INTERSTATE NETWORKS AND URBAN MORPHOLOGY

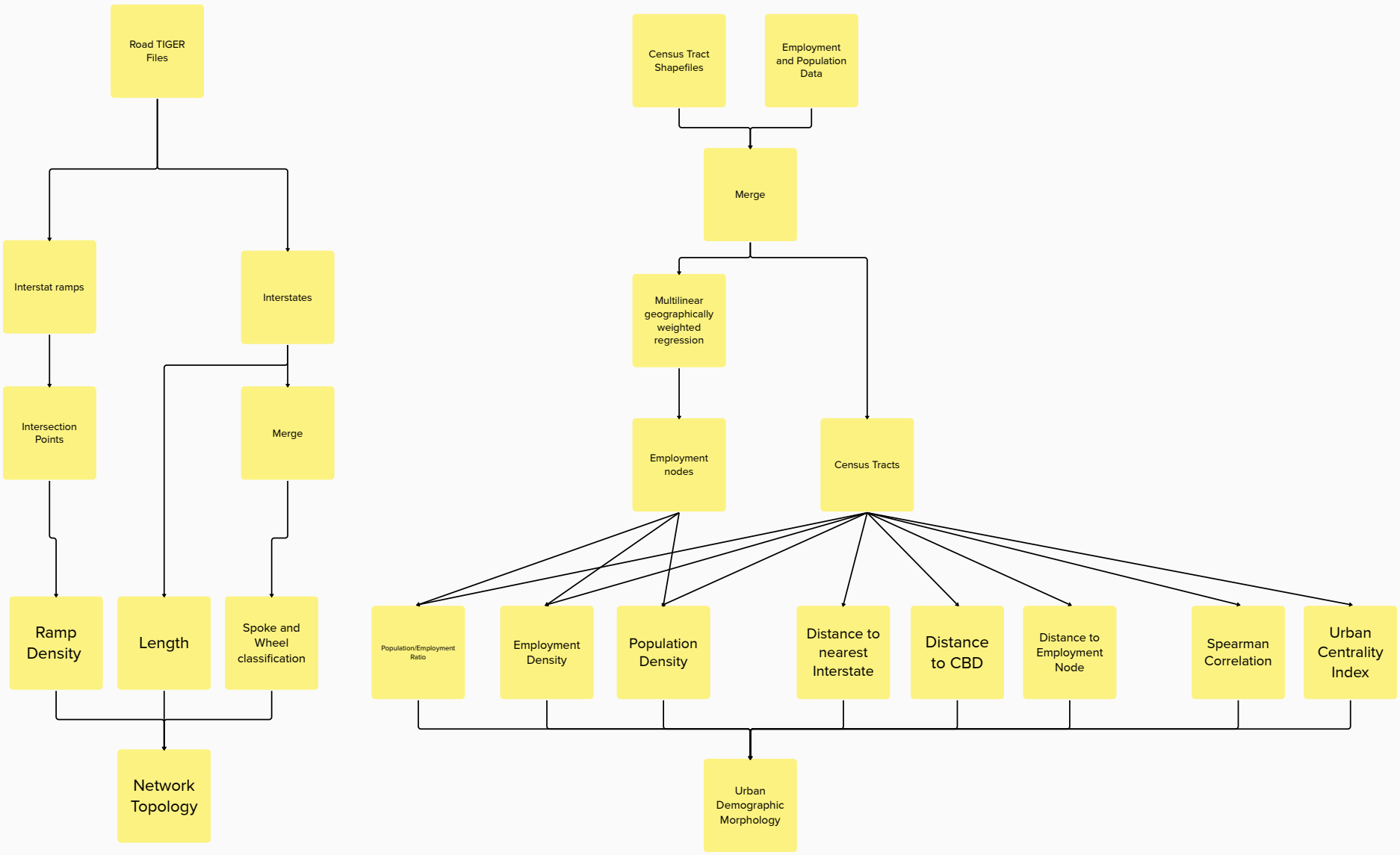
Nikko Siegfried

CAPSTONE STATEMENT AND RESEARCH QUESTION

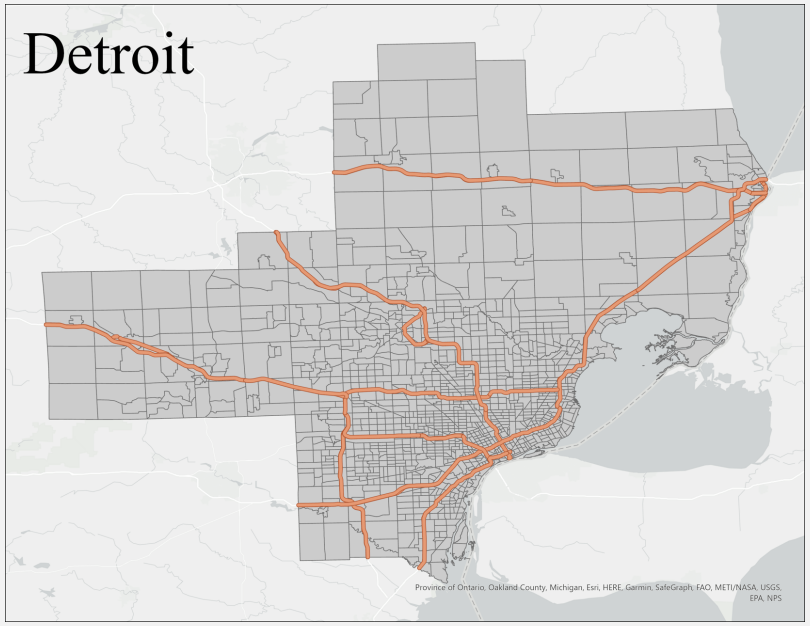
Since the mid-twentieth century, freeway networks have become a dominant mode of intercity transportation in the USA, coinciding with dramatic changes in urban form. This study aims to explore these changes by investigating the relationship between urban morphology and the geometry and topology of interstate networks. Using spatial analysis techniques, urban nodes will be identified and scaled based on employment and population data of three similarly sized metropolitan areas. Urban interstates will then be compared to evaluate the influence of interstate networks on urban morphology.

What is the relationship between interstate topology and urban employment/population morphology?

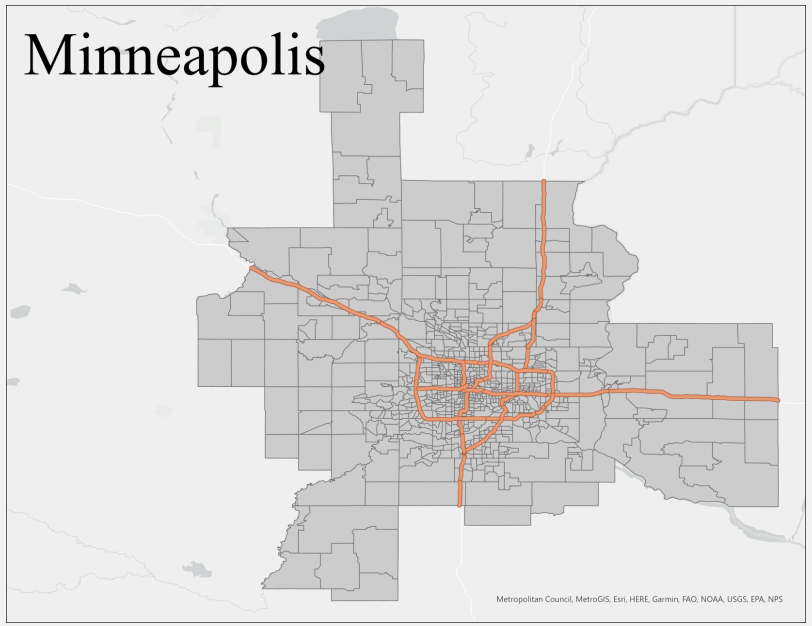
IMPLEMENTATION DIAGRAM



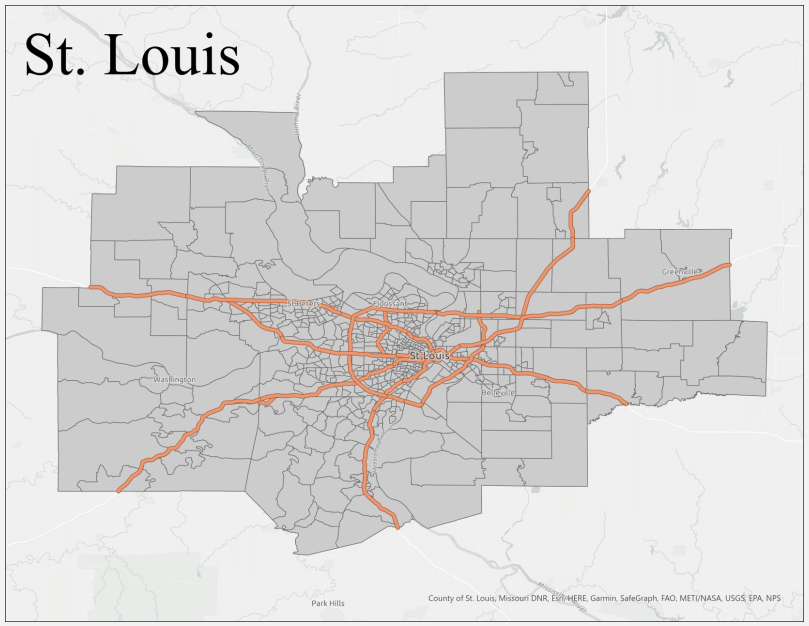
MSA OVERVIEW COMPARISON



Area (mi^2)	3892.28
Population Density (per mi^2)	1,013.5
Total Interstate Miles	733.9
Interstate Density (mi/mi^2)	0.1886



