Machine Learning Centralized Traffic Control System for City Intersections

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CS4490Z
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Introduction

Context:
- Artificial Intelligence should be leveraged.
- AI poses a safety concern without mediation.

Research Gap Addressed:
- Traffic lights may not be needed for autonomous vehicles.
- Numerical simulations lack important analytical factors.

Results Attained:
- Comparison between traffic light performance and machine learning centralized traffic control system (CTCS).

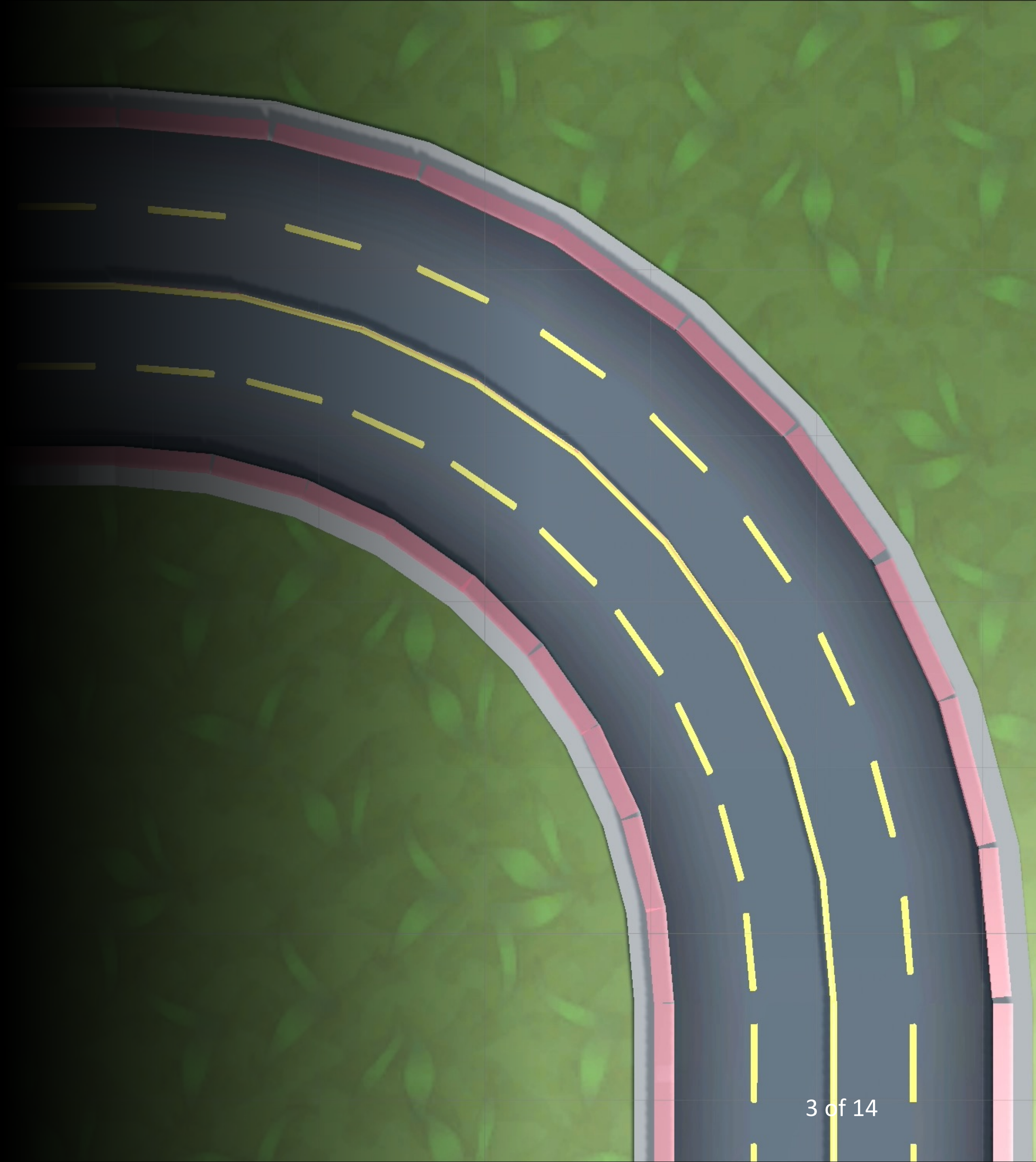
Novelty:
- Visual simulation environment.
- Exploration of an alternative traffic control method.

