

Cross-City Analysis of Pedestrian Demand Estimation Models: Insights from Sydney, and Melbourne

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Introduction

Background

- Pedestrian travel modeling and trip generation analysis are fundamental components of urban transportation planning.
- Sustainable transportation mode.
- Pedestrian travel modeling addresses unique characteristics and behaviors.
- They have not been well-researched.

Our Research

- Focuses on studying and predicting the movement of individuals on foot within urban areas.
- Pedestrian travel trip generation at the LGA level in Sydney, Melbourne.
- Built a transformable model.
- Making a suitable and transferable pedestrian model.



Previous Studies

- Transferability of the models.
- key differences in pedestrian demand dynamics across cities

Title	Author /Year	Finding	Limitations
Adding temporal information to direct-demand models: Hourly estimation of bicycle and pedestrian traffic in Blacksburg, VA	Lu et al, 2018	<ul style="list-style-type: none"> • Spatial and temporal walking and cycling traffic volume. • Stepwise linear regression 	<ol style="list-style-type: none"> 1. Small town data 2. generalized
A walk trip generation model for Portland, OR	Tian et al, 2017	<ul style="list-style-type: none"> • home-based walk trips in Portland, investigating the influence of built environment variables and sociodemographic factors. • Used two stage models: 1. Probability of home-based trips. 2. Predict the number of home-based trips • negative binomial regression model. 	<ol style="list-style-type: none"> 1. Specified in one city (Portland) 2. Data limitation 3. Does not consider pedestrian behavior. 4. How many of the variables are important
Representing pedestrian activity in travel demand models: Framework and application	Kelly Clifton, et al, 2016	<ol style="list-style-type: none"> 1. The cross-classification models predict the number of trips. 	<ol style="list-style-type: none"> 1. The model can not be transferred (generalized) 2. Data limitation 3. How many of the variables are important
Facility-Demand Models of Peak Period Pedestrian and Bicycle Traffic	Hankey et al, 2016	Step-wise linear regression model to predict the pedestrian and bicycle traffic volume.	<ol style="list-style-type: none"> 1. Generalized. 2. Lack of checking other methods.

1. Lu, T., Mondschein, A., Buehler, R. and Hankey, S., 2018. Adding temporal information to direct-demand models: Hourly estimation of bicycle and pedestrian traffic in Blacksburg, VA. *Transportation Research Part D: Transport and Environment*, 63, pp.244-260.
2. Tian, G. and Ewing, R., 2017. A walk trip generation model for Portland, OR. *Transportation Research Part D: Transport and Environment*, 52, pp.340-353.
3. Clifton, K.J., Singleton, P.A., Muhs, C.D. and Schneider, R.J., 2016. Representing pedestrian activity in travel demand models: Framework and application. *Journal of transport geography*, 52, pp.111-122.
4. Hankey, S. and Lindsey, G., 2016. Facility-demand models of peak period pedestrian and bicycle traffic: comparison of fully specified and reduced-form models. *Transportation research record*, 2586(1), pp.48-58.

Data

Census Household Travel Survey Data

Sydney (45 LGAs) (2016~2019)

Melbourne (32 LGAs)(2012~2020)

Brisbane (8 LGAs) (2019~2022)

Trips, weighted population, Vehicles, Household Income

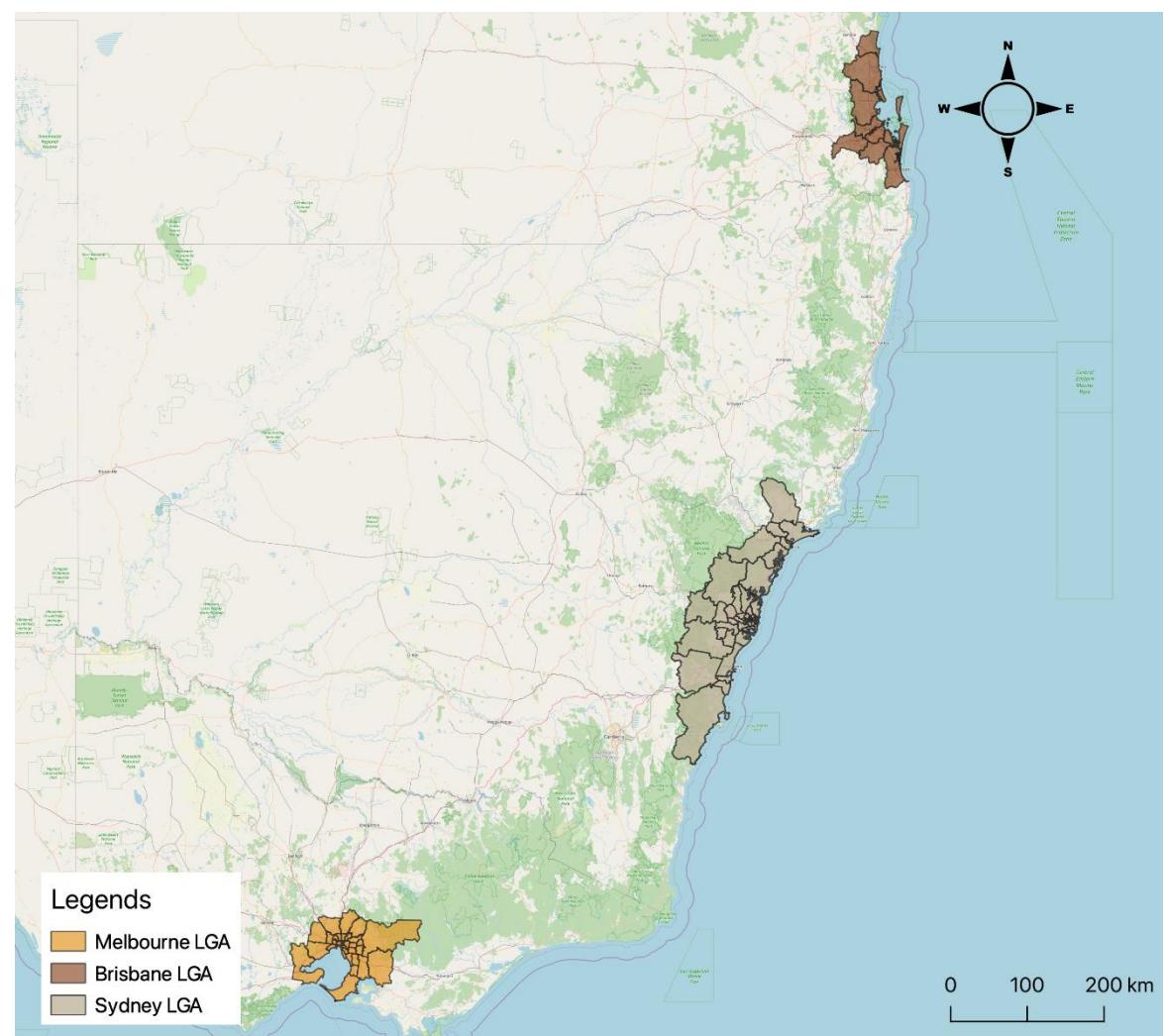
Land use

Industrial, Commercial, Hospital, Education, Residential,
Production, Parkland, Transportation, Water, Other

Point Of Interest(POI)

