For Linux

Please use HackMD to view the file.

1. Download Ripes

1. Download the release version of Ripes from Ripes Release
    - For example, `Ripes-v2.2.4-linux-x86_64.AppImage` is the current version for Linux platform.
2. Actually, `Ripes-v2.2.4-linux-x86_64.AppImage` is an executable program. You can execute the program by simply double-click the icon of `Ripes-v2.2.4-linux-x86_64.AppImage`.

2. Install Toolchain

1. Please download the SiFive RISC-V toolchain from SiFive github.
    - For example, `riscv64-unknown-elf-toolchain-10.2.0-2020.12.8-x86_64-linux-ubuntu14.tar.gz` is the current version for Ubuntu.
    - Note: Different Ubuntu version does not matter as usually.
2. Open the terminal and use **tar** command to extract the file to a folder.
    - For example :

    ```
    tar zxvf riscv64-unknown-elf-toolchain-10.2.0-2020.12.8-x86_64-linux-ubuntu14.tar.gz
    ```

3. Locate the folder that contains **riscv64-unknown-elf-gcc.** Set this folder as `$RV64_GCC_PATH` and add it to the search path (see the following step).
    - For example :
      Assume the folder is `~/HW5/riscv64-unknown-elf-toolchain-10.2.0-2020.12.8-x86_64-linux-ubuntu14/bin`.
      You can use the following commands to set the variable and add it to the search path. You may also add them to your login shell.

    ```
     RV64_GCC_PATH=~/HW5/riscv64-unknown-elf-toolchain-10.2.0-2020.12.8-x86_64-linux-ubuntu14/bin
     export PATH=$PATH:$RV64_GCC_PATH
    ```

3. Test Setup

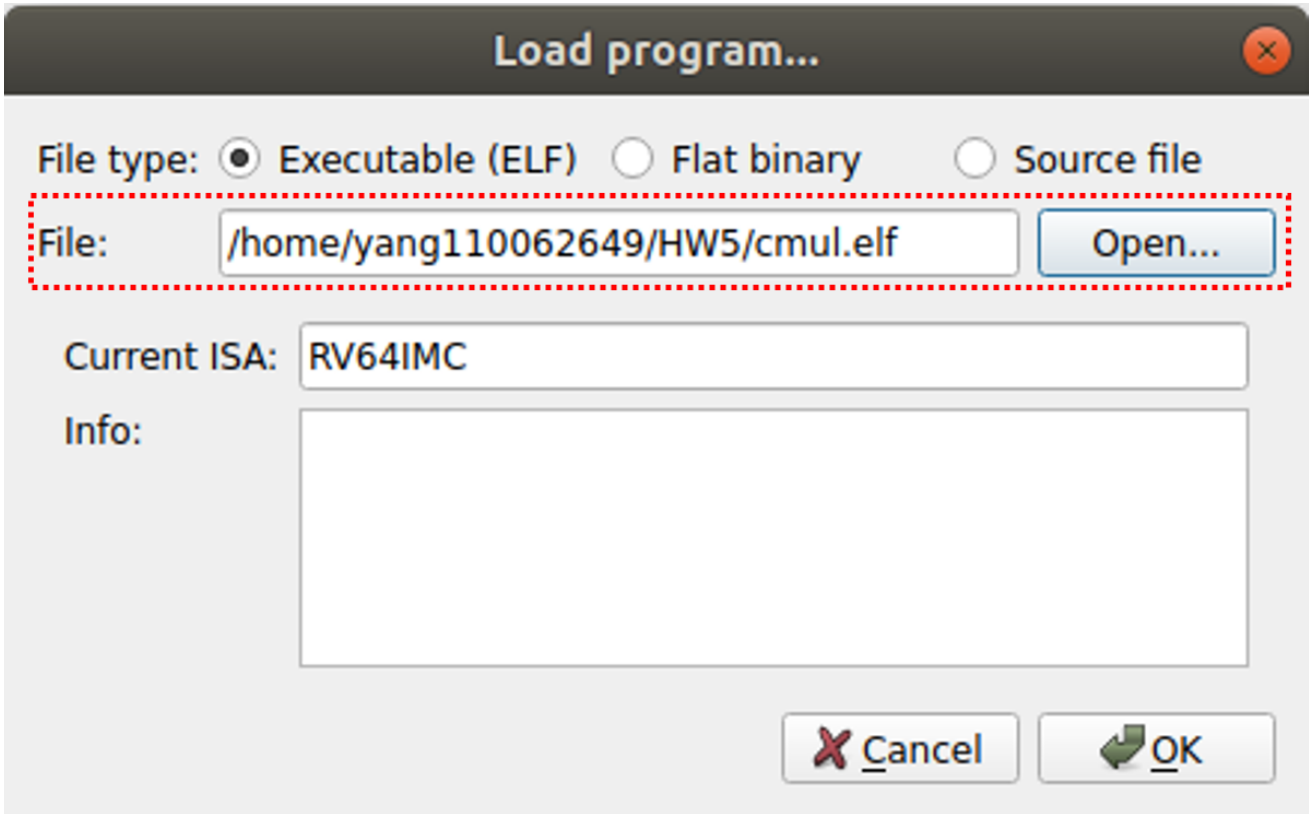
1. Download cmul.S from EECLASS for HW5 and open a terminal. Generate an rv64im executable by the RISC-V compiler.
    - For example :

```
$RV64_GCC_PATH/riscv64-unknown-elf-gcc -march=rv64im -mabi=lp64 -s -static -
nostdlib -o cmul.elf cmul.S
```

