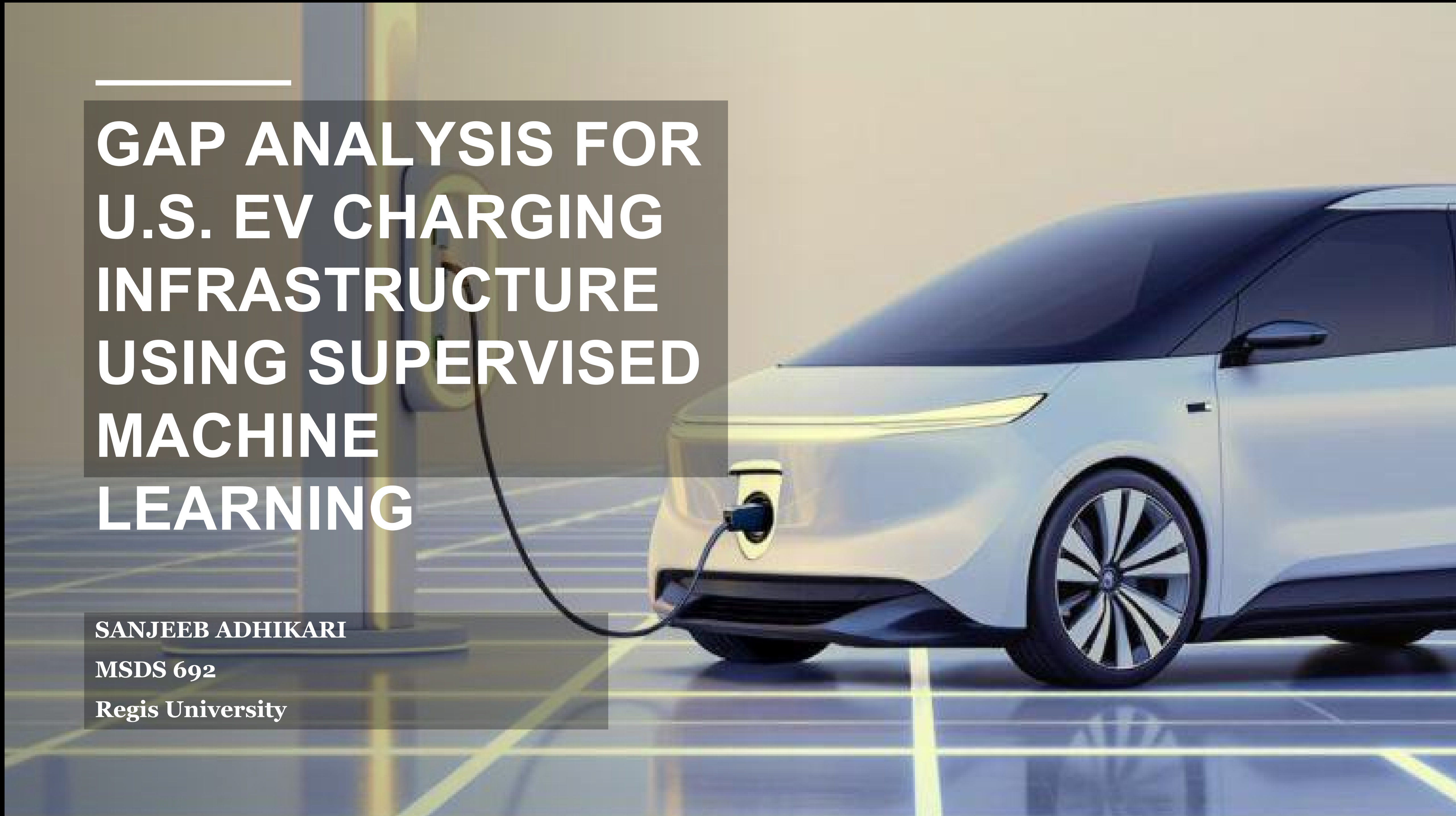
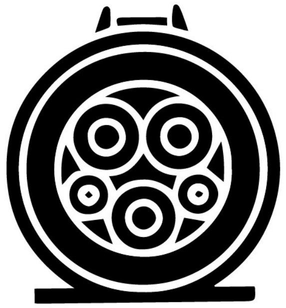


GAP ANALYSIS FOR U.S. EV CHARGING INFRASTRUCTURE USING SUPERVISED MACHINE LEARNING

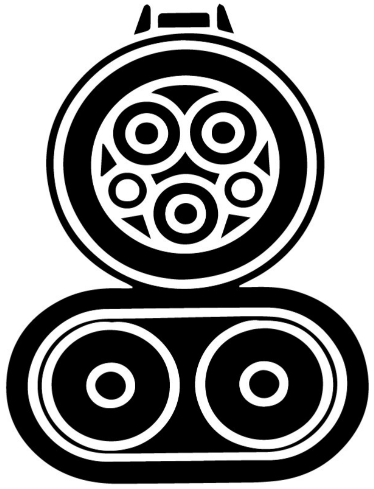
SANJEEB ADHIKARI
MSDS 692
Regis University