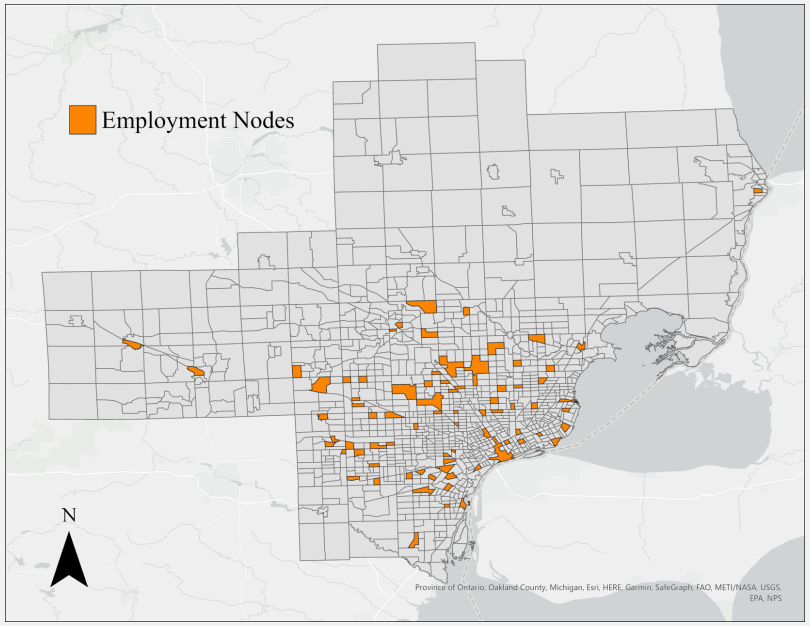
Area (mi^2)	7047.69
Population Density (per mi^2)	538.2
Total Interstate Miles	650.7
Interstate Density (mi/mi^2)	0.0923



Area (mi^2)	7863.55
Population Density (per mi^2)	316.3
Total Interstate Miles	958.3
Interstate Density (mi/mi^2)	0.1229

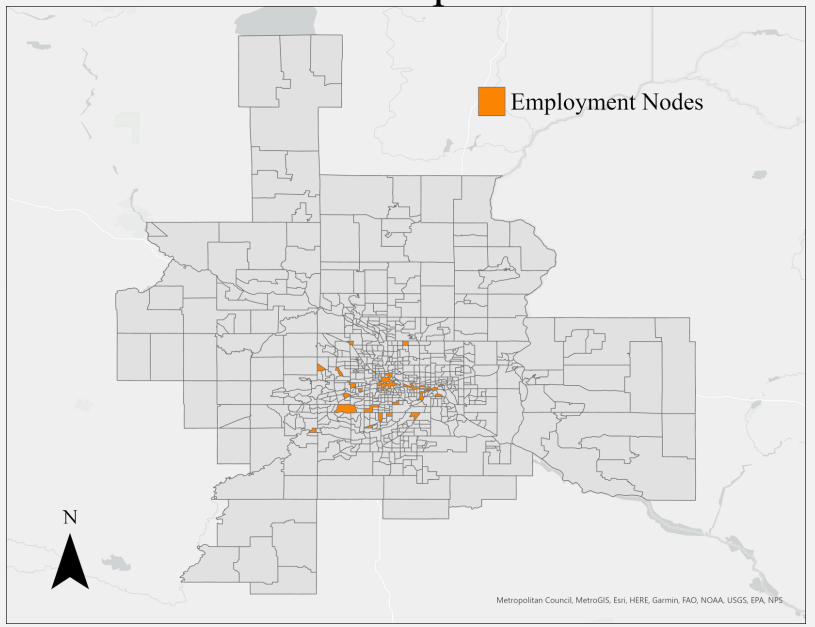
MGWR AND EMPLOYMENT NODE COMPARISON OVERVIEW

Detroit



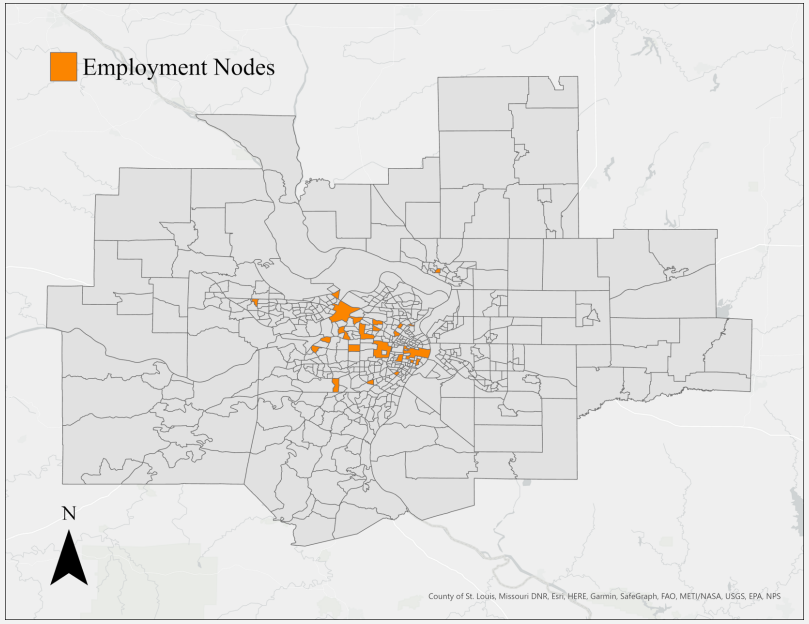
Number of Nodes	73
Prop. Emp. Node Area	2.80%
Prop. Total Population	9.08%
Prop. Total Employment	40.46%

Minneapolis



Number of Nodes	25
Prop. Emp. Node Area	0.57%
Prop. Total Population	5.67%
Prop. Total Employment	29.90%

