

26/03/20

# Compilers tutorial 6

B<sub>1</sub>

- 1.)  $i = m - 1$
- 2.)  $j = n$
- 3.)  $t_1 = 4 * n$
- 4.)  $U = a[t_1]$

B<sub>2</sub>

- 5.)  $i = i + 1$
- 6.)  $t_2 = 4 * i$
- 7.)  $t_3 = a[t_2]$
- 8.) if  $t_3 < U$  goto 5 (B<sub>2</sub>)

B<sub>3</sub>

- 9.)  $j = j - 1$
- 10.)  $t_4 = 4 * j$
- 11.)  $t_5 = a[t_4]$
- 12.) if  $t_5 > U$  goto 9 (B<sub>3</sub>)

B<sub>4</sub>

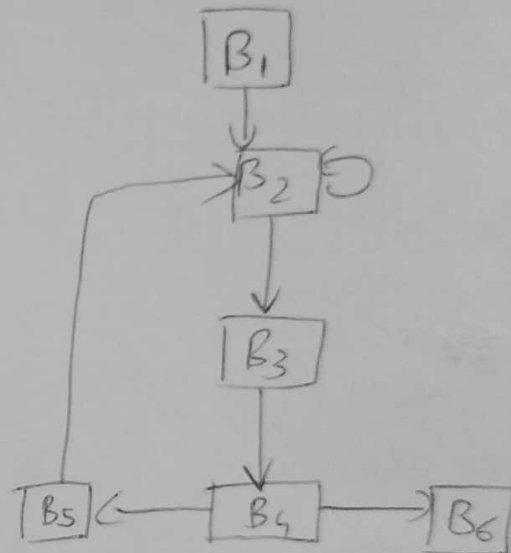
- 13.) if  $i >= j$  goto 23 (B<sub>6</sub>)

B<sub>5</sub>

- 14.)  $t_6 = 4 * i$
- 15.)  $x = a[t_6]$
- 16.)  $t_7 = 4 * i$
- 17.)  $t_8 = 4 * j$
- 18.)  $t_9 = a[t_8]$
- 19.)  $a[t_7] = t_9$
- 20.)  $t_{10} = 4 * j$
- 21.)  $a[t_{10}] = x$
- 22.) goto 5 (B<sub>2</sub>)

B<sub>6</sub>

- 23.)  $t_{11} = 4 * i$
- 24.)  $x = a[t_{11}]$
- 25.)  $t_{12} = 4 * i$
- 26.)  $t_{13} = 4 * n$
- 27.)  $t_{14} = a[t_{13}]$
- 28.)  $a[t_{12}] = t_{14}$
- 29.)  $t_{15} = 4 * n$
- 30.)  $a[t_{15}] = x$



