DX'24
The 35th International Conference on Principles of Diagnosis and Resilient Systems
4 - 7 November 2024
Vienna, Austria

This study was conducted within the framework of the project ARCHIMEDES, receiving funding from KDT JU and National Authorities under Grant 101112295 funded by the European Union and the FFG under Grant FO999899377.

Data-Driven Diagnosis of Electrified Vehicles: Results From a Structured Literature Review

Stan Muñoz Gutiérrez, Adil Mukhtar, and Franz Wotawa

Institute for Software Technology - Graz University of Technology

Research Questions

This study systematically reviews intelligent, data-driven techniques for health monitoring and prognosis of electrified powertrains. We categorize existing research based on diagnostic functions and machine learning methods, focusing on approaches that do not require prior knowledge of faulty operational states.

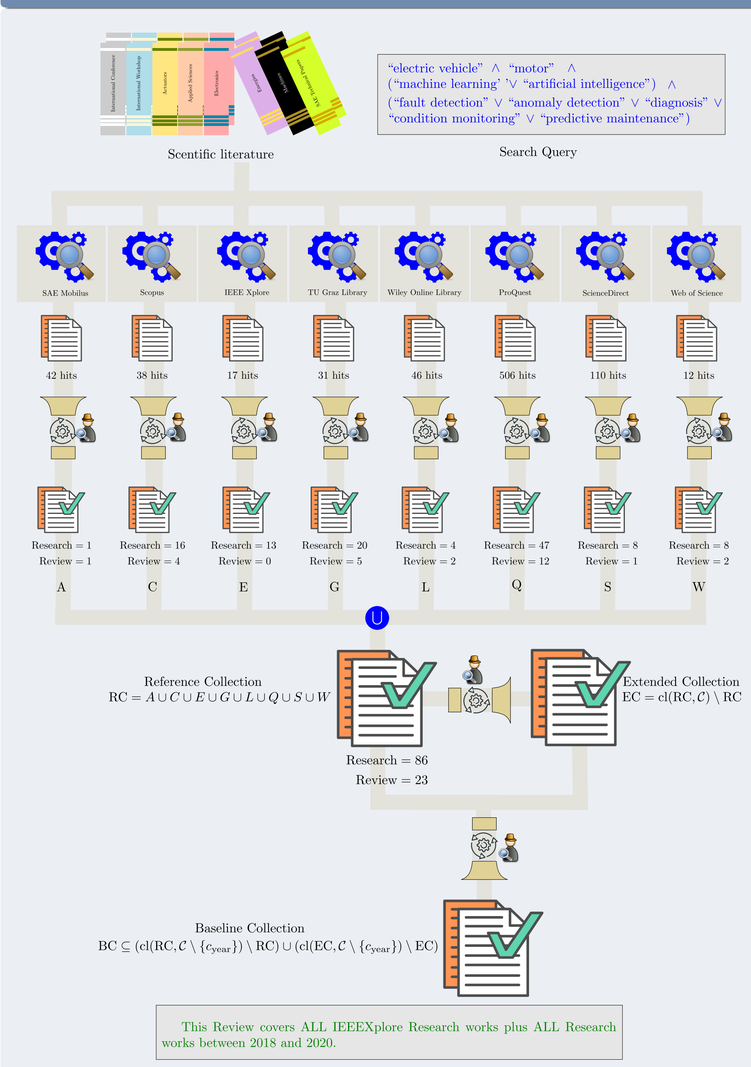
We posed the following research questions:

- RQ1. What are the diagnostic functions covered in the research?
- RQ2. What components of the electrified powertrain are considered?
- RQ3. What anomalies or faults were included in the study?
- RQ4. What are the AI techniques applied to implement the diagnostic functions?
- RQ5. To what extent is it feasible to develop diagnostic functions implemented with unsupervised machine learning techniques that rely exclusively on unlabeled data corresponding with the healthy behavior of the system?

