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Final Paper

GIS Certificate Spring 2012

Disc Golf Course:

A GIS Design in Locational and Cost Distance Analysis

Introduction

Disc golf has long been a recreation that gives back to the community (Siniscalchi et al. 2005). It is completely free, it cleans up local parks, and it allows people to enjoy what might have been an underutilized park. By applying a value to parks, recreational activity groundwork can be valuable to maintain a healthy environment for park seekers to enjoy (Chiou et al. 2010). The purpose of this project is to plan the best options for a new disc golf course in western Washington. I believe that disc golf has a great opportunity to expand its reach while at the same time be of low environmental impact. It is widely stated that more exercise is needed today in American society; what could be more fun than taking your family to a park and playing a little disc golf? I would like to be able to look at a park and all of its features and say "this would be an optimal location for a disc golf course", especially if it is a location that needs more recreational activity and already has a park that can be used as a community project. Using spatial and locational analysis, I was able to find the perfect park for a Professional Disc Golf Association 18-hole disc golf course. South Hill Community Park in Puyallup, Washington became the focus of my project and by Ground truthing the park became a test for my theoretical model. Its accurate representation gave proof of the power of GIS as a tool for analysis.

Theoretical Foundation

In my research question I seek to answer the question "Where would the best possible place in Washington State to put a new 18-hole disc golf course be and what classification of course will it be (i.e. beginner or advanced)?"

The intended audience is the general public, community members, the professional disc golf association (PDGA), city planners, and park advocates. The general public needs more outlets for free recreation that is easily adaptable and loved by all ages (Siniscalchi et al. 2005). Disc golf is played year-round in all types of weather which makes it easily accessible to people of all ages and backgrounds. Demographics from the PDGA show members ranging from 17-76 (http://www.pdga.com/). The installation of a disc golf course would benefit the surrounding community by increasing and enhancing recreational opportunities, park safety and conservation goals (Chiou et al. 2010). The parks and recreation departments can consider disc golf as a way to boost park use as a high benefit-to-cost ratio. Most disc golf courses are designed to use the natural setting of the park as natural “hazards” and in doing so, lend to an environmentally friendly sport that attracts environmentally conscience people (Siniscalchi et al. 2005). As people walk the park grounds many pitch in to clean it up and dispose of trash properly. Courses have been proposed and built on old covered up landfills, near reservoirs where hundred year-flood buffers exist, and sensitive areas where land disturbance needs to be kept at a minimum (Siniscalchi et al. 2005). Unlike traditional golf, a disc golf course does not require trees to be removed, grass to be constantly monitored with daily mowing, native plants to be uprooted, or non-native species planted. Eventually, people are going to want to enjoy snacks and drinks out on the course, so attracting commerce to the area by means of foot traffic can alleviate some low income business owners. Many businesses even bring in food pods for bigger events such as PDGA Championships (http://www.pdga.com/). The authors in the paper “Using GIS to Generate Mutually Exclusive Service Areas Linking Travel on and Off a Network” describe a method developed to generate service areas for a light rail statistical study. They refer to this method as the linked on off network (LOON). This paper discusses the LOON method in detail for an area in Sacramento (Upchurch et al. 2004). The method, however, is not limited to light rail or transit research and I briefly entertained the idea to use it as a research model to generate network based service areas for facilities to a disc golf course. Service coverage is usually used to talk about an area that may need a police station or other such emergency facility (Alexandris et al. 2010). What about using a model for service coverage on a basket for a disc golf course? Attempts of this kind of analysis quickly dissipated as time became a precious commodity and I explain the time intensive methods of the planning process in the next section.

Discussion of Planning Process

Currently there are 47 disc golf courses in western with 40% having 18 or more holes on the course (http://www.pdga.com/). In eastern Washington there are 19 holes with 42% having 18 or more holes on the course. During my spatial search for a proper footprint, I planned on looking for state, city, or county parks for locational analysis on where to fit a course. Typically a hole can use about 2-4 acres of land and have a good fit, so I planned on looking for parks with 36-80 acres of space with mixed use recreational availability. I planned at looking at Washington State for the best places to lay the framework to establish a new 18-hole disc golf course. This project has the ability to be utilized anywhere in the world, but the reason I am choosing Washington State is the proximity to where I live, work, and play.

This project was intended to bring a new course to the world of disc golf and most spatial data acquisition will be from the state, city, and county level. I planned on and utilized public records for most of this data retrieval such as: USGS for digital elevation models (DEMS) and land cover use, National Agriculture Imagery Program (NAIP) for orthophotos, LIDAR (Light Detection And Ranging) and Landsat imagery. I looked at ambiance and made an index of diversity by digitizing tree cover, open areas, low brush and wetlands. I planned on eliminating useable space by means of the intersect tool to find major roads and rail ways, lakes and waterways, and already developed parks. I created boundaries with the buffer tool to separate park land from other areas.

