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Thesis Preparation
Professor Ann Forsyth
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Purpose:

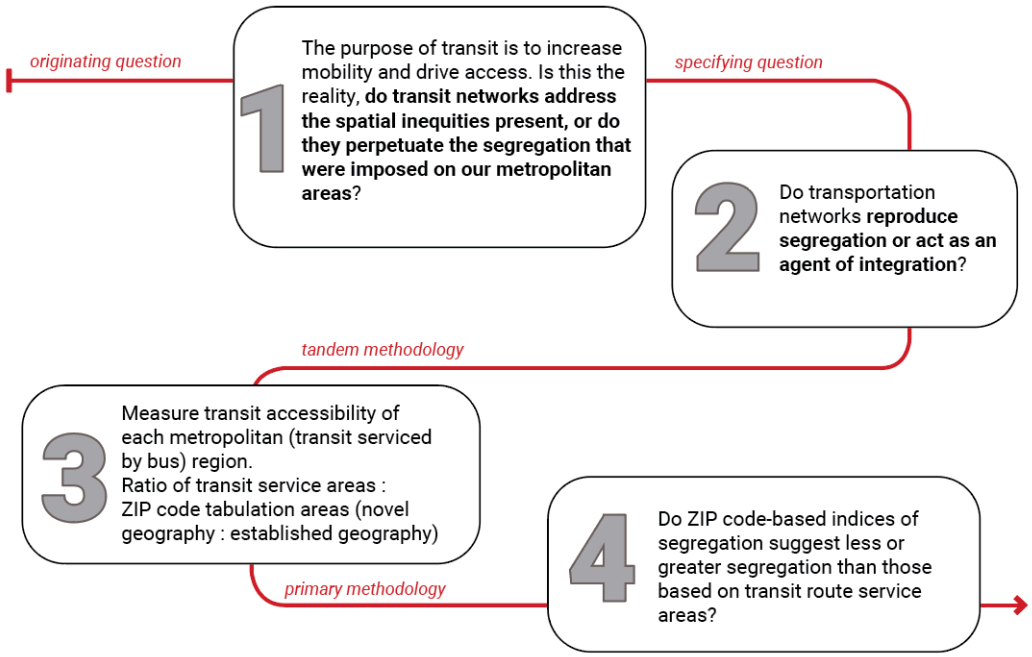
Segregation is a complex social dynamic that exists across multiple socio-spatial contexts. Furthermore, segregation is multidimensional and operates at a variety of scales. To wholistically capture the effects of segregation analysis can include the perspectives of people, place, and mobility flow. As a student that is interested in transportation and mobility's intersection with housing, I am interested in how inequities manifests in metropolitan regions and how transportation can act as a method to address these inequities. My proposed research exists as a confluence of precedent research of segregation in residential spaces and spatial mismatch, and contemporary research of how segregation exists in outside of residential areas. In conducting this research, I hope to contribute to the broader theory that public transit is a holistic service that can act as a public benefit to 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 race and ethnicity, and planning efforts have both directly and indirectly created and perpetuated segregation in metropolitan regions.

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 route service areas suggest social and economic exclusion. There are numerous originating questions that have guided me to this research topic. Some of them being: What steps can be taken to amend the inequities and inefficiencies that may result from transit? What role does exclusion in transit route service areas play in limiting access and mobility to public goods and services? Does exclusion in transit route service areas contribute to the fragmented nature of US communities leading to degradation of inclusivity and furthering segregation? How can this research inform transit planning efforts to ensure that transit acts as a public good that increases access, mobility, and equity in cities?

Research Design:

These interests have guided the design of this thesis and the associated research will achieve three specific underlying goals. It will understand the positionality it holds in its argument and in its relation to prior work; develop in a manner that is answerable – it will address conceptually abstract topics in an empirical way; and finally, address a concern or issue and advance knowledge. To this end, this analysis explores the specifying question of *whether transit networks – specifically bus networks – address present spatial inequities, or if they perpetuate the segregation that is inherent in our metropolitan areas.* Simply put, I hope to understand whether bus networks in the metropolitan transit regions included in this study exacerbate segregation or alleviate segregation. The question that will guide the primary

method for quantitative analyses: *do ZIP code-based indices of segregation suggest less or greater segregation than those based on transit route service areas.* Furthermore, tandem quantitative analysis will assess *the serviceability of bus transit service in the respective geographies* and will be performed by measuring the accessibility of bus service in each geography of study. This multilayered analysis intends to deepen the research.



