to hurricane generation in the Atlantic Ocean?

As with problem-solving versus exercise solving, both research topics and research questions are important and necessary. However, one cannot substitute for the other. Having a solid research topic does not take the place of having well-defined research question. Both a compelling topic area and an actionable research question are needed.

Audience

One more aspect of research that has an impact on the quality of our investigatory work is our understanding of our "audience". While audience is not central to all parts of the research plan, it is important to remember who your audience is and what their specific needs are as you plan your research and how you communicate it.

Consider these possibilities:

- Your research audience is comprised of **senior executives** in your organization. While they expect you to look after all the details and be able to explain any aspect of your research well, these people deal largely with major issues that impact the overall health of the entire organization. This might mean that a research presentation to senior executives might well be best positioned with a focus on the strategic, big picture meaning of your findings for upcoming organizational decision-making. Unprompted digging into highly focused sub issues impacting small components of the overall organization is likely not the best use of your time in this case, unless you have received a specific request to focus on a specific set of micro details.
- Alternatively, your research audience could be comprised of **middle management** who have focused needs and a high degree of specialization in a specific area. These audience members likely share a common set of focused interests and language that you should build into your research work. The message here ought to be substantially different than the message you would provide to an audience of senior executives.

- Lastly, consider the situation where your audience is comprised of **clients of your business** or **interested members of the general public**. As you plan research for this audience, consider their unique needs as external members of your organizational community, and the unique needs of your organization and its need to present itself well to this particular and very important group. The details and overall tone of a message to a client group should be very different from the message you send (even based on the same research) to an internal group.

It is important to recognize that the very nature of the investigation done may differ at a fundamental level based on the audience the work is intended to serve.

Making an Argument

One last item for our discussion here is the concept of an "argument", or how complete and persuasive a solution you can assemble based on the results you have found. When a problem-solving project is complete, a good way to know whether it has succeeded is to focus on assessment of the quality of the argument you have made. Here again, Booth et al. (2016) provide a helpful construct to help shape our thinking.

Distilling the work of Booth and colleagues, a good argument has at least four strong components*:

1. **Claim:** what the reader is asked to accept or believe
2. **Evidence:** why the reader should accept or believe that specific claim
3. **Warrants:** why the evidence provided is sufficient
4. **Qualifications:** presentation of what limits exist on the claims made

* Booth et al. actually cover five, but I use four here as the ones most directly applicable to this book's context.

Planning for Effective, Problem-Focused Research

From this, note that:

1. The claim is the central result of your problem-solving activity. This is a statement that encapsulates crucial insight provided by your findings. The claim is (of course) closely tied to the results, but note the distinction we are making here. Statement of your claim does not involve summarizing or restating your research findings. Claims are the next step beyond findings.

2. After the claim, the other three elements back up the claim. Each is essential to composition of a complete argument. Missing any of evidence, warrants, or qualifications will reduce the value of the research product. For example, if a project report includes minimal reference to evidence, anything else it provides will be vulnerable to questioning. Businesses that have problems that need solving need evidence to substantiate that a rigorous process of investigation and analysis is the basis for any solutions provided. Without evidence, a solution really becomes an opinion.

Given this background, this book develops a framework for problem-solving in business. The framework focuses on using the ideas developed over the past several pages, together with the practical contributions of a spatial perspective and the investigatory and analytical power provided by GIS, to create new, data-driven answers to the problems we face (see Figure A-1). The next few pages dive into the research planning component of this framework.

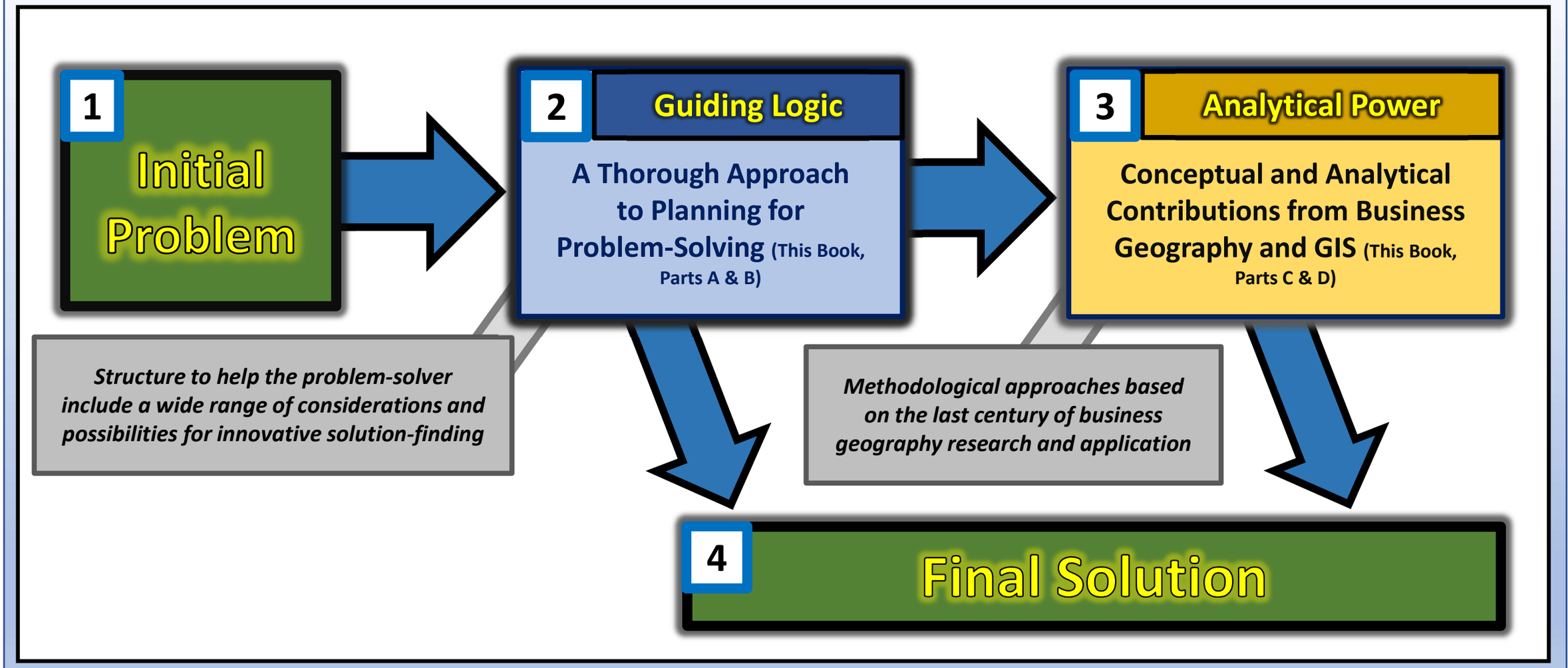

Figure A-1: A Problem-Solving Framework

2. Problem Solving: A Simple Planning Framework

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Practical Thoughts on Problem-Solving

As Parts C and D will discuss, real-world business problems vary greatly in the sophistication of the geospatial analytics necessary to respond. Business geographers have many established approaches to a range of problems, varying from simple, one-step schemes to solutions linking several tools and steps. Knowing the geospatial tools and solutions that exist is of great value for a business geographer. However, beyond understanding a roster of set 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 is the point where *technical knowledge of business GIS software* and solutions (developed through exercise completion) intersects with the domain of *business understanding and creative solution building* (developed through problem solving). As already asserted, both sides of this process are necessary, but it is also important to note that while advancement on the exercise completion side might be seen as straightforward (follow the standard rules), development of problem-solving skills can be more elusive, given their creative and customized nature. Is there a way of conceptualizing this creative problem-solving process to enable students to more rapidly master this area of practice?

For this insight, we are fortunate to have the experience of problem solving as developed through the discipline of engineering. Engineering is a field with a long history of practical problem-solving (Sharp 1991; Ullman 2010). Of the spectrum of problem-solving approaches emerging from engineering, 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).

CRISP-DM

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
- From this understanding, formulate a specific question or questions that will form the focus for all other work

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, assess, and use the methods for the problem at hand to generate the results needed

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)

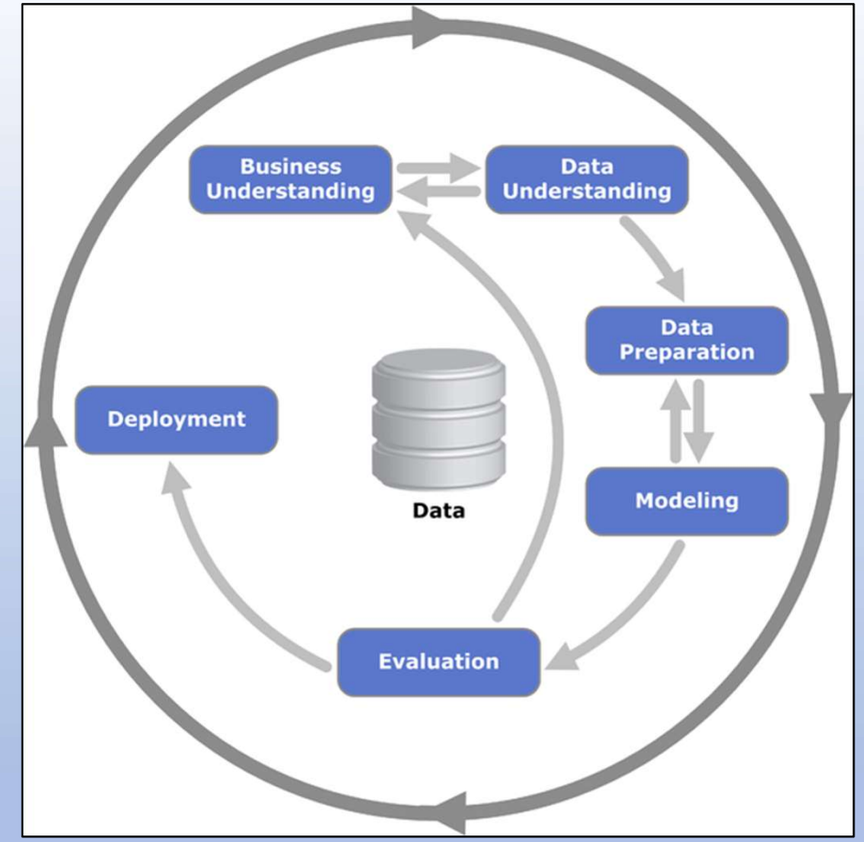
6. Deployment
- Produce final report, present findings to relevant stakeholders, deploy results, monitor and assess use of research findings

This six-task structure can be alternatively represented as a diagram (Figure A-1). 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 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.



Source: Jensen (2012). This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

Figure A-1: The Cyclical Structure of the CRISP-DM Model

CRISP-DM and Problem-Solving in Business GIS

In the context of this book and the needs of business GIS education and practice to bridge the distinctions between problem-solving and exercise completion, consider the basic points below.

1. Exercise Completion Continues to be Necessary

- A rigorous business GIS education will always include practical exercise-based experience in using specific GIS software packages
- Competence in the range of analytical capabilities provided by modern GIS is a necessary pre-requisite for entry to the field
- The tools outlined in Part C of this handbook define a core set of capabilities that business GIS professionals need
- However, Part C is meant to be inspirational, not complete; there is room to include more tools as field progress occurs

2. Each Step in CRISP-DM Should be Considered as an Area for Skill Development

- Competence in running GIS tools is not enough on its own
- CRISP-DM help us see that there are many skills that are an essential part of GIS analysis
    - GIS tools (the focus of Part B) might be most directly associated with step 4 (modeling)
    - But step 4 is not possible if steps 1, 2, and 3 have not been done well: business understanding, data understanding, and data preparation must all be completed well before modeling is even possible
    - Likewise, steps 5 and 6 also essential: evaluation of results and deployment are also essential to a complete solution
- Each of the six CRISP-DM steps is a potential and valuable subject for exercise completion activity

3. CRISP-DM is one Helpful Guide on the Progression from Exercise Completion to True Problem Solving

- CRISP-DM highlights a basic structure to organize the kind of complete approach that true problem-solving entails
- True and comprehensive problem-solving involves the entire range of CRISP-DM steps (see figure on the following page)

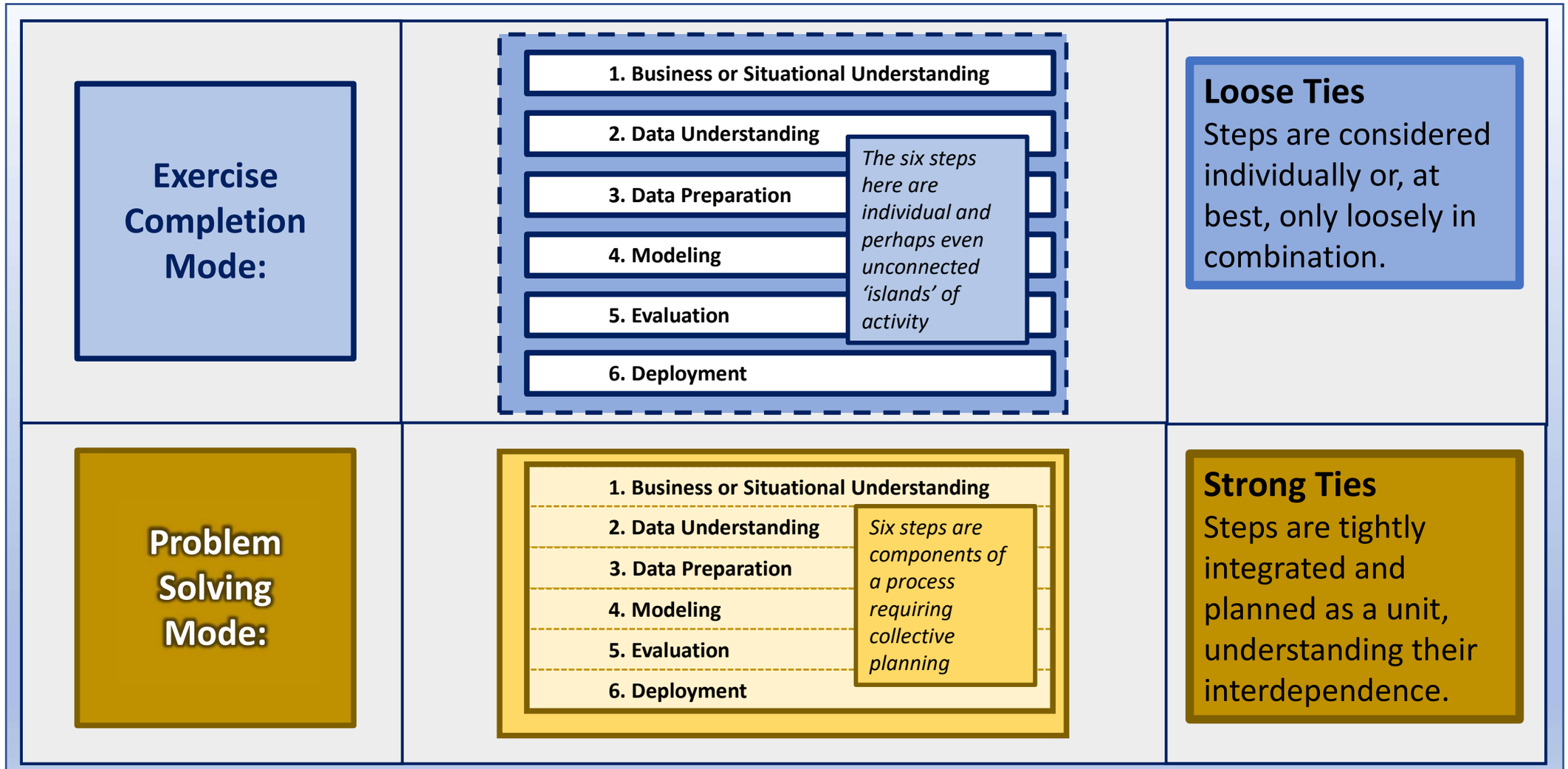


Figure A-2: The Six Steps of CRISP-DM in an Exercise Completion versus Problem-Solving Context

Planning for Effective, Problem-Focused Research

In the end, what we need to become as skilled researchers and problem-solvers is a challenging place to go. Problem-solving is facilitated by technical abilities, analytical skills and tools. Such skills are well-developed by advancement through an exercise completion emphasis in education. However, our discussion has highlighted other necessary developments as well, represented by the spectrum of competencies recognized by CRISP-DM.

This handbook focuses on the technical skills associated by business GIS practice. The key point of this Part A discussion is that every reader can add technical and GIS skills to their portfolio, and that these technical skills certainly contribute to an individual's growth as an analyst or even a researcher. But we all need to understand that technical skills on their own do not build researchers who are equipped to master the next step and solve real-world problems.

Although this handbook does not attempt to be a comprehensive guide to problem solving skill development, there are resources here that provide support in this direction. A reader who aspires to gain problem-solving abilities should recognize their need to pay attention to developing their ability to:

1. Understand a complex problem in its complete context,
2. Understand and sort through the data available in order to collect the best data possible to address the given problem,
3. Plan and perform an analysis selected to meet the problem-solving needs of the situation, and
4. Provide a clear, cogent interpretation of the results that helps the intended reader to make informed decisions.

Part A of this handbook has focused on a framework for understanding the overall problem-solving challenge, with some focus on undertaking item 1 well. Part B provides a brief overview of some of the most important data considerations. Parts C and D focus on item 3. For item 4 and all the other gaps that remain, the following summary offers a few resources to start.

Further Problem-Solving Resources

Academic Research

Archbald, Doug (2008) Research versus Problem Solving for the education leadership doctoral thesis: Implications for form and function. *Educational Administration Quarterly* 44(5): 704-739. Link: https://journals.sagepub.com/doi/10.1177/0013161X07313288

Brady, Corey, Cheryl Eames, and Dick Lesh (2015). Connecting Real-World and In-School Problem-Solving Experiences. *Quadrante* 24(2), 5–38. Link: https://doi.org/10.48489/quadrante.22924

Gick, Mary L. (1986) Problem-Solving strategies. *Educational Psychologist* 21(1-2): 99-120. Link: https://www.tandfonline.com/doi/abs/10.1080/00461520.1986.9653026

Haavold, Per Øystein, and Sriraman, Bharath (2022) Creativity in Problem Solving: Integrating two different views of insight. *Mathematics Education* 54(1): 93-96. Link: https://link.springer.com/article/10.1007/s11858-021-01304-8

Lesh, Richard, Miriam Amit, and Roberta Y. Schorr (1997) Using “Real-Life” Problems to Prompt Students to Construct Conceptual Models for Statistical Reasoning. In Gal, I. & Garfield, J. B. (editors). *The Assessment Challenge in Statistics Education*. IOS Press: 65-83.

Online Resources

Blog Entry: "Problem-Solving Strategies to Turn Challenges on Their Head". BetterUp.
Link: https://www.betterup.com/blog/problem-solving-strategies

Web Site: "Problem Solving: Solving Complex Business Problems". MindTools.
Link: https://www.mindtools.com/pages/main/newMN_TMC.htm

End of Part A

Part B: Data Access & Data Quality

A Brief Look at Key Data-Related Issues

Data and Business: The Basic Idea

While methodological considerations form the single most substantial concern for this book, we must acknowledge that no analysis is possible without data. Further, we need to acknowledge that the quality of the data we use is the single most limiting factor in any analysis. In this connection, the classic phrase **"Garbage In, Garbage Out" ("GIGO")** summarizes the issue well.

We can:

1. Understand well the **nature of the problem** to be addressed by our research,
2. Define an **appropriate analytical question** to guide our work,
3. Identify **fitting analytical methods** to generate the answers needed, and
4. Be prepared to understand and explain the **analytical output**

But **if the data we use are flawed** in any of several fundamental ways, our entire set of work is of doubtful value. We simply must understand the issues relevant to understanding the data we need and how the quality of these data can be compromised.

This brief discussion is no substitute for the much more extensive and thorough attention provided for data and research issues by others (Montello and Sutton 2012; Sebastian-Coleman 2013; Kerski 2012, 2021), but this section serves to set the major data challenges in a broad context, provide some overall guidelines, and point to more resources that carry the data quality dialogue further.

Context for the "Data and Business" Discussion in Geography

Connection of data use and the needs of business is by no means a recent concern for researchers in geography. Geographer Allan Pred's (1976) decision matrix provided a compelling framework that related data issues to business success. The clear message provided by Pred was that a lack of quality data paired with a lack of ability to analyze what data a business might have is an unmistakable sign of impending business failure. Since then, major businesses like Walmart, Home Depot, and Target have provided business schools around the world with classic case study material that indicate the benefits of treating data seriously, as well as the potential pitfalls of using available data poorly (Mohanty et al. 2013; Johnson and Mark 2019; Casadesus-Masanell and Elterman 2019).

For example, Walmart's efforts to collect and analyze data associated with the 2004 landfall of Hurricane Frances (and its impact on Walmart's sales by store and region in the impact zone) led directly to insights that allowed Walmart to play a substantial and highly beneficial role in responding to the even more dislocating outcomes associated with Hurricane Katrina (Mohanty et al. 2013). Walgreen's widely known capabilities related to tracking sales across its national network have given it advanced and timely abilities to visualize and understand the development flu waves (Clancy 2015). The commonality among these and other cases of business data use is a focus on a "win-win" situation:

- **The business benefits** in terms of enhanced competitive positioning and public good will, while
- **The community benefits** in terms of levels of goods and service provision that more precisely meet the needs of the community.

This is of special consequence in times of challenge, such as the cases of natural disasters and disease spread. Data are well worth tracking and using well, for multiple reasons.

Issues with Data Acquisition

The Overall Data Acquisition Concern

Data acquisition refers to the practical concern of being able to obtain the data you need to solve your current problem. Recognizing this issue means that we understand a real possibility: some data needs might not be possible to meet. Being able to imagine a specific dataset could possibly exist does not mean that such a file is actually within your reach as a researcher.

On considering this data acquisition issue generally, at some point we can see this overall problem reducing to two further issues, namely, **data availability** and **data accessibility.**

Data availability can in turn be defined with two more sub-questions.

1. Have the data of interest *actually* been collected? Alternatively, *could* the data be collected if a need arose?
2. Do the data that actually exist refer to the *geographic location or region* in which my interest falls?

At its root, the ultimate data availability concern is whether "the precise dataset that I need exists somewhere."

Data accessibility centers on a related but separate concern: practically speaking, how can I *actually* locate, select, and retrieve the data I need for my research? Put another way, are the needed data (defined exactly as you need them by kind and location) truly accessible by you?

In this dimension, the ultimate data availability concern is whether "I can actually get the data I need."

Data Acquisition and Geography

Given the focus of this handbook on geographic research, it is helpful to explore data acquisition as it relates specifically to geographic data. Following Church and Murray (2009), we can usefully break this issue out into location data referring to:

- **Points:** data that define specific locations (such as a house, building, or business location)
- **Lines:** data that define specific corridors (such as a highway, river, or power line)
- **Areas:** data that define specific regions (such as a political division – state or county – or something like a trade area for a business)

It is quite possible to obtain any of a wide range of data files that focus on this geographic element: point files that indicate business locations (e.g. all Walmart store locations), line data that define the linear corridor followed by a specific road, or area data that define the location and boundaries of a specific state, county, or city. Knowledge of geographic data by type is one crucial input to the formulation of effective research plans.

Data Access & Quality Considerations

Of course, knowledge of data types in an abstract sense is not sufficient for us to acquire the data we need. Once we have decided on appropriate data types for use in our research, we need to identify sources for these data. In the location dimension, Church and Murray (2009) again define a useful typology of sources for geographic data in particular. This typology breaks into:

- **Existing data sources** that provide geographic datafiles that can be directly opened by geographic information system (GIS) software with no conversion or intermediate processing necessary. Many levels of government department agencies and departments provide geographic datafiles in a variety of GIS formats.
- **Semi-existing data sources** that make geographic data available in some form, but not necessarily in a ready-to-use format. For example, datafiles that include addresses as a separate and well-defined field can possibly be processed to yield a geographic location for each observation, but making this geographic data accessibly for GIS analysis may require some intermediate data massaging. Also included in this case might be historical hardcopy documents that list locations in some fashion, but unlocking the location information in this case also involves transferring the needed data from paper to a digital format.
- **Survey sources** encompass situations where the researcher must take the initiative to directly encode location data themselves. This is necessary when existing and semiexisting sources simply do not exist. In practical terms, survey approaches can include surveying of research subjects directly (on the ground), or use of aerial photography or other remotely-sensed data via airplane or satellite.

It is crucial that researchers investigating geographic questions are able to understand and navigate through this ecosystem of data sources and data types.

Issues with Data Quality

The Overall Data Quality Concern

Data quality refers to practical concern about the condition of the data we use. This concern can be encapsulated by the question, “Does a given dataset of potential interest have the specific characteristics needed to do the analysis that is planned?”

For example, in doing research on fire station locations, coverage areas, and response times across a given city, it is possible for a researcher to identify a need for datasets that break out the fire stations that exist in the city of interest. However, simply locating and acquiring a datafile that provides data about fire stations in the right city will not necessarily give us what we need. When were the data collected? Is the current set of fire stations serving the city reflected in the dataset? If the dataset is outdated and does not reflect the current situation, it is of much reduced use.

The above is a simple example of data quality and impacts on data use. Data age is an important consideration, but it is not the only dimension requiring attention. For research to proceed on a sound basis, we need a comprehensive approach to assessing the quality of individual datasets. The following provides some language and concepts around which we can construct a solid assessment and critique of the quality of the datasets we use.

Data Access & Quality Considerations

Spatial data quality concerns can be subdivided into five categories (Veregin 2005).

1. Data Accuracy: the difference between the actual value of a variable (if measured 100% accurately) and the variable value encoded in a dataset. For a simple example, see Figure B-1. This example indicates that the route actually taken by a truck varies slightly from the route recorded by the tracking datafile.

How important is this issue? Assessment must come on a case-by-case basis. Deviations between actual and recorded values can have serious implications that depend on the amount of deviation present and the use being made of the dataset.

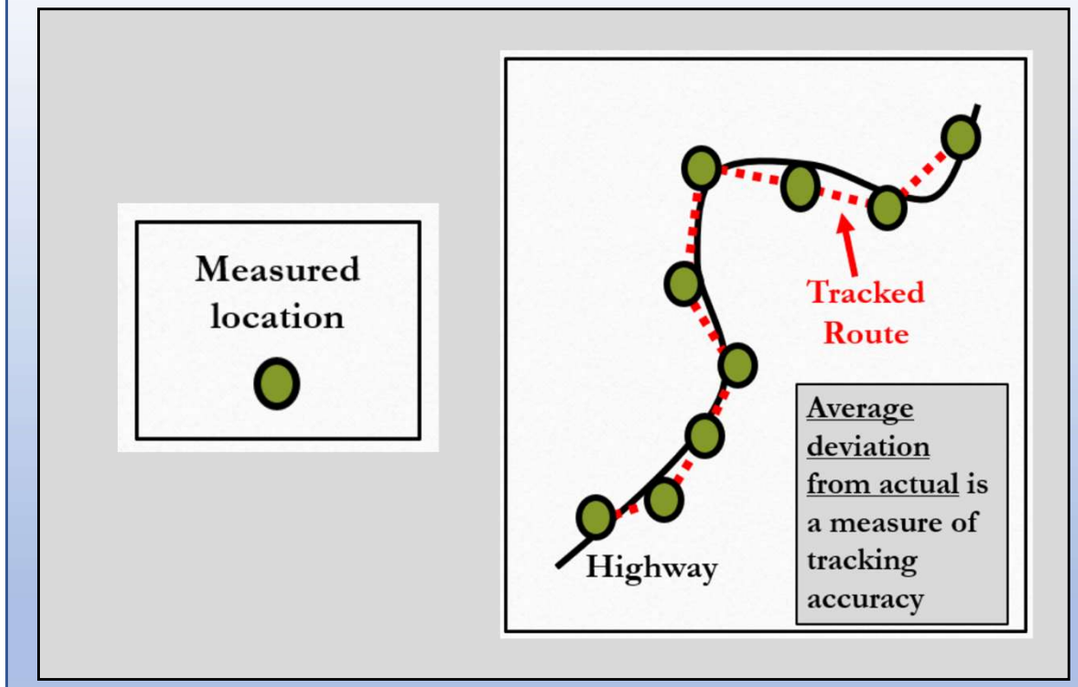


Figure B-1: Data Accuracy in Truck Location Tracking

2. Data Precision: this can be conceptualized as the degree of detail displayed in the database. How much detail is evident in the dataset? The degree of *resolution* present and the *granularity* evident in the data are other words or ideas that address this issue.

For example, Figure B-2 represents two different levels of granularity.

- A dataset capturing data at the level of resolution of **Map A** represents location at the **state level**, across the United States (50 subregions of the US).
- Meanwhile, **Map B** represents a dataset reflecting location at the **county level** (approximately 3,200 subregions of the US). Map B represents a dataset having a much higher level of granularity than Map B.

Does a given research project benefit from having location encoded at the county level, or is location at the state level sufficient for a given use? The answer to this question is important to understand so an appropriate dataset choice can be made.

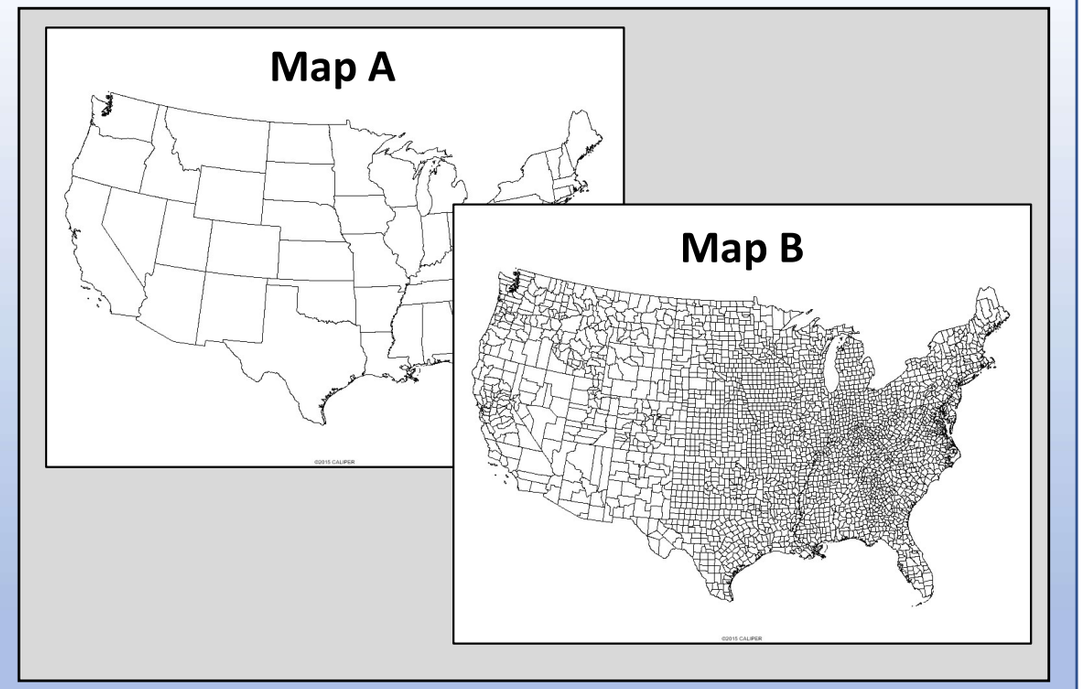


Figure B-2: Data Precision as Represented by Two Maps

Text Box B-1: Accuracy and Precision Compared

Before going further, it is helpful to acknowledge the common perception that accuracy and precision are simply different words meaning the same thing. In actuality, these two terms have different but supplementary meanings that enrich the ability of the English language to address fine points.

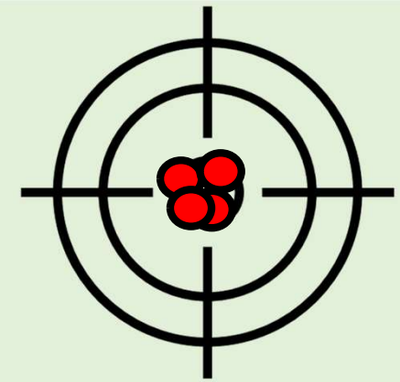
Accuracy refers specifically to the relationship between the data points collected and the actual underlying phenomenon being represented. An accurate dataset provides a representation of real-world phenomena that is a close representation of reality. An example of accuracy in a spatial context would be a point dataset's ability to locate a specific landmark, such as generating a set of location coordinates consistently located within 5 meters of the actual location of the landmark. A less accurate database might consistently locate landmarks by coordinate within 100 meters of the actual location.

Precision by contrast refers only to the characteristics of the dataset itself, and not the dataset versus actual value relationship. For example, in a spatial context a highly precise point dataset that queries the same location repeatedly will consistently yield coordinates that vary little from query to query. A low-precision database will return a wider "scatter" of coordinates for the same situation, indicating a higher degree of measurement variation. The distinction with accuracy comes when we bring the actual phenomenon being measured into consideration: a high precision database will have low scatter with repeated measurements of the same thing, but with (A) high accuracy this tight cluster will converge close to the actual, real world value, while with (B) low accuracy the tight cluster will converge around a value substantially differing from the real world value. Figure B-3 illustrates the accuracy and precision concepts through a simple example.

Continued…

A

A point database that is both **accurate** (on target) and **precise** (tight distribution)



B

A point database that is both **inaccurate** (off target) and **imprecise** (loose or scattered distribution)

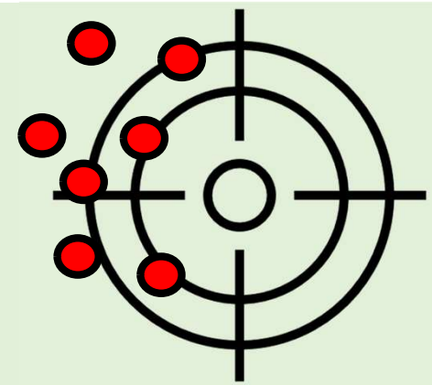


Figure B-3: Accuracy versus Precision

3. Data Completeness: this is a measure of the totality of the selection of variables included in a database. Are all of the variables that are potentially needed in a given database actually present in the database? A database with no missing variables can be thought of as "data-complete".

Figure B-4 gives a simple example of data completeness. Business Database A includes more variable fields than Business Database B. If the fields included in Business Database A are both important and collectively sufficient for a given application, Business Database A could be termed as data-complete for the application. Because Business Database B lacks some of these necessary fields, it would not be considered data-complete.

Business Database A

Business Name	City	State	ZIP Code	Revenues	Profits	Employees	Industry
ABC Co.	New York	NY	10110	$1.9 Billion	$500 Million	15000	Retail
GGX Inc.	Miami	FL	39430	$1.1 Billion	$300 Million	20000	Manu.
Framco	Dallas	TX	75201	$0.7 Billion	$100 Million	1000	Energy

versus

Business Database B

Business Name	Employees	Industry
ABC Co.	15000	Retail
GGX Inc.	20000	Manu.
Framco	1000	Energy

Figure B-4: Data Completeness

Data Access & Quality Considerations

4. Data Consistency: an indication of the absence (or presence) of logical conflicts in the data records recorded. Some tolerance might be allowed for highly unusual situations, but the below are for the most part good examples of consistency from a spatial perspective:

- **Points:** only one customer data point occupying any given location
- **Lines:** rivers are geocoded to flow into another river, lake, or ocean (they do not end in the middle of nowhere)
- **Areas:** census tracts are surrounded by a complete set of boundaries

5. Data Uncertainty: the degree to which user error and/or measurement issues cloud the accuracy of the data.

- Are there systematic issues with the data that we can know and assess?
- Such assessment follows from knowledge of the collection process that generated the dataset being considered

Going from Here with Data Access and Quality Issues

An understanding of the data provision options and quality issues is fundamental to planning for research that generates fair results that can be relied upon. Solutions to real-world problems require access to data that are relevant and directly suited to the problem situation. Once the problem to be solved is fully understood, a reasonable next step is to engage with the data issues surveyed here to assemble a factual basis for problem solving. Attention to factors that impact our ability to access **quality data** and shape the roster of **data types that can be used** is a crucial step in solving the overall problem.

Once relevant datasets are identified and their availability is confirmed, a next concern relates to analysis of the data and interpretation of the analytical results. It is rare to have a problem that is so simple that collection of data on their own is sufficient. Usually, problem-solving involves using or transforming the raw data in some way to provide insights not evident from inspection of the dataset alone. The discussion in the next sections provides a foundation for understanding the analytical options available to researchers addressing problems that relate to both businesses and their location.

End of Part B

Part C: Foundational Methods

Building Blocks for Business GIS Application

Foundational Methods: The Basic Idea

This section of the handbook explores a roster of routine methods that are available in most GIS packages that retail and business geographers use on a regular basis. The common tie that binds the methods included here is this: *each one is so basic and foundational that it is often used in combination with other methods, like the letters of the alphabet*.

For example, the addition of a location component to an existing business database ("geocoding") 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 solving a bigger problem. Thus, geocoding might be a first stage in locating customers so further geospatial analysis can be completed using other methods, such as those that are covered later in this "Foundational Methods" section. 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 foundational methods is thus intended to provide some definition of a basic toolkit whose elements can be combined and extended in an infinite number of ways to solve a wide spectrum of business problems.

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 ***Caliper Maptitude*** and ***ArcGIS 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

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- Point-Based Geocoding 57
- Area-Based Geocoding 59

Resources and Processes to Add a Location Component to a Database 61

Next Steps After Adding a Location Component to a Database 62

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

Figure C-1: Point-Based Geocoding Example

Detailed Discussion

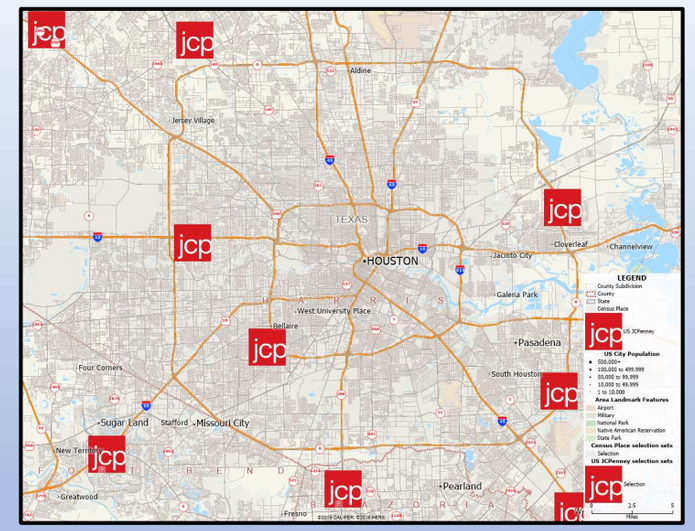
Point-Based Geocoding Result: Visualization of the location dimension that was implicit in the original database because of the inclusion of some form of address or place information, but not obvious.