I was able to put together an index of diversity considering trees, low brush open areas, and wetlands and how they related to the overall difficulty of the course. The model proposed by the authors in (Zhang et al. 2011) follows a two-step process for finding the best location for a pulp wood mill in Michigan. This model follows my locational analysis of finding availability of parks that require characteristics to identify disc golf locations and in this article would require the preferred location to be selected using a total transportation cost model. My cost model would require LiDAR data for a total cost analysis. These LiDAR points are then used to create a raster of elevation data from the Puget Sound LiDAR consortiums text files on hand. I was then able to use this data for a cost path analysis raster by weighing at a 40% grade to this with previously digitized and rasterized classification of the park. A research paper done by a scientist in urban planning looked at hiking trails and tried to plan the best possible route through a park by using GIS (Wei-Ning 1996). It took into account many factors that are necessary for inclusion of my project to plan a disc golf course. Of noteworthy mention is: land suitability, visibility assessments, and locational analysis. This paper by Wei-Ning was very useful in planning how I would project my disc golf course over the park.

The South Hill Community Park is a 40-acre site with two soccer fields, a parking lot, several acres of manmade wetlands, a children's play apparatus, bathrooms, and a network of paved meandering trails. The fields are used for youth soccer, baseball, and softball programs (http://www.co.pierce.wa.us). This Park was chosen for a proposed Disc Golf course by using locational analysis in ArcGIS. The indexes generated from my descriptions of the best disc golf course location will be made of two parts, (1) the database of existing disc golf courses with four described criteria for standardizing measures and (2) Applied measures to potential parks in the western Washington region to evaluate the usefulness. (Silberman et al. 2010)

Methods and Implementation

I used a projection for my feature dataset that I thought would be consistent with most parks I was looking for in King and Pierce County. I decided on the projection:

NAD_1983_HARN_StatePlane_Washington_North_FIPS_4601_Feet.

I was able to find all the County data on the WAGDA site at wagda.lib.washington.edu. I was then able to create a union between pierce and king county park data and created an acreage field so that I could find the best suitable range of acreage for my park. 1 acre = 43560 square feet so the attribute data I created found: Acreage = [Shape_Area] / 43560. In the paper "Reinventing mountain settlements: A GIS model for identifying possible ski towns in the U.S. Rocky Mountains" (Silberman et al. 2010) the authors examined the location to best serve a new ski town, I could not help but see the potential use in the workflow the authors had established. The environmental and accessibility characteristics from which they drew their conclusions are of upmost importance to understand in producing my own project. Showing how to generate and execute a problem solution was the main objective of the paper "A GIS Approach to Shopping Mall Location Selection" (Cheng et al. 2007). Even though a shopping mall location was the basis for the query, I used it as a reference for the functional components of GIS before laying out the major steps for the queries I created for my locational analysis. The query was as followed:

SELECT from County_Parks_Union WHERE "PARKNAME" AND "SITENAME" LIKE '%Lake%' '%River%' '%Trail%' '%Golf%' '%Recreation%' '%Habitat%' '%Property%' '%Wetlands%' '%Natural%' '%Farm%' '%Creek%' '%Marsh%'

This narrowed my qualified parks to 10 from which I applied buffers to major road and rail systems. The final 3 parks became the focus of my high resolution orthoimagery downloads from the USGS http://seamless.usgs.gov/website/seamless/viewer.htm from http://seamless.usgs.gov/. I also downloaded elevation data from which I made a slope raster and also made a hillshade raster but this lead to data sets that were unusable. The data was too coarse and I needed a more detailed elevation map for my analysis. As I looked over my research papers I found this study that generated maps by using different statistical methods to determine which classified urban growth the best in Korea (Park et al. 2011). These methods were used to synthesis information gathered that is close to the type of information I would need for parks data like elevation, slope, (topographical factors) distance from roads, and distance from urban areas (geographic factors). I turned to the Puget Sound LiDAR Consortium (PSLC) for LiDAR data http://pugetsoundlidar.ess.washington.edu/lidardata. Changing the LiDAR text files I was able to create point layers and exported them in order to make them permanent feature classes. A raster elevation grid was interpolated using *Inverse Distance Weight* (IDW). Using the USGS NAIP imagery program, 18" resolution 2011 orthoimagery were used to digitized and classify areas of the park by the following parameters:

Classified as a difficulty rating 1 being easier 4 being harder.

