Foresee the Unseen

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Sequential Reasoning about Hidden Obstacles for Safe Driving

Safe driving requires autonomous vehicles to anticipate **potential hidden traffic participants and objects**. Existing methods typically do not consider **arbitrary shapes** of hidden obstacles and do not reason about **observations over time**. We overcome these limitations by (1) **modeling possible hidden obstacles as a set of states** of a point mass model and (2) **sequential reasoning based on reachability analysis** and previous observations.

The Problem

Autonomous vehicles need to model possible hidden obstacles **conservatively enough**, such that any possible unseen obstacle is represented and considered, regardless of their size or orientation, such as the motorcycle in **Figure 1**.

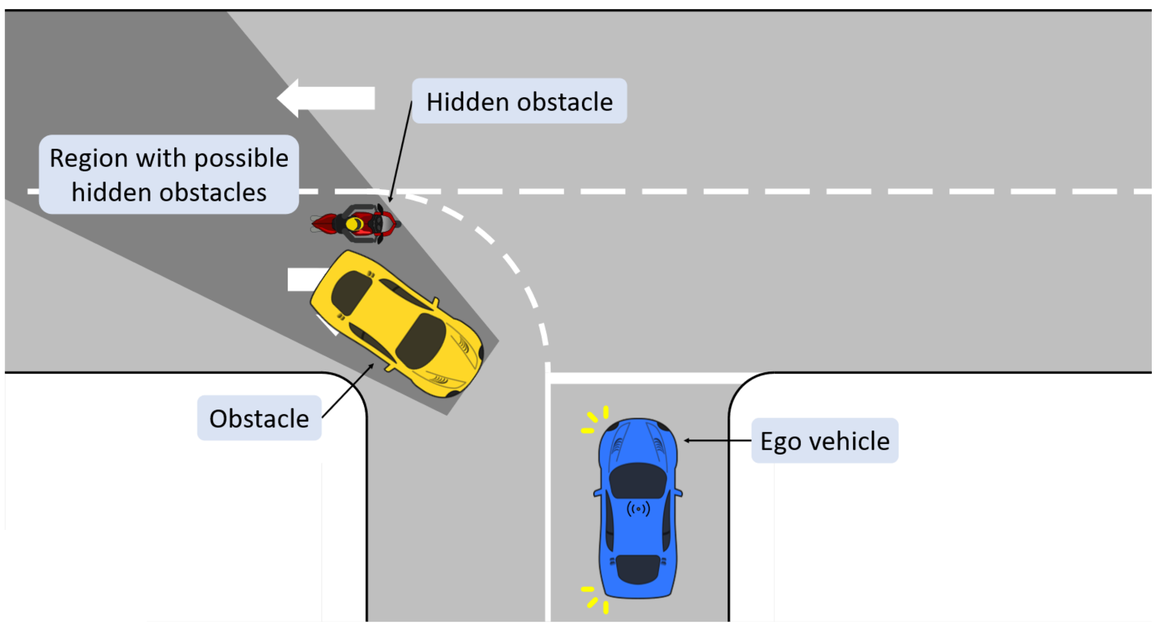

***Figure 1**. A dangerous situation where defensive driving is needed.*

However, modeling possible hidden obstacles **too conservatively** limit autonomous vehicles from finding safe and efficient paths.

Given **past observations** and assumed constraints on driving (e.g., maximum speed and other traffic rules), currently unseen regions can still be concluded free from obstacles, such as the checkered region in **Figure 2**.

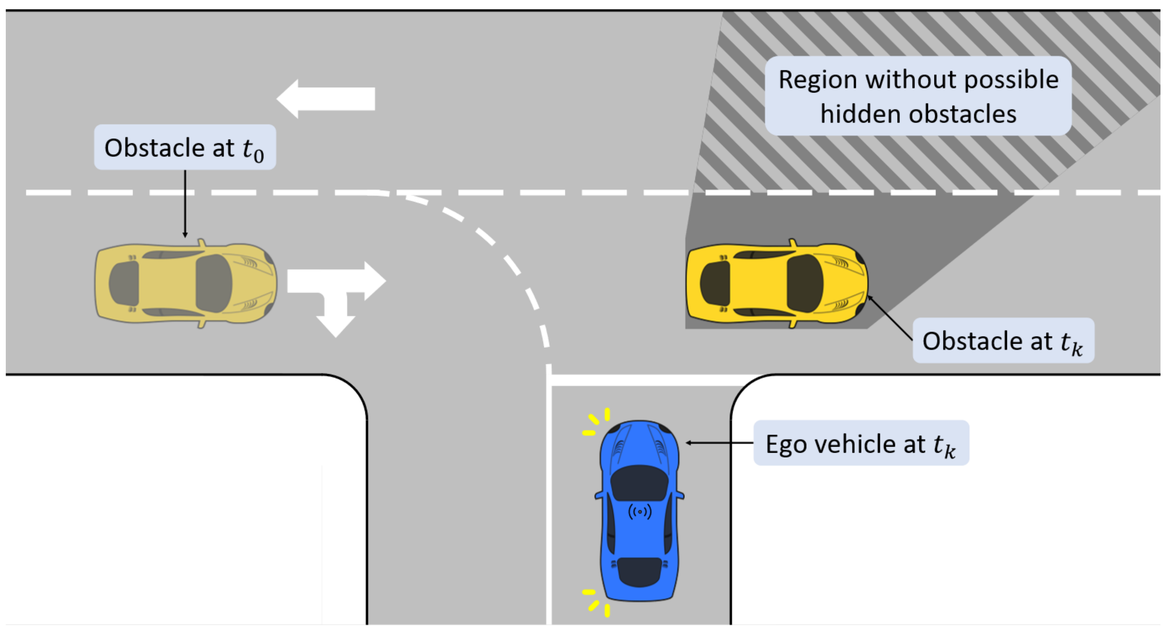

***Figure 2**. A typical situation where autonomous vehicles generally are too conservative. The checkered region was previously seen, and it can be concluded that no object could have reached there.*