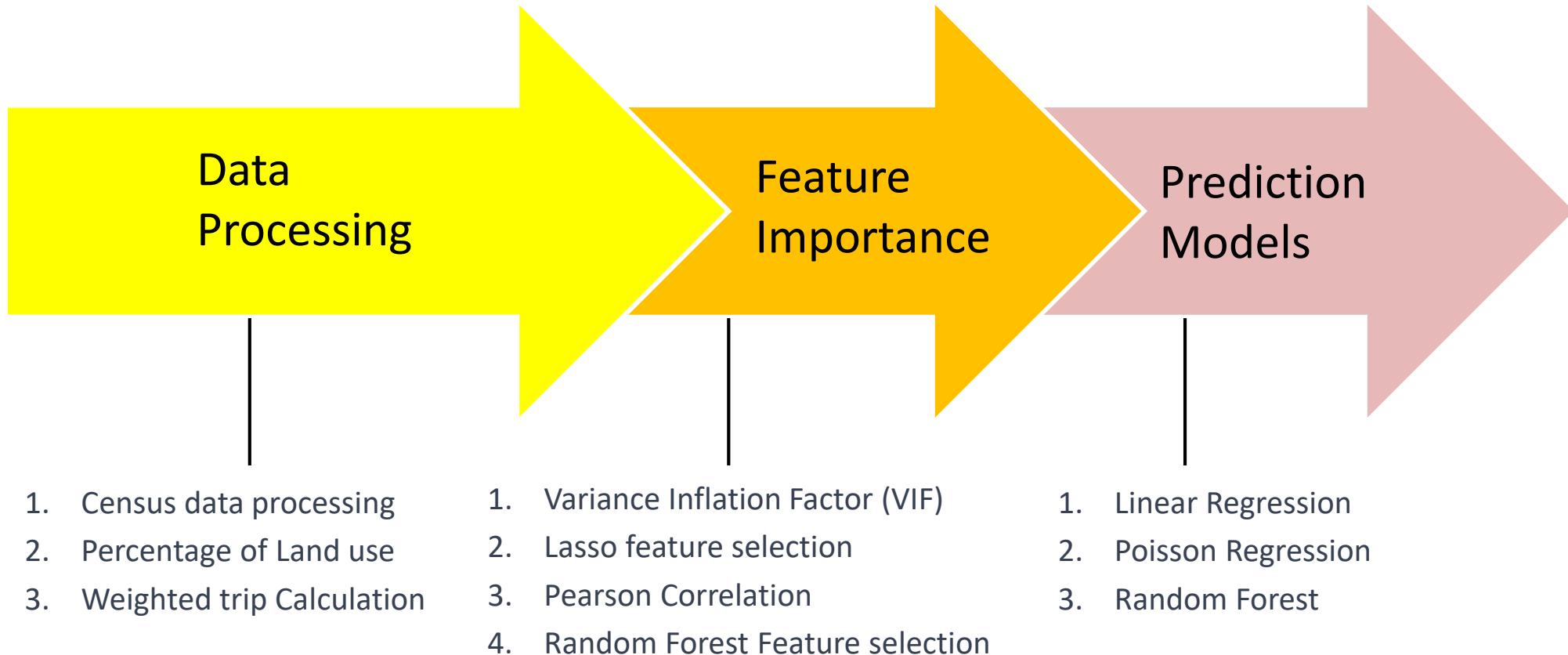
Point of Interest:

OSMNX



Methodology

Diagram



Results-Feature Importance

VIF

Sydney

Variable	VIF
%of industrail landuse	3.55
%of commercial landuse	4.26
POIs	5.71
Weighted Population	5.89
Weekly household income	39.90
%of hospital landuse	2.46
%of education landuse	9.18
%of other landuse	6.09
%of parkland landuse	23.99
%of primary production landuse	11.41
%of residential landuse	44.13
%of transport landuse	2.32
%of water landuse	1.59
Vehicle/Population	94.82

Melbourne

Variable	VIF
%of industrial landuse	5.35
%of commercial landuse	14.09
POIs	33.34
Weighted Population	21.76
Weekly household income	155.82
%of hospital landuse	14.85
%of education landuse	9.89
%of other landuse	10.88
%of parkland landuse	32.40
%of primary production landuse	43.28
%of residential landuse	262.53
%of transport landuse	1.97
%of water landuse	7.88
Vehicle/Population	278.30

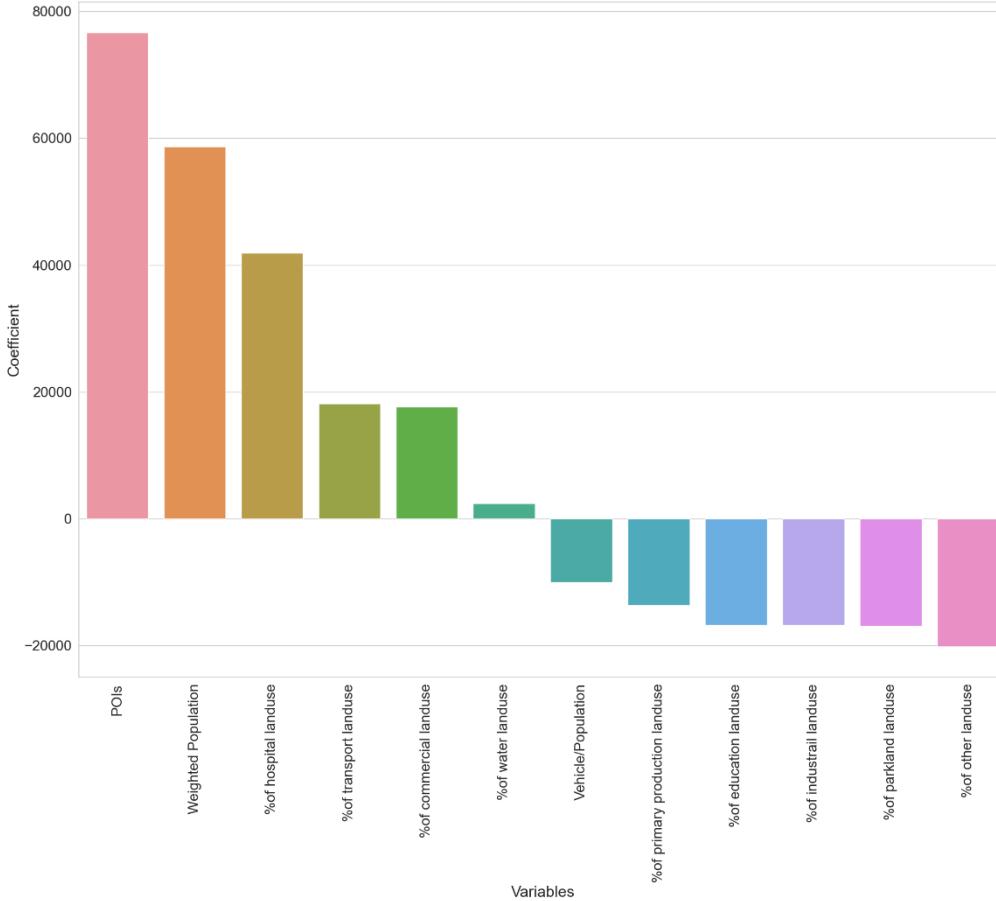
Brisbane

Variable	VIF
Weekly household income	inf
%of commercial landuse	inf
%of education landuse	inf
%of hospital landuse	inf
%of industrial landuse	inf
%of other landuse	inf
%of parkland landuse	inf
%of primary production landuse	inf
%of residential landuse	inf
%of transport landuse	inf
%of water landuse	inf
POIs	inf
Weighted Population	inf
Vehicle/Population	inf