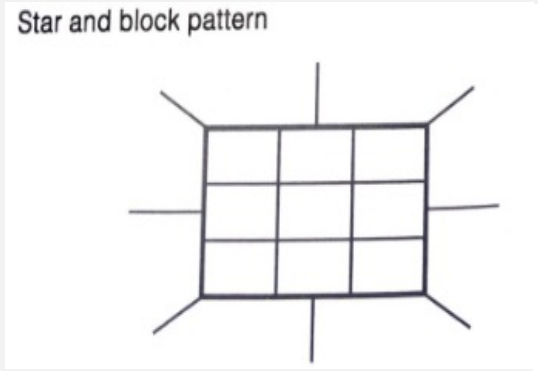
St. Louis

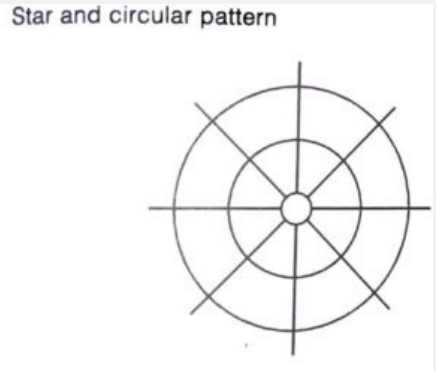


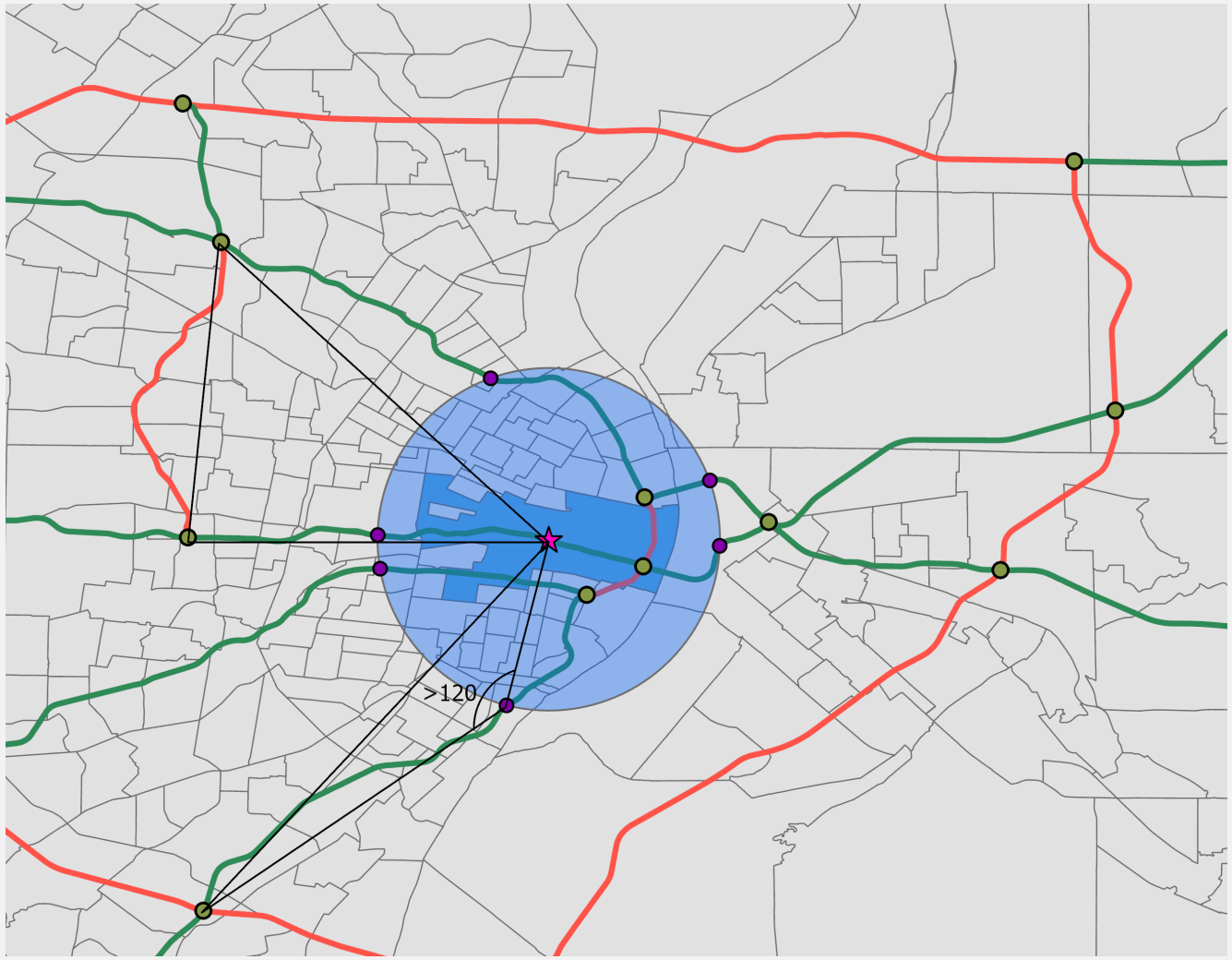
Number of Nodes	22
Prop. Emp. Node Area	0.79%
Prop. Total Population	7.20%
Prop. Total Employment	31.61%

SPOKE & WHEEL METHOD AND INTERSTATE COMPARISON OVERVIEW

- Identify "spoke" and "wheel" interstates based on inner angles of triangle created from interstate endpoints and CBD center
  - Triangles with an inner angle of over 120˚ categorized as a spoke type
  - Used 4-mile buffer for interstates near CBD

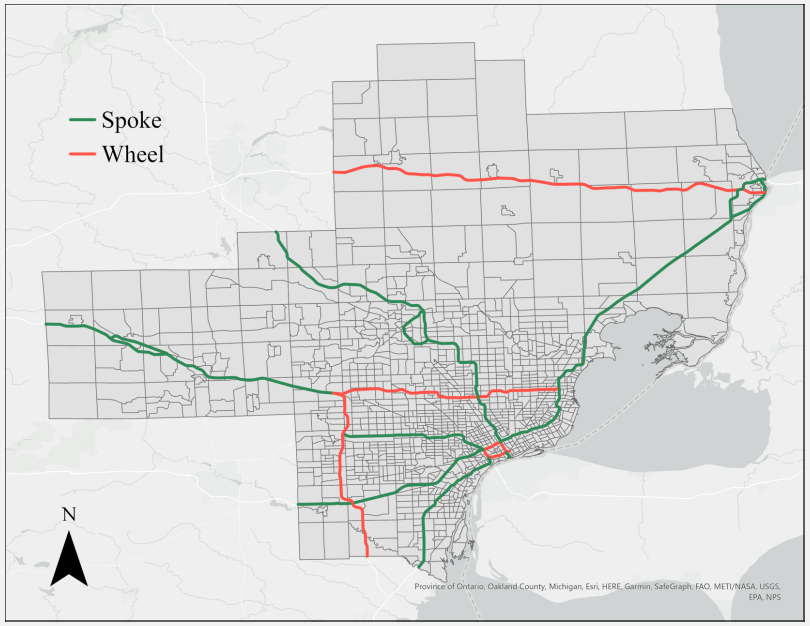






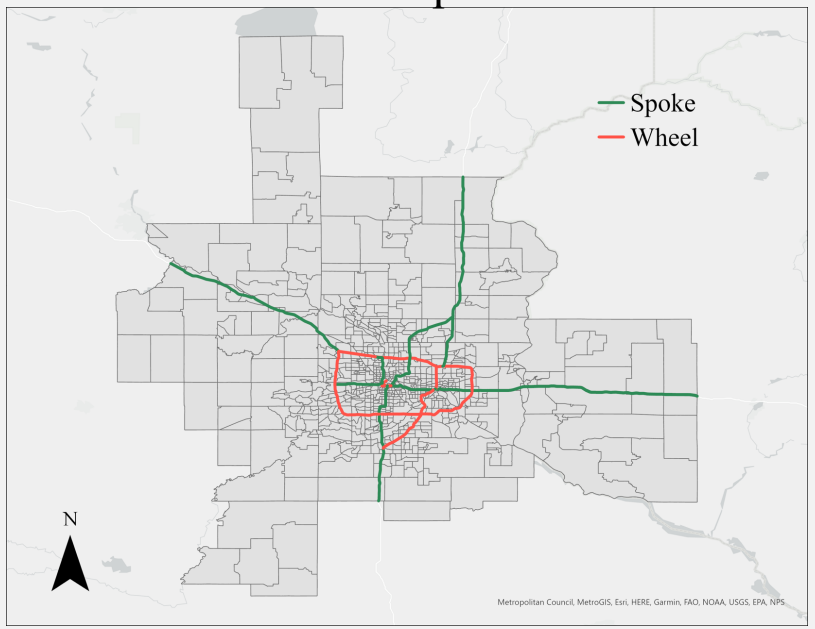
SPOKE & WHEEL METHOD AND INTERSTATE COMPARISON OVERVIEW

Detroit



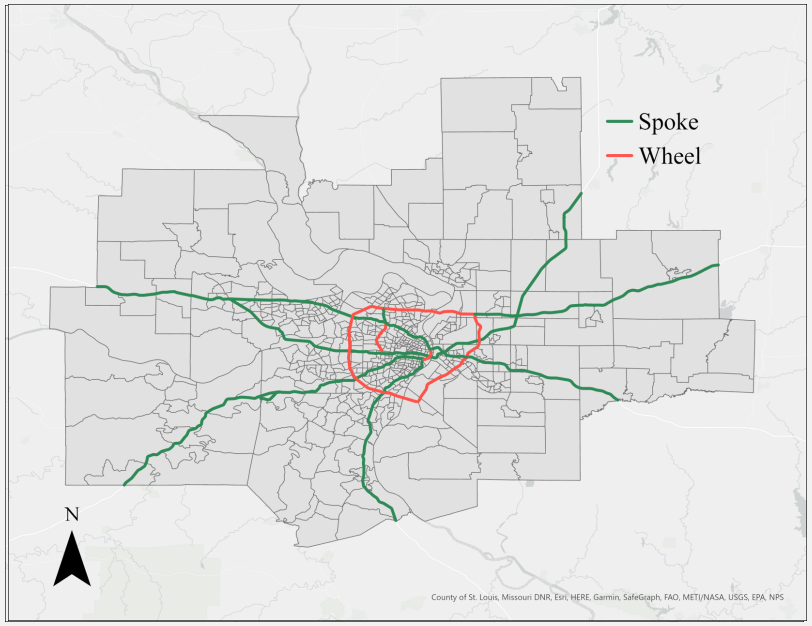
Proportion Spoke (by Length)	66.7% (81.5%)
Proportion Wheel (by Length)	33.3% (18.5%)
Avg. Spoke Ramp Density (per mi^2)	2.44
Avg. Wheel Ramp Density (per mi^2)	1.98 (3.69)

Minneapolis



Proportion Spoke (by Length)	70.9%
Proportion Wheel (by Length)	29.1%
Avg. Spoke Ramp Density (per mi^2)	1.75
Avg. Wheel Ramp Density (per mi^2)	4.03

St. Louis



Proportion Spoke (by Length)	79.4%
Proportion Wheel (by Length)	20.6%
Avg. Spoke Ramp Density (per mi^2)	2.02
Avg. Wheel Ramp Density (per mi^2)	4.47

SPECIFIC FOCUSES

- Compare Employment and Population variables to distance measures for Census tracts across MSAs
  - Census tract employment density, population density, and employment to population ratio to tract distance to **CBD**
  - Census tract employment density, population density, and employment to population ratio to tract distance to **nearest interstate**
  - Census tract employment density, population density, and employment to population ratio to tract distance to **nearest employment node**
- Compare Interstate ramp density and average Census Tract employment and population

