Data Structures

Lecture: Sorting Techniques

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Outlines

- Introduction
- Insertion Sort
- Merge Sort
- Bubble Sort
- Quick Sort
- Heap Sort
- Selection Sort

Sorting (Bubble Sort)

- Sorting refers to the operation of rearranging the elements of A so they are in some particular order.

- Complexity of Bubble Sort Algorithm is: $O(n^2)$

- Example of Bubble Sort

Bubble Sort Algorithm

Bubble (DATA, N)

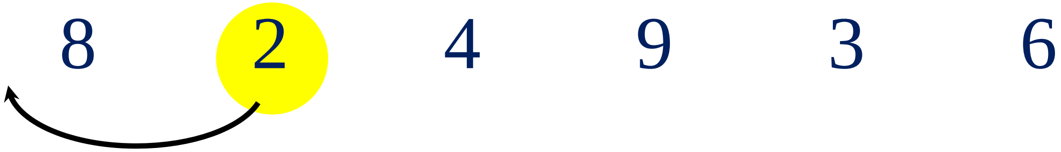
```
1.  Repeat Step 2 and 3 for K=1 to N-1.
2.   [Initialize Pass Pointer P] Set P=1.
3.   [Execute Pass] Repeat while P <= N-K.
         (a) if DATA [P] > DATA [P+1], then:
               Interchange DATA [P] and DATA[P+1]
                [End of if Structure.]
          (b) Set P = P+1.
     [End of Inner Loop.]
 [End of Step1 Outer Loop.]
4. Exit
```

