Mechanizations of JavaScript

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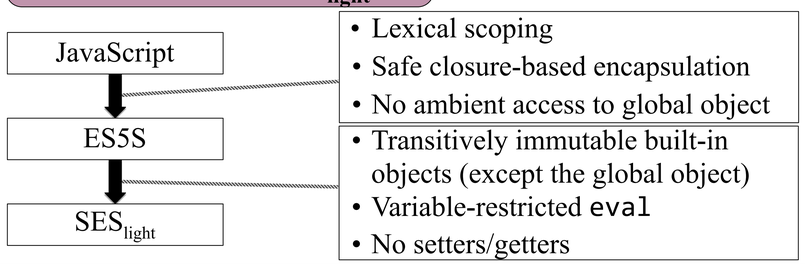
Introduction

Since the JavaScript standard is vast and informal, it is not amenable to apply conventional proof techniques. As a result, there are several studies to make formal syntax and semantics of JavaScript. In this poster, we introduce two of such studies and present our research.

SES_{light} [1]

From JS to SES_{light}

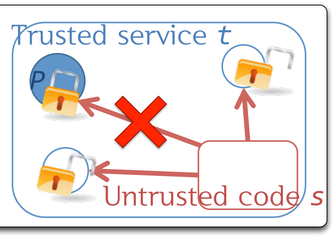


- Let `t` be the trusted code and `s` be the untrusted code. Then, the overall program that executes in the system can be expressed as :

```
t; var un; eval(s, "api", "un").
```

Confinement Property

- A trusted service `t` safely encapsulates a set of forbidden allocation-site labels *P*.

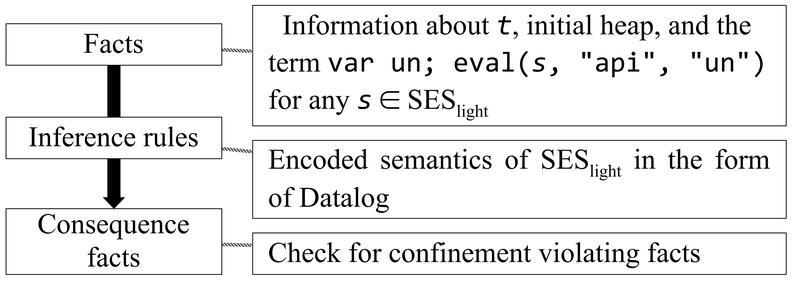


Proof Overview

Datalog

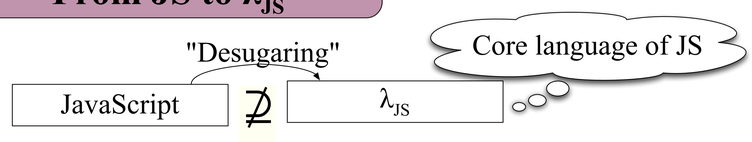
A Datalog program consists of *facts* and *inference rules*. We can get the set of all consequence facts that can be obtained by applying the inference rules to the facts, upto a fixed point.

Procedure Overview



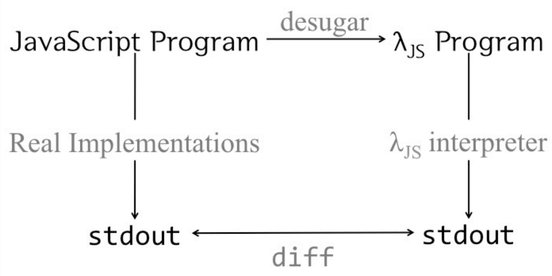
λ_{JS} [2]

From JS to λ_{JS}



- JavaScript → λ_{JS} compiler by Haskell
- λ_{JS} interpreter by PLT Scheme
- (recent) Mechanized by Coq

Testing Strategy



Bugs

- Various type-setting errors
- A semantic error

Soundness of λ_{JS} [3]

Theorem

For all λ_{JS} programs, p, either:

1. $p \rightarrow^* v$,
2. $p \rightarrow^*$ ***err***, or
3. $p \rightarrow^* p_2$, and there exists p_3 such that $p_2 \rightarrow p_3$.

Coq Code

```
Definition progress := forall sto e,
  lc e ->
  val e \/ e = exp_err \/
  (exists e', exists sto', step sto e sto' e').

Definition preservation := forall sto1 e1 sto2 e2,
  lc e1 ->
  step sto1 e1 sto2 e2 ->
  lc e2.
```

Our Research

λ_{JS} with Modules [4]

We introduce a module system to JavaScript, and we formally describe its semantics via desugaring to a slightly modified λ_{JS}.

JavaScript + module —desugar→ λ_{JS} + α

Current Work

We are working on mechanizing the soundness of the modified λ_{JS} in Coq.

Soundness?

λ_{JS} + α

References

SES_{light}

[1] A. Taly, U. Erlingson, J. C. Mitchell, M. S. Miller, J. Nagra, *"Automated Analysis of Security-Critical JavaScript APIs"*, SP 2011

λ_{JS}

[2] A. Guha, C. Saftoiu, S. Krishnamurthi, *"The Essence of JavaScript"*, ECOOP 2010

[3] http://brownplt.github.com/2012/06/04/lambdajs-coq.html

λ_{JS} with modules

[4] Seonghoon Kang and Sukyoung Ryu. *"Formal Specification of a JavaScript Module System"*, OOPSLA 2012