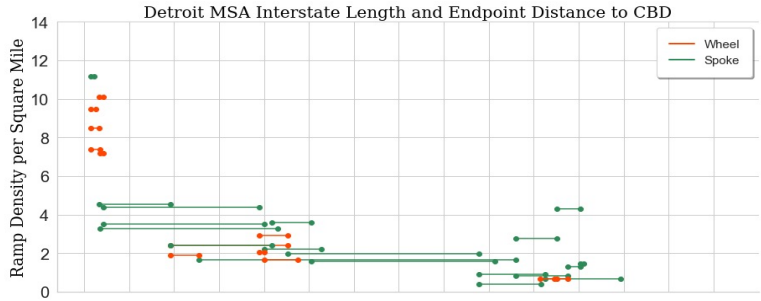
Distance Measurement

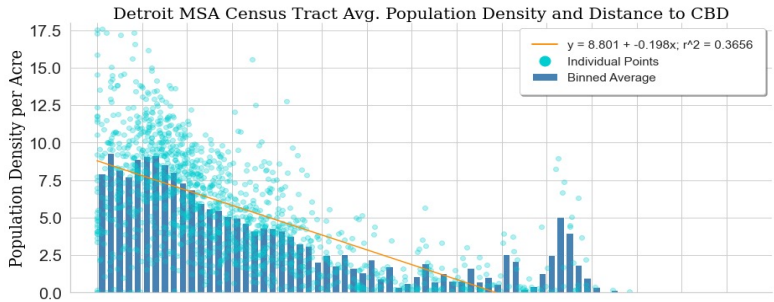
CBD

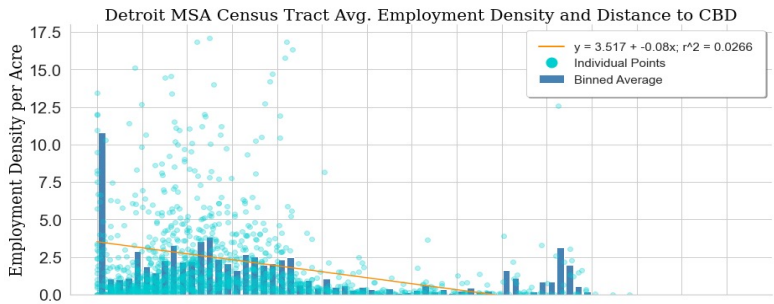
Nearest Interstate

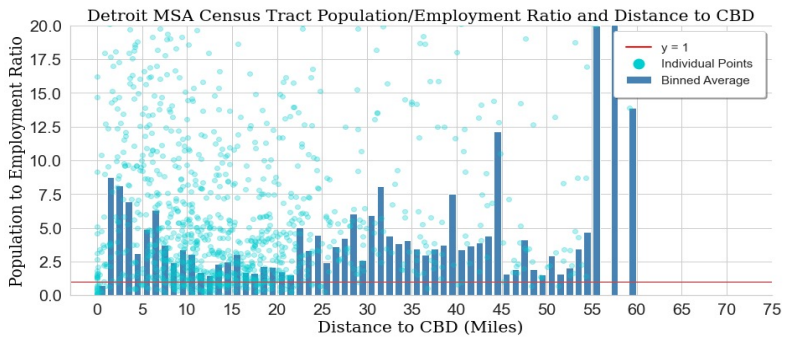
Nearest Employment Node

Detroit









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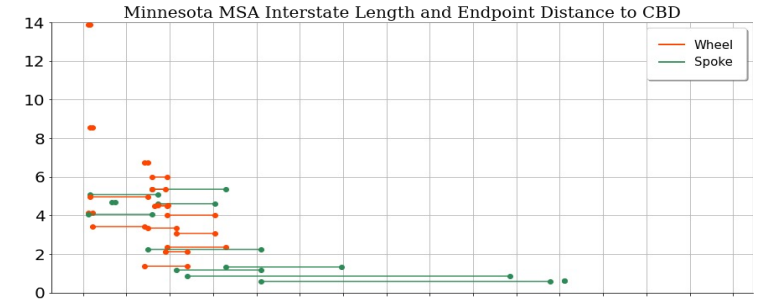
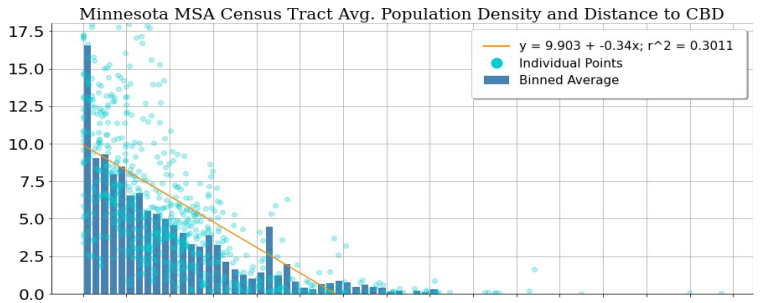
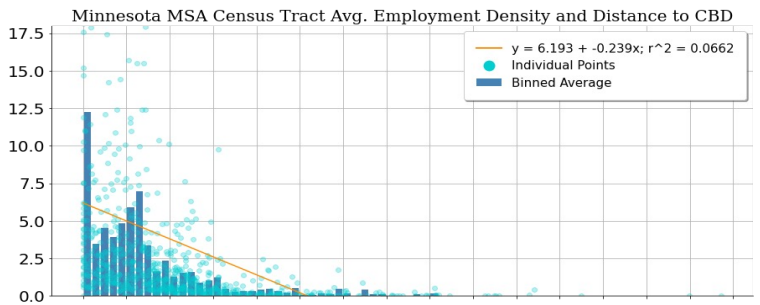
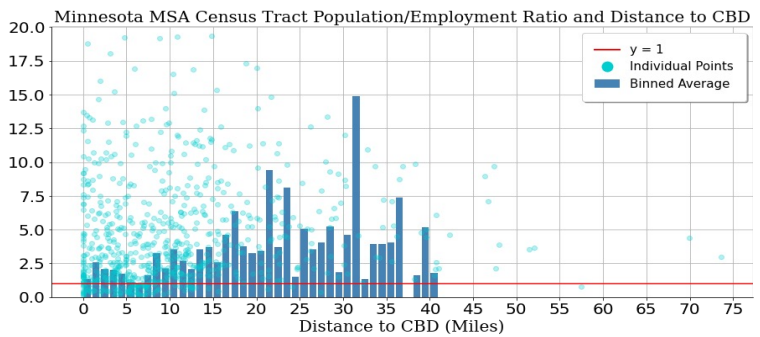
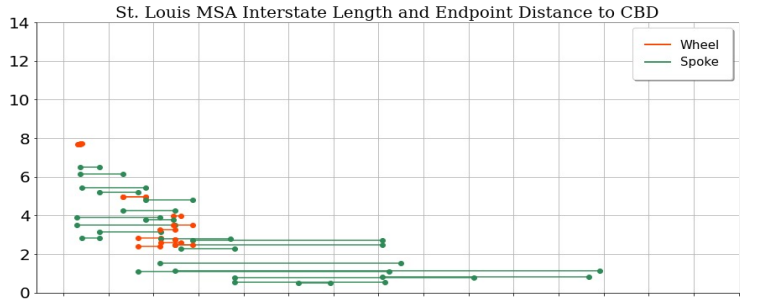


