

CommonRoad-CriMe: A Toolbox for Criticality Measures of Autonomous Vehicles

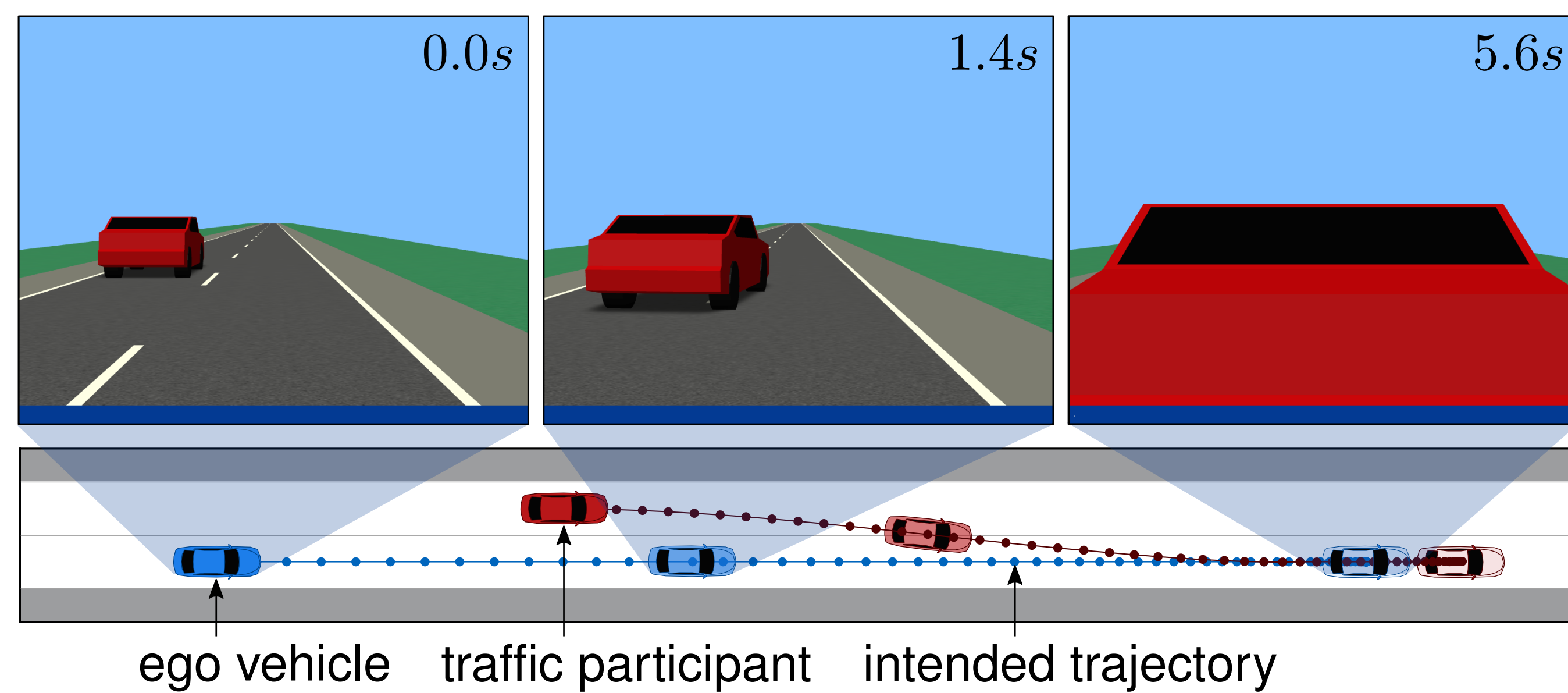
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<https://commonroad.in.tum.de/tools/commonroad-crime> | `pip install commonroad-crime`

I. Criticality Measures

Scope: primarily developed to objectively determine the behavioral safety and threat level of autonomous driving systems



An exemplary critical scenario in which the other traffic participant (red) cuts into the lane of the ego vehicle (blue) and brakes hard.

