

The Trade Area Analysis Model

Trade area analysis models encompass a variety of techniques designed to generate trade areas around stores or other services based on the probability of an individual patronizing a particular location. It is possible to identify market islands in a network of competing stores using criteria such as the attractiveness of a store and the distance one must travel to get to the store. Store attractiveness can be defined by parameters such as total floor space or shelf space, number of parking spaces, age of the store, or any combination of elements which defines its appeal. Using commercially available wealth and market profile information for potential customers located within each trade area, it is possible to estimate revenue for store locations and model the influence of competing stores or the effect of adding or removing stores.

Two Types of Trade Area

Trade areas can be determined or defined by simple circular boundaries around a store location. In this case, it is assumed that the store has a spatial monopoly on the customers or neighbourhoods within the boundary since they are either in the trade area or not. These trade areas are easy to visualize and construct and provide a standard for comparing stores. Trade areas determined in this way do not, however, account for the existence of competing stores, and assume that the store has a monopoly over customers within the area. There is the common sense concept that, all other things being equal, a person is likely to shop at a closer store rather than a more distant one. It is this concept of likelihood that forms the basis for defining probabilistic trade areas.

Defining the likelihood or probability that a given customer will patronize a certain store requires the use of a spatial interaction model. Examining movement over space for things such as shopping trips, worker commuting, or migration patterns, became popular with the use of gravity models in the 1960s and 1970s. There has recently been a greatly renewed interest in gravity models as desktop GIS makes its way into the business office.

Gravity models are based on an analogy to Newton's theory of gravitational attraction. *The degree of attraction between two objects is based on the size of the objects and the distance between them.* Objects that are closer together will exert a greater pull on each other compared with objects which are farther away. Larger objects have a greater gravitational pull than smaller objects. Refinements to the gravity model were made by Professor David Huff now at the business school of the University of Texas. The Huff Model is still one of the most popular models for predicting retail customer behaviour. It enables us to map the neighbourhoods from which each store derives its patronage. The answer is not a single circle or polygon but a probability surface or grid. This probability grid can be contoured to produce regions of patronage probability, as shown later in this discussion. The key feature implicit in the probability surface is that it accounts for overlapping trade areas.

The Huff Model implementation in *Vertical Mapper* allows users to calculate the probable trade area of a single store (Figure 4.1) or, compute the patronage probability values for every store and extract the maximum probability value at each grid location (Figure 4.2). This can be used to determine areas where people are least serviced or areas where there is great competition for a customer's business, i.e., there is no preferred store location clearly winning a customer's patronage.

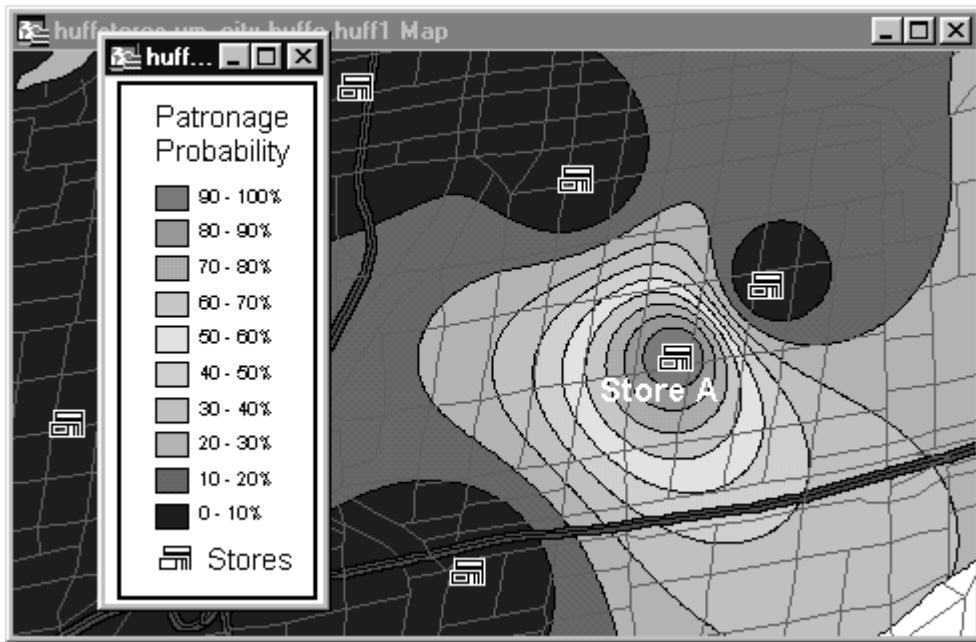


Figure 4.1. This illustration shows how it is possible to map the probability that a consumer will patronize Store A. The influence of all stores is taken into account in this model so that the locations of stores surrounding Store A influence the shape of the contours. Patronage probability decreases as distance from the store increases.