M. Rabbani

# local common subexpression elimination

B<sub>5</sub>

$$t_6 = 4 * i$$

$$t = a[t_6]$$

$$t_7 = t_6$$

$$t_8 = 4 * j$$

$$t_9 = a[t_8]$$

$$a[t_7] = t_9$$

$$t_{10} = t_8$$

$$a[t_{10}] = t$$

goto B<sub>2</sub>

B<sub>6</sub>

$$t_{12} = 4 * i$$

$$t = a[t_{11}]$$

$$t_{12} = t_{11}$$

$$t_{13} = 4 * n$$

$$t_{14} = a[t_{13}]$$

$$a[t_{12}] = t_{14}$$

$$t_{15} = t_{13}$$

$$a[t_{15}] = t$$

Copy Propagation for  $t_7, t_{10}, t_{12}, t_{15}$

$$t_6 = 4 * i$$

~~$$t_6 = 4 * i$$~~  
$$t = a[t_6]$$

$$t_7 = t_6$$

$$t_8 = 4 * j$$

$$t_9 = a[t_8]$$

$$a[t_6] = t_9$$

$$t_{10} = t_8$$

$$a[t_7] = t$$

goto B<sub>2</sub>

$$t_{11} = 4 * i$$

$$t = a[t_{11}]$$

$$t_{12} = t_{11}$$

$$t_{13} = 4 * n$$

$$t_{14} = a[t_{13}]$$

$$a[t_{12}] = t_{14}$$

$$t_{15} = t_{13}$$

$$a[t_{15}] = t$$

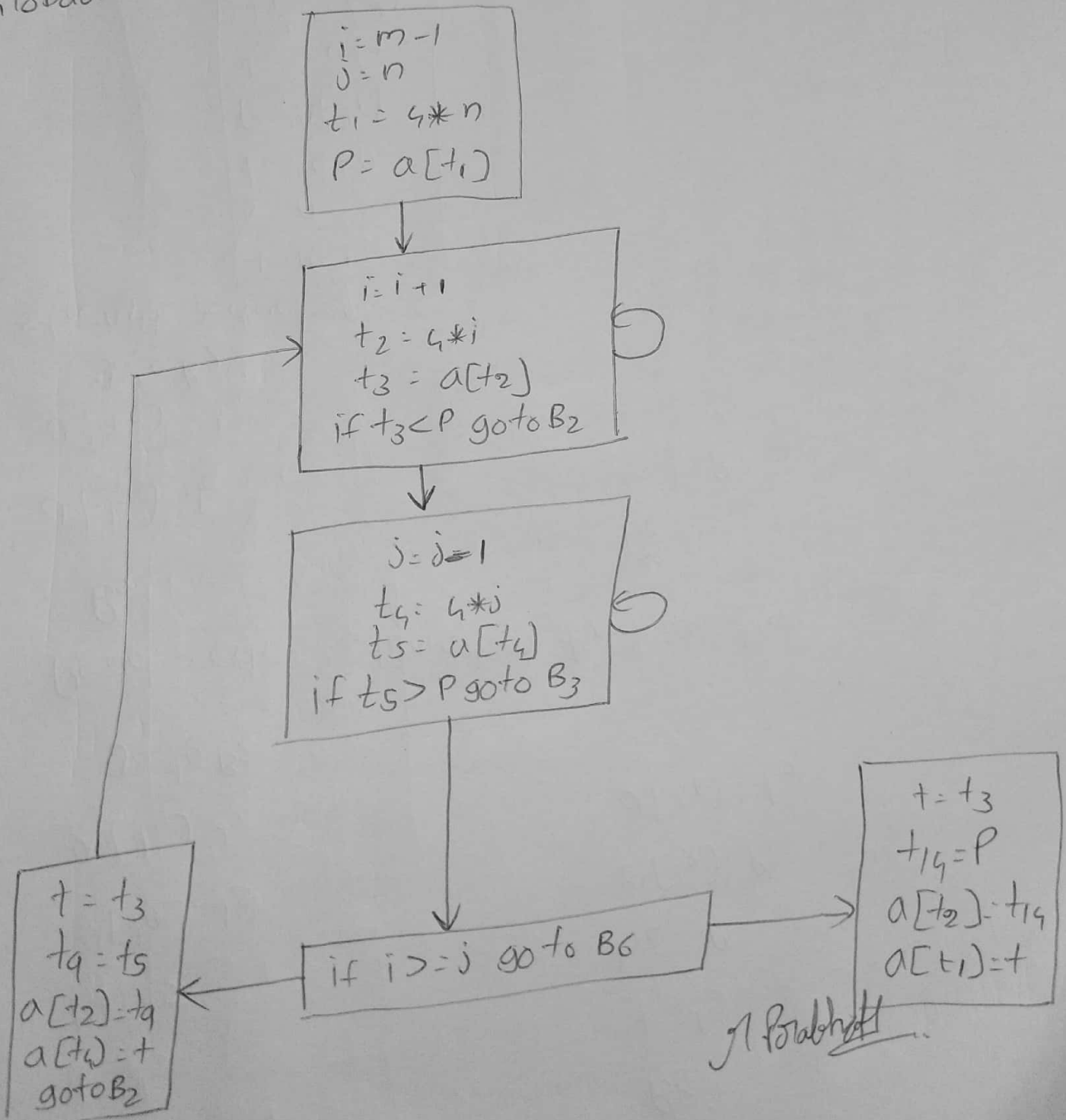
M. Pathak

Dead code elimination for  $t_7, t_{10}, t_{12}, t_{15}$

$t_6 = 4 \times i$	$a[t_6] = t_9$	} $t_{11} = 4 \times i$	
$t = a[t_6]$	$a[t_8] = t$		$t = a[t_{11}]$
$t_8 = 4 \times j$	$\text{goto } B_2$		$t_{13} = 4 \times n$
$t_9 = a[t_8]$			$t_{14} = a[t_{15}]$
			$a[t_{11}] = t_{10}$
			$a[t_{13}] = t$
			elimination:-

Global common

Subexpression



Copy Propagation on  $t_2, t_4, t_9$

$B_5$   
 $t = t_3$   
 $t_9 = t_5$   
 $a[t_2] = t_5$   
 $a[t_4] = t$   
go to  $B_2$

