# Fine-Tuning Spectrum Based Fault Localisation with Sequence Mining

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Universiteit Antwerpen

# Overview


CHANGES
CHANGES
CHANGES
CHANGES


class
class
class Token{
char
char

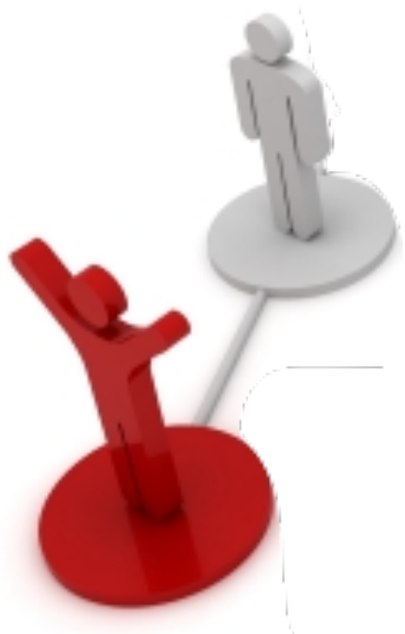
# Fault Localisation

Locate Understand Fix

Fault Localisation an important step in debugging process

# Fault Localisation

## Test to code mapping



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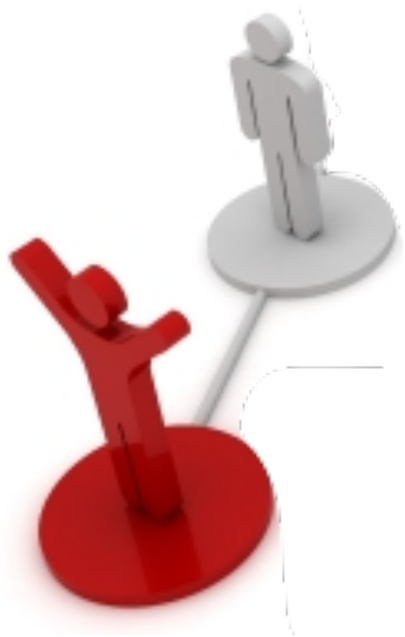

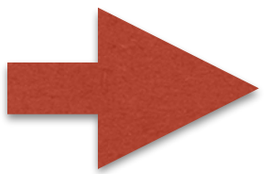

# Fault Localisation

## Test to code mapping

# Fault Localisation

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* Failing test in Apache Commons Math

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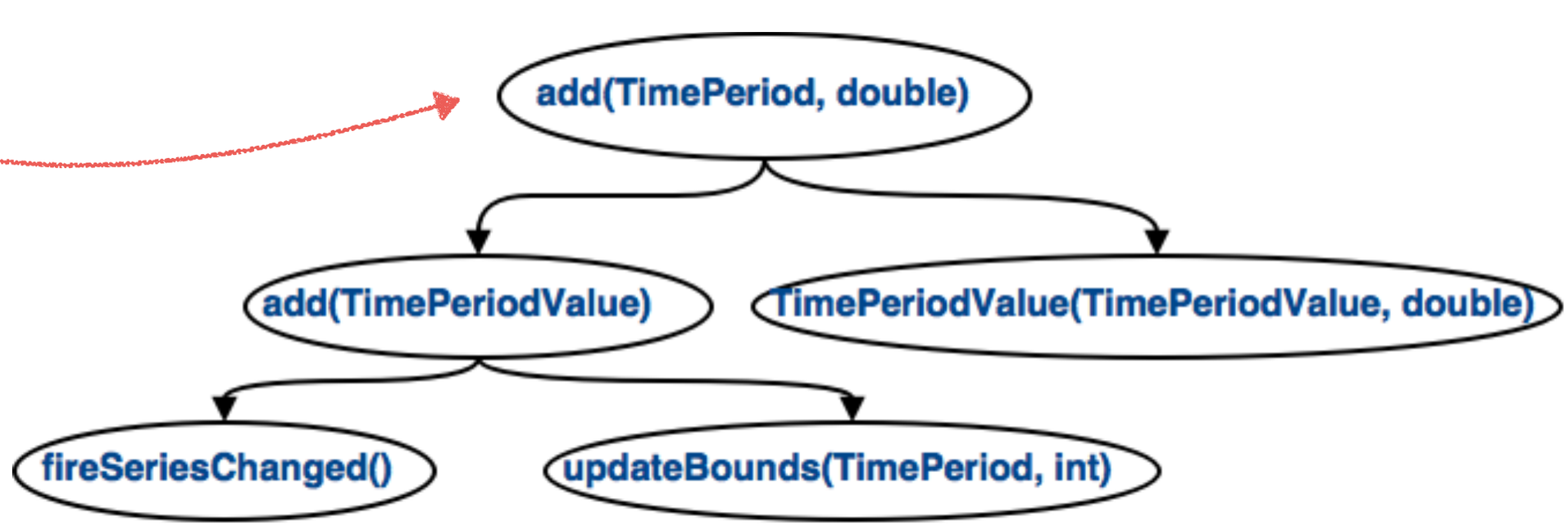

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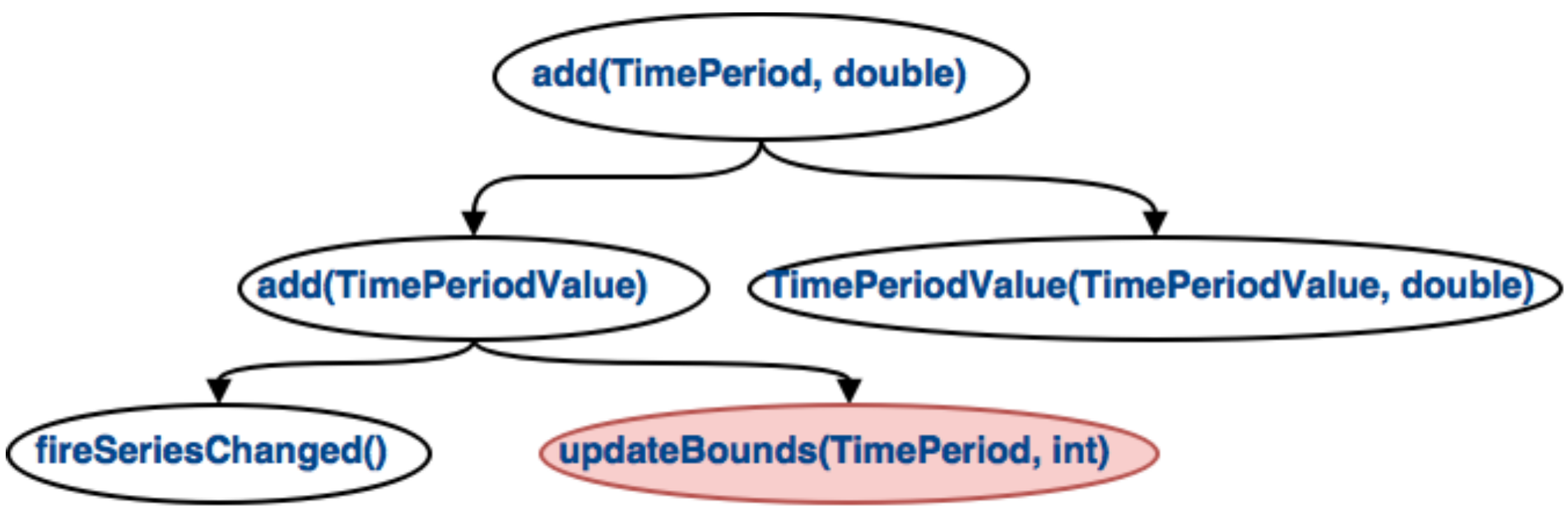

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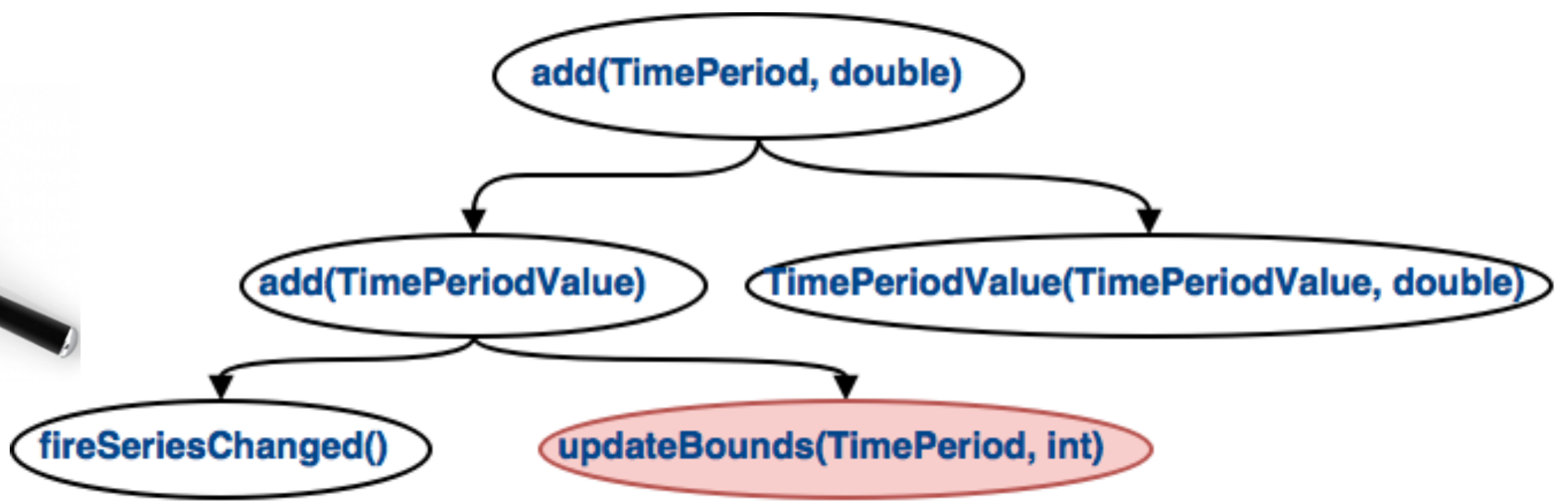

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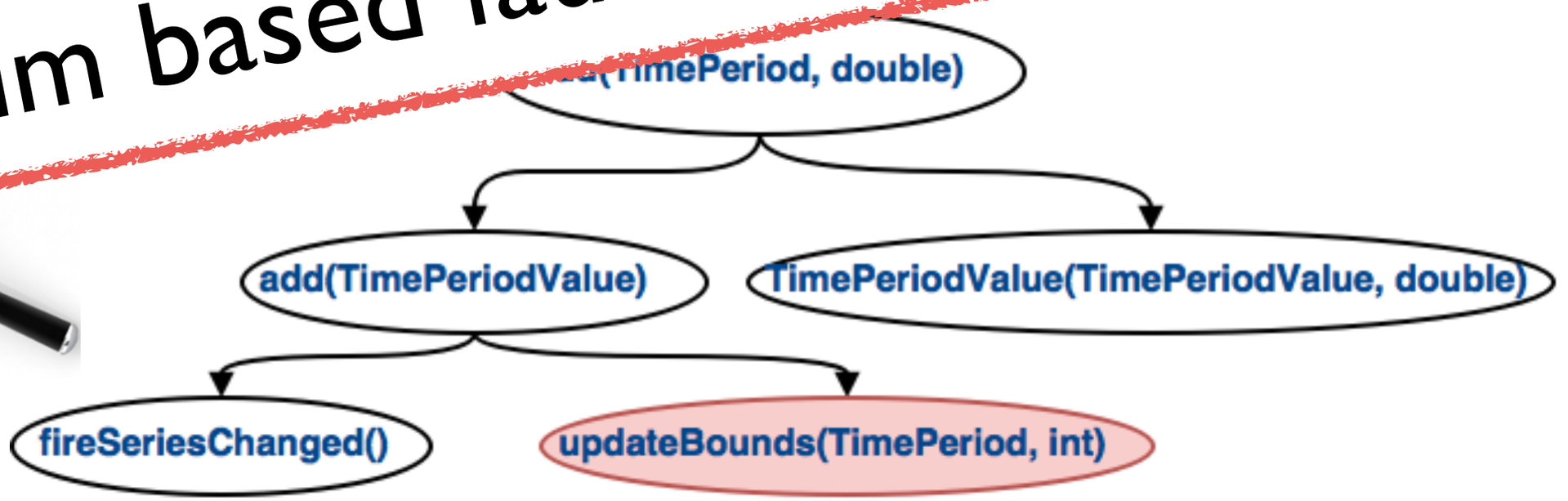
Spectrum based fault localisation



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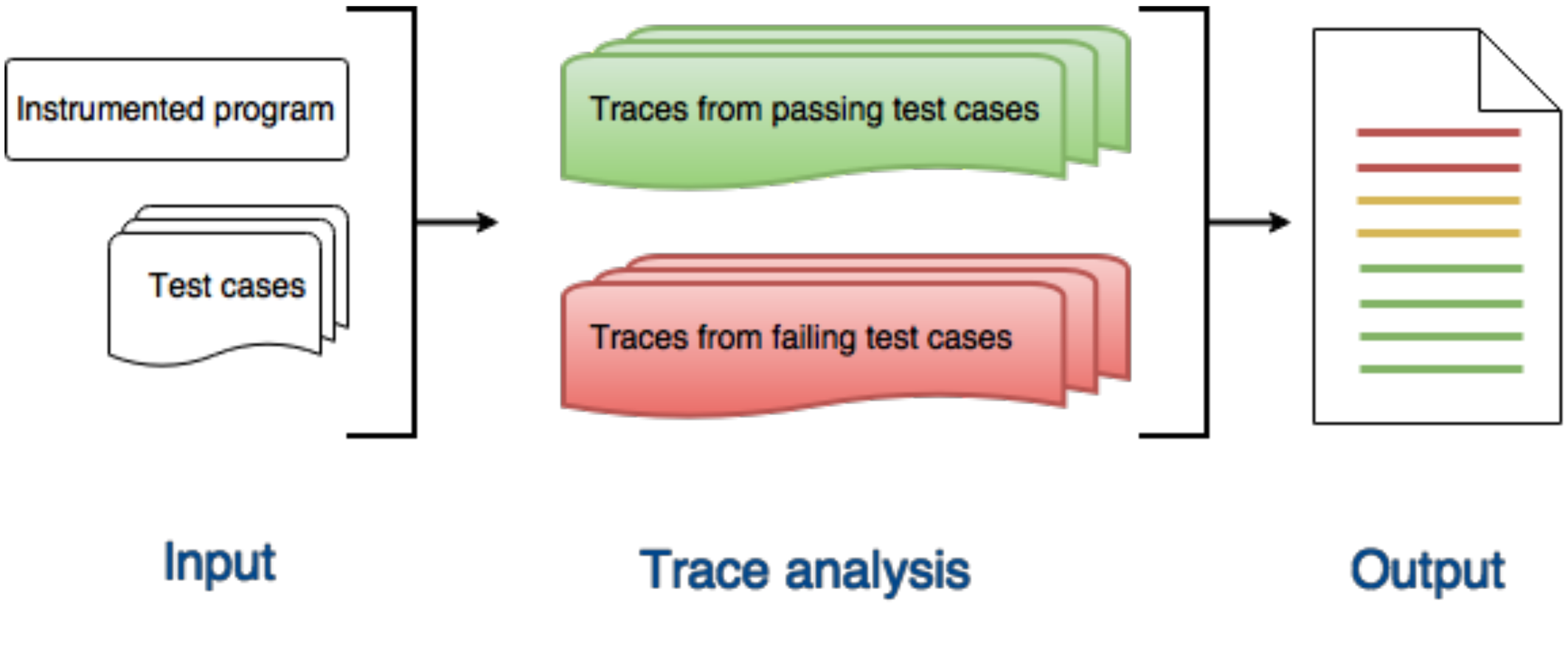
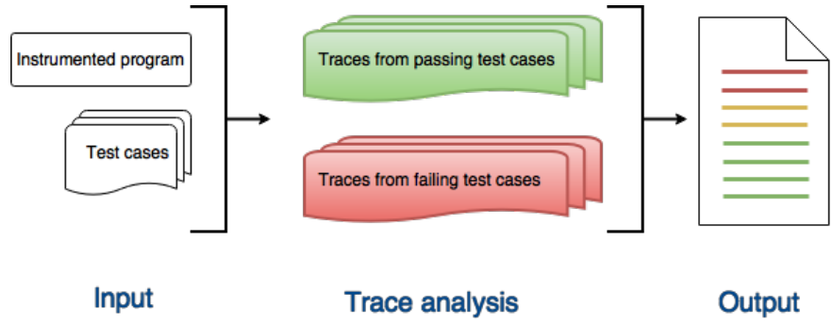


# Spectrum Based Fault Localisation

## Granularity




Method

Block

Statement

# Spectrum Based Fault Localisation

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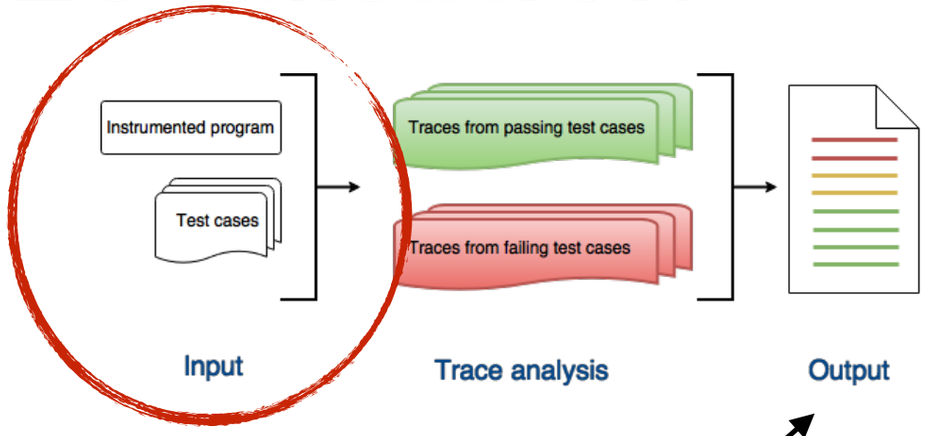


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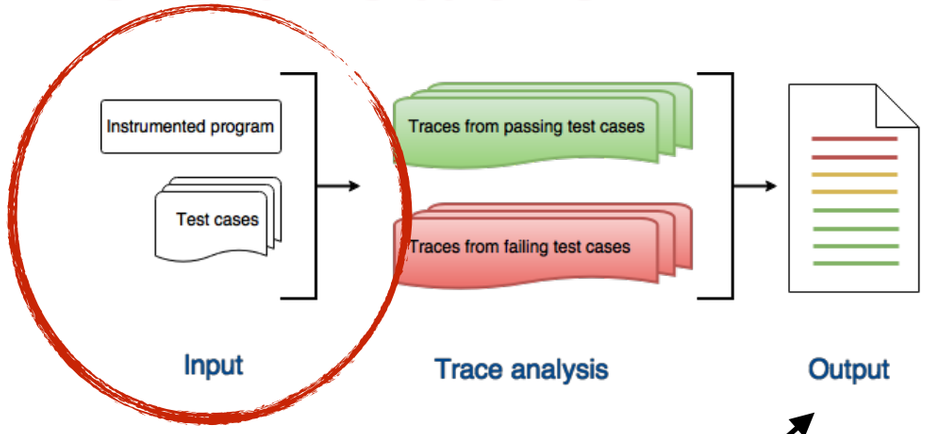


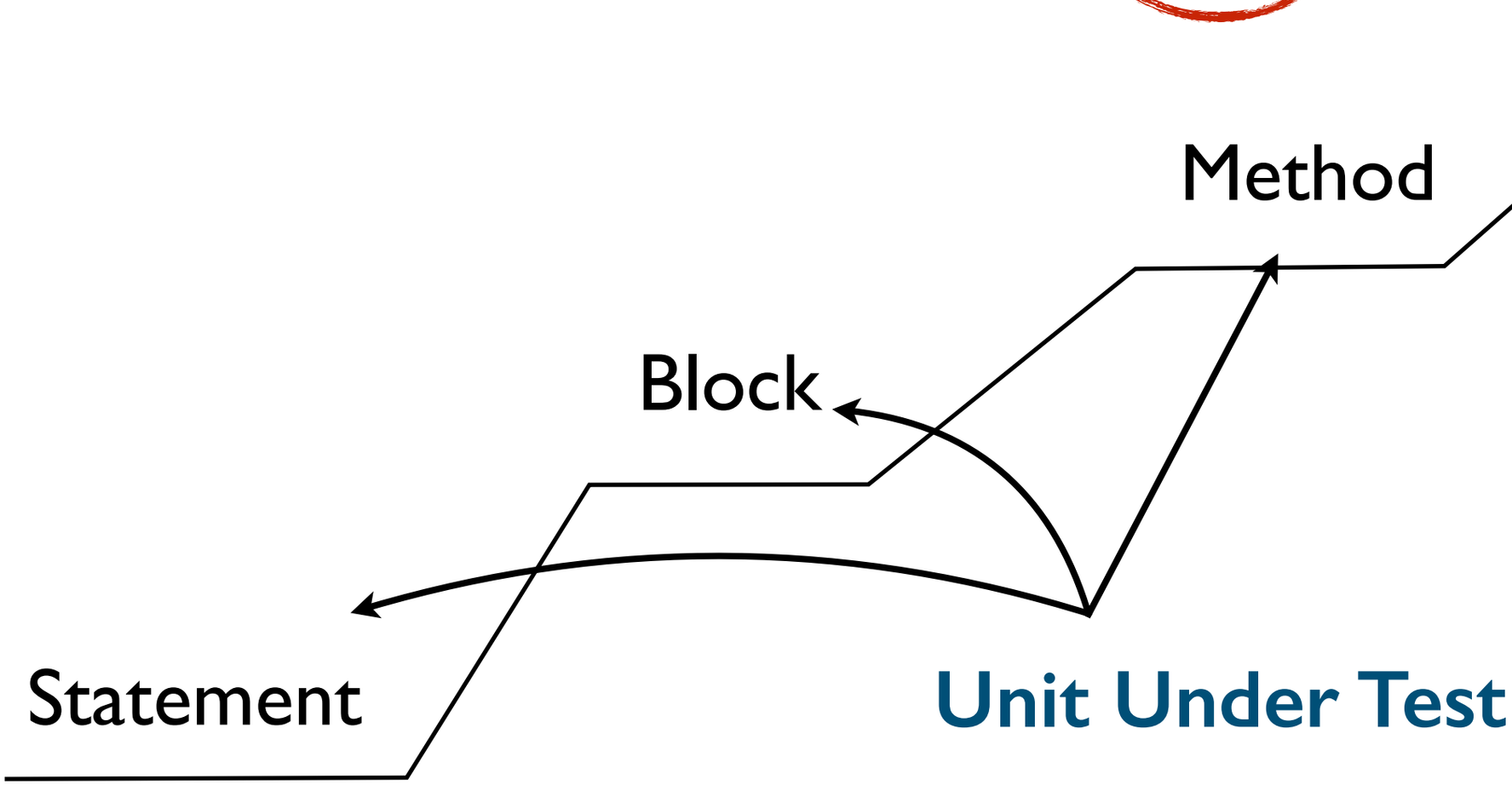

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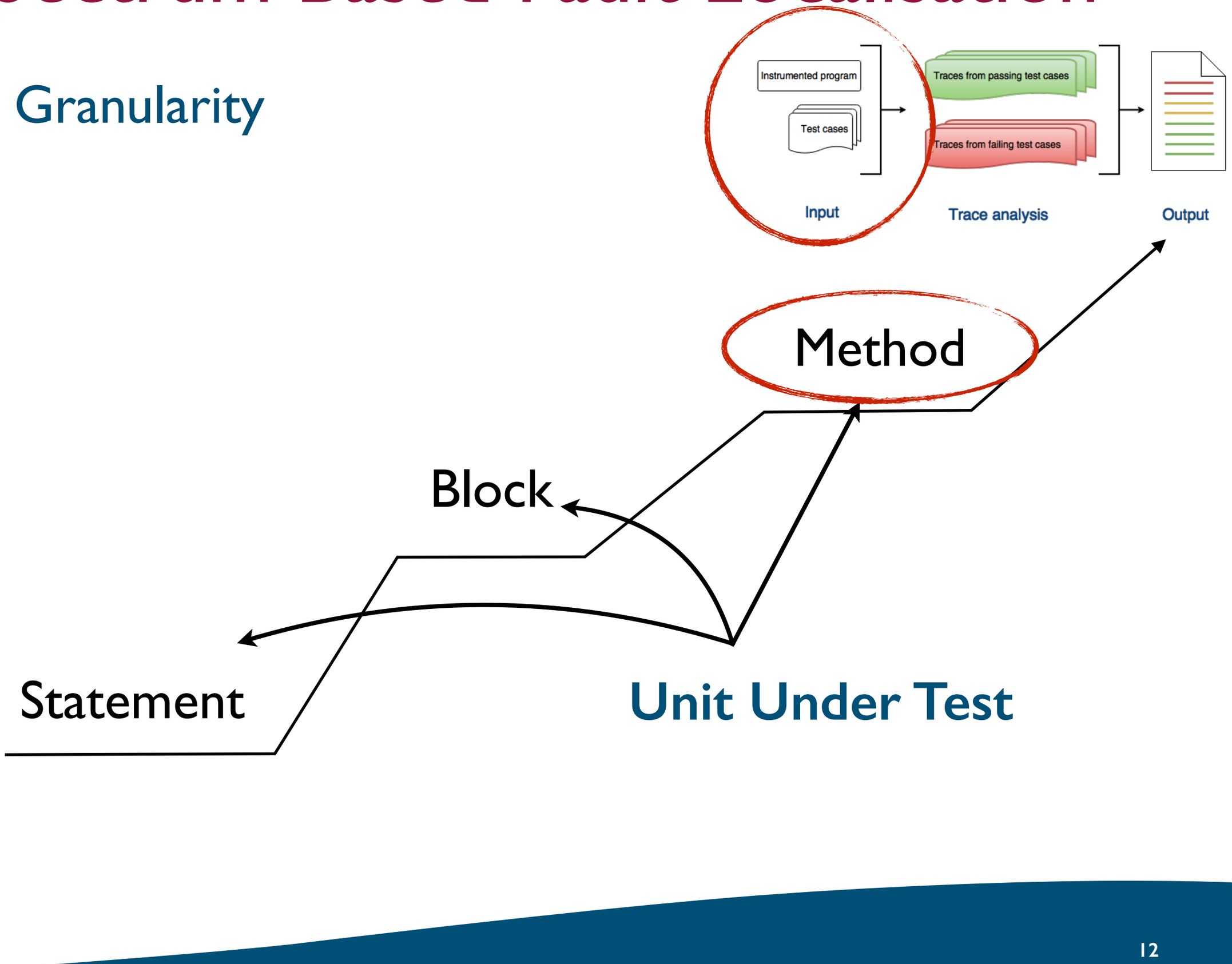
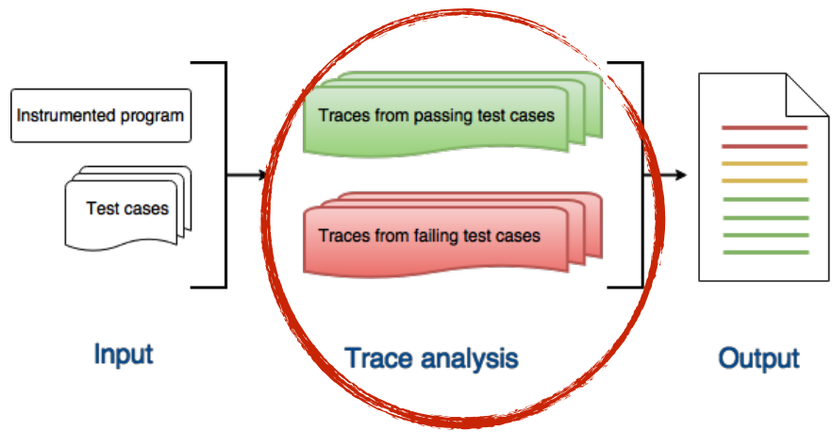
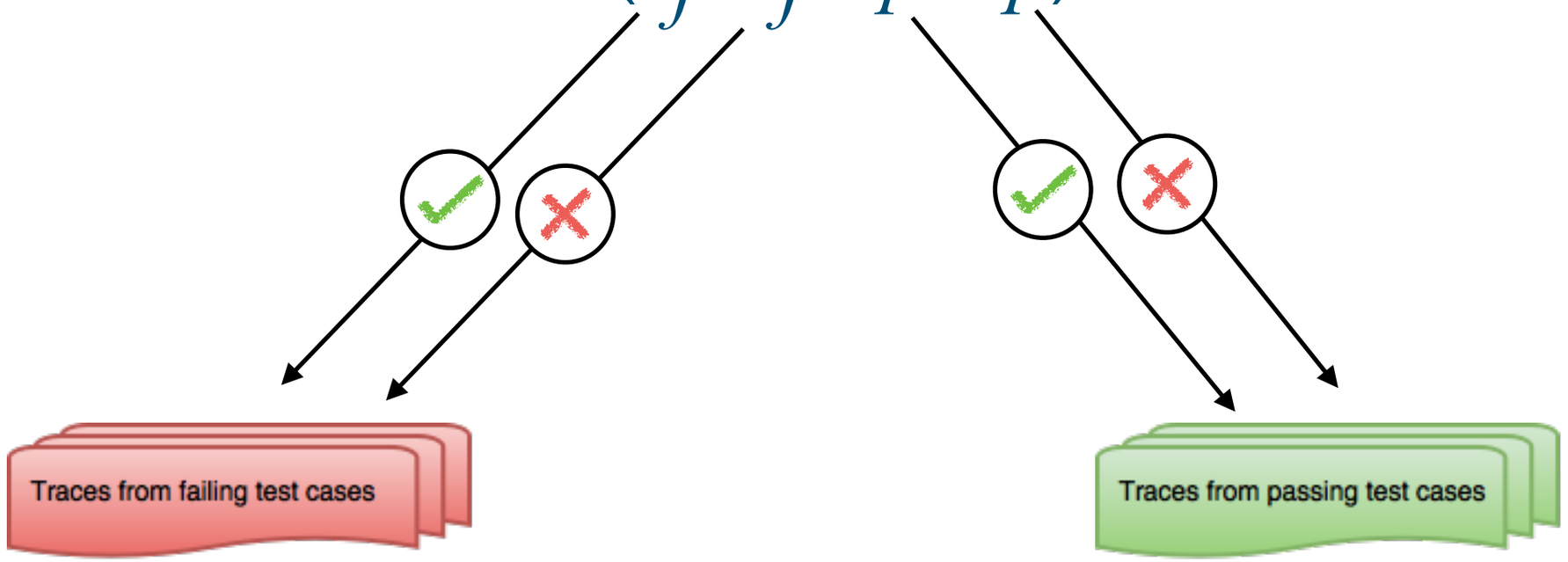


# Spectrum Based Fault Localisation

## Hit Spectrum



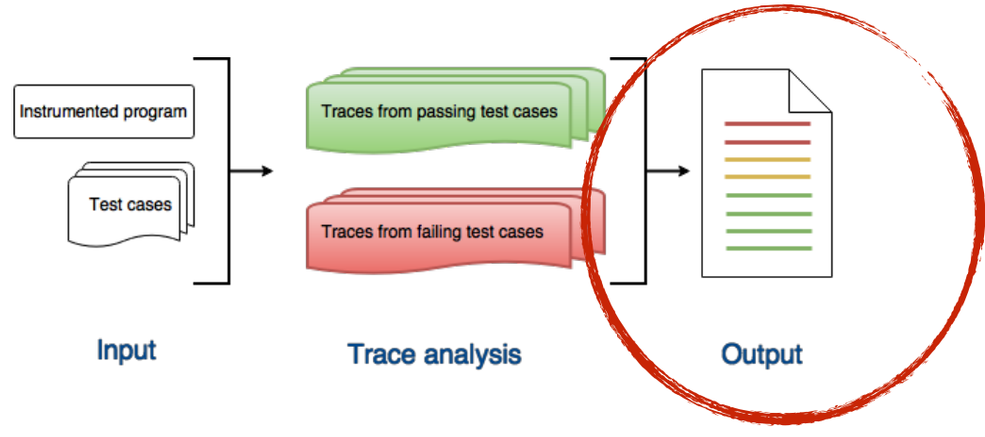

UUT = $(e_f, n_f, e_p, n_p)$




- ✓ Number of traces that contain UUT
- ✗ Number of traces that do not contain UUT

# Spectrum Based Fault Localisation

## Fault Locator




Fault Locator

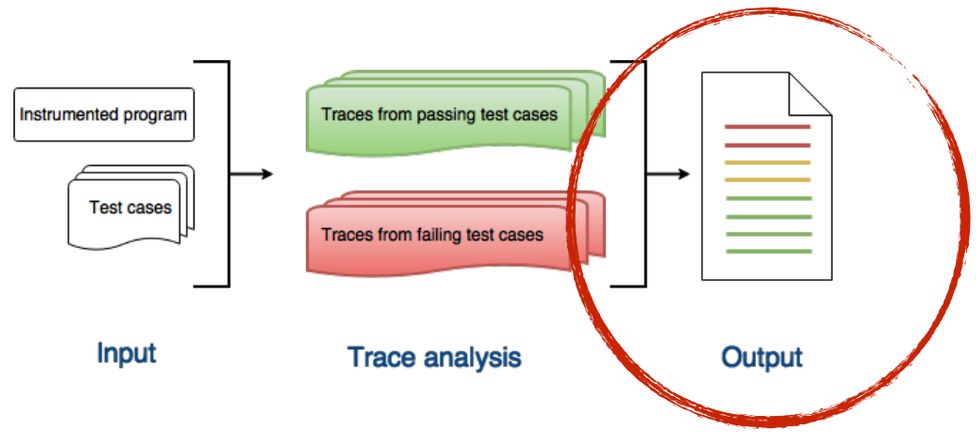
UUT = $(e_f, n_f, e_p, n_p)$

UUT = Suspiciousness

$$suspiciousness = \frac{e_f}{\sqrt{(e_f + n_f)(e_f + e_p)}}$$

# Spectrum Based Fault Localisation

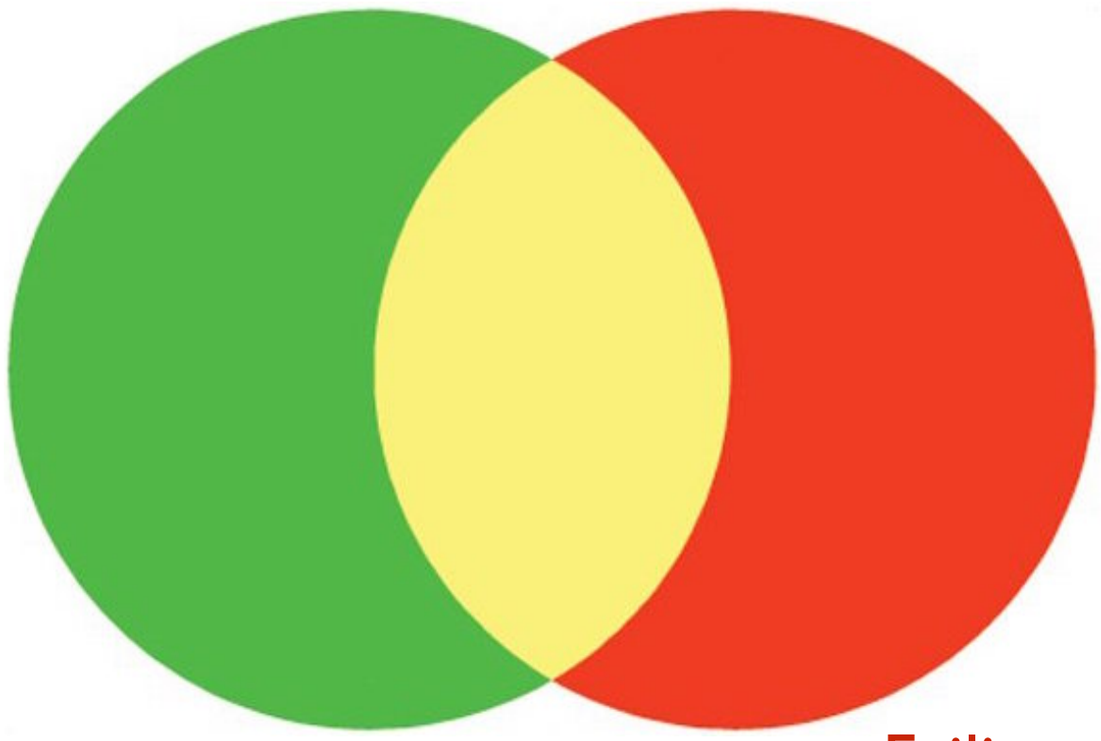
## Fault Locator




Suspiciousness = [0,1]

