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Thesis Preparation
Professor Ann Forsyth
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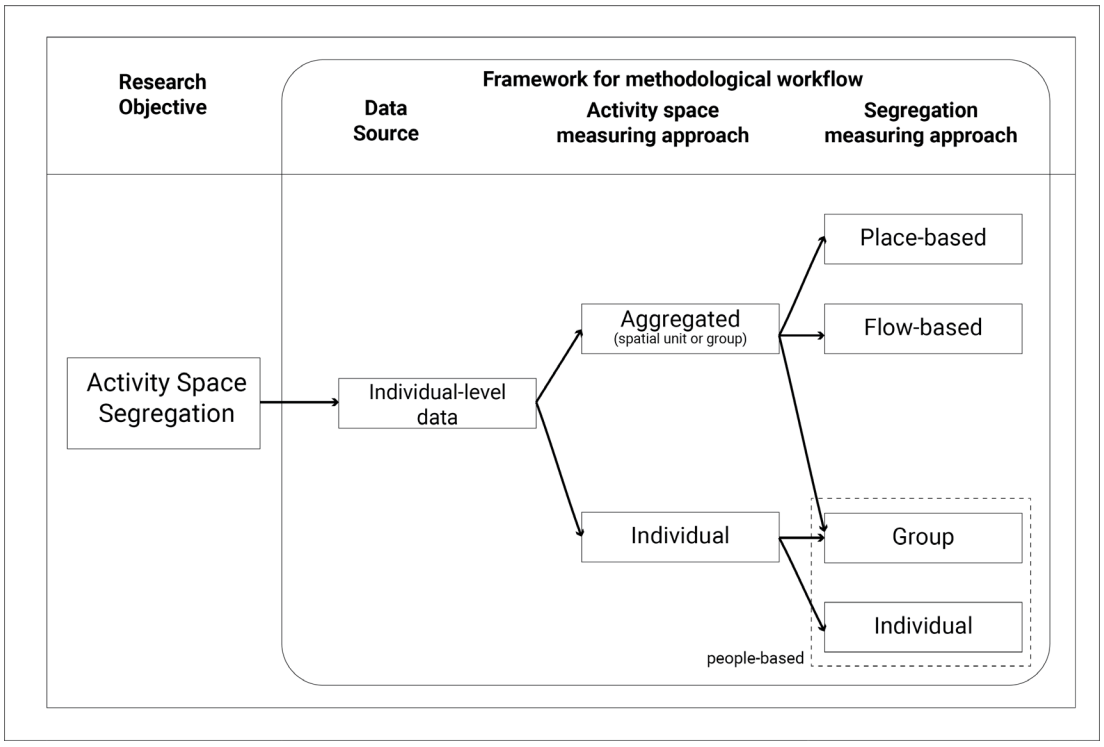
Partial Draft Thesis Proposal –

Preliminary literature review has identified that activity space segregation can be studied from the perspective of people, places, and mobility flows. *This research addresses the question of whether tract-based isolation indices suggest less or greater isolation than those based on transit route service areas.* I will examine isolation in terms of race, poverty, and nativity. Geography of analysis will be created and defined by placing half-mile walkshed around bus lines. Analysis of these transit service areas address one slice of what is defined as activity space. Analysis will be conducted in the largest cities in each Census Bureau Division. Further review of existing research will help to narrow how isolation indices will be calculated.

Initial hypothesis: tract-based isolation indices will suggest greater isolation than those within the established transit route service areas.

The activity space approach is being increasingly utilized in spatial segregation research to broaden the scope of research away from residential neighborhoods and into other socio-spatial contexts (Massey and Denton, 1988; Tammaru et al., 2015). Socio-spatial contexts are defined as environments where individuals or groups live their everyday lives. Given that residential spaces are not the only contexts that people exist in, and that significant amount of time is spent outside of residential spaces in what are defined as activity spaces it is important to understand how segregation manifests. This proposal will refer to research that has captured segregation beyond residential neighborhoods, across individuals, multiple activity locations, and mobility broadly as activity space segregation.

A review of activity space segregation research identifies approaches, methods, and data sources that can be applied to conducting this form of research. Initial review has highlighted that the activity space approach allows for segregation to be studied from the perspective of people, places, and mobility flows. It has also illustrated that traditional data sources and novel data sources – such as social media – are valuable to this form of research. Additionally, review has highlighted a three-step methodology for analysis that should be replicated in future research (Müürisepp, 2022).