Impact:
- Innovative research procedure.
- Evidence that modern traffic control methods can be improved.

Background and Related Work

Problems with current traffic control systems

Theorized Solutions



Research Objectives

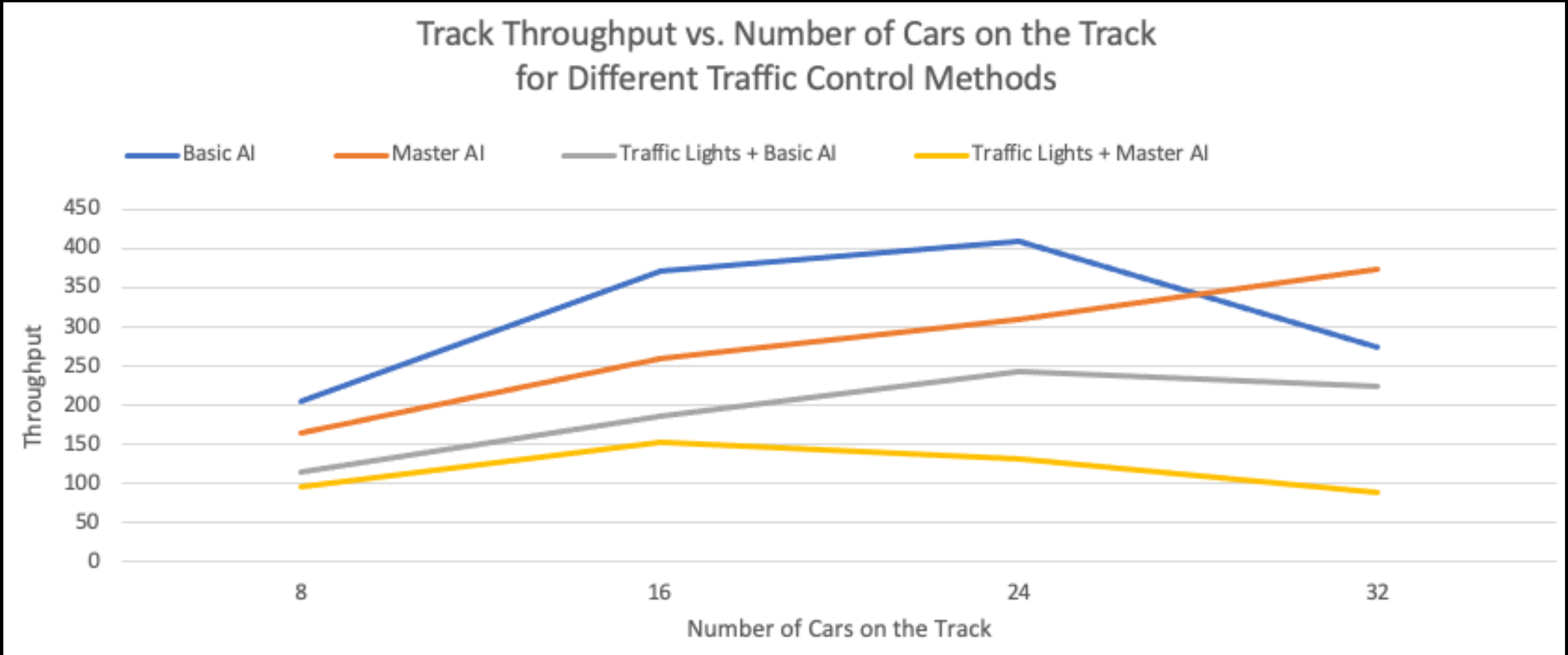
O1: Compare and contrast traffic control methods based on their throughput of roads, safety, efficiency, and potential when all vehicles are autonomous.

O2: Develop a visual simulation that can assist with introducing realism into traffic control algorithms and provide a means to qualitatively analyze them.

