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Towards Language Independent (Dynamic) Symbolic Execution

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Didier Buchs [1]

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What are we doing?

- 1 MLOC code *(Control)*
- no automated unit testing until three ago
- frequent changes in execution environment
- (mostly) manual verification
- big expenses (time) on QA side

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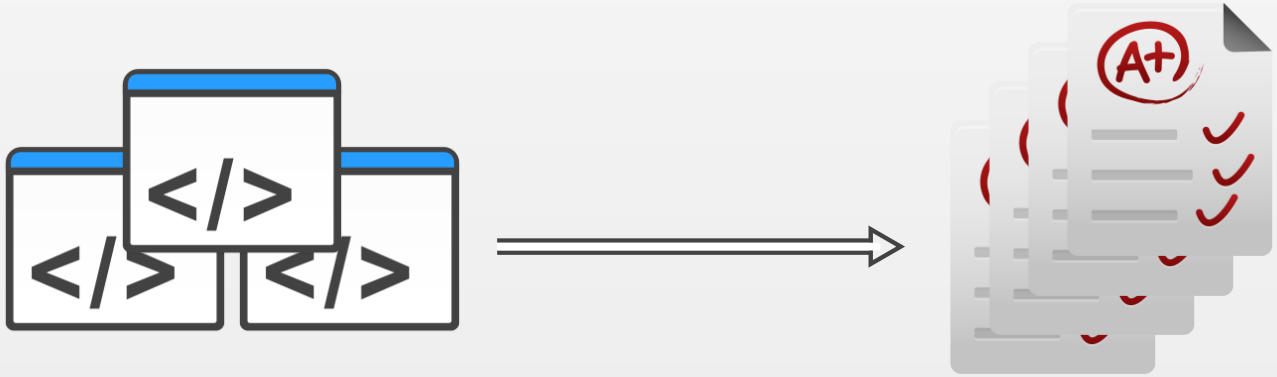
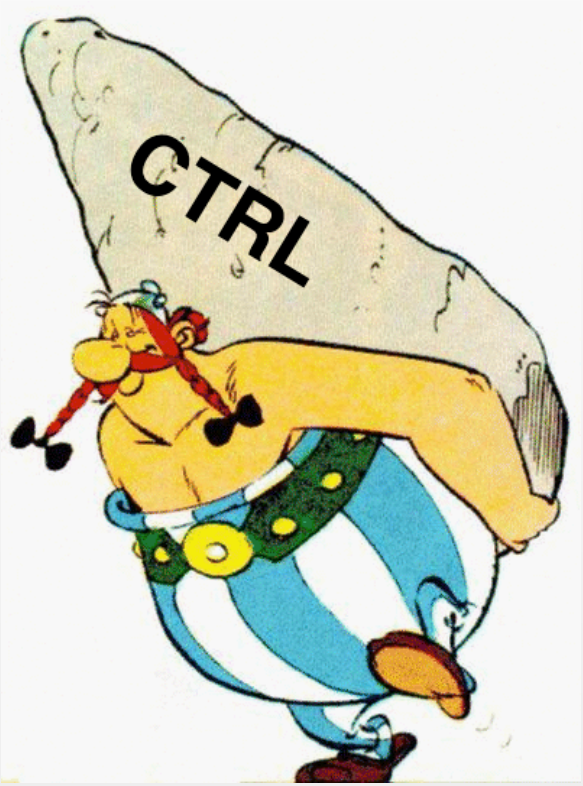
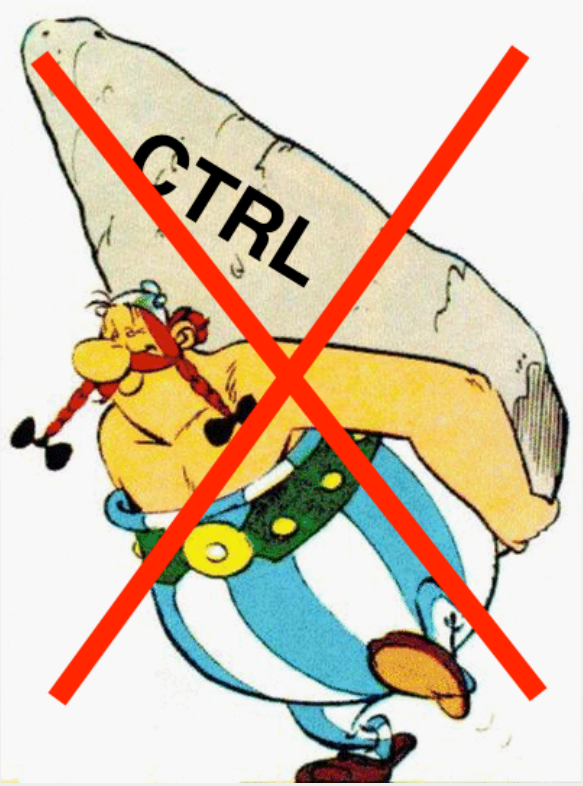


Language Independent Test Case Generation



https://thriftytraveller.files.wordpress.com/2013/11/asterix_obelix3.gif

Language Independent Test Case Generation



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Language Independent Test Case Generation

1. Develop generic tool

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http://asterix.wikia.com/wiki/Asterix_and_Cleopatra

Language Independent Test Case Generation

1. Develop generic tool
2. Modify parser and execution

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https://www.efiliale.de/efiliale/images/aktionen/asterix/5624_Troubadix.png

