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# CA2023 Fall HW1

— RISC-V Assembly Code —

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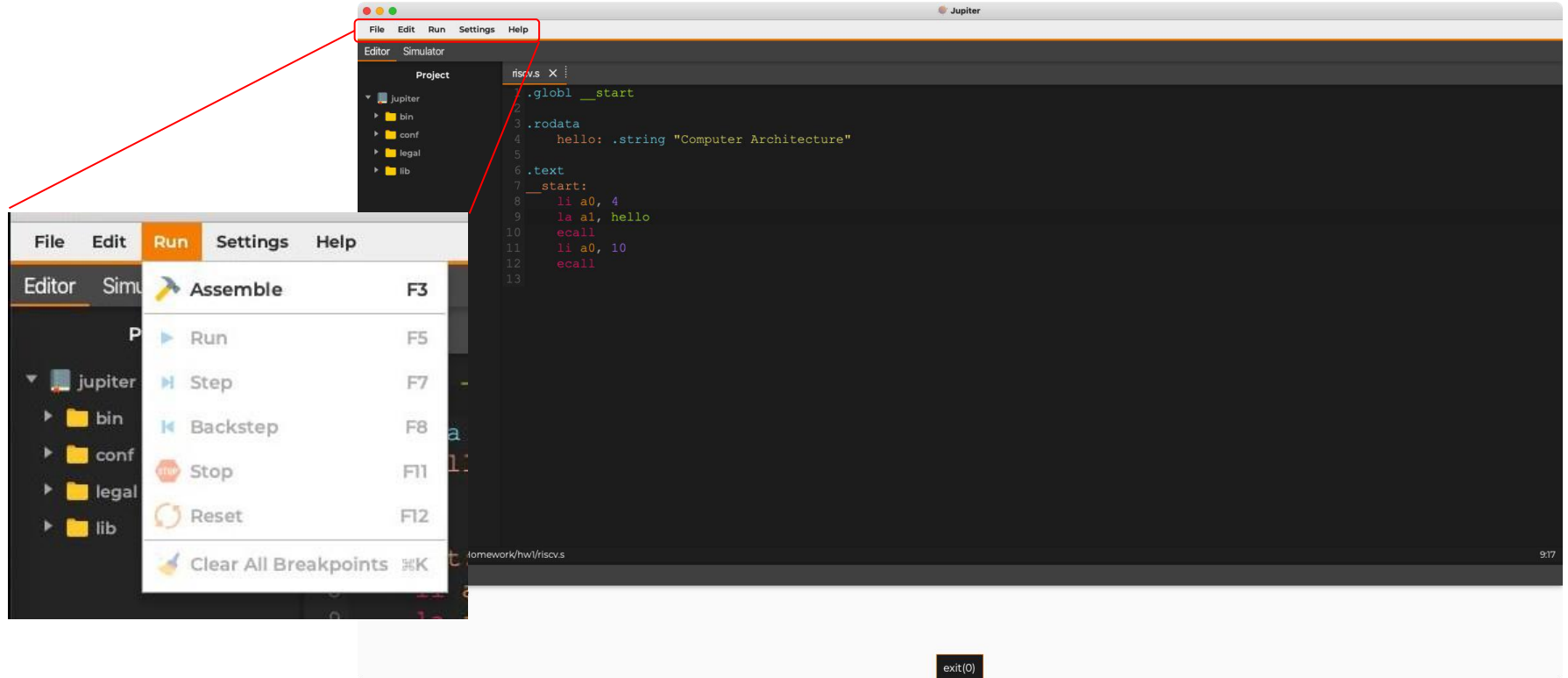
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# Description

- In this homework, you are going to use [Jupiter RISC-V simulator](#) to develop a simple calculator.
- After finishing this homework, you will be familiar with the usage of Jupiter RISC-V simulator, register definition, and some basic operations in RV32I Base Integer Instruction Set.