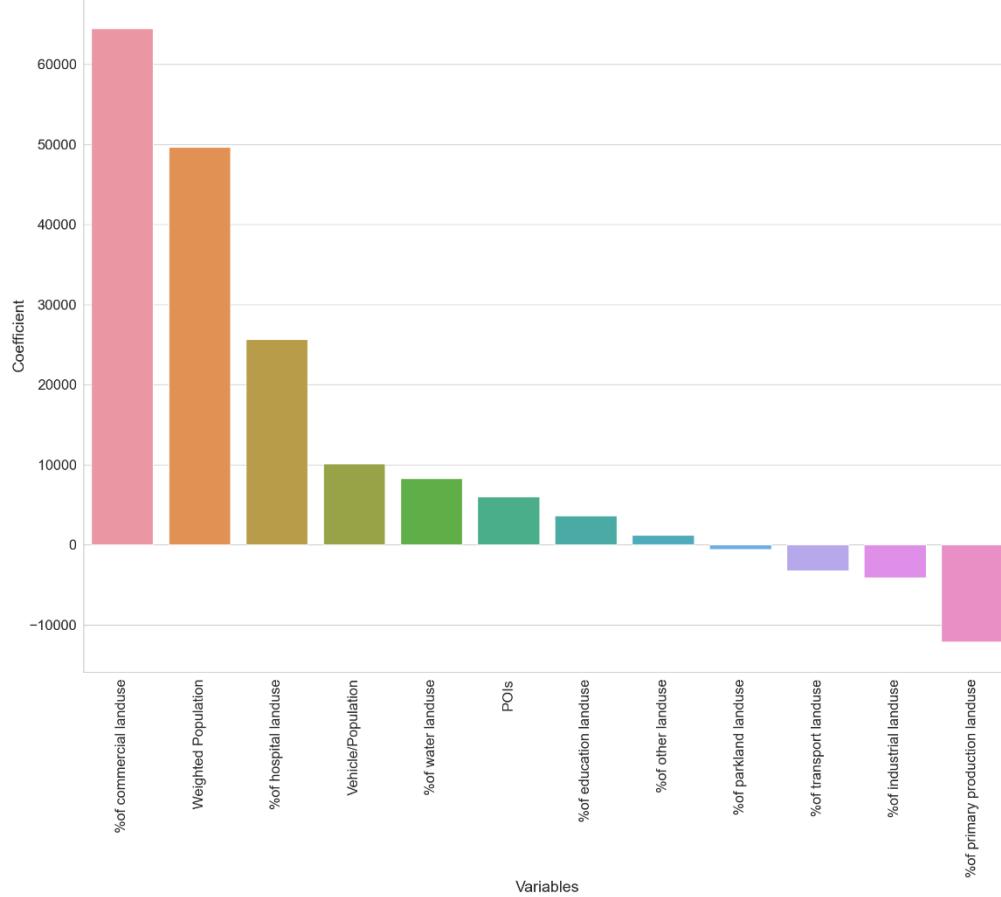
Results-Feature Importance

Lasso Regression

Sydney



Melbourne



Results-Feature Importance

Lasso Regression

Sydney

Variable	Coefficient
POIs	76598.580269
Weighted Population	58638.824649
%of hospital landuse	41872.705570
%of transport landuse	18177.943914
%of commercial landuse	17676.321337
%of water landuse	2428.266375
Vehicle/Population	-10000.129913
%of primary production landuse	-13658.135366
%of education landuse	-16771.507135
%of industrail landuse	-16788.531646
%of parkland landuse	-16878.342339
%of other landuse	-20111.482582

Melbourne

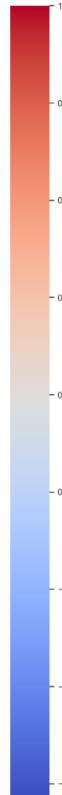
Variable	Coefficient
%of commercial landuse	64454.999642
Weighted Population	49655.573918
%of hospital landuse	25676.121602
Vehicle/Population	10098.003292
%of water landuse	8290.833335
POIs	5997.492306
%of education landuse	3631.418152
%of other landuse	1262.873552
%of parkland landuse	-531.079730
%of transport landuse	-3193.478010
%of industrial landuse	-4105.760064
%of primary production landuse	-12086.982912

Results-Feature Importance

Pearson Correlation

Sydney

	Weighted trips	%of commercial landuse	%of education landuse	%of hospital landuse	%of industrial landuse	%of other landuse	%of parkland landuse	%of primary production landuse	%of transport landuse	%of water landuse	POIs	Weighted Population	Vehicle/Population
Weighted trips	1.00	0.68	0.47	0.48	0.37	-0.34	-0.15	-0.43	0.14	-0.15	0.77	0.62	-0.59
%of commercial landuse	0.68	1.00	0.50	0.29	0.32	-0.38	-0.35	0.31	0.25	-0.13	0.64	0.21	-0.56
%of education landuse	0.47	0.50	1.00	0.59	0.31	-0.59	-0.46	-0.50	0.33	-0.36	0.27	0.04	-0.63
%of hospital landuse	0.48	0.29	0.59	1.00	0.19	-0.36	-0.27	-0.36	0.05	-0.18	0.17	0.10	-0.37
%of industrial landuse	0.37	0.32	0.31	0.19	1.00	-0.32	-0.24	-0.29	0.56	-0.12	0.21	0.36	-0.47
%of other landuse	-0.34	-0.38	-0.59	-0.36	-0.32	1.00	0.22	0.21	0.30	0.34	-0.14	-0.00	0.41
%of parkland landuse	-0.15	-0.35	-0.46	-0.27	-0.24	0.22	1.00	-0.16	-0.33	0.15	0.10	0.06	0.35
%of primary production landuse	-0.43	-0.31	-0.50	-0.36	-0.29	0.21	-0.16	1.00	-0.23	0.22	-0.26	-0.25	0.64
%of transport landuse	0.14	0.25	0.33	0.05	0.56	-0.30	-0.33	-0.23	1.00	-0.17	-0.02	-0.09	-0.42
%of water landuse	-0.15	-0.13	-0.36	-0.18	-0.12	0.34	0.15	0.22	-0.17	1.00	-0.10	0.03	0.27
POIs	0.77	0.64	0.27	0.17	0.21	-0.14	0.10	-0.26	-0.02	-0.10	1.00	0.43	-0.36
Weighted Population	0.62	0.21	0.04	0.10	0.36	-0.00	0.06	-0.25	-0.09	0.03	0.43	1.00	-0.31
Vehicle/Population	-0.59	-0.56	-0.63	-0.37	-0.47	0.41	0.35	0.64	-0.42	0.27	-0.36	-0.31	1.00