INSERTION SORT

Example of insertion sort

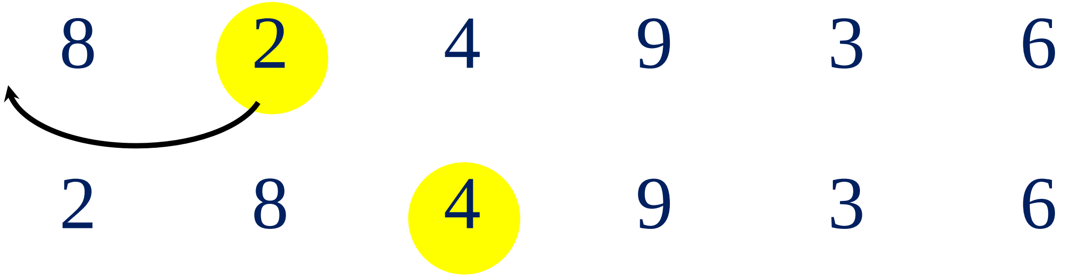
8 2 4 9 3 6

Example of insertion sort



8 2 4 9 3 6

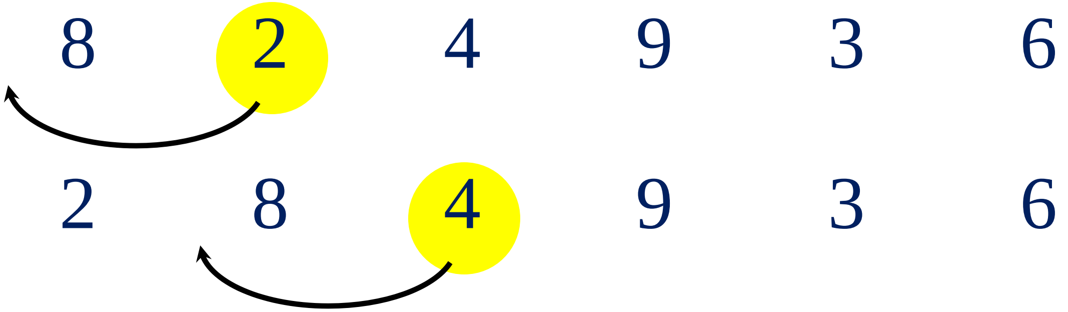
Example of insertion sort



8 2 4 9 3 6

2 8 4 9 3 6

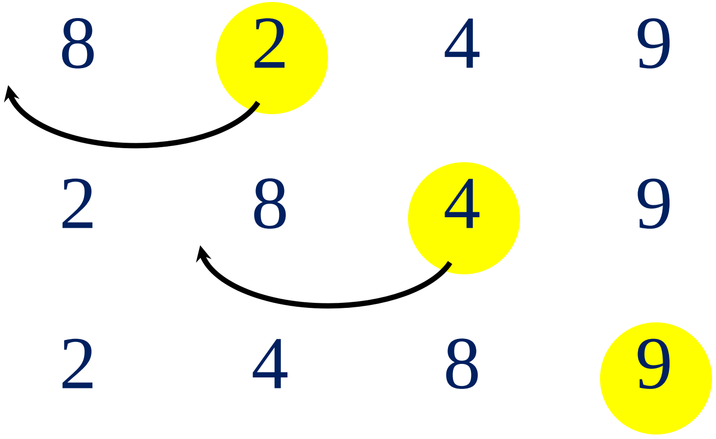
Example of insertion sort



8 2 4 9 3 6

2 8 4 9 3 6

Example of insertion sort

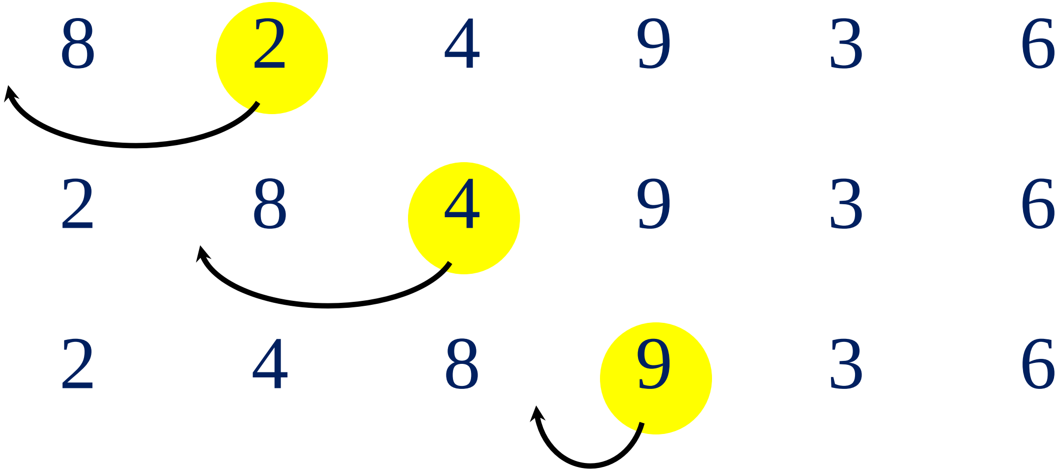


8 2 4 9 3 6

2 8 4 9 3 6

2 4 8 9 3 6

Example of insertion sort

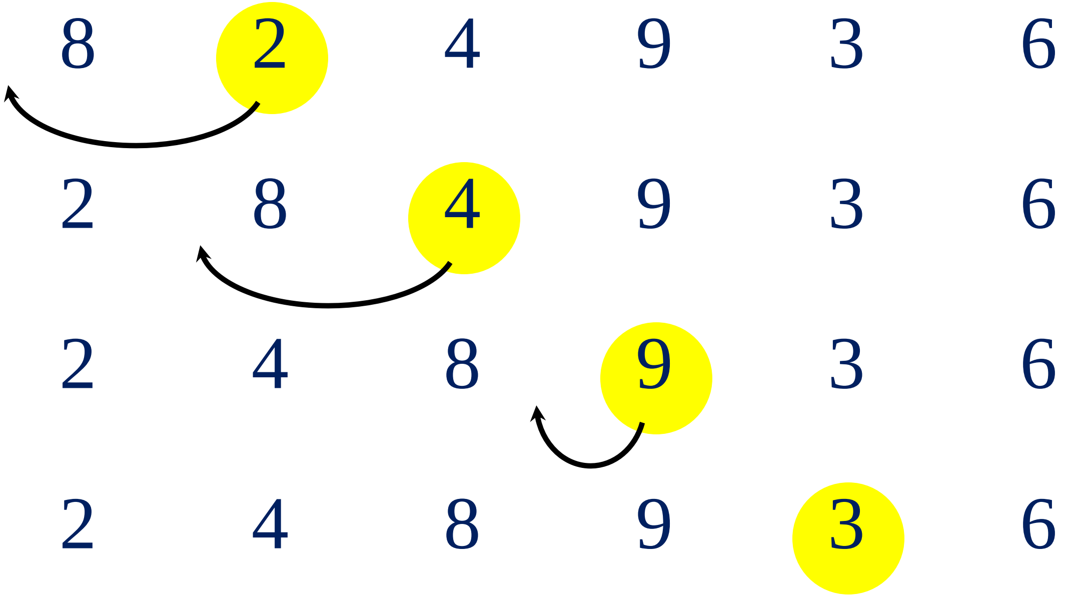


8 2 4 9 3 6

2 8 4 9 3 6

