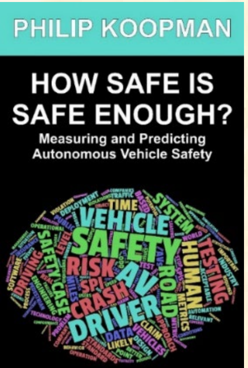
Safety Case Considerations For Scenario-Based Assurance

Prof. Philip Koopman



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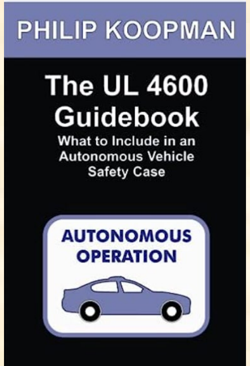
HOW SAFE IS SAFE ENOUGH?

Measuring and Predicting Autonomous Vehicle Safety



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The UL 4600 Guidebook

What to Include in an Autonomous Vehicle Safety Case

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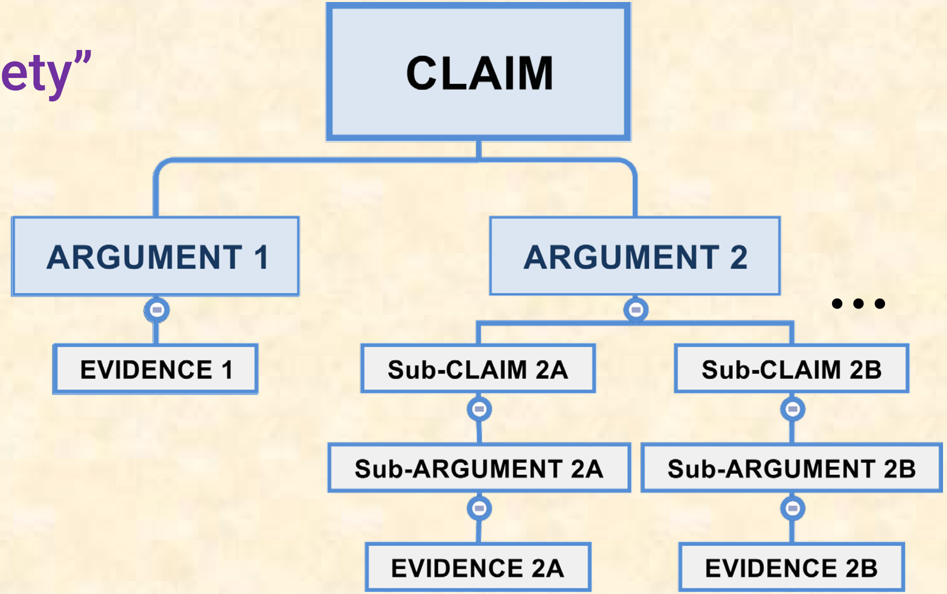
Safety Case

- Claim – what you think is true
  - “Scenario-based testing proves safety”
- Argument – why this is true
  - “A & B & C & D and not E”
- Evidence – supports argument
  - Tests, analysis, simulations, …
- Sub-claims/arguments address complexity
  - “No loss events in scenario simulations”
  - “Simulation results predict real-world safety”
  - *… other considerations we’ll discuss today …*



Limits To Simulation Scope?

- What, exactly, is out of scope for scenario-based validation?
  - Perception limitations?
    - Misclassified objects, age-related degradation, …
  - Equipment failures (e.g., degraded modes)?
    - Camera lens cleaning system failure
  - Infrastructure failures?
    - Missing/degraded road markings
    - HD map missing a bridge collapse
  - Novel road users, objects, events
    - Tumblegeddon (Jan. 2020, WA state)
- Track these for resolution in safety case

https://bit.ly/3COCkrg

Tool Qualification

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- Could someone die because of a tool defect?
  - Simulations are life critical if they replace road testing
- Simulation software quality
- Simulated object/event completeness
  - Do you have 1 billion miles of weirdness captured?
- Simulation campaign management
  - Simulations being run correctly?
  - Low probability * high consequence accounted for?
  - Pass/fail criteria defined and reported accurately?
  - Results recorded & reported accurately?