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

Map of Address Locations



Databases from Maptitude

Figure C-2: Point-Based Geocoding Example Result

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

Figure C-3: Area-Based Geocoding Example, Database Component

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].ID	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

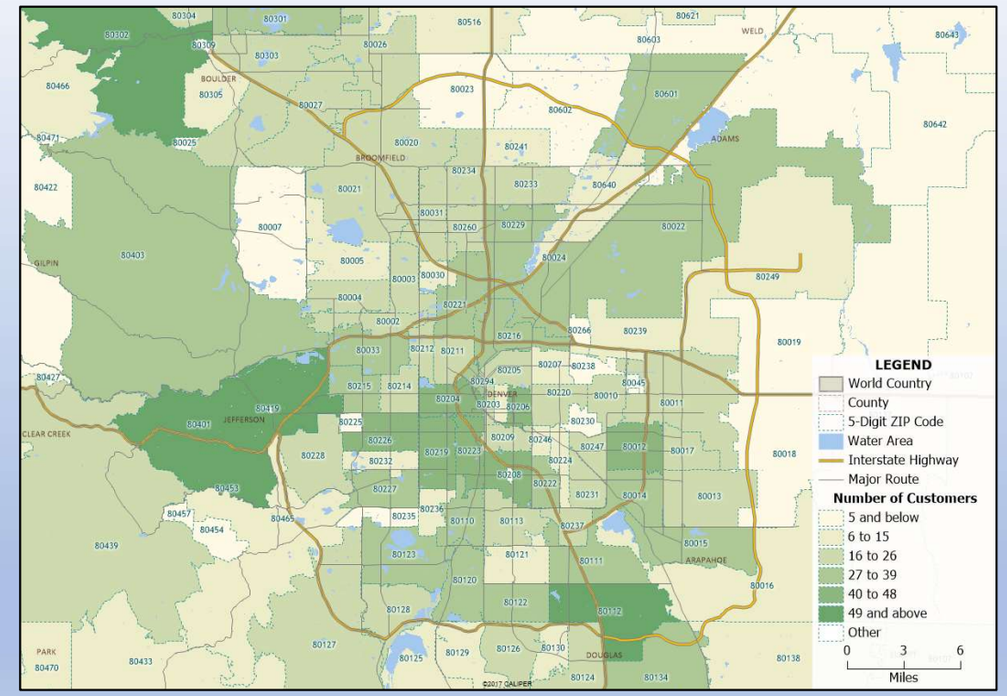
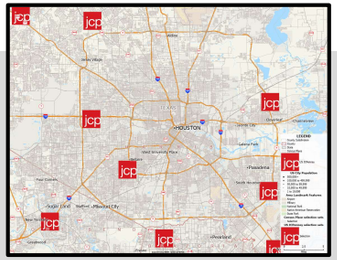
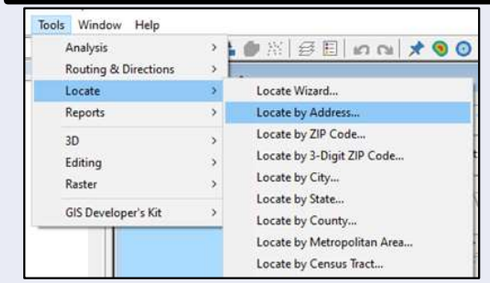


Figure C-4: Area-Based Geocoding Example, Mapping Component

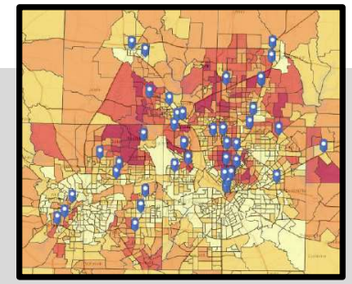
Resources and Processes to Add a Location Component to a Database

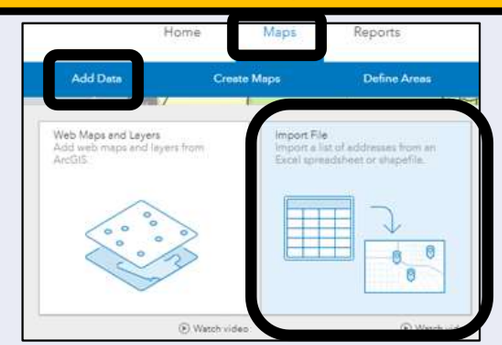
In Caliper Maptitude:



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 ArcGIS 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?

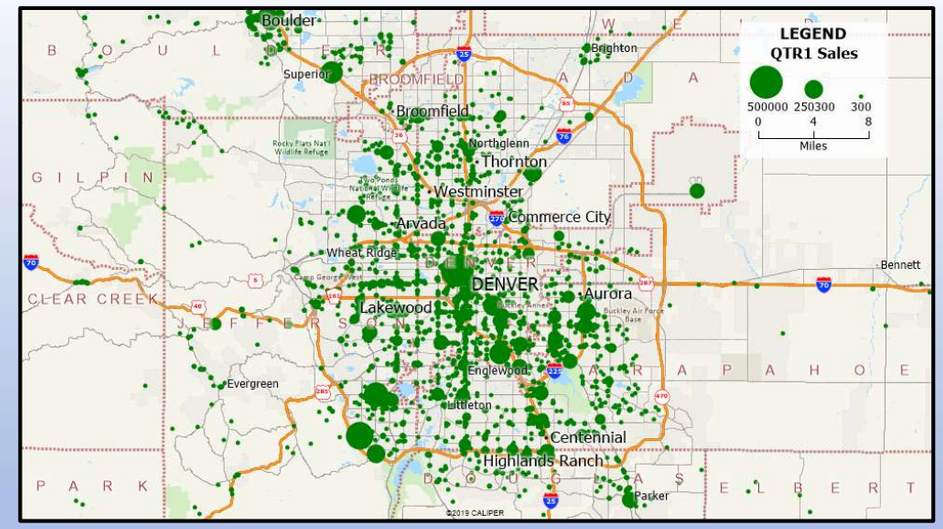
For a database representing individual places (point locations), such as residential or work addresses for individual people or business locations for stores, restaurants, or offices, you have a foundation for a variety of analytical extensions that depict point patterns.

- For example, by adding residential location coordinates to a customer purchase database, you now have the ability to map purchases that could have never been visualized in the original 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 Database: A Standard Excel File



Mapping Now Possible with Location Coordinates

Figure C-5: From a Standard Database to a Powerful Tool for Geo-visualization

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

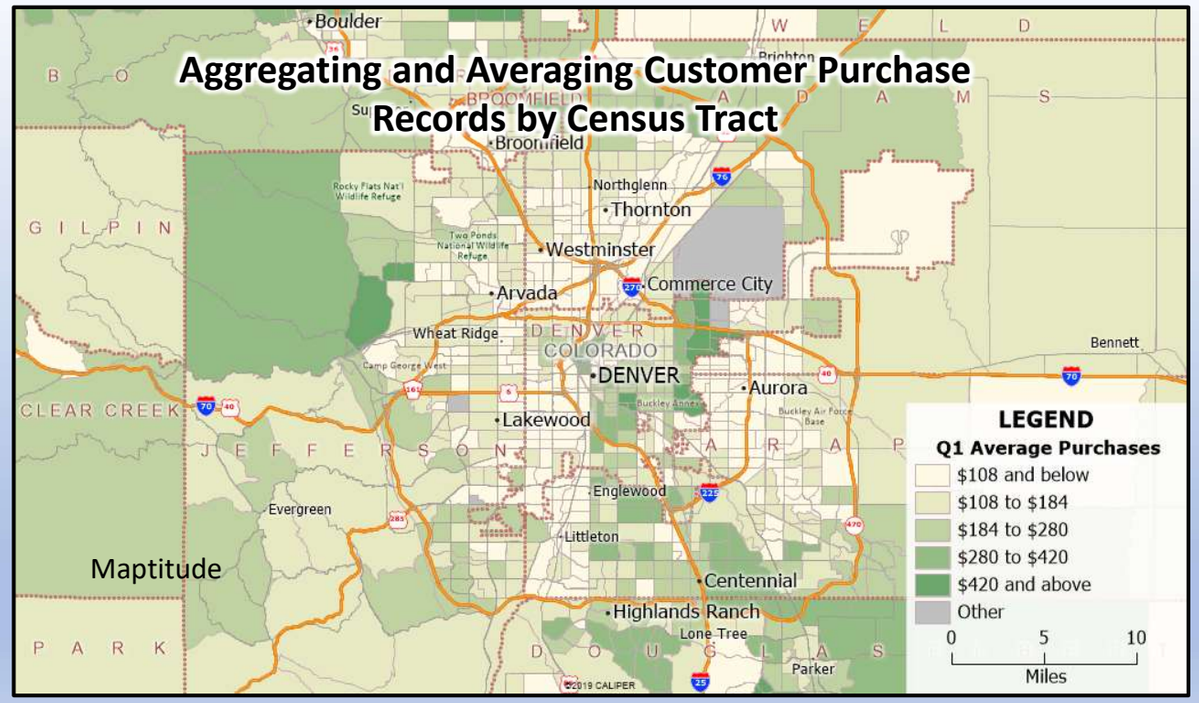


Figure C-6: Taking Geo-visualization a Step Further: Aggregating by Zone

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 109).

- 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

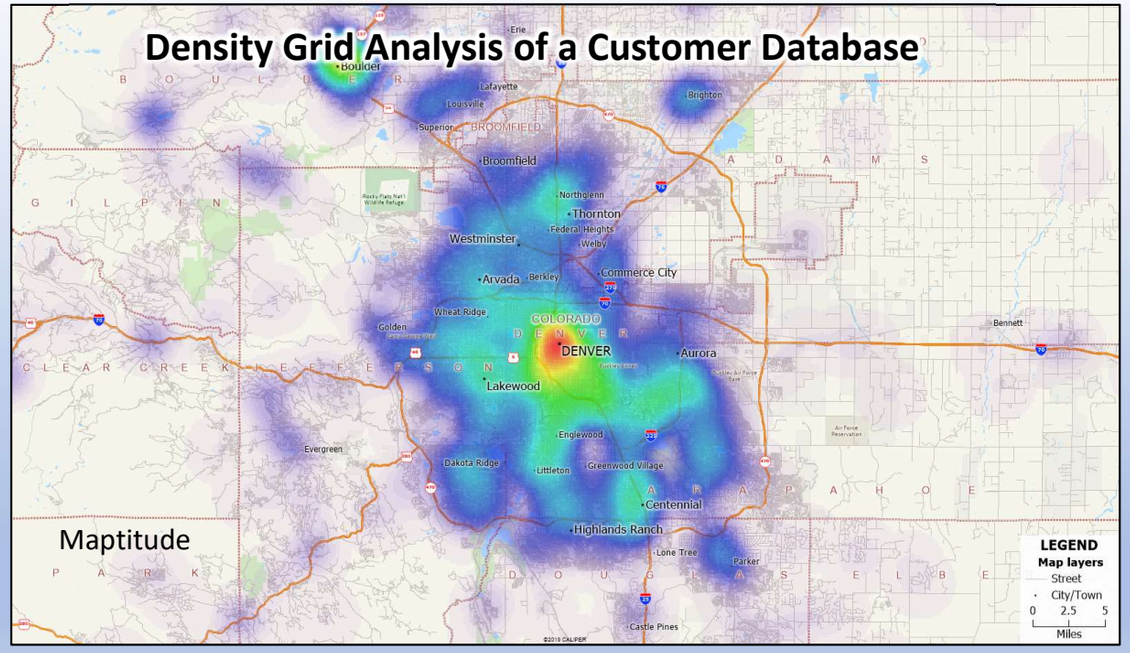


Figure C-7: Taking Geo-visualization a Step Further: Density Grid Analysis

Method 2: Buffer/Drive-Zone Analysis

Overview of Buffer/Drive-Zone Analysis 66

Detailed Discussion:
A. Buffer: Straight-line distance 67
B. Drive-zone analysis 68

Resources and Processes to do a Buffer/Drive-Zone Analysis 71
In ArcGIS Web App (Special Note) 72

Next Steps After Creating a Buffer/Drive-Zone 73

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.

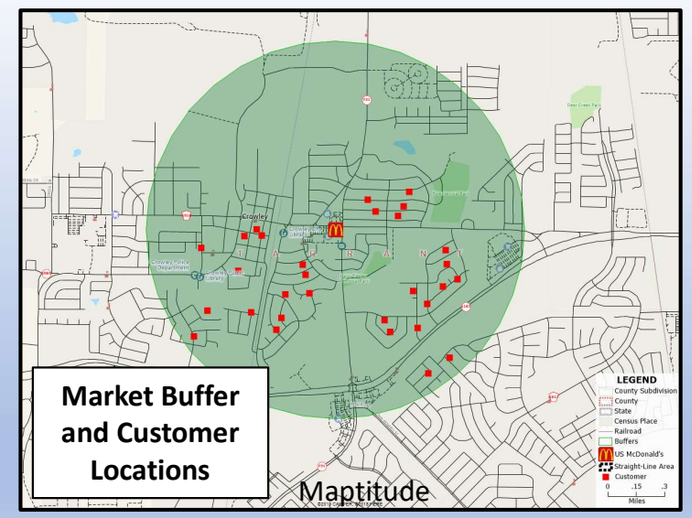


Figure C-8: A Basic Buffer Example

A. Buffer: Straight-Line Distance

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

Example: Figure C-9 illustrates a zone based on a 10-mile buffer around a specific location

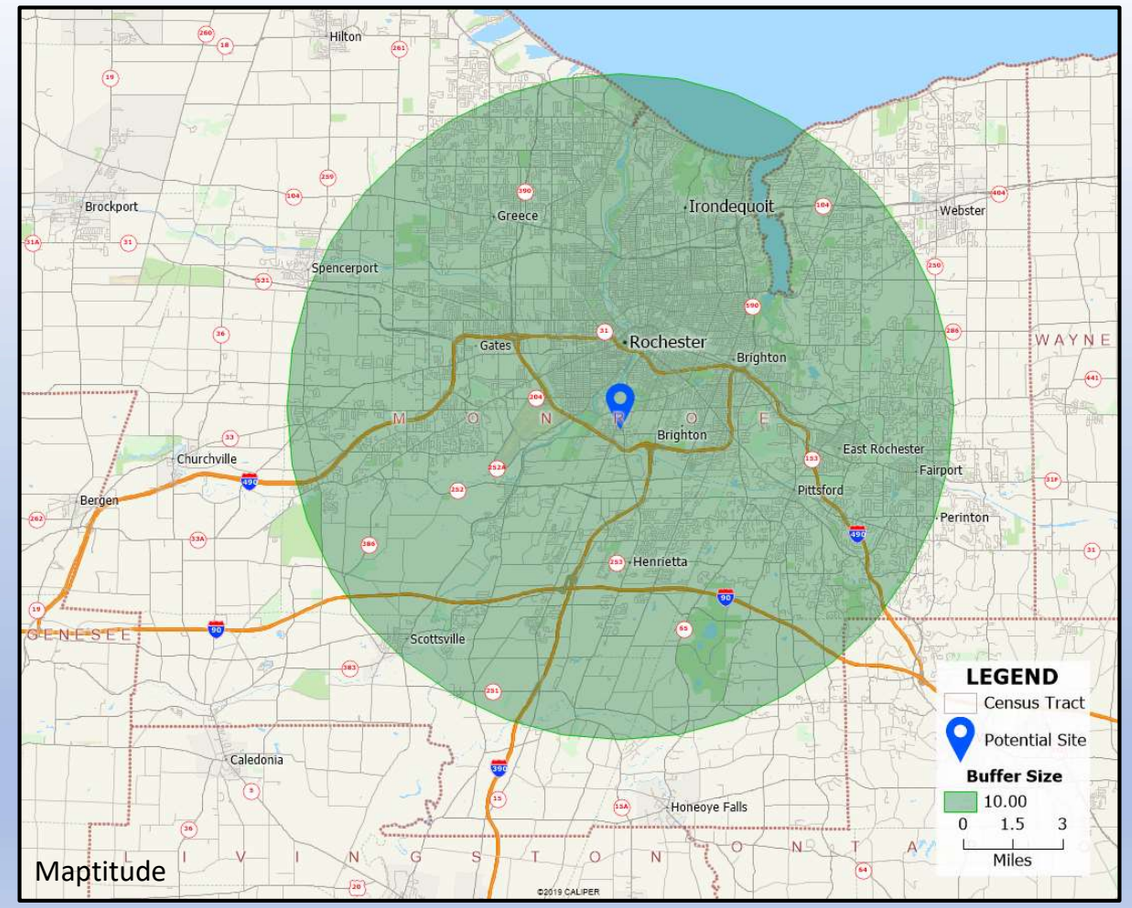


Figure C-9: A Simple Distance-Based Buffer Around a Business

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)

Example: Figure C-10 depicts a 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

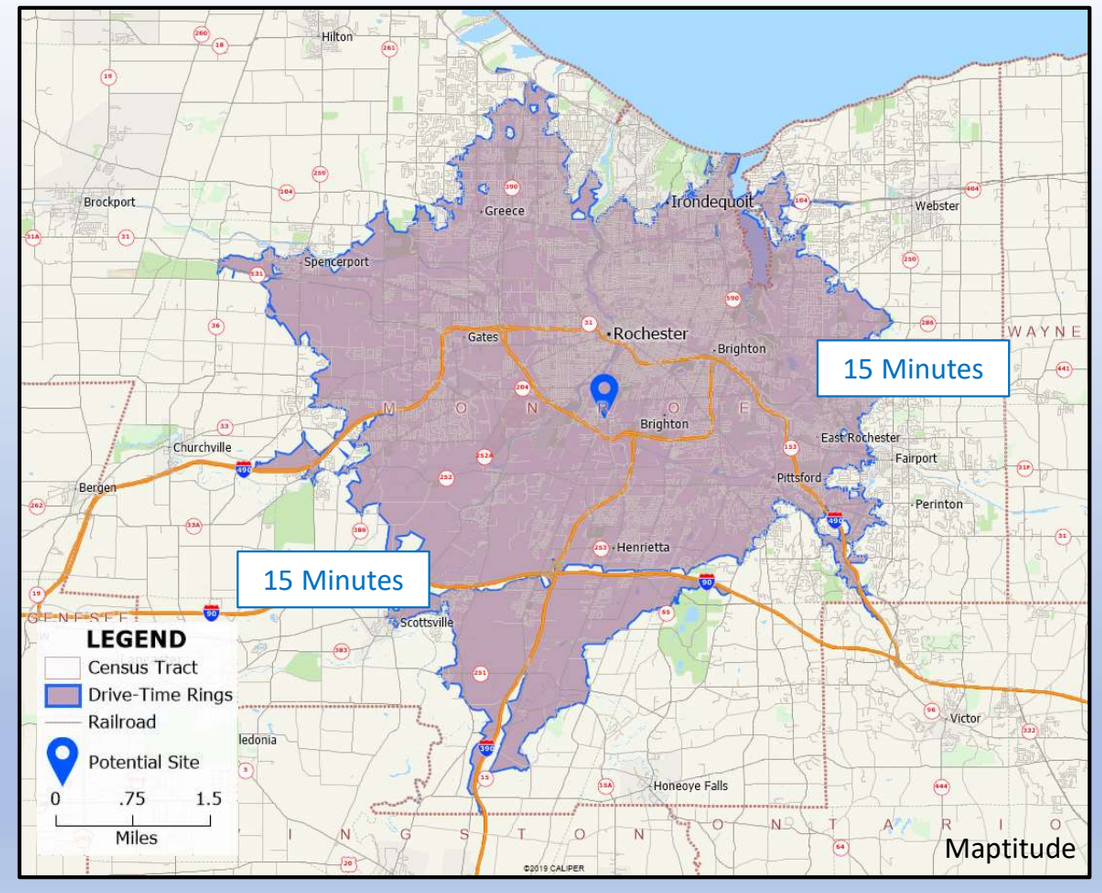


Figure C-10: A Drive-Time Buffer Around a Business

Detailed Discussion

Single-Zone: one value to consider

Example: Figure C-11 provides a situation with one zone definition based on a single 10-minute drive time around a retail location

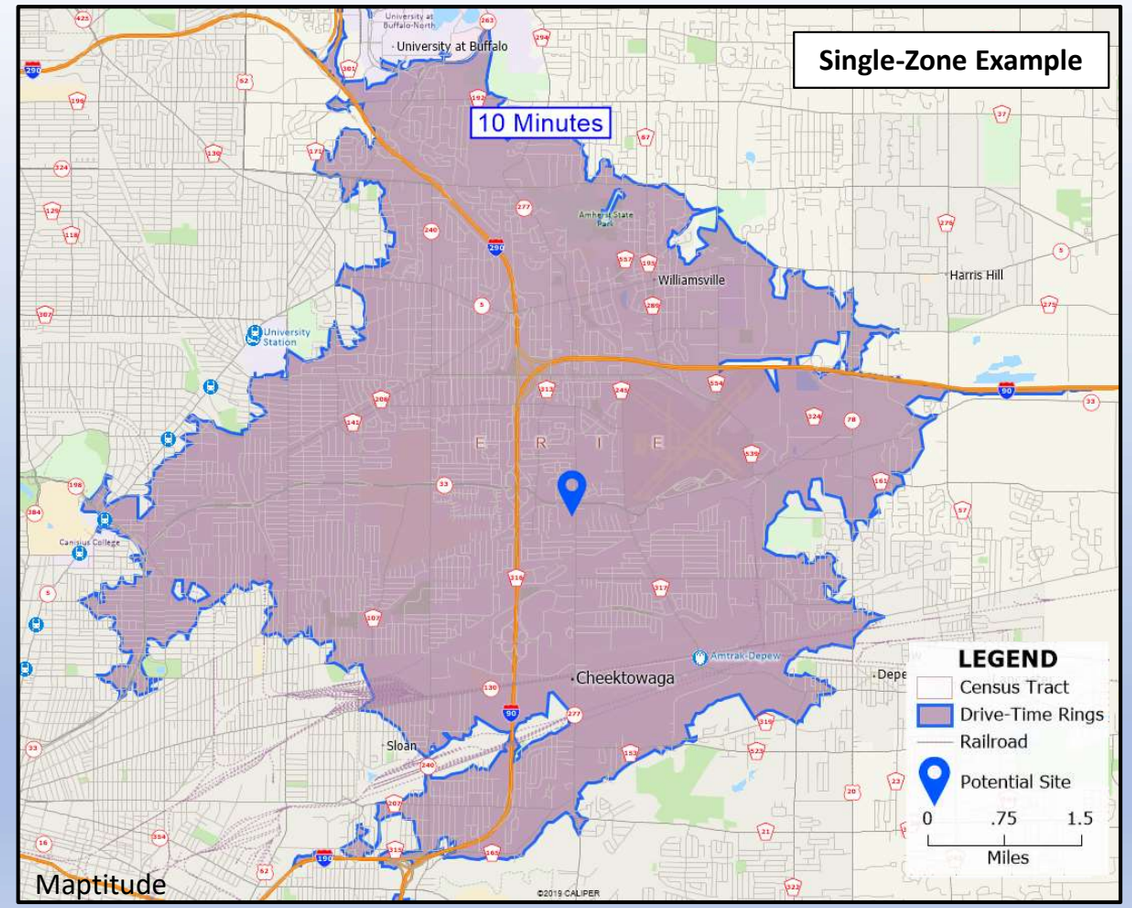


Figure C-11: A Single-Zone Buffer

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

Example: Figure C-12 shows nested zones based on a series of drive time around the same retail location, building from 2 minutes to 10 minutes

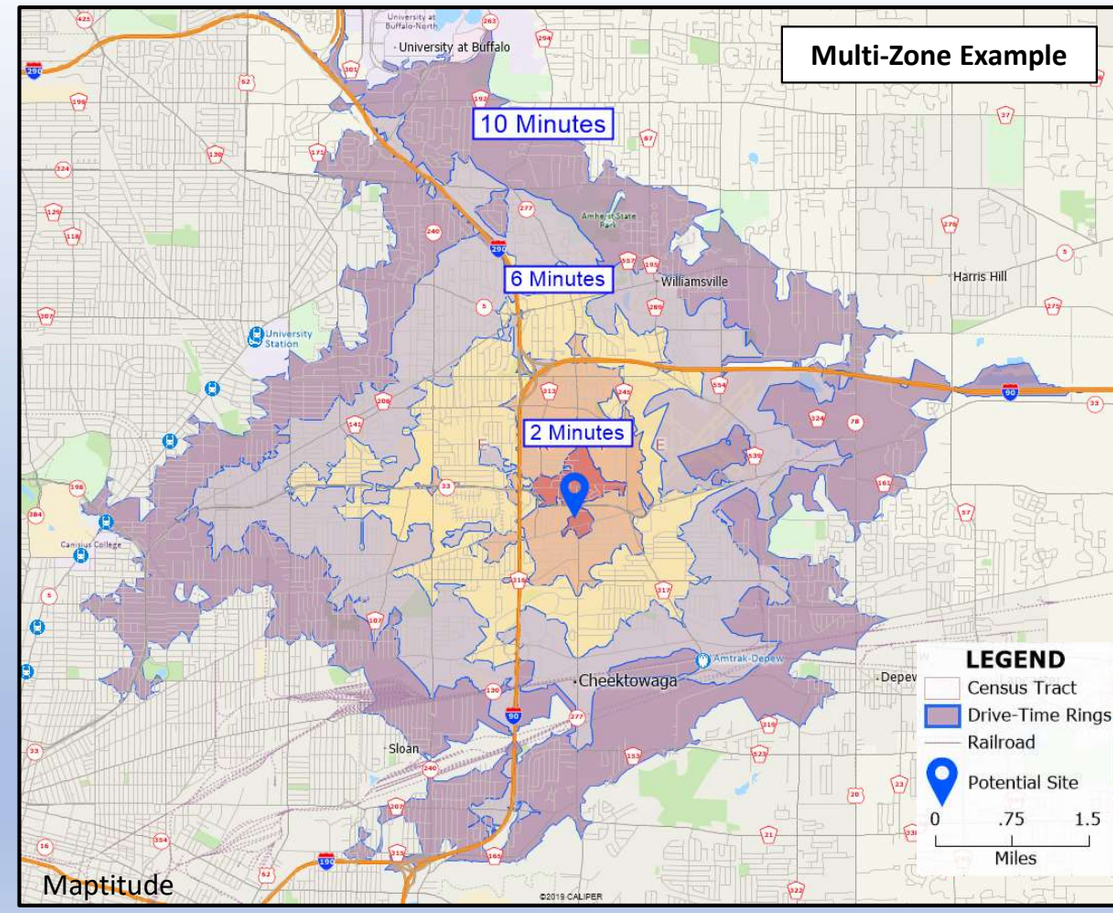
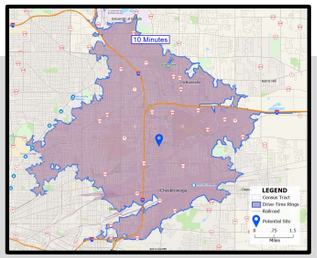


Figure C-12: A Multi-Zone Buffer

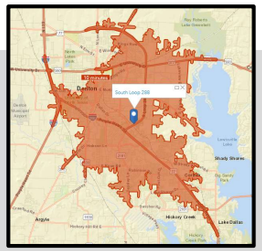
Resources and Processes to do a Buffer/Drive-Zone Analysis

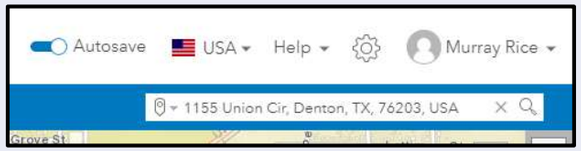
In Caliper Maptitude:



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 ArcGIS BA Web App:



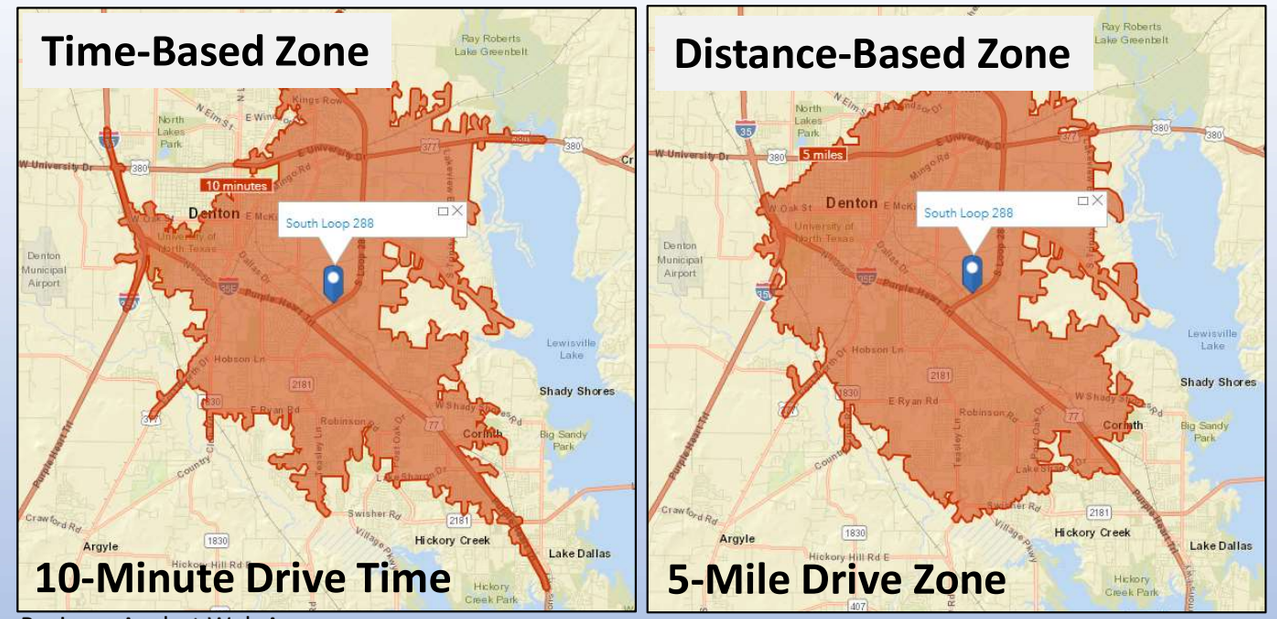
Buffer/Drive Zone Analysis…	
Supported by BA Web App	Yes
Starting the Analysis	"Address locate" tool on main screen 
More guidance from Esri	https://doc.arcgis.com/en/business-analyst/web/find-location.htm

In ArcGIS BA Web App (Special Note):

Buffers/Drive-Zone Results with BA Web App

ArcGIS BA Web provides some intriguing output options in the buffers/drive-zone analysis area. As represented in Figure C-13, ArcGIS 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 ArcGIS BA Web App also provides a useful 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.

Figure C-13: Possible Zone Options with BA Web App

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	Cu					5228	4885
1021	15	Cu					969	1328
1021							121291	153393
1021							962	1288
1021	1018	Cu					1049	1284
1021	1019	Cu					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

In this case, buffer analysis results in the appending of a store ID field representing the closest store to the customer

Figure C-14: 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 Figure C-15 in detail, we can see some areas of concern along with some positive features.

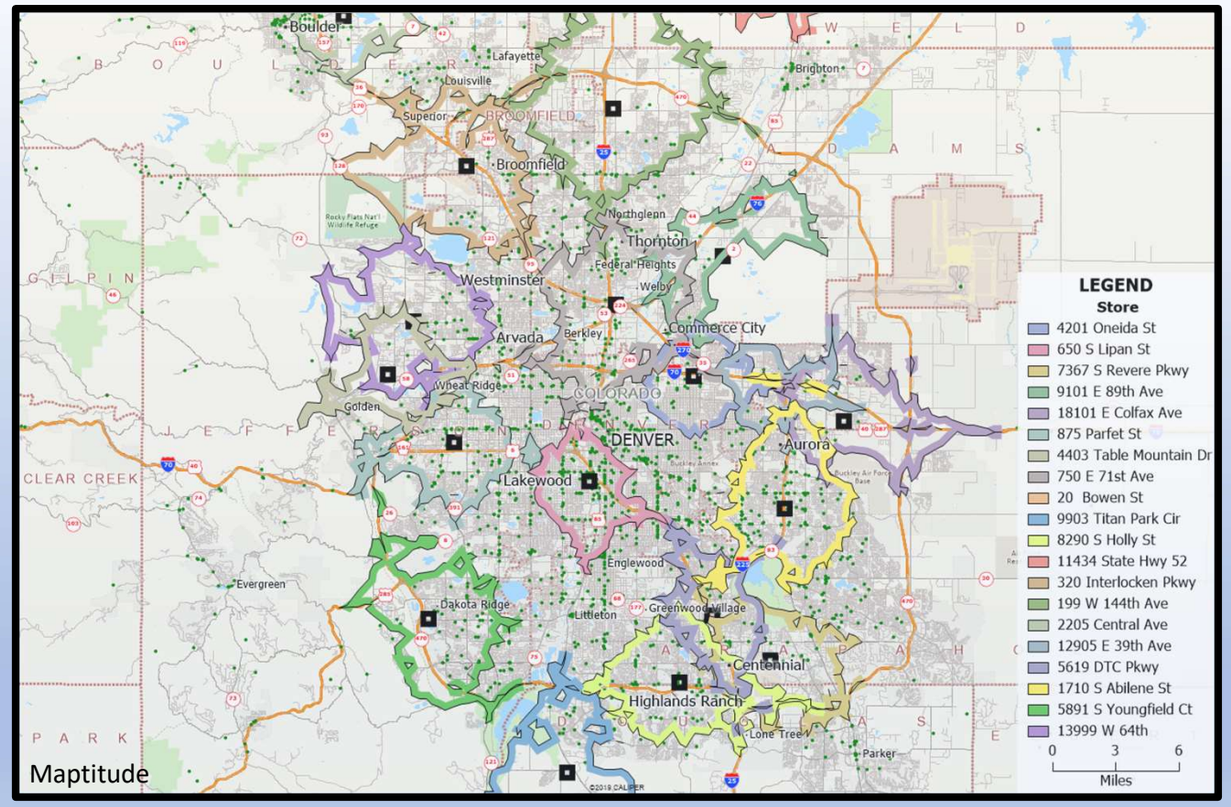


Figure C-15 : Denver-Area Customers and Store-Based Drive-Zones

What Next

1 Figure C-16 (a detail extracted from Figure C-15) represents a first concern: an <u>excessive market area overlap</u> in one portion of the map.

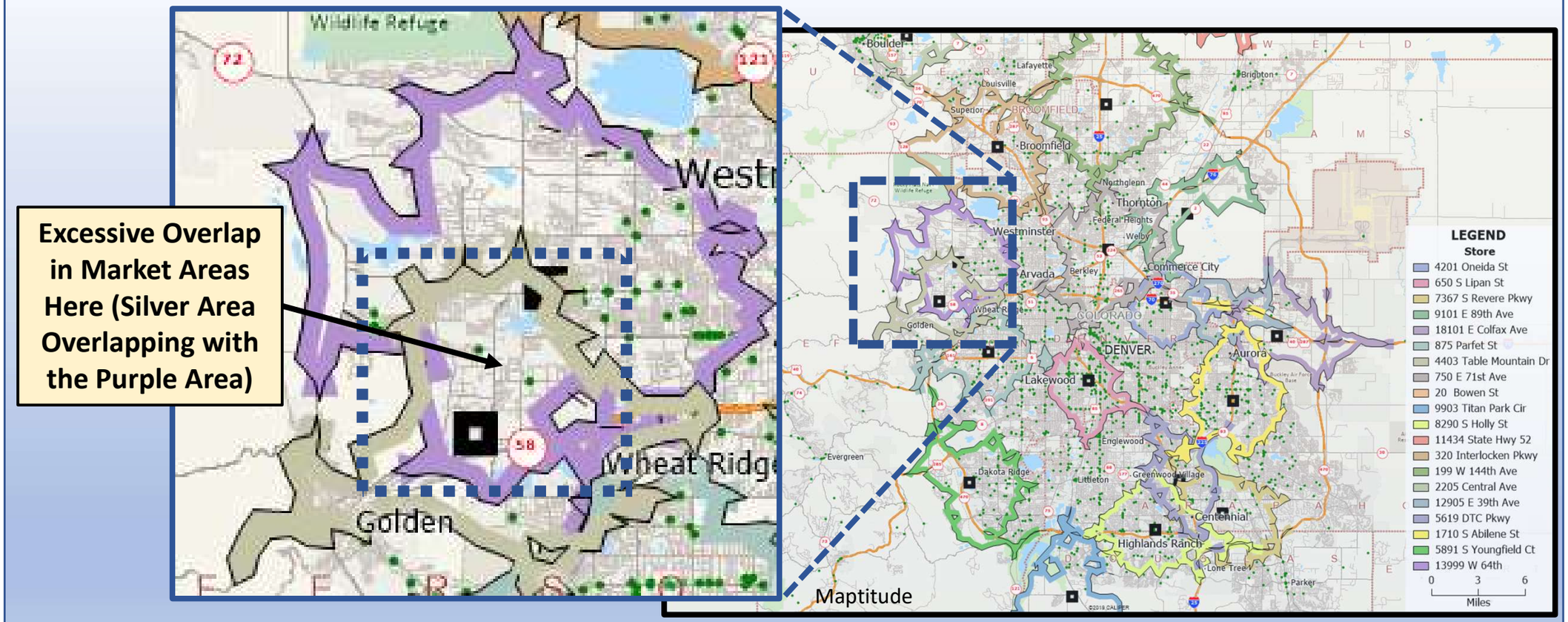


Figure C-16: One Concern Highlighted by Buffer Analysis – Excessive Overlap

What Next

2 Figure C-17 highlights a second concern, again extracted from Figure C-15: an <u>excessive gap in coverage</u>, leaving a portion of a larger market under-served.

