



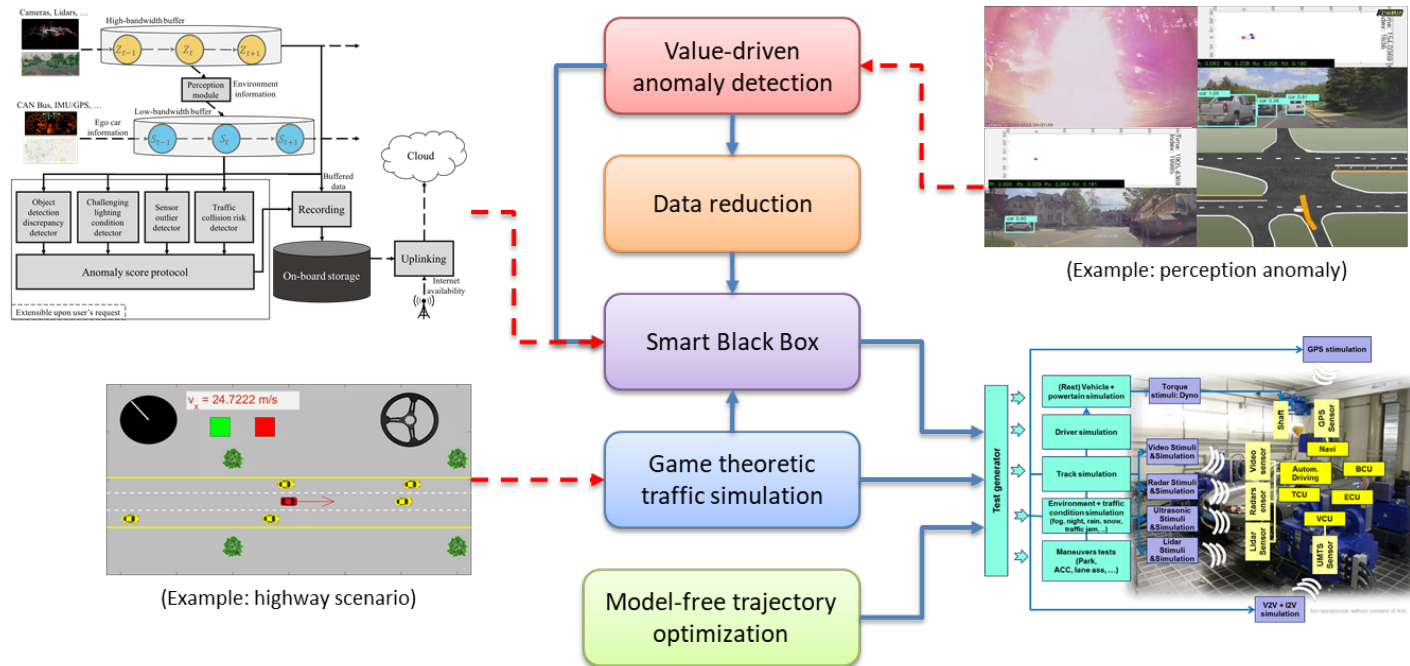
## CPS: GOALI: Synergy: Maneuver and Data Optimization for High Confidence Testing of Future Automotive Cyber-Physical Systems



