3rd UCAAT User Conference on Advanced Automated Testing

ETSI World Class Standards

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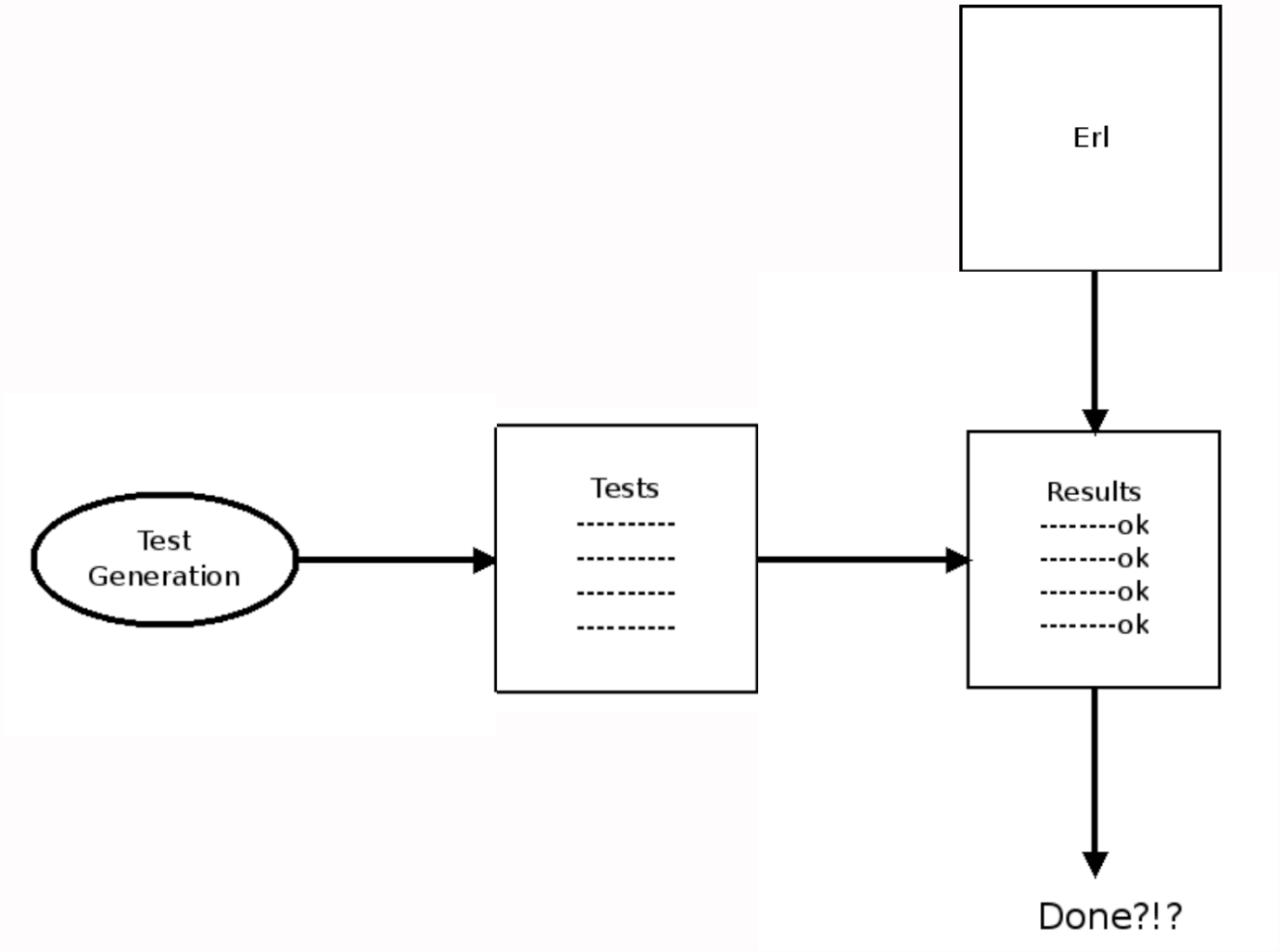
Can I stop testing yet?

Test adequacy metrics as feedback for automated test generation

Presented by Ramsay Taylor

The University Of Sheffield.

Test Adequacy



Test Adequacy

- Have we tested all of the code?
- Have we tested it in all meaningful ways?
- If the answer to either question is “no”, how can I do better?