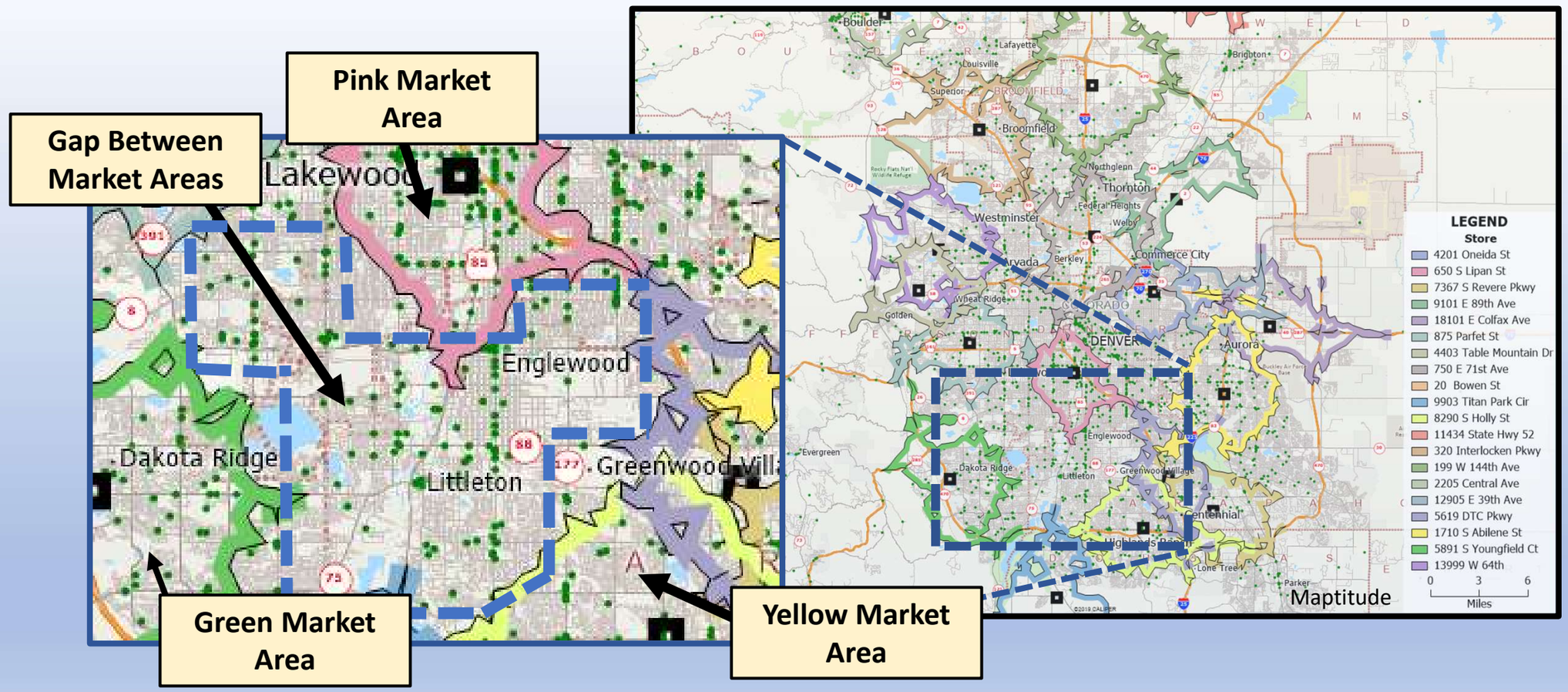


Figure C-17: Another Concern Highlighted by Buffer Analysis – An Excessive Coverage Gap

What Next

3 Finally, Figure C-18 shows a portion of the Denver market area where the situation depicted in Figure C-15 appears to be working well, in terms of market coverage.

Customers and Store-Based Drive-Zones

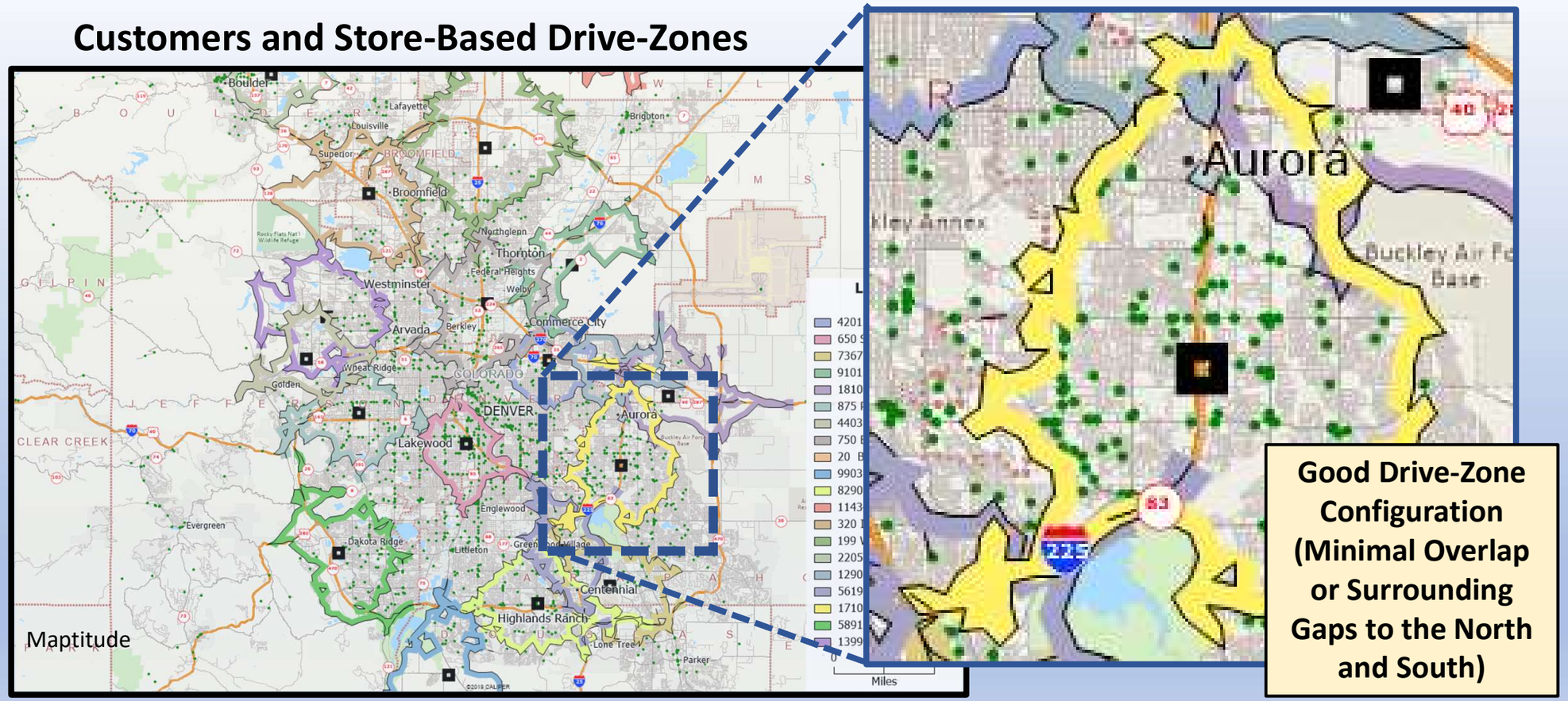


Figure C-18: Buffer Analysis – A Good Situation

Method 3: Choropleth Mapping

Overview of Choropleth Mapping	80
Detailed Discussion: Choropleth Mapping Considerations	81
Resources and Processes to do Choropleth Mapping	83
What Next: Once You've Created a Choropleth Map	84

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 57). 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 58).
- 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 62).

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 Considerations

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

Chicago Example: Figure C-19 represents the variation across the Chicago metropolitan area of 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.

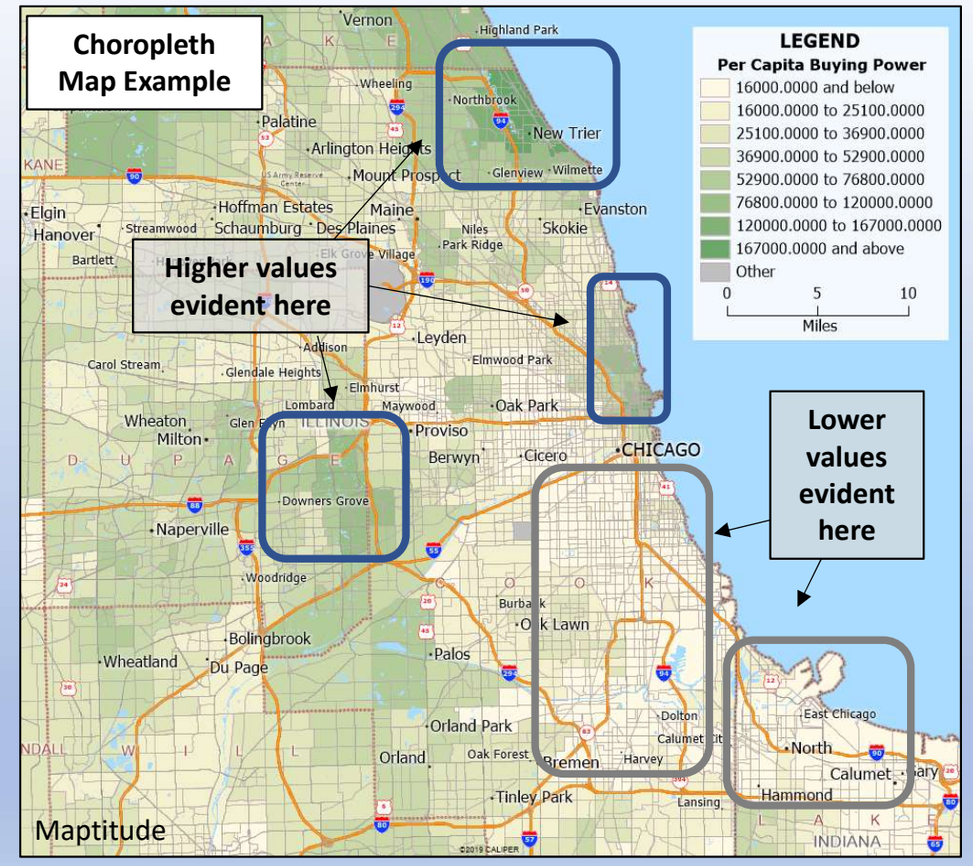


Figure C-19: A Basic Choropleth Map Example

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: Figure C-20 represents 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.

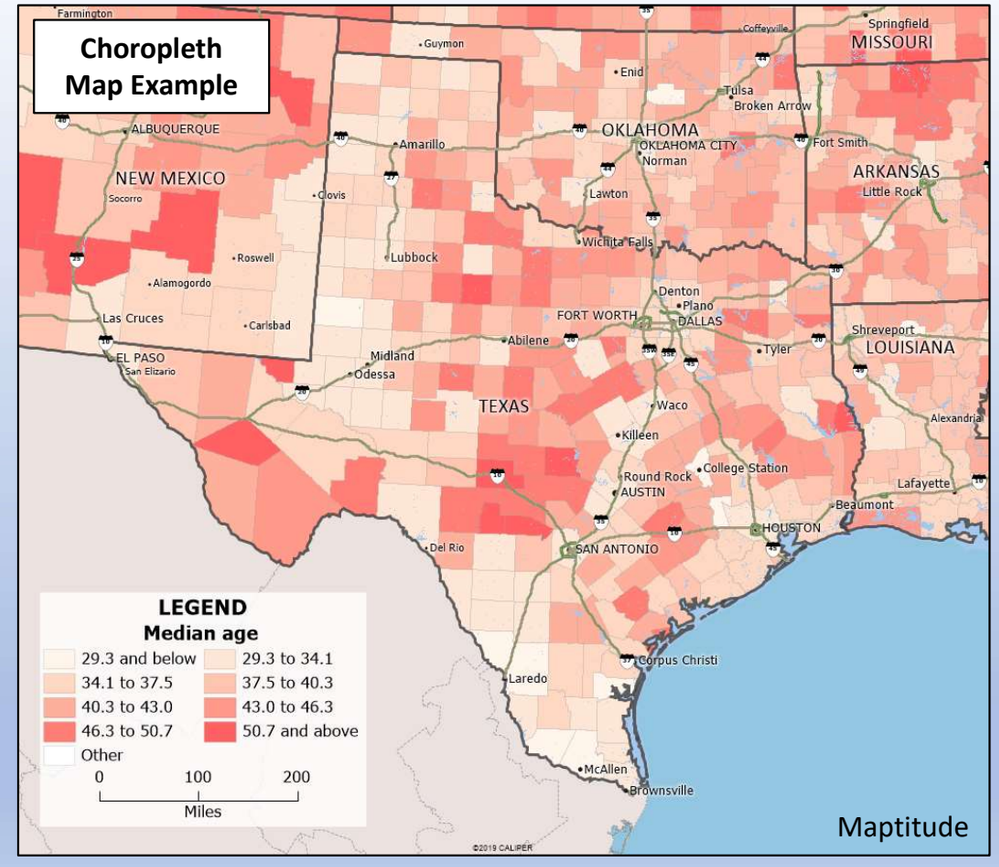
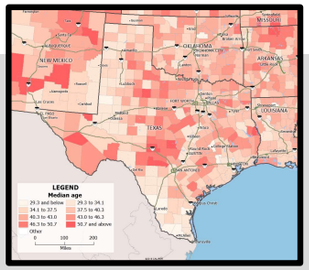
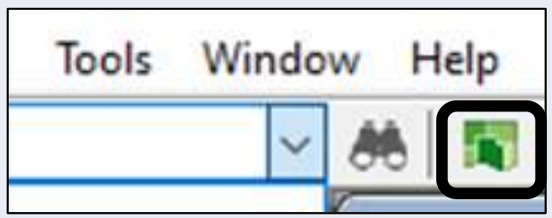


Figure C-20: Large-Area Choropleth Map Example

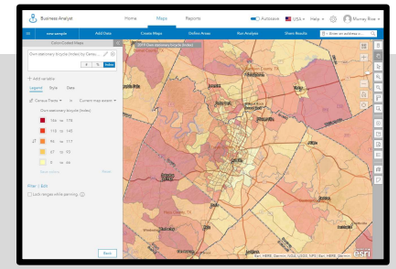
Resources and Processes to Complete a Choropleth Map

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 ArcGIS 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: Figure C-21 depicts 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.

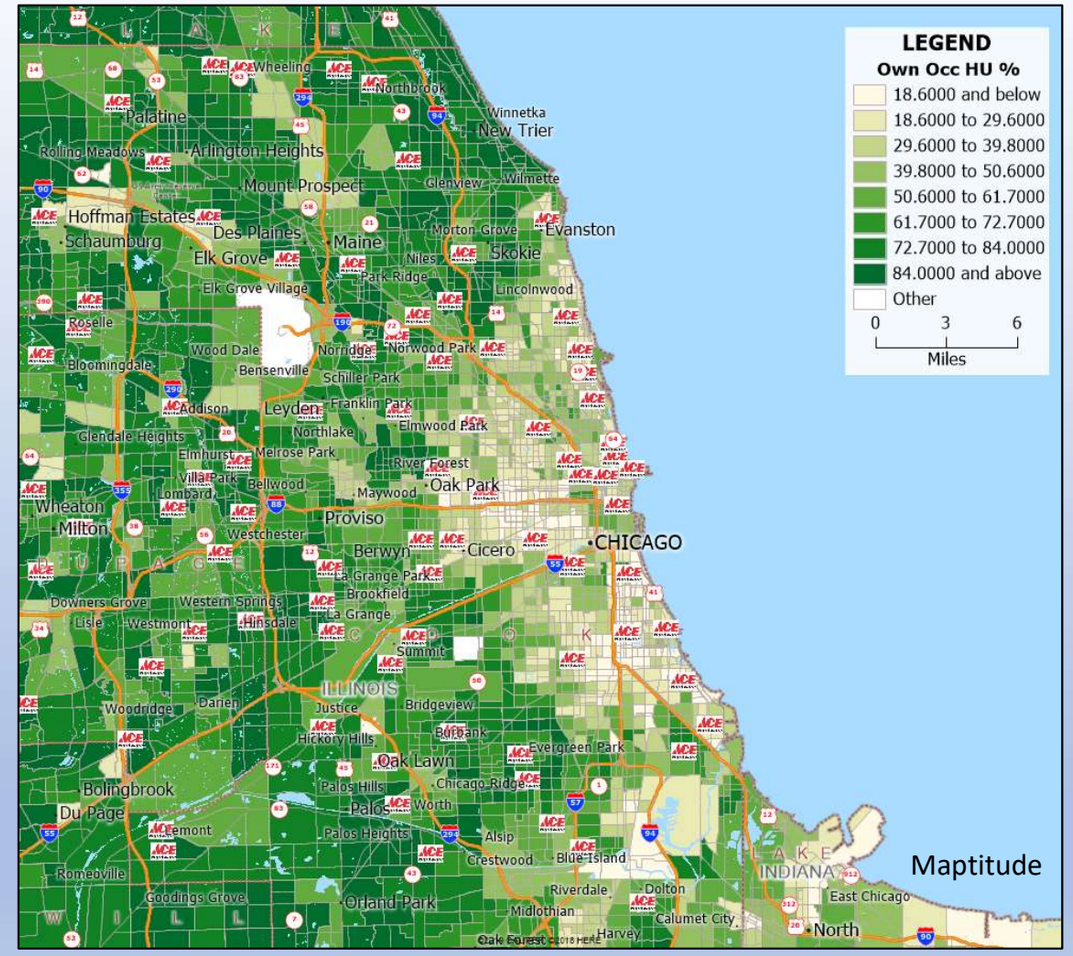


Figure C-21: Hardware Store Locations versus Owner-Occupied Housing Units Choropleth Theme

Method 4: Target Zone Identification

Overview of Target Zone Identification 86

Detailed Discussion:
A. Target Zone: Single-Factor 88
B. Target Zone: Multi-Factor 91

Resources and Processes to do a Target Zone Analysis 95

Next Steps After Completing a Target Zone Analysis 96

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: Figure C-22 identifies census tracts hosting households with much above average hunting and fishing expenditures

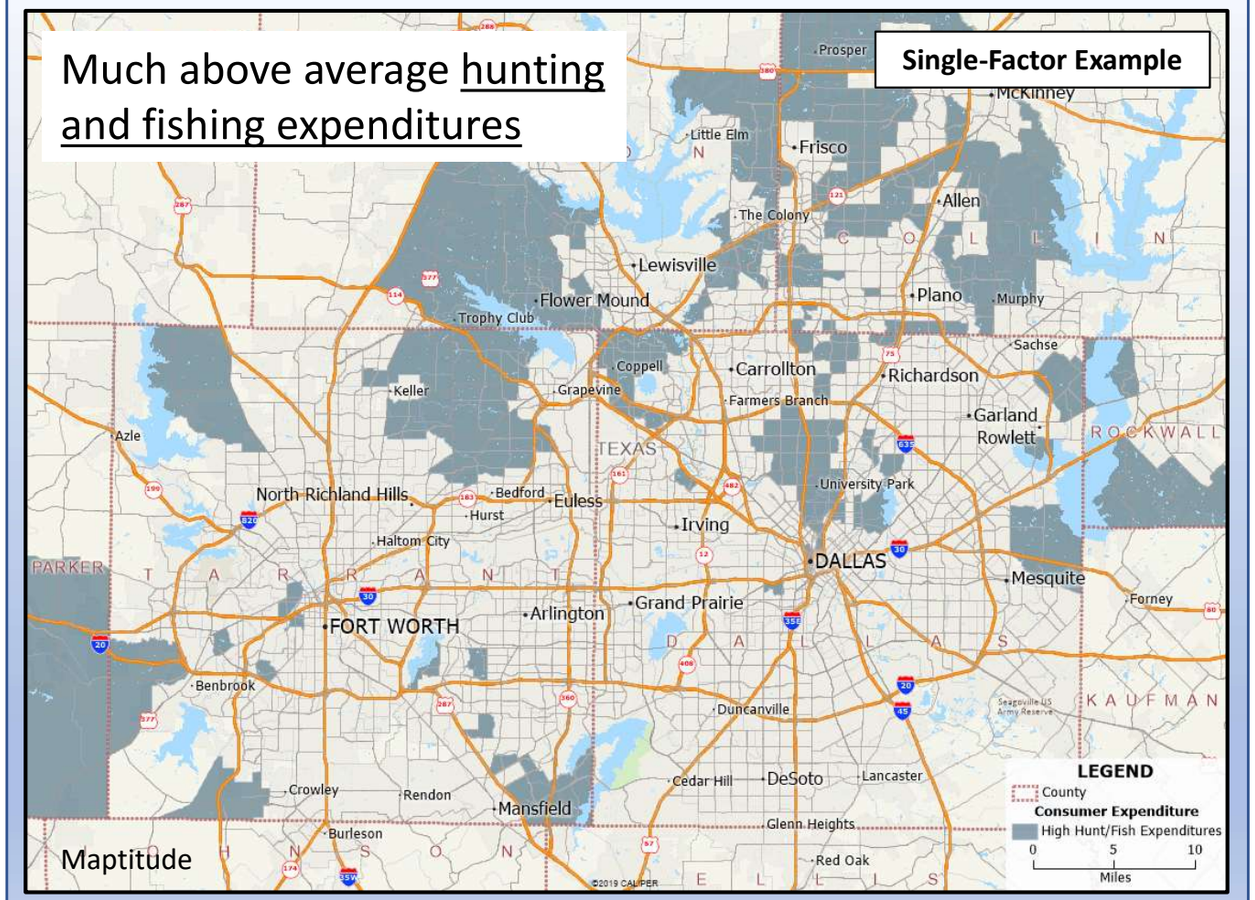


Figure C-22: Initial Target Zone Analysis Example

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

The Dallas-Fort Worth example in Figure C-23 includes a map indicating the census tracts with households that with much above average median household incomes (straightforward use of a single variable known for all census tracts)

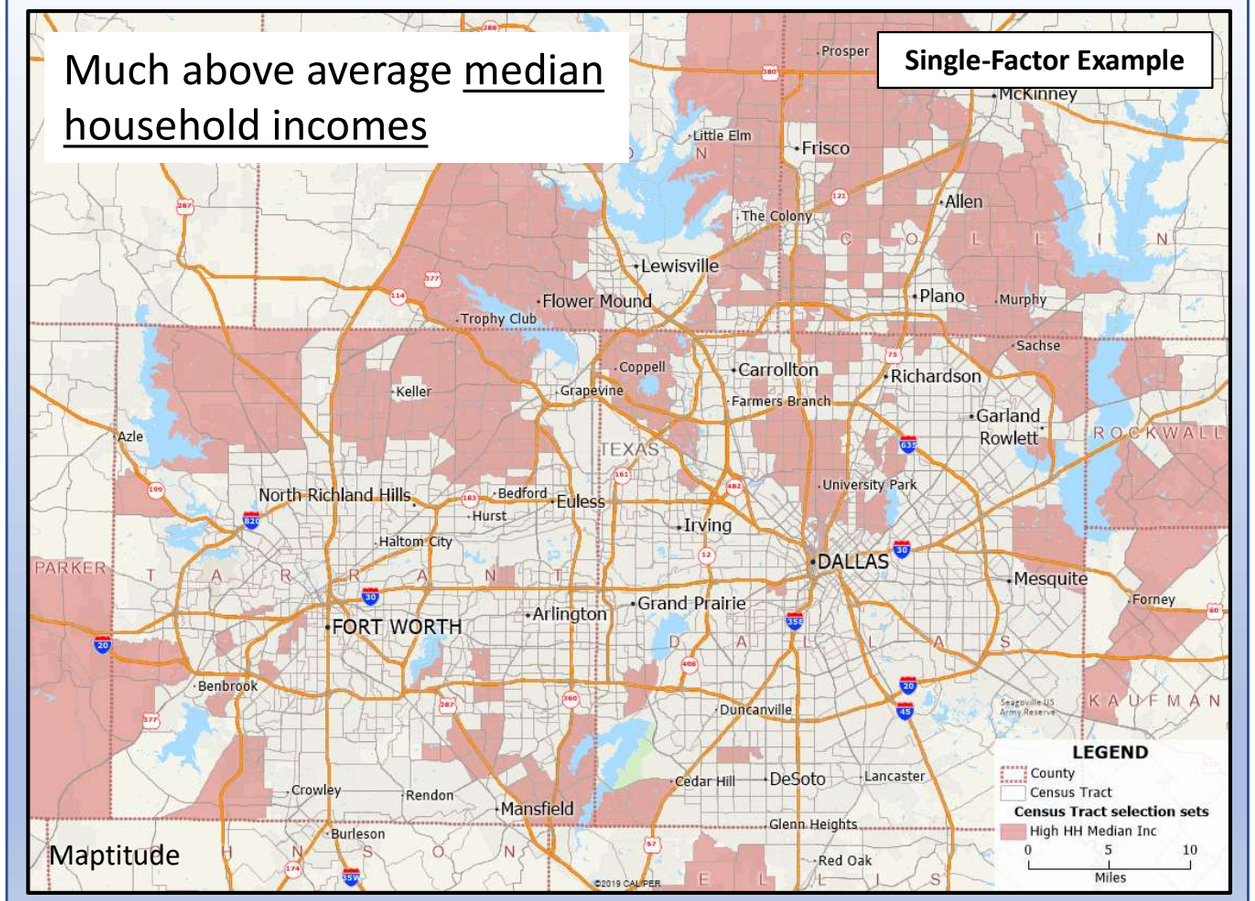


Figure C-23: Single Factor Target Zone Example

Detailed Discussion

Figure C-24 illustrates a sequential development of

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

Note how GIS can support the creation of new variables not in the original database that can be used in a target zone analysis like any other variable

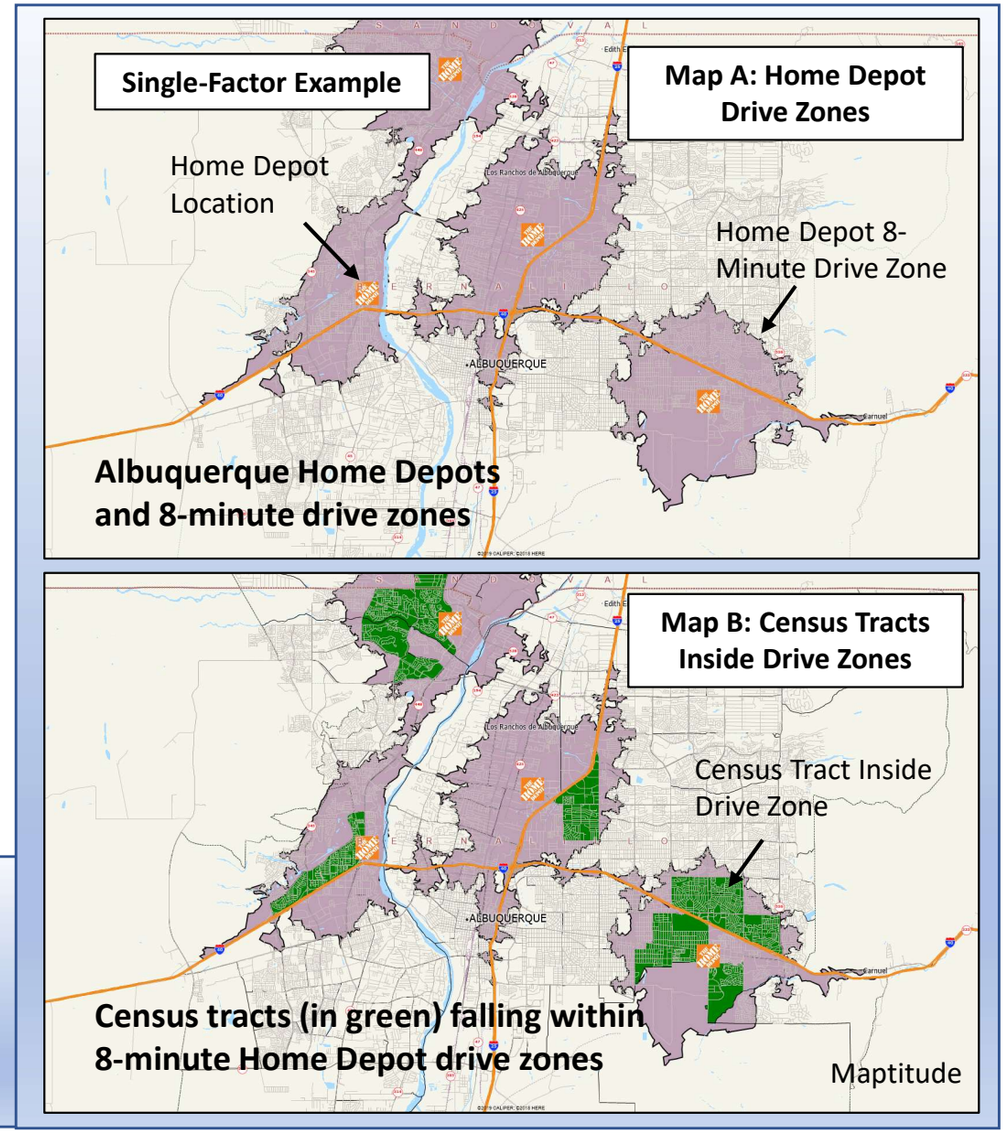


Figure C-24: Single Factor Target Zone Example (Based on Geospatial Analysis)

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

The Dallas-Fort Worth example in Figure C-25 focuses on a map indicating the census tracts with households with much above average diaper purchases and much above average median household incomes

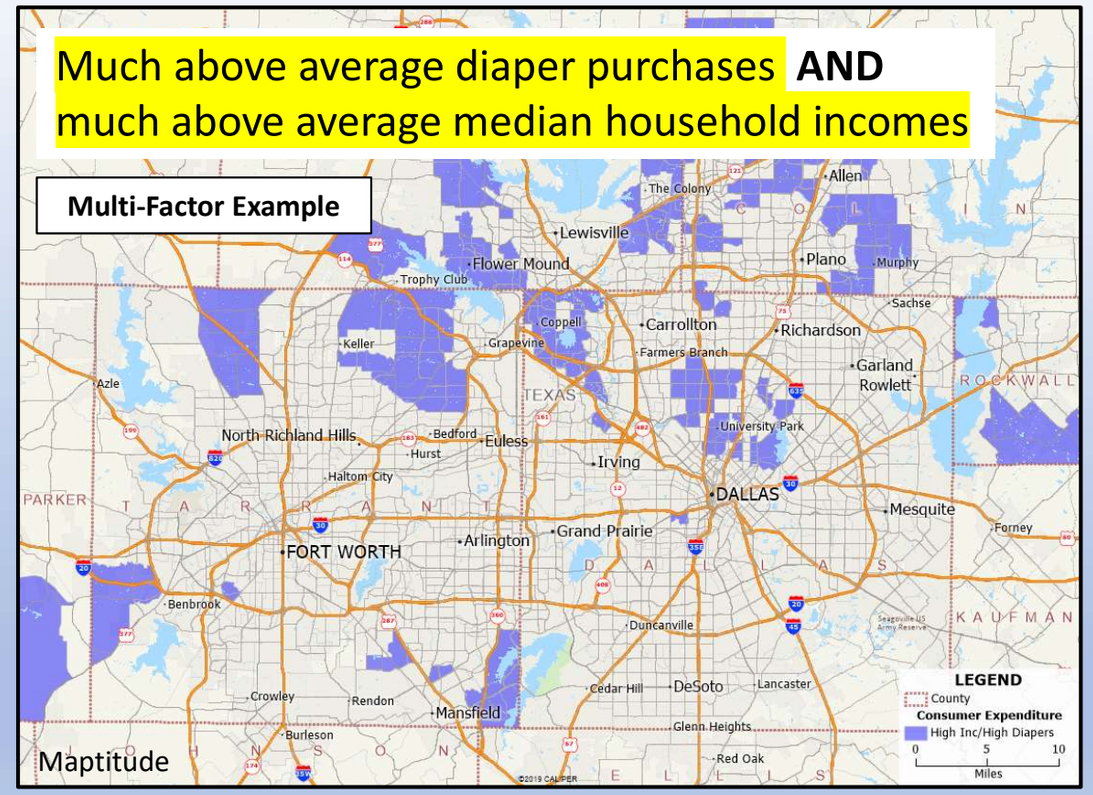


Figure C-25: Multi-Factor Target Zone Example

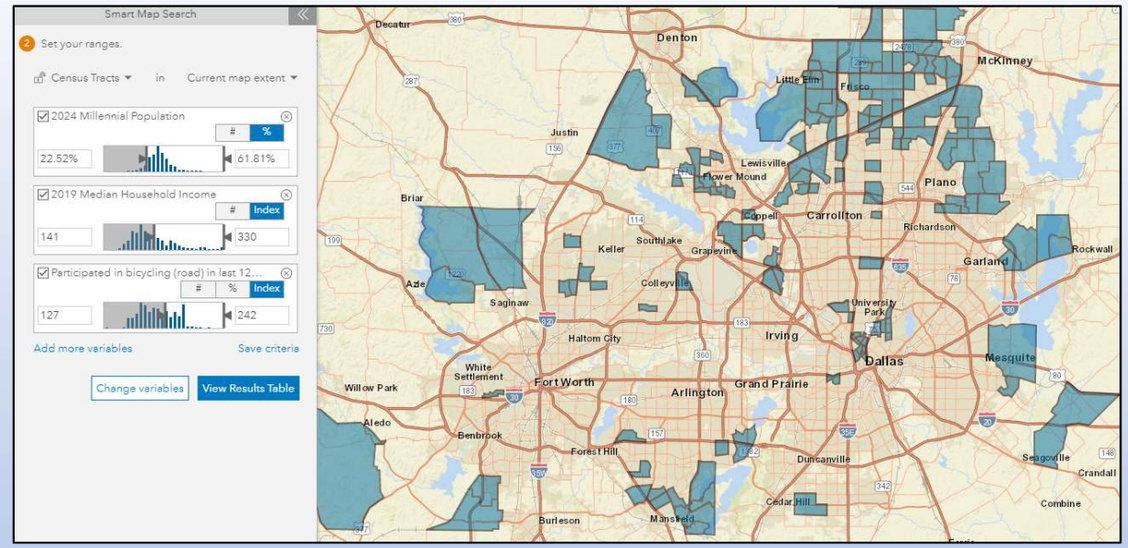
Detailed Discussion

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

Figure C-26 provides a tangible example of the AND function, applied to a situation with three conditions. Figures C-27 and C-28 sum up the discussion to give an overview.



ArcGIS Business Analyst Web App

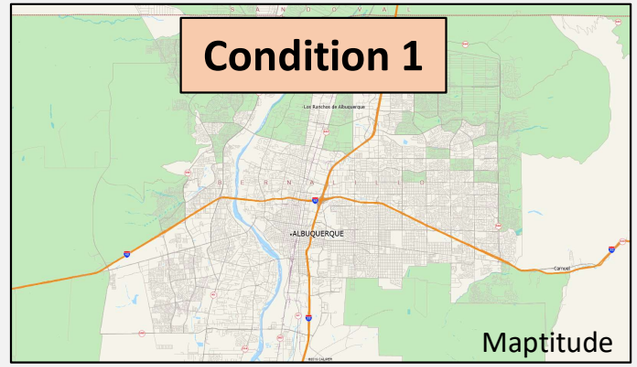
Dallas-Fort Worth Example: map indicating the census tracts with high levels of

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

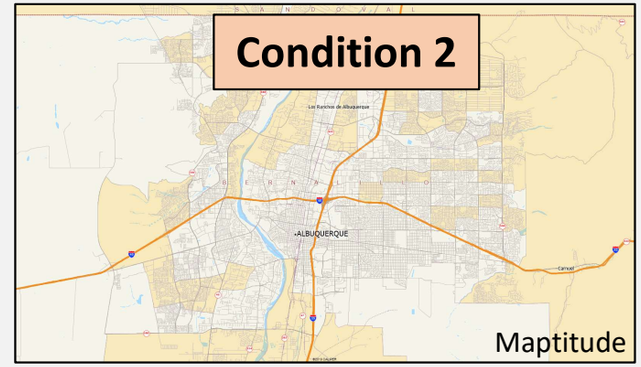
Figure C-26: Multi-Factor Target Example Using Boolean Functions

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>

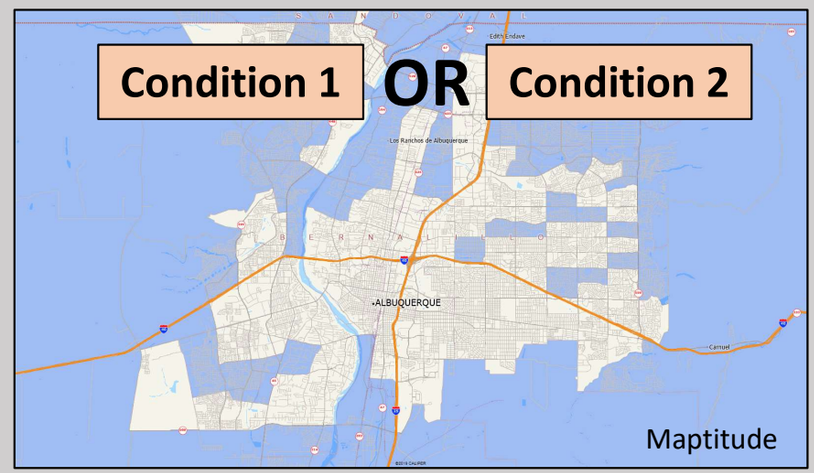
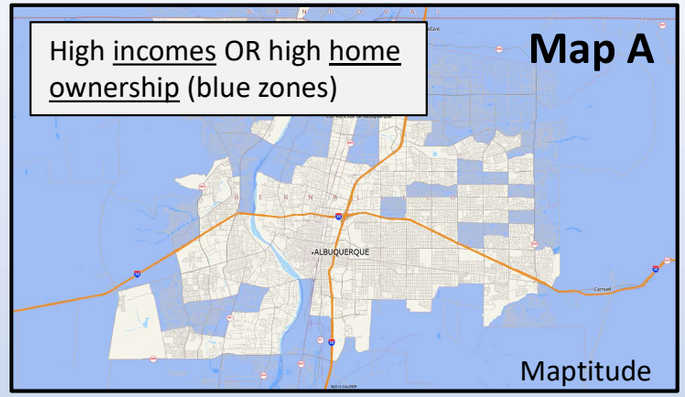


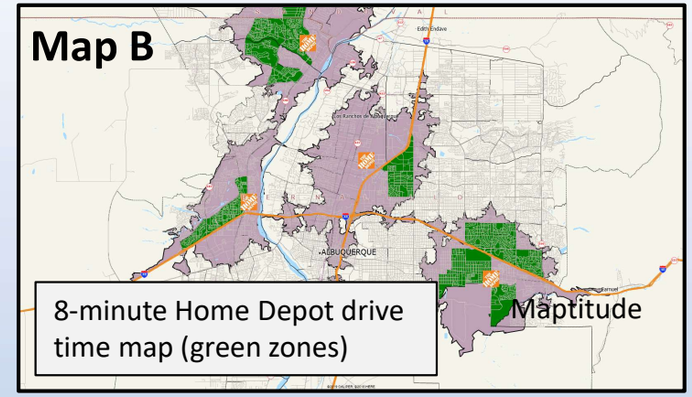
Figure C-27: Multi-Factor Target Example (Components)

Detailed Discussion

Combining our Albuquerque examples from the last few pages:

- **Map A:** our conditional map from Figure C-28 (high incomes OR high home ownership)
- **Map B:** our 8-minute drive time Home Depot proximity map (Figure C-24)
- **Final map:** representing a combined attribute and location based selection target zone map





Map A + Map B =

Which census tracts are identified in both?