Melbourne

	Weighted trips	Weekly household income	%of commercial landuse	%of education landuse	%of hospital landuse	%of industrial landuse	%of other landuse	%of parkland landuse	%of primary production landuse	%of residential landuse	%of transport landuse	%of water landuse	POIs	Weighted Population	Vehicle/Population
Weighted trips	1.00	-0.24	0.85	0.27	0.84	0.13	-0.30	-0.01	-0.20	-0.01	0.10	0.48	0.88	0.43	-0.54
Weekly household income	-0.24	1.00	-0.10	0.11	0.01	-0.41	0.08	0.06	-0.32	0.38	0.07	-0.20	-0.18	-0.38	-0.06
%of commercial landuse	0.85	-0.10	1.00	0.31	0.89	0.27	-0.25	0.00	0.31	0.02	0.24	0.49	0.84	-0.03	-0.69
%of education landuse	0.27	0.11	0.31	1.00	0.28	0.12	-0.47	-0.16	-0.65	0.65	0.31	-0.22	0.28	-0.04	-0.51
%of hospital landuse	0.84	0.01	0.89	0.28	1.00	0.12	-0.25	0.03	-0.34	0.07	0.18	0.52	0.86	-0.02	-0.60
%of industrial landuse	0.13	-0.41	0.27	0.12	0.12	1.00	-0.17	0.05	-0.29	-0.09	0.14	0.26	0.10	-0.11	-0.30
%of other landuse	-0.30	0.08	-0.25	0.47	-0.25	0.17	1.00	-0.12	0.32	-0.47	-0.24	0.12	-0.26	-0.20	0.38
%of parkland landuse	-0.01	0.06	0.00	-0.16	0.03	0.05	-0.12	1.00	-0.12	-0.26	-0.06	0.16	0.11	-0.11	0.16
%of primary production landuse	-0.20	-0.32	-0.31	-0.65	-0.34	-0.29	0.32	-0.12	1.00	-0.77	-0.31	0.25	-0.12	0.29	0.39
%of residential landuse	-0.01	0.38	-0.02	0.65	0.07	-0.09	-0.47	-0.26	-0.77	1.00	0.20	-0.58	-0.14	-0.09	-0.24
%of transport landuse	0.10	0.07	0.24	0.31	0.18	0.14	-0.24	-0.06	-0.31	0.20	1.00	-0.01	0.20	-0.15	-0.35
%of water landuse	0.48	-0.20	0.49	-0.22	0.52	0.26	0.12	0.16	0.25	-0.58	-0.01	1.00	0.65	0.01	-0.10
POIs	0.88	-0.18	0.84	0.28	0.86	0.10	-0.26	0.11	-0.12	-0.14	0.20	0.65	1.00	0.21	-0.51
Weighted Population	0.43	-0.38	-0.03	-0.04	-0.02	-0.11	0.29	-0.09	-0.15	0.01	0.21	1.00	-0.01	-0.01	
Vehicle/Population	-0.54	-0.06	-0.69	-0.51	-0.60	-0.30	0.38	0.16	0.39	-0.24	-0.35	-0.10	-0.51	-0.01	1.00



Results-Feature Importance

Pearson Correlation: >0.55

Sydney

Variable	Corr
POIs	0.77
% of Commercial Land use	0.68
Weighted Population	0.63
Vehicle/Population	-0.60

Melbourne

Variable	Corr
POIs	0.88
% of Commercial Land use	0.85
% of Hospital Land use	0.84
Vehicle/ population	-0.55

Results-Feature Importance

Random Forest

Sydney

Variable	Feature Importance
POIs	0.306
Weighted Population	0.213
Vehicle/Population	0.189
%of commercial landuse	0.093
%of hospital landuse	0.054
%of education landuse	0.052
%of industrail landuse	0.028
%of primary production landuse	0.019
%of parkland landuse	0.017
%of transport landuse	0.013
%of water landuse	0.007
%of other landuse	0.007

Melbourne

Variable	Feature Importance
Weighted Population	0.283
Vehicle/Population	0.159
%of hospital landuse	0.158
POIs	0.141
%of commercial landuse	0.118
%of water landuse	0.089
%of industrial landuse	0.011
%of other landuse	0.008
%of transport landuse	0.007
%of parkland landuse	0.007
%of residential landuse	0.006
Weekly household income	0.006
%of education landuse	0.005
%of primary production landuse	0.002

Results-Selected Variables

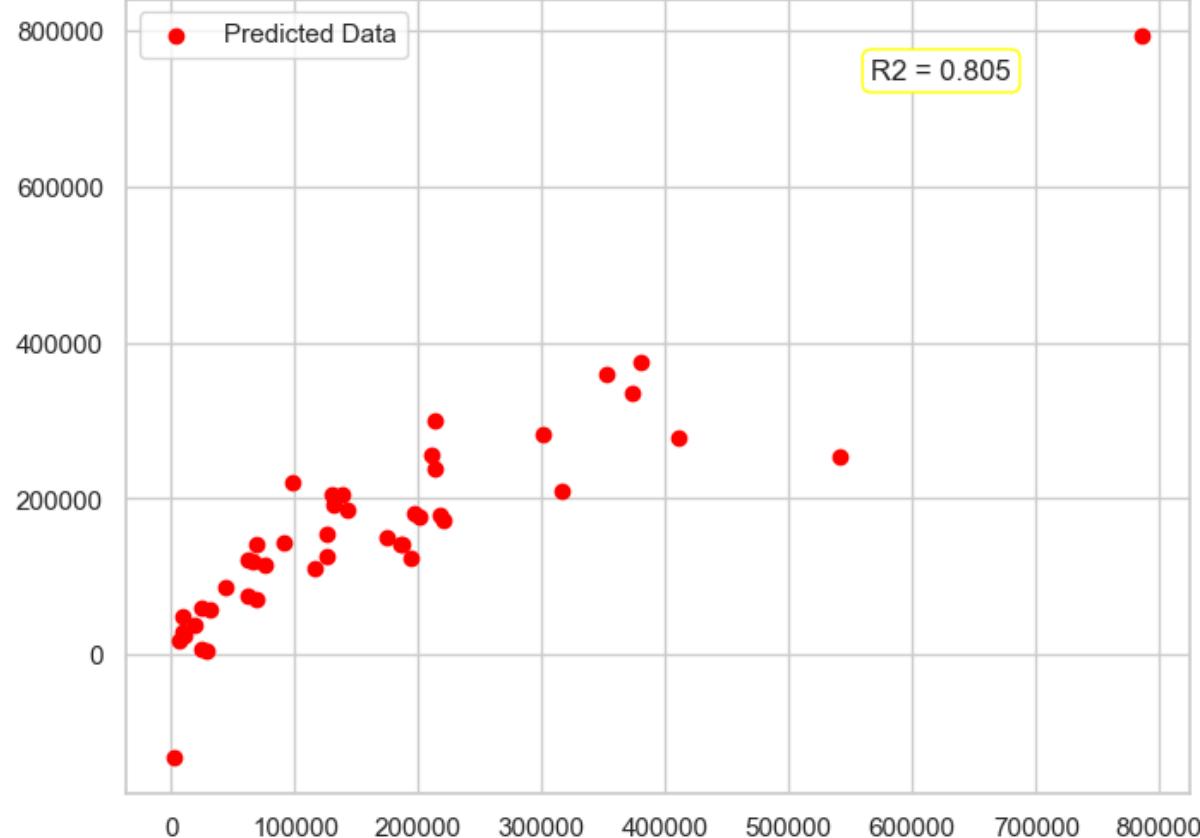
Target Variable
Dependent Variables
Weighted trips in each LGA
POIs
Weighted Population
Vehicle/Population
% of Commercial Land use
% of Hospital/Medical Land use
% of Industrial Land use
% of Primary Production Land use
% of Park Land use