INTRODUCTION

- EV Vehicles are rapidly adopted worldwide
- Need reliable Charging stations for regular dependency
- Because of Rapid growth, Infrastructure are not built on a same pace
- This project tries to determine required number of ports(Level 2 and DC) in Census Tract level using Machine Learning



J1772 Level 2
AC Port

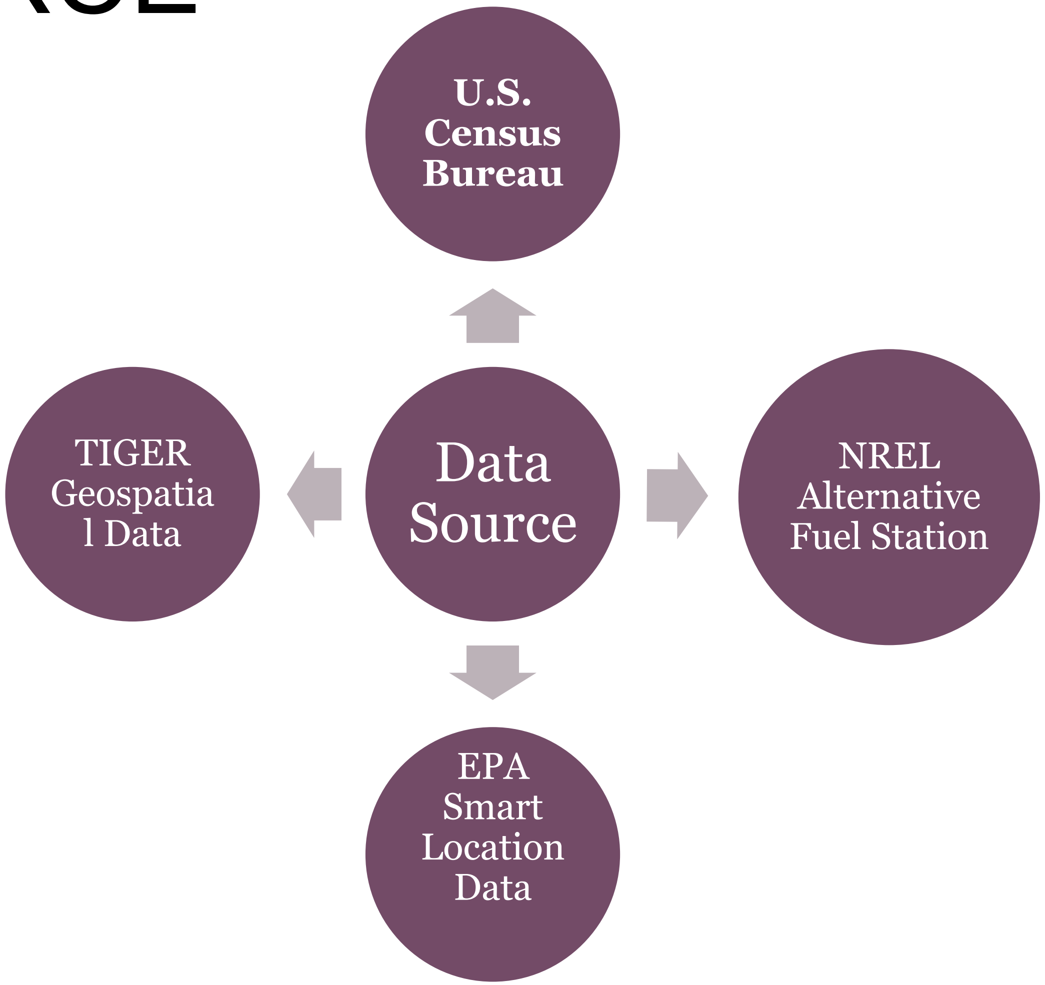


CCS1 DC Port

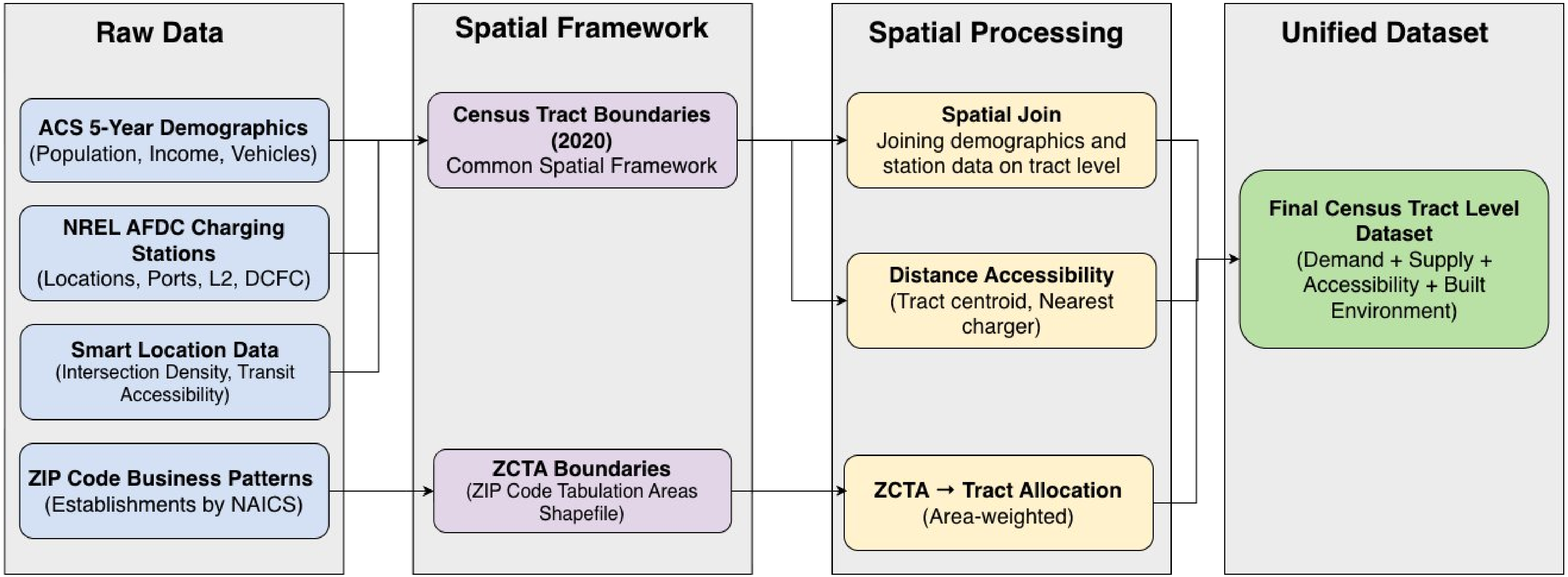
PROBLEM STATEMENT

- A sustainable EV adaptation need proper charging infrastructure
- Although US is adopting EV vehicles fast but its infrastructure are not built evenly in all region
- Not having even and fulfilling infrastructure may create negative impact among people
