

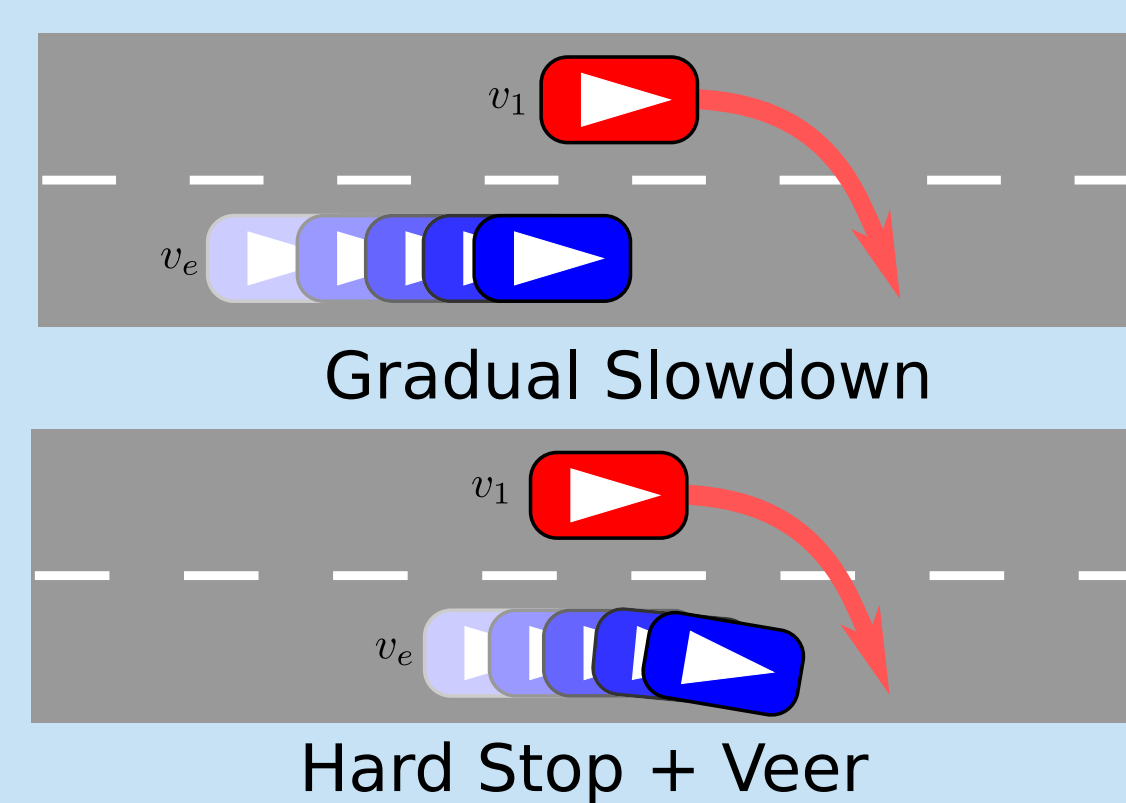
# Minimum Effort Avoidance for Autonomous Vehicle Safety Evaluation

