Towards Analysis and Bug Finding of JavaScript Web Applications in the Wild

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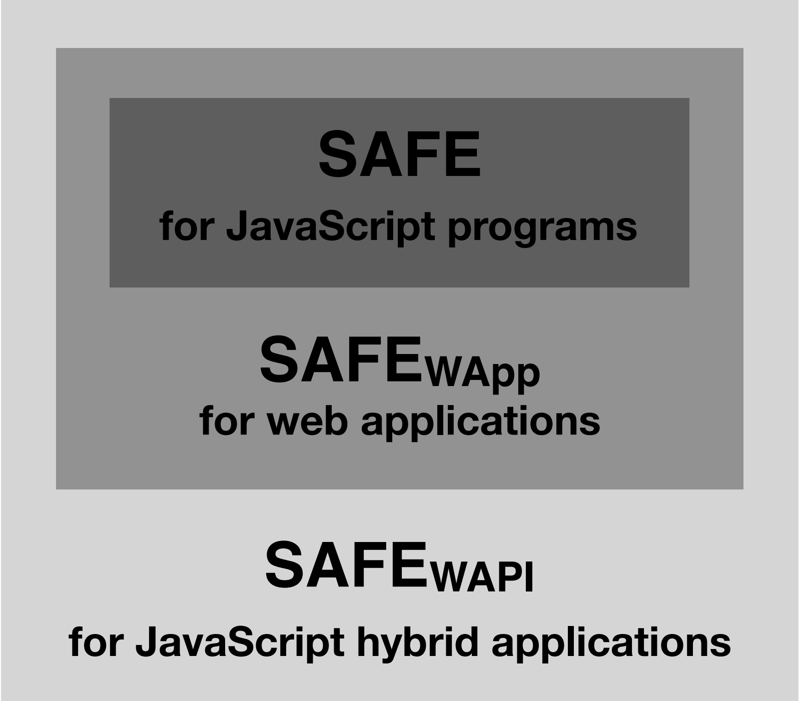
JavaScript

- **Expressivity**
  - First-class functions
  - Dynamic code generations
- **Portability**
  - Web browsers
  - Smart devices

Bugs in JavaScript

- **Loosely typed language**
  - Type-related run-time errors
- **Third-party libraries**
  - Vulnerable to security attacks

SAFE Family



SAFE

for JavaScript programs

SAFE$_{\text{WApp}}$

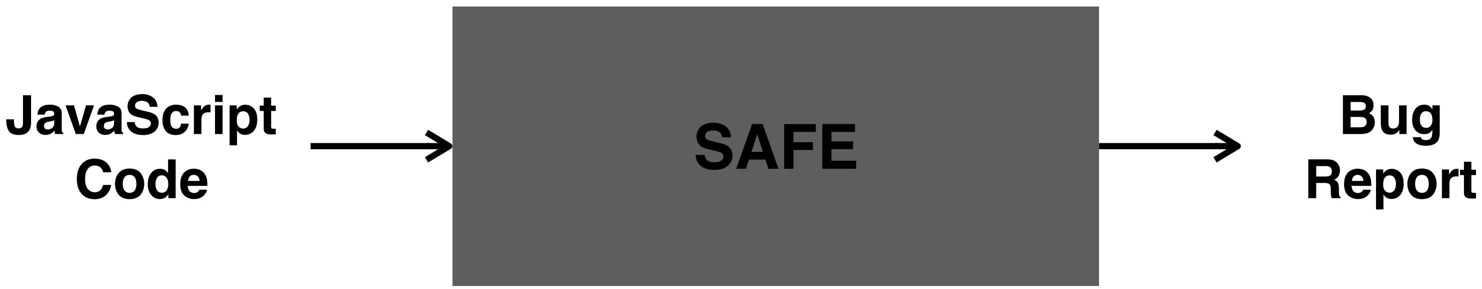
for web applications

SAFE$_{\text{WAPI}}$

for JavaScript hybrid applications

To develop a tool that can
analyze and detect bugs
in *real-world JavaScript web applications*

Analysis of JavaScript Program



JavaScript Code

SAFE

Bug Report

* H. Lee, S. Won, J. Jin, J. Cho, and S. Ryu, SAFE: Formal specification and implementation of a scalable analysis framework for ECMAScript
* C. Park, H. Lee, and S. Ryu, All about the with statement in JavaScript: Removing with statements in JavaScript applications
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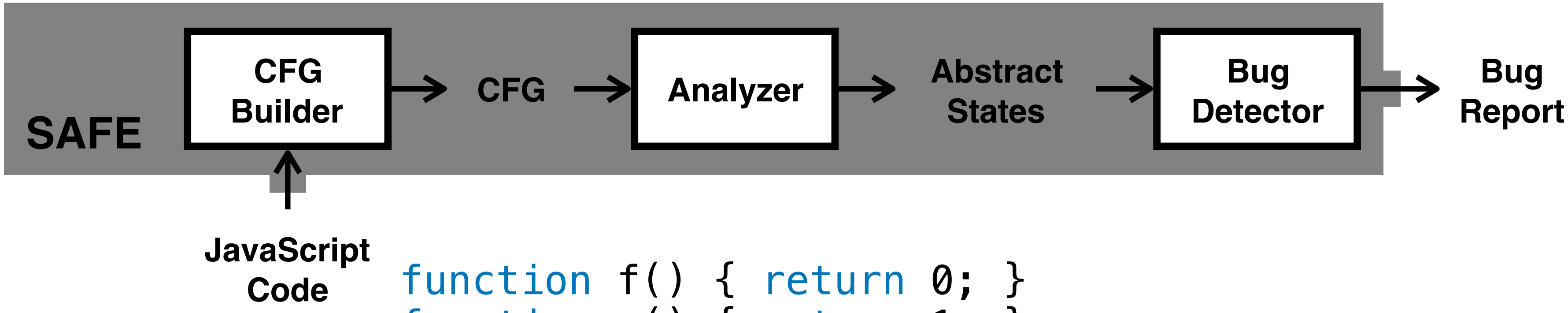

