RISCV Assembly Programming

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Ripes simulator

Introduction:

- Ripes is a graphical RISC-V simulator aimed at teaching and understanding computer architecture and assembly programming.

- Developed by Mads Sig Agerbæk.

Key Features:

- **Graphical Interface**: Easy-to-use graphical interface to visualize pipeline stages and register values.

- **Support for RISC-V ISA**: Full support for RV32I and extensions.

- **Interactive Simulation**: Step through execution cycles, view data flow, and track instruction progress.

- **Educational Focus**: Ideal for students learning about computer architecture, assembly language, and the RISC-V ISA.

Setting up Ripes simulator

Download and Installation:

- Visit the Ripes GitHub page to download the latest version.

Link: https://github.com/mortbopet/Ripes/releases

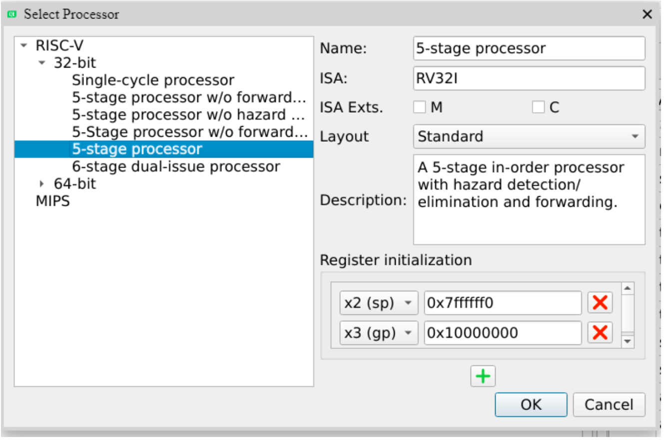
Initial Setup:

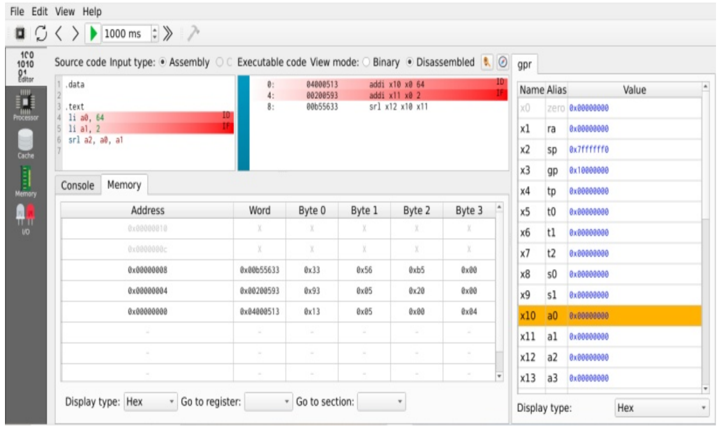
- Launch Ripes and select the RISC-V configuration (e.g., RV32I).
- Familiarize yourself with the main interface: code editor, register view, memory view, and pipeline diagram.

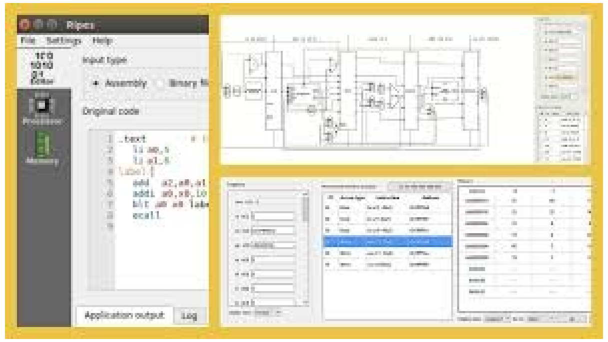
Online Ripes simulator:

