An Investigation of Compression Techniques to Speed up Mutation Testing

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Our paper: speed up

Cost reduction techniques

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Offutt and Untch 2000

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Challenged by Gopinath et al. (ICSE 2016,TR 2017):
No practical advantage over **pure random sampling**

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Mutation data compression

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647 KB

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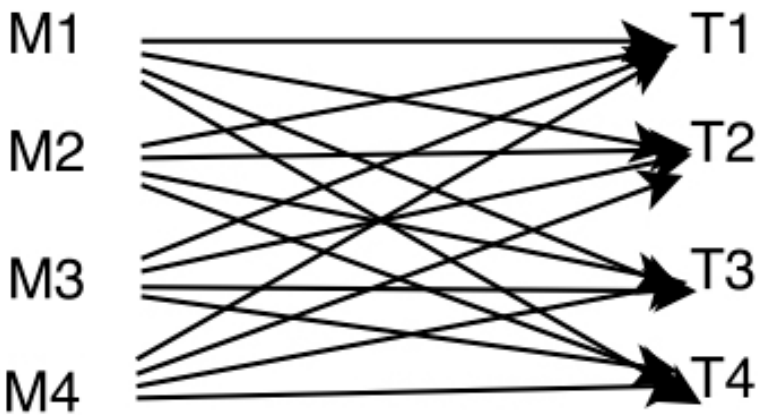

16 tests executed

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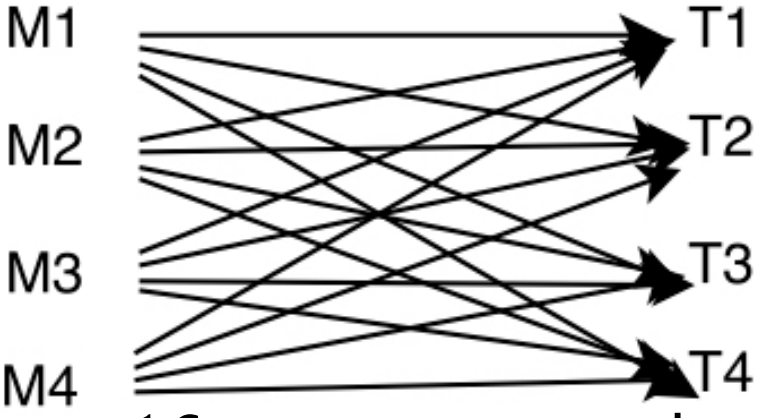

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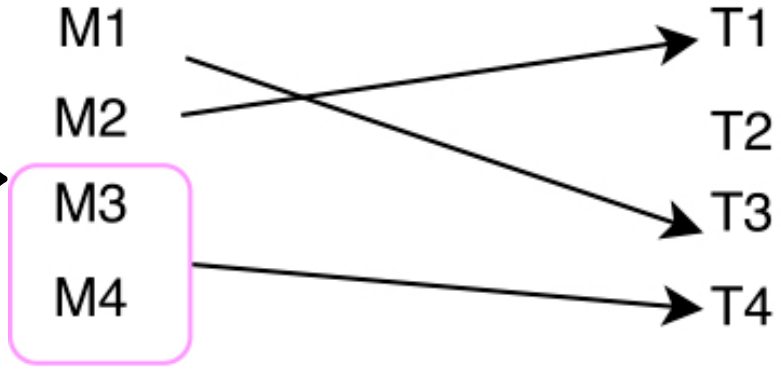

3 tests executed

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    Program:
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2     int c;
3     if(a>0)
4       c=a+b;
5     else
6       c=a-b;
7     return abs(c);
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assertEquals(fun(0,-1),1)

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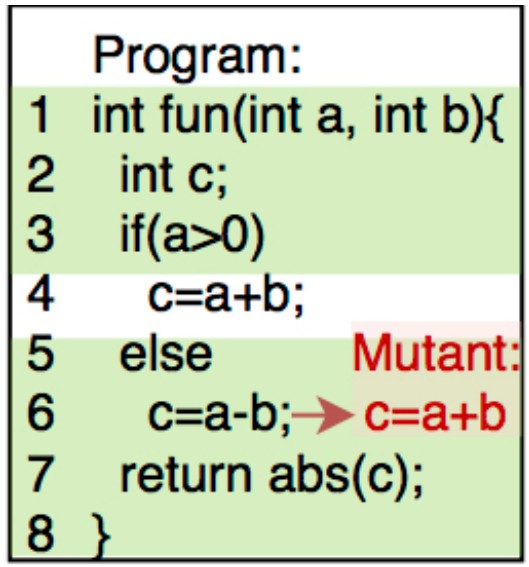

