

README FILE (Phase 1)

Group-6

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Git-Hub link to the project: <https://github.com/Silent-faith/RISC-V-Simulator>

Welcome to the phase 1 of the RISC-V simulator. In this phase, we have tried to simulate the working of Machine Code execution in a non-pipelined approach. The code can be found as `GUI_Phase1.py` (for explicitly seeing the non-GUI version, see `non_GUI_Phase1.py`)

INPUT TO CODE: A file with the machine code (here it is `code.mc`). This file has the machine code divided into two segments: data segment and text segment.

0x0	0x10000197	Text segment (instructions)
0x4	0x0001A183	
0x8	0x10000217	
0xc	0xFFC22203	
0x10000008	0x17020010	Data segment
0x10000004	0x83A10100	
0x10000000	0x97010010	

OUTPUT OF CODE:

In console: Displays the **5 step execution** of each instruction, by displaying the **fields** (*opcode, rs, rd, func3, func7, imm*) of each instruction when applicable. Also, displays the **register values** and **memory state** before and after execution. In order to check successful completion of the code, the user has to check necessary memory and register states at the end of execution.

In GUI simulator window: The register states can also be checked using the display GUI window. (To directly go to the process to use this simulator, jump to **HOW TO USE** part of this document)

After execution, all the data memory is written in the `memory.mc` file before the program terminates.

INSTRUCTIONS SUPPORTED BY OUR CODE:

- R format - add, and, or, sll, slt, sra, srl, sub, xor, mul, div, rem
- I format - addi, andi, ori, lb, lh, lw, jalr
- S format - sb, sw, sh
- SB format - beq, bne, bge, blt
- U format - auipc, lui
- UJ format - jal
- This code **DOES NOT** support any pseudo instruction.

BRIEF OUTLINE/LOGIC OF THE CODE:

1. There has been OOP implementation in Python 3. The code contains 4 classes:
`class execute, class register, class memory, class GUI`
2. `class execute`: This is the driving class of the code. An object is created of this class in the method called `programRun()`, where the machine code is read and successive methods `run()` is called for each decoded instruction. This class also defines methods like `storeInstruction()` (stores each instruction in the memory after reading them, so as to load them one after another in the IR), `fetch()` (fetches the instruction from the memory), `checkFormat()` (decides which format the instruction belongs to), `decode()` (based on format, checks the exact information based on the extracted fields), `memoryAccess()` (the 4th step of execution cycle where values can be stored or loaded from the memory module), `writeRegister()` (the writeback stage of the execution cycle for register value update). In all, this class simulates the whole 5-stage execution cycle. This class also creates instances of the `memory` and `register` classes, to simulate the *Register File* and the *Memory module*
3. `class register`: This class has the methods which are needed for writing and reading the current register values. An instance of this class will behave like a *Register File* which is accessed in the decode and writeback stages of the 5-stage execution cycle.
4. `class memory`: This class has the methods which facilitate the method called `memoryAccess()` which is in charge of reading to and from the memory module, and also storing values in it. An instance of this class will be needed in any instruction that requires the 4th step of the 5-step cycle (memory access stage)
5. `class GUI`: This class is the one that enables the GUI part of the code. Essentially, in the output display window, there will be 32 labels for the 32 registers, each with text fields that contains the stored value.
6. The memory and registers are simulated using **dictionary** in the Python environment. Dictionary has *keys* and *values*, similar to a list/array. The values (here the stored values) can be accessed by the keys (here, the addresses in memory, or the register numbers in register file)
7. All the instructions are encoded in 32-bit format in `code.mc`, and the memory module is **byte-addressable** and **Big Endian**. Therefore, to read and write to memory, different functions for word, byte etc. has been defined. After execution, all the data memory is written in the `memory.mc` file before the program terminates.

HOW TO USE THE SIMULATOR?

The Simulator has an in-built GUI feature to make the code more user-friendly. The simulator shows the register values, before and after the execution. (Please install `bitstring` module in Python before running this code) The following steps will show how to use the simulator.

Step 1) Run `GUI_Phase1.py` on the console. A display window will pop-up, that lists the default values of registers x0-x31. (Note that the stack pointer(x2) and x3 are pre-loaded with their default values).



Step 2) On waiting for **5 seconds**, the simulator window will close by itself and then pop-up again. The new window will list the registers x0-x31 with their final values (i.e. after the code execution) Note that the user doesn't have to perform any specific operation on the simulator, just has to let the window remain idle for 5+ seconds) **The output can also be seen as text in the console.**



For example,

Suppose `code.mc` has the following code written in machine format. The actual instruction also has been shown here to understand.

```
0x0  0x00C00213
0x4  0x00800193
0x8  0x00321463
0xc  0x00500293
0x10 0xFFE18193
```

```
addi x4, x0, 12
addi x3, x0, 8
bne x4, x3, label
addi x5, x0, 5
label: addi x3, x3, -2
```

As an output to the above code, register x4 should have value 12 (0x0000000C) and x3 should have value 6 (0x00000006). Hence, the simulator shows:

Register values
updated!



x0	0x00000000
x1	0x00000000
x2	0x7FFFFFF0
x3	0x00000006
x4	0x0000000C
x5	0x00000000
x6	0x00000000
x7	0x00000000
x8	0x00000000
x9	0x00000000
x10	0x00000000
x11	0x00000000
x12	0x00000000