A Language for Autonomous Vehicles Testing Oracles
Ana Nora Evans, Mary Lou Soffa, Sebastian Elbaum
University of Virginia

End-to-end AV Testing
- AV Software
- Simulation Software
- Monitor

SCORING ORACLES

AV Specifications/Oracles
Sources:
1. Traffic rules and regulations
2. Local driving customs
3. Human driver behavior
4. Safe/defensive driving rules
5. Formal safety models

Conflicting Goals: Safety and Efficiency

Challenges:
1. Large number of smaller specifications
2. Either imprecise or too formal for most AV developers
3. Mostly pass/fail, cannot be used in search and optimizations
4. A numerical score assigned to a an execution is useful for raking AV solutions.

Goal: A New Framework

Scoring Functions
Event: predicate on trace element.
Action: score update.
Notification: to another scoring function.
Condition: predicate on a sequence.

Lane Keeping
- Every time the AV drives on the line for more than three seconds subtract one.

Speeding
- Deduct one every time the speed limit is exceeded.

Timeliness
- Every time the AV reaches a fixed point on the path keeping
- The time a trace element is processed, the expiration is:
  - predicate on trace
  - action
  - expiration (false/true).

Deceleration:
- Every time the AV decelerates for at least two seconds. When the deceleration triggers, the expiration variable of the collisions scoring functions is set to half second.

Temporal Specification
Deceleration before collision:
- If the AV decelerates within half of second for at least two seconds before a collision, then the score is one otherwise is zero.

Safety Specification
Condition: not set. The function triggers every time the event is true.

Results and Conclusions
We encoded three open source specifications in the DSL. We used the simulator and 474 student solutions to the Path Planning Project of Udacity’s Self Driving Car program.

Conclusions:
- Trustworthy AVs Require Testing the Specifications!
- We propose a language for specifications and an oracle independent of the AV frameworks and simulators.
- Future work:
  1. Define test coverage criteria for specifications.
  2. Develop testing techniques for specifications.
  3. Static analyses to find similarities between specifications.

We propose a language for Autonomous Vehicles Testing Oracles.