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
Problem 2

Assume the following sequential code:

```plaintext
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!