

CS 516, Spring 2020

Homework 3: Concurrency

Due date: Friday, April 3, 2020

Problem 1

For each of the following loops, specify whether or not dependences exist. If a dependence exists, give the distance vector and direction vector. If the dependence is not consistent, just give the direction vector. For each dependence, state its type, namely true, anti, or output.

```
(1)
do i = 1, 4
  A(2*i) = A(i) + 1
enddo
```

```
(2)
do i = 1, 100, 2
  A(2*i) = A(7*i) + 1
Enddo
```

```
(3)
do i = 1, 4
  A(i) = A(i+4) + 2
enddo
```

```
(4)
do i = 1, 10
  A(i) = A(10-i) - 5
enddo
```

```
(5)
do i = 1, 100
  do j = 1, 100
    A(i, j) = A(i-1, j+3) * 2
  enddo
enddo
```

```
(6)
do i = 1, 100
  A(i) = ...
  do j = 1, 100
    = A(i+1)
  enddo
enddo
```

```

(7)
do i = 1, 100
    A(i) = ...
enddo
do j = 1, 100
    = A(j+1)
enddo

```

```

(8)
do i = 1, 100
    do j = 1, 100
        A(i, j, i) = A(i, j+1, i-1) * 2
    enddo
enddo

```

Problem 2

Assume the following sequential code:

```

DO I = 2, 100
S1   D(I) = 100
      DO J = 1, 100
S2       B(I, J) = C(I-1, J+1) + 5
          DO K = 1, 100
S3           A(I, J, K) = A(I-1, J, K+1) + B(I, J+1) * 2
              ENDDO
S4       C(I, J) = D(I+1) * B(I, J)
          ENDDO
S5   E(I) = D(I) + 2
      ENDDO

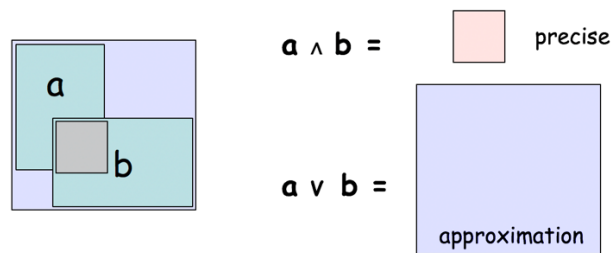
```

This problem has several parts:

1. Show the statement level dependence graph for this loop, with dependence edges labeled according to the type and level of the dependence (see lecture slides).
2. Show the output of the simple vectorization algorithm for the program above.
3. Apply the advanced vectorization algorithm to the program and show the results; also show the level k=2 dependence graph.

Problem 3

Remember the lattice of rectangular regions from our approximation lecture:



Assume that the rectangular regions describe parts/subregions of two-dimensional arrays. Describe how this lattice can be used for dependence analysis between procedures, allowing independent procedure calls to be executed concurrently if independence can be shown.

Homework Questions

All homework related questions should be posted on piazza. Thanks!