- This Project aims to predict required number of charging port in small region i.e., census tract using demographics, land use, accessibility data

DATA SOURCE


U.S. Census Bureau
TIGER Geospatia l Data
Data Source
NREL Alternative Fuel Station
EPA Smart Location Data

DATA PROCESSING PIPELINE



MODEL SELECTION

Two approach were used to find optimal model:

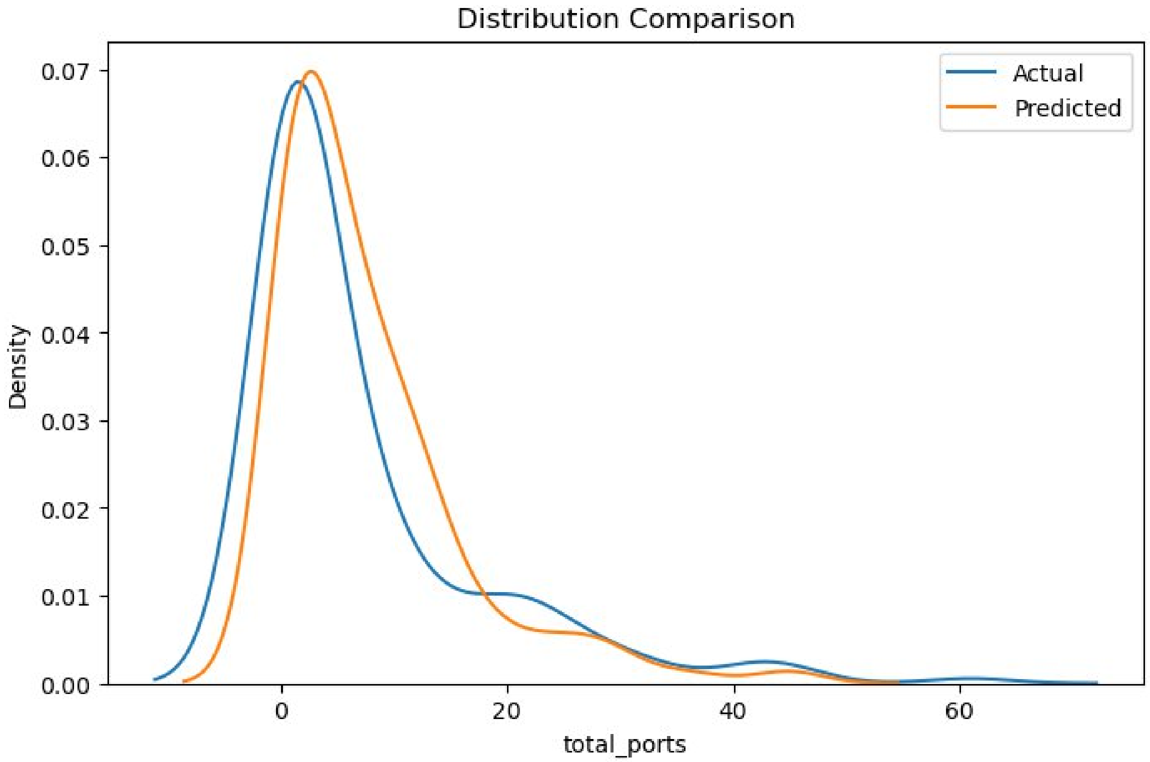
- **Approach 1:** XGBoost Regressor and LightGBM were used to predict total number of port.
- **Approach 2:** Almost 60% training data had zero ports, so two stage model also implemented
  - **Stage 1**: Classification – predict presence of charging infrastructure
  - **Stage 2:** Regression – predict number of charging ports