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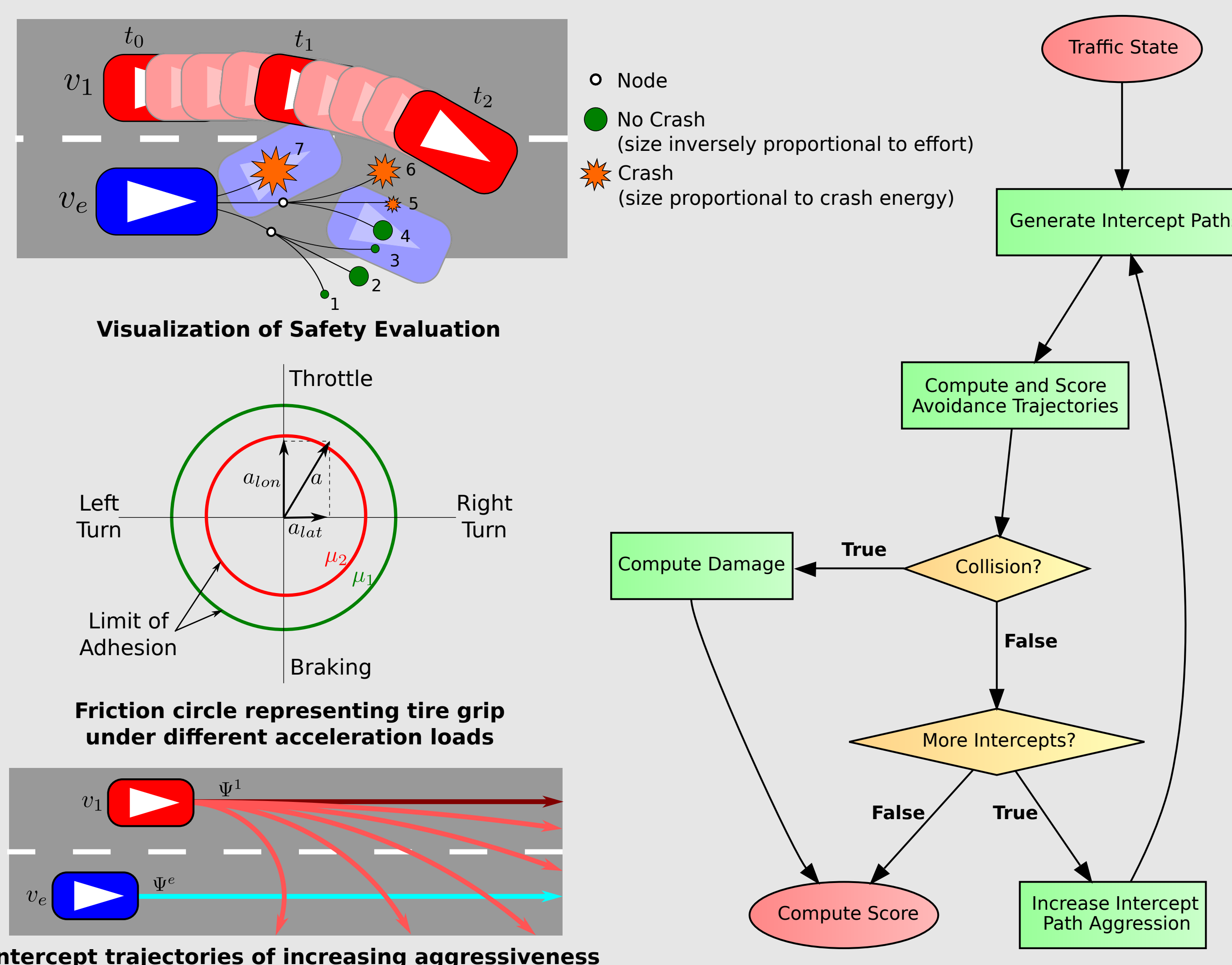
## Motivation:

- Advancements in sensing and planning techniques have made **autonomous driving more feasible**.
- **Measuring the safety** of an autonomous vehicle **remains difficult**.
- **Physical vehicle limitations**, e.g. available **control authority**, provide an **objective, low-level safety metric**.



