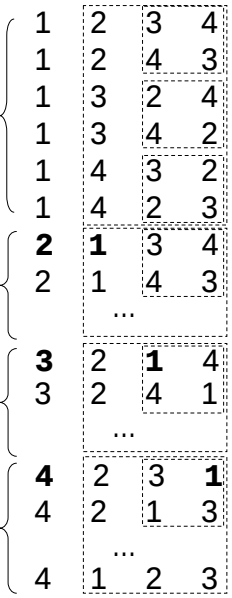
Permutation from Swapping (1/4)

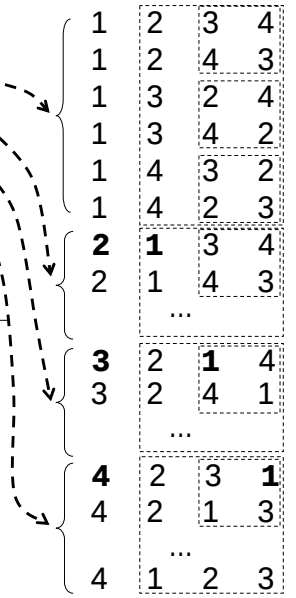
- **Recursive**
  - 1 + permutations of {2, 3, 4}
  - 2 + permutations of {1, 3, 4}
  - 3 + permutations of {2, 1, 4}
  - 4 + permutations of {2, 3, 1}



Permutation from Swapping (1/4)

- **Recursive**
  - 1 + permutations of {2, 3, 4}
  - 2 + permutations of {1, 3, 4}
  - 3 + permutations of {2, 1, 4}
  - 4 + permutations of {2, 3, 1}

```
for (i=0; i<n; i++) a[i] = i+1;
permutation(a, 0, n-1);
```

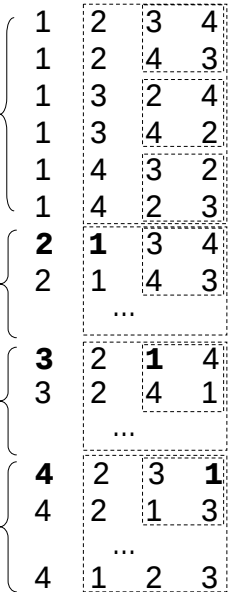


Permutation from Swapping (1/4)

- **Recursive**
  - 1 + permutations of {2, 3, 4}
  - 2 + permutations of {1, 3, 4}
  - 3 + permutations of {2, 1, 4}
  - 4 + permutations of {2, 3, 1}

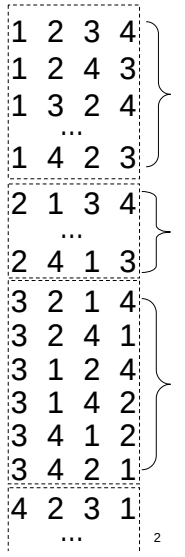
```
for (i=0; i<n; i++) a[i] = i+1;
permutation(a, 0, n-1);
```

```
void permutation(int perm[], int start, int end) {
    if (start == end) printPerm(perm, end+1);
    for (int i=start; i<=end; i++) {
        swap(&perm[start], &perm[i]);
        permutation(perm, start+1, end);
        swap(&perm[start], &perm[i]);
    }
}
```



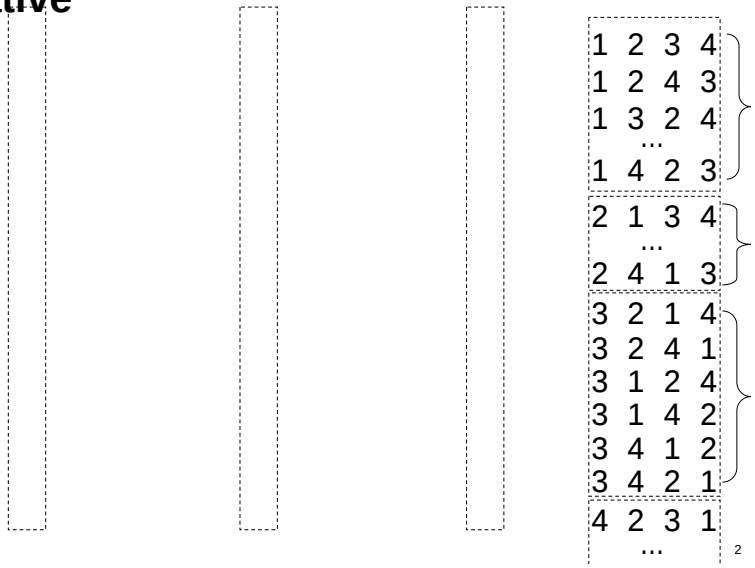
Permutation from Swapping (2/4)