Results-Regression Models

Linear Regression

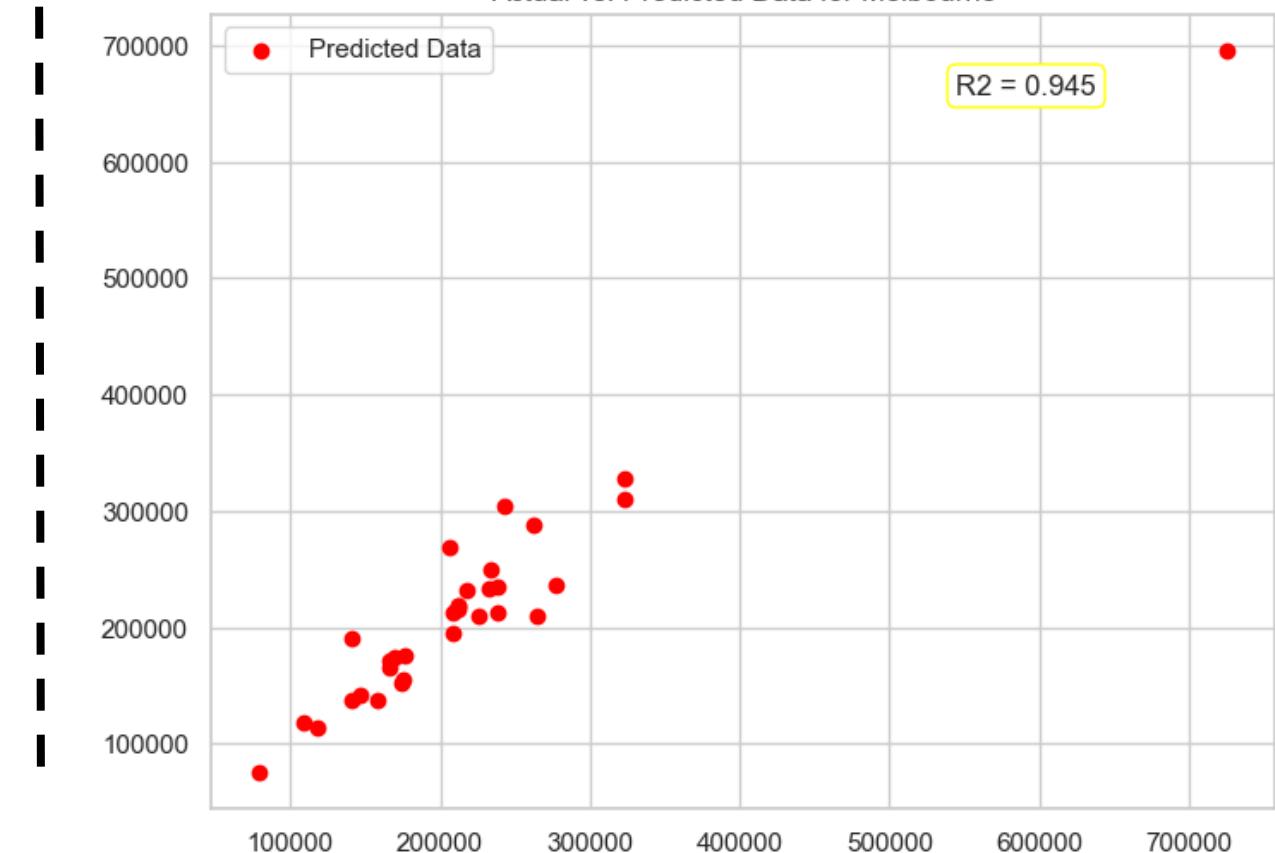
Sydney

Actual vs. Predicted Data for Sydney



Melbourne

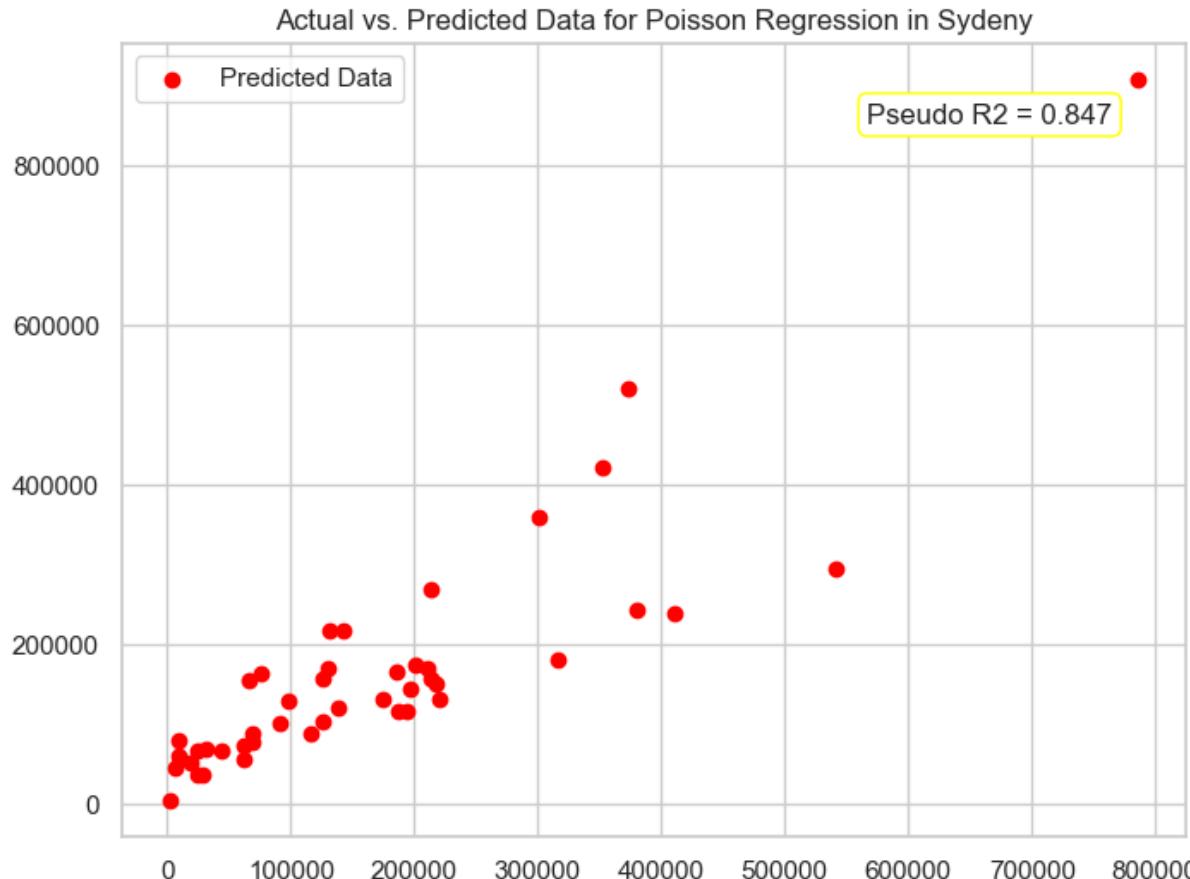
Actual vs. Predicted Data for Melbourne



