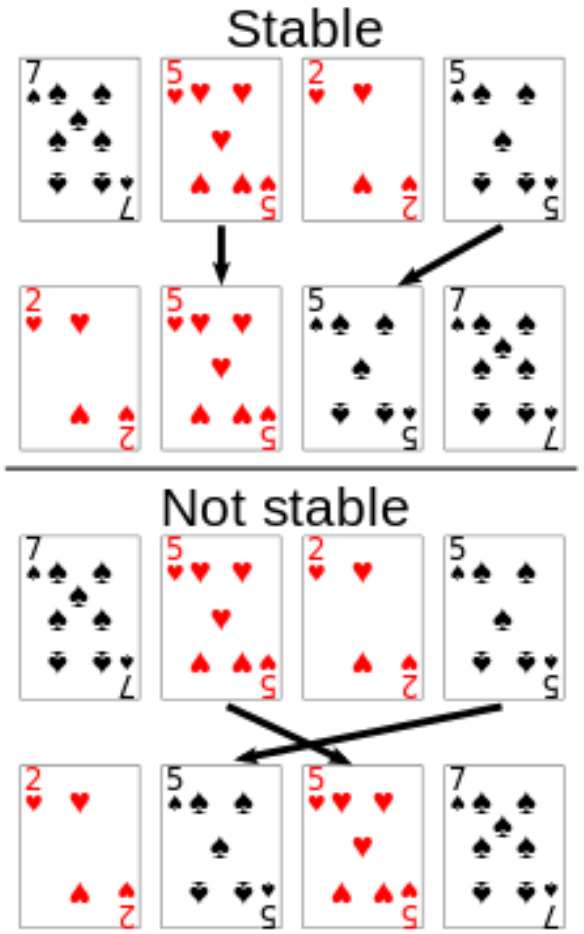
Sorting Values

Introduction to Sorting

- Sometimes you want to sort data
  - 5, 8, 14, 2, 9 → 2, 5, 8, 9, 14
  - For now, assume that the data is in an array
- Sorting can also be used to optimize other parts of the code
  - Searching for certain item is easier if the data is organized
- This a broad topic
  - There are **many** techniques (Bubble, Selection, Insertion, Merge, Quick, Heap, Counting…)
  - Our focus: **Bubble Sort**, **Selection Sort**, **Insertion Sort**, & **Merge Sort**

How do we choose a method?

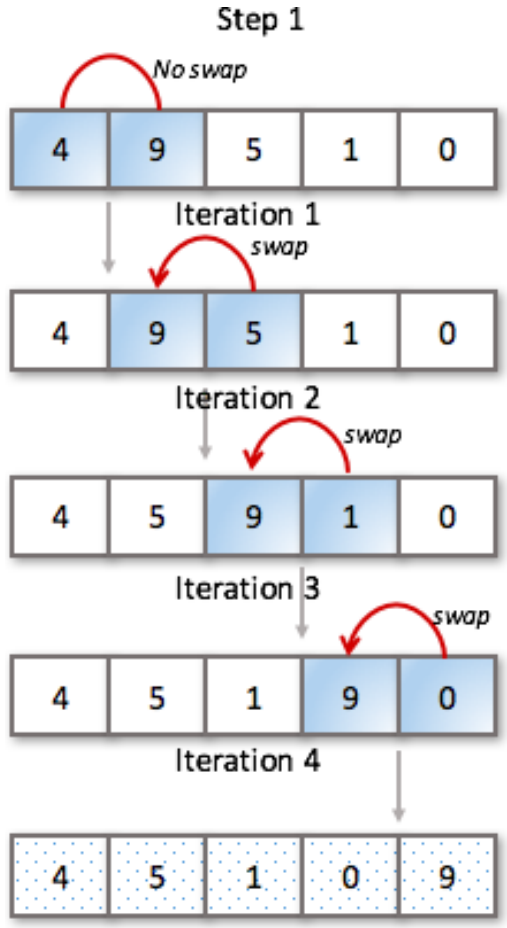
- Runtime
  - Best, average, and worst case
- Space usage
  - Can it be sorted in-place, does it require external memory
- Stability
  - If two elements are equal, they appear in the same order in the output as they were in the input
  - Needed because data is often sorted based on only part of the data



Wikipedia.org

Bubble sort

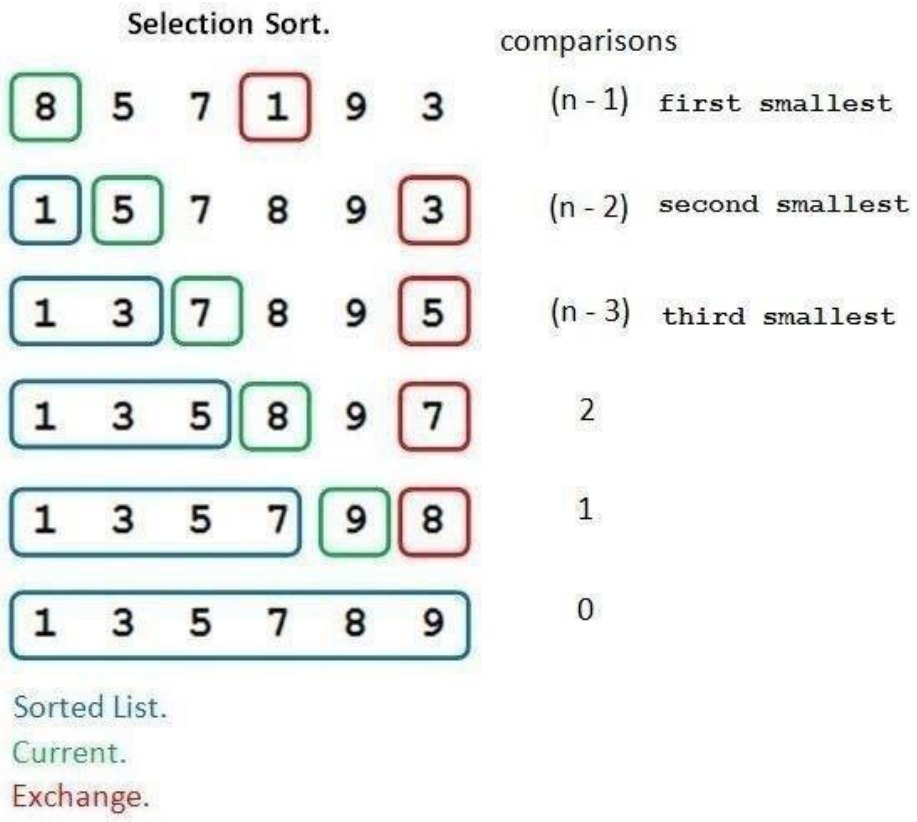
- Simplest algorithm
- Repeatedly swaps adjacent elements if they are in the wrong order
- Stable
- Slower on average
- In-place, no significant extra space needed
- https://visualgo.net/bn/sorting



http://www.equestionanswers