CSE305 Computer Architecture

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Project #1 – Simple MIPS Assembler

**Introduction**

An assembler is a program that compiles the given assembly code into an object file, which contains some constants and machine codes. Although modern compiler toolchains generate a symbol table and a relocation table within the output object file, this assembler does not generate them.

This assembler uses nine types of instructions internally for the consistency of the parsing logic. The format is as follows (unnamed fields are automatically initialized to zero by the assembler):

R format: ADDU AND NOR OR SLTU SUBU

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 6 bits | source1: 5 bits | source2: 5 bits | destination: 5 bits | 5 bits | function: 6bits |

op destination, source1, source2

JR format: JR

|  |  |  |  |
| --- | --- | --- | --- |
| 6 bits | source: 5 bits | 15 bits | function: 6 bits |

op source

SR format: SLL SRL

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 11 bits | source: 5 bits | destination: 5 bits | shiftAmount: 5 bits | Function: 6bits |

op destination, source, shiftAmount

I format: ADDIU ANDI ORI SLTIU

|  |  |  |  |
| --- | --- | --- | --- |
| operation: 6 bits | source: 5 bits | destination: 5 bits | immediate: 16 bits |

op destination, source, immediate

BI format: BEQ, BNE

|  |  |  |  |
| --- | --- | --- | --- |
| operation: 6 bits | source: 5 bits | destination: 5 bits | offset: 16 bits |

op source, destination, offset

II format: LUI

|  |  |  |  |
| --- | --- | --- | --- |
| operation: 6 bits | 5 bits | destination: 5 bits | immediate: 16 bits |

op destination, immediate

OI format: LB LW SB SW

|  |  |  |  |
| --- | --- | --- | --- |
| operation: 6 bits | operand1: 5 bits | operand2: 5 bits | offset: 16 bits |

op operand2, offset(operand1)

J format: J JAL

|  |  |
| --- | --- |
| operation: 6 bits | target: 26 bits |

op target

LA format (pseudo instructions): LA

op destination, target

**Project Structure**

The project contains three directories: Public, Source, and Tests. Public contains header files, Source contains C++ source files, and Tests contains unit tests. Source files in Tests are not necessary to build runfile.

Source contains 5 source files, whose roles are as the following:

* Tokenization.cc implements source tokenization.
* Parsing.cc parses tokenization result.
* Genertion.cc implements machine code generation.
* File.cc contains file I/O functions.
* Main.cc contains the entry point and converts errors into strings.

**Build Instructions**

This assembler is written in C++17. Although GCC 7 supports C++17, it lacks some standard C++17 headers (e.g. <filesystem> or <charconv>). To properly build the program, please use GCC 9 or higher. To install GCC 9 on Ubuntu 18.04, run:

|  |
| --- |
| sudo add-apt-repository ppa:ubuntu-toolchain-r/test  sudo apt update  sudo apt install gcc-9 g++-9 |

This project uses CMake 3.13. To build the program with CMake, run:

|  |
| --- |
| mkdir build  cd build  cmake -DCMAKE\_CXX\_COMPILER=g++-9 ..  cmake --build .  ./runfile input.s |

If CMake 3.13 or higher is not available in your system, you can use this command instead:

|  |
| --- |
| g++-9 -std=c++17 -I./Public \  -o runfile \  ./Source/File.cc \  ./Source/Generation.cc \  ./Source/Main.cc \  ./source/Parsing.cc \  ./Source/Tokenization.cc  ./runfile input.s |

**Acknowledgements**

The parsing logic was inspired by [nom](https://github.com/Geal/nom), a Rust parser combinators library.