Revving Up the Competition: Speed Prediction in a Car-Following Model

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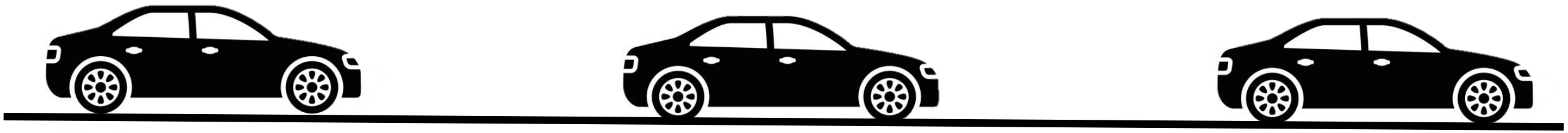
AGENDA

- Introduction
- Terminologies
- Project Motivation
- Project Objectives
- Data Description
- Machine Learning Models
- Data Preparation
- Results
- Conclusion

INTRODUCTION

- Car-following model is the study of the interaction between front and rear vehicles in a single lane
  - It focuses on how drivers adjust their speed and position relative to the vehicle in front of them while driving in the same lane.
  - It helps traffic engineers design better traffic control strategies, such as optimizing traffic signal timings, implementing speed limits, and improving lane management.

TERMINOLOGIES IN A CAR-FOLLOWING MODEL

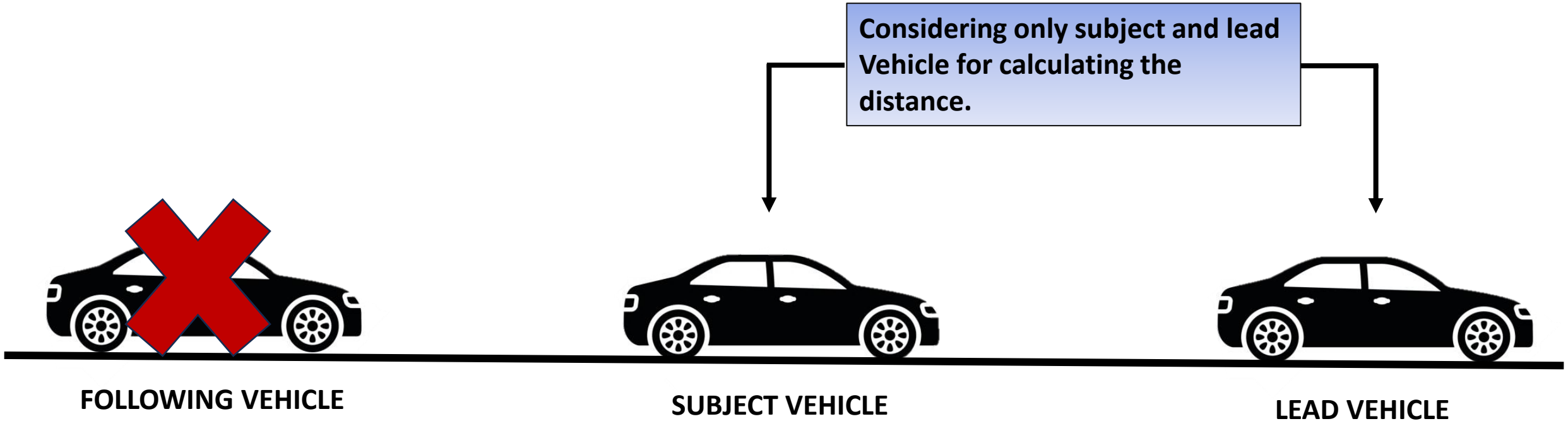


FOLLOWING VEHICLE

SUBJECT VEHICLE

LEAD VEHICLE

TERMINOLOGIES IN A CAR-FOLLOWING MODEL



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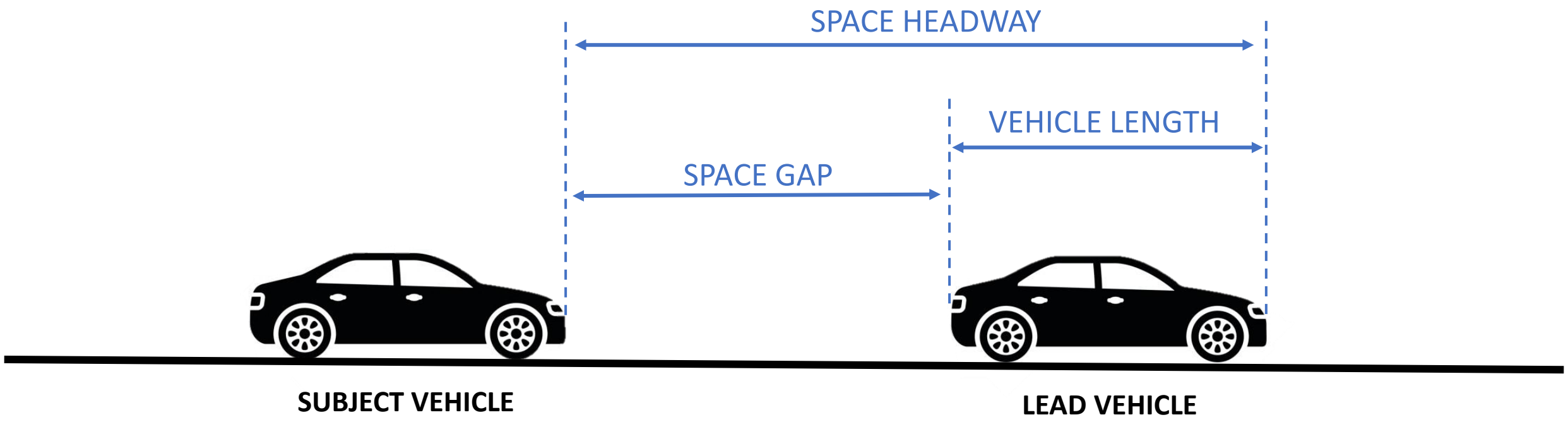