(1= open space 2 = low brush 3 = tree cover 4 =wetlands) = "SouthHill_LandCover"

I was able to create a weighted raster using the parameters:

("SouthHill_LandCover" *.6) + ("SouthHill_Reclass")*.4) = "SouthHill_Calc" (**Fig 1**)

Inversing this parameter:

((("SouthHill_LandCover" -(3))*(-1))*.6) + ((("SouthHill_Reclass" -(10))*(-1))*.4)

= *"SouthHill_Calc_Inverse"* (**Fig 2**)

This created a cost surface analysis raster from which I built a model to facilitate making an amateur and professional 18-hole disc golf course located on the park grounds. By applying bins to generate local spatial autocorrelation statistics, I can theoretically give a higher value to neighboring landscapes around the observation point which would be my “hole” (Comer et al. 2008). I was able to create a weighted raster using parameters to weigh certain landscapes higher than the other depending on difficulty for a disc golf course. It allowed me to accrue a cost distance from the end of a hole. I then created a cost path raster from the start of a hole. This was all entered into a the disc golf model (**Fig 3**) which reduced time from 9 minutes per disc golf hole building down to roughly 90 seconds.

Results and Discussion

The results of the disc golf model includes an 18 hole course geared towards amateur players (red) with a length average of 300 feet, and a professional 18 hole disc golf course (blue) created from the rasters mentioned above (**Fig 4**). I was able to model in ArcGIS a way to iterate multiple steps that would have taken the project a lengthened amount of time. The model built was set up for me or any user to input a cost raster and the start and end of a hole (**Fig 5**). The DiscGolfModel™ could then theoretically be used anywhere in the world to build a disc golf course! I am very and confident in my analysis of South Hill’s disc golf project, yet there are things that would have enhanced this study.

As more and more research is done into critical GIS and using participatory GIS as a foundation for map manipulation, I admit that my research did not branch out to the disc golf and park community as a whole. Given more time and foresight, I think I would have put more of an emphasis on what the golfers enjoy and how they would rate disc golfing in terms of difficulty. This revised data standardization would have become a focus of the research project and increased efficacy in suggested routes for the course. Park advocates may not even want a disc golf course at South Hill. Even though I believe it is an underutilized park, supporters of the park may feel the project is being invasive and resist it altogether. Simply questioning and getting a feel for park goers and the community may have just brought this project to the next level in terms of participatory GIS.

Ground-truthing the South Hill community park was a great way for me to grasp the effectiveness of this project as part of ArcGIS. As I walked the grounds of the park and strolled around its trail, I found great satisfaction and accomplishment derived from two quarters worth of research and development of the park. Even though some inconsistencies arose from Ground-truthing, overall I was able to find little problems with having this course built by contacting Pierce County Parks. The 18th hole, unfortunately, falls within an inundated area of wetland that seems to be consistently wet year round. My data suggested otherwise and the only way to rectify this inconsistency was to walk the grounds before actually digitizing the park. This way I could have been more accurate in finding paths for the course layout and implemented an increase of disc golf methodology. Instead of just picking random start and end holes, a community enhanced methodical approach would prove to give the best disc golf experience for anyone interested in the game.

Index

Fig 1

Fig 2

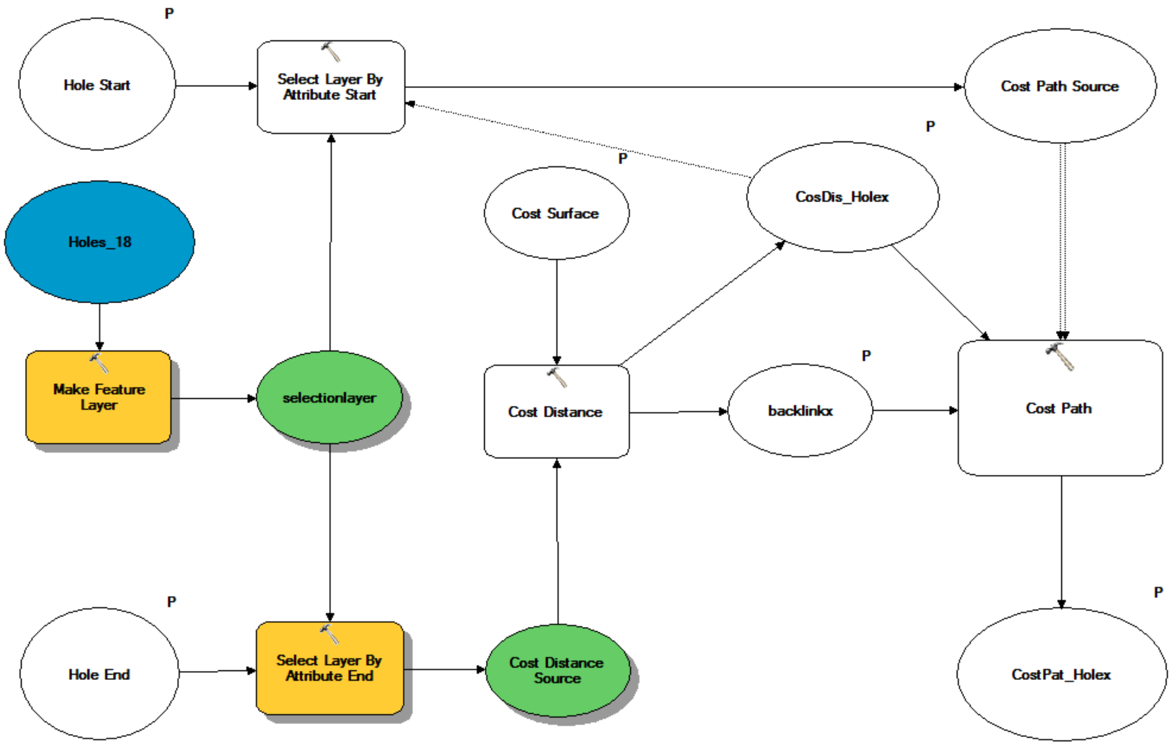
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Fig 3

