

Marcelo Túlio Alves de Barros  
 LISTA - 16 - EXERCICIO - 1

Pilha

6660				
5	0	3		
132	15°	56	2°	56
661	1	3		
4	1	2		
44	9°	56	4°	44
661	1	3		
3	2	1		
44	5°	56	8°	44
661	2	3		
2	1	0		
44	3°	44	6°	56
661	2	1		
1	0	1		
44	1°	56	7°	56
661	1	1		

Registradores

\$ pc	148
\$ ra	132
\$ rp	1220
\$ ao	5
\$ vd	0
\$ so	666
\$ si	666

LISTA - 17 - EXERCICIO - 1 - LETRA - A

LW n1, 32 (\$ rp)

ADD1 n2, 1, -4

ADD n3, n1, n2

ADD1 n4, \$ rp, 28

LW n5, 0 (n3)

SW n5, 0 (n4)

Mario Túlio Alves de Barros

LISTA - 17 - EXERCICIO - 1 - LETRA - B

ADDI  $n_1$ , \$zero, 32

ADD  $n_2$ , \$sp,  $n_1$

LW  $n_3$ , 0( $n_2$ )

ADDI  $n_4$ , \$zero, 4

SUB  $n_5$ , 1,  $n_4$

ADD  $n_6$ ,  $n_3$ ,  $n_5$

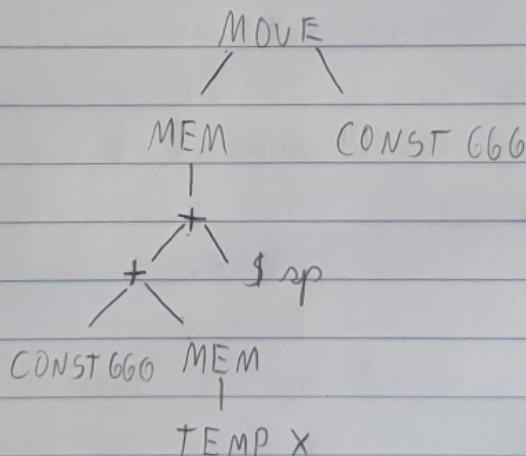
ADDI  $n_7$ , \$zero, 28

ADD  $n_8$ , \$sp,  $n_7$

LW  $n_9$ , 0( $n_8$ )

SW  $n_9$ , 0( $n_6$ )

LISTA - 17 - EXERCICIO - 2 - LETRA - A



LISTA - 17 - EXERCICIO - 2 - LETRA - B

ADDI  $n_1$ , \$zero, 666

LW  $n_2$ , 0(X)

ADD  $n_3$ ,  $n_1$ ,  $n_2$

ADD  $n_4$ ,  $n_3$ , \$sp

ADDI  $n_5$ , \$zero, 666

SW  $n_9$ , \$zero, 666

Marcos Júlio Alves de Barros

LISTA - 17 - EXERCÍCIO - 2 - LETRA - C

ADDI  $n_1$ , \$zero, 666

LW  $n_2$ , 0( $x$ )

ADD  $n_3$ ,  $n_1$ ,  $n_2$

ADD  $n_4$ ,  $n_3$ , \$np

ADDI  $n_5$ , \$zero, 666

SW  $n_5$ , 0( $n_4$ )

LISTA - 17 - EXERCÍCIO - 3

$n_1$

TEMP

12° SGT  $n_k$ ,  $n_1$ ,  $n_j$

ADDI  $n_k$ , \$zero, 1

CONST

$n_i$ ,  $n_j$

13° ADDI  $n_k$ , \$zero, 1

ADD  $n_k$ ,  $n_i$ ,  $n_j$

$\neq$

BEQ  $n_1$ ,  $n_j$ , EXIT-1

SUB  $n_k$ ,  $n_i$ ,  $n_j$

$=$

ADDI  $n_k$ , \$zero, 0

$n_i$ ,  $n_j$

EXIT-1:

DIV  $n_i$ ,  $n_j$

$\%$

14° ADDI  $n_k$ , \$zero, 1

MFHI  $n_k$

$n_i$ ,  $n_j$

BNE  $n_i$ ,  $n_j$ , EXIT-2

MOVE  $n_i$ ,  $n_j$

$\equiv$

ADDI  $n_k$ , \$zero, 0

$n_i$ ,  $n_j$

EXIT-2:

ADD  $n_i$ ,  $n_i$ ,  $n_j$

$\neq$

15° ADDI  $n_k$ , \$zero, 0

$n_i$ ,  $n_j$

BNE  $n_i$ ,  $n_j$ , EXIT-3

SUB  $n_i$ ,  $n_i$ ,  $n_j$

$\neq$

BEQ  $n_i$ , \$zero, EXIT-3

$n_i$ ,  $n_j$

ADDI  $n_k$ , \$zero, 1

SIE  $n_k$ ,  $n_i$ ,  $n_j$

$\neq$

EXIT-3:

$n_i$ ,  $n_j$

16° ADDI  $n_k$ , \$zero, 1

SGE  $n_k$ ,  $n_i$ ,  $n_j$

$\geq$

BEQ  $n_i$ ,  $n_k$ , EXIT-4

$n_i$ ,  $n_j$

BEQ  $n_j$ ,  $n_k$ , EXIT-4

SLT  $n_k$ ,  $n_i$ ,  $n_j$

$\leq$

ADDI  $n_k$ , \$zero, 0

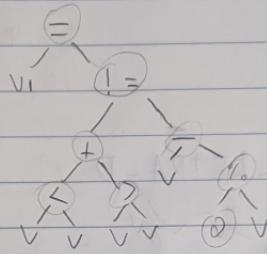
$n_i$ ,  $n_j$

Exit-4:

Marcos Filipe Alves de Barros

- 17º AND  $\text{R}_K, \text{R}_I, \text{R}_J$   $\begin{matrix} & 8 \\ & \diagdown \\ \text{R}_K \text{ R}_J \end{matrix}$  10º SLL  $\text{R}_K, \text{R}_I, \text{R}_J$   $\begin{matrix} & 11 \\ & \diagup \\ \text{R}_K \text{ R}_J \end{matrix}$
- 18º OR  $\text{R}_K, \text{R}_I, \text{R}_J$   $\begin{matrix} & 1 \\ & \diagdown \\ \text{R}_K \text{ R}_J \end{matrix}$  21º SAL  $\text{R}_K, \text{R}_I, \text{R}_J$   $\begin{matrix} & 22 \\ & \diagup \\ \text{R}_K \text{ R}_J \end{matrix}$
- 19º XOR  $\text{R}_K, \text{R}_I, \text{R}_J$   $\begin{matrix} & 1 \\ & \diagdown \\ \text{R}_K \text{ R}_J \end{matrix}$

### LISTA-17-EXERCICIO-4-LETRA-A



SLT  $\text{R}_1, \text{V}, \text{V}$

ADDI  $\text{R}_1, \$zero, 1$

SGT  $\text{R}_2, \text{V}, \text{V}$

BNE  $\text{R}_3, \text{R}_4, \text{EXIT-2}$

ADDI  $\text{R}_3, \text{R}_1, \text{R}_2$

ADDI  $\text{R}_3, \$zero, 0$

ADDI  $\text{R}_4, \$zero, 2$

EXIT-2

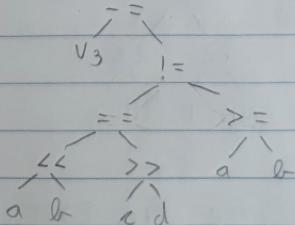
DIV  $\text{R}_4, \text{V}$

MOVE  $\text{V}_1, \text{R}_7$

MFHI  $\text{R}_5$

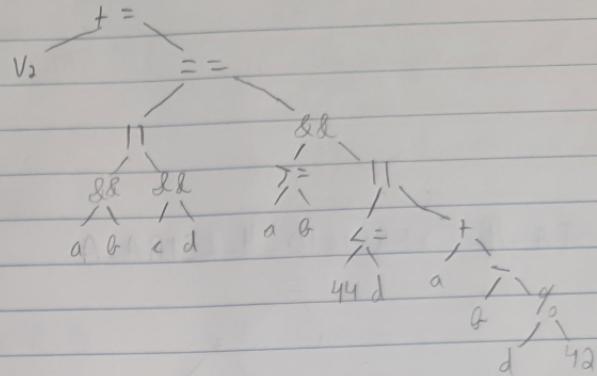
SUB  $\text{R}_6, \text{V}, \text{R}_5$

### LISTA-17-EXERCICIO-4-LETRA-C

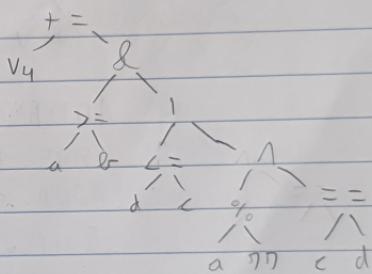


Marco Lúcio Alves de Barros

LISTA-17-EXERCICIO-4-LETRA-B



LISTA-17-EXERCICIO-4-LETRA-D



LISTA-17-EXERCICIO-4-LETRA-E

ADDI  $n_1$ , \$zero,  $111$

ADDI  $n_2$ , \$zero,  $1$

SLL  $n_3$ ,  $n_1$ ,  $n_2$

ADDI  $n_4$ , \$zero,  $111$

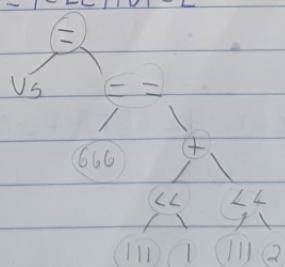
ADDI  $n_5$ , \$zero,  $2$

SLL  $n_6$ ,  $n_4$ ,  $n_5$

ADDI  $n_7$ ,  $n_3$ ,  $n_6$

ADDI  $n_8$ , \$zero,  $666$

ADDI  $n_9$ , \$zero,  $1$



BEQ  $n_8$ ,  $n_7$  EXIT -1

ADDI  $n_9$ , \$zero 0

EXIT :