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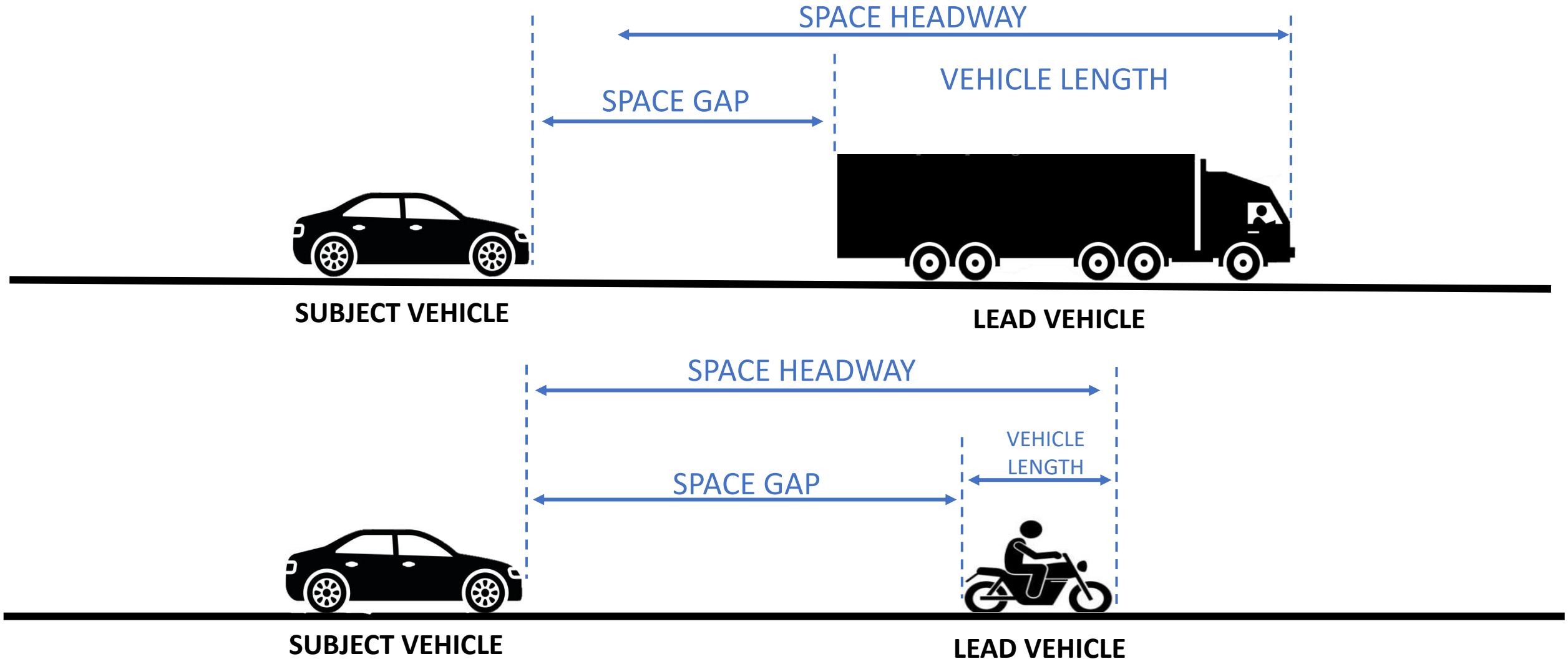
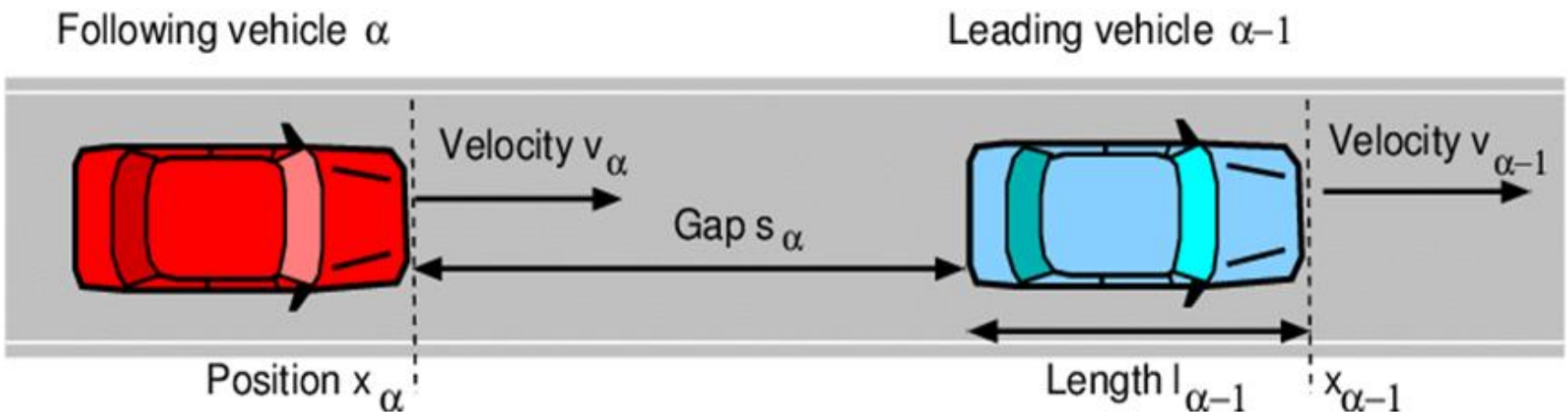


PROJECT MOTIVATION

- Improve traffic flow patterns and improve safety on roads and highways
- Reduce congestion in cities

PROJECT OBJECTIVES

- Leverage the principles of motion to forecast the speed and intervehicle distance in the next time frame
- Perform comparative analysis of the predictions generated by the three machine learning models



DATA DESCRIPTION

18

COLUMNS

1M

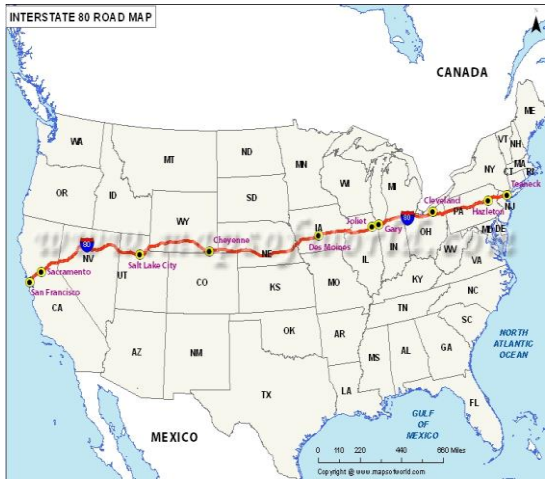
ROWS

3

DIFFERENT TIME ZONE

1

LOCATION
I80



Transportation.gov
U.S. Department of Transportation

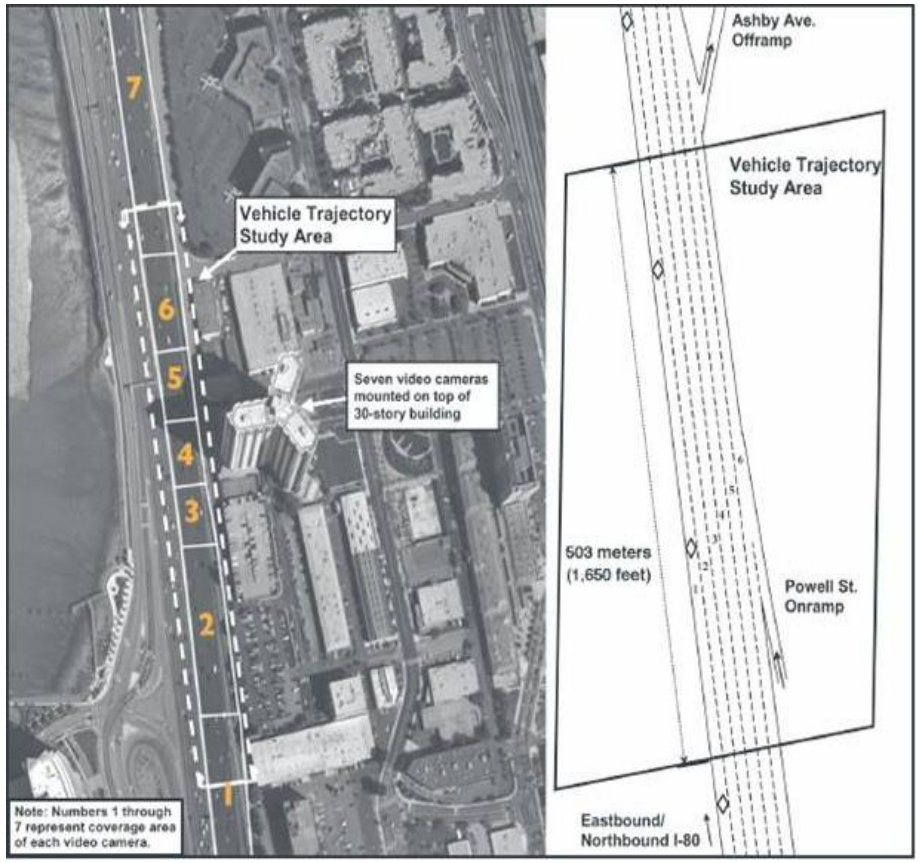
Next Generation Simulation (NGSIM) Open Data https://datahub.transportation.gov/stories/s/Next-Generation-Simulation-NGSIM-Open-Data/i5zb-xe34/