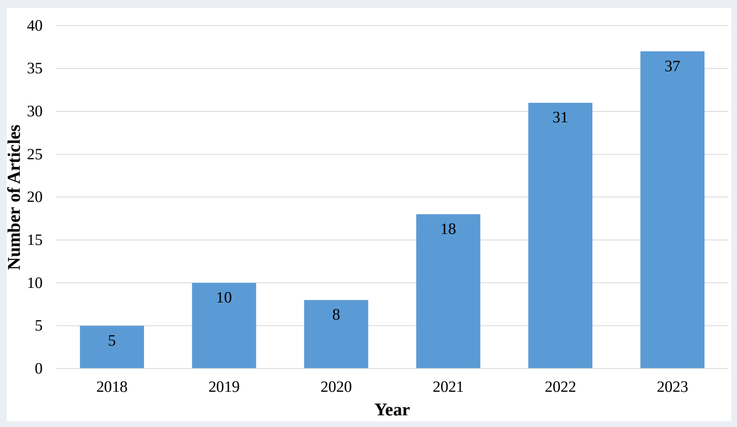
Summary of Prescreening Results

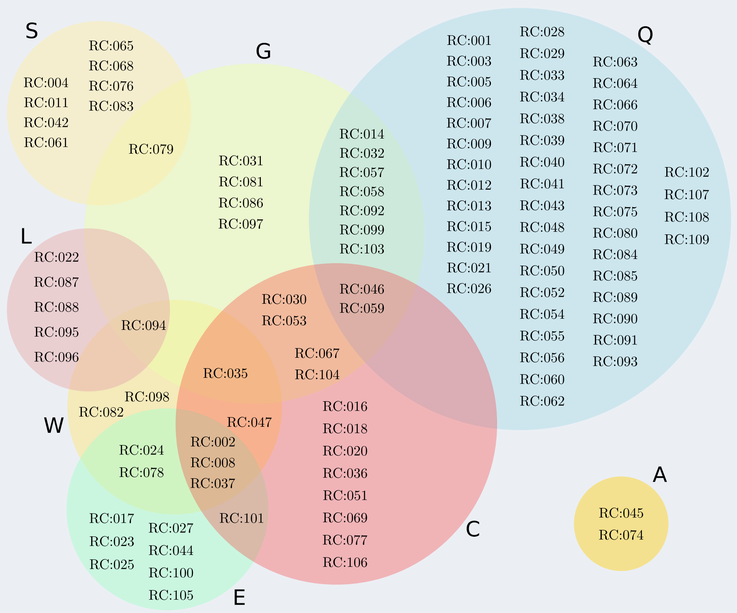
Science Portal	Hits	Included (✓)		Excluded (✗)	
		Research	Review	Access	No access
SAE Mobilus	42	1	1	39	1
Scopus	38	16	4	16	2
IEEE Xplore	17	13	0	4	0
TU Graz Library Search	31	15	5	11	0
Wiley Online Library	46	4	2	40	0
ScienceDirect	110	8	1	101	0
ProQuest	506	47	12	447	0
Web of Science	12	8	2	1	1
Total	804	112	27	659	4
Unique	754	86	23	642	3

