

Application of Actual Causality Canvas for CPS Failure Diagnosis

Anwenden des Actual Causality Canvas für Fehlerdiagnose bei CPS

Master's Thesis

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Context

Despite advances in model-based and rule-based diagnosis regarding failure identification and fault location, human experts are indispensable for failure diagnosis becoming more and more the bottle neck in the development cycle. In order to support the human expert, we want to incorporate causal reasoning into the diagnosis process as a way to increase the degree of automation.

In general, a failure is an abnormal condition or the *observable* deviation from the correct, expected behavior. This implies that before observing a failure there might be unobservable deviations, which we term errors. Now, a developer can neither fix failures nor errors. A developer can only repair flaws in the design / implementation of a system, which we call faults. In other words faults are manifested as errors, which in turn are manifested as failures. Apparently, there is a causal relation between faults, errors and failures, which we want to take as a starting point for exploring *actual causality* in the context of failure diagnosis.

Goal

In the course of this Master's Thesis the applicability of the actual causality canvas for automatic failure diagnosis for CPS will be investigated. We map the CPS failure diagnosis to the actual causality framework and afterwards we automate the causal reasoning by applying the actual causality canvas. The goal is to operationalize the theoretic framework of actual causality as a building block for automatic failure diagnosis.

Working Plan

1. Review the literature on automatic failure diagnosis in particular abductive reasoning-based approaches.
2. Familiarize with the concept of actual causality and the actual causality canvas.
3. Identify a simple, suitable CPS example to base discussions on (i.e. taken from the literature, some (open-source) simulation, ...).
4. Map the domain of CPS failure diagnosis to the actual causality framework.
5. Prepare a CPS case study: description, faults/errors/failures, causal model (i.e. FMEA, fault tree, ...)
6. Apply the actual causality canvas to automate the actual causality reasoning on the CPS case study (resp. its causal model).

Deliverables

- Causal model for the CPS case study
- Final thesis report written in conformance with TUM guidelines.
- Presentation of the work at the chair

References

- [1] Halpern, J. Y. "A modification of the halpern-pearl definition of causality". In: *Br. J. Philos. Sci.* (2015). arXiv: [1505.00162](https://arxiv.org/abs/1505.00162).
- [2] Ibrahim, A., Klesel, T., Zibaei, E., Kacianka, S., and Pretschner, A. "Actual Causality Canvas : A General Framework for Explanation-based Socio-Technical Constructs". In: *9th Int. Conf. Prestigious Appl. Intell. Syst. PAIS@ECAI2020*. 2020.