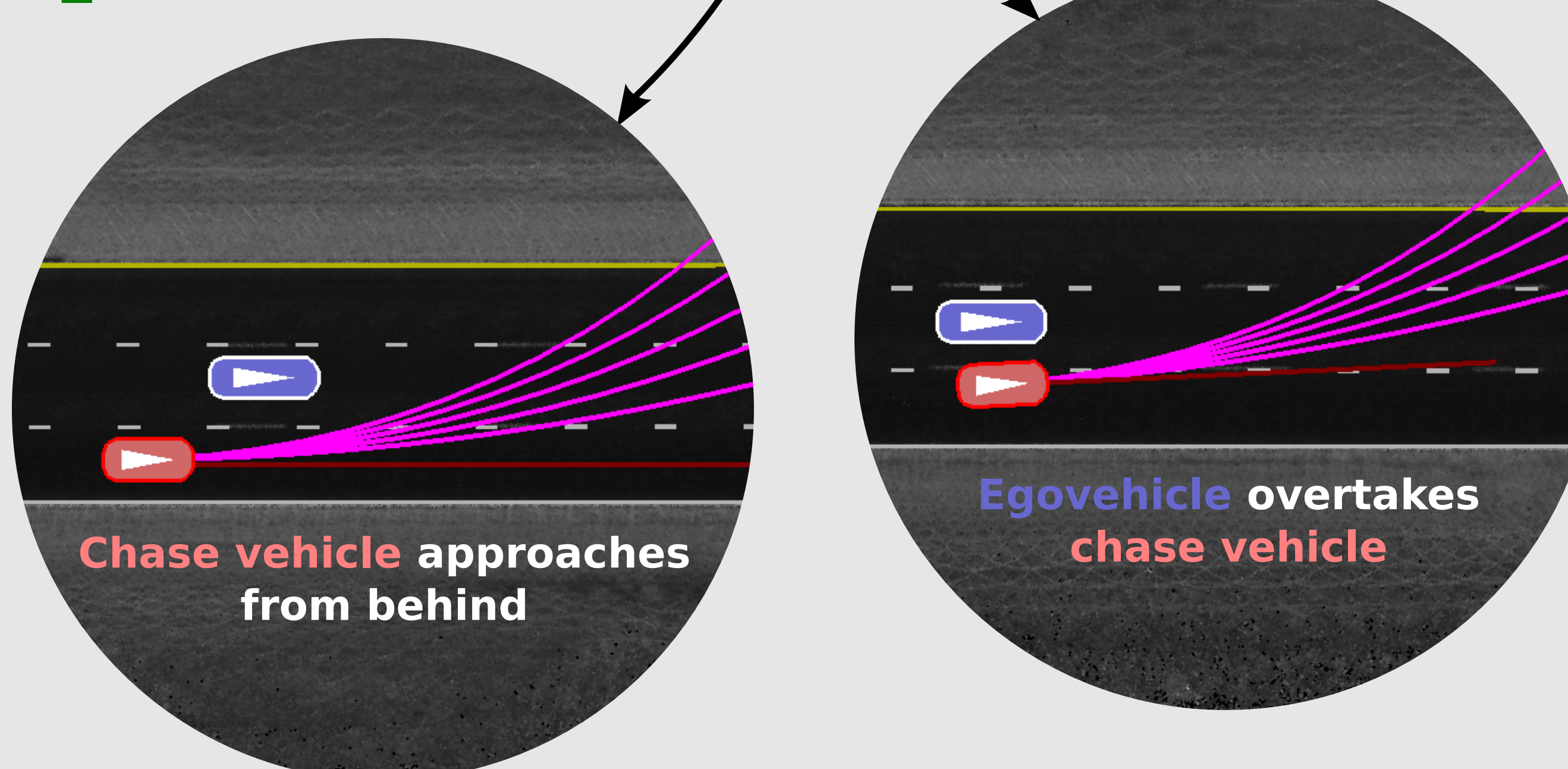