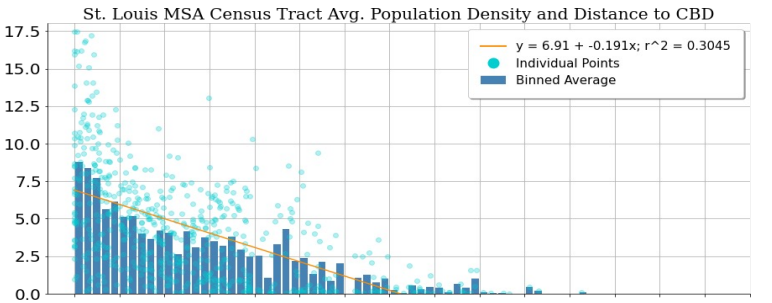


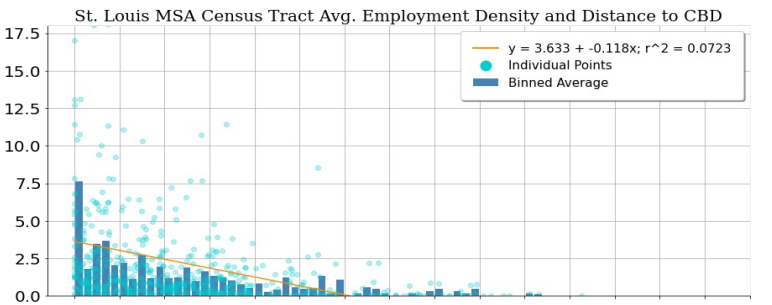


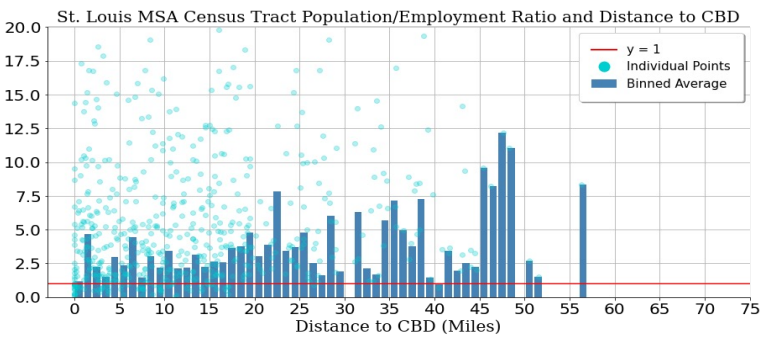


St. Louis









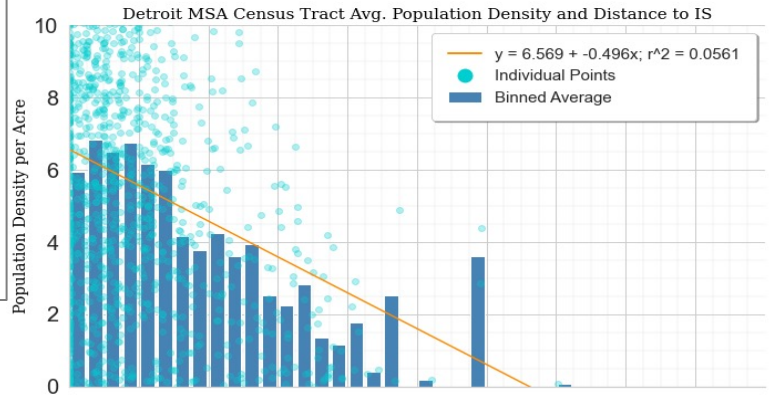
Distance Measurement

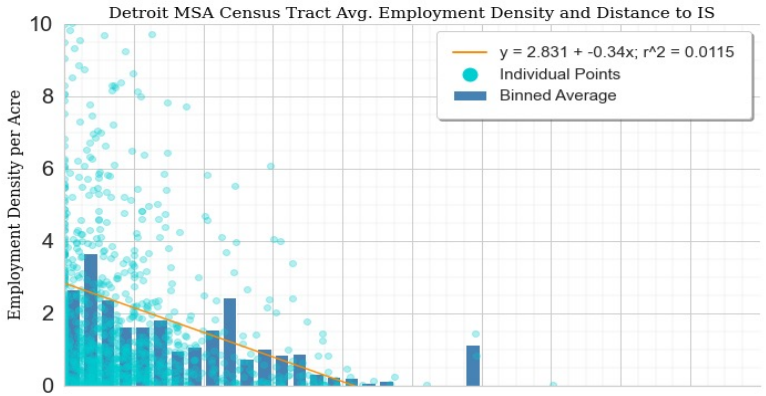
CBD

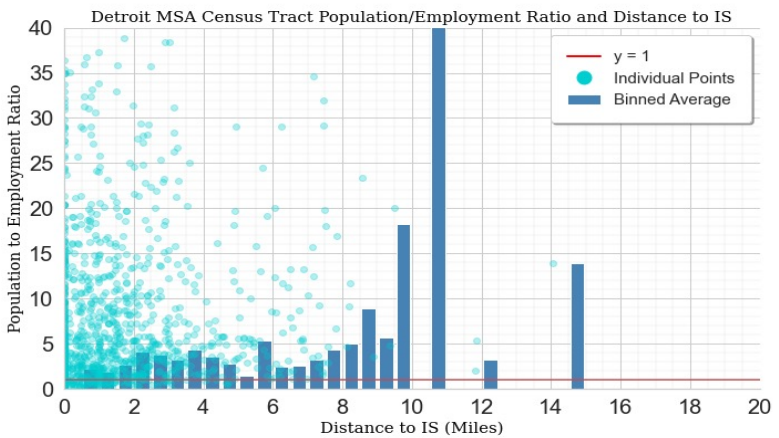
Nearest Interstate

Nearest Employment Node

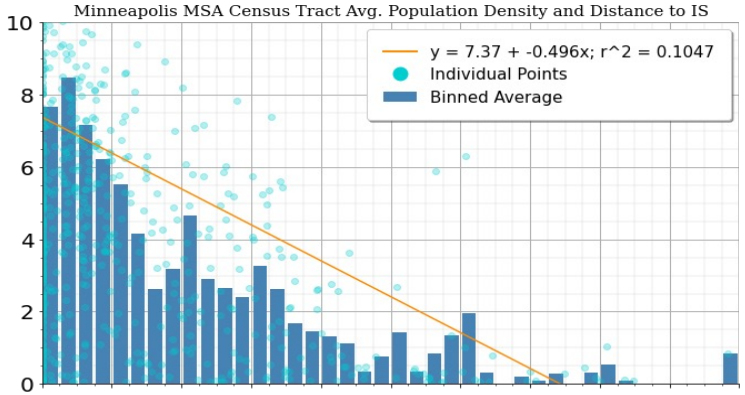
Detroit

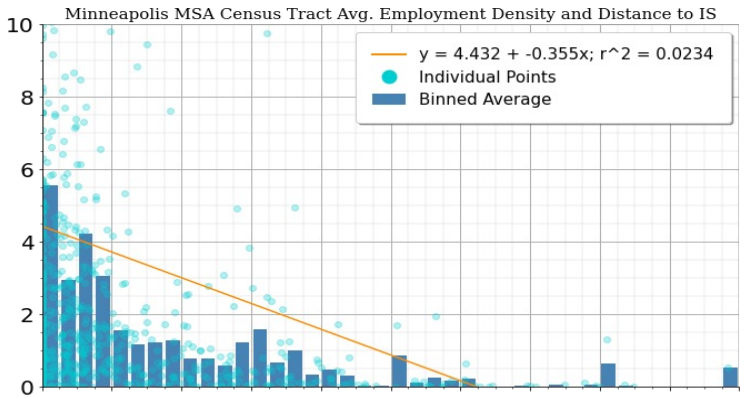


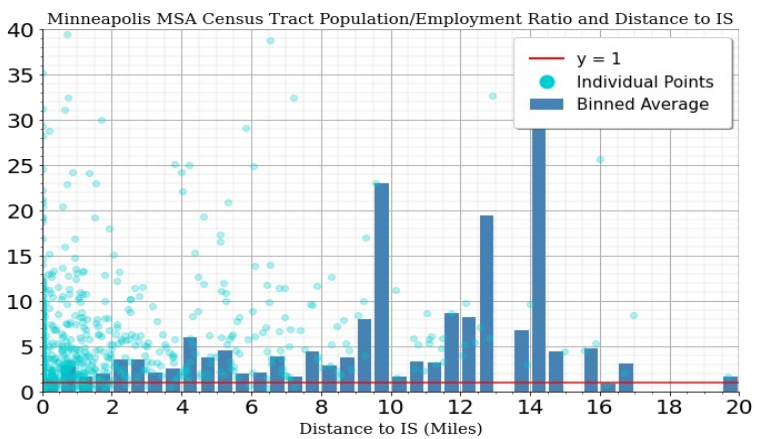




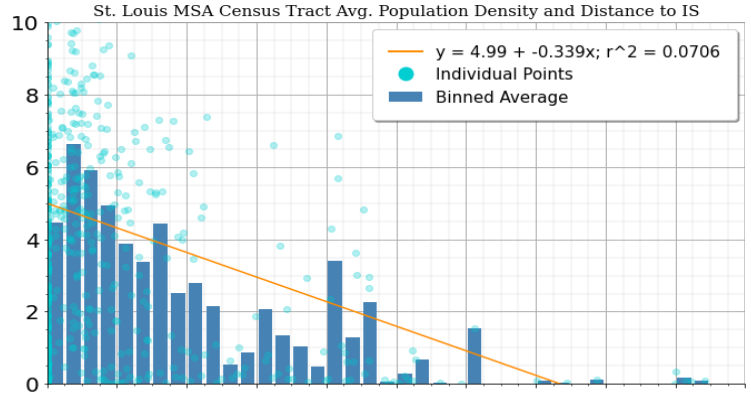
