

VISUALIZING ASPECTS OF IDENTITY AND INFLUENCE THROUGH GEOSTATISTICAL ANALYSIS



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A key obstacle in the “mapping” of complex social networks is the crux of relationally and geospatially bounding the network in order to effectively represent highly notional boundaries.¹ The issue grows exceedingly complex when dealing with the truly notional and fluctuating case of socio-cultural boundaries, which are often defined by conflicting semantics that wax and wane in line with the sentiments of the population and the whims of the researcher.² This paper will proffer a set of possible solutions to these problems by detailing methods designed to mitigate the arbitrary and inconsistent nature of boundary creation in the case of tribal/social mapping. The goal is to provide standardized, meaningful, and effective methods for the conversion of geo-social data into formats that may be leveraged by geographic information systems (GIS), and provide meaningful visual representations of the socio-cultural environment, enabling the type of “semi-automated analytical process” optimized by the science of Visual Analytics.³

Identity Data: Collection and Processing

When collecting data related to social identity markers like religion, sect, tribe, etc. identity information will be aggregated at the village, neighborhood, or individual level depending on the resolution of social data and the unit of analysis, but raw data will most likely consist of a series of geo-points corresponding to said identity markers. Following the collection of identity data (and a thorough analysis of the anthropological “meaning” of the various aspects of identity) through an appropriate collection regime (survey, interview, archive, etc) geo-data must be converted from a collection of individual points corresponding to tribal (or other markers of identity) population centers into a format allowing for more detailed analysis. Perhaps the most common method of aggregating point data is to simply draw a rough boundary line around the points and refer to the resulting polygon as a specific “tribal territory.” While neatly color-coded polygons representing social aspects of influence and identity are certainly comforting at first glance, upon further analysis and collection the analyst will inevitably conclude that in the case of complex social systems, these discrete boundaries are both highly artificial and highly misleading to the viewer (see Figure 1).

1. Heath et al. “Chasing Shadows: Defining Network Boundaries in Qualitative Social Network Analysis.” *Qualitative Research* 2009 9: 645

2. Piselli, Fortunata. “Communities, Places, and Social Networks.” *American Behavioral Scientist* Volume 50 Number 7 March 2007 867-878

3. Merten, Steffen. “Employing Data Fusion in Cultural Analysis and Counterinsurgency in Tribal Social Systems.” *Strategic Insights*, Vol. 8 Iss. 3. Aug 2009.

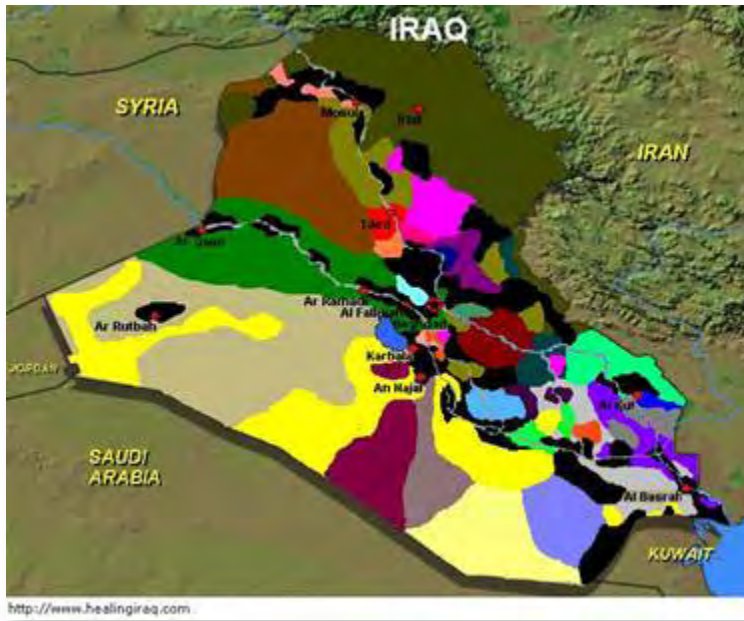


Figure 1- A representation of the Iraqi tribal system illustrates the confusing and artificial nature of some tribal visualizations. When viewed in light of the nested, interspersed, and fluctuating nature of the system, visualizations like these clearly fall short.