Language Independent Test Case Generation

1. Develop generic tool
2. Modify parser and execution
3. Translate to existing tool language

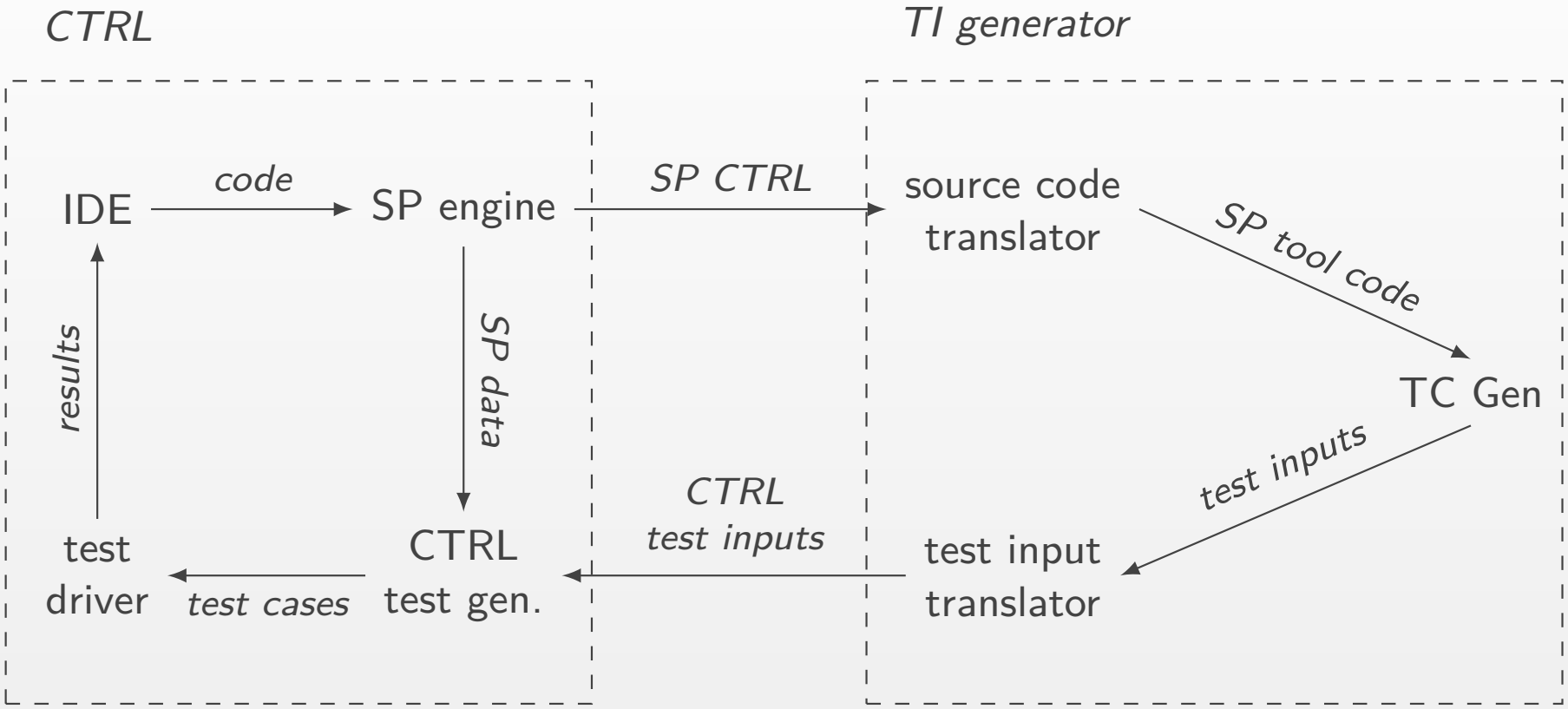
http://www.asterix.com/asterix-de-a-a-z/les-personnages/perso/a43b.gif

Semantics, semantics, semantics

- small differences – big impacts

http://samcnitt.tumblr.com/

How do we generate TCs?