Minneapolis

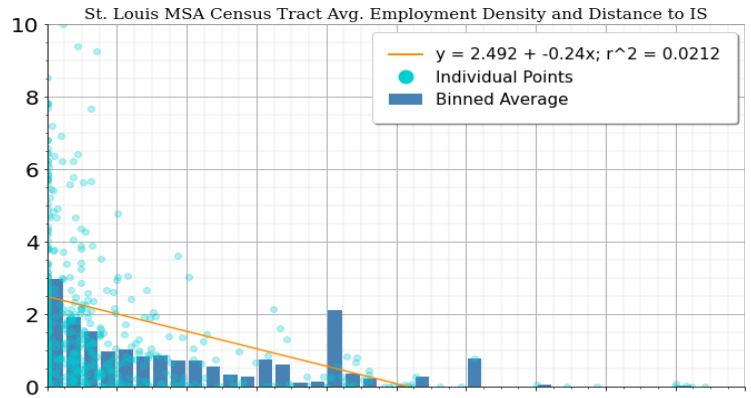


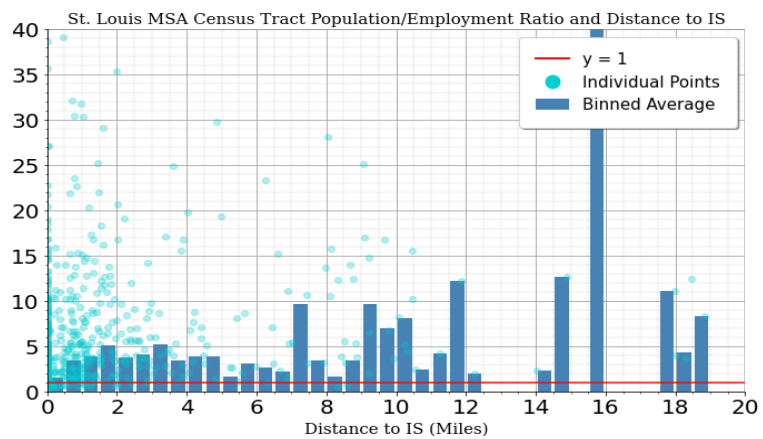




St. Louis







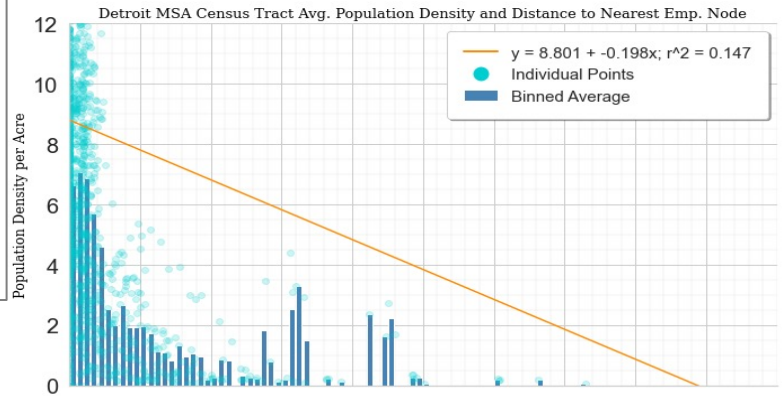
Distance Measurement

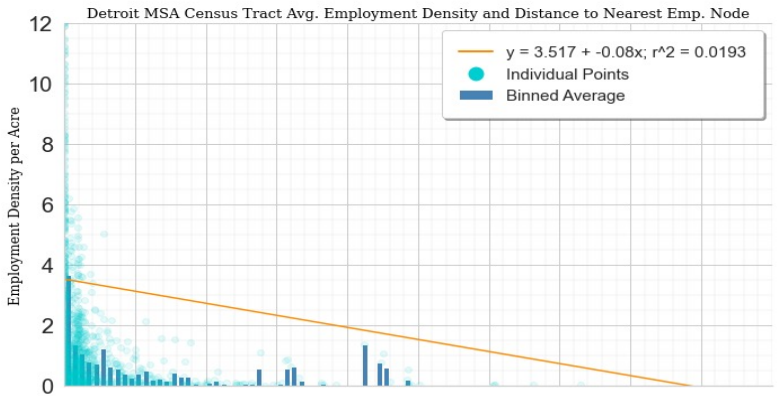
CBD

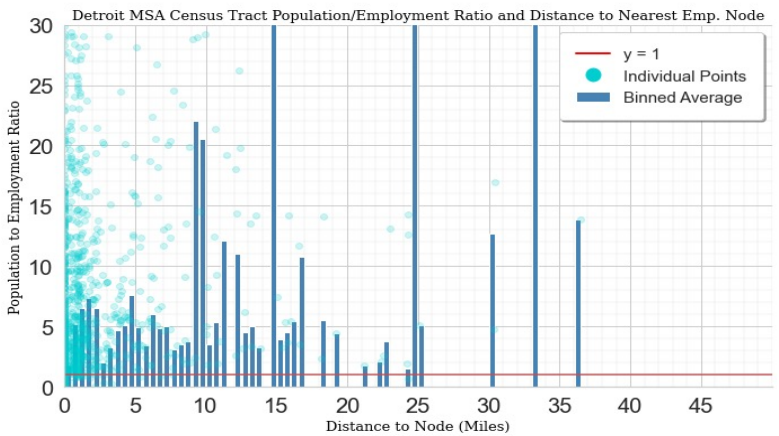
Nearest Interstate

Nearest Employment Node

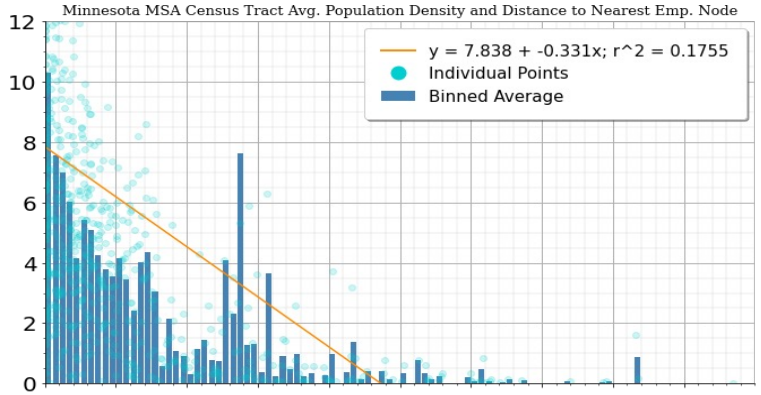
Detroit

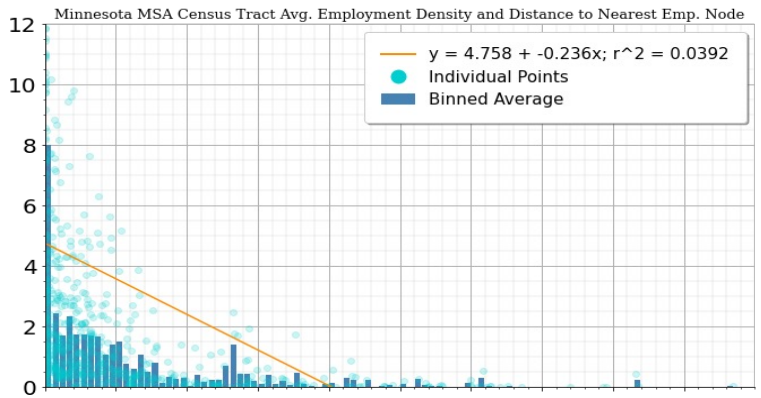


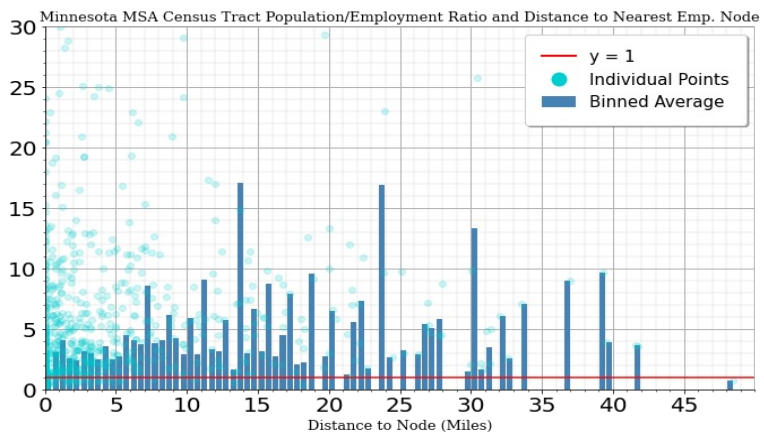




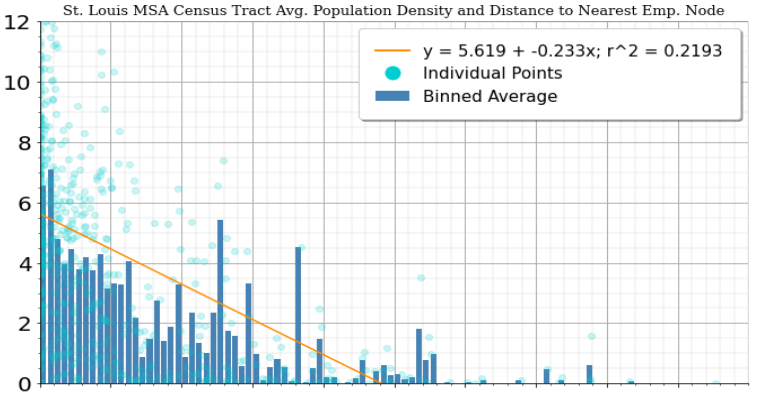
Minneapolis