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function f() { return 0; }
function g() { return 1; }
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var o = { a : 0, b : 1, c : 2 };

with(o) {
  a = f; b = g; c = h;
};

for (name in o) {
  eval("o[name] = o[name]();");
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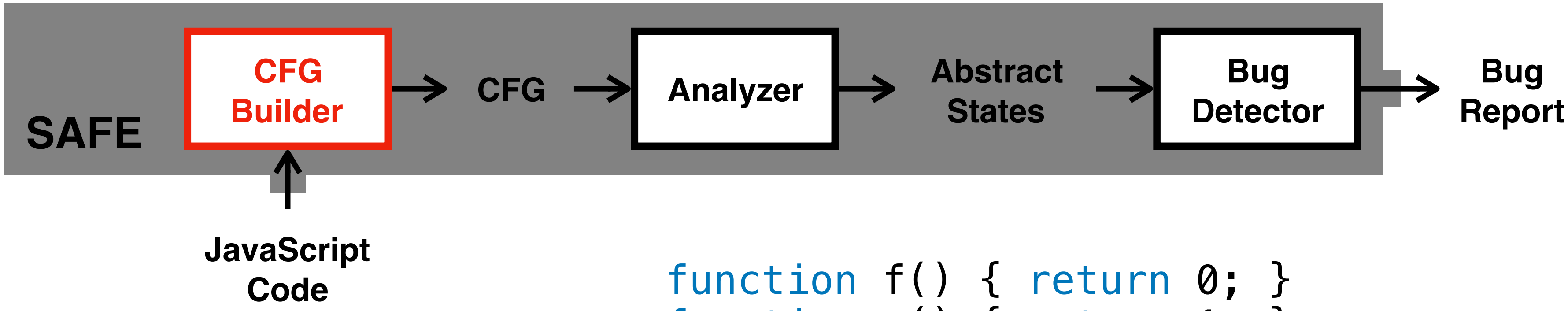

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2. Dynamic scoping via `with` statements
3. Join of analysis results for loops
4. First-class property names

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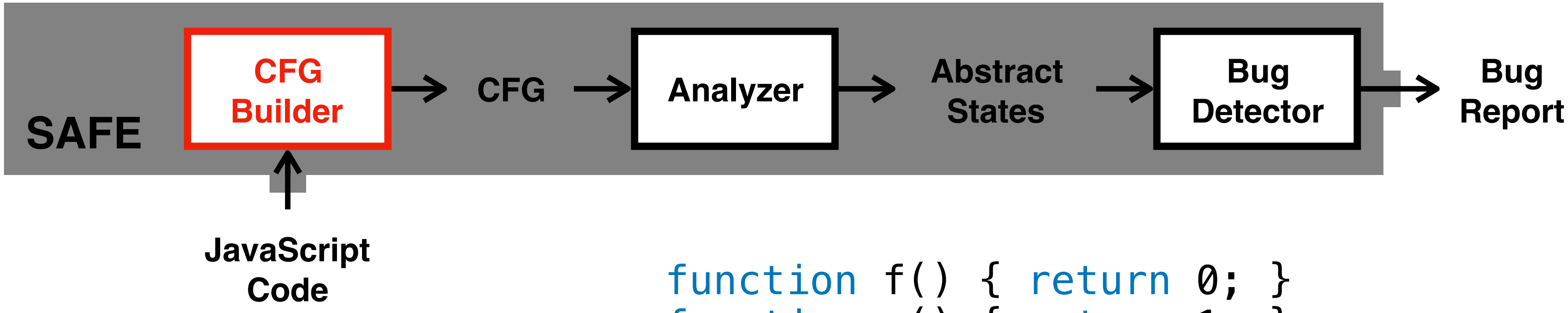

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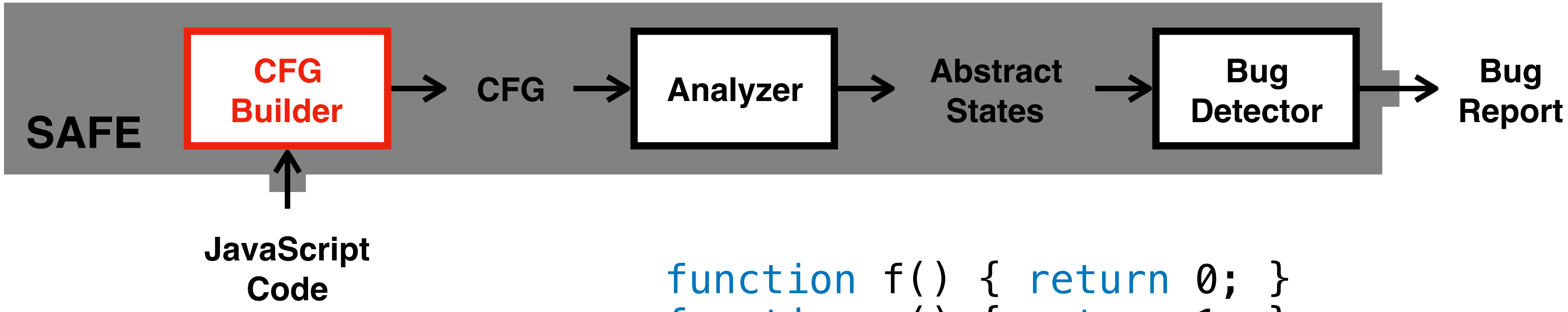

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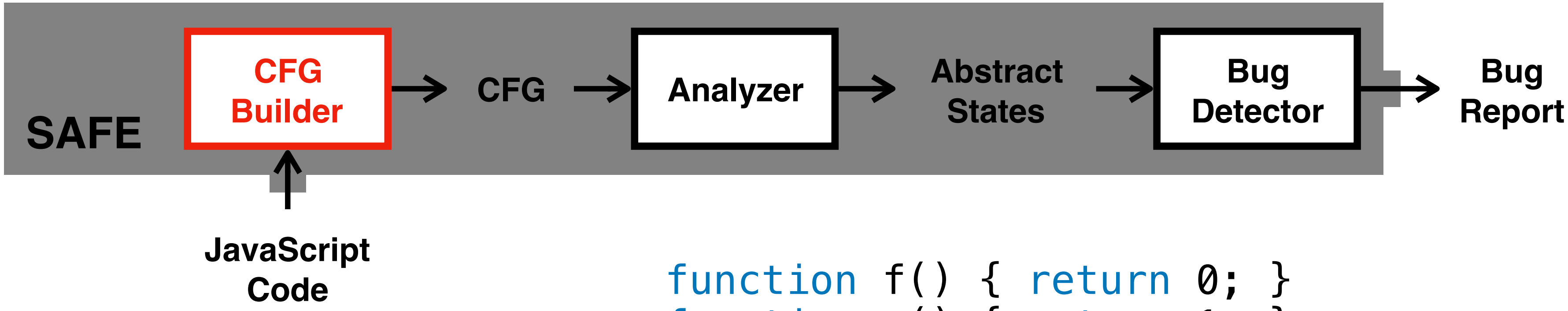

