Chapter 11
Aspatial and Spatial Applications of Indices of Uneven Distribution

The difference of means formulations of indices of uneven distribution makes it relatively straightforward to implement segregation measurement in either conventional *aspatial* formulations or in *spatial* formulations. Aspatial versions of segregation indices are familiar because they are widely used in empirical studies. They are obtained by applying any of the computing formulas reviewed here using data for non-overlapping, bounded areas such as census tracts, block groups, or blocks. It is appropriate to designate the resulting scores as "aspatial" because the spatial arrangements of the units (e.g., blocks, block groups, tracts) have no implications for the scores obtained. Spatial formulations would differ on this key point; namely, the spatial arrangement of units can potentially impact index scores.

In truth, opportunities to compute spatial versions of indices of uneven distribution have always existed. But apparently this has not been widely appreciated. Or, more carefully, researchers have rarely taken advantage of this possible option. One simple way to implement popular indices of uneven distribution in either aspatial or spatial versions is to use computing formulas that give index scores as population averages for area-specific residential outcomes. Figures in Appendices present formulations of this type for all popular indices of uneven distribution. Here I note only two such formulations, one for D and one for S. Both take the general form $100 \cdot (1/T) \cdot \Sigma y$ where y is a residential outcome for individuals scored on the basis of their area of residence. The value of D can be obtained using $y = |p_i - P|/2PQ$ and the value of S can be obtained using $y_k = (p_i - P)^2/PQ$.

If y and p are calculated using only the data for the block the individual resides in, the calculations will yield the usual index score which is aspatial because how individual blocks are arranged in space has no impact on index scores. However, if one chooses to do so, one can calculate y and p based on spatially defined neighborhoods. For example, one could define the neighborhood as a "first order" contiguity neighborhood based on combining data for the block the individual resides in and also the blocks that are adjacent to that block. This is the only modification that is required; all other steps in the calculations remain the same.

M. Fossett, *New Methods for Measuring and Analyzing Segregation*,
The Springer Series on Demographic Methods and Population Analysis 42,
DOI 10.1007/978-3-319-41304-4_11

This neighborhood formulation makes the index "spatial" because how blocks are arranged in space will now potentially affect index scores. The key change is that an individual's neighborhood has shifted from being equated with a discrete "bounded" area that applies only to individuals in the area to a spatially-defined region that in some degree is shared with individuals in adjacent areas. I ignore the fact that the size of the neighborhood has changed because it is not a fundamental issue. It can be rendered irrelevant by defining bounded areas and spatially defined areas to be comparable in size.

Following this example, it is obvious that difference of means formulations of indices also can be implemented as either spatial or aspatial. The key terms that determine the index scores are individual residential outcomes (y) that are scored from area group proportion (p). Calculate p for bounded areas and the index is aspatial; calculate p for spatially defined areas and the index is spatial. Assessment of group means and associated segregation index scores is easy to accomplish either way and results will be spatial or aspatial depending on this choice of how area group proportions are calculated. I have drawn on these options when conducting simulation studies of segregation dynamics using the SimSeg simulation model (Fossett and Waren 2005; Fossett and Dietrich 2008; Clark and Fossett 2008; Fossett 2011a) and also in applications using block-level census data to assess segregation using neighborhoods that vary in spatial scale (Fossett 2011b).

Spatial and aspatial implementations of indices are both potentially interesting. However, my own experience in empirical analyses has been that they rarely yield different substantive findings when they are implemented at spatial scales that yield comparable neighborhood-level population counts. But it is logically possible that they might yield different findings in some circumstances. For example, one can imagine that some administrative boundaries (e.g., school district lines, city boundaries, zoning areas, etc.) and/or urban ecological barriers (e.g., highways, roads patterns, rivers, etc.) could delimit sociologically meaningful spatial domains that are sharply "bounded" based on the impact of physical barriers or administrative boundaries on social interaction. In the extreme case, racial composition in adjacent areas would not matter because social interaction and common residential fate are determined solely inside the boundaries of the spatial units used. In practice, however, boundaries for the spatial units used most often in segregation research can be somewhat arbitrary and spatially defined areas may potentially correspond more closely to sociologically meaningful neighborhoods. For example, a block located near the boundary of census tract may have more in common with the nearby blocks in an adjacent tract than with blocks on the far side of the same tract. So both approaches can be defended on conceptual grounds.

Again, there is as yet little evidence to indicate that the choice between spatial and aspatial implementations of segregation indices carries compelling practical consequences for findings regarding aggregate segregation patterns. However, I discuss the issue here because I can think of at least one practical reason for investigators to consider using spatially defined neighborhoods. It is for studying segregation involving smaller groups and segregation in smaller communities (e.g., small cities and CBSAs). I noted earlier that in conducting analyses of segregation in CBSAs I have found that census tracts and even census block groups can be too large to capture segregation patterns in smaller CBSAs. In particular, I find that tracts and block groups are not well suited for studying segregation involving smaller populations – for example, studying segregation for Latinos in areas of recent settlement. Among available census geography that leaves census blocks as the best option to use for computing standard aspatial segregation indices. However, some researchers might worry that census blocks are too small. One way to address this concern is to assess segregation using first- or second-order spatial neighborhoods based on block data. These would meet the needs of using spatial units that are small enough to capture segregation in smaller communities and for smaller groups while at the same time being potentially more appealing with regard to reflecting sociologically meaningful neighborhoods.

References

Clark, W. A. V., & Fossett, M. (2008, March 18). Understanding the social context of the schelling model. *Proceedings of the National Academy of Sciences*, *105*(11), 4109–4114.

Fossett, M. (2011a). Generative models of segregation: Investigating model-generated patterns of residential segregation by ethnicity and socioeconomic status. *Journal of Mathematical Sociology, 35*, 114–135.

Fossett, M. (2011b). *Spatial implementations of segregation indices: New implementations for popular indices of uneven distribution*. Paper presented at the session on racial residential segregation at the annual meetings of the Southwestern Sociological Association, Las Vegas, Nevada, March 16–19.

Fossett, M., & Dietrich, D. R. (2008). Effects of city size, shape, and form, and neighborhood size and shape in agent-based models of residential segregation: Are schelling-style preference effects robust? *Environment and Planning B: Planning and Design, 36*, 149–169.

Fossett, M., & Waren, W. (2005). Overlooked implications of ethnic preferences for residential segregation in agent-based models. *Urban Studies, 11*, 1893–1917.