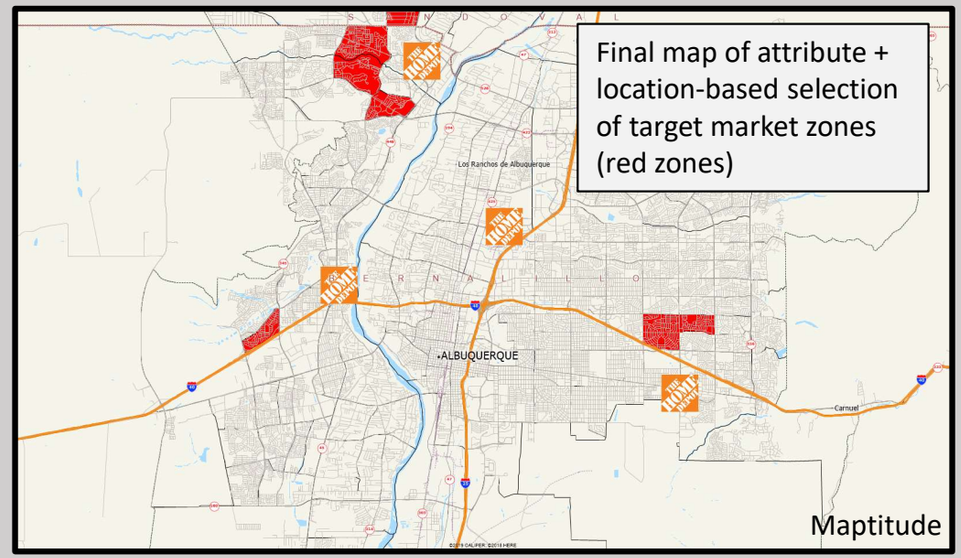
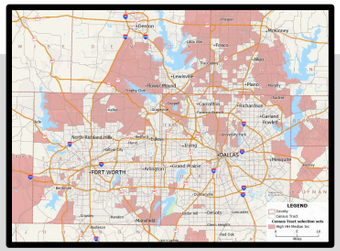
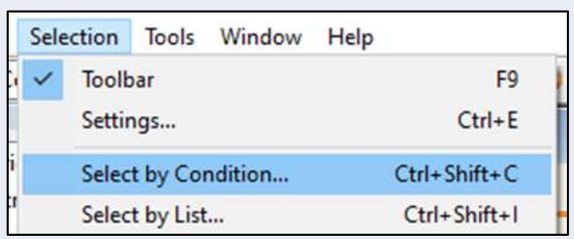


Figure C-28: Combined Target Example

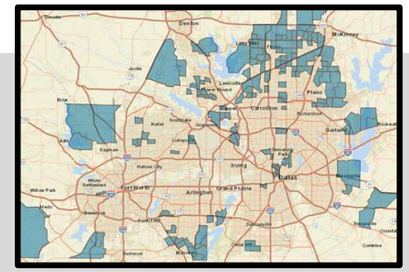
Resources and Processes to Do a Target Zone Analysis

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 ArcGIS 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

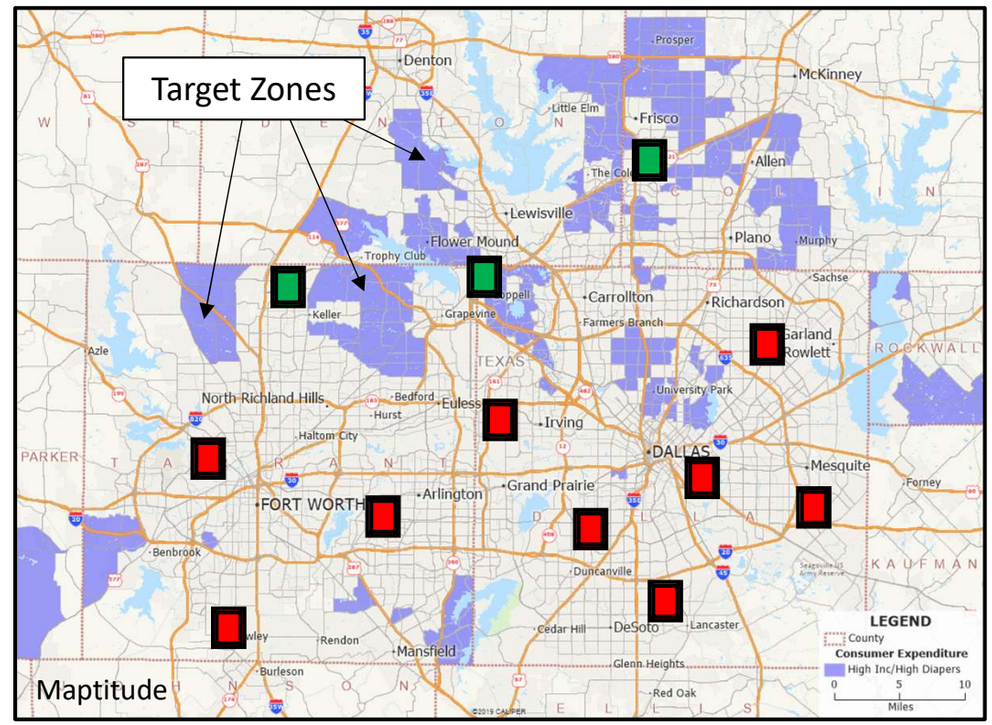


Figure C-29: Map of Target Zones and Potential Store Locations

What Next

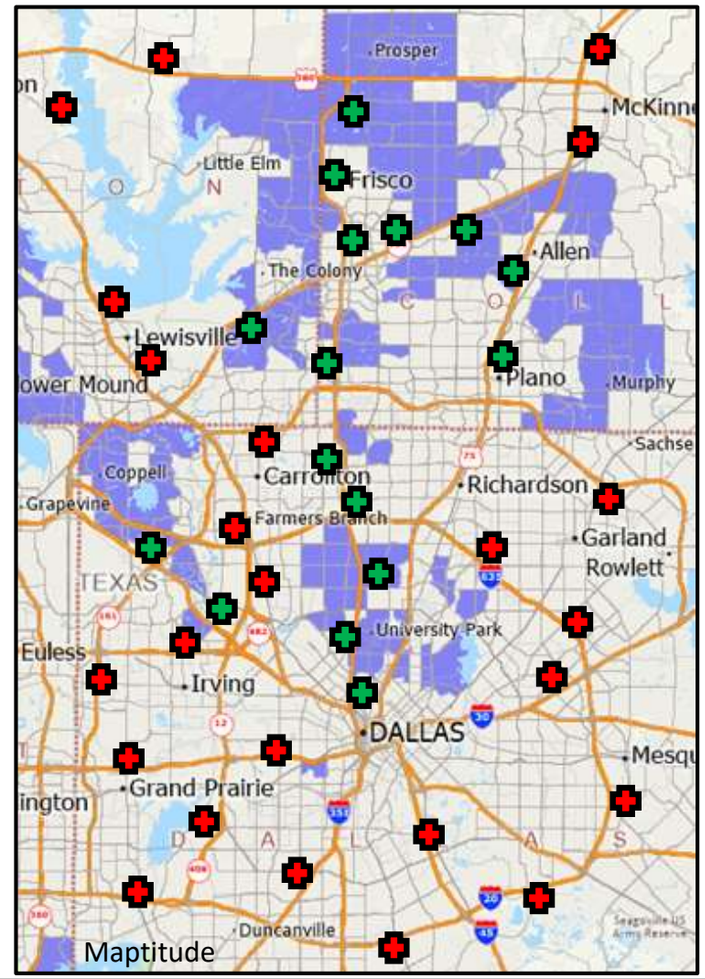
Target zone analysis also provides a foundation to visualize the use of physical advertising assets (such as billboard placement) for reaching households in the target zones already identified

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

Figure C-30: Map of Target Zones and Potential Billboard Locations



Identify the Best Billboard Opportunities for Effective Communication with a Target Market*

* This target zone approach can be combined with use of traffic data and a network-based analysis (see pages 137-145) for a more robust solution.

Method 5: Geodemographic Segmentation

Overview of Geodemographic Segmentation 100

Detailed Discussion:
- Geodemographic Segmentation 101

Resources and Processes to do a Geodemographic Segmentation Analysis 104

Next Steps After Completing a Geodemographic Segmentation Analysis 105

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 power of considering 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 foreign business links. 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.

Figure C-31: 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-age, middle-income, moderately-educated, SUV-owning households.

Figure C-32: Middle-Class Suburb in Denton, Texas

Detailed Discussion

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.

Figure C-33: Boston's Beacon Hill

The three example neighborhoods are summarized in Table C-1, representing the variation in neighborhood prevalence that is characteristic of such a geodemographic analysis.

Table C-1: The Three Example Neighborhood Types Discussed Here

Neighborhood Number	Neighborhood Brief Description	Representative Segment Type (Name from 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.

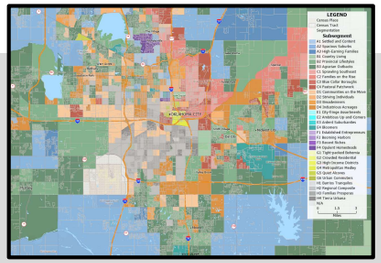
Because such segmentation systems are complex and expensive to build and update in an ongoing basis, generally geospatial analysts rely on segmentation schemes that are created by major GIS and geospatial analytics firms.

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

* One related point is worth making here. While not an example of 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.

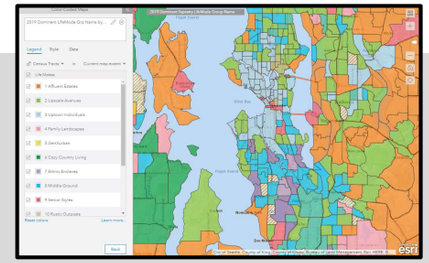
Resources and Processes to do a Geodemographic Segmentation Analysis

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 ArcGIS 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?
One extension: 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 or census block group

- 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

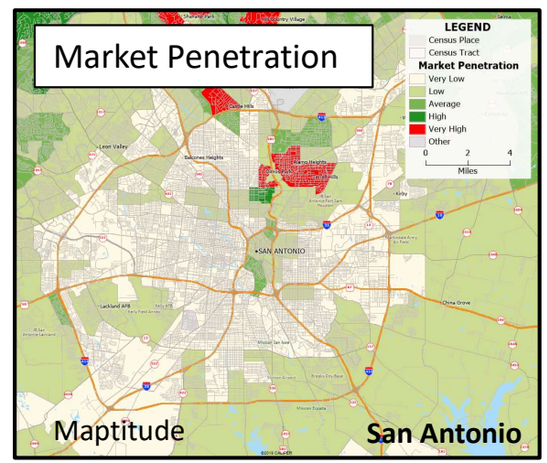
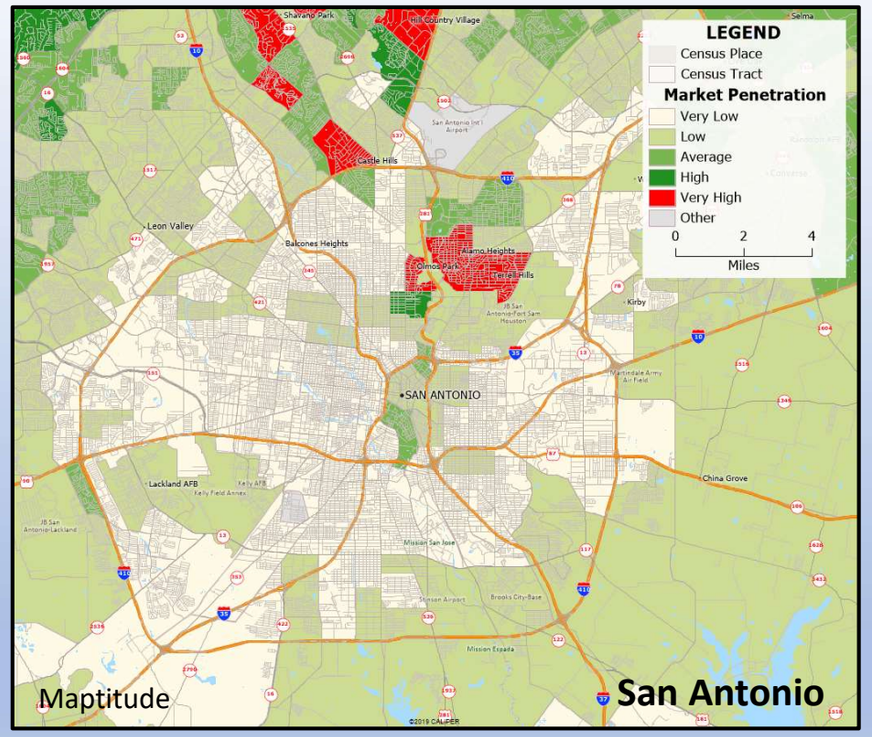


Figure C-34: Market Penetration Mapping

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

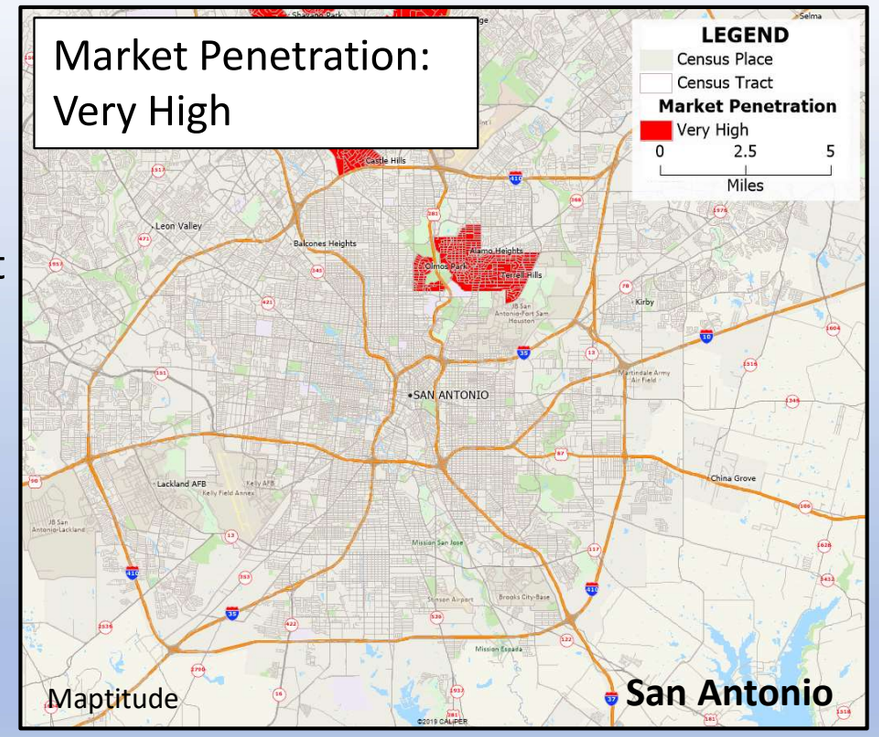


Figure C-35: Market Penetration With a Focus on Very High Penetration Zones

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. In this case, these segments are:

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

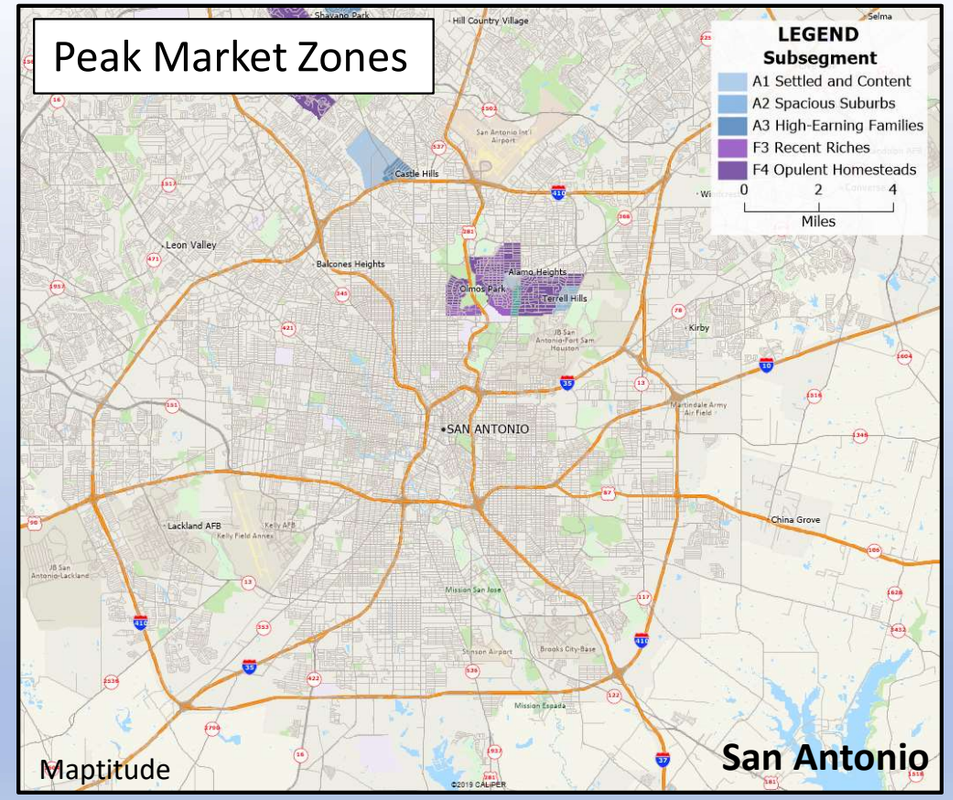


Figure C-36: Extracting Geodemographic Segments from Very High Penetration Zones

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

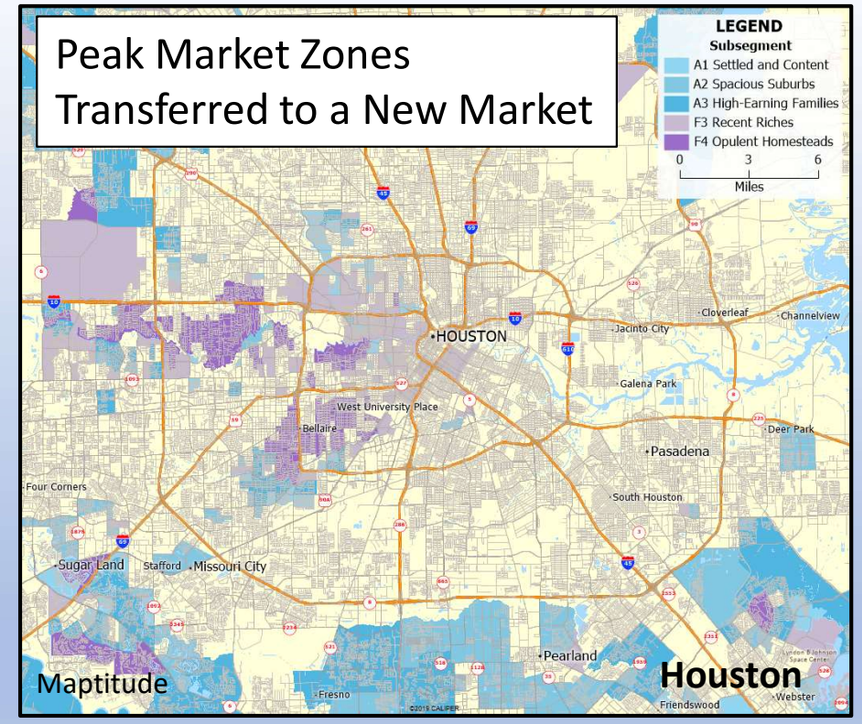


Figure C-37: Locating Very High Penetration Geodemographic Segments in a New Market Area

Method 6: Density Grid Analysis

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Overview of Density Grid Analysis

In adding a location component to an existing database (method 1, page 55), we often end up with a map of point locations. Making sense of point distributions is often a challenging task.

For example, Figure C-38 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.

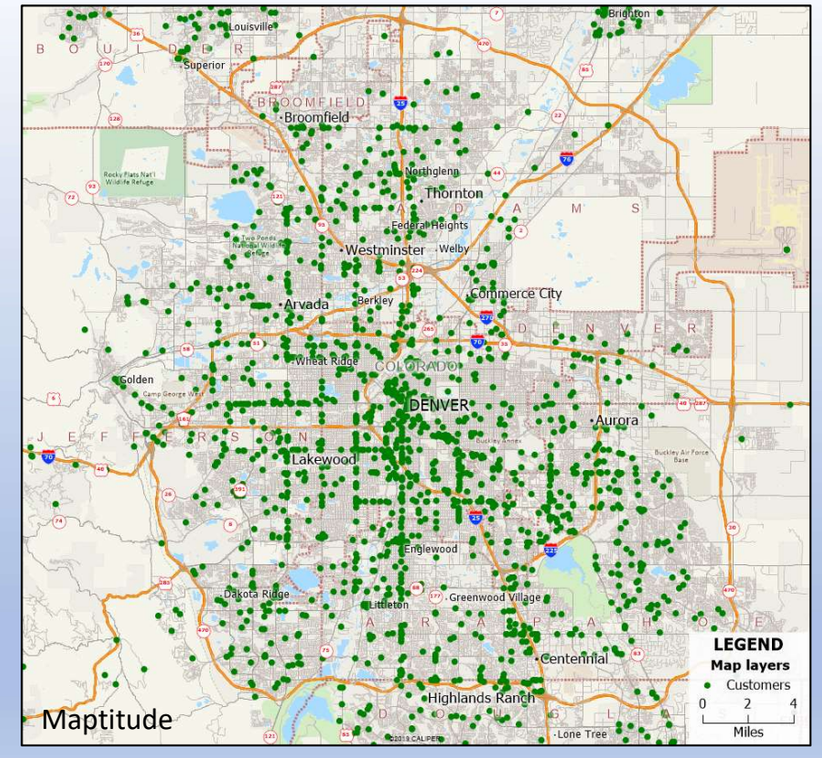


Figure C-38: Customer Dot Map

Detailed Discussion: Density Grid Analysis

The starting point: a complex map of point locations, such as our customer location theme, that defies simple description (see Customer Location Map in Figure C-39).

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 density grid map in Figure C-39. But before we unpack that result further, how do we actually get there?

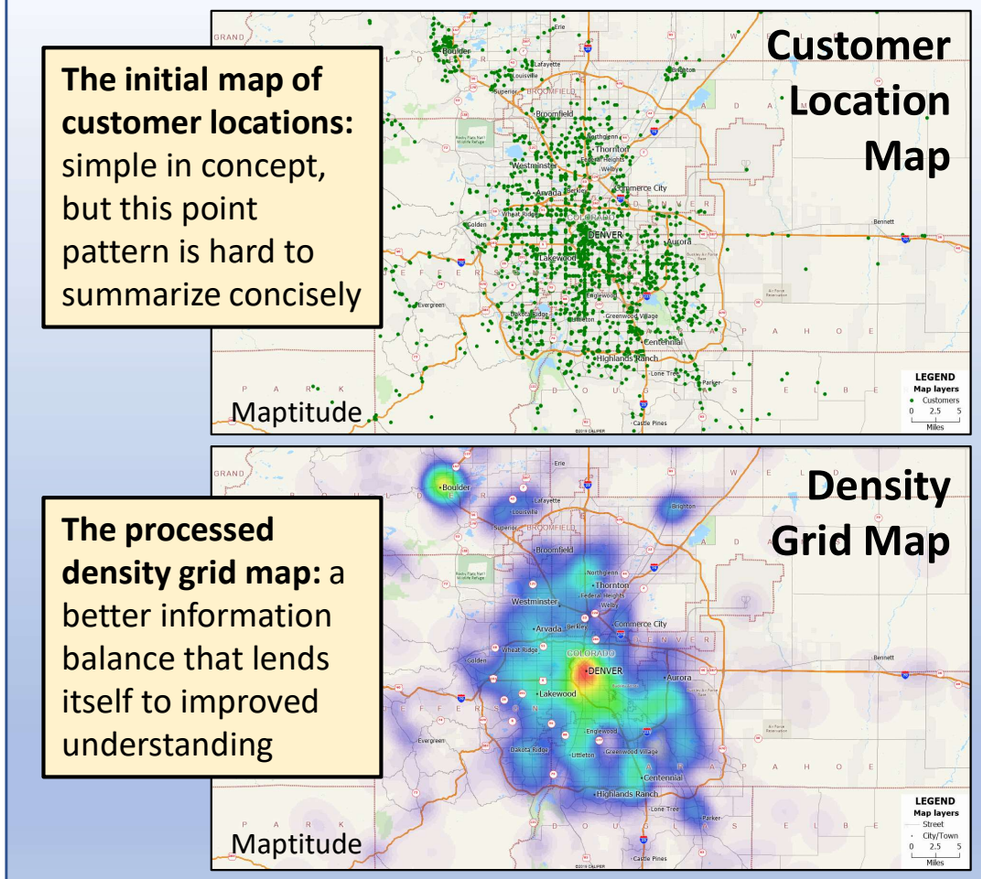


Figure C-39: Dot Map Transformed to a Density Grid Map

Detailed Discussion

The density calculation, explained: on our customer map, let's take a sample location to illustrate the process (Figure C-40). 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.

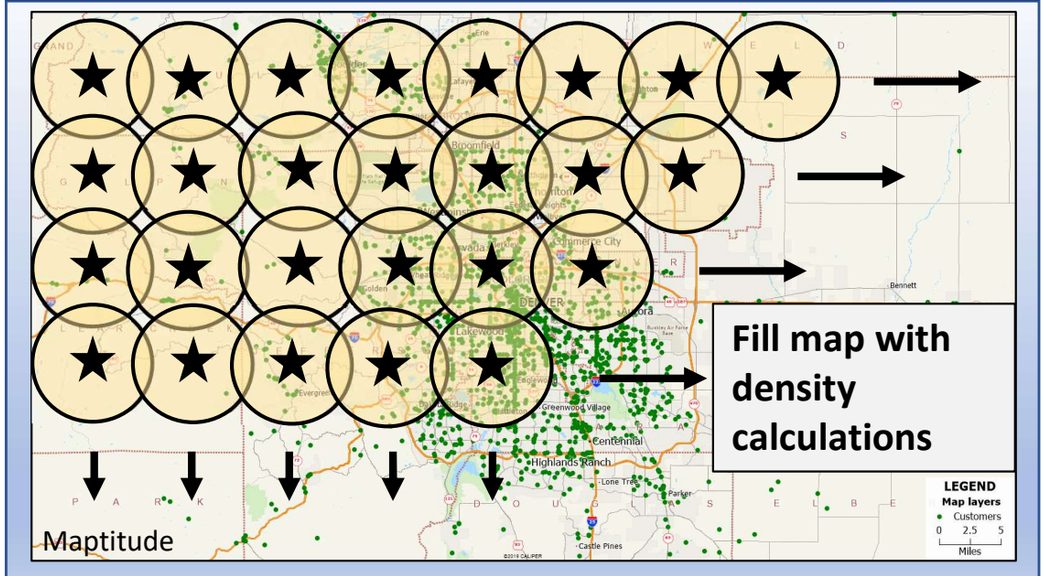


Figure C-41: Customer Density Grid Map, Filled

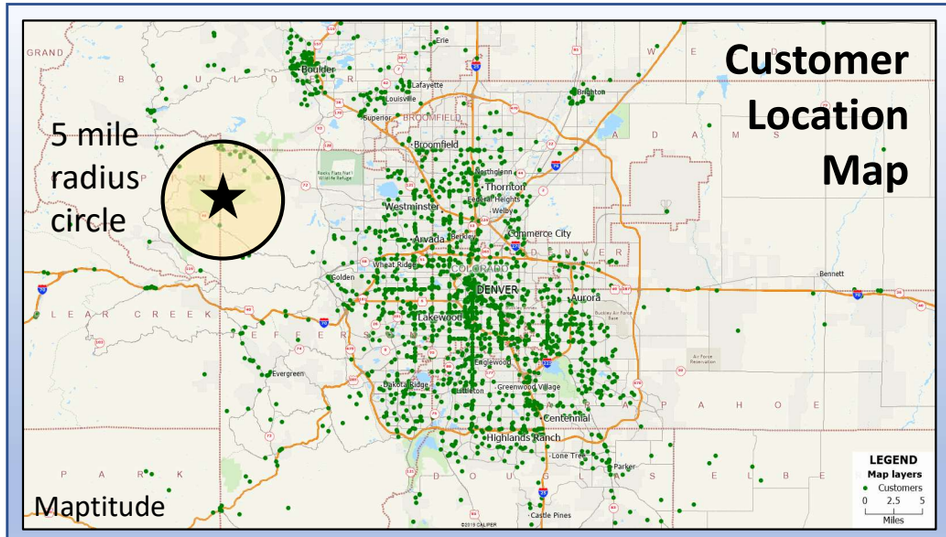


Figure C-40: Customer Map, Sample Point

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 grid than our example map in Figure C-41 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 (Figure C-42), 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.

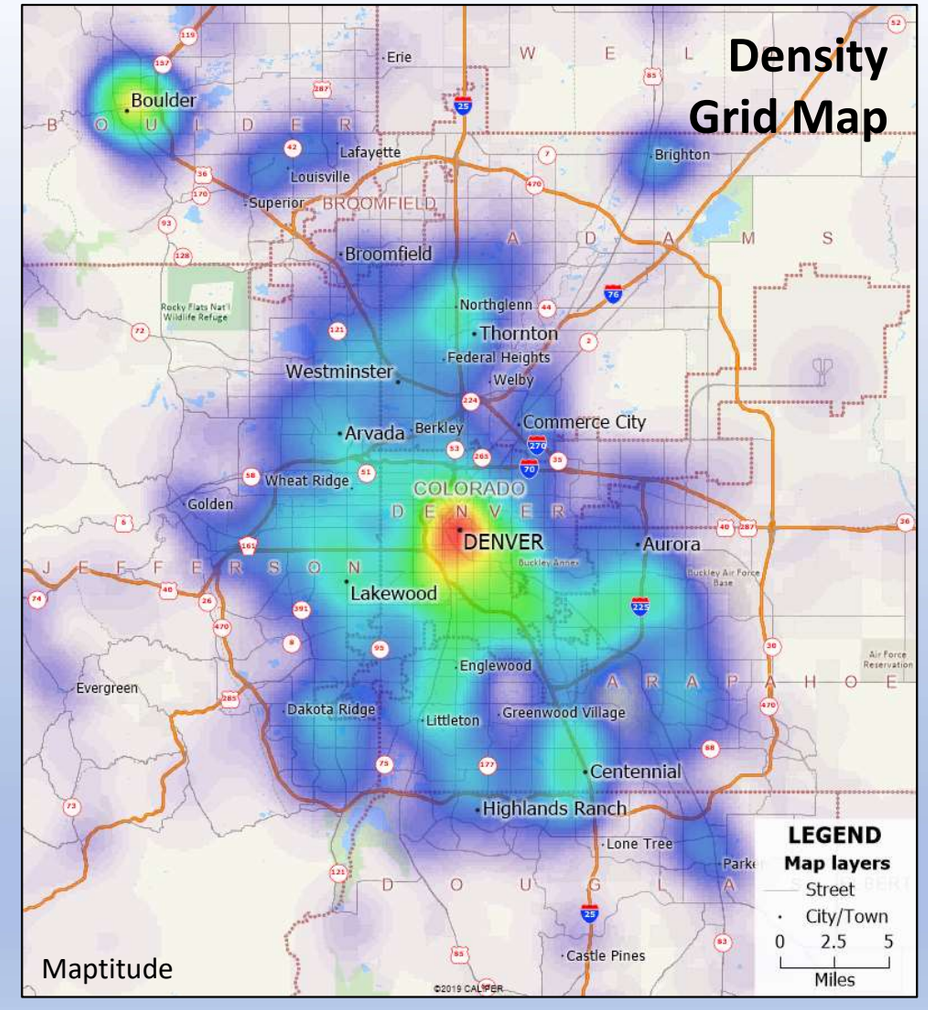
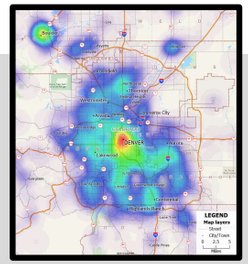
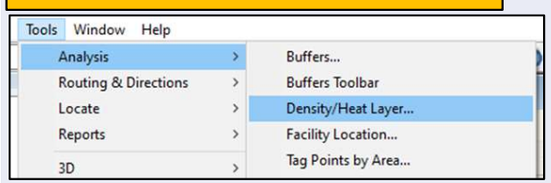


Figure C-42: The Final Customer Density Grid Map Result

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

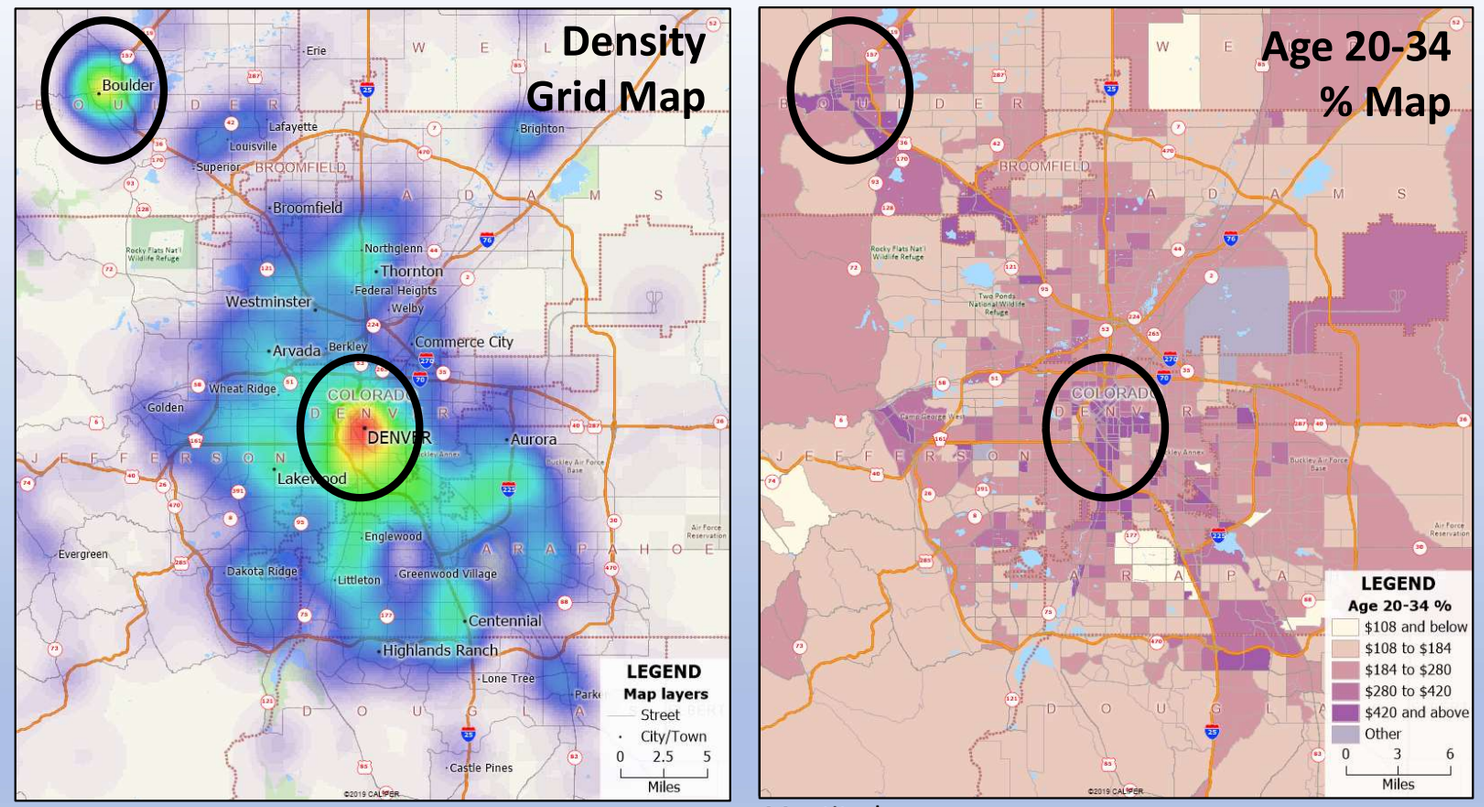
In ArcGIS BA Web App:

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

Figure C-43: Using the Density Grid Map as a Tool for Data Exploration

Method 7: Areas of Influence

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Detailed Discussion
A. Straight-Line Area of Influence 119
B. Drive-Time Area of Influence 121
C. Comparing the Two Area of Influence Methods 123

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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: Figure C-44 represents 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.

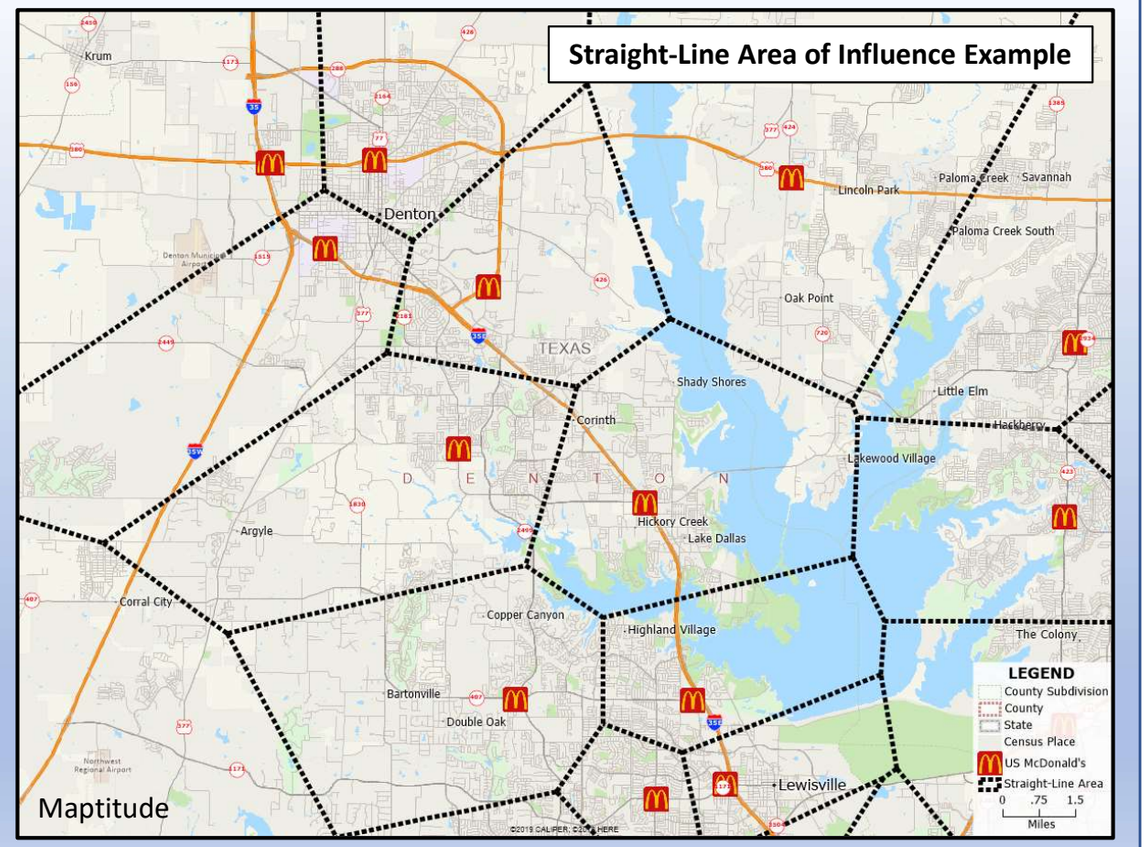


Figure C-44: Straight-Line Area of Influence Example

Note: these areas of influence are only simple approximations. For example, see the way that the zones in Figure C-45 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.

