The Structure of a GCC Front End

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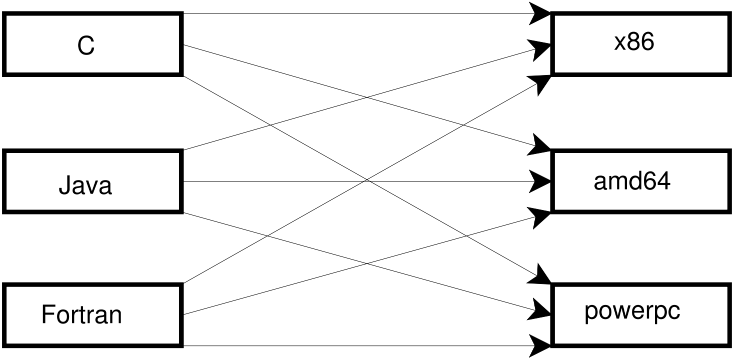
1. Introduction
2. General Structure of a Front End
3. General Structure of GCC
4. The GCC ILs
5. The Front End Interface
6. Further Information
7. Contact

Languages and Targets

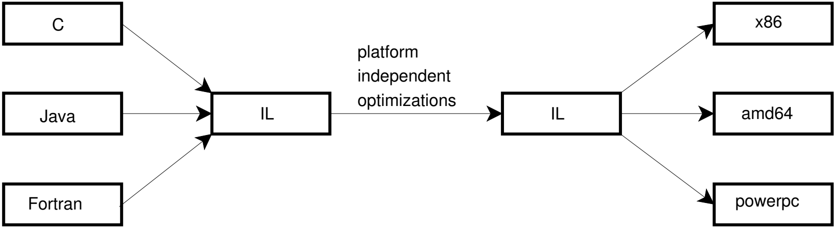
To compile C, Java, and Fortran to x86, amd64, powerpc we would need 9 compilers!



Intermediate Languages

Introduction

Using a common intermediate language:

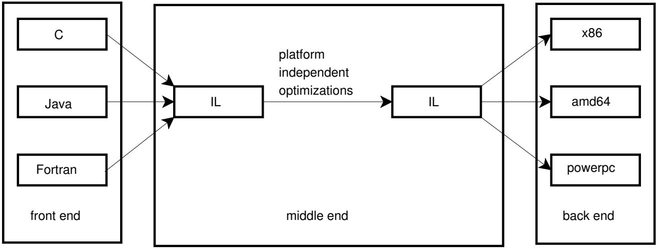


Only 6 *translators* are needed.

Nomenclature

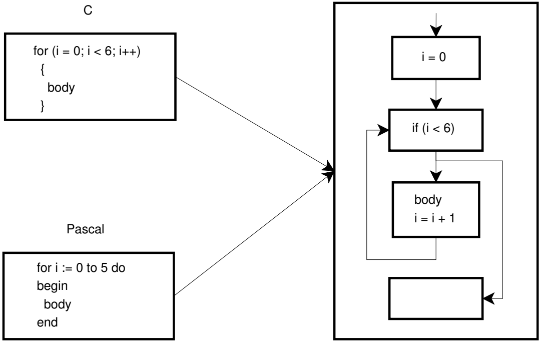
- The language to IL translators are called **front ends**
- The IL to assembly translators are called **back ends**
- The IL → IL passes are called the **middle end**
- Most optimizations can be implemented on **middle end** level and are language and target independent

Compiler Layers — The Big Picture



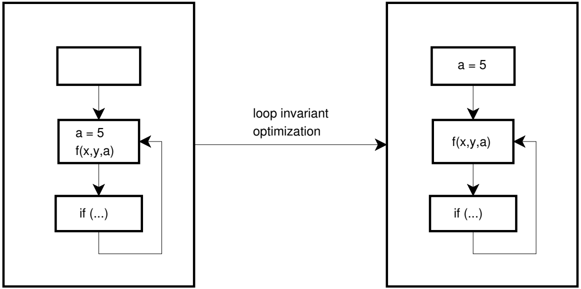
Front end example

Introduction



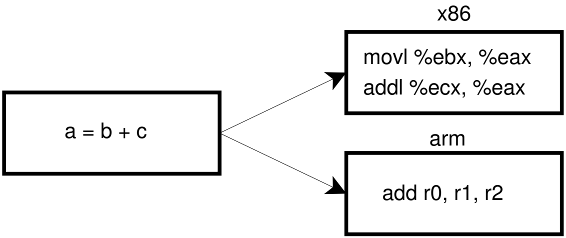
Middle end example

Introduction



Back end example

Introduction



a = b + c

x86

```
movl %ebx, %eax
addl %ecx, %eax
```

arm

```
add r0, r1, r2
```

General Structure of a Front End

A front end usually has

- A lexer
- A parser
- An abstract syntax tree
- Type checking
- A converter for the syntax tree to the compiler IL
- Some front ends may not have some of them

General Structure of GCC

- There is a compiler and a driver for each language
- The compiler just translates the source to assembly
- The driver calls the compiler, the assembler and the linker
- Drivers: gcc, gcj
- Compilers: cc1, jc1
- Each compiler lives in a directory of the gcc directory
  - `gcc/cp`: the c++ front end
  - `gcc/java`: the java front end

Intermediate Languages

The GCC ILs

GENERIC Very high level. Generated by most front ends

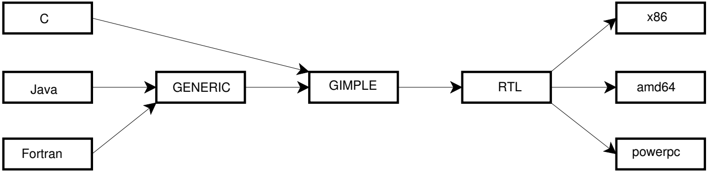
GIMPLE A simplified GENERIC in Static Single Assignment (SSA) form

RTL Register Transfer Language. A low level representation used in the back ends

- GENERIC and GIMPLE use the same data structure
- The difference is in which constructs are allowed

GCC Intermediate Language Relationship

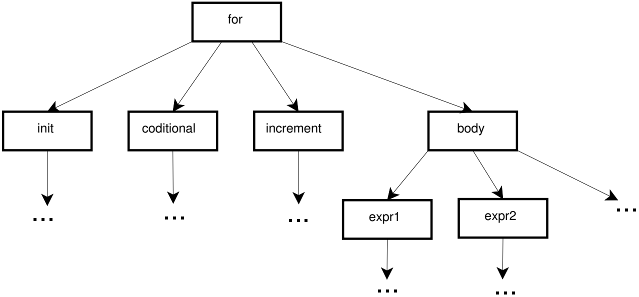
The GCC ILs



GCC Data Structure: Tree

The GCC ILs

- The data structure used for GENERIC and GIMPLE is called *tree*
- It is a gigantic union. Each instance can be a variable, a function, a statement, etc
- It is called *tree* because of how the representation looks like:



Building Trees

The GCC ILs

The front end has to

- understand the source language
- build the trees

For building trees there are many helper functions

- `build_fn_decl(name, type)`
- `build_string(len, size)`
- `build_pointer_type(type)`
- `build_function_call_expr(function, args)`

Callbacks

The Front End Interface

GCC controls most of the compiler behavior

- Provides the main function
- Parses options
- Handle language independent options

The Front End

- Provides callbacks for
  - Initialization
  - Parsing a file
  - Processing a language specific option
  - *Many* others

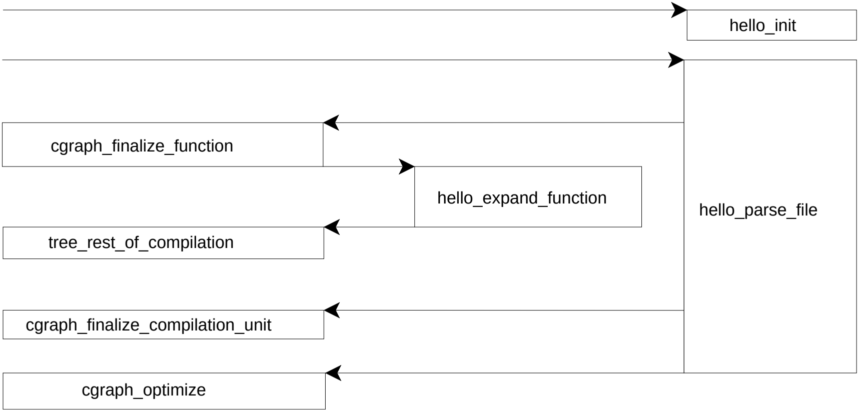
The cgraph Module

The Front End Interface

- The front end interface is managed by the cgraph module
- Each constructed function is transferred with `cgraph_finalize_function`
- To finish the compile unit call `cgraph_finalize_compilation_unit`
- To finish the job call `cgraph_optimize`
- cgraph may compile one function at a time or accumulate

Call Graph

The Front End Interface



Further Information

Further Information

- The Hello World front end: http://svn.gna.org/viewcvs/gsc/branches/hello-world/
- GCC Scheme Compiler (GSC): http://gna.org/projects/gsc
- GCC TreeLang: `/trunk/gcc/treelang`
- `info gcc`

Contact

Contact

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