- **Iterative**



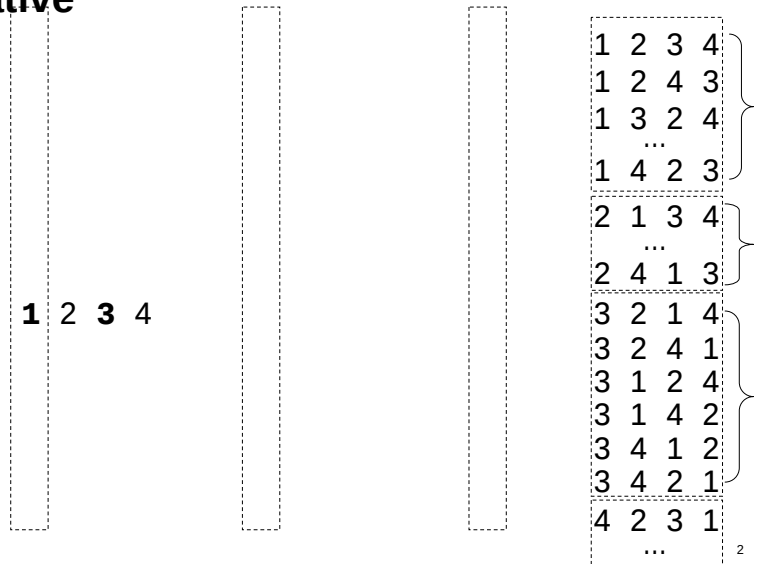
Permutation from Swapping (2/4)

- **Iterative**



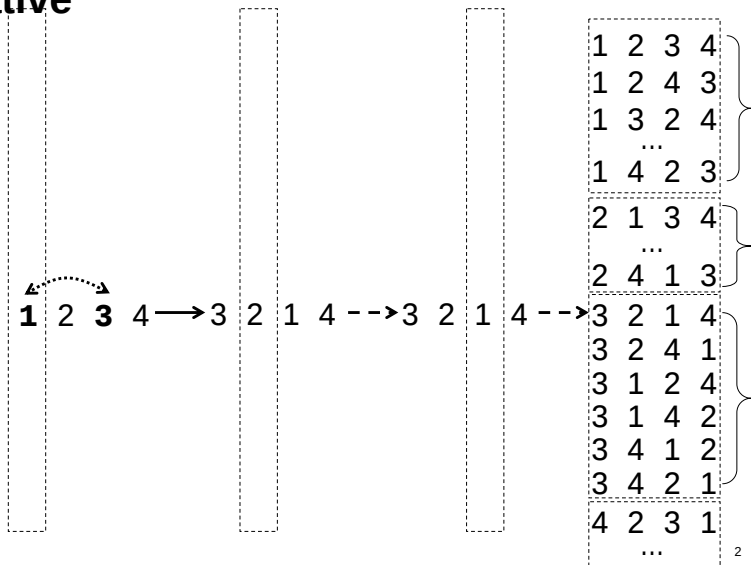
Permutation from Swapping (2/4)

- **Iterative**



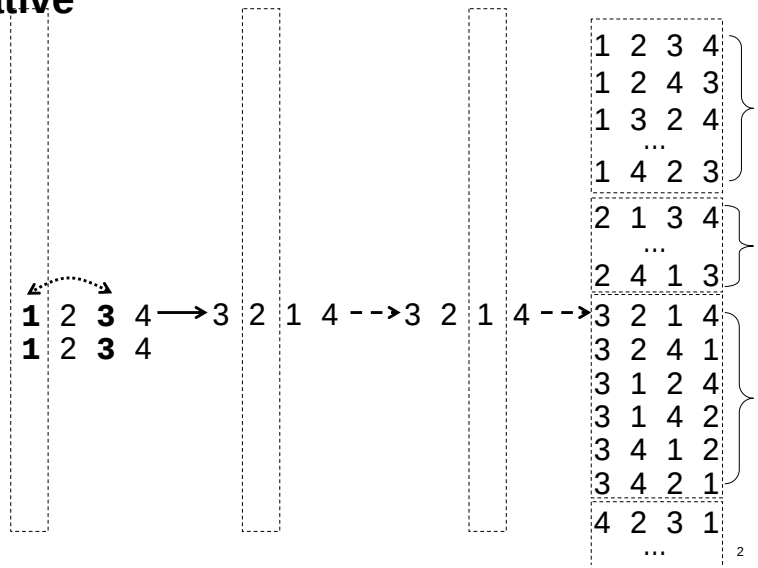
Permutation from Swapping (2/4)