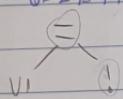
MOVE  $v_5$ ,  $n_9$

Marcos Julio Alves de Barros

LISTA-17-EXERCICIO-5

- 1º  $n_i$  Temp i  $\eta^o$  LW  $n_k, 0(n_i)$   $n_i$
- 2º ADDI  $n_k, \$zero, c$  (const e)  $n_i$
- 3º ADD  $n_k, \$zero, n_i$   $n_i$   $\eta^o$  ADDI  $n_k, \$zero, 0$   $n_i$   
NOR  $n_{k+1}, n_i, n_{k+1}$   $n_i$
- 4º SUB  $n_k, \$zero, n_i$   $n_i$   $\eta^o$  ADDI  $n_k, \$zero, 1$   $n_i$   
BEQZ,  $n_i$ , EXIT  $n_i$
- 5º ADDI  $n_i, n_i, 1$   $n_i$   $\eta^o$  ADDI  $n_k, \$zero, 0$   
EXIT  $n_i$
- 6º ADDI  $n_i, n_i, -1$   $n_i$

LISTA-17-EXERCICIO-6-LETRA-A



AND  $n_1, 0, b$

ADDI  $n_5, \$zero, 0$

ADDI  $n_2, \$zero, 0$

EXIT:

NOR  $n_3, c, n_2$

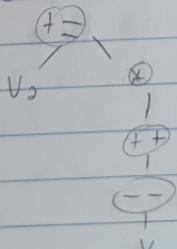
MOVE  $V_1, n_5$

OR  $n_4, n_1, n_3$

ADDI  $n_5, \$zero, 1$

BEQZ  $n_4$ , EXIT

LISTA-17-EXERCICIO-6-LETRA-B



ADDI  $V, V, -1$

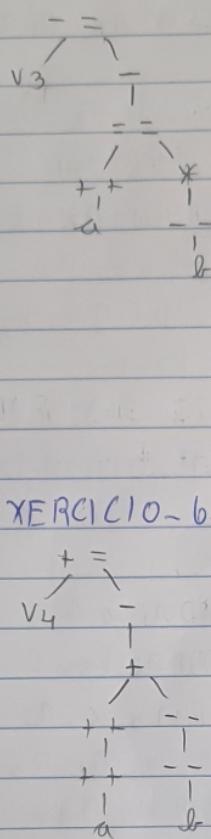
ADDI  $V, V, 1$

LW  $n, 0(V)$

ADD  $V_2, V_2, n$

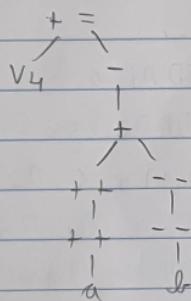
Marco Filho Alves de Barros

### LISTA-17-EXERCICIO-6-LETRA-C



ADDI a, a, 1  
ADDI b, b, -1  
LW n1, 0(b)  
ADDI n2, \$zero, 1  
BEQ a, n1, EXIT  
ADDI n2, \$zero, 0  
EXIT  
SUB n3, \$zero, n2  
SUB V3, V3, n3

### LISTA-17-EXERCICIO-6-LETRA-D



### LISTA-17-EXERCICIO-6-LETRA-E

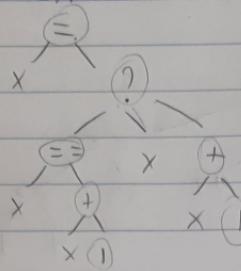
ADDI n1, \$zero, 1  
SUB n2, \$zero, n1  
SUB V3, V3, n2

### LISTA-17-EXERCICIO-7.

? BEQZ EXP, FALSE  
/ \ TRUE: ADD n1, \$zero, +  
Exp T F J EXIT  
FALSE: ADD n1, \$zero, - F  
EXIT

Marcos Lúcio Alves de Barros

LISTA-17-EXERCICIO-8-LETRA-A



ADD1  $n_1$ , \$zero, 1  
ADD1  $n_2$ ,  $x$ ,  $n_1$ ,  
ADD1  $n_3$ , \$zero, 1  
BEQ  $x$ ,  $n_2$ , EXIT-1  
ADD1  $n_3$ , \$zero, 0  
EXIT-1:  
ADD1  $n_4$ , \$zero, 1  
ADD  $n_5$ ,  $x$ ,  $n_4$

BEQ2  $n_3$ , FALSE

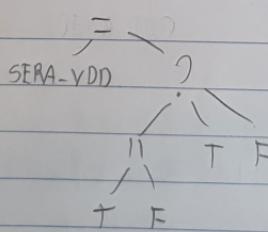
TRUE: ADD  $n_6$ , \$zero,  $x$   
J EXIT

FALSE: ADD  $n_6$ , \$zero,  $n_5$

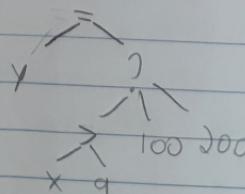
EXIT:

MOVE  $x$ ,  $n_6$

LISTA-17-EXERCICIO-8-LETRA-B

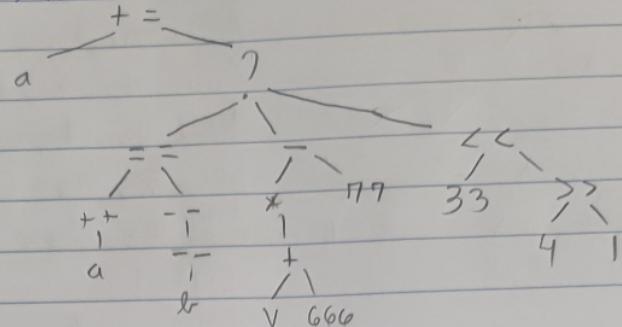


LISTA-17-EXERCICIO-8-LETRA-D

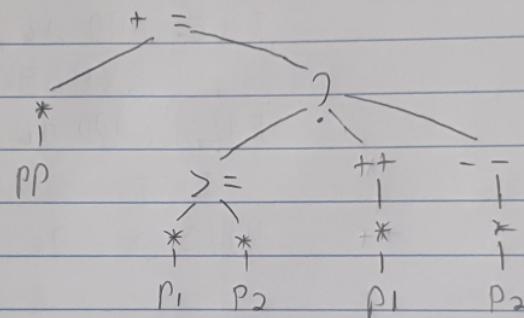


Maria Lilié Alves de Barros

LISTA-17-EXERCICIO-8-LETRA-C



LISTA-17-EXERCICIO-8-LETRA-E



LISTA-18-EXERCICIO-1

addi \$s0, \$zero, -1 // n

j test-while

label-while:

jal value

add \$s1, \$zero, \$V0 // a

jal value

add \$s2, \$zero, \$V0 // b

jal value

add \$s3, \$zero, \$V0 // c

Maria Lúcia Alves de Barros

add n<sub>0</sub>, \$n<sub>2</sub>, \$n<sub>3</sub> // b + c

slt n<sub>1</sub>, \$n<sub>1</sub>, n<sub>0</sub> // a < b + c

add n<sub>2</sub>, \$n<sub>1</sub>, \$n<sub>3</sub> // a + b

slt n<sub>3</sub>, \$n<sub>2</sub>, n<sub>2</sub> // b < a + c

add n<sub>4</sub>, \$n<sub>1</sub>, \$n<sub>2</sub> // a + b

slt n<sub>5</sub>, \$n<sub>3</sub>, n<sub>4</sub> // c < a + b

beqz n<sub>1</sub>, end-if-1

beqz n<sub>2</sub>, end-if-1 // AND

beqz n<sub>5</sub>, end-if-1

bne \$n<sub>1</sub>, \$n<sub>2</sub>, false-if-2 // a == b

bne \$n<sub>2</sub>, \$n<sub>3</sub>, false-if-2 // b == c

add \$n<sub>0</sub>, \$zero, \$zero // n = 0

g end-if-2

false-if-2:

beq \$n<sub>1</sub>, \$n<sub>2</sub>, true-if-3 // a == b

beq \$n<sub>2</sub>, \$n<sub>3</sub>, true-if-3 // a == c OR

beq \$n<sub>3</sub>, \$n<sub>2</sub>, true-if-3 // c == b

addi \$n<sub>0</sub>, \$zero, 2 // n = 2

g end-if-3

true-if-3:

addi \$n<sub>0</sub>, \$zero, 1 // n = 1

Marcos Lúcio Alves de Barros

end - if - 3

end - if - 2

end - if - 1

test - while :

addi \$t\_6, \$zero, 1

beg \$t\_{20}, \$t\_6, label - while // while ( $t_7 = 2 \neq 1$ )

