# FuzzChick

Beck, Calvin  Huang, Jiani  Li, Yishuai

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## We'll come back to this...

# QuickChick: A Brief Review

QuickChick is a properties based testing framework for Coq.

- You build (or derive) generators for data types.
- Using those generators you can feed data into test cases.
- These test cases can be any arbitrary predicate.

# QuickChick: Pros and Cons

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What's not so great about QuickChick?

- Getting *good* generators can be hard!

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In general you want good coverage. How can you achieve that with minimal work?

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Why is this good?

# FuzzChick Intuition

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Maybe we can utilize AFL's smarts to achieve better test coverage.

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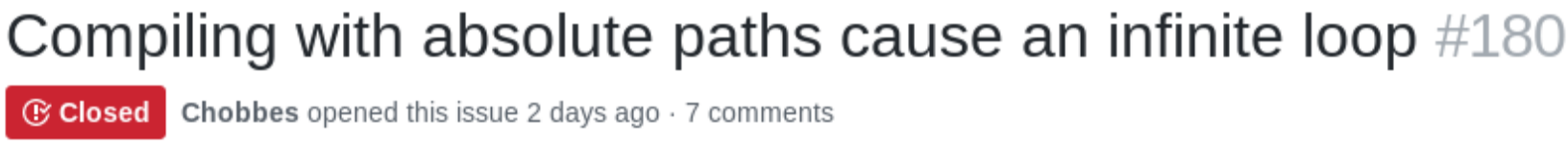
This *mostly* went smoothly...



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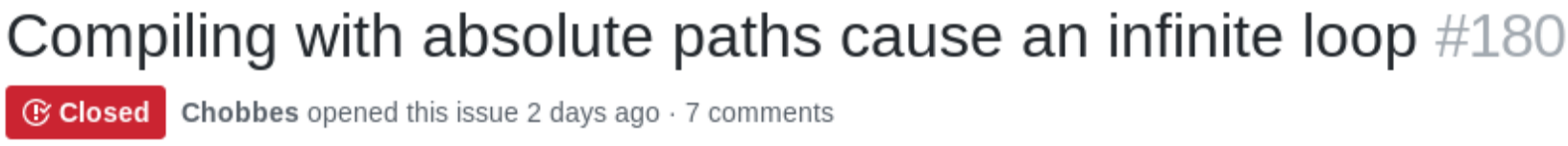


Maintainer fixed this issue promptly, which was *awesome*!

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  - Modified QuickChick to include test case in name, but still not ideal.

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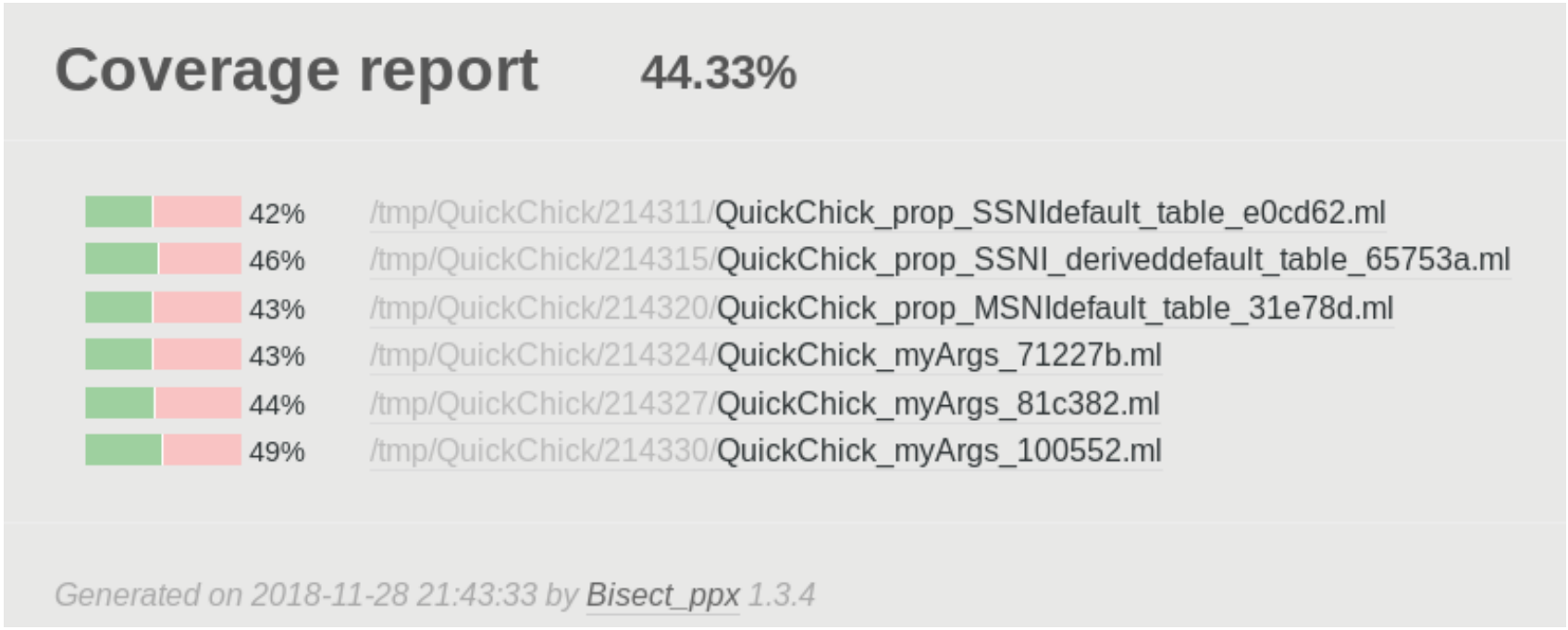
## It works! We can measure stuff!

