Modelos de Computación.
Práctica 4.

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Resumen

Prácticas con el simulador URM.
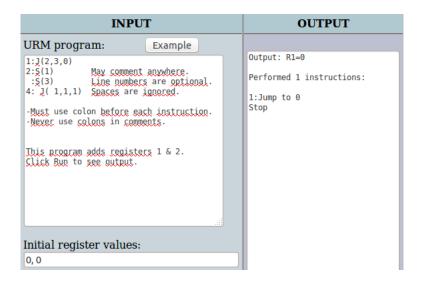
1. Ejercicio 1

Computaciones para el programa

```
J(2,3,0)
S(1)
S(3)
J(1,1,1)
```

1.1. Computación para la entrada $R1 = 0, R2 = 0$

$$(1, < R1 = 0, R2 = 0, R3 = 0 >) \sim (0, < R1 = 0, R2 = 0, R3 = 0 >)$$

1.2. Computación para la entrada $R1 = 1, R2 = 1$
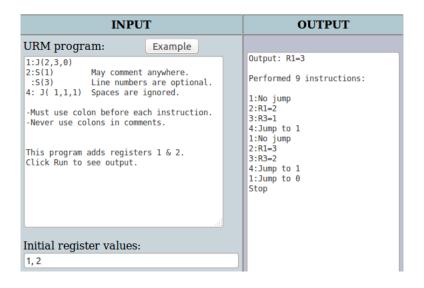
$(1, < R1 = 1, R2 = 1, R3 = 0 >) \sim (2, < R1 = 1, R2 = 1, R3 = 0 >) \sim (3, < R1 = 2, R2 = 1, R3 = 0 >) \sim$
$(4, < R1 = 2, R2 = 1, R3 = 1 >) \sim (1, < R1 = 2, R2 = 1, R3 = 1 >) \sim (0, < R1 = 2, R2 = 1, R3 = 1 >)$

INPUT	OUTPUT
URM program: [Example]	
| ```
1:J(2,3,0)
2:S(1)        May comment anywhere.
 :S(3)        Line numbers are optional.
4: J( 1,1,1)  Spaces are ignored.

-Must use colon before each instruction.
-Never use colons in comments.


This program adds registers 1 & 2.
Click Run to see output.
``` | ```
Output: R1=2

Performed 5 instructions:

1:No jump
2:R1=2
3:R3=1
4:Jump to 1
1:Jump to 0
Stop
``` |
| Initial register values: | |
| 1, 1 | |

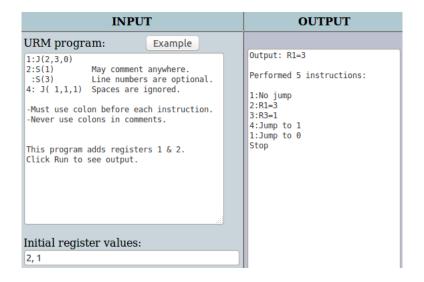## 1.3. Computación para la entrada $R1 = 1, R2 = 2$

$(1, < R1 = 1, R2 = 2, R3 = 0 >) \sim (2, < R1 = 1, R2 = 2, R3 = 0 >) \sim (3, < R1 = 2, R2 = 2, R3 = 0 >) \sim$
$(4, < R1 = 2, R2 = 2, R3 = 1 >) \sim (1, < R1 = 2, R2 = 2, R3 = 1 >) \sim (2, < R1 = 2, R2 = 2, R3 = 1 >) \sim$
$(3, < R1 = 3, R2 = 2, R3 = 1 >) \sim (4, < R1 = 3, R2 = 2, R3 = 2 >) \sim (1, < R1 = 3, R2 = 2, R3 = 2 >) \sim$
$$(0, < R1 = 3, R2 = 2, R3 = 2 >)$$

INPUT	OUTPUT
URM program: [Example]	
| ```
1:J(2,3,0)
2:S(1)        May comment anywhere.
 :S(3)        Line numbers are optional.
4: J( 1,1,1)  Spaces are ignored.

-Must use colon before each instruction.
-Never use colons in comments.


This program adds registers 1 & 2.
Click Run to see output.
``` | ```
Output: R1=3

Performed 9 instructions:

1:No jump
2:R1=2
3:R3=1
4:Jump to 1
1:No jump
2:R1=3
3:R3=2
4:Jump to 1
1:Jump to 0
Stop
``` |
| Initial register values: | |
| 1, 2 | |

1.4. Computación para la entrada $R1 = 2, R2 = 1$

$(1, < R1 = 2, R2 = 1, R3 = 0 >) \sim (2, < R1 = 2, R2 = 1, R3 = 0 >) \sim (3, < R1 = 3, R2 = 1, R3 = 0 >) \sim$
$(4, < R1 = 3, R2 = 1, R3 = 1 >) \sim (1, < R1 = 3, R2 = 1, R3 = 1 >) \sim (0, < R1 = 3, R2 = 1, R3 = 1 >)$

2.   Ejercicio 2

El programa

```
J(1,2,3)
J(1,1,4)
S(2)
T(2,1)
```

calcula la función

$$f(x) = \begin{cases} x & \text{si } x > 0 \\ 1 & \text{en otro caso} \end{cases}$$

3.   Ejercicio 3

Código propuesto para el programa "bloque de transferencia":

```
T(1,2)
J(1,1,1)
```

4.   Ejercicio 4

Computaciones para el programa

```
J(1,4,10)
T(1,4)
S(2)
J(1,2,10)
Z(3)
S(3)
S(4)
J(1,3,3)
J(1,1,6)
T(4,1)
```

4.1. Computación para la entrada $R1 = 0$

$$(1, < R1 = 0, R2 = 0, R3 = 0, R4 = 0 >) \sim (10, < R1 = 0, R2 = 0, R3 = 0, R4 = 0 >) \sim$$
$$(11, < R1 = 0, R2 = 0, R3 = 0, R4 = 0 >)$$

INPUT	OUTPUT
URM program: Example	
| ```
:J(1,4,10)
:T(1,4)
:S(2)
:J(1,2,10)
:Z(3)
:S(3)
:S(4)
:J(1,3,3)
:J(1,1,6)
:T(4,1)
``` | ```
Output: R1=0

Performed 2 instructions:

1:Jump to 10
10:R1=0
Stop
``` |
| Initial register values: | |
| 0 | |

4.2. Computación para la entrada $R1 = 1$

$$(1, < R1 = 1, R2 = 0, R3 = 0, R4 = 0 >) \sim (2, < R1 = 1, R2 = 0, R3 = 0, R4 = 0 >) \sim$$
$$(3, < R1 = 1, R2 = 0, R3 = 0, R4 = 1 >) \sim (4, < R1 = 1, R2 = 1, R3 = 0, R4 = 1 >) \sim$$
$$(10, < R1 = 1, R2 = 1, R3 = 0, R4 = 1 >) \sim (11, < R1 = 1, R2 = 1, R3 = 0, R4 = 1 >)$$

INPUT	OUTPUT
URM program: Example	
| ```
:J(1,4,10)
:T(1,4)
:S(2)
:J(1,2,10)
:Z(3)
:S(3)
:S(4)
:J(1,3,3)
:J(1,1,6)
:T(4,1)
``` | ```
Output: R1=1

Performed 5 instructions:

1:No jump
2:R4=1
3:R2=1
4:Jump to 10
10:R1=1
Stop
``` |
| Initial register values: | |
| 1 | |

4.3. Computación para la entrada $R1 = 2$

$(1, < R1 = 2, R2 = 0, R3 = 0, R4 = 0 >) \sim (2, < R1 = 2, R2 = 0, R3 = 0, R4 = 0 >) \sim$
$(3, < R1 = 2, R2 = 0, R3 = 0, R4 = 2 >) \sim (4, < R1 = 2, R2 = 1, R3 = 0, R4 = 2 >) \sim$
$(5, < R1 = 2, R2 = 1, R3 = 0, R4 = 2 >) \sim (6, < R1 = 2, R2 = 1, R3 = 0, R4 = 2 >) \sim$
$(7, < R1 = 2, R2 = 1, R3 = 1, R4 = 2 >) \sim (8, < R1 = 2, R2 = 1, R3 = 1, R4 = 3 >) \sim$
$(9, < R1 = 2, R2 = 1, R3 = 1, R4 = 3 >) \sim (6, < R1 = 2, R2 = 1, R3 = 1, R4 = 3 >) \sim$
$(7, < R1 = 2, R2 = 1, R3 = 2, R4 = 3 >) \sim (8, < R1 = 2, R2 = 1, R3 = 2, R4 = 4 >) \sim$
$(3, < R1 = 2, R2 = 1, R3 = 2, R4 = 4 >) \sim (4, < R1 = 2, R2 = 2, R3 = 2, R4 = 4 >) \sim$
$(10, < R1 = 2, R2 = 2, R3 = 2, R4 = 4 >) \sim (11, < R1 = 4, R2 = 2, R3 = 2, R4 = 4 >)$