move \$t\_0, \$t\_{20} // return  $t_7$

### LISTA-19-EXERCICIO-1-LETRA-A

$$G_i = \{d_1, d_5\}$$

$$G_j = \{d_2, d_8\}$$

$$G_{t_1} = \{d_3\}$$

$$G_V = \{d_4\}$$

$$G_{t_5} = \{d_6\}$$

$$G_{t_3} = \{d_7\}$$

$$G_{t_4} = \{d_9\}$$

$$G_{t_6} = \{d_{11}\}$$

$$G_x = \{d_{12}, d_{18}\}$$

$$G_{t_7} = \{d_{13}\}$$

$$G_{t_8} = \{d_{14}\}$$

$$G_{t_9} = \{d_{15}\}$$

$$G_{t_{10}} = \{d_{16}\}$$

$$G_{t_{11}} = \{d_{17}\}$$

$$G_{t_{12}} = \{d_{19}\}$$

$$G_{t_{13}} = \{d_{20}\}$$

$$G_{t_{14}} = \{d_{21}\}$$

$$G_{t_{15}} = \{d_{22}\}$$

$$P(B_1) = \emptyset$$

$$P(B_2) = \{B_1, B_2, B_5\}$$

$$P(B_3) = \{B_2, B_3\}$$

$$P(B_4) = \{B_3\}$$

$$P(B_5) = \{B_4\}$$

$$P(B_6) = \{B_4\}$$

$$\text{gen } B_1 = \{d_1, d_5, d_3, d_4\}$$

$$\text{kill } B_1 = \{d_5, d_8\}$$

$$\text{gen } B_2 = \{d_5, d_6, d_7\}$$

$$\text{kill } B_2 = \{d_1, 2\}$$

$$\text{gen } B_3 = \{d_8, d_9, d_{10}\}$$

$$\text{kill } B_3 = \{d_9\}$$

$$\text{gen } B_4 = \emptyset$$

$$\text{kill } B_4 = \emptyset$$

$$\text{gen } B_5 = \{d_{11}, d_{12}, d_{13}, d_{14}, d_{15}, d_{16}\}$$

$$\text{kill } B_5 = \{d_{11}\}$$

$$\text{gen } B_6 = \{d_{17}, d_{18}, d_{19}, d_{20}, J_{11}, J_{12}\}$$

$$\text{kill } B_6 = \{d_{12}\}$$

Marcos Julio Alves de Barros

IN:  $V_{out}(P(B))$

OUT:  $genB \cup (IN(B) - kill(B))$

1° IN OUT

B<sub>1</sub> d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>

B<sub>2</sub> d<sub>3</sub>, d<sub>6</sub>, d<sub>7</sub>

B<sub>3</sub> d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>

B<sub>4</sub> d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>

B<sub>5</sub> d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>6</sub> d<sub>17</sub>, d<sub>18</sub>, d<sub>19</sub>, d<sub>20</sub>, d<sub>21</sub>, d<sub>22</sub>

IN

OUT

d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>

d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>, d<sub>17</sub>, d<sub>18</sub>, d<sub>19</sub>, d<sub>20</sub>, d<sub>21</sub>, d<sub>22</sub>

d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>

d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>

d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>17</sub>, d<sub>18</sub>, d<sub>19</sub>, d<sub>20</sub>, d<sub>21</sub>, d<sub>22</sub>

2° IN

OUT

B<sub>1</sub> d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>

B<sub>2</sub> d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>3</sub> d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>4</sub> d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>

d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>5</sub> d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>

d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>6</sub> d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>

d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

3° → 4°

IN

OUT

B<sub>1</sub> d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>

B<sub>2</sub> d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>3</sub> d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>4</sub> d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

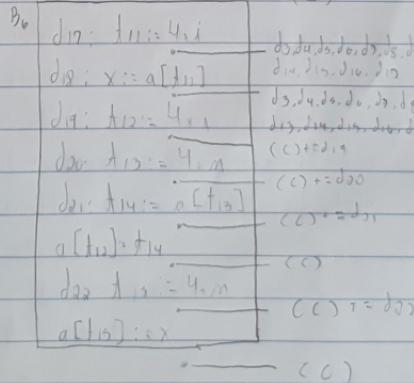
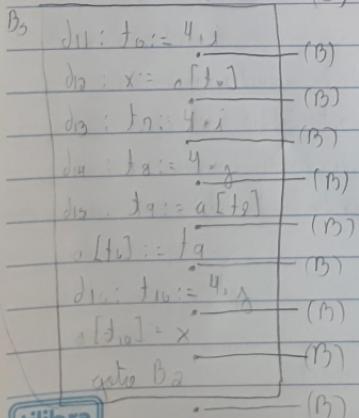
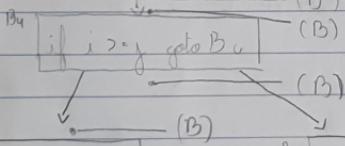
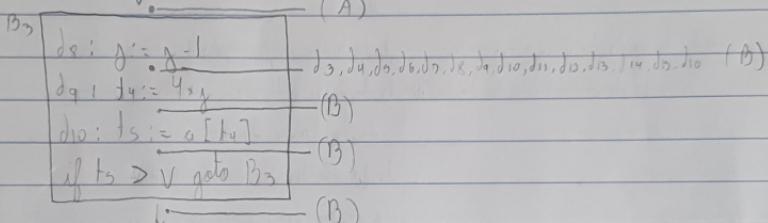
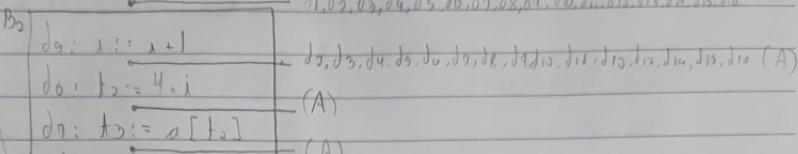
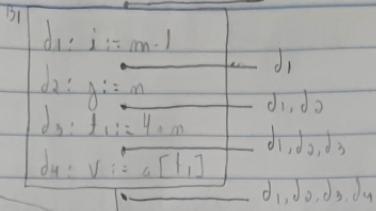
B<sub>5</sub> d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>6</sub> d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

Marco Julio Alves de Barros



Maria Lúcia Alves de Barros

LISTA A-19- EXERCICIO -1- LETRA-B

$$G_c = \{d_1, d_{15}\}$$

$$G_a = \{d_2, d_{15}\}$$

$$G_b = \{d_2, d_6, d_7, d_9, d_{13}, d_{17}\}$$

$$G_d = \{d_{10}, d_{14}\}$$

$$G_m = \{d_3\}$$

$$G_e = \{d_9, d_{10}\}$$

$$G_f = \{d_4, d_8\}$$

$$G_g = \{d_{11}, d_{16}, d_{19}\}$$

IN OUT ( $P(B)$ )

$$P(B_0) = \emptyset$$

$$P(B_4) = \{B_0\}$$

$$OUT = G_{in} B \cup (P(B) \cup B)$$

$$P(B_1) = \{B_0, B_6\}$$

$$P(B_5) = \{B_4\}$$

$$P(B_2) = \{B_1\}$$

$$P(B_6) = \{B_3, B_4, B_9\}$$

$$P(B_3) = \{B_3\}$$

$$P(B_7) = \{B_1, B_6\}$$

$$gen B_0 = \{d_1, d_2, d_3, d_4\}$$

$$kill B_0 = \{d_{15}, d_6, d_7, d_9, d_{13}, d_{17}, d_8\}$$

$$gen B_1 = \{d_5, d_6\}$$

$$kill B_1 = \{d_{18}, d_2, d_7, d_9, d_{13}, d_{17}\}$$

$$gen B_2 = \{d_7, d_8\}$$

$$kill B_2 = \{d_3, d_6, d_{13}, d_{17}, d_4\}$$

$$gen B_3 = \{d_9, d_{10}\}$$

$$kill B_3 = \{d_{12}, d_{14}\}$$

$$gen B_4 = \{d_{11}, d_{12}\}$$

$$kill B_4 = \{d_{16}, d_{19}, d_8\}$$

$$gen B_5 = \{d_{13}, d_{14}\}$$

$$kill B_5 = \{d_2, d_6, d_7, d_{17}, d_{10}\}$$

$$gen B_6 = \{d_{17}, d_{16}\}$$

$$kill B_6 = \{d_1, d_{11}, d_9\}$$

$$gen B_7 = \{d_{17}, d_{18}, d_{19}\}$$

$$kill B_7 = \{d_2, d_6, d_7, d_{13}, d_5, d_{11}, d_{16}\}$$

IN	OUT	IN	OUT
$B_0$	$d_1, d_2, d_3, d_4$		$d_1, d_2, d_3, d_4$
$B_1$	$d_9, d_6$	$d_1, d_2, d_3, d_4, d_{15}, d_{16}$	$d_1, d_3, d_4, d_5, d_6, d_9, d_{14}$
$B_2$	$d_7, d_8$	$d_9, d_6$	$d_9, d_7, d_8$
$B_3$	$d_9, d_{10}$	$d_7, d_8$	$d_7, d_8, d_9, d_{10}$
$B_4$	$d_{11}, d_{12}$	$d_9, d_8$	$d_7, d_8, d_{11}, d_{12}$
$B_5$	$d_{13}, d_{14}$	$d_{11}, d_{12}$	$d_{11}, d_{12}, d_{13}, d_{14}$
$B_6$	$d_{19}, d_{16}$	$d_9, d_6, d_{11}, d_{13}, d_{17}, d_{14}$	$d_9, d_{10}, d_{12}, d_{13}, d_{14}, d_{15}, d_{16}$
$B_7$	$d_{17}, d_8, d_{11}$	$d_5, d_6, d_{13}, d_{16}$	$d_{15}, d_{17}, d_{18}, d_{19}$

Marco Júlio Alves de Barros

IN

OUT

B<sub>0</sub>

d, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>

B<sub>1</sub> d, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>1</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>12</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>2</sub> d, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>

d<sub>1</sub>, d<sub>3</sub>, d<sub>5</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>

B<sub>3</sub> d<sub>5</sub>, d<sub>7</sub>, d<sub>8</sub>

d<sub>5</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>

B<sub>4</sub> d<sub>5</sub>, d<sub>7</sub>, d<sub>8</sub>

d<sub>5</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>11</sub>, d<sub>12</sub>

B<sub>5</sub> d<sub>7</sub>, d<sub>8</sub>, d<sub>11</sub>, d<sub>12</sub>

d<sub>7</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>

B<sub>6</sub> d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>

d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>7</sub> d<sub>1</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>10</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>1</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>10</sub>, d<sub>12</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>, d<sub>18</sub>, d<sub>19</sub>