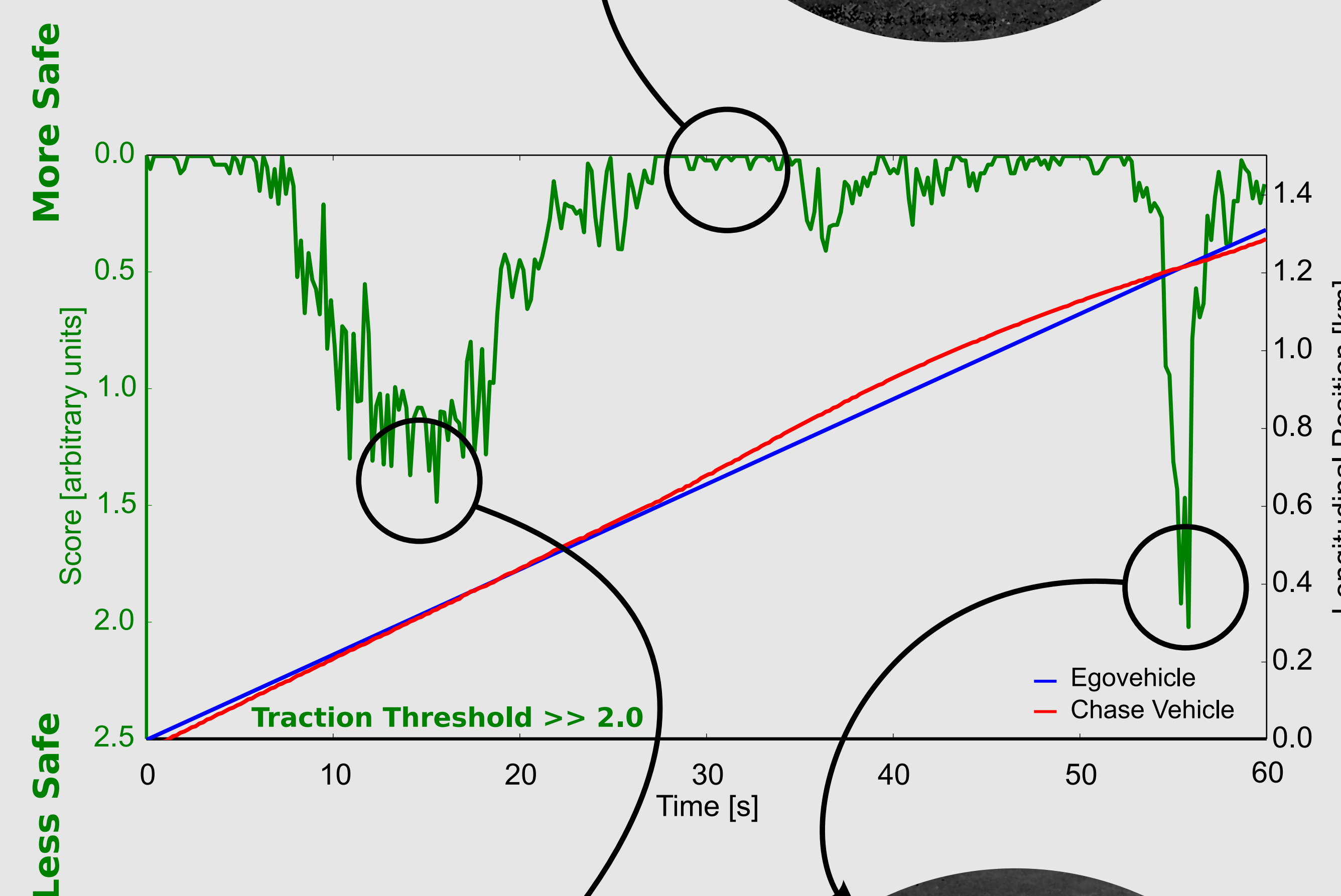
## Approach:

