



[GitHub Repo](#)

Dedicated Autonomous Vehicle Lanes

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- AVs may drive more conservatively than humans, so a "safe" lane could be useful.
 - We modeled this in our project by giving all AVs a fixed speed and behavior.
- AVs may have specific destinations (like major transit / entertainment hubs) so placing them in the leftmost lane may be beneficial for exiting freeways.

Concerns

- Like dedicated lanes for HOV, we suspect that a dedicated lane for AVs will reduce travel time and collisions.
- With a dedicated lane, and faster travel time, air pollution can be reduced, along with congestion.

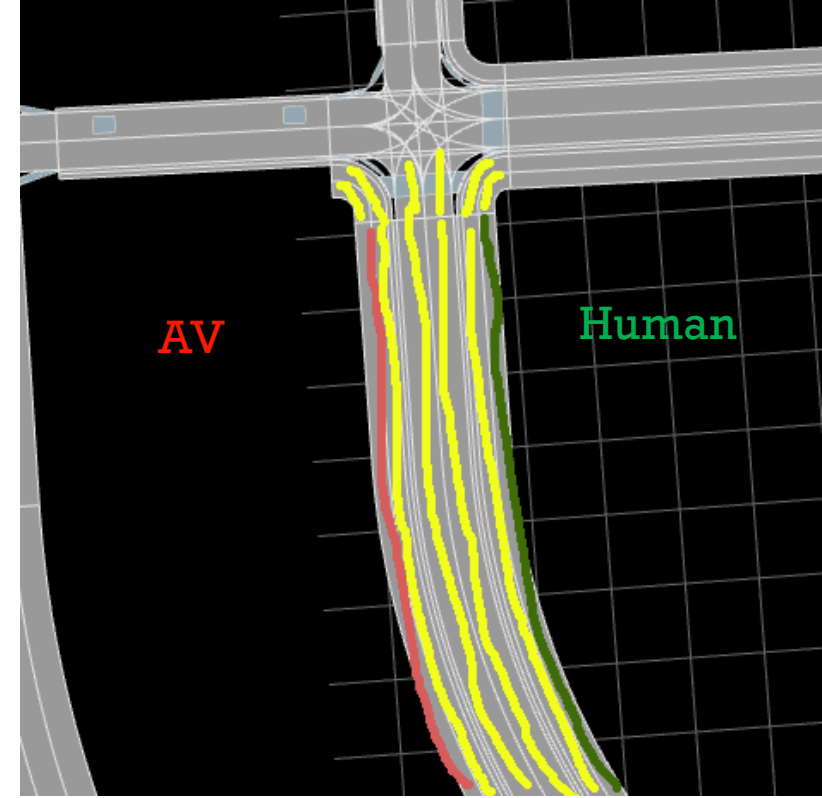
A decorative graphic at the bottom of the slide consisting of several concentric, curved lines in a light gray color, set against a dark gray background.

Benefits

Proposal: Dedicated
Autonomous
Vehicle Lanes



- **Six AV** vehicles
 - Spawned in leftmost lane.
 - Using CARLA's "normal" vehicle profile.
 - Uniform speed of 60 km/h.
- **Fifteen Human** vehicles
 - Spawned in any lane but leftmost.
 - Randomly assigned a vehicle profile.
 - Randomly assigned a speed $\in [30, 80]$ km/h.
- Simulation is run in **synchronous mode with fixed timestep** and limited to 10,000 ticks.
- **Four results** using seed $\in [5100, 5103]$ were analyzed.
 - Control => no lane restrictions.
 - Experimental => AV given an exclusive left lane; humans given an exclusive right lane. No exclusivity at intersections.



Implementation

- Large amounts of collisions would cause CARLA to become unresponsive.
 - Mitigations:
 - In periods of high collisions-per-tick, disable collisions temporarily.
 - Reduce number of vehicles in simulation.
- CARLA simulations are non-deterministic by default.
 - Mitigations:
 - Run simulator in synchronous mode with a fixed time step.
 - Set a fixed random seed for each unrelated run.
 - Limit each run to 10,000 ticks.