4°

IN

OUT

B<sub>0</sub>

d, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>

B<sub>1</sub> d, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>1</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>12</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>2</sub> d, d<sub>3</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>

d<sub>1</sub>, d<sub>3</sub>, d<sub>5</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>12</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>3</sub> d, d<sub>2</sub>, d<sub>3</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>10</sub>, d<sub>11</sub>

d<sub>1</sub>, d<sub>3</sub>, d<sub>5</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>12</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>4</sub> d, d<sub>2</sub>, d<sub>3</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>

d<sub>1</sub>, d<sub>3</sub>, d<sub>5</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>15</sub>

B<sub>5</sub> d<sub>2</sub>, d<sub>3</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>11</sub>, d<sub>12</sub>

d<sub>2</sub>, d<sub>3</sub>, d<sub>8</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>

B<sub>6</sub> d<sub>5</sub>, d<sub>6</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>13</sub>, d<sub>14</sub>

d<sub>5</sub>, d<sub>6</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

B<sub>7</sub> d, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>11</sub>, d<sub>12</sub>, d<sub>13</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>16</sub>

d<sub>1</sub>, d<sub>3</sub>, d<sub>4</sub>, d<sub>5</sub>, d<sub>6</sub>, d<sub>7</sub>, d<sub>8</sub>, d<sub>9</sub>, d<sub>10</sub>, d<sub>12</sub>, d<sub>14</sub>, d<sub>15</sub>, d<sub>17</sub>, d<sub>19</sub>, d<sub>10</sub>

# Marcos Julio Almeida Marques

$$\boxed{B_0} \begin{cases} d_1: c = a + b \\ d_2: b = b + c \\ d_3: m = d - e \\ d_4: f = 0 \end{cases}$$

$d_1, d_2, d_3, d_4$

$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8, d_9, d_{10}, d_{11}, d_{12}, d_{13}, d_{14}, d_{15}, d_{16} \quad (A)$

$$\boxed{B_1} \begin{cases} d_5: a = d - e \\ d_6: b = b + a \end{cases}$$

$d_1, d_2, d_3, d_4, d_5, d_6, d_8, d_9, d_{10}, d_{12}, d_{14}, d_{15}, d_{16} \quad (B)$

$$\boxed{B_2} \begin{cases} d_7: b = b + c \\ d_8: f = 1 \end{cases}$$

$d_1, d_2, d_3, d_4, d_5, d_7, d_8, d_9, d_{10}, d_{12}, d_{14}, d_{15}, d_{16} \quad (C)$

$$\boxed{B_3} \begin{cases} d_9: e = a + b \\ d_{10}: d = d - e \end{cases}$$

$d_1, d_2, d_3, d_4, d_5, d_7, d_8, d_9, d_{10}, d_{12}, d_{14}$

$$\boxed{B_4} \begin{cases} d_{11}: g = 30 \\ d_{12}: e = b - a \end{cases}$$

$(C) - d_{16} + d_{11}$

$$\boxed{B_5} \begin{cases} d_{13}: b = f + g \\ d_{14}: d = d - e \end{cases}$$

$(D) - d_7 + d_{13}$

$$\boxed{B_6} \begin{cases} d_{15}: c = b + e \\ d_{16}: g = f + 23 \end{cases}$$

$(E) - d_1 + d_{15}$

$$d_3, d_5, d_7, d_8, d_{10}, d_{11}, d_{12}, d_{13}, d_{14}, d_{15}, d_{16}$$

$$d_1, d_2, d_4, d_5, d_6, d_8, d_9, d_{10}, d_{11}, d_{12}, d_{13}, d_{14}, d_{15}, d_{16} \quad (F)$$

$$\boxed{B_7} \begin{cases} d_{17}: b = b + c \\ d_{18}: a = b - a \\ d_{19}: g = f + 1 \end{cases}$$

$(F) - d_6 - d_7 - d_{13} + d_{17}$

$(F) - d_5 + d_8$

$$d_1, d_2, d_3, d_4, d_8, d_9, d_{10}, d_{12}, d_{14}, d_{15}, d_{17}, d_{18}, d_{19}$$

Maria Silvia Alves de Barros

LISTA-19- EXERCICIO - 1-LETRA - C

$$G_c = \{d_1, d_{10}\}$$

$$G_f = \{d_4, d_8\}$$

$$G_B = \{d_7\}$$

$$G_d = \{d_2\}$$

$$G_g = \{d_5\}$$

$$G_{dr} = \{d_9\}$$

$$G_e = \{d_3\}$$

$$G_a = \{d_6\}$$

$$P(B_1) = \emptyset$$

$$P(B_2) = \{B_2\}$$

$$P(B_3) = \{B_3, B_4\}$$

$$P(B_5) = \{B_1, B_3\}$$

$$P(B_6) = \{B_3\}$$

$$P(B_6) = \{B_4\}$$

$$g_m B_1 = \{d_1, d_2, d_3\}$$

$$kull B_1 = \{d_{10}\}$$

$$g_m B_2 = \{d_4, d_5, d_6\}$$

$$kull B_2 = \{d_8\}$$

$$g_m B_3 = \{d_7\}$$

$$kull B_3 = \{\}$$

$$g_m B_4 = \{d_8\}$$

$$kull B_4 = \{d_4\}$$

$$g_m B_5 = \{d_9\}$$

$$kull B_5 = \{\}$$

$$g_m B_6 = \{d_{10}\}$$

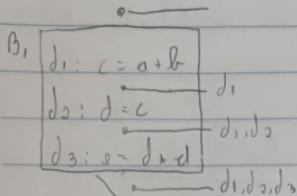
$$kull B_6 = \{d_1\}$$

1°	OUT	IN	OUT	IN	OUT
$B_1$	$d_1, d_2, d_3$		$d_1, d_2, d_3$		$d_1, d_2, d_3$
$B_2$	$d_4, d_5, d_6$	$d_1, d_2, d_3, d_4$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8, d_9$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8, d_9$
$B_3$	$d_7$	$d_4, d_5, d_6$	$d_4, d_5, d_6, d_7$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8$
$B_4$	$d_8$	$d_4, d_5, d_6$	$d_5, d_6, d_8$	$d_1, d_2, d_3, d_4, d_5, d_6, d_9$	$d_1, d_2, d_3, d_4, d_6, d_8, d_9$
$B_5$	$d_9$	$d_7, d_8$	$d_7, d_8, d_9$	$d_4, d_5, d_6, d_7, d_8$	$d_4, d_5, d_6, d_7, d_8, d_9$
$B_6$	$d_{10}$	$d_8$	$d_8, d_{10}$	$d_7, d_8, d_9$	$d_7, d_8, d_9, d_0$

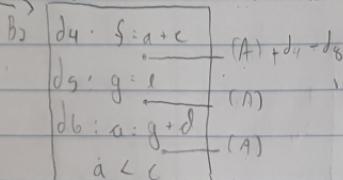
4°

IN	OUT
$B_1$	$d_1, d_2, d_3$
$B_2$ $d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8$
$B_3$ $d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8$
$B_4$ $d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8$
$B_5$ $d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8, d_9$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8, d_9$
$B_6$ $d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8, d_9, d_{10}$	$d_2, d_3, d_5, d_6, d_8, d_9, d_{10}$

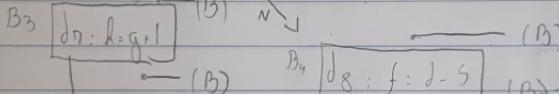
# Marco Júlio Alves de Barros



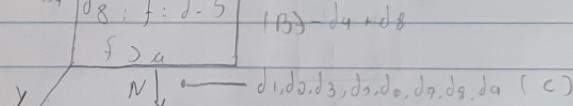
$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8, d_9, d_{10} \text{ (A)}$



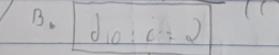
$y \downarrow$   $d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8 \text{ (B)}$



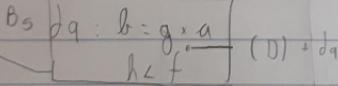
$(B) \rightarrow d_4 + d_8$



$d_1, d_2, d_3, d_5, d_6, d_7, d_8, d_9, d_{10} \text{ (C)}$



$\leftarrow d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8, d_9, d_{10} \text{ (D)}$



EXIT

$\leftarrow (D)$

$N$

Marco Filho Alves de Barros

LISTA-19 - EXERCICIO-2 - LETRA - A

$$B_1 \quad \begin{array}{|c|} \hline b_1: a = 5 \\ \hline b_2: c = 1 \\ \hline \end{array} \quad d_1, d_2$$

L1: if  $c > a$  goto L2

$$B_3 \quad \begin{array}{|c|} \hline b_3: c = c + c \\ \hline \text{goto L1} \\ \hline \end{array} \quad d_1, d_2, d_3$$

B2

$$B_4 \quad \begin{array}{|c|} \hline b_4: a = c - a \\ \hline b_5: c = 0 \\ \hline \text{print}(c) \\ \hline \end{array} \quad \begin{array}{l} d_1, d_2, d_3 \\ d_2, d_3, d_4 \\ d_4, d_5 \end{array}$$

$$B_1 \quad \begin{array}{|c|} \hline a = 5 \\ \hline c = 1 \\ \hline \end{array}$$