DATA DESCRIPTION

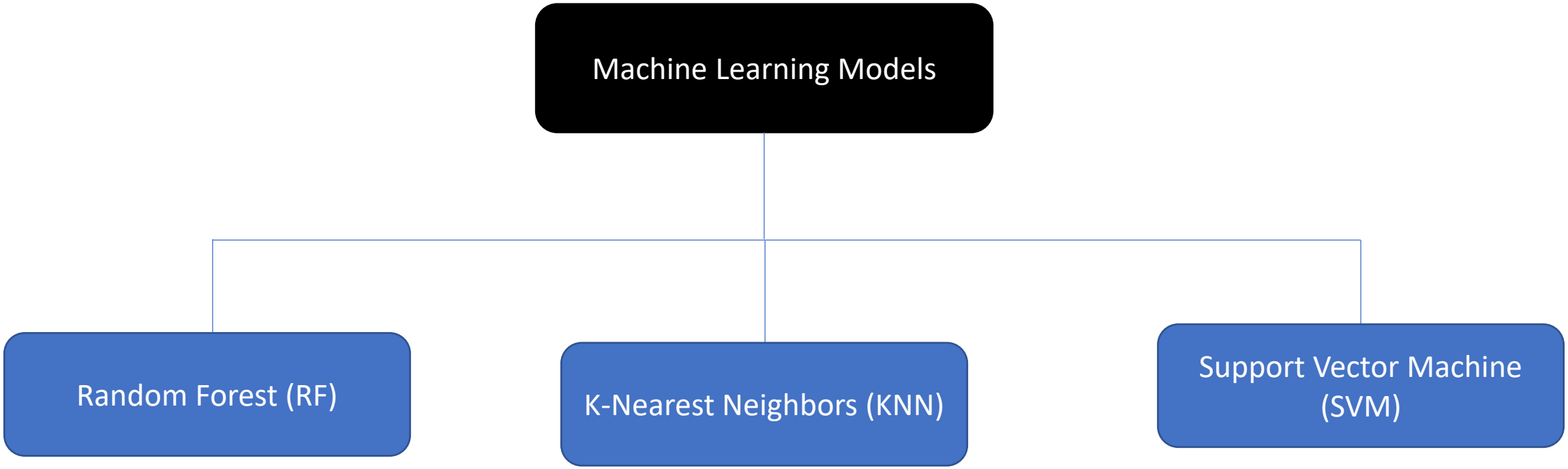
Interstate-80

45 Min Data

using **7** Cameras



MACHINE LEARNING MODELS



- Regression and classification

EQUATIONS OF MOTION

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$s = \frac{1}{2}(u + v)t$$

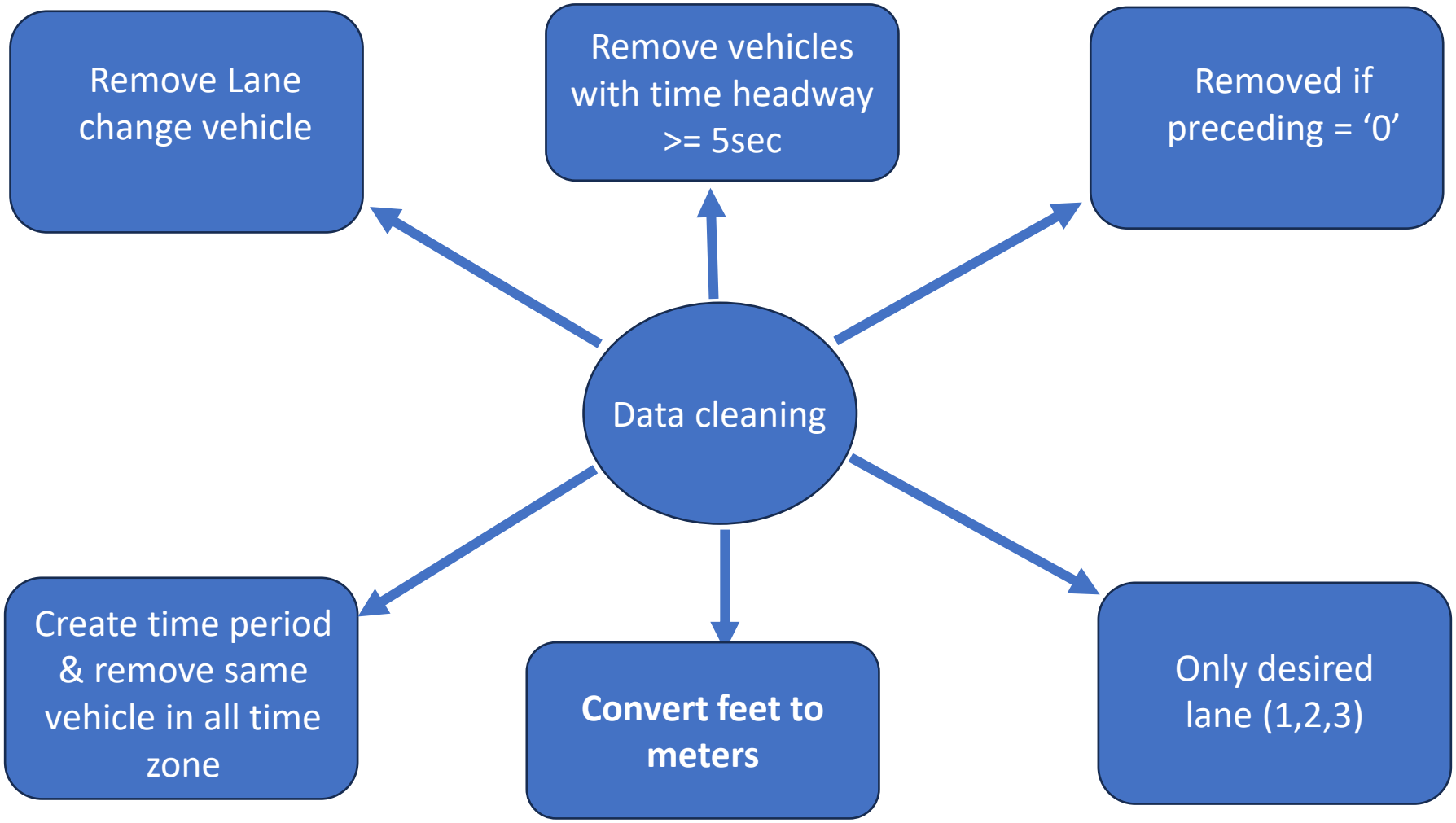
Where v = final speed

u = initial speed

a= acceleration

t = time at any moment during motion

DATA PREPARATION