2 4 8 9 3 6

Example of insertion sort



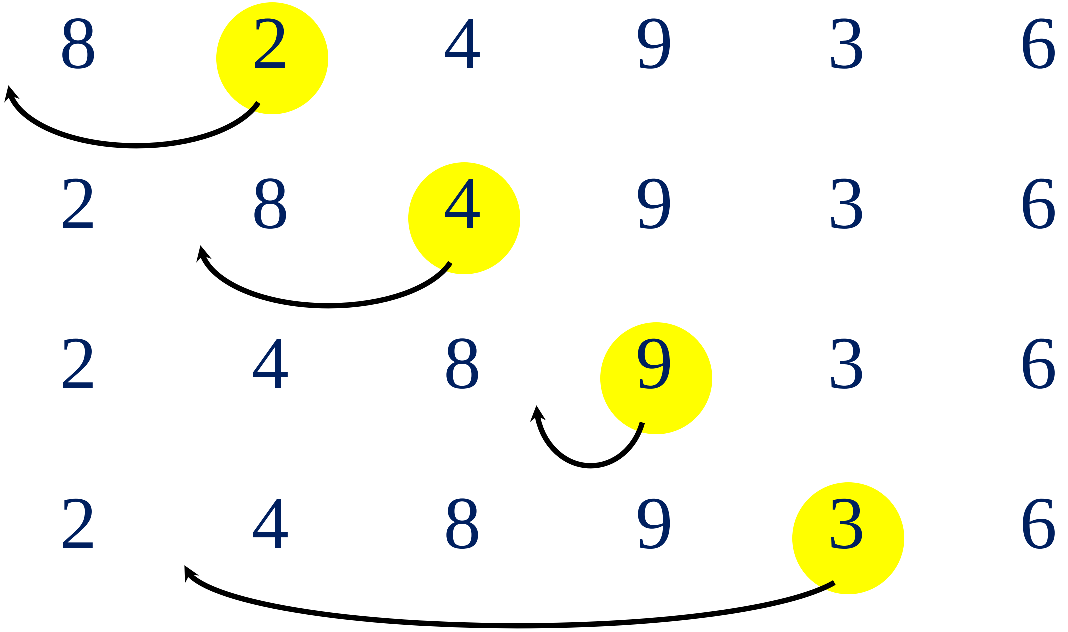
8 2 4 9 3 6

2 8 4 9 3 6

2 4 8 9 3 6

2 4 8 9 3 6

Example of insertion sort



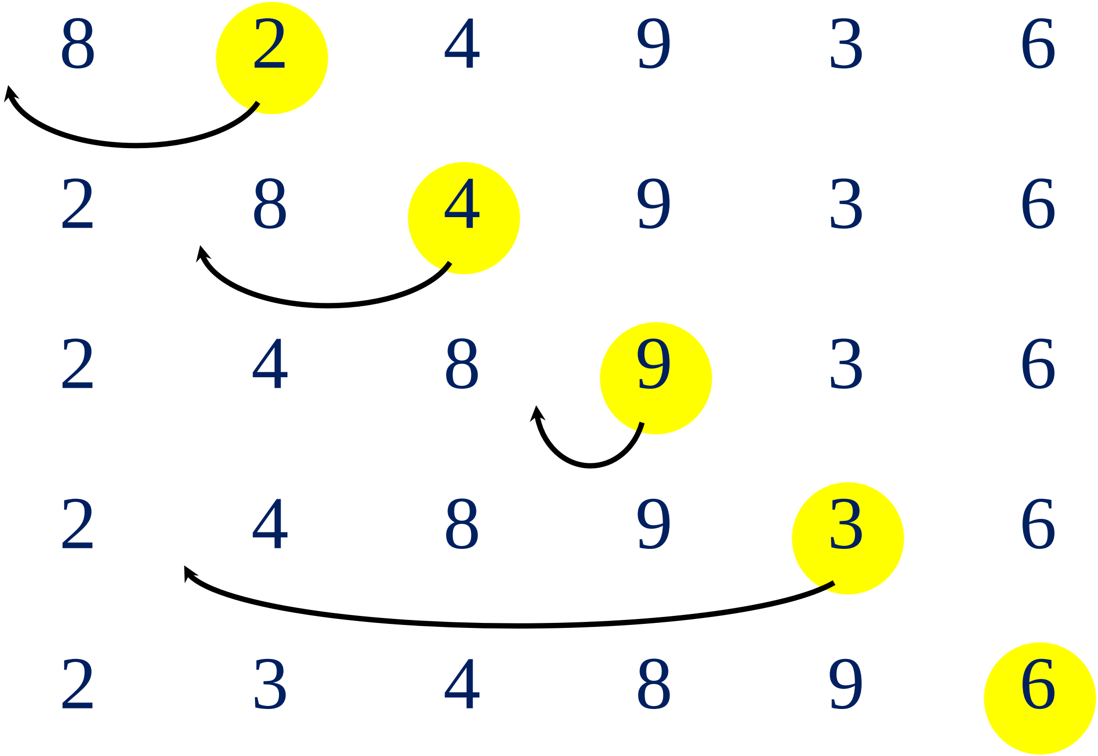
8 2 4 9 3 6

2 8 4 9 3 6

2 4 8 9 3 6

2 4 8 9 3 6

Example of insertion sort



8 2 4 9 3 6

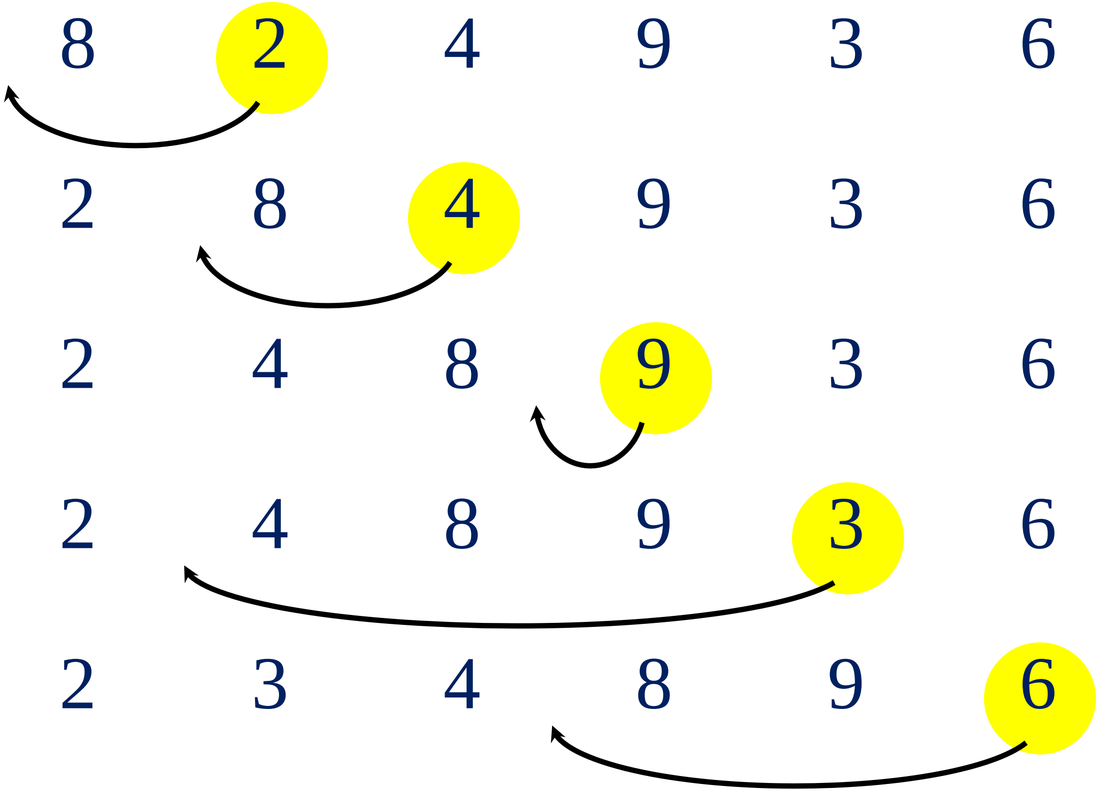
2 8 4 9 3 6

2 4 8 9 3 6

2 4 8 9 3 6

2 3 4 8 9 6

Example of insertion sort



8 2 4 9 3 6

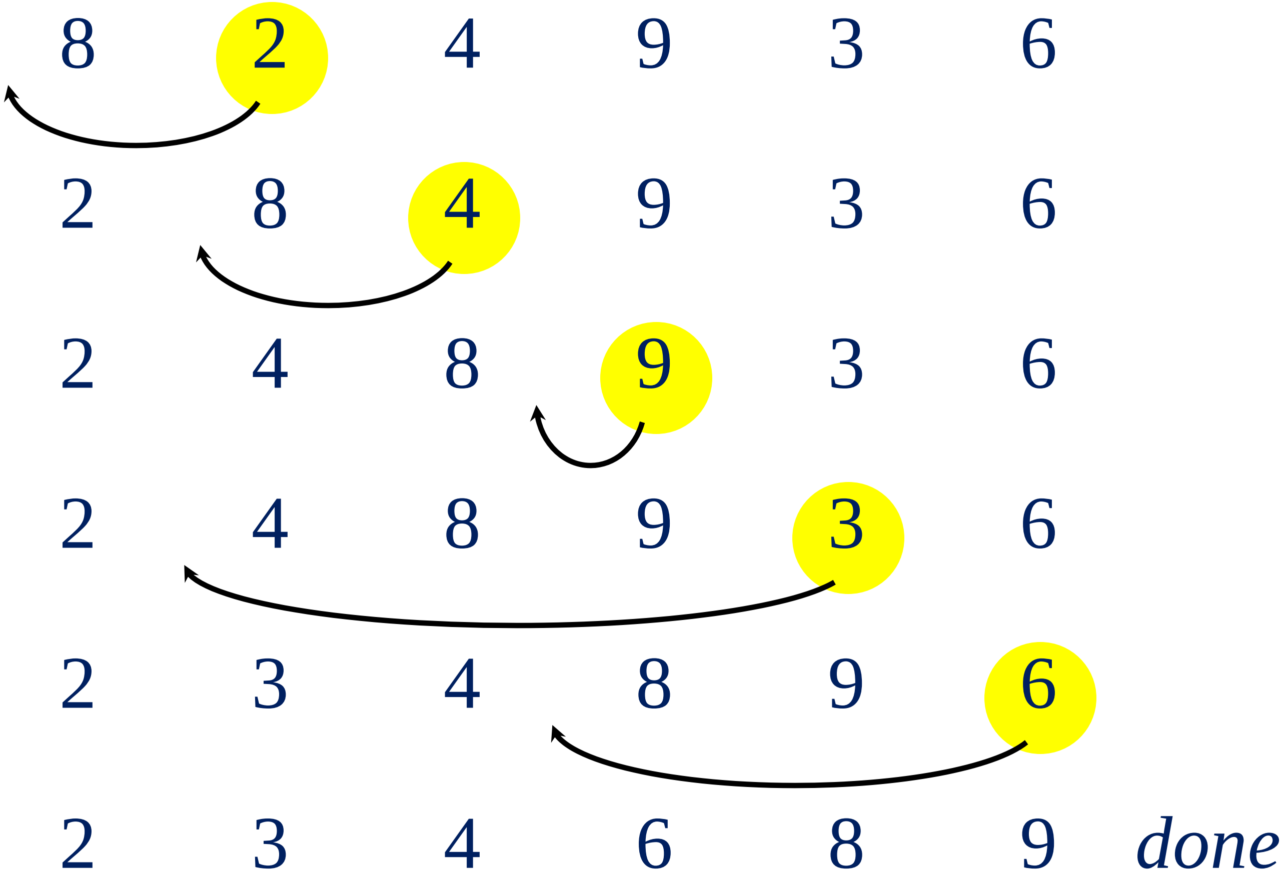
2 8 4 9 3 6

2 4 8 9 3 6

2 4 8 9 3 6

2 3 4 8 9 6

Example of insertion sort