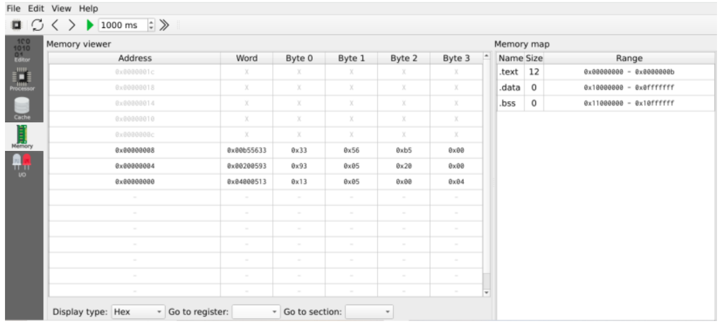
Write ripes.me in the google search bar and it will give you free online access to ripes.

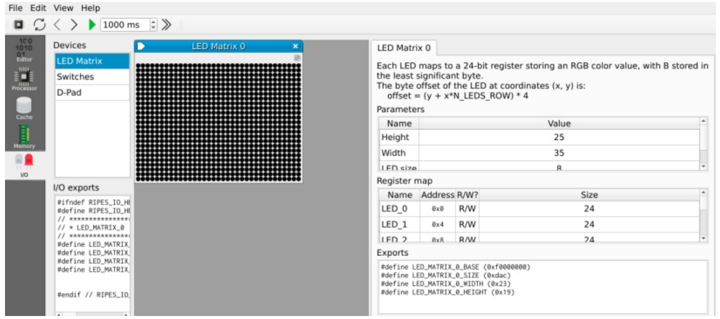
Ripes simulator











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Basics Assembly Structure in Ripes

Creating a New Program:

- Open the code editor and start a new assembly file.
- Define the .data and .text sections.
- Write the entry point with the _start label.

Example:

```
.data
.text
.globl_start
_start:
# Your instructions here
```

Initializing Registers in Ripes

Loading Immediate Values:

- Initialization is the process of assigning a value to the Variable.

- Use the li (Load) instruction to initialize registers with specific values.

Example:

li t0, 10 # Load immediate value 10 into register t0

lui t3, 0x12345 #load 20 bits as a most significant bits in 32 bit register by lui

Declaring Registers in Ripes

Using Registers:

- Declaration tells the compiler about the existence of an entity in the program and its location.
- Understand the different types of registers (temporary t0-t6, saved s0-s11, argument a0-a7).

Example:

```
lw t0, s0 #load s0 register into t0 register
lw t6, s11 #load s11 register into t6 register
```

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Logic Operations on Registers in Ripes

NOT Operation:

li a0, 5

not a1, a0 #(not): Inverts all the bits of the operand

AND Operation:

li a0, 9 li a1, 5

and a2, a1, a0 #(and): Sets each bit to 1 if both corresponding bits are 1.

OR Operation:

li a0, 9 li a1, 5

or a2, a1, a0 #(or): Sets each bit to 1 if at least one corresponding bit is 1

XOR Operation:

li a0, 9 li a1, 5

xor a2, a1, a0 #(xor): Sets each bit to 1 if only one of the corresponding bits is 1.

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Arithmetic Operations in Ripes

Addition:

```
li a0, 10
li a1, 20
add a2, a0, a1 # a2 = a0 + a1
```

Subtraction:

```
li a0, 20
li a1, 10
sub a2, a0, a1 # a2 = a0 - a1
```

Multiplication (using shifts):

```
li a0, 9
li a1, 1
sll t0, a0, a1
# Logical shift left a0 by a1 positions
(9x2^1=18)
```

Division (using shifts):

```
li a0, 16
li a1,  3
srl t0, a0, a1
# Logical shift right a0 by a1 positions
(16x2^3=2)
```