The Solution

By **initially** considering the complete unseen region as potentially occupied, our method captures **any** hidden obstacle (**Figure 3a**). By **iteratively** updating which regions possibly can be occupied, we avoid being **too conservative.**

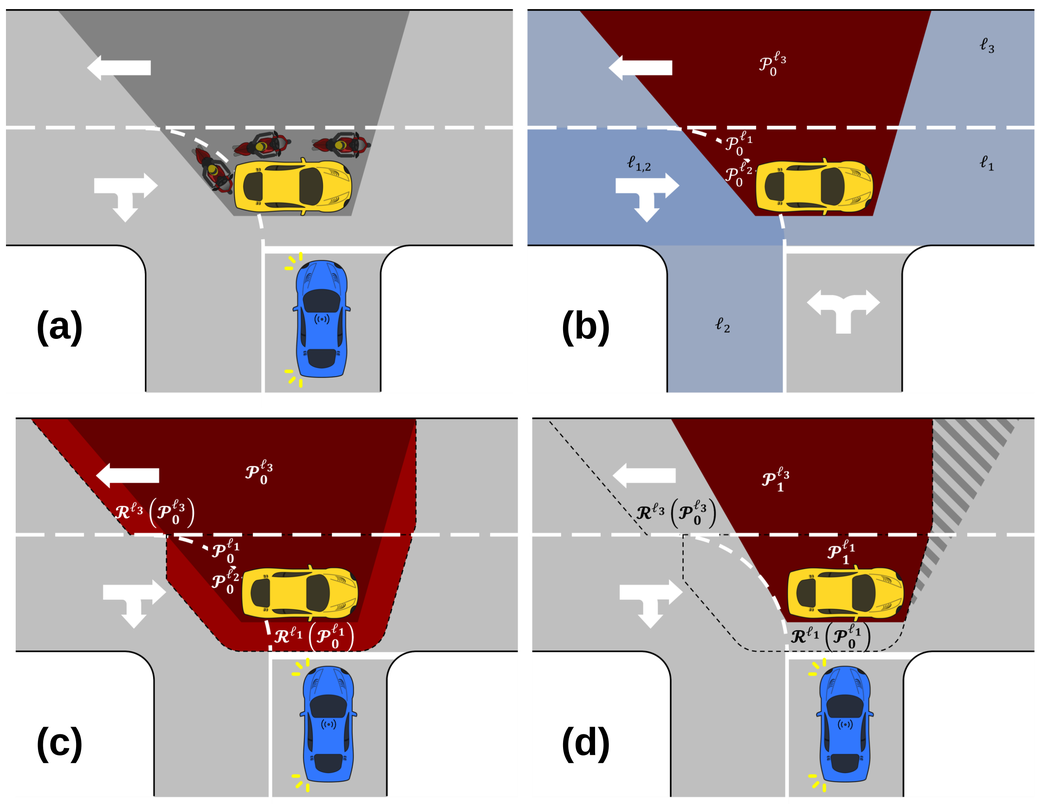

***Figure 3**. Algorithmic steps for reasoning.*

For each lane (**Figure 3b**), the reachability is computed for the possible hidden obstacles (bright red in **Figure 3c**). New unseen regions are deemed free if they cannot have been reached since the last observation (the checkered region in **Figure 3d**). The result can be seen in **Figure 4**, where the time to traverse the intersection is **greatly reduced** by reasoning about possible hidden obstacles over time.

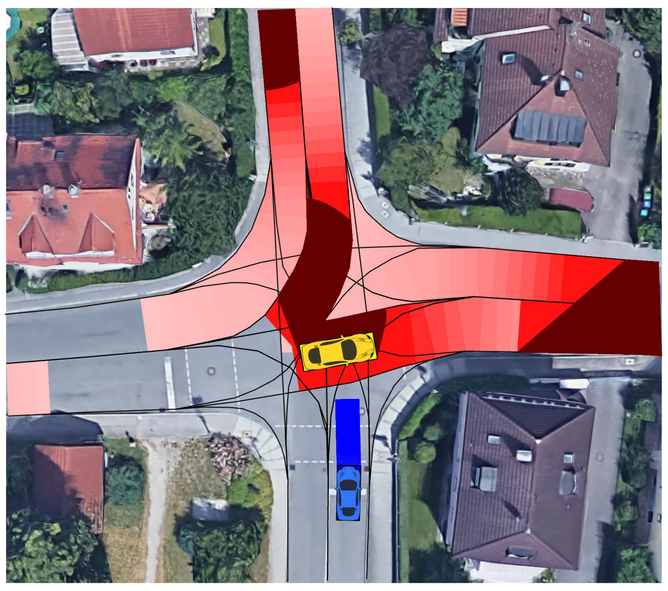

***Figure 4**. Simulation in CommonRoad of intersection in Fürstenfeldbruck, using the proposed algorithm.*

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