Issues

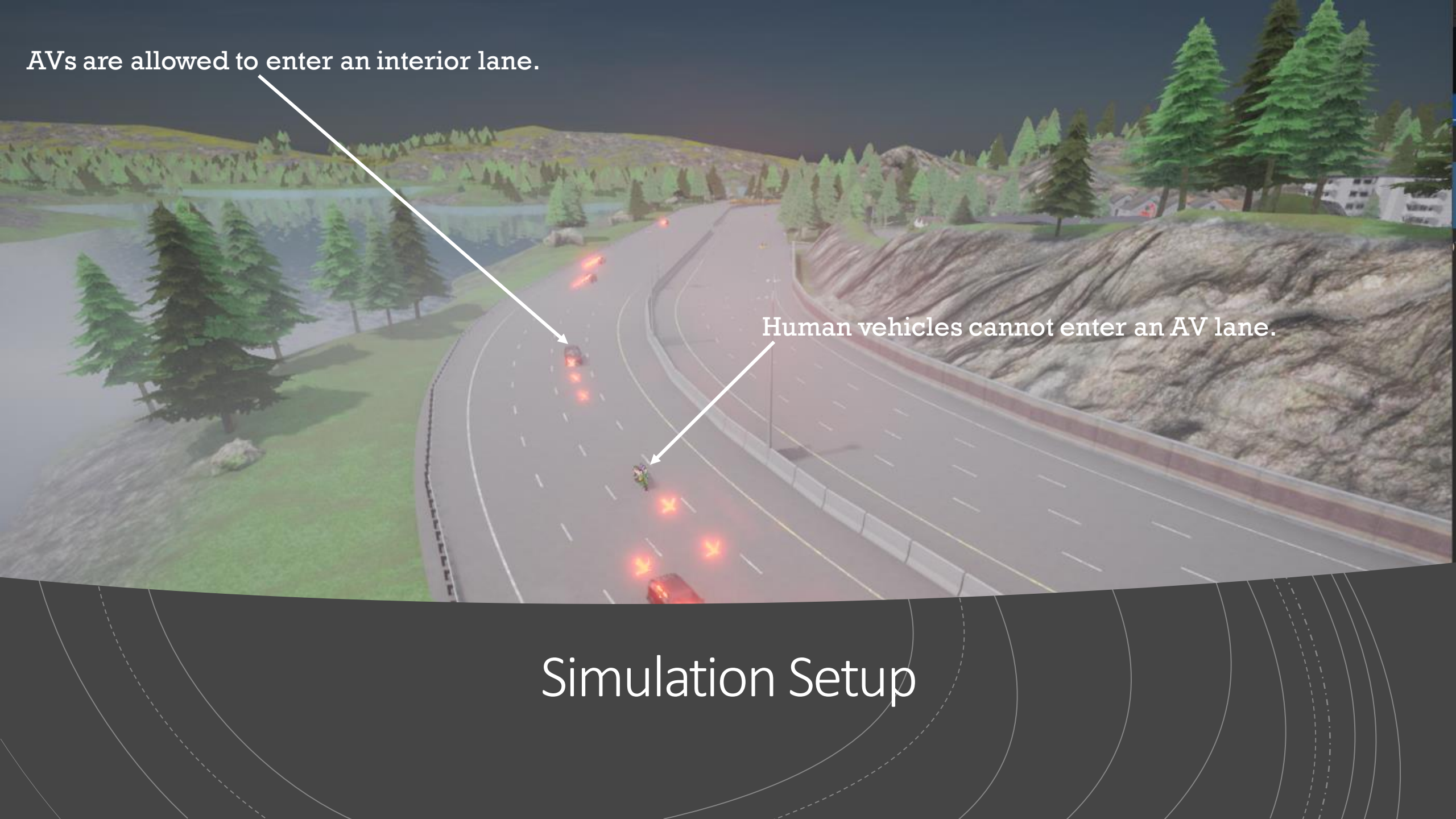


Simulation

AVs are allowed to enter an interior lane.

Human vehicles cannot enter an AV lane.