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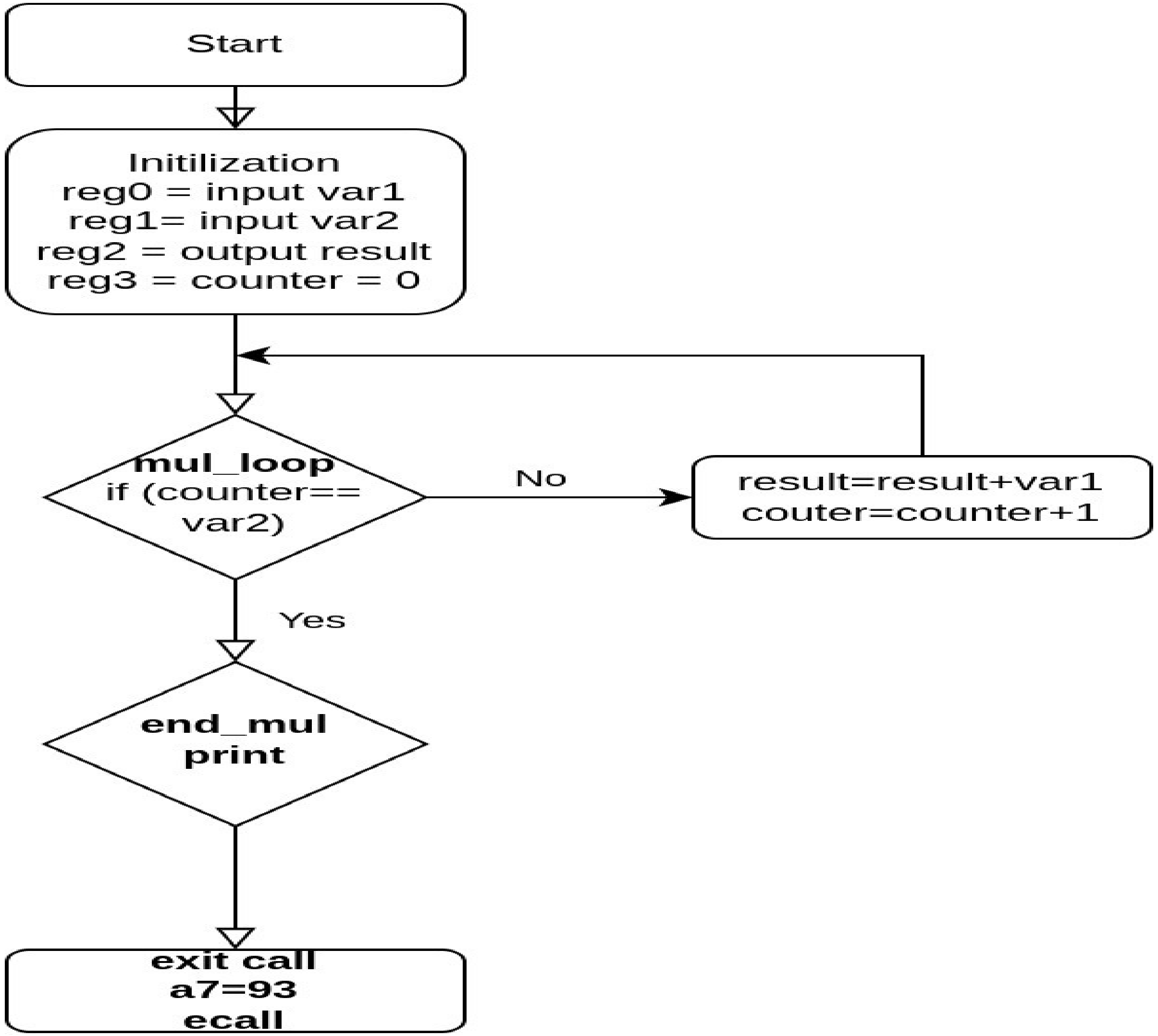
Multiplication with the Support of Addition (pseudo code)