# QuickChick Coverage: ifc-basic

Coverage with QuickChick in the ifc-basic example:



# QuickChick vs FuzzChick: ifc-basic

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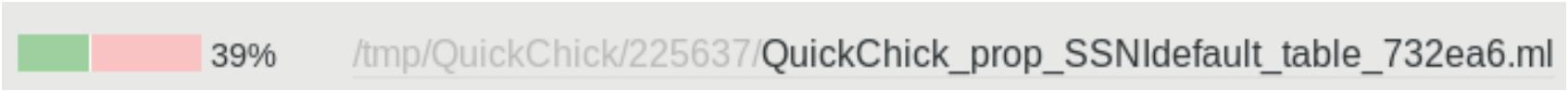


For some reason it seems that FuzzChick actually gets worse coverage than QuickChick on this test case... At least in the time I let it run (I'm not terribly patient)

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  - Hard to tell what "good coverage" is due to the extraneous code extracted by QuickChick.
- Something's not instrumented correctly?
- This test case, for whatever reason, is fuzzer unfriendly?
  - Maybe extracted Coq could be fuzzer unfriendly? Lots of inefficient data types like like `nat` (basically a linked list whose length represents a number).
  - Could result in excessively long paths and hard to solve predicates for DSE?
  - Not sure that having pointers everywhere would be AFL's strength...

# Some Further Coverage Testing...

Test case:

```
Extract Constant unlikely_branch =>
" fun i ->
  if (0 < i)
  then if (i mod 100 == 0)
       then if (i mod 1000 == 0)
            then if (i mod 10000 == 0)
                 then if (i mod 100000 == 0)
                      then if (i mod 1000000 == 0)
                           then if (i < 1000001)
                                then 42
                                else 0
                           else 0
                      else 0
                 else 0
            else 0
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Definition always_zero := forAll (choose (0%Z, 9999999%Z)) (fun n =>
     unlikely_branch n =? 0).
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Trying to give AFL a good chance to find the failing branch...

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Well, in fairness, it does eventually, but it takes a good 30 minutes. QuickChick was much faster.

Suggests maybe the extracted ocaml is harder for AFL to analyze? The C branches were discovered very quickly by AFL.

# Performance

- Fuzzing is an order of magnitude slower than random testing.
- Performance bottleneck: disk access.
- Experiments to see whether the instrumentation overhead is worth it are still in preliminary stages.

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And unfortunately they performed not so well.

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Setting up the experiment:

coq $\xrightarrow{???}$ C (apache)

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$$\text{coq} \xrightarrow{???} \text{C (apache)}$$

$$\text{coq} \xrightarrow{\textit{Extract}} \text{Ocaml} \xrightarrow{\textit{Unixcall}} \text{C (apache)}$$

# Fuzzing Large Project

Good news:
Both Quickchick and FuzzChick successfully run on the apache server.

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Both Quickchick and FuzzChick successfully run on the apache server.
Bad news:
We failed to go deeper than the client side on the server.

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But this patch used pthread to launch the server and what is happening at the backend is obscure (aka. neither humanbeing nor AFL knows what it is doing).

The pthread is not AFL instrumented and AFL cannot analysis the underlying path in the blackbox and do its state driven fuzzing technique. (GDB results said so :p)

# Fuzzing Large Project

Since I don't know what is the string that will make Apache run normally. (Thanks to the lack of documentation and the pthread function the patch is using.) I want the fuzzers to help me capture what is a string that will make the patched apache run successfully (exit with 0).

# Fuzzing Large Project

Quickchick:

- pros: Quickchick runs pretty fast at generating test cases.
- Cons: Quickchick fails to capture the successful case I want when we generate 10000 random strings. (That sounds natural I guess).

# Fuzzing Large Project

FuzzChick:

- pros: FuzzChick runs AFL and AFL does not generate random string, but it can cheat on having some testscript that people wrote.
- cons: It runs pretty slowly ( 1.2s per testcase). Maybe the string it comes up with is meaningful to the server.

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Aborted.

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Technical difficulties:

- The linkage between C to Ocaml and Ocaml to Coq is pretty messy. Code working in Ocaml does not necessarily compile when it is extracted to Coq.
- When we try to obtain more information from both of stderr and stdout in Ocaml, it is nontrivial to not stuck the terminal.

# Fuzzing Large Project

Takeaway:

It is not yet very practical to fuzz large real world project with coq and ocaml.

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- Plain AFL!
  - Similar story to Honggfuzz.

# Conclusion! Questions?

Whew! Questions?

# References


Calvin Beck, Jiani Huang, and Yishuai Li. *Quick700*. 2018. URL: https://github.com/Quick700/Quick700 (visited on 11/29/2018).

Leonidas Lampropoulos, Zoe Paraskevopoulou, and Benjamin C Pierce. "Generating Good Generators for Inductive Relations". In: ().

Michal Zalewski. *AFL*. URL: http://lcamtuf.coredump.cx/afl/ (visited on 11/29/2018).


These are all good resources! You should look at them!