Single XGBoost with importance feature provides best result.

MODEL PERFORMANCE

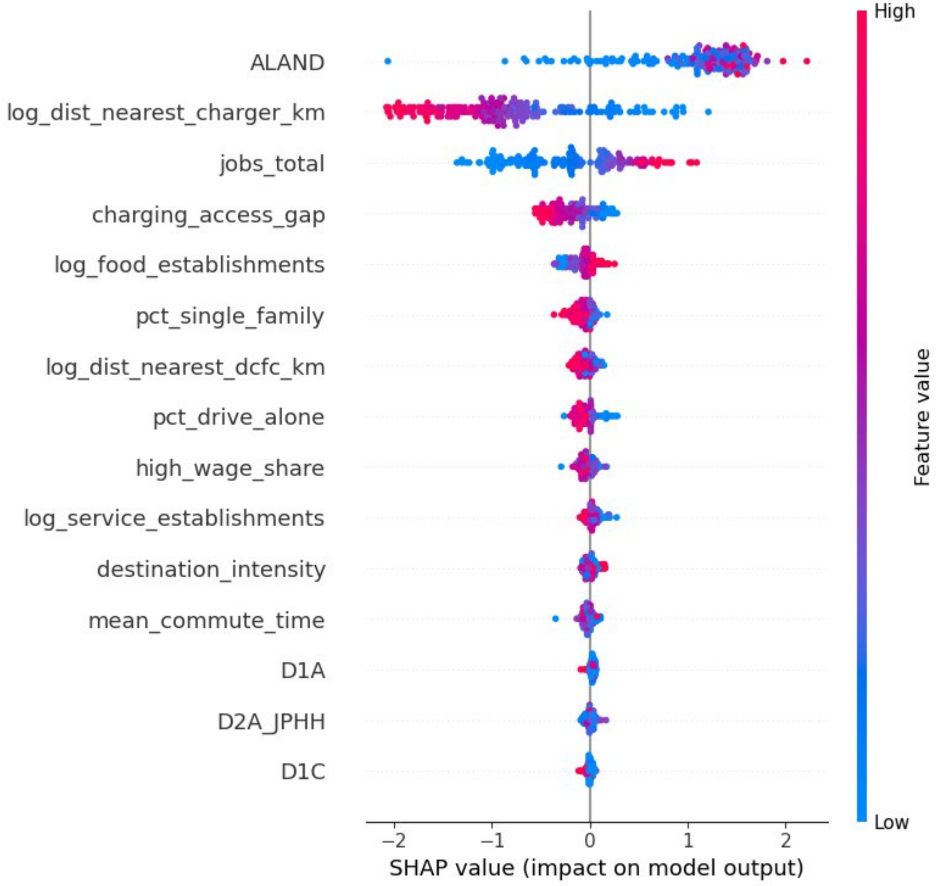
- The model shows moderate predictive capability for EV charging demand.
- Final Model predicted almost 15% more number of charger for Vermont State.