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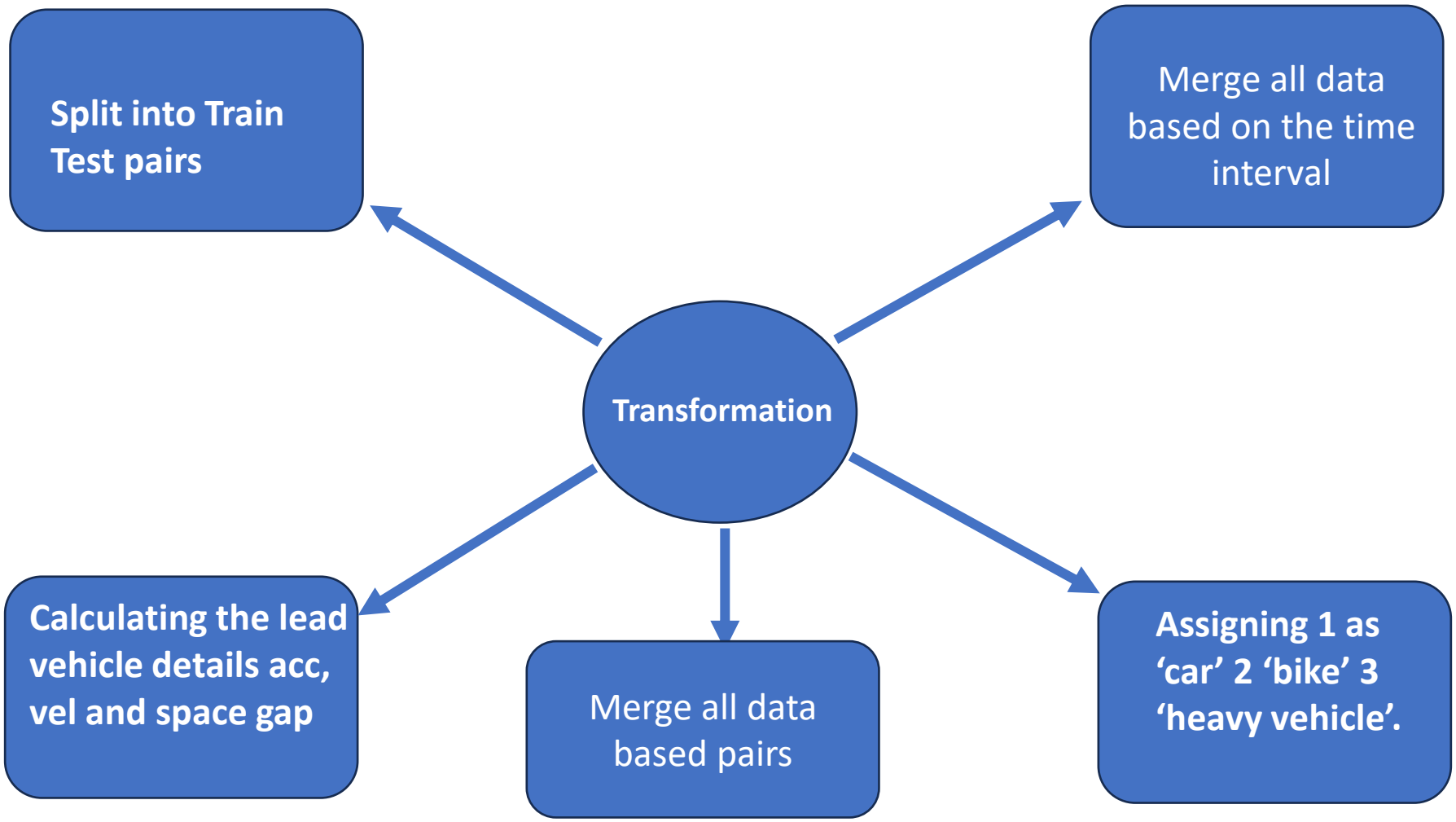
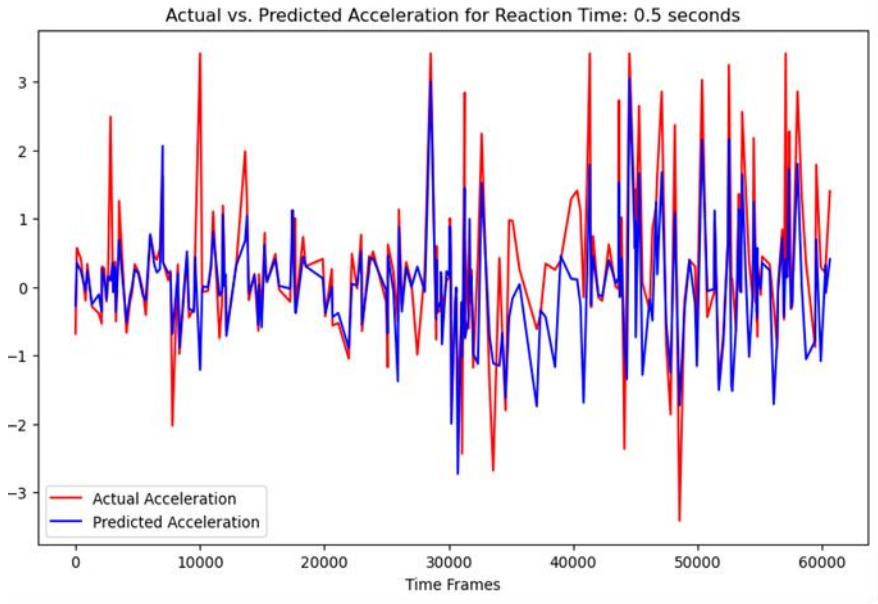
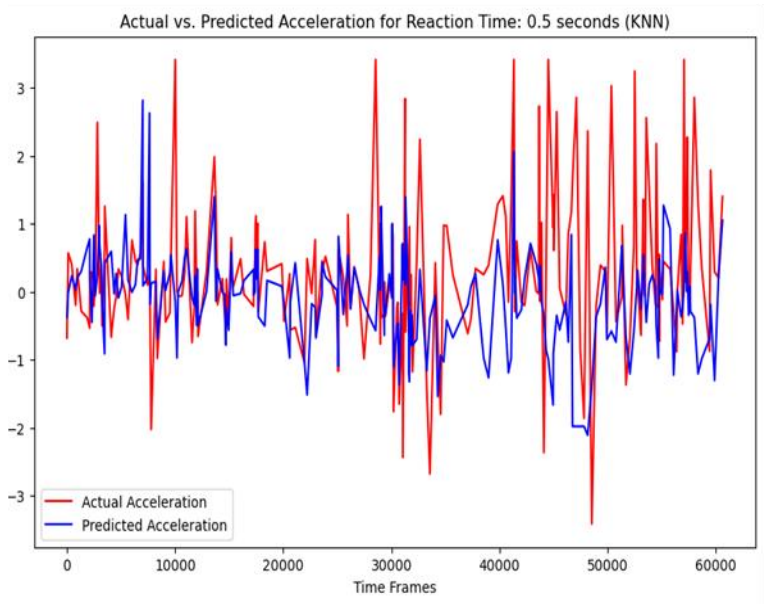


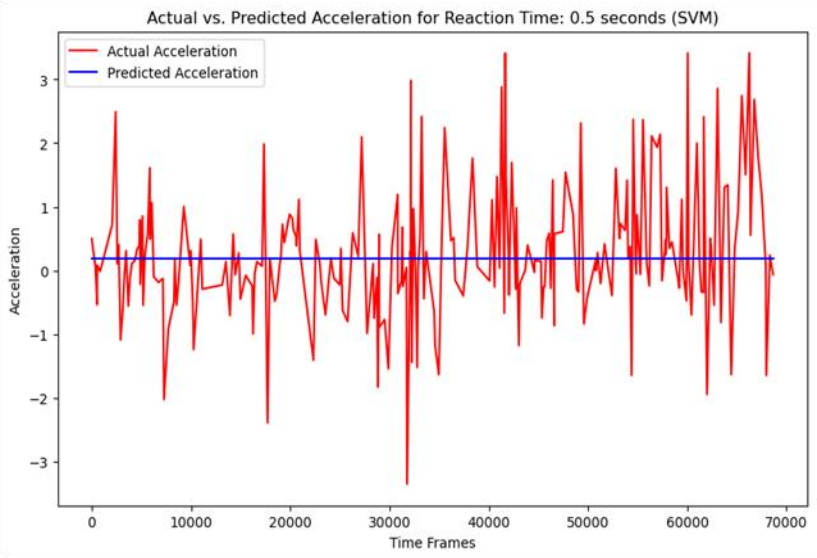
COMPARISON BETWEEN MODELS

MODEL NAME	KNN	RF	SVM
Time to fit	35 s	180s	2hr
Split of data(train/test)	80/20	80/20	80/20
Loading the model	0.2 s	5 s	15s
Train/Test pairs	1024/257	1024/257	1024/257
Time taken(pairs reaction)	9 min	25 min	65 min
Test set completion	58 min	225 min	900 min