$B_6$   
 $t = t_3$   
 $t_{14} = P$   
 $a[t_2] = P$   
 $a[t_1] = t_3$

Dead code elimination  $t, t_{10}, t_9$

$B_5$

$a[t_2] = t_5$   
 $a[t_4] = t_3$   
goto  $B_2$

$B_6$

$a[t_2] = P$   
 $a[t_1] = t_3$

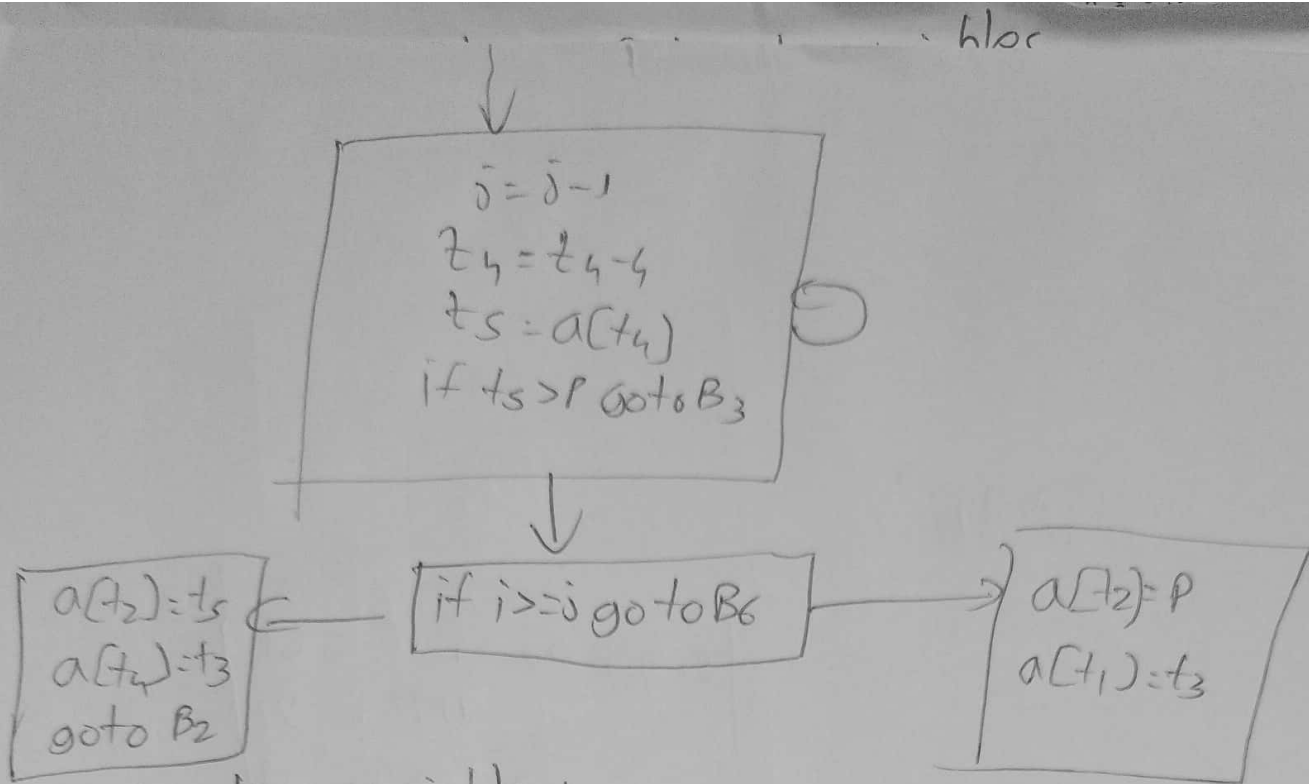
Strength reduction

$i = m-1$   
 $j = n$   
 $t_1 = 4 * n$   
 $P = a[t_1]$   
 $t_2 = 4 * i$   
 $t_4 = 4 * j$