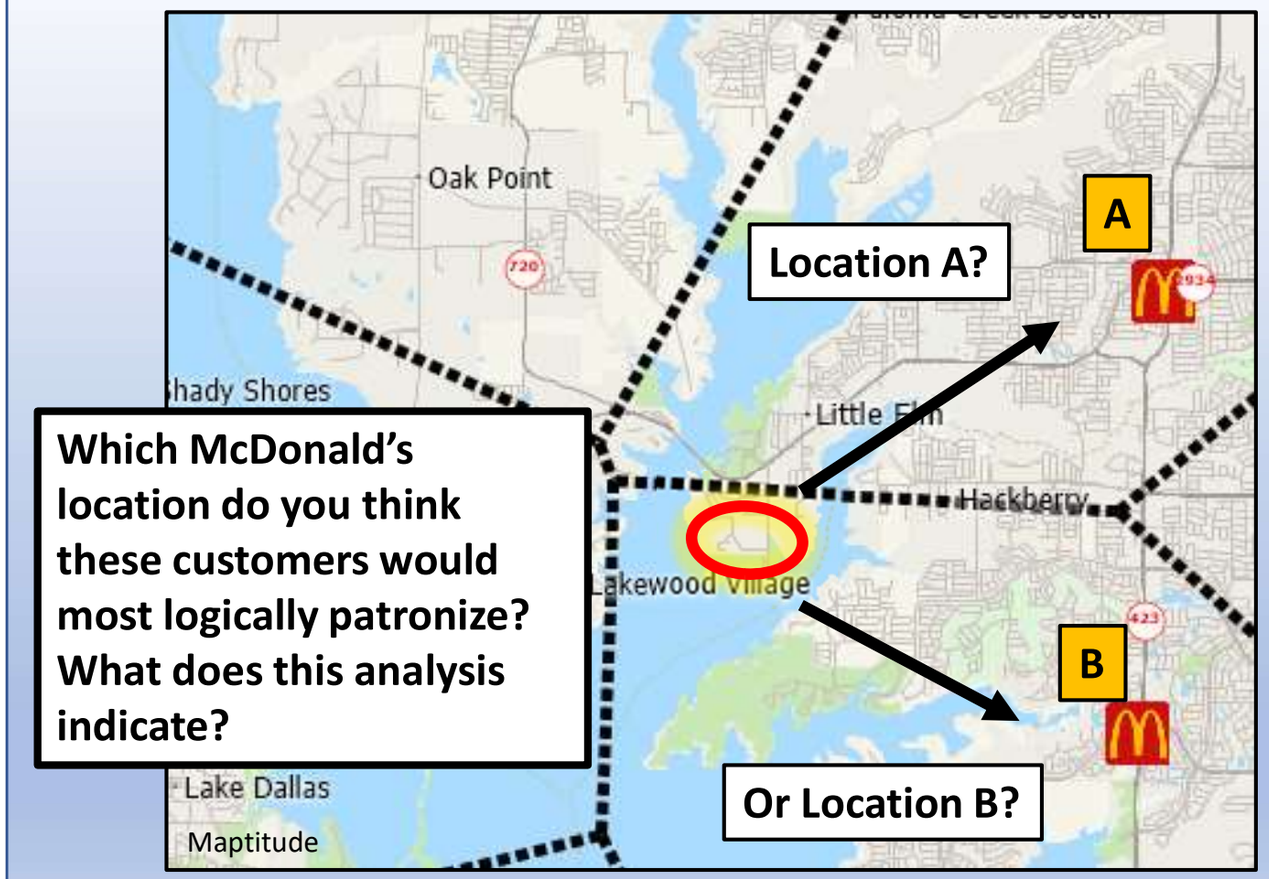


Figure C-45: Straight-Line Area of Influence Problem

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: Figure C-46 represents the geographically-proximate drive-time zones for each of the McDonald's restaurants in and around the city.

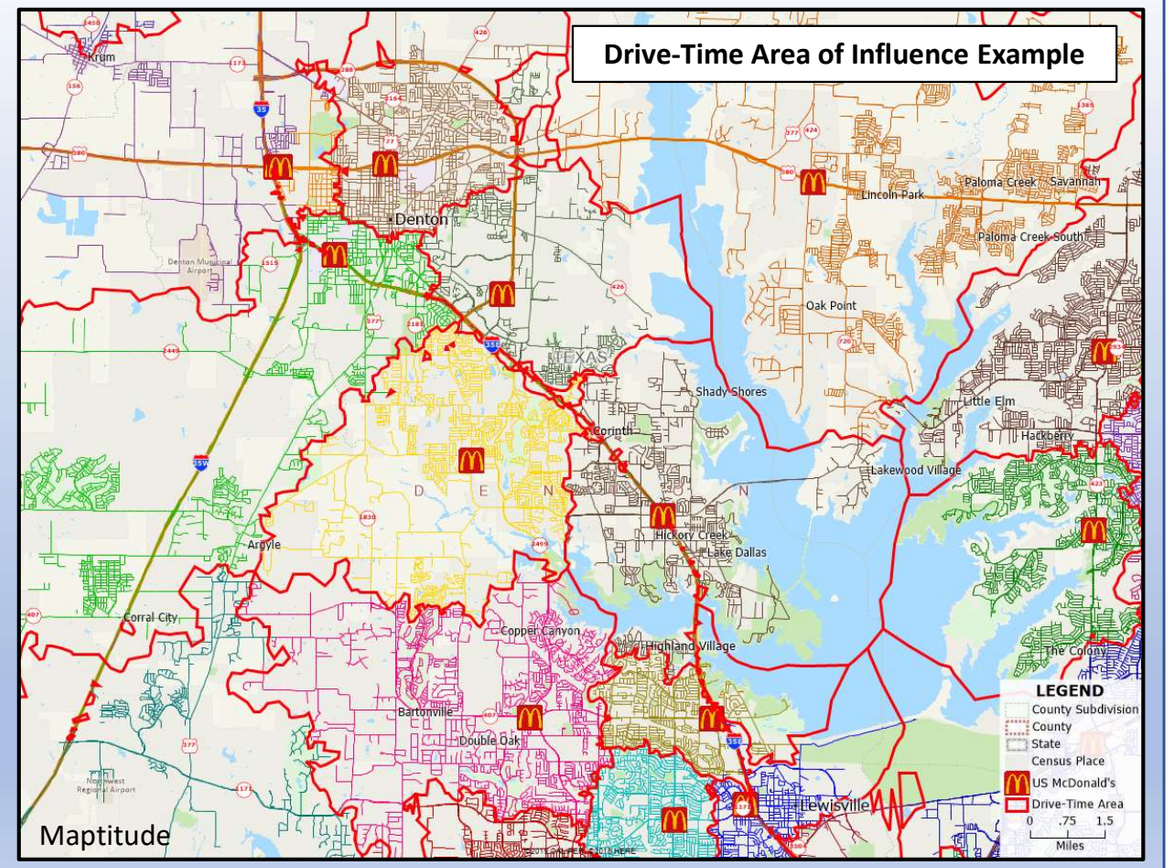


Figure C-46: Drive-Time Area of Influence Example

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 (Figure C-47).

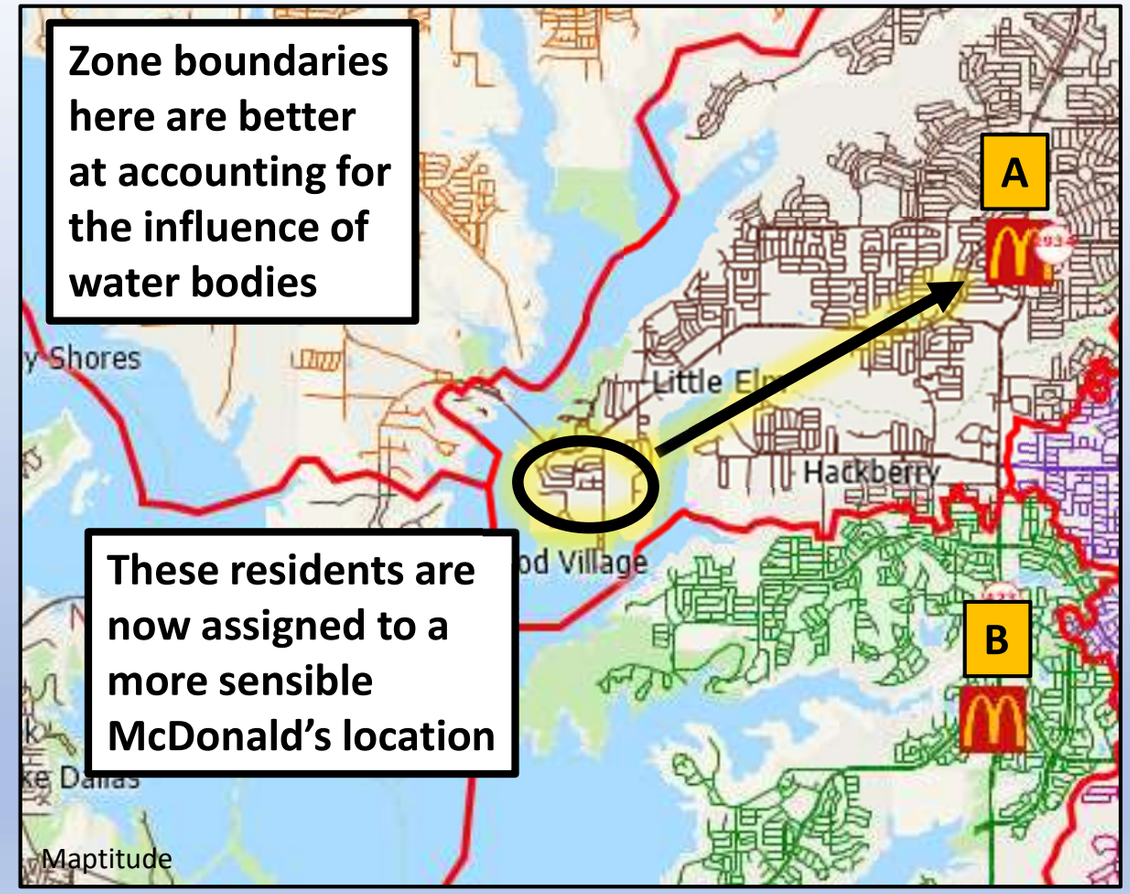


Figure C-47: Improvement with Drive-Time Analysis

C. Comparing the Two Area of Influence Methods

Head to Head: how do the two methods compare? Figure C-48 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 and its impact on .

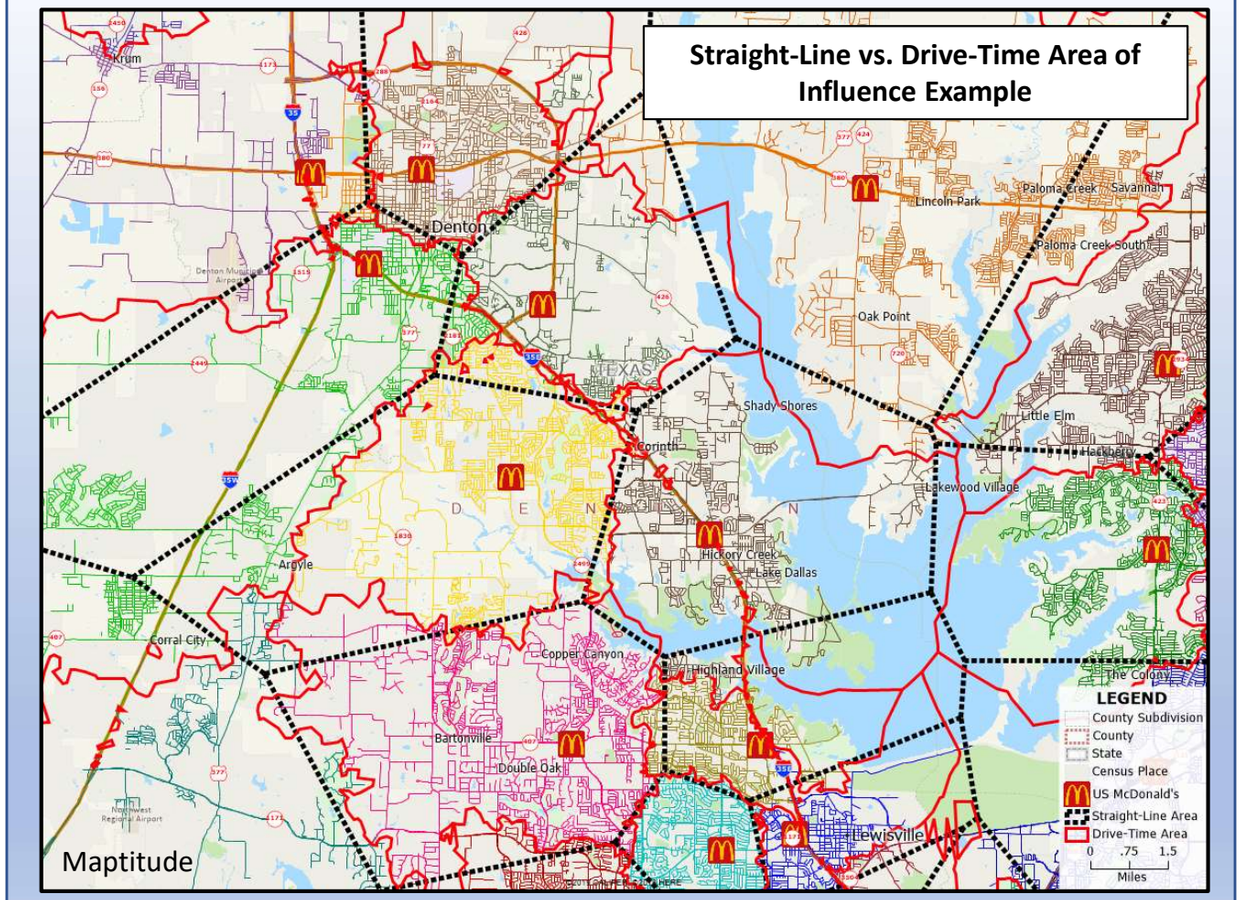
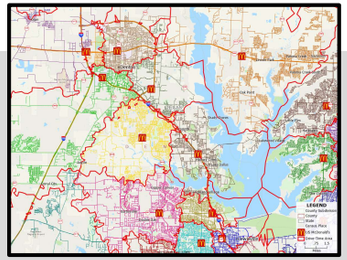


Figure C-48: Straight-Line versus Drive-Time Analysis

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 ArcGIS BA Web App:

Area of Influence Analysis…	
Supported by BA Web App	No, but Area of Influence Analysis is supported by the Esri desktop software package ArcGIS Business Analyst
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)

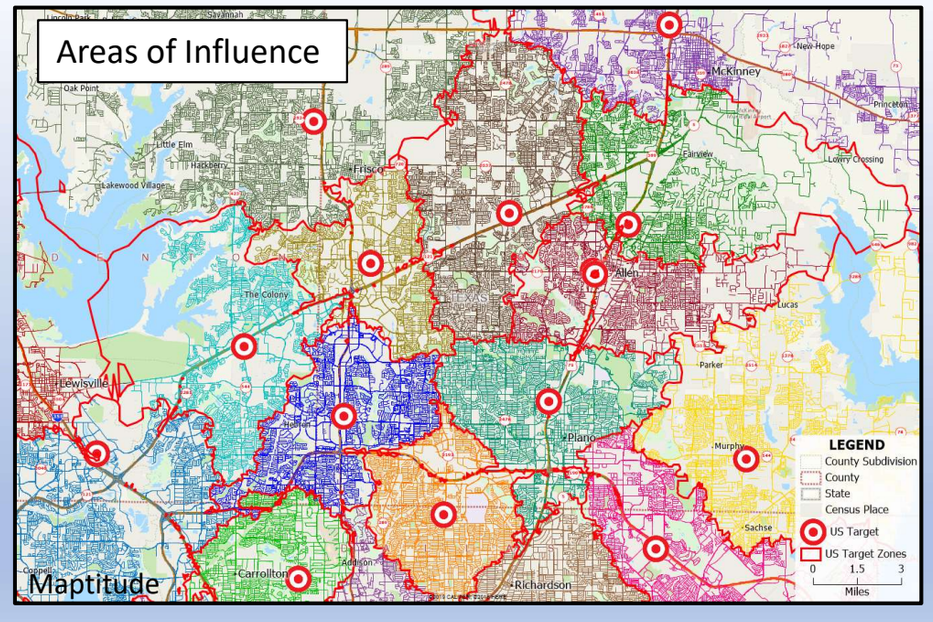


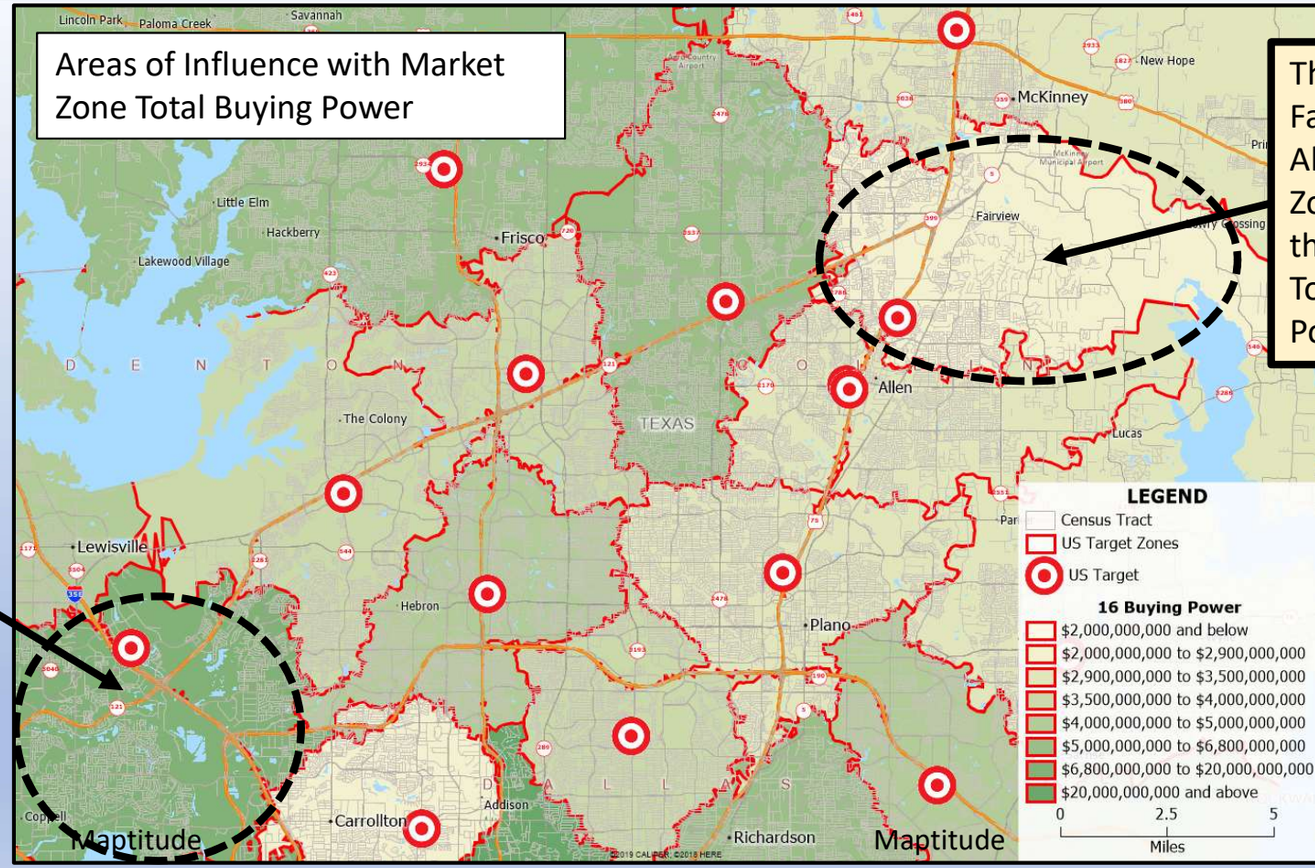
Figure C-49: Area of Influence Analysis of Your Choice

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

Figure C-50: Area of Influence Analysis Overlaid with Census Data Layer

* See pages 152 and following 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 8: Consumer Choice Modeling

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Overview of Consumer Choice Modeling

Consumer choice modeling, known widely as “Huff modeling” after its originator, is another methodology that addresses the extent of the market served by a given store in a given location.

The uniqueness of the Huff model approach is that, rather than defining a precise zone that can be associated with the primary geographic market for a given store, this choice-based approach produces a probabilistic surface that represents the likelihood of consumers across a broad region shopping at the store (Huff 1963). In the example map in Figure C-51, the zones shown in shades of green represent the highest market share performance for a retailer, while the red zones represent better market share performance by its competition.

Using this approach recognizes a crucial characteristic of the retail landscape: markets are often not an “all or nothing” phenomenon. The Huff model explicitly represents the contour lines that reflect high and low market performance by a given firm across a region.

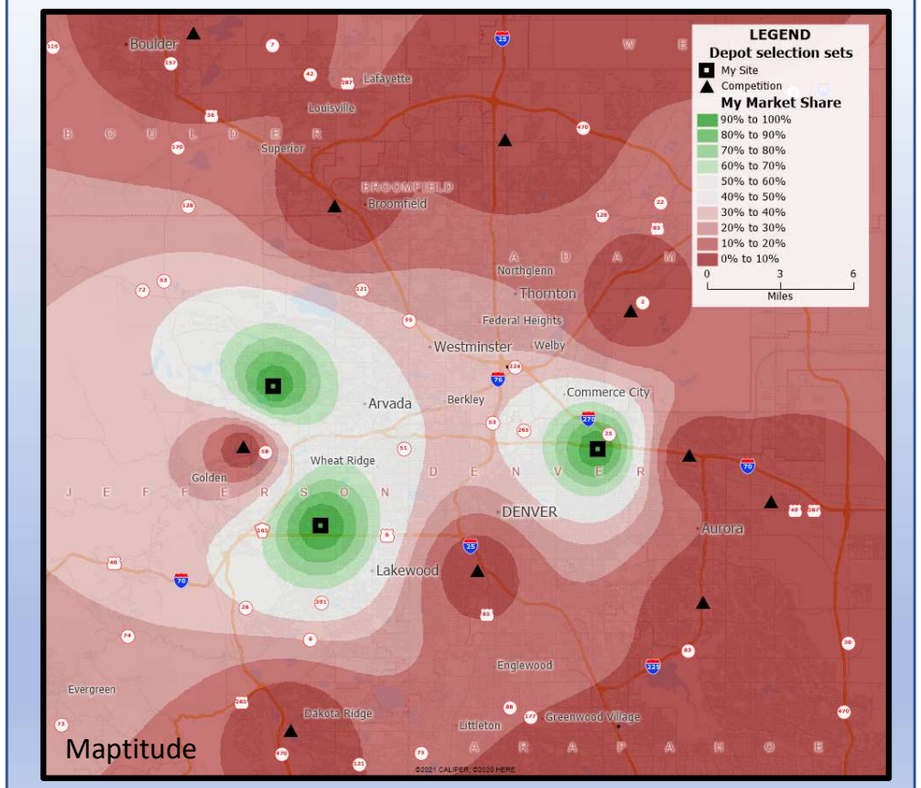


Figure C-51: Consumer Choice Modeling

Consumer Choice Modeling

The Huff Model is one of the best-known business analysis tools in geography. It exists to define the spatial impact of location and competition.

Foundational Concept: a consumer's perceived utility, or the consumer's perspective on how valuable or useful a given store is for them

Core of Huff Approach: compare the perceived utility of a given store with the perceived utility of all competitive shopping options in the area

In the Cincinnati example: we can analyze the overall draw of each mall in comparison with the total attractive power of all the other malls together (Figure C-52)

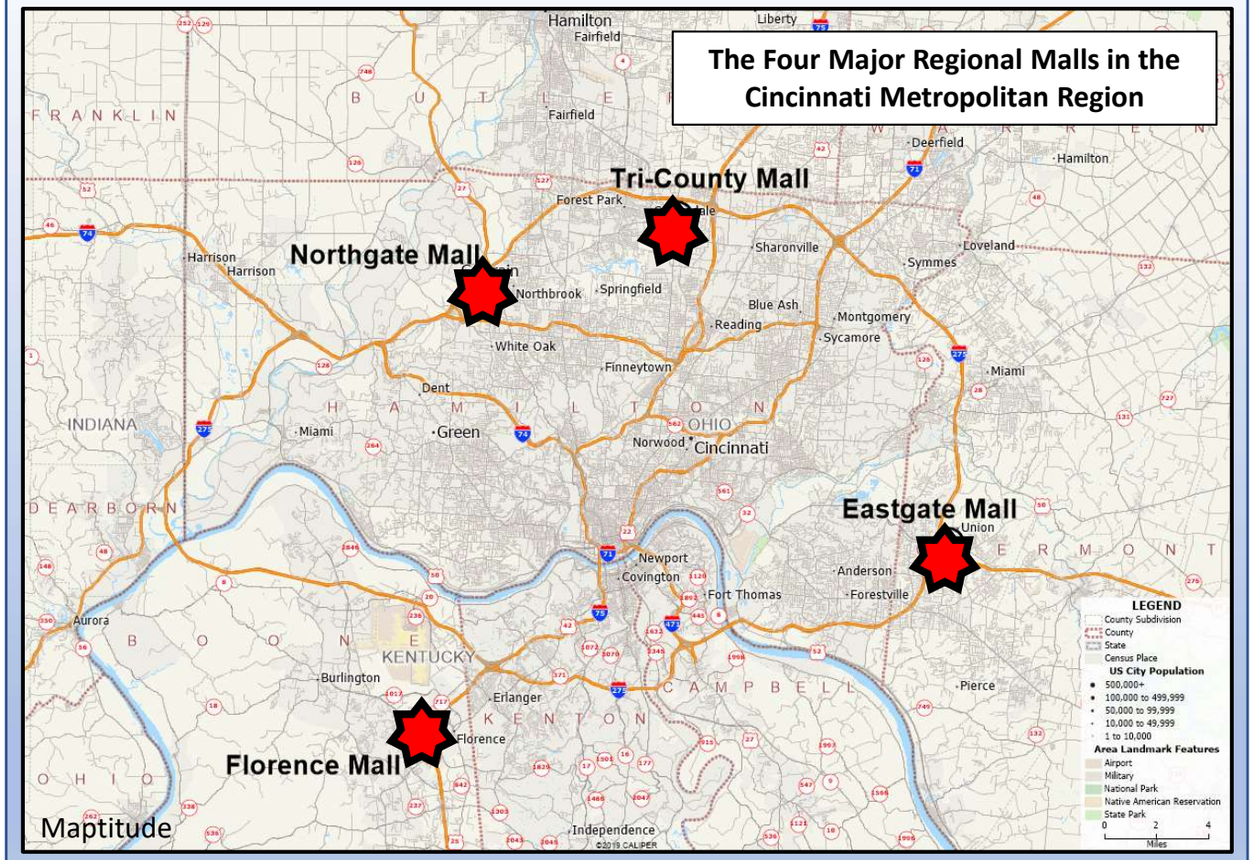


Figure C-52: Major Regional Malls in the Cincinnati Metropolitan Region

Detailed Discussion

In terms of map output, we have two options in using the Huff model.

First, as with Figure C-53, we can represent mall attractiveness by area-based zones. In this case, we are using Zip codes. This particular analysis depicts the geography of draw or attraction to Northgate Mall from Zip codes across the Cincinnati region.

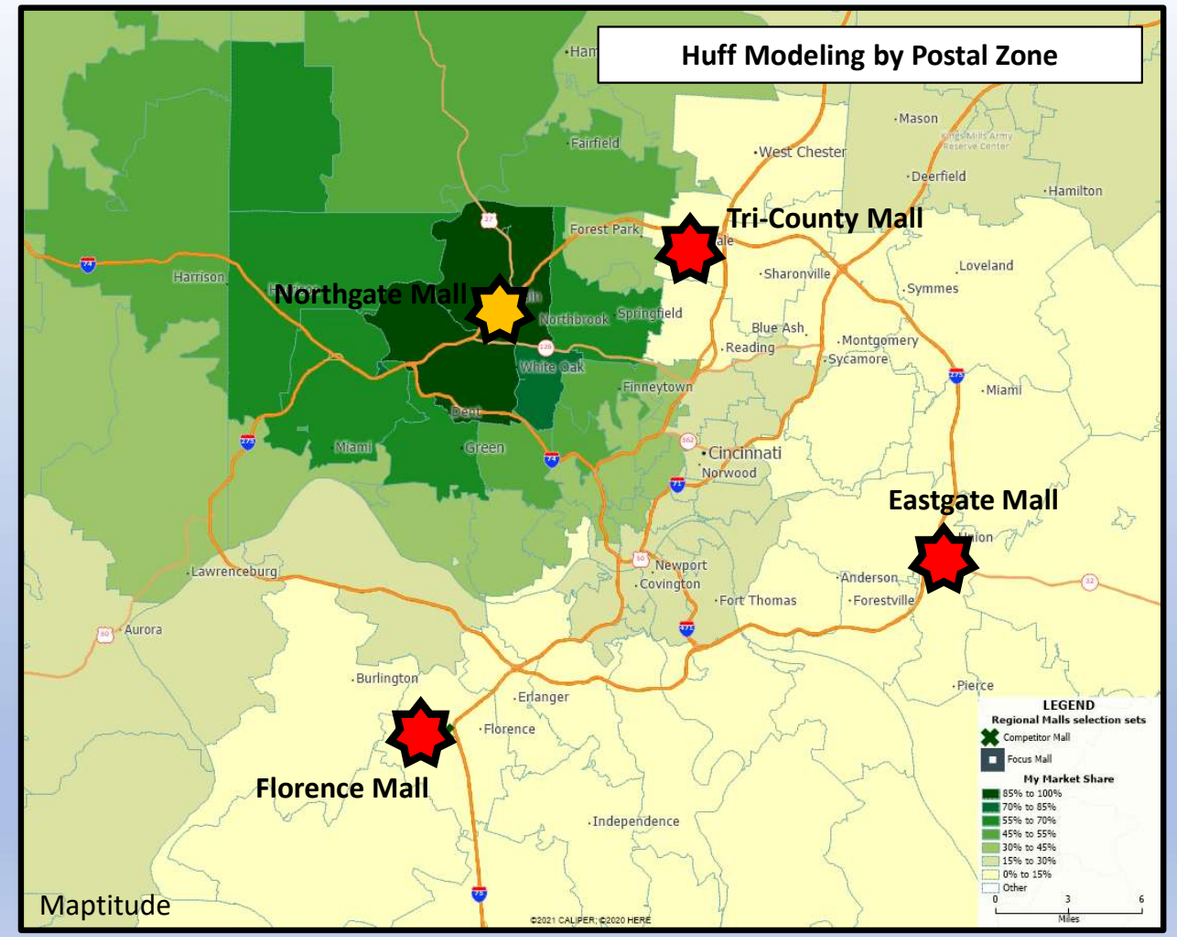


Figure C-53: Consumer Choice Modeling by Postal Zone

Detailed Discussion

A second option, as with Figure C-54, has us representing mall attractiveness by bands, with the representation being similar to a topographic map. Again, this analysis depicts the geography of draw or attraction to Northgate Mall from across the Cincinnati region. A crucial advantage of this method is that it avoids issues with the use of Zip code or other boundaries whose origin and relevance to the definition of retail markets may be minimal.

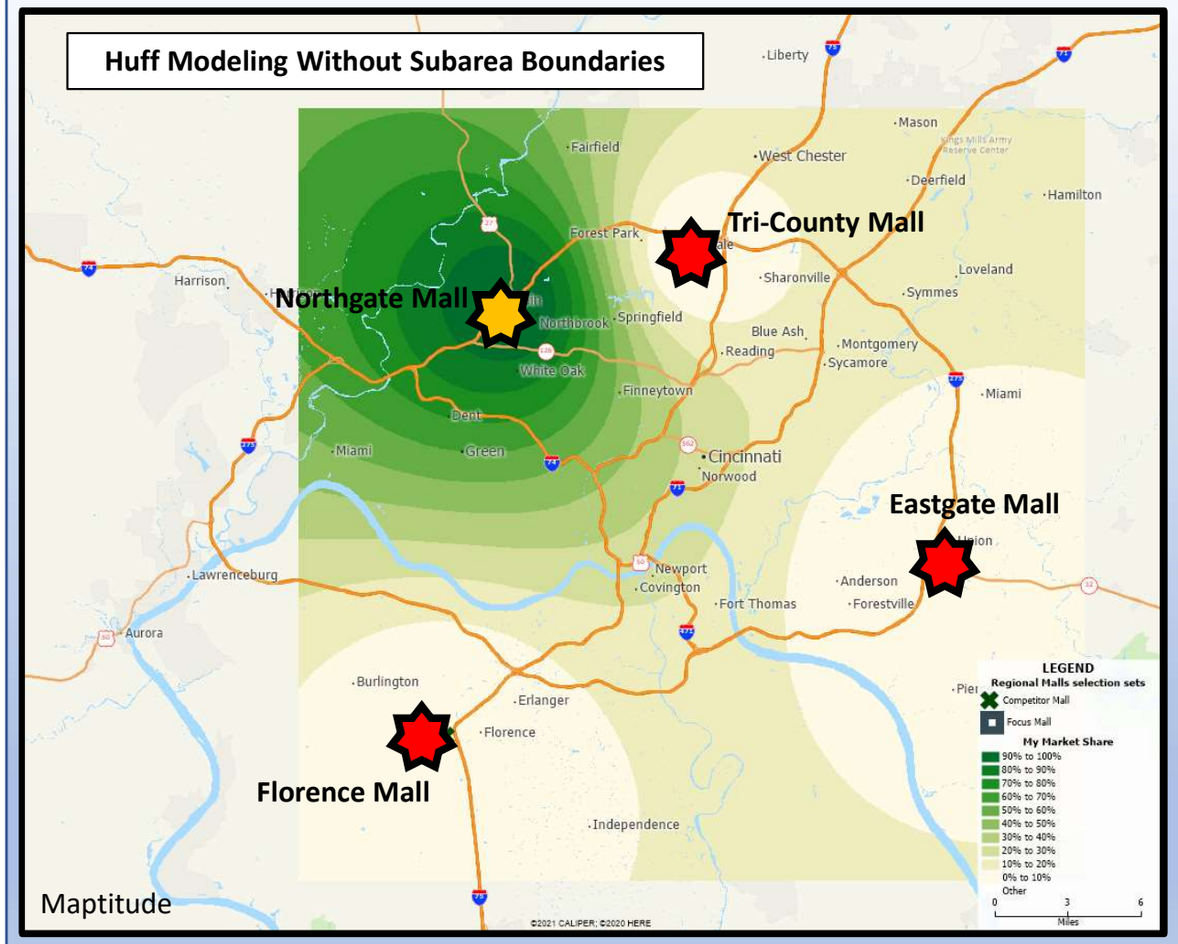
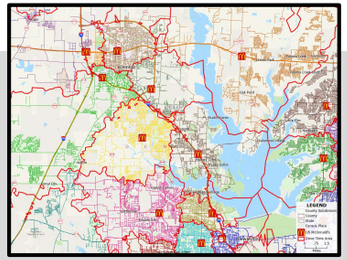


Figure C-54: Consumer Choice Modeling Without Subarea Boundaries

Resources and Processes to do a Consumer Choice Analysis

In Caliper Maptitude:



Consumer Choice Modeling…	
Supported by Maptitude	Yes
Starting the Analysis	Tools > Analysis > Market Share (Huff Model)
More guidance from Caliper	https://www.caliper.com/learning/articles/how-do-i-calculate-brand-market-share-by-region/

In ArcGIS BA Web App:

Consumer Choice Modeling…	
Supported by BA Web App	No, but Esri supports Huff Modeling through the desktop software package ArcGIS Business Analyst
Starting the Analysis	N/A
More guidance from Esri	N/A

Next Steps After Completing a Consumer Choice Analysis

Now that you have created your area of influence map, what is possible now? One exploratory analysis: market size comparison using the Huff Model results, versus trade area results calculated from Area of Influence zones.

