Evaluating Fall-of Curves with Straight-line or Least Cost Path Distance

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Evaluating Fall-off Curves with Straight-line or Least Cost Path Distance

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Purpose:
A fundamental part of interaction is distance. Interaction can be modeled by plotting distance against the frequency of an object. My purpose is to evaluate whether straight-line distance is an acceptable proxy for actual distance or whether using more realistic distance measures is required. In this poster, I use the distribution of San Juan Red Ware in a portion of the southwestern United States to examine the differences between straight-line distance, the length of least cost paths (LCP), and the time to travel the LCP between points. San Juan Red Ware was produced in southeastern Utah between approximately A.D. 750 and 1100 and was widely traded.

Randomized Points:
In order to test whether LCP paths significantly affect correlation, I used a LCP script created in R to generate 100 random points in a 100 x 100 km square and create LCPs to these points. The starting point is the Nancy Patterson site in Montezuma Canyon. The results indicate very little change in correlation between the three distance measurements; however, the residuals show significant variation between paths traveled in a straight line and LCPs that account for slope in the travel time.

San Juan Red Ware:
I used the same methods from the randomized points study to examine the relationship between distance and the proportion of San Juan Red Ware at various sites in southeastern Utah and southwestern Colorado. The Nancy Patterson site was chosen as the starting point for heuristic purposes, although this ceramic ware was produced in other locations. The sites in Colorado come from the Dolores and Animas-La Plata projects. The results showed almost no change in correlation, although the residuals do show variation between distances.

Conclusion:
The study indicates little variation in correlation between distance measurements, which is surprising given the rugged terrain. Numerous factors affect LCPs and the various areas and objects being studied, including the cell size of the DEM and the cost algorithm used. Interaction studies often look at how individual sites vary from predictions to argue that a site was either more prominent in trade or more isolated. The variation among individual points suggests this could be a factor of how distance is calculated. Caution should be used when interpreting individual points, and the use of LCPs may be a better proxy than straight-line distance when modeling this type of interpretation, despite the minor impact in correlation seen in this study area.

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Methods:
LCPs are becoming more common in archaeology due to the benefits of modeling routes that are more probable than straight-line distance and the ability to include various factors as costs (see Surface-Evans and White [editors] 2012), but they still require knowledge of GIS and can be relatively time-consuming to use. I chose to model LCPs using the gdistance package in R (van Etten 2017). Cost was calculated using Tobler’s hiking function (Tobler 1993). The FedData package (Bocinsky et al. 2017) was used to download and mosaic a digital elevation model (DEM) from the National Elevation Dataset. The cell size was ~90m to speed up calculations. An anisotropic transition matrix was created and Dijkstra’s algorithm was used to find the LCP between point a and point b. An optimal speed of 4.2 km/h was used to account for terrain and pack weight. Three measurements are used in the case studies: the time to travel along the LCP accounting for slope, the time to travel the LCP at a constant speed of 4.2 km/h, and the time to travel in a straight line at an identical speed.

References: