What Went Wrong?

Automatic Triage of Precision Loss During Static Analysis of JavaScript

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- Focus on Program Analysis
- Current projects
  - Java vulnerability detection
  - Frappé: impact analysis
  - Soufflé: Datalog engine for program analysis
  - **Web-based vulnerability detection**
- Past project
  - Oracle Parfait: bug-checker for C/C++

Precision Loss During Static Analysis of JavaScript

- ✓ Introduction
- Idea and motivation
- Our current implementation

Precision in JavaScript static analysis

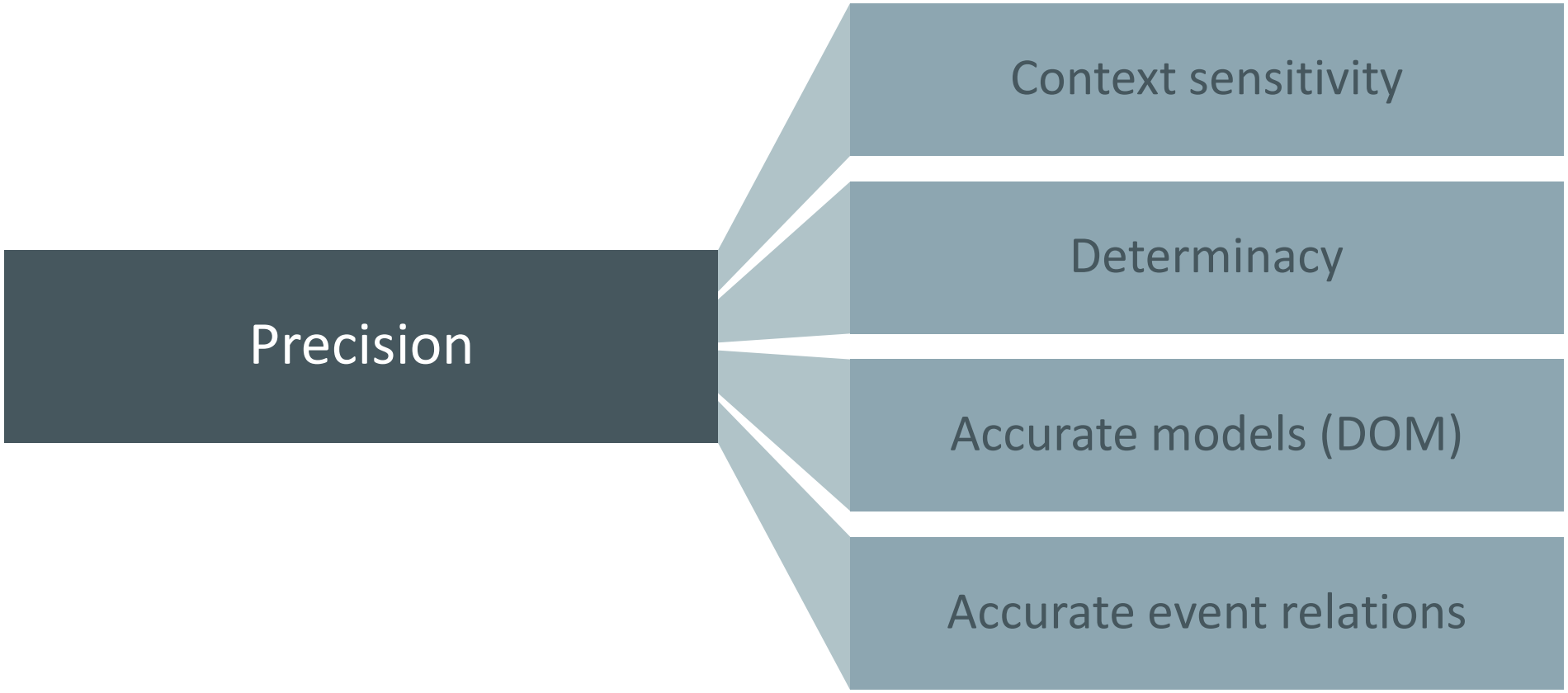
Why keep track?

