

DVRE: Dominator-based Variables Reduction of Encoding for Model-Based Diagnosis

**Jihong OUYANG, Sen HUANG, Jinjin CHI,
Liming ZHANG**

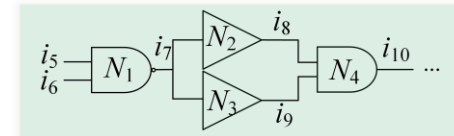
Frontiers of Computer Science, DOI: [10.1007/s11704-024-40894-w](https://doi.org/10.1007/s11704-024-40894-w)

Problems & Ideas

Model-Based Diagnosis Problem:

- An MBD problem can be defined as a triple $\langle SD, Comps, Obs \rangle$, which is a model of the diagnosed system. Comps is a set of components, Obs is an observation, and SD is a system describes.
- Δ is set of components, x is component.
- Diagnosis problem: $SD \wedge Obs \wedge \bigwedge_{x \in \Delta} Ab(x) \wedge \bigwedge_{x \in Comps \setminus \Delta} \neg Ab(x) \neq \perp$

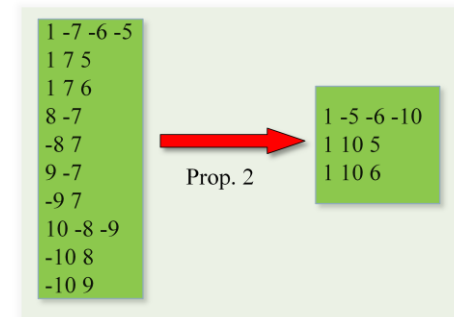
Ideas: (1) If the output value of a dominated component N_i can be correlated with the output value of its predecessor component N_j , then the output value of N_i does not need to be included in the CNF encoding. (2) If the $N_i.out$ of a dominator component N_i can be correlated with $N_i.in$, then $N_i.in$ can be replaced by $\neg N_i$. If the component N_i is a dominated component, then $N_i.in$ can be replaced by $N_i.out$.



(a) a part of the circuit

- $\neg N_1 \rightarrow (i_7 \leftrightarrow \neg(i_5 \wedge i_6))$
- $\neg N_2 \rightarrow (i_8 \leftrightarrow i_7)$
- $\neg N_3 \rightarrow (i_9 \leftrightarrow i_7)$
- $\neg N_4 \rightarrow (i_{10} \leftrightarrow i_8 \wedge i_9)$

(b) system description



(c) MBD encoding

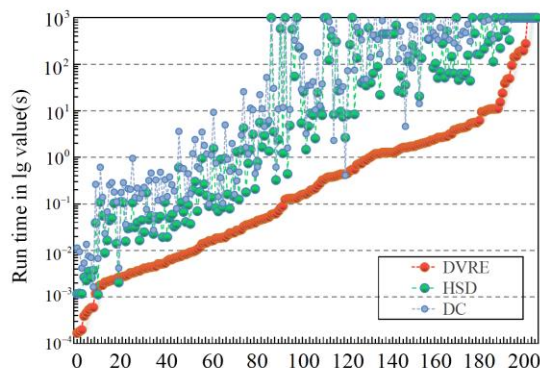
Main Contributions

- Contributions:

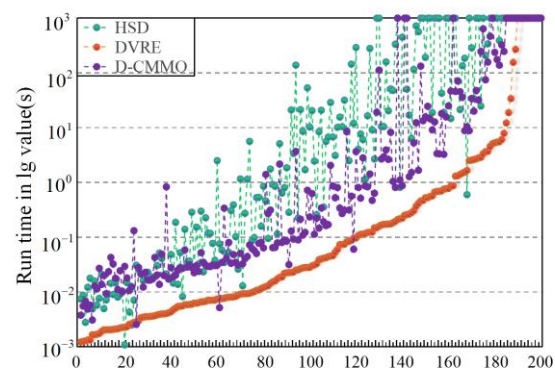
- In the offline phase, DVRE effectively reduces the generation of encoding variables and clauses, enhancing efficiency without adding any additional observations.
- DVRE is able to reduce the modeling encoding of certain components, even if their output values are uncertain, based on system inputs and outputs.
- DVRE demonstrates applicability to both single observation and multiobservation diagnosis problems.

- Experiments:

- Comparison of algorithms: HSD, D-CMMO, DC, DC*
- Experimental data: ISCAS-85



(a) The number of ISCAS-85 instances



(b) The number of ISCAS-85 instances

Left: #Single observation runtime for the ISCAS-85 benchmark circuit.

Right: #Multiple observations runtime for the ISCAS-85 benchmark circuit.