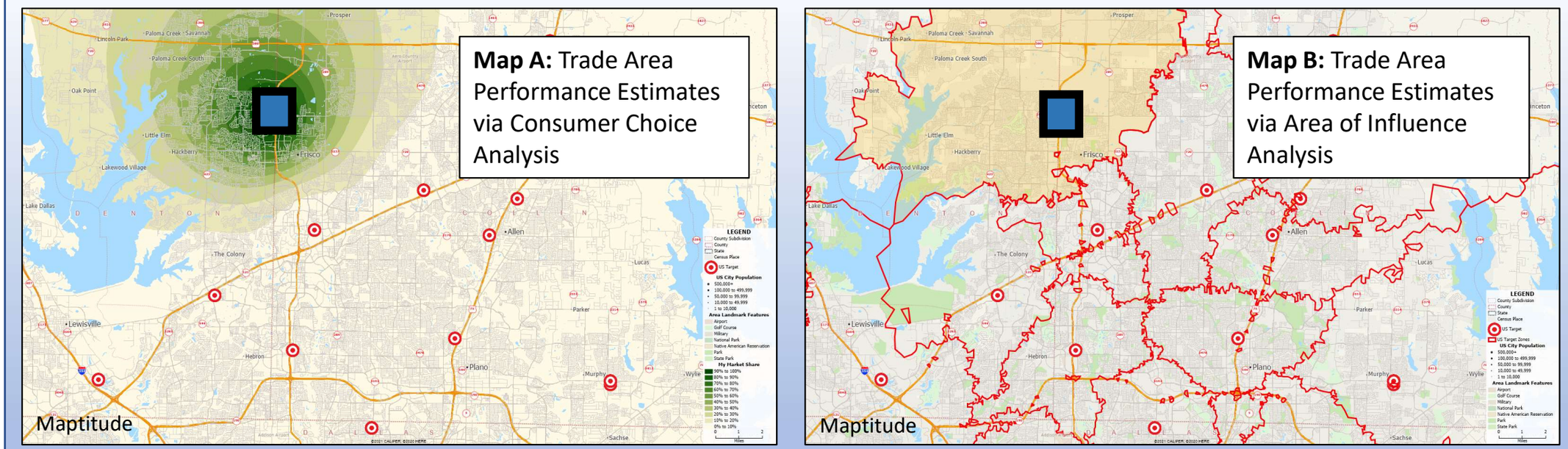


Figure C-55: Trade Area Comparative Analysis, Consumer Choice-Based Analysis versus Area of Influence-Based Analysis

Method 9: Network Analysis

Overview of Network Analysis 138

Detailed Discussion:
A. Multiple Stop Delivery: Routing Analytics 139
B. System-wide Distance and Travel Time Modeling 141

Resources and Processes to Aid in Network Analysis 142

Next Steps After Completing a Network Analysis 143

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: Map A depicts the gas stations that a delivery truck needs to service in a single trip. How can this be done to minimize the travel time necessary? Map B provides the optimal solution, taking into account the street network and driving speeds and speed limits along the way.

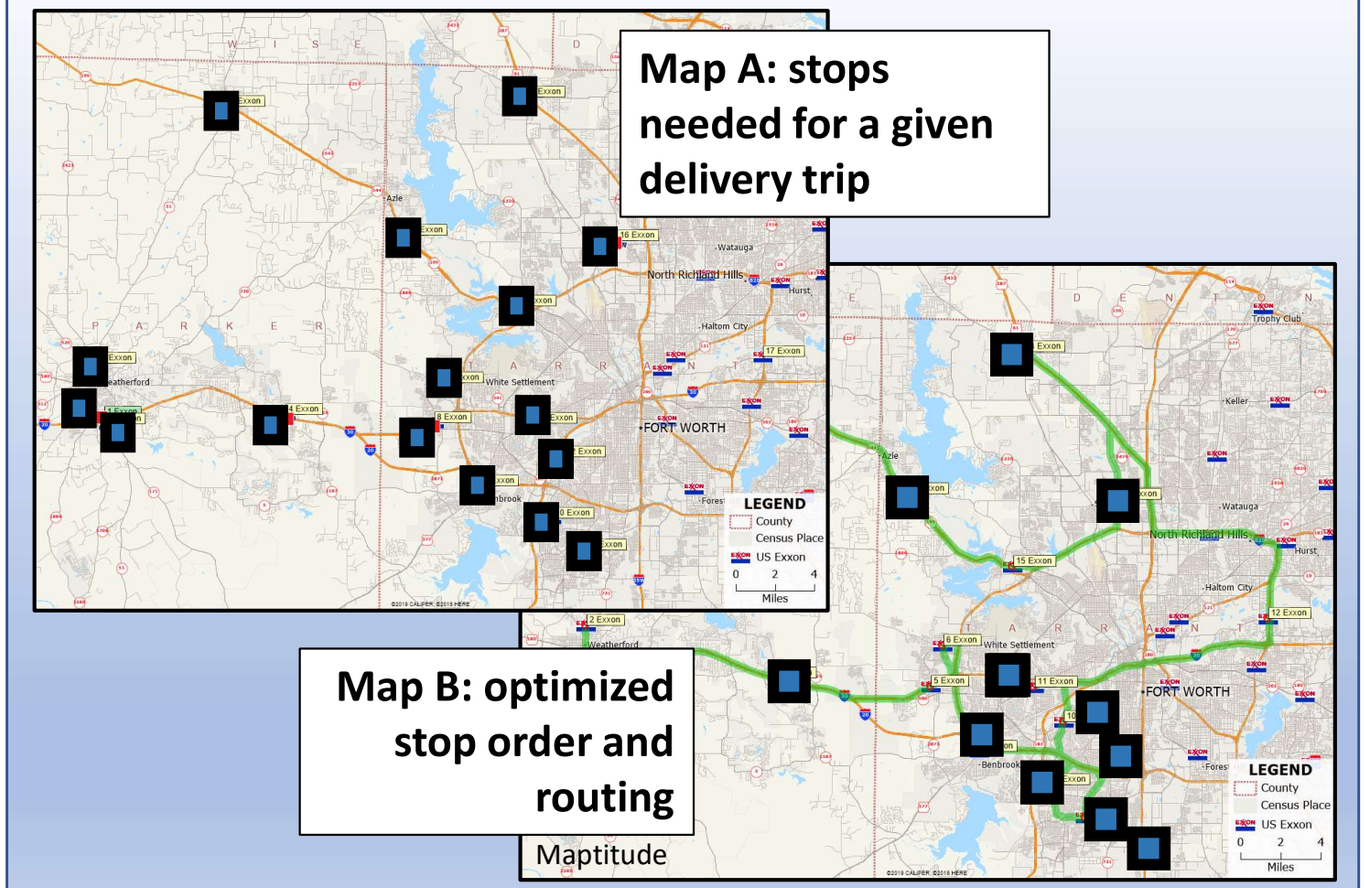
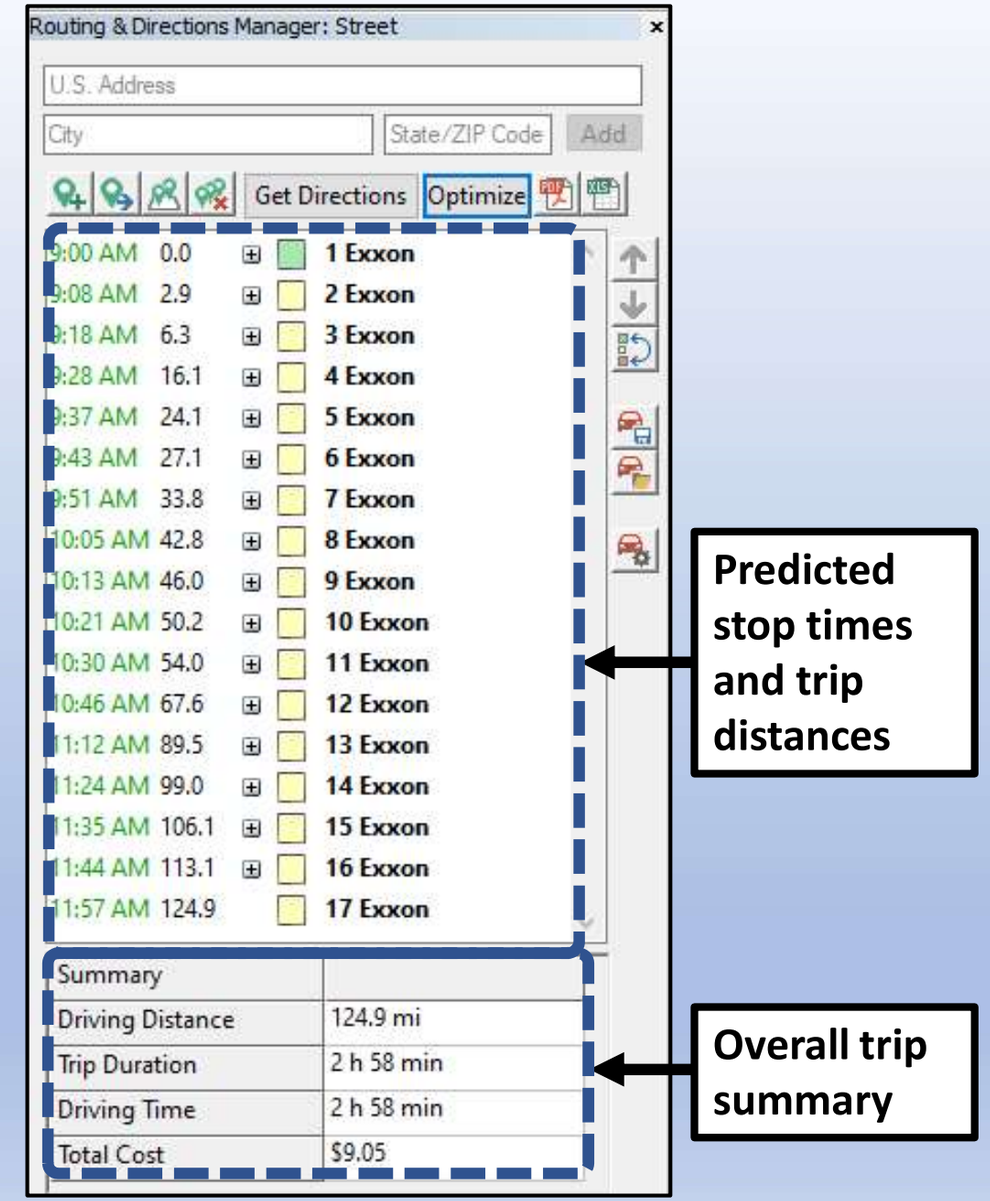


Figure C-56: From a Stop Set to Most Efficient Routing

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.*

* 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.



Maptitude

Figure C-57: Mileage Tracking Table for Most Efficient Routing

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: 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.

Table C-2: Travel Time Matrix for the 17-Stop Sample Problem

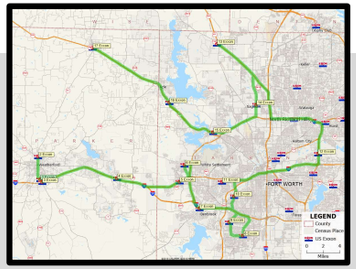
Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	--	2.35	8.21	12.04	24.11	33.15	21.75	19.00	23.67	29.82	26.24	29.61	34.46	29.81	47.19	35.09	39.26
2	2.21	--	9.54	10.62	25.44	32.61	20.33	17.58	22.26	28.40	24.82	28.19	33.04	28.39	45.78	33.68	37.84
3	8.39	9.59	--	17.06	15.90	29.89	26.77	24.02	28.69	34.83	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	--

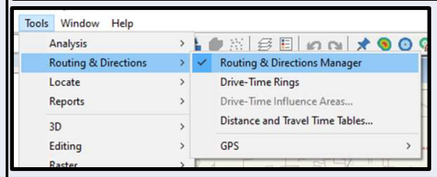
Travel Time (Minutes) | Distance (Miles)

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 ArcGIS 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

Why? After thoughtful interpretation of the earlier, single-vehicle routing results, we could come to the conclusion that single-vehicle routing yields a delivery cycle that is too lengthy (see Figure C-58).

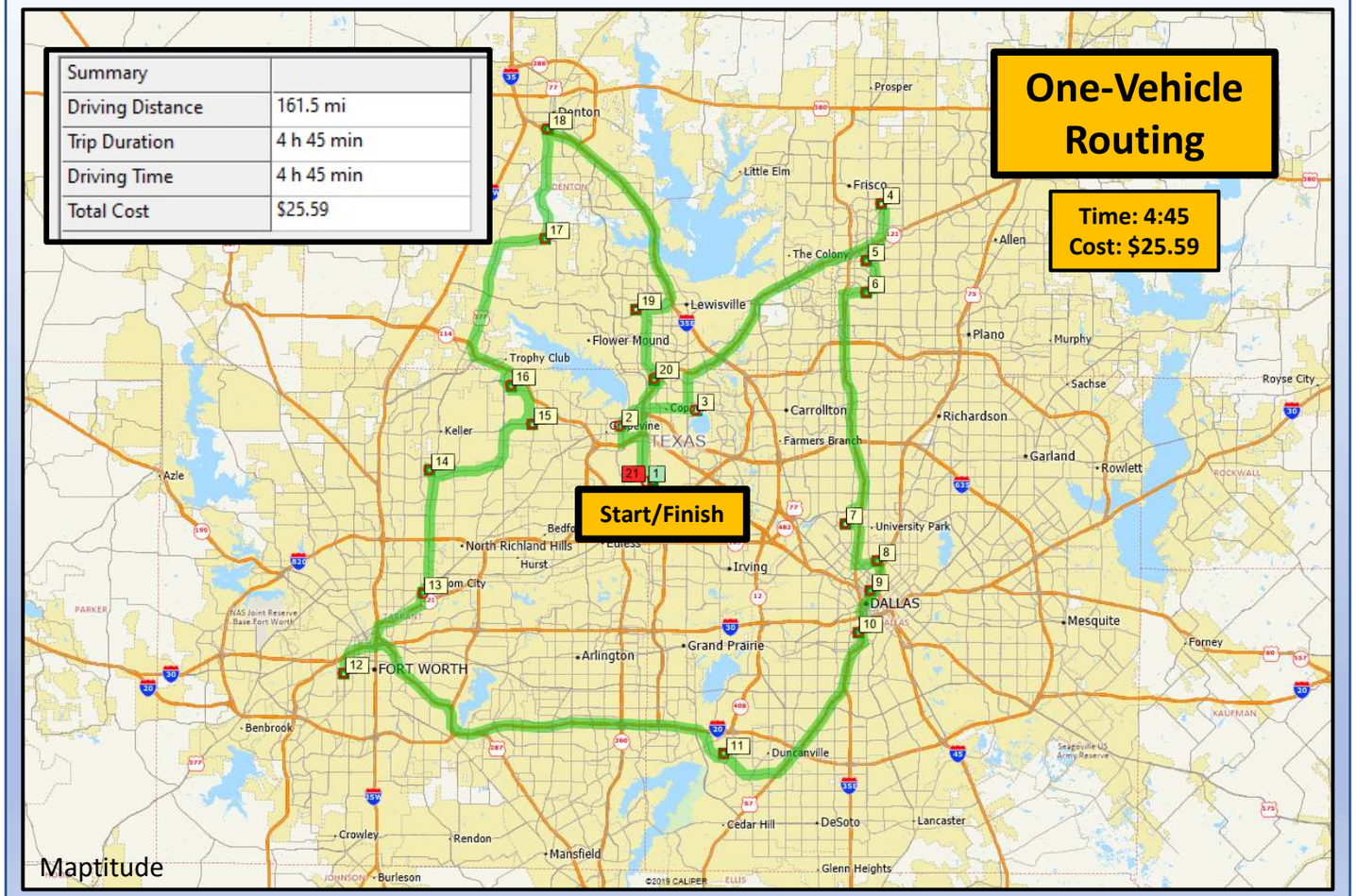


Figure C-58: Single-Vehicle Routing

What Next

We can divide the stops into groups to determine the impact of using two delivery vehicles to shorten the delivery cycle duration (Figure C-59).

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

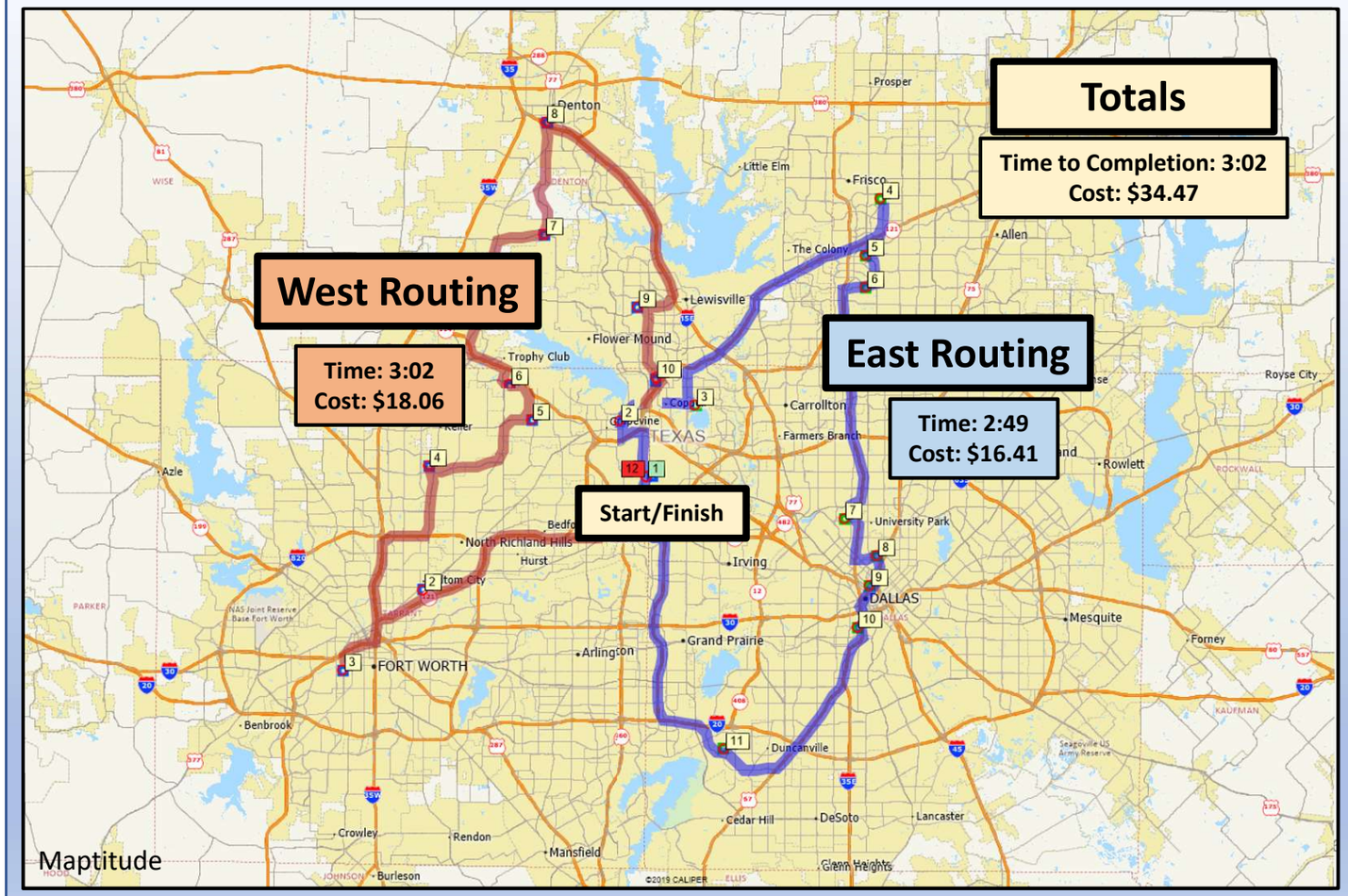


Figure C-59: Multi-Vehicle Routing

End of Part C

Part D: 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, or
- 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 a number of 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

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Step-by-Step: Business Data Enhancement 153

Resources and Processes to Aid in Business Data Enhancement 158

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 via an overlay operation 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.

Original Database

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

Figure D-1: Database with Address Information Only

Step 1 (continued)

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

Appended Location Data

Original Database

Dataview2 - US BMO Harris Ban

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

Figure D-2: Database with Latitudinal and Longitudinal Data Appended via Geocoding

Step 2

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.

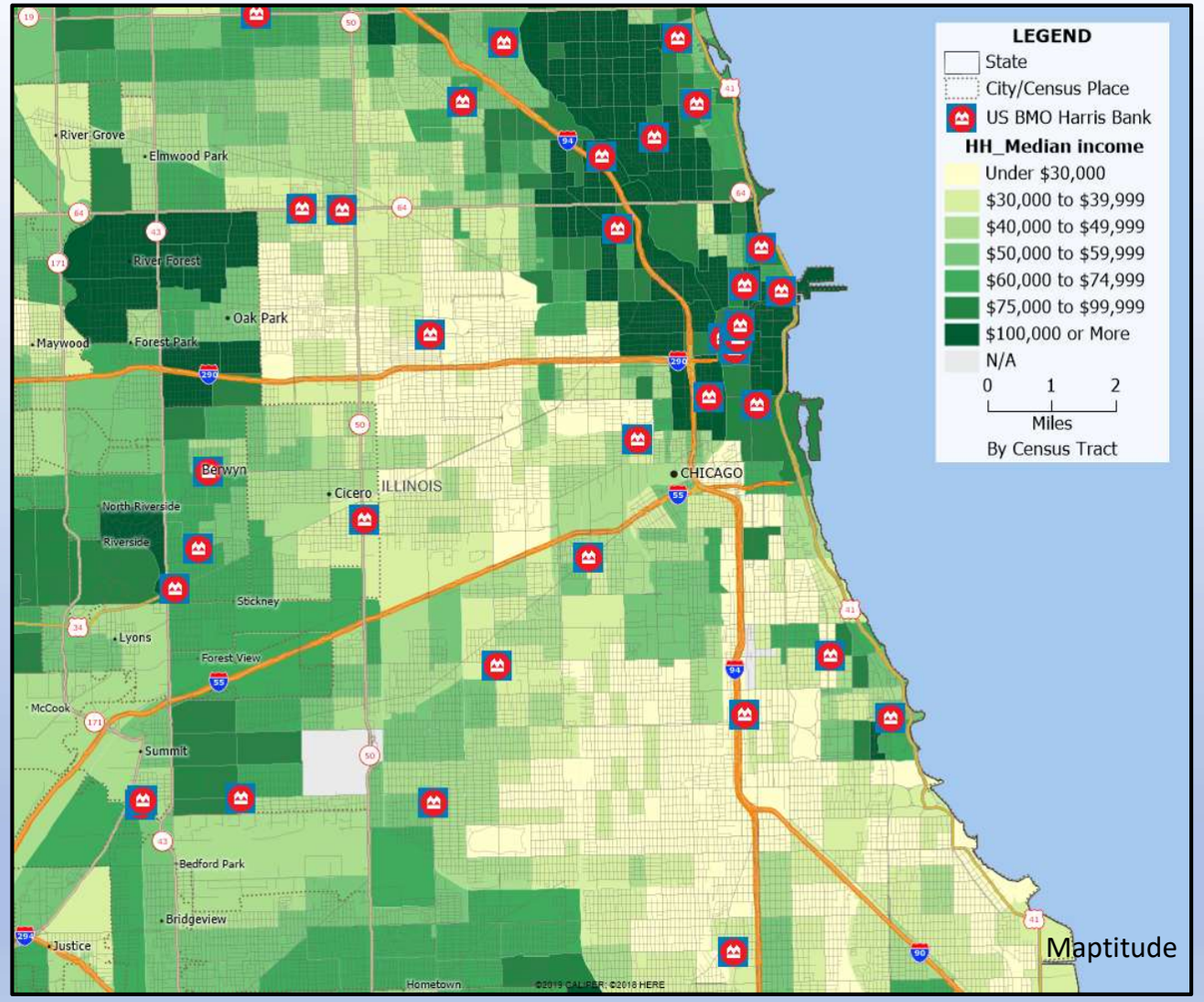


Figure D-3: Map With Bank Locations and a Median Income Census Tract Choropleth Theme

Step 3

Now take a step further: connect each bank branch record with financial information for the market area surrounding it.

For each bank location, identify the associated market area (in this case, the green border) and import the financial characteristics of that zone

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

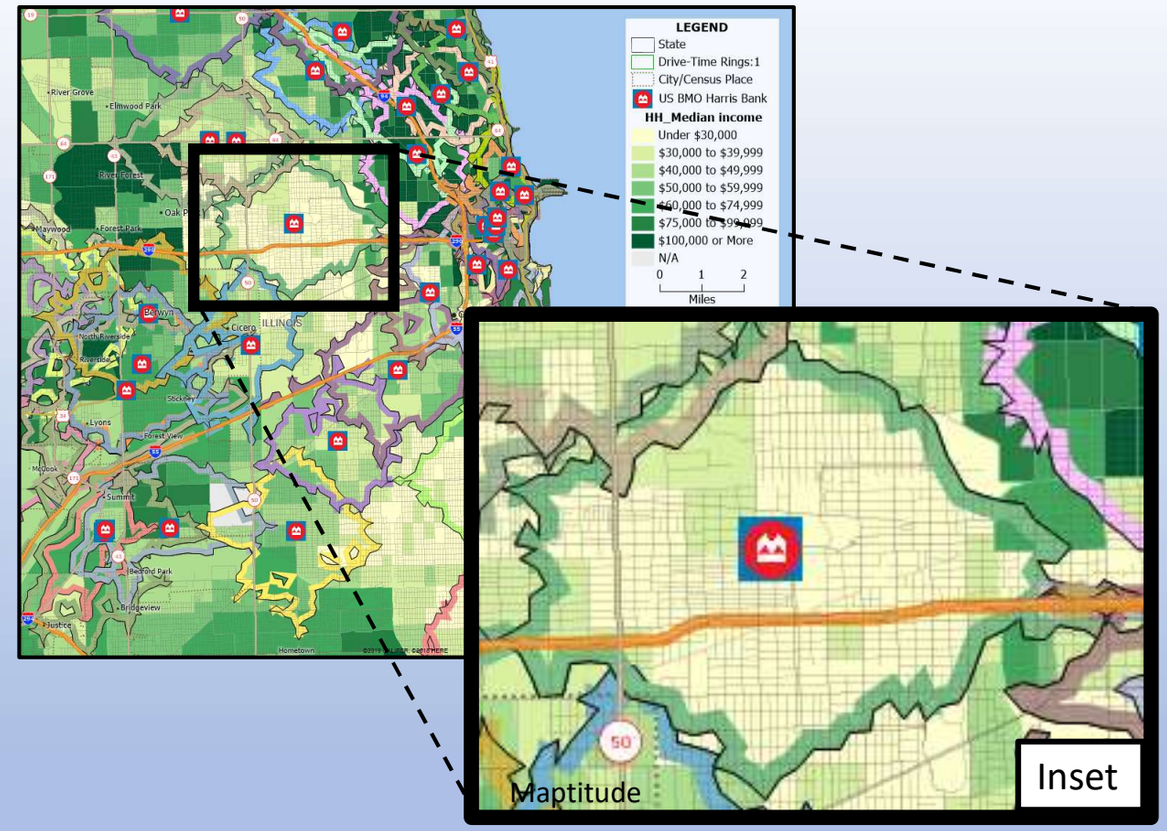


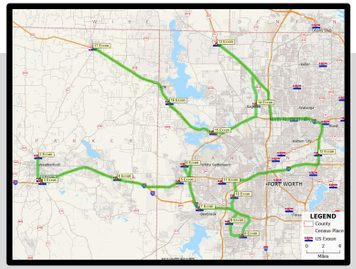
Figure D-4: Bank Locations and their Associated Market Areas

Step 3 (continued)

Note:

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

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 ArcGIS 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 160

Resources and Processes to Aid in Business Data Enhancement 162

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 assembles a database of point location data, with the points being your customers (see page 55 and following). In the sample map in Figure D-5, customers are shown by 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).

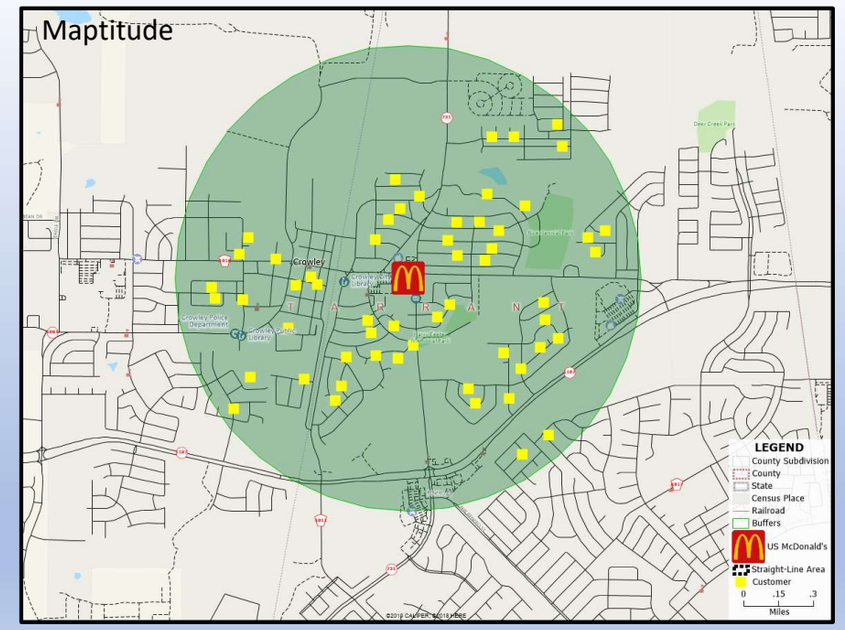


Figure D-5: Customer Analytics by Market Area

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 in Figure D-6). However, if you have multiple locations (and thus multiple markets), your task is more complicated (as in the drive-time example in Figure D-6). However, application of geocoding and buffer/drive-time zones together gives you great insight into the customers you serve in your immediate local market.*

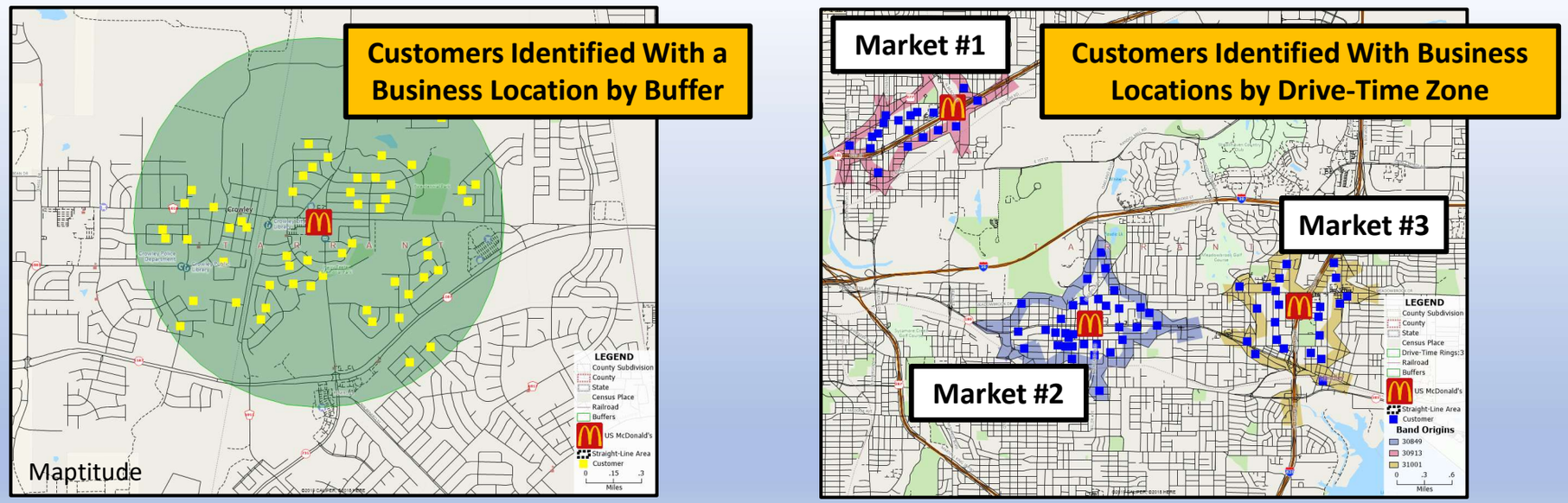
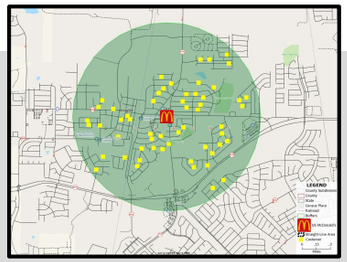


Figure D-6: Customer Analytics Based on Buffers versus Drive-Time Zones

* 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 55 to 64** • Result: customer records can be mapped **Buffers/drive-time (define the market area connected to each location) – pages 65 to 77** • Result: identify customers living in an area **Overlays (to total the customer data for each market area) – method used on pages 151-158** • Result: collect and analyze business data by market area
More guidance from Caliper	See individual video tutorials for the three methods listed above

In ArcGIS 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

Application Overview: Site Selection **164**

A. Step-by-Step: Rules of Thumb **166**
Resources and Processes to Aid in Rule of Thumb Decisions 170
B. Step-by-Step: Ranking **171**
Resources and Processes to Aid in Ranking Decisions 176
C. Step-by-Step: Analogs **177**
Resources and Processes to Aid in Analog Modeling 183
D. Step-by-Step: Regression **184**
Resources and Processes to Aid in Regression Modeling 186
E. Step-by-Step: Location-Allocation **187**
Resources and Processes to Aid in Location-Allocation 191

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 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 experiences: (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.

* One source of relationships that can become valuable mentorships: professional communities like that represented by the AGX, the publisher of this handbook.

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 specific business mix (an Exxon and a McDonald's in close proximity) for expansion.

Sample GIS Response: Identify locations where there is an Exxon and a McDonald's close to each other. A good start: begin by mapping Exxon locations (Figure D-7).

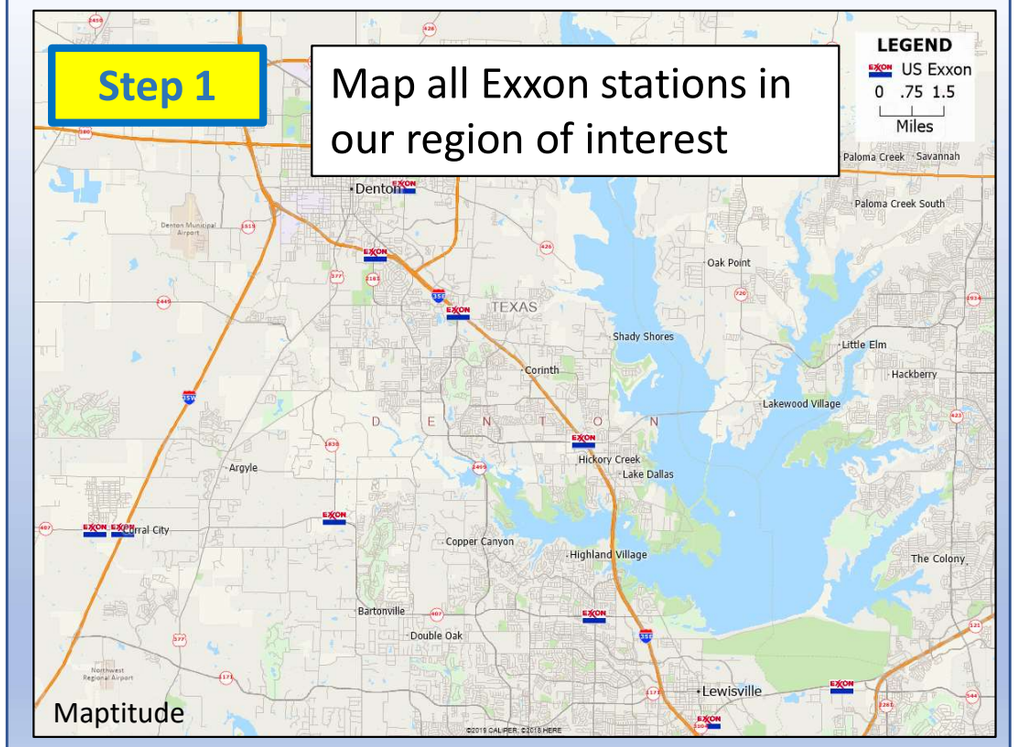


Figure D-7: Map All Exxon Stations in Area

Detailed Discussion

A next step would be to generate 5-minute drive time zones around the Exxon locations just identified. 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.