Parameter reference:

- "-march=rv64im" to use an 64-bit ISA version with integer ("i") and multiply ("m") supports.
- "-mabi=lp64" to specify the language data model. In this setup, long ("l") and pointer are all 64 bits.
- "-s" to strip symbols from binary.
- "-static" to link statically to produce a complete executable.
- "-nostdlib" do no use stdlib.
- "-o" specify output name.

2. Start Ripes GUI by double clicking the program. Then, select `File > Load Program`. Use Open to search for cmul.elf.
   - For example :



Load program...

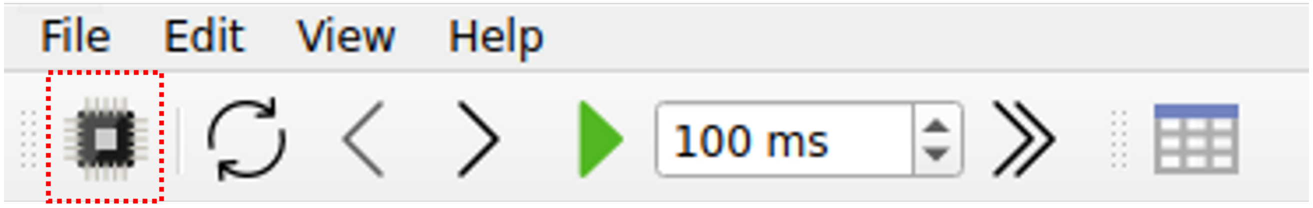
File type: [✓ Executable (ELF)] Flat binary Source file

