Scala.js integration with Leon to improve counterexample presentation in the web interface

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Abstract

Although a main feature of Leon is to provide counterexamples to invalid programs, it can remain difficult when provided with a counterexample to understand how the input breaks the program. We propose to integrate Scala.js with Leon and implement ideas from Bret Victor's essay on "Learnable Programming" [1] to improve experience for users when presented with a counterexample.

1 Introduction

Currently the Leon web interface shows counterexamples in a dialog, or in a tip when user hovers the pointer over a variable. This is unfriendly, as the programmer has to remember the variable values and do substitution and execution in mind in order to reason where the problem lies.

Why not just annotate(or substitute) the variables in the buggy function with the counterexample as input values? This way, user can easily figure out which line goes wrong by following the execution in an interactive and visual way.

The detailed solution is as follows:

- When user clicks *debug* button in the counterexample dialog, a debug box appears, with all the formal parameters in the function being annotated(or substituted) by the counterexample values.

- *Function calls* are annotated by their return values. If user clicks a function call in a debug box, another debug box will overlay current debug box. User can close a debug box by clicking [x] in the up-right corner of the debug box.

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[1] See http://worrydream.com/#!/LearnableProgramming

- *Local variables* are annotated by the values they hold. The value of *this* will be shown as environment in each debug box. *Free variables*(closure variables) in a function are correctly handled and annotated as well.

Advanced features we consider(but may beyond current scope of the project):

- User can modify the annotated program in debug box and check if current counterexample passes or not.

- User can try different values of function formal parameters in debug box, and check if the postcondition holds or not.

2   Technical Details

This project has three technical aspects:

- Front-end web programming in order to implement the GUI for end users

- Parsing of Leon programs using JavaScript in order to do correct annotation(or substitution) of program for display.

- Interpret Leon programs using JavaScript in order to annotate function return values correctly.

Front-end programming is a manageable task, given that the GUI is not complex, and there are plenty of open source GUI libraries. Parsing of Leon programs in JavaScript requires some work, but it's doable.

Writing a Leon interpreter in JavaScript for our special purpose is a real challenge. However, given that we can write the interpreter in Scala, and then use Scala.js to compile the interpreter to JavaScript, this task is promising. But currently we're unable to estimate how much work is needed for this task.