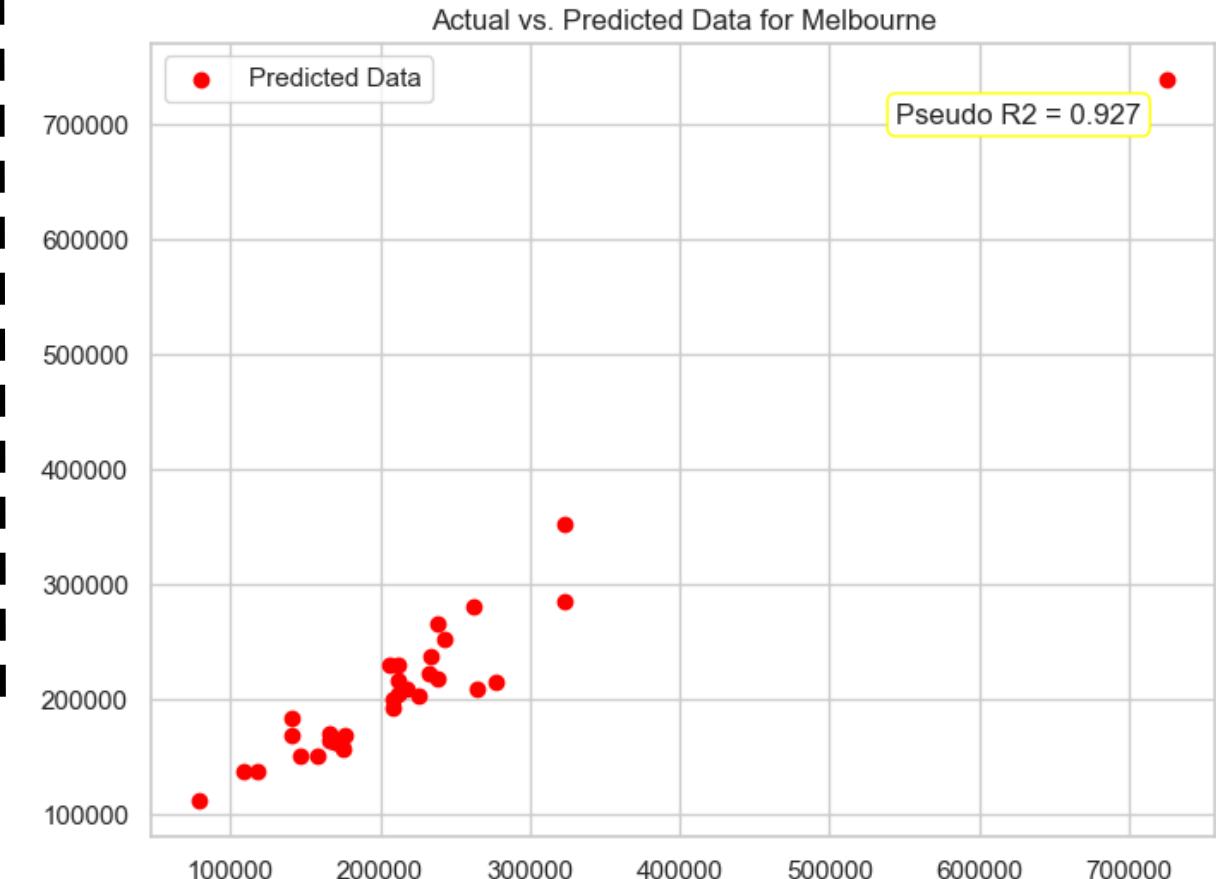
Results-Regression Models

Poisson Regression

Sydney



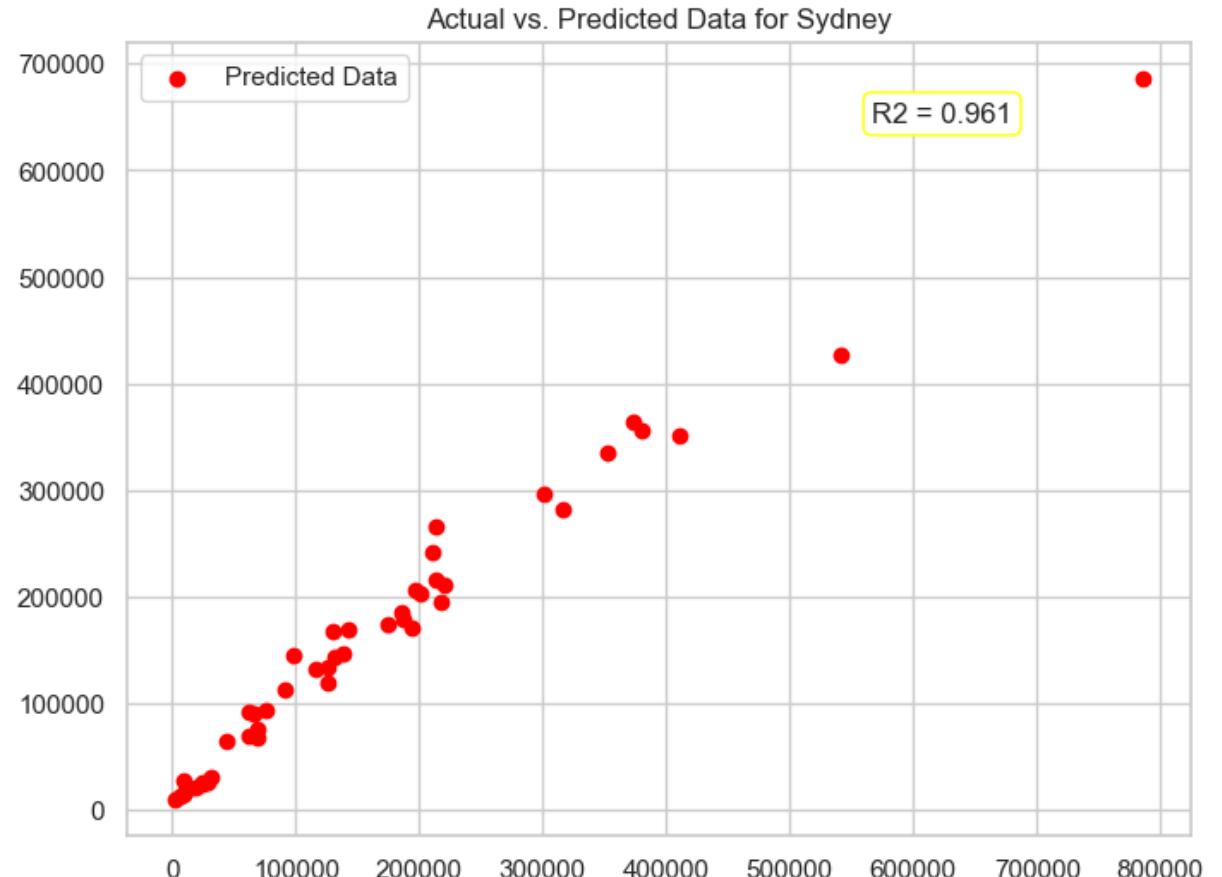
Melbourne



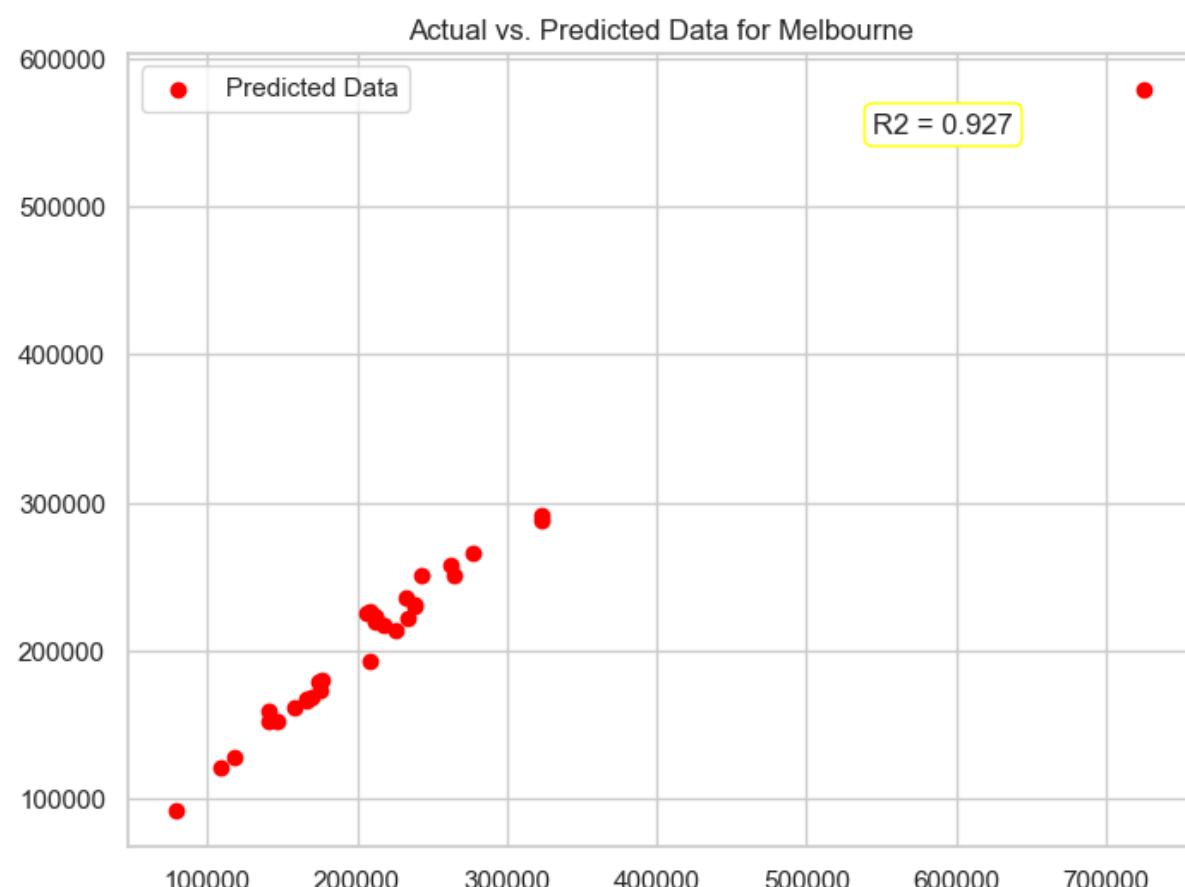