In this talk:

- Code Coverage
  - Testing all of the code that you have written
  - Testing it in meaningful ways
- Mutation Testing
  - Testing the code you might have written…
  - Testing the code in novel ways
  - Actually checking the answers!
- Model Inference

Code Coverage done badly

```
      |  -module(abiftest).
      |  -export([dv/2]).
      |
      |  dv(A,B) ->
 0..  |      if (A == 0) and (B > 4) ->
 0..  |           B;
      |         true ->
 0..  |           B / A
      |      end.
```

Code Coverage done badly

```
      |   -module(abiftest).
      |   -export([dv/2]).
      |
      |   dv(A,B) ->
1..   |       if (A == 0) and (B > 4) ->
1..   |              B;
      |          true ->
0..   |              B / A
      |       end.
```

Code Coverage done badly

```
      |   -module(abiftest).
      |   -export([dv/2]).
      |
      |   dv(A,B) ->
 2..  |       if (A == 0) and (B > 4) ->
 1..  |              B;
      |          true ->
 1..  |              B / A
      |       end.
```

Code Coverage done badly

** exception error: an error occurred when evaluating an arithmetic expression
in function abiftest:dv/2
(abiftest.erl, line 8)

dv(0,5)
dv(5,5)
dv(0,2)

Code Coverage done better
Modified Condition/Decision Coverage

- Instrument not just what got called, but in what way
- Focus on decision points not large blocks of sequential lines
- Measure/require all (reasonable) ways of taking or not taking a branch

Code Coverage done better

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-export([dv/2]).

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```

(A == 0) and (B > 4)

- matched: 1
- non-matched: 2

When false:

	matched	non-matched
A == 0	0	2
B > 4	1	1

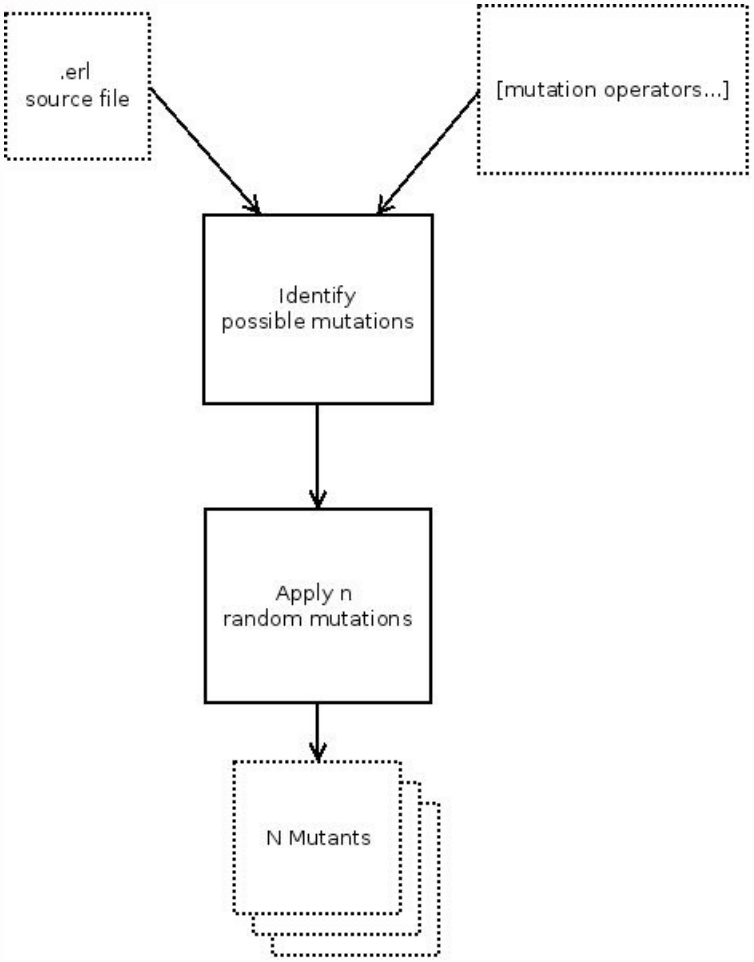
Code Coverage Limitations

- Only assess the code that you have written, not the code you should have written…
- Says nothing except that the code has been executed and maybe didn't crash.