ITEC workflow

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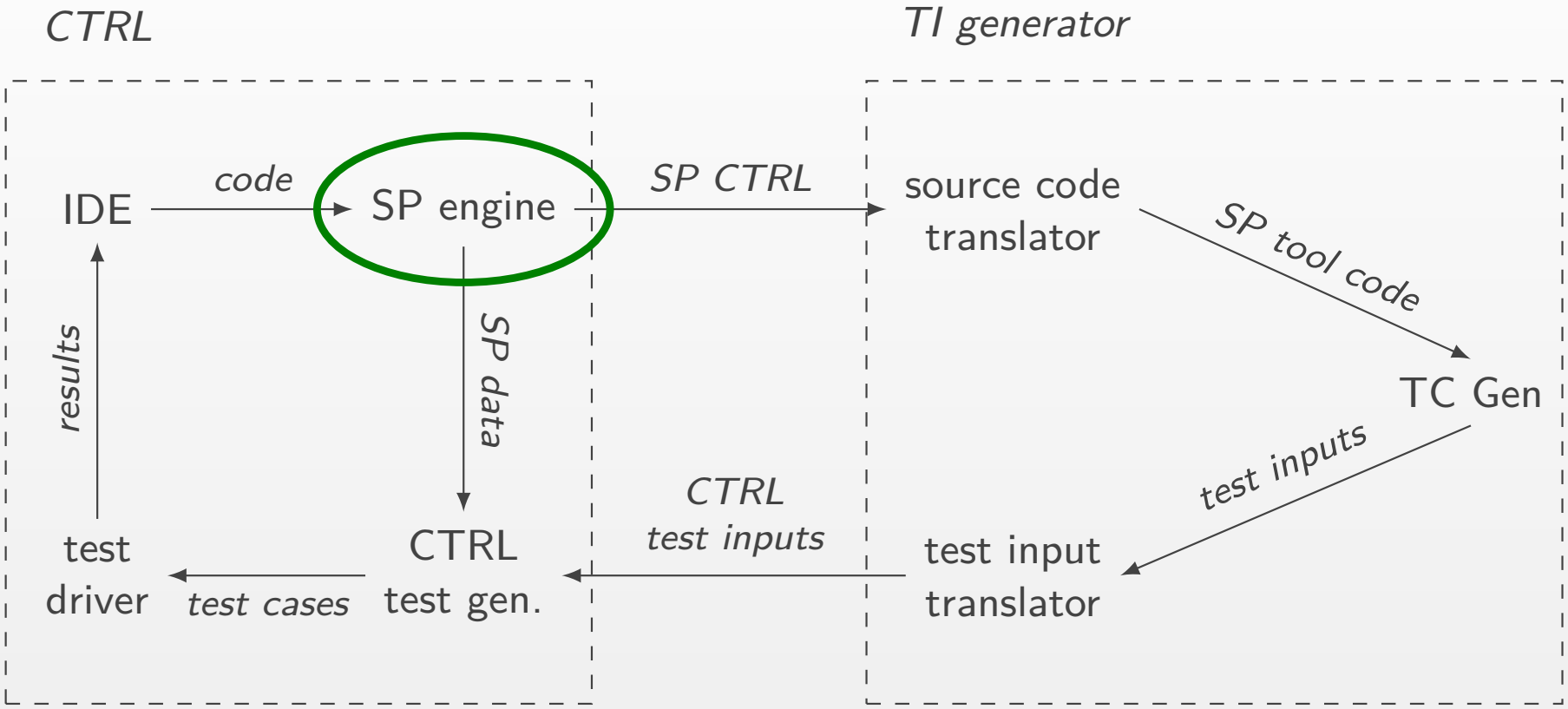


ITEC workflow

Considering Execution Environment Resilience: A White-Box Approach

Klikovits et. al., Proc. SERENE 2015, Paris

Semi-purification

- replace dependencies with parameters

```
f(x){
  if GLOBAL_VAR:
    return dbGet(x)
  else:
    return -1
}
```

A non-pure function

```
f_sp(x,a,b){
  if a:
    return b
  else:
    return -1
}
```

Semi-purified `f(x)`

```
test_f_sp(){
  x = f("test",True,5) //act
  assert(x == 5) //assert
}
```

Test case

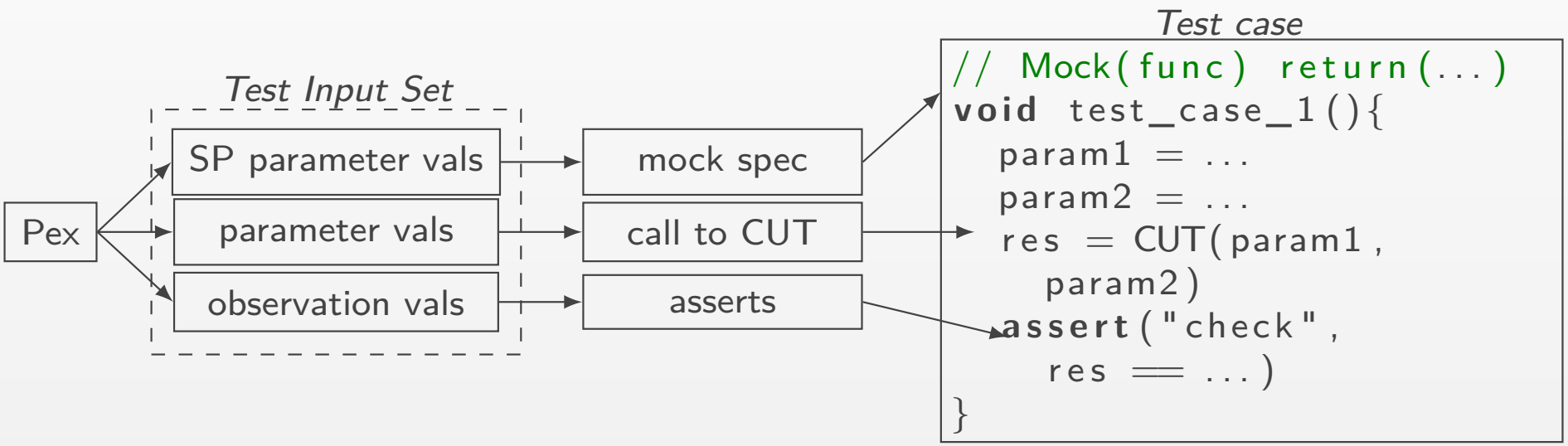
CUT translation & TC Gen

- Pex (Microsoft Research)
- Dynamic Symbolic Execution

- translate CUT, generate PUT
- manually create Pex factories, data types, built-in functions