INPUT	OUTPUT
URM program: [Example]	Output: R1=4
`:J(1,4,10)` `:T(1,4)` `:S(2)` `:J(1,2,10)` `:Z(3)` `:S(3)` `:S(4)` `:J(1,3,3)` `:J(1,1,6)` `:T(4,1)`	Performed 15 instructions: 1:No jump 2:R4=2 3:R2=1 4:No jump 5:R3=0 6:R3=1 7:R4=3 8:No jump 9:Jump to 6 6:R3=2 7:R4=4 8:Jump to 3 3:R2=2 4:Jump to 10 10:R1=4 Stop
Initial register values: `2`	

4.4. Computación para la entrada $R1 = 3$

$(1, < R1 = 3, R2 = 0, R3 = 0, R4 = 0 >) \sim (2, < R1 = 3, R2 = 0, R3 = 0, R4 = 0 >) \sim$
$(3, < R1 = 3, R2 = 0, R3 = 0, R4 = 3 >) \sim (4, < R1 = 3, R2 = 1, R3 = 0, R4 = 3 >) \sim$
$(5, < R1 = 3, R2 = 1, R3 = 0, R4 = 3 >) \sim (6, < R1 = 3, R2 = 1, R3 = 0, R4 = 3 >) \sim$
$(7, < R1 = 3, R2 = 1, R3 = 1, R4 = 3 >) \sim (8, < R1 = 3, R2 = 1, R3 = 1, R4 = 4 >) \sim$
$(9, < R1 = 3, R2 = 1, R3 = 1, R4 = 4 >) \sim (6, < R1 = 3, R2 = 1, R3 = 1, R4 = 4 >) \sim$
$(7, < R1 = 3, R2 = 1, R3 = 2, R4 = 4 >) \sim (8, < R1 = 3, R2 = 1, R3 = 2, R4 = 5 >) \sim$
$(9, < R1 = 3, R2 = 1, R3 = 2, R4 = 5 >) \sim (6, < R1 = 3, R2 = 1, R3 = 2, R4 = 5 >) \sim$
$(7, < R1 = 3, R2 = 1, R3 = 3, R4 = 5 >) \sim (8, < R1 = 3, R2 = 1, R3 = 3, R4 = 6 >) \sim$
$(3, < R1 = 3, R2 = 1, R3 = 3, R4 = 6 >) \sim (4, < R1 = 3, R2 = 2, R3 = 3, R4 = 6 >) \sim$
$(5, < R1 = 3, R2 = 2, R3 = 3, R4 = 6 >) \sim (6, < R1 = 3, R2 = 2, R3 = 0, R4 = 6 >) \sim$
$(7, < R1 = 3, R2 = 2, R3 = 1, R4 = 6 >) \sim (8, < R1 = 3, R2 = 2, R3 = 1, R4 = 7 >) \sim$
$(9, < R1 = 3, R2 = 2, R3 = 1, R4 = 7 >) \sim (6, < R1 = 3, R2 = 2, R3 = 1, R4 = 7 >) \sim$
$(7, < R1 = 3, R2 = 2, R3 = 2, R4 = 7 >) \sim (8, < R1 = 3, R2 = 2, R3 = 2, R4 = 8 >) \sim$
$(9, < R1 = 3, R2 = 2, R3 = 2, R4 = 8 >) \sim (6, < R1 = 3, R2 = 2, R3 = 2, R4 = 8 >) \sim$
$(7, < R1 = 3, R2 = 2, R3 = 3, R4 = 8 >) \sim (8, < R1 = 3, R2 = 2, R3 = 3, R4 = 9 >) \sim$
$(3, < R1 = 3, R2 = 2, R3 = 3, R4 = 9 >) \sim (4, < R1 = 3, R2 = 3, R3 = 3, R4 = 9 >) \sim$
$(10, < R1 = 3, R2 = 3, R3 = 3, R4 = 9 >) \sim (11, < R1 = 9, R2 = 3, R3 = 3, R4 = 9 >)$

```
           INPUT                          OUTPUT

URM program:        Example       Output: R1=9
:J(1,4,10)
:T(1,4)                           Performed 33 instructions:
:S(2)
:J(1,2,10)                        1:No jump
:Z(3)                             2:R4=3
:S(3)                             3:R2=1
:S(4)                             4:No jump
:J(1,3,3)                         5:R3=0
:J(1,1,6)                         6:R3=1
:T(4,1)                           7:R4=4
                                  8:No jump
                                  9:Jump to 6
                                  6:R3=2
                                  7:R4=5
                                  8:No jump
                                  9:Jump to 6
                                  6:R3=3
                                  7:R4=6
Initial register values:         8:Jump to 3
3                                 3:R2=2
                                  4:No jump
```