- **Iterative**



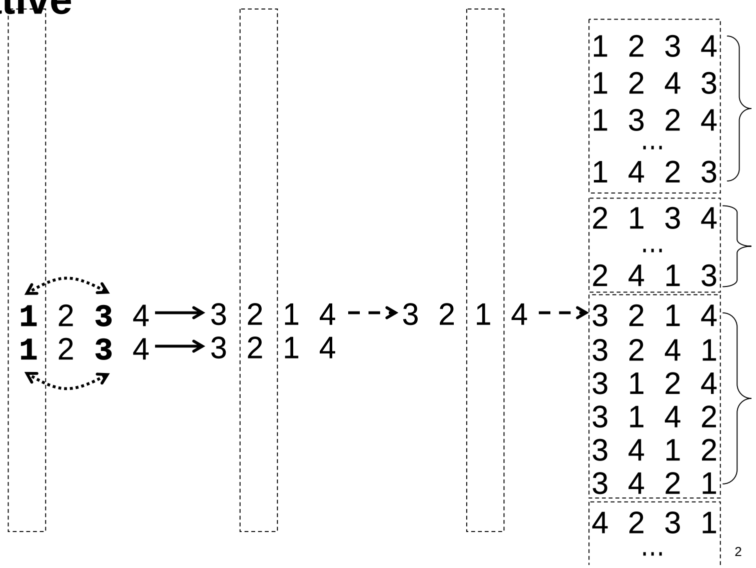
Permutation from Swapping (2/4)

- **Iterative**



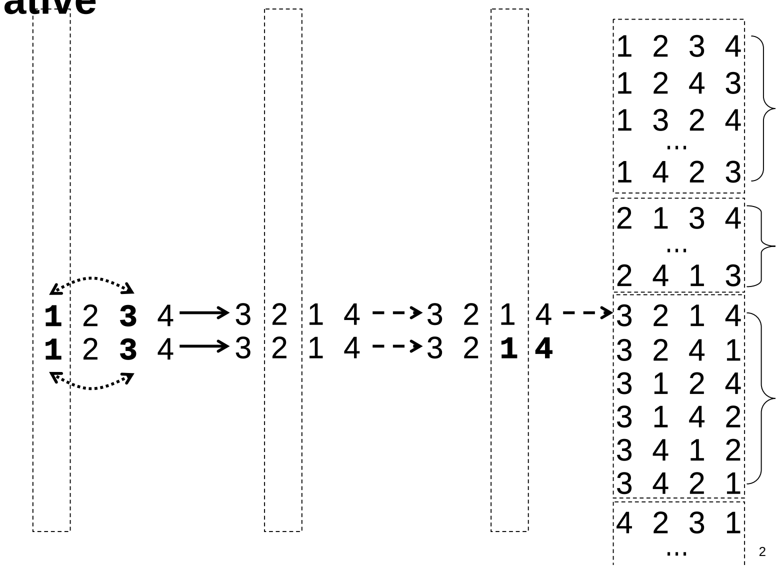
Permutation from Swapping (2/4)

- **Iterative**



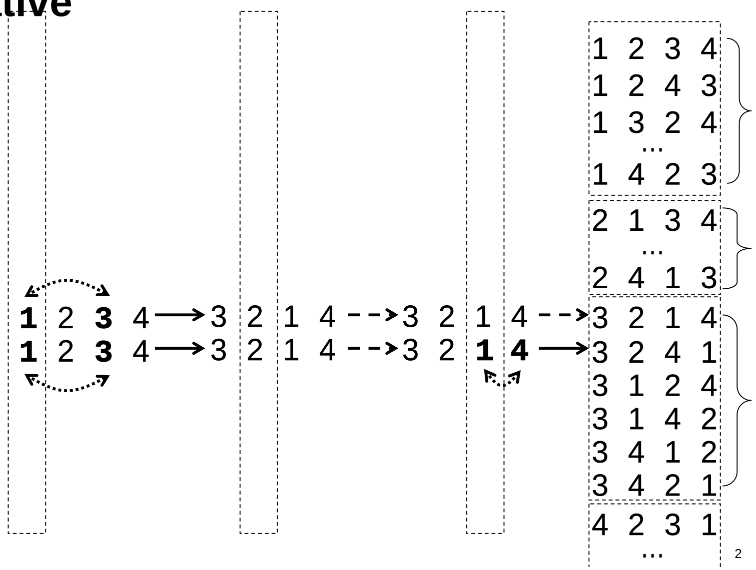
Permutation from Swapping (2/4)