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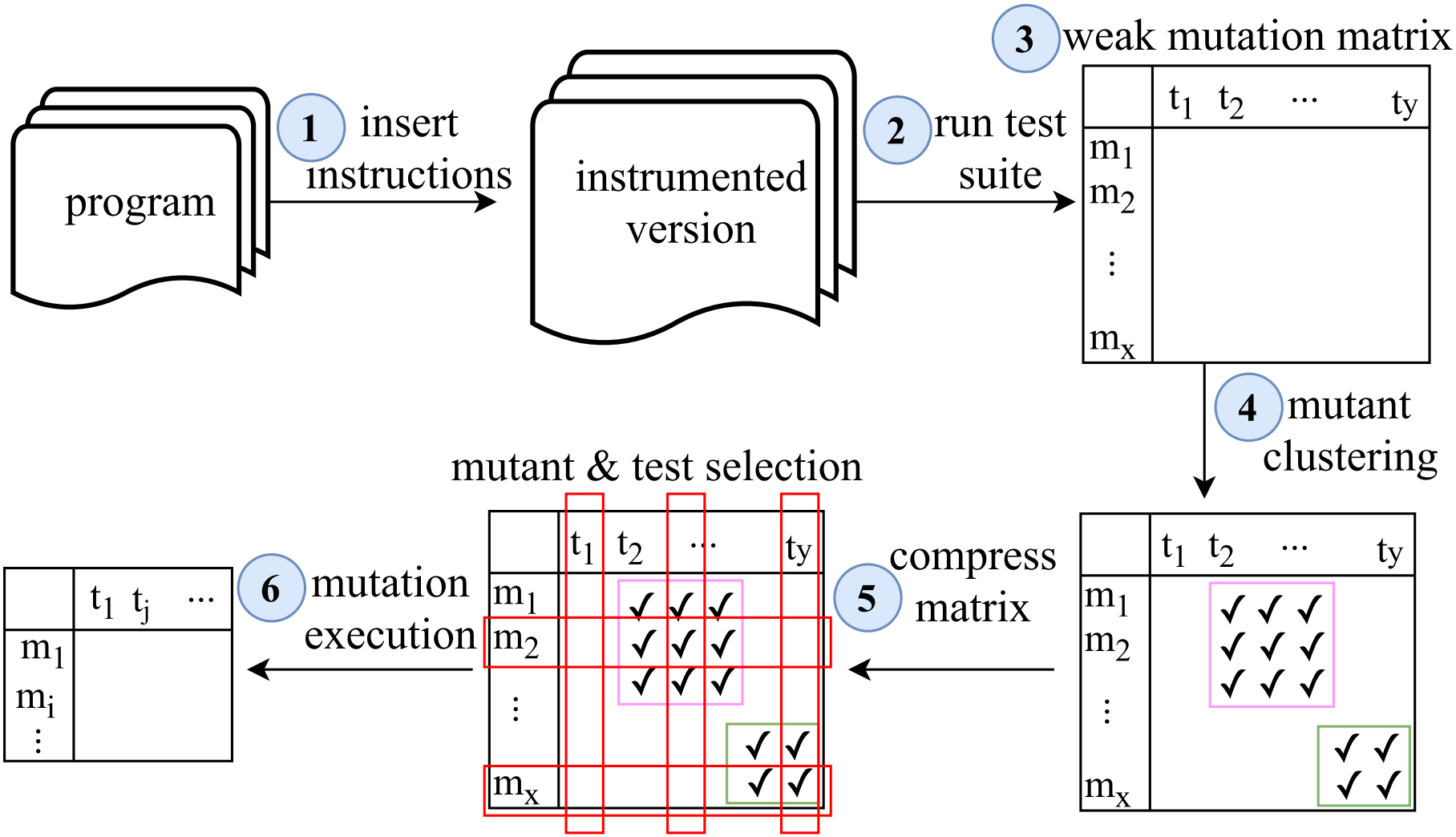
Overall methodology



Mutant clustering

Based on weak mutation

- **Overlapped grouping**
  elements are only grouped together if they are identical

- **FCA-based grouping**
  Formal Concept Analysis; convey binary relations

	t_1	t_2	t_3	t_4
m_1	0	1	0	0
m_2	1	0	0	0
m_3	0	0	0	1
m_4	0	0	1	0
m_5	1	1	0	0
m_6	1	1	0	0

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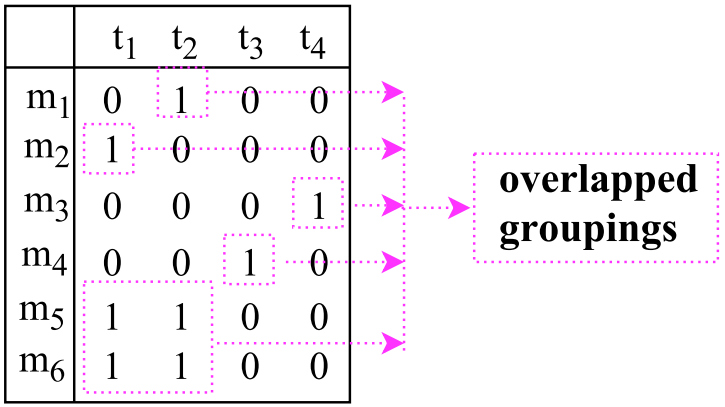

