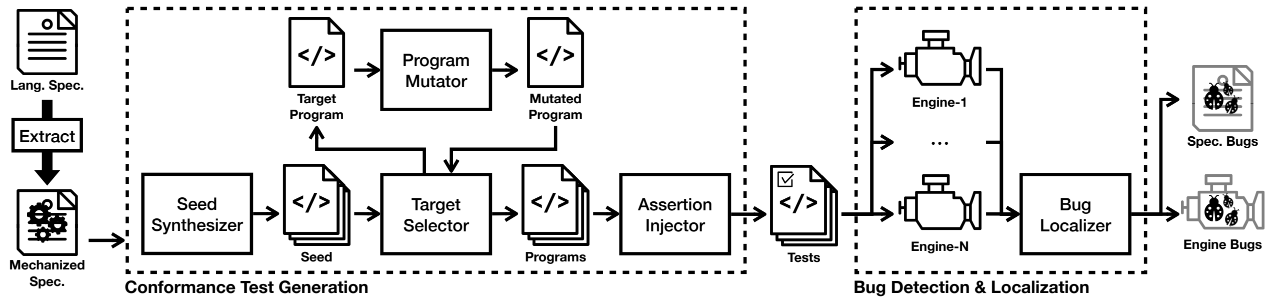
JEST: N+1-version Differential Testing of Both JavaScript Engines and Specification

Artifact Evaluation

Jihyeok Park Seungmin An Dongjun Youn Gyeongwon Kim Sukyoung Ryu

KAIST, South Korea

1 Artifact Description



The artifact consists of following modules to perform N+1-version differential testing of JavaScript engines and specification:

- **SeedSynthesizer** synthesizes an initial seed programs using the language syntax.
- **TargetSelector** selects a target program in the program pool that potentially increases the coverage of the language semantics by the pool.
- **ProgramMutator** generates a new program by mutating a given target program in order to increase the coverage of the language semantics by the program pool.
- **AssertionInjector** generates conformance tests by injecting assertions to the synthesized programs to check their final program states.
- **DifferentialTester** detects bugs in the specification and implementations via executing the conformance tests on multiple implementations.
- **BugLocalizer** localizes bugs on the specification using statistical information.

2 Getting Started Guide

The artifact is open-source can be obtained by cloning the following git repository:

```
$ git clone https://github.com/jhnaldo/jest.git
$ cd jest
```

To build and execute the artifact, you should follow the instrucitons in the `INSTALL` file in the artifact. Since we implement the artifact in Scala, it requires `sbt`, which is an intereactive build tool for Scala. Moreover, for differential testing, you also need to install four different JavaScript engines: V8 (v8.5), GraalJS (v20.1.0), QuickJS (2020-04-12), and Moddable XS (v10.3.0).

Additionally, we packaged the artifact in a docker container. If you want to skip the environment setting, we recommend you to use it. You can install the docker by following the instruction in https://docs.docker.com/get-started/ and downlaod our docker image with the following command:

```
$ docker pull jhnaldo/icse-21-jest
$ docker run -it jhnaldo/icse-21-jest # user: guest, password: jest
```

WARNING: The docker image is X.XGB large thus be patient when you download it.

3 Basic Commands

You can run the artifact with the following command:

```
$ jest <sub-command> <option>*
```

with the following sub-commands:

- `help` shows the help message.
- `sample` represents **SeedSynthesizer** and dumps seed programs to `result/seed`.
- `generate` loads seed programs from `result/seed`, repeatedly performs **ProgramMutator** with **Target-Selector**, dumps generated programs to `result/programs`. You can change the maximum iteration via the option `-generate:iter=<number>` (default: 10).
- `inject` loaded programs from `result/programs` and dumps results of **AssertionInjector** to `result/tests`.
- `check` performs **DifferentialTester** for `result/tests` and records bugs to `result/bugs`.
- `localize` performs **BugLocalizer** for found bugs in `result/bugs`. When the option `-localize:answer` is given, it reads answers from `answer` and shows their ranks.
- `run` integrates all modules to perform N+1-vesion differential testing at once.

and global options:

- `-time` shows duration time.
- `-bugfix` uses semantics extracted from bug-fixed ECMAScript.
- `-detail` prints intermediate processes.

4 Step-by-Step Instructions

4.1 RQ1. Coverage of Generated Tests

Execute the following command to check the size of seed programs and their syntactic coverage.

```
$ jest sample
```

Then, check the basic program generation wth the following commmand.

```
$ jest generate
```

It shows the semantics coverage changes (Figure 4), and the number of generated programs and covered branch-esof mutation methods (Table I) during program generation. Even though it is impossible to exactly reproduce results because of the randomness in the program generation, you can check the tendencies by running the program generation with a large maximum iteration ($\geq 1,000$).

```
$ jest generate -generate:iter=1000
```

4.2 RQ2. Accuracy of Bug Localization

To reproduce the result in Figure 5, we provide the data used in the evaluation including programs generated by a single process and example programs invoke specification/engine bugs we found via the artifact. Type the following command:

```
$ rm -r result/programs
$ cp -r data result/programs
$ jest inject && jest check && jest localize -localize:answer
```

Moreover, we provide detailed data of each bug detected by the artifact in `bugs.md`. You can check the table in Section IV.B with this file.

4.3 RQ3/4. Bug Detection in JavaScript Engines/Specification

The file `bugs.md` also explains the Table II and Table III.