

Safety Evaluation of Automation Using Counterfactual Simulations



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This project focuses on counterfactual (“what-if”) virtual safety assessment of automated vehicles in scenarios where they interact with vulnerable road users (VRU; bicyclists and pedestrians). Bayesian statistical methods are used, and one aim is to enable integration of computational models of human interaction with automated vehicles into the virtual simulations.

BACKGROUND

- 1.3 million people died in traffic in 2016 (WHO;2018)
- It is necessary to assess and evaluate automated vehicles functionalities before the systems is in production and on the road
- Virtual safety assessment is an effective safety assessment method
- There is a lack of methods for virtually assessing the safety of automated vehicle interaction with pedestrians and bicyclists
- There is a lack of robust statistical methods for virtual safety assessment

COUNTERFACTUAL SIMULATION

- AEB system effectiveness by counterfactual simulations
- Similar crash position distribution across different AEB algorithm approaches
- Results (see Figure 1) show similarities in, e.g., impact position – important knowledge when developing future in-crash and automated protection system

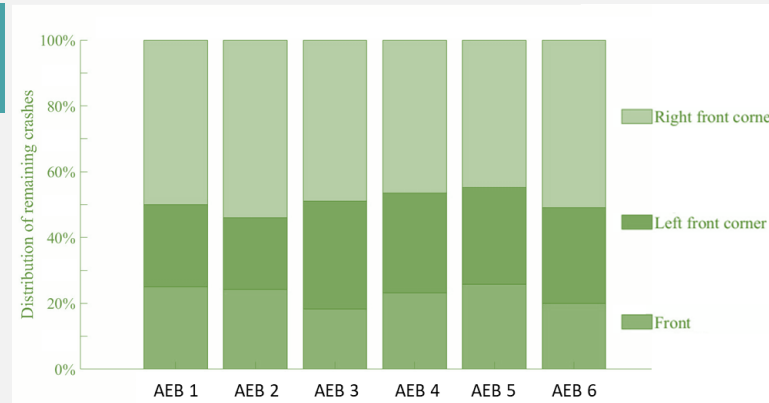


Fig. 1: Impact position distribution after six AEB system implementation

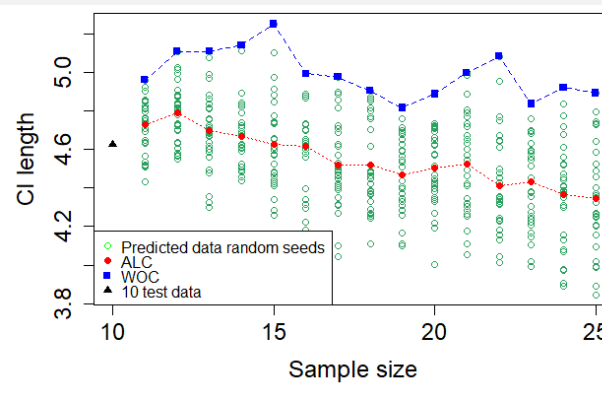


Fig. 2: Example of average and worst case stopping criteria for sample size determination

BAYESIAN STOPPING CRITERIA

- Unlike frequentist methods, the “state of knowledge” about whatever is being studied is the basis of Bayesian mindset
- Bayesian stopping criteria could be used in sample size determination – both for physical experiments and for simulations
- Figure 2 demonstrates Bayesian stopping criteria for a simple high-way driving speed study. It shows that, with a larger sample size, different criteria (ALC and WOC) suggests different sample size requirement for the same precision of the speed (CI, credible interval length)
- Application to virtual simulations will follow application to experiment data

LATEST RESEARCH

Yang, X., Lubbe, N., & Bårgman, J. (2021). Different automated emergency braking algorithm designs result in similar residual crash characteristics: Virtual benefit assessment of AEB for car-to-two-wheeler crashes in China. Accident Analysis & Prevention, in review.

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