Initial hypothesis: *Indices will suggest less segregation in transit service areas than ZIP code tabulation areas at the metropolitan scale – additionally, I believe there will be significant variation in segregation between cities. I expect that within the respective metropolitan areas there will be observable differences between the evenness, exposure, and concentration of populations.*

Why Bus?
In this analysis buses are the mode of transportation being studied. This is because buses represent a very resilient mode of transportation that largely operates on existing infrastructure – meaning it requires less investment to establish service than other forms of transit, such as rail. Furthermore, whereas rail is fixed and cannot be adjusted without large capital investment, buses are flexible, their routes can be changed and altered to fit the identified transportation need.

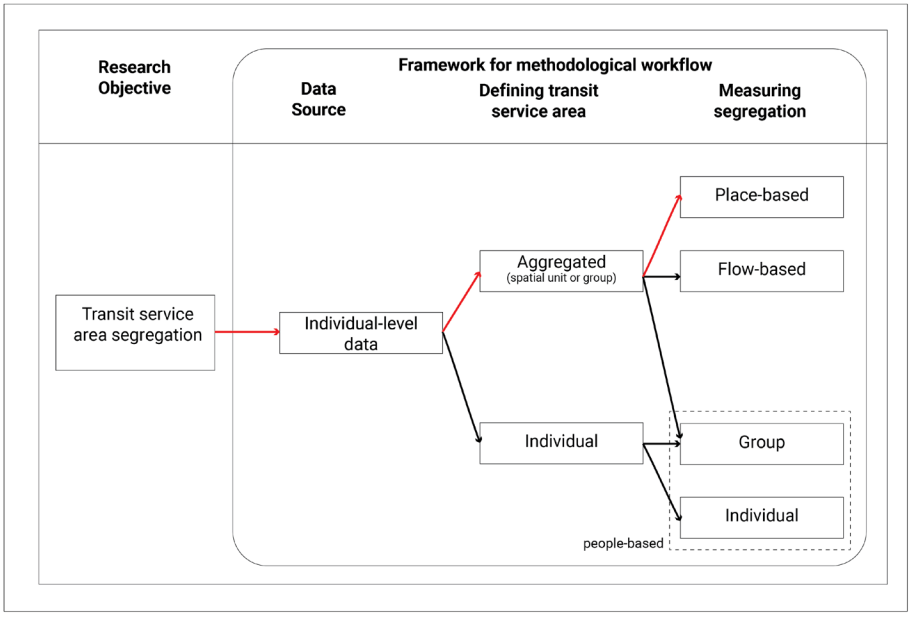
Precedent:

This research is informed by multiple fields of segregation research (residential segregation and activity space segregation) and how segregation impacts social outcomes (spatial mismatch). I have pulled methodologies from the more established literature concerning residential

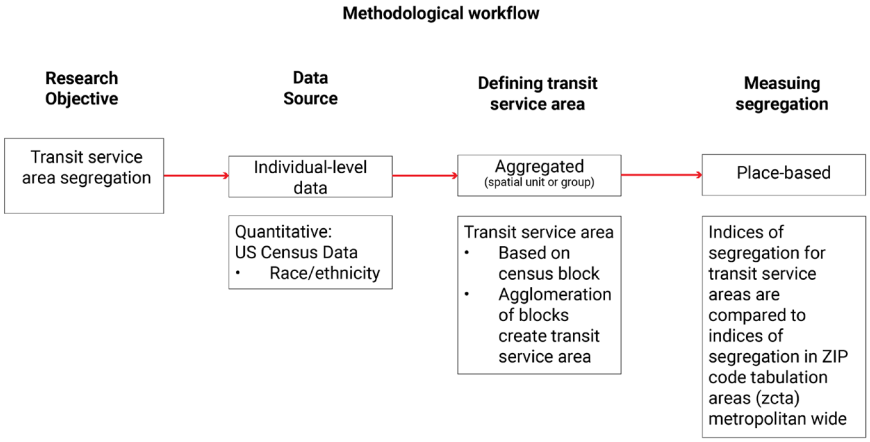
segregation and spatial mismatch and gained inspiration the burgeoning field of activity space segregation. Segregation can be defined as spatially uneven distributions and relationships – spatial arrangements, patterning, and spatial interactions – between people belonging to different populations (Yao et al., 2019). It is important to underscore that this thesis is limited in the scope of segregation that is being measured. It measures residential segregation in both transit route service areas and ZCTAs. This is different from the activity space approach, which is much more data intensive and complex method that measures segregation outside of residential spaces.