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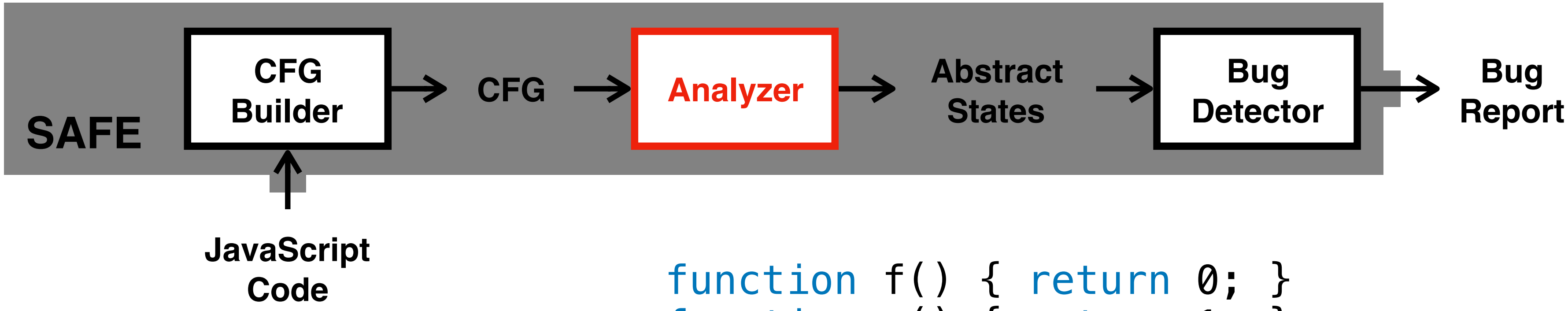

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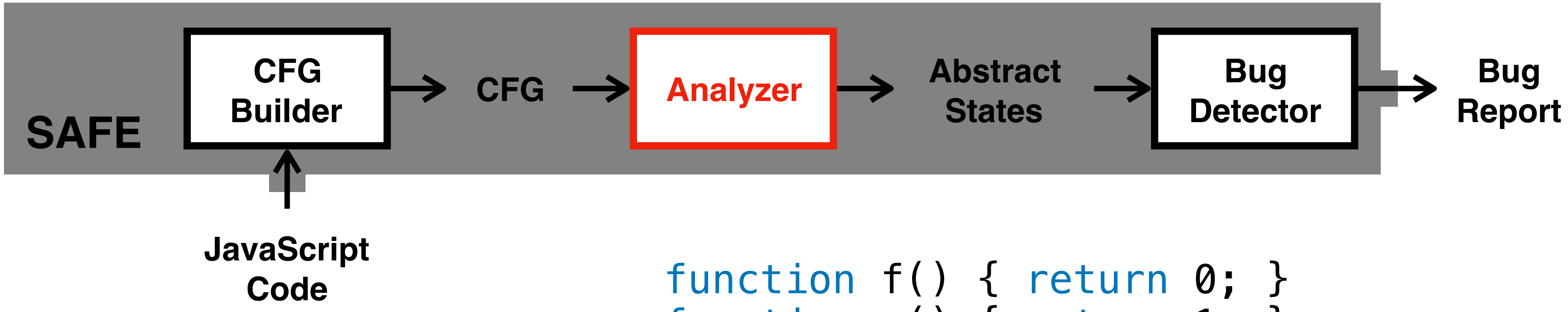

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loop sensitive analysis (LSA)

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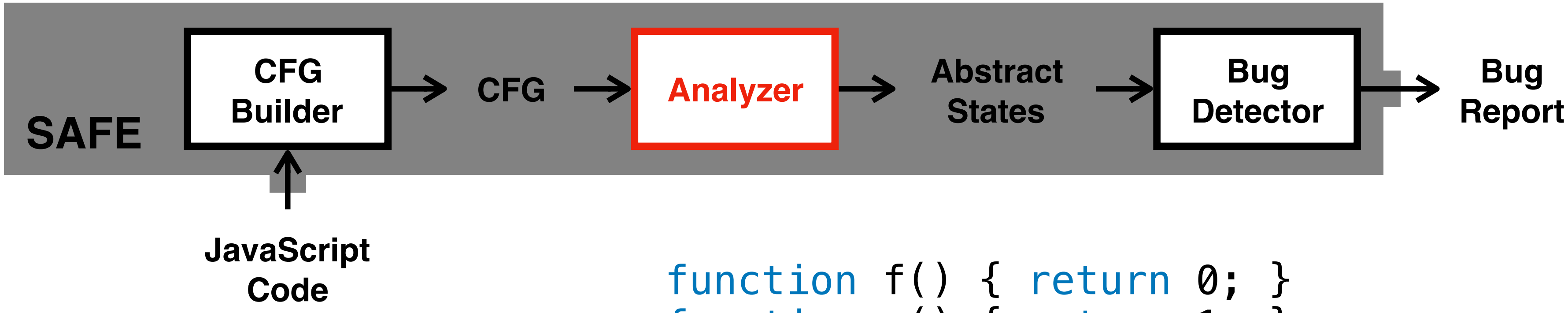

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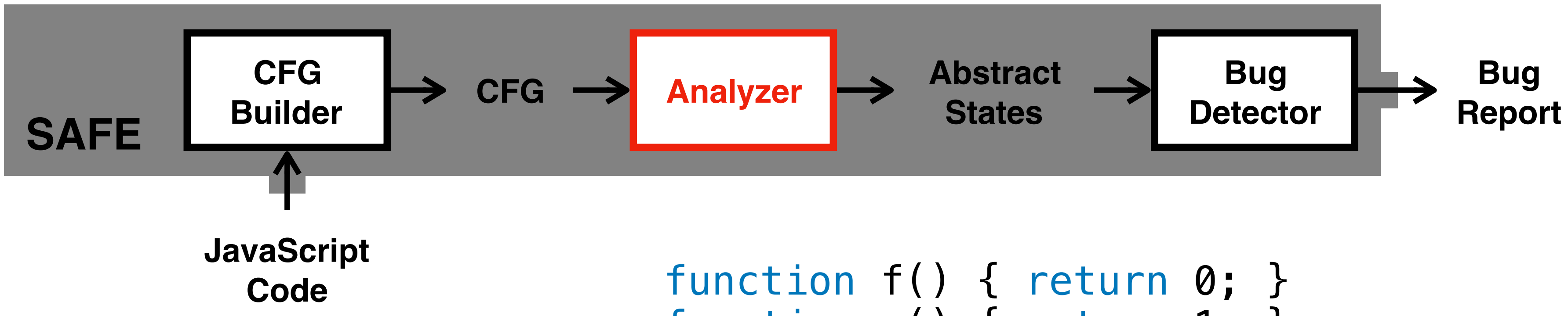

