**1. Select s such that Parent(s1, s2) with s2.stmt# = n**

Find statements s1 such that s2 is directly nested in s1 and s2.stmt# = n

n=3: None

There is no container statement that wraps statement 3

n=10: 8

The container statement here is the if statement in line 8, and line 10 is directly nested in the if statement and its statement number is 10

n=12: 10

The container statement here is the while statement in line 10, and line 12 is directly nested in the while statement and its statement number is 12

n=20: 18

The container statement here is the while statement in line 18, and line 20 is directly nested in the while statement and its statement number is 20

**2. Select s such that Parent (s, n)**

Find statements s such that n is directly nested in s

n=3: None

There is no container statement that wraps statement 3

n=10: 8

The container statement here is the if statement in line 8, and line 10 is directly nested in the if statement and its statement number is 10

n=12: 10

The container statement here is the while statement in line 10, and line 12 is directly nested in the while statement and its statement number is 12

n=20: 18

The container statement here is the while statement in line 18, and line 20 is directly nested in the while statement and its statement number is 20

**3. Select s such that Parent (n, s)**

Find statements s such that s is directly nested in n

n=3: None

Statement 3 has no parent

n=8: 9, 11, 14, 15, 16

The child of 8 and are directly nested are 9 and 11 (Note if and else statements counts)

n=9: None

Statement 9 is not a container statement

n=24: None

Statement 24 is not a container statement

**4. Select s such that Parent\* (s, n)**

Find statements s such that program line n is nested in s

n=3: None

Line 3 has no parent

n=10: 8

n=12: 8, 10

n=20: 18

**5. Select w such that Parent\* (s, n)**

Find while statements w such that there exist a program line n that is nested in s

n=3: None

Line 3 has no parent

n=10: 10, 18

n=12: 10, 18

n=20: 10, 18

**Parent\* (s, n) is true for 10, 12 and 20 hence return all while loop statements in program John**

**6. Select w such that Parent\* (w, n)**

Find while statements w such that line n is nested in w

n = 9: None

n=11: 10

n=13: 10

n=21: 18

**7. Select s such that Follows (s, n)**

Find statements s such that it is before n

*\*Follows(s1, s2) holds true if s2 is the direct right sibling of s1*

*\*Same nesting level, directly after s1 and in same stmtlist*

n=1: None

n=8: 7

n=9: None

n=10: 9

n=12: 11

n=13: 12

**8. Select a such that Follows (a, n)**

Find assignments a such that it is before line n

n=1: None

n=8: 7 (assignment of y)

n=9: None

n=10: 9 (assignment of k)

n=12: 11 (assignment of x)

n=13: 12 (assignment of z)

**9. Select w such that Follows\* (s, w)**

Find while statements w such that there exist a statement s that Follows w

9

The while statement in line 9 fits the criteria above

**10. Select w such that Follows\* (w, s)**

Find while statement w such that there exists a statement s that follows after w

10, 18

The while statement 10 as Line 13 holds true for the above criteria

The while statement 18 as Line 22 holds true for the above criteria

**11. Select s such that Follows\* (s, n)**

Find statement s such that there it is before line n

*\*Same nesting level, directly after s1 and in same stmtlist*

N=1: None

N=8: 1, 2, 3, 4, 5, 6, 7

N=9: None

N=13: 11, 12

N=19: None

N=22: 19, 20, 21

**12. Select ifstat such that Follows\* (ifstat, n)**

Select if statements such that there exists an if statement before line n, in the same nesting level and in the same statement list

N=8: None

N=17: 8

N=24: None

N=26: 23

**13. Select a such that Follows\* (a, n)**

Find assignments such that it appears after line n

N=6: 7 (Assignment y)

N=9: 13 (Assignment m)

N=10: None (The statement that follows after 10 is call Ringo which is not an assignment)

N=12: None (There is no more statement that follows after 12 – end of while)

N=17: None (There is no more statements after line 17 in the same procedure)

N=27: None (There is no more statements after line 27)

**14. Select v such that Modifies (s, v)**

Select variables v such that there exist a statement s that modifies v

S=3: “x” x is modified

S=4: “x”,”m”, “z” (The procedure paul modifies x, m, z)