The activity space approach is being increasingly utilized in spatial segregation research to broaden the scope of research from residential neighborhoods and into other socio-spatial contexts (Massey and Denton, 1988; Tammaru et al., 2015). I define socio-spatial contexts 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 it is important to understand how segregation manifests. While this work does not analyze segregation in other socio-spatial contexts it does attempt to understand how residential spaces are influence by and interact with an individual's potential activity space. This proposal will engage with research that has captured segregation beyond residential neighborhoods, across individuals, multiple activity locations, and mobility broadly, but is not classified as activity space research.

Review of Methodology:
Literature review has identified approaches, methods, and data sources that can be appropriated to conduct this research. Review has highlighted that methods allow for analysis to be conducted through the perspectives of people, places, and mobility flows.



My research falls into the place-based category.



Within the realm of segregation research there are several methods and measures that have been proposed, tested, developed, and in this way works to turn abstract concepts into measurable observations. It is important that future work contains strong links to segregation theory, and that is something this research project will do – ground quantitative data in theory. 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' mobility spaces?", and "how segregated are potential mobility flow patterns between locations?" Future research should bring place- and people-based methods together as well as flow-based perspectives. This thesis will tackle segregation across place while incorporating transit service, which will reflect how mobility relates to segregation.

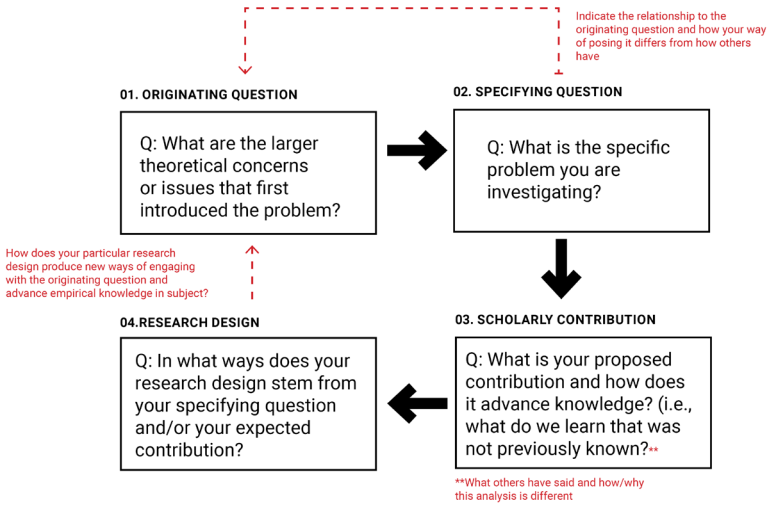
My approach to researching segregation builds upon the activity space segregation (Wong and Shaw, 2011; Palmer, 2013) and spatial mismatch research (Blumenberg & Ong, 1998). The concept of activity spaces (Golledge and Stimson, 1997) proposes that segregation is produced and reproduced across all locations that a person visits and routes and areas the person travels through. This highlights the importance of both activity locations and spatial mobility and residential segregation in shaping people's segregation experiences. Spatial mismatch theory works to understand the gap between where the jobs are and where people live. Spatial inequities and the lack of mobility will impact access to opportunity. Mobility is crucial for understanding the intersection between segregation in residential neighborhoods, schools, workplaces, and leisure time. The purpose of transit is to increase mobility and drive access. However, I am interested in understanding if this is the reality, do transit networks address the spatial inequities present, or do they perpetuate the segregation that is inherent in our metropolitan areas?

Measuring Segregation:
Segregation can be measured 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 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 indices of race and ethnicity and will largely follow the work conducted by Silm et al. (2018). This approach allows one to ascertain which place (ZIP code tabulation area or transit service area) suggests less or greater isolation.

Justification:

This methodology of utilizing transit service areas to more deeply understand how segregation is produced and reproduced through bus service is apt as it follows a sound research framework.