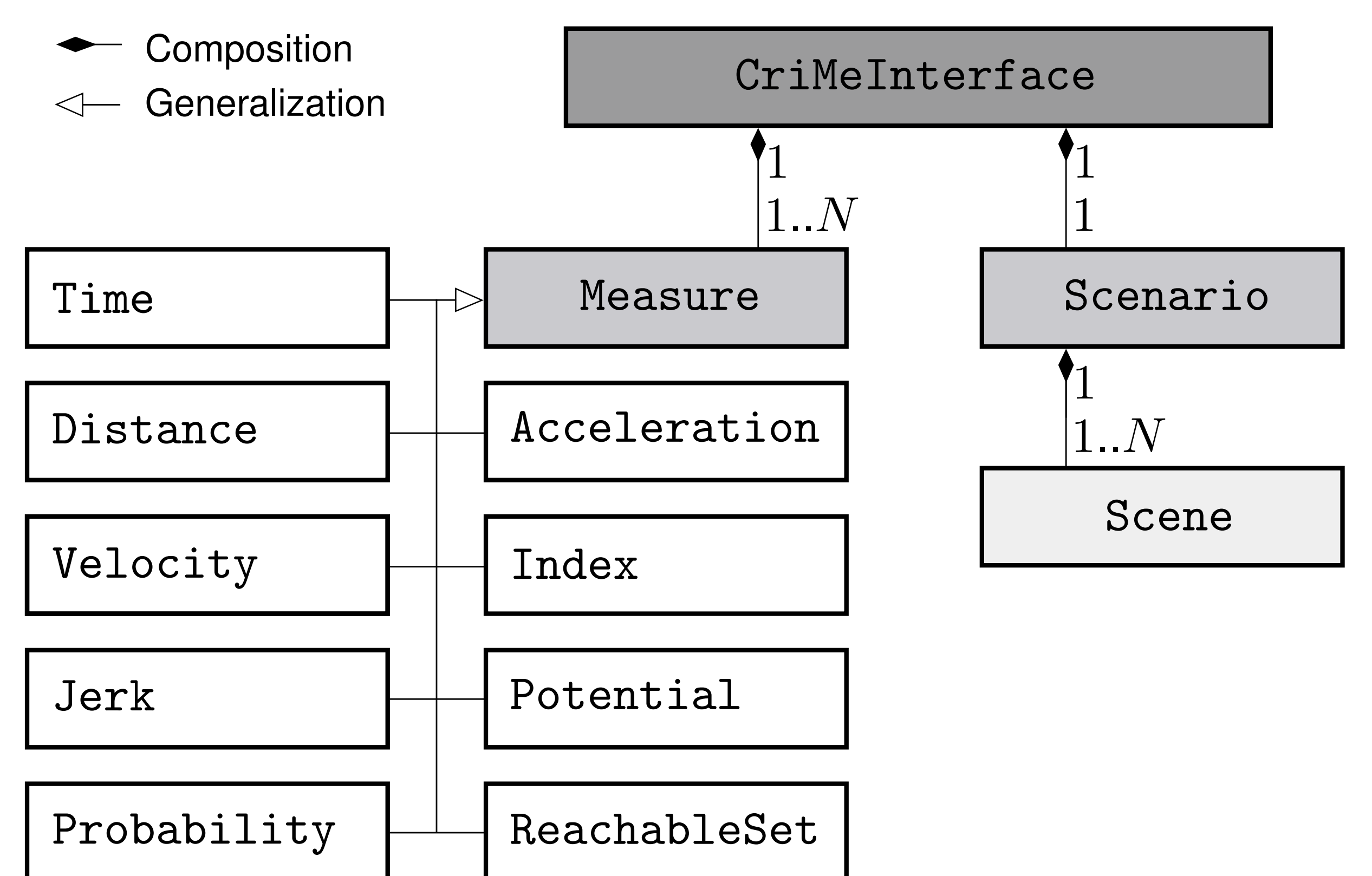
II. Contributions

To effortlessly measure and compare the criticality of an autonomous vehicle, the novel CommonRoad Criticality Measures (CommonRoad-CriMe) toolbox:

- provides a unified framework in **Python**;
- adopts and supplements the **categorization** of criticality measures;
- is **open-source** and allows users to easily modify, add, and compare criticality measures; and
- offers **efficient and reliable** computation by bridging to powerful scenario evaluation tools:

drivability checker | scenario designer
set-based predictor | reachability analyzer

