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# **CHAPTER NINE**

In 2000, a young Philadelphia couple was looking to buy their first home. As many people do in this situation, they put together a list of criteria that were important to them. They wanted to live in a leafy neighborhood, preferably close to Center City. They didn't own a car, so close proximity to a grocery store was of vital importance. They similarly preferred to be within biking or walking distance of work, restaurants, and their favorite hobby – fencing. Unlike most people facing this type of decision, one of them happened to work in the geospatial industry and quickly recognized this quest as an ideal opportunity to apply spatial analysis. Given that the dilemma they faced was not unique, though their particular criteria were, they saw this as an ideal opportunity to build a web-based application that would enable others to make their own, customized, location decisions.

REX and DecisionMaps are both software applications that were designed to assist in location prioritization (see Figure 1). Each uses GIS to analyze and map variables affecting location selection decisions, enabling complex and customized spatial analysis to be performed by users without GIS expertise. REX is an application that helps users identify target neighborhoods for a housing search based on user-defined and weighted criteria. DecisionMaps was developed for the City of Philadelphia Mayor's Office of Information Services (MOIS) as part of the Mayor's Neighborhood Transformation Initiative (NTI). While NTI ended in 2008, DecisionMaps is still used by MOIS and other city agencies. This software takes a user-centered approach to business siting, couples it with a map interface, and enables the user to create site suitability maps for business and economic development. Both REX and DecisionMaps currently cover only the city of Philadelphia, but each framework could be adapted to other locations. REX and DecisionMaps draw on geographic technologies to analyze local landscapes, helping users to make informed decisions about their real estate purchases.

## WHERE TO LIVE - REX REAL ESTATE METRICS

Purchasing a home can be an overwhelming endeavor. Real estate specialists know that the neighborhood in which a home is located is often more important to the homeowner's ultimate happiness than the house itself (Getson, 2006). Yet most real estate applications are not designed to help users with this all-important aspect of their search. Rather, many real estate search tools provide user queries based on price, house size, and neighborhood



FIGURE 1 REX users can assign weights to criteria based on personal preferences and designate a desired price range. The results map highlights those areas that best meet the specified criteria and where the median home value is within the specified range. location, assuming that users already have a specific area in mind. REX, by contrast, enables searches for locations that match not only the price range but also preferences of the user for neighborhood characteristics. It does not depend on the user's knowledge of particular areas (which may or may not be accurate), but incorporates data for a variety of location-based factors including proximity to neighborhood parks, restaurant districts, and high-achieving schools. REX analyzes the city based on price range and preferences to generate an interactive map showing those areas that best match what the user wants and can afford.

REX's functionality is based on its use of raster GIS and map algebra. Philadelphia is represented by 37 map layers, each representing a particular decision factor. On each layer, values ranging from 0 to 100 indicate the degree to which that layer's decision factor is satisfied. These values are associated with 500ft x 500ft "cells" that completely cover the City in a grid of perpendicular rows and columns. Since each layer is based on the same grid, selected layers can be digitally superimposed onto one another in order to calculate a weighted average of values for each cell. The result is a map in which each location has a value from 0 to 100 with high numbers indicating locations that best satisfy the selected decision factors.

The real power of REX lies not in its ability to superimpose data layers and combine decision factors but, rather, in its ability to customize weighted preferences for individual users. Users are invited to rate each of the decision factors on a scale of 0 to 5, with 1 indicating low preference, 5 indicating high preference, and 0 indicating no preference. The data layers are then weight-averaged on this basis (see Figure 2). REX ultimately displays a map that highlights areas with housing values in the user's price range, areas that match the user preferences, and areas where price and preference overlap.

The user can click on this map to find a wealth of information (see Figure 3):

- recent sales;
- trends in home prices;
- current real estate listings;
- crime statistics;
- zoning; and/or
- nearby schools, recreation centers, and restaurants.



#### FIGURE 2

DecisionMaps users specify criteria weights using slider bars. Criteria can be weighted positively or negatively.



FIGURE 3 REX enables users to view recent sales and median housing values for any location in the city. In addition to searching for locations based on user-defined criteria, users can also find information on explicitly-specified locations. These inquiries can be based on street addresses or locations selected by clicking on an interactive map. Like the criterion-based searches, these queries provide users with information on the most recent residential real estate sales in the vicinity, nearby schools, recreation centers, and restaurants, as well as links to current real estate listings, crime statistics, aerial photos and zoning maps of the location. REX also allows users to bookmark locations for quick reference in later sessions.

REX supports a broad user base. Potential home buyers can use it to guide their searches, allowing them to compare different neighborhoods in terms of their preferences and price ranges. Potential sellers can use REX to find timely information on trends in their neighborhood, helping them determine the best price at which to put their home on the market. Current homeowners can use REX to evaluate changes in the value of their investment over time. For developers and real estate investors, REX can be a comprehensive tool providing a bird's eye view of the market and revealing potential investment opportunities (see Figure 3).

### WHERE TO WORK: DECISION MAPS

The DecisionMaps application uses the same basic principles as REX but makes use of certain pre-defined decision factors relating to business development based on a grid of 100ft x 100ft cells. The primary objective of Philadelphia's NTI was to revitalize neighborhoods through residential and business development. DecisionMaps helps to promote business development by enabling business owners and development/planning organizations to efficiently match their needs with Philadelphia's assets (see Figure 4).