- We propose using **minimum control effort** to avoid collisions as a metric for measuring safety.
- This effort is limited by the **physical traction threshold** of the tires
- **Trajectory planning** is used to determine the minimum control effort **collision-free path**.
- This metric **incorporates vehicle state**, leading to a **more refined evaluation** than other metrics, e.g. probability of collision.

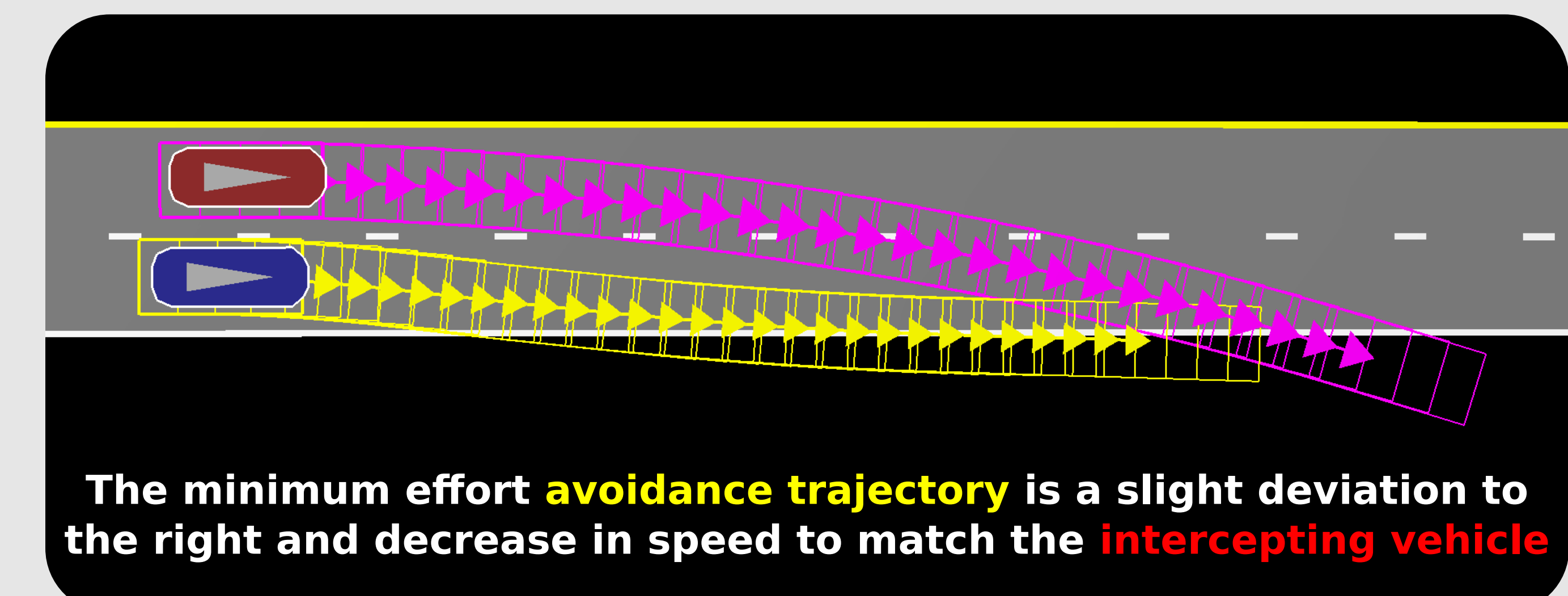


## Results:

Evaluation of  
autonomous straight-  
line passing maneuver  
with two real vehicles:

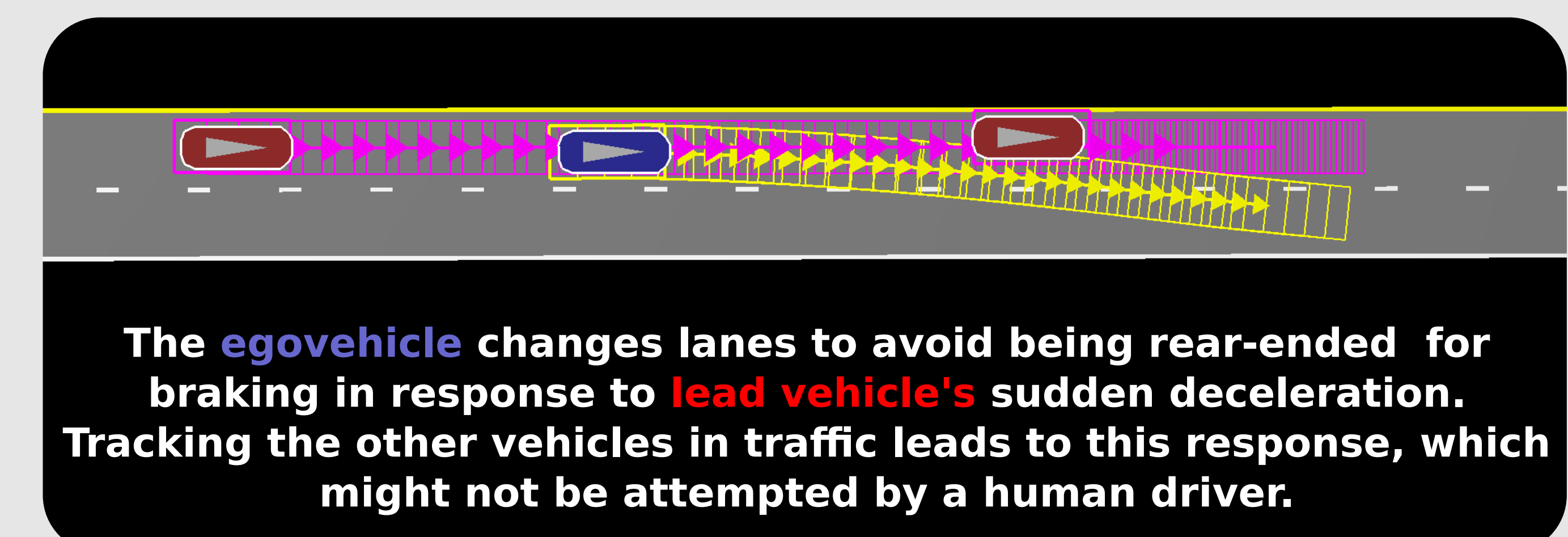


Two-vehicle simulation:



The minimum effort **avoidance trajectory** is a slight deviation to the right and decrease in speed to match the **intercepting vehicle**

Three-vehicle simulation:



The **ego vehicle** changes lanes to avoid being rear-ended for braking in response to **lead vehicle's** sudden deceleration. Tracking the other vehicles in traffic leads to this response, which might not be attempted by a human driver.

## Continuing Work:

- Improve avoidance trajectories with **optimization-based methods**.
- Include **driver awareness model** to compute intercept probabilities.
- Incorporate possible intercept vehicles approaching from **blind spots**.
- **Compare** minimum effort metric to **other safety evaluation** techniques.
- Test with **complex situations in urban environments**, e.g. **McCity**.



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