JavaScript v. Static Analysis

A non-exhaustive list of grievances:

- Few static guarantees (un-typed & dynamic)
- Ubiquitous use of reflection
- Intricate semantics and side-effects

JavaScript v. Static Analysis



When analysis fails

At least in our experience

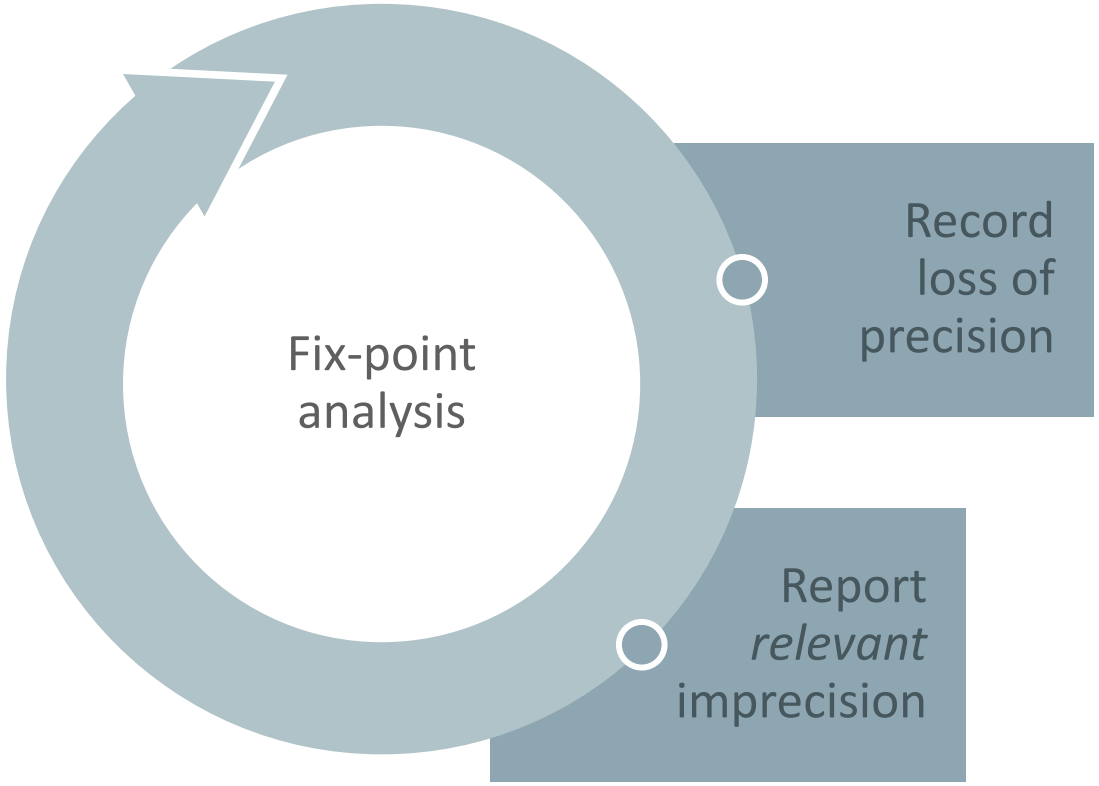
1. ¯_(ツ)_/¯
2. Try again with different analysis settings
3. Tweak the program under analysis
4. Last resort: inspect abstract state, add logging

When analysis fails

A better way

- Fail fast (early during analysis)
- Explain why

Precision tracking



User notified in two ways:

1. Warnings about potentially detrimental effects of precision loss
2. When imprecision causes analysis to become infeasible: stop and emit all precision loss information relevant to current state

Precision tracking

- Better means of debugging analysis problems related to precision
  - Ensuring precision is hard
  - It is easier to validate soundness of our analysis
- Pinpoint static analysis “hotspots”
  - *That DOM function that is only a stub*
  - *That essential part of the program that needs more context sensitivity*

"There is always a larger volume of work that is worth doing than can be done currently"

– Mervin Kelly, Bell Labs

Precision tracking in SAFE

A work in progress

Precision tracking in SAFE

1. Imprecision Sources
   - Abstract domain operations
   - Partially modelled DOM and built-in functions
2. Attach imprecision hints to abstract values
   - $\widehat{Value} = \widehat{PValue} \times p(\widehat{Loc})$
3. Sinks
   - Call, apply
   - Property access

In addition: keep track of the size of the work list

Results

Example: jQuery analyzed with SAFE's highest sensitivity setting

Precision problems found:

- Math.random
- jQuery.extend
- SAFE's String and Number domains
- jQuery's list of event handlers
- SAFE's Array.prototype.sort model

Summary

- Precision tracking now
  - Means of debugging analysis problems
  - Guiding efforts to model built-in and library code
- Future applications?
  - Automatic analysis refinement (e.g. context-sensitivity, abstract domains)

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