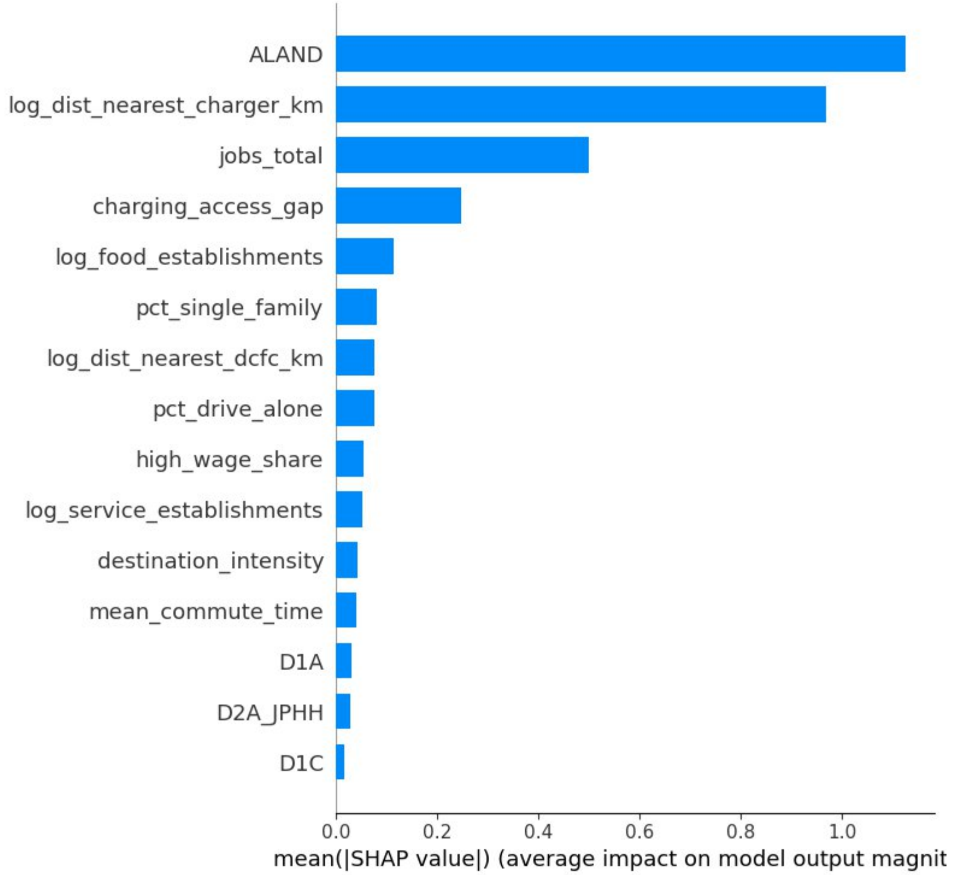
R^2	MAE
0.44	4.33



SHAP ANALYSIS / FEATURE IMPORTANCE

(SHAPLEY ADDITIVE EXPLANATIONS)