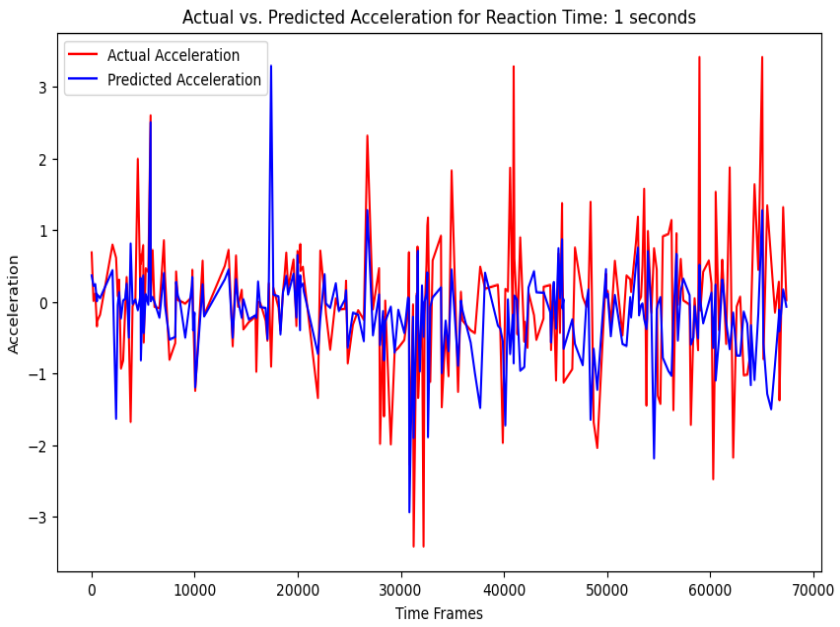
ACCELERATION RESULTS – Reaction time (0.5s)

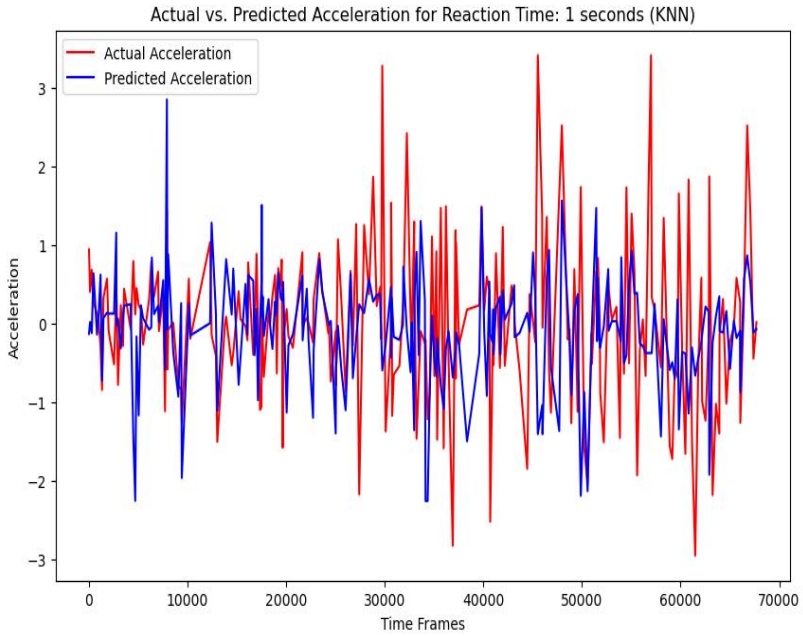


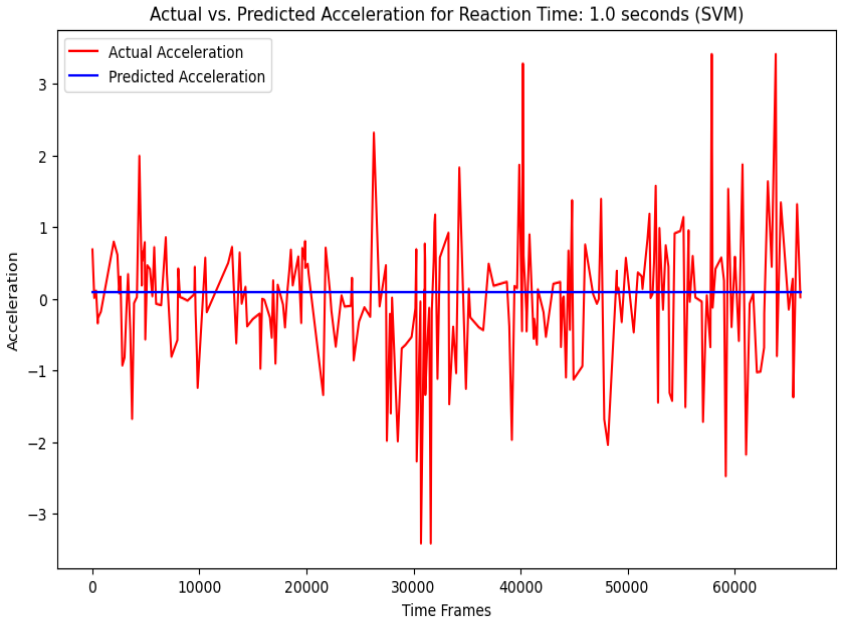




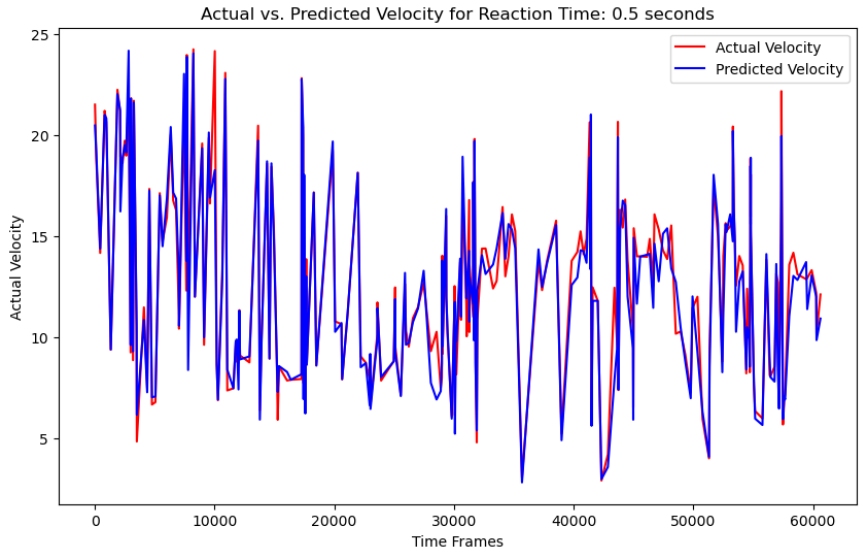
ACCELERATION RESULTS – Reaction time (1s)

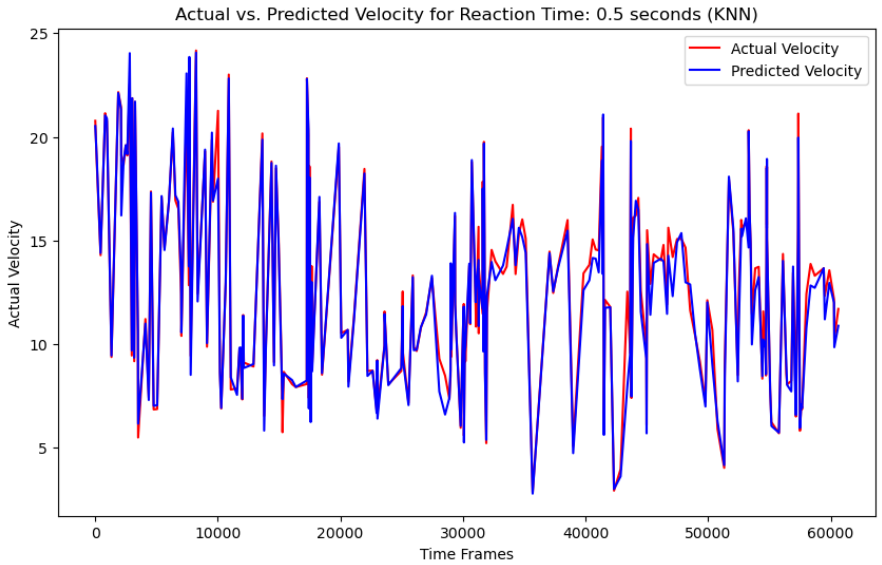


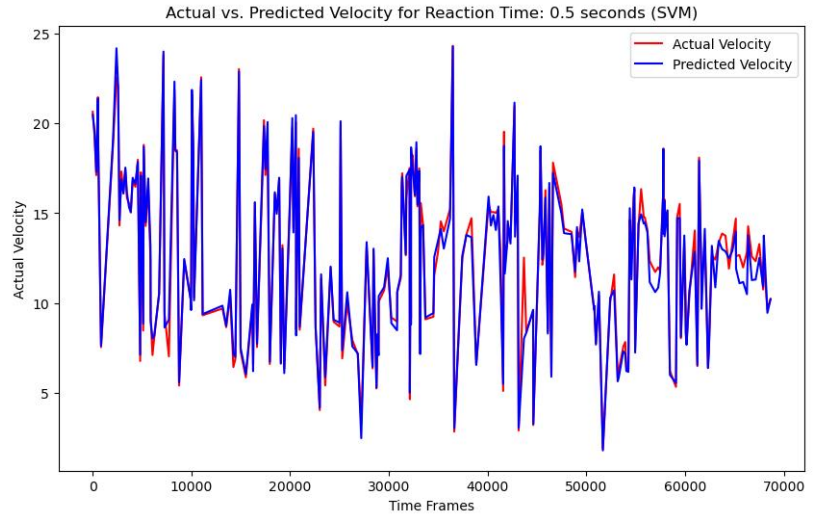




SPEED RESULTS – Reaction time (0.5s)