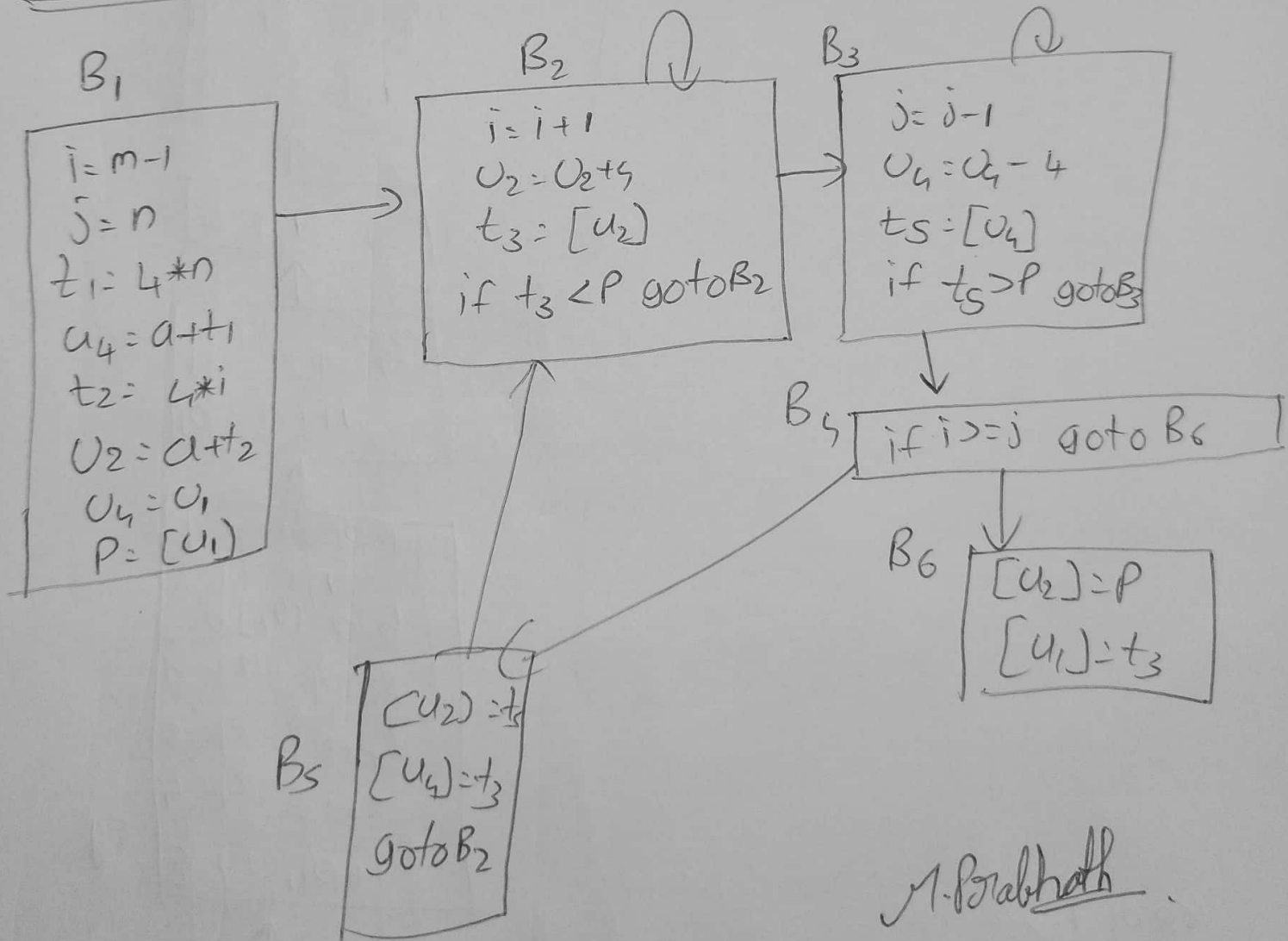
$i = i+1$   
 $t_2 = t_2 + 4$   
 $t_3 = a[t_2]$   
if  $t_3 < P$  goto  $B_2$

A. Bralhat





Induction variables:-



M. Prabhath

2-)

B<sub>1</sub> 1.  $\bar{i} = 1$



B<sub>2</sub> 2.  $\bar{j} = 1$



B<sub>3</sub> 3.  $t_1 = 10 * i$   
4.  $t_2 = t_1 + j$   
5.  $t_3 = 8 * t_2$   
6.  $t_4 = t_3 - 88$   
7.  $a[t_2] = 0.0$   
8.  $\bar{j} = \bar{j} + 1$   
9. if  $\bar{j} \leq 10$  goto 3



10.  $\bar{i} = \bar{i} + 1$   
11. if  $\bar{i} \leq 10$  goto 2



12.  $\bar{i} = 1$



13.  $t_5 = \bar{i} - 1$   
14.  $t_6 = 88 * t_5$   
15.  $a[t_6] = 10$   
16.  $\bar{i} = \bar{i} + 1$   
17. if  $\bar{i} \leq 10$  goto 13