Results-Machine Learning Models

Random Forest Regression

Sydney



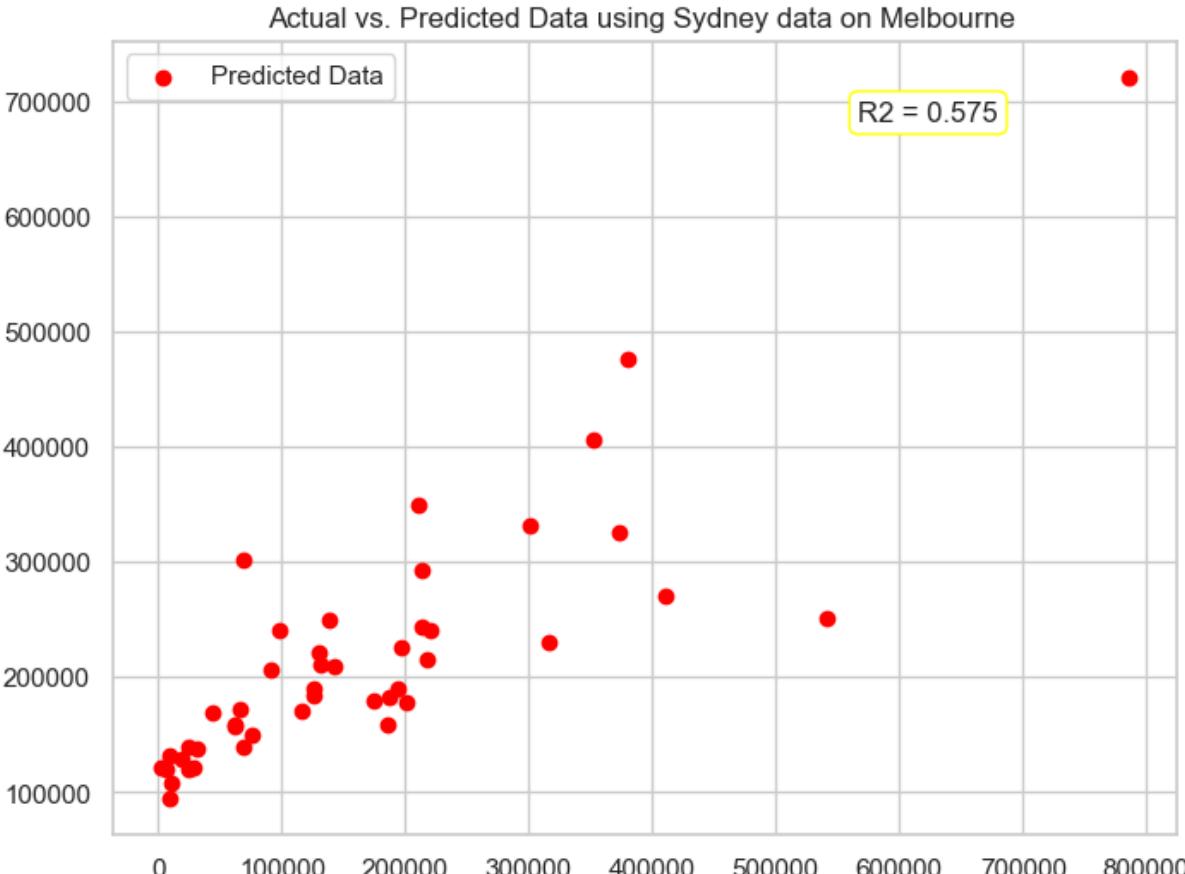
Melbourne



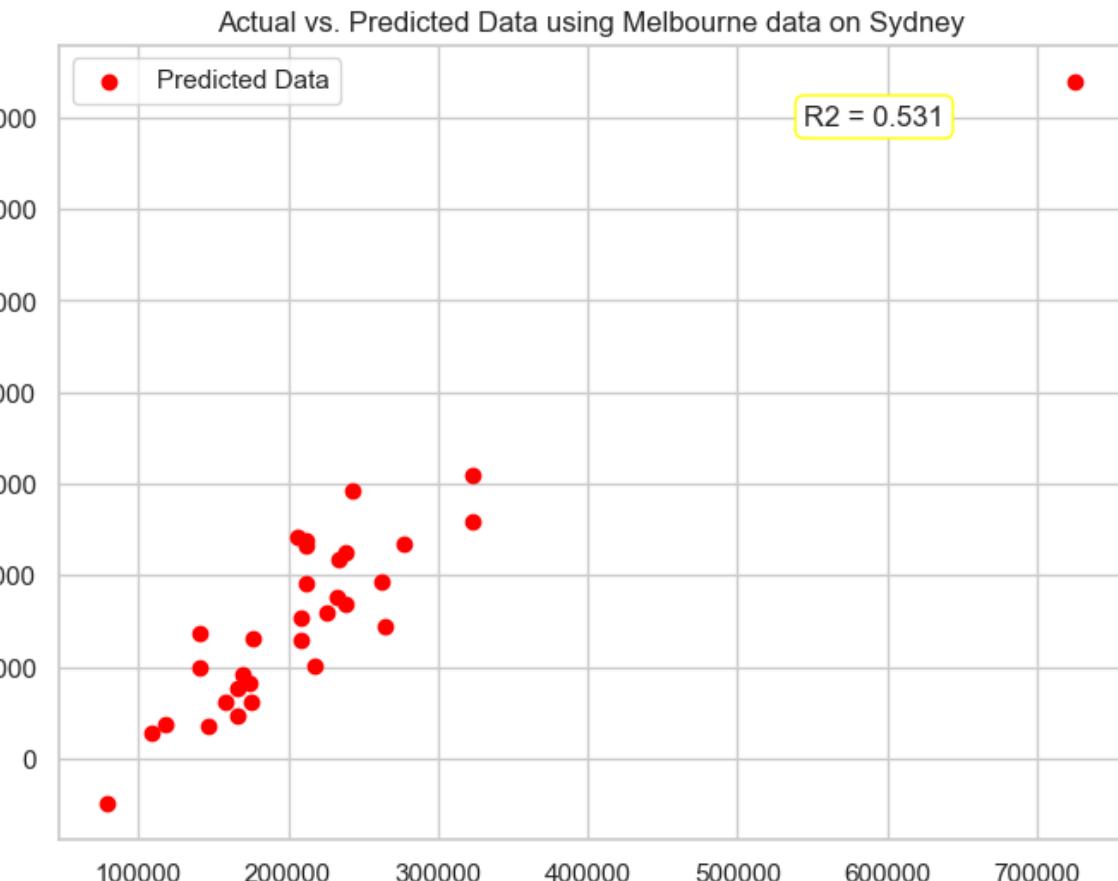
Results-Transferability-Regression Models