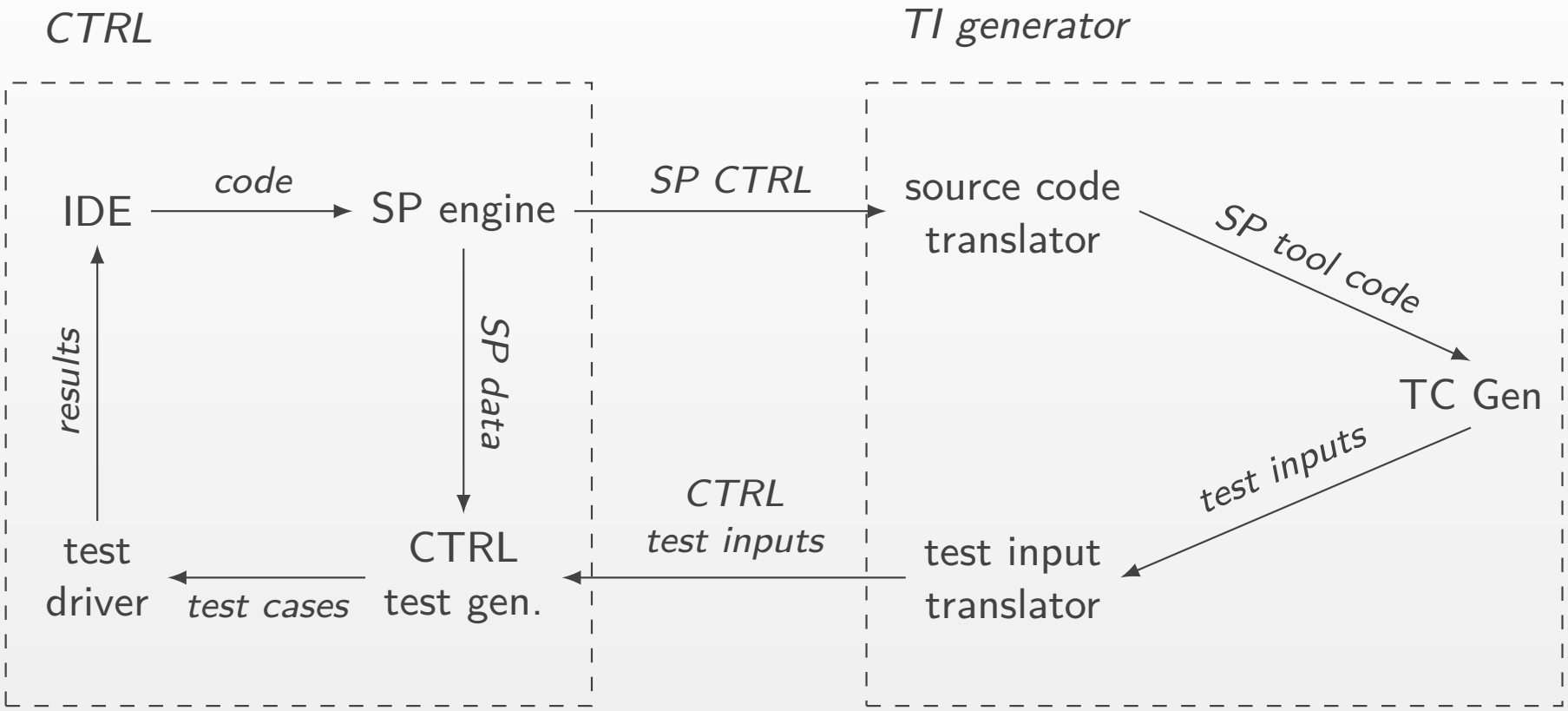
https://sites.google.com/site/diedruidenmt/_/rsrc/1367838067499/miraculix/Miraculix.jpg

From Pex to test cases



Test case generation from Pex output

How are we doing it?