4.5. Función calculada

El programa calcula la función
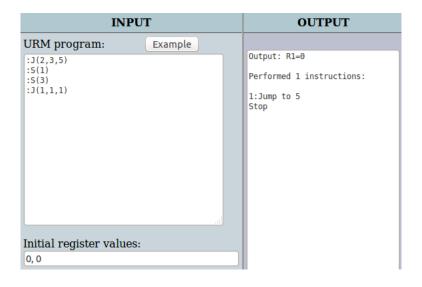
$$f(x) = x * x$$

5. Ejercicio 5

Computaciones para el programa

```
J(2,3,5)
S(1)
S(3)
J(1,1,1)
```

5.1. Computación para la entrada $R1 = 0$, $R2 = 0$

$$(1, < R1 = 0, R2 = 0, R3 = 0 >) \sim (5, < R1 = 0, R2 = 0, R3 = 0 >)$$

```
           INPUT                          OUTPUT

URM program:        Example       Output: R1=0
:J(2,3,5)
:S(1)                             Performed 1 instructions:
:S(3)
:J(1,1,1)                         1:Jump to 5
                                  Stop









Initial register values:
0, 0
```

5.2. Computación para la entrada $R1 = 1$, $R2 = 0$

$$(1, < R1 = 1, R2 = 0, R3 = 0 >) \sim (5, < R1 = 1, R2 = 0, R3 = 0 >)$$

INPUT	OUTPUT
URM program: [Example]	

```:J(2,3,5)```
```:S(1)```
```:S(3)```
```:J(1,1,1)```
	```Output: R1=1```
	
	```Performed 1 instructions:```
	
	```1:Jump to 5```
	```Stop```

Initial register values:	
```1, 0```	

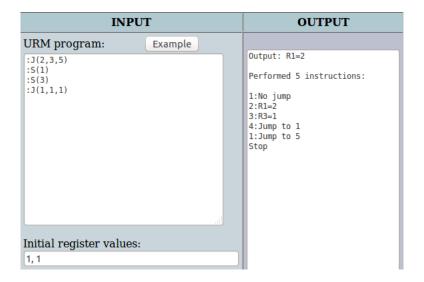## 5.3. Computación para la entrada $R1 = 0$, $R2 = 1$

$$(1, < R1 = 0, R2 = 1, R3 = 0 >) \sim (2, < R1 = 0, R2 = 1, R3 = 0 >) \sim (3, < R1 = 1, R2 = 1, R3 = 0 >) \sim$$
$$(4, < R1 = 1, R2 = 1, R3 = 1 >) \sim (1, < R1 = 1, R2 = 1, R3 = 1 >) \sim (5, < R1 = 1, R2 = 1, R3 = 1 >)$$

INPUT	OUTPUT
URM program: [Example]	

```:J(2,3,5)```
```:S(1)```
```:S(3)```
```:J(1,1,1)```
	```Output: R1=1```
	
	```Performed 5 instructions:```
	
	```1:No jump```
	```2:R1=1```
	```3:R3=1```
	```4:Jump to 1```
	```1:Jump to 5```
	```Stop```

Initial register values:	
```0, 1```	

5.4. Computación para la entrada $R1 = 1$, $R2 = 1$

$$(1, < R1 = 1, R2 = 1, R3 = 0 >) \sim (2, < R1 = 1, R2 = 1, R3 = 0 >) \sim (3, < R1 = 2, R2 = 1, R3 = 0 >) \sim$$
$$(4, < R1 = 2, R2 = 1, R3 = 1 >) \sim (1, < R1 = 2, R2 = 1, R3 = 1 >) \sim (5, < R1 = 2, R2 = 1, R3 = 1 >)$$

5.5. Función calculada

El programa calcula la función
$$f(x_1, x_2) = x_1 + x_2$$

6. Ejercicio 6

Computaciones para el programa

```
J(1,2,6)
S(3)
S(2)
J(1,1,1)
Z(0)
J(1,3,10)
S(1)
J(1,1,7)
```

