

06/03/2020

Compiler Tutorial - 6

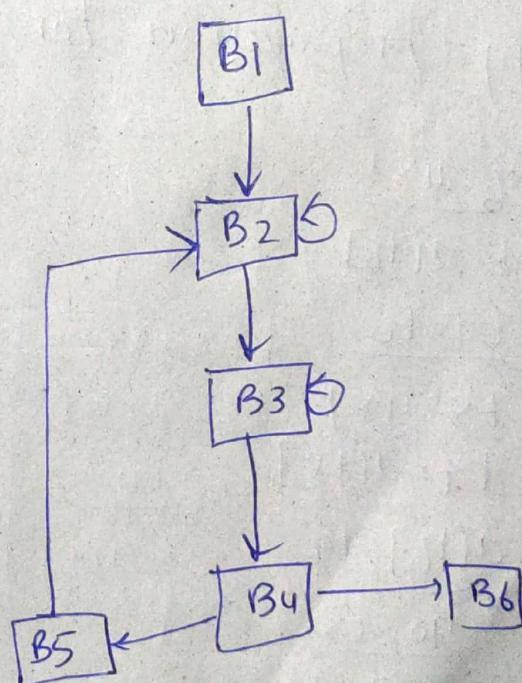
Akshaya S

U4CSE17332

Code-1:

1. $i = m - 1$
2. $j = n$
3. $t_1 = u * n$
4. $v = a[t_1]$
- B1
5. $i = i + 1$
6. $t_2 = u * i$
7. $t_3 = a[t_2]$
8. if $t_3 < v$ goto 5 (B2)
- B2
9. $j = j - 1$
10. $t_4 = u * j$
11. $t_5 = a[t_4]$
12. if $t_5 > v$ goto 9 (B3)
- B3
13. if $i > j$ goto 23 (B6)
- B4
14. $t_6 = u * i$
15. $x = a[t_6]$
16. $t_7 = u * i$
17. $t_8 = u * j$
18. $t_9 = a[t_8]$
19. $a[t_7] = t_9$
20. $t_{10} = u * j$
21. $a[t_{10}] = x$
22. goto 5 (B2)
- B5