Although the use of discrete boundaries may be appropriate under some circumstances (discussed in the next section), the presentation of raw identity data (locations of tribal villages for example-see **Figure 2**) is often used as a way to mitigate the introduction of biases related to the creation of discrete artificial boundaries. Visualization of raw geo-data removes the introduction of these biases, but also risks serious misinterpretation, since some will undoubtedly interpret the notional “boundaries” of the discrete system differently than others out of contrary understandings of spheres of influence or even patterns of physical movement (ex.- nomadic vs. sedentary communities). This is especially problematic in the case of tribal mapping, since it is influence that is of interest, not necessarily the physical locations of the tribesmen themselves. Furthermore, representing “territory” or “influence” as a series of geo-points may limit the types of analysis that may be performed between tribal boundary sets, since the tribal territory is not represented by a polygon (see Figure 2).

Although the abstract and fluctuating nature of influence networks makes a “true” representation of the system quite impossible, “density mapping” and “convex hull modeling” are two techniques for visualizing geo-data effectively and systematically when the point method will not do. These techniques are based on the assumption that an individual may be fused with his/her geospatial “anchor points” through the process of data fusion and “relational tethering.”⁴

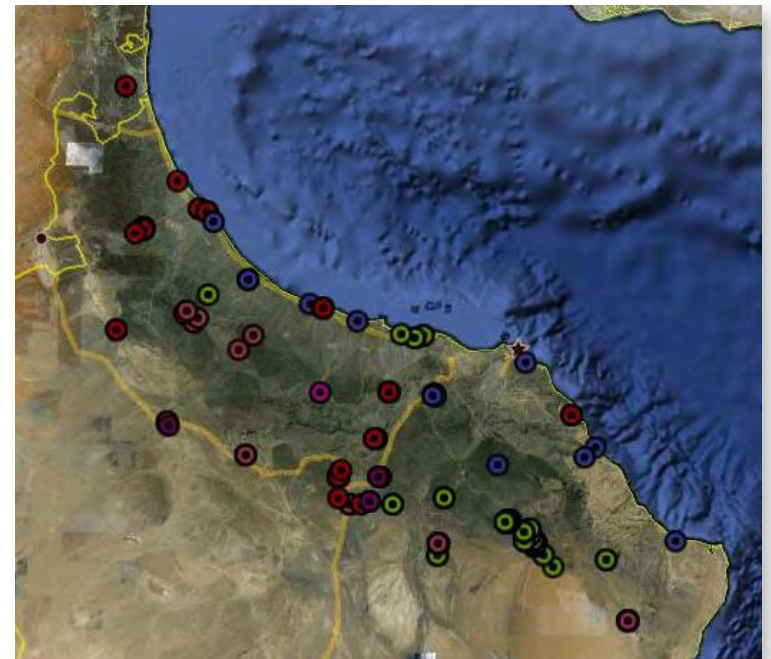
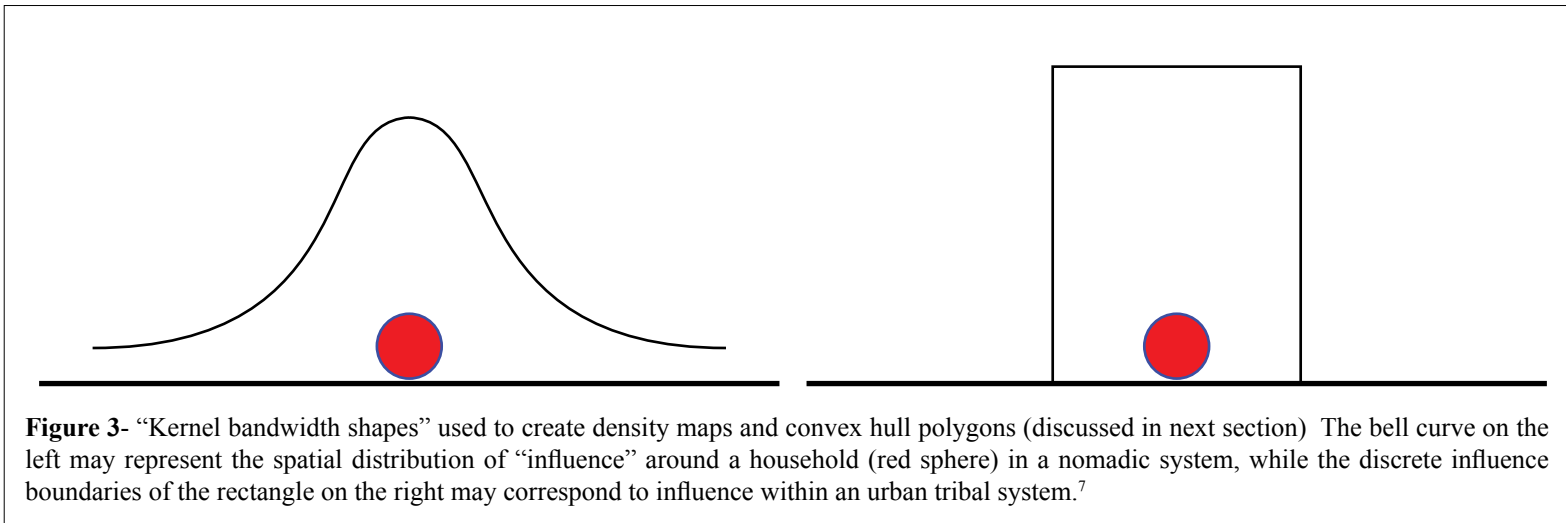