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# Description

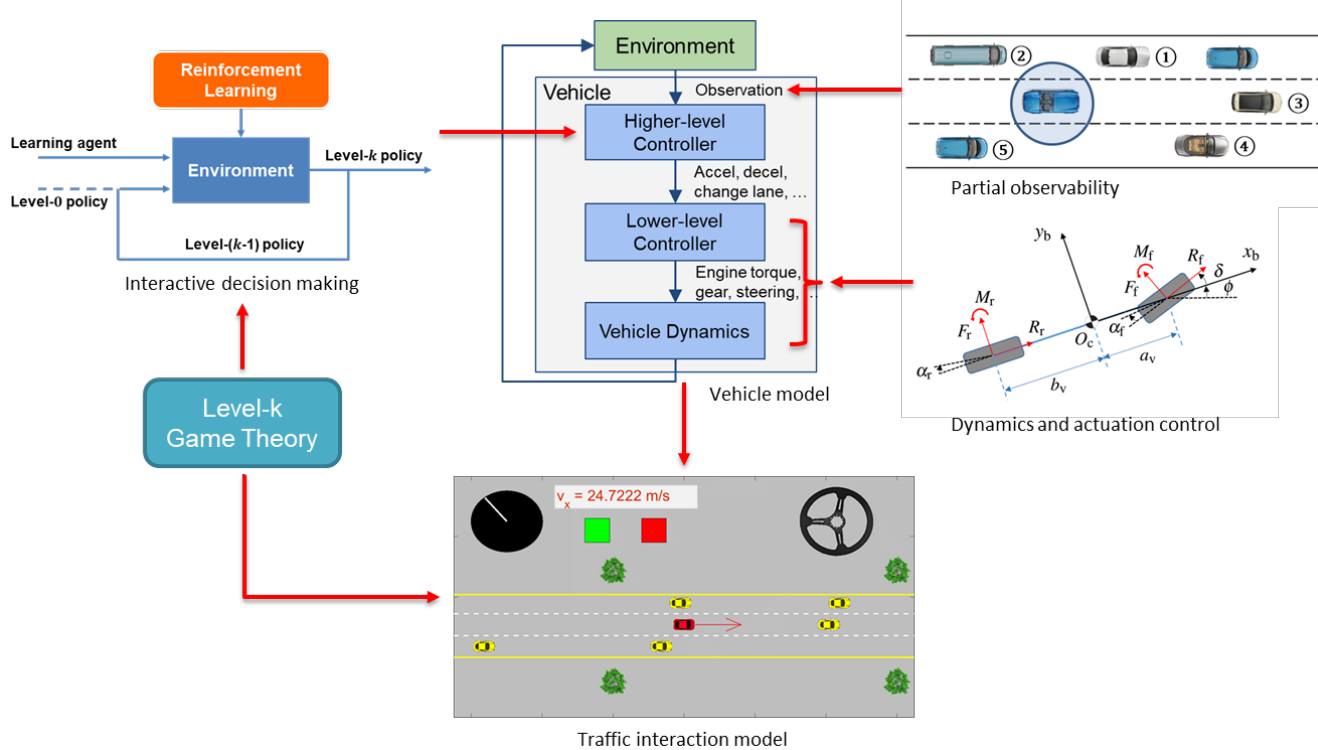
- The development of a toolchain for high confidence testing, validation, and verification of advanced, connected, and autonomous vehicles is required<sup>1</sup> to support the introduction of such vehicles into mass production.
- The development of such tools is pursued based on research into maneuver and data optimization using *game theory, model-free trajectory optimization, data-driven anomaly detection, and Smart Black Box* approaches to determine test trajectories and scenarios for vehicle testing.



<sup>1</sup>  $10^9$  vehicle operational hours of (conventional) testing would be needed to assure the same rate of reliability as existing human-driven cars<sup>[1]</sup>.

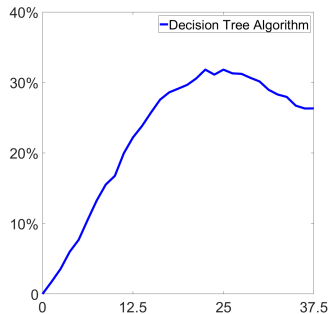
# Representative Finding

- In-traffic vehicle interactions can be modeled with Level-k game theory<sup>[2]</sup>.

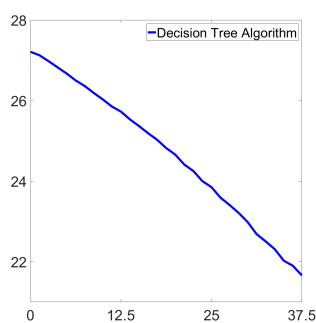


- Driving safety and performance can be assessed using game theoretic traffic simulation.

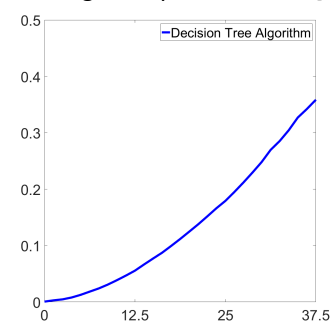
Rate of safety violations  
(percentage of 200-[s] simulation runs that has safety violations)



Average travel speed [m/s]



Average computation time [s]

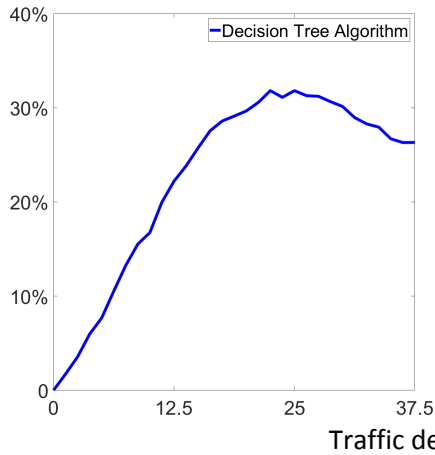


Traffic density (number of cars per kilometer)

