Feedback — Quiz #6

Help

You submitted this quiz on **Mon 19 May 2014 9:09 PM PDT**. You got a score of **9.00** out of **9.00**.

Question 1

Consider the basic block:

y := 3

x := y

z := 4 * x

Now consider the local optimizations: constant propagation, copy propagation, and constant folding. For this example, what is the best order in which to apply the three optimizations, if each can be applied only once?

Your Answer		Score	Explanation
○ constant propagation, copy propagation, constant folding			
◉ copy propagation, constant propagation, constant folding	✔	1.00	
○ copy propagation, constant folding, constant propagation			
○ constant propagation, constant folding, copy propagation			
○ constant folding, copy propagation, constant propagation			
○ constant folding, constant propagation, copy propagation			
Total		1.00 / 1.00	

Question Explanation

After copy propagation, we have: y = 3; x = y; z = 4 * y.
Then after constant propagation, we have y = 3; x = 3; z = 4 * 3.
Then after constant folding, we have y = 3; x = 3; z = 12.

Question 2

Now consider an optimization strategy that picks an order for applying copy propagation, constant folding, and constant propagation, and repeatedly performs those three optimizations in the same order until nothing changes.

What is the worst possible order (i.e. requires the most passes) for the basic block given in last question (Question 1)?

Your Answer		Score	Explanation
(selected) constant folding, constant propagation, copy propagation	✔	1.00	
copy propagation, constant folding, constant propagation			
constant propagation, copy propagation, constant folding			
copy propagation, constant propagation, constant folding			
constant folding, copy propagation, constant propagation			
constant propagation, constant folding, copy propagation			
Total		1.00 / 1.00	

Question Explanation

If we apply optimization in the order of constant folding, constant propagation, copy propagation, in the first pass, we can only apply constant propagation, in the second pass, we can only apply constant propagation, and in the third pass, we can apply constant folding. That is the worst order which requires most passes.

Question 3

Consider the following intermediate code:

1 X := 2

2 Label1:

3 Y := X + 1

4 if Z > 8 goto Label2

5 X := 3

```
6    X := X + 5
7    Y := X + 5
8    X := 2
9    if Z > 10 goto Label1
10    X := 3
11  Label2:
12    Y := X + 2
13    X := 0
14    goto Label3
15    X := 10
16    X := X + X
17  Label3:
18    Y := X + 1
```

Using the algorithm for constant propagation in the videos, in which of the following lines could the use of X could be replaced by a constant? Assume that no other optimizations are performed before constant propagation.

[check all that apply]

Your Answer		Score	Explanation
[x] 6	✓	0.17	
[x] 3	✓	0.17	
[ ] 12	✓	0.17	
[ ] 7	✓	0.17	
[x] 18	✓	0.17	
[ ] 16	✓	0.17	
Total		1.00 / 1.00	

Question Explanation

At the "in" point of line 3, x is constant 2.
At the "in" point of line 6, x is constant 3.
At the "in" point of line 7, x is unknown.
At the "in" point of line 12, x is unknown.
At the "in" point of line 16, x is unreachable.
At the "in" point of line 18, x is constant 0.

Question 4

Which of the following statements about dataflow analyses is true?

For these choices, dataflow analysis 1 initializes the variables to $\top$ at entry, and to $\bot$ at all other points, as discussed in class, while dataflow analysis 2 initializes the variables to $\top$ at all points in the control flow graph.

Your Answer		Score	Explanation
☑ Assuming dataflow analysis 1 is correct (overapproximates the possible values of variables) and dataflow analysis 2 terminates, dataflow analysis 2 must be correct.	✔	0.25	
☐ Dataflow analysis 2 always produces a different final set of variable-value pairs than dataflow analysis 1.	✔	0.25	
☑ If there is a fixed, finite number of possible annotations each variable can take in our dataflow analysis, then the dataflow analysis is guaranteed to terminate.	✔	0.25	
☑ The order in which a dataflow analysis iterates over the different statements of the code does not change the final set of variable-value pairs, as long as the analysis repeats this process until there is no change.	✔	0.25	
Total		1.00 / 1.00	

Question 5

Consider the following program:

1: x := 5

2: if y $>$ 1 goto Label3

3: Label1:

4: w := w + 1

5: if y $>$ 2 goto Label3

6: Label2:

7:   q := 3

8:   if z < 1 goto Label1

9: Label3:

10: w := 2

11: if z > 1 goto Label2

12: q := y + w

Which variables are live immediately before the execution of statement 7? Assume only variable q is live after statement in line 12.

