Model-based Diagnosis in Automotive System-Level Testing

Bachelor's Thesis, Master's Thesis

Supervisor: Prof. Dr. Alexander Pretschner
Advisor: Claudius Jordan
Email: `claudius.jordan@tum.de`
Phone: `+49 (89) 289 - 17314`
Starting date: Any time

Informatik 4 – Lehrstuhl für Software und Systems Engineering
Prof. Dr. Alexander Pretschner
Fakultät für Informatik
Technische Universität München

Boltzmannstraße 3
85748 Garching bei München

`https://www.in.tum.de/i04/`

sponsored by

Context

In the context of vehicle function development, Hardware-in-the-Loop test benches are used for functional validation on integration and system level. Such test benches are complex cyber-physical systems themselves and for their operation engineers require deep knowledge and understanding about the various components and their interdependencies. This is in particular important when they need to find out what exactly went wrong when a test case fails. Practitioners investigate the causes for the failures and, most importantly, they determine whether the test results are trustworthy. In other words, they decide whether a test case failure is *valid*, i.e. a flaw in the system-under-test (SUT) has been discovered, or *invalid*, i.e. the test case fails due to the inherent unreliability of the test bench. This investigation is associated with significant amount of time and, thus, is an important cost factor for validation & verification (V&V) projects.

In the literature various data-driven approaches to failure diagnosis can be found. One key characteristic of data-driven approaches is that they rely upon data. Hence, if no (or not enough) data is available, it is difficult to apply such approaches. In the literature, this problem is called the *cold-start problem* [3]. In particular, for freshly started projects (hence the term 'cold-start') there is no data (not enough past test runs) available that could be used to train a data-driven failure diagnosis tool.

On the other end of the spectrum there are model-based diagnosis approaches (e.g. [2, 1, 4]). Their problem is of course the requirement of a model. Hence, the effort of employing them in industrial settings is oftentimes prohibitive. The trade-off between effort and utility may benefit from reuse of models across different projects and, in particular, when not starting from scratch for every new project.

Goal

This thesis aims to integrate model-based diagnosis as a supportive tool into the V&V projects of our industry partner. Therefore, prominent approaches and algorithms will be gathered and evaluated for their practical application in real-world settings in a case study.

Application:
Please apply via email to claudius.jordan@tum.de. Your email should explain your interest in the topic and contain your current transcript of records. The most promising candidates will be invited for an informal interview. Upon mutual agreement, the thesis will be performed in cooperation with TraceTronic GmbH.

Working Plan

1. Familiarize with the literature on model-based diagnosis (MBD)
2. Summarize prominent approaches and algorithms rg. MBD
3. Plan the case study to compare and evaluate aforementioned approaches with regard to their applicability in the real-world setting [1]
4. Write the exposé
5. Implement a selected subset of approaches
6. Carve out the open challenges for the adoption of MBD approaches in the concrete real-world setting
7. Write the thesis report

Deliverables

- Exposé (about 6 weeks after kick-off)
- Source code of the implementation.
- Technical report with comprehensive documentation of the implementation, i.e. design decision, architecture description, API description and usage instructions.
- Final thesis report written in English and in conformance with TUM guidelines
- Presentation of the work at the chair (2-3 weeks after submission)

[1] `https://github.com/acmsigsoft/EmpiricalStandards/blob/master/docs/CaseStudy.md`

References

[1] Johan de Kleer and Brian C. Williams. “Diagnosing multiple faults”. In: *Artif. Intell.* 32.1 (Apr. 1987), pp. 97–130.

[2] Raymond Reiter. “A theory of diagnosis from first principles”. In: *Artif. Intell.* 32.1 (Apr. 1987), pp. 57–95.

[3] Inbal Roshanski et al. “The Cold Start Problem in Software Fault Prediction”. In: *30th Int. Work. Princ. Diagnosis*. 2019.

[4] Roni Stern et al. “Exploring the duality in conflict-directed model-based diagnosis”. In: *Proc. Natl. Conf. Artif. Intell.* 1 (2012), pp. 828–834.

Informatik 4 – Lehrstuhl für Software und Systems Engineering
Prof. Dr. Alexander Pretschner
Fakultät für Informatik
Technische Universität München

Boltzmannstraße 3
85748 Garching bei München

https://www.in.tum.de/i04/

sponsored by