



Mutation Testing in Practice using Ruby

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Motivation

- Mutation testing
 - Strongest coverage
 - High costs
 - Mutation -> Statement?
- Why is it hard for practitioners to apply mutation testing?



Applying Mutation Testing in Practice



- Real-world product / agile development
- Development / test managers involved
- Amazon Elastic Compute Cloud (Amazon EC2)
- Mutant (muRuby)
 - Stronger than Statement Deletion Operator

Installation

Install the gem `mutant` via your preferred method.

```
gem install mutant
```

Experiments

- **Subjects**
 - 96% statement coverage
- **Procedure**
 - Ran existing test sets 
 - Developed additional mutation tests and identified equivalent mutants
 - Ran the mutation-adequate tests 



Results

| | #Original Test | SC % | #All Mutants | MS-Original | #Mutation Tests | #Equivalent | MS-All |
|----------|----------------|------------|--------------|-------------|-----------------|-------------|-------------|
| 1 | 98 | 97.5 | 27 | 0.96 | 1 | 0 | 1.00 |
| 2 | 10 | 100 | 64 | 0.23 | 4 | 0 | 1.00 |
| 3 | 15 | 80 | 204 | 0.53 | 7 | 5 | 1.00 |
| 4 | 13 | 100 | 114 | 0.96 | 2 | 2 | 1.00 |
| 5 | 12 | 100 | 145 | 0.99 | 2 | 1 | 1.00 |
| 6 | 54 | 100 | 852 | 0.69 | 20 | 13 | 0.98 |
| 7 | 5 | 100 | 10 | 1.00 | 0 | 1 | 1.00 |
| 8 | 17 | 100 | 300 | 0.90 | 2 | 9 | 1.00 |
| Ave | | 97.2 | | 0.78 | | | 0.99 |
| Total | 148 | | 1716 | | 38 | 31 | |

Lessons Learned

- Not hard to understand mutation testing
- Developers should perform mutation testing
- Tests are meaningful
- Equivalent mutants (deletion) are helpful

Results on Execution Time (seconds)

| Instance | Core | Memory | 3 | 4 | 6 | 8 |
|------------|------|--------|-----|-----|-------------|-----|
| MBP i7 | 4 | 16 | 23 | 40 | 2382 | 63 |
| M3.medium | 1 | 4 | 238 | 316 | 17895 | 632 |
| M3.large | 2 | 8 | 75 | 139 | 8444 | 202 |
| M3.xlarge | 4 | 15 | 42 | 74 | 4547 | 108 |
| M3.2xlarge | 8 | 30 | 24 | 39 | 2357 | 60 |
| C3.xlarge | 4 | 8 | 42 | 74 | 8564 | 107 |
| C3.2xlarge | 8 | 15 | 23 | 39 | 2318 | 57 |
| C3.4xlarge | 16 | 30 | 14 | 23 | 1305 | 33 |
| C3.8xlarge | 32 | 60 | 9 | 16 | 1165 | 21 |

Long Execution Time ☹️

Suggestions and Conclusions

- A good tool
 - Easy to install and use
 - Effective operators
 - Parallel computing
 - Options to choose mutation operators to use
 - Remember which mutants are killed
 - Time-out
- Mutation testing can be used in the real-world

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