6.1. Computación para la entrada $R1 = 0$

$$(1, < R1 = 0, R2 = 0, R3 = 0 >) \sim (6, < R1 = 0, R2 = 0, R3 = 0 >) \sim (9, < R1 = 0, R2 = 0, R3 = 0 >)$$

INPUT	OUTPUT
URM program: [Example]	Output: R1=0
| ```
:J(1,2,6)
:S(3)
:S(2)
:J(1,1,1)
:Z(0)
:J(1,3,10)
:S(1)
:J(1,1,7)
``` | Performed 2 instructions:<br><br>1:Jump to 6<br>6:Jump to 10<br>Stop |
| Initial register values: | |
| 0 | |

6.2. Computación para la entrada $R1 = 1$

$(1, < R1 = 1, R2 = 0, R3 = 0 >) \sim (2, < R1 = 1, R2 = 0, R3 = 0 >) \sim (3, < R1 = 1, R2 = 0, R3 = 1 >) \sim$
$(4, < R1 = 1, R2 = 1, R3 = 1 >) \sim (1, < R1 = 1, R2 = 1, R3 = 1 >) \sim (6, < R1 = 1, R2 = 1, R3 = 1 >) \sim$
$(9, < R1 = 1, R2 = 1, R3 = 1 >)$

INPUT	OUTPUT
URM program: [Example]	Output: R1=1
| ```
:J(1,2,6)
:S(3)
:S(2)
:J(1,1,1)
:Z(0)
:J(1,3,10)
:S(1)
:J(1,1,7)
``` | Performed 6 instructions:<br><br>1:No jump<br>2:R3=1<br>3:R2=1<br>4:Jump to 1<br>1:Jump to 6<br>6:Jump to 10<br>Stop |
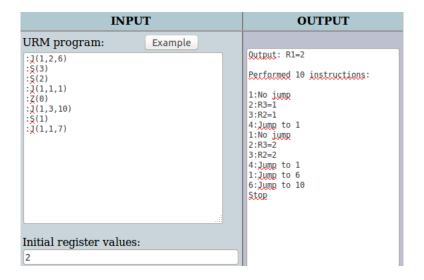| Initial register values: | |
| 1 | |

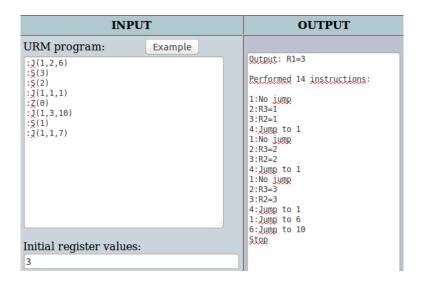## 6.3. COmputación para la entrada $R1 = 2$

$(1, < R1 = 2, R2 = 0, R3 = 0 >) \sim (2, < R1 = 2, R2 = 0, R3 = 0 >) \sim (3, < R1 = 2, R2 = 0, R3 = 1 >) \sim$
$(4, < R1 = 2, R2 = 1, R3 = 1 >) \sim (1, < R1 = 2, R2 = 1, R3 = 1 >) \sim (2, < R1 = 2, R2 = 1, R3 = 1 >) \sim$
$(3, < R1 = 2, R2 = 1, R3 = 2 >) \sim (4, < R1 = 2, R2 = 2, R3 = 2 >) \sim (1, < R1 = 2, R2 = 2, R3 = 2 >) \sim$
$(6, < R1 = 2, R2 = 2, R3 = 2 >) \sim (9, < R1 = 2, R2 = 2, R3 = 2 >)$

```
                INPUT                              OUTPUT

URM program:        Example
                                        Output: R1=2
:J(1,2,6)
:S(3)                                   Performed 10 instructions:
:S(2)
:J(1,1,1)                               1:No jump
:Z(0)                                   2:R3=1
:J(1,3,10)                              3:R2=1
:S(1)                                   4:Jump to 1
:J(1,1,7)                               1:No jump
                                        2:R3=2
                                        3:R2=2
                                        4:Jump to 1
                                        1:Jump to 6
                                        6:Jump to 10
                                        Stop

Initial register values:

2
```