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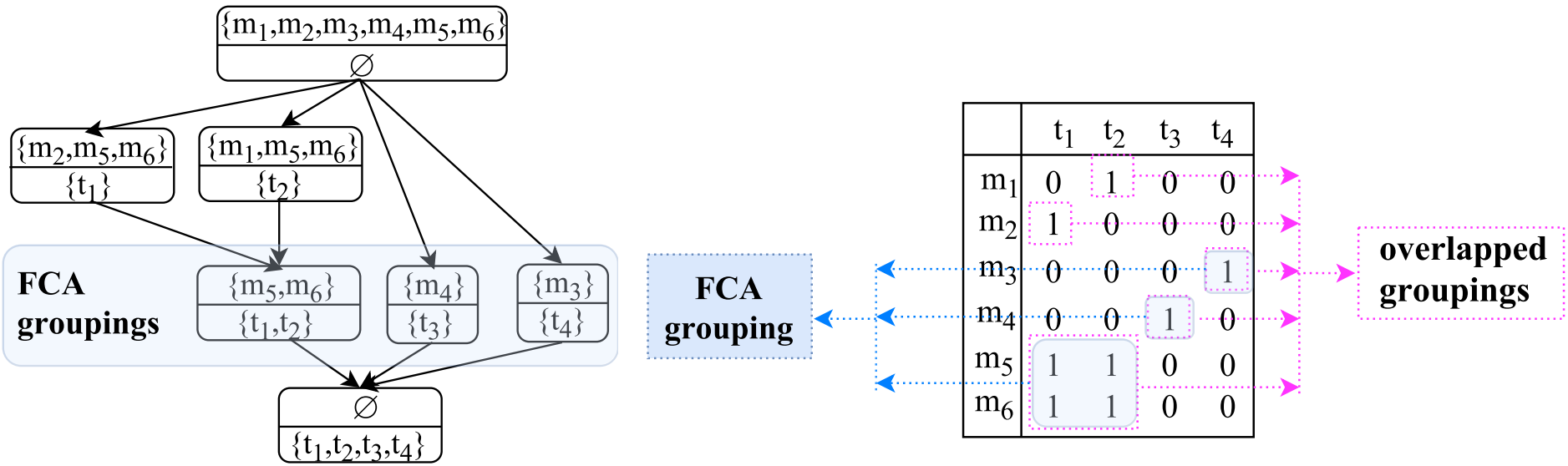

Mutant selection strategies

- **Cluster-based selection (CS)**

  randomly chooses one mutant from each cluster
- **CS + mutation operator type (mop)**

  divide each cluster into partitions by mutation operator types and then random selection
- **CS + mutation location (mloc)**

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m_1	1	Line5
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Empirical study

