# EFFICIENT MODEL BASED DIAGNOSIS WITH MAXIMUM SATISFIABILITY

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# MODEL-BASED DIAGNOSIS

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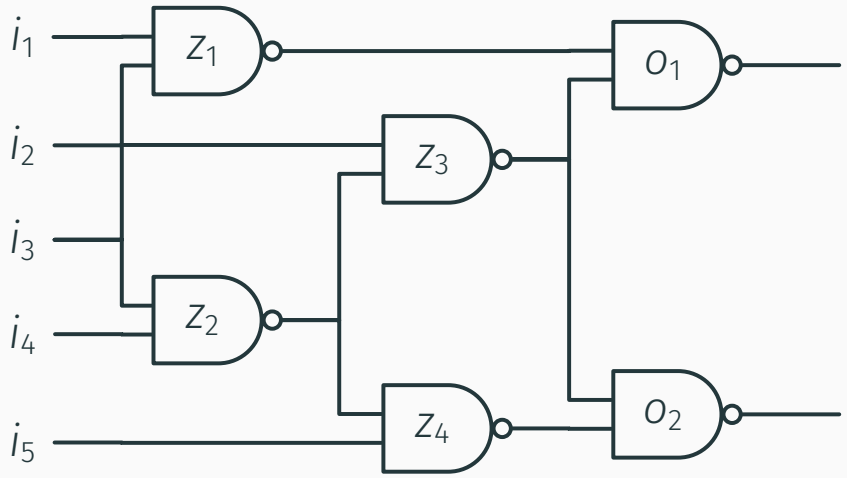

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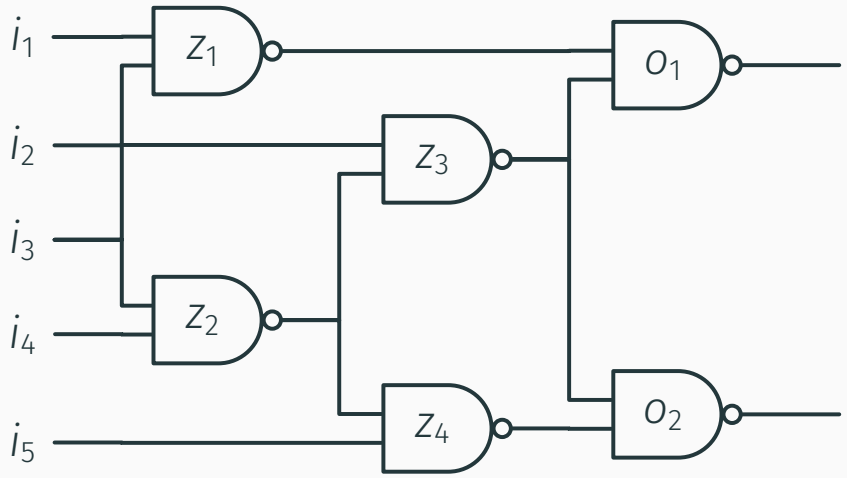


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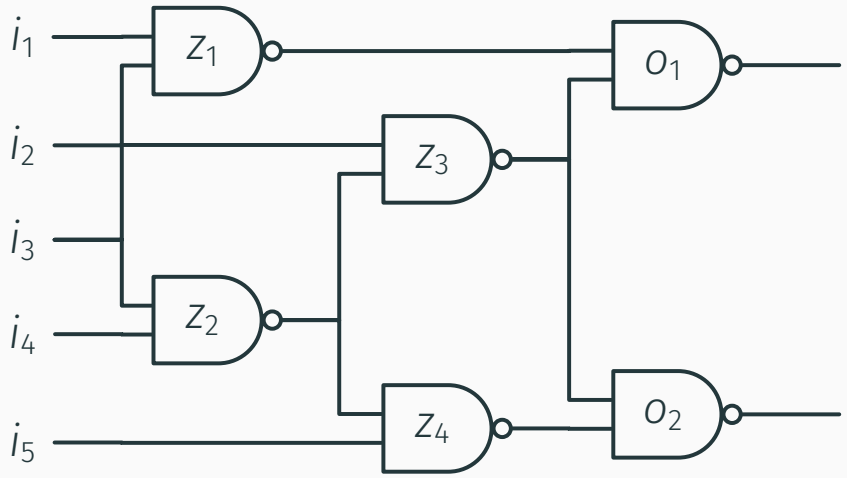


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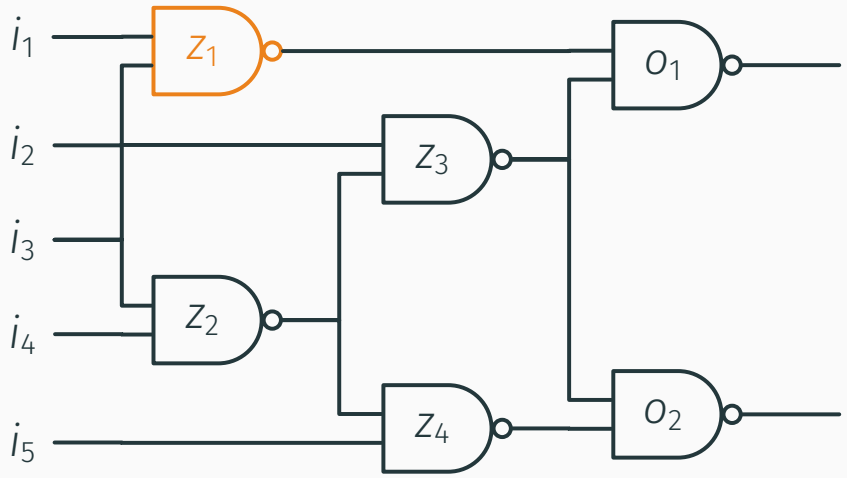


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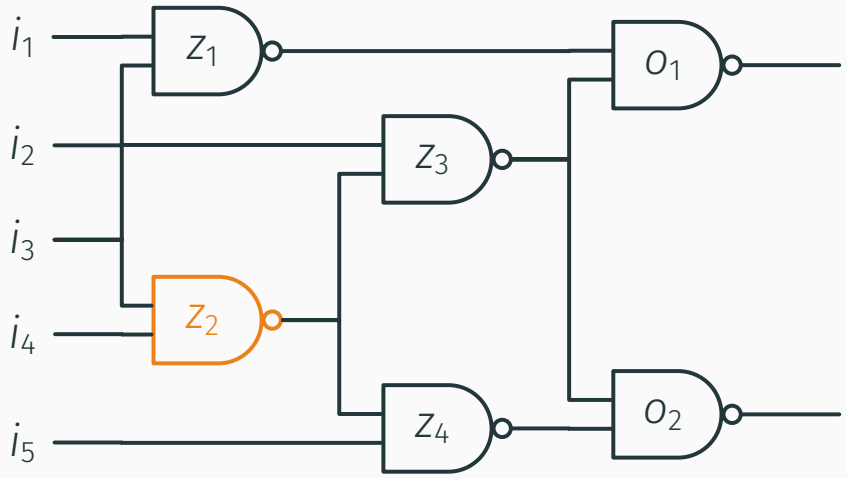


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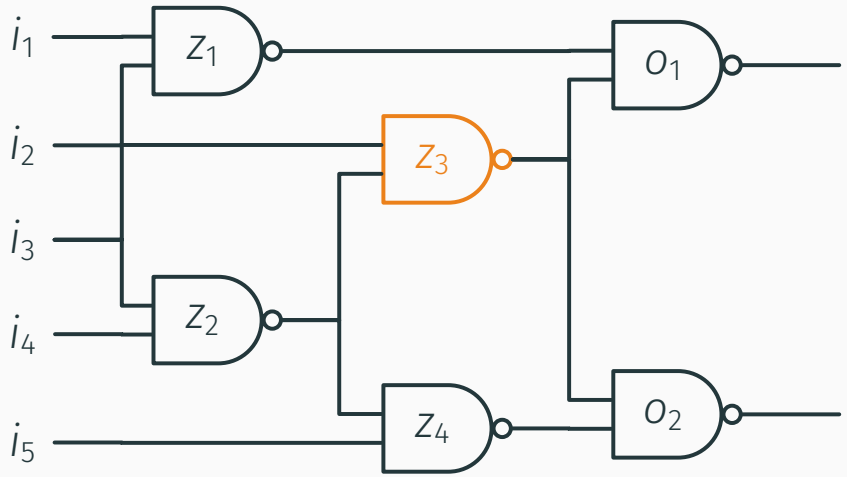


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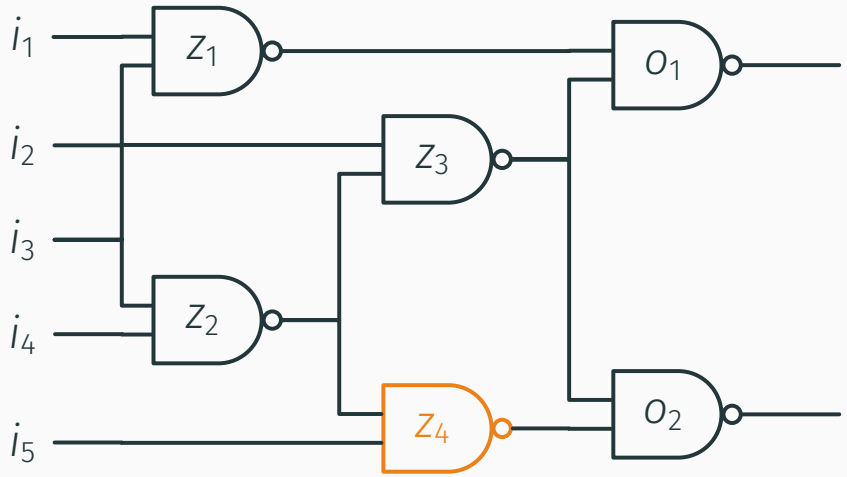