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regular expression domain

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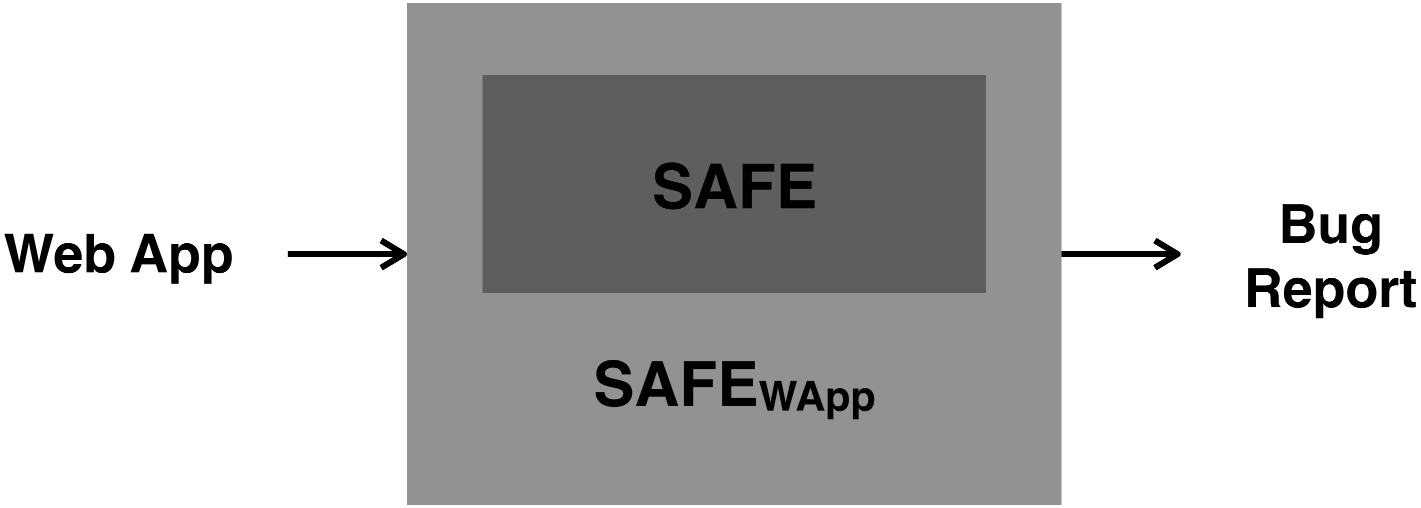
Analysis of Web Applications



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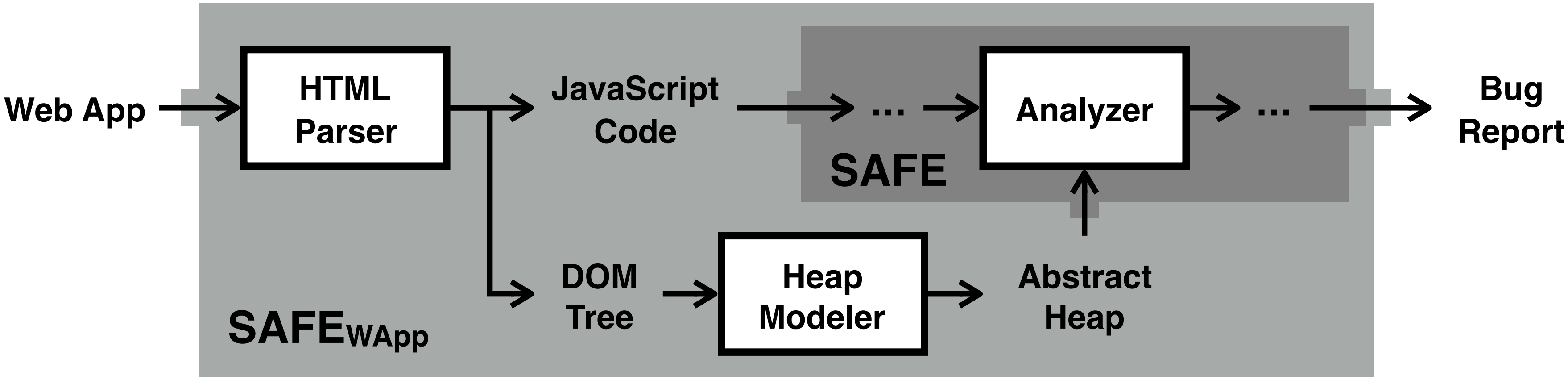

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var app = chrome.app;
function isDiv(elem) {
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<div onclick="isDiv(this)">foo</div>
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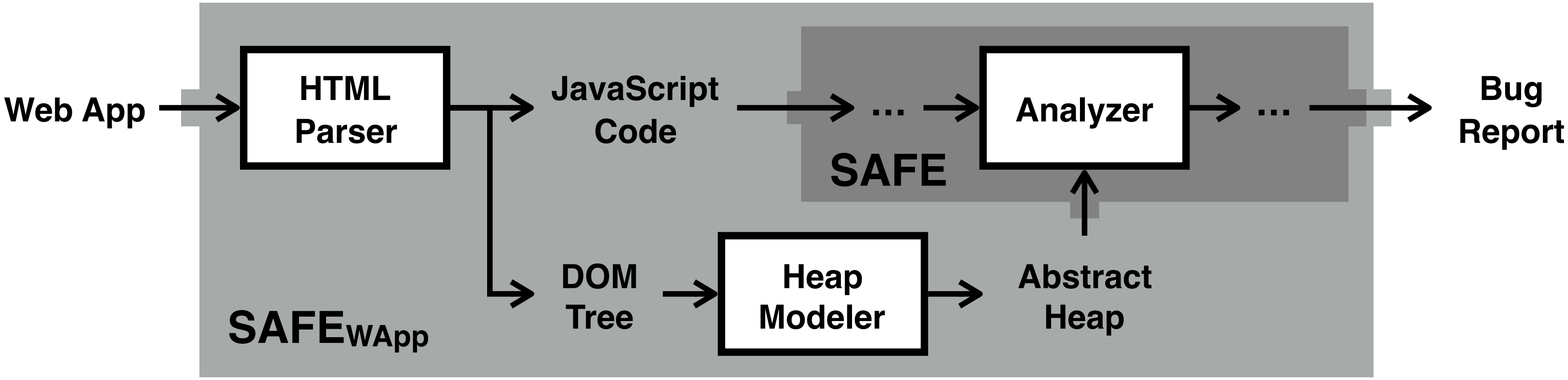

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3. Browser-specific APIs
4. Dynamic file loading