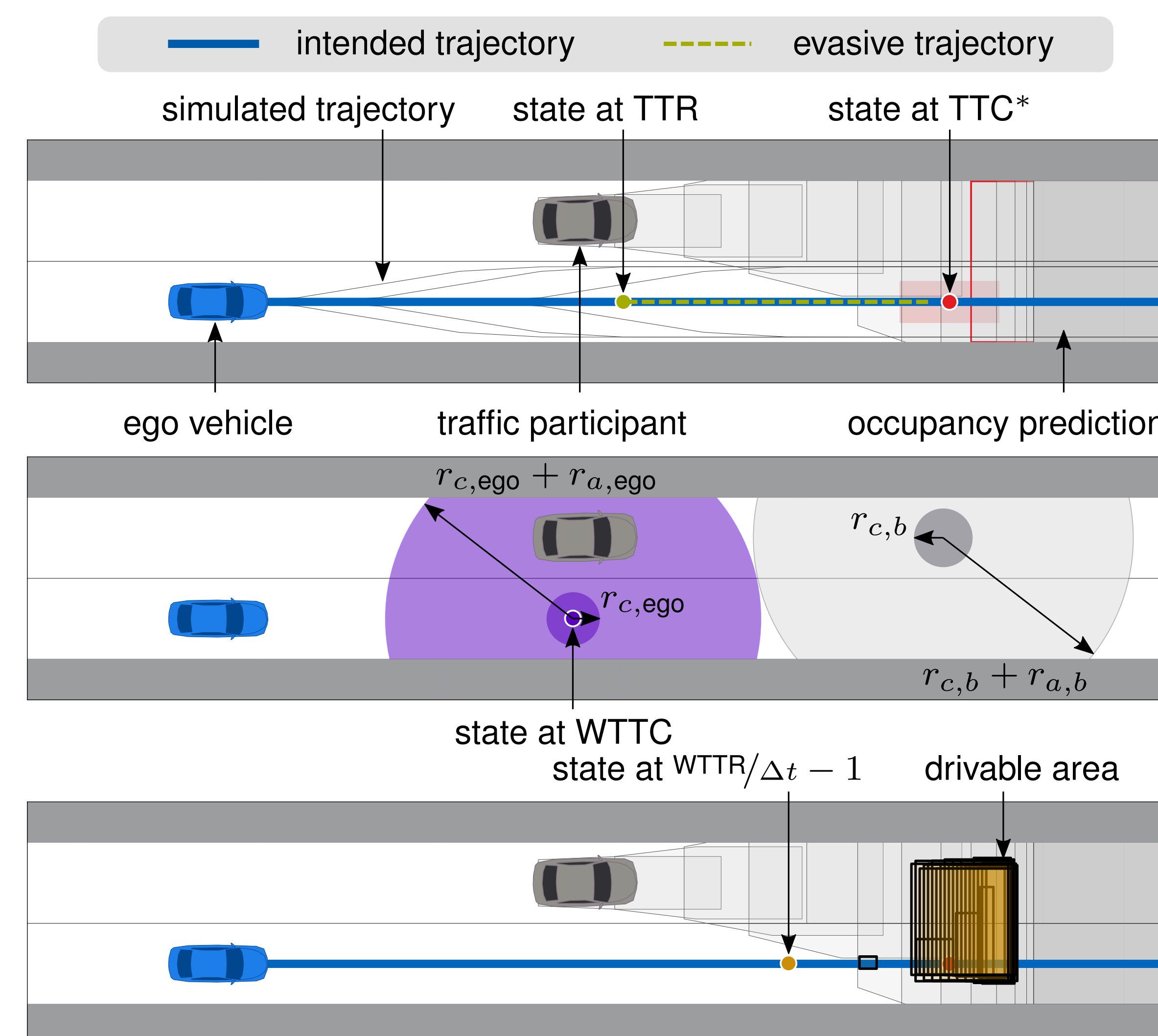
III. Overview



UML class diagram of CommonRoad-CriMe.

IV. Exemplary Measures

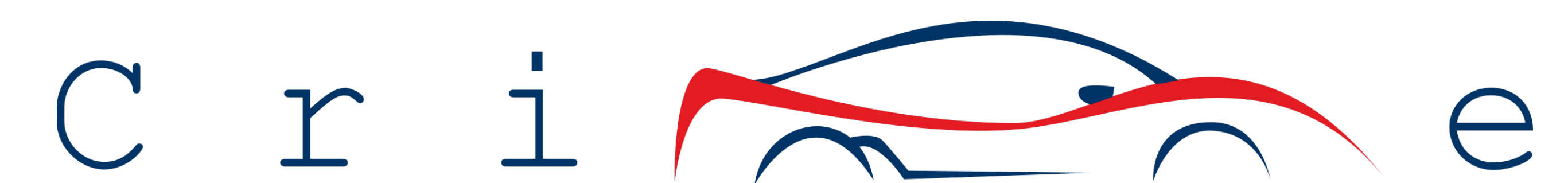
- **Definition (Time-To-Collision (TTC))** *TTC is a measure of the time remaining until a collision occurs.*
- **Definition (Time-To-React (TTR))** *TTR is the maximum remaining time for the last possible evasive maneuver, which can be approximated as the maximum of time-to-brake (TTB), time-to-steer (TTS), and time-to-kickdown (TTK).*
- **Definition (Worst-Time-To-Collision (W TTC))** *W TTC is the minimum time until a potential collision, assuming all participants move to expedite the collision.*
- **Definition (Worst-Time-To-React (W TTR))** *W TTR tightly overlaps and approximates the TTR by iteratively checking the existence of collision-free reachable sets (drivable areas) of the ego vehicle.*



VI. Conclusions

We present the **first** toolbox for measuring the criticality of autonomous vehicles that is **open-source, easy-to-use, and contains state-of-the-art measures**.

We hope that CommonRoad-CriMe will make it easier for intelligent transportation researchers to evaluate their autonomous driving functions with various criticality measures and traffic scenarios.



Contributions to further improve and expand the capabilities and structure of CommonRoad-CriMe are welcomed!

References

- [1] C. Neurohr, L. Westhofen, M. Butz, M. H. Bollmann, U. Eberle, and R. Galbas, "Criticality analysis for the verification and validation of automated vehicles," IEEE Access, vol. 9, pp. 18 016–18 041, 2021.
- [2] <https://criticality-metrics.readthedocs.io>



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