A type inferred programming language

Scala Lite

August 12, 2016

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Introduction

Scala−− is a prototype towards to be a full-fledged production-ready functional programming language presently, only support of a small subset of Scala language functionalities. However, it is way faster than JVM-based Scala for both compilation startup time and execution time of the target at runtime leveraging LLVM optimization/analyse. The prototype compiler translates Scala-like source code LLVM IR with OCaml implementation.

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Language Features

Language Features

- Machine code ← Assembly ← LLVM-IR ← OCaml-LLVM-binding← OCamlYacc ← OCamlLex
- Basic control flow and scoped varible declaration
- Basic arithmetic
- Similar to Scala syntax defining functions and variables

Issus:

1. TL;DR
2. Functional ?
3. Type inference ...
4. OOP ?

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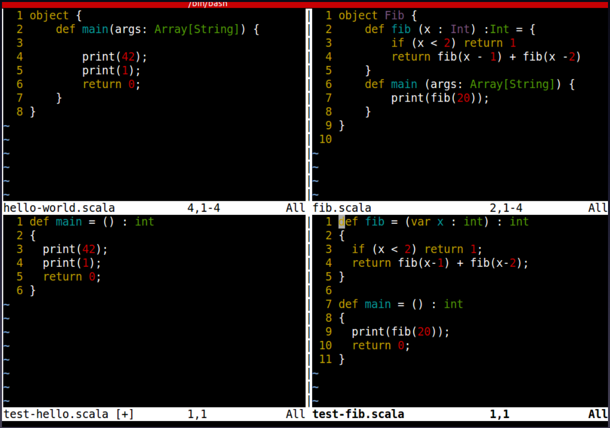
Bencharkmarking

Experiments

- ARM
  - ArchLinux
  - FreeBSD
- amd64
  - Archlinux
  - Ubuntu
  - FreeBSD
  - OS X

Benchmarking

Results



/bin/bash

```
object {
    def main(args: Array[String]) {

        print(42);
        print(1);
        return 0;
    }
}
~
~
~
~
~
~
hello-world.scala              4,1-4           All
```

```
object Fib {
    def fib (x : Int) :Int = {
        if (x < 2) return 1
        return fib(x - 1) + fib(x -2)
    }
    def main (args: Array[String]) {
        print(fib(20));
    }
}

~
~
~
~
fib.scala                      2,1-4           All
```

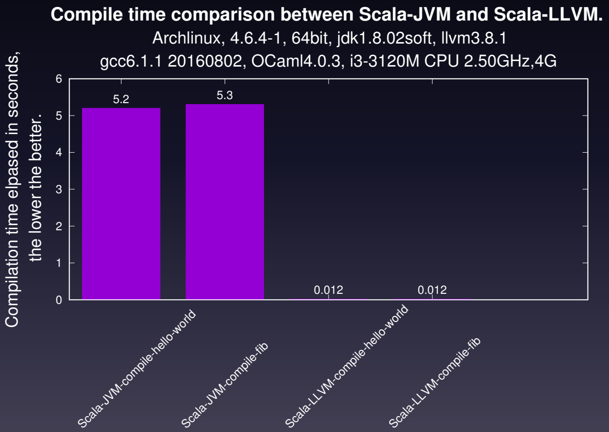
```
def main = () : int
{
  print(42);
  print(1);
  return 0;
}
~
~
~
~
~
~
~
~
test-hello.scala [+]           1,1             All
```

```
def fib = (var x : int) : int
{
  if (x < 2) return 1;
  return fib(x-1) + fib(x-2);
}

def main = () : int
{
  print(fib(20));
  return 0;
}
~
~
~
test-fib.scala                 1,1             All
```

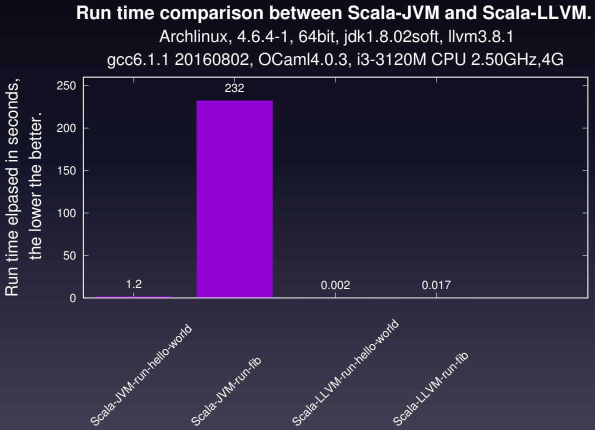
Bencharkmarking

Compile time



Bencharkmarking

Run time



Run time comparison between Scala-JVM and Scala-LLVM.
Archlinux, 4.6.4-1, 64bit, jdk1.8.02soft, llvm3.8.1
gcc6.1.1 20160802, OCaml4.0.3, i3-3120M CPU 2.50GHz,4G