Figure 2- A sample of Omani tribal points (villages) coded by color (data collected by author).

4. Ibid

Density Mapping: Benefits and Drawbacks

The process of density mapping consists of dividing the geographic area of the social system into a grid and applying a density score to each grid square corresponding to the number of data points within the grid square as well as the number of data points within the surrounding squares. The researcher is able to define what is known as the “kernel density measurement” for each data-point, which adds a tapered radius score to the point itself (see Figure 3).⁵ This score should be based on an understanding of the meaning of the data-points themselves in terms of the nature of their “influence” within the particular system. For example, within a nomadic tribal system the researcher may surmise that influence extends well beyond the population center itself (the village) before gradually declining, whereas in an urban tribal system influence may be precisely limited (i.e. the confines of the household), but also interconnected with other tribal nodes (see Figure 3).⁶



5. Levine, Ned. “Crimestat Version 3.2a Update Notes.” October 2009.

6. Due to the disjointed and often spatially incoherent nature of what Maffesoli refers to as “neo-tribalism” in nontraditional tribal systems, a social network diagram will often prove invaluable to understanding the structural nature of the system. Maffesoli, Michel (1996). *The Time of the Tribes: The Decline of Individualism in Mass Society*. London: Sage.

7. Smith, Susan and Christopher Bruce. “Crimestat III.” National Institute of Justice. Available at: <http://www.icpsr.umich.edu/CrimeStat/workbook.html>

Based upon the kernel density measurement, the kernel bandwidth shape, and the relative density score, grid squares are color-coded on a continuous gradient scale that reflects the density measurement. The resulting picture shows a color-coded representation of tribal density within the area for a given tribal unit (see **Figure 4**). The advantage of this type of visualization lies in the coherent representation of tribal “influence” beyond the individual geo-points themselves, based on a nuanced understanding of the network’s socio-cultural dynamics.

Using Statistical Methods to Draw Boundaries

Despite the considerable utility of density modeling, some analytics and problem sets require a discrete representation of social boundaries- i.e. polygons. In order to address this need researchers are known to employ the “squint and draw” technique in order to draw rough boundaries around a set of points like the ones seen in **Figure 2**. In addition to the problems endemic in the use of discrete boundaries to represent amorphous concepts like influence discussed previously, the technique also clearly lacks scientific rigor. Therefore, in cases where the construction of polygons is based solely upon the interpretation of point data, we may rely on modeling techniques known as “standard deviation ellipses” and “convex hull modeling” to draw elliptical and polygonal boundaries around point data based on the measurements of density discussed in the previous section.

