

Tiger to RISC V Compiler

Sourabh Aggarwal

Mentor: Dr. Piyush P. Kurur

November 2019

Department of Computer Science And Engineering
IIT Palakkad



What Has Been Achieved - MISC

1. More graceful error termination.

```
Compiler > TestFiles > err2.tig
1  /* Hello World! */
2  let
3
4      var N := "\tHello\n\t\tWorld!\n"
5
6  in
7      print (N)
8  end
9
```

PROBLEMS 6 OUTPUT DEBUG CONSOLE TERMINAL

LEXING ERROR: Error is at line no: 4 and column no is: 21. Message: Newline without terminating string

uncaught exception Error
raised at: tiger.lex.sml:137.9-137.23
tiger.lex.sml:2577.45
parse.sml:34.53

PROBLEMS 28 OUTPUT DEBUG CONSOLE TERMINAL 1: Code +

LEXING ERROR: Error is at line no: 4 and column no is: 21. Message: Newline without terminating string



What Has Been Achieved

2. Wrote complete documentation of my compiler at tigercompiler.ml. This is done to help me and anyone interested in this project to quickly revise the fundamentals and understand the working of this compiler.

The screenshot shows the Tiger Compiler documentation website. The header is purple with the Tiger Compiler logo and name. The left sidebar contains a navigation menu with links to Introduction, Intro, Understanding Function Calls, Phase III, Introduction, Canonisation (highlighted in blue), Instruction Selection, Liveness Analysis and Interference, Graph, and Register Allocation. The main content area is titled 'Canonisation' and has an 'EDIT' button. Below the title is an 'Abstract' section. The abstract text reads: 'It's useful to be able to evaluate the sub-expressions of an expression in any order. If tree expressions did not contain ESEQ and CALL nodes, then the order of evaluation would not matter.' Below the abstract is a section titled 'Why CALL nodes are an issue?'. The text in this section reads: 'In actual implementation. CALL nodes will return value in the'. On the right side of the page, there is an 'Abstract' section with two links: 'Why CALL nodes are an issue?' and 'Why ESEQ nodes are an issue?'.

Tiger Compiler

Introduction

Intro

Understanding Function Calls

Phase III

Introduction

Canonisation

Instruction Selection

Liveness Analysis and Interference

Graph

Register Allocation

Canonisation

[EDIT](#)

Abstract

It's useful to be able to evaluate the sub-expressions of an expression in any order. If tree expressions did not contain ESEQ and CALL nodes, then the order of evaluation would not matter.

Why CALL nodes are an issue?

In actual implementation. CALL nodes will return value in the

Abstract

[Why CALL nodes are an issue?](#)

[Why ESEQ nodes are an issue?](#)



What Has Been Achieved

3. Wrote automated testing using [Travis](#). Now I'll be able to see whether my changes don't break the existing functionalities and also it is useful in case someone sends a pull request.

sourabh2311 / btp build passing

Current Branches Build History Pull Requests More options

✓ master Report Update - 14 passed Restart build

Commit 33a9781
Compare 8f27478...33a9781
Branch master
Sourabh Aggarwal

Python: 3.6
AMD64

Job log View config

Remove log Raw log

1 Worker information
6
7 Build system information



What Has Been Achieved

4. **Fixed** a major bug; Initially my compiler supported only fixed number of arguments. Now this has been extended to support any number of arguments.

The screenshot shows a code editor window with a file named `tc2.tig`. The code defines a function `last` that takes 12 integer arguments and prints them. The terminal output shows the program running and exiting with code 0. Below the editor is a commit message: "Added support for more than one function arguments" by `sourabh2311` on Oct 4. The commit diff shows changes to `Compiler/accessConv.sml`, adding a signature and two val bindings for `ACCESSCONV`.

```
Compiler > TestFiles > tc2.tig
1 let
2   function last (a : int, b : int, c : int, d : int, e : int, f : int, g :
      int, h : int, i : int, j : int, k : int, l : int) : int = l
3 in printI(last(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12)); print("\n"); exit(0)
4 end

PROBLEMS 1 OUTPUT DEBUG CONSOLE TERMINAL 1: Code + - x ^
12
Exited with code: 0
Program terminated by calling exit
```

Added support for more than one function arguments [Browse files](#)

`sourabh2311` committed on 4 Oct 1 parent 74cc398 commit 5270be5c637331a29cfb40092c3b5011735652fa

Showing 5 changed files with 674 additions and 3 deletions. [Unified](#) [Split](#)

```
39 [REDACTED] Compiler/accessConv.sml ...
... @@ -0,0 +1,39 @@
1 + signature ACCESSCONV =
2 + sig
3 +   val frameToTree: RiscFrame.access list -> Tree.access list
4 +   val treeToFrame: Tree.access list -> RiscFrame.access list
5 + end
```



What Has Been Achieved

5. Added 2 more arithmetic operations, viz. left shift and right shift.

```
Compiler > TestFiles > tc9.tig
1  let
2      var N := 8
3      var S := N << 2
4      var D := S >> 2
5  in
6      (printI(S); print(" and "); printI(D); print("\n"); exit(0))
7  end
8

PROBLEMS 19 OUTPUT DEBUG CONSOLE TERMINAL 1: Code + []
32 and 8
Exited with code: 0
Program terminated by calling exit
```



What Has Been Achieved

6. Implemented multiplication by power of 2 optimization inside basic block thus laid foundation for other basic block optimizations like constant propagation, constant folding.

```
Compiler > TestFiles > tc10.tig
1  let
2      var N := 8
3      var M := 4 * N
4      var O := N * 4
5  in
6      (printI(M); print("\n"); printI(O); print("\n"); exit(0))
7  end
8
PROBLEMS 19 OUTPUT DEBUG CONSOLE TERMINAL 1: Code
32
32
Exited with code: 0
```

```
Compiler > TestFiles > ASM tc10.tig.s
28      mv s10, s11
29      li s7, 8
30      slli s1, s7, 2
31      mv s11, s1
32      slli s1, s7, 2
```



What Has Been Achieved

7. Started work on giving a guess of literal in case of small typo.
 - Printing suggestions which are atmost 2 **distance** apart. This will bring the time complexity of standard DP approach of $O(n^2)$ to just $O(n)$.
 - Currently the issue is that to implement this, I would have to do lots of modification of the current code. Although I have **abstracted** out *Not Found* error messages out with the environment, what is just left is to compare the literal with those of nearby length in the environment.
 - The main issue is that in the current design, environment just have integers mapped to environment entry. We got this integer by mapping string to counter, not storing the reverse map. This can be worked around by using **Atom**.



What Has Been Achieved

8. Started work on improving my Register Allocator. Current version is a bit simplified version of the algorithm mentioned in the text and is without coalescing.



- Register Allocator as mentioned.
- Basic blocks has to optimizations as mentioned.
- Error messages improvement in semantic phase as mentioned.
- String comparison has to be made as simple as "`str1 > str2`", etc., instead of calling the string comparison functions to determine it.
- To implement ability to include pre-written code (header) files.
- To implement garbage collection.
- To implement dataflow analyses such as reaching definitions and available expressions and use them to implement some of the optimizations.
- To implement first-class function values in Tiger, so that functions can be passed as arguments and returned as results.
- Add support for compile time (initial) arguments.

Thanks!