Justice in Charging Infrastructure: Mapping Inequality Across Socioeconomic Divides

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INTRODUCTION

This is a study in the initial stages focused on the complicated dynamics of charging infrastructure distribution, especially as it aligns spatially with diverse income communities. Using location of public charging stations and public housing, housing prices, and community socioeconomic status as key variables, this investigation explores the intersection between charging stations and socioeconomics. In analyzing such spatial distribution patterns, this research aims to reveal the underlying injustices prevalent in the accessibility of charging infrastructure, thus bringing awareness to such inequities in society.

METHODOLOGY

Initial data cleansing involved handling missing values, normalizing data formats, and ensuring data integrity. We utilized geospatial analysis techniques to calculate distances between points of interest, specifically focusing on the average distance from residential areas to the nearest public EV charging stations. We used Geopandas, a Python library for geographical data processing, for our geospatial analysis, allowing for the integration of socioeconomic data with spatial information on EV charging infrastructure. This integration enabled the mapping of charging station accessibility across different income groups, providing a visual and quantitative assessment of spatial disparities in EV infrastructure access. For statistical analysis, we used scipy.stats, Pearson's Correlation Coefficient, and Linear Regression Analysis. We calculated Pearson's r to measure the strength and direction of the linear relationship between median household income and the average distance to the nearest public EV charging station and performed linear regression analysis to further investigate