These statistical modeling techniques rely on the same idea as density mapping (application of an appropriate kernel density measurement for the points and relative density measures for the grid), but instead of using color gradients to represent tribal “density,” they use these measurements to draw ellipses and boundary polygons around the points in-line with the projected influence of the tribe (see **Figure 5** and **Figure 6**). In this case we assume that tribal villages represent “samples” of influence data within a spatially notional “influence population,” and attempt to use these “samples” in order to infer the true “influence population” boundaries with an acceptable degree of error. The result is a statistically meaningful boundary line for the tribe, which may be uploaded into a GIS to represent the broader tribal system with polygons. Once represented as statistically significant polygons, subordinate elements (sub-tribes, families, households, etc) may be nested within them.⁸

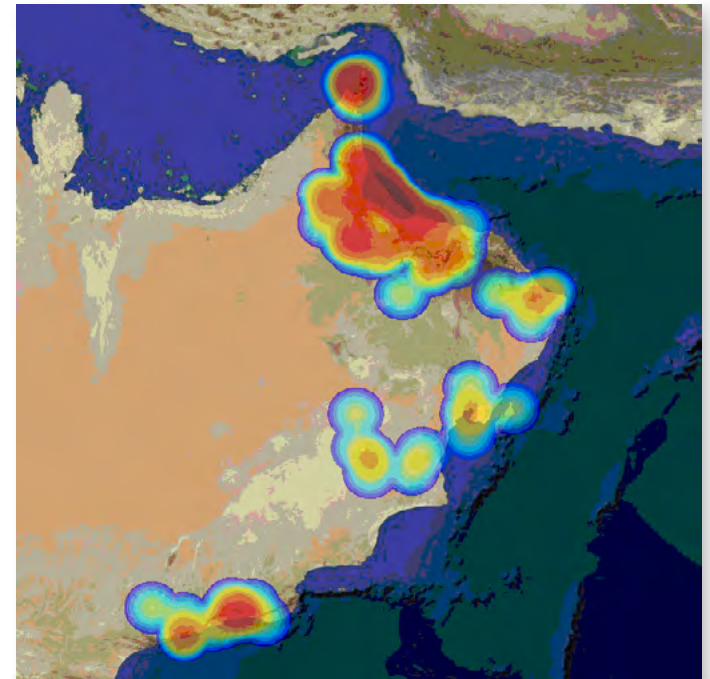


Figure 4 - Density map of a larger tribe in Oman (data collected by author).

8. In this case the Z-axis (altitude) may be used in order to depict various levels of social aggregation within the population.