Not suspicious → Highly suspicious

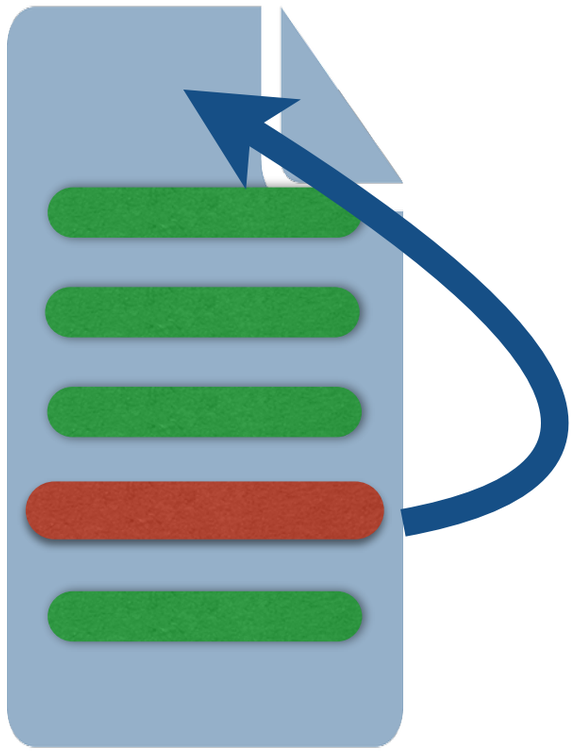
0 — 1



Passing test cases

Failing test cases

# Spectrum Based Fault Localisation

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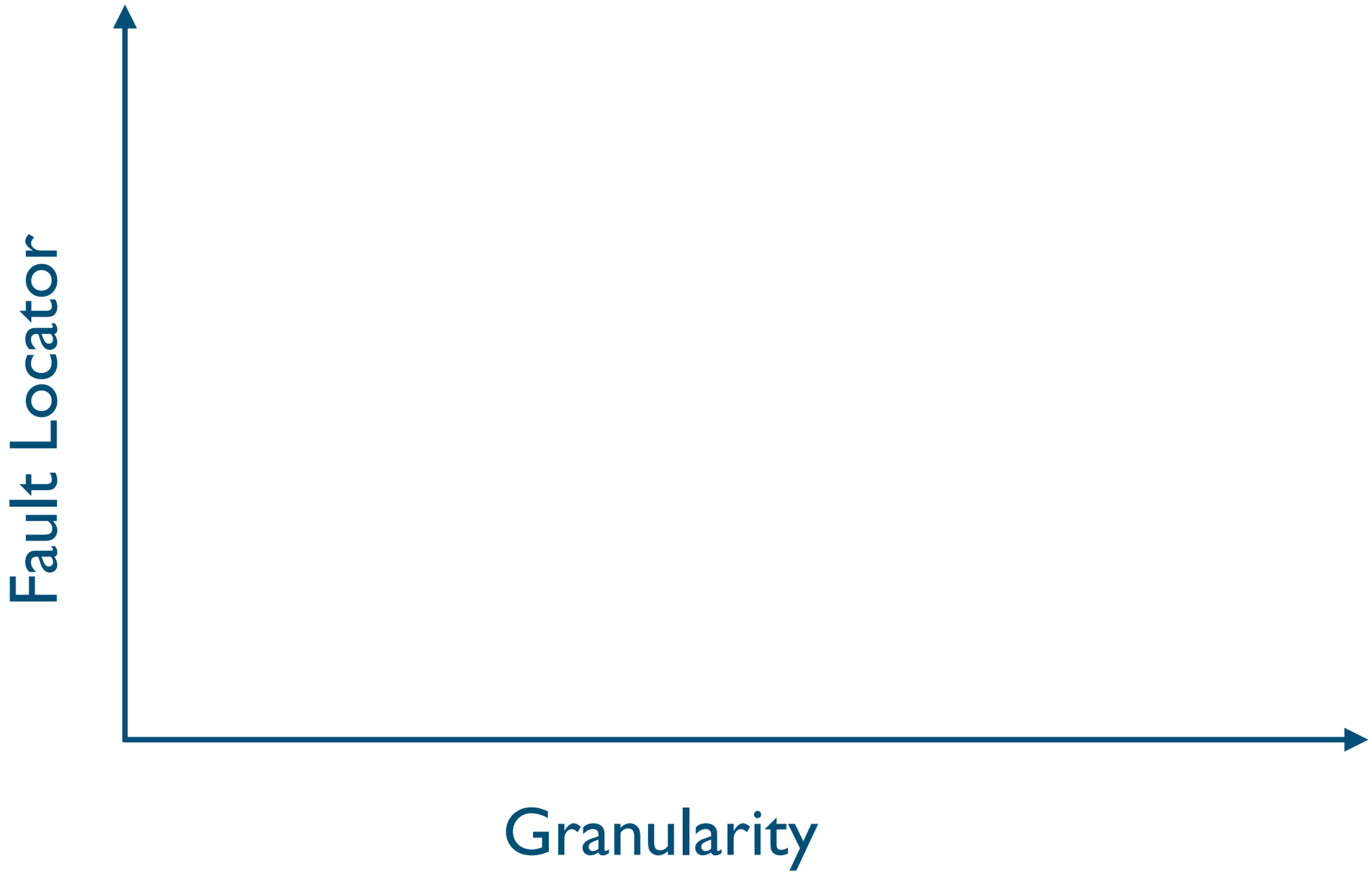

# Spectrum Based Fault Localisation

# Raw Spectrum Analysis

## Missing

```
method1(){
        methodA()
        methodB()
        if(condition){
          return
        }
        methodC()
}
```

Fault

# Raw Spectrum Analysis

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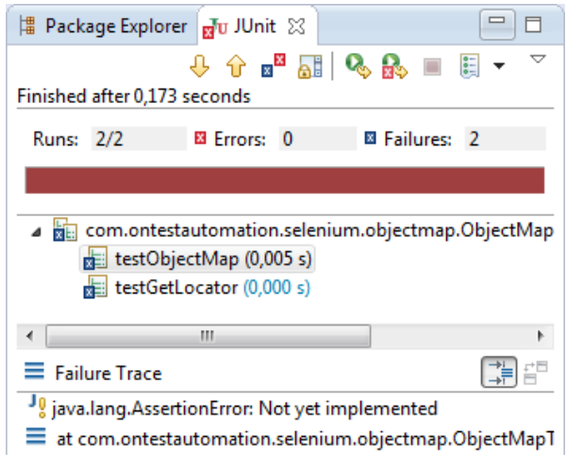


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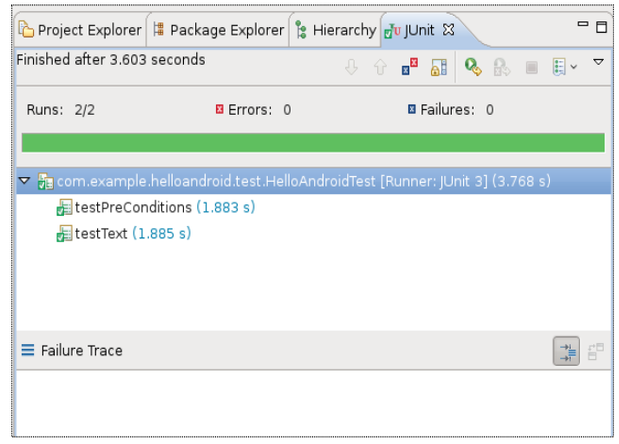


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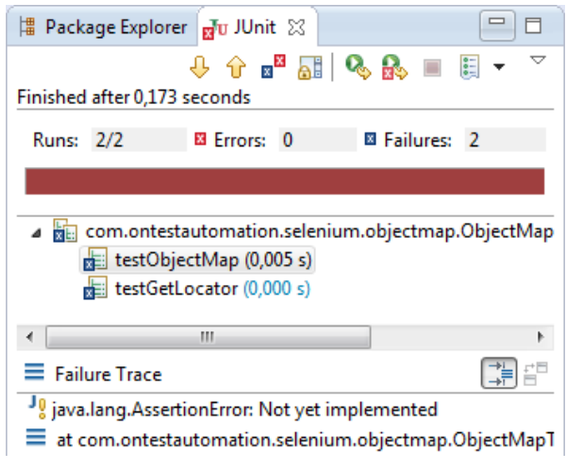


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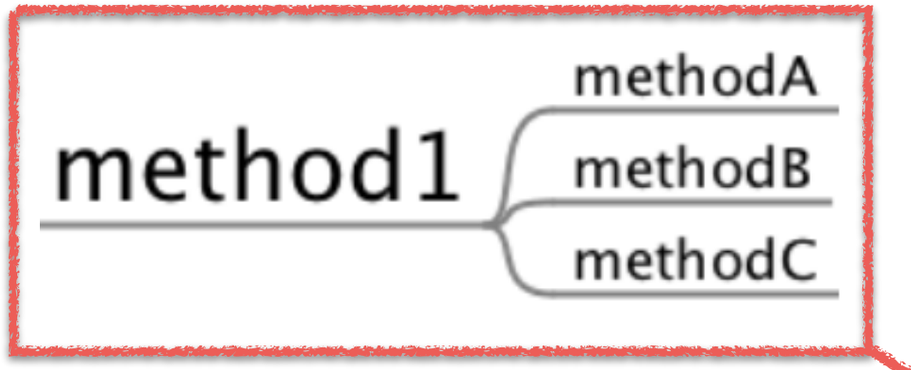


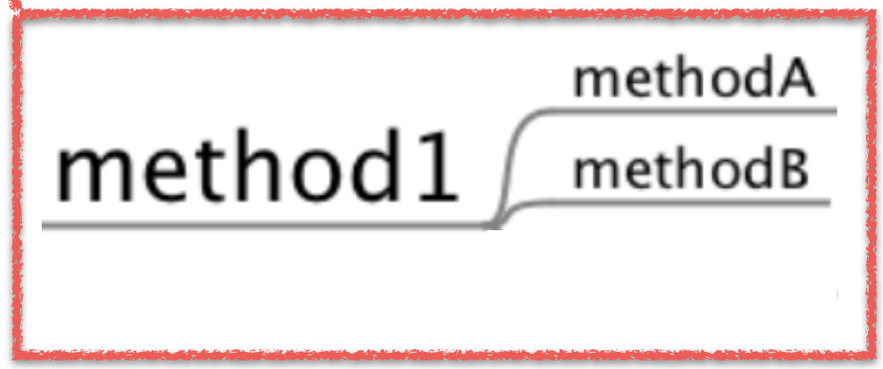


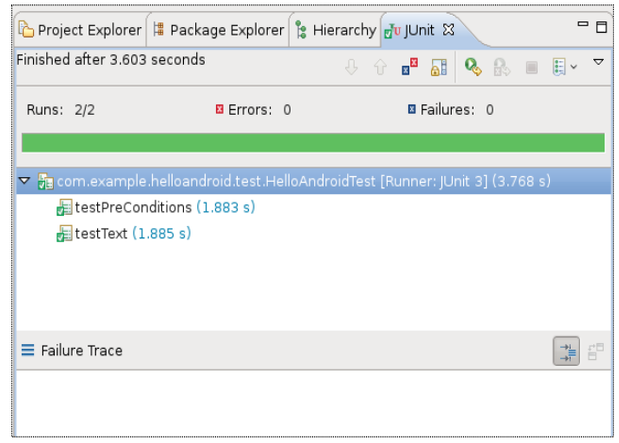


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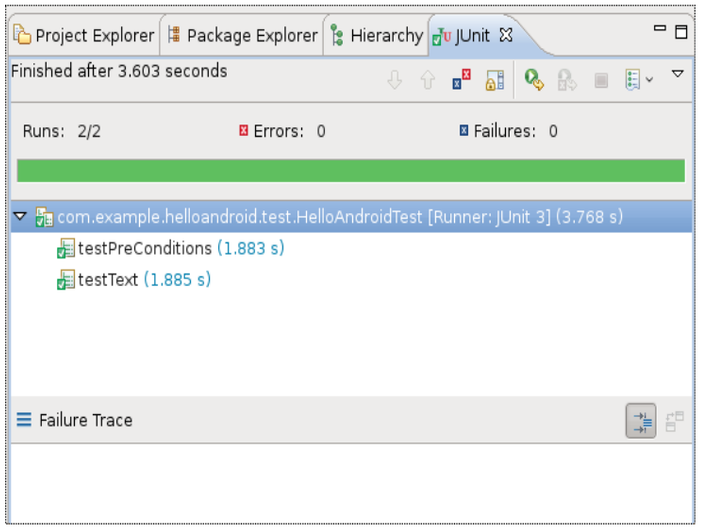


