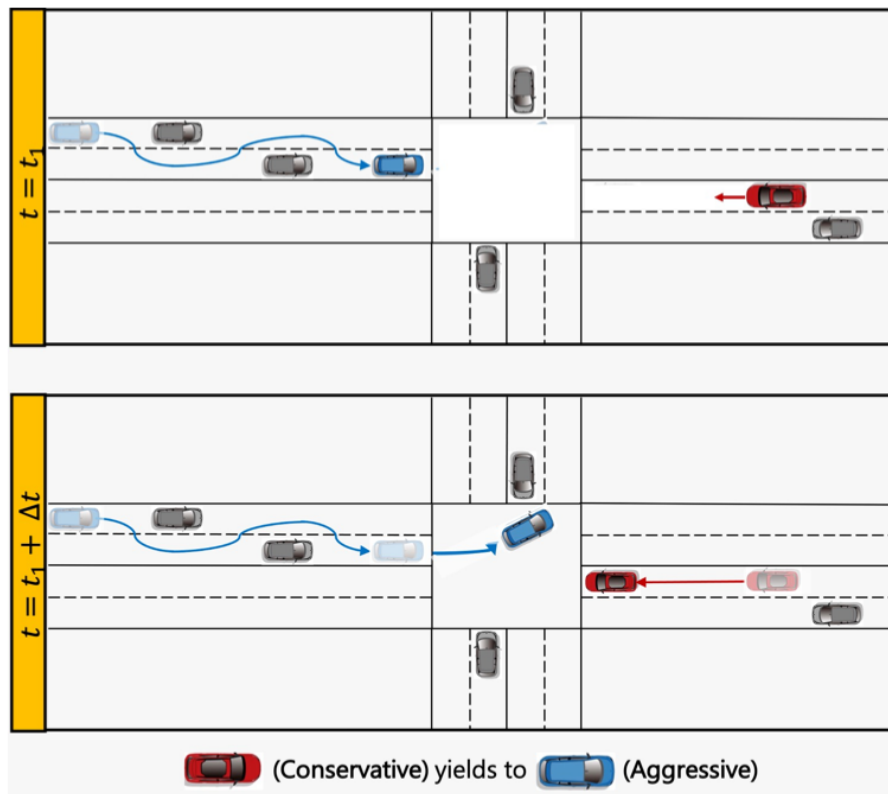


# **Game-Theoretic Planning for Autonomous Driving among Risk-Aware Human Drivers**

Stanford researchers in the Multi-Robot Systems Lab have developed a software model for predicting risk-aware human behavior in multi-agent traffic scenarios that include a range of human driver behavior from aggressive (speeding, overtaking, sudden zigzagging, and lane-changes) to conservative (driving slowly and conforming to the right-most lane). Existing autonomous driving approaches plan conservatively and forgo game-theoretic reasoning. In contrast, the human driver behavior model, CMetric, maps drivers' entropic risk preferences. The game-theoretic risk-sensitive planner uses the risk preference to model risk-aware interactions among human drivers and an autonomous vehicle in various traffic scenarios. (See Figure 1.) This planner recognizes aggressive human drivers and yields to them while maintaining a greater distance from them. The CMetric integrated planner systematically includes uncertainty, leads to safer navigation, and leverages the autonomous vehicles' influence on other cars to achieve safe and efficient driving.



**Figure 1:** (top) The aggressive human agent (blue) with the ego-vehicle as a conservative agent (red). (bottom) The model determines human agent risk sensitivity and generates a game theory based optimal and safe risk-aware trajectory for the red agent where the red agent yields to the blue human driver allowing it to cross first. (Figure courtesy Multi-Robot Systems Lab.)

### Stage of Development - Computer Model

Researchers have tested the method via an open-loop simulation. Future work includes a more realistic closed-loop simulation that combines human behavior model and the risk-aware trajectory planner. Research is ongoing.

## Applications

- Autonomous vehicles

## Advantages

- Safer navigation than existing methods
  - Risk-aware planner recognizes aggressive driving, and yields to them while maintained a greater following distance

## Publications

- R. Chandra, M. Wang, M. Schwager, and D. Manocha, (2022). Game-Theoretic Planning for Autonomous Driving among Risk-Aware Human Drivers. *Under Review IEEE*.
- R. Chandra, D. Manocha, M. Wang, and M. Schwager, (2022) Game-Theoretic Planning for Autonomous Driving among Risk-Aware Human Drivers. *U.S. Pat. App. No. 63/251,359*.

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