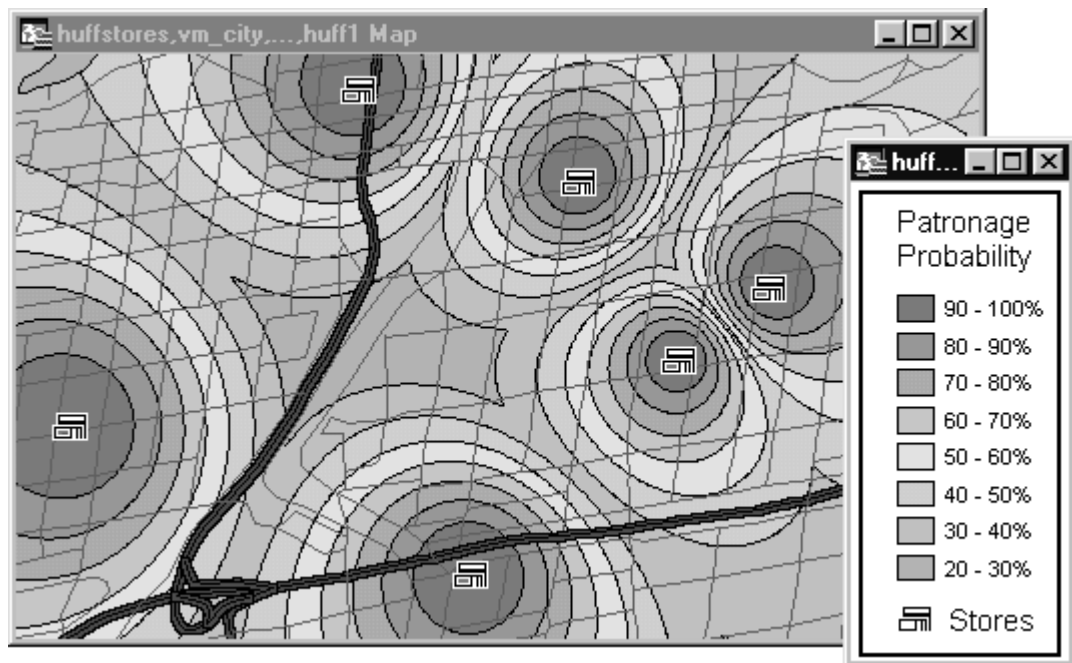


Figure 4.2. This figure illustrates a map of the maximum probability, at every potential customer location, that a consumer will patronize any one of the selected stores when presented with all of them.

Retailers can modify the Huff equation parameters by defining the attractiveness of each store competing for a customer's patronage and determining the rate at which the pulling power of a store

drops off or decays with distance from the store. This produces a map estimating the probability that a potential **Customer** residing at a given grid location will patronize a particular store at location **ReferenceStore** given a network of competing stores *Store1 to StoreN* where *N* = the total number of stores **including** the reference store. See the plain English equation below.

$$\text{CUSTOMER PROBABILITY} = \frac{\frac{(\text{Attractiveness of ReferenceStore})^\alpha}{(\text{Distance between Customer and ReferenceStore})^\beta}}{\text{SUM of } \left[\frac{(\text{Attractiveness of Store1})^\alpha}{(\text{Distance between Customer and Store1})^\beta} \right] \text{ for Store1 to StoreN}}$$

where:

= attractiveness coefficient estimated from empirical observations.

= distance decay coefficient estimated from empirical observations.