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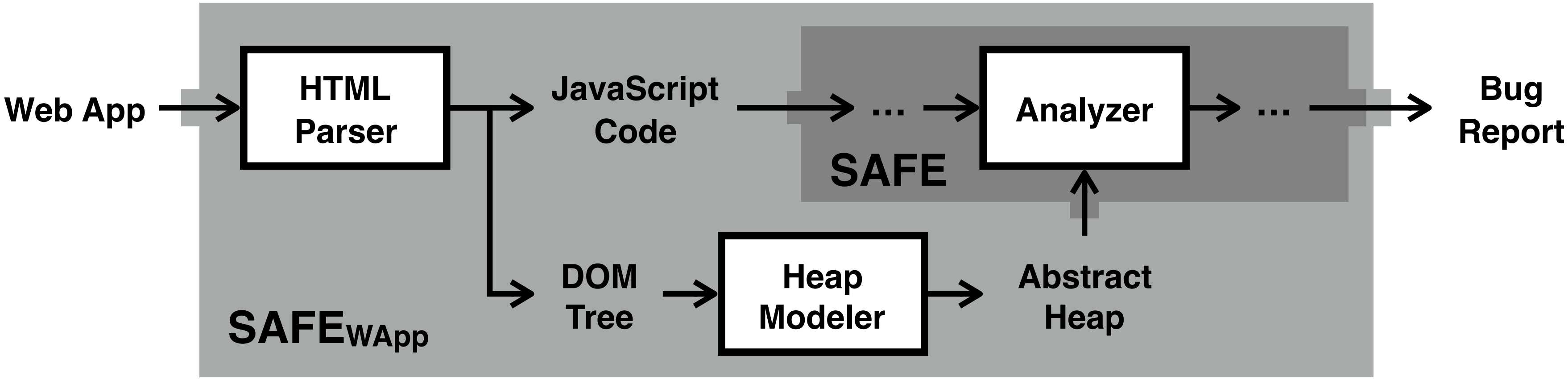

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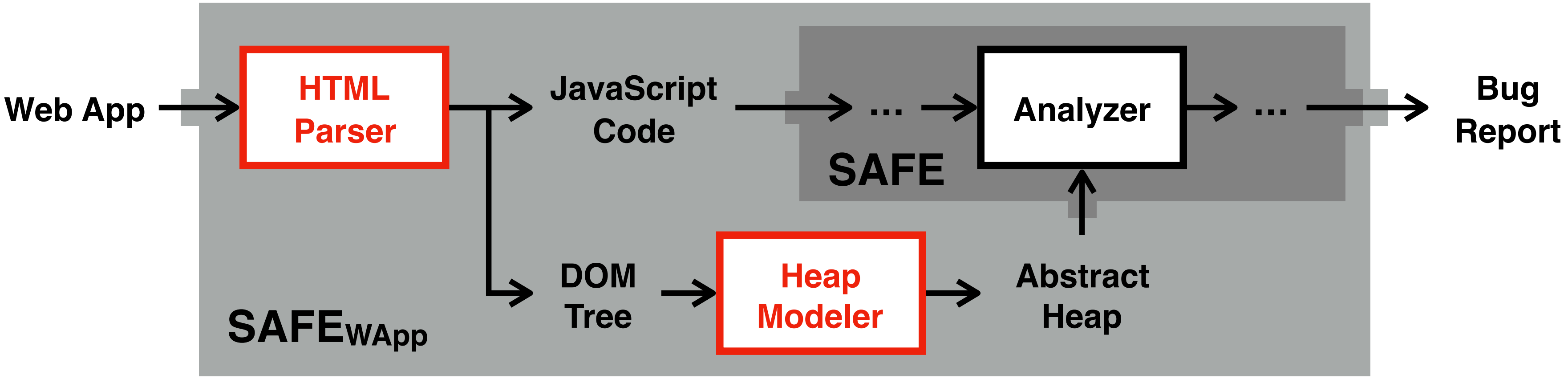

modeling DOM objects / APIs

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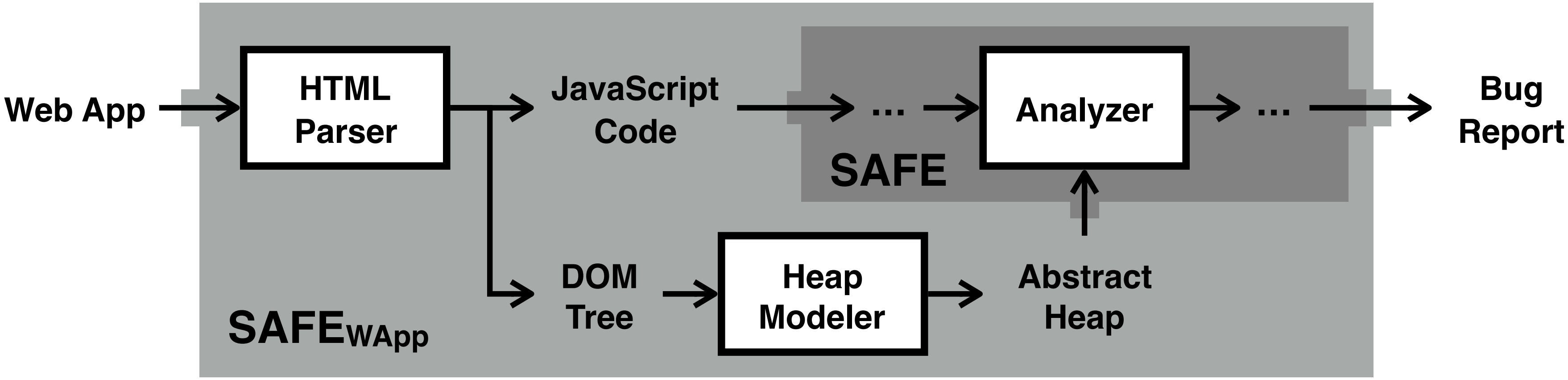

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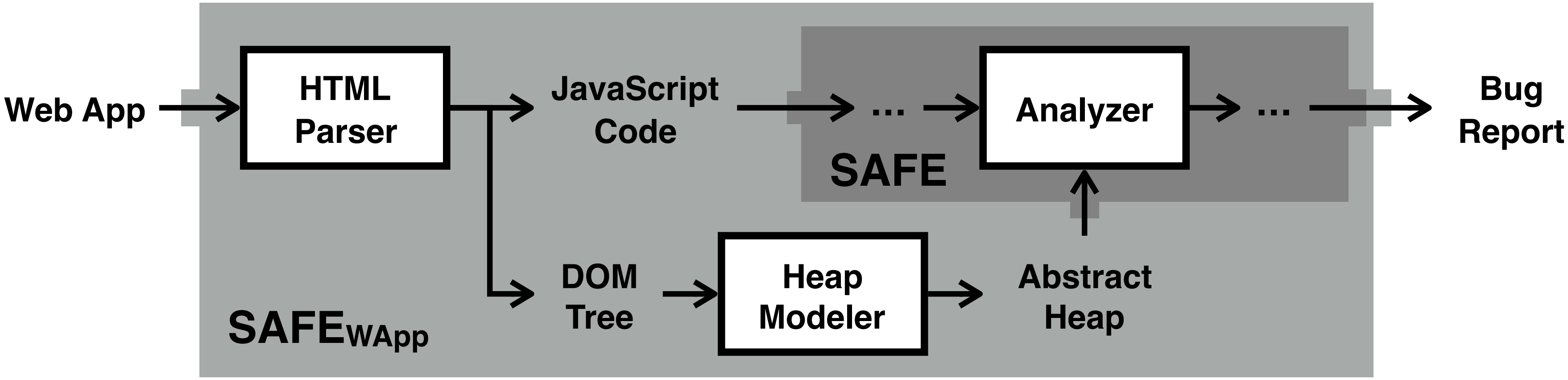