Induction variables

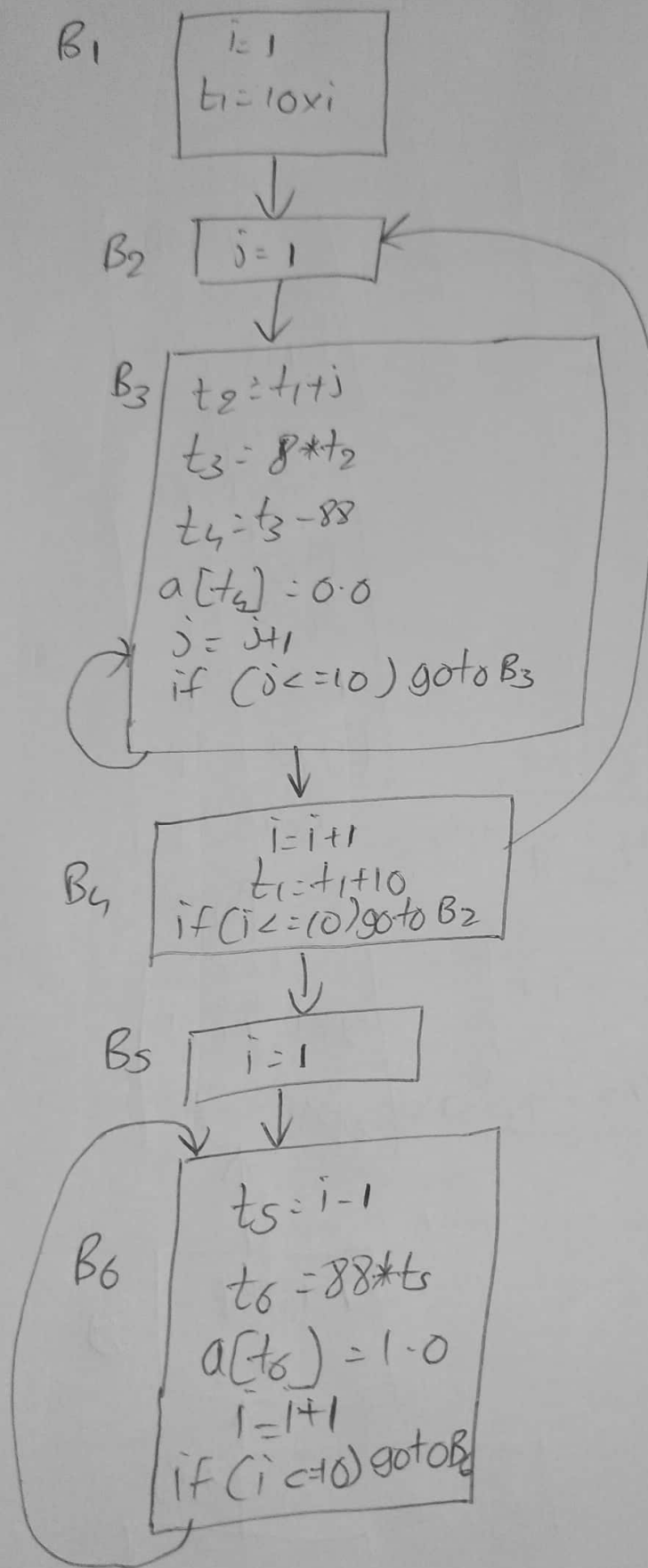
$j \rightarrow C(\bar{i}, 1, 1)$

$\bar{i} \rightarrow C(\bar{i}, 1, 1)$

$t_1 \rightarrow C(\bar{i}, 10, 0)$

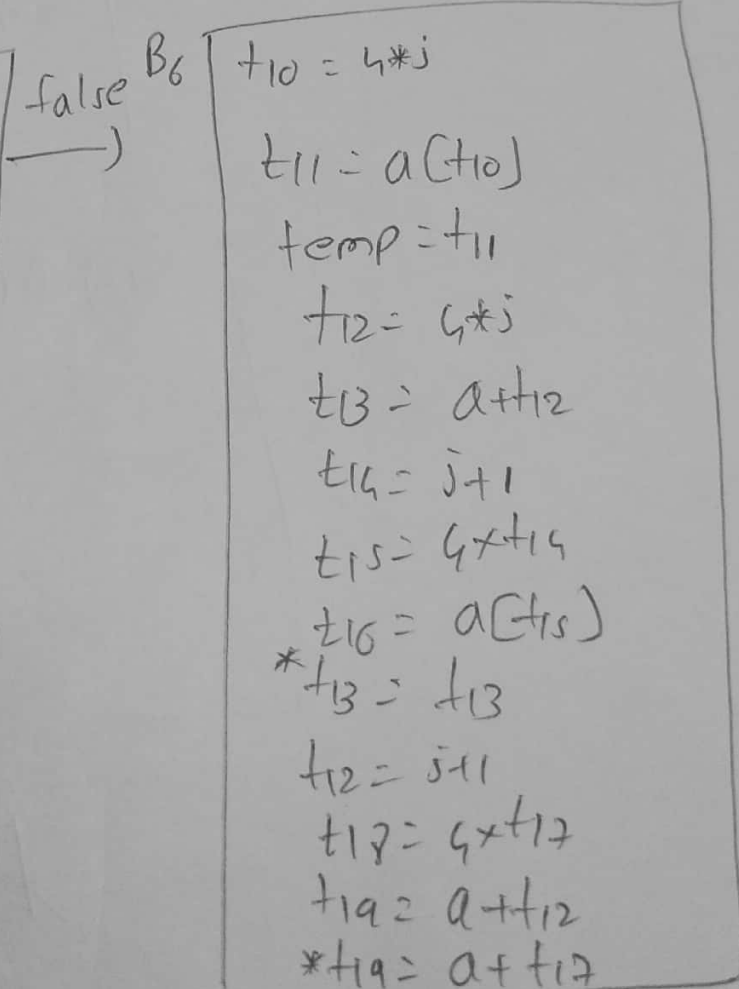
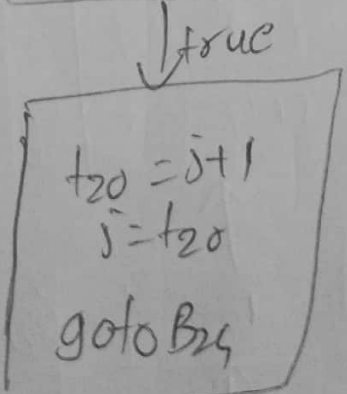