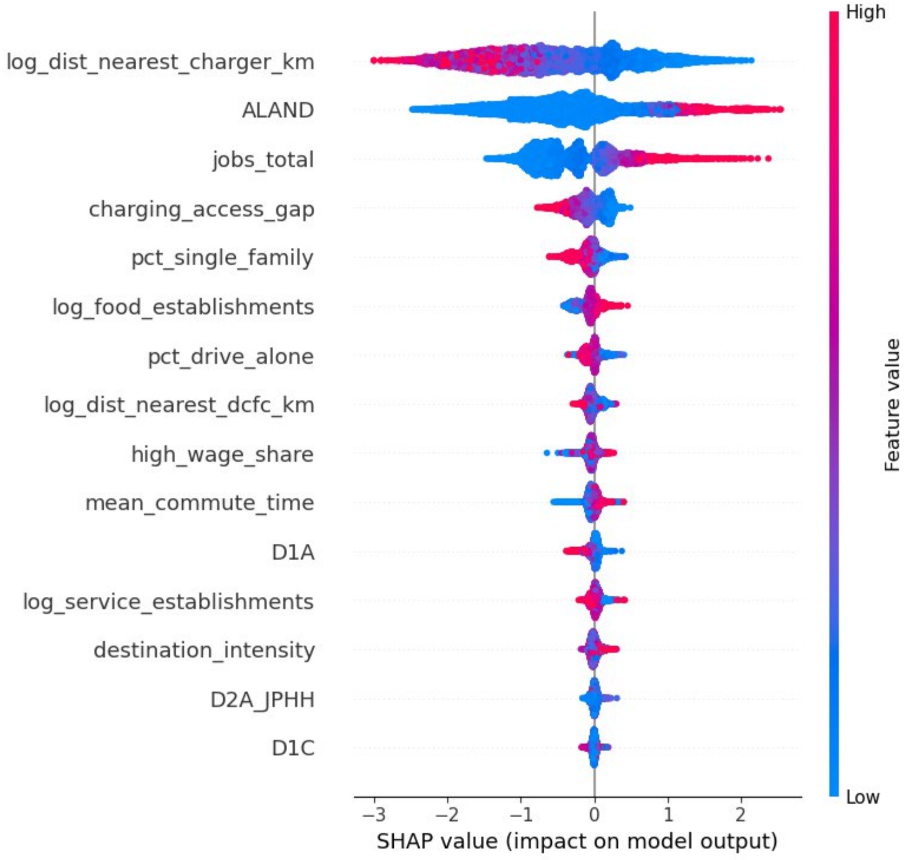


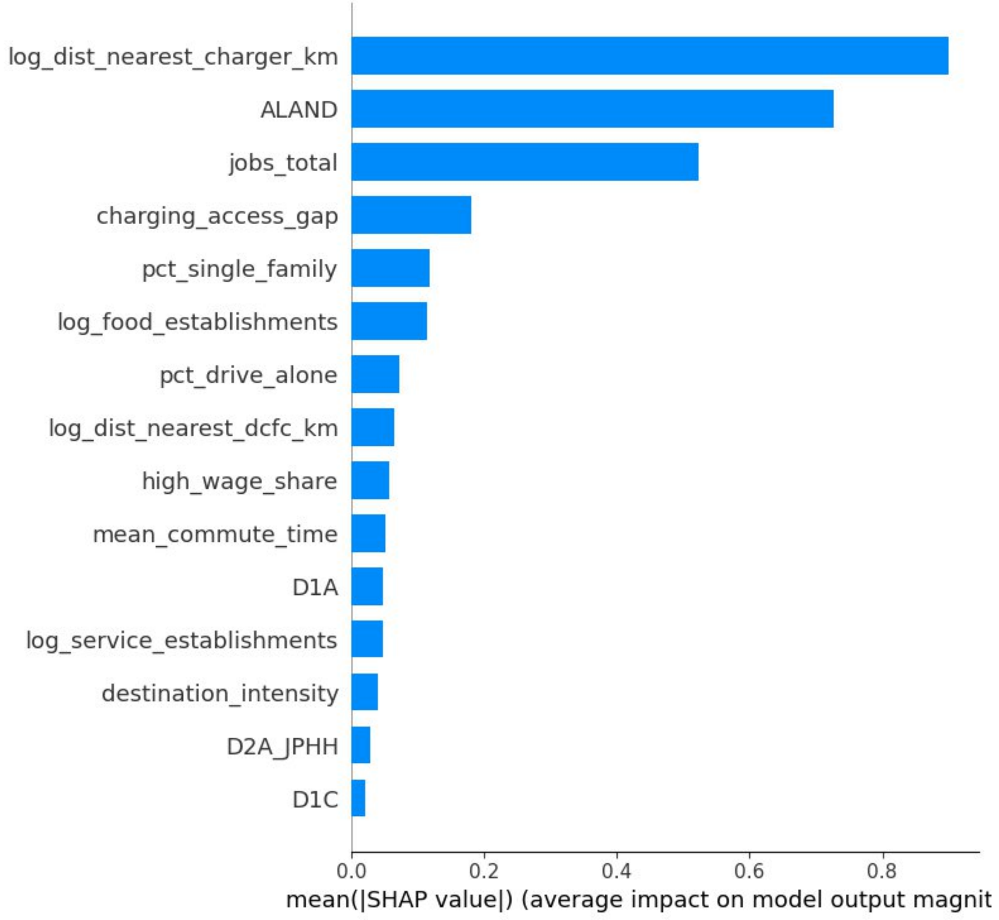


SHAP Analysis for Vermont State

SHAP ANALYSIS / FEATURE IMPORTANCE

(SHAPLEY ADDITIVE EXPLANATIONS)





SHAP Analysis for California State

GAP CLASSIFICATION

