(a)

liangYan Li

1. D<J

2. D<I

$$A(I+1,\ 2*J) \xleftarrow{(0,1)} = A(I,\ 2*J) + B(J,1) + 10$$

$$A(I,\ 2*J+1) \xrightarrow{(0,2)} = A(I-1, 2*J) + B(J, I+1)$$

(0,1) (0,1)

(b) (c) reference groups.

For loop J.

① $\{A(I+1, 2J), A(I, 2J), A(I-1, 2J)\}$ $\frac{N+1}{2} \cdot N = \frac{N(N+1)}{2}$

② $\{A(I, 2*J+1)\}$ $\frac{N+1}{2} \cdot N = \frac{N(N+1)}{2}$

③ $\{B(J, I)\}$ $\frac{\frac{N+1}{2}}{\frac{4}{4}} \cdot N = \frac{N(N+1)}{2}$

④ $\{B(J, I+1)\}$ $\frac{\frac{N+1}{2}}{\frac{4}{4}} \cdot N = \frac{N(N+1)}{2}$

For J: trip = $(N-1+2)/2$

stride = $2*2=4$

let cls = 4

total $2N(N+1)$

For loop I

① $\{A(I+1, 2J), A(I-1, 2J), A(I, 2J)\}$ $\frac{N}{4} \cdot \frac{N+1}{2} = \frac{N(N+1)}{8}$

② $\{A(I, 2*J+1)\}$ $\frac{N}{4} \cdot \frac{N+1}{2} = \frac{N(N+1)}{8}$

③ $\{B(J, I+1), B(J, I)\}$ $N \cdot \frac{N+1}{2}$

For I: trip = $(N-1+1)/1 = N$

stride = 1.

let cls = 4

Interchge wouldn't improve

total: $\frac{3}{4}N(N+1)$

The loop interchange is legal, since $\frac{3}{4}N(N+1) < 2N(N+1)$, so put J to outter is better d). pruned dependence graph.

(0,1)

A(I+1, 2J) = A(I, 2J) + B(J, I) + 10

(0,2) (0,1)

A(I, 2J+1) = A(I-1, 2J) + B(J, I+1).

the generators are.

A(I, 2J+1). A(I+1, 2J). B(J, I+1).

ignore it.

Determine number of registers

A(I+1, 2J) need 3. register.

B(J, I+1) need 2 register.

Replace references and Insert ~~Copie~~ copies.

```
Do J = 1, N, 2
  Do I = 1, N
    A$0$0 = A$0$1 + B$1$1 + 10
    A(I+1, 2J) = A$0$0
    B$1$0 = B(J, I+1)
    A(I, 2J+1) = A$0$2 + B$1$0
    A$0$2 = A$0$1
    A$0$1 = A$0$0
    B$1$1 = B$1$0
  ENDDO
ENDDO
```

Initialization and Loop unrolling

peel 3-1 = 2 which means I = 1, 2

unroll loop by 3. Do I = 3, N, 3.

```
Do J = 1; N, 2
  ! Iteration 1, I=1
  A$0$0 = A(1,2J) + B(J,1) +10
  A(2,2J) = A$0$0
  B$1$0 = B(J,2)
  A(1,2J+1) = A(0,2J) + B$1$0.
  A$0$1 = A$0$0
  B$1$1 = B$1$0
  ! Iteration 2, I=2
  A$0$0 = A$0$1 + B$1$1
  A(3,2J) = A$0$0
  B$1$0 = B(J.3)
  A(2,2J+1) = A(1,2J) + B$1$0
  A$0$2 = A$0$1
  A$0$1 = A$0$0
  B$1$1 = B$1$0.
  Do I=3, N, 3
    A$0$0 = A$0$1 + B$1$1 +10
    A(I+1,2J) = A$0$0
    B$1$0 = B(J, I+1)
    A(I,2J+1) = A$0$2 + B$1$0
    A$0$2 = A$0$0 + B$1$0+10
    A(I+2,2J) = A$0$2
    B$1$0 = B(J. I+2)
    A(I+1,2J+1) = A$0$1 + B$1$0
    A$0$1 = A$0$2 + B$1$0
    ~~A$0$1~~ =
    A(I+3,2J) = A$0$1.
    B$1$0 = B(J, I+3)
    A(I+2,2J+1) = A$0$0 + B$1$0
    B$1$1 = B$1$0
  ENDDO
ENDDO.
```

2).

According to B.

$S_1 \rightarrow S_2$

K J I

$B(1, J, K)$

$= B(I, 100-J, K)$

$K=1 \quad J * 100-J \quad 1 \le I$

$( = \quad * \quad \ge )$

$\{><=\} \quad \{>=\}$.

$( = \; = \; = )$

$S_1 \, \delta_\infty \, S_2$

$( = \; < \; = )$

$S_1 \, \delta_2 \, S_2$

$( = \; > \; = )$

$S_2 \, \delta_2^{-1} \, S_1$

According to A.

$S_2 \rightarrow S_1$

K J I.

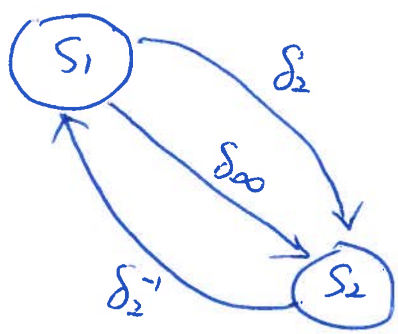
$= A(1 \cdot J-1, K)$

$A(I+1, J, K)$

$K=1 \quad J > J-1 \quad I+1 > 1$

$( = \; < \; < )$

no dependence.




according to Advanced Vectorization algorithm.

$S_1$ need vectorize $P(\pi_i) - K + 1 = 2 - 3 + 1 = 0$. dimensions no change

$S_2$ need vectorize $P(\pi_i) - K + 1 = 3 - 3 + 1 = 1$ dimensions.

So code would be like.

```
Do K=1, 100.
   Do J=1, 100
      B(1, J, K) = A(1, J-1, K).
      A(2:101, J, K) = B(1:100, 100-J, K) + C
   ENDDO
```