6.4. Compuación para la entrada $R1 = 3$

$(1, < R1 = 3, R2 = 0, R3 = 0 >) \sim (2, < R1 = 3, R2 = 0, R3 = 0 >) \sim (3, < R1 = 3, R2 = 0, R3 = 1 >) \sim$
$(4, < R1 = 3, R2 = 1, R3 = 1 >) \sim (1, < R1 = 3, R2 = 1, R3 = 1 >) \sim (2, < R1 = 3, R2 = 1, R3 = 1 >) \sim$
$(3, < R1 = 3, R2 = 1, R3 = 2 >) \sim (4, < R1 = 3, R2 = 2, R3 = 2 >) \sim (1, < R1 = 3, R2 = 2, R3 = 2 >) \sim$
$(2, < R1 = 3, R2 = 2, R3 = 2 >) \sim (3, < R1 = 3, R2 = 2, R3 = 3 >) \sim (4, < R1 = 3, R2 = 3, R3 = 3 >) \sim$
$(1, < R1 = 3, R2 = 3, R3 = 3 >)(6, < R1 = 3, R2 = 3, R3 = 3 >) \sim (9, < R1 = 3, R2 = 3, R3 = 3 >)$

```
                INPUT                              OUTPUT

URM program:        Example
                                        Output: R1=3
:J(1,2,6)
:S(3)                                   Performed 14 instructions:
:S(2)
:J(1,1,1)                               1:No jump
:Z(0)                                   2:R3=1
:J(1,3,10)                              3:R2=1
:S(1)                                   4:Jump to 1
:J(1,1,7)                               1:No jump
                                        2:R3=2
                                        3:R2=2
                                        4:Jump to 1
                                        1:No jump
                                        2:R3=3
                                        3:R2=3
                                        4:Jump to 1
                                        1:Jump to 6
                                        6:Jump to 10
                                        Stop

Initial register values:

3
```

6.5. Función calculada

El programa calcula la función

$$f(x) = x$$

7. Ejercicio 7

Computaciones para el programa

```
J(2,3,9)
J(1,3,9)
S(3)
S(4)
J(2,4,7)
J(1,1,2)
Z(4)
J(1,1,2)
T(4,1)
```

7.1. Computación para la entrada $R1 = 0$, $R2 = 0$

$$(1, < R1 = 0, R2 = 0, R3 = 0, R4 = 0 >) \sim (9, < R1 = 0, R2 = 0, R3 = 0, R4 = 0 >) \sim$$
$$(10, < R1 = 0, R2 = 0, R3 = 0, R4 = 0 >)$$

INPUT	OUTPUT
URM program: Example	

`:J(2,3,9)`
`:J(1,3,9)`
`:S(3)`
`:S(4)`
`:J(2,4,7)`
`:J(1,1,2)`
`:Z(4)`
`:J(1,1,2)`
`:T(4,1)`
	`Output: R1=0`
	
	`Performed 2 instructions:`
	
	`1:Jump to 9`
	`9:R1=0`
	`Stop`

Initial register values:	
`0, 0`	

7.2. Computación para la entrada $R1 = 0$, $R2 = 1$

$$(1, < R1 = 0, R2 = 1, R3 = 0, R4 = 0 >) \sim (2, < R1 = 0, R2 = 1, R3 = 0, R4 = 0 >) \sim$$
$$(9, < R1 = 0, R2 = 1, R3 = 0, R4 = 0 >) \sim (10, < R1 = 0, R2 = 1, R3 = 0, R4 = 0 >)$$

INPUT	OUTPUT
URM program: Example	

`:J(2,3,9)`
`:J(1,3,9)`
`:S(3)`
`:S(4)`
`:J(2,4,7)`
`:J(1,1,2)`
`:Z(4)`
`:J(1,1,2)`
`:T(4,1)`
	`Output: R1=0`
	
	`Performed 3 instructions:`
	
	`1:No jump`
	`2:Jump to 9`
	`9:R1=0`
	`Stop`

Initial register values:	
`0, 1`	

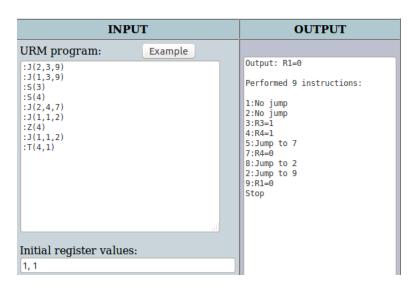### 7.3. Computación para la entrada $R1 = 1$, $R2 = 0$

$$(1, < R1 = 1, R2 = 0, R3 = 0, R4 = 0 >) \sim (9, < R1 = 1, R2 = 0, R3 = 0, R4 = 0 >) \sim$$
$$(10, < R1 = 0, R2 = 0, R3 = 0, R4 = 0 >)$$