ITEC workflow

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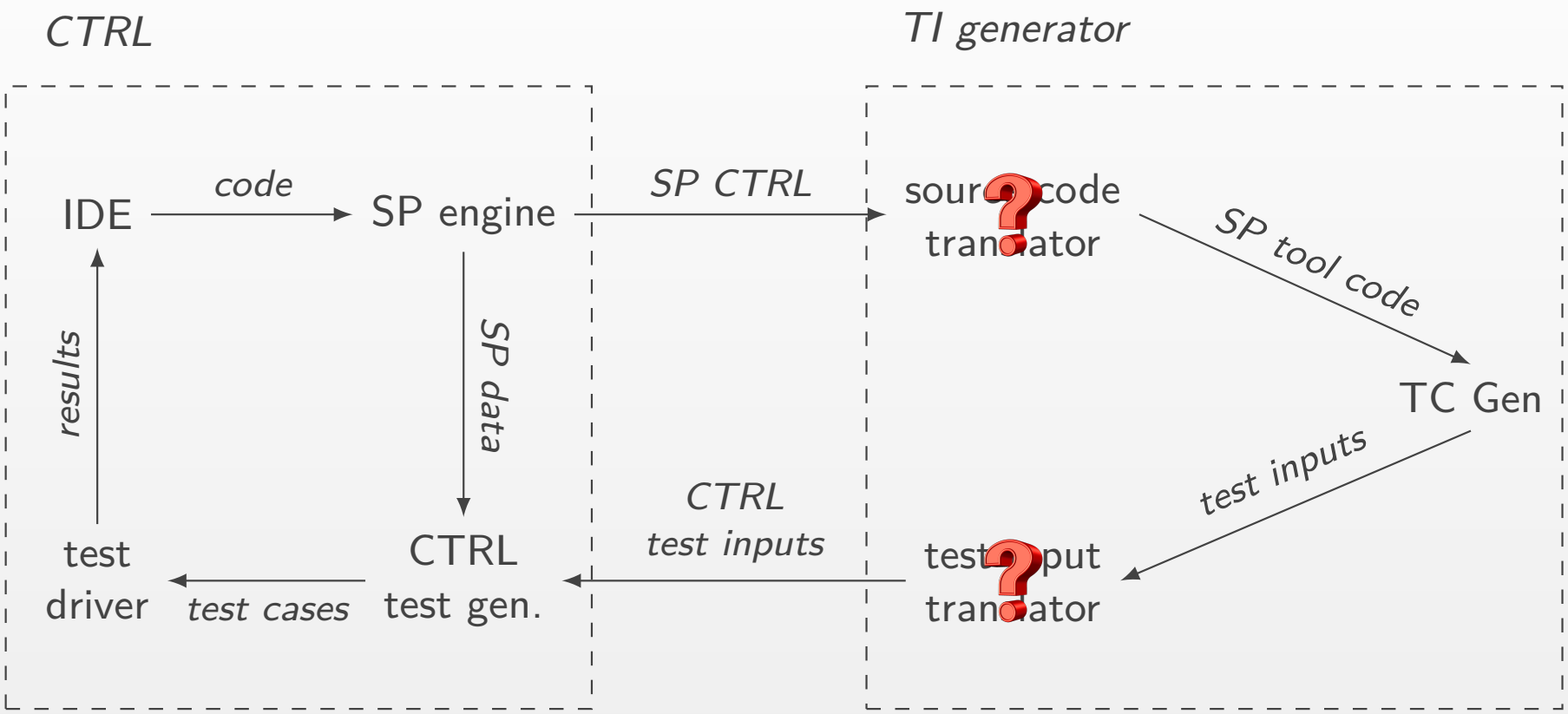

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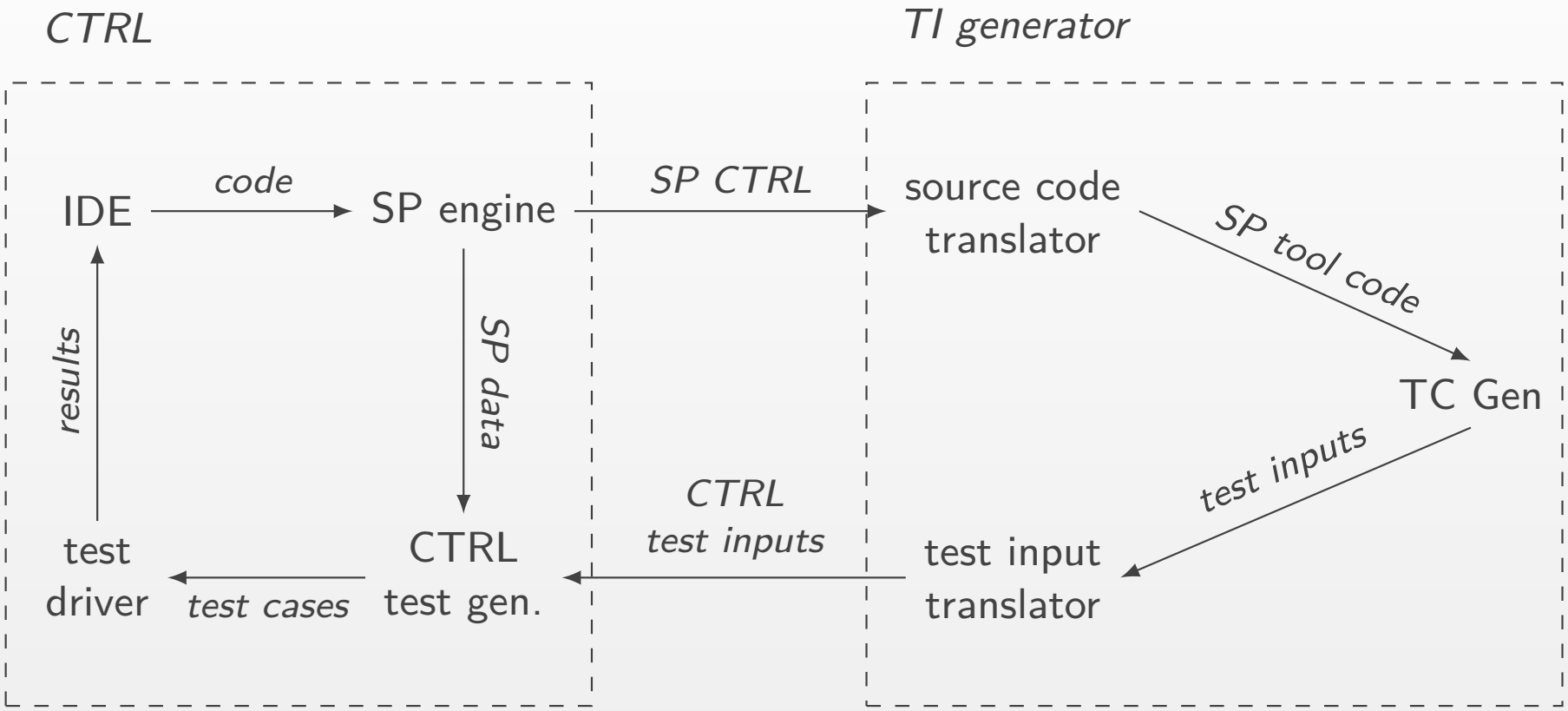

ITEC workflow

Automated Test Case Generation for CTRL using Pex: Lessons Learned

Klikovits et. al., Proc. SERENE 2016, Gothenburg

How to test translation?