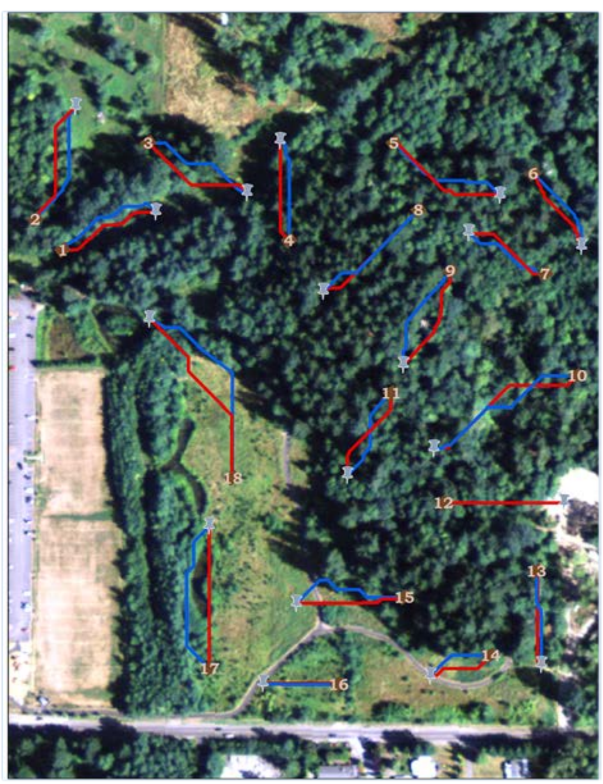
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Fig 4

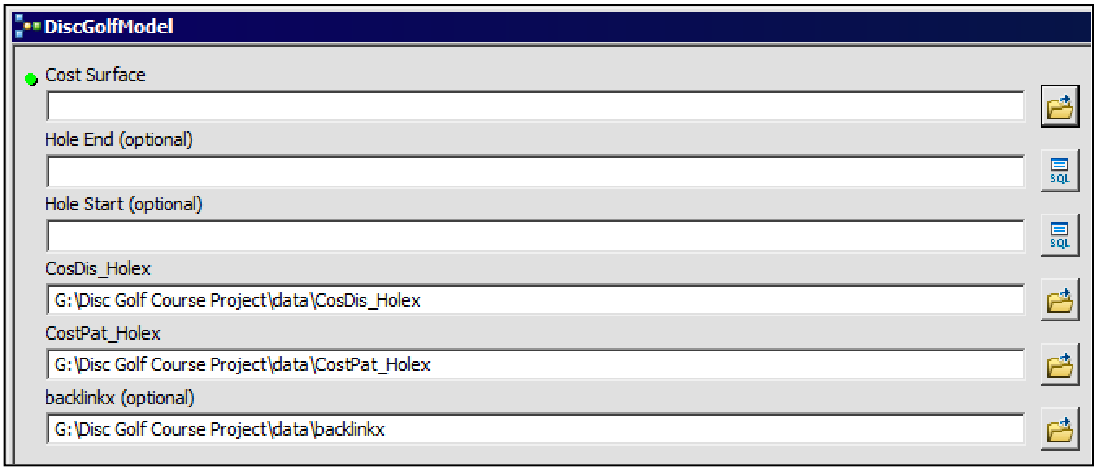
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Fig 5

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