INPUT	OUTPUT

URM program: [Example]
 	
 `:J(2,3,9)`
 `:J(1,3,9)`
 `:S(3)`
 `:S(4)`
 `:J(2,4,7)`
 `:J(1,1,2)`
 `:Z(4)`
 `:J(1,1,2)`
 `:T(4,1)`
 	
 Initial register values:
 `1, 0`
	`Output: R1=0`
	
	 `Performed 2 instructions:`
	
	 `1:Jump to 9`
	 `9:R1=0`
	 `Stop`

7.4. Computación para la entrada $R1 = 1$, $R2 = 1$

$$(1, < R1 = 1, R2 = 1, R3 = 0, R4 = 0 >) \sim (2, < R1 = 1, R2 = 1, R3 = 0, R4 = 0 >) \sim$$
$$(3, < R1 = 1, R2 = 1, R3 = 0, R4 = 0 >) \sim (4, < R1 = 1, R2 = 1, R3 = 1, R4 = 0 >) \sim$$
$$(5, < R1 = 1, R2 = 1, R3 = 1, R4 = 1 >) \sim (7, < R1 = 1, R2 = 1, R3 = 1, R4 = 1 >) \sim$$
$$(8, < R1 = 1, R2 = 1, R3 = 1, R4 = 0 >) \sim (2, < R1 = 1, R2 = 1, R3 = 1, R4 = 0 >) \sim$$
$$(9, < R1 = 1, R2 = 1, R3 = 1, R4 = 0 >) \sim (10, < R1 = 0, R2 = 1, R3 = 1, R4 = 0 >)$$

INPUT	OUTPUT

URM program: [Example]
 	
 `:J(2,3,9)`
 `:J(1,3,9)`
 `:S(3)`
 `:S(4)`
 `:J(2,4,7)`
 `:J(1,1,2)`
 `:Z(4)`
 `:J(1,1,2)`
 `:T(4,1)`
 	
 Initial register values:
 `1, 1`
	`Output: R1=0`
	
	 `Performed 9 instructions:`
	
	 `1:No jump`
	 `2:No jump`
	 `3:R3=1`
	 `4:R4=1`
	 `5:Jump to 7`
	 `7:R4=0`
	 `8:Jump to 2`
	 `2:Jump to 9`
	 `9:R1=0`
	 `Stop`

7.5. Función calculada

El programa calcula la función

$$f(x_1, x_2) = \begin{cases} x_1 \bmod x_2 & \text{si } x_2 > 0 \\ 0 & \text{en otro caso} \end{cases}$$

8. Ejercicio 8

Computaciones para el programa

```
T(1,3)
J(2,3,10)
S(2)
S(1)
S(1)
J(1,1,2)
```

8.1. Computación para la entrada $R1 = 0$

$$(1, < R1 = 0, R2 = 0, R3 = 0 >) \sim (2, < R1 = 0, R2 = 0, R3 = 0 >) \sim (7, < R1 = 0, R2 = 0, R3 = 0 >)$$

8.2. Computación para la entrada $R1 = 1$

$$(1, < R1 = 1, R2 = 0, R3 = 0 >) \sim (2, < R1 = 1, R2 = 0, R3 = 1 >) \sim (3, < R1 = 1, R2 = 0, R3 = 1 >) \sim$$
$$(4, < R1 = 1, R2 = 1, R3 = 1 >) \sim (5, < R1 = 2, R2 = 1, R3 = 1 >) \sim (6, < R1 = 3, R2 = 1, R3 = 1 >) \sim$$
$$(2, < R1 = 3, R2 = 1, R3 = 1 >) \sim (7, < R1 = 3, R2 = 1, R3 = 1 >)$$

```
            INPUT                              OUTPUT

URM program:        [ Example ]
:T(1,3)                             Output: R1=3
:J(2,3,10)
:S(2)                               Performed 7 instructions:
:S(1)
:S(1)                               1:R3=1
:J(1,1,2)                           2:No jump
                                    3:R2=1
                                    4:R1=2
                                    5:R1=3
                                    6:Jump to 2
                                    2:Jump to 10
                                    Stop

Initial register values:
1
```