S=6: “i” (The procedure George modifies i)

S=18: “i”, “z”, “x”, “m” (The while statement modifies i and z and procedure paul modifies x, m and z)

S=23: “x”, “m” (The if statement modifies x and m)

S=27: “i”

**15. Select w such that Modifies (w, v)**

Select while loops such that it modifies the variable v

V=”x”:10, 18 (The variable x is modified in line 11, w=10, in the while statement 18, the variable x is modified in Call Paul (line 20))

V=”z”: 10 (The variable z is modified in line 12, w=10, in the while statement 18, the variable z is modified in line 21 and Call Paul)

**16. Select v such that Modifies(“Ringo”, v)**

Select variable that the procedure Ringo modifies

i, z, x m

Ringo modifies i, z, x directly, and modifies x and m in directly via Procedure Paul

**17. Select s such that Uses(s, v)**

Select statements such that it uses variable v

V=”x”: 4 (Paul Uses x), 9, 11, 12, 13, 14, 17 (Ringo uses x), 19, 20 (Paul uses x), 25, 26

V=”z”: 10 (while loop uses z), 16, 17 (Ringo uses z), 18 (while loop uses z), 21

**18. Select v such that Uses(n, v)**

Find variables such that it is used in line n

N=10: z, x, i (while loop uses z, the container statement list in line 10 uses x, i

N=18: z, x, m, i, k, y (while loop uses z, container statement list in line 19 uses x and m, the call to procedure paul uses i, m, x, k, y, 21 uses z, 22 uses i)

**19. Select v such that Uses (a, v)**

Find variables that are used in an assignment

i, m, x, z, k, y

**20. Select a such that Modifies (a,v) and Uses (a,v)**

Find assignments such that it modifies **and** uses the variable v

11 (x= x+i), 16 (z = z-1), 25 (m=i\*m+x+k+y), 27 (i = m+i)

V=”m”: 25

V=”x”: 11

V=”y”: None

V=”z”: 16

**21. Select a such that Modifies (a, “i”) and Parent(w, a)**

Find assignments such that it modifies the variable i and its parent is a while statement

18

**22. Select a such that Parent(w, a) and Modifies (a, “i”)**

Find assignments such that its parent is a while statement and it modifies the variable i

18

**23. Select a such that Modifies (a, “i”) such that Parent(w, a)**

Find assignments such that it modifies the variable i and such that its parent is a while statement

18

**24. Select p such that Calls\*(p, “Paul”)**

Select procedures that directly or indirectly calls Paul

John, Ringo,

**25. Select p such that Calls(“John”, p) and Modifies(p, “z”) and Uses (p, “m”)**

Select procedures that John Calls directly and modifies the variable z and uses the variable m

Procedures that modifies z: Set A {Paul, Ringo, John}

Procedures that uses m: Set B {George, Paul, Ringo and John}

Procedures that John Calls: Set C: {Paul, George, Ringo}

Hence, = {Paul, RIngo}

**26. Select p such that Calls\* (“John”, p) and Modifies(p, “z”)**

Select Procedures that John Calls directly or indirectly and modifies the variable z

Procedures that modifies z: Set A {Paul, Ringo, John}

Procedures That John Calls Directly: Set B: {Paul, George, Ringo}

Procedures That John Calls Indirectly: Set C {Paul}

Hence, = {Paul, RIngo}

**27. Select a pattern a(“x”, \_)**

Select assignments with a pattern variable “x” on its left hand side

3, 11, 22, 24

**28. Select a pattern a(“i”, “3\*m”)**

Find assignments with the pattern i on the left hand side, and 3\*m on the right hand side

None

**29. Select a Pattern a(“m”, \_) such that Follows (w,** a)

Find assignments with pattern m on the left hand side and it follows after a while loop

13

**30. Select a pattern a(\_, “x + 1”)**

Find assignments with pattern x + 1 on the right hand side

12

**31. Select a pattern a(\_, “x \* 5 + 3”)**

Find assignments with pattern x \* 5 + 3 on the right hand side

None

**32. Select a pattern a(\_, \_”x + k \* y”\_)**

Select assignments a with the pattern x+k\*y that may be part of a longer expression on the right hand side