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Divide

http://chapleau.us/Img/caesar_asterix.gif

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Analyse Blocks

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Conquer

https://www.pinterest.com/pin/336784878358770673/

How to test translation?

```
int func(int a, int b) {
  a++
  a++
  b = b+2
  if(a > b){
    return a % b
  } else {
    return a + b
  }
}
```

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Anonymise

```
int func(int a, int b) {
  int++                    1
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  int = int+int            1
  if(int > int){           0
    return int % int       0
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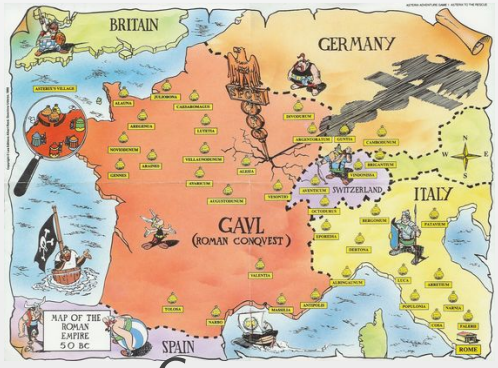
```

Analyse Blocks



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    return int % int     0
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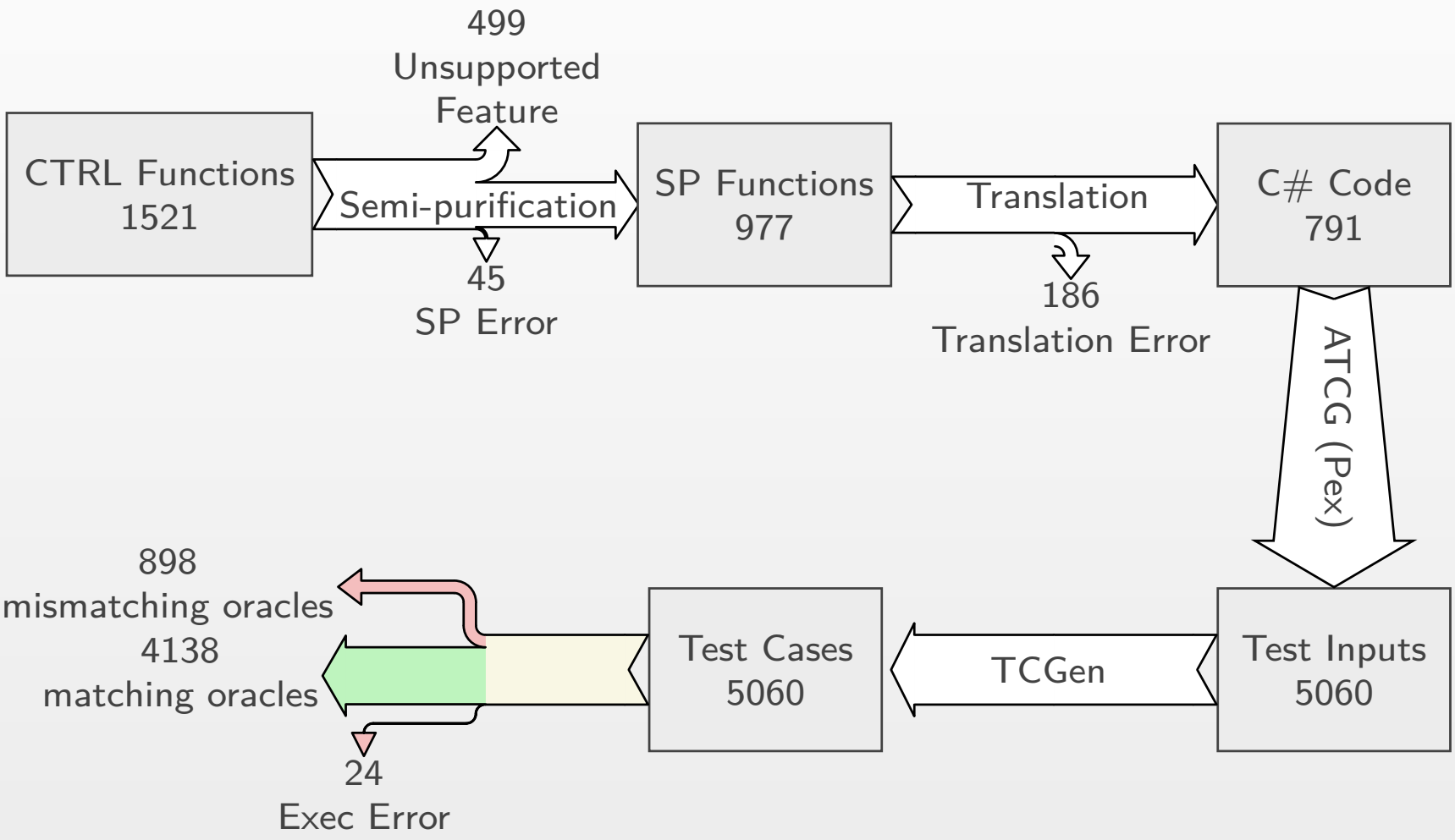
```

Analyse Blocks

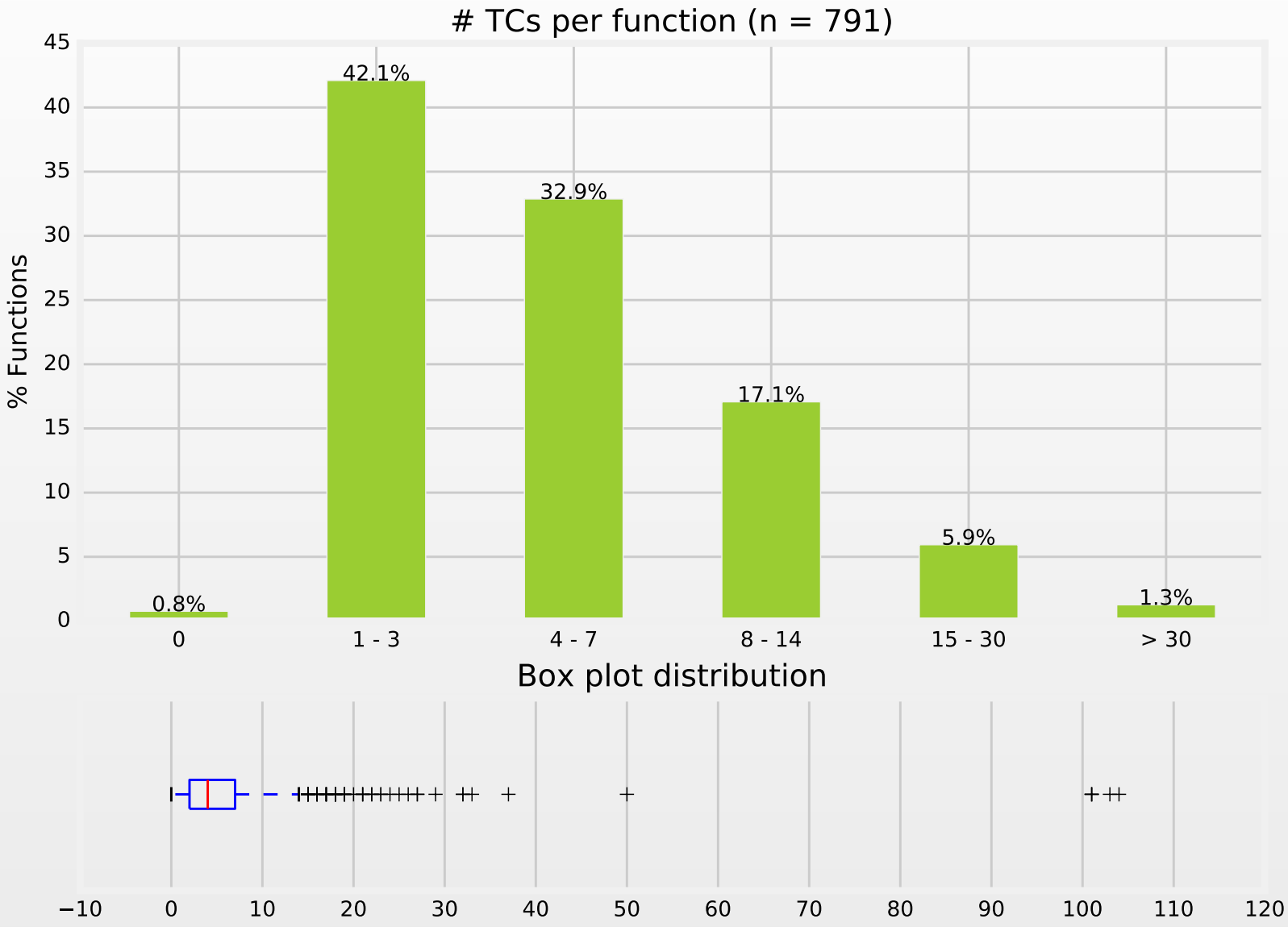
$$\phi = \frac{\sum \phi(L_i)}{|L|}$$

Conquer

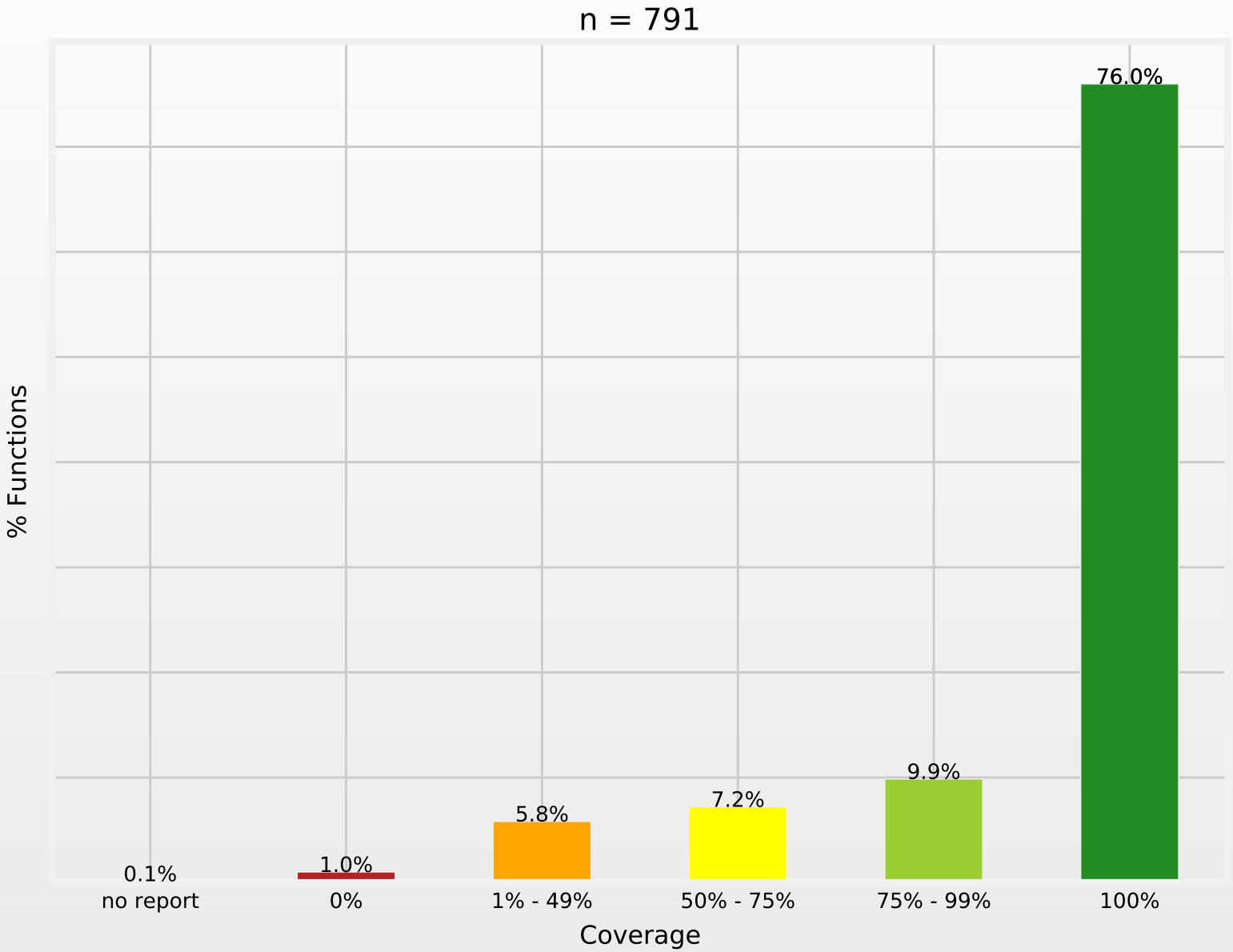
Test case generation: results



Number of Test Cases



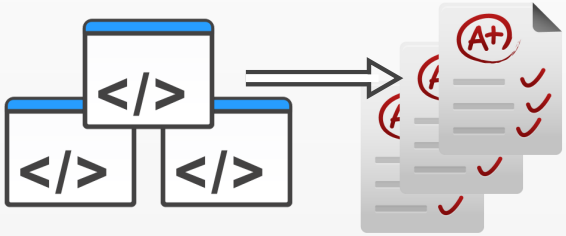
Coverage


n = 791
% Functions
0.1%
1.0%
5.8%
7.2%
9.9%
76.0%
no report
0%
1% - 49%
50% - 75%
75% - 99%
