Human Centered Autonomy

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A Survey of the State of the Art in Modeling and Predicting Human Driver Behavior

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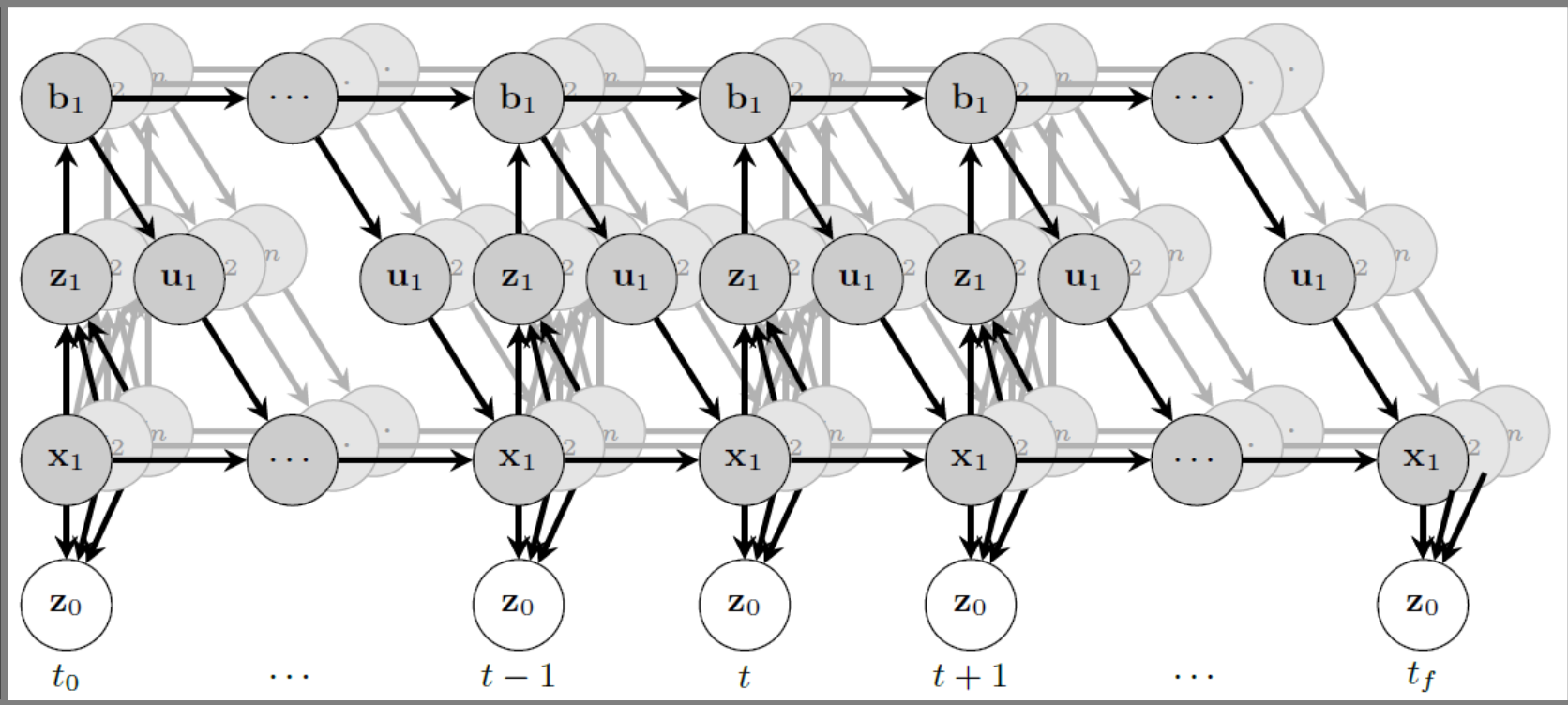