This formula ensures that all the probabilities are between zero and 1.0 and sum to 1.0 when considering all the shopping destinations. The α and β coefficients allow the user to account for non-linear behaviour when modeling the effects of store attractiveness or distance. Users interested in examining the effects of distance to customer density should consider the use of the Point Density Calculation tool found under the Natural Neighbourhood Analysis section of the main *Vertical Mapper* menu (see Chapter 13). For example, consider a business that posts an interviewer at its entrance to collect location data of incoming customers. Zip code, street intersection, or other geocodable information would be collected for, say, 1000 customers. Point densities can be calculated for all the interviewed customers and the density values surfaced using *Vertical Mapper* interpolation. This generates a relative customer density map in the surrounding area per 1000 visitors. Cross section profile graphs of the customer density surface outwards from the store can yield valuable insight into patterns of distance decay.

Patronage Probability as a Grid

When *Vertical Mapper* generates a grid, the location of each grid node is considered to be the location of a potential customer. The calculation involves estimating the probability that a customer at that site (grid node) will patronize a particular store (Figure 4.3).

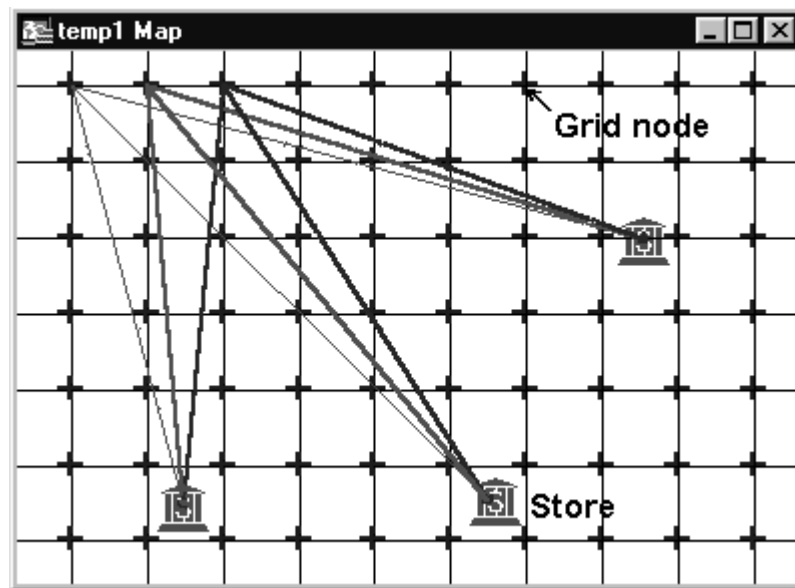


Figure 4.3. A patronage probability value is calculated for each grid node based on its distance from every store and the store's attractiveness. The grid nodes are usually so close together in the actual grid map that they are not clearly visible as individual cells when coloured.

In terms of a supply and demand model, the resulting “potential” or “idealized” probability surface spatially represents the supply side of the equation. It does not directly take into account any actual underlying demand data such as consumer households or census tract information. To process the demand data so that revenue calculations can be made, it is necessary to update the probability regions (produced by contouring the probability grid) with any underlying income information you have. For instance, a grocery store may be interested in determining the amount of revenue generated from people living in the 30 to 40 percent probability contour surrounding the store. Using MapInfo routines the user could update the contour region by summing all the census tract information regarding number of households and average income. This total buying power figure multiplied by eight percent (the average percent of household income spent on groceries) times 35 percent (the likelihood that these households will buy from a specific store) yields the expected revenue from this region. The effects of moving, adding, or removing stores can be examined in this way. For an instructional lesson on the *Trade Area Analysis* modeling tool refer to Lesson 4 of the *Installation and Tutorials* manual.

Tip: Instead of trying to update the probability regions with overlying demographic (population/wealth) point data, try to update the demographic data table with values from the probability grids. You can load as many grid files as you like into the *Grid Manager*, then use the *Grid Analysis > Point Inspection* routines to easily add the grid values to the demographic data table.

Suggested Readings on Trade Area Analysis

For an excellent review covering the basics of probabilistic trade area analysis refer to:

Dudley, G. 1996: Probability Primer: Spatial insights into StoreBase trading areas. F.Y.I. Vol.4,#2, August. A Publication of Blackburn/Polk Marketing Services Inc., Toronto.

For further readings on the more esoteric topic of spatial interaction, refer to:

Fotheringham, S. and O'Kelly, M. 1989: Spatial interaction models: Formulations and applications. Kluwer Academic Publishers.

Taylor, P.J. 1975: Distance decay models in spatial interactions. Concepts and techniques in modern geography. Norwich: Geo Books