There are several methods and measures that have been proposed, tested, developed; this realm of research must work to turn abstract concepts into measurable observations. A review of the effectiveness of these strategies would be beneficial, however, that is beyond the scope of this work.

It is important that future work ensure that activity space segregation research contains strong links to segregation theory, and that is something this research project will do – ground quantitative data in theory. In future research there are three central perspectives that can be addressed when examining segregation – place, people, and movement flows. Central questions to address these themes are – "how segregated are neighborhoods?", "how segregated are individuals' activity spaces?", and "how segregated are mobility flow patterns between activity locations?" Future research should bring place- and people-based methods together as well as flow-based perspectives, which has received minimal attention. This thesis will tackle segregation across place and movement flows, which among other things reflects and reinforces mobility injustice.

Context:

The activity space approach to segregation (Wong and Shaw, 2011; Palmer, 2013) that builds on the concept of activity spaces (Golledge and Stimson, 1997) proposes that segregation is produced and reproduced across all locations that a person visits and routes and areas the person travels through. This highlights the importance of both activity locations and spatial mobility in shaping people's segregation experiences. Mobility is crucial for understanding the

intersection between segregation in residential neighborhoods, schools, workplaces, and leisure time.

Preliminary literature review has underscored two key concepts: segregation and activity space. Segregation is defined as spatially uneven distributions and relationships – spatial arrangements and patterning and/or spatial interactions – between people belonging to different populations (Yao et al., 2019). Activity spaces are defined with reference to Golledge and Stimson (1997) as geographic space that captures an individual's activity locations and mobility over a period of time.

Data Sources & Social Dimension:

Research on activity space segregation is relatively young compared to the longer history of residential segregation, meaning research in this field has developed in tandem with the accessibility of big data sources and can include big data to supplement traditional data (Wang et al., 2018). Activity research have used various data sources to analyze individuals' mobility and activity locations quantitatively. Early studies relied on small-scale surveys of self-reported data or automatically collected data. (Scheiner, 2000). Activity space segregation studies incorporate other quantitative data to contextualize location data, such census data to obtain specific characteristics to examine individuals' exposure to different socio-economic contexts (Jones and Pebley, 2014; Li and Wang, 2017).

Activity space segregation studies, like residential segregation research, focus mainly on socioeconomic, and ethnic, racial, etc., data. Most studies have taken the perspective of one social dimension. Lessons can be learned from international study design and contexts. In China, studies focused on income groups (Zhou et al., 2015), and people that reside in a range of housing types (Li and Wang, 2017) or neighborhoods (Wang et al., 2012). Some studies have formed population groups by intersecting background characteristics age and language (Silm et al., 2018), and race and income level (Wang et al., 2018).

Measurement of Activity Spaces:

Activity spaces are calculated at the individual level or the aggregate level – measured by social group, spatial unit, or flows between locations. Schnell et al. (2015) and Li and Wang (2017) measured activity spaces solely at the individual level, while Wang and Li (2016) and Silm et al. (2018) examine activity spaces at both the individual and the aggregate level. In terms of aggregate level activity space measure, which appears to be the most salient methodology will for this this thesis, two metrics stand out. Locations visited were aggregated to predefined spatial units such as municipalities or districts within a city (Mooses et al., 2016), or census areas (Lathia et al., 2012). Furthermore, movement of people between activity locations was aggregated to a physical network (Netto et al., 2018) or to an origin-destination matrix (Shen, 2019). Aggregation to spatial units often will utilize big data sources, and aggregation to movement flows often relies on census data or other statistical data.

Segregation Measurement:

Activity space segregation can be calculated for a spatial unit (place-based), a movement flow (flow-based), an individual's or group's activity space (people-based), or a mixed approach (combined measure). One methodology is to calculated individual-level segregation indices (Schell, 2001), some researchers used statistical regression measurements (Li and Wang, 2017), and others apply a geovisual map comparison method (Greenberg, Raanan, and Shoval, 2014). Researchers will often aggregate data on individual activity spaces into predefined spatial units. One strategy identified is to calculate a dissimilarity index based on the distribution of activity locations across study districts (Silm et al., 2018), others will apply a social interaction potential metric to identify and map spatial patterns in social contact opportunities (Farber et al., 2015), and some will use a co-presence metric to examine and compare exposure to poverty and wealth in different urban areas at different times (Östh et al., 2018).