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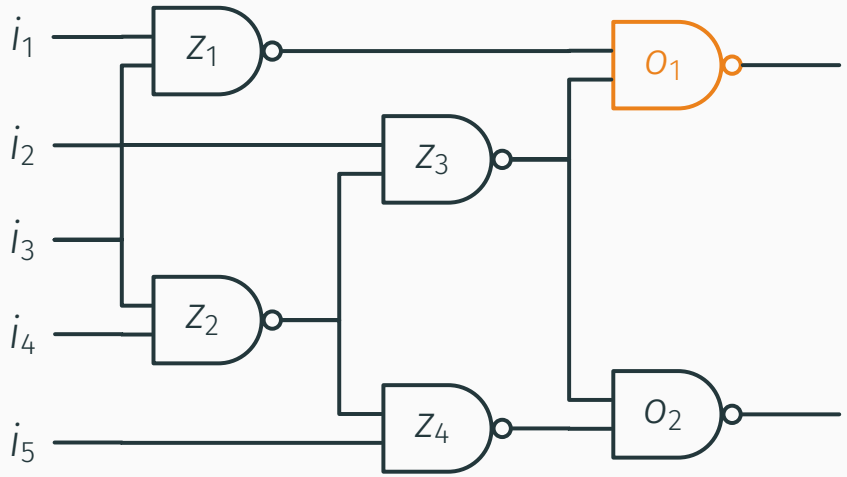


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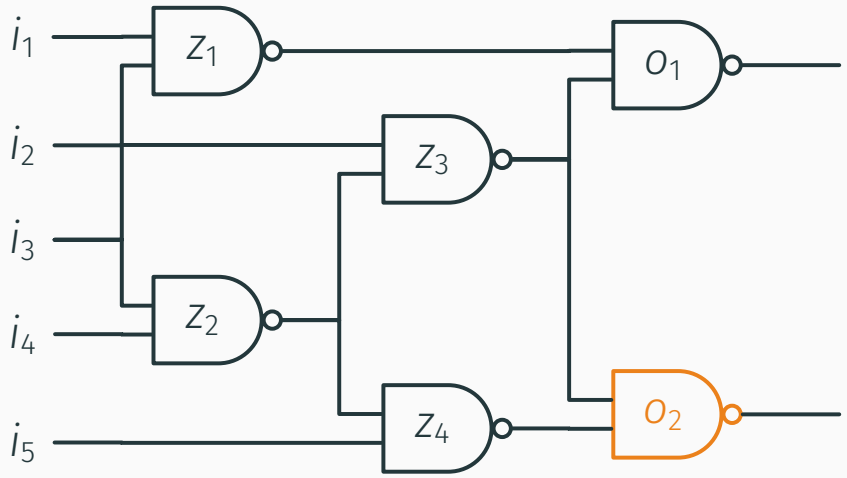


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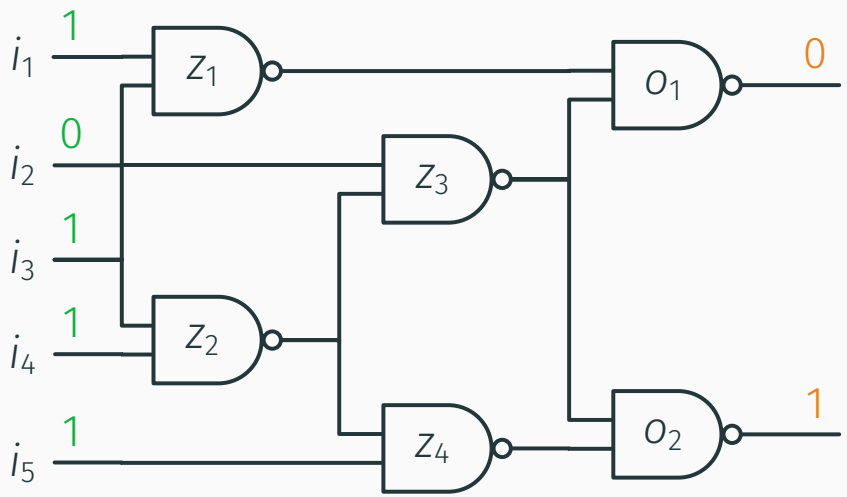


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$$\text{Obs} = \{\langle i_1, i_2, i_3, i_4, i_5\rangle = \langle 1, 0, 1, 1, 1\rangle, \quad \langle o_1, o_2\rangle = \langle 0, 1\rangle\}$$

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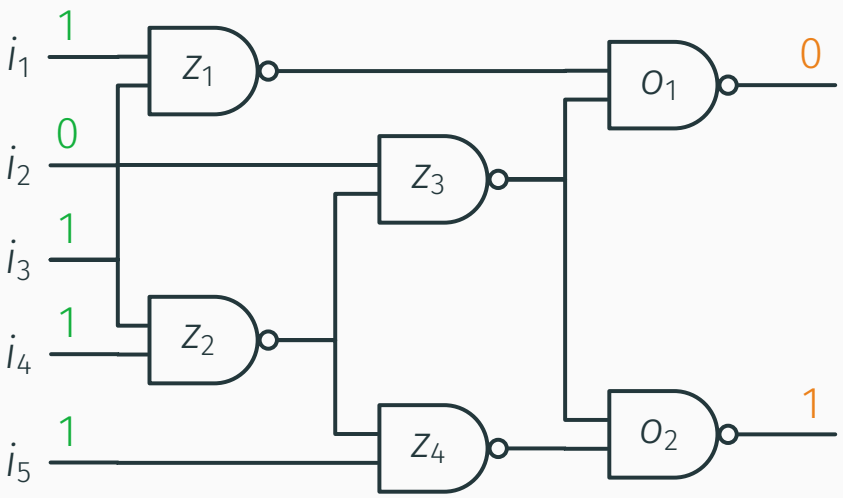


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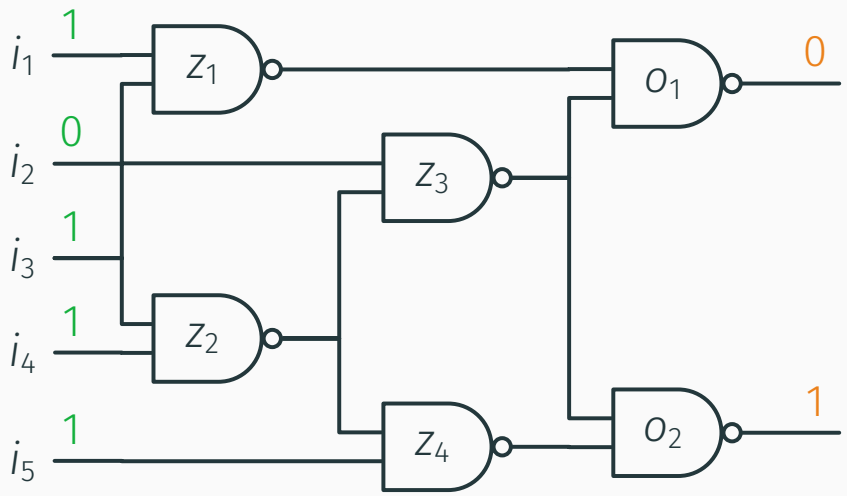


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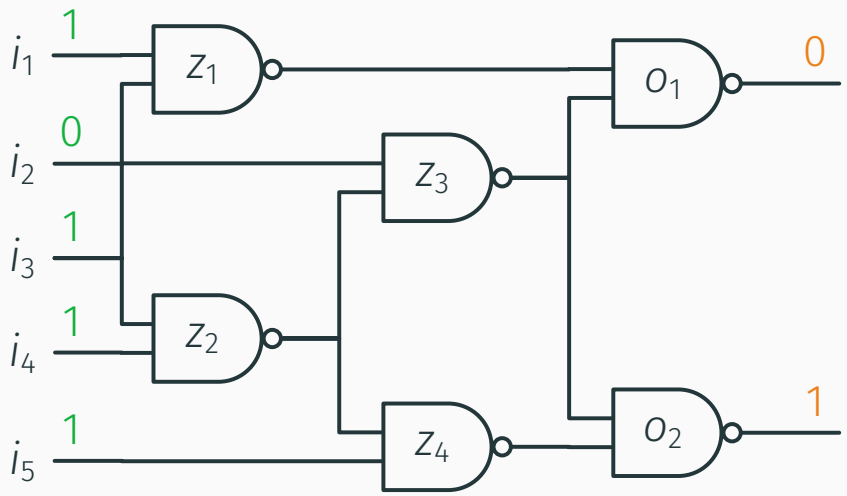


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find $\Delta \subseteq \text{Comps}$ s.t.

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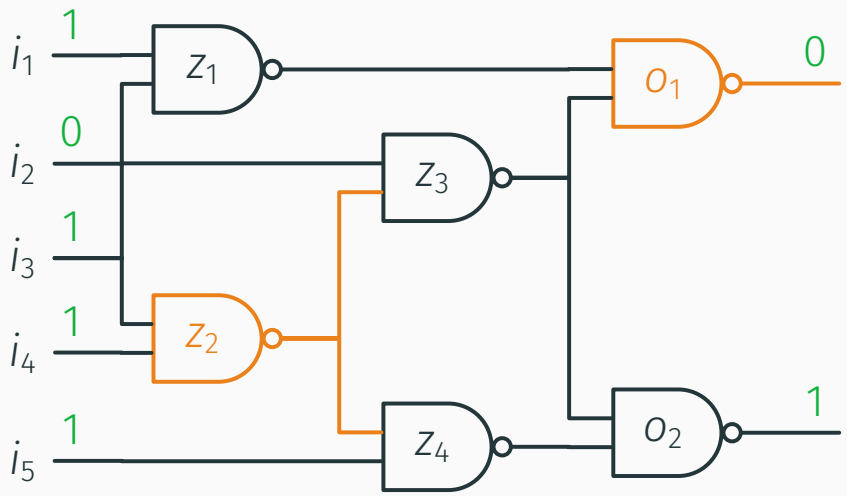