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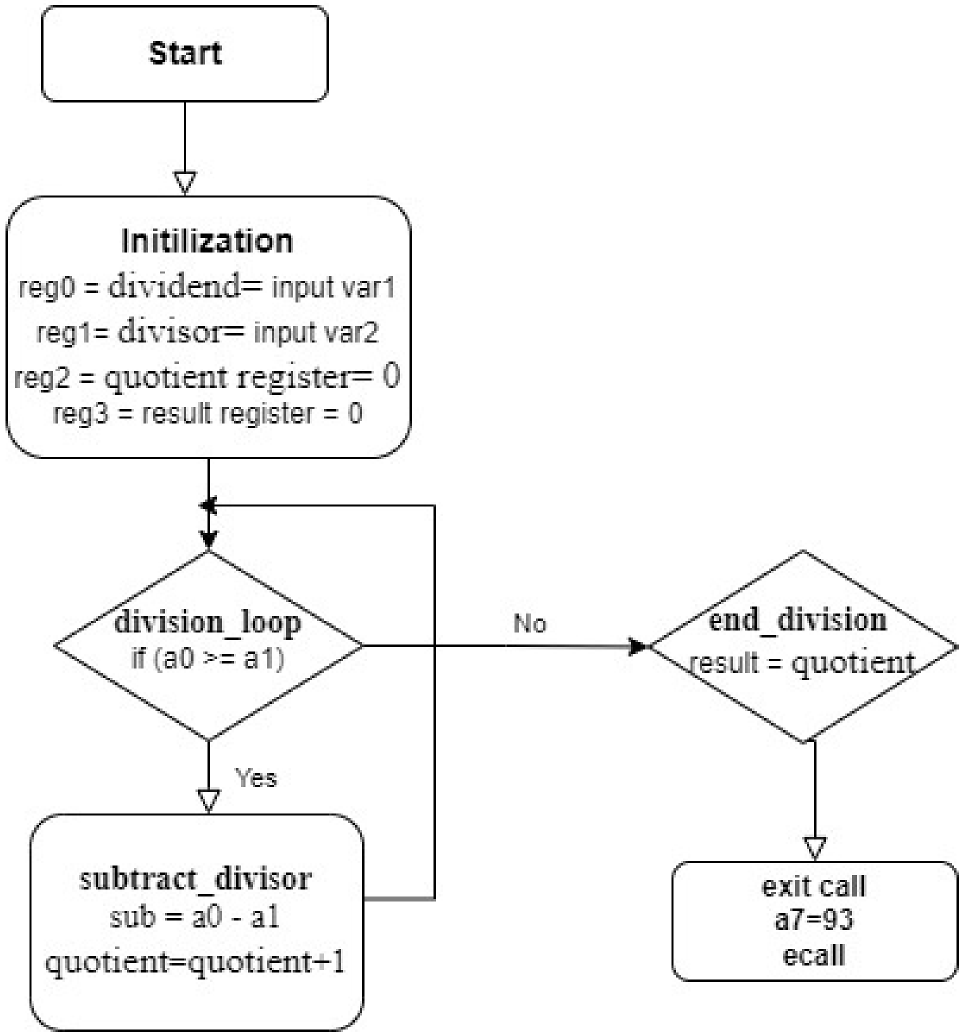
Division with the Support of Subtraction (pseudo code)



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Memory Access (Basic Concept)

Accessing memory beyond the registers involves using load and store instructions. This is typically done using lw (load word) and sw (store word).

Example:

```
.data
val1: .word 10
val2: .word 20
.text
.globl _start
 _start:
lw t0, val1 # Load the value at address val1 into t0
lw t1, val2 # Load the value at address val2 into t1
add t2, t0, t1 # Add the values in t0 and t1
sw t2, 0x100(t0) # Store the result at a specific memory address
```

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External Peripheral Access (Basic Concept)

Interfacing with peripherals (like timers, keyboards, displays) typically involves memory-mapped I/O, where peripheral registers are accessed via specific memory addresses.

Accessing Memory Mapped IO: Interact with peripherals via specific memory addresses.

Example:

```
li t0, 0x10008000 # Address of peripheral
li t1, 1 # Data to write
sw t1, 0(t0) # Write data to peripheral
```