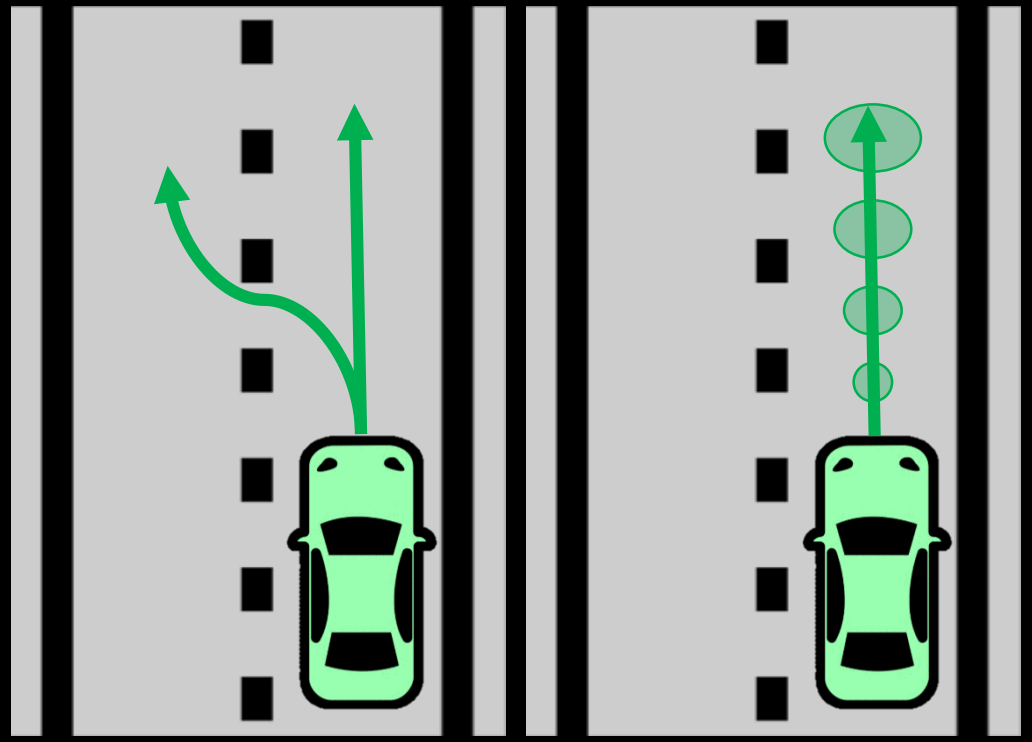
- Canonical tasks
  - State estimation
  - Internal state estimation
  - Motion prediction
  - Motion planning
- Input Features
- Dataset
- Model Scope
- Evaluation Metrics