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



Akshaya

Local common Subexpression elimination

B5

$$\underline{t_6 = u \times i}$$

$$t = a[t_6]$$

$$\underline{t_7 = t_6}$$

$$t_8 = u \times j$$

$$t_9 = a[t_8]$$

$$a[t_7] = t_9$$

$$\underline{t_{10} = t_8}$$

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

goto B2

B6

$$\underline{t_{11} = u \times i}$$

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

$$\underline{t_{12} = t_{11}}$$

$$\underline{t_{13} = u \times n}$$

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

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

$$\underline{t_{15} = t_{13}}$$

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

copy propagation for $t_7, t_{10}, t_{12}, t_{15}$

$$\underline{t_6 = u \times i}$$

$$t = a[t_6]$$

$$\underline{t_7 = t_6}$$

$$t_8 = u \times j$$

$$t_9 = a[t_8]$$

$$a[t_6] = t_9$$

$$\underline{t_{10} = t_8}$$

$$a[t_8] = t$$

goto B2

$$\underline{t_{11} = u \times i}$$

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

$$\underline{t_{12} = t_{11}}$$

$$\underline{t_{13} = u \times n}$$

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

$$a[t_{11}] = t_{14}$$

$$\underline{t_{15} = t_{13}}$$

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

Dead code

$$t_6 = u \times i$$

$$t = a[t_6]$$

$$t_8 = u \times j$$

$$t_9 = a[t_8]$$

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

$$a[t_6] = t_9$$

$$a[t_8] = t$$

goto B2

$$t_{11} = u \times i$$

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

$$t_{13} = u \times n$$

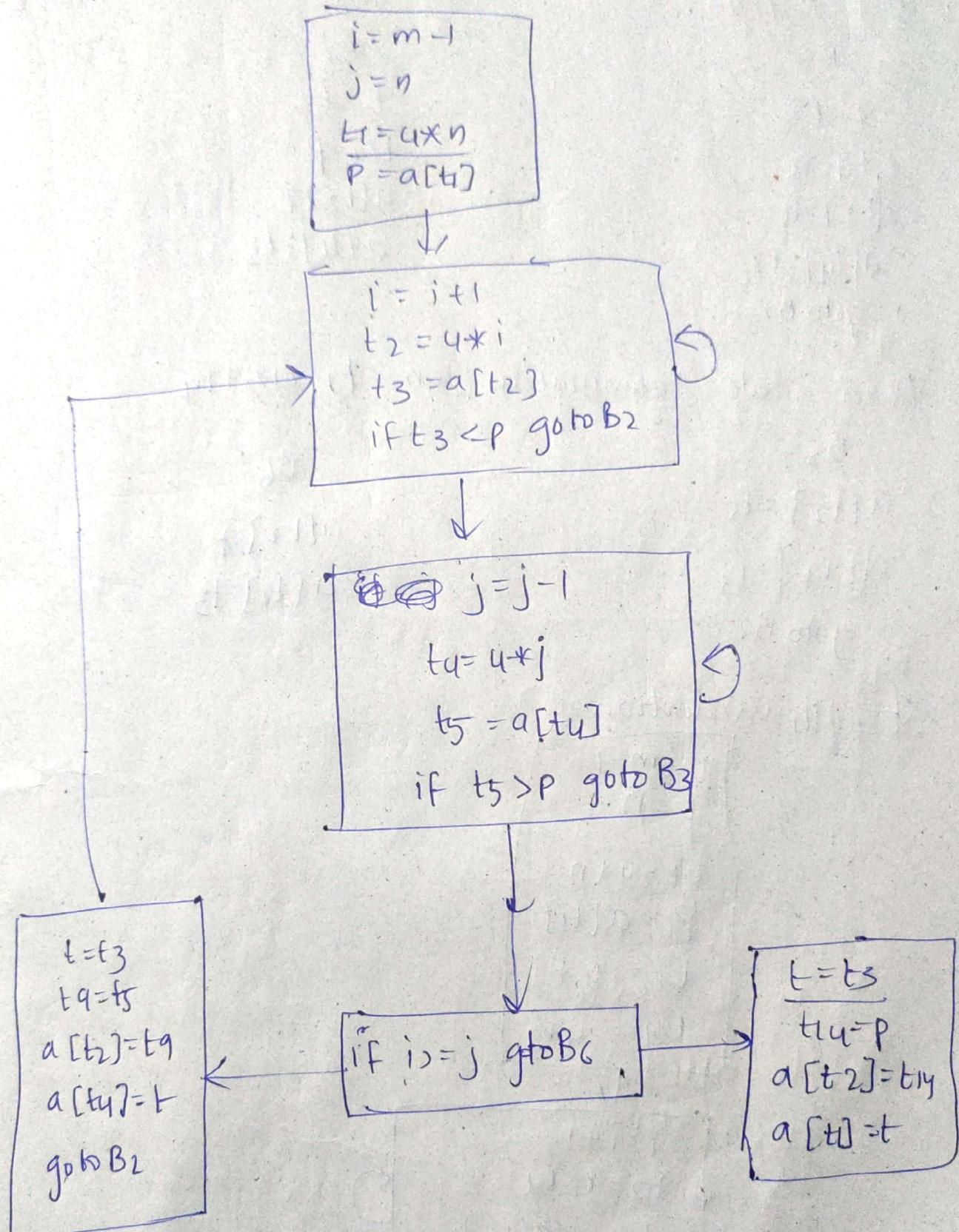
$$t_{14} = a[t_{13}]$$

$$a[t_{11}] = t_{14}$$

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

Akashaya

Global common subexpression elimination



Akashya

Copy propagation on t_2, t_3, t_4

B5

$$\begin{aligned}t &= t_3 \\t_2 &= t_5 \\a[t_2] &= t_5 \\a[t_4] &= t_3 \\&\text{goto B2}\end{aligned}$$

B6

$$\begin{aligned}t &= t_3 \\t_4 &= p \\a[t_2] &= p \\a[t_4] &= t_3\end{aligned}$$