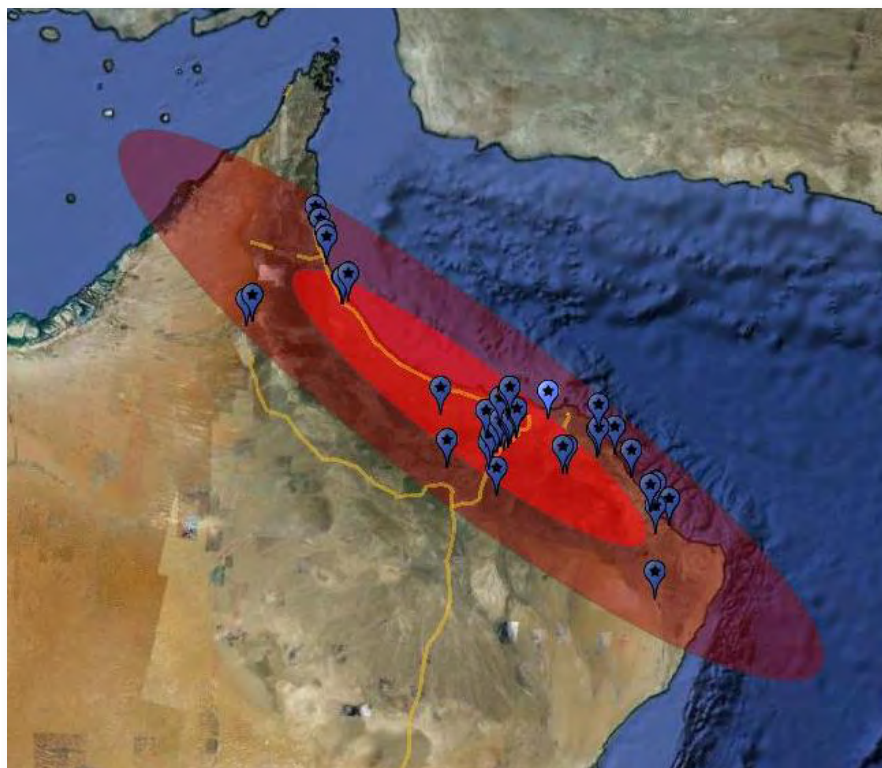


Figure 5 - Point data for an Omani tribe (shown with blue star points) is processed statistically and “influence boundaries” generated for the tribe based on the points. The technique assumes that the tribal data points are samples from a larger tribal population and, based on point location, guesses at the boundaries of the population. The smaller ellipse represents one standard deviation away from the points’ mean center, while the larger ellipse represents a calculation for two standard deviations from the mean center. Thus, based upon the point data and assuming a normal distribution about the mean point, the program calculates that 95% of the “influence population” will fall under the larger ellipse, while around 70% will fall under the smaller ellipse.



Figure 6- Geostastics may also be represented as a convex hull, as shown here at one standard deviation from the mean.

The standard deviation ellipse and convex hull model techniques for the representation of “influence” are admittedly imperfect, considering that the program assumes a normal distribution about the mean center point. In fact, the often clustered and fragmented nature of tribal systems around geographical features like water sources, mountains, or deserts makes the assumption of normality slightly absurd. As such, use of this method may be limited to situations where grounded observation has not yet been conducted, or when conducting initial processing of large amounts of geo-data to create baseline polygons. The baseline polygons may then be manipulated based on evolving understanding of the system, and in any case, will often prove superior to the highly subjective “squint and draw” approach.

Conclusions and Future Research

These protocols for drawing and understanding tribal boundaries and modeling tribal “density” will enable much more detailed analysis of tribal geo-data than was previously possible, while also providing more scientifically rigorous techniques for drawing and understanding said boundaries. The methods also provide a case in point for the marriage of geospatial analysis and anthropology, as researchers struggle with the challenges of modeling abstract, notional, and fluctuating perception-based social systems. Without deep anthropological knowledge of the specific social system enhanced visualization techniques will fail to model ambiguous social aspects like influence, since links must first be drawn and defined between vague concepts of “influence” and “identity,” and measurable aspects of social systems like tribal affiliation, ethno-linguistic group, or religious sect. These conceptions of identity and influence will inevitably differ widely between and within even small communities and require detailed knowledge in order to interpret and effectively model.

Future research may draw upon concepts of identity-based, layered social networks (see **Figure 7.**) in order to develop a methodology for visualizing competing aspects of identity (sect, tribe, nationality) within social networks, and understanding how competing notions of identity interact within the individual/network to yield influence (example: when does tribe trump nation?). Further research might also explore ways that the socio-cultural geo-mapping techniques discussed in this paper might be combined with relational and temporal modeling techniques in order to produce a truly comprehensive and integrated methodology for visualizing social systems.