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Surprises

- Claim: “Scenario set is complete”
  - ➔ Every surprise is a safety case defect
- Need to instrument surprise arrival rate
  - – Ideas from Software Reliability Modeling

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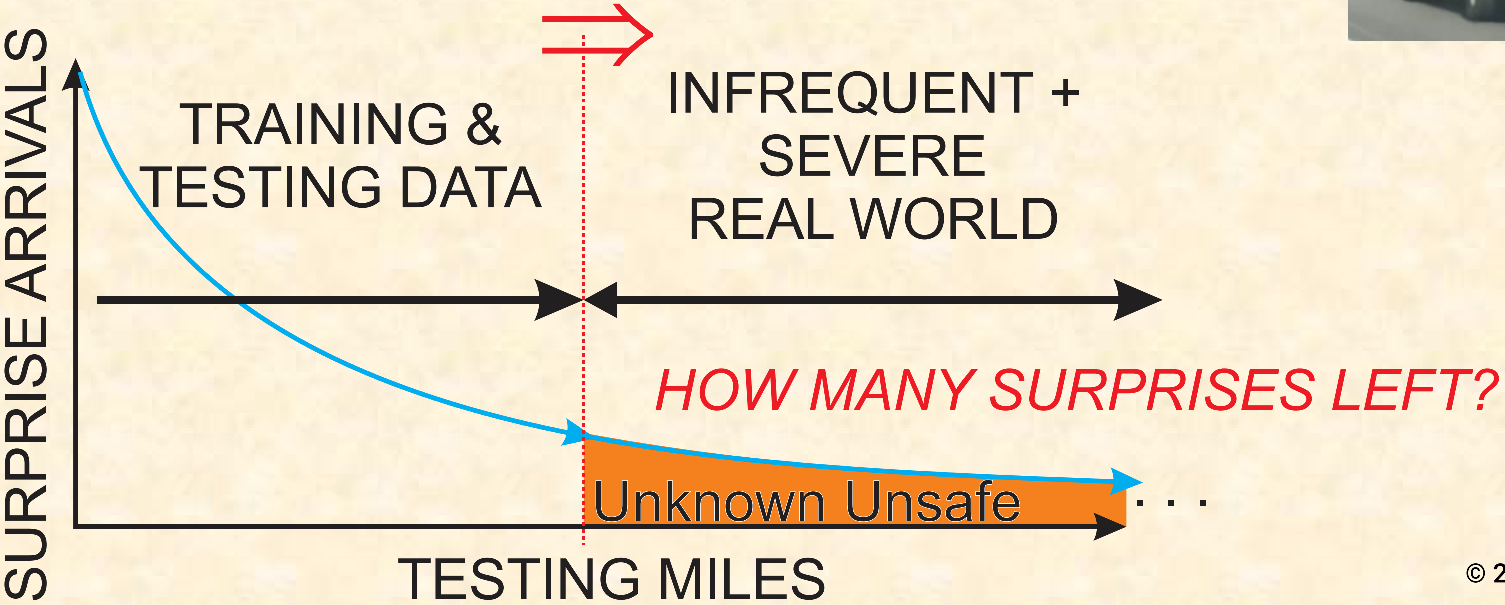

Acceptable Safety

- Set robust pass/fail expectations
  - Getting lucky is not enough for safety!
  - Did AV violate traffic laws?
  - Did AV honor safety buffers?
  - Is prediction capability accurate enough?
- Prioritize lack of negligent driving
  - Average driver improvement is not enough
  - Compare to a Reasonable Driver
    (i.e., lack of negligent behaviors)

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Take-Aways

- Use a written safety case
  - It helps expose gaps in safety thinking
- Simulations are doomed to succeed
  - Ensure safety even if holes in scenario set
- Tooling just got life critical
  - If you skip any part of real-world validation…
    … that simulation is now life critical
  - That includes models, test orchestration, report spreadsheets, …
- The real world does not follow your rules
  - “That wasn’t supposed to happen” … will find a way to happen

https://on.gei.co/2r2rjzg

You Might Forget the Rare Events

…

But They Won’t Forget You!