- **Iterative**



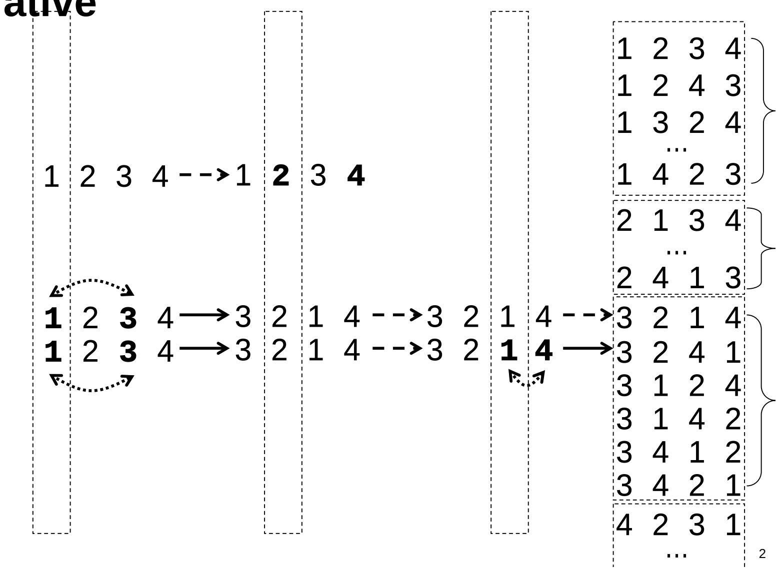
Permutation from Swapping (2/4)

- **Iterative**



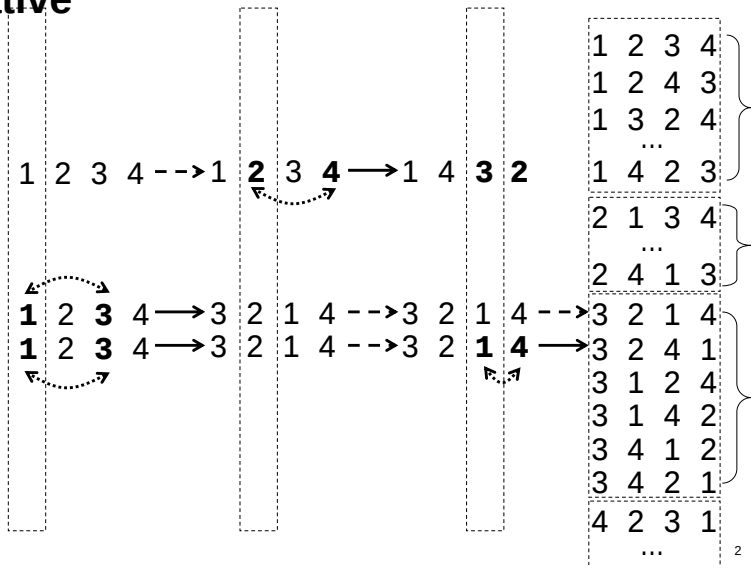
Permutation from Swapping (2/4)

- **Iterative**



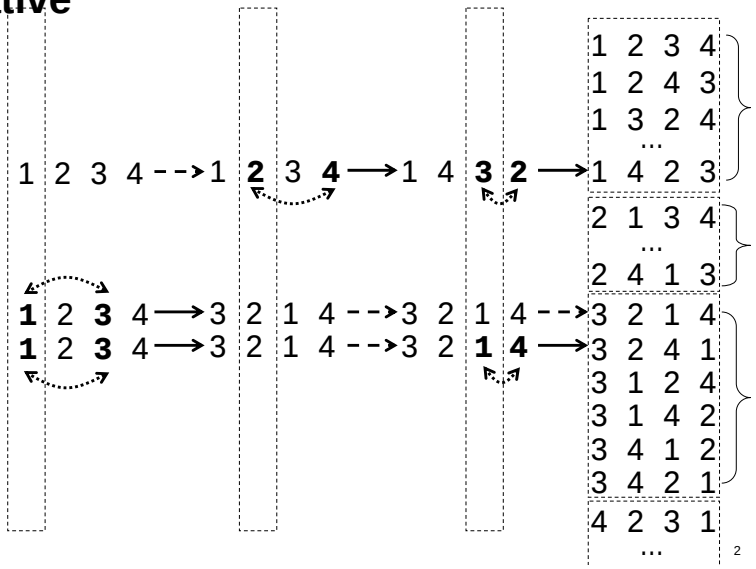
Permutation from Swapping (2/4)