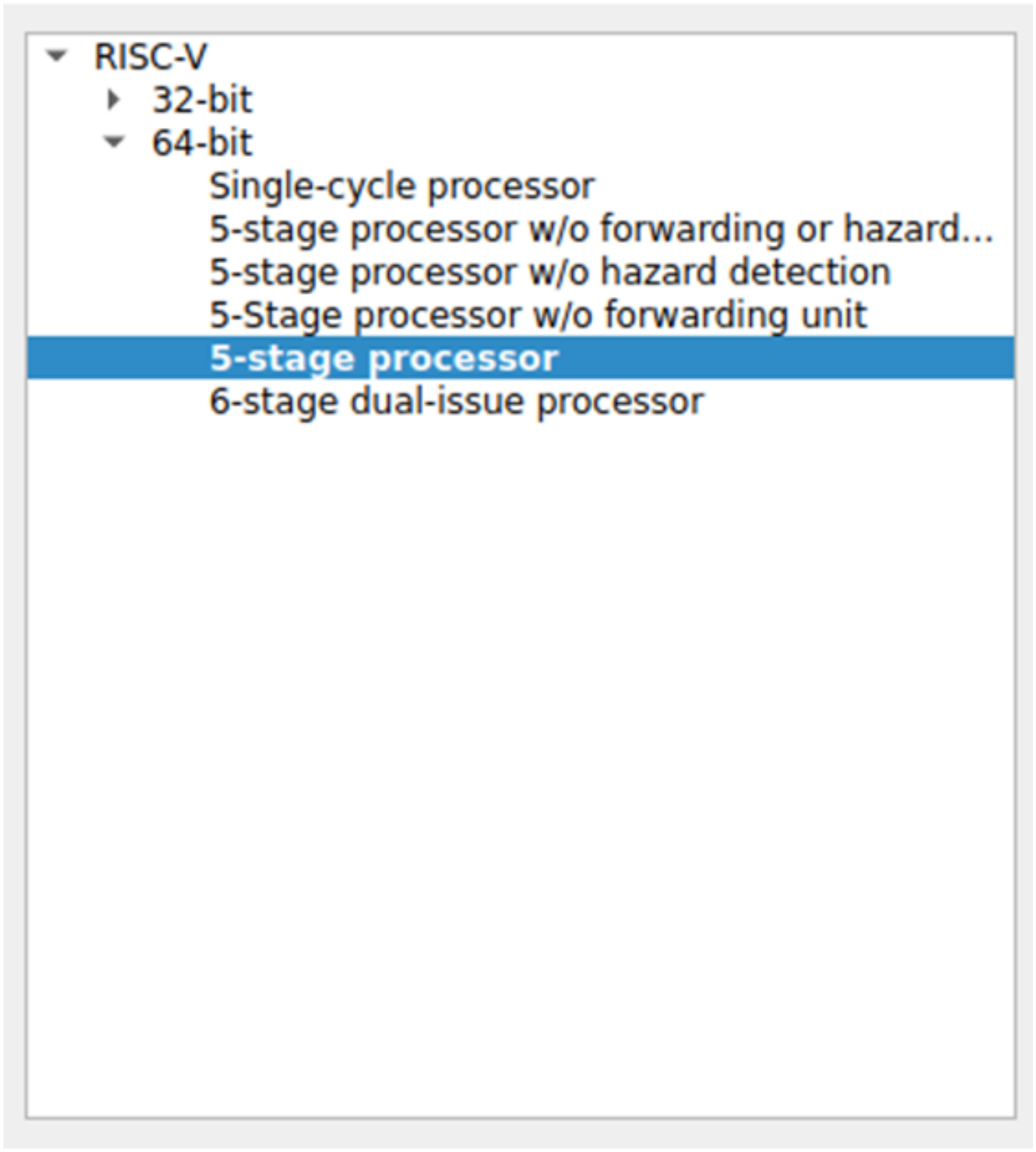
File: /home/yang110062649/HW5/cmul.elf

Current ISA: RV64IMC

Info:

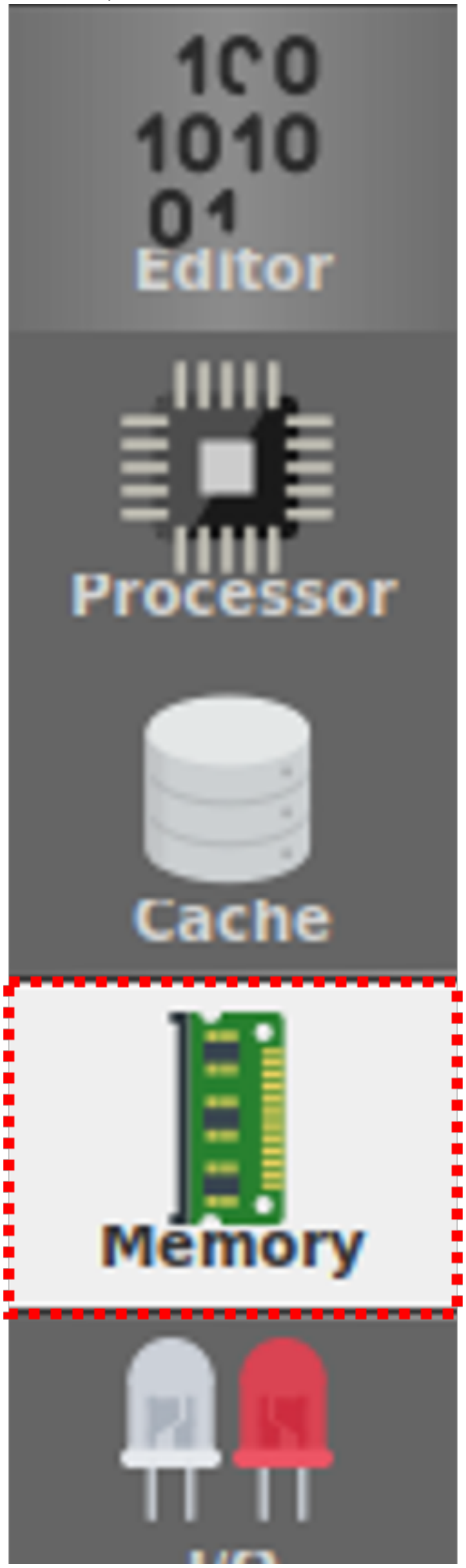
   - If you found that current ISA in `Load Program` is not RV64, please click on `processor selection button` at the top-left and then select the `RISC-V > 64bit > 5-stage processor` with extension `M` & `C`