Simulation Setup



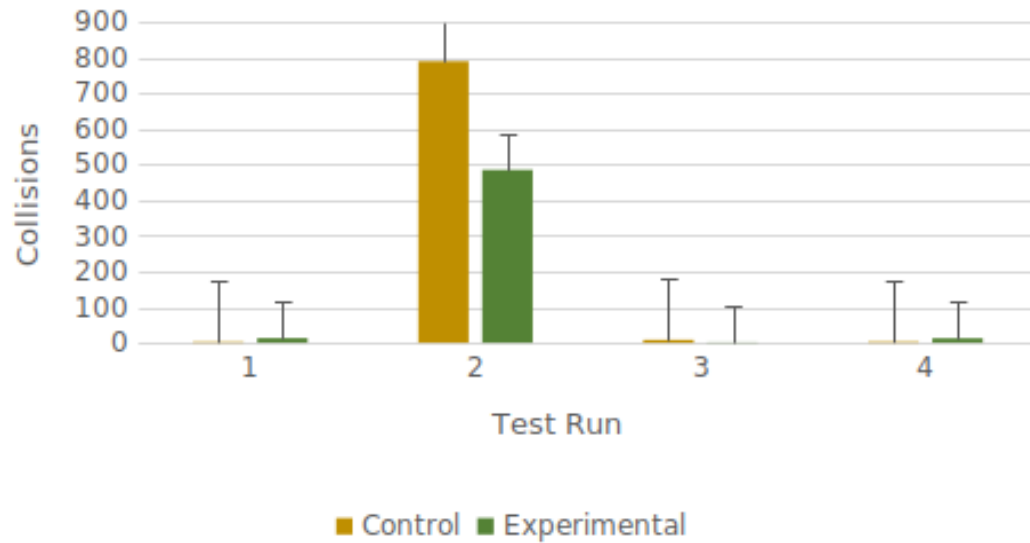
Video Link

Video

Results



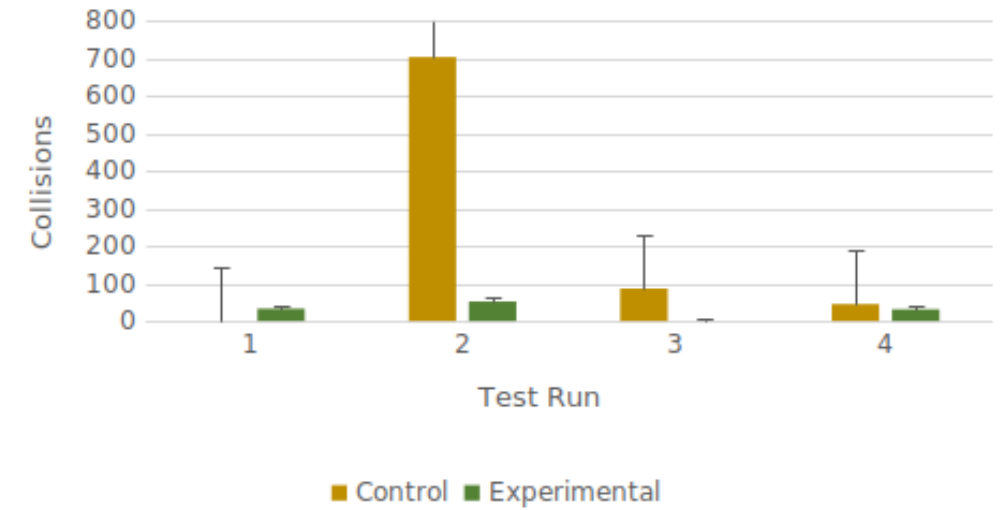
Human Collisions (average)



Collisions involving human vehicles were not significantly reduced in experimental runs.

Anomalous data on run #2 were the result of a fast vehicle trapped behind a slower one, resulting in a large amount of collisions-per-tick.

