

Modelos de Computación.

Práctica 4.

Luis José Quintana Bolaño

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

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre>1:J(2,3,0) 2:S(1) May comment anywhere. 3: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.</pre> <p>Initial register values: 0, 0</p>	<p>Output: R1=0</p> <p>Performed 1 instructions:</p> <p>1:Jump to 0 Stop</p>

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

$(1, \langle R1 = 1, R2 = 1, R3 = 0 \rangle) \sim (2, \langle R1 = 1, R2 = 1, R3 = 0 \rangle) \sim (3, \langle R1 = 2, R2 = 1, R3 = 0 \rangle) \sim$
 $(4, \langle R1 = 2, R2 = 1, R3 = 1 \rangle) \sim (1, \langle R1 = 2, R2 = 1, R3 = 1 \rangle) \sim (0, \langle R1 = 2, R2 = 1, R3 = 1 \rangle)$

INPUT	OUTPUT
<p>URM program: Example</p> <pre> 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. </pre> <p>Initial register values:</p> <p>1, 1</p>	<p>Output: R1=2</p> <p>Performed 5 instructions:</p> <pre> 1:No jump 2:R1=2 3:R3=1 4:Jump to 1 1:Jump to 0 Stop </pre>

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

$(1, \langle R1 = 1, R2 = 2, R3 = 0 \rangle) \sim (2, \langle R1 = 1, R2 = 2, R3 = 0 \rangle) \sim (3, \langle R1 = 2, R2 = 2, R3 = 0 \rangle) \sim$
 $(4, \langle R1 = 2, R2 = 2, R3 = 1 \rangle) \sim (1, \langle R1 = 2, R2 = 2, R3 = 1 \rangle) \sim (2, \langle R1 = 2, R2 = 2, R3 = 1 \rangle) \sim$
 $(3, \langle R1 = 3, R2 = 2, R3 = 1 \rangle) \sim (4, \langle R1 = 3, R2 = 2, R3 = 2 \rangle) \sim (1, \langle R1 = 3, R2 = 2, R3 = 2 \rangle) \sim$
 $(0, \langle R1 = 3, R2 = 2, R3 = 2 \rangle)$

INPUT	OUTPUT
<p>URM program: Example</p> <pre> 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. </pre> <p>Initial register values:</p> <p>1, 2</p>	<p>Output: R1=3</p> <p>Performed 9 instructions:</p> <pre> 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 </pre>

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

$(1, \langle R1 = 2, R2 = 1, R3 = 0 \rangle) \sim (2, \langle R1 = 2, R2 = 1, R3 = 0 \rangle) \sim (3, \langle R1 = 3, R2 = 1, R3 = 0 \rangle) \sim$
 $(4, \langle R1 = 3, R2 = 1, R3 = 1 \rangle) \sim (1, \langle R1 = 3, R2 = 1, R3 = 1 \rangle) \sim (0, \langle R1 = 3, R2 = 1, R3 = 1 \rangle)$

INPUT	OUTPUT
<p>URM program: Example</p> <pre> 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. </pre> <p>Initial register values:</p> <input type="text" value="2, 1"/>	<p>Output: R1=3</p> <p>Performed 5 instructions:</p> <pre> 1:No jump 2:R1=3 3:R3=1 4:Jump to 1 1:Jump to 0 Stop </pre>

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)

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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 $R1 = 0$

$$(1, \langle R1 = 0, R2 = 0, R3 = 0, R4 = 0 \rangle) \sim (10, \langle R1 = 0, R2 = 0, R3 = 0, R4 = 0 \rangle) \sim (11, \langle R1 = 0, R2 = 0, R3 = 0, R4 = 0 \rangle)$$

INPUT	OUTPUT
<p>URM program: Example</p> <pre>: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)</pre> <p>Initial register values:</p> <p>0</p>	<p>Output: R1=0</p> <p>Performed 2 instructions:</p> <p>1:Jump to 10 10:R1=0 Stop</p>

4.2. Computación para la entrada $R1 = 1$

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre>: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)</pre> <p>Initial register values:</p> <p>1</p>	<p>Output: R1=1</p> <p>Performed 5 instructions:</p> <p>1:No jump 2:R4=1 3:R2=1 4:Jump to 10 10:R1=1 Stop</p>