Dead code elimination on t_2, t_3, t_4

B5

$$\begin{aligned}a[t_2] &= t_5 \\a[t_4] &= t_3 \\&\text{goto B2}\end{aligned}$$

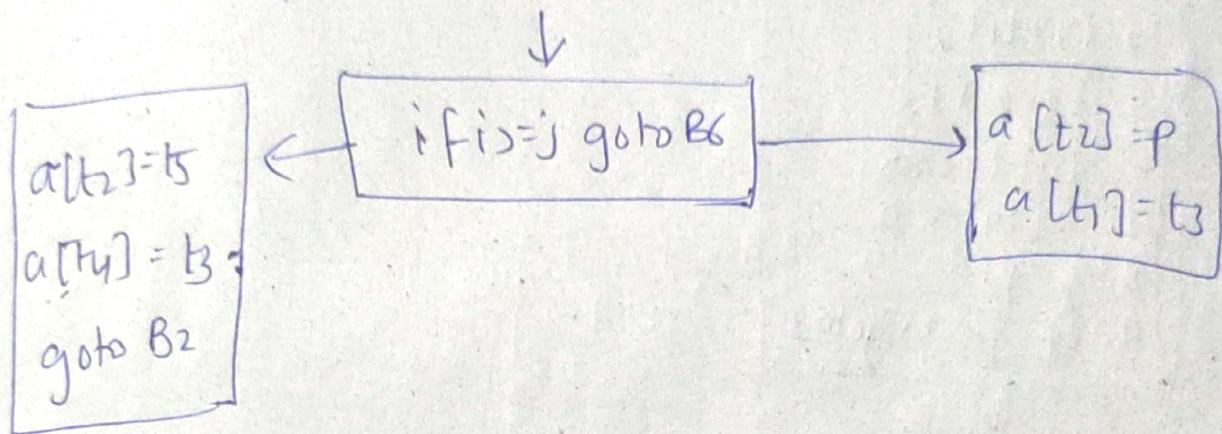
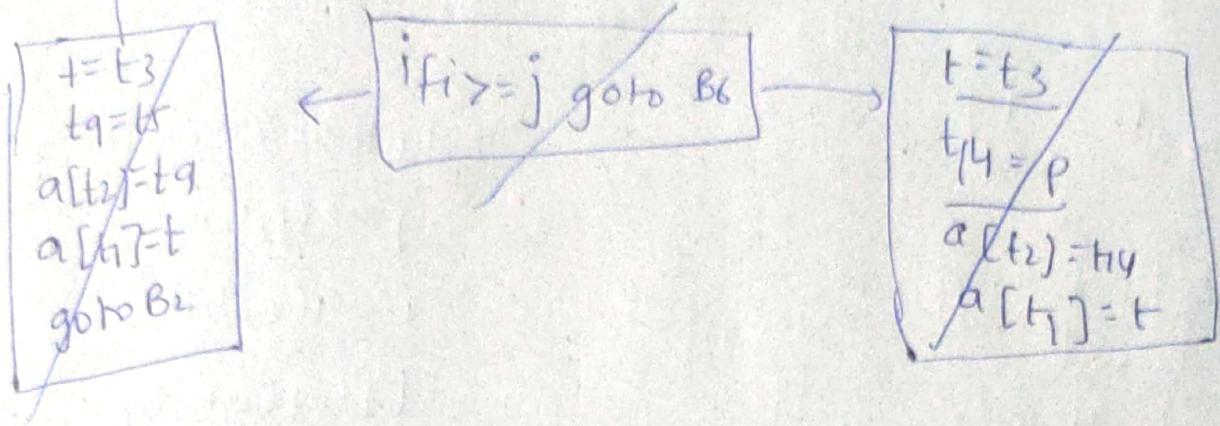
B6