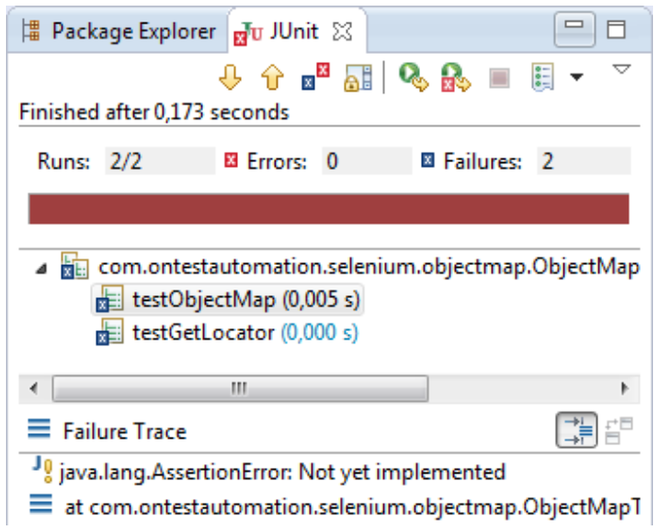


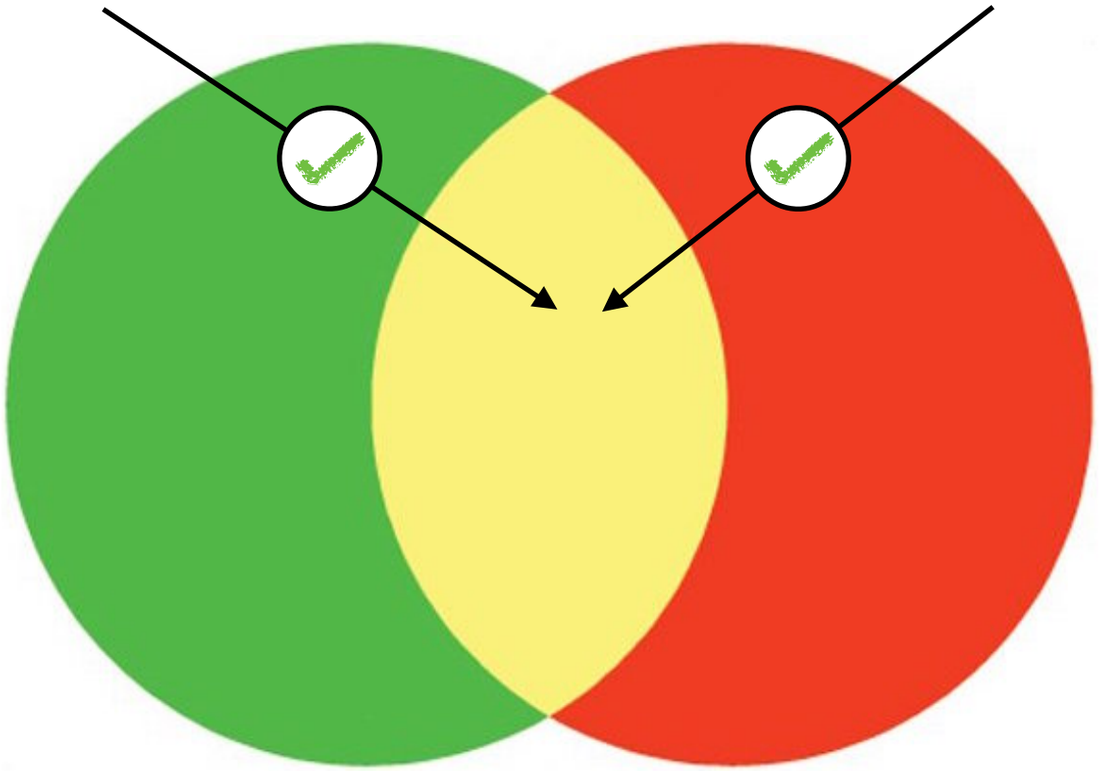

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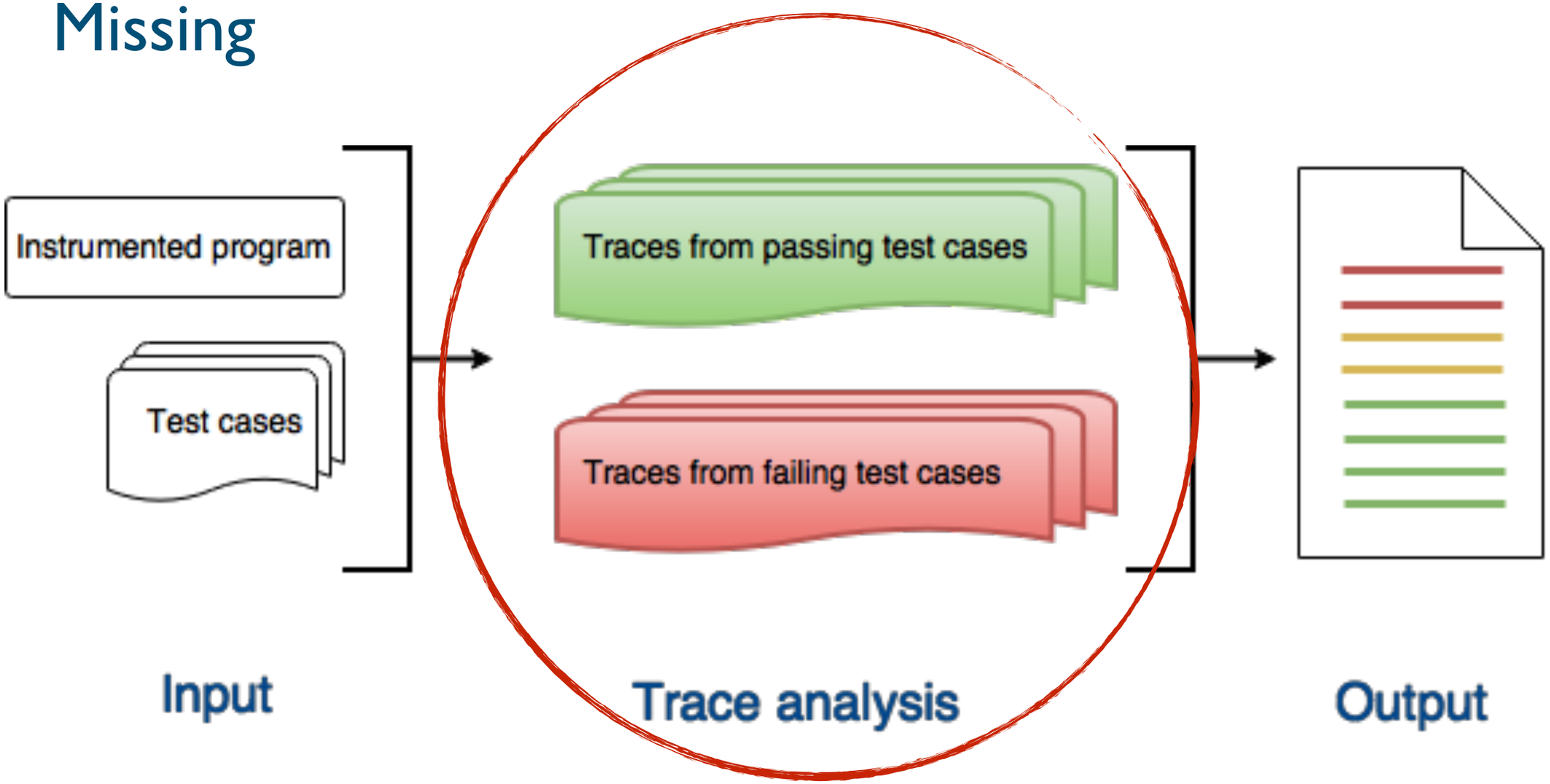

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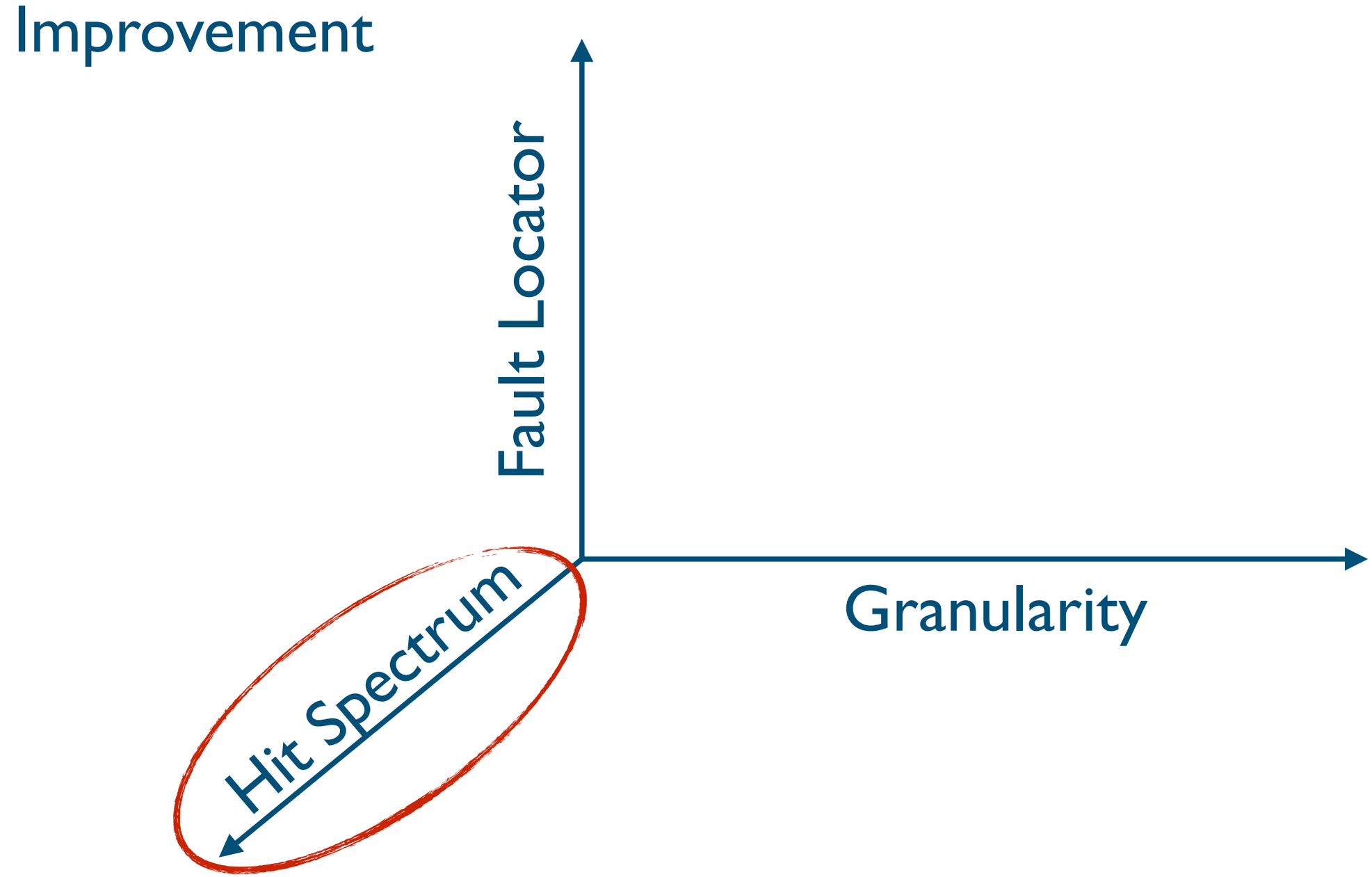