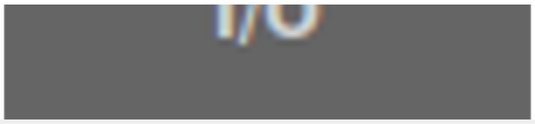


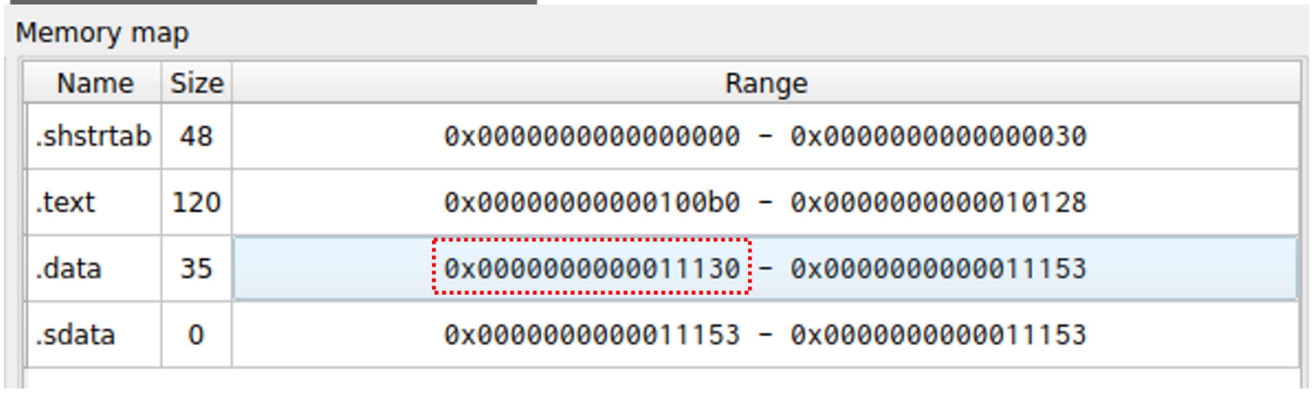

RISC-V
32-bit
64-bit
Single-cycle processor
5-stage processor w/o forwarding or hazard...
5-stage processor w/o hazard detection
5-Stage processor w/o forwarding unit
5-stage processor
6-stage dual-issue processor

3. Select `Memory Tab`. In `Memory Tab`, we check the `data segment base memory address` to calculate the `global pointer (x3)`.

- For example :





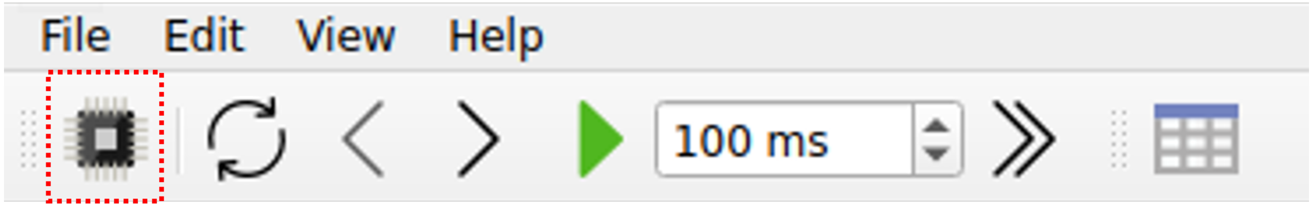

Memory map

Name	Size	Range
.shstrtab	48	0x0000000000000000 - 0x0000000000000030
.text	120	0x00000000000100b0 - 0x0000000000010128
.data	35	0x0000000000011130 - 0x0000000000011153
.sdata	0	0x0000000000011153 - 0x0000000000011153

