

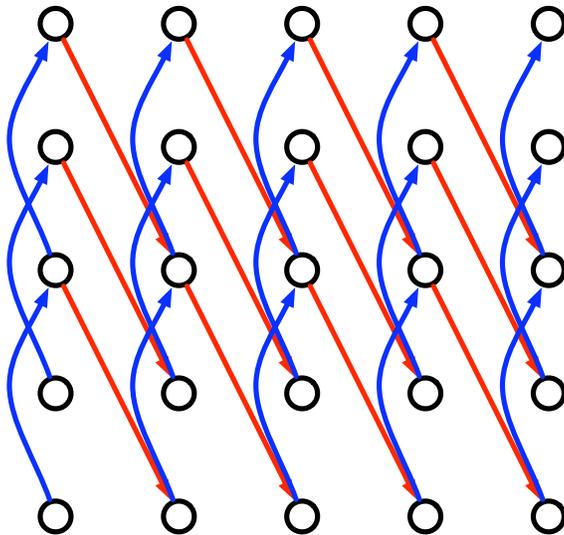
1. Draw the iteration space graph for the following loop:

```

for (int i = 0; i < 10; i++) {
    for (int j = 0; j < 10; j++) {
        A[i][j] = A[i - 1][j + 2] + A[i][j - 2];
    }
}

```

The iteration space graph is given below (I have only shown the first 5 iterations in each direction, but the dependences are uniform, so it is straightforward to extend this to the whole space). The red arrows are the dependences between the write and the $A[i-1][j+2]$ read, and the blue arrows are the dependences between the write and the $A[i][j-2]$ read.



2. Show the distance vector(s) for the loop from the previous problem.

The distance vectors are $(1, -2)$ and $(0, 2)$

3. Show the direction vector(s) for the loop.

The direction vectors are $(+, -)$ and $(0, +)$ (or, alternately, $(<, >)$ and $(0, <)$)

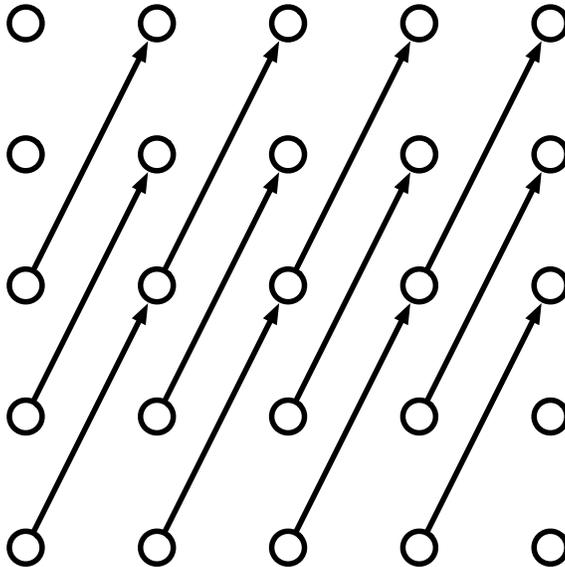
4. Can the two loops be interchanged? Why or why not?

The loops cannot be interchanged because the $(1, -2)$ flow dependence would transform into a $(-2, 1)$ dependence, which is not possible (more specifically, we would eliminate the flow dependence and introduce a $(2, -1)$ anti-dependence).

- Repeat the previous four steps for the following loop:

```
for (int i = 0; i < 10; i++) {
    for (int j = 0; j < 10; j++) {
        A[i][j] = A[i - 1][j - 2];
    }
}
```

The iteration space graph is below



The distance vector is $(1, 2)$, and the direction vector is $(+, +)$. This loop *can* be interchanged, as it would turn the $(1, 2)$ flow dependence into a $(2, 1)$ flow dependence, which is still valid.

The transformed loop is:

```
for (int j = 0; j < 10; j++) {
    for (int i = 0; i < 10; i++) {
        A[i][j] = A[i - 1][j - 2];
    }
}
```

The iteration space graph of the transformed loop is