Linear Regression

Sydney in Melbourne model



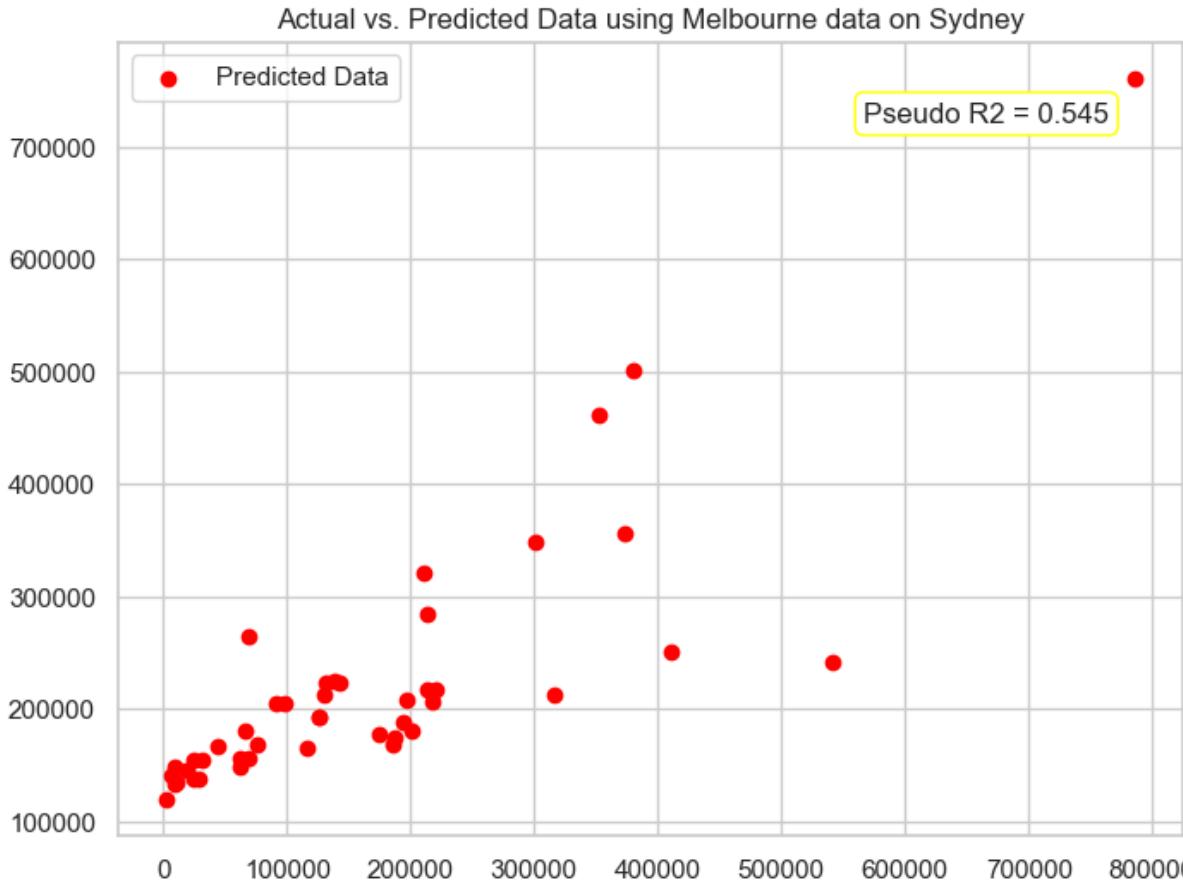
Melbourne in Sydney model



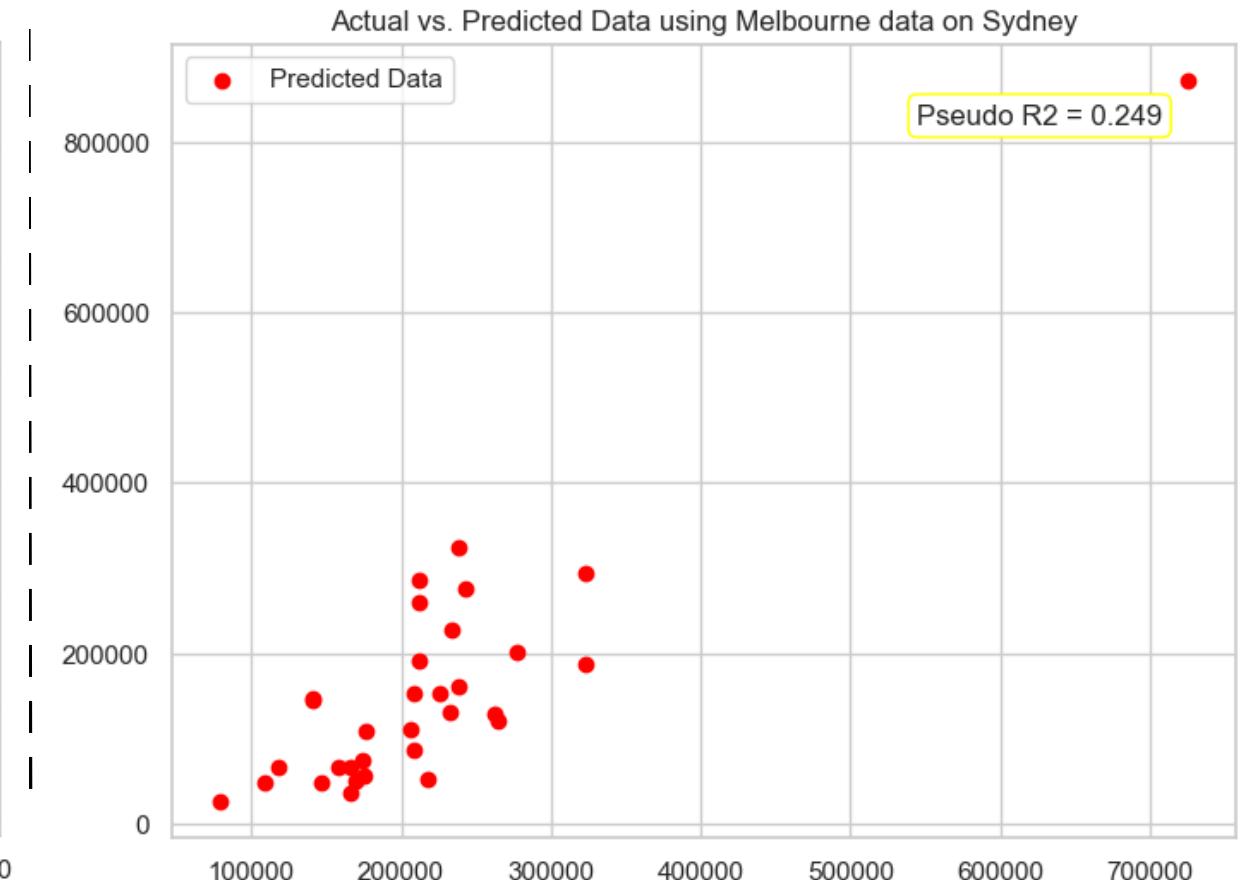
Results-Transferability-Regression Models

Poisson Regression

Sydney in Melbourne model



Melbourne in Sydney model



Conclusion

- POI, Commercial, and Population variables showed the most effect in the walking data.
- The models show high performance for both statistics and ML models.
- The model transferability can be seen for the Linear Regression and Poisson Regression model in the top 4 most important variables.

Future Work

- Add different variables to train the model.
- Check the transferability for Brisbane data.
- Check the transferability for other models.

Thank You!

Any Question?



UNSW
SYDNEY

Civil and Environmental
Engineering