- **20 open-source projects (Java):** 397K+ LOC, 2K+ tests, 166K+ mutants
- **6+2 methods:**
  - overlap
  - overlap+mop
  - overlap+mloc
  - fca
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  - pure random
  - weak mutation
- **Research questions:**
  - **RQ1:** How accurate are different compression techniques?
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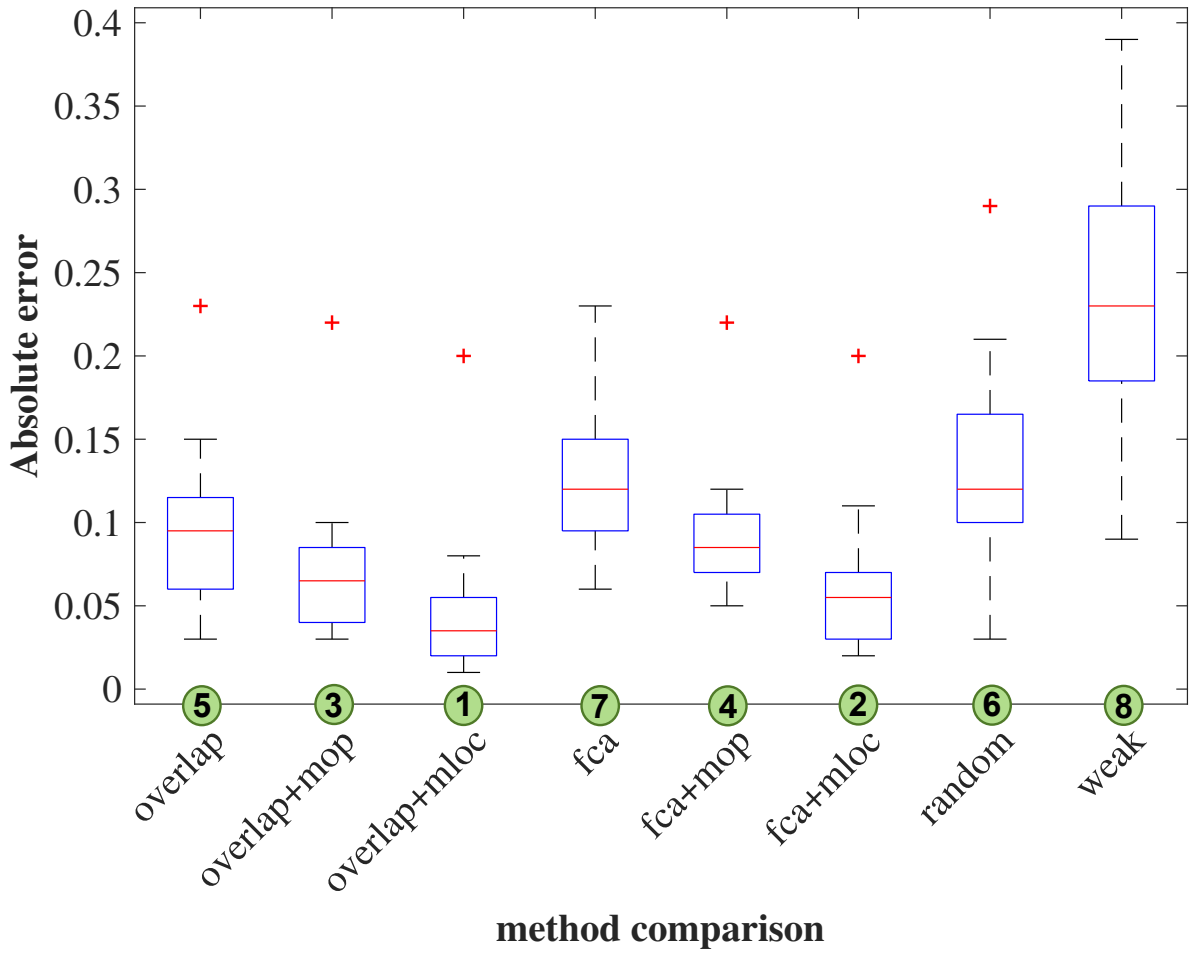
RQ1: accuracy performance

- **Absolute error**

$$AE(C,T) = | \, strong_M(C,T) - estimated_M(C,T) \, | \qquad (1)$$

- **Results:**



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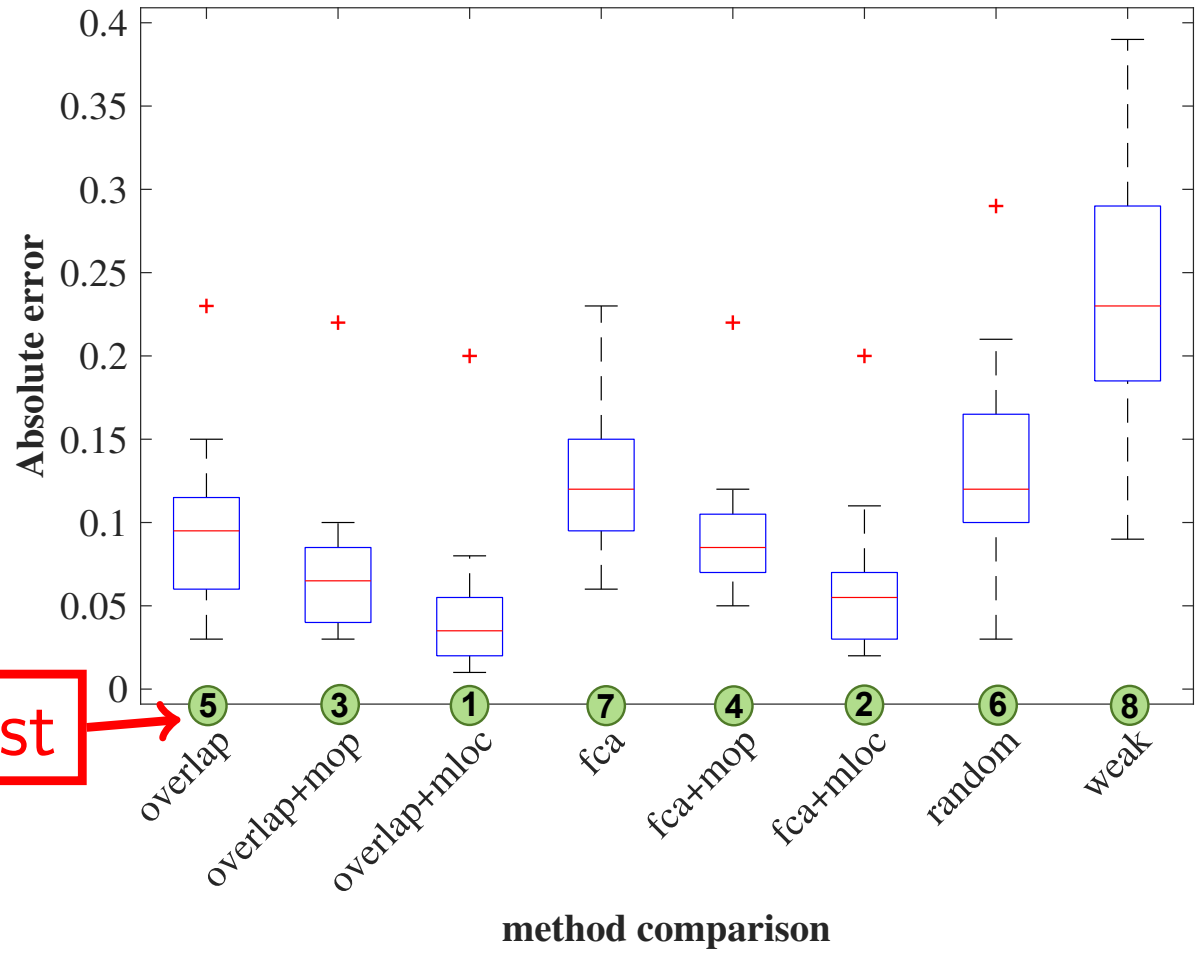