8.3. Computación para la entrada $R1 = 2$

$$(1, < R1 = 2, R2 = 0, R3 = 0 >) \sim (2, < R1 = 2, R2 = 0, R3 = 2 >) \sim (3, < R1 = 2, R2 = 0, R3 = 2 >) \sim$$
$$(4, < R1 = 2, R2 = 1, R3 = 2 >) \sim (5, < R1 = 3, R2 = 1, R3 = 2 >) \sim (6, < R1 = 4, R2 = 1, R3 = 2 >) \sim$$
$$(2, < R1 = 4, R2 = 1, R3 = 2 >) \sim (3, < R1 = 4, R2 = 1, R3 = 2 >) \sim (4, < R1 = 4, R2 = 2, R3 = 2 >) \sim$$
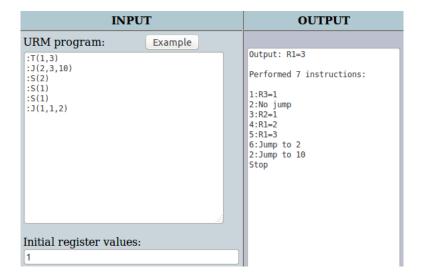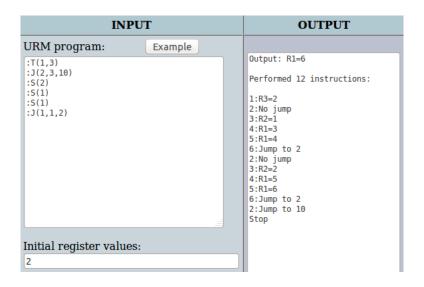$$(5, < R1 = 5, R2 = 2, R3 = 2 >) \sim (6, < R1 = 6, R2 = 2, R3 = 2 >) \sim (2, < R1 = 6, R2 = 2, R3 = 2 >) \sim$$
$$(7, < R1 = 6, R2 = 2, R3 = 2 >)$$

```
            INPUT                              OUTPUT

URM program:        [ Example ]
:T(1,3)                             Output: R1=6
:J(2,3,10)
:S(2)                               Performed 12 instructions:
:S(1)
:S(1)                               1:R3=2
:J(1,1,2)                           2:No jump
                                    3:R2=1
                                    4:R1=3
                                    5:R1=4
                                    6:Jump to 2
                                    2:No jump
                                    3:R2=2
                                    4:R1=5
                                    5:R1=6
                                    6:Jump to 2
                                    2:Jump to 10
                                    Stop

Initial register values:
2
```

8.4. Computación para la entrada $R1 = 3$

$$(1, < R1 = 3, R2 = 0, R3 = 0 >) \sim (2, < R1 = 3, R2 = 0, R3 = 3 >) \sim (3, < R1 = 3, R2 = 0, R3 = 3 >) \sim$$
$$(4, < R1 = 3, R2 = 1, R3 = 3 >) \sim (5, < R1 = 4, R2 = 1, R3 = 3 >) \sim (6, < R1 = 5, R2 = 1, R3 = 3 >) \sim$$
$$(2, < R1 = 5, R2 = 1, R3 = 3 >) \sim (3, < R1 = 5, R2 = 1, R3 = 3 >) \sim (4, < R1 = 5, R2 = 2, R3 = 3 >) \sim$$
$$(5, < R1 = 6, R2 = 2, R3 = 3 >) \sim (6, < R1 = 7, R2 = 2, R3 = 3 >) \sim (2, < R1 = 7, R2 = 2, R3 = 3 >) \sim$$
$$(3, < R1 = 7, R2 = 2, R3 = 3 >) \sim (4, < R1 = 7, R2 = 3, R3 = 3 >) \sim (5, < R1 = 8, R2 = 3, R3 = 3 >) \sim$$
$$(6, < R1 = 9, R2 = 3, R3 = 3 >) \sim (2, < R1 = 9, R2 = 3, R3 = 3 >) \sim (7, < R1 = 9, R2 = 3, R3 = 3 >)$$

INPUT	OUTPUT
URM program: Example	

```
:T(1,3)
:J(2,3,10)
:S(2)
:S(1)
:S(1)
:J(1,1,2)
```

```
Output: R1=9

Performed 17 instructions:

1:R3=3
2:No jump
3:R2=1
4:R1=4
5:R1=5
6:Jump to 2
2:No jump
3:R2=2
4:R1=6
5:R1=7
6:Jump to 2
2:No jump
3:R2=3
4:R1=8
5:R1=9
6:Jump to 2
2:Jump to 10
Stop
```

Initial register values:

```
3
```

8.5. Función calculada

El programa calcula la función

$$f(x) = 3x$$