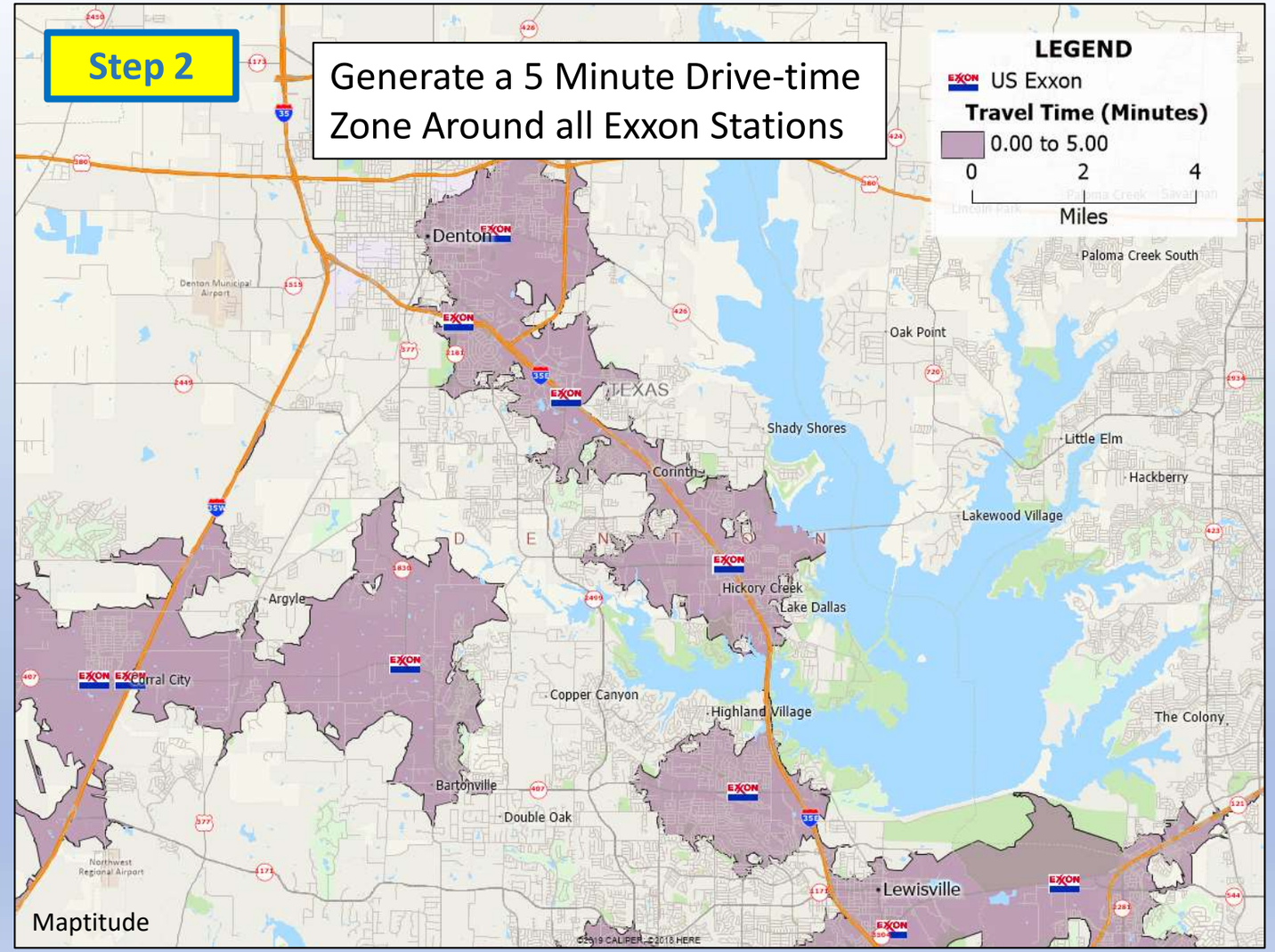


Figure D-8: Place a Five-Minute ZoneAround Exxon Stations

Detailed Discussion

A final step is to locate all McDonald's restaurants in this same region (Figure D-9). With our two business layers (Exxon and McDonald's) and our 5-minute drive time zones, we now have almost all the elements that we need to achieve our ultimate purpose

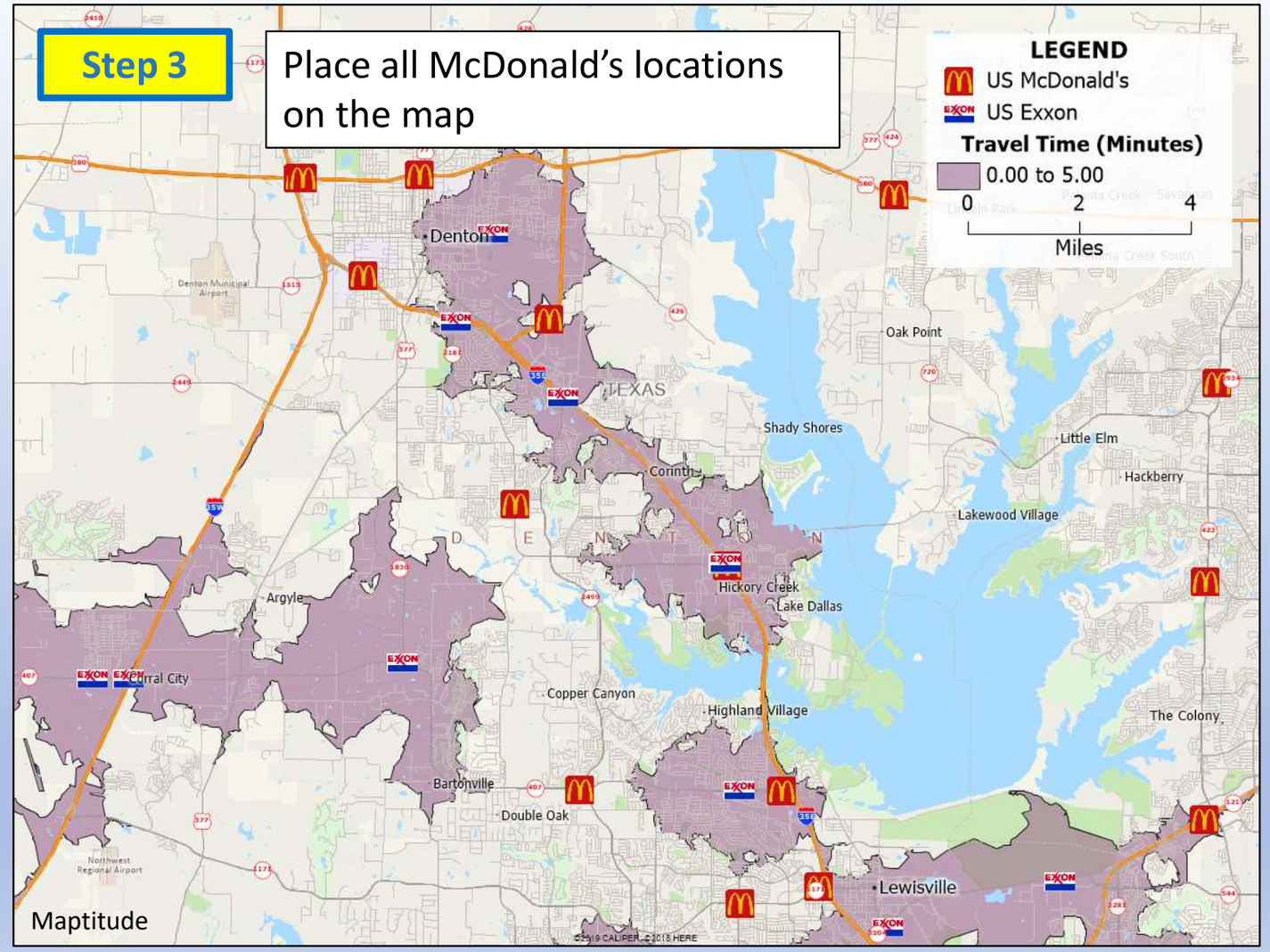


Figure D-9: Enter McDonald's Locations into Analysis

All that remains is to identify the locations that meet the given rule of thumb: locate the Exxon drive-time zones that contain a McDonald's.

In this case, this simple rule of thumb-based analysis reveals <u>three potential location options</u> for the business to consider in Denton County (Figure D-10).

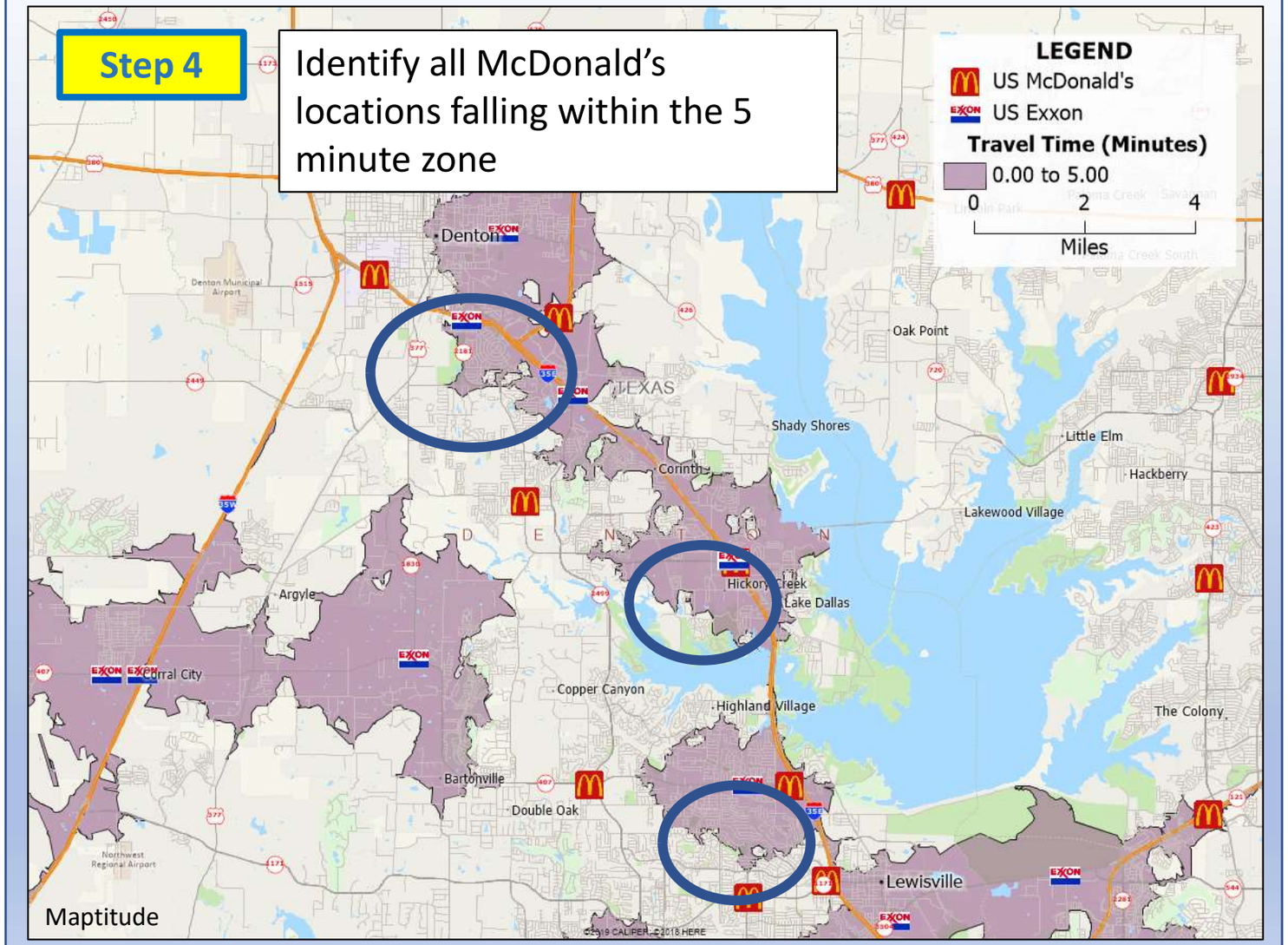
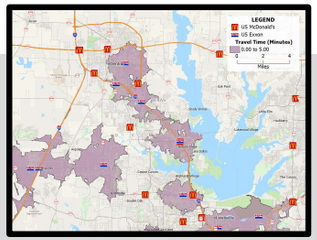


Figure D-10: Identify All McDonald's Falling within Exxon Drive-Time Zone

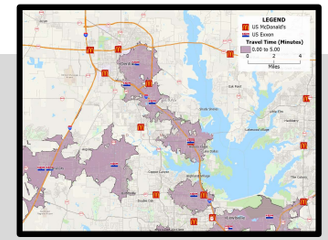
Resources and Processes to Support Rule of Thumb Decisions

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 55 to 64** • Result: customer records can be mapped **Buffers/drive-time (define the market area connected to each location) – pages 65 to 78** • Result: identify customers living in an area
More guidance from Caliper	See individual video tutorials for the two methods listed above

In ArcGIS BA Web App:



Rule of Thumb Decisions…	
Supported by BA Web App	Yes
Starting the Analysis	**Geocoding (to locate each customer record on a map) – pages 55 to 64** • Result: customer records can be mapped **Buffers/drive-time (define the market area connected to each location) – pages 65 to 78** • Result: identify customers living in an area
More guidance from Esri	See individual help sections for the two methods listed above

B. Ranking

- This is a simple rating system that assesses locations on a scale for several dimensions (Clarke 1998; Swales 2018). Table D-1 provides an example of application in location assessment for new bank branches.

Table D-1: Sample Rating Dimensions for Bank Branch Location Assessment

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)**

What can we accomplish using this approach? The following Text Box works through the situation defined by Table D-1 to demonstrate the outcomes of using this method.

Text Box D-1: Bank Branch Location Using the Ranking Approach

- The basic idea here is to complete one sub-analysis for each dimension identified. From Table D-1, we can extract:
  - 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

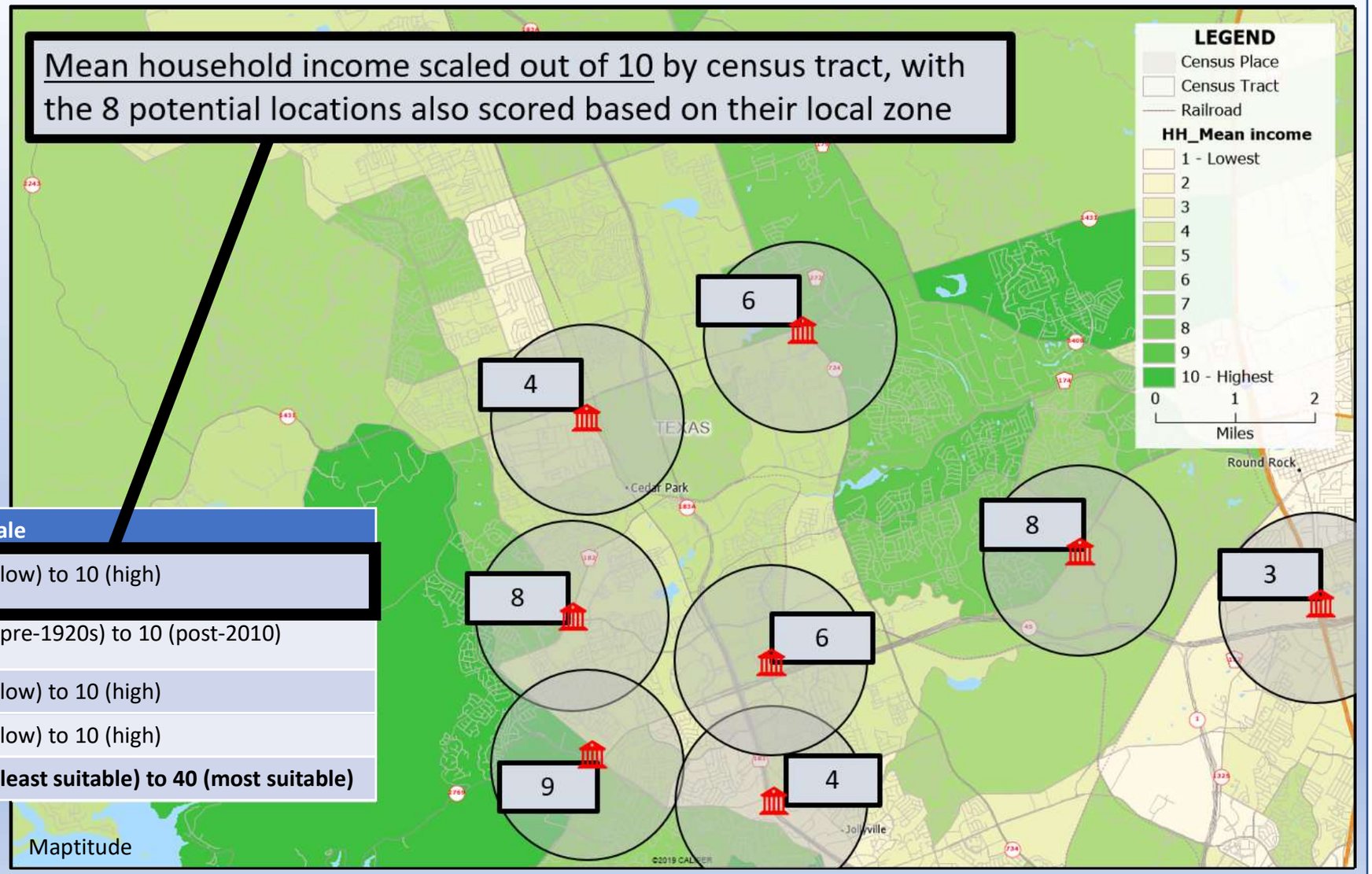
Detailed Discussion

Map 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
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)**



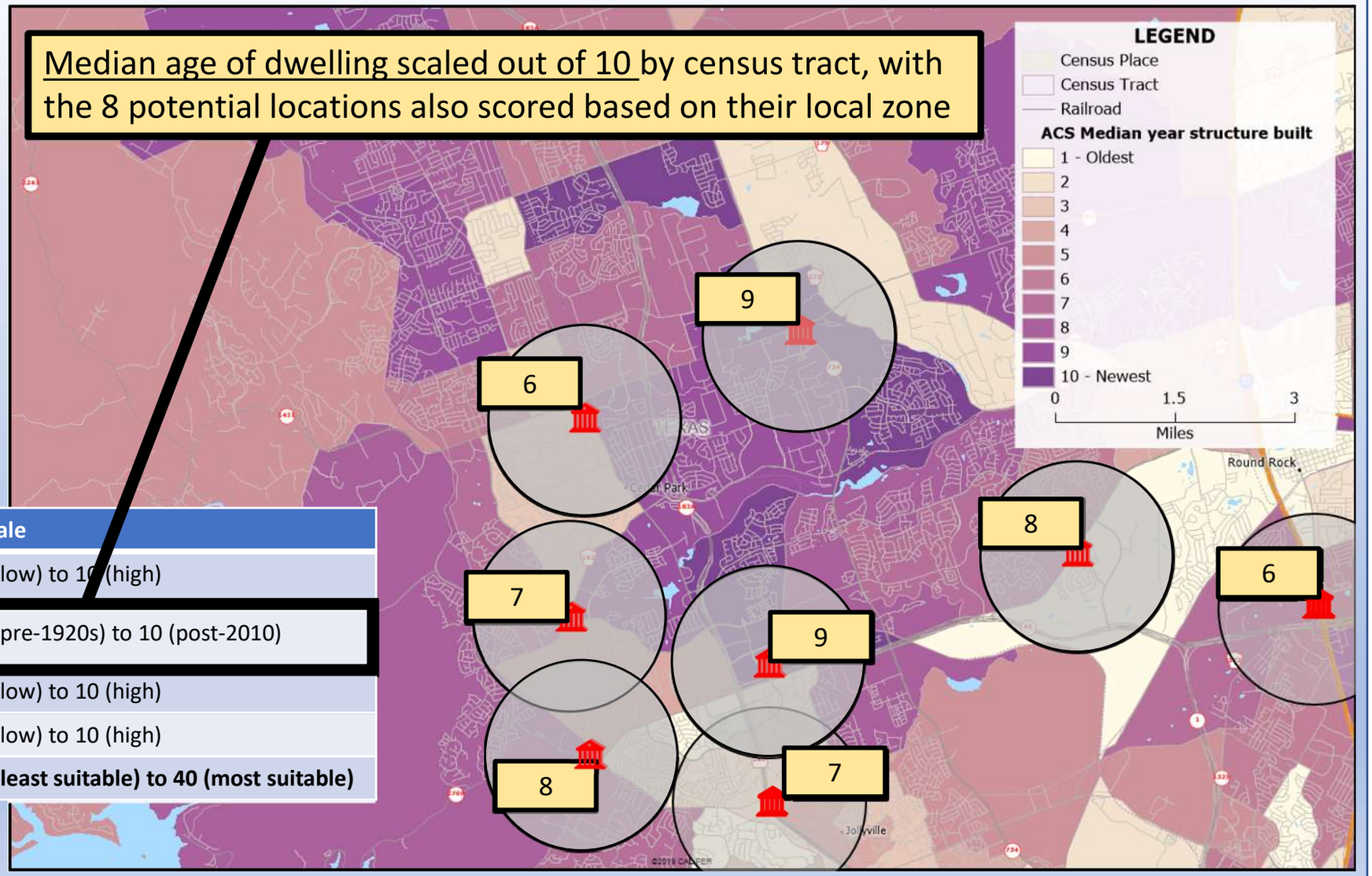
Detailed Discussion

Map 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
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)**



Maptitude

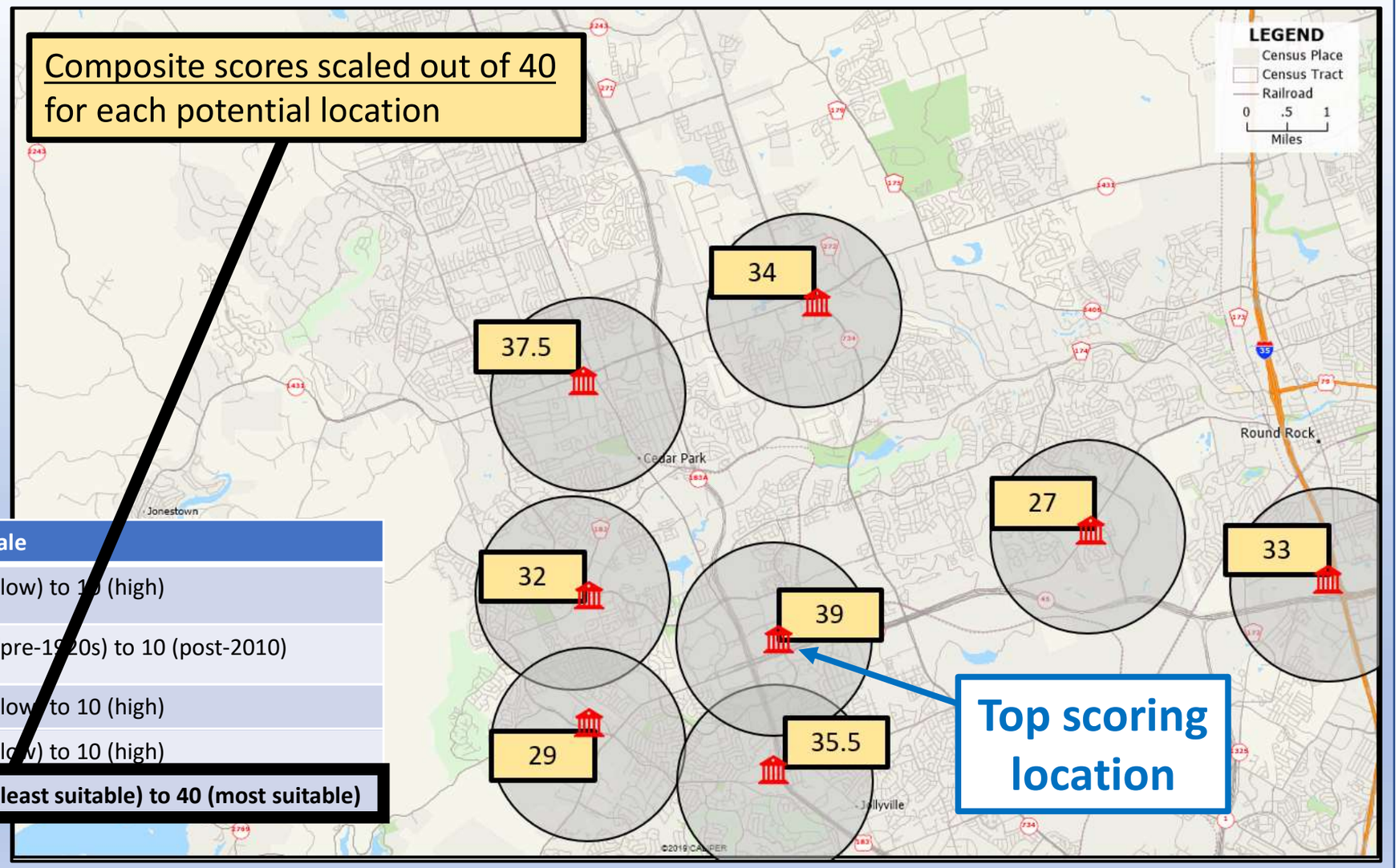
Detailed Discussion

Map 5

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.

Composite scores scaled out of 40 for each potential location

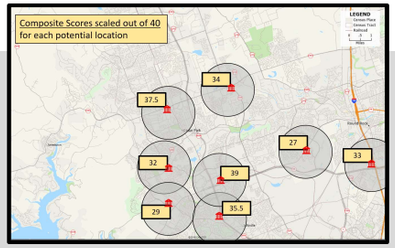


Dimension	Scale
Mean Household Income	0 (low) to 10 (high)
Median Age of Homes in Area	0 (pre-1920s) to 10 (post-2010)
Mean Retirement Account Balance	0 (low) to 10 (high)
Level of Competition	0 (low) to 10 (high)
Total Score	**0 (least suitable) to 40 (most suitable)**

Maptitude

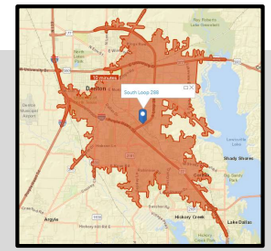
Resources and Processes to Support Site Ranking

In Caliper Maptitude:



Site Ranking…	
Supported by Maptitude	Yes
Starting the Analysis: A Combined Approach	**Choropleth mapping – pages 79 to 84** • Result: evidence base, each dimension **Buffers/drive-time zones – pages 65 to 78** • Result: identify customers in a specific area **Overlays – page 152** • Result: total customer data for each area
More guidance from Caliper	See individual video tutorials for the methods listed above

In ArcGIS BA Web App:



Site Ranking…	
Supported by BA Web App	Partially
Starting the Analysis	**Choropleth mapping – pages 79 to 84** • Result: evidence base, each dimension **Buffers/drive-time zones – pages 65 to 78** • 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

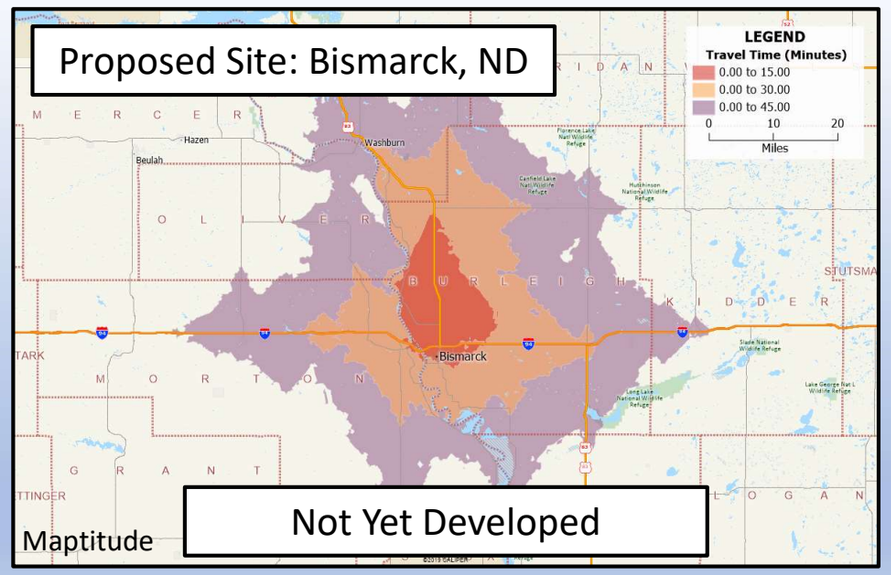


Figure D-11: Map of Proposed Site with Drive-Times

Detailed Discussion

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

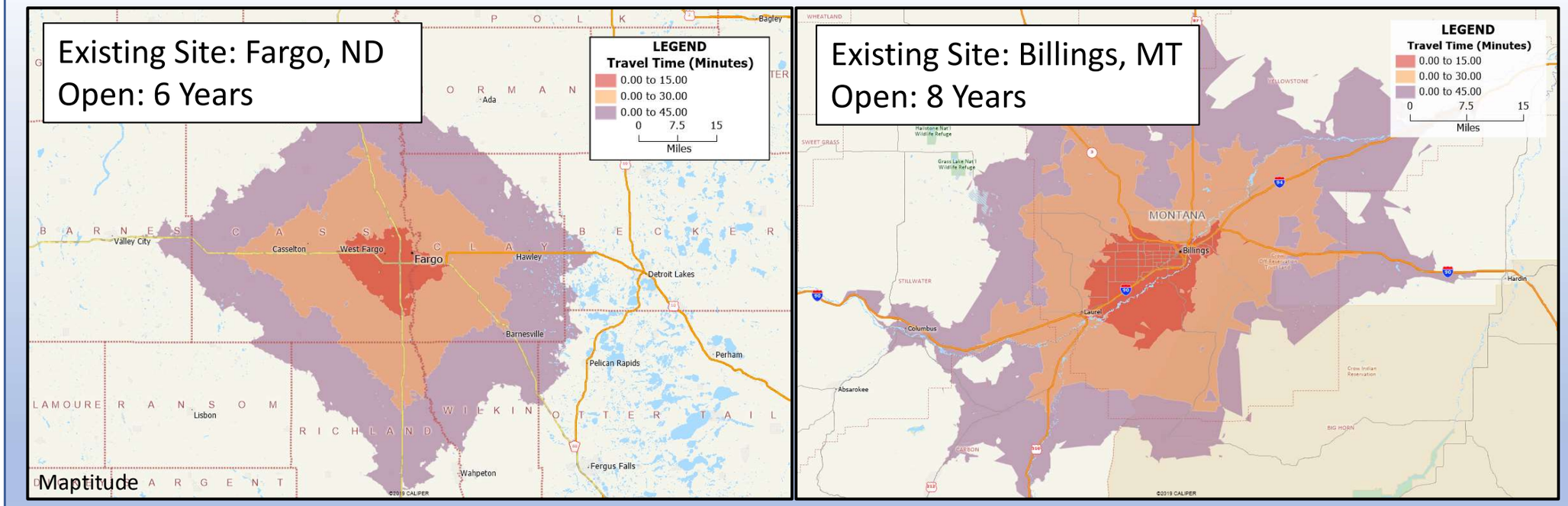
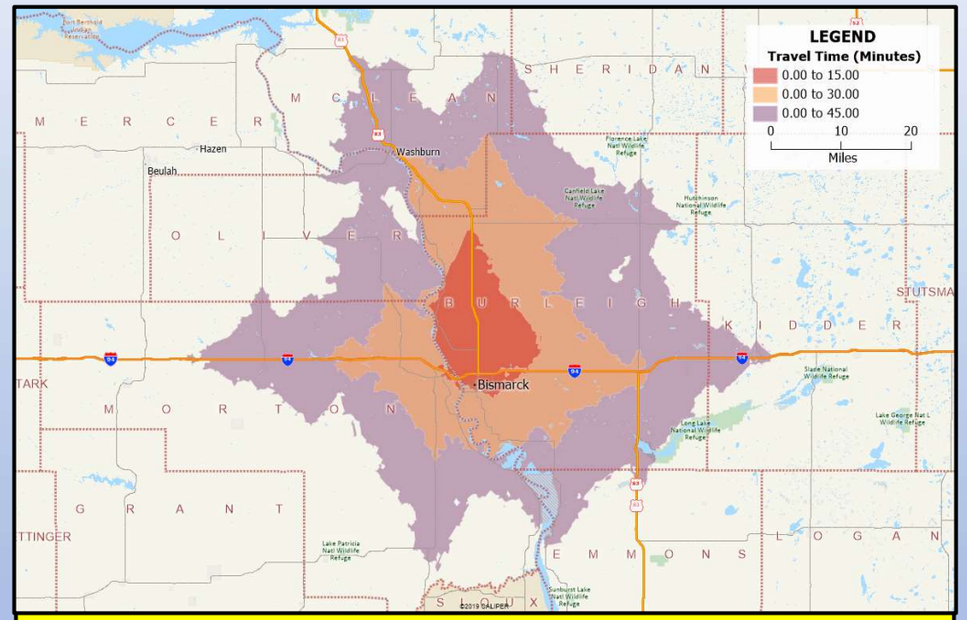


Figure D-12: Maps of Existing Store Locations in Comparable Markets

Text Box D-2: Analog Application for Bismarck, North Dakota

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	2,652
HH_Income $10[illegible]-14,999	953	1,727	1,824
HH_Income $15[illegible]-24,999	2,482	3,830	[illegible],042
HH_Income $25K-[illegible]34,999	2,654	3,881	[illegible],092
HH_Income $35K-[illegible],999	4,027	6,395	6,700
HH_Income $50K-74,[illegible]99	5,124	8,557	9,115
HH_Income $75K-99,9[illegible]	4,229	7,202	7,667
HH_Income $100K-149,[illegible]99	5,279	8,699	9,296
HH_Income $150K-199,[illegible]999	1,766	2,[illegible]	3,160
[illegible]	1,715	2,694	2,860
[illegible]	88,896	113,321	120,461
[illegible]	2.99%	2.28%	2.11%

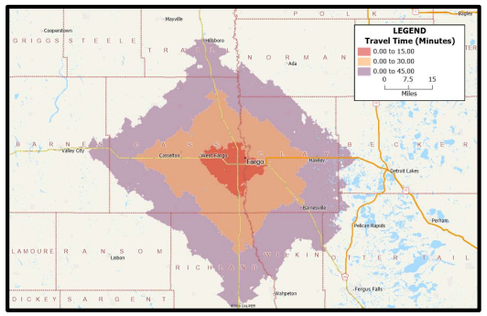
Mix of <u>demographic</u> (demand) and <u>competitive</u> (supply) variables need to be included here

Continued…

Detailed Discussion

Step 2

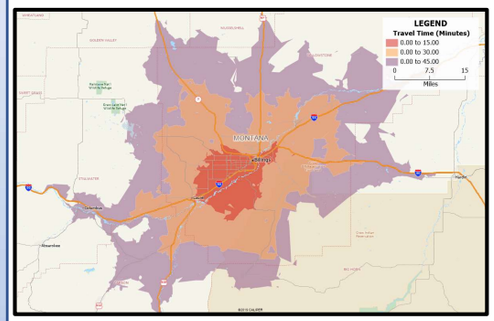
Assemble demographic and financial profile statistics for current stores and markets (in this case: showing Fargo, ND and Billings, MT)



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%

These two markets can be considered along with any other current operations in the northern plains that the business wishes to include

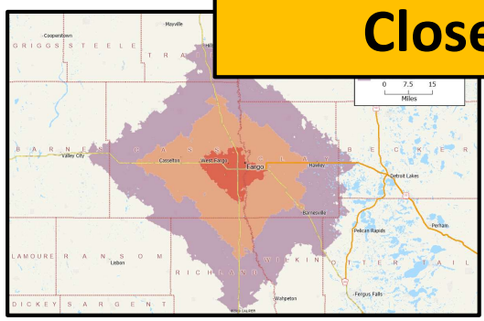
Continued…

Detailed Discussion

Step 3

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

Closest Match



Current Site: Fargo, ND

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
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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
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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%

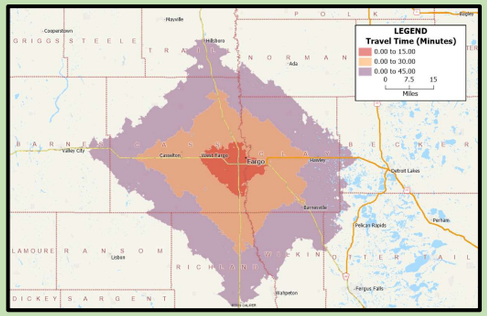
These two markets can be considered along with any other current operations in the northern plains that the business wishes to include

Continued…

Detailed Discussion

Step 4

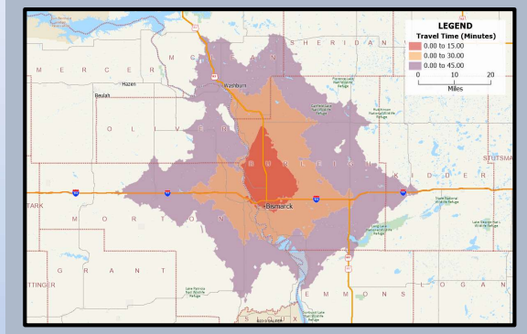
With the closest analog matches identified, we can now use the demographic and competitive status of the current location(s) to calculate projections for the proposed site



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: Fargo, ND (Open 6 Years)



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	$86,655
% Change in Average HH_Income	0.31%	1.94%	2.00%
HH_Income <$10K	1,407	2,392	2,552
HH_Income $10K-14,999	953	1,727	1,824
HH_Income $15K-24,999	2,482	3,830	4,042
HH_Income $25K-34,999	2,654	3,881	4,092
HH_Income $35K-49,999	4,027	6,395	6,700
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 66 to 69 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 ArcGIS BA Web App:

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

Rings or Drive-time zone dialogues (again, see pages 66 to 69 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

- Regression modeling focuses on placing the key site factors in a quantitative model which provides a direct prediction of financial results associated with a specific site (Taylor 2015)

Text Box D-3: 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

Continued…

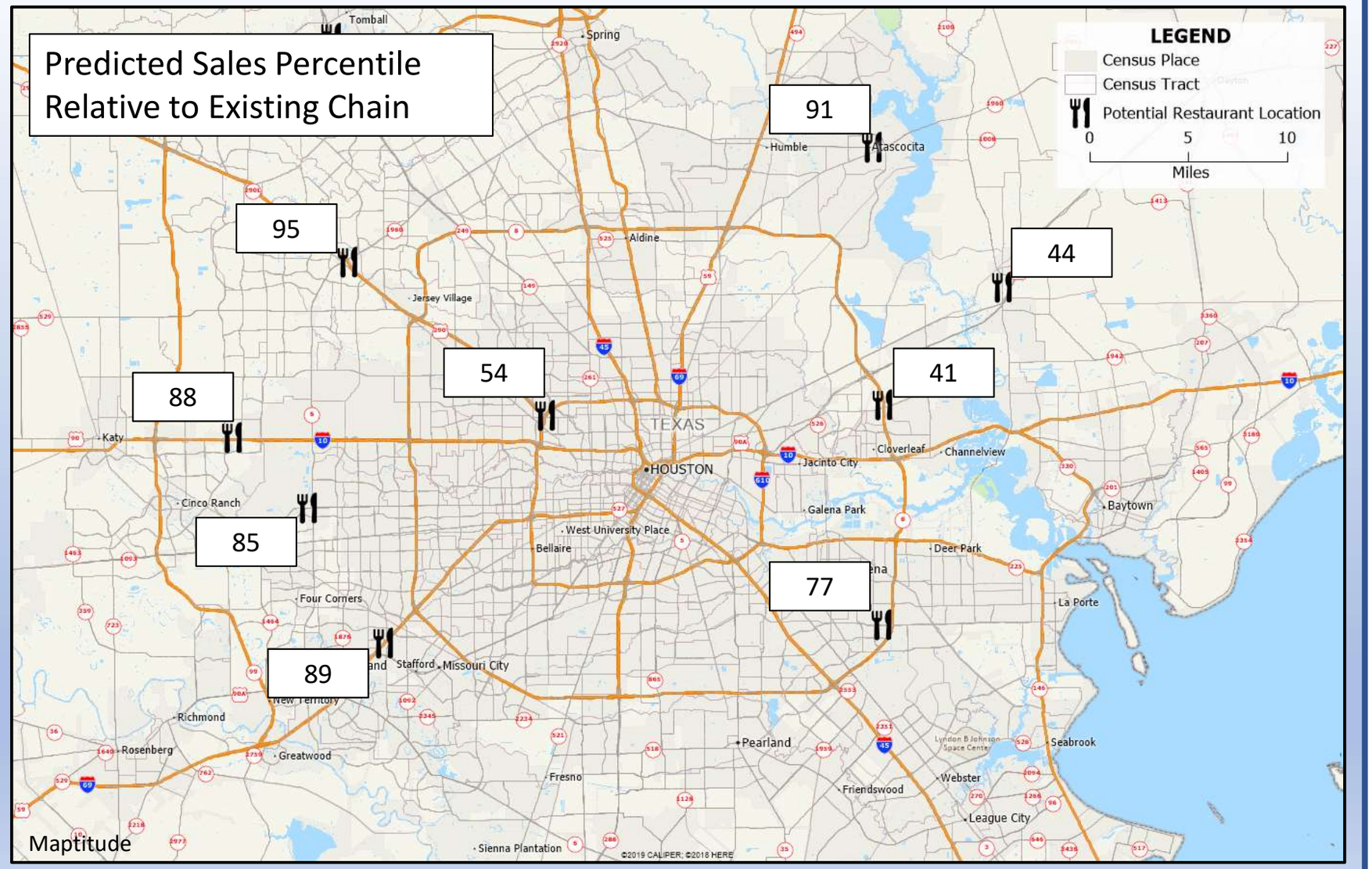
Detailed Discussion

Step 2

Build and apply the regression model.*

Step 3

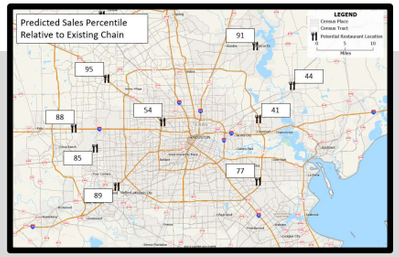
At the end, use the model to generate a predicted sales value (in this case, relative to the entire chain)



* 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.