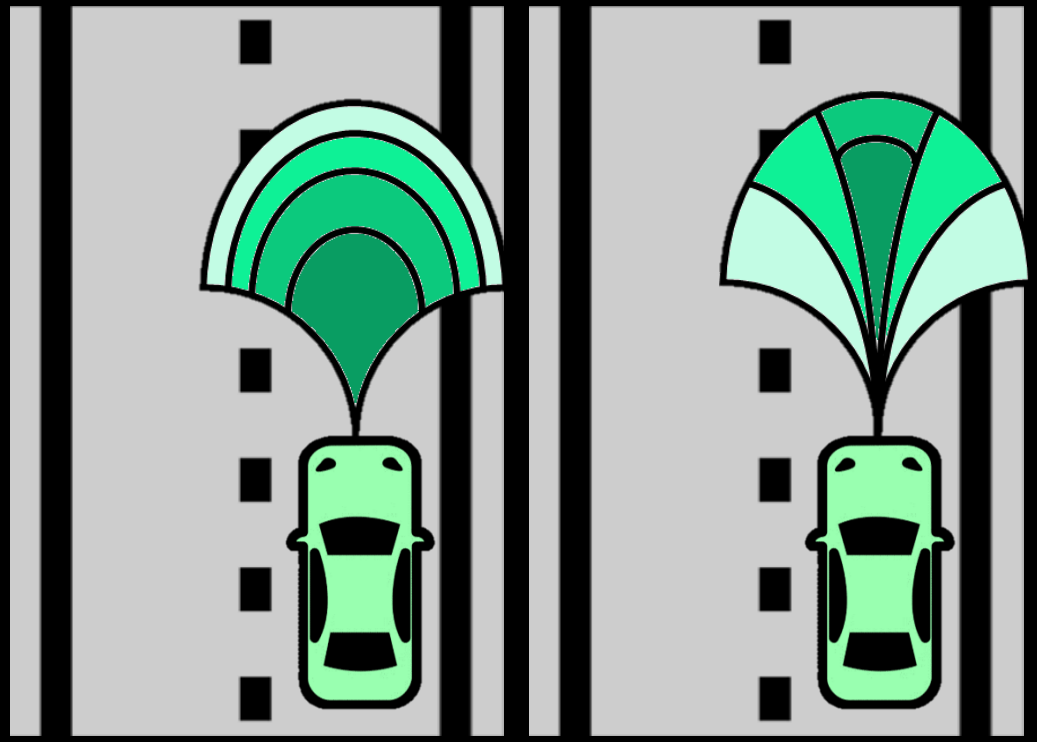


Predictive Modeling

Informative Models



Robust Models



Reachability for Behavior Prediction

Empirical Reachable Sets

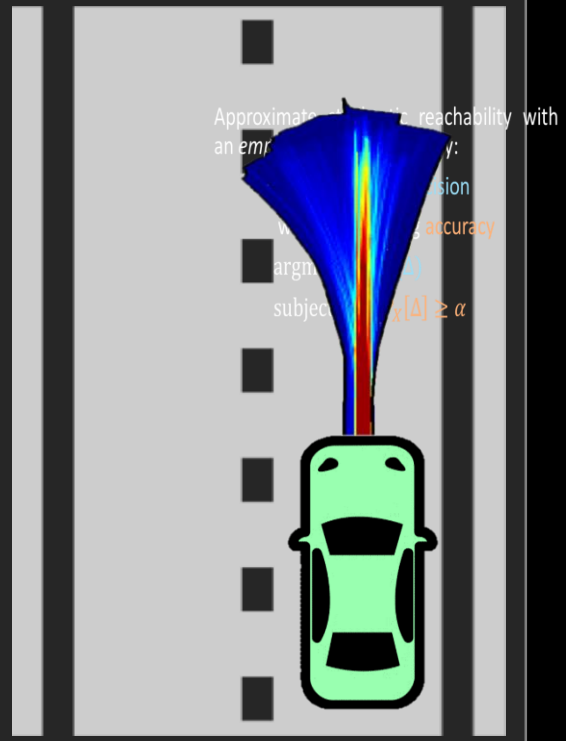
Approximate stochastic reachability with an *empirical reachable set,* by:

maximizing precision

while maintaining accuracy

$\text{argmin}_{\Delta \subset \mathbb{R}^n} \ \lambda(\Delta)$

subject to $\hat{P}_X[\Delta] \geq \alpha$



K. Driggs-Campbell, et al., *Improved Driver Modeling for Human-in-the-Loop Control*, ICRA 2015.
K. Driggs-Campbell, et al., *Robust, Informative Human-in-the-Loop Predictions via Empirical Reachable Sets,* in Transactions on Intelligent Vehicles, 2018.
V. Govindarajan, **K. Driggs-Campbell**, and R. Bajcsy, *Data-Driven Reachability Analysis for Human-in-the-Loop Systems.* CDC 2017.