4.3. Computación para la entrada $R1 = 2$

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre> :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) </pre> <p>Initial register values:</p> <p>2</p>	<p>Output: R1=4</p> <p>Performed 15 instructions:</p> <pre> 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 </pre>

4.4. Computación para la entrada $R1 = 3$

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre> :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) </pre> <p>Initial register values:</p> <p>3</p>	<p>Output: R1=9</p> <p>Performed 33 instructions:</p> <pre> 1:No jump 2:R4=3 3:R2=1 4:No jump 5:R3=0 6:R3=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 8:Jump to 3 3:R2=2 4:No jump </pre>

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 $R1 = 0, R2 = 0$

$$(1, \langle R1 = 0, R2 = 0, R3 = 0 \rangle) \sim (5, \langle R1 = 0, R2 = 0, R3 = 0 \rangle)$$

INPUT	OUTPUT
<p>URM program: Example</p> <pre> :J(2,3,5) :S(1) :S(3) :J(1,1,1) </pre> <p>Initial register values:</p> <p>0, 0</p>	<p>Output: R1=0</p> <p>Performed 1 instructions:</p> <pre> 1:Jump to 5 Stop </pre>

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

$$(1, \langle R1 = 1, R2 = 0, R3 = 0 \rangle) \sim (5, \langle R1 = 1, R2 = 0, R3 = 0 \rangle)$$

INPUT	OUTPUT
<p>URM program: Example</p> <pre>:J(2,3,5) :S(1) :S(3) :J(1,1,1)</pre> <p>Initial register values:</p> <p>1, 0</p>	<p>Output: R1=1</p> <p>Performed 1 instructions:</p> <p>1: Jump to 5 Stop</p>

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

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre>:J(2,3,5) :S(1) :S(3) :J(1,1,1)</pre> <p>Initial register values:</p> <p>0, 1</p>	<p>Output: R1=1</p> <p>Performed 5 instructions:</p> <p>1: No jump 2: R1=1 3: R3=1 4: Jump to 1 1: Jump to 5 Stop</p>

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

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre>:J(2,3,5) :S(1) :S(3) :J(1,1,1)</pre> <p>Initial register values:</p> <p>1, 1</p>	<p>Output: R1=2</p> <p>Performed 5 instructions:</p> <pre>1:No jump 2:R1=2 3:R3=1 4:Jump to 1 1:Jump to 5 Stop</pre>

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
<p>URM program: Example</p> <pre>:J(1,2,6) :S(3) :S(2) :J(1,1,1) :Z(0) :J(1,3,10) :S(1) :J(1,1,7)</pre> <p>Initial register values:</p> <input type="text" value="0"/>	<p>Output: R1=0</p> <p>Performed 2 instructions:</p> <p>1:Jump to 6 6:Jump to 10 Stop</p>

6.2. Computación para la entrada $R1 = 1$

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre>:J(1,2,6) :S(3) :S(2) :J(1,1,1) :Z(0) :J(1,3,10) :S(1) :J(1,1,7)</pre> <p>Initial register values:</p> <input type="text" value="1"/>	<p>Output: R1=1</p> <p>Performed 6 instructions:</p> <p>1:No jump 2:R3=1 3:R2=1 4:Jump to 1 1:Jump to 6 6:Jump to 10 Stop</p>

6.3. Computación para la entrada $R1 = 2$

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

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

6.4. Compuación para la entrada $R1 = 3$

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre> :J(1,2,6) :S(3) :S(2) :J(1,1,1) :Z(0) :J(1,3,10) :S(1) :J(1,1,7) </pre> <p>Initial register values:</p> <p>3</p>	<p>Output: R1=3</p> <p>Performed 14 instructions:</p> <pre> 1:No jump 2:R3=1 3:R2=1 4:Jump to 1 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 </pre>

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 $R1 = 0, R2 = 0$

$(1, \langle R1 = 0, R2 = 0, R3 = 0, R4 = 0 \rangle) \sim (9, \langle R1 = 0, R2 = 0, R3 = 0, R4 = 0 \rangle) \sim$
 $(10, \langle R1 = 0, R2 = 0, R3 = 0, R4 = 0 \rangle)$

INPUT	OUTPUT
<p>URM program: Example</p> <pre> :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) </pre> <p>Initial register values:</p> <p>0, 0</p>	<p>Output: R1=0</p> <p>Performed 2 instructions:</p> <p>1:Jump to 9 9:R1=0 Stop</p>