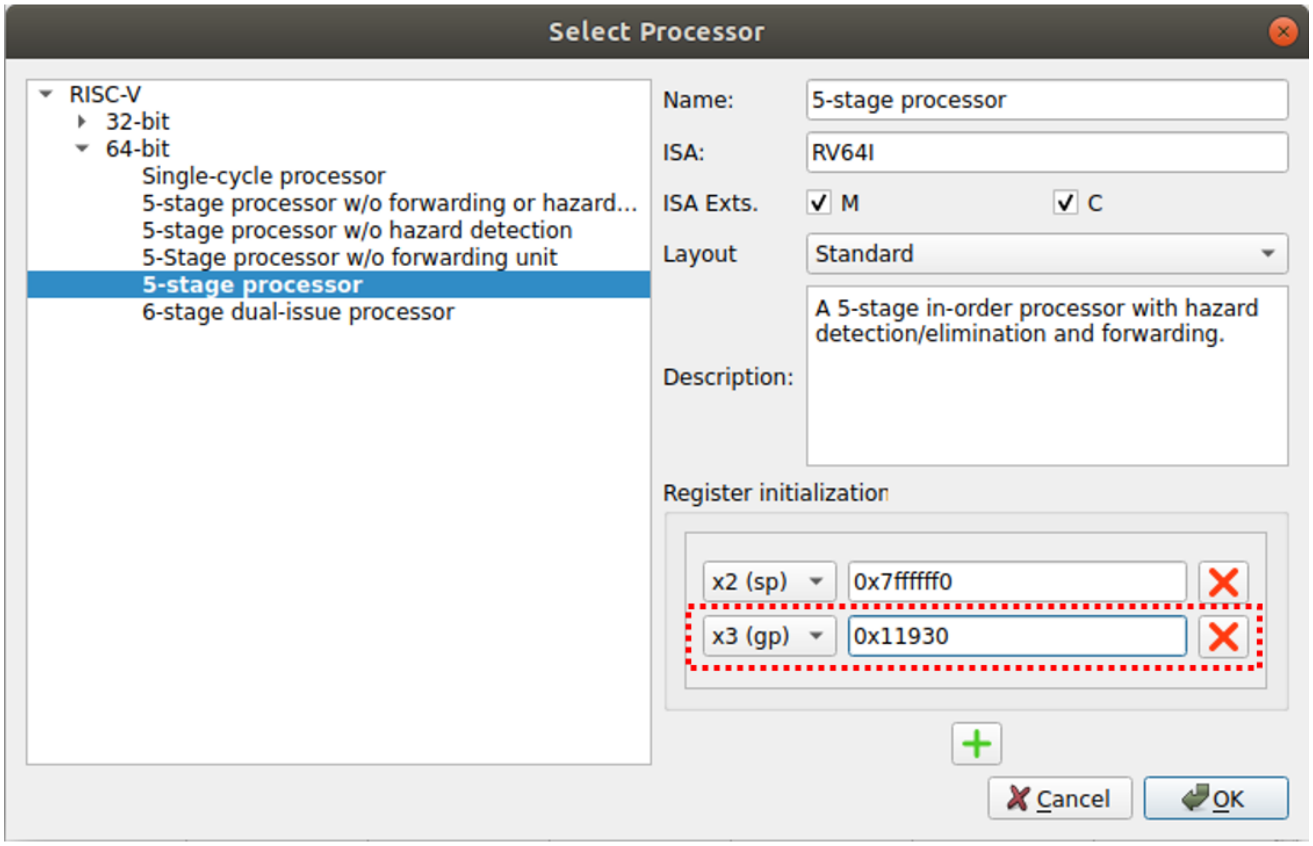
Here we find that the base is `0x11130`. Since the assembler assumes the `global pointer (x3)` to be set at the `base + 0x800`, we will use `0x11130+0x800=0x11930` to set up the `global pointer`.