- **Iterative**



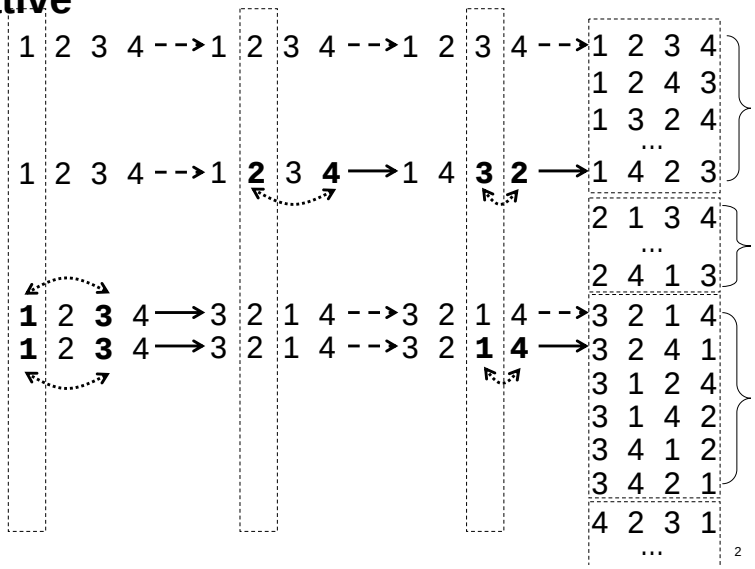
Permutation from Swapping (2/4)

- **Iterative**



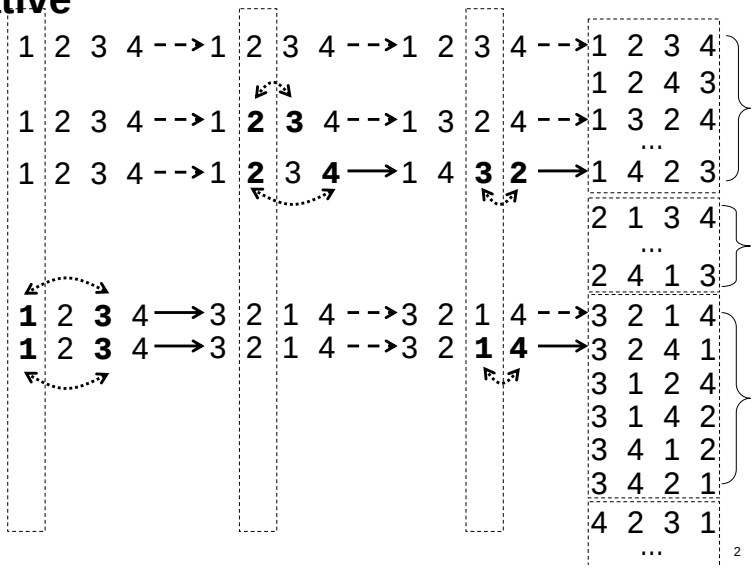
Permutation from Swapping (2/4)

- **Iterative**



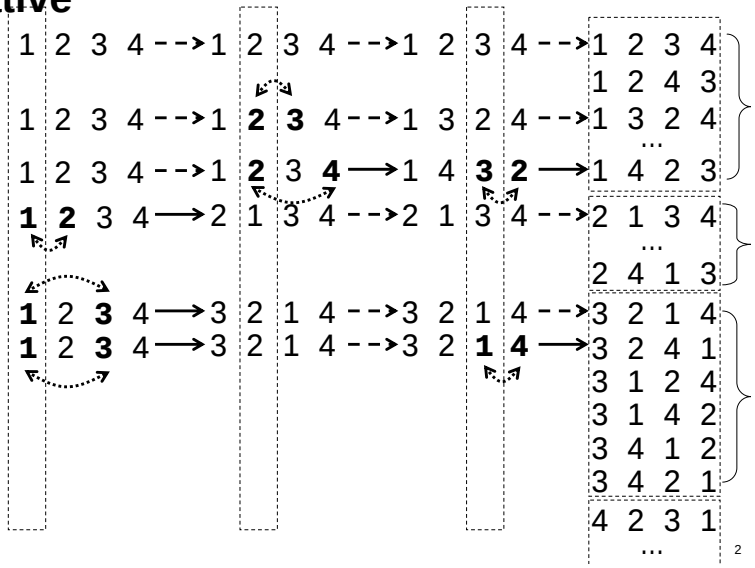
Permutation from Swapping (2/4)

- **Iterative**



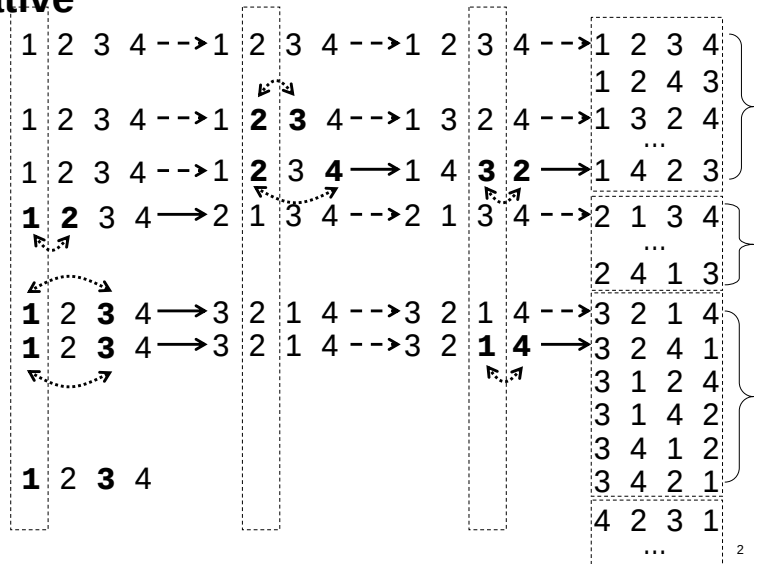
Permutation from Swapping (2/4)