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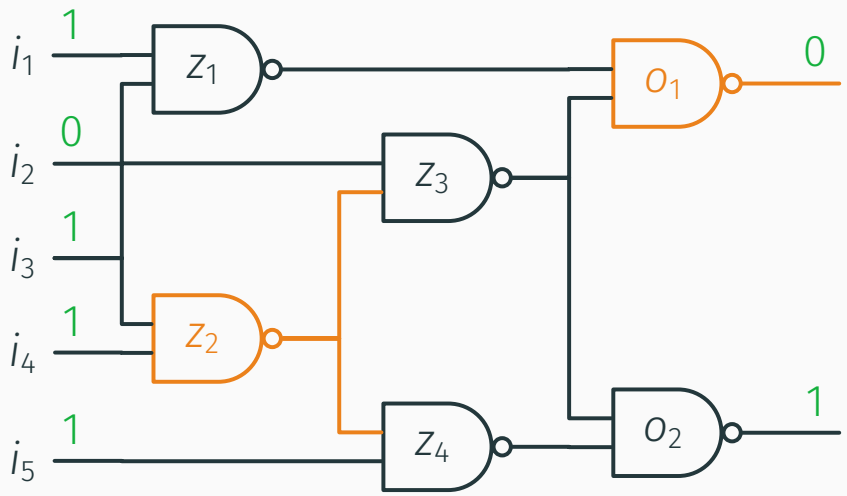


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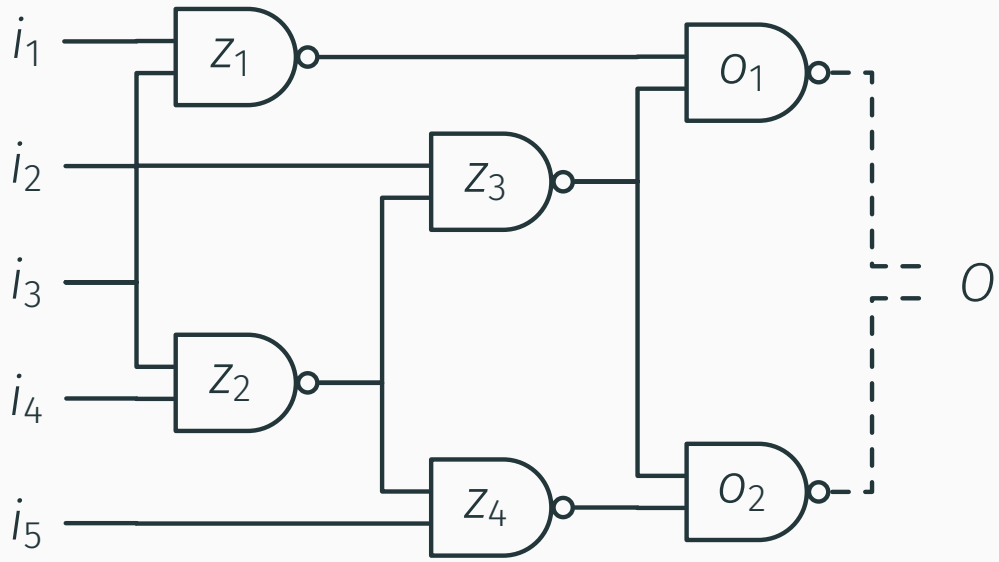
$\Delta = \{z_2, o_1\}$ — **minimize $\Delta$ with MaxSAT**

# Dominator-oriented encoding

# DOMINATORS AND TLDS




*v* ***dominates*** *u* $\iff$ ***all*** paths from *u* to *O* include *v*

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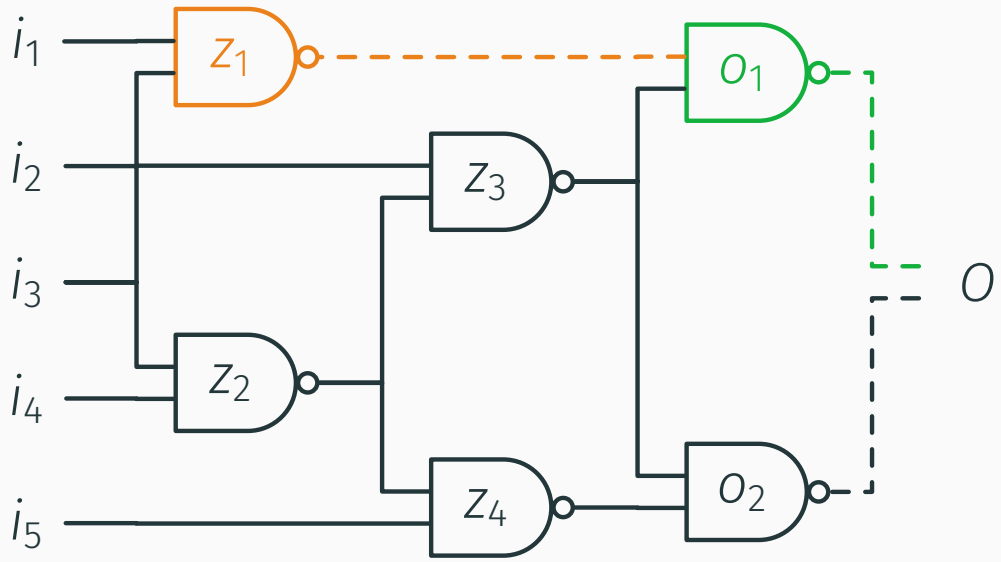


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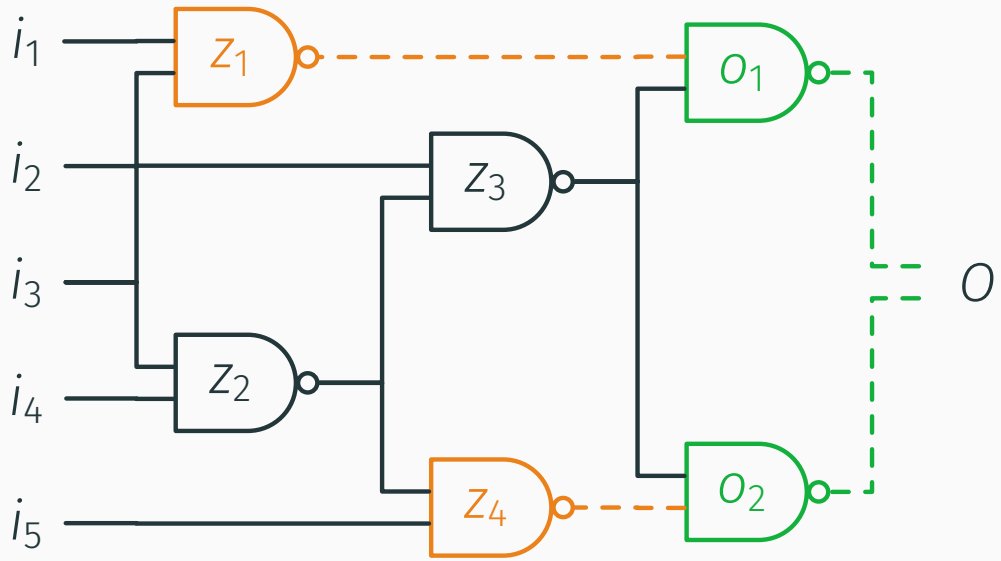


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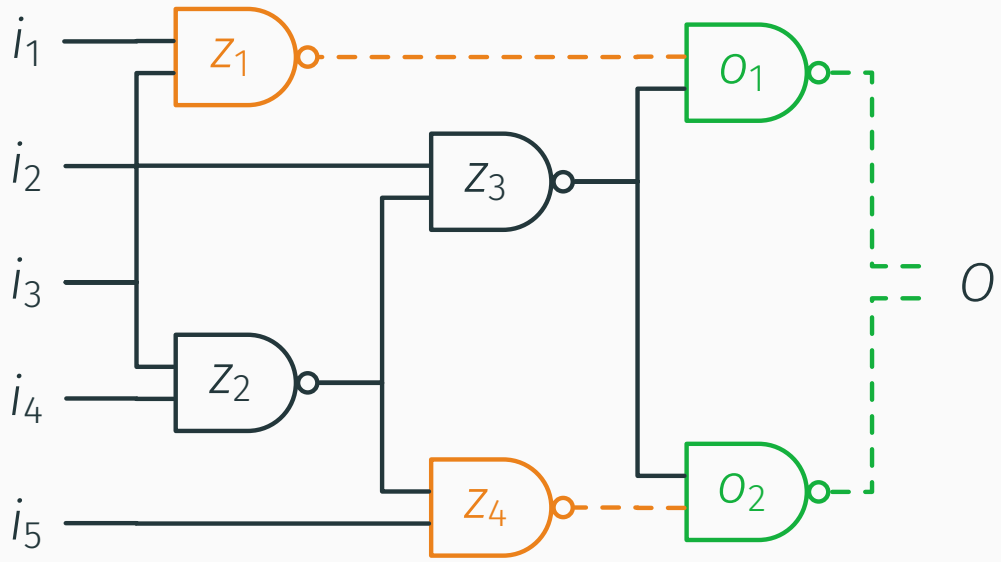


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diagnosis $\Delta$ is a **TLD** if it *does not contain* dominated gates

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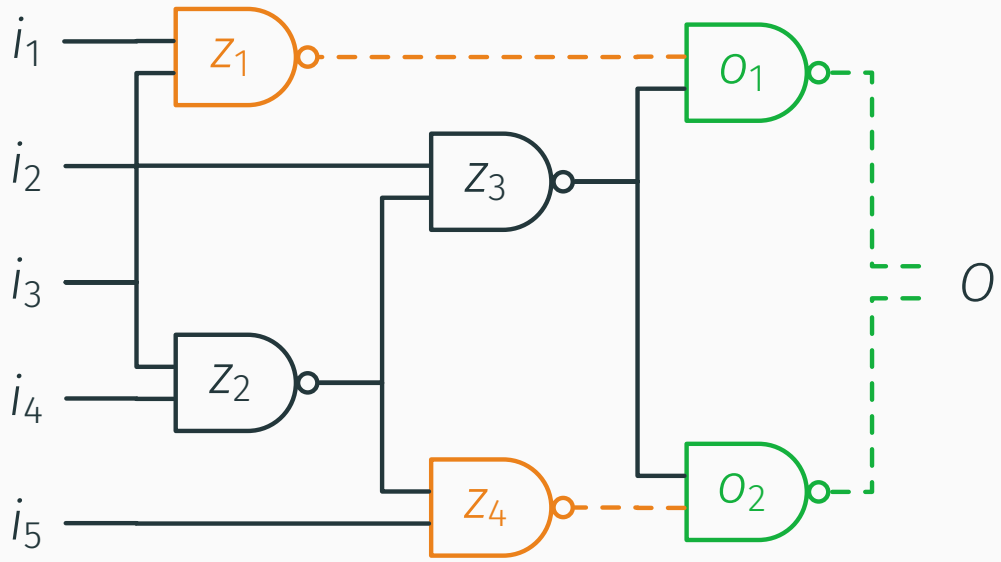