4. Set up the `global pointer` :

   - **Method 1** :
     Click on `processor selection button` at the top-left.



Then, set up the `global pointer` as 0x11930.


Select Processor
RISC-V
32-bit
64-bit
Single-cycle processor
5-stage processor w/o forwarding or hazard...
5-stage processor w/o hazard detection
5-Stage processor w/o forwarding unit
5-stage processor
6-stage dual-issue processor
Cancel
OK

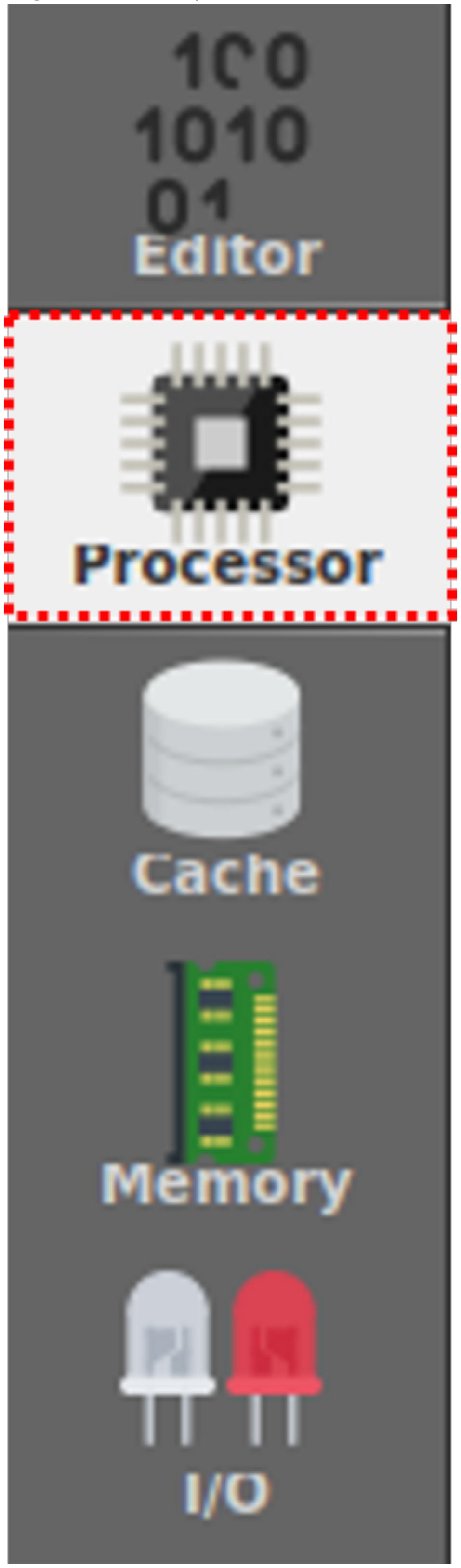
Name: 5-stage processor
ISA: RV64I
ISA Exts. ✓ M ✓ C
Layout: Standard
Description: A 5-stage in-order processor with hazard detection/elimination and forwarding.