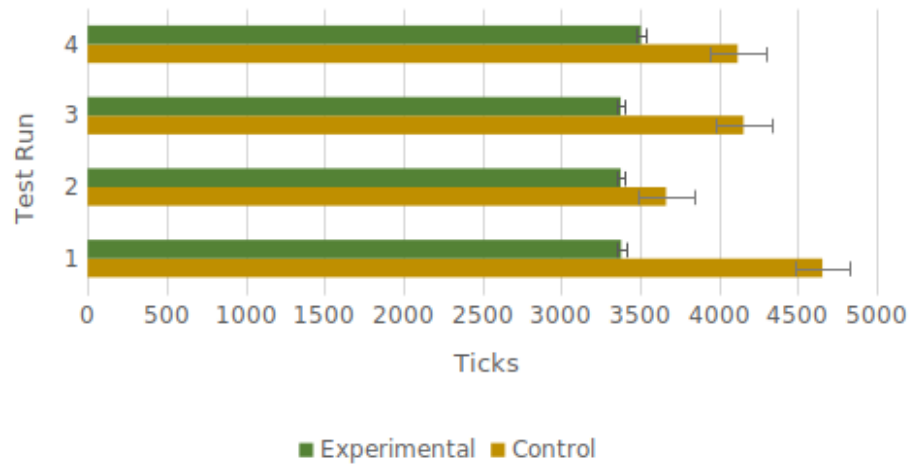
AV Collisions (average)



Collisions involving autonomous vehicles were not conclusively reduced across all experimental runs.

Results

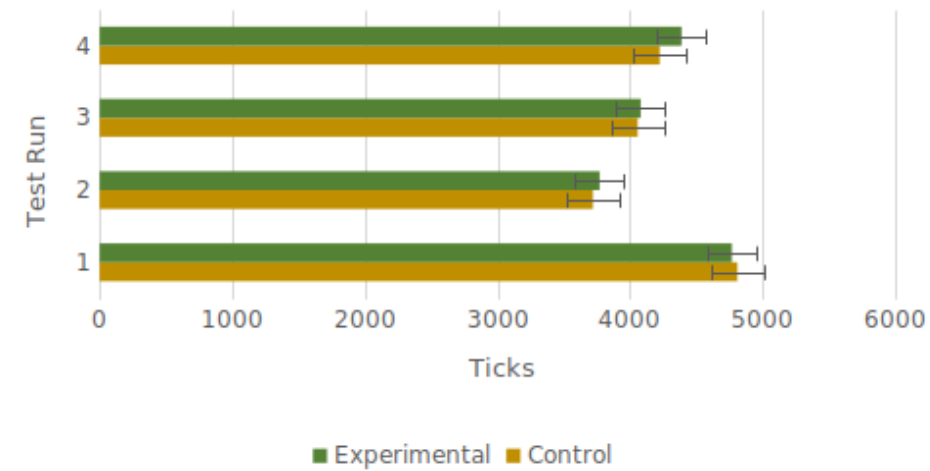
AV TTC (average)



Experimental results showed a significant reduction in ticks-to-completion (TTC) compared to the control.

A comparatively low standard error for experimental runs is promising.

Human TTC (average)



Human TTC did not have a significant variation between experimental and control.

Results

- Ticks-to-completion (our version of a fixed simulator time) showed a decided difference in experimental runs compared to the control for AV vehicles.
 - Human vehicles did not have a noticeable change in TTC.
- Collisions for both AV and human vehicles did not show much variation between the experimental runs and control.

An exclusive lane for AVs within our simulation matches with observed results seen in HOV lanes in use in large cities!

- **Namely, we saw a reduced travel time.**
- <https://www.transportation.gov/mission/health/High-Occupancy-Vehicle-Lanes>

Conclusion

- Actual modeling of an "AV"
 - We only modeled an approximate AV, but using a real self-driving model will yield more generalizable results.
- Use of a real roadway, with real traffic patterns.
 - Due to computing limitations, we had a greatly reduced number of vehicles on an artificial path, using a "real" scenario is an area of future research.

Further Research

A photograph of a car's dashboard and steering wheel, viewed from the driver's perspective. The dashboard features three main gauges: a tachometer on the left, a speedometer in the center, and a fuel/temperature gauge on the right. The steering wheel is visible at the bottom, with various control buttons. A large, semi-transparent red rectangle is overlaid on the center of the image, containing the word "Questions" in white text. The background outside the car shows a rocky, mountainous landscape under a clear sky.

Questions