

Felipe V. Côrtes

Type Extractor

Projeto Final de Programação

Especificação apresentada como requisito parcial para obtenção de grau da disciplina Projeto final de Programação em Informática, do Departamento de Informática da PUC-Rio .

Advisor: Prof. Roberto Ierusalimsky

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Abstract

Cortes, Felipe; Ierusalimschy, Roberto (Advisor). **Type Extractor**. Rio de Janeiro, 2018. 18p. Dissertação de Mestrado – Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Inspecting dynamically typed code is hard due to the lack of type information provided. Inspired by this challenge, we built a tool capable of inspecting Lua programs and extracting types from the functions in it. Sustained by the reflection capabilities of the language, it's possible to extract parameter and return values from each function execution and generate a useful report for code documentation and inspection. This document presents the software design and implementation, as well as results obtained by some Lua benchmark programs.

Keywords

Lua; Programming Languages; Type Systems; Code Inspection.

Resumo

Cortes, Felipe; Ierusalimschy, Roberto. **Extrator de tipos**. Rio de Janeiro, 2018. 18p. Dissertação de Mestrado – Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Inspecionar código dinamicamente tipado é uma tarefa difícil devido a falta de informação sobre tipos. Inspirado por esse desafio, construímos uma ferramenta capaz de inspecionar programas feitos em Lua, extraindo os tipos das funções nele presentes. Sustentado pelas capacidades introspectivas da linguagem, é possível extrair os valores dos parâmetros e retornos de cada execução de função, gerando um relatório útil para documentação e inspeção. Esse documento apresenta a especificação e implementação do software, assim como os resultados obtidos em alguns programas Lua de referência.

Palavras-chave

Lua; Programming Languages; Type Systems; Code Inspection.

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List of Abbreviations

1

Introduction

There are several reasons that motivate the adoption of statically typed languages. Maintaining large systems built with dynamic types can become a nightmare due to the lack of type information (TAKIKAWA et al.,). Typed languages also generally has better performance because compile-time type information helps generating optimized machine code. However, programmers are frequently left empty-handed when inspecting dynamically typed code while having to re-write systems to a statically typed language if gradually typed languages are not an option.

Inspired by the challenge of inspecting dynamically typed code, we built a type extractor for the Lua programming language. By inspecting a program's execution during runtime, it can generate enough information to help programmers visualize the types being transfered between functions of their program. The software output can be used as an useful documentation, while also helping programmers migrate code to a statically typed one or even for debugging.

The document is structured as follows. In Chapter 2 we present previous work related to type systems in Lua. In Chapter 3 we describe the software goal. Chapter 4 explain the software modules and how they interact. In Chapter 5 it's shown the software key functions, the modules relationship and basic utilization. In Chapter 6 we present and discuss some results obtained by the type extractor on some Lua benchmarks. Finally on Chapter 7 we present our conclusion and future work.

2

Previous Work

There has been some notable works about Type System with Lua that we must cite. Typed Lua (MAIDL; MASCARENHAS; IERUSALIMSKY, 2014) has already defined an optional type system for the language. More than enriching documentation, this extension ensures static type safety while preserving Lua idioms. Typed Lua encodes the main data structure mechanism from Lua into arrays, records, tuples and maps. It uses a bracket syntax to denote table types:

Code 1: Insert Typed Lua

```
1 local interface Element
2     info:number
3     next:Element?
4 end
5
6 local function insert (e:Element?,v:number):Element
7     return { info = v, next = e }
8 end
```

The type system is designed to be lightweight and type-safe and extends for typing object, classes and modules by adding type annotations. In Code 1 example, a simple algorithm for inserting numbers in a list is shown using type annotations. The Element interface is defined recursively and referenced twice on the function's header, indicating it's return type. The ? symbol means that *e* is optional and can assume empty values. Although Typed Lua's type system share some parts with other optional type systems for dynamically typed languages, it's design demanded uncommon features due to Lua's characteristics.

Lua Type System has also been explored for scripting optimization with Pallene (GUALANDI; IERUSALIMSKY,). The language design is inspired by optional type systems and it's semantical and syntactical similarity with Lua enables integrating seamlessly with Lua's dynamic code.

Code 2: Pallene Array Sum

```
1 function sum ( xs : { float } ): float
2     local s : float = 0 .0
3     for i = 1 , # xs do
4         s = s + xs [ i ]
5     end
```

```
6     return s
7 end
```

As opposed to Typed Lua, Pallene is designed for efficiency. It performs runtime checks to ensure type safety with a tweak flexibility. But similarly, Pallene uses type annotations. As shown in Code 2, the function *sum* receives an array of float and returns a single float. Pallene has a built in interoperability with Lua by sharing its runtime and data-structures. These features allow converting Lua code to Pallene code more easily.

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Project Scope

Type extraction for existing dynamic code is still an uncovered subject. Our software has the purpose of collecting type information from an user's program and reporting this data for documentation, inspection and code migration. The type extractor analyse each function call and return by using reflection properties of the Lua programming language. The debug library allow us to register hook functions to inspect a program's execution, computing the types present in the code.

The type extractor can be used by two approaches, as a full program analysis or as a inspection library.

- Full Analysis: A full program analysis is made by passing a Lua program as input to the extractor. In this approach, each possible function call and return types will be analysed.
- Inspection library: An auxiliar library, capable of registering specific functions for inspection. In this approach, the programmer can select what part of the program they want to analyse.

These usage scenarios enables the extractor to be used as an auxiliary tool for migrating from dynamically to statically typed languages. At the end, a report containing information about parameters and return types of each analysed function is generated and shown to the user. This data serves as a good documentation for functions parameter and return types. Giving tools for understanding the type relations inside a program helps programmers to debug and optimize dynamically typed code.

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Project Specification

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Development

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Results

7

Final Considerations

GUALANDI, H. M.; IERUSALIMSKY, R. Pallene: A companion language for lua. v. 189, p. 102393. ISSN 01676423. Disponível em: <<https://linkinghub.elsevier.com/retrieve/pii/S0167642320300046>>.

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