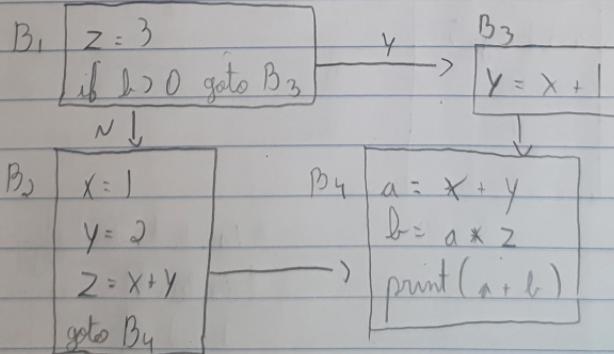
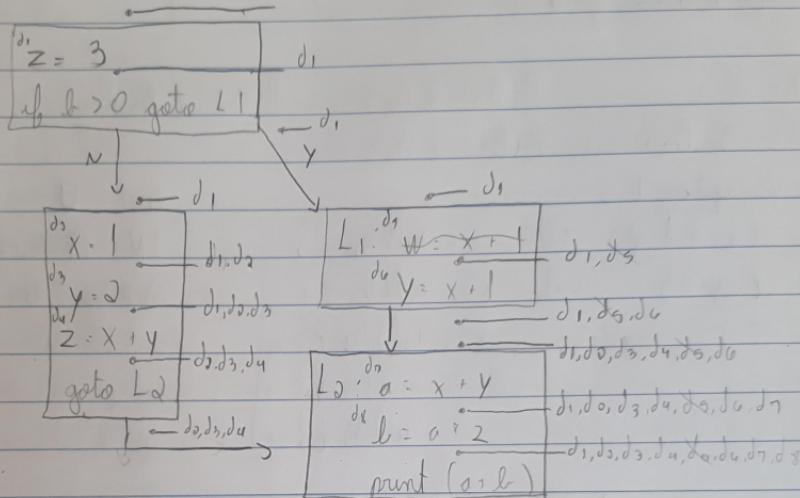
B2  
if  $c > a$  goto B4

$$B_3 \quad \begin{array}{|c|} \hline c = c + c \\ \hline \text{goto B2} \\ \hline \end{array}$$

$$B_4 \quad \begin{array}{|c|} \hline c = 0 \\ \hline \text{print}(c) \\ \hline \end{array}$$

Mario Túlio Alves de Barros

LISTA - 19. EXERCICIO - 2 - LETRA - B



Marcos Lúcio Alves de Barros

LISTA-20- EXERCÍCIO-1-LETRA-A

$$U = \emptyset \quad a = 3, d = 2, g = 5 \}$$

$$P(B_1) = \emptyset$$

$$P(B_3) = \{B_3\}$$

$$P(B_5) = \{B_3, B_4\}$$

$$P(B_2) = \{B_1, B_3\}$$

$$P(B_4) = \{B_2\}$$

\* Constant propagation 1

$$\text{gen } B_1 = \{a = 3, d = 2\}$$

$$\text{kll } B_1 = \{\}$$

$$\text{OUT} = U - \text{kll}(B)$$

$$\text{gen } B_2 = \{g = 5\}$$

$$\text{kll } B_2 = \{\}$$

$$IN = \bigcap \text{OUT}(P(B))$$

$$\text{gen } B_3 = \{\}$$

$$\text{kll } B_3 = \{\}$$

$$\text{gen } B_4 = \{\}$$

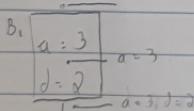
$$\text{kll } B_4 = \{\}$$

$$\text{gen } B_5 = \{d = 2\}$$

$$\text{kll } B_5 = \{\}$$

$$\text{OUT} = \text{gen } B \cup (IN_B - \text{kll } B)$$

IN	OUT	IN	OUT
$B_1$	$a = 3, d = 2, g = 5$		$a = 3, d = 2, g = 5$
$B_2$		$a = 3, d = 2, g = 5$	
$B_3$			
$B_4$			
$B_5$			



$$B_2: f = \frac{a+d}{3+2}$$

$$g = 5$$

$$h = 5 - 2$$

$$a = 3, d = 2, g = 5$$

$$y \leftarrow \text{if } f \leq 5$$

$$v \leftarrow a = 2, d = 2, g = 5$$

$$B_3: f = 5 + 1$$

$$a = 3, d = 2, g = 5$$

$$a = 3, d = 2, g = 5$$

$$d = 2$$

$$a = 3, d = 2, g = 5$$

\* Constant Folding:



$$B_2: f = 5$$

$$g = 5$$

$$a = 3$$

$$\text{if } f \leq 5$$

$$y \leftarrow \text{if } f \leq 5$$

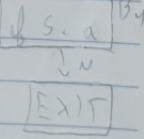
$$v \leftarrow a = 2, d = 2, g = 5$$

$$B_3: f = 6$$

$$a = 3, d = 2, g = 5$$

$$d = 2$$

$$a = 3, d = 2, g = 5$$



Marcos Silvio Alves de Barros

\* Constant propagation 2

$$V = \{a=3, d=2, f=5, g=5, f=6\}$$

$$\text{gen } B_1 = \{a=3, d=2\}$$

kill  $B_1 : \{f=5\}$

$$\text{gen } B_2 = \{f=5, g=5, a=3\}$$

kill  $B_2 : \{f=5, g=6\}$

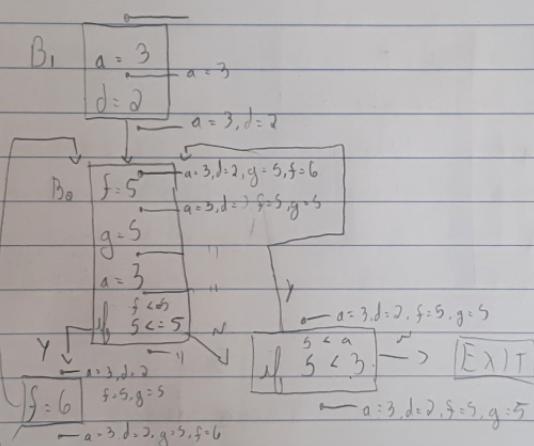
$$\text{gen } B_3 = \{f=5\}$$

kill  $B_3 : \{f=5\}$

$$\text{gen } B_4 = \{\}$$

kill  $B_4 : \{\}$

	IN	DUT	IN	OUT
$B_1$	$a=3, d=2, f=5, g=5, f=5$			$a=3, d=2$
$B_2$	$a=3, d=2, f=5, g=5$	$a=3, d=2, g=5, f=6$	$a=3, d=2, f=5, g=5$	
$B_3$	$a=3, d=2, g=5, f=6$	$a=3, d=2, f=5, g=5$	$a=3, d=2, g=5, f=6$	
$B_4$	$a=3, d=2, f=5, g=5, f=6$	$a=3, d=2, f=5, g=5$	$a=3, d=2, f=5, g=5$	



eliminación

en los bloques

nenhum outro método de otimização pode ser aplicado //

Marco Lílio Alves de Barros

## LISTA-20- EXERCICIO -1- LETRA -B

$$U = \{ d = c, g = e \}$$

$$\underline{P(B_1)} = \emptyset$$

$$P(B_3) = \{B_2\}$$

$$P(B_2) = \{B_1, B_5\}$$

$$P(B_4) = \{B_2\}$$

$B_{16} \rightarrow$  demora para não retorna  
para o fluxo principal.

$$\text{gen } B_1 = \emptyset \text{ d} = \{ \}$$

Kill B<sub>1</sub>: 23

$$out = U - kill(B)$$

$$\sin B_2 = \frac{g}{e} \quad g = e^k$$

null Back

$$IN = \cap OUT(P(M))$$

$$\text{gn } B_3 = \{$$

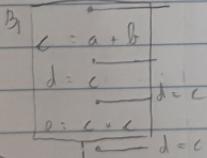
$$W B_3 = \emptyset$$

$$\text{OUT} = \text{genB} \vee (\text{INB} - \text{keB})$$

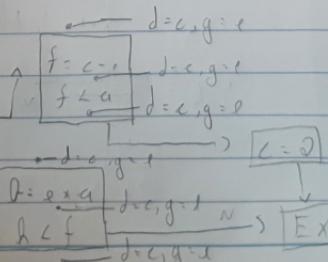
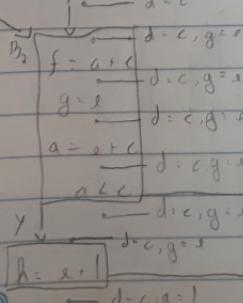
$\text{gen } B_4 = \{ \}$

Kill By: 9

	IN	OUT	IN	OUT
B1		d=c,g=e		d=c,g=e
B2	1 11	d=c,g=e		11
B3	11		11 e	11
B4	11		11 e	11
B5	11		11 e	11



A única iteração possível foi uma passada de copy propagation



Maria Lúcia Alves de Barros

OUT = U - kill(B)

LISTA-21-EXERCÍCIO-1

IN = A out(P(B))