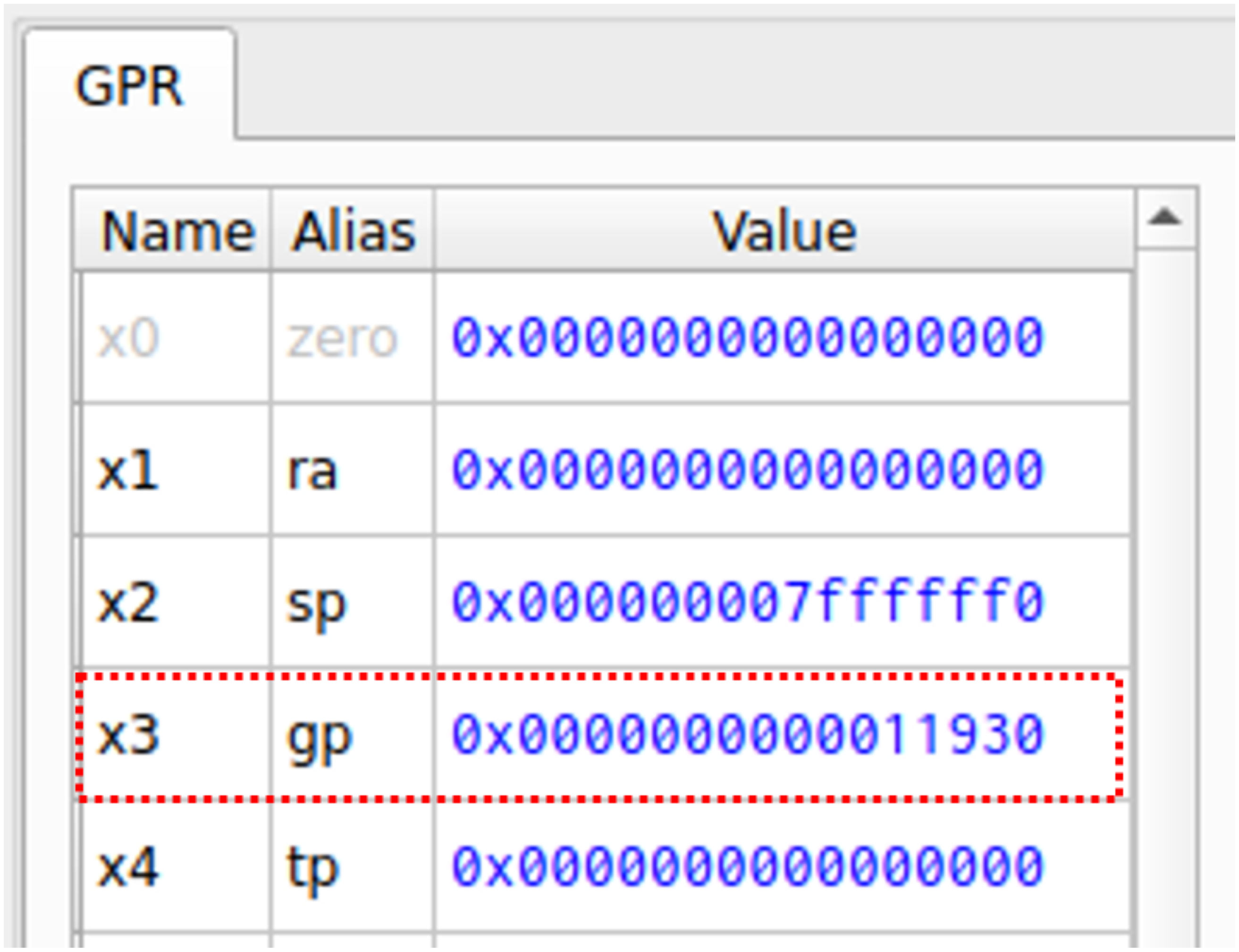
Register initialization

x2 (sp)	0x7ffffff0
x3 (gp)	0x11930

After we set the `global pointer` for the processor, **we need to reload the cmul.elf again (do step 2 again).**

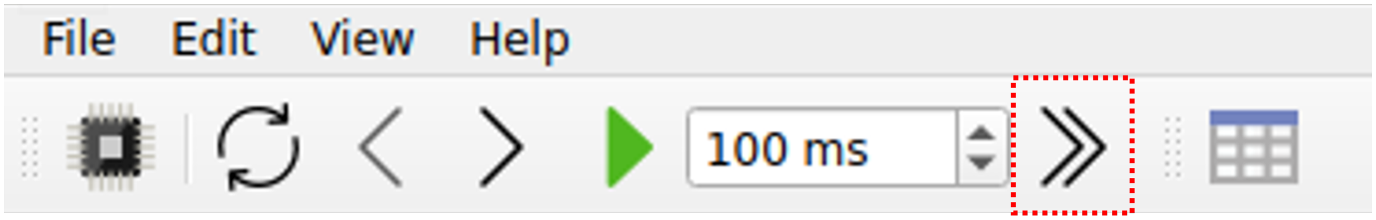
- **Method 2** :
  Click on `processor Tab` and modify the global pointer to 0x11930 directly on general purpose registers (GPR) panel.