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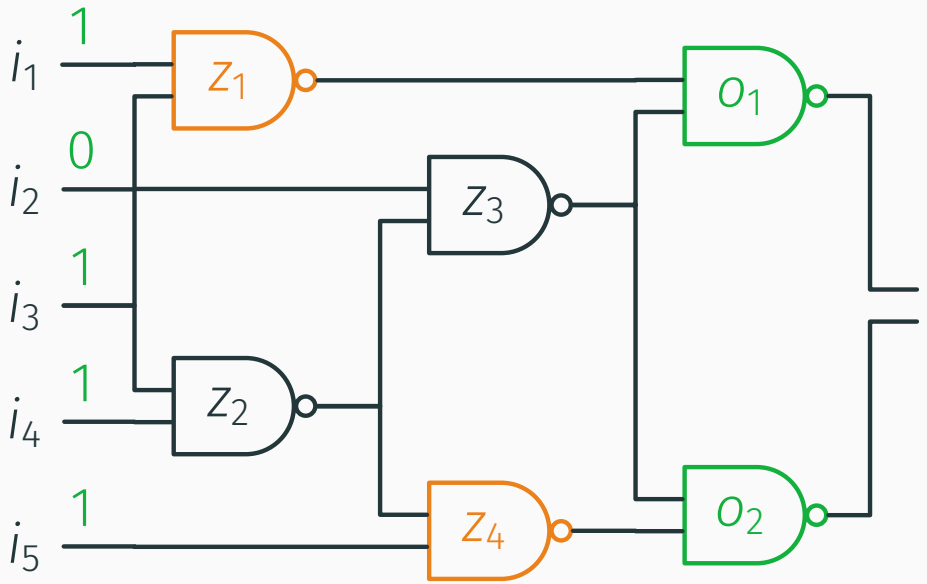
dominated gates are hard

# BACKBONE NODES




$z_1$ is ***dominated*** and its output is ***fixed***

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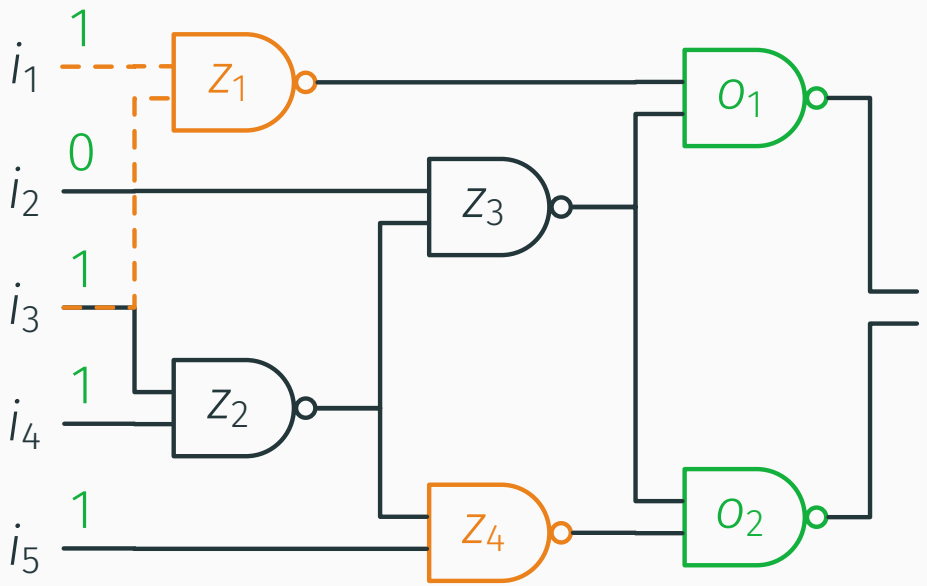


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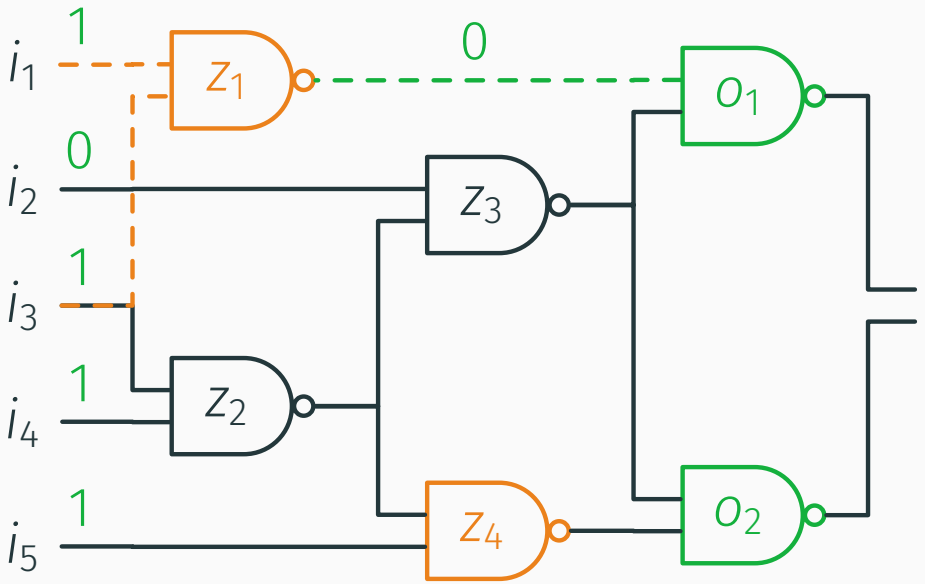


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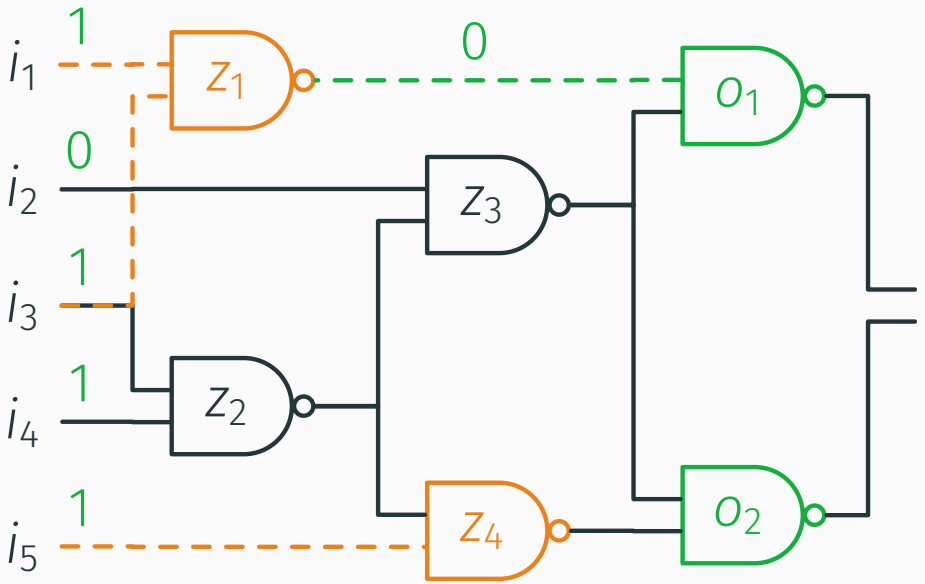


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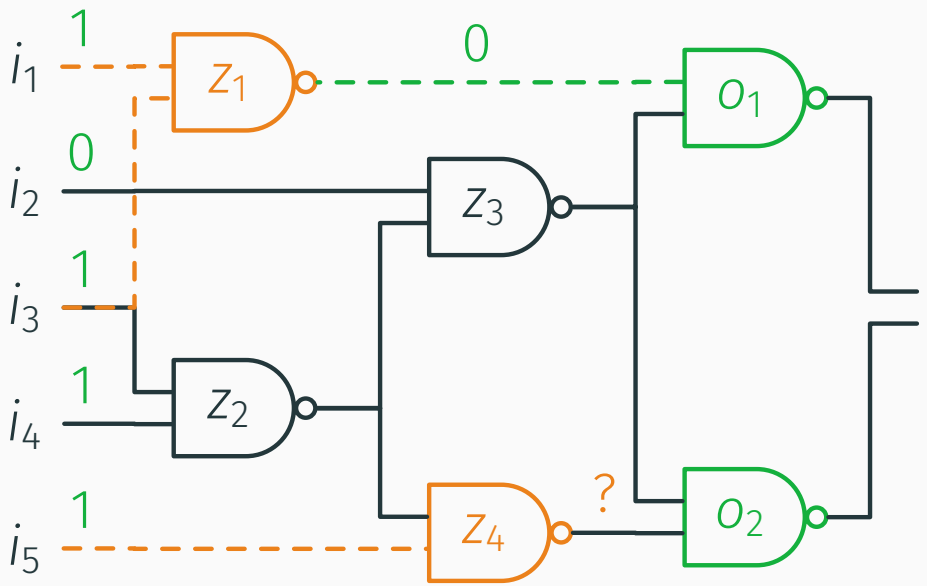