- **Iterative**



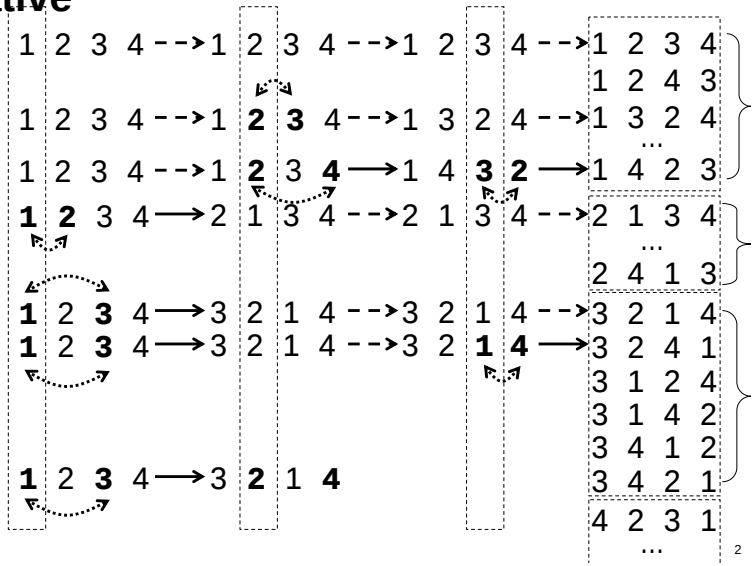
Permutation from Swapping (2/4)

- **Iterative**



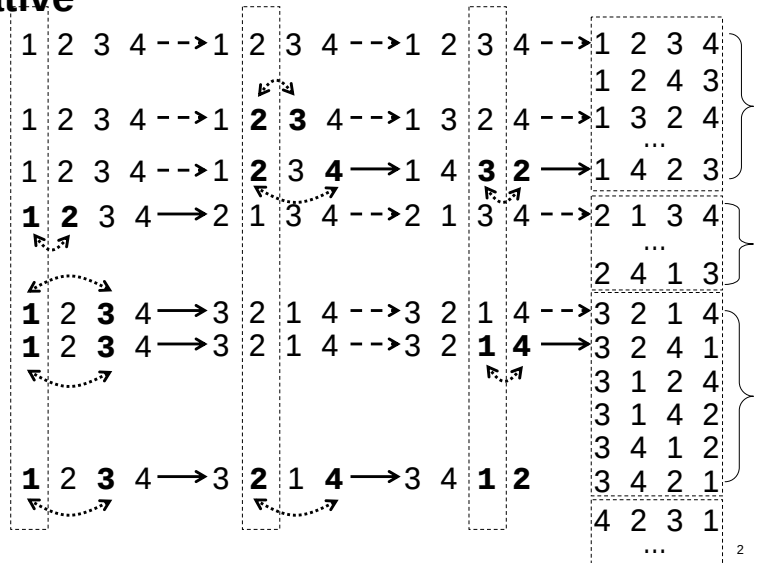
Permutation from Swapping (2/4)

- **Iterative**



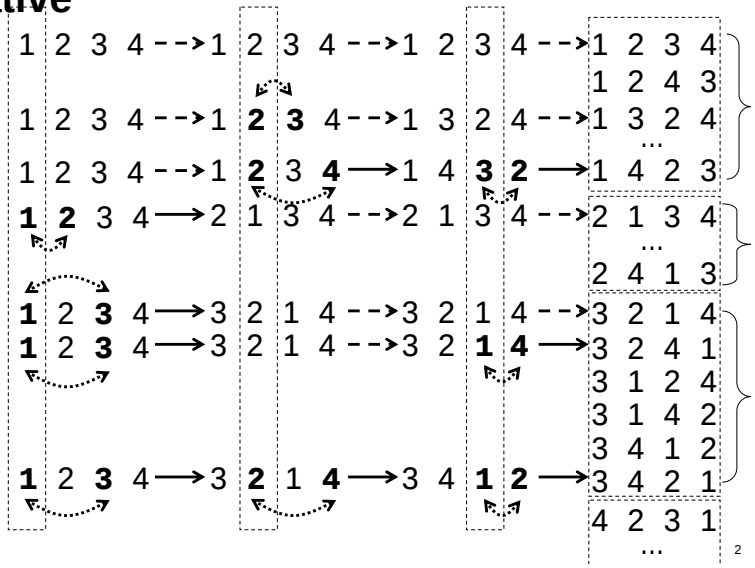
Permutation from Swapping (2/4)

