λ_{JS} à la Carte

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CCS Concepts: • **Software and its engineering → Software verification**.

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1 Introduction

Half a page for overview and explaining motivation

2 à-la-carte-ness

We chose Rocq[11] because of metatooling support

We follow closely ideas from Coq à la Carte[5] to enable modularity. Direct use of the meta programming tools developed there is prohibitively difficult due to outdated Metarocq[10], but the overall structure of reasoning holds surprisingly well even without them.

Why can't use directly

Explain functors

Imporovements, what I want to do

3 Targets for formalization

One can do the same formalization as λ_{JS} for Featherweight Java[7].

There exists industrial cases where it is paramount to have reusable proofs. For example: React vs Signals proposal.

There is yet to be a significant test of modularity for mainstream programming languages formalization.

There are several[6][1] developments that attempt to formalize and reason about JavaScript, however non of them is easy to extend with new features. Being one of the most used language, JavaScript provides a fertile ground for evaluating existing approaches for modular reasoning. Lack of sophisticated type system streamlines the encoding and makes it easier to gradually prove language properties, while keeping the formalization open to extension. Extensive specification[3] in natural language is also a very welcome addition.

Moreover, JavaScript has several frameworks[4] and dialects(e.g. TypeScript) that enable different styles of programming. Ability to reuse proofs about core language for dialects would be a nice showcase of modularity. The t39 proposal process[8] is transparent and well documented thus permitting mechanization of ongoing specification of nightly features before they are adopted to core language.

To the best of our knowledge no modular technique from above was ever used for mechanisation of a mainstream language.

We plan to, at first, follow λ_{JS}[6] formalization and then gradually extend it with features described in ECMA, while preserving the following properties.

- preservation of local closeness w.r.t small step semantics

```
forall c e c' e', lc e
                    -> step c e c' e'
                    -> lc e'.
```

- progress theorem

```
forall c e, lc e
            -> isValue e
            \/ isError e
            \/ (exists c' e', step c e c' e').
```

The aim of the project is not to formalize the whole existing JavaScript semantics, but rather to test how far one can go with mechanisation, while maintaining extendability. With this goal in mind the following features of JavaScript are of the most interest: mutability, exceptions, reactivity and asynchronicity. Ongoing Rocq development is available here[1].

4 Discussion

There are other solutions to increase modularity of proofs.

Proof modularity papaers

1. Family Polymorphism[9]

   Rocq plugin for type family polymorphism

2. Program Logics à la Carte[13]

   Coinduction with ITrees.

3. Interpreters à la Carte[12]

   Containers as functors for fixpoints

Argue about that indirect encoding is too taxing.

It's interesting to look into the possibility of gradually encoding calculus of inductive constructions in a modular fashion.

[1] https://github.com/FrogOfJuly/js-a-la-Carte

Proof modularity comes with the cost of departing from the usual way of reasoning about inductive types. Even in case of Coq à la Carte departure is not quite dramatic, but still requires to rethink how one approaches proofs.

The ideal solution would be to have a correspondence between modular and inductive proofs. There is an existing work[2] that could enable that proofs transfer between "equivalent" datatypes.

Talk about how they achieve that and is it possible to leverage that for functor representation of chosen datatype.

Is it possible to use containers as a meta language, while presreving ability to do actual reasoning with inductive types in Rocq?

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