$$U = \{a+b, a+c, d+d, c+d, i+i\}$$

$$OUT = genB \cup (INB - killB)$$

$$P(B_1) = \emptyset$$

$$P(B_3) = \{B_3\}$$

$$P(B_5) = \{B_3, B_4\}$$

$$P(B_2) = \{B_1, B_5\}$$

$$P(B_4) = \{B_2\}$$

$$genB_1 = \{a+b, a+c, d+d\}$$

$$killB_1 = \{c+d, i+i\}$$

$$genB_2 = \{a+b\}$$

$$killB_2 = \{c+d, a+c\}$$

$$genB_3 = \{a+c\}$$

$$killB_3 = \{i\}$$

$$genB_4 = \{d+d\}$$

$$killB_4 = \{i\}$$

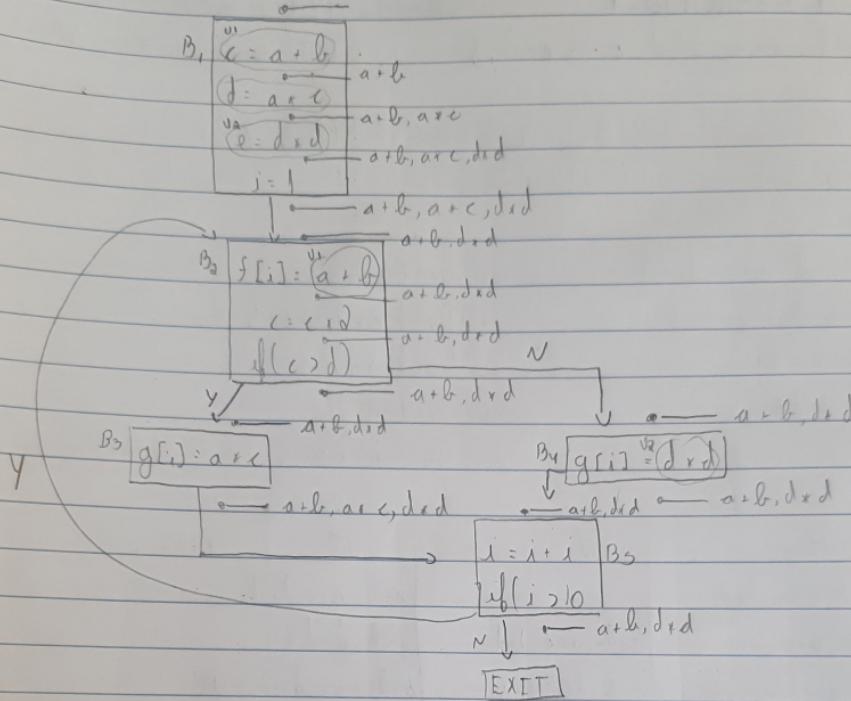
$$genB_5 = \{i\}$$

$$killB_5 = \{i+i\}$$

IN	OUT	IN	OUT
$B_1$	$a+b, a+c, d+d$		$a+b, a+c, d+d$
$B_2$	$a+b, d+d, i+i$	$a+b, a+c, d+d$	$a+b, d+d$
$B_3$	$a+b, a+c, d+d, c+d, i+i$	$a+b, d+d, i+i$	$a+b, a+c, d+d, i+i$
$B_4$	$a+b, a+c, d+d, c+d, i+i$	$a+b, d+d, i+i$	$a+b, d+d, i+i$
$B_5$	$a+b, a+c, d+d, c+d$	$a+b, a+c, d+d, c+d, i+i$	$a+b, a+c, d+d, c+d$

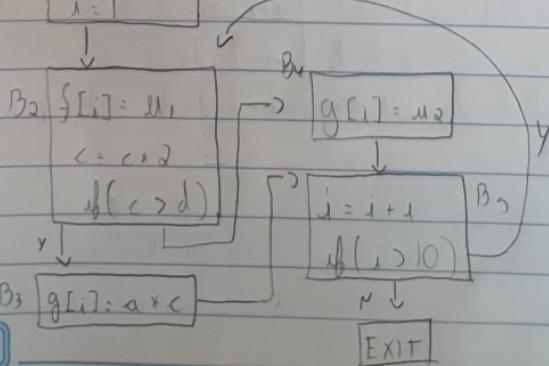
IN	OUT	IN	OUT
$B_1$	$a+b, a+c, d+d$	$a$	$a+b, a+c, d+d$
$B_2$	$a+b, a+c, d+d$	$a+b, d+d$	$a+b, d+d$
$B_3$	$a+b, d+d$	$a+b, a+c, d+d$	$a+b, a+c, d+d$
$B_4$	$a+b, d+d$	$a+b, d+d$	$a+b, d+d$
$B_5$	$a+b, d+d, i+i$	$a+b, d+d$	$a+b, d+d$

Marcos Lúcio Alves de Barros



$$\begin{aligned}
 B_1: \quad & U_1 := a + b \\
 & c = u_1 \\
 & d = a * c \\
 & U_2 = d * d \\
 & i = 1
 \end{aligned}$$

CFG após aplicar uma  
vez de CSE



Marco Lúlio Alves de Barros

## LISTA - 21 - EXERCÍCIO 10 - 2

\* Aplicar CSE

$$U = \{a+b, c+b, e+d, g+h\}$$

$$\text{OUT} = U - \text{kill}(B)$$

$$IN = \Delta \text{out}(P(B))$$

$$\text{OUT} = \text{gen}(B) \cup (\text{IN}(B) - \text{kill}(B))$$

$$P(B_1) = \emptyset$$

$$P(B_2) = B_1$$

$$P(B_3) = B_1$$

$$P(B_4) = B_2, B_3$$

$$\text{gen } B_1 = \{a+b\}$$

$$\text{kill } B_1 = \{c+d, e+d, c+b\}$$

$$\text{gen } B_2 = \{c+b, a+b\}$$

$$\text{kill } B_2 = \{e+d\}$$

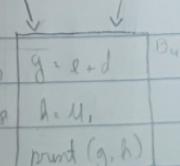
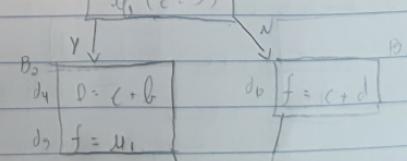
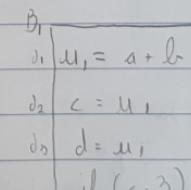
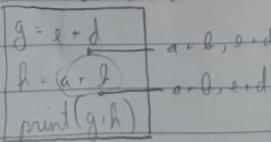
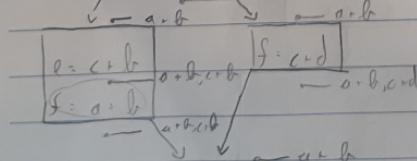
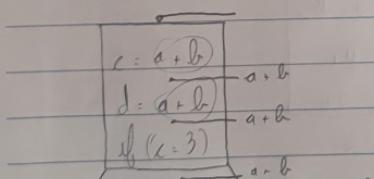
$$\text{gen } B_3 = \{c+d\}$$

$$\text{kill } B_3 = \{\}$$

$$\text{gen } B_4 = \{e+d, a+b\}$$

$$\text{kill } B_4 = \{\}$$

IN	OUT	IN	OUT	IN	OUT
$B_1$	$a+b$		$a+b$		$a+b$
$B_2$	$a+b, c+b, e+d$	$a+b$	$a+b, c+b$	$a+b$	$a+b, c+b$
$B_3$	$a+b, c+b, e+d, c+d$	$a+b$	$a+b, c+d$	$a+b$	$a+b, c+d$
$B_4$	$a+b, c+b, e+d, c+d$	$a+b, c+b, c+d$	$a+b, c+b, e+d, c+d$	$a+b$	$a+b, e+d$



Marcos Lúcio Alves de Barros

Aplicar agora Dead Code Elim.

$$G_{H_1} = \{d_1\}$$

$$G_d = \{d_2\}$$

$$G_f = \{d_5, d_6\}$$

$$G_a = \{d_8\}$$

$$G_c = \{d_3\}$$

$$G_o = \{d_4\}$$

$$G_g = \{d_7\}$$

$$P(B_1) = \emptyset$$

$$P(B_2) = B_1$$

$$P(B_3) = B_1$$

$$P(B_4) = B_2, B_3$$

$$\text{gen } B_1 = \{d_1, d_2, d_3\}$$

$$\text{kull } B_1 = \{\}$$

$$IN = V \text{ out}(P(B))$$

$$\text{gen } B_2 = \{d_4, d_5\}$$

$$\text{kull } B_2 = \{d_6\}$$

$$OUT = \text{gen } B \cup (IN B - \text{kull } B)$$

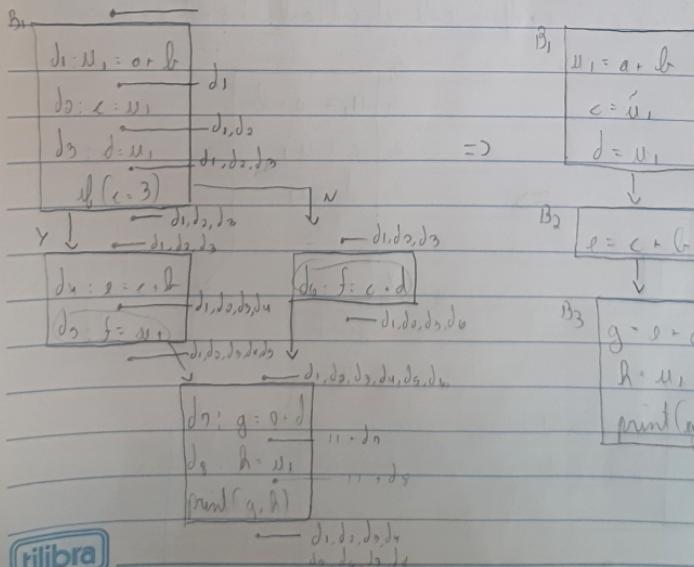
$$\text{gen } B_3 = \{d_6\}$$

$$\text{kull } B_3 = \{d_5\}$$

$$\text{gen } B_4 = \{d_7, d_8\}$$

$$\text{kull } B_4 = \{\}$$

$B_1$	$d_1, d_2, d_3$	$d_1, d_2, d_3$	$d_1, d_2, d_3$	$d_1, d_2, d_3$	$d_1, d_2, d_3$
$B_2$	$d_4, d_5$	$d_1, d_2, d_3$	$d_1, d_2, d_3, d_4, d_5$	$d_1, d_2, d_3$	$d_1, d_2, d_3, d_4, d_5$
$B_3$	$d_6$	$d_1, d_2, d_3$	$d_1, d_2, d_3, d_6$	$d_1, d_2, d_3$	$d_1, d_2, d_3, d_6$
$B_4$	$d_7, d_8$	$d_4, d_5, d_6$	$d_4, d_5, d_6, d_7, d_8$	$d_1, d_2, d_3, d_4, d_5, d_6$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8$