Like REX, DecisionMaps integrates critical geographic decision factors with property information. The tool allows a user to define a set of criteria such as proximity to local subway stops, demographics, or tax incentive zones. It also enables the user to weight those criteria. From the weighted criteria, the system generates a map highlighting the most suitable areas. By selecting an area, the user can then gain access to a variety of aggregate and location-specific data including demographics, zoning information, recent sales, occupancy, and ownership. Users can also store search preferences in the system for repeated use and, once a location of interest is found, it can be bookmarked for later reference. DecisionMaps was made possible by a strong GIS infrastructure already in place in the City of Philadelphia. The City had invested considerable resources in the design and implementation of its Unified Land Records System (ULRS). ULRS includes a seamless map layer of real estate parcels and an Address Integration system that integrates parcel-level data with other important geographic information such as inspections, revenue records, land title records and tax accounts. These and various other related data sets are maintained by the City.

While NTI no longer exists, it was launched in April of 2001 as a multi-faceted, \$300 million effort to reverse a decades-long history of blight and disinvestment in Philadelphia's neighborhoods. NTI outlined an action plan to tackle blight and stimulate investment. Information technology in general and GIS in particular played a critical role in developing policy for this initiative, making NTI a major client and user of the City's GIS infrastructure.

While a number of City agencies work on economic development initiatives, many do not have the GIS tools or experience to make choices about location. Decision-Maps draws on the data and expertise of these agencies, integrating their resources in a manner that does not require specialized GIS expertise for effective operation.

DecisionMaps is currently housed on the City of Philadelphia's intranet and, as such, is available only to City employees. Users can access DecisionMaps in a webbased browser with a user-friendly interface. They are presented with a menu of geographic factors like distance to transit lines, proximity to business districts, and inclusion in an economic incentive zone or wireless Internet coverage area. They are also given a menu of various demographic factors such as age, per capita income, and educational attainment. Users then assign weights, not only giving preference ratings and leaving some factors neutral, but also giving negative scores to conditions they wish to avoid.

DecisionMaps relies on components of the ArcGIS geographic information system. It uses ArcGIS Server and the Spatial Analyst Extension to enable multiple decision scenarios to be calculated in an iterative manner by using the ArcObjects frame-



FIGURE 4 Decision-Maps combines the weighted criteria to create a hotspot map showing those locations that best meet user preferences.



FIGURE 5 With a grant from the US Department of Agriculture, Avencia developed DecisionTree<sup>®</sup>, a software framework that can perform geographic prioritization calculations at speeds fast enough to support web deployment. Used here by the City of Asheville's Priority Places.

work. Thus, the user is able to quickly return to the preference menu, revise weights, and see new results on an interactive map. The system normally utilizes over 50 standard siting factors but can incorporate additional factors.

Though DecisionMaps was initially designed to support business-siting decisions, the framework is easily adaptable for other kinds of decision support. The NTI used the application to achieve its blight removal goals. The Department of Licenses and Inspections (L&I), which administers Philadelphia's building code requirements could use DecisionMaps to quickly identify target areas for intervention based on the density of dangerous buildings and severity of violations. The multi-layer format structure of DecisionMaps makes it an ideal application for integrating information from various departments and using it to locate key areas for new initiatives. With an ever-tightening municipal budget, each decision takes on greater importance, and DecisionMaps helps to make those decisions.

# THE FUTURE OF DECISION SUPPORT

While REX and DecisionMaps both proved to be successful in assessing the relative merits of potential sites, neither was particularly scalable. On the one hand, web-based deployment spreads hardware and software costs among users and decreases the complexity associated with similar calculations in desktop software. On the other hand, visitors to web sites expect responses to be displayed in a few seconds, at most, and the time required to make the calculations of this nature remained a significant challenge. The calculations being performed in REX and DecisionMaps are based on raster data structures. To cover a compact urban area such as Philadelphia at DecisionMaps' grid cell resolution of 100 feet requires 891,000 cells (and only 35,640 cells at the 500-foot resolution of REX). These are relatively small files that can be processed in just a few seconds. But when we try to handle a much larger area, such as a few rural counties or a state, calculation times are dramatically extended.

In 2006, Avencia was awarded a research grant from the US Department of Ag-

riculture to develop these concepts into DecisionTree®, a software framework that can perform these geographic prioritization calculations at speeds fast enough to support web deployment – even for relatively large rural areas. Reducing the calculation time was achieved through development of

a custom raster data format and a distributed calculation system which would split calculations for large areas into chunks that could be processed separately and then stitched back together for display in the web browser (see Figure 5). Despite challenges, geographically-enabled decision support offers great promise for the future of site selection and economic development in a wide variety of venues. Location decisions for housing purchases and development, businesses siting, and support services deployment are crucial to the success and growth of local economies, to say nothing of the quality of life for residents or the financial health of individual companies. As more and more businesses, governments, and individuals recognize the benefits of using GIS in decision support, demand will increase for easy-to-use tools that do not require the infrastructure or training that are necessary for large-scale GIS deployments. Decision tools that effectively and efficiently incorporate a wide array of spatial data with consideration for user needs and preferences offer a unique and promising addition to current decision-making practices.

## REFERENCE

Getson, Lisa. (2006) "Know the neighborhood before you buy," The Legal Intelligencer. Sept 14, 2006.



#### FIGURE 6 DecisionTree is used here by the City of Asheville's Priority Places.