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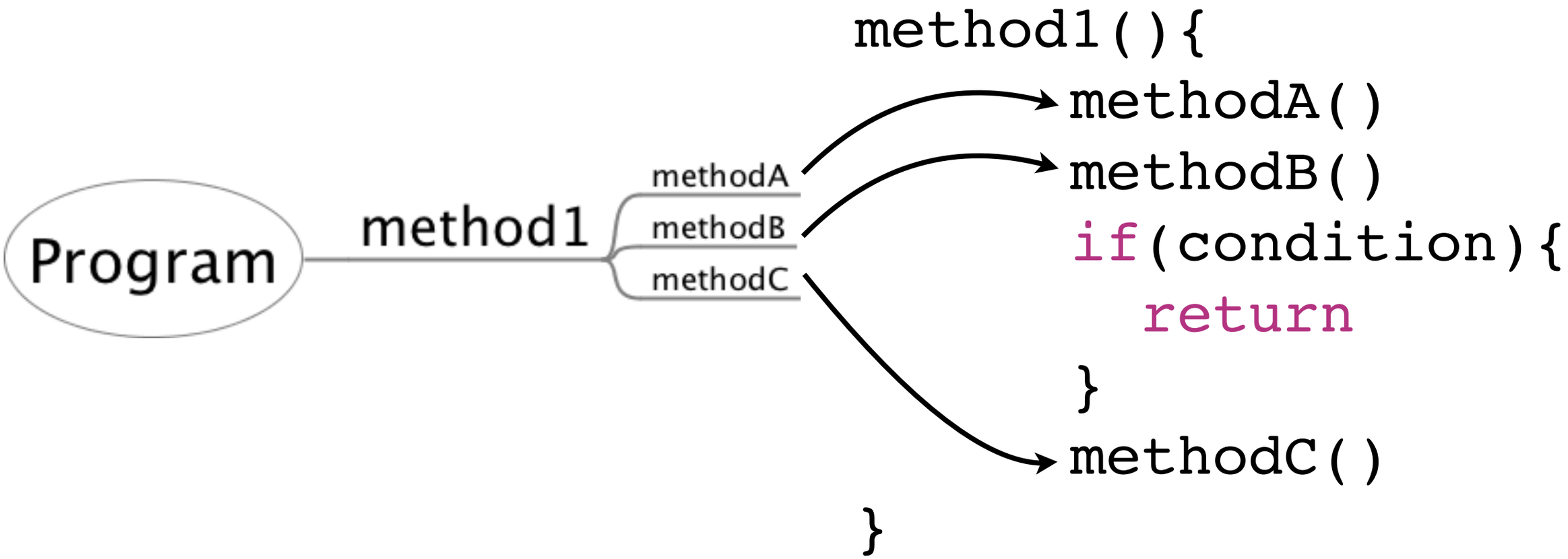

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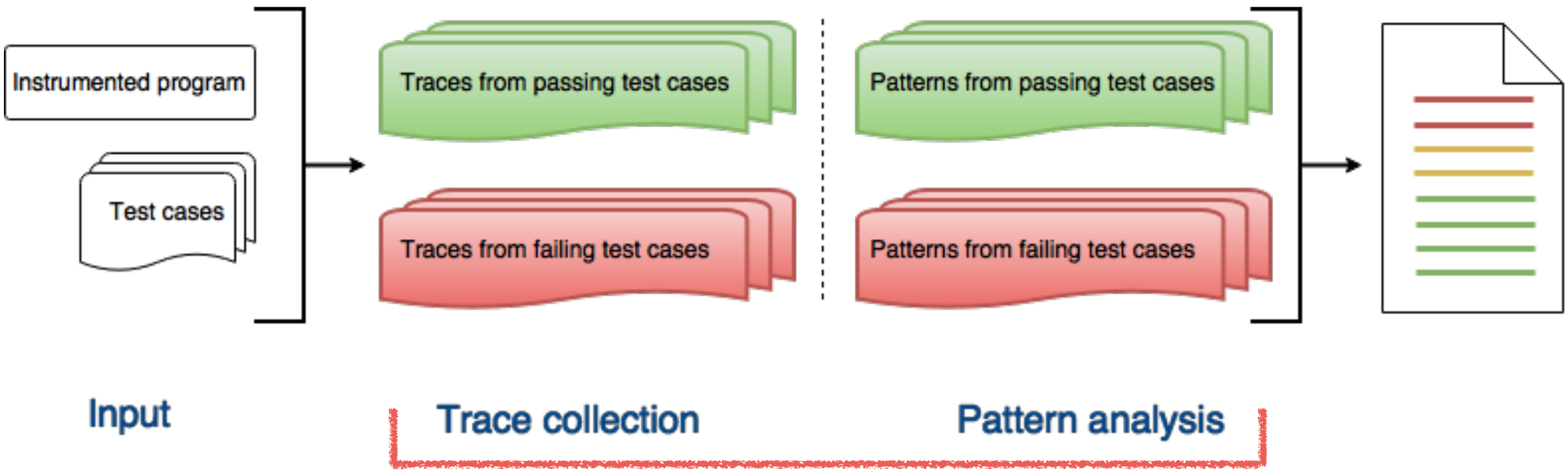

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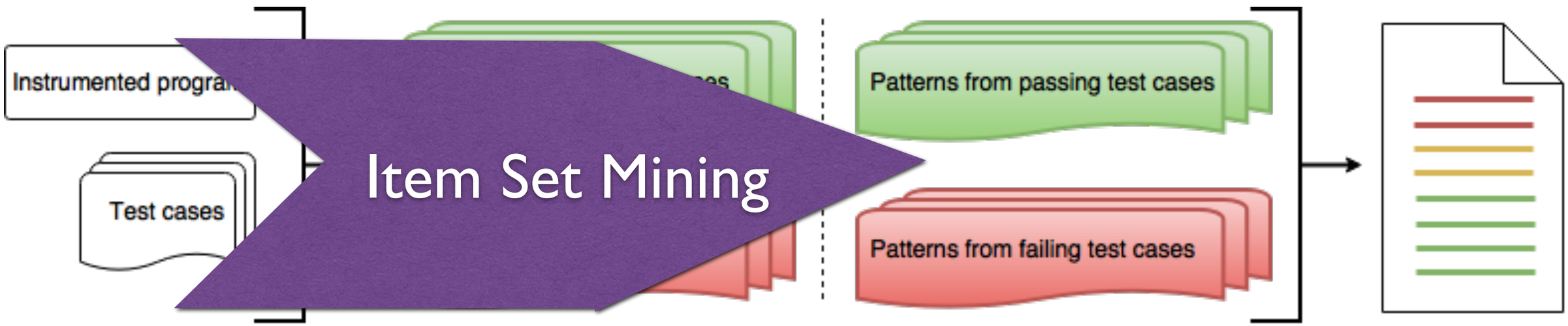


# Raw Spectrum Analysis

## Improvement

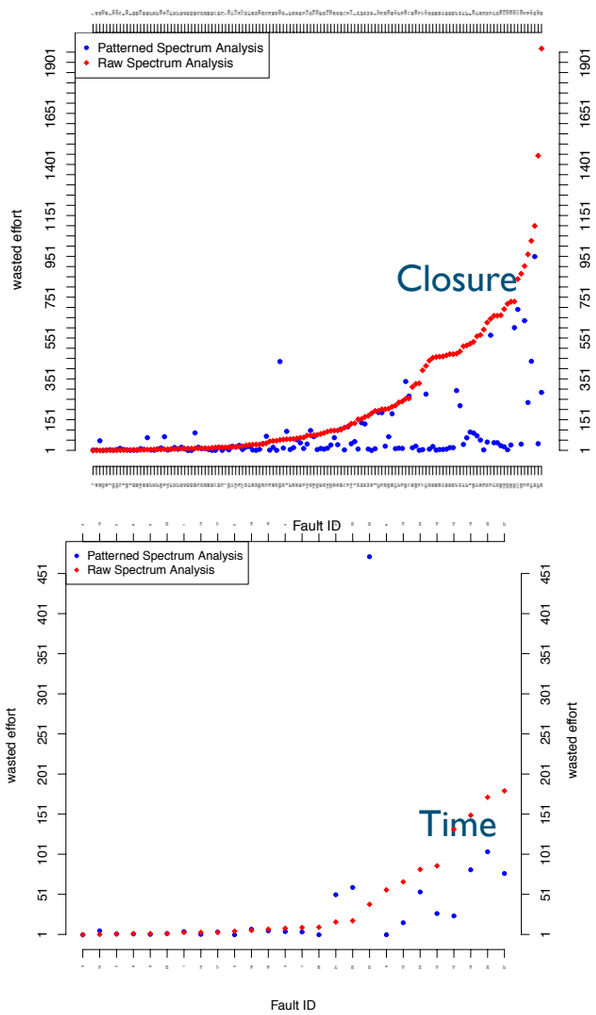
# Case Study

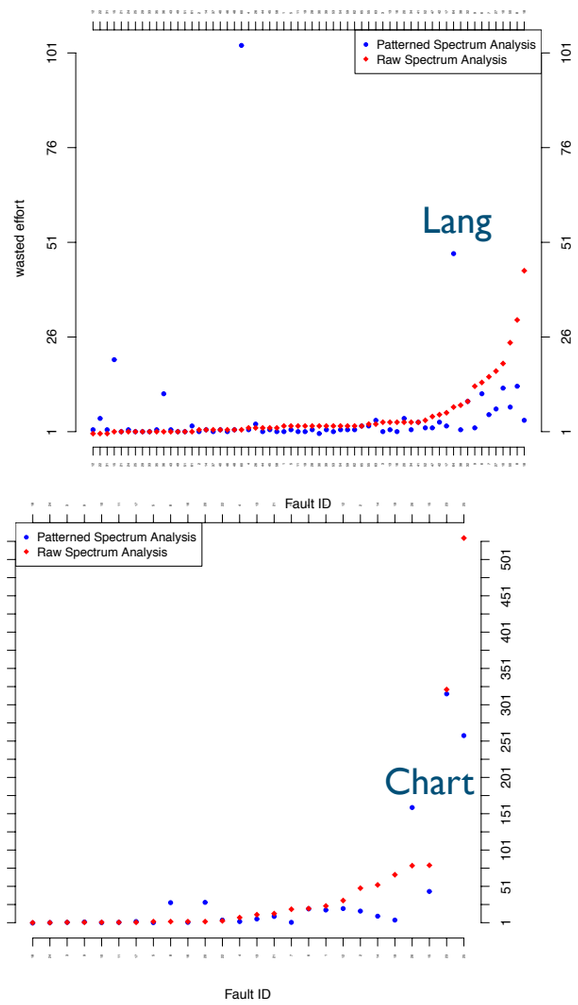

5 Open source projects

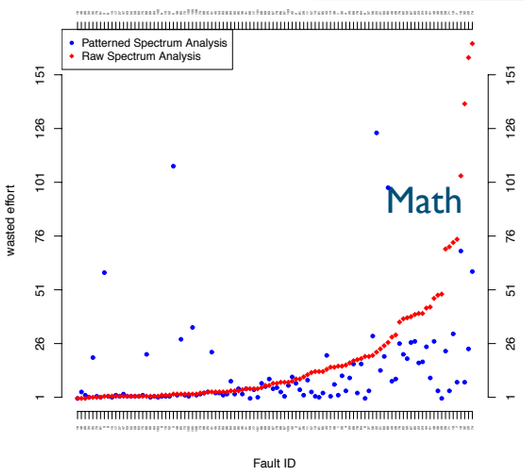
351 faults

## Evaluation metric

# Previous Study

# Patterned Spectrum Analysis

## Further improvement?

## Example: Fault in Google Closure Compiler

| | Patterned Spectrum analysis | Raw Spectrum analysis |
|---|---|---|
| Wasted effort | 85 | 532 |

# Patterned Spectrum Analysis

## Further improvement?

## Example: Fault in Google Closure Compiler

| | Patterned Spectrum analysis | Raw Spectrum analysis |
|---|---|---|
| Wasted effort | 85 | 532 |

```
Node.getLastChild()
NodeUtil.getCatchBlock(Node)
NodeUtil.hasCatchHandler(Node)
NodeUtil.hasFinally(Node)
Node.getLastChild()
tryMinimizeExits(Node,int,String)
```

Unique pattern of a faulty method in Google Closure Compiler only in failing tests