Marcos Lúcio Alves de Barros

Aplique Copy Propagation

$$U = \{c = u_1, d = u_1, h = u_1\}$$

$$\text{gen } B_1 = \{c = u_1, d = u_1\}$$

$$\text{kll } B_1 = \{\}$$

$$\text{OUT} = U - \text{kll } B$$

$$\text{gen } B_2 = \{\}$$

$$\text{kll } B_2 = \{\}$$

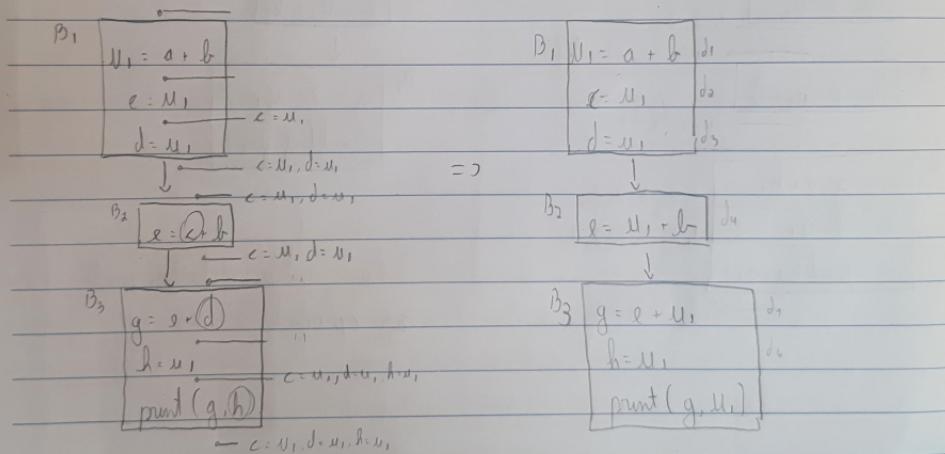
$$\text{IN} = \text{A OUT}(P(3))$$

$$\text{gen } B_3 = \{h = u_1\}$$

$$\text{kll } B_3 = \{\}$$

$$\text{OUT} = \text{gen } B \cup (\text{IN} B - \text{kll } B)$$

IN	OUT	IN	OUT
$B_1$	$c = u_1, d = u_1, h = u_1$		$c = u_1, d = u_1, h = u_1$
$B_2$		$c = u_1, d = u_1, h = u_1$	
$B_3$			



Aplique Dead Code Elim

$$G_U = \{d_1\}$$

$$G_D = \{d_3\}$$

$$G_g = \{d_5\}$$

$$G_c = \{d_2\}$$

$$G_e = \{d_4\}$$

$$G_h = \{d_6\}$$

# Marco Lúcio Alves de Barros

$$\text{gen } B_1 : \{ d_1, d_2, d_3 \} \quad \text{null } B_1 : \emptyset$$

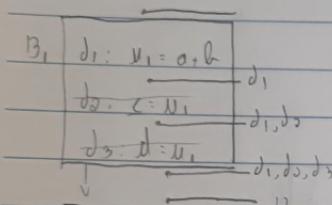
$$\text{gen } B_2 : \{ d_4 \} \quad \text{null } B_2 : \emptyset$$

$$\text{gen } B_3 : \{ d_2, d_6 \} \quad \text{null } B_3 : \emptyset$$

$$IN = U \text{ out}(P(B))$$

$$OUT = \text{gen } B \cup (IN B - \text{null } B)$$

IN	OUT	IN	OUT	IN	OUT
$B_1$	$d_1, d_2, d_3$		$d_1, d_2, d_3$		$d_1, d_2, d_3$
$B_2$	$d_4$	$d_1, d_2, d_3$	$d_1, d_2, d_3, d_4$	$d_1, d_2, d_3$	$d_1, d_2, d_3, d_4$
$B_3$	$d_2, d_6$	$d_4$	$d_4, d_3, d_6$	$d_1, d_2, d_3, d_4$	$d_1, d_2, d_3, d_4, d_5, d_6$



$$B_1 \boxed{u_1 = a + b}$$

$$B_2 \boxed{l = u_1 + b}$$

$$B_2 \boxed{d_4 : l = u_1 + b}$$

$$B_3 \boxed{g = l + u_1, \\ \text{print}(g, u_1)}$$

$$B_3 \boxed{d_5 : g = l + u_1, \\ d_6 : l = u_1 \\ \text{print}(g, u_1)}$$

Nenhum outro método pode ser aplicado.

Marcos Lúcio Alves de Barros

## LISTA-21-EXERCICIO-3

Não tem onde aplicar Constant Fielding / Propagation

Aplicar CSE

$$U = \{m-1, 4 \cdot m, i+1, 4 \cdot i, j-1, 4 \cdot j\}$$

$$P(B_1) = \emptyset$$

$$P(B_3) = B_2, B_3$$

$$P(B_5) = B_4$$

$$P(B_2) = B_1, B_2, B_5$$

$$P(B_4) = B_3$$

$$P(B_6) = B_4$$

$$\text{gen } B_1 = \{m-1, 4 \cdot m\}$$

$$\text{null } B_1 = \{j+1, 4 \cdot i, j-1, 4 \cdot j\}$$

$$\text{gen } B_2 = \{4 \cdot i\}$$

$$\text{null } B_2 = \{j-1\}$$

$$\text{gen } B_3 = \{4 \cdot j\}$$

$$\text{null } B_3 = \{j-1\}$$

$$\text{gen } B_4 = \{\}$$

$$\text{null } B_4 = \{\}$$

$$\text{gen } B_5 = \{4 \cdot i, 4 \cdot j\}$$

$$\text{null } B_5 = \{\}$$

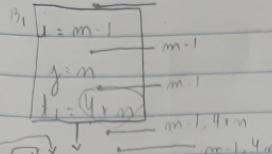
$$\text{gen } B_6 = \{4 \cdot i, 4 \cdot m\}$$

$$\text{null } B_6 = \{\}$$

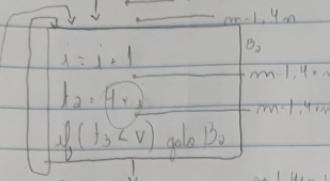
	IN	OUT	IN	OUT
$B_1$	$m-1, 4 \cdot m$			$m-1, 4 \cdot m$
$B_2$	$m-1, 4 \cdot m, 4 \cdot i, j-1, 4 \cdot j$	$m-1, 4 \cdot m$		$m-1, 4 \cdot m, 4 \cdot i$
$B_3$	$m-1, 4 \cdot m, i+1, 4 \cdot i, 4 \cdot j$	$m-1, 4 \cdot m, 4 \cdot i, 4 \cdot j$		$m-1, 4 \cdot m, 4 \cdot i, 4 \cdot j$
$B_4$	$m-1, 4 \cdot m, i+1, 4 \cdot i, j-1, 4 \cdot j$	$m-1, 4 \cdot m, i+1, 4 \cdot i, 4 \cdot j$		$m-1, 4 \cdot m, i+1, 4 \cdot i, 4 \cdot j$
$B_5$	"	$m-1, 4 \cdot m, i+1, 4 \cdot i, j-1, 4 \cdot j$		$m-1, 4 \cdot m, i+1, 4 \cdot i, j-1, 4 \cdot j$
$B_6$	"	"		"

	IN	OUT	IN	OUT
$B_1$		$m-1, 4 \cdot m$		$m-1, 4 \cdot m$
$B_2$	$m-1, 4 \cdot m$	$m-1, 4 \cdot m, 4 \cdot i$	$m-1, 4 \cdot m$	$m-1, 4 \cdot m, 4 \cdot i$
$B_3$	$m-1, 4 \cdot m, 4 \cdot i$	$m-1, 4 \cdot m, 4 \cdot i, 4 \cdot j$	$m-1, 4 \cdot m, 4 \cdot i$	$m-1, 4 \cdot m, 4 \cdot i, 4 \cdot j$
$B_4$	$m-1, 4 \cdot m, 4 \cdot i, 4 \cdot j$	$m-1, 4 \cdot m, 4 \cdot i, 4 \cdot j$	$m-1, 4 \cdot m, 4 \cdot i, 4 \cdot j$	"
$B_5$	$m-1, 4 \cdot m, i+1, 4 \cdot j$	$m-1, 4 \cdot m, i+1, 4 \cdot j$	$m-1, 4 \cdot m, i+1, 4 \cdot j$	"

# Marcos Lúcio Alves de Barron

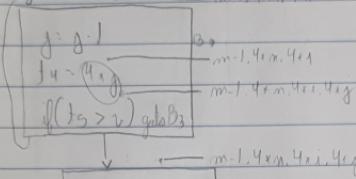
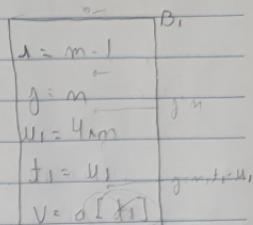


Não vou escrever expressões com vetor para poupar tempo

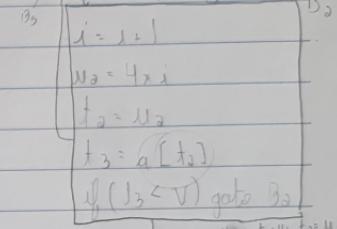


m - 1, 4 \* m, 4 \* i

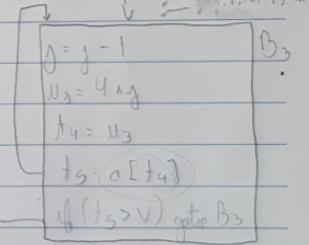
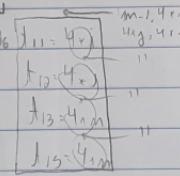
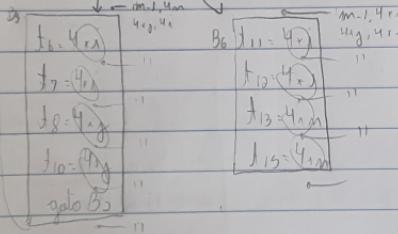
$\Rightarrow$