$$\begin{aligned}a[t_2] &= p \\a[t_4] &= t_3\end{aligned}$$

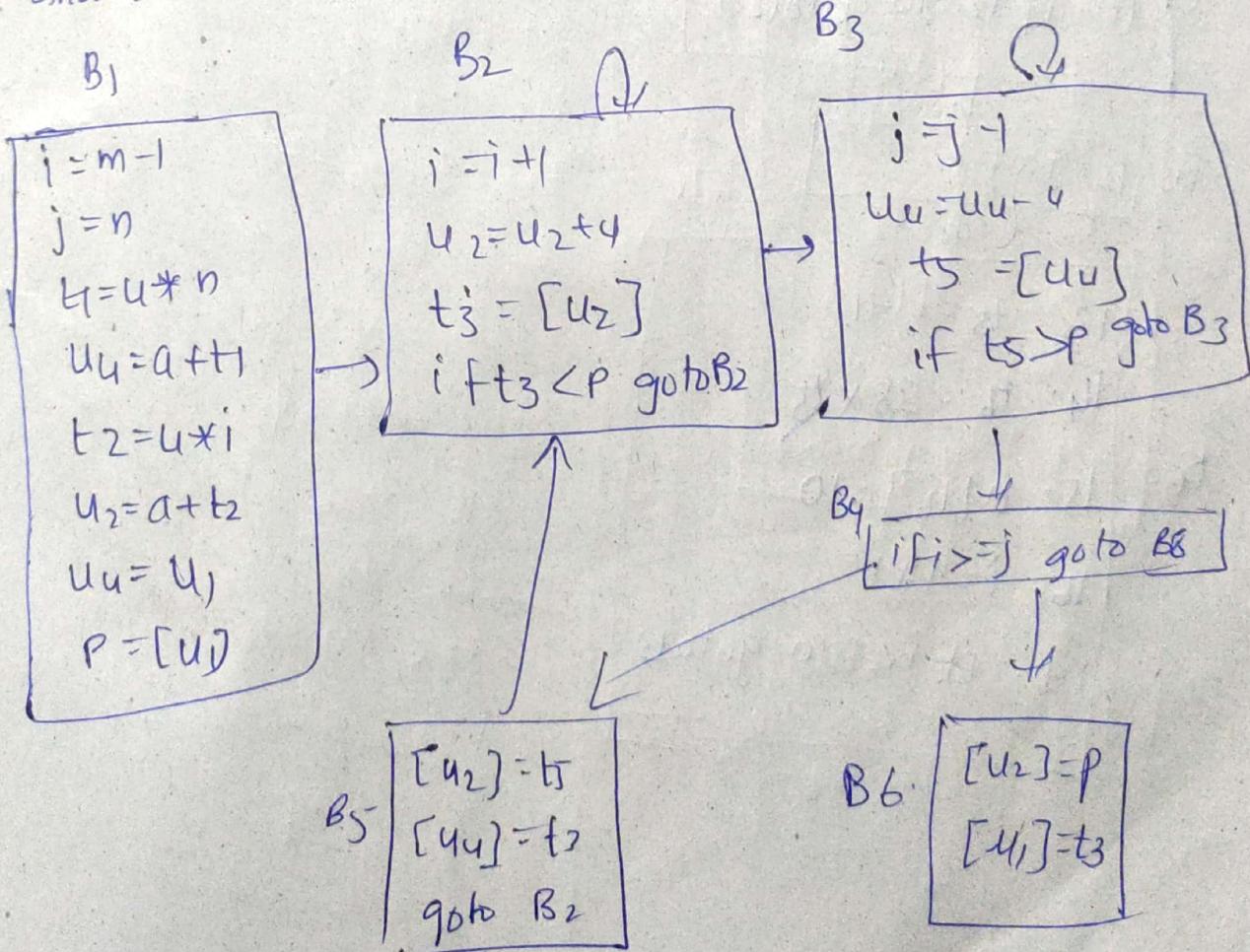
Strength reduction

$$\begin{cases} i = m - 1 \\ j = n \\ t_1 = u * n \\ p = a[t_1] \\ t_2 = u * j \\ t_4 = u * j \end{cases}$$
$$\begin{cases} i = i + 1 \\ t_2 = t_2 + u \\ t_3 = a[t_2] \\ \text{if } t_3 < p \text{ goto B2} \end{cases}$$
$$\begin{cases} j = j - 1 \\ t_4 = t_4 - u \\ t_5 = a[t_4] \\ \text{if } t_5 > p \text{ goto B3} \end{cases}$$

