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

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- QuickChick generates "random" files for each test, and the names aren't all that useful
  - 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:

Coverage report 44.33%

42%	/tmp/QuickChick/214311/QuickChick_prop_SSNIdefault_table_e0cd62.ml
46%	/tmp/QuickChick/214315/QuickChick_prop_SSNI_deriveddefault_table_65753a.ml
43%	/tmp/QuickChick/214320/QuickChick_prop_MSNIdefault_table_31e78d.ml
43%	/tmp/QuickChick/214324/QuickChick_myArgs_71227b.ml
44%	/tmp/QuickChick/214327/QuickChick_myArgs_81c382.ml
49%	/tmp/QuickChick/214330/QuickChick_myArgs_100552.ml

Generated on 2018-11-28 21:43:33 by Bisect_ppx 1.3.4

QuickChick vs FuzzChick: ifc-basic

QuickChick:

42% /tmp/QuickChick/214311/QuickChick_prop_SSNIdefault_table_e0cd62.ml

QuickChick vs FuzzChick: ifc-basic

QuickChick:

42% /tmp/QuickChick/214311/QuickChick_prop_SSNIdefault_table_e0cd62.ml

FuzzChick:

39% /tmp/QuickChick/225637/QuickChick_prop_SSNIdefault_table_732ea6.ml

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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- 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
       else 0
  else 0
".


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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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.

Fuzzing a Large Project

How do QuickChick and FuzzChick perform on a large scale project?

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

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

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Good news:

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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.

Fuzzing a 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 a 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 a 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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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!