Project Part 1: Warmup (LLVM)

Points: 10%
Handed Out: October 25, 2023
Due Date: November 6, 2023

Objectives:

- Install and set up the LLVM 12 environment.
- Get familiar with its basic toolchains.
- Know how to write LLVM passes.

Tasks:

- **Step 1**: Install and set up the environment. Download the template folder and install LLVM and Clang in its LLVM subfolder. (some installation tips are given later in this doc.)
- **Step 2**: Perform a list of small experiments with the **tested program** (test.c in test/phase1), including:

a) learn and try the basic uses of the following commands from those documentations: Command Guide Getting Started: Building and Running Clang
clang, opt, llc, lli, llvm-link, llvm-as, llvm-dis

b) translate between different code representations using some of the above tools with different flags.

i) source (.c) to binary (executable)
ii) source (.c) to object file (.o)
iii) source (.c) to machine assembly (.s)
iv) source (.c) to LLVM bitcode (.bc); source (.c) to LLVM IR (.ll)
v) LLVM IR (.ll) to LLVM bitcode (.bc)
vi) LLVM bitcode (.bc) to LLVM IR (.ll)
vii) LLVM IR (.ll) to machine assembly (.s)

Reference: The LLVM Compiler Infrastructure

- **Step 3**: Compile and run the pass HelloPass (pass/HelloPass) using `opt`. Then modify the HelloPass to **print the number of predecessors and successors of each basic block** of each function in the tested program (test.c in test/phase1 docs: ProgrammersManual)
- **Step 4**: Write a report that lists your experiments in **step-2b** and **step-3** with commands and inputs/outputs. Submit your report (in PDF) along with your working folder, which includes the temporary files you used and generated in step-2 and step-3 for the experiments (try to use different file names so your experiment history would be preserved, instead of being overwritten).

PDF name format: **CS201-23Fall-Part1-StudentNumbers(each group member).pdf**

Grading:

- The grading will be mainly based on the completeness of the tasks and the clarity of the report.

LLVM and Clang Installation

Before Installation:

- Make sure the command line environment works well;
- Check the following toolchains are available; The Version column provides “known to work” versions of the package.

Recommendation:
It is recommended that you try to install LLVM and Clang in a VM (e.g., VirtualBox or Parallels) that has Ubuntu 22.04 installed, which has been tested with no issues.

Package	**Version**	**Notes**
CMake	>=3.13.4	Makefile/workspace generator
GCC	>=5.1.0	C/C++ compiler
Python	>=3.6	For automated test suite
zlib	>=1.2.3.4	Compression library
GNU Make	3.79, 3.79.1	Makefile/build processor

Installation:

- Under your project’s root directory:

```
$ cd LLVM
```

- Get LLVM 12:

```
$ wget
https://github.com/llvm/llvm-project/releases/download/llvmorg-12.0.1/llvm-
12.0.1.src.tar.xz
$ tar -xf llvm-12.0.1.src.tar.xz
$ mv llvm-12.0.1.src llvm/
```

- Get Clang 12:

```
$ wget
https://github.com/llvm/llvm-project/releases/download/llvmorg-12.0.1/clang
-12.0.1.src.tar.xz
$ tar -xf clang-12.0.1.src.tar.xz
$ mv clang-12.0.1.src clang/
```

- Build LLVM and Clang:

```
$ mkdir build
$ mkdir install
$ cd build
$ cmake -G "Unix Makefiles" -DLLVM_ENABLE_PROJECTS=clang
-DCMAKE_INSTALL_PREFIX=../install -DCMAKE_BUILD_TYPE=Release ../llvm
$ make -j 8 install
```

Replace 8 with the number of cores that your machine has
Building process may take from 40 mins to 3 hours, time varies on different machines
This builds both LLVM and Clang for release mode

- Add “install/bin/” to your PATH

Append `export PATH=/PathToYourLLVM/install/bin/:$PATH` to ~/.bash_profile (MacOS) or ~/.bashrc (Linux) and then `source ~/.bash_profile` or ~/.bashrc

- Verify the installation

```
$ clang --version
should show your Clang and LLVM version.
$ opt -version
should show the LLVM version.
```

Note on how to compile the LLVM pass (under the *Pass* directory)**:**

```
cd ../build/
cmake -DCMAKE_BUILD_TYPE=Release ../HelloPass/
make
```

The above is a simplified version of LLVM and Clang installation. See the original and install extra libraries as needed.

- Getting Started: Building and Running Clang
- LLVM Documentation