# Patterned Spectrum Analysis

## Further improvement?

## Example: Fault in Google Closure Compiler

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|---|---|---|
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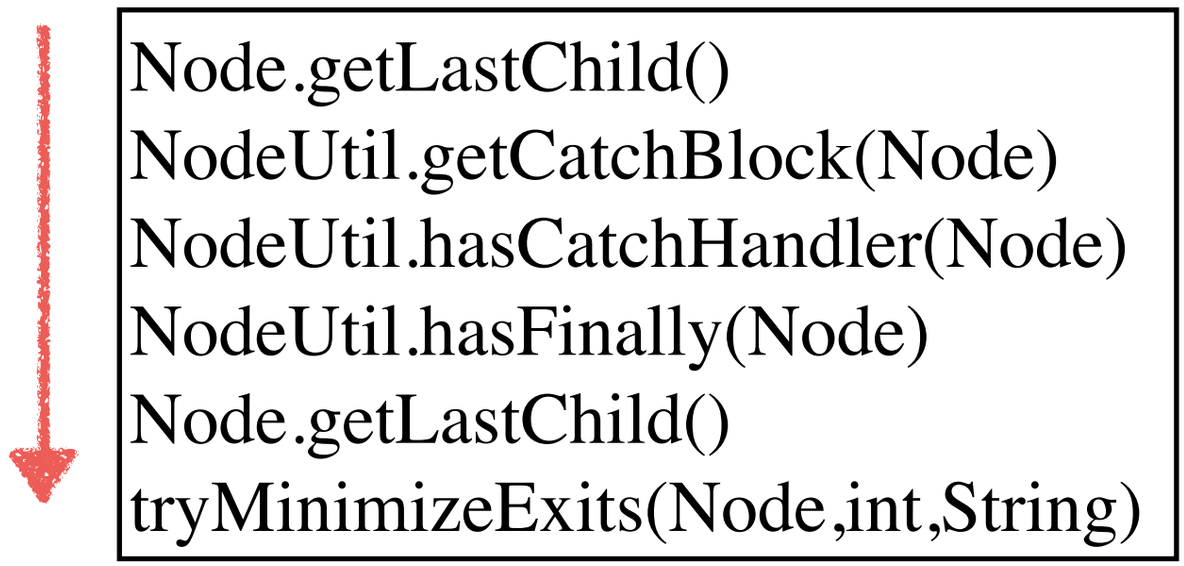


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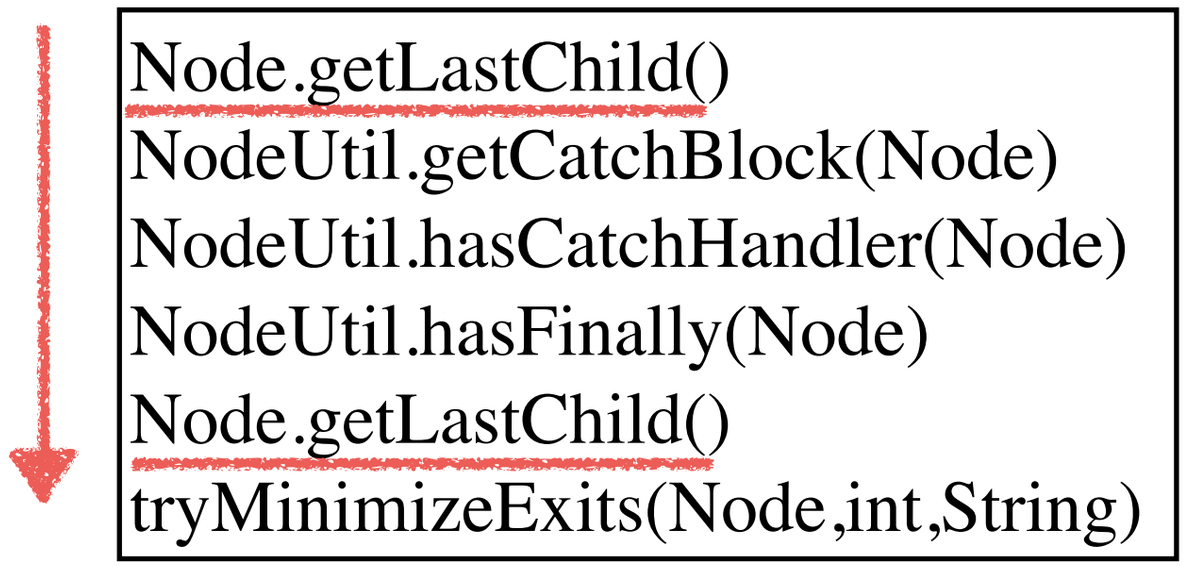


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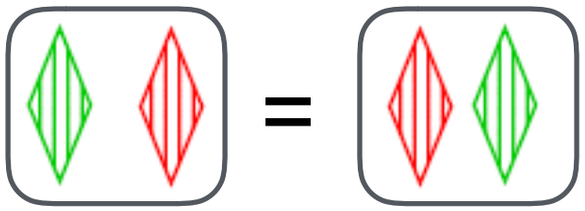
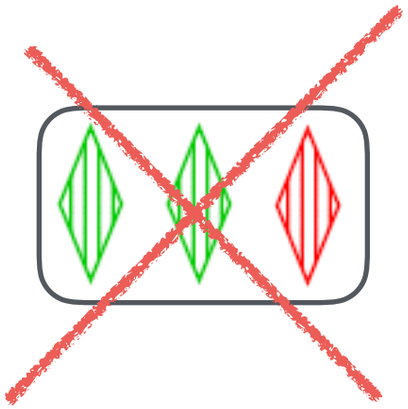
# Patterned Spectrum Analysis

## Item Set Mining





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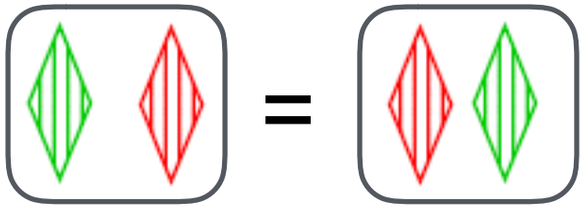
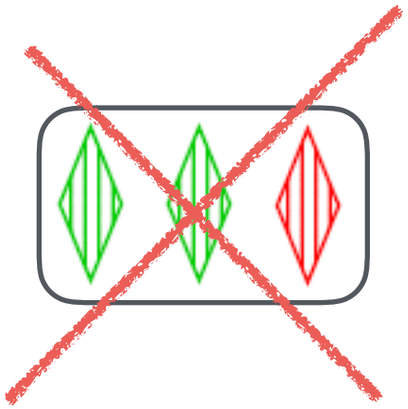
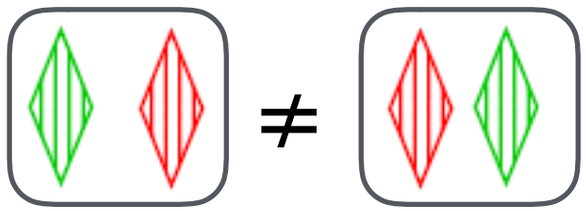
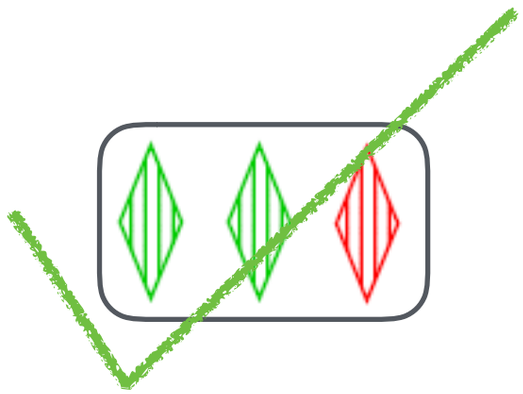
## Item Set Mining