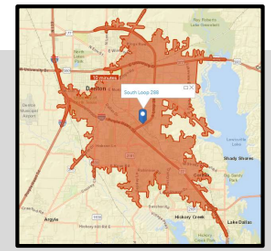
Resources and Processes to Support Regression Modeling

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 ArcGIS 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?

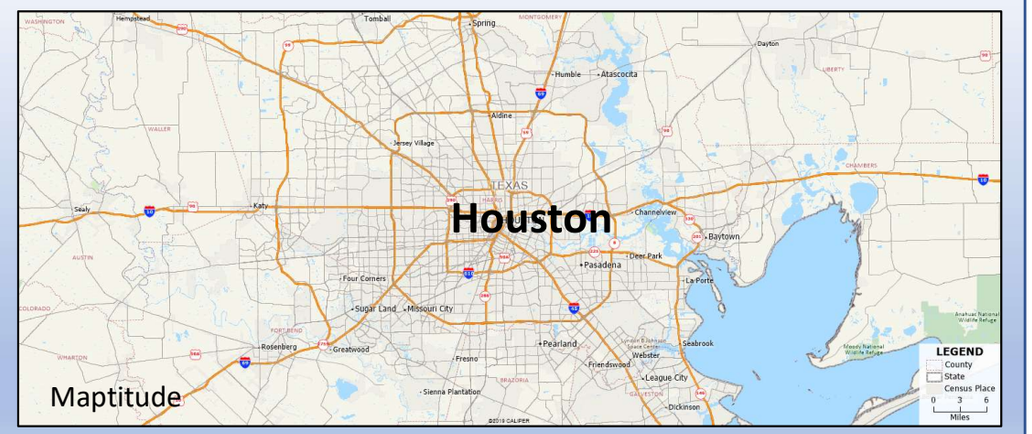


Figure D-13: A Location-Allocation Business Scenario

Detailed Discussion

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

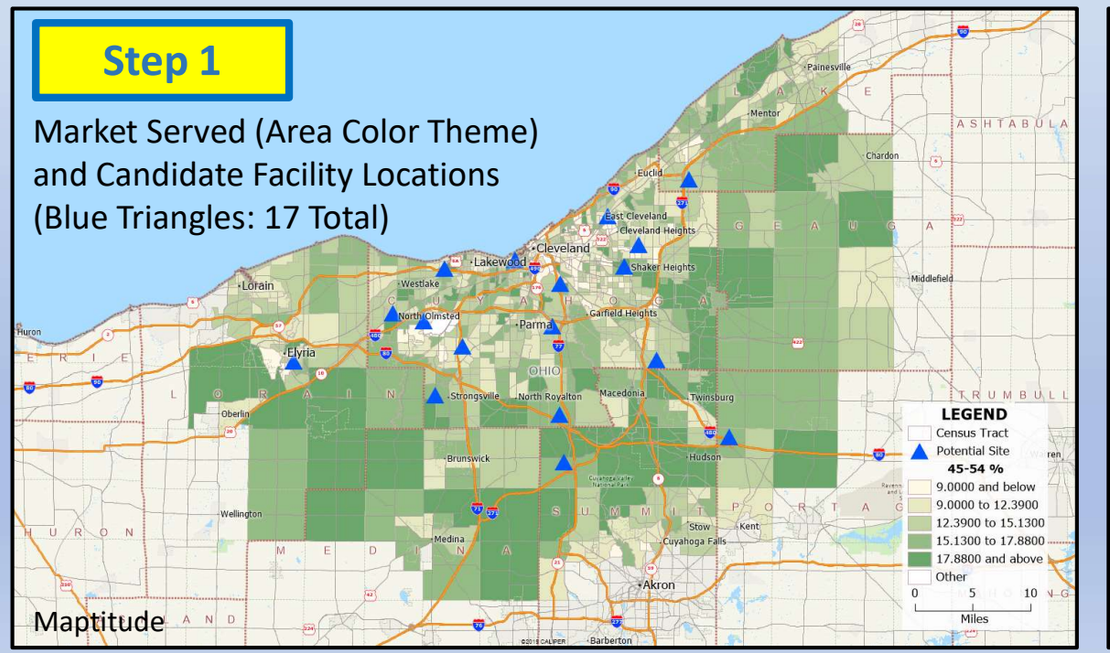
  - **1. P-median problem (PMP):** locate a fixed number (p) of service-providing facilities to provide the most efficient coverage of client demand across a given region
    - **Note:** efficient coverage of all client demand may entail leaving a select few clients with very poor service coverage.
    - **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.

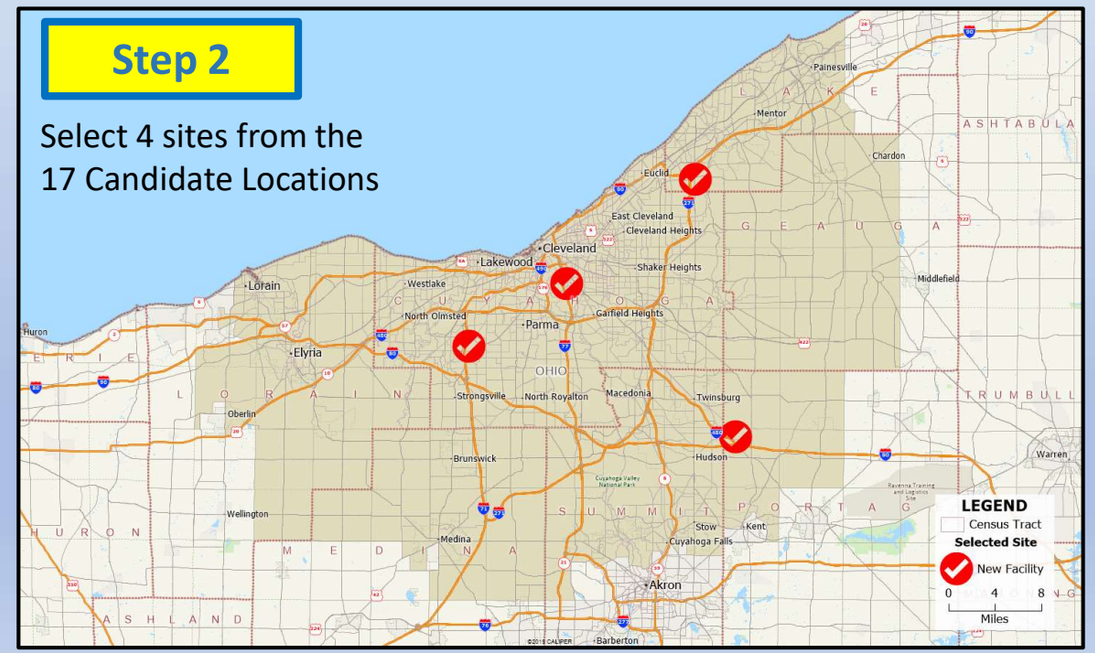
  - **2. Maximal covering location problem (MCLP):** locate a fixed number of facilities to maximize the percentage of clients who are served within a given service coverage standard
    - **What is a "service coverage standard"?** This could be defined as a maximum distance (as many children as possible 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

Text Box D-4: A Complete Location-Allocation 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 in this case

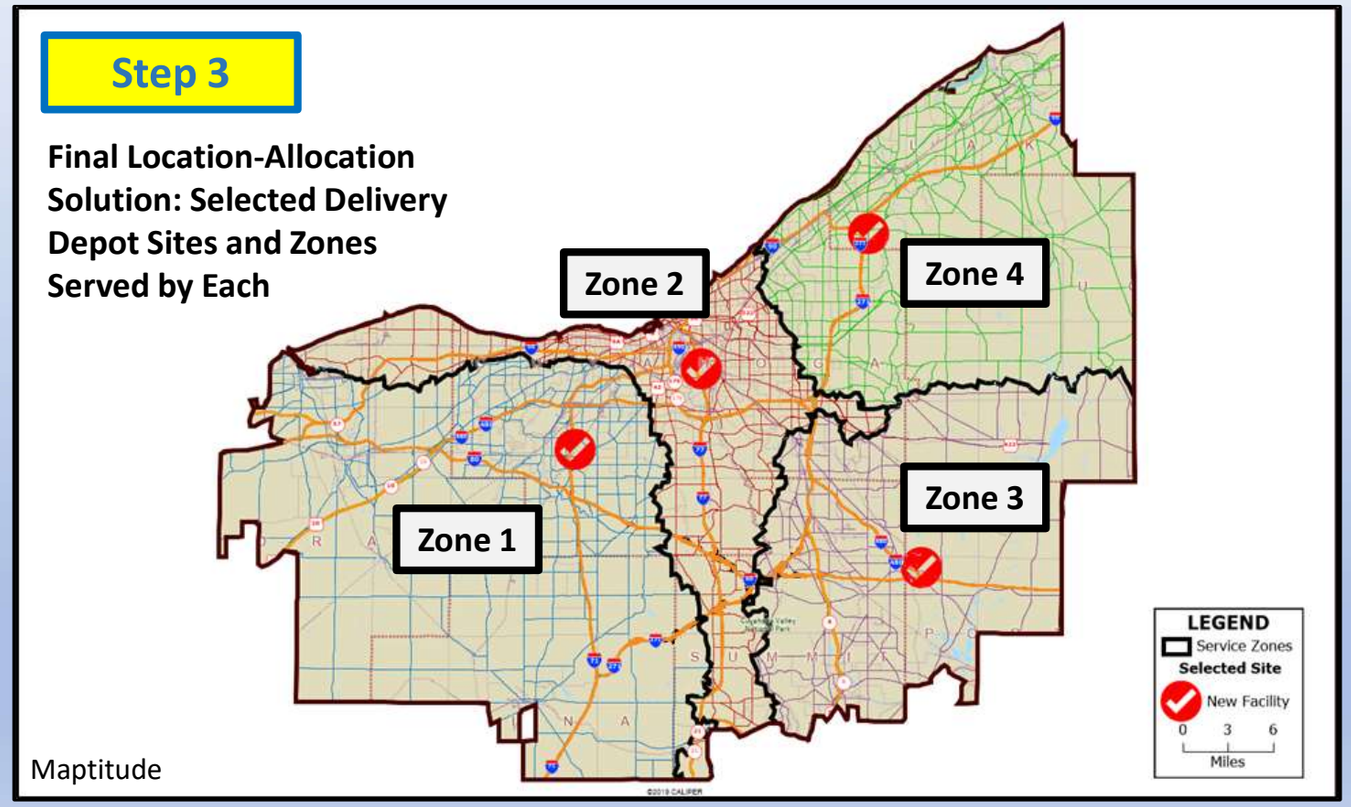




Continued…

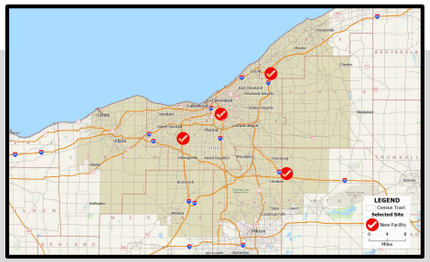
Detailed Discussion

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



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 ArcGIS 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

Application Overview: Market Area Delimitation & Analysis 196

A. Spatial Monopoly 197
B. Market Penetration 199
C. Dispersed Markets 201

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.

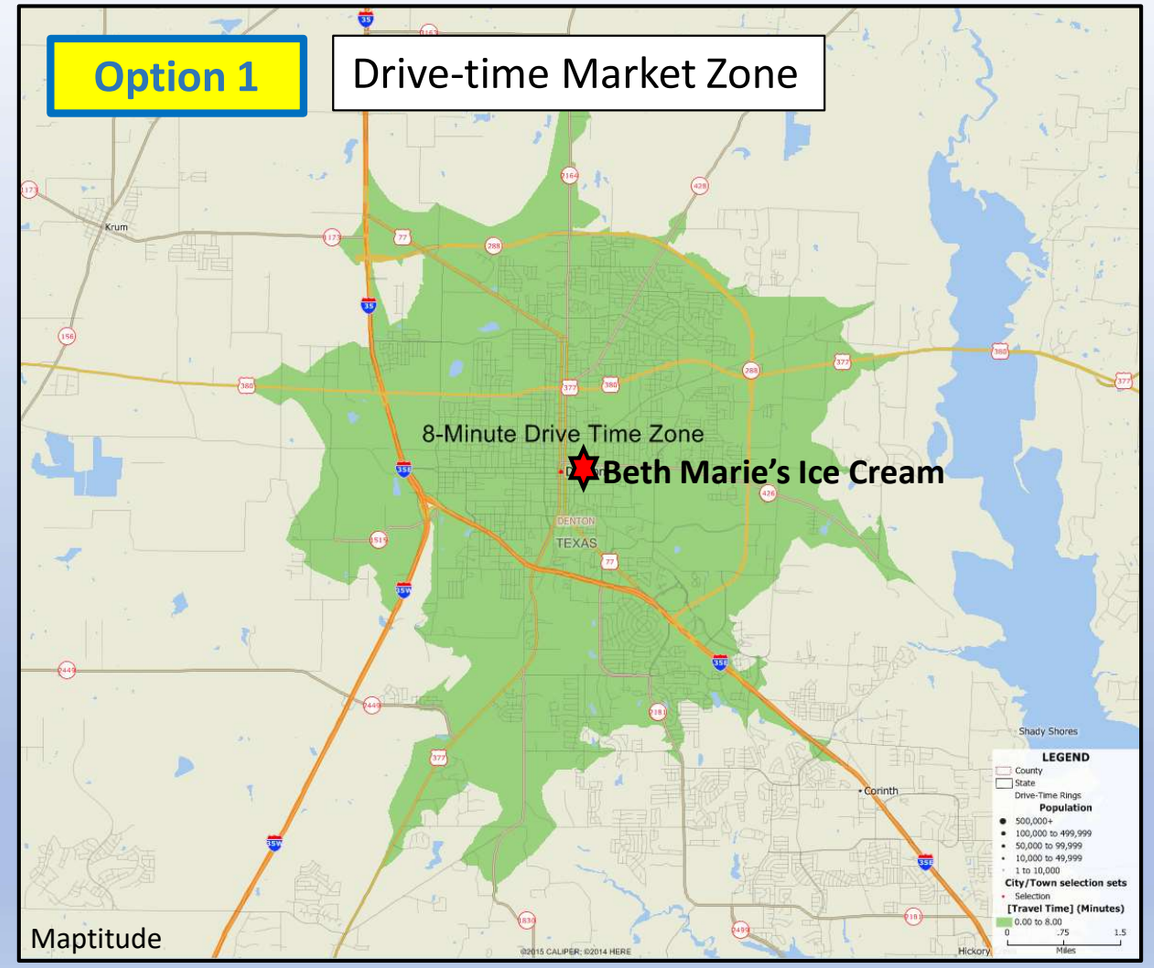


Figure D-14: Spatial Monopoly, Option 1 (Drive-Time)

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 66 and 67 for related discussion regarding buffers.

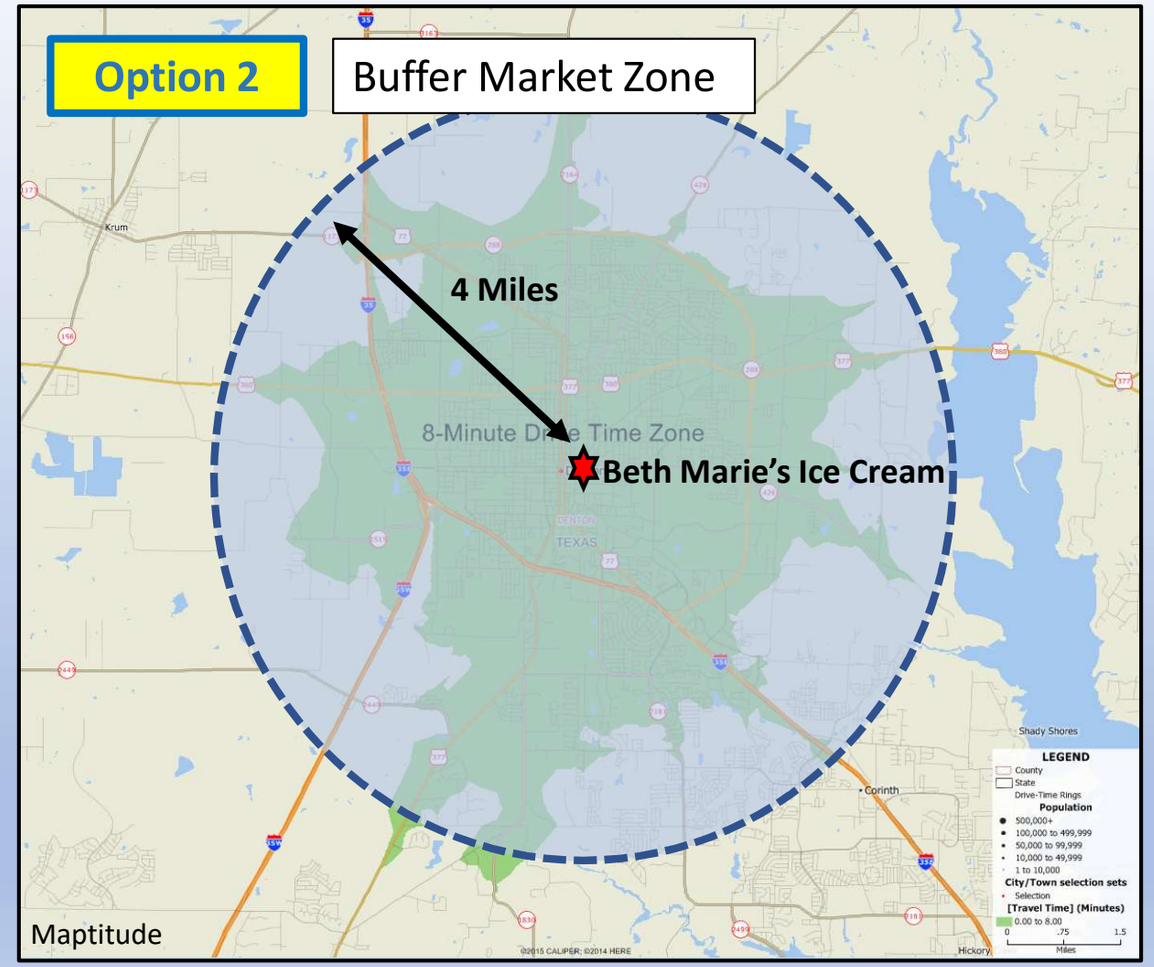


Figure D-15: Spatial Monopoly, Option 2 (Buffer)

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.

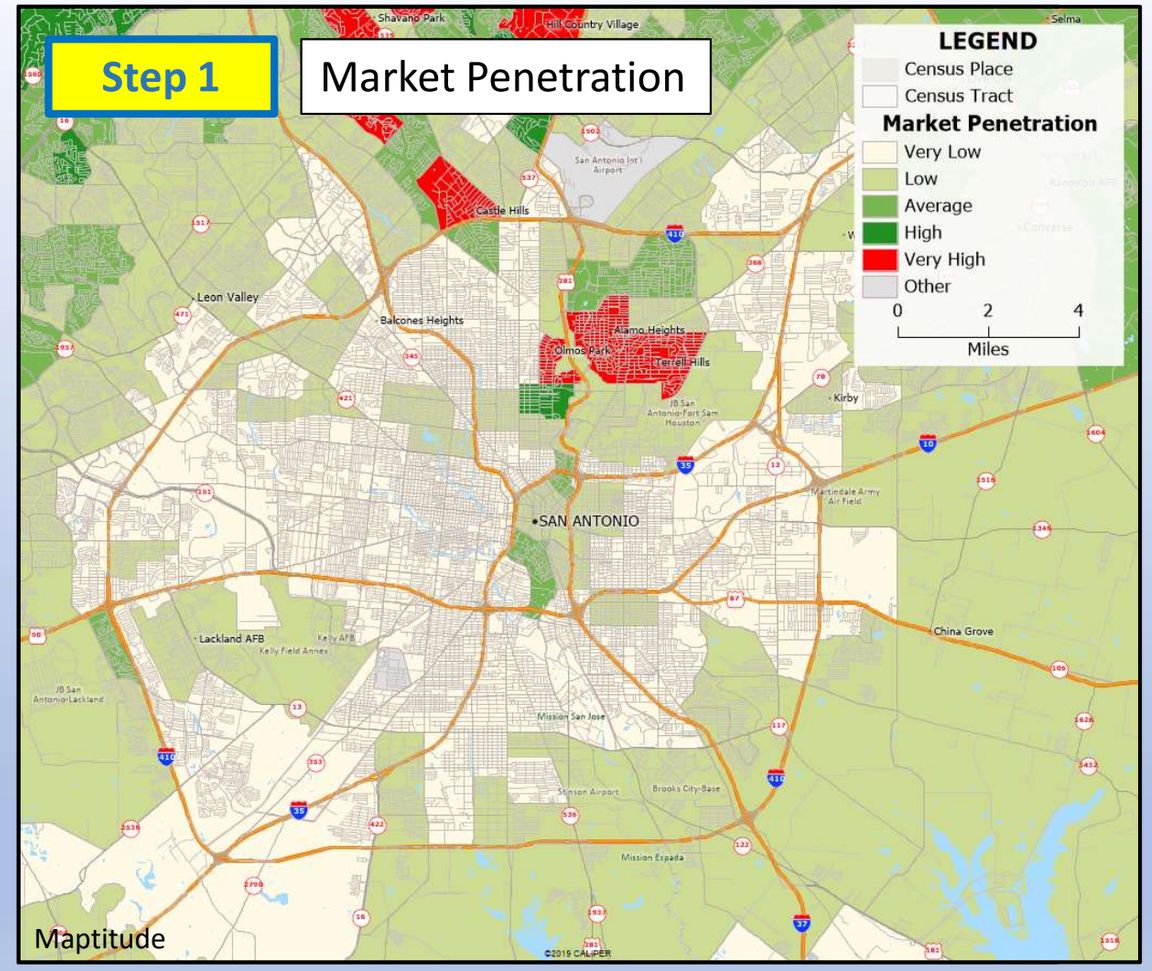


Figure D-16: Market Penetration, Step 1 (Basic Penetration Analysis)

Detailed Discussion

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.

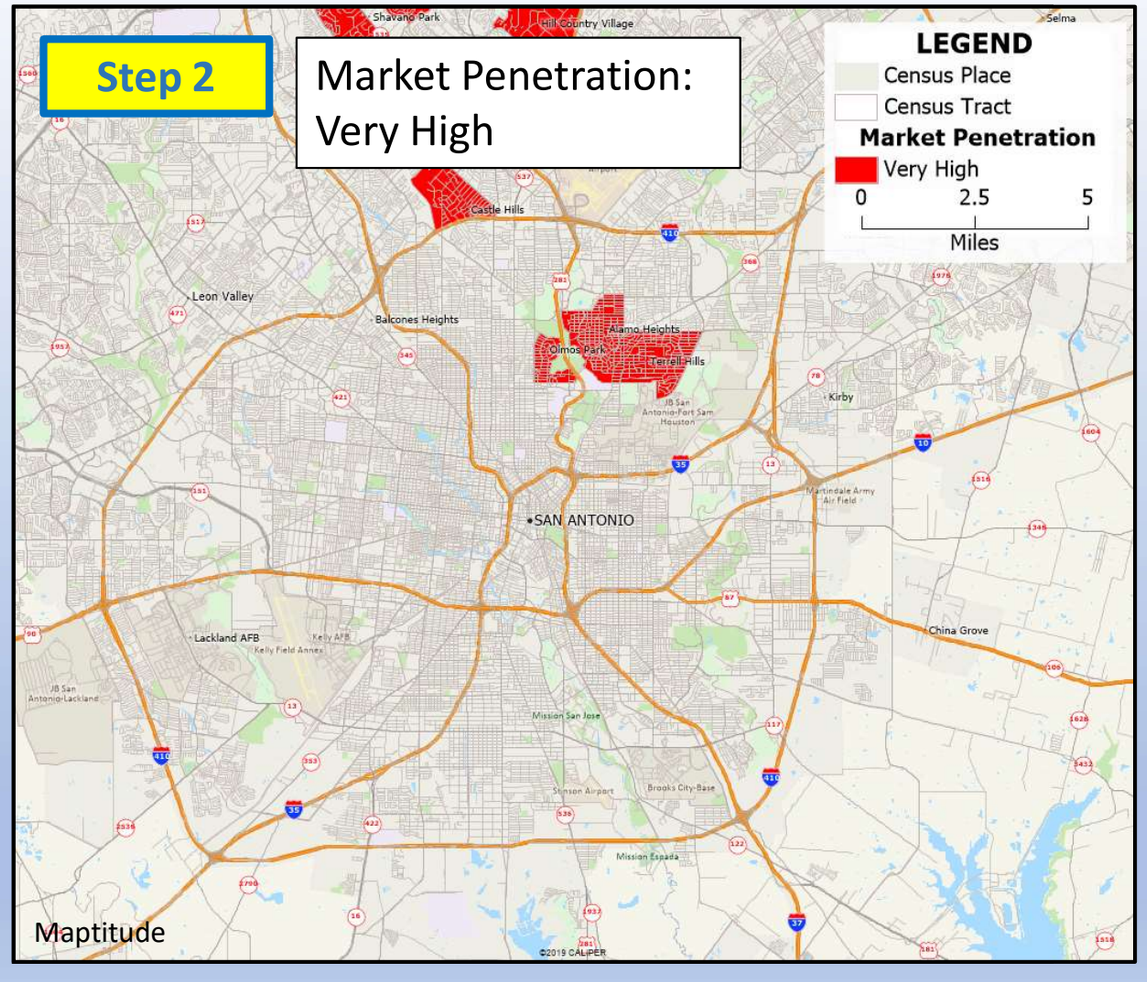


Figure D-17: Market Penetration, Step 2 (Focus on Very High Zones Only)

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.

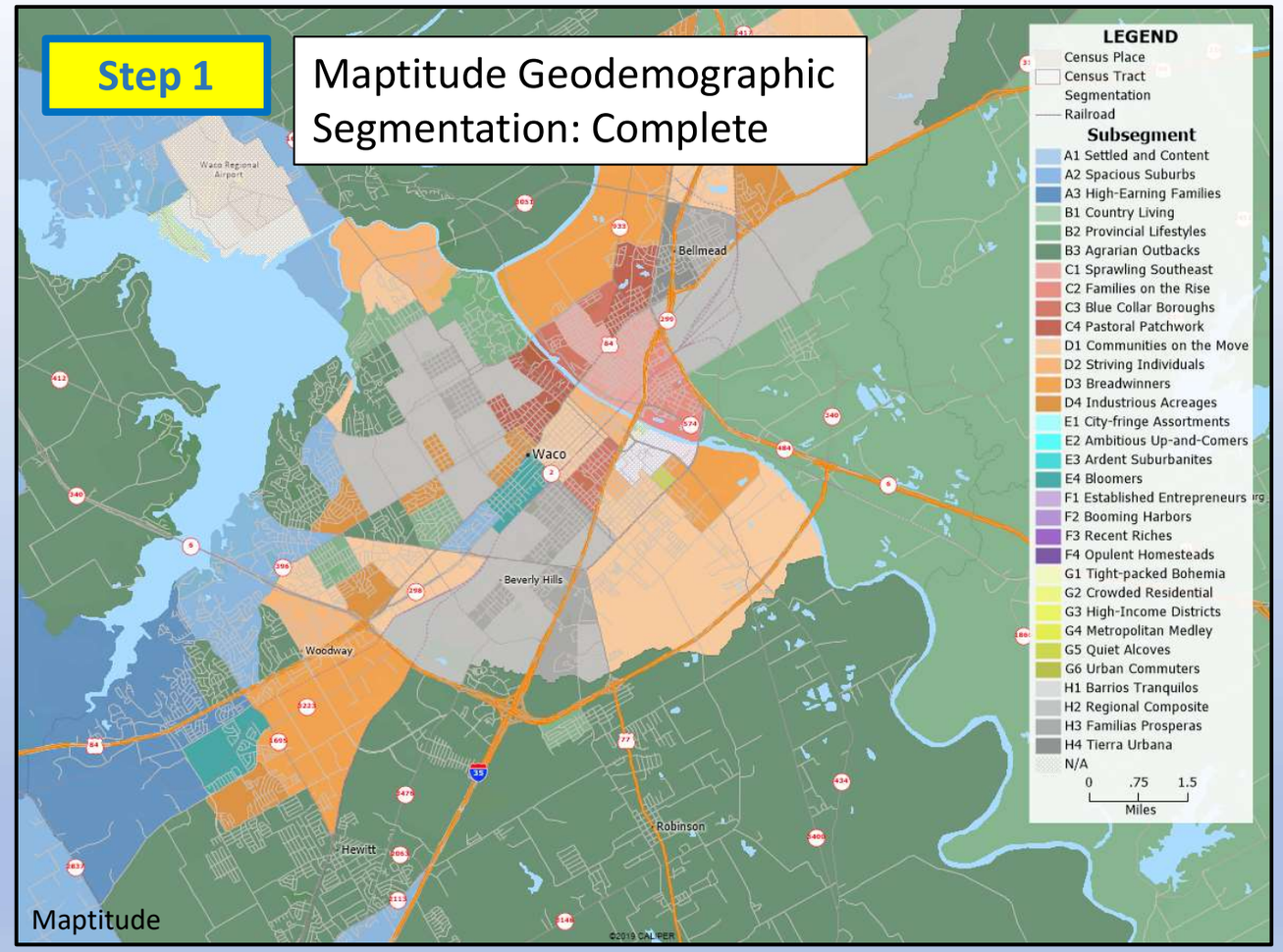


Figure D-18: Dispersed Markets, Step 1 (All Geodemographic Segments)

Detailed Discussion

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 99-108 for more, related discussion on the subject of geodemographic segmentation.

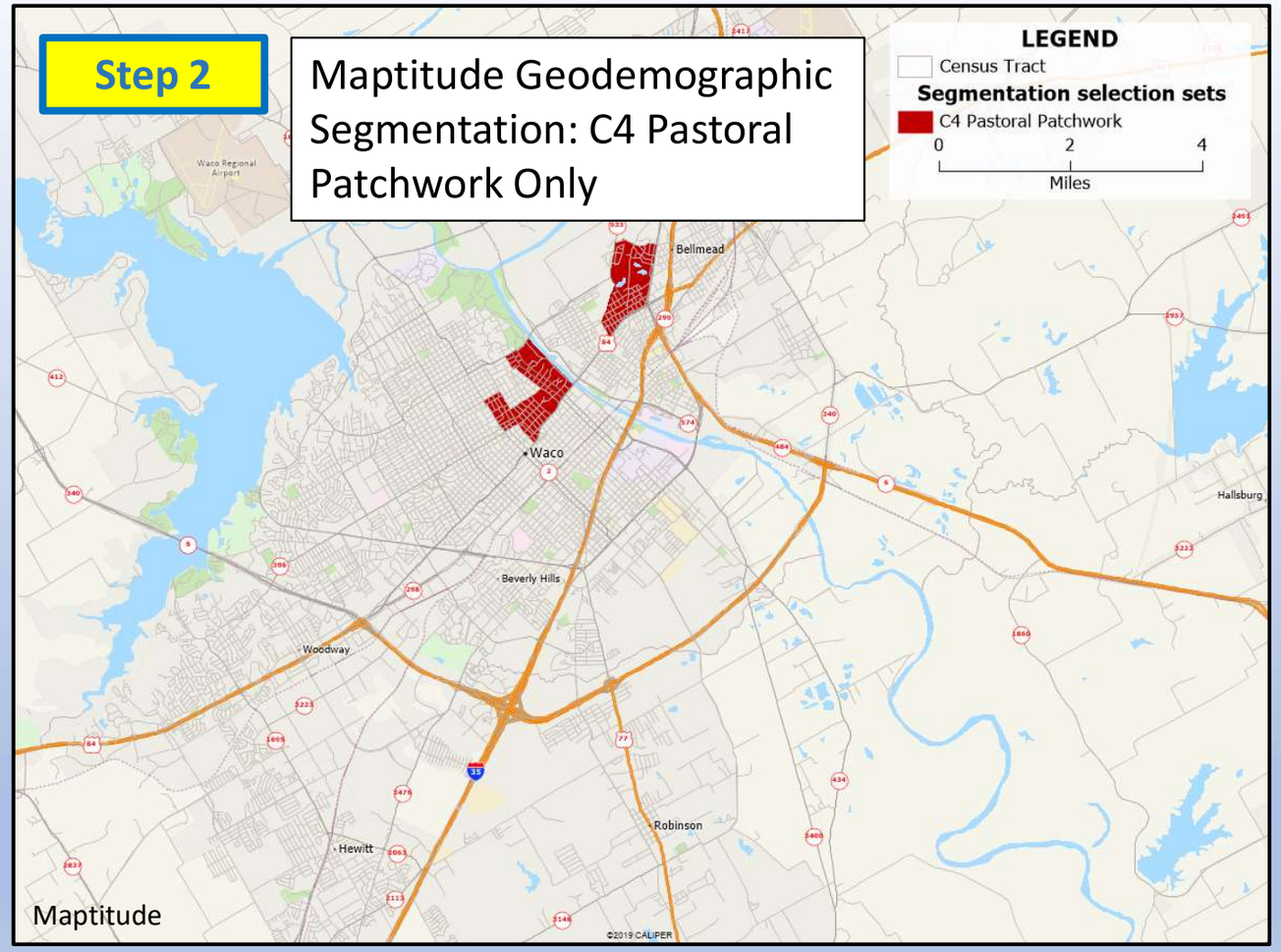


Figure D-19: Dispersed Markets, Step 2
(Focus on Segments in Very High Penetration Zones Only)

End of Part D

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 much reduced. 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 without question in need of reshaping and revisioning in consideration of this new era, but the basic thinking behind these methods 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

Appendix A: Additional Problem and Method Suggestions 209

Appendix B: Additional Video Resources 212

Appendix A: Additional Problems and Methods

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.

Appendix B: Additional Video Resources

Here are a few online resources related to the methods highlighted here. Table Appendix B-1 covers Maptitude.

Table Appendix B-1: Maptitude Video Resources

Method/Application	Video Resource Link
1. Adding a Location Component to an Existing Database	**Creating a Map Using Your Data:** https://www.caliper.com/video/maptitude/maptitude-create-a-map-wizard-video/maptitude-create-a-map-wizard-video.html (6:37 in length)
2. Buffer/Drive-Zone Analysis	**Buffers:** https://www.caliper.com/video/maptitude/maptitude-overlays-and-buffers-video/maptitude-overlays-and-buffers-video.html (5:41) **Drive-Zones:** https://www.caliper.com/video/maptitude/maptitude-drive-time-rings-video/maptitude-drive-time-rings-video.html (3:24)
3. Choropleth Mapping	**Creating a Thematic Map:** https://www.caliper.com/video/maptitude/maptitude-thematic-mapping-video/maptitude-thematic-mapping-video.html (7:13)
4. Target Zone Identification	**Working with Selection Sets:** https://www.caliper.com/video/maptitude/maptitude-selections-and-filters-video/maptitude-selections-and-filters-video.html (7:13)
5. Geodemographic Segmentation	No tutorial video, but a basic explanation of Maptitudes Geodemographic system can be found here: https://www.caliper.com/featured-maps/maptitude-geodemographic-segmentation.html (4:00)
6. Areas of Influence	**Influence Areas & Drive-Time Territories:** https://www.caliper.com/video/maptitude/maptitude-areas-of-influence-video/maptitude-areas-of-influence-video.html (4:00)
7. Consumer Choice Modeling (Huff Modeling)	No tutorial video is available for this function, but a good online article outlining the power of this application can be found here: https://www.gislounge.com/how-to-measure-hotel-market-share-using-the-huff-model-in-maptitude/
8. Density Grid Analysis	**Hot-Spot Density Grid Map:** https://www.caliper.com/video/maptitude/maptitude-density-grid-hot-spot-video/maptitude-density-grid-hot-spot-video.html (1:37)
9. Network Analysis	**Finding Shortest Paths and Routes:** https://www.caliper.com/video/maptitude/maptitude-routing-video/maptitude-routing-video.html (4:40)

Appendix B: Video Resources

While Esri does not have an extensive video tutorial library keying specific applications to individual, targeted videos (like exists for Maptitude), there are several useful video tutorial resources available for ArcGIS Business Analyst Web. Table Appendix B-2 provides a sampling from Esri and other video creators.

Table Appendix B-2: ArcGIS Business Analyst Web Video Resources

Video Theme	Video Resource Link
Getting Started with the Business Analyst Web App	https://www.youtube.com/watch?v=ORXLT20PYZ0 (2:34 in length)
Business Analyst Web App for Beginners Webinar: Guided Tour	https://www.youtube.com/watch?v=xeIf01CXCkQ (52:54 in length) **In this video:** orientation (0:00), site selection (4:42), site suitability analysis (18:10), target marketing (28:50), simple maps and visualizations (38:50)
Adding Web Maps and Layers in Business Analyst	https://www.youtube.com/watch?v=lkdmF-ixXD4 (2:14 in length)
ESRI Business Analyst Web Application Demo	https://www.youtube.com/watch?v=mHshB9hJgJk (13:18 in length)
Using the Import File Tool in Business Analyst	https://www.youtube.com/watch?v=lOEYR1-ntLk (2:45 in length)
Business and Facilities Search in Business Analyst	https://www.youtube.com/watch?v=doFbxgJwp5E (2:31 in length)

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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. However, to address business GIS practice well, this book also provides guidelines for beginning practitioners on the transition they are making as they become true researchers. This guide clarifies the basic issues, approaches, tools, and ideas that retail and business geography students can learn to understand and 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 emeritus of AGX (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, and their Distinguished Service Award in 2022. Dr. Rice is also a past chair of the BGSG and the Southwest Division of the American Association of Geographers.

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