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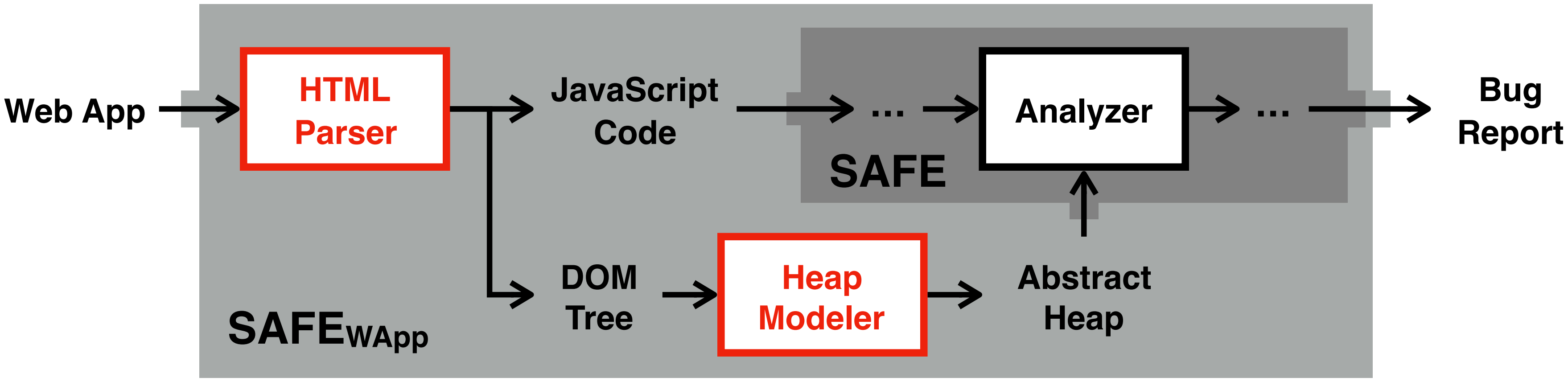

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dynamic information

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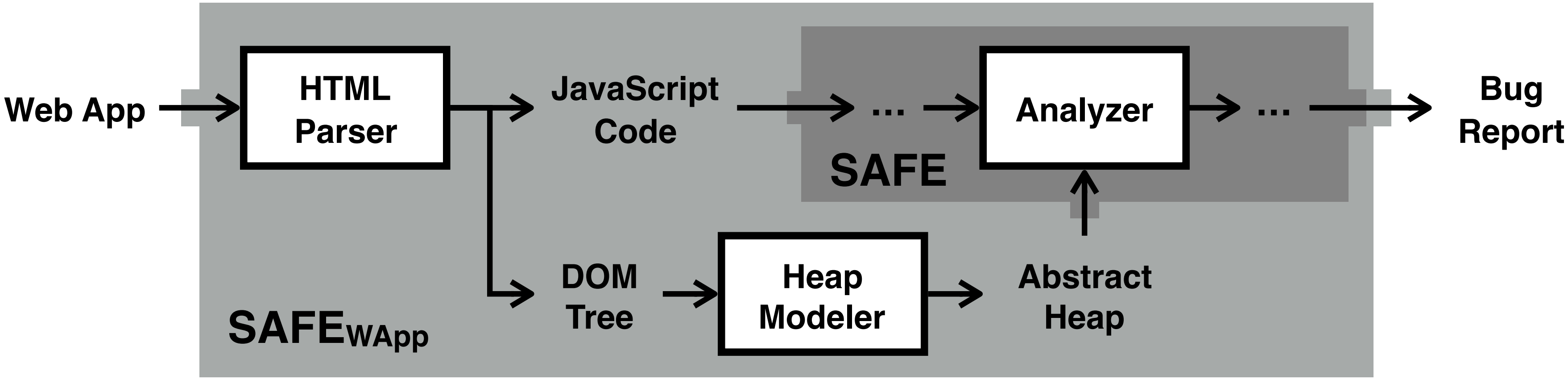

WIKIPEDIA
The Free Encyclopedia

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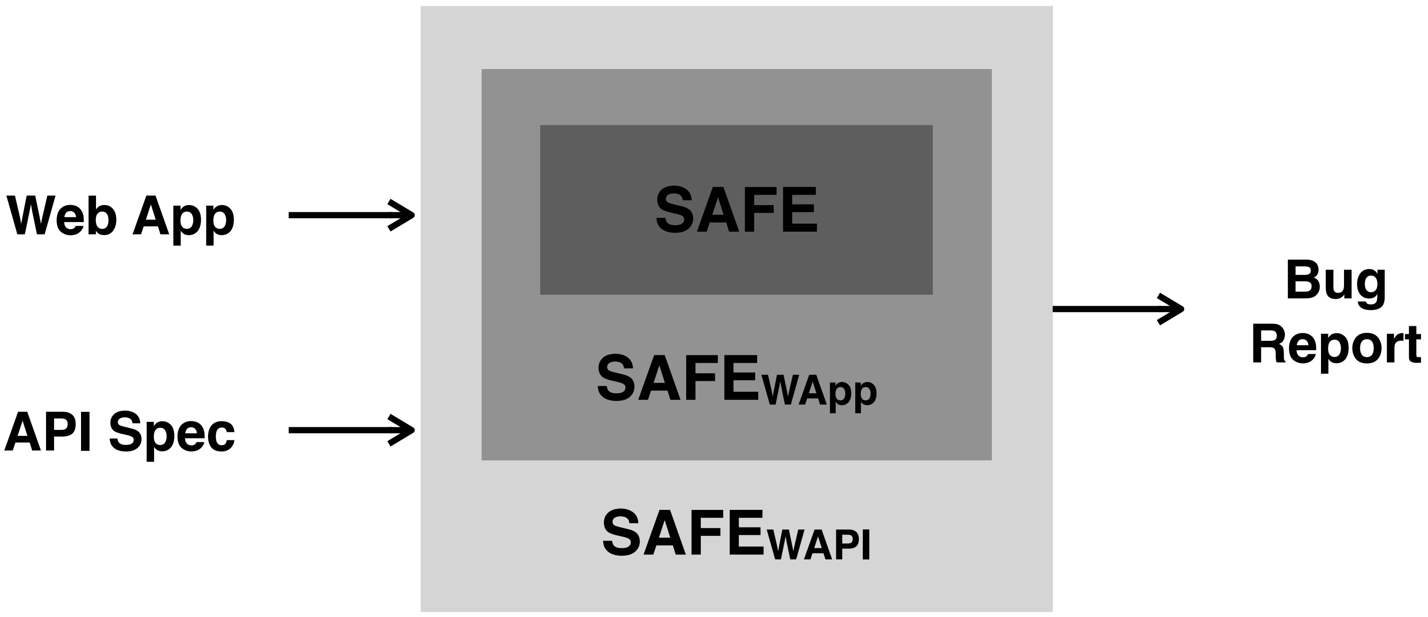
Always false!!