8 2 4 9 3 6

2 8 4 9 3 6

2 4 8 9 3 6

2 4 8 9 3 6

2 3 4 8 9 6

2 3 4 6 8 9 *done*

Insertion Sort

INSERTION_SORT (A, N)

```
1.  Set A[0] = -∞.
2.  Repeat Step 3 to 5 for K = 2, 3, …, N:
3.      Set TEMP = A[K] and PTR = K – 1.
4.      Repeat while TEMP < A[PTR]:
            (a) Set A[PTR+1] = A[PTR]
            (b) Set PTR = PTR – 1.
        [End of Loop.]
5.      Set A[PTR+1] = TEMP.
6.  Return.
```

Insertion Sort Complexity

- This Sorting algorithm is frequently used when n is very small.

- Worst case occurs when array is in reverse order. The inner loop must use K – 1 comparisons.

$$f(n) = 1 + 2 + 3 + \ldots. + (n - 1) = n(n - 1)/2$$
$$= O(n^2)$$

- In average case, there will be approximately (K – 1)/2 comparisons in the inner loop.

$$f(n) = 1 + 2 + 3 + \ldots. + (n - 1)/2 = n(n - 1)/4$$
$$= O(n^2)$$

Animation Link

- Insertion Sort
- http://courses.cs.vt.edu/~csonline/Algorithms/Lessons/InsertionCardSort/insertioncardsort.swf

- https://www.hackerearth.com/practice/algorithms/sorting/bubble-sort/visualize/

- https://visualgo.net/en/sorting