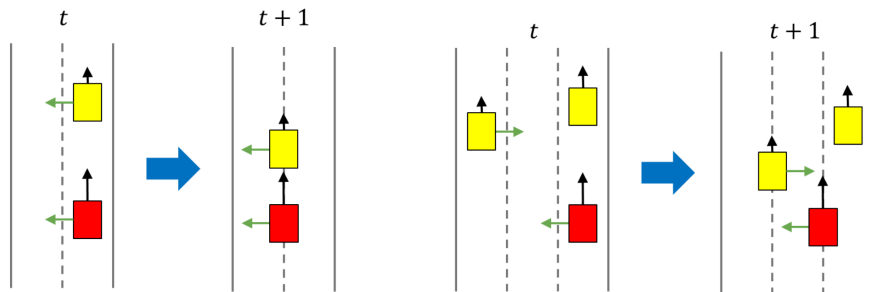
# Representative Finding

- Autonomous driving algorithms that do not account for interactions between traffic participants may lead to significant amount of faults.

Rate of safety violations (percentage of 200-[s] simulation runs that has safety violations)

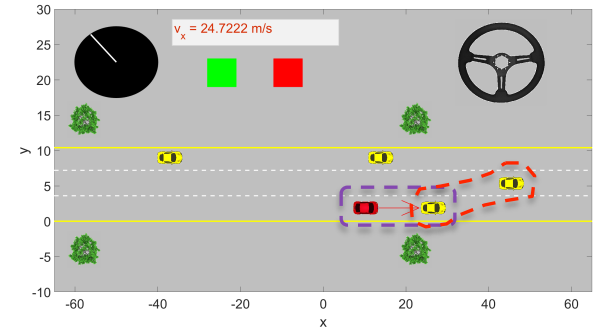
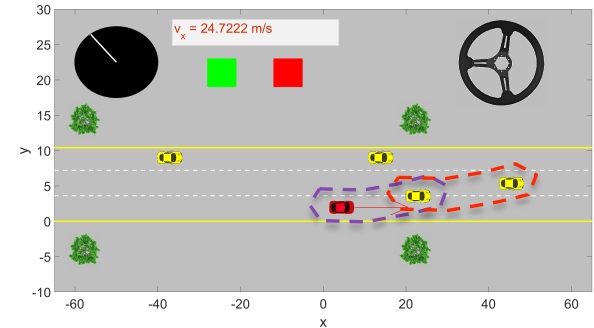
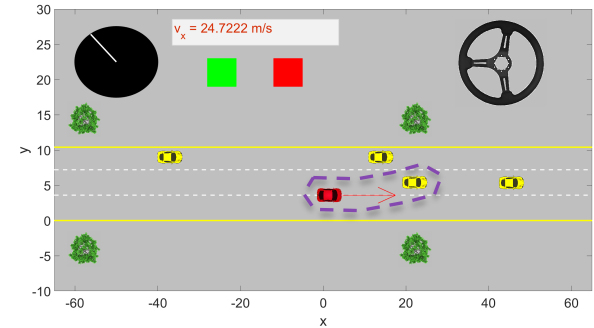
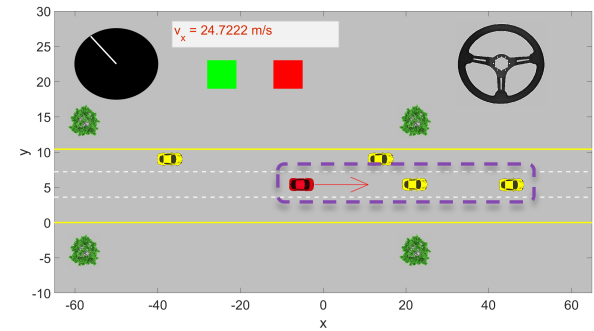


- Game theoretic traffic simulation highlights fault scenarios due to traffic interactions to inform testing



Safety violation scenarios due to traffic interactions.

[2] Li, N., Oyler, D. W., Zhang, M., Yildiz, Y., Kolmanovsky, I., & Girard, A. R. (2017). Game Theoretic Modeling of Driver and Vehicle Interactions for Verification and Validation of Autonomous Vehicle Control Systems. IEEE Transactions on Control Systems Technology.



Interactions may happen beyond perception.