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

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre> :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) </pre> <p>Initial register values:</p> <p>0, 1</p>	<p>Output: R1=0</p> <p>Performed 3 instructions:</p> <p>1:No jump 2:Jump to 9 9:R1=0 Stop</p>

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

$$(1, \langle R1 = 1, R2 = 0, R3 = 0, R4 = 0 \rangle) \sim (9, \langle R1 = 1, R2 = 0, R3 = 0, R4 = 0 \rangle) \sim (10, \langle R1 = 0, R2 = 0, R3 = 0, R4 = 0 \rangle)$$

INPUT	OUTPUT
<p>URM program: Example</p> <pre>: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)</pre> <p>Initial register values:</p> <p>1, 0</p>	<p>Output: R1=0</p> <p>Performed 2 instructions:</p> <p>1:Jump to 9 9:R1=0 Stop</p>

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

$$\begin{aligned} (1, \langle R1 = 1, R2 = 1, R3 = 0, R4 = 0 \rangle) &\sim (2, \langle R1 = 1, R2 = 1, R3 = 0, R4 = 0 \rangle) \sim \\ (3, \langle R1 = 1, R2 = 1, R3 = 0, R4 = 0 \rangle) &\sim (4, \langle R1 = 1, R2 = 1, R3 = 1, R4 = 0 \rangle) \sim \\ (5, \langle R1 = 1, R2 = 1, R3 = 1, R4 = 1 \rangle) &\sim (7, \langle R1 = 1, R2 = 1, R3 = 1, R4 = 1 \rangle) \sim \\ (8, \langle R1 = 1, R2 = 1, R3 = 1, R4 = 0 \rangle) &\sim (2, \langle R1 = 1, R2 = 1, R3 = 1, R4 = 0 \rangle) \sim \\ (9, \langle R1 = 1, R2 = 1, R3 = 1, R4 = 0 \rangle) &\sim (10, \langle R1 = 0, R2 = 1, R3 = 1, R4 = 0 \rangle) \end{aligned}$$

INPUT	OUTPUT
<p>URM program: Example</p> <pre>: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)</pre> <p>Initial register values:</p> <p>1, 1</p>	<p>Output: R1=0</p> <p>Performed 9 instructions:</p> <p>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</p>

7.5. Función calculada

El programa calcula la función

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

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 $R1 = 0$

$(1, \langle R1 = 0, R2 = 0, R3 = 0 \rangle) \sim (2, \langle R1 = 0, R2 = 0, R3 = 0 \rangle) \sim (7, \langle R1 = 0, R2 = 0, R3 = 0 \rangle)$

INPUT	OUTPUT
<p>URM program: <input type="button" value="Example"/></p> <pre>:T(1,3) :J(2,3,10) :S(2) :S(1) :S(1) :J(1,1,2)</pre> <p>Initial register values:</p> <input type="text" value="0"/>	<p>Output: R1=0</p> <p>Performed 2 instructions:</p> <p>1:R3=0 2:Jump to 10 Stop</p>

8.2. Computación para la entrada $R1 = 1$

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

INPUT	OUTPUT
<p>URM program: Example</p> <pre>:T(1,3) :J(2,3,10) :S(2) :S(1) :S(1) :J(1,1,2)</pre> <p>Initial register values:</p> <p>1</p>	<p>Output: R1=3</p> <p>Performed 7 instructions:</p> <pre>1:R3=1 2:No jump 3:R2=1 4:R1=2 5:R1=3 6:Jump to 2 2:Jump to 10 Stop</pre>

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
<p>URM program: Example</p> <pre>:T(1,3) :J(2,3,10) :S(2) :S(1) :S(1) :J(1,1,2)</pre> <p>Initial register values:</p> <p>2</p>	<p>Output: R1=6</p> <p>Performed 12 instructions:</p> <pre>1:R3=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</pre>

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 <pre> :T(1,3) :J(2,3,10) :S(2) :S(1) :S(1) :J(1,1,2) </pre>	Output: R1=9 Performed 17 instructions: <pre> 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 Stoo </pre>
Initial register values: <input type="text" value="3"/>	

8.5. Función calculada

El programa calcula la función

$$f(x) = 3x$$