Methodology

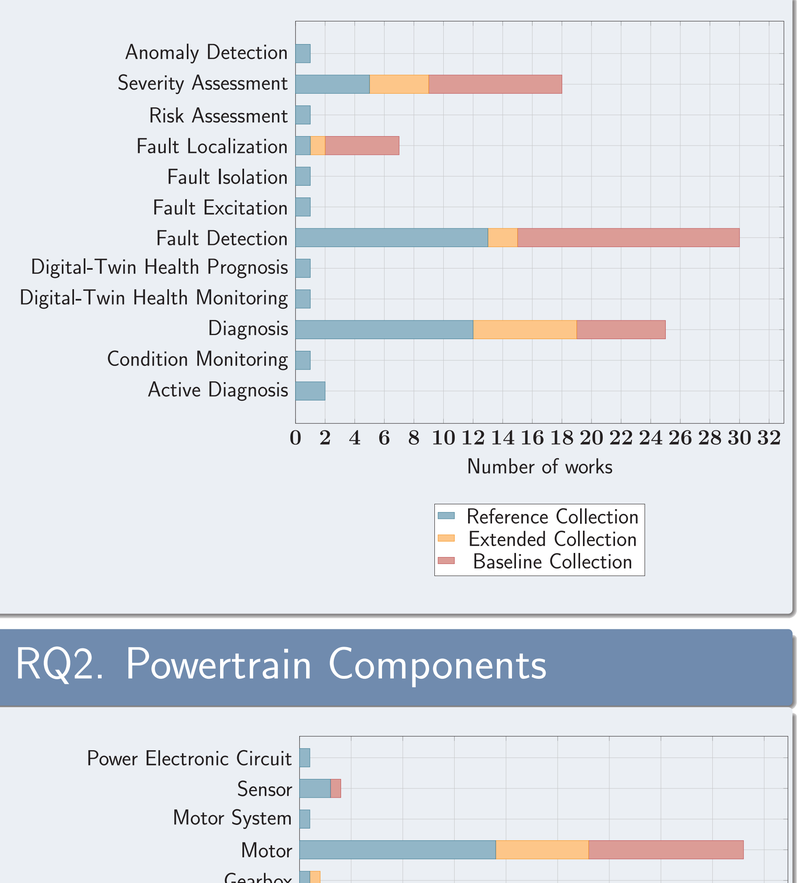


Trends and Search Engine Coverage

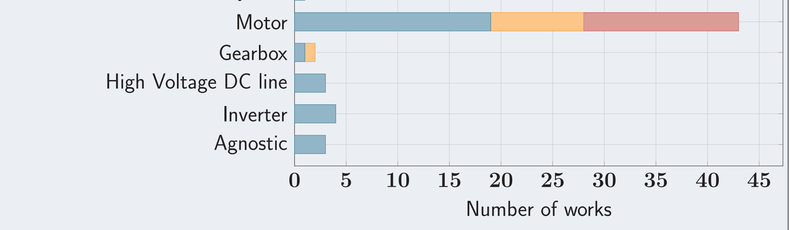




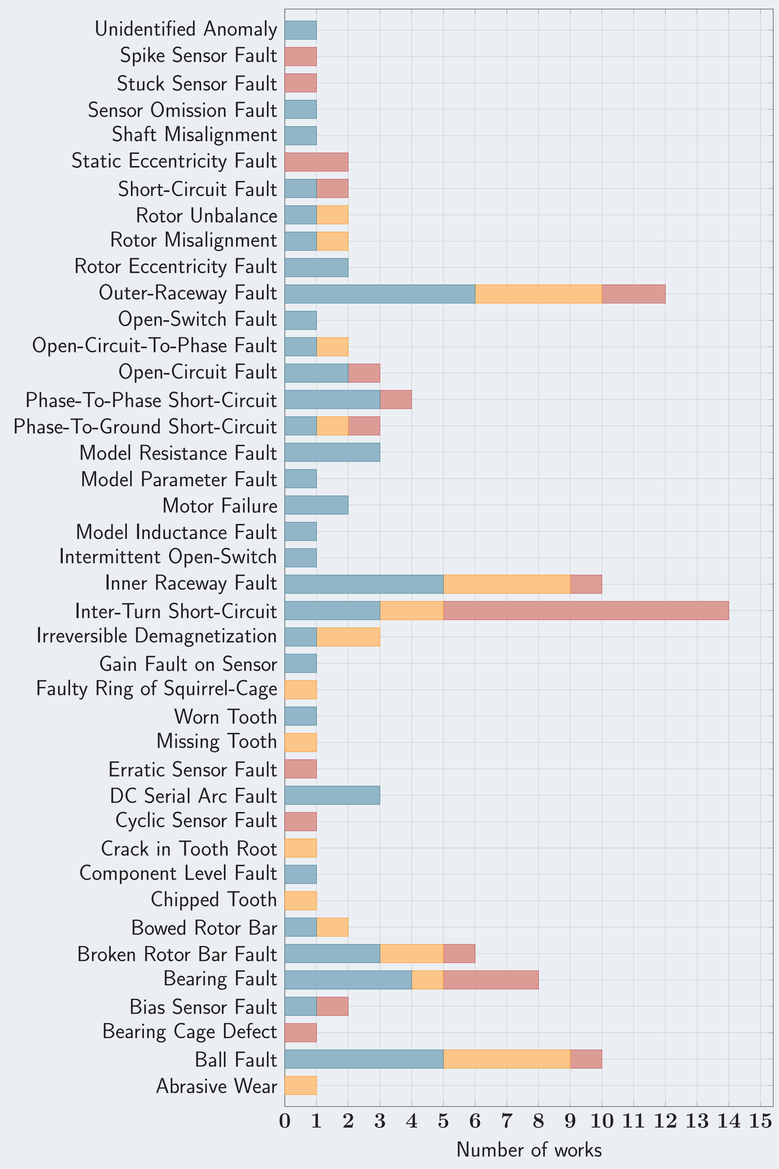
RQ1. Diagnostic Functions



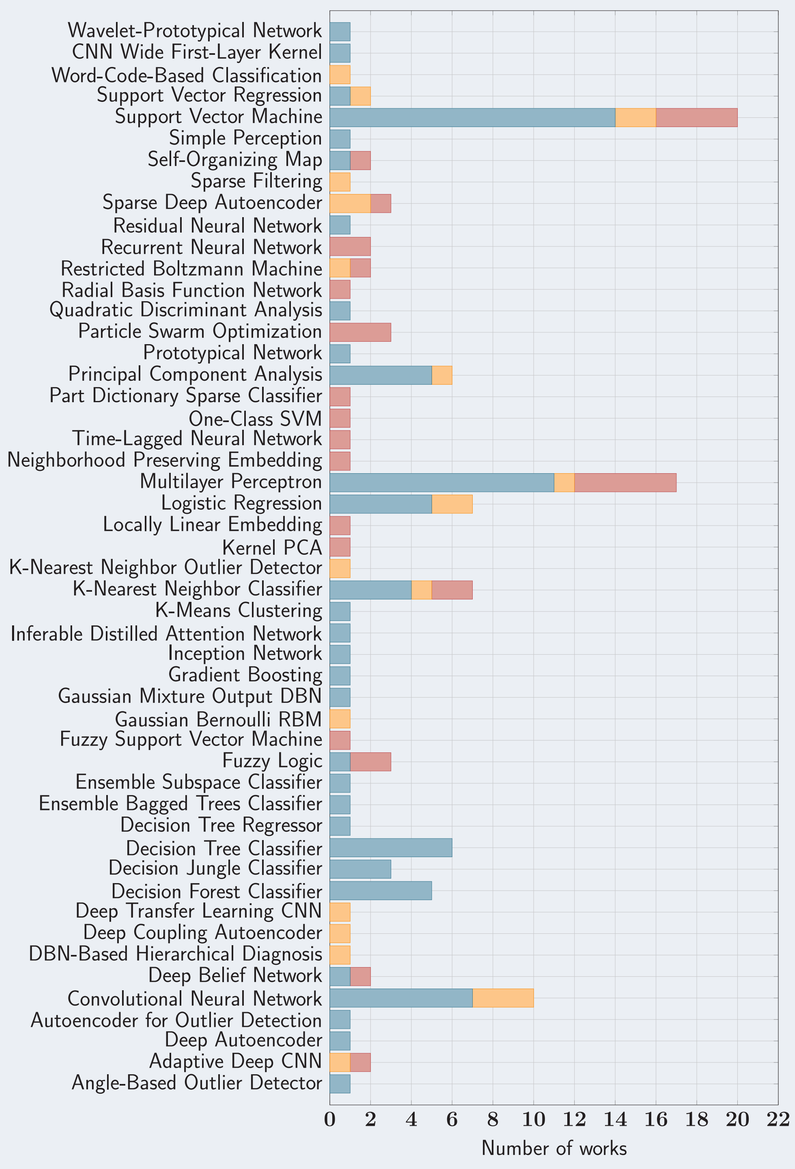
RQ2. Powertrain Components



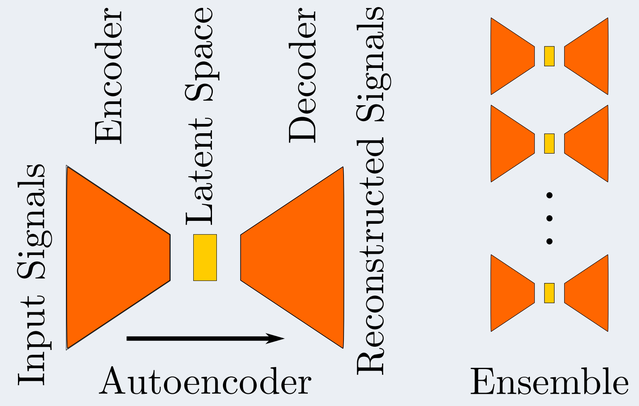
RQ3. Fault Types



RQ4. Artificial Intelligence Techniques



RQ5. Learning Healthy Behavior Only



CNN-based (Geglio et al. 2022)

Deep Coupling (Ma et al. 2018)

Sparse (Chen and Li 2017)

- Reconstruction based anomaly detection.
- Mainly supported by deep autoencoder family.
- Other: LSTM, SVR, and RNN + PSO.

Highlights

- Growing adoption of deep learning models across applications.
- Comprehensive diagnosis of mechanical, electrical, and magnetic faults.
- Diverse AI techniques enable several diagnostic functions.
- Learning exclusively from healthy behavior is supported by autoencoders.
- Presence of active diagnosis and digital twins.

https://www.tugraz.at/institute/ist/institute/ {sgutierr,amukhtar,wotawa}@ist.tugraz.at