Akashaya

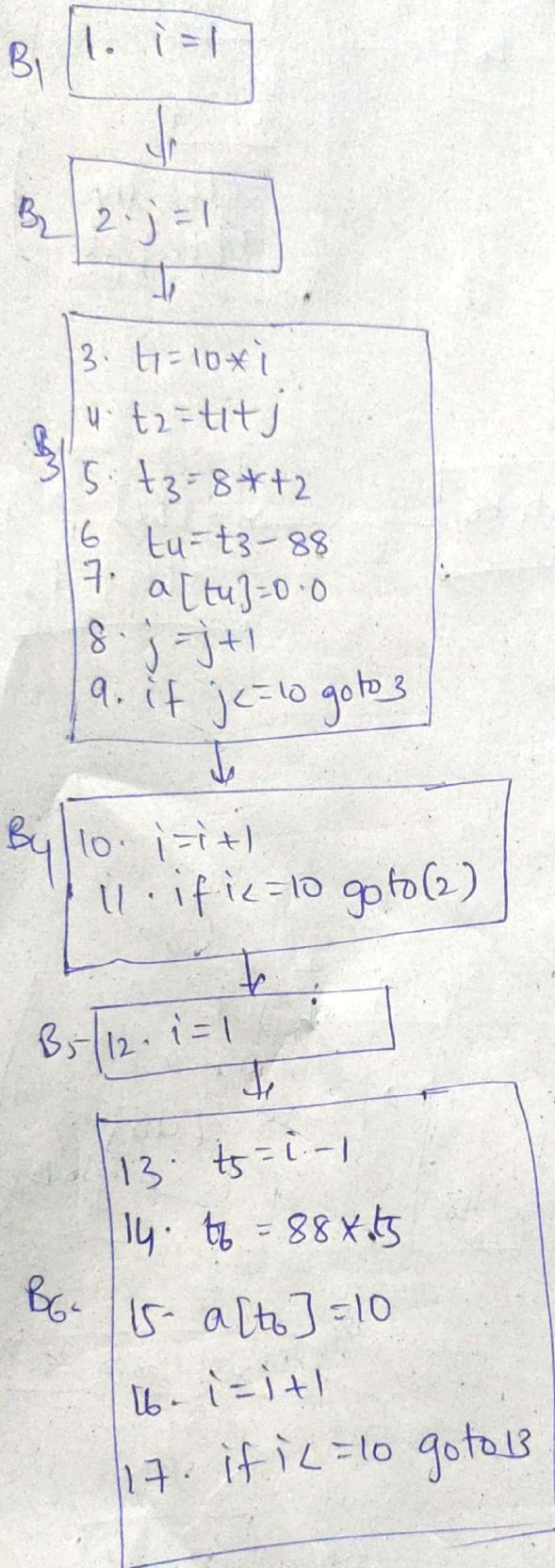


Induction variables



Afshayer

2. Code 2



Induction Variable

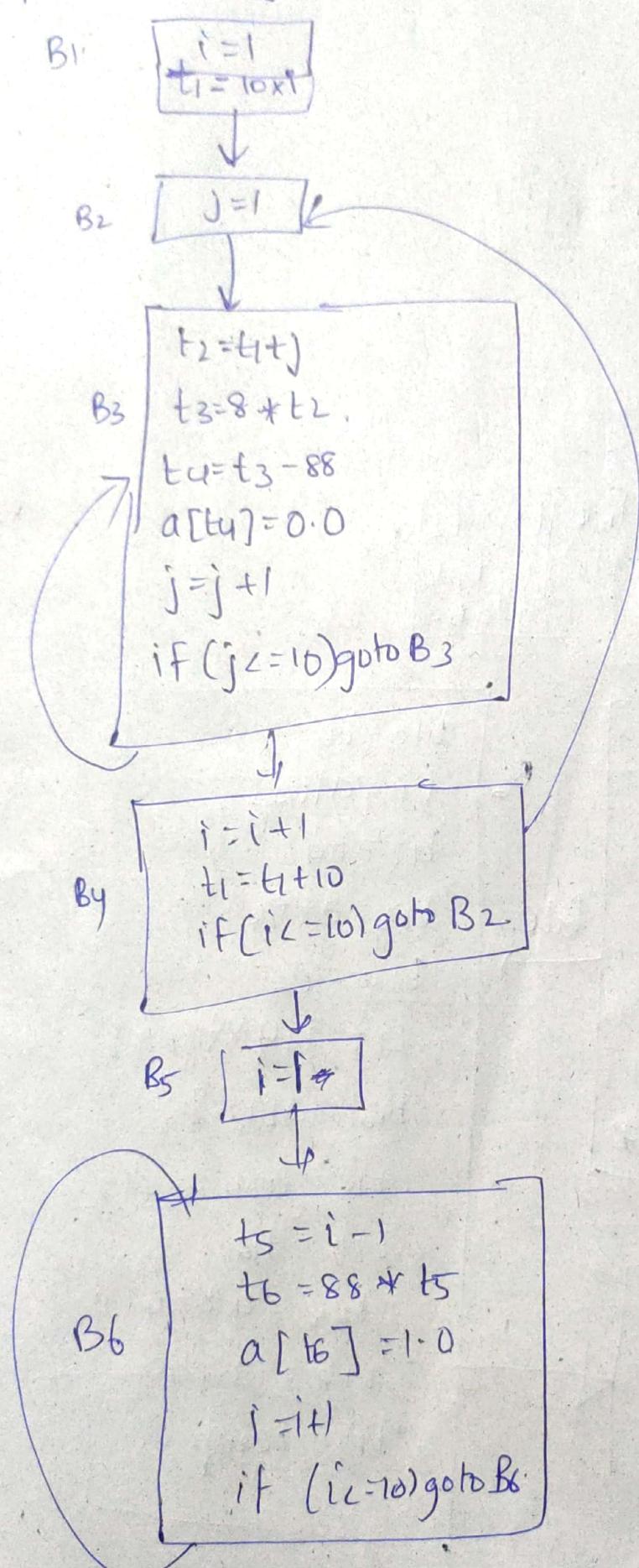
$$j \rightarrow (j, 1, 1)$$

$$i \rightarrow (i, 1, 0)$$

$$t_1 \rightarrow (t_1, 10, 0)$$

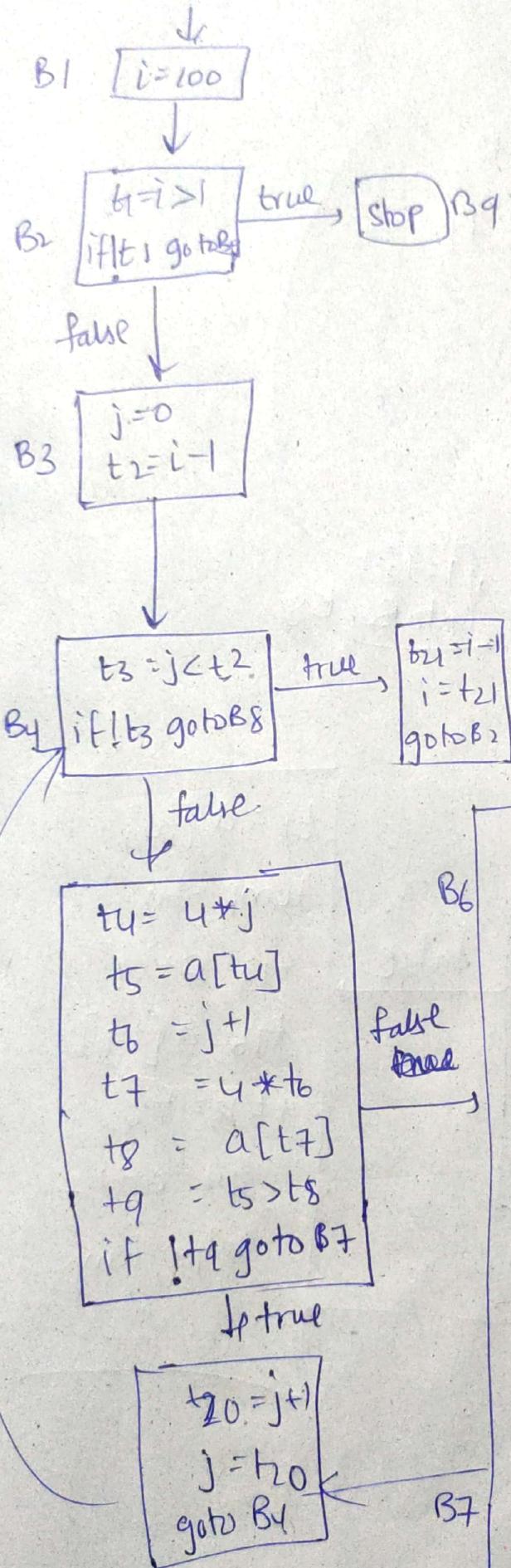
Akhaya

After eliminating induced variables



Akashay

3.

Code-3

B6:

$$\begin{aligned}
 t4 &= u * j \\
 t5 &= a[t4] \\
 \text{temp} &= t11 \\
 t12 &= u * j \\
 t13 &= a + t12 \\
 t14 &= j + 1 \\
 t5 &= u * t14 \\
 t16 &= a[t5] \\
 \\
 * t13 &= t13 \\
 t12 &= j + 1 \\
 t8 &= \cancel{0} \cancel{0} \cancel{0} \cancel{0} \\
 t9 &= a + t12 \\
 * t9 &= a + t12
 \end{aligned}$$

Abshayer

Global common sub-exp elimination

B1 $i = 100$

B2 $t_1 = i > 1$
if ! t_1 goto B9
↓ false

B3 $j = 10$
 $t = i - 1$

B4 $t_3 = j < t_2$
if ! t_3 goto B8
↓ false

B5 $t_4 = u * j$
 $t_5 = a[t_4]$
 $t_6 = j + 1$
 $t_7 = u * t_6$
 $t_8 = a[t_7]$
 $t_9 = t_5 > t_8$
if ! t_9 goto B7
↓ true