# Jupyter GUI



# Jupiter GUI

The screenshot displays the Jupiter GUI interface. The top menu bar includes File, Edit, Run, Settings, and Help. Below the menu is a toolbar with icons for running, stepping through code, and other simulation functions. The main area is divided into two panes: the left pane shows assembly code with columns for Bkpt, Address, Machine Code, Basic Code, and Source Code; the right pane shows the state of registers, memory, and cache. The console at the bottom shows the output of the program, which is 'exit(0)'.

**Assembly Code Table:**

Bkpt	Address	Machine Code	Basic Code	Source Code
<input type="checkbox"/>	0x00010000	0x00000317	auipc x6, 0	auipc x6, 0
<input type="checkbox"/>	0x00010004	0x00830067	jalc x0, x6, 8	jalc x0, x6, 8
<input type="checkbox"/>	0x00010008	0x00400513	addi x10, x0, 4	li a0, 4
<input type="checkbox"/>	0x0001000c	0x00000597	auipc x11, 0	la a1, hello
<input type="checkbox"/>	0x00010010	0x01458593	addi x11, x11, 20	la a1, hello
<input type="checkbox"/>	0x00010014	0x00000073	ecall	ecall
<input type="checkbox"/>	0x00010018	0x00a00513	addi x10, x0, 10	li a0, 10
<input type="checkbox"/>	0x0001001c	0x00000073	ecall	ecall

**Registers Table:**

Mnemonic	Number	Value
zero	x0	0x00000000
ra	x1	0x00000000
sp	x2	0xbfffffff0
gp	x3	0x10000000
tp	x4	0x00000000
t0	x5	0x00000000
t1	x6	0x00010000
t2	x7	0x00000000
s0	x8	0x00000000
s1	x9	0x00000000
a0	x10	0x0000000a
a1	x11	0x00010020
a2	x12	0x00000000
a3	x13	0x00000000

**Console Output:**

```
exit(0)
```

# Jupiter CLI

```
> jupiter riscv.s  
Computer Architecture  
  
Jupiter: exit(0) FILE
```

# TODO

- You are going to develop a simple calculator, which supports seven operations.
- Addition(0), subtraction(1), multiplication(2), integer division(3), minimum(4), power(5), and factorial(6).

# Sample I/O

- Input file contains 3 lines, operand A, operation op, operand B, respectively. ( $0 \leq A, B \leq 1024$ ,  $op \in \{0, 1, 2, 3, 4, 5, 6\}$ )
- Your program should output the correct result (A op B).

```
> jupiter hw1.s
10
0
10
20

Jupiter: exit(0)
```

```
> jupiter hw1.s
10
1
10
0

Jupiter: exit(0)
```

```
> jupiter hw1.s
10
2
10
100

Jupiter: exit(0)
```

```
> jupiter hw1.s
10
3
0
division by zero

Jupiter: exit(0)
```

## Sample Code

- In the sample code, you don't need to do I/O operations by yourself. A, op, B will be stored at register s0, s1, s2 registers.
- You need to store the result to register s3.

```
22 #####  
23 #   TODO: Develop your calculator   #  
24 #                                   #  
25 #####
```



## Sample Code

- If  $op=3$  and  $B=0$ , just jump to `division_by_zero_except`

```
38 division_by_zero_except:
39     li a0, 4
40     la a1, division_by_zero
41     ecall
42     jal zero, exit
```

# Grading Policy

- Total 100%
  - For operations +, -, x, / and min, each has 4 test cases, 3 points per test case.
  - For operations ^ and !, each has 5 test cases, 4 points per test case.
- We will judge the correctness of your program by running the following command:

```
$ jupyter [student_id].s < input_file
```

- Don't worry about overflow and underflow.
- No need to handle  $0^0$ .
- 10 points off per day for late submission.
- You will get 0 point for plagiarism.

# Submission

- Due date: 10/03 23:59 (Tuesday)
- Please rename your program [student\_id].s and upload it to NTU COOL.
  - For example, if your student id is **b12345678**, your program file name should be **b12345678.s**.