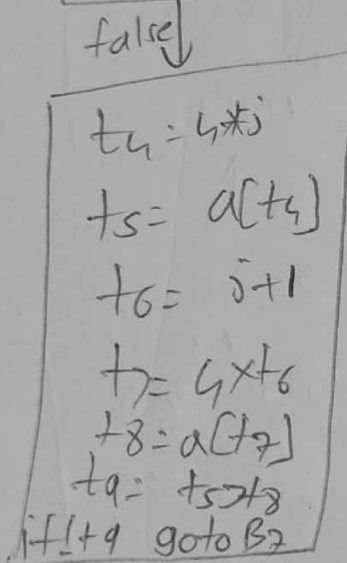
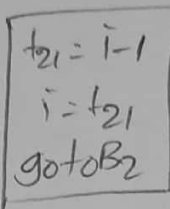
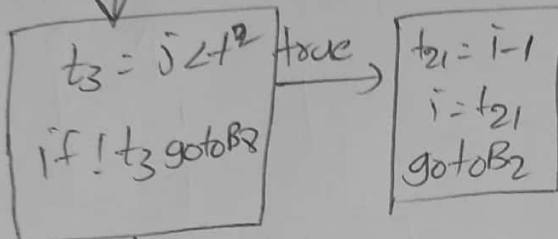
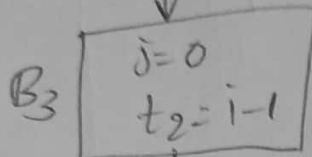
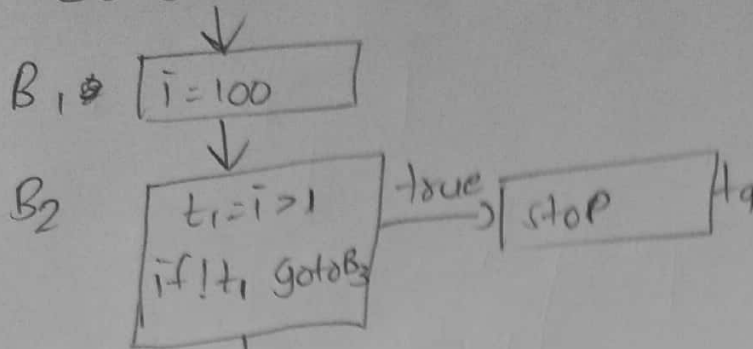
M. Prabhakar