the relationship between economic factors and access to EV charging stations. This step included fitting linear models to the data, enabling us to quantify the impact of income on charging station accessibility and visualize these relationships through regression plots segmented by income bins. Data visualization using Geopandas and Folium, Matplotlib, and Seaborn enabled us to present the data and reveal underlying patterns of infrastructural inequality.
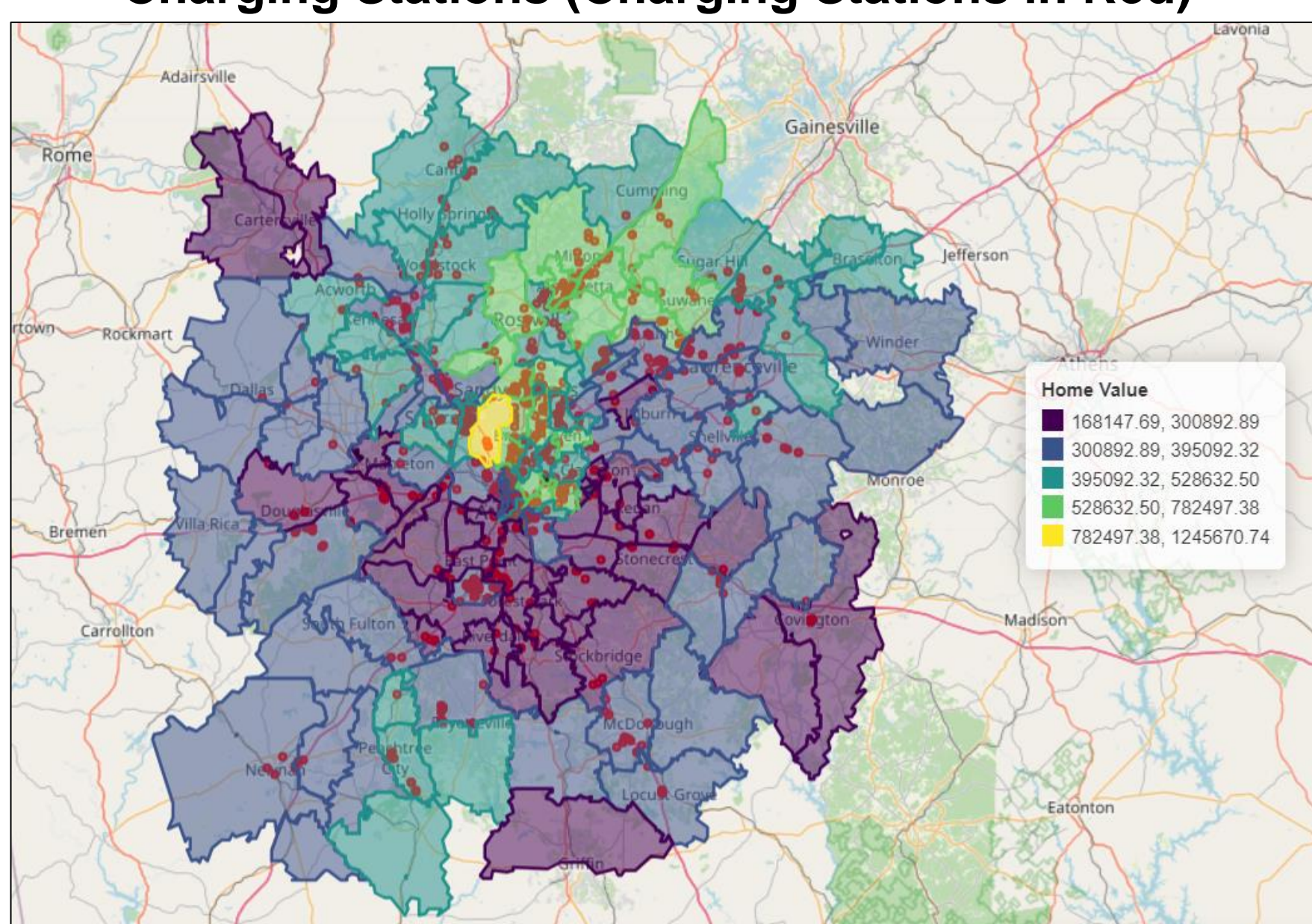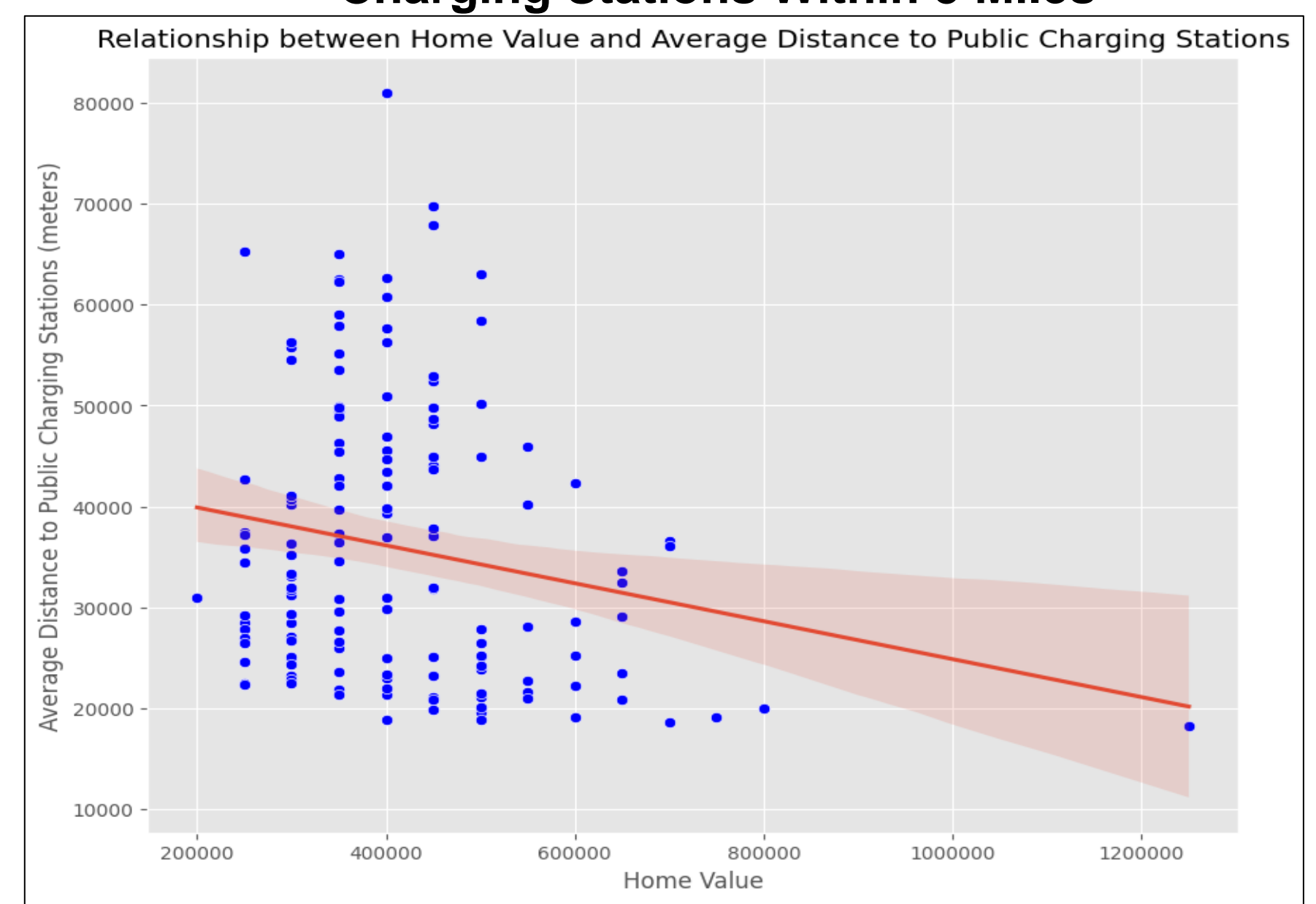
RESULTS
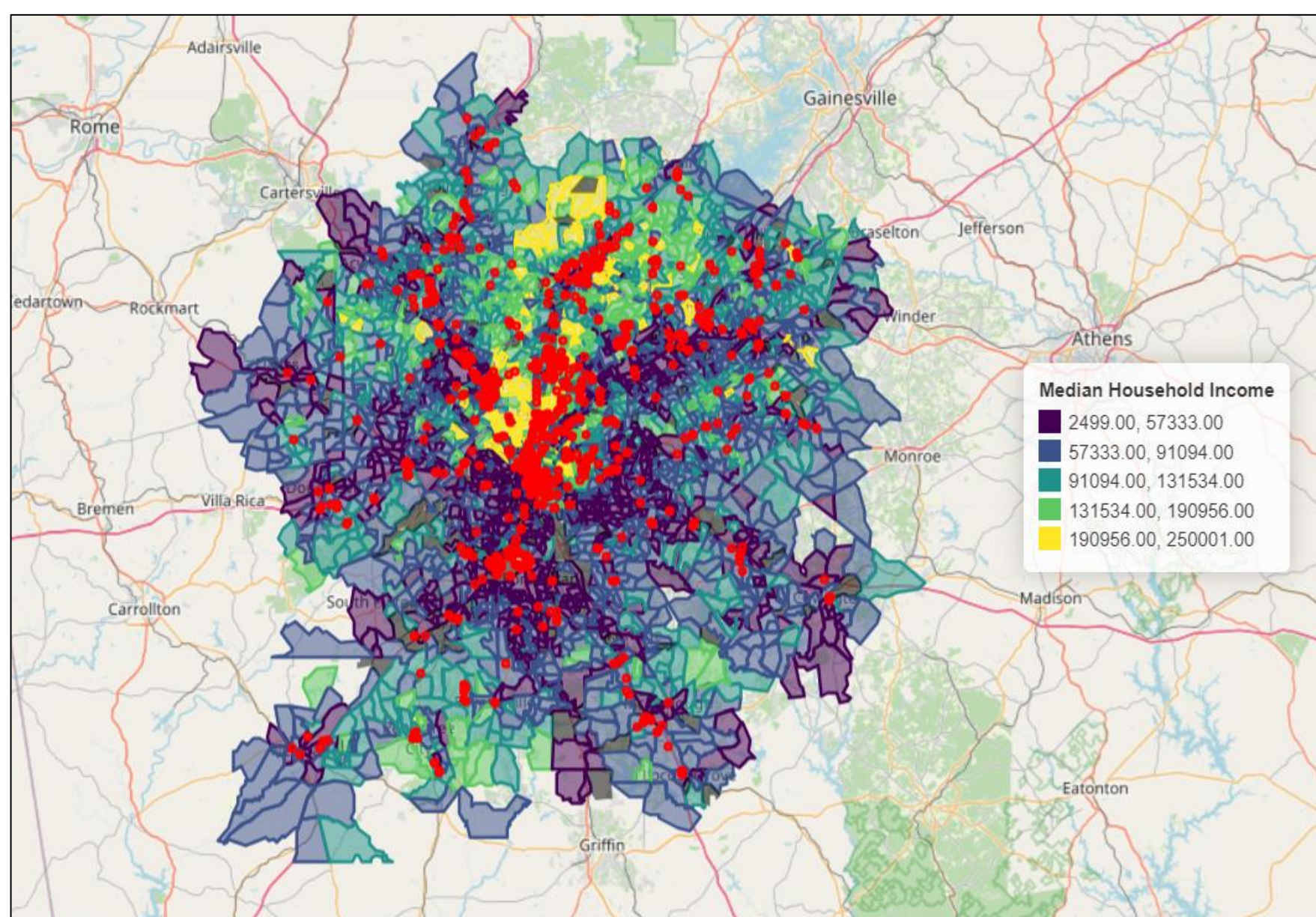
Median Household Income and EV Public Charging Stations (Charging Stations in Red)
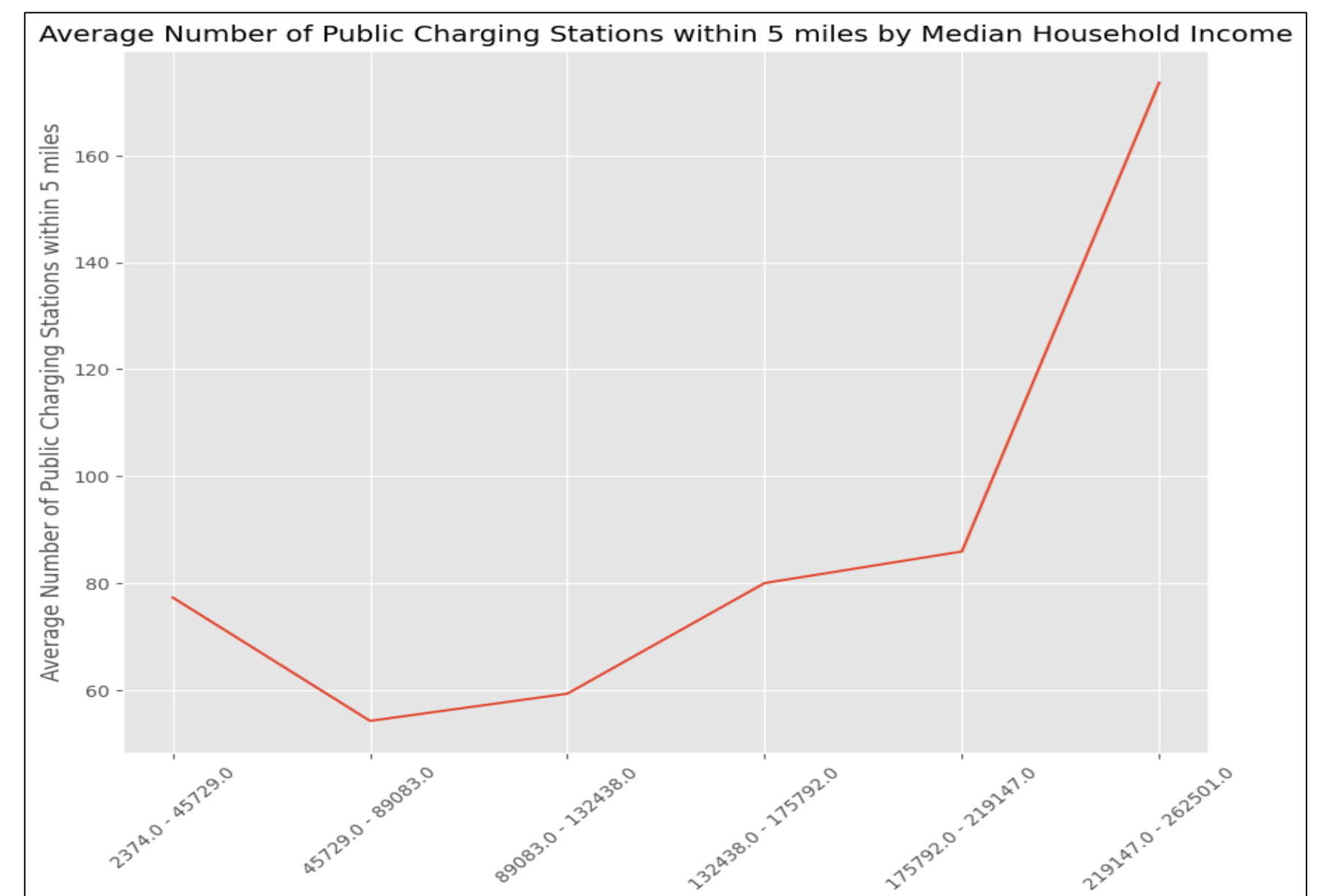
Median Household Income v. Avg. Number of Public Charging Stations Within 5 Miles

Home Value and EV Public Charging Stations (Charging Stations in Red)

Average Distance to Public Charging Stations v. Home Value

CONCLUSIONS & FUTURE WORK

In mapping existing charging stations and regional densities, we find that there is positive correlation between public charging station access and income. There also exists another factor, which has highlighted that black and hispanic populations face the greatest amount of inequity, independent of housing value or household income. Additionally, an analysis of charging station distribution concerning housing prices and socioeconomic status reveals that government subsidies and incentives to provide public charging cater to communities where independent charging is already an option.

In the future, we aim to investigate ways to decrease the impact of at-home charging on the power grid, how to influence policymakers in addressing equity during the EV transition, and learning more about how to target traditionally underrepresented groups in EV adoption.

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