Efficient Discovery of Actual Causality using Abstraction-Refinement

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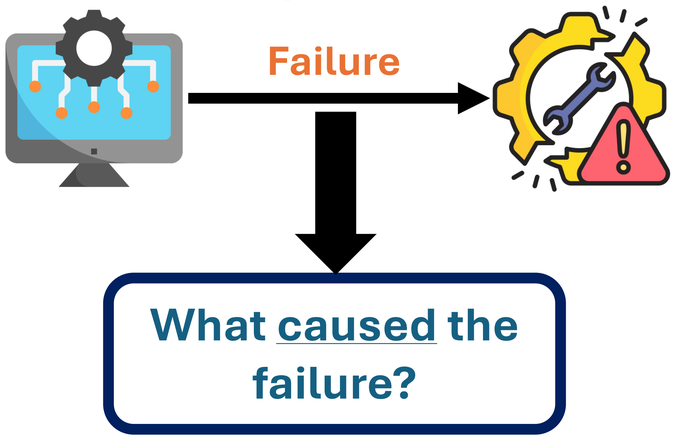
Paper

Research Question



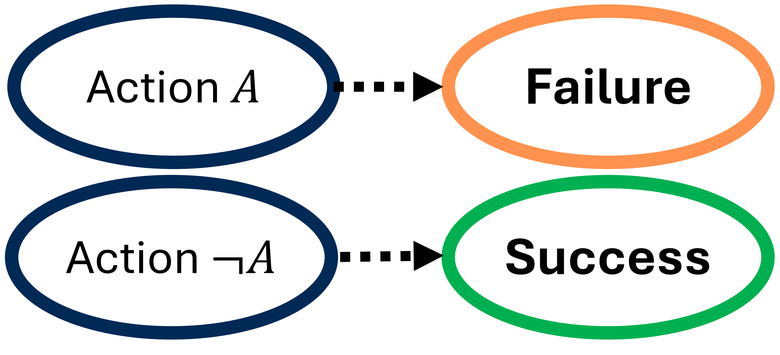
In this study, we are investigating the actions and decisions in Cyber-Physical Systems that cause failure. We believe that by acknowledging the failures, we can fix or prevent them.

What is Causality ?

Causality is the science of cause (action) and effect (failure). We identify a framework to reason about causality mathematically.

What is Actual Causality?

A causality framework established by Halpern & Pearl. Based on counterfactual reasoning.

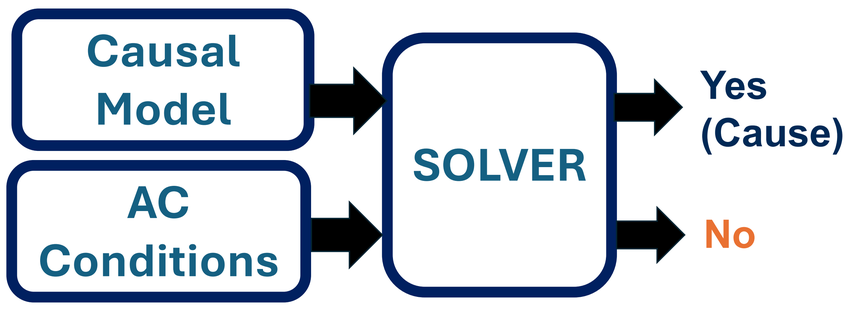


A is a cause of Failure (effect) if, but for A, Failure would not have happened.

Actual Causality Conditions

- Both Cause and Effect Happen.
- Changing the cause to a counterfactual setting will result in the effect not occurring.
- Ensure that no other event, besides the cause, is influencing the effect.
- The set of causes must be minimal.

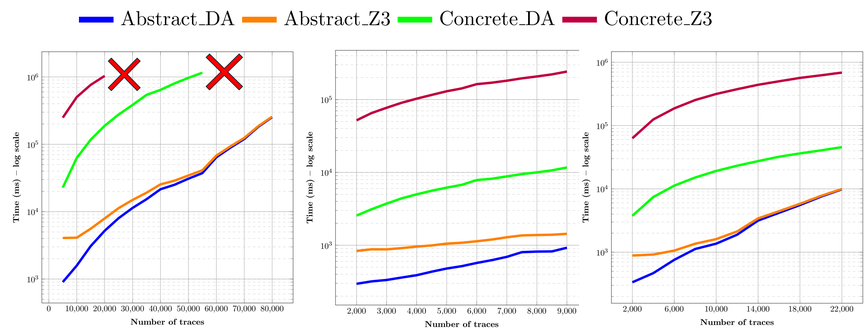
Discovery of Actual Cause



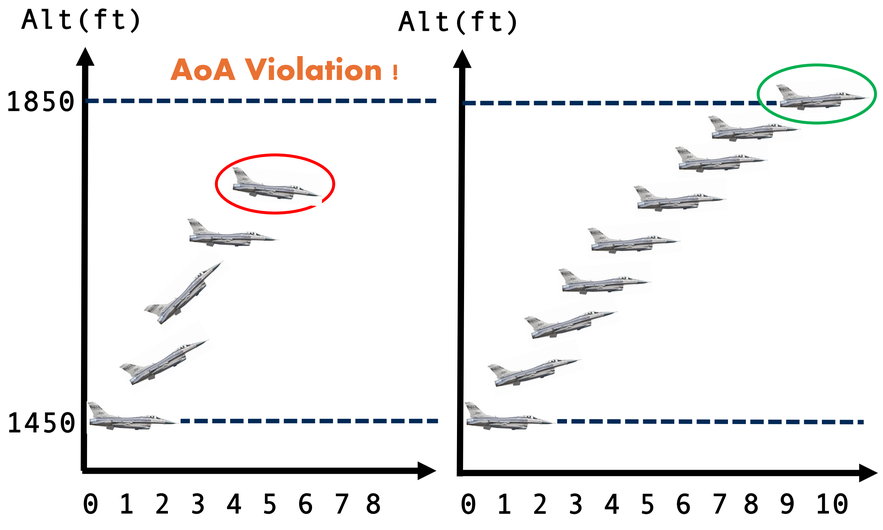
Abstraction Method

Actual causality follows the form ∃∃∀, making the solution non-scalable and DP-complete. An abstraction-refinement method is used to address this issue.

How Efficient is this?



Why is Finding the Actual Cause Important in CPS?



Take Aways!

- Actual causality enables us to explain the root cause of events.
- SMT encoding to discover the actual cause.
- An abstraction-refinement method to make it more efficient.