## Sequence Mining?





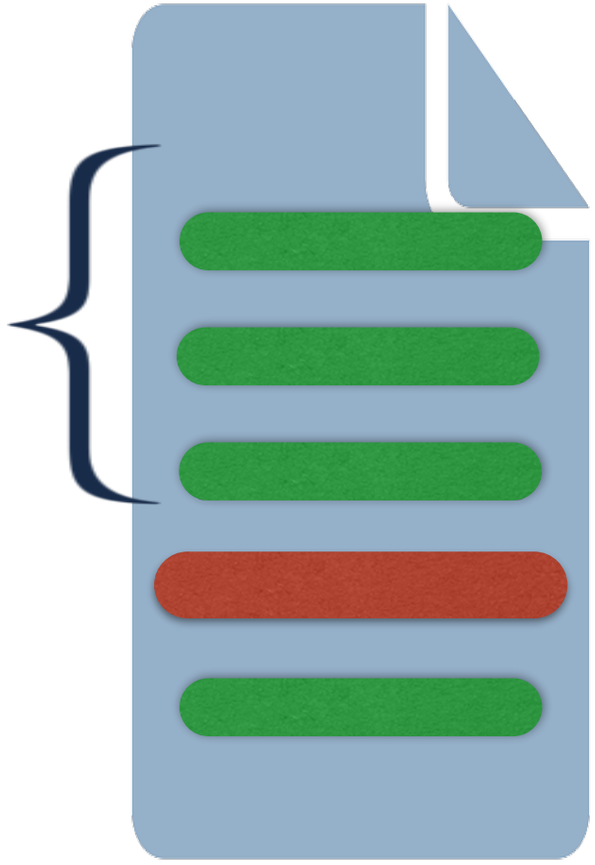
# Preliminary Study

2 Open source projects (88 faults)

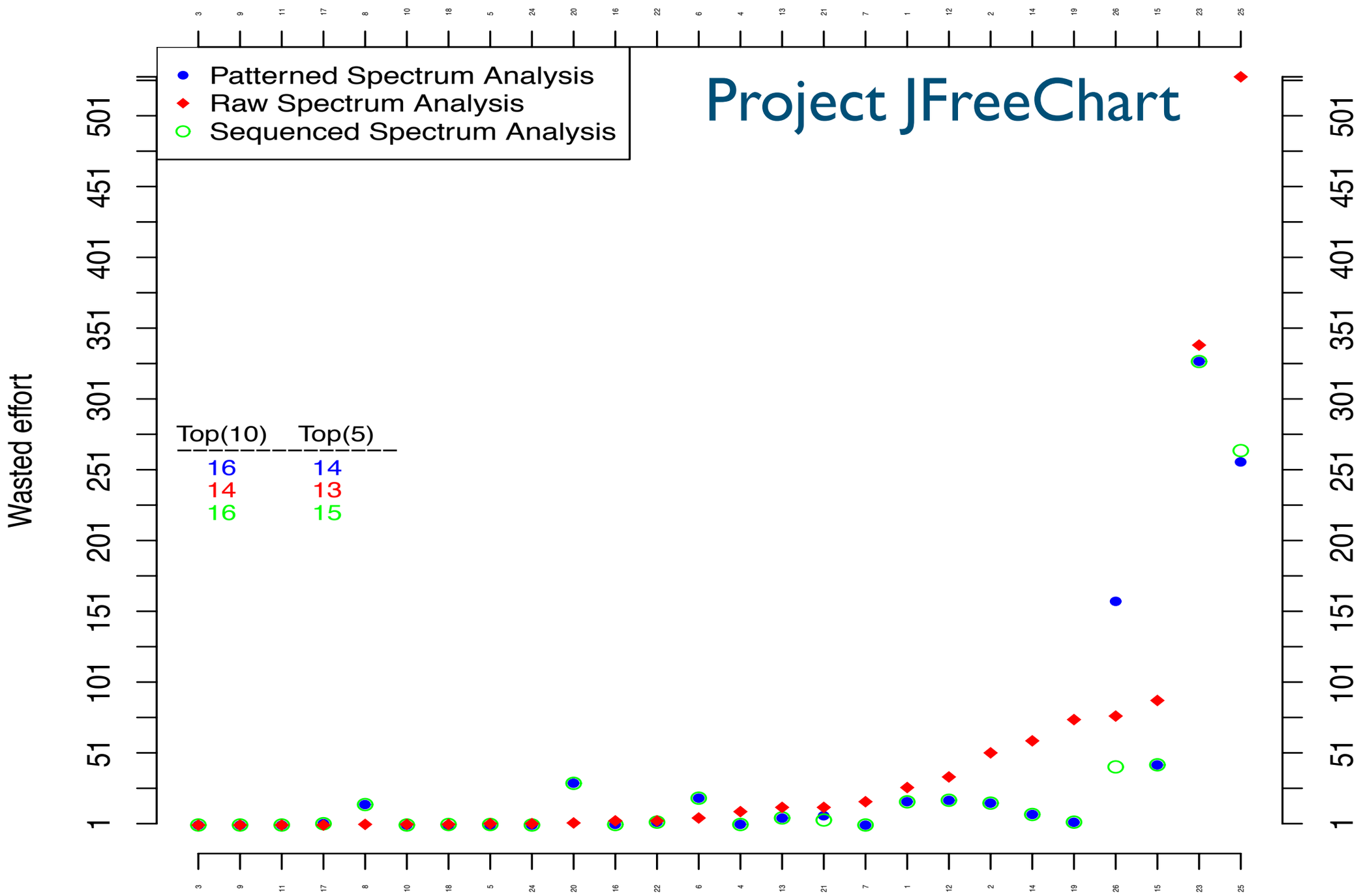
Comparison of three analyses

Evaluation metric

Wasted effort

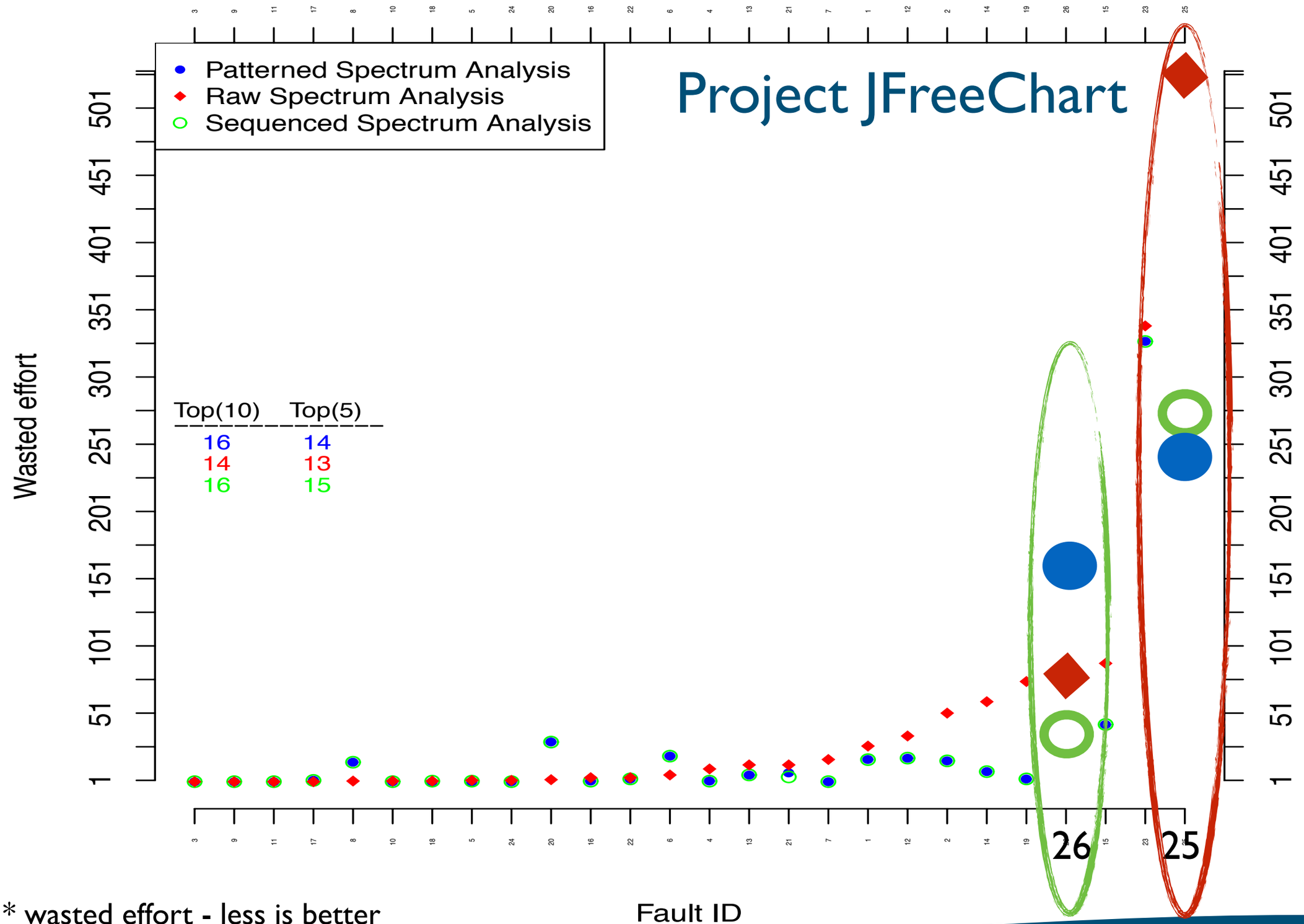


# Preliminary Results



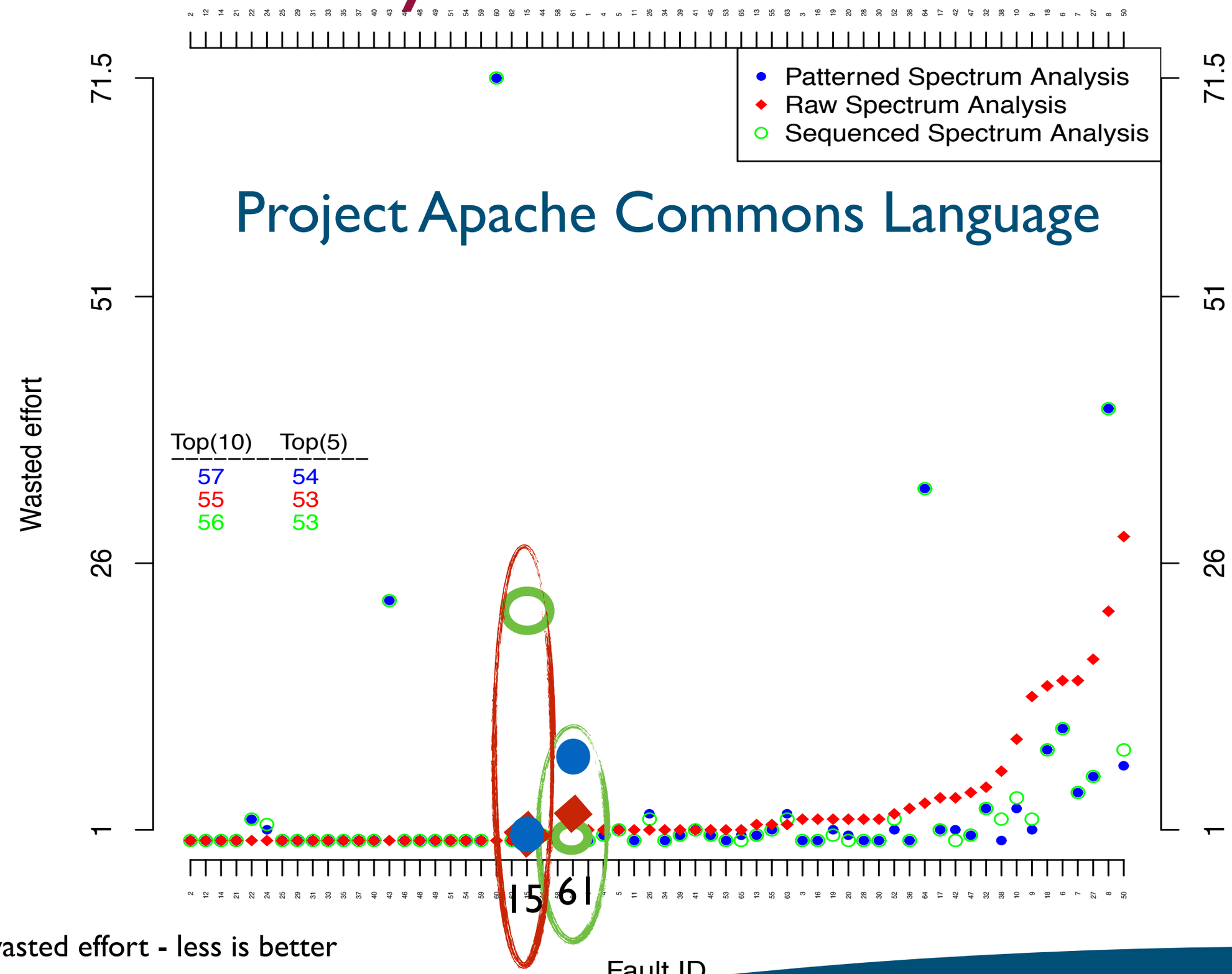

* wasted effort - less is better

# Preliminary Results




* wasted effort - less is better

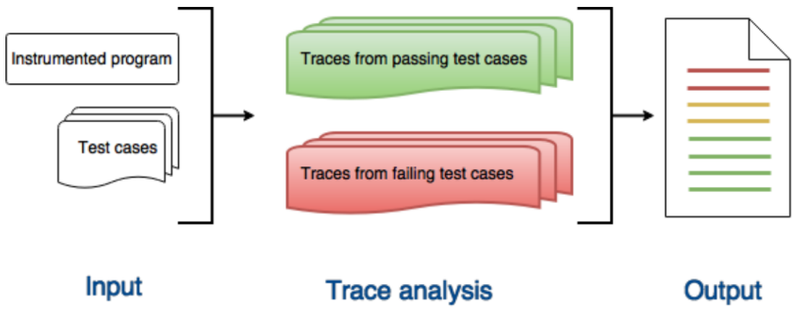
# Preliminary Results




* wasted effort - less is better

# Summary

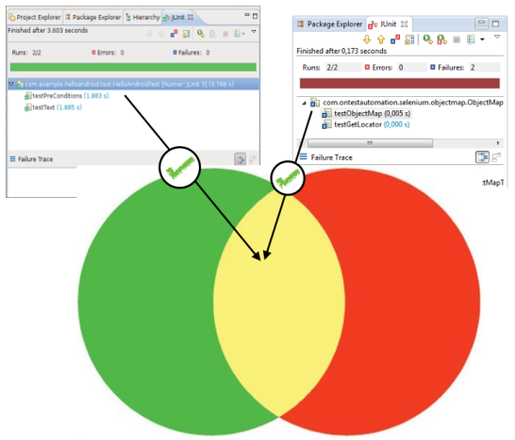
## Spectrum Based Fault Localisation






## Raw Spectrum Analysis

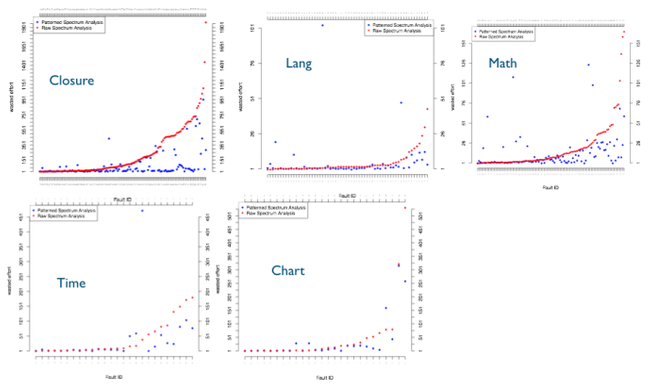
### Missing



```
public void method1(){
            ..........
            methodA()
            methodB()
            if(condition){
                return
            }
            ..........
            methodC()
            ..........
}
```

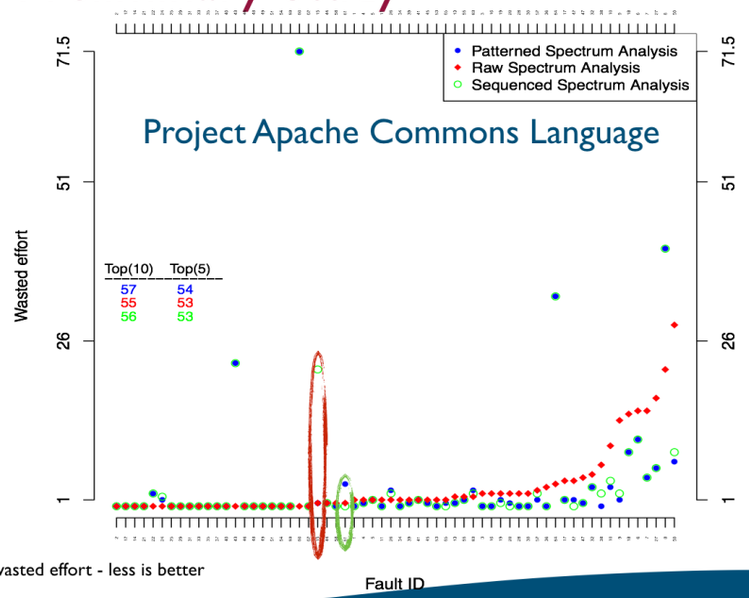


## Previous Study




## Preliminary Study




* wasted effort - less is better