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Implementation

	Methods	**Compiler phases**	**Data flow**
Scala-- Compiler front end	ocamllex	Scanner	Token
	ocamlyacc	Parser	Ast
	OCaml	Semantic checker	SAst
	OCaml Hindley-Milner	Type inferrer	TAst
	OCaml LLVM binding	Code generator	LLVM-IR
Scala-- Compiler back end	LLVM toolchain	llc compiler	Assembly
	platform-dependent gcc compiler	assembler	Machaine executable

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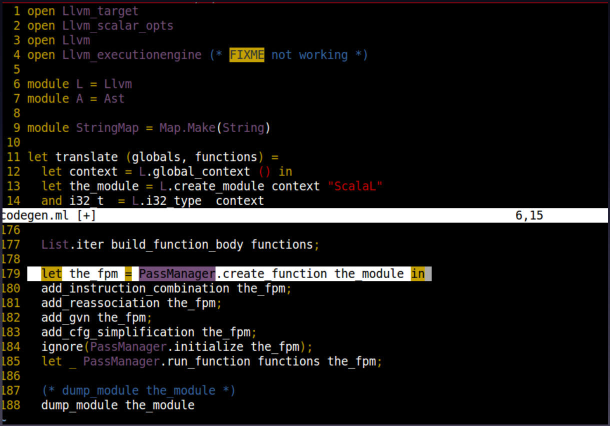
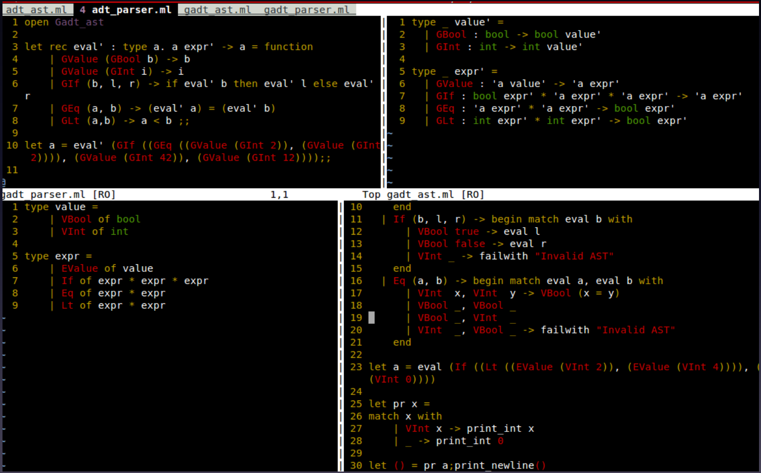
Attempt of Harness advantage of LLVM's optimization power



```
open Llvm_target
open Llvm_scalar_opts
open Llvm
open Llvm_executionengine (* FIXME not working *)

module L = Llvm
module A = Ast

module StringMap = Map.Make(String)

let translate (globals, functions) =
  let context = L.global_context () in
  let the_module = L.create_module context "ScalaL"
  and i32_t  = L.i32_type  context
codegen.ml [+]                                                    6,15

  List.iter build_function_body functions;

  let the_fpm = PassManager.create_function the_module in
  add_instruction_combination the_fpm;
  add_reassociation the_fpm;
  add_gvn the_fpm;
  add_cfg_simplification the_fpm;
  ignore(PassManager.initialize the_fpm);
  let _ PassManager.run_function functions the_fpm;

  (* dump_module the_module *)
  dump_module the_module
```

Some 'other . Cool stuff

GADT



```
open Gadt_ast

let rec eval' : type a. a expr' -> a = function
    | GValue (GBool b) -> b
    | GValue (GInt i) -> i
    | GIf (b, l, r) -> if eval' b then eval' l else eval' r
    | GEq (a, b) -> (eval' a) = (eval' b)
    | GLt (a,b) -> a < b ;;

let a = eval' (GIf ((GEq ((GValue (GInt 2)), (GValue (GInt 2)))), (GValue (GInt 42)), (GValue (GInt 12))));;

```

```
type _ value' =
  | GBool : bool -> bool value'
  | GInt : int -> int value'

type _ expr' =
  | GValue : 'a value' -> 'a expr'
  | GIf : bool expr' * 'a expr' * 'a expr' -> 'a expr'
  | GEq : 'a expr' * 'a expr' -> bool expr'
  | GLt : int expr' * int expr' -> bool expr'
```

```
type value =
    | VBool of bool
    | VInt of int

type expr =
    | EValue of value
    | If of expr * expr * expr
    | Eq of expr * expr
    | Lt of expr * expr
```

```
    end
  | If (b, l, r) -> begin match eval b with
      | VBool true -> eval l
      | VBool false -> eval r
      | VInt _ -> failwith "Invalid AST"
    end
  | Eq (a, b) -> begin match eval a, eval b with
      | VInt  x, VInt  y -> VBool (x = y)
      | VBool _, VBool _
      | VBool _, VInt  _
      | VInt  _, VBool _ -> failwith "Invalid AST"
    end

let a = eval (If ((Lt ((EValue (VInt 2)), (EValue (VInt 4)))), (
(VInt 0))))

let pr x =
match x with
    | VInt x -> print_int x
    | _ -> print_int 0

let () = pr a;print_newline()
```