Friedman's test

RQ2: Speed-up performance

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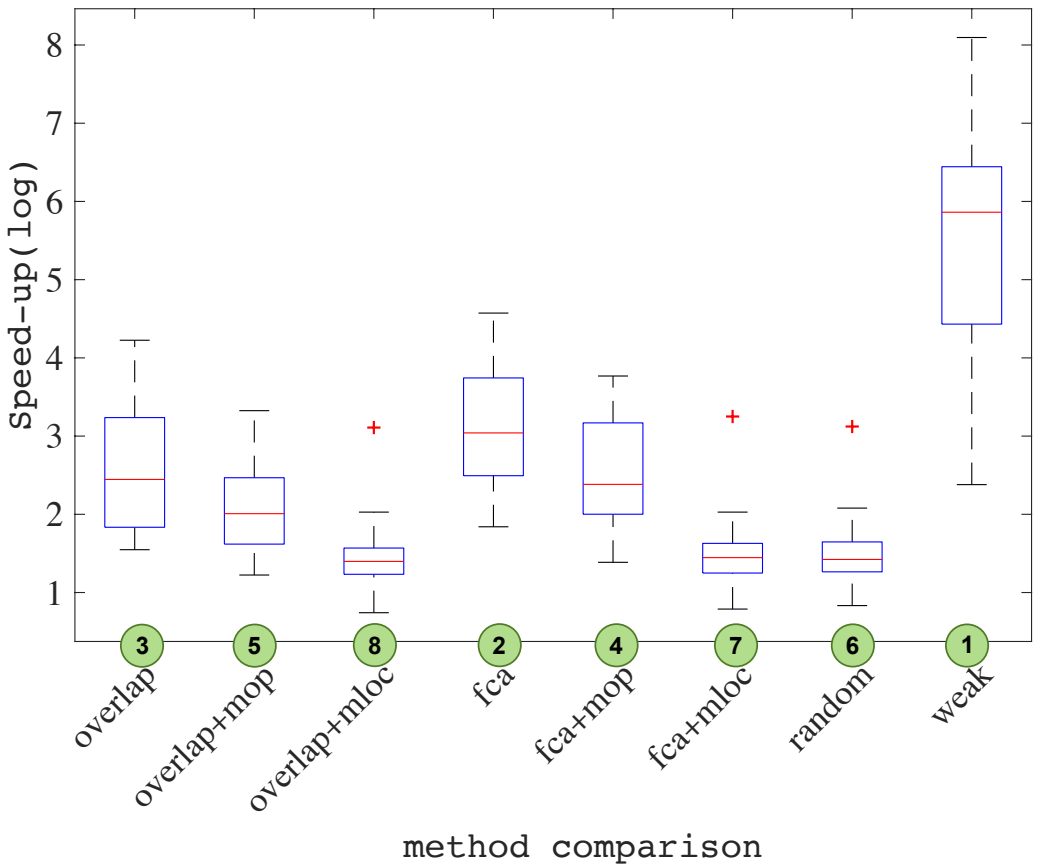