[Choose all that apply]

Your Answer		Score	Explanation
[x] w	✔	0.20	
[ ] q	✔	0.20	
[ ] x	✔	0.20	
[x] z	✔	0.20	
[x] y	✔	0.20	
Total		1.00 / 1.00	

Question Explanation

After applying the liveness analysis to the data flow graph, we can conclude that variables y, z, w are live before statement 7.

Question 6

For the program in last question (Question 5), assume the constant propagation algorithm has completed.

Which of the following statements is true?

L_N is the statement at line N, and C(L,v,in) = C means that at the "in" of statement L variable v is some constant, and C(L,v,in) = $\top$ means v is not a constant.

[Choose all that apply]

Your Answer		Score	Explanation
☐ C(L2, y, out) = C	✔	0.20	
☑ C(L7, w, in) = ⊤	✔	0.20	
☑ C(L4, y, in) = ⊤	✔	0.20	
☑ C(L5, x, out) = C	✔	0.20	
☐ C(L8, z, out) = C	✔	0.20	
Total		1.00 / 1.00	

Question Explanation

Apply the constant propagation algorithm, we can conclude that:
C(L2, y, out) = ⊤.
C(L4, y, in) = ⊤.
C(L8, z, out) = ⊤.
C(L7, w, in) = ⊤.
C(L5, x, out) = C.

Question 7

Assume that the following lines are added before line 1 of the above code in Question 5:

z := 2

y := 3

Which lines (using the numbering given above) are now unreachable?

[Choose all that apply]

Your Answer		Score	Explanation
☑ 5	✔	0.14	
☑ 4	✔	0.14	
☐ 11	✔	0.14	
☐ 10	✔	0.14	
☐ 8	✔	0.14	
☐ 7	✔	0.14	

☑ 12	✔	0.14	
Total		1.00 / 1.00	

Question Explanation

After plugging the values of y and z into the program, we can conclude that line 4, 5 and 12 are now unreachable.

Question 8

Consider the program:

1: z := 3

2: if b > 0 goto Label1

3: x := 1

4: y := 2

5: z := x + y

6: goto Label2

7: Label1:

8: w := x + 1

9: y := x + 1

10: Label2:

11: a := x + y

12: b := a * z

Which of the following local optimal optimizations could be applied to the program, considering all possible orders of applying different optimizations? Assume that only variable b is live on exit from the program.

[Check all that apply]

Your Answer		Score	Explanation
☑ Dead code elimination	✔	0.17	
☐ Copy propagation	✔	0.17	
☑ Constant propagation	✔	0.17	
☑ Common subexpression elimination	✔	0.17	

☑ Constant folding	✔	0.17	
☐ Algebraic Simplification	✔	0.17	
Total		1.00 / 1.00	

Question Explanation

Dead code elimination example: line 5.
Common subexpression elimination example: line 8 and line 9.
Constant propagation and folding example: line 3, 4 and 5.

Question 9

Considering the program in the previous question, which of the following local optimizations will change the output of constant propagation? Mark those that will change the result only when used in conjunction with other optimizations as well.

Your Answer		Score	Explanation
☑ Constant folding	✔	0.20	
☐ Algebraic simplification	✔	0.20	
☐ Dead code elimination	✔	0.20	
☐ Common subexpression elimination	✔	0.20	
☑ Copy/Constant propagation	✔	0.20	
Total		1.00 / 1.00	

Question Explanation

Applying copy/constant propagation and constant folding together, we will have z=3 in line 5.
Then in the constant analysis's result, the state of z will be changed from unknown "$\top$" to Constant.