Testing of Autonomous Systems

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The Emergence of Autonomous Systems

❏ Autonomous systems exist in various application domains, which they expose different level of autonomy and require different testing techniques and approaches.

Challenges in Testing of Autonomous Systems

❏ Testing towards autonomous systems remains an unresolved area
- ❏ Complexities in the system
- ❏ Unambiguous requirements
- ❏ Unpredicted environments
- ❏ Non-deterministic behaviors

❏ Some examples of failure in testing of autonomous systems and their consequences
- ❏ Fatal accidents by Tesla and Uber autonomous car in 2018, pedestrians killed.
- ❏ Crashing of the ExoMars Mars Lander in 2016, had cost $350 million in lost equipment and time.

Solutions and Good Practices Needed for Testing of Autonomous Systems

❏ It is critical to ensure the correctness and safety over time yet there is no such an approach to validate and verify the autonomous systems in a systematic manner.

❏ No quality, safety, or testing standard has been settled by both the academia and industry, hence it is important to understand and explore what and how to test these systems.

❏ Limited tools, processes, guidelines are available for both test and safety assurance.

Approaches Available from the Academia

- ❏ Approaches and techniques used for testing of autonomous systems
  - ❏ Model-based testing - to systematically explore system states
  - ❏ Formal methods - to verify properties against a formal specification
  - ❏ Combinatorial testing - to reduce the test effort
  - ❏ Metamorphic testing - to address test oracle issues
  - ❏ Fuzzy testing - to randomly select test inputs
  - ❏ Fault injection - to address corner cases by dedicated values
  - ❏ Neuron coverage based approaches - to activate more neurons of the neural networks
  - ❏ Safety cage - to separate anomaly inputs based on confidence level
  - ❏ Simulation (SIL, HIL, VIL) - to reduce test cost, replicate failures, improve flexibility in test design
  - ❏ Publicly available datasets and virtual environments
  - ❏ ...