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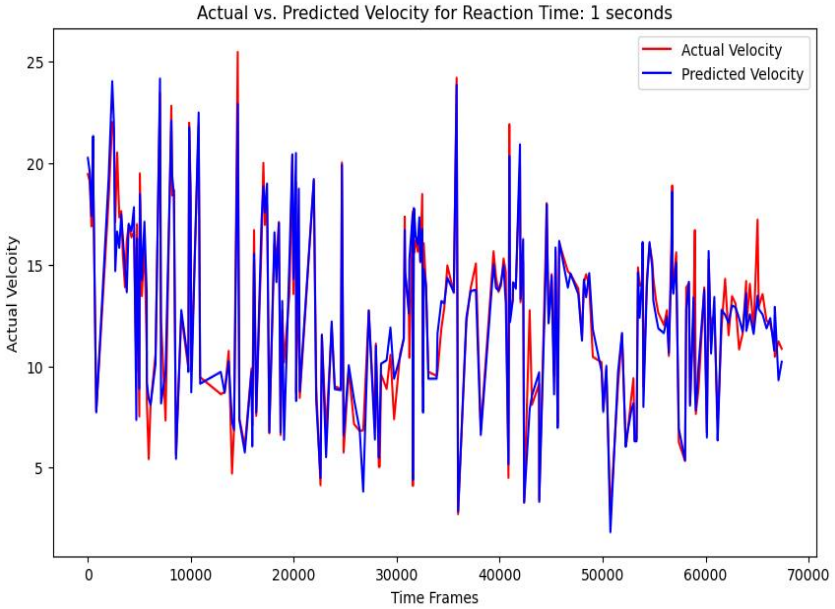
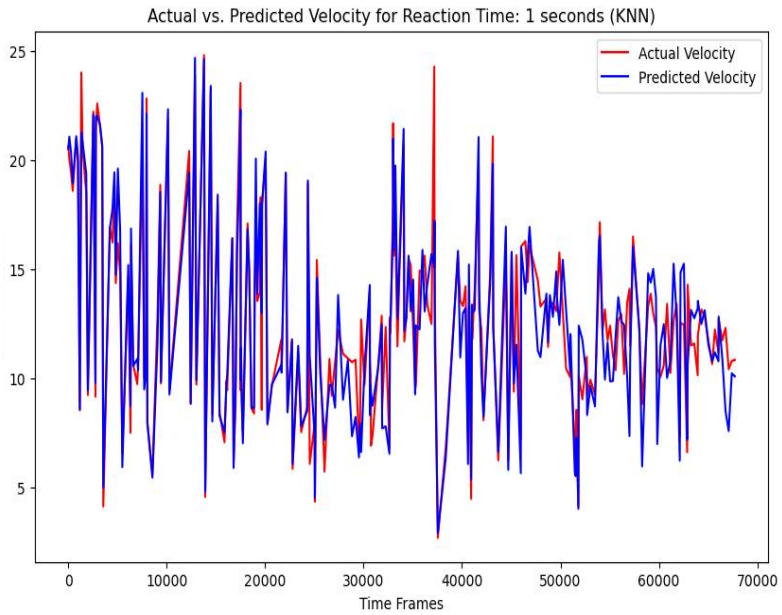
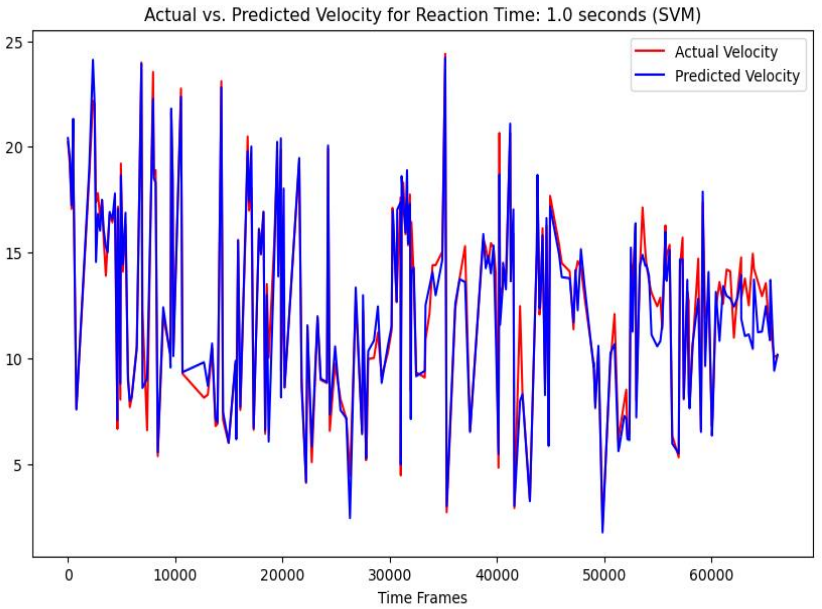
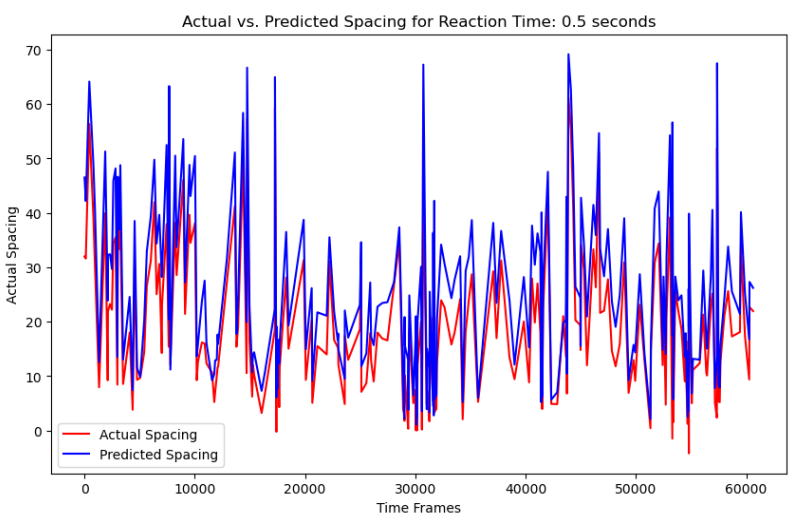
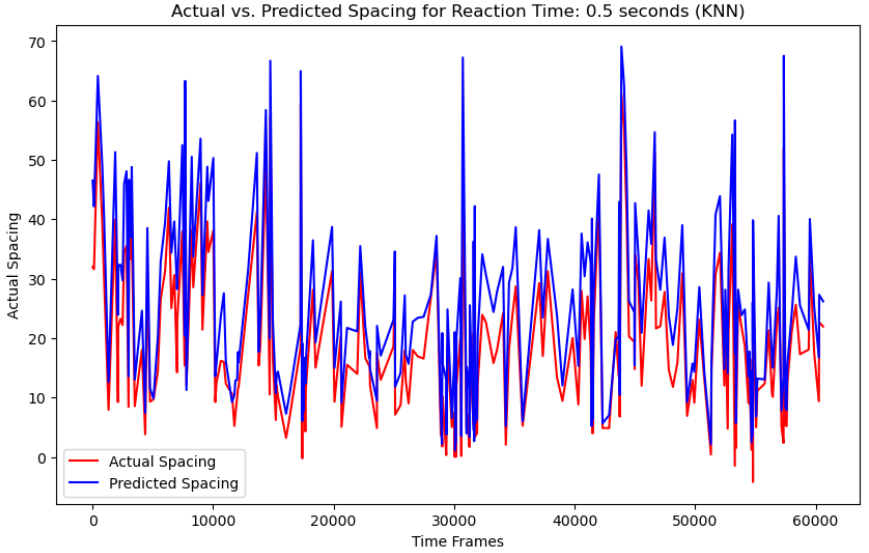