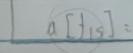
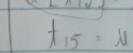
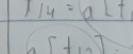
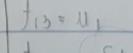
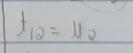
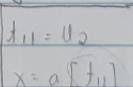
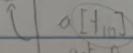
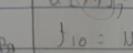
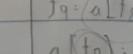
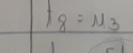
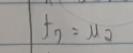
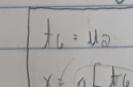
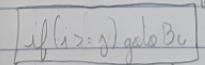
m - 1, 4 \* m, 4 \* i



$\Rightarrow$



$\Rightarrow$



Marcos Lúcio Alves de Barros

Aplicar Copy Propagation

$$U = \{ j = n, t_1 = u_1, t_2 = u_2, t_3 = u_3, t_6 = u_2, t_7 = u_3, t_{10} = u_3, t_{11} = u_2, t_{12} = u_2, t_{13} = u_1, t_{14} = u_1 \}$$

$$\text{gen } B_1 = \{ j = n, t_1 = u_1 \}$$

$$\text{null } B_1, \emptyset \emptyset$$

$$P(B_1) = \emptyset$$

$$\text{gen } B_2 = \{ t_2 = u_2 \}$$

$$\text{null } B_2, \emptyset \emptyset$$

$$P(B_2) = B_1, B_2, B_3$$

$$\text{gen } B_3 = \{ t_4 = u_3 \}$$

$$\text{null } B_3, \emptyset \emptyset$$

$$P(B_3) = B_2, B_3$$

$$\text{gen } B_4 = \{ \}$$

$$\text{null } B_4, \emptyset \emptyset$$

$$P(B_4) = B_3$$

$$\text{gen } B_5 = \{ t_6 = u_2, t_7 = u_3, t_8 = u_3, t_{10} = u_3 \}$$

$$\text{null } B_5, \emptyset \emptyset$$

$$P(B_5) = B_4$$

$$\text{gen } B_6 = \{ t_6 = u_2, t_{12} = u_2, t_{13} = u_1, t_{15} = u_3 \}$$

$$\text{null } B_6, \emptyset \emptyset$$

$$P(B_6) = B_4$$

IN	OUT	IN	OUT	IN	OUT
$B_1$	$U$		$j = n, t_1 = u_1$		$j = n, t_1 = u_1$
$B_2$	$U$	$U$	$U$	$j = n, t_1 = u_1$	$j = n, t_1 = u_1, t_2 = u_2$
$B_3$	$U$	$U$	$U$	$U$	$U$
$B_4$	$U$	$U$	$U$	$U$	$U$
$B_5$	$U$	$U$	$U$	$U$	$U$
$B_6$	$U$	$U$	$U$	$U$	$U$

IN	OUT	IN	OUT
$B_1$	$j = n, t_1 = u_1$		$j = n, t_1 = u_1$
$B_2$	$j = n, t_1 = u_1$	$j = n, t_1 = u_1, t_2 = u_2$	$j = n, t_1 = u_1, t_2 = u_2$
$B_3$	$j = n, t_1 = u_1, t_2 = u_2$	$j = n, t_1 = u_1, t_2 = u_2, t_3 = u_3$	$j = n, t_1 = u_1, t_2 = u_2, t_3 = u_3$
$B_4$	$U$	$U$	$j = n, t_1 = u_1, t_2 = u_2, t_3 = u_3$
$B_5$	$U$	$U$	$U$
$B_6$	$U$	$U$	$U$

Maria Túlio Alves de Barros

B1	i = m - 1	j1
	j = m	j2
	m - 4 * m	j3
	t1 = u1	j4
	v = a[u1]	j5

\* Não se pode usar copy propagation

pode ser aplicada em índices de vetores,

tanto do lado esquerdo quanto direito da atribuição

i = i + 1	B2
$u_2 = 4 \cdot i$	j6
$t_2 = u_2$	j7
$t_3 = a[u_2]$	j8
$\text{if } (t_3 < v) \text{ goto } B_2$	j9

j = j - 1	B3
$u_3 = 4 \cdot j$	j10
$t_4 = u_3$	j11
$t_5 = a[u_3]$	j12
$\text{if } (t_5 > v) \text{ goto } B_3$	j13

$t_6 = u_2$	j14	$t_{11} = u_2$	j20
$x = a[u_2]$	j15	$x = a[u_2]$	j21
$\cancel{t_7 = u_2}$	j16	$\cancel{t_{12} = u_2}$	j22
$\cancel{t_8 = u_3}$	j17	$\cancel{t_{13} = u_1}$	j23
$t_9 = a[u_3]$	j18	$t_{14} = a[u_1]$	j24
$a[u_2] = t_9$		$\cancel{a[u_3]} = t_{14}$	
$\cancel{t_{10} = u_3}$	j19	$\cancel{t_{15} = u_1}$	j25
$a[u_3] = x$		$a[N_1] = x$	
goto B2			— 3-14, 16-25

— 3-19

# Marcos Lúcio Alves de Barros

Aleman Dead Code Elim

$$G_1 = \{d_1, d_6\}$$

$$G_{10} = \{d_9\}$$

$$G_{22} = \{d_{17}\}$$

$$G_{15} = \{d_{25}\}$$

$$G_2 = \{d_2, d_{10}\}$$

$$G_{13} = \{d_{11}\}$$

$$G_9 = \{d_{18}\}$$

$$IN = U \text{ OUT}[P(B)]$$

$$G_{11} = \{d_3\}$$

$$G_{14} = \{d_{10}\}$$

$$G_{110} = \{d_{10}\}$$

$$G_4 = \{d_4\}$$

$$G_{5} = \{d_{13}\}$$

$$G_{111} = \{d_{20}\}$$

$$G_V = \{d_9\}$$

$$G_{6} = \{d_{14}\}$$

$$G_{110} = \{d_{20}\}$$

$$G_{13} = \{d_{13}\}$$

$$G_{x} = \{d_{13}, d_{21}\}$$

$$G_{113} = \{d_{23}\}$$

$$G_{12} = \{d_8\}$$

$$G_{7} = \{d_{16}\}$$

$$G_{114} = \{d_{24}\}$$

$$\text{gen } B_1 = \{d_1, d_2, d_3, d_4, d_5\}$$

$$\text{null } B_1 = \{d_6, d_{10}\}$$

$$P(B_1) = \emptyset$$

$$\text{gen } B_2 = \{d_6, d_7, d_8, d_9\}$$

$$\text{null } B_2 = \{d_1\}$$

$$P(B_2) = B_3, B_5$$

$$\text{gen } B_3 = \{d_{10}, d_{11}, d_{12}, d_{13}\}$$

$$\text{null } B_3 = \{d_9\}$$

$$P(B_3) = B_2, B_3$$

$$\text{gen } B_4 = \{d_9\}$$

$$\text{null } B_4 = \{d_9\}$$

$$P(B_4) = B_9$$

$$\text{gen } B_5 = \{d_{14}, d_{15}, d_{16}, d_{17}, d_{18}, d_{19}\}$$

$$\text{null } B_5 = \{d_{21}\}$$

$$P(B_5) = B_4$$

$$\text{gen } B_6 = \{d_{20}, d_{21}, d_{22}, d_{23}, d_{24}, d_{25}\}$$

$$\text{null } B_6 = \{d_{15}\}$$

$$P(B_6) = B_4$$

IN	OUT	IN	OUT	IN	OUT
$B_1$	$d_1, d_2, d_3, d_4, d_5$			$1-5$	$1-5$
$B_2$	$d_6, d_7, d_8, d_9$	$d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8,$ $d_9, d_{14}, d_{15}, d_{16}, d_{17}, d_{18}, d_{19}$		$1-9, 14-19$	$1-9, 14-19$
$B_3$	$d_{10}, d_{11}, d_{12}, d_{13}$	$d_6, d_7, d_8, d_9$ $d_{10}, d_{11}, d_{12}, d_{13}$	$6-13$	$1-14$	$1-3-19$
$B_4$		$d_{10}, d_{11}, d_{12}, d_{13}$	$10-13$	$6-13$	$6-13$
$B_5$	$d_{14}, d_{15}, d_{16}, d_{17}, d_{18}, d_{19}$			$14-19$	$10-13$
$B_6$	$d_{20}, d_{21}, d_{22}, d_{23}, d_{24}, d_{25}$			$20-25$	$10-13, 20-25$

IN	OUT	IN	OUT	IN
$B_1$	$1-5$		$1-5$	
$B_2$	$1-19$	$2-19$	$1-19$	$2-19$
$B_3$	$1-19$	$2-19$	$2-19$	$1-19$
$B_4$	$1-3-19$	$1-3-19$	$1-3-19$	$1-3-19$
$B_5$	$6-13$	$6-19$	$3-19$	$3-19$
$B_6$	$6-13$	$6-14, 16-25$	$3-19$	$3-14, 16-25$

Marco Túlio Alves de Barros

$$i = m - 1$$

$$j = m$$

$$M_1 = 4 \times m$$

$$V = a[M_1]$$

$$i = i + 1$$

$$M_2 = 4 \times i$$

$$t_3 = a[U_2]$$

if ( $t_3 < V$ ) goto B<sub>2</sub>

$$j = j - 1$$

$$N_2 = 4 \times j$$

$$t_5 = a[U_3]$$

if ( $t_5 > V$ ) goto B<sub>3</sub>

if ( $i \geq j$ ) goto B<sub>6</sub>

$$x = a[U_2]$$

$$t_9 = a[U_3],$$

$$a[U_2] = t_9$$

$$a[U_3] = x$$

goto B<sub>2</sub>

$$x = a[U_2]$$

$$t_{14} = a[U_1],$$

$$a[U_2] = t_{14}$$

$$a[U_1] = x$$

Esse é o CFG após aplicar CSE  $\rightarrow$  Copy Hoisting  $\rightarrow$  Dead Code e aparentemente não há mais otimizações possíveis

A maneira que seja possível aplicar Copy Hoisting com as variações que receberam valores de vetores