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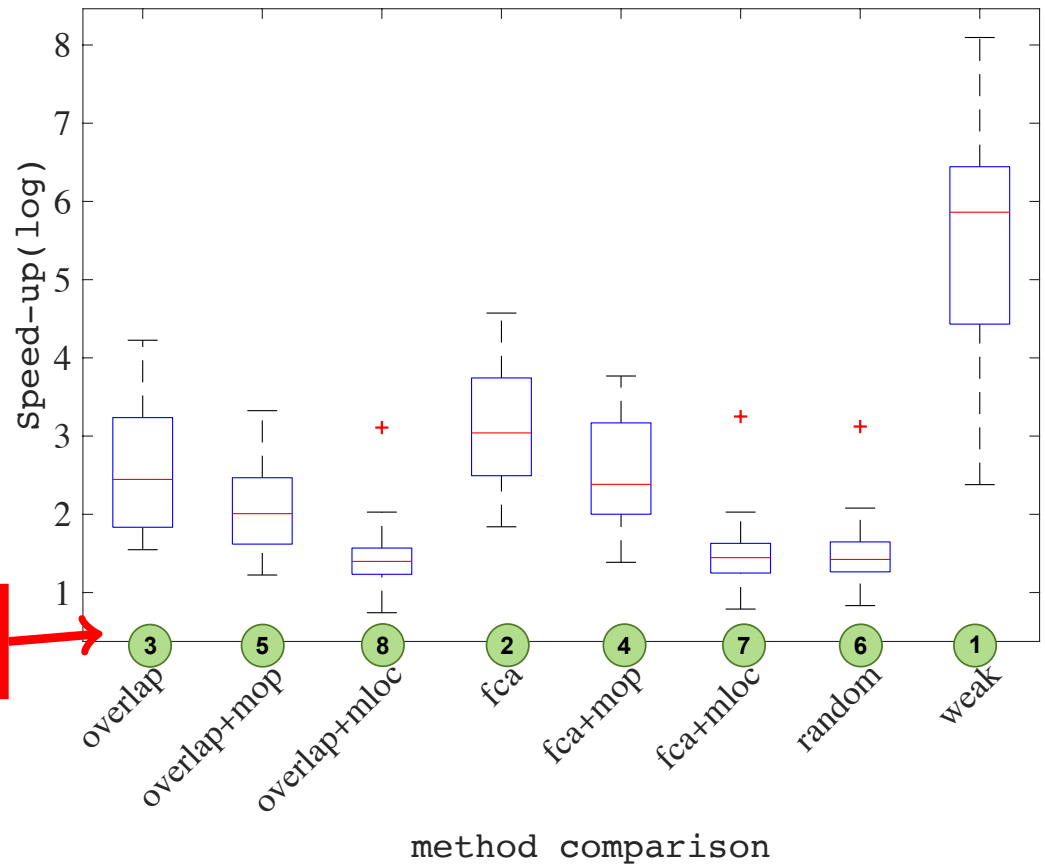

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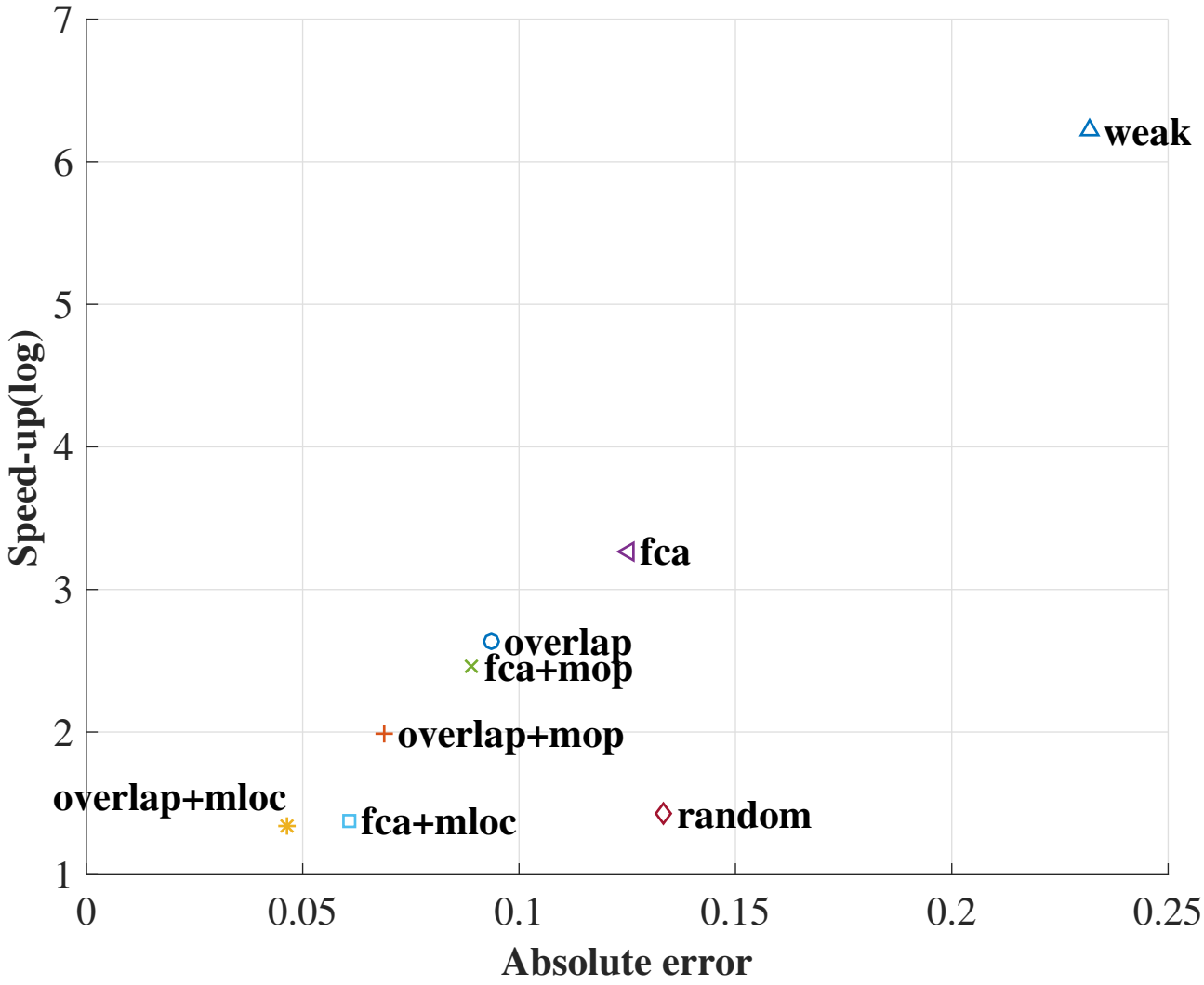
RQ3: Trade-off