B7 $t_{20} = t_6$
 $j = t_{20}$
goto B4

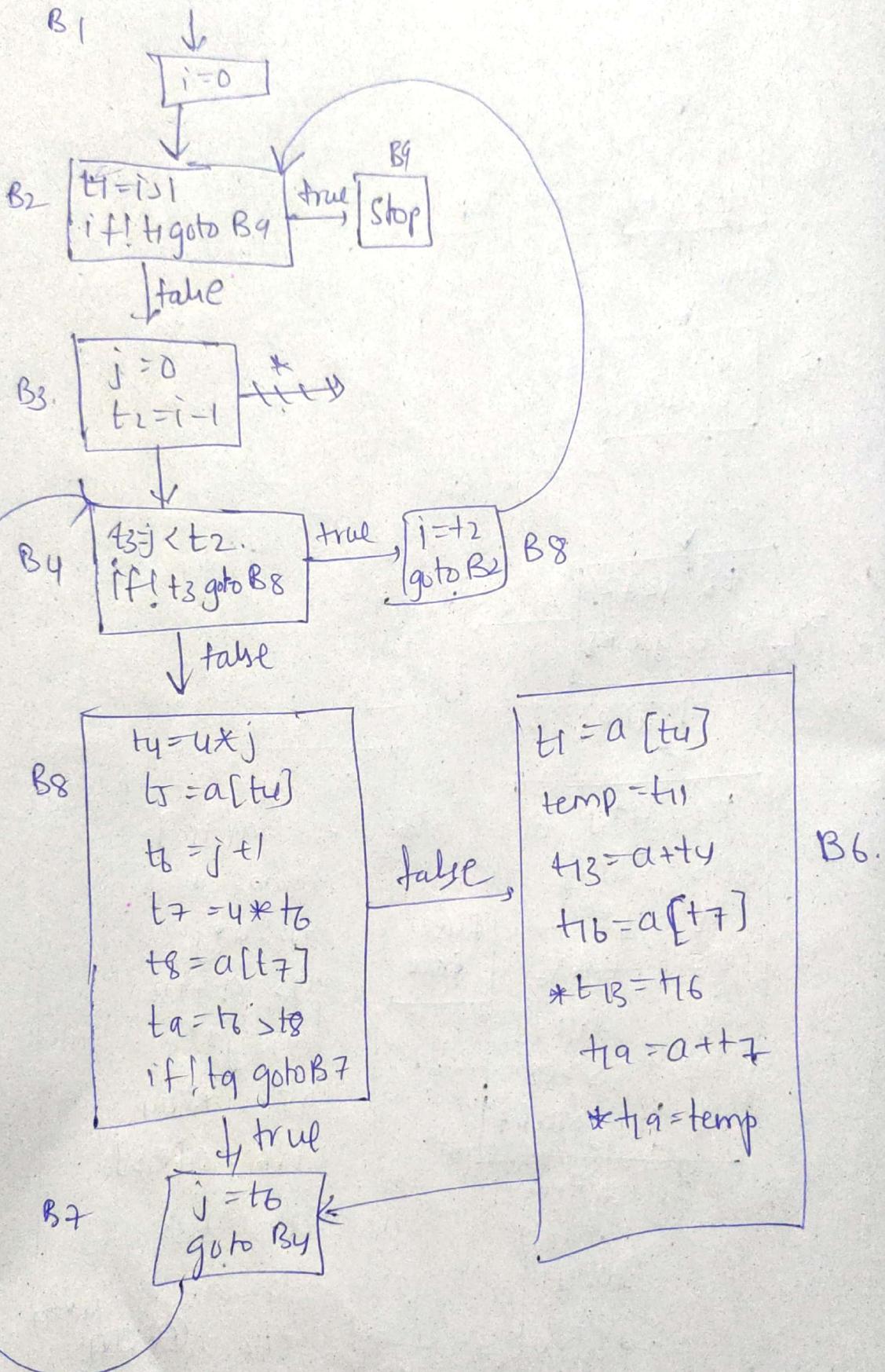
B8 $t_{21} = t_2$
 $i = t_{21}$
goto B2

false

B6 $t_{10} = t_4$
 $t_{11} = a[t_{10}]$
 $t_{12} = t_6$
 $t_{13} = a + t_{12}$
 $t_{14} = t_6$
 $t_{15} = 4 * t_{14}$
 $t_{16} = a[t_{15}]$
 $t_{17} = t_{16}$
 $t_{18} = t_{16}$
 $t_{19} = a + t_{18}$
 $*b_{19} = \text{temp}$