Analysis of JS Hybrid Applications



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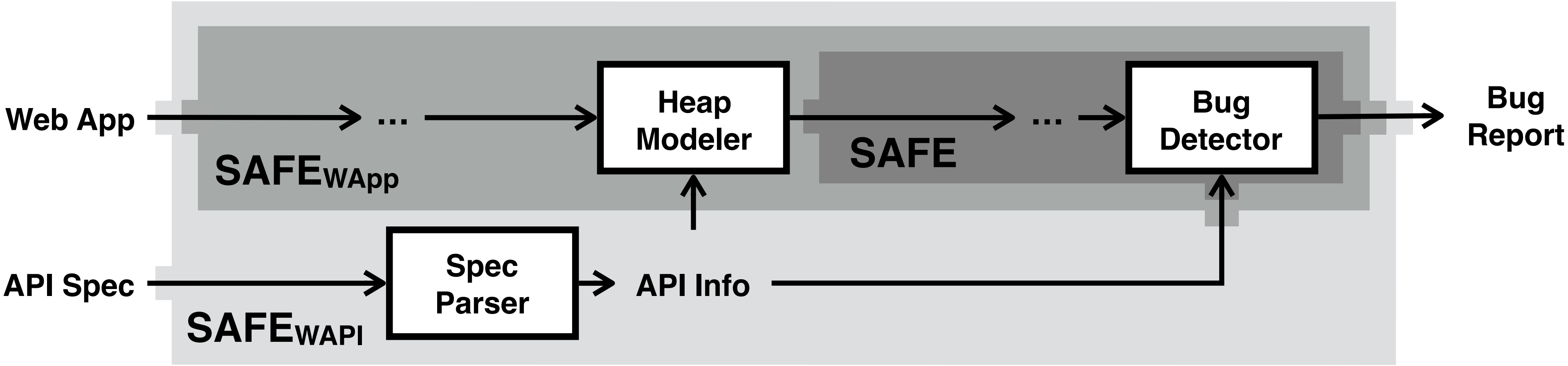

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function f(cs) { cs.map(c => c.type); }
var c = webapis.calendar;
c.getCalendars("EVENT", f);
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interface CalendarManager {
  void getCalendars(
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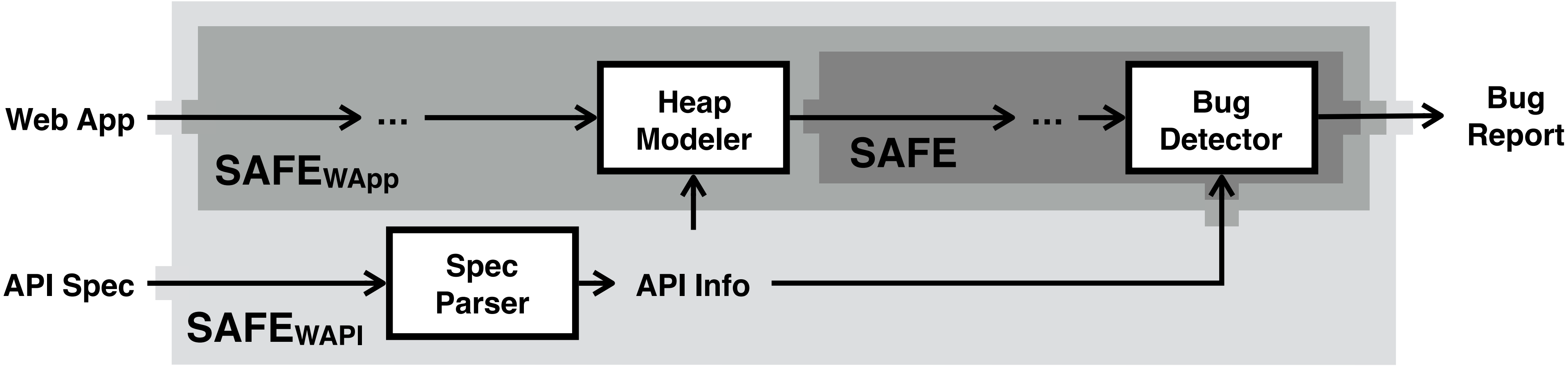

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2. Implicit callback functions

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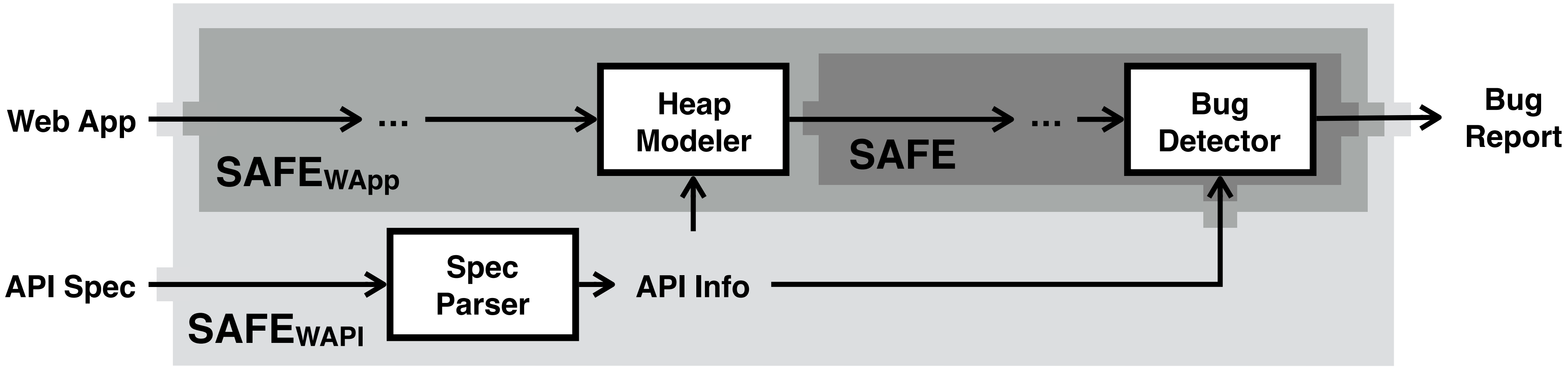