Based on actual and predicted number of ports, tracts are categorized into three group:

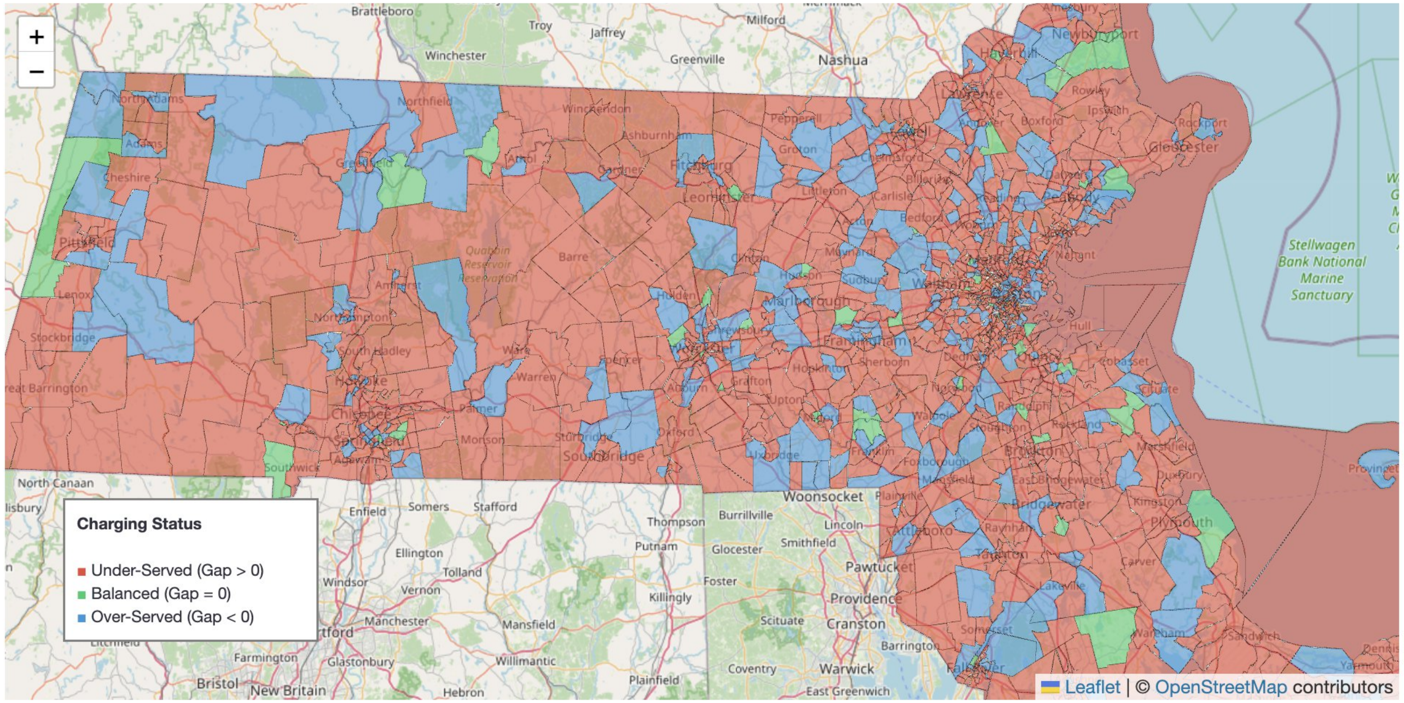
- **Underserved Area**: Predicted ports > Existing ports
- **Balanced Areas:** Predicted ports = Existing ports
- **Overserved Areas:** Existing ports > Predicted ports