Speed-up v.s. absolute error (mean)



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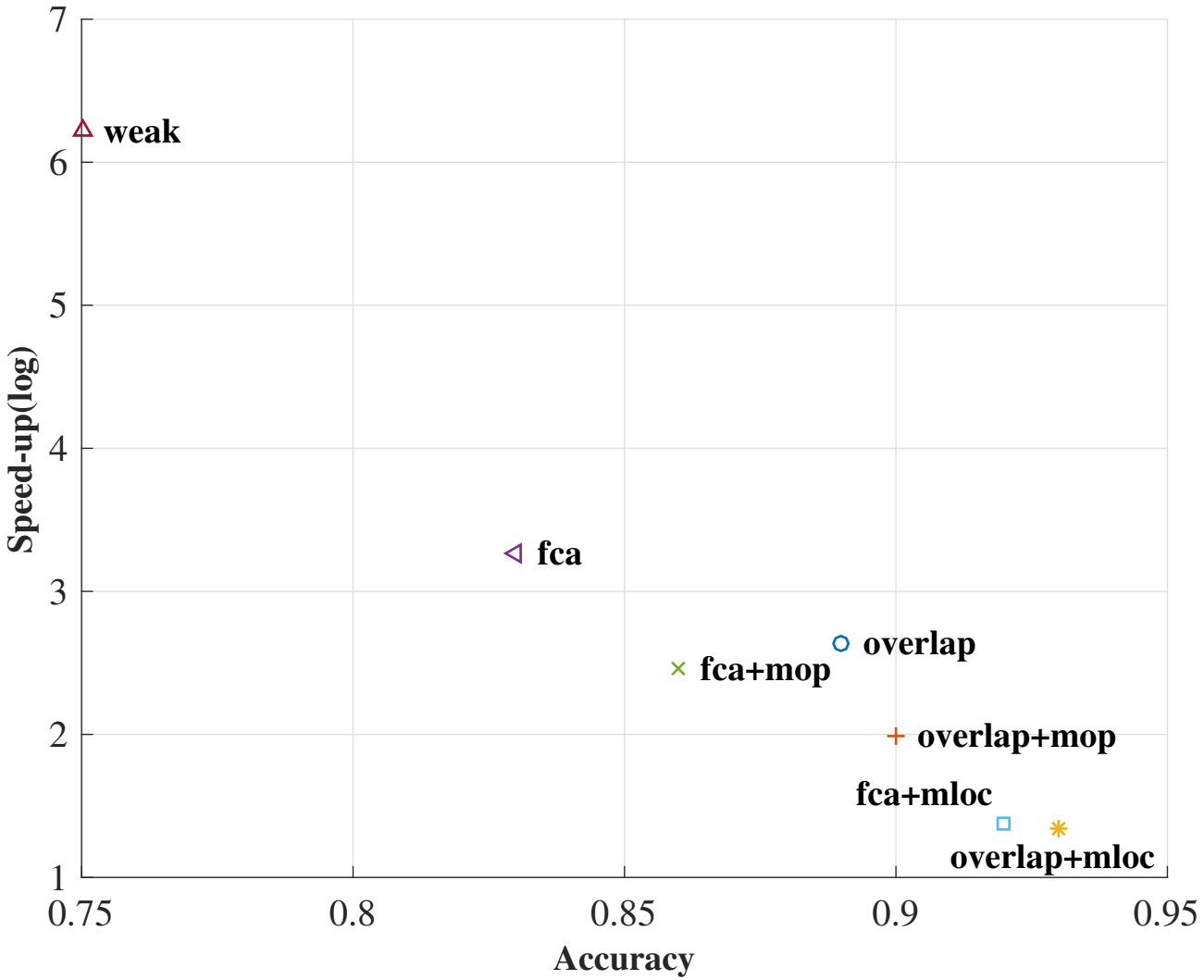