One study used a flow-based segregation metric, where a segregation indicator was calculated for each movement flow between two spatial units (Shen, 2019), while others employ a combination of people-based and place-based, and flow-based and place-based approaches (Jarv et al., 2015; Wong and Shaw, 2011). This research will apply a place-based approach using segregation indexes and density patterns of different social indicators – race, nativity, and income – and will largely follow the work conducted by Silm et al. (2018). This approach allows one to ascertain which place (non-service area tract or service area) suggests less or greater isolation.

Justification:

Utilizing transit service areas to understand how segregated individuals' activity spaces are contributes to a broader theory that public transit is a holistic service that acts as a public benefit that advances social change. To build sustainable communities, regions must provide access to markets, employment, health services, and education. Access becomes increasingly relevant in areas that are highly segregated by income, race, and nativity. Current and previous planning efforts have both directly and indirectly created and perpetuated segregation in US cities. Zoning, environmental review processes, highway construction and expansion are all examples of these efforts.

Research has suggested that social and economic exclusion can be linked to segregated residential systems and spaces. This research aims to begin to understand if segregated transit service areas suggest social and economic exclusion. What steps can be taken to amend for these inequities and inefficiencies that may result from transit? What role does exclusion in transit service areas play in limiting access and mobility to public goods and services? Does exclusion in transit service areas contribute to the fragmented nature of US communities and lead to degradation of inclusivity as well as further segregation? Can this research inform transit planning efforts to ensure that transit acts as a public good that increases access, mobility, and equity in cities?

Currently, this research works to understand whether tract-based isolation indices suggest less or greater isolation than those based on transit route service areas. This statistical analysis sets up an independent variable – indices of isolation – and has the potential to incorporate a dependent variable to create a correlative study. This research could follow a method of descriptive statistical analysis to explore two continuous variables – index of isolation and another (such as tract-based voting outcomes). Initial analysis of the proposed research question could provide a launchpad for a correlative study, which would provide a deeper analysis of the impact of transit, ***which may be incorporated***.

Methods:

The General Transit Feed Specification (GTFS) is a datasets public transit agencies generate and share openly with the public. GTFS feeds contain data for scheduled transit service including stop and route locations, and schedules information. To create the geography for my analysis it is necessary to perform spatial analysis through the geographic information system (GIS), RStudio. The first step will be to perform a table join with the route identification and stop identification that is available through GTFS feeds. A buffer of ½ mile will be placed around bus lines to create transit service areas and will provide the geography to pull various the various Census demographics from at the block level (race, income, nativity). This will then be compared to tract-based indicators in non-transit service areas using an index of isolation.

Since the index of isolation is very sensitive to scale, the index was calculated at the lowest possible level available, census tracts by block, to increase accuracy. Census blocks are the smallest unit of geography that the Census Bureau uses and in the decennial census data on the race composition of each census block is measured. Segregation is measured by an index of dissimilarity, which is one of the most commonly applied indexes in segregation studies (Silm et al., 2018). The formula for the index of isolation, given by the Population Studies Center at the University of Michigan, states:

"w_i = the white population of a component part, for example census tracts, of the larger geographic entity for which the ***isolation index*** is calculated.

t_i = the total population of a component part of the larger geographic entity for which the ***isolation index*** is calculated.

W_i = the total white population of the larger geographic entity for which the ***isolation index*** is being calculated.

Then the ***isolation index*** for whites equals"

$SUM(w_i / W) (w_i / t_i)$"

This formula reports the percentage of the white population in the census tract, for the typical or average white person. Index of dissimilarity provides a measure of (un)evenness, showing

the degree to which two populations are distributed differently. The values of the index of dissimilarity vary from 0 to 1, where 0 indicates a completely even distribution (integration) and 1 indicates a completely uneven distribution (segregation).

As stated previously, this methodology produces an independent variable that after answering the initial research question of *whether tract-based isolation indices suggest less or greater isolation than those based on transit route service areas* can be used to complete a correlative study that will provide deeper understanding of activity space segregation and inform planning and policy efforts.

Project Timeline – Fall 2022

Project Element	Start Date	End Date
Literature Review	September 2022	Ongoing
Mid Review	October 21, 2022	October 21, 2022
Data Collection	October/November 2022	December 2022
Meeting GIS Librarian	October 2022	November 2022
Preliminary Meeting with Harvard Statistics Support	October/November 2022	November 2022
Secondary Meeting with Harvard Statistics Support	November 2022	November 2022
Data Analysis	October/November 2022	December 2022
Final Presentation	October 2022	December 2022
Final Draft Thesis Proposal	October 2022	December 2022

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