Select State

MA

Total Existing Ports	Total Predicted Ports	Overall Charging Gap
10597	12921	2324

Charging Status by Tract - MA



GAP ANALYSIS OF MASSACHUSETTS

Select State

VT

Total Existing Ports

1370

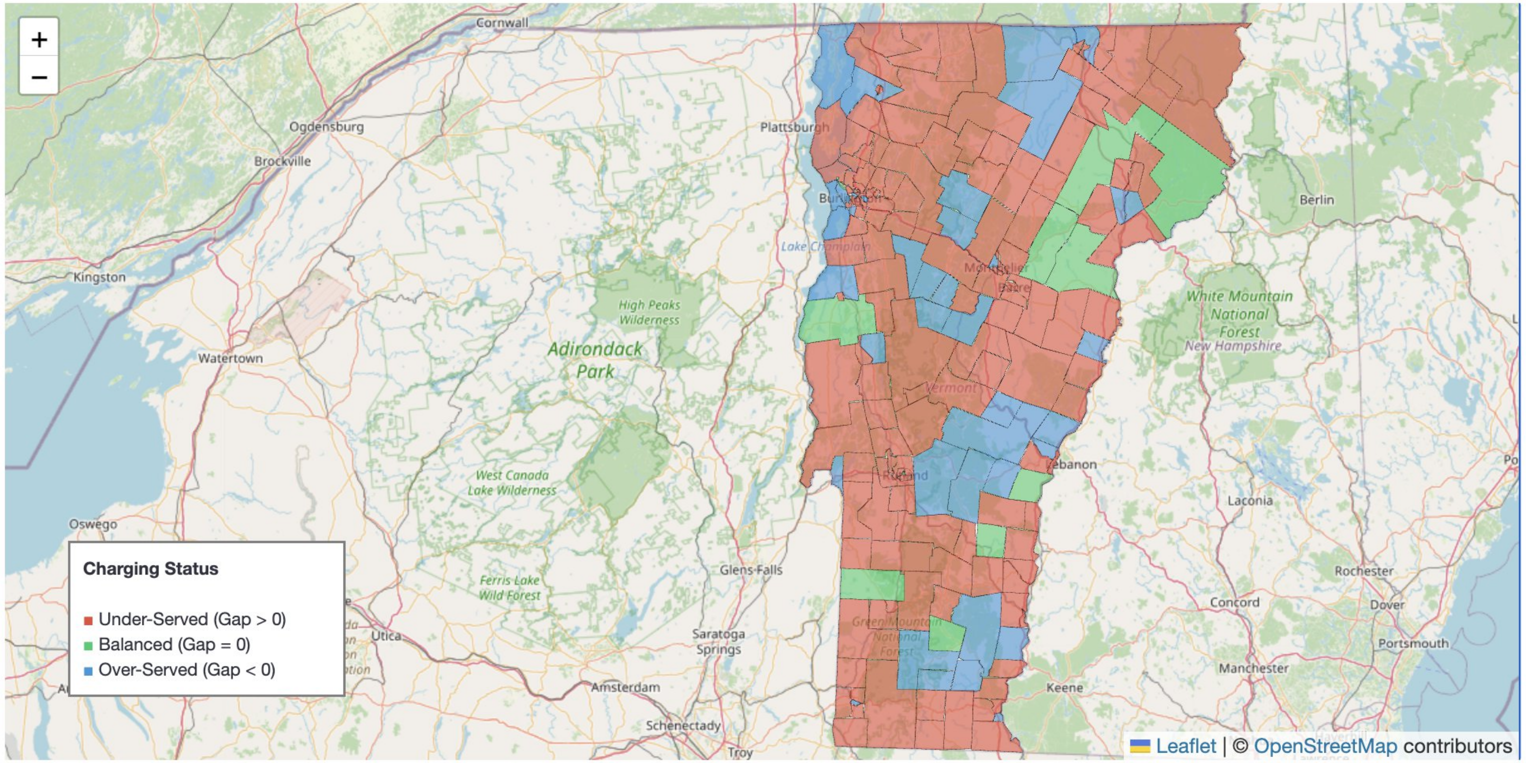
Total Predicted Ports

1563

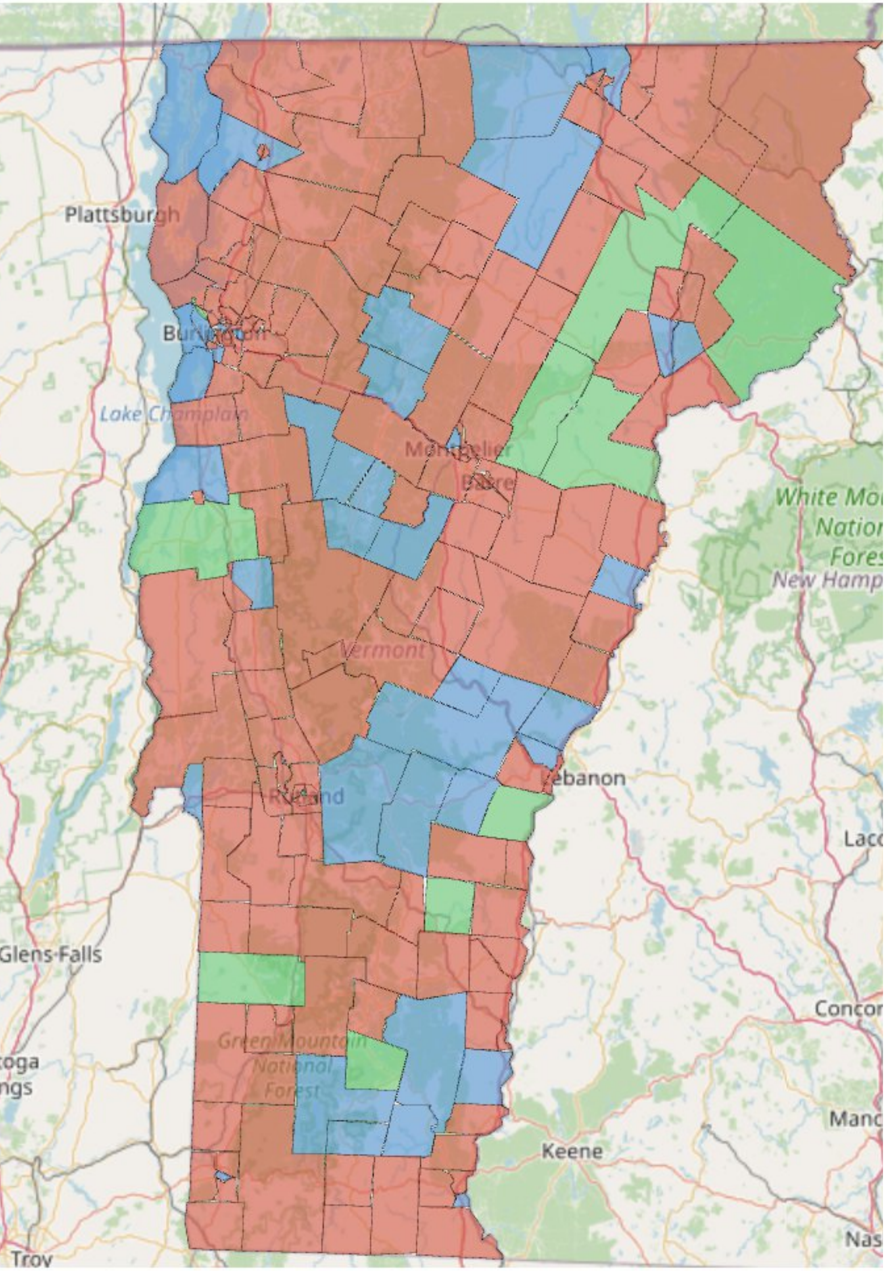
Overall Charging Gap

193

Charging Status by Tract - VT



GAP ANALYSIS OF VERMONT



MODEL PREDICTION ANALYSIS

- Overserved Tract has many underserved neighbor
- Overserved tracts gap and the gap of nearby underserved tracts are quite corelated.
- In real life charging station are not perfectly install on tract basis.
- We can merge multiple neighbor tract to get better result for specific area.

FUTURE WORK

- EV registration and adaptation data, Traffic data, and Highway data could be added for better result.
- Instead of generalizing some well-established state's data for model training we could collect some real suitable data through research or survey.
- Instead of limited within a tract level, we could find more useful area by combining multiple tracts.
- We can even build a system to determine location for new charging station based on the demand predicted by this model.

CONCLUSION

- Developed a model to predict total number of required charging ports on tract level based on demographics, business activity, and built environment data.
- Applied trained model to analyze the Charging Infrastructure gap for different state.
- The data-driven insight could be used for EV infrastructure planning and investment decisions.

Thank You

Any Questions?