Statistical Robustness for Automated Driving Software

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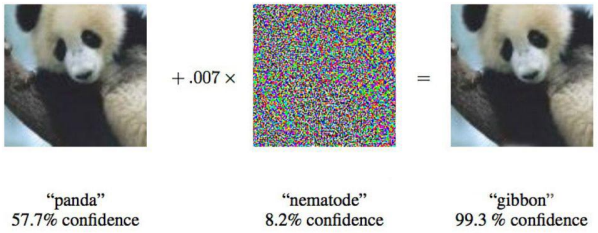
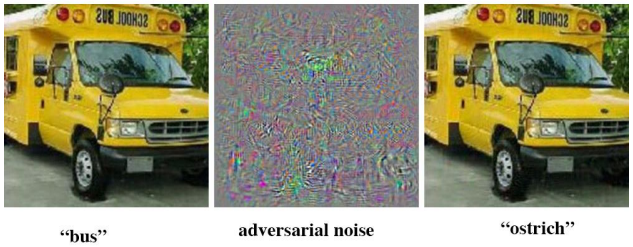
Uncertainty

- There are many uncertainties in automated driving systems:
  - Unpredictable environments
  - Limitations and noise of sensors
  - Unpredictable actuation
  - Inaccurate motion model
  - Stochastic features of algorithms such as localization, perception, and timing properties
- Robustness w.r.t uncertainties analysis provides measures for safely deploying and being accepted in public

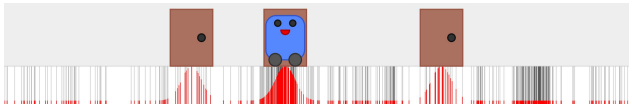
- During 1 hour of operation, is the probability that the object detection produces different output on a perturbed input smaller than 10^{-9}?



- During 1 hour of operation, is the probability that the (MCL) localization produces significant different pose on noised Lidar data smaller than 10^{-9}?



- During 1 hour of operation, is the probability that the latency of sending any message is within 10 ms smaller than 10^{-9}?



10^{-9} is required failure rate for ASLI D

Statistical Robustness

- It requires at least 10^9 hours of operation or around 3.10^{10} miles
- It is absolutely impossible in practice even in simulation

This proposal provides:

- A framework for automatically estimating very small probabilities of how robust a software module is w.r.t uncertainty
- The estimation run-time is in the order of several hours
- The software module can be highly trained ML models, localization, or any software's timing properties