After eliminating Induced variables



M. Peralta

3-) code-3



*J. Raulhalla*



# Global common sub-exp elimination

B<sub>1</sub>  $\boxed{\bar{i} = 100}$

B<sub>2</sub>  $\boxed{\begin{array}{l} t_1 = \bar{i} > 1 \\ \text{if } !t_1, \text{ goto } B_9 \end{array}}$   $\xrightarrow{\text{true}}$   $\boxed{\text{stop}}$  B<sub>9</sub>

$\downarrow \text{false}$   
B<sub>3</sub>  $\boxed{\begin{array}{l} \bar{j} = 10 \\ t = \bar{i} - 1 \end{array}}$

$\downarrow$   
B<sub>4</sub>  $\boxed{\begin{array}{l} t_3 = \bar{j} < t_2 \\ \text{if } !t_3, \text{ goto } B_8 \end{array}}$   $\xrightarrow{\text{true}}$   $\boxed{\begin{array}{l} t_{21} = t_2 \\ \bar{i} = t_{21} \\ \text{goto } B_2 \end{array}}$  B<sub>8</sub>

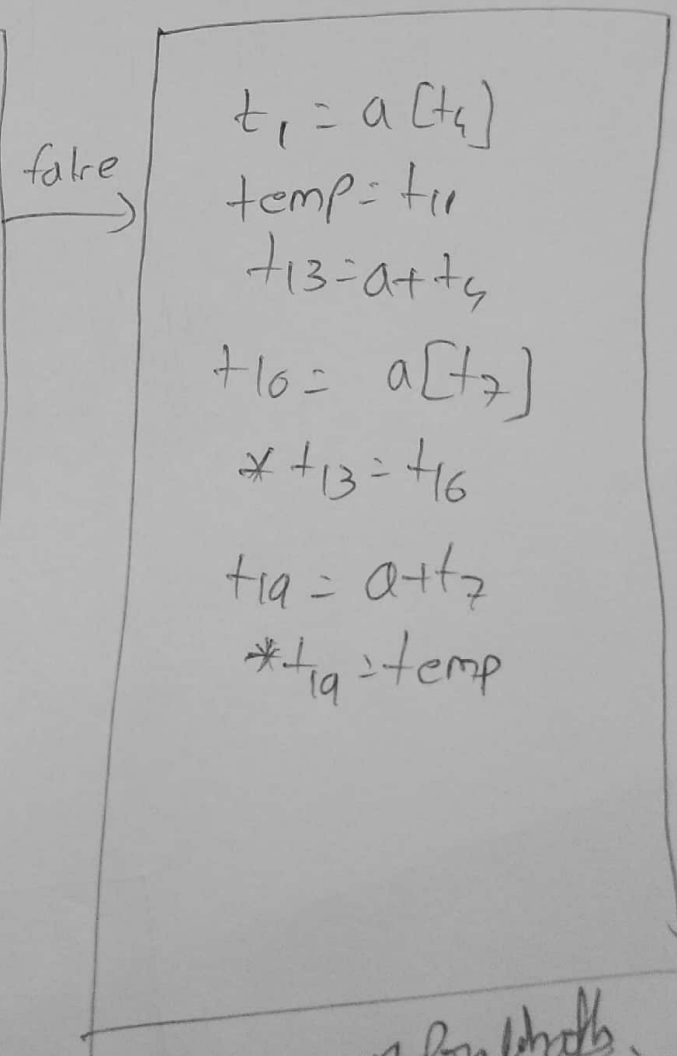
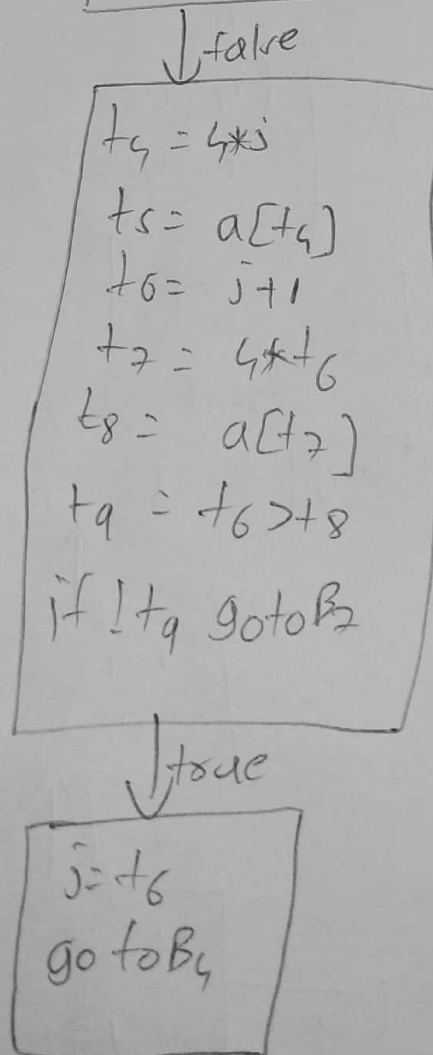
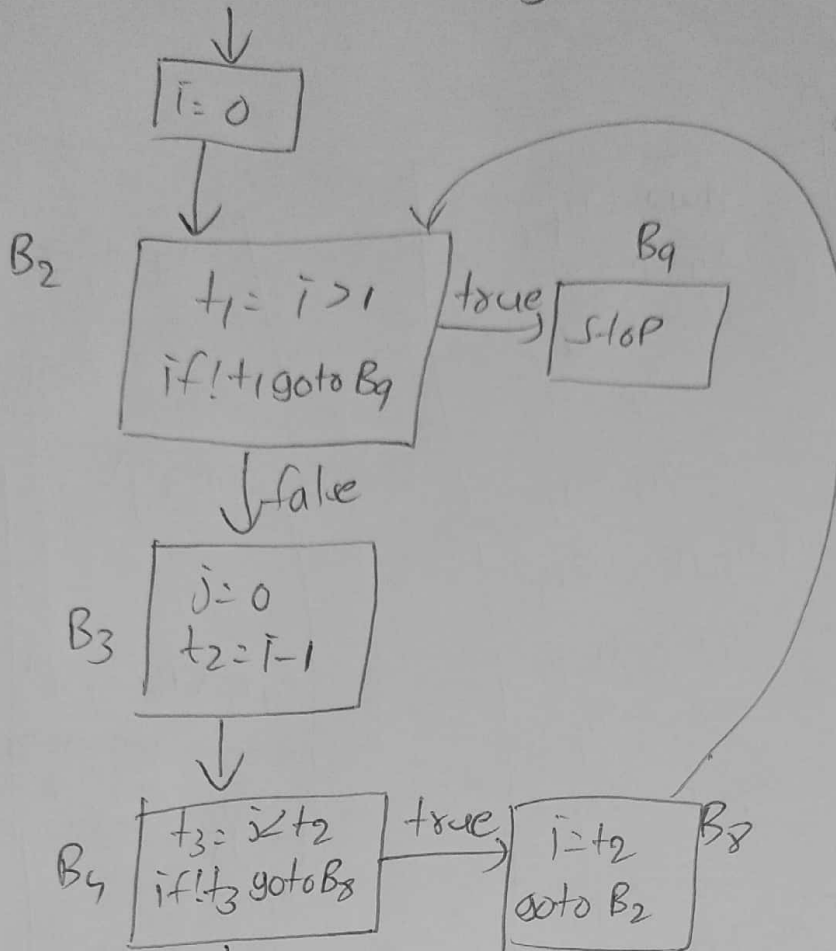