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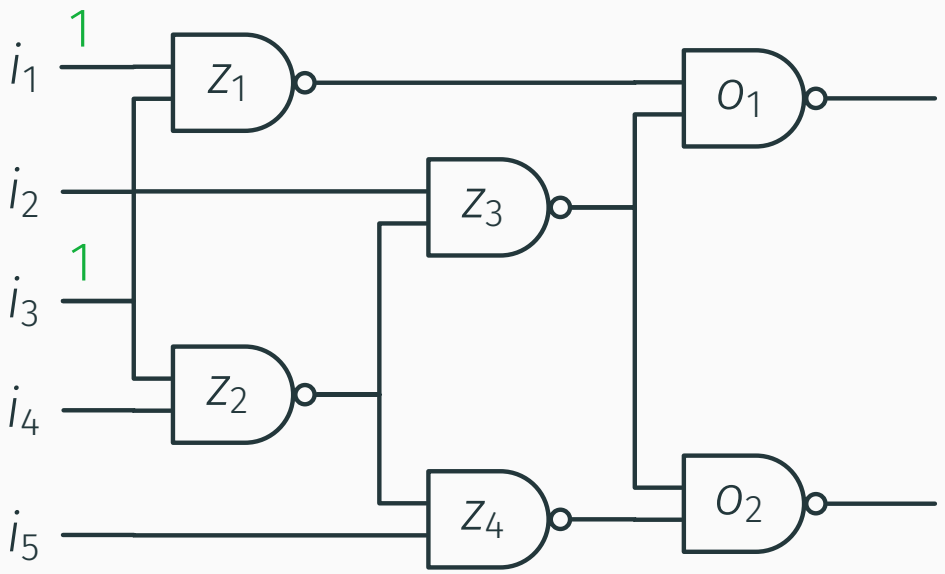
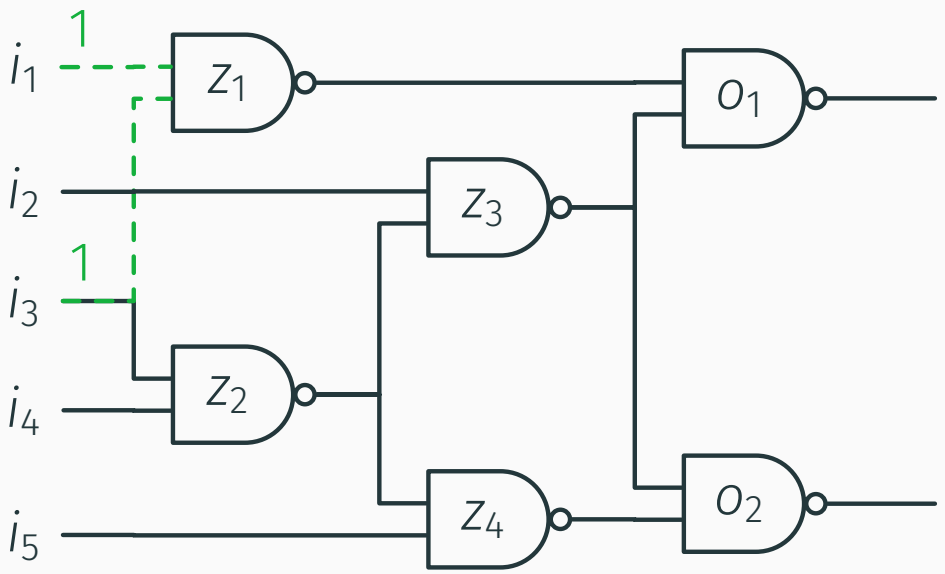



output of $o_1$ is ***unchanged*** for any value assigned to edge $(z_3, o_1)$

edge $(z_3, o_1)$ is ***blocked***

# BLOCKED EDGES

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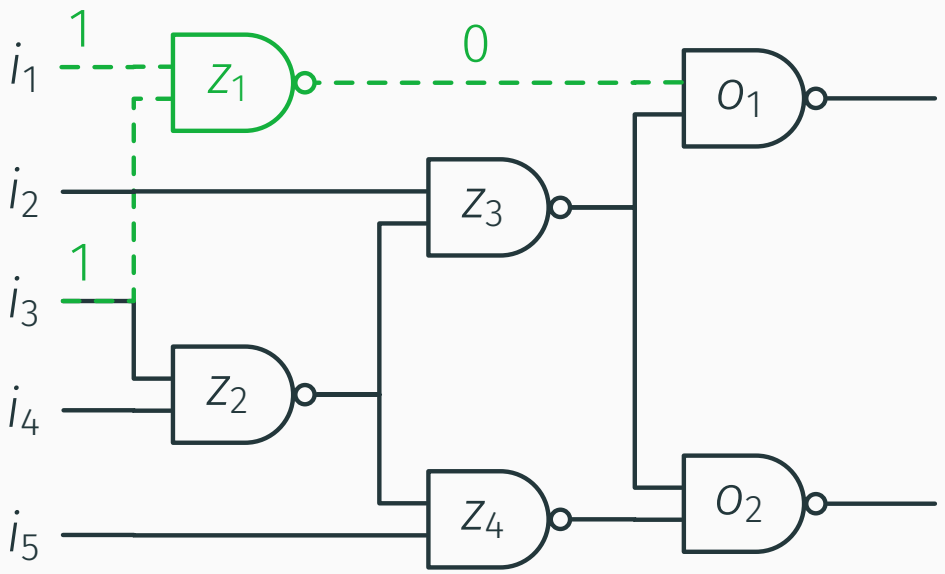


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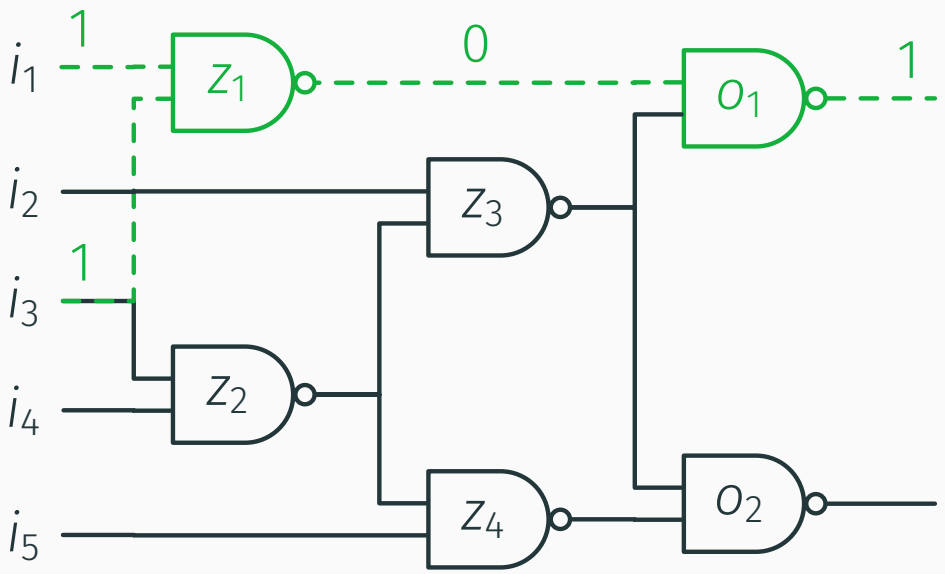


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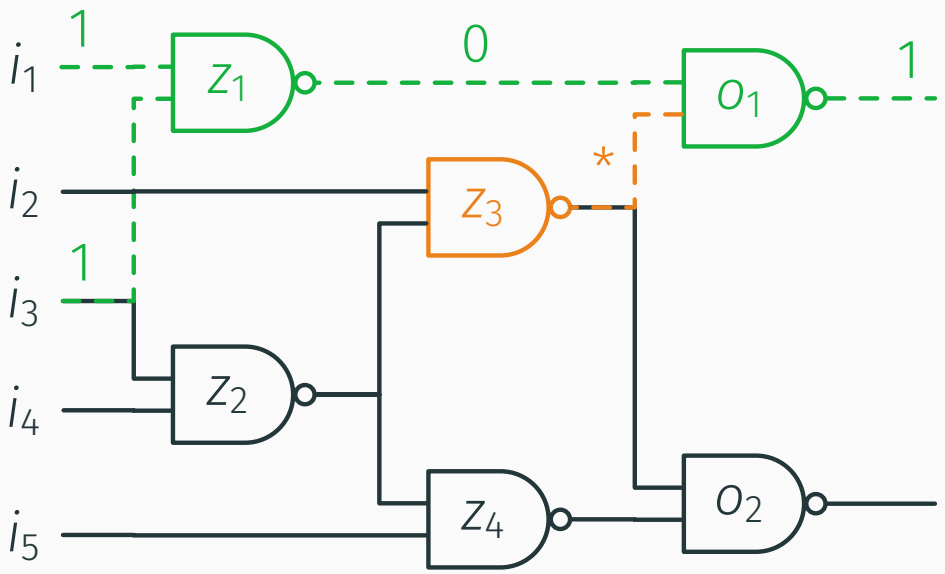


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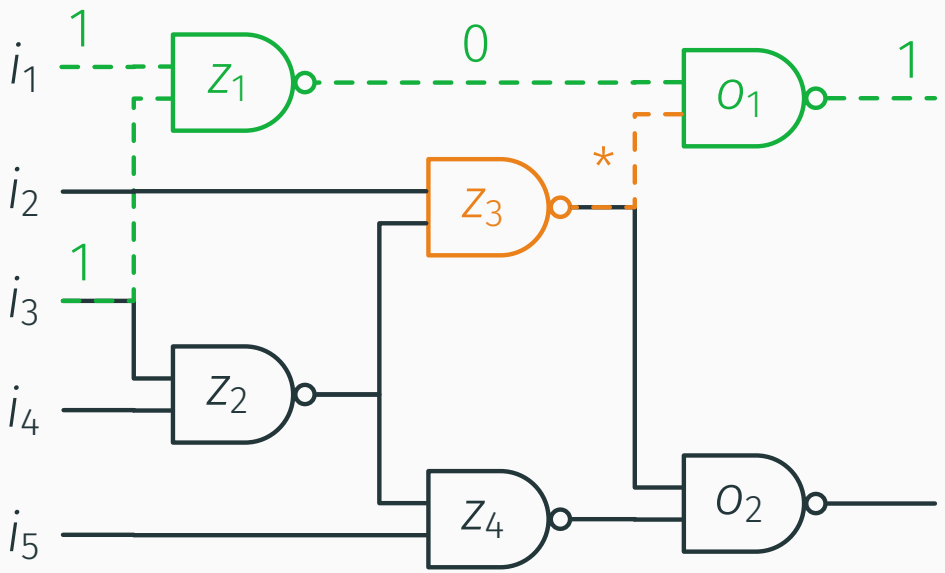