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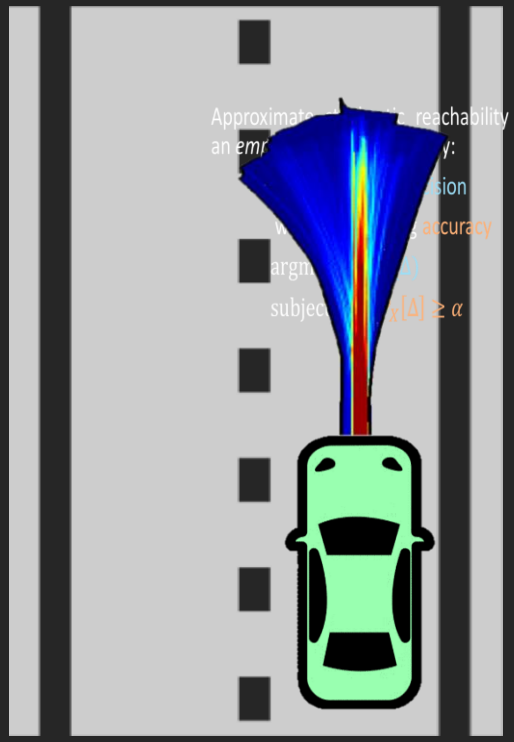
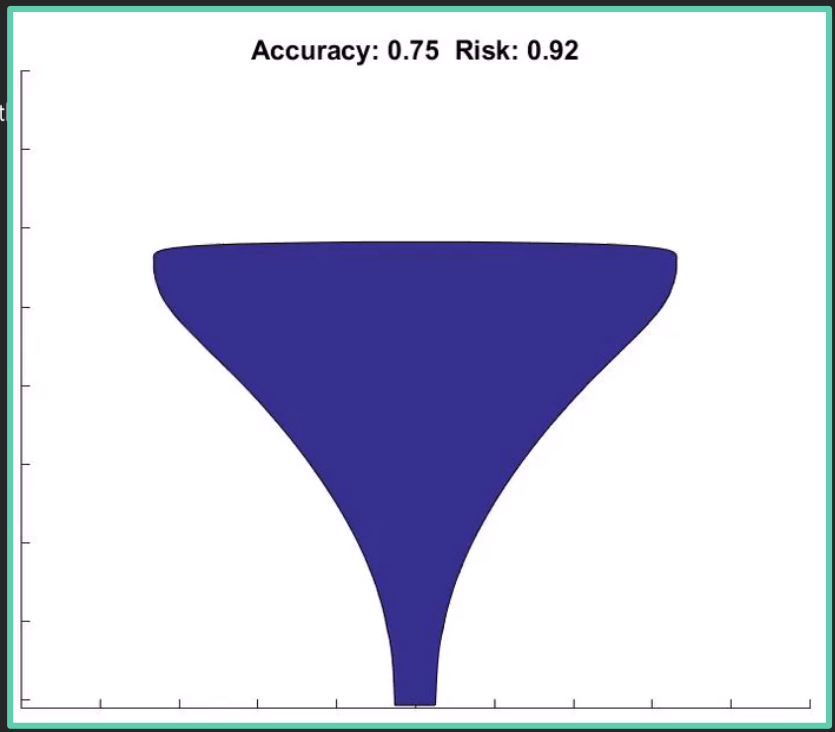


Optimizing Disturbances for Reachable Sets



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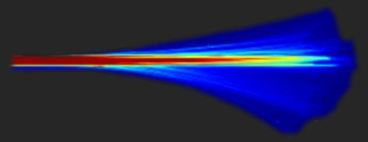
Driver Modeling and Active Safety

If we can identify the driver state and effectively predict their likely behavior, can we design better, less invasive active safety systems?