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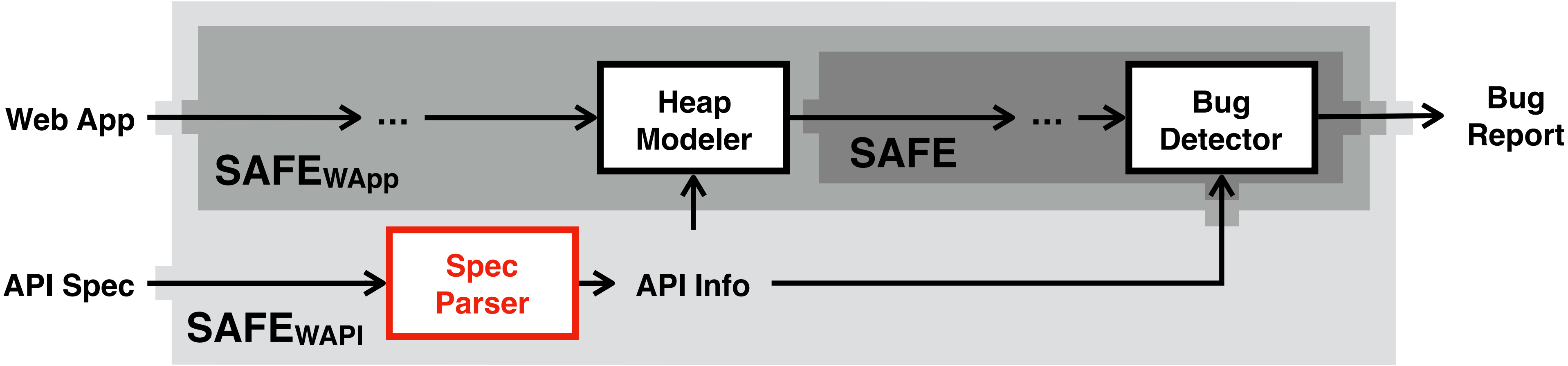

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automatic modeling based on API spec

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Moving Forward

- **Dynamic code generation / Event loops**
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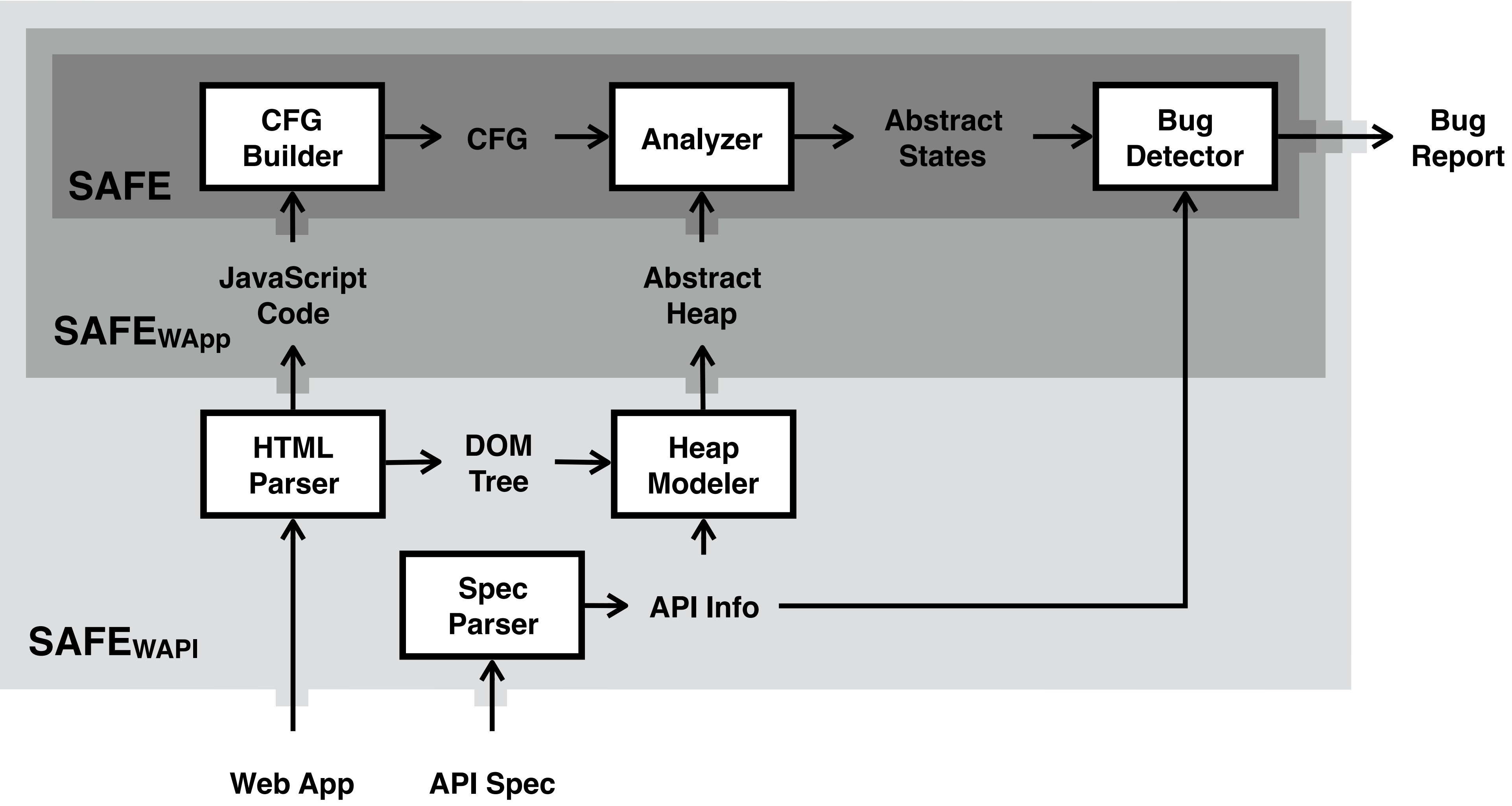
- **APIs implemented in platform specific languages**
  - Advanced automatic modeling
- **Finding the best analysis configuration**
  - Automatic suggestion for the best configuration

Question?


SAFE
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Bug Report
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