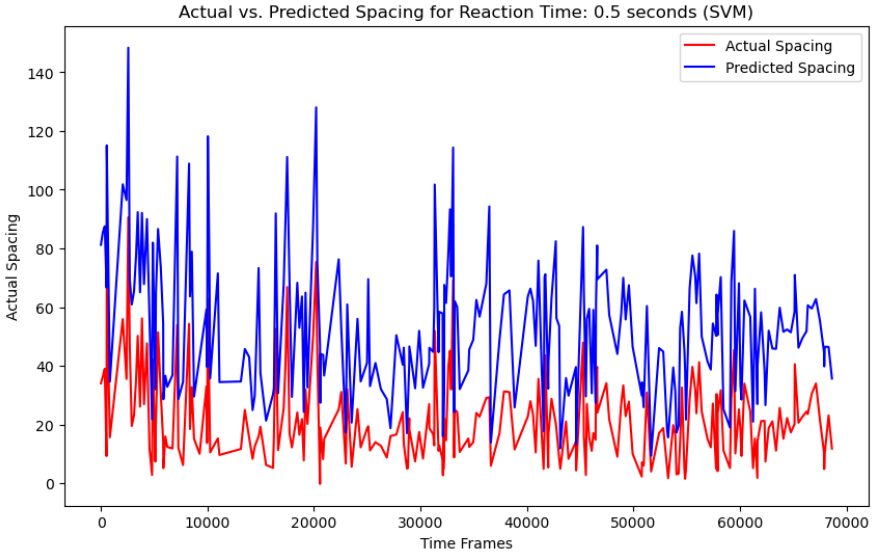




SPACE GAP RESULTS – Reaction time (0.5s)







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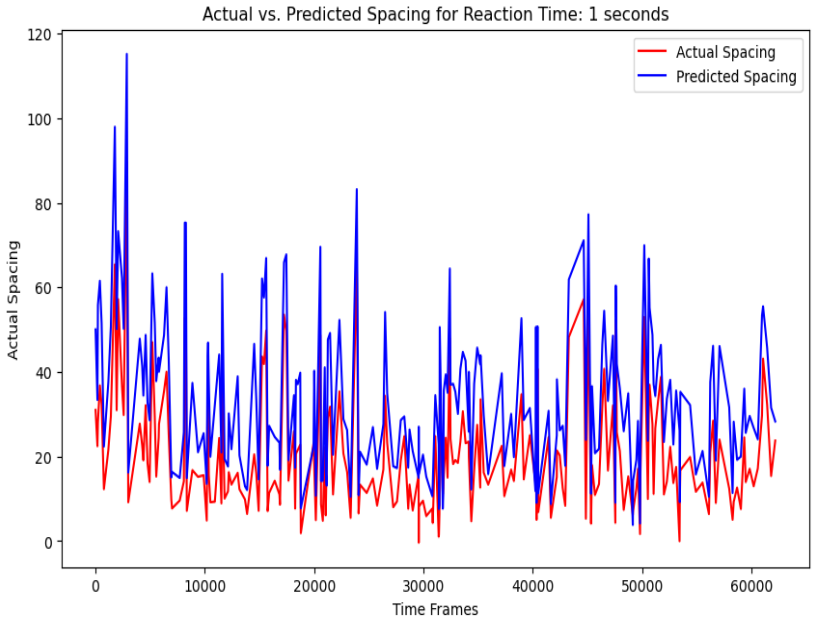