- **Iterative**



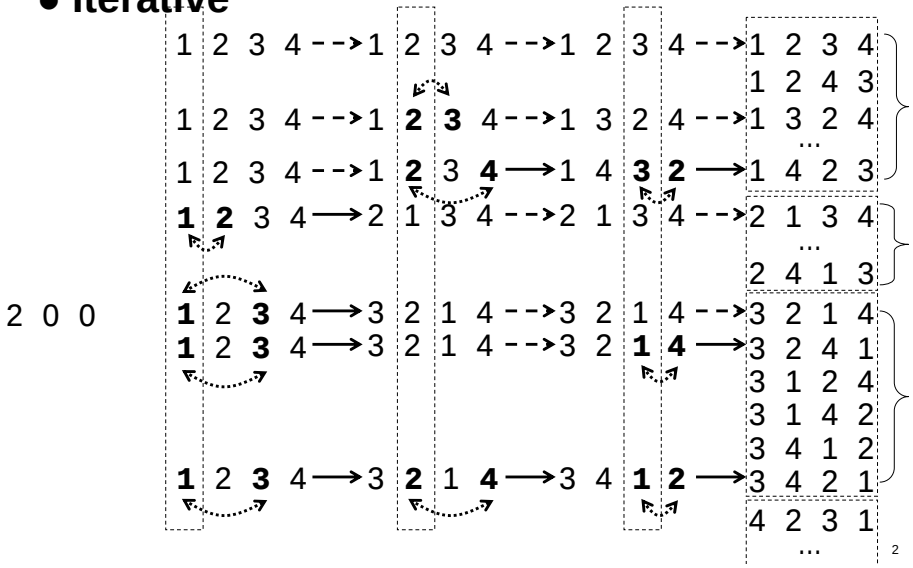
Permutation from Swapping (2/4)

- **Iterative**



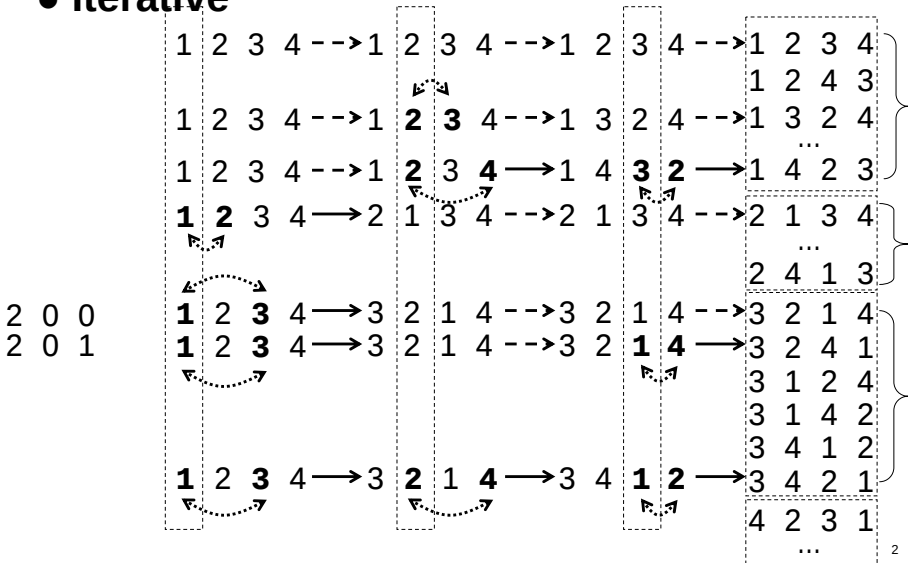
Permutation from Swapping (2/4)