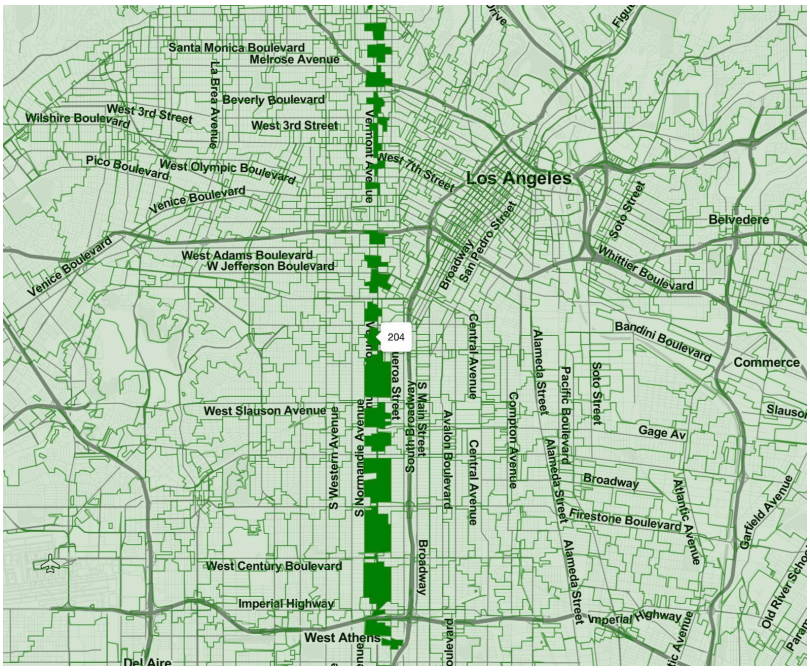
I have systematically addressed how the originating question has informed the specifying question, as well as how this research builds upon theory and precedent while posing a new methodology to engage with the subject. Interestingly, this research design does produce a

new way of engaging the originating question and advance empirical knowledge in the subject as it is replicable and provides a good foundation for various types of study. In this research I compare residential segregation in four various metropolitan transit areas, however, that is not the extent to which this methodology is useful. One could produce a longitudinal study that observes how changes in transit service impact segregation. This would be particularly relevant as numerous transit agencies and governments are attempting to use transit to rectify past and present injustices.

In addition to facilitating future engagement, this methodology will test the 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 race and ethnicity. 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 route service areas suggest social and economic exclusion.

Methodology:

Primary Methodology:

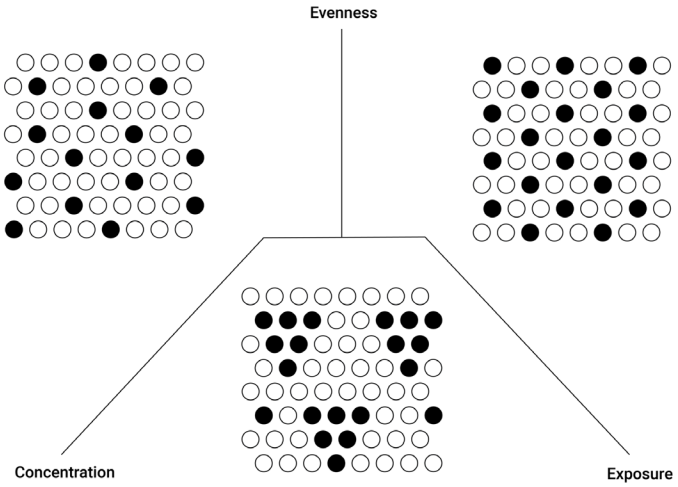


To conduct this analysis, I will compare indices of segregation in transit route service areas, a novel geography that is derived from Census blocks and created specifically for the purpose of this study, and an established geography through which Census data can be analyzed. The

transit route service area geography was formed by assigning census blocks to the closest bus stop and the associated bus line. If more than one bus line is associated with the census block, the highest frequency bus line was chosen. In this way, an agglomeration of census blocks that share the same bus line form a transit route service area. A limitation to this method is the number of transit route service areas will not exactly match another geography. At this stage I have created transit route service areas for the Los Angeles region and found that ZCTAs are the most apt geography for this analysis as there are a similar number of each transit route service areas to ZCTAs.

To measure segregation, I employ indices utilized in precedent study. Segregation acts as a multidimensional phenomenon varying along five distinct axes of measurement: evenness, exposure, concentration, centralization, and clustering. Due to spatial constraints and the nature of this research, I will utilize three identified axes to ground my research in precedent while contributing new findings.

1. Evenness – as measured by the Index of Dissimilarity
    a. This index measure represents the proportion of minority members that would have to change their area of residence to achieve an even distribution.
2. Exposure – as measured by the Index of Isolation
    a. This index measures the extent to which minority members are exposed only to one another, rather than the majority members.
3. Concentration – as measured by the Relative Concentration Index
    a. This index measures the geographic concentration of a minority group in an absolute sense.



Each of these indices will measure race and ethnicity in the ZCTAs and transit route service areas. The results of this spatial and statistical analysis will be compared, revealing which geography suggest less or greater segregation. Because these indices operate in a binary sense,

indices for race and ethnicity will be calculated against non-Hispanic whites. Non-Hispanic whites will act as the majority for these measurements and will be compared to Blacks, Asian, Hispanic, and other. I will examine segregation in terms of race because race is the most salient indicator of segregation that could be garnered from Census data at the scale of the Census block.