Live Demo of Methodology

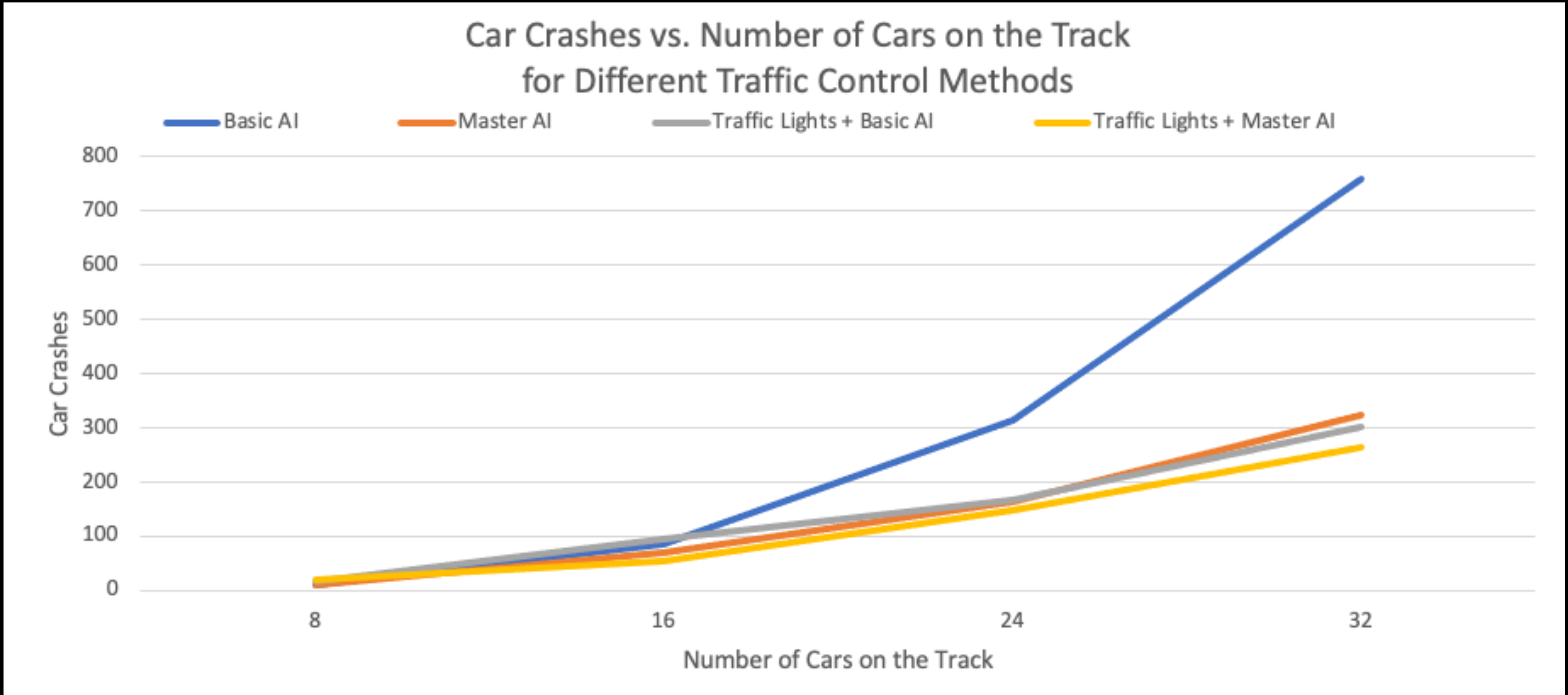
Results

Track Throughput



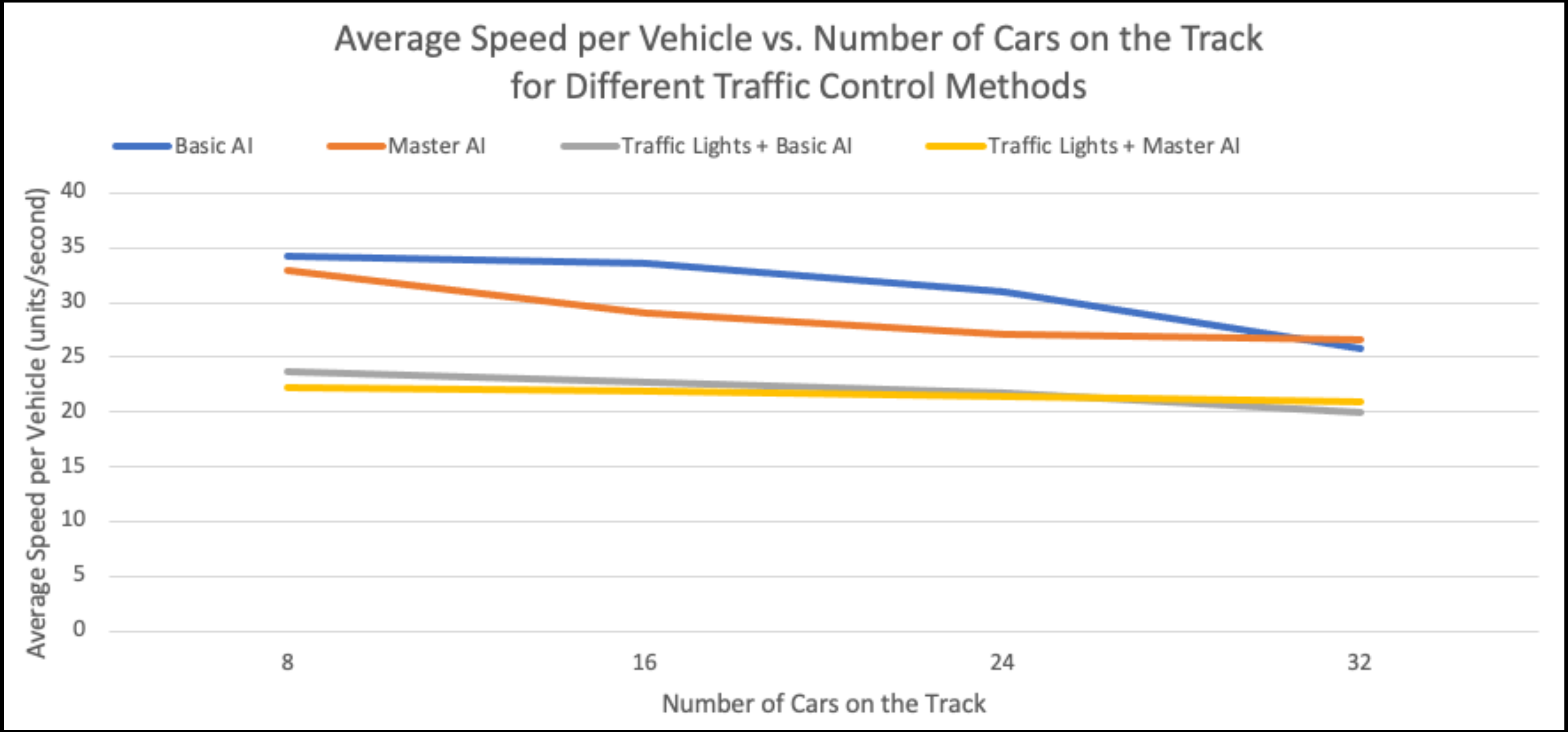
Results

Car Crashes



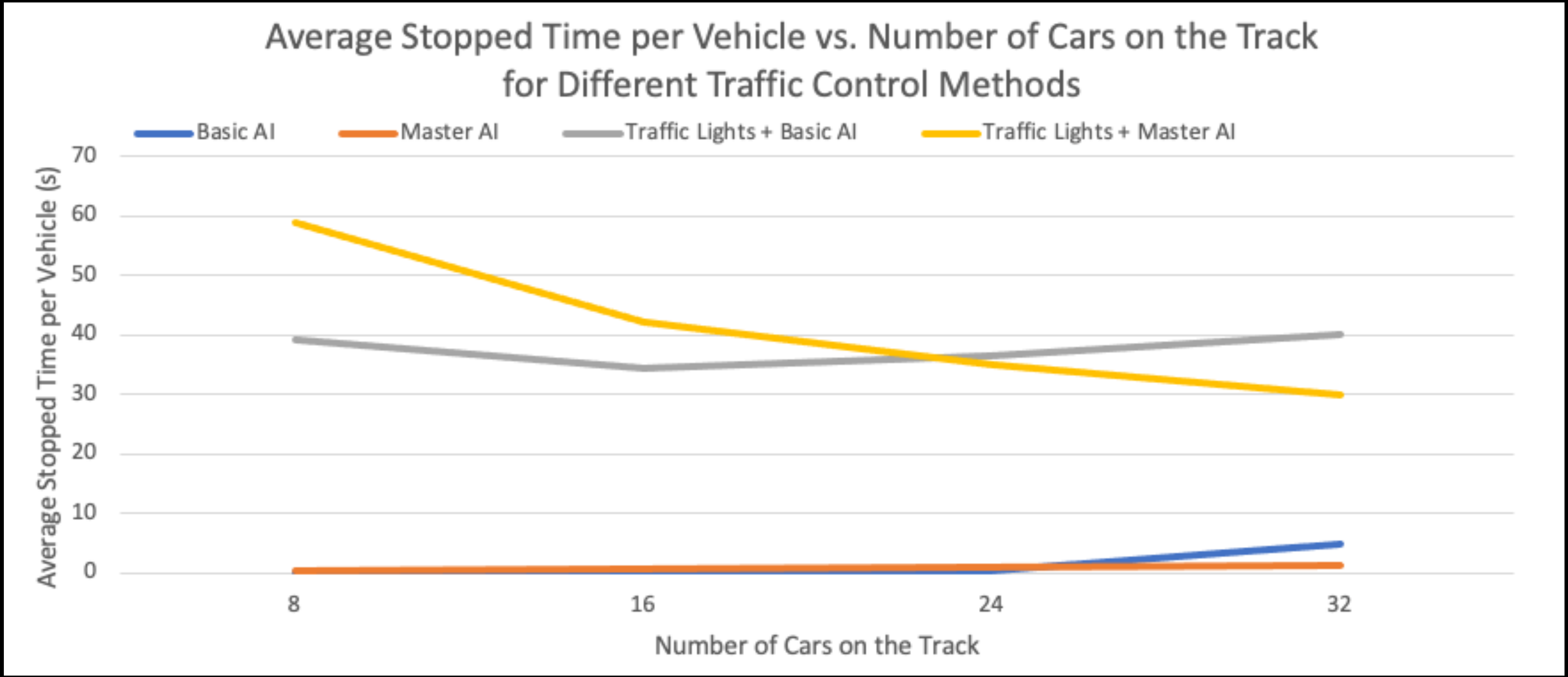
Results

Average Car Speed



Results

Average Stopped Time



Overall Scores

SCORE = *(Throughput) + (CarsOnTheTrack/2*AverageCarSpeed)*
*- (3*Crashes) - (CarsOnTheTrack/2*AverageStoppedTime)*

Number of Cars on the Track	Basic AI	Master AI	Traffic Lights + Basic AI	Traffic Lights + Master AI
8	309	268	-2	-108
16	383	278	-195	-169
24	-167	132	-437	-478
32	-1666	-189	-1007	-847
Grand Total	**-1141**	**489**	**-1641**	**-1601**

Data and Results Analysis

Validity:
- Sufficiently long trials (12 minutes).
- Repeated several times to observe stable patterns.

Limitations:
- Simplified simulation lacking real-world factors.
- Lack of testing for generalizability.

Novelty:
- Visual simulation environment which allows researchers to qualitatively analyze traffic control methods.
- Exploration of an alternative traffic control method (CTCS).

Impact:
- Supportive evidence for innovative traffic control method.
- Influential traffic control simulation that can stimulate future ideation and research.

Conclusions

Need for innovation:

- Autonomous vehicle protocol differences.
- Traffic lights are inefficient.

Support for Centralized Traffic Control Systems:

- Master AI achieved highest overall score and coordination.
- Master AI was more efficient and showed more potential for superior performance in the future.

Simulation:

- Lacks complexity, but serves as reasonable proof of concept.
- Visual aspect is important for interpreting qualitative factors.
- Inspire more complex simulations.

Future Work and Lessons Learned

Future Work:
- More routes and larger city.
- Weather and road conditions.
- Bikers and pedestrians.
- Emergency vehicles.
- SAFETY.

Lessons Learned:
- AI training can be optimized in many ways.
- Hierarchy model of traffic control is more efficient.

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Results Summary (Not part of presentation)

Track Throughput:
- Traffic lights consistently performed worse than trials without traffic lights.
- Master AI achieved increasing throughputs.
- Basic AI had the highest throughput in trials with 8-24 cars.

Car Crashes:
- Basic AI is the most unsafe with very high crash rates as more cars are on the grid.
- Other three traffic control methods achieved similar crash rates.

Efficiency

Average Car Speed:
- Basic AI: 32u/s
- Master AI: 29u/s
- Traffic Lights + Basic AI: 22u/s
- Traffic Lights + Master AI: 22u/s

Average Stopped Time:
- Basic AI: 1s
- Master AI: 0u/s
- Traffic Lights + Basic AI: 38s
- Traffic Lights + Master AI: 45s