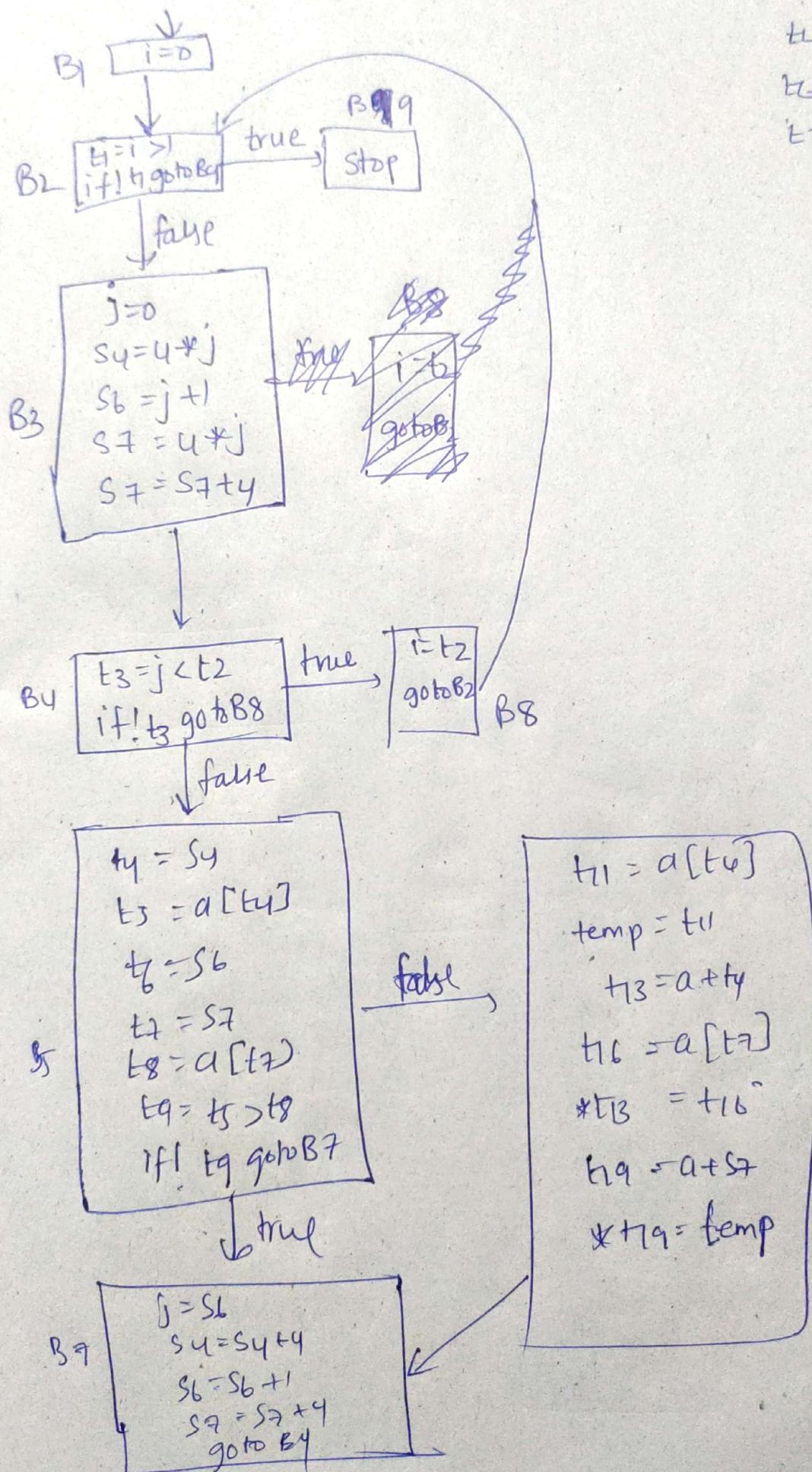
Akhilesh

GCSE and copy propagation:



Ans

I.V detection and CSE triples for I.V
(Induction variables)



$$\begin{aligned}j &= (j, i, 0) \\t4 &= (j, u, 0) \\t6 &= (j, v, 1) \\t7 &= (j, u, 4)\end{aligned}$$