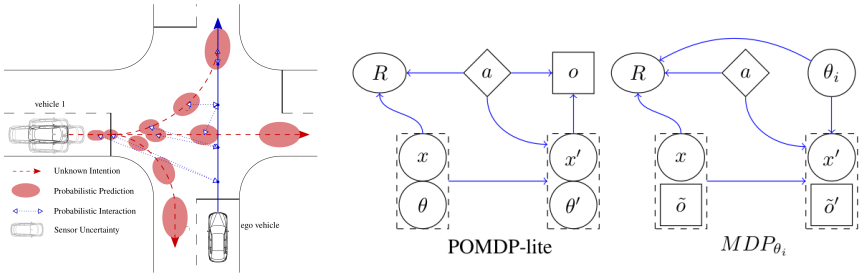
Karlsruhe Institute of Technology

Master Thesis

Efficiently solving POMDPs with constant hidden states by solving an equivalent family of MDPs

A principal framework for decision making under uncertainty are Partially Observable Markov Decision Processes (POMDPs). Prior work has utilized POMDPs to plan stochastically in autonomous driving environments with incomplete information about other agents' intentions and uncertain perception. [1, 2].
In many situations in autonomous driving, the dominant uncertainty is the unknown intention and future behavior of other traffic participants. Most of the time this uncertainty can be modeled by a constant parameter encoding e.g. the planned route or the aggressiveness/cooperation of other vehicles.



Intersection scenario with uncertainties [1] (left), POMDP-lite reformulation as family of MDPs [3] (center and right)

The POMDP-lite algorithm exploits the structure of POMDPs with constant hidden parameters by reformulating the problem as a family of MDPs, one for each possible hidden parameter [3].
The goal of this thesis is to use the ideas of this POMDP-lite algorithm and apply it to an autonomous driving scenario. This can also involve to transfer the POMDP-lite idea to other POMDP algorithms to allow for continuous observation spaces.

This sounds exciting? Then apply to us! Methods and scope of the thesis can be adapted to your interests and previous knowledge. The proposed thesis consists of the following parts:

+ Literature research about online POMDP algorithms
+ Implementation of autonomous driving scenarios in simulation
+ Combine POMDP-lite ideas with other POMDP algorithms
+ Evaluation of the implemented methods

I am happy to answer any questions you might have. Feel free to ask for an appointment or directly ask at my office!

References

[1] Hubmann et al., "Decision Making for Autonomous Driving Considering Interaction and Uncertain Prediction of Surrounding Vehicles", (2017)
[2] Bouton, Cosgun, and Kochenderfer, "Belief State Planning for Autonomously Navigating Urban Intersections", (2017)
[3] Chen et al., "POMDP-Lite for Robust Robot Planning under Uncertainty.", (2016)

Institute of Measurement and Control Systems (MRT)
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Programming language(s)[1]:
Python / Julia — advanced

System, Framework(s):
Linux

Required skills:
- Solid mathematical foundations
- Work on your own

Language(s):
German, English

For more information please contact:

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Or directly send in your application including your current grades as well as our questionnaire!

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[1] **skill levels:**

beginner	< 500 lines of code (LOC)
advanced	500 – 5000 LOC
proficient	> 5000 LOC