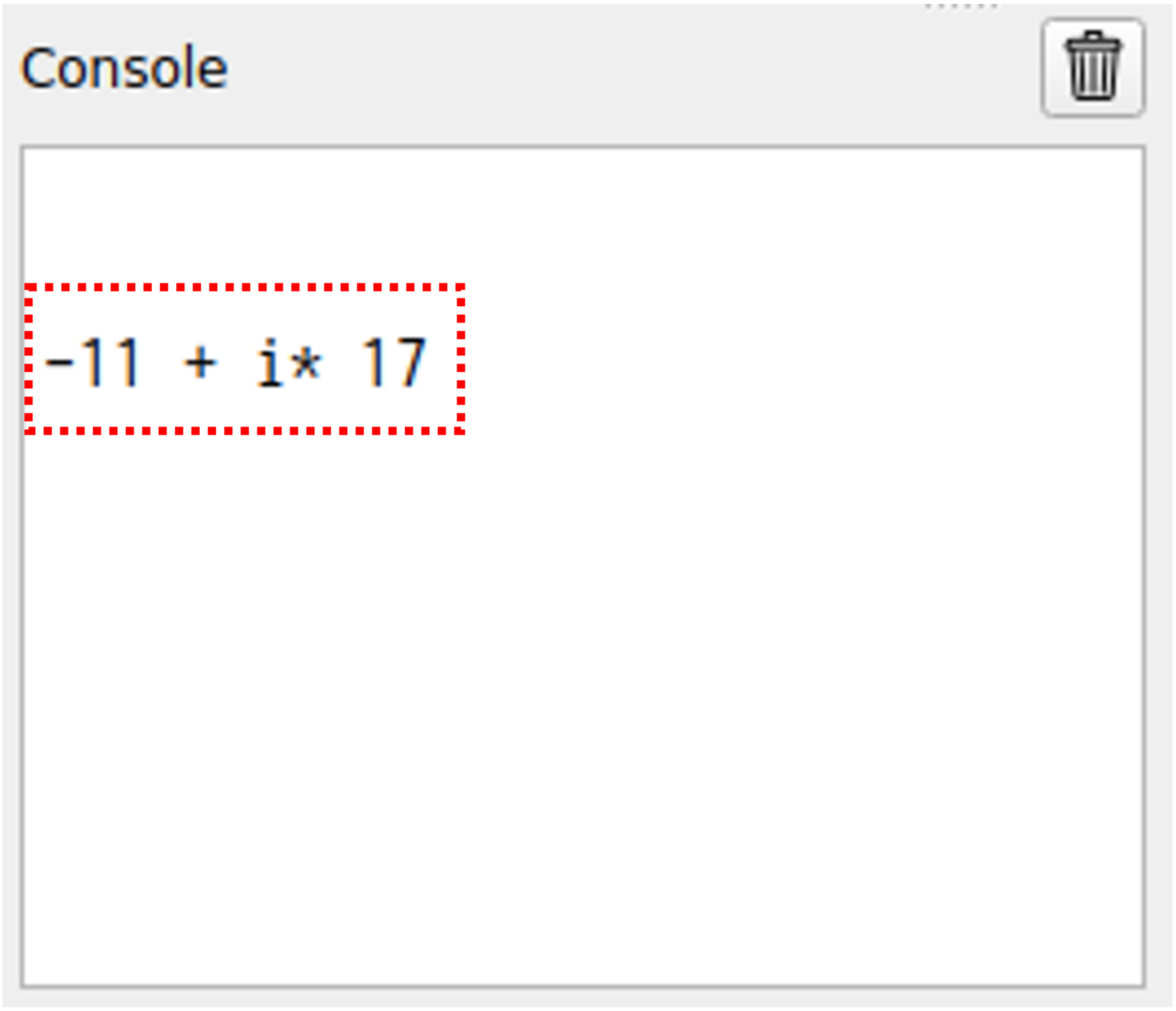


Name	Alias	Value
x0	zero	0x0000000000000000
x1	ra	0x0000000000000000
x2	sp	0x000000007ffffff0
x3	gp	0x0000000000011930
x4	tp	0x0000000000000000

5. Click `>>` on the top-right to run and simulate the binary in Ripes without GUI updates.



We should see the program finishes and prints `11 + i* 17` on the console.



```
-11 + i* 17
```

- Note: We need to set the global pointer for each new elf program load (since the data segment changes according to the text segment).