Mutation Testing

- Deliberately break the code and see if the tests "notice"
- Try to simulate common faults
  - With the system
  - With the programmer…

Mutation Testing

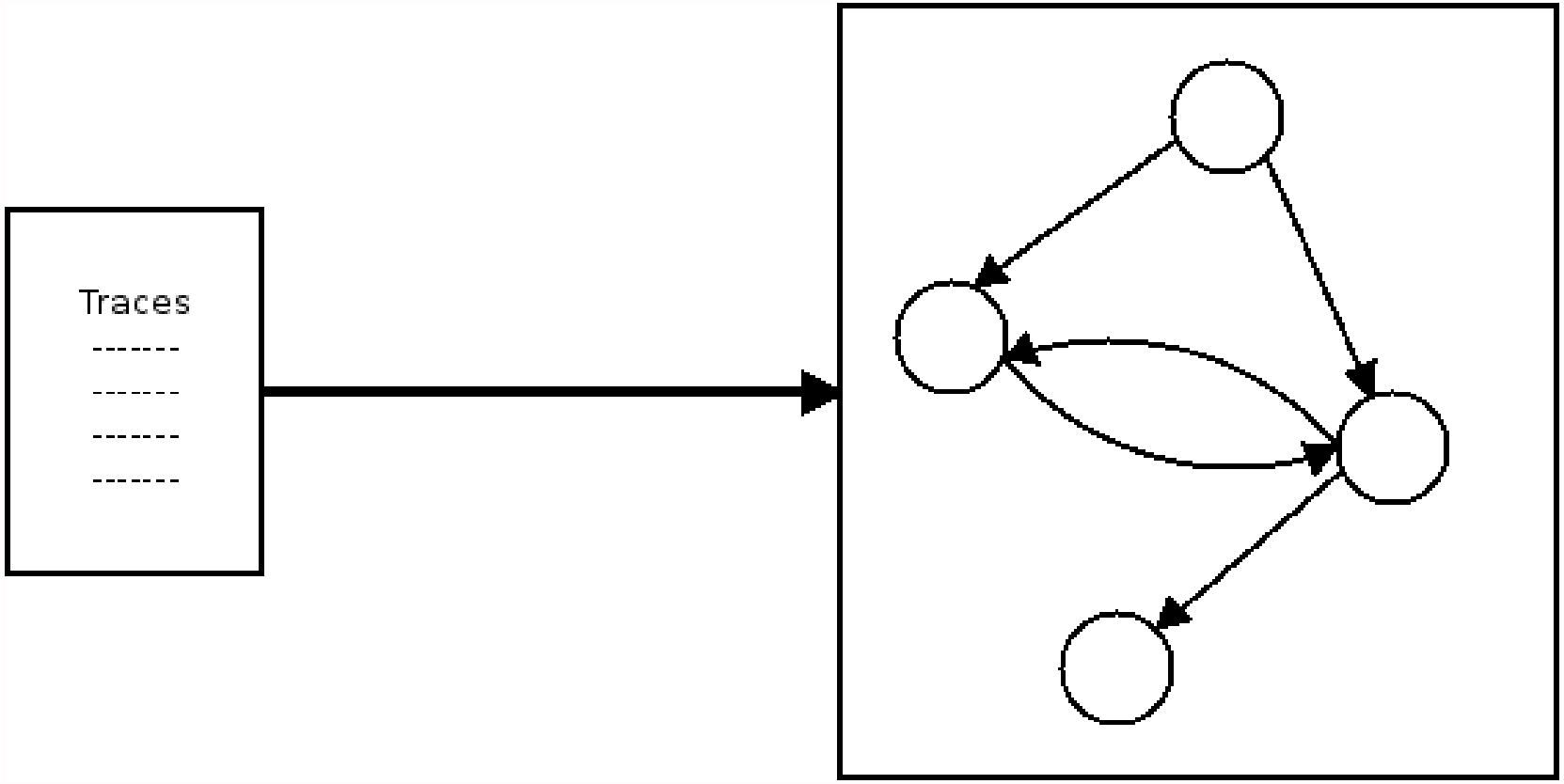


- Fails - Good! It found the fault
- Passed - Bad! It didn't notice the change
  - unless its "semantically equivalent"

Mutation Testing Limitations

- Have to compile lots of mutants
- Have to run the test set lots of times

Model Inference



Conclusions

- You should be testing your tests
  - but don't ask me to recurse again ;)
- Code coverage is cheap so use it
  - but do it properly!
- Mutation testing is a useful complement
  - but its expensive so use it wisely…
- Model inference is cool!
  - look into it

Any Questions?