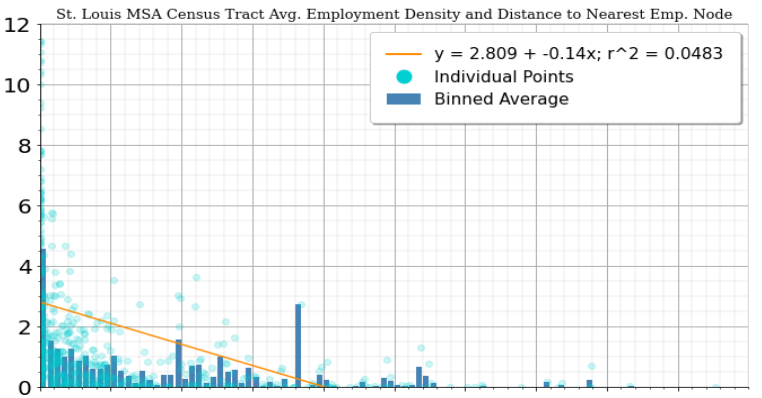


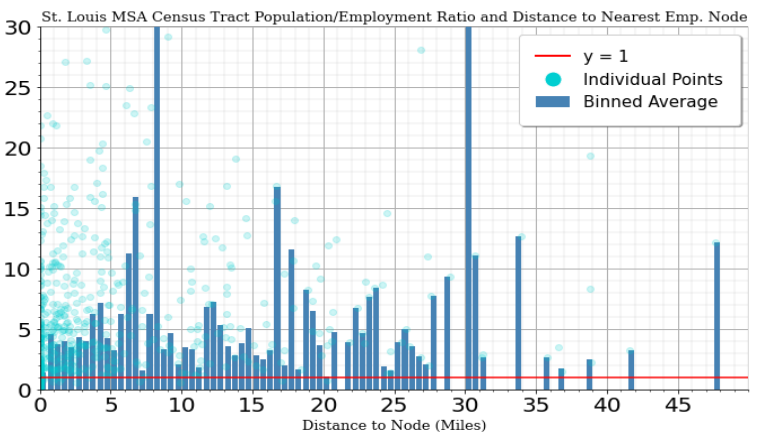




St. Louis

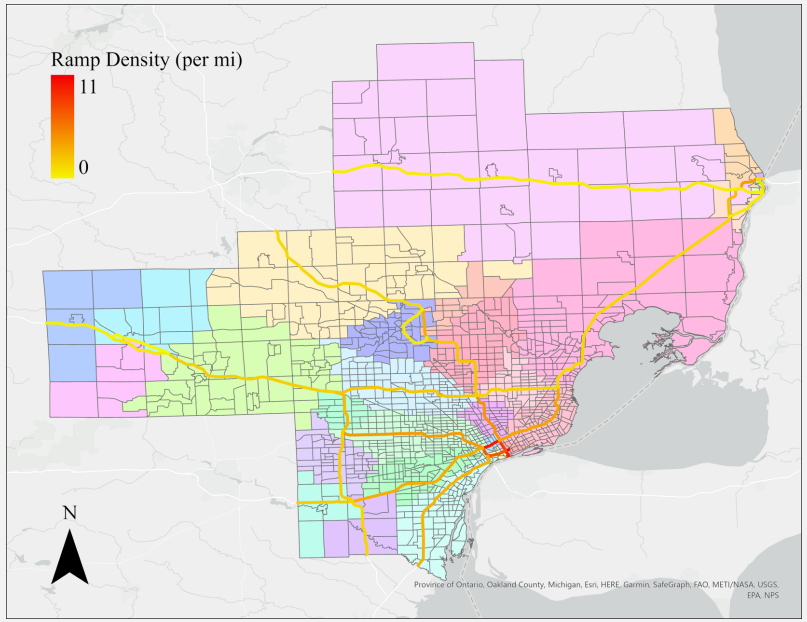




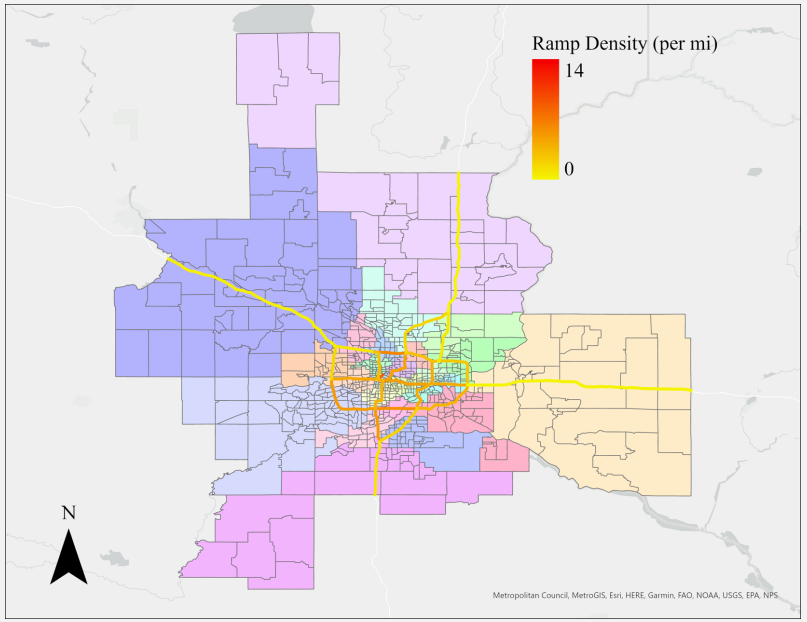


COMPARE INTERSTATE RAMP DENSITY AND AVERAGE CENSUS TRACT EMPLOYMENT AND POPULATION

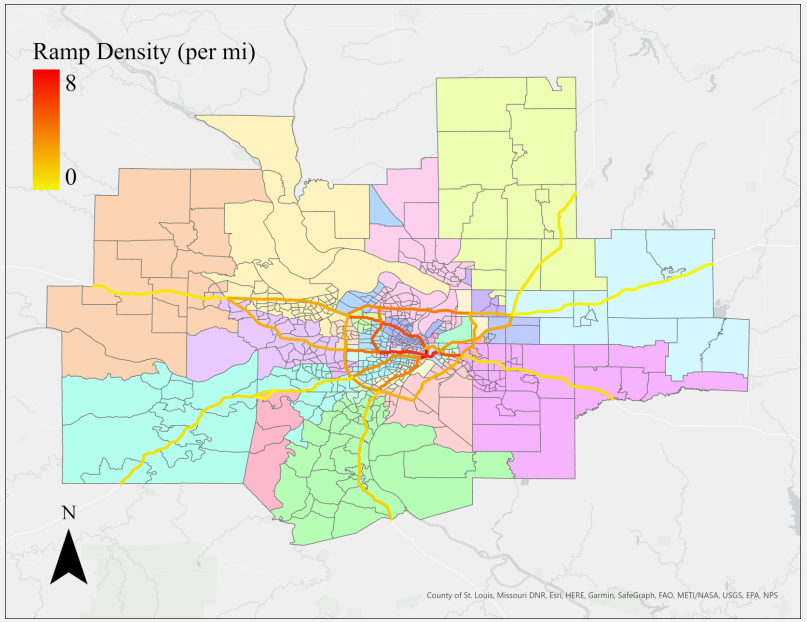
Detroit



Minneapolis



St. Louis



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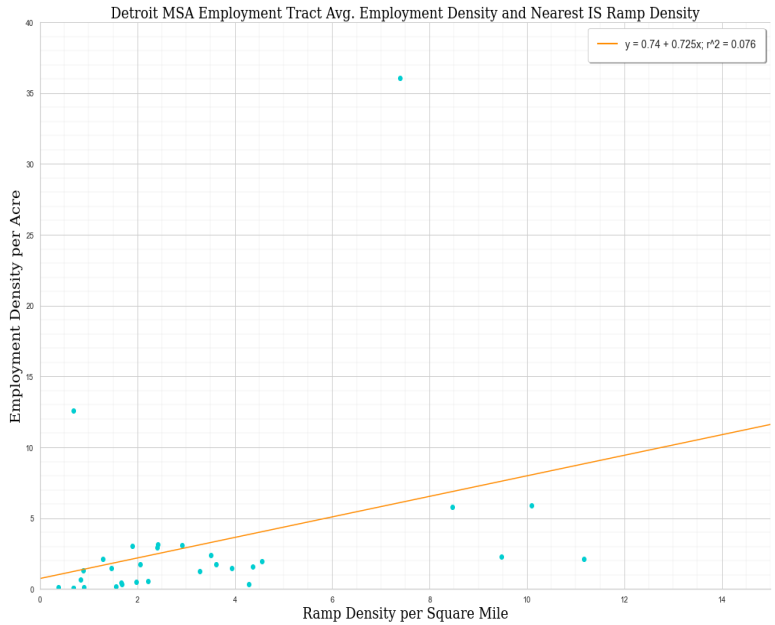

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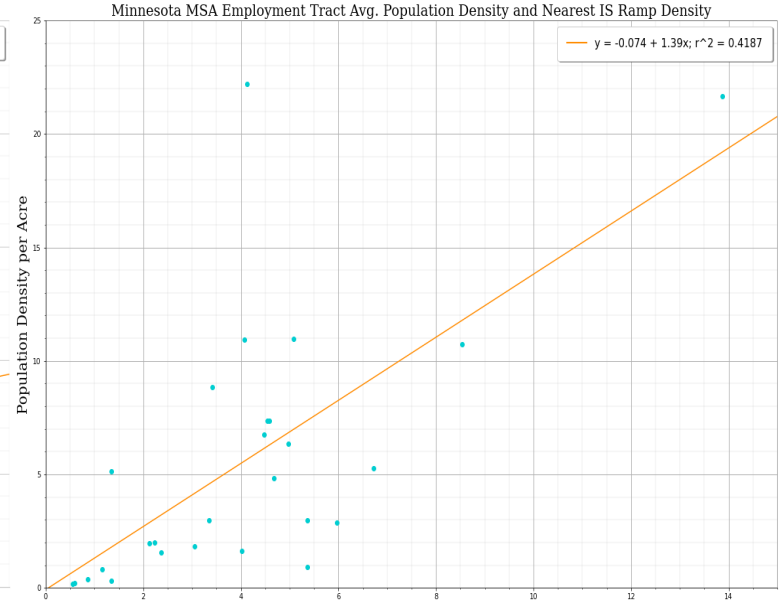