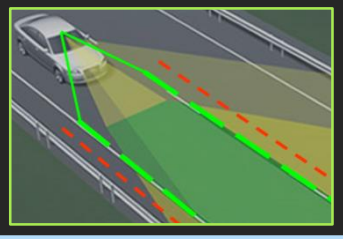
Driver Prediction



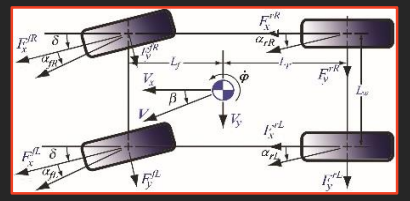
Intervention Function

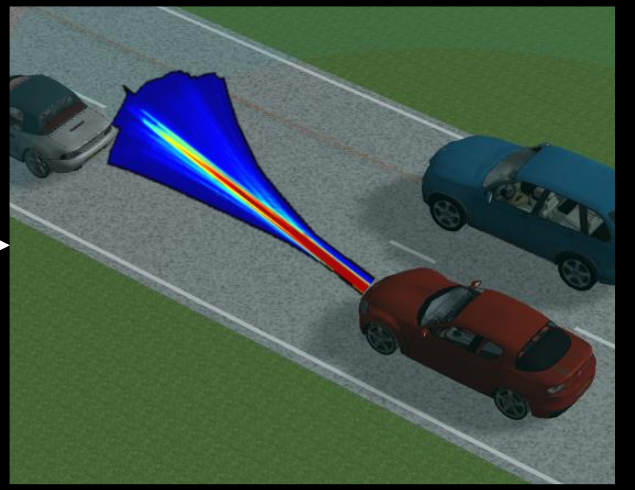
$$\mathcal{G}_k(\alpha,\tau) = \begin{cases} 1\text{ , if } \exists k\ s.t. |\Delta_k \cap \mathcal{C}_k| \geq \tau \\ 0\text{ , otherwise} \end{cases}$$

Environment Model



Model Predictive Control





V. Shia, Y. Gao, R. Vasudevan, **K. Driggs-Campbell,** et al. *Semi-Autonomous Vehicular Control Using Driver Modeling*, Transactions on ITS 2014.

Interaction Constrained Autonomous Planning

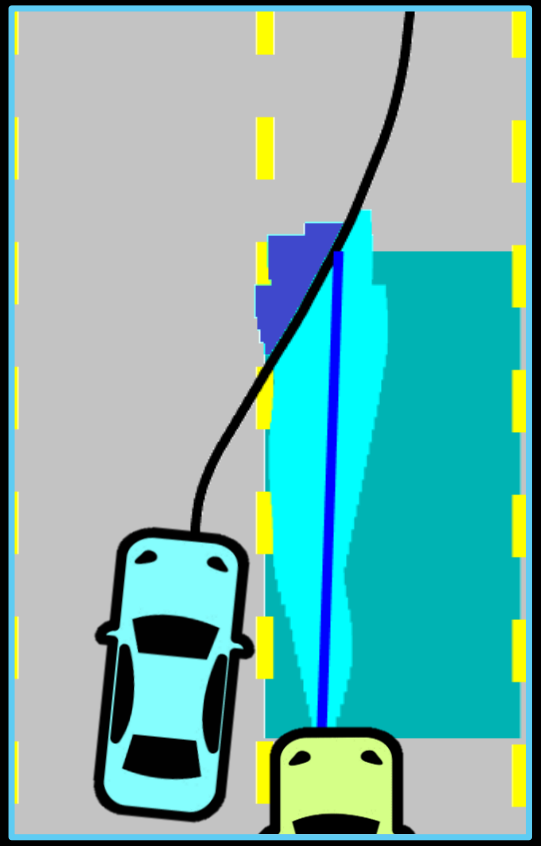
If we can predict likely driver responses in cooperative maneuvers, can we design autonomous systems that can effectively integrate with human drivers?

optimize *cost function*

subject to *dynamic feasibility*

safety constraints:

<insert human model>



K. Driggs-Campbell, et al., *Integrating Intuitive Driver Models in Autonomous Planning for Interactive Maneuvers,* in Transactions on Intelligent Transportation, 2017.