100%
Coverage

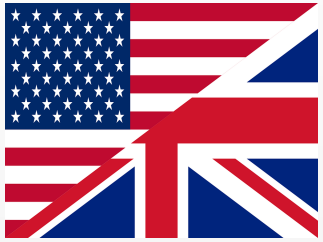
Lessons learned

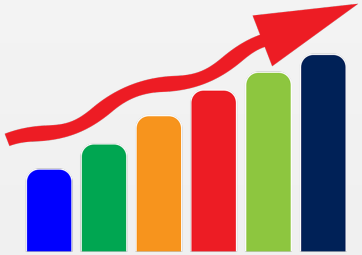
- not everything can be translated (easily)
- *nor should it ... (?)*
- C# is no silver bullet
- improving the quality of test cases ?
- tools have “features”

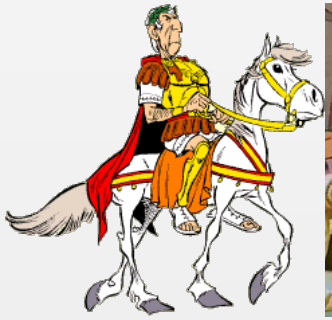
Summary

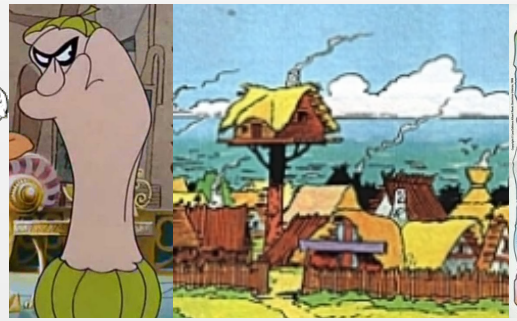

A+


CLACK!










BRITAIN
GERMANY
SWITZERLAND
ITALY
GAVL
(ROMAN CONQVEST)
SPAIN
MAP OF THE ROMAN EMPIRE 50 BC

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What next?

- expand TC generation
- other/different use cases
- trade-off complexity vs. usefulness
- research unsupported features