Check Line 25

Assign

m: var

:plus

:times

k: var

y: var

:plus

x: var

:times

i: var

m: var

The Pattern x + k \* y does not hold as the value to plus to k \* y is i \* m + x before adding to k \* y

The pattern i \* m + x however holds

Ans: None

**33. Select a pattern a(\_, \_”x+i”\_)**

Select assignments with pattern x+i that may be part of a longer expression on the right hand side

11, 13, 14

**34. Select a pattern a(\_, \_”k+x”\_)**

Select assignments with pattern k+x that may be part of a longer expression on the right hand side

26

**35. Select a pattern a(\_, \_”3\*m”\_)**

Select assignments with pattern 3 that may be part of a longer expression on the right hand side

19

**36. Select a pattern a(\_, \_”5+3”\_)**

Select assignments with pattern k+x that may be part of a longer expression on the right hand side

None

37. Select s.stmt# = c.value

Find all statements whose statement number is equal to some constant in the program

1, 2, 3, 5

38. Select Boolean pattern ifstat(“i”, \_, \_) with co.value = 2

Is it true that any if statement in the program has a pattern i on the left hand side (i.e. uses i) and with some constant value assigned to 2

False

**39. Select Boolean such that Next (n1, n2)**

Is it true that n1 execute immediately after n2 in the same procedure?

\*Caution While Loop Trap!

(1, 2): True

(6, 8): False

(8, 9): True

(10, 11): True

(12, 10): True

(12, 11): False

(13, 14): False

(13, 17): True

(16, 17): True

(17, 18): False

**40. Select Boolean such that Next\*(n, n)**

Is it true that the program line n can be executed recursively in some program execution sequence?

N=9: True -> Next(9, 10) Next(10, 11) Next (11,12), Next (12, 8), Next(8, 9)

N=10: True -> Next (10,11) Next(11,12) Next(12, 8) Next (8, 9) Next (9, 10)

N=12: True -> Next (12, 8) Next (8, 9) Next (9, 10) Next (10, 11) Next (11, 12)

N=20: True -> Next (20, 21) Next (21, 18) Next(18, 19) Next(19, 20)

**41. Select Boolean such that Affects (a1, a2)**

Does the assignment in a1 affects the assignment in a2?

(1, 2): True

(1, 3): True

(1, 4): False (Not an assignment)

(2, 5): False (Paul modifies m)

(2, 7): False (Paul modifies m)

(3, 11): False (Paul modifies x)

(3, 12): False (Paul modifies x)

(14, 27): False (Cross Procedure Affect)

(24, 25): False (Next\*(24, 25) Fails)

(24, 26): True

**42. Select a1 such that Affects(a1, a2)**

Find assignments a1 that affects the assignment in a2

i.e. a1 modifies v, a2 uses v Next\*(a1, a2) v not modified

a2=1: None (Next\* False)

a2= 9: None (m and x is modified in Paul)

a2=22: 19 (19 modifies i, 22 uses i and i is not modified)

a2=27: None (Next\* false)

**43. Select a2 such that Affects(a1, a2)**

Find assignments a2 that will be affected by a1

a1=1: 2, 3, 4 (Paul does not modifies i), George modifies i, all statements after 6 are false)

a1=12: 10

a1=22: None (next\* is false)

a1=27: None (next\* is false)

**44. Select Boolean such that Affects\* (a1, a2)**

Does the assignment in a1 affects a2 directly or indirectly?

(1, 2): True

(1, 3): True

(1, 5): True

m does not hold as it is modified in Paul

Affects(1,2) Affects(2, 5) Hence Affects\* Holds for variable i

(1, 7): False

m does not hold as it is modified in Paul

i does not hold as it is modified in George

(11, 11): True

(11, 13): True

45. **Select a1 such that Affects\*(a1, a2)**

Find assignments a1 that affects the assignment in a2 directly or indirectly

a2=11: 11

a2= 22: 19

a2=26: 24

a2=27: None

46. **Select a2 such that Affects\*(a1, a2)**

Find assignments a2 that will be affected by a1 directly or indirectly

a1=5: 17 (Ringo uses y)

a1=19: 20 (Paul uses i), 22

a1=24: 26

a1=27: None