$\downarrow \text{false}$   
 $\boxed{\begin{array}{l} t_4 = 4 \times j \\ t_5 = a[t_4] \\ t_6 = \bar{j} + 1 \\ t_7 = 4 \times t_6 \\ t_8 = a[t_7] \\ t_5 > t_8 \\ t_4 = \text{temp} \\ \text{if } !t_9, \text{ goto } B_2 \end{array}}$   $\xrightarrow{\text{false}}$   $\boxed{\begin{array}{l} t_{10} = t_4 \\ t_{11} = a[t_{10}] \\ t_{12} = t_4 \\ t_{13} = a + t_{12} \\ t_{14} = t_6 \\ t_{15} = 4 * t_{14} \\ t_{16} = a[t_{15}] \\ t_{15} = t_{16} \\ t_{17} = t_{16} \\ t_{18} = 4 \times t_{17} \\ t_{19} = a + t_{18} \\ *t_{19} = \text{temp} \end{array}}$

$\downarrow \text{true}$   
B<sub>7</sub>  $\boxed{\begin{array}{l} t_{20} = t_6 \\ \bar{j} = t_{20} \\ \text{goto } B_4 \end{array}}$

M. Poulakakis

# GCE and copy Propagation

B<sub>1</sub>



I-U detection and C.S.E triplets for I-U.  
(Induction variables)