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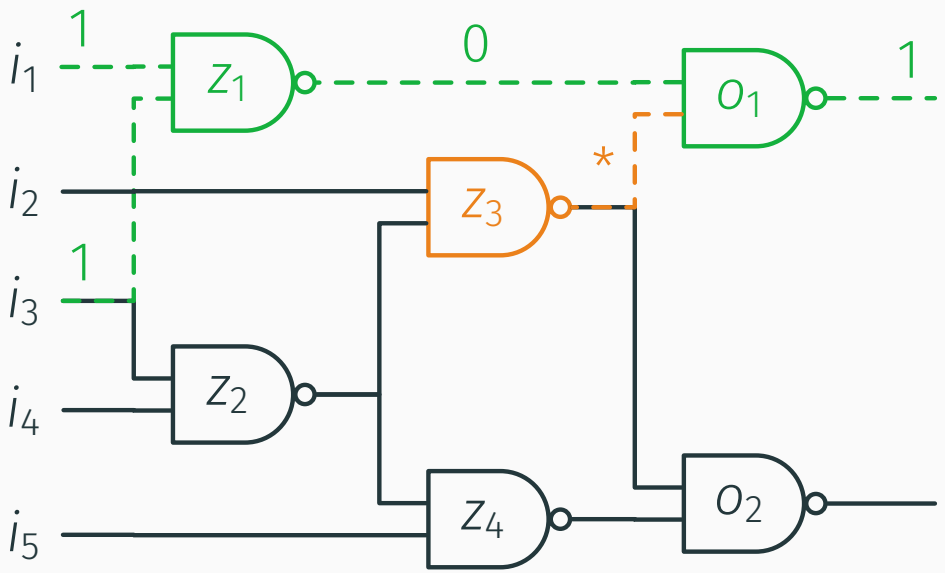


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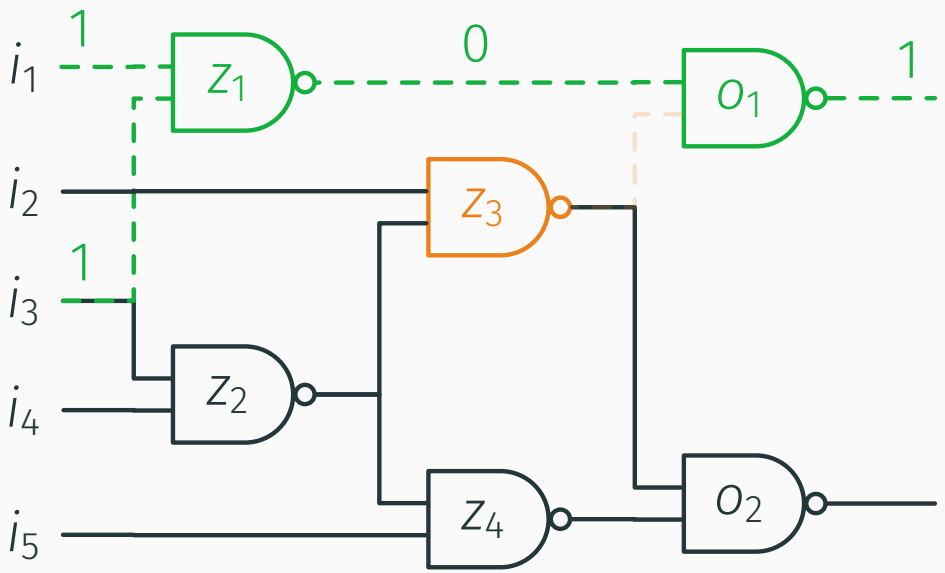


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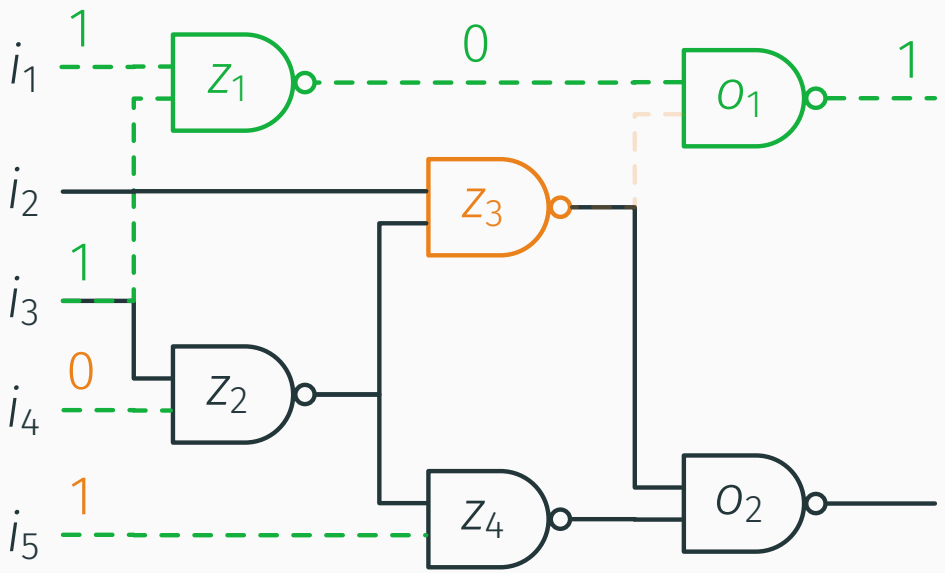


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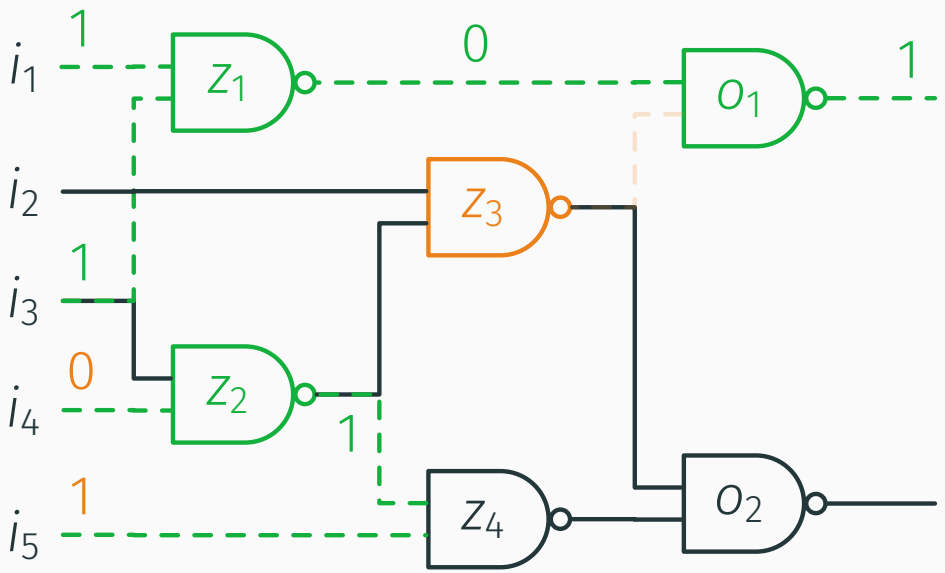


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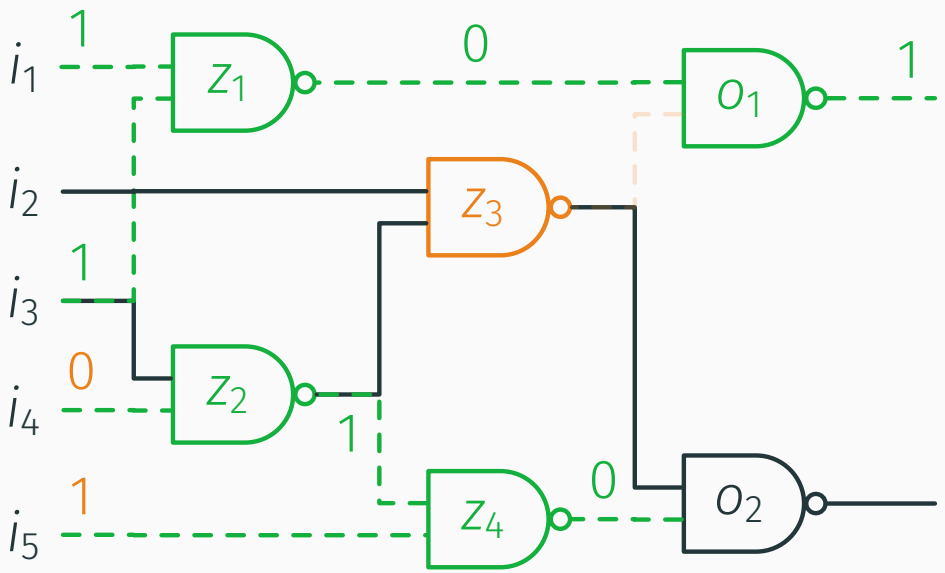


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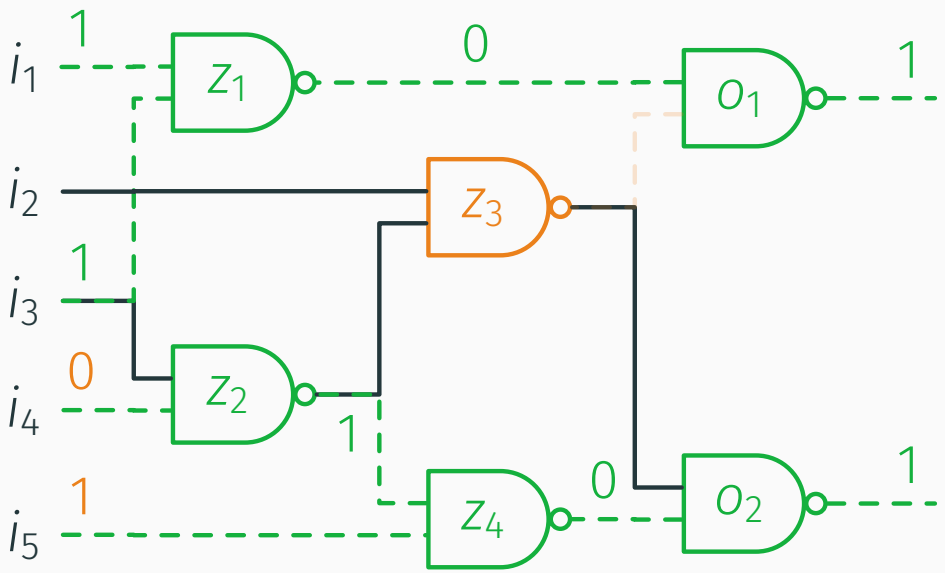