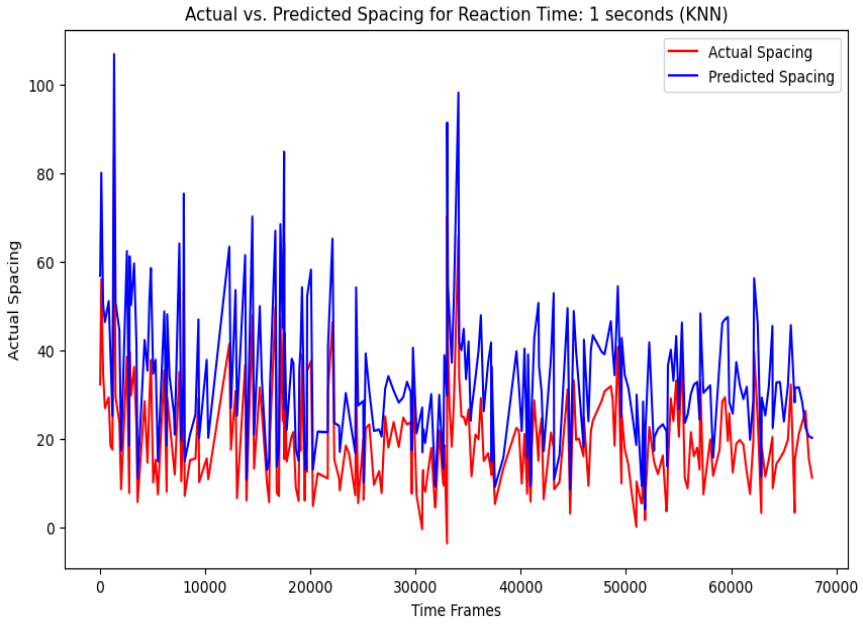

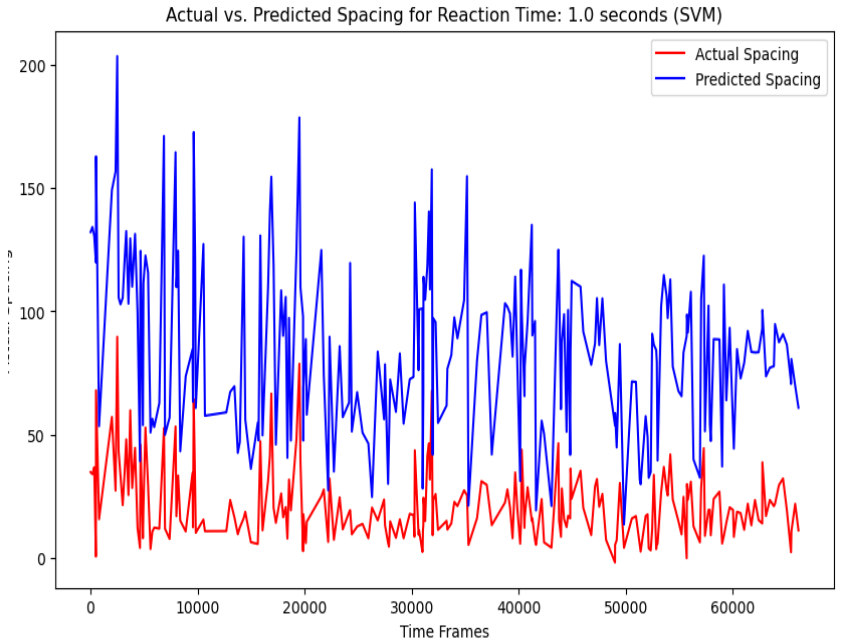

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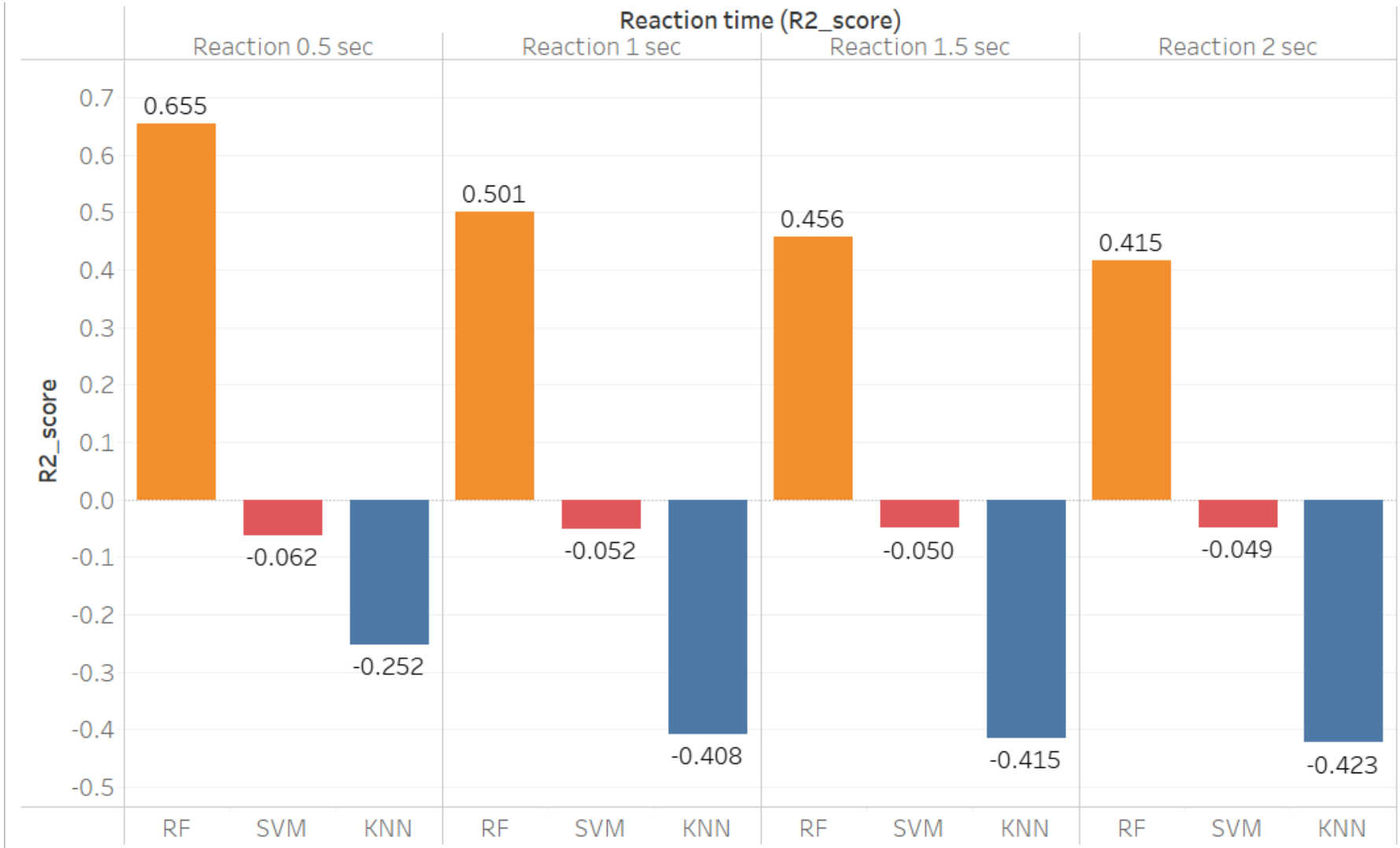

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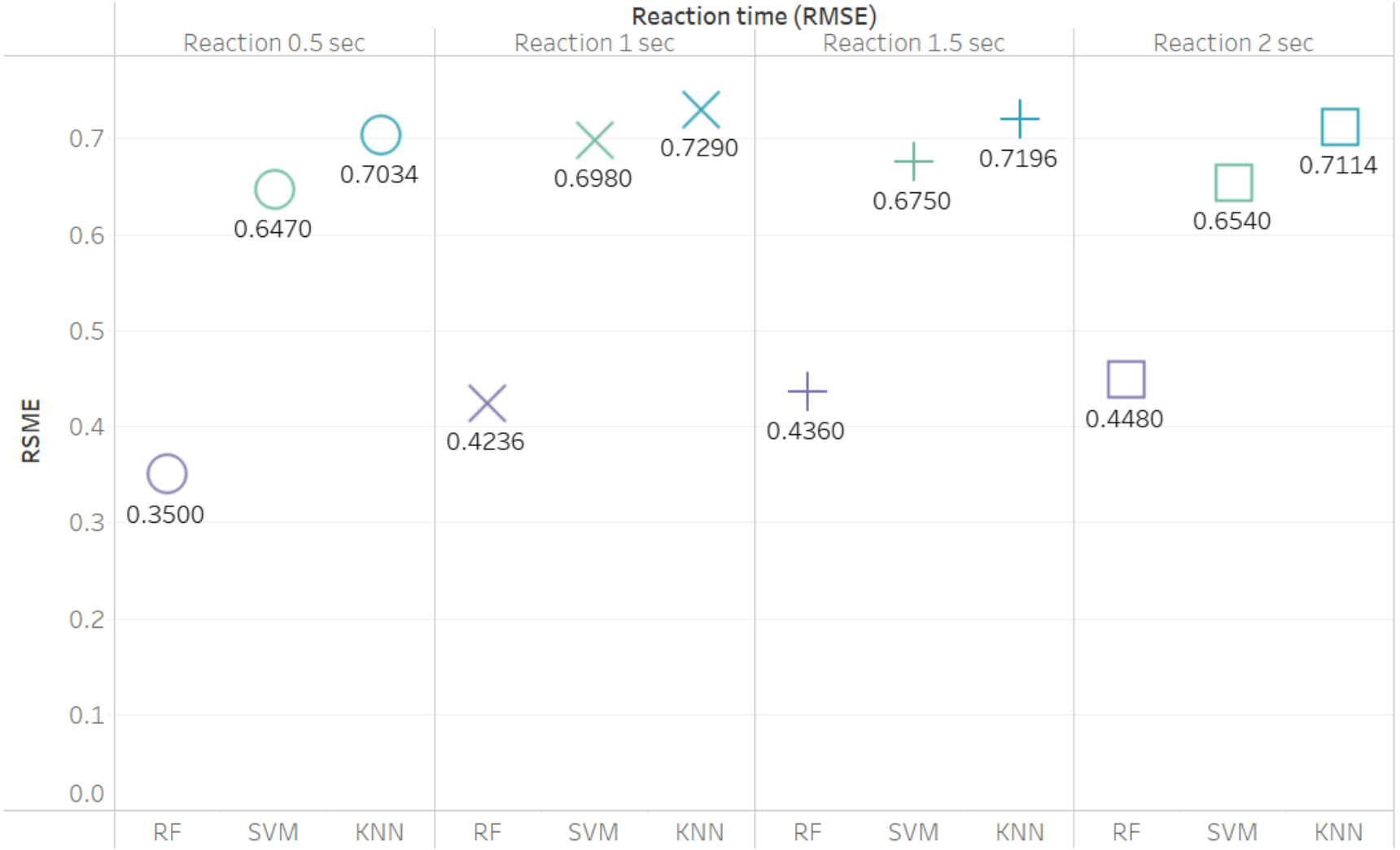

CONCLUSION

- RF outperformed KNN and SVM in predictive accuracy.
- Improved prediction of velocity and spacing with all three models for reaction time (0.5/1sec).
- The best overall prediction among all three models was achieved with RF, particularly when the reaction time was 0.5 seconds.

FUTURE WORK AND RESEARCH

- Ensemble models: Future research should explore the use of ensemble techniques, such as combining KNN/SVM with other models, to leverage their respective strengths and achieve even better prediction results.


THANK
YOU!