

Discovering Causal Models for PX4 Unmanned Aerial Vehicle

Master's Thesis

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Context

Causal models are essential for diagnosing the failures of Unmanned Aerial Vehicles [1]. These models are usually in the form of directed acyclic graphs where nodes are events that happened at runtime and edges are representing the causal influence (see [2] for examples of such graphs). Although many methods exist in the literature to discover causal models from data [3], there is no comprehensive study on their effectiveness in the context of UAVs. In this thesis, different causal discovery algorithms such as Fast Causality Inference (FCI) are investigated by running them on a data-set of PX4 UAV [4] flight logs. Characteristics of those algorithms such as robustness and performance will be compared throughout the thesis.

Goal

The goal of this thesis is to characterize causal discovery methods in the context of PX4-powered UAVs. In this regard the following research question will be answered:

1. Which causal discovery method shows higher completeness, correctness and robustness in the context of PX4 UAVs?
2. How to improve causal discovery methods to generate better models for the diagnosis of PX4 UAVs?

Working Plan

1. Familiarize yourself with PX4 autopilot software and prepare the data-set
2. Review existing literature on Causal Model Discovery
3. Implement a pipeline for running causal discovery methods
4. Evaluate the characteristics of the methods and discuss the results
5. Write the thesis

Deliverables

- 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 conformance with TUM guidelines

References

- [1] Zibaei, Ehsan, Sebastian Banescu, and Alexander Pretschner. "Diagnosis of safety incidents for cyber-physical systems: A uav example." 2018 3rd International Conference on System Reliability and Safety (ICSRS). IEEE, 2018.
- [2] Schumann, Johann, et al. "Towards real-time, on-board, hardware-supported sensor and software health management for unmanned aerial systems." International Journal of Prognostics and Health Management (2015).
- [3] Spirtes, Peter. "Introduction to causal inference." Journal of Machine Learning Research 11.5 (2010).
- [4] <https://px4.io/>