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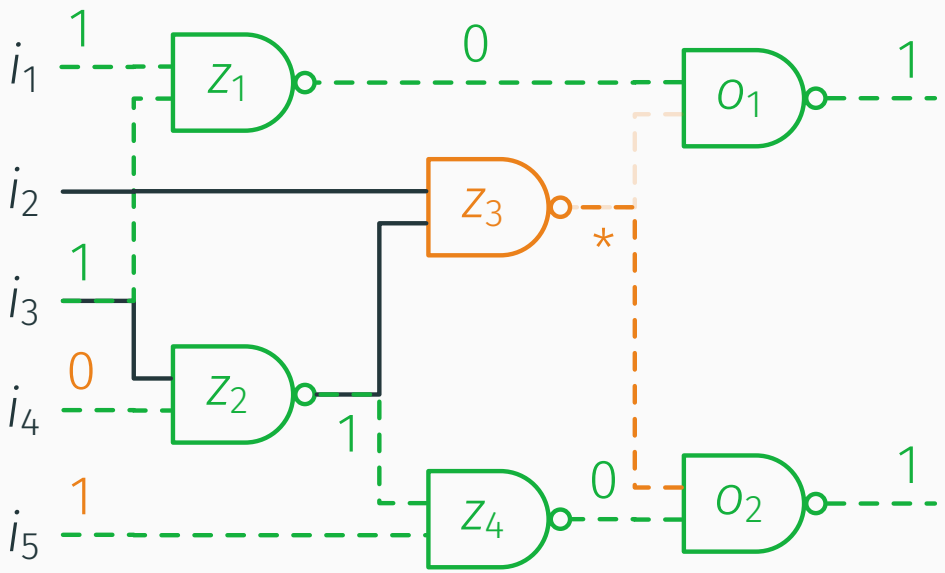


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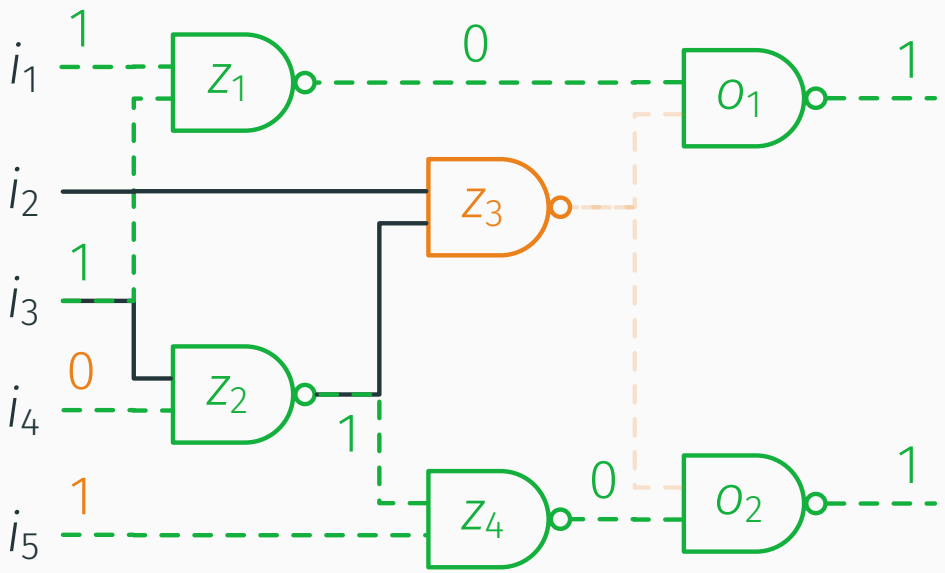


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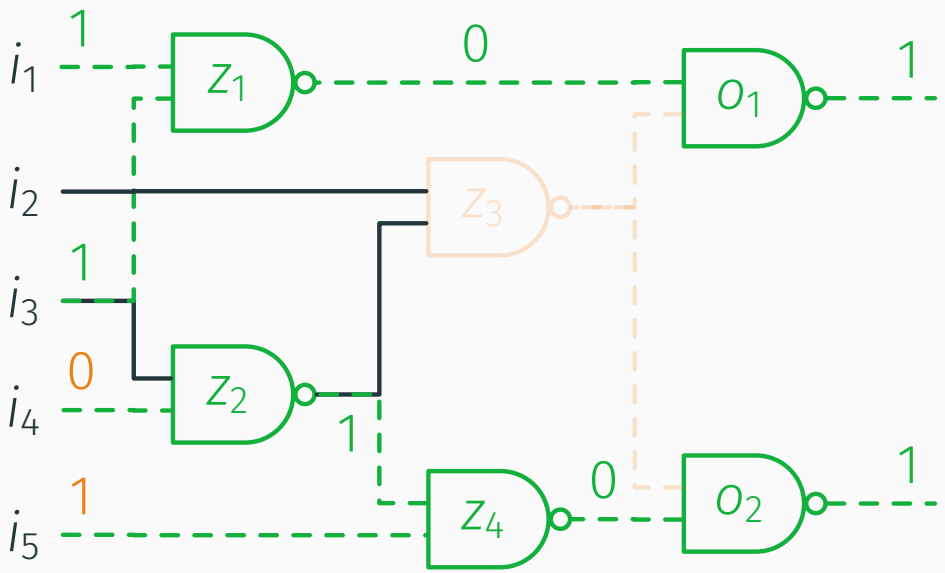


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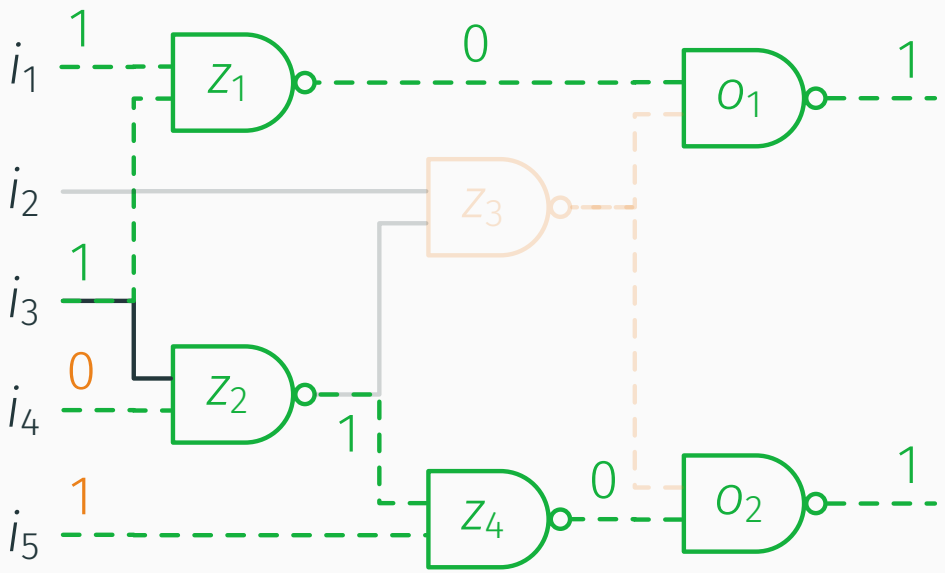


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# DOE ALGORITHM

```
1 global: ⟨SD, Comps, Obs⟩
2 repeat
3 |   FindDominators()
4 |   FindBackboneComponents()
5 |   FindBlockedConnections()
6 |   if MaxNumberIterations(): break
7 until NoMoreChanges()
8 GenMaxsatModel()
```

**Algorithm 1:** MBD to MaxSAT compilation

# PROBLEM DECOMPOSITION

DOE approach:

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1. computing dominators

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possible structural decompositions

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# ITC99 BENCHMARK INSTANCES

# ITC99 benchmark instances

**ISCAS85** instances are easy

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- $-$2097 instances ***(hard for SATbD/SCryptoDiagnoser)*** $=$ 5903

# EXPERIMENTAL RESULTS

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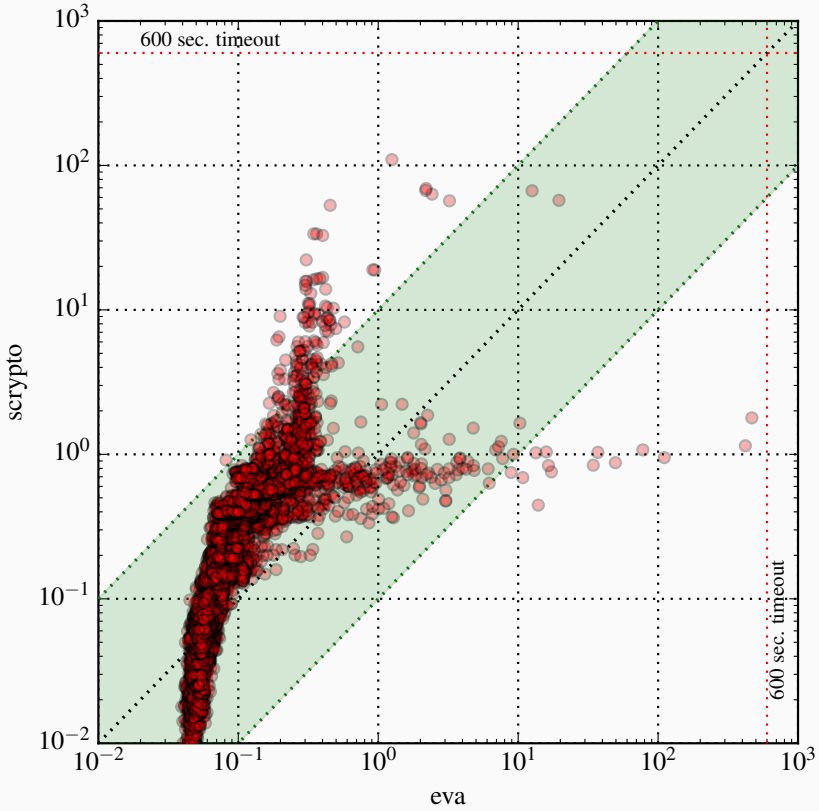
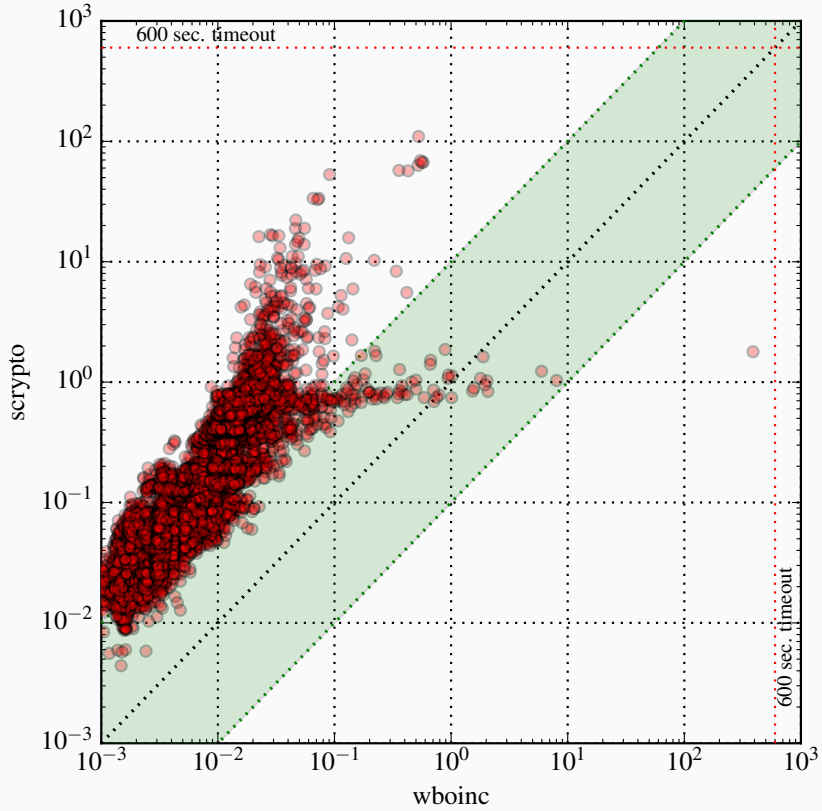
# ISCAS85 SUITE