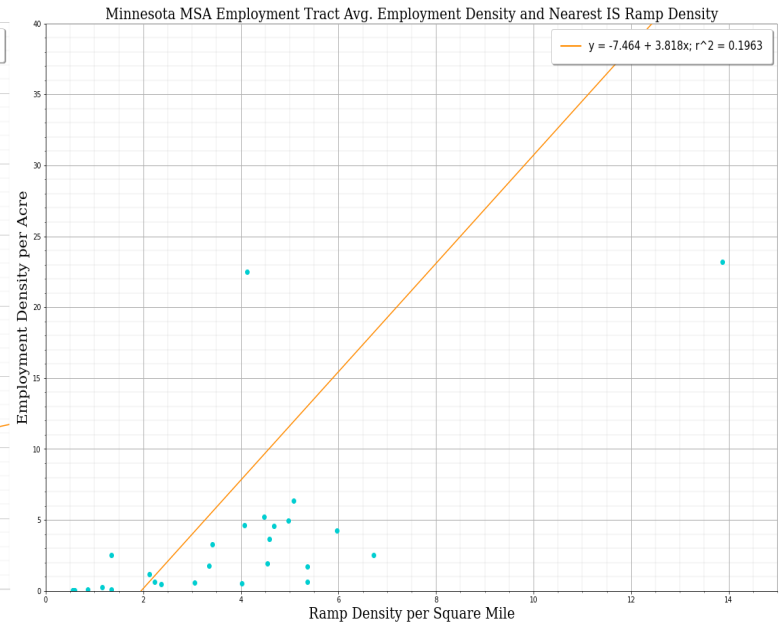

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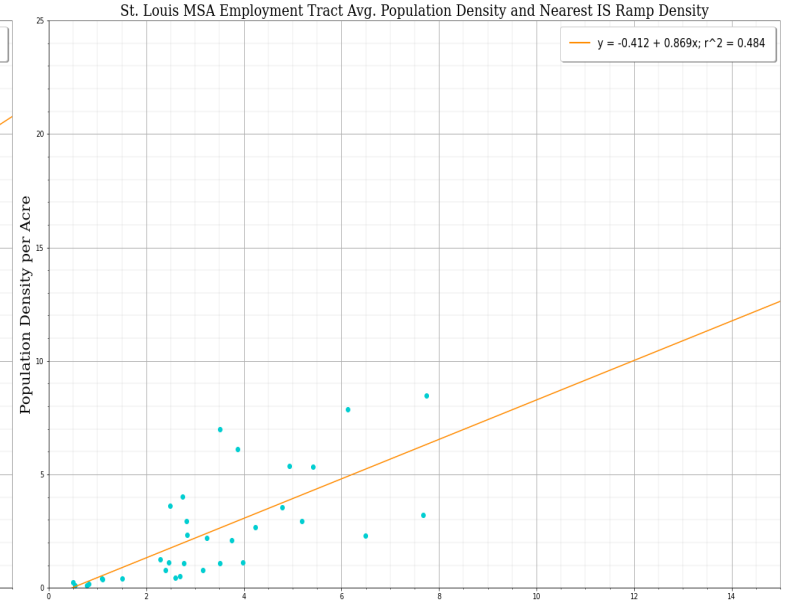
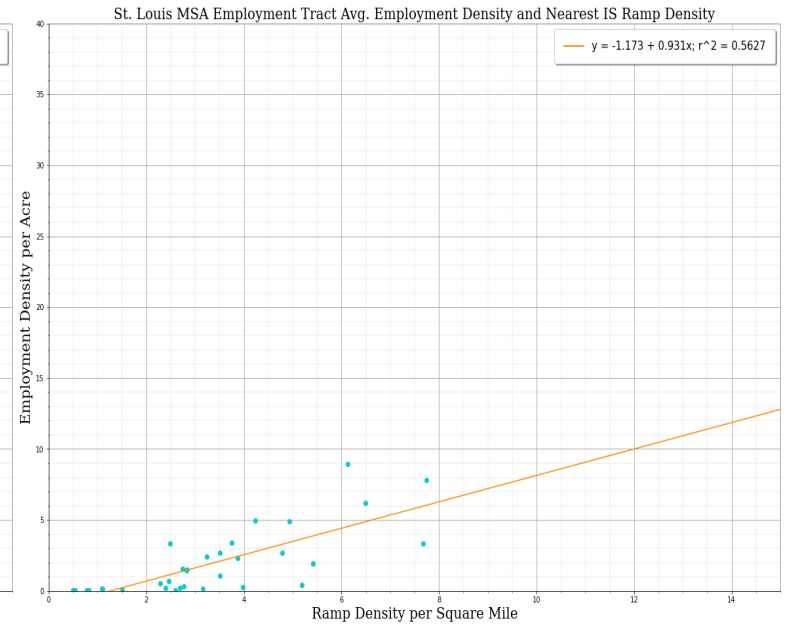




ANALYSIS

Urban Centrality Index

- Uses: Calculates spread/concentration of variable across area
  - Controls for different sizes and shapes of study area
  - Can be used with different variables (population density, employment, etc.)
- Variables:
  - Location Coefficient (LC): measures unequal distribution factor in area
    - n = number of areas
    - S_i = Share of employment or population in tract / total employment in MSA
    - E = Total number of employment or population in MSA
  - Venables Index (V): calculates changes in spatial distribution
    - S = column vector of S_i
    - D = distance matrix
  - Proximity Index (P): normalizes Venables index because it has no max value

$$UCI = LC \times P$$

$$LC = \frac{1}{2}\sum_{i}^{n}\left|s_i - \frac{1}{n}\right|$$

$$V = S' \times D \times S$$

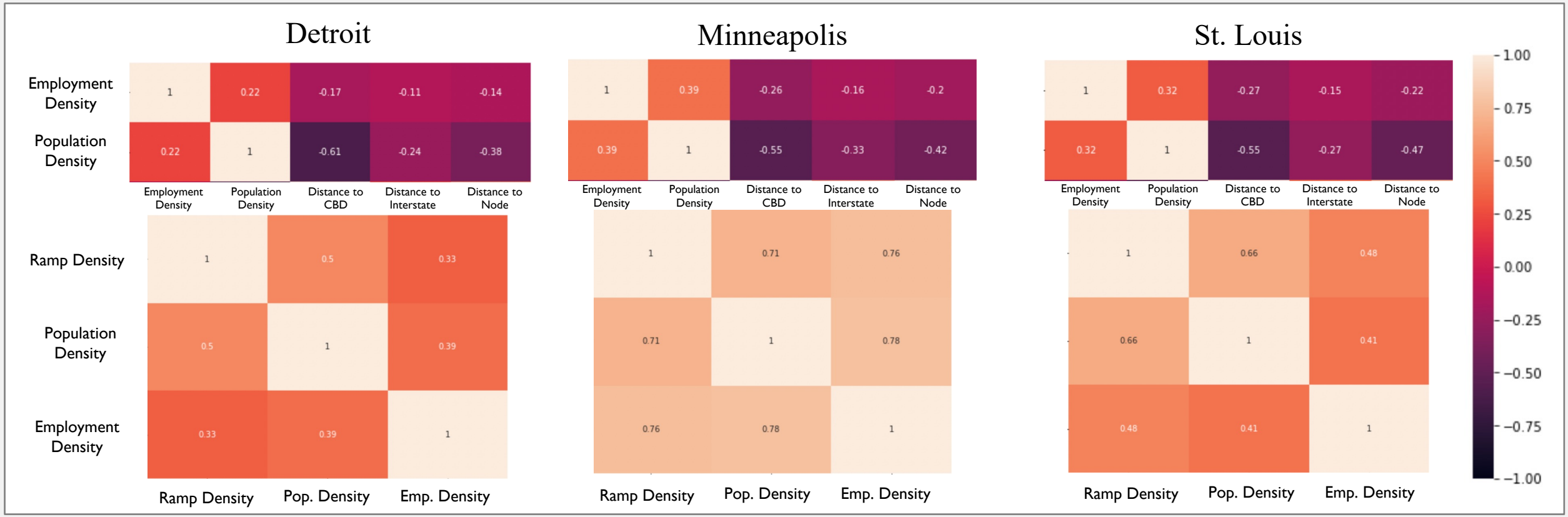
$$P = 1 - \frac{V}{V_{max}}$$

	Detroit MSA	Minneapolis MSA	St. Louis MSA
Population Density UCI	0.1619	0.4199	0.2486
Employment Density UCI	0.3084	0.4101	0.4035

ANALYSIS

Spearman Rank Correlation

- Nonparametric measure of monotonicity
  - Measures rank correlation between two variables
- Range: -1 – 1
  - Values towards 1 mean stronger positive correlation
  - Values towards -1 mean stronger negative correlation



CONCLUSION

- Higher interstate ramp density may be correlated with higher census tract Employment and Population Density
  - Showed the highest and most consistent correlation
- Population and employment distribution may be correlated with “wheel” radius
- More methods for measuring interstate topology and form needed

LIMITATIONS AND FUTURE STUDY

- Limited methods for calculating interstate topology
  - Network analysis would be useful
- Large differences in MSA sizes
- Modifiable areal unit problem
- Difficulty defining employment node
- Analysis focus too broad
- Possible other methods
  - OLS

THANK YOU