Tandem Methodology:
I intend to deepen my research through a multilayered analysis or secondary methodology. Tandem quantitative analysis will assess *the place-based accessibility of bus transit service in the respective geographies* and will be performed by measuring the accessibility of a bus network in each geography of study to underscore the nuances in the various metropolitan transit service regions.

To complete this analysis, I will follow the work of Higgins et al., 2022, where researchers calculated accessibility scores by:

1. Create a combined street and transit network for analysis. I will gather the required input files to assemble routable multi-modal networks. This includes street networks and GTFS transit schedules.
2. Calculate origin-destination (OD) matrices for trips. Here, I will calculate the shortest path between origin-destination pairs.
3. Calculate accessibility for each origin place. The final step is to utilize the returned OD matrices to calculate place-based accessibility for the origin.

Metropolitan Transit Service Regions:
To strengthen my research and provide another layer of analysis, I have extended my research to include the four most populous regions in each of the Census Divisions. All the metropolitan regions that I have chosen to have a long history of racial violence.

Northeast:
In the case of the Northeast Census Division, I have decided to forego analysis of New York because it is very much an outlier in transportation research. Additionally, although the Philadelphia metropolitan region is larger than Boston, the current political environment in Boston's city hall provides an interesting context to understand the interaction between my findings and recent attempts to utilize transportation policy and planning to reconcile a discriminatory past and present.

Midwest:
In the Midwest I have chosen Chicago. Covert segregatory partitions continue to dominate the city, outliving the legal tools and apparatuses such as racially restrictive covenants. The Chicago region has continually been tested and strained by integration. During the Great Migration, tens of thousands of Black Americans fled racial terror in the South and found refuge in Chicago.

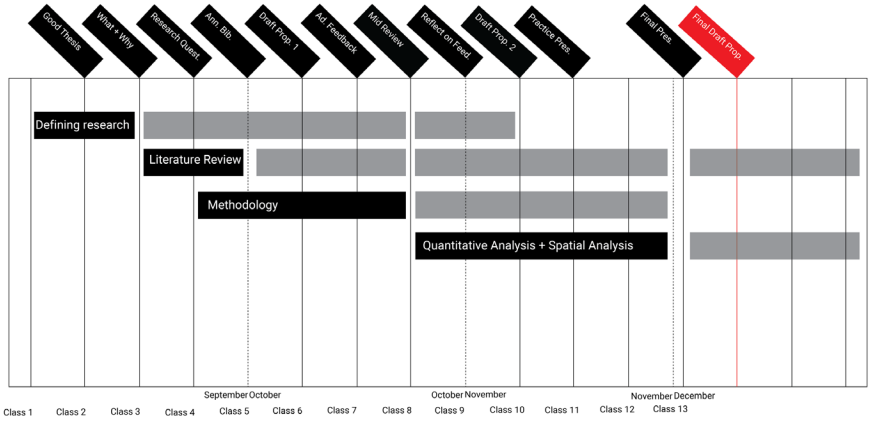
South:

Dallas is the largest city in the Southern Division and is a city of stark opposites. In many ways, Dallas' demographics follow its regions – whites live in the north, Blacks to the south, Latinos mostly reside to the west and east. There appear to be cities nested within the city that follow race, income, and nativity.

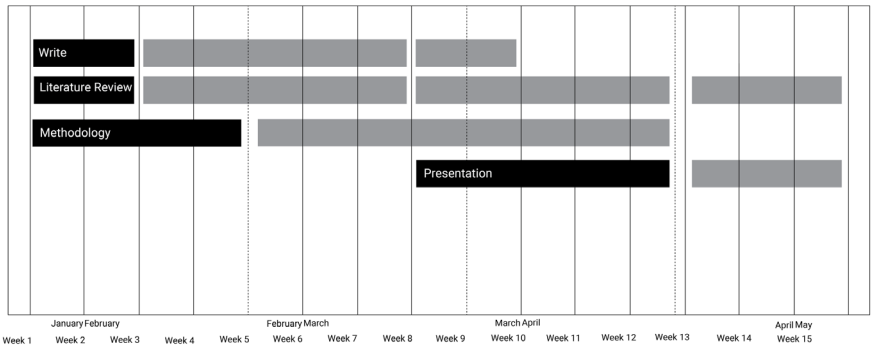
West:
Los Angeles is the largest metropolitan area in the West Division and has a deep history of racism and discrimination in housing and transportation. It is also an extremely large region that is dominated by land use patterns that suit the automobile.

Timeline:

Timeline sem. 1



Timeline sem. 2



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