(a) eva vs. scrypto




(b) wboinc vs. scrypto

**Figure 1:** Scatter plots for ISCAS85 suite

# ISCAS85 SUITE

| 16174 instances | scrypto | eva | wboinc |
|---|---|---|---|
| % solved | 100.0 | 100.0 | 100.0 |
| % scrypto wins | — | 23.4 | 0.1 |
| % eva wins | 76.6 | — | 0.0 |
| % wboinc wins | 99.9 | 100.0 | — |

**Table 1:** Statistics for ISCAS85 suite

# ITC99 SUITE

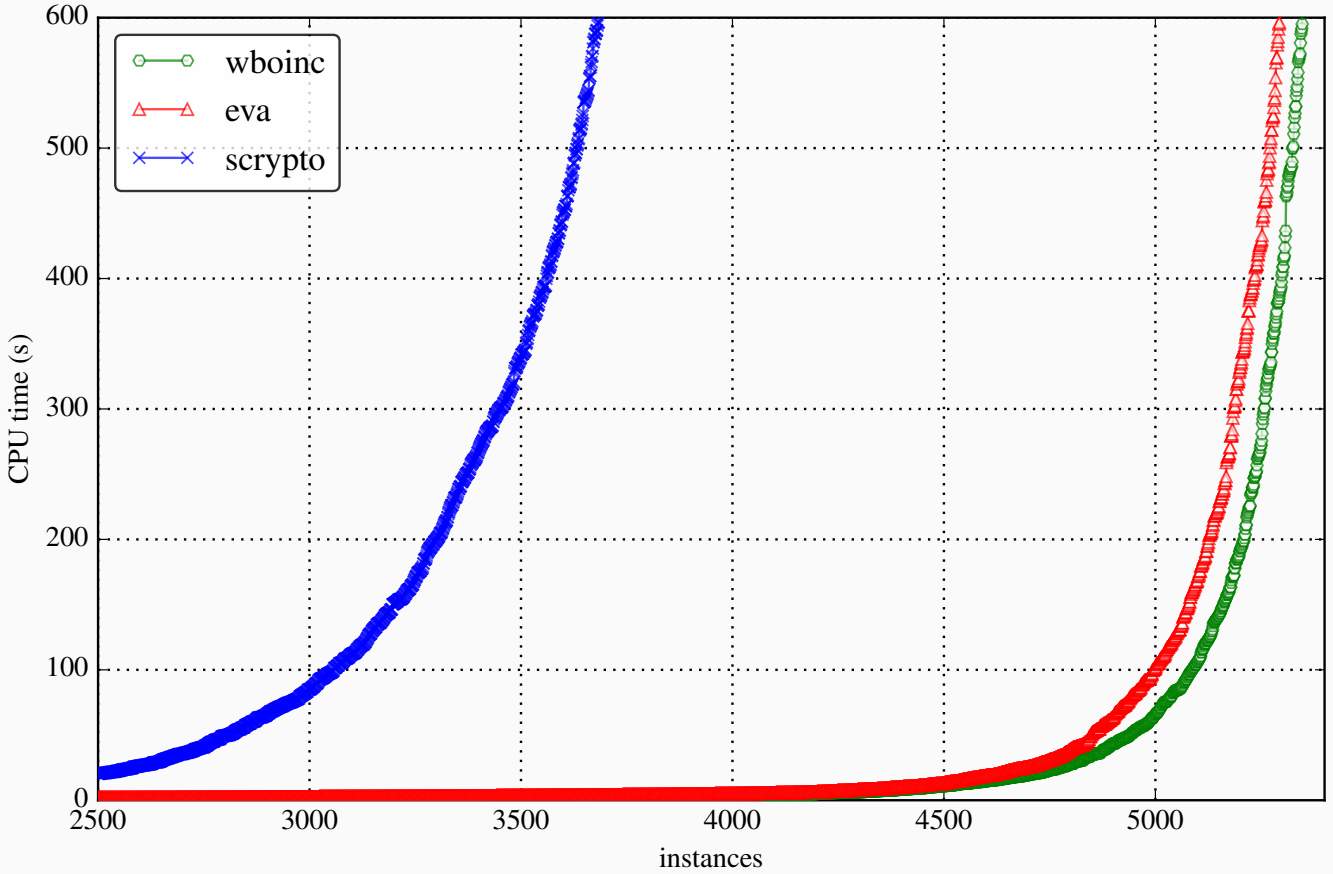



**Figure 2:** Cactus plot for ITC99 suite

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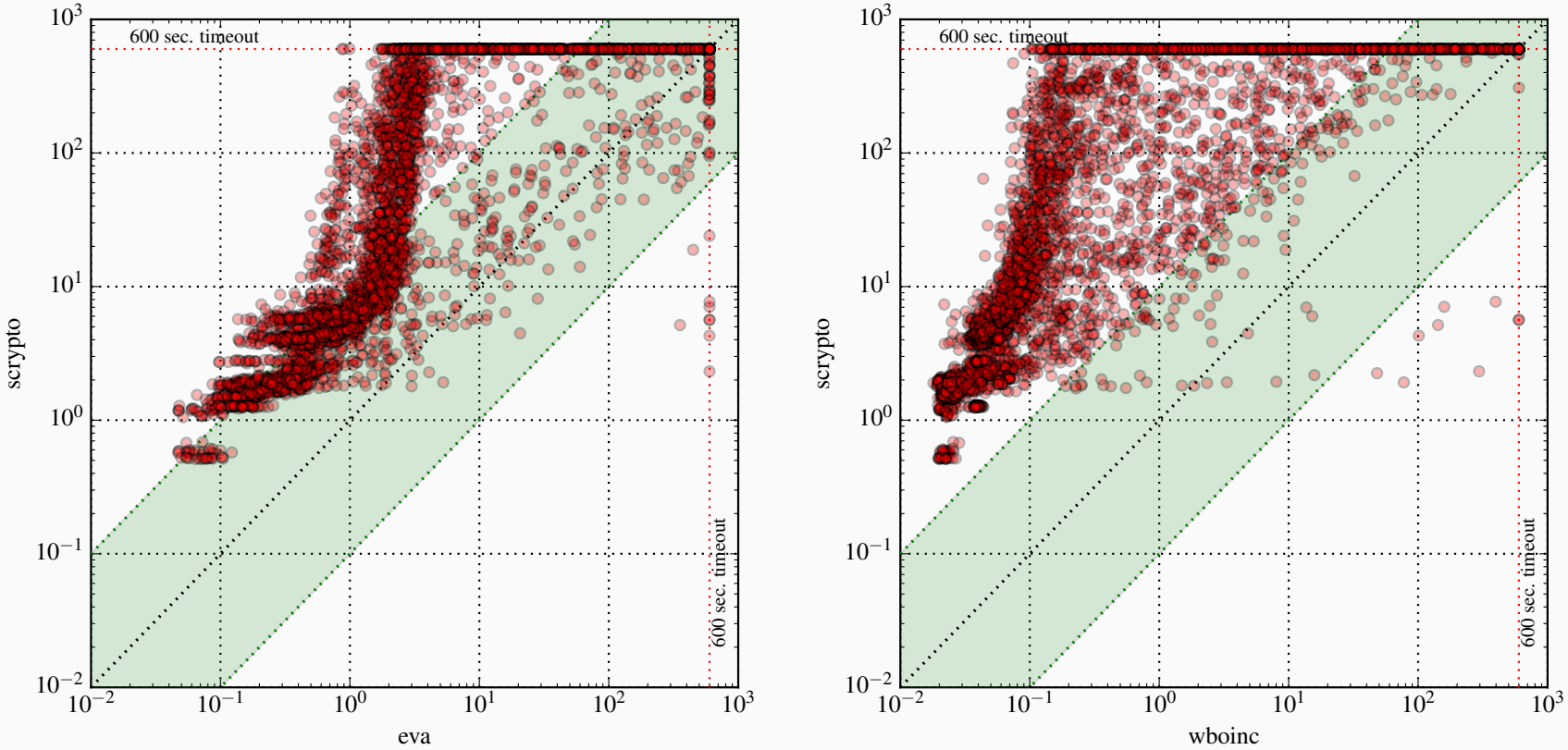


(a) eva vs. scrypto

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**Figure 3:** Scatter plots for ITC99 suite

| 5903 instances | scrypto | eva | wboinc |
|---|---|---|---|
| % solved | 62.4 | 89.7 | 90.6 |
| % scrypto wins | — | 2.2 | 0.4 |
| % eva wins | 97.8 | — | 13.4 |
| % wboinc wins | 99.6 | 86.6 | — |

**Table 2:** Statistics for ITC99 suite

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# Questions?