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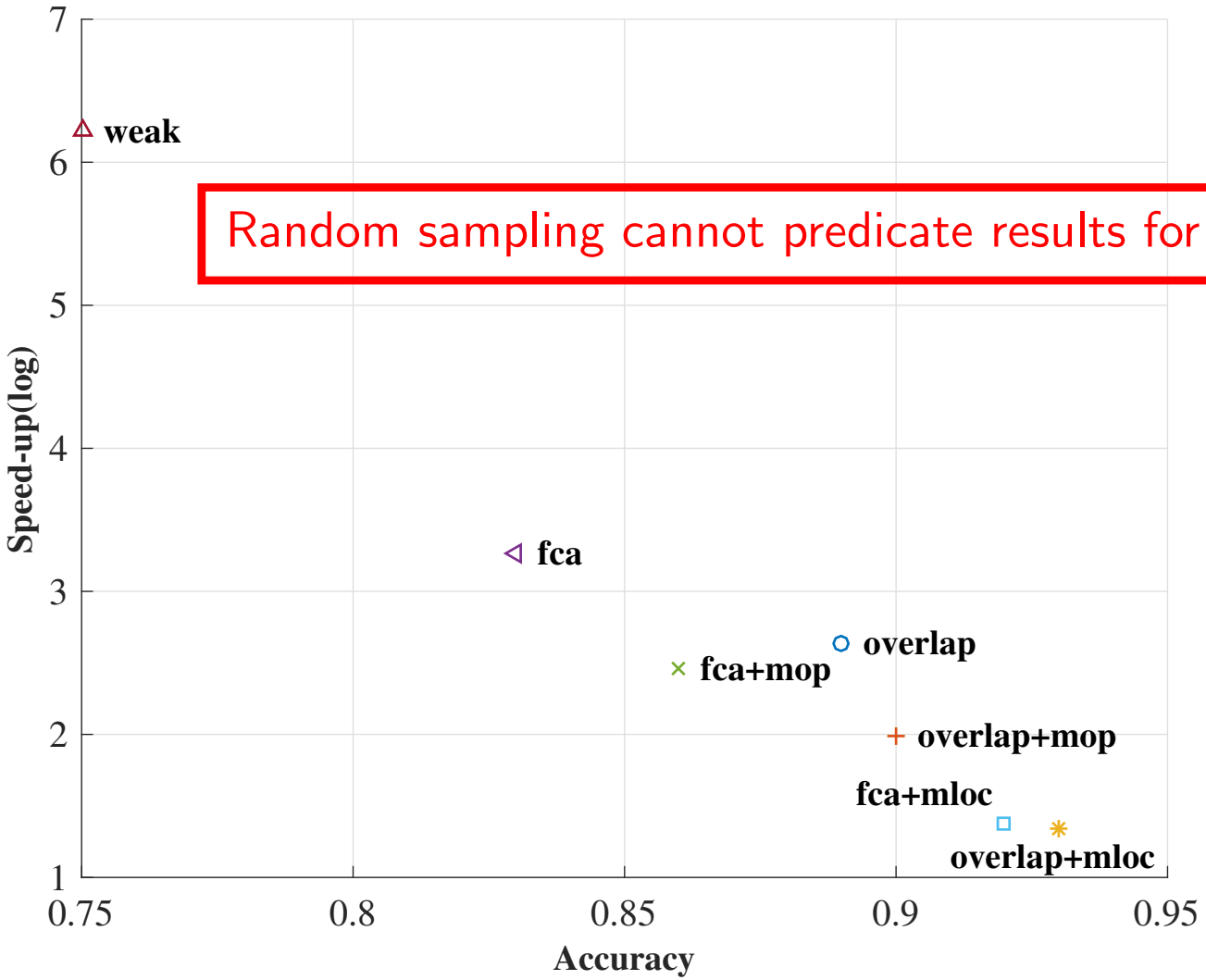

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  - Killable mutant results outperform overall mutation score
- Mutation location trumps mutation operator
- Future work:
  - Combining mutation operator and mutation location
  - Exploring other compression techniques
  - Applying to test-data generation