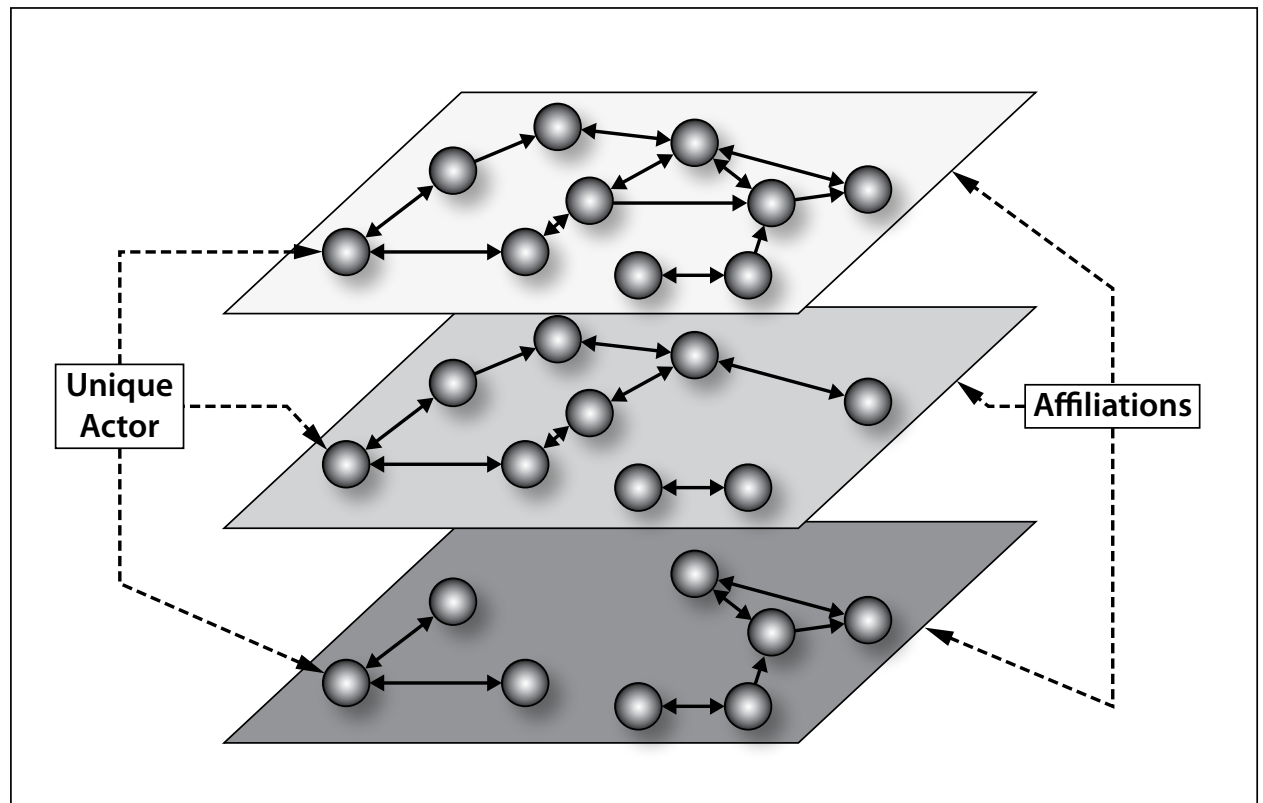


Figure 7- A visual representation of “layered social networks.” Layers could correspond to an individual’s “mosque network,” “friend network,” and “tribal network” for example.

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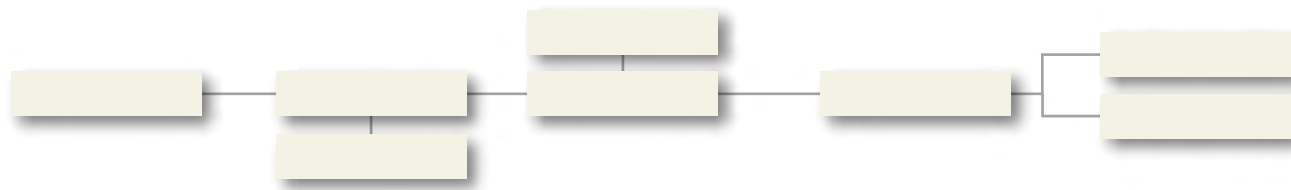
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TRIBAL ANALYSIS CENTER

Traditional anthropological research conducted among tribes inhabiting remote areas where insurgents and criminals operate has become increasingly difficult to implement. Studies carried out among people living in small-scale societies now are nearly impossible due to the physical dangers associated with the civil and religious unrest found in those areas. Swat, for example, has become so dangerous that Frederick Barth's studies only could be repeated at the risk of the investigator's life. Similar research is not feasible among Burma's Rohingya tribes located on both sides of the border with Bangladesh, as well as with the Pashtuns in Afghanistan's interior and within Pakistan's Federally Administered Tribal Areas, where even Pakistan's army enters with reluctance.

Given the difficulties of conducting direct fieldwork in conflictive areas, the Tribal Analysis Center utilizes an indirect approach. Using multidisciplinary research, we seek to collect and analyze data obtained from a wide variety of sources, both current and historical. In the absence of new ethnographic fieldwork to update our base of knowledge, the Tribal Analysis Center compiles and summarizes existing research and documents on tribal societies, combining this material with contemporary press reports and articles. We assume that much can be gleaned from well-informed observers who are not anthropologists, ranging from journalists and travelers to government officials.



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