- **Iterative**



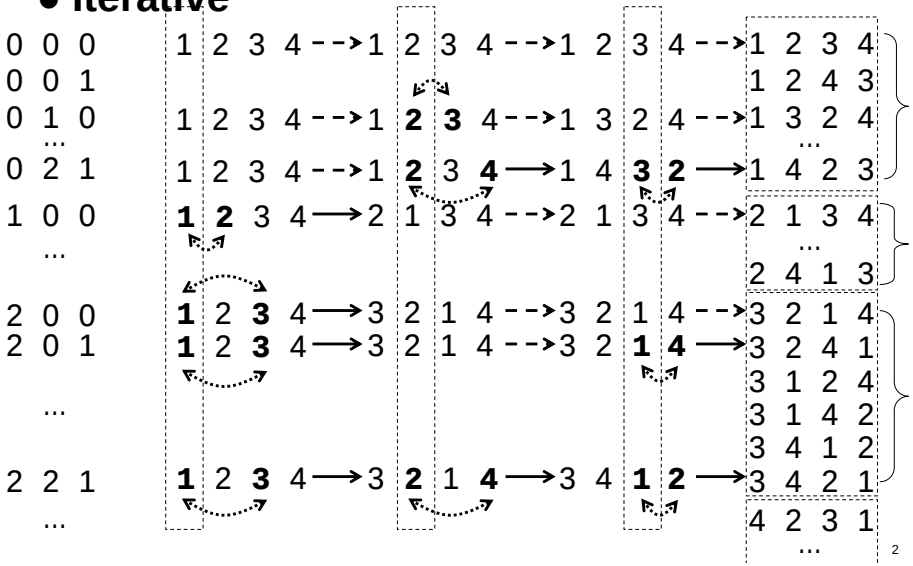
Permutation from Swapping (2/4)

- **Iterative**



Permutation from Swapping (2/4)

- **Iterative**

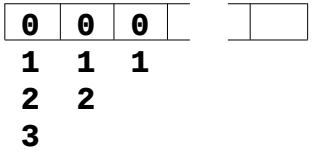


Permutation from Swapping (3/4)

- counting up

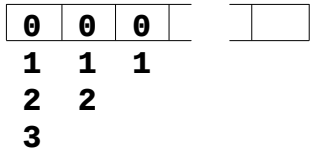
Permutation from Swapping (3/4)

- counting up



Permutation from Swapping (3/4)

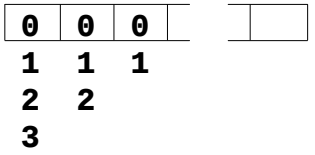
- counting up



0 0 0
0 0 1
0 1 0
0 1 1
0 2 0
0 2 1

Permutation from Swapping (3/4)

- counting up

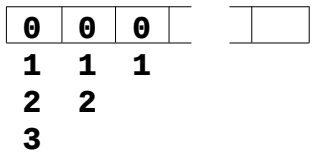


0 0 0
0 0 1
0 1 0
0 1 1
0 2 0
0 2 1

1 0 0
1 0 1
1 1 0
1 1 1
1 2 0
1 2 1

Permutation from Swapping (3/4)

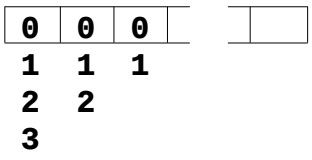
- counting up



0	0	0	2	0	0
0	0	1	2	0	1
0	1	0	2	1	0
0	1	1	2	1	1
0	2	0	2	2	0
0	2	1	2	2	1
1	0	0			
1	0	1			
1	1	0			
1	1	1			
1	2	0			
1	2	1			

Permutation from Swapping (3/4)

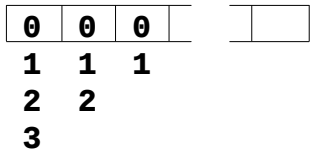
- counting up



0	0	0	2	0	0
0	0	1	2	0	1
0	1	0	2	1	0
0	1	1	2	1	1
0	2	0	2	2	0
0	2	1	2	2	1
1	0	0	3	0	0
1	0	1	3	0	1
1	1	0	3	1	0
1	1	1	3	1	1
1	2	0	3	2	0
1	2	1	3	2	1

Permutation from Swapping (3/4)

- counting up

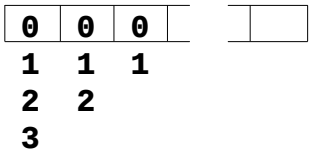



```
int next(int counter[], int size) {
    int i;
    for (i=size-1; i>=0; i--) {
        counter[i]++;
        if (counter[i]<=size-i)
            return 1;
        counter[i] = 0;
    }
    return 0;
}
```

0	0	0	2	0	0
0	0	1	2	0	1
0	1	0	2	1	0
0	1	1	2	1	1
0	2	0	2	2	0
0	2	1	2	2	1
1	0	0	3	0	0
1	0	1	3	0	1
1	1	0	3	1	0
1	1	1	3	1	1
1	2	0	3	2	0
1	2	1	3	2	1

Permutation from Swapping (3/4)

- counting up

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        counter[i] = 0;
    }
    return 0;
}
```

Initially, 0 0 -1

0	0	0	2	0	0
0	0	1	2	0	1
0	1	0	2	1	0
0	1	1	2	1	1
0	2	0	2	2	0
0	2	1	2	2	1
1	0	0	3	0	0
1	0	1	3	0	1
1	1	0	3	1	0
1	1	1	3	1	1
1	2	0	3	2	0
1	2	1	3	2	1