classmate

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Page 1

COMPILERS

Studies in bounded query hierachies.

BASIC BLOCKS AND CONTROL FLOW GRAPHS

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some slides are based on keith cooper's cs412 @ rice university.

THREE ADDRESS CODE

```
for i from 1 to 10 do
    for j from 1 to 10 do
        a[i,j] = 0.0;
for i from 1 to 10 do
    a[i,i] = 1.0;
```

INTERMEDIATE CODE IN THREE-ADDRESS FORMAT

bb1
1. i = 1

bb2
2. j = 1

bb3
3. t1 = 10 * i
4. t2 = t1 + j
5. t3 = 8 * t2
6. t4 = t3 - 88
7. a[t4] = 0.0

bb4
8. j = j + 1
9. if j <= 10 goto 3

bb5
10. i = i + 1
11. if i <= 10 goto 2

bb6
12. i = 1
13. t5 = i - 1
14. t6 = 88 * t5

bb { (15) a[t6] = 1.0
(14) i = i+1
(17) if i<=10 goto (13) }

BASIC BLOCK

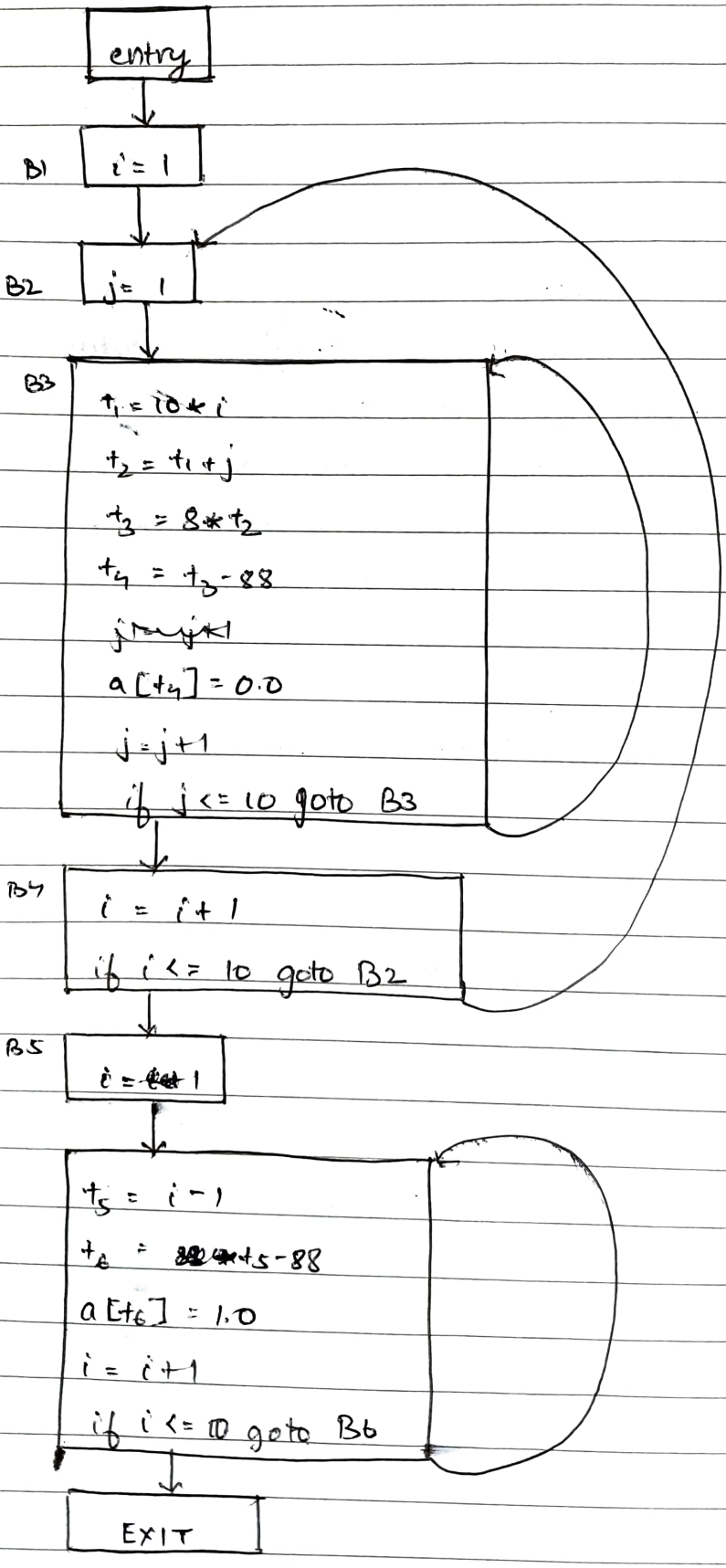
a basic block is a maximal consecutive 3-address instructions such that
- control can only enter the basic block through the first instruction of the basic block.
- control will leave the basic block only at the last instruction.

the first instruction of a basic block is called its leader.

ex: which of the following instruction sequences are basic blocks?

✓(1) $I_1 - I_1$ (2) $I_1 - I_2$ (3) $I_1 - I_3$ (4) $I_2 - I_5$
(5) $I_3 - I_5$ ✓(6) $I_3 - I_9$

CONTROL FLOW GRAPH



BASIC BLOCKS

BB1
1. prod := 0
2. i := 1

BB2
3. $t_1 = 4 * i$
4. $t_2 := a[t_1]$
5. $t_3 := 4 * i$
6. $t_4 := b[t_3]$
7. $t_5 := t_2 * t_4$
8. $t_6 := prod + t_5$
9. prod := t_6
10. $t_7 := i + 1$
11. $i := t_7$
12. if $i <= 20$ goto (3)

problem:
partition the sequence of 3-address instructions into basic blocks.

1. the 1st 3-address instruction in the IR is a leader.
2. any instruction that is the target of a conditional or unconditional jump is a leader.
3. any instruction that immediately follows a conditional or unconditional jump is a leader.

b1
1. i = m-1
2. j = n
3. $t_1 = 4 * n$
4. $v = a[t_1]$

b2
5. $i = i + 1$
6. $t_2 = 4 * i$
7. $t_3 = a[t_2]$
8. if $t_3 < v$ goto (5)

b3
9. $j = j - 1$
10. $t_4 = 4 * j$
11. $t_5 = a[t_4]$
12. if $t_5 > v$ goto (9)

b4
13. if $i >= j$ goto (23)

b5
14. $t_6 = 4 * i$
15. $x = a[t_6]$

b6
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)

b7
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. $a[t_{15}] = x$