WRT-1011: Incubator: Validation for AI and Autonomous Systems

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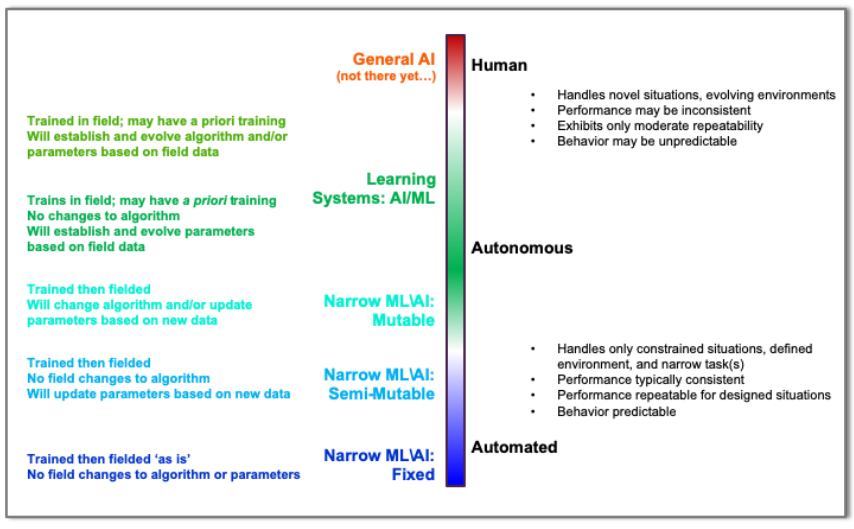
Research Task / Overview

We are applying a structured, analytical concept of validation as a guidance technology for all design and development phases of autonomous and learning-enabled AI systems.



The power of AI is to create systems that perform functions beyond their design, adapting to situations that were never anticipated by their designers. Traditional methods based on requirements and verification fail such systems, which pose unique fielding challenges:

- ***Here ≠ There***: Training in the CONUS or Theater X is frequently not transferable to performance in Theater Y. Not only will the notion of ***asset transferability*** break down, but so will the concept of a ***Digital Twin***.
- Notions of ***sufficiency*** change tremendously moving from automated to LE systems. When is training sufficient? How does that answer change when a system must learn in the field?

These systems should not be designed to execute a closed set of Required functions which are then Verified.

Goals & Objectives

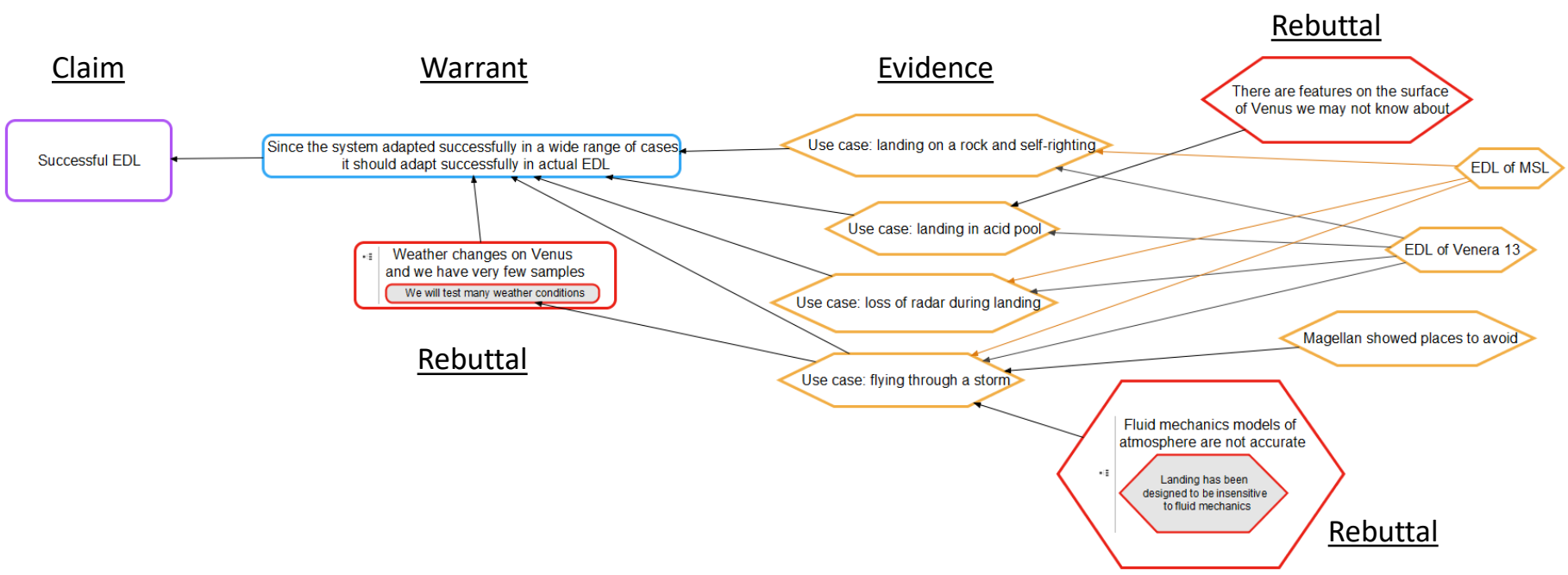
1) Evaluate existing paradigms for LE or complex systems that are similarly analytically intractable (namely, autonomous vehicles and operational simulations such as OneSAF and COMBAT XXI) to understand existing notions of what can be validated and acceptable levels of risk. Define the spectrum of AI capabilities relevant to validation as a framework for what may serve as an argument basis in each. Begin to fill in the components of the Toulmin Argument Pattern, and establish the correspondence of this method to the SE process. Establish the calculation of confidence from the elements of the argument.
2) Identify a relevant DoD system development program that will serve as a basis from which to evaluate our approach and assess construction of a validation argument for LE systems.
3) Develop a conceptual design of the validation tool and construct a plan for development of a prototype.

Methodology

To formalize and articulate validation, we use Stephen Toulmin's analysis of argument, shown in the example below. The argument consists of claims we wish to prove, warrants which provide reasons for accepting the claims, evidence that support the warrants, and rebuttals that expose flaws in warrants and grounds. Throughout development, the validation process gathers and builds evidence, adds and refutes rebuttals, and enhances warrants.

Data & Analysis

One claim from an example application of the Toulmin framework to validation of an autonomous Venus lander



Future Research

Formal, structured validation is a tool that can guide development of an autonomous system from concept to Initial Operating Capability with minimal dependence on functional requirements and maximum freedom to find the most effective and robust design. We hope to develop and demonstrate a comprehensive set of methods, processes and tools for developing AI and Autonomous Systems, and unleash the potential power of AI across commercial and military applications.

Contacts/References

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