

The LLVM compiler framework

Writing a pass: Quick Start

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These slides were originally written by Stefano Cherubin for the “Code Transformation and Optimization” course.

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Understanding LLVM

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LLVM is **not** a compiler.

LLVM is a
collection of components
which is **useful**
to build a compiler.

Getting LLVM

- ▶ “old” git mirrors
 - ▶ only llvm repo (subprojects in separated repos, can be added later)
 - ▶ `git clone -b release_90 --single-branch
git@github.com:llvm-mirror/llvm.git`
- ▶ “new” git monorepo
 - ▶ all in one repo (llvm + major subprojects)
 - ▶ `git clone -b release/9.x --single-branch
git@github.com:llvm/llvm-project.git`

What LLVM is made of

- ▶ C++ libraries
 - ▶ `src/include/llvm/...`
 - ▶ `src/lib/...`
- ▶ small application (tools)
 - ▶ `src/tools/...`
 - ▶ `src/utils/...`

You can find binaries of them in the installation directory under `root/bin/...`

clang

- ▶ clang is a compiler based on LLVM
- ▶ It compiles all major C-like languages
- ▶ It is part of the git monorepo
- ▶ It can be added as a tool in the LLVM framework but must be manually cloned in the tool directory
 1. `cd src/tools`
 2. `git clone http://llvm.org/git/clang (git mirror version)`
- ▶ You can easily see on a production quality compiler the impact of changes you made on your local copy of LLVM

Commands

llvm-as LLVM assembler

llvm-dis LLVM disassembler

opt LLVM optimizer

llic LLVM static compiler

lli directly execute programs from LLVM bitcode

llvm-link LLVM bitcode linker

llvm-mca LLVM machine code analyzer

llvm-nm list LLVM bitcode and object file's symbol table

llvm-stress generate random .ll files

llvm-config prints out install configuration parameters

llvm-dwarfdump print contents of DWARF sections

For a complete reference, see the LLVM command guide*

*<http://llvm.org/docs/CommandGuide/index.html>

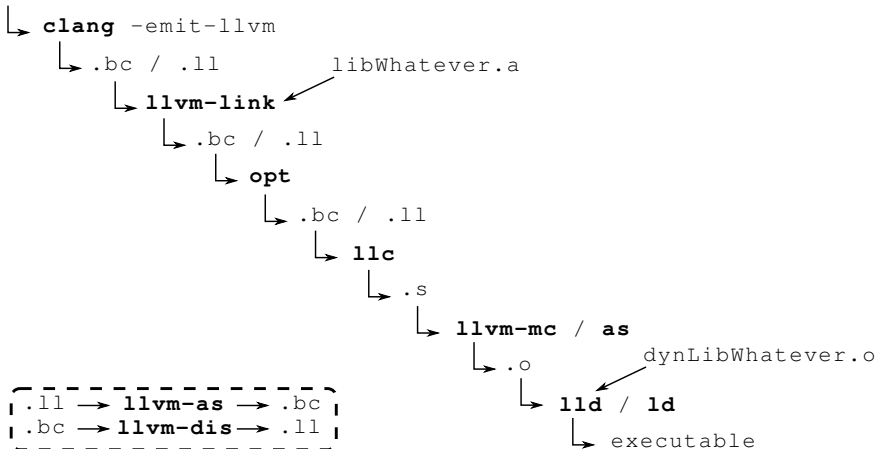
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Simulating a LLVM driver manually

.c source



Writing a LLVM pass

There are a lot of tutorials available:

- ▶ Official developer guide
`llvm.org/docs/WritingAnLLVMPass`
- ▶ Out-of-source pass
`github.com/quarkslab/
llvm-dev-meeting-tutorial-2015`

We will follow the first one, with a few adjustments.

Building LLVM

To test your pass you need a **Debug+Assertions** build of LLVM.

This build needs to be **kept separated** from normal Release builds
(it's very slow!)

The best way to get such a LLVM build is to **make it yourself!**

Building LLVM

- Detailed instructions:
<https://llvm.org/docs/GettingStarted.html>

Problem 1 With the **default options**, a finished build takes **25 GB of disk space**

Problem 2 A standard build with the GNU toolchain uses **a lot of RAM** (≈ 16 GB or more with a modern 4 core CPU!) especially when linking

We need to customize the build process a bit...

Building LLVM

- The build flags I like to use:

```
-GNinja  
-DLLVM_ENABLE_PROJECTS='clang'  
-DLLVM_INSTALL_UTILS=ON  
-DLLVM_BUILD_LLVM_DYLIB=ON  
-DLLVM_LINK_LLVM_DYLIB=ON  
-DLLVM_OPTIMIZED_TABLEGEN=ON  
-DLLVM_INCLUDE_EXAMPLES=OFF  
-DCMAKE_INSTALL_PREFIX=/opt/llvm-9.0-d  
-DLLVM_USE_LINKER=lld  
-DCMAKE_C_COMPILER=clang-9  
-DCMAKE_CXX_COMPILER=clang++-9
```

- Building with LLVM itself solves the RAM usage problem!
- Using **shared libraries** drops the disk usage to **10 GB**.

The build products alone will still take 20 GB of disk space...

Testing

LLVM has an internal testing infrastructure*. Please use it.

llvm-lit LLVM Integrated Tester

1. Forge a proper LLVM-IR input file (.ll) for your test case
2. Instrument it with `lit` script comments
3. Run `lit` on your test
 - ▶ `llvm-lit /llvm/test/myTests/singleTest.ll`
run a single test
 - ▶ `llvm-lit /llvm/test/myTests`
run the test suite (folder)
4. Run `lit` on the LLVM test suite (regression testing)

To submit a bug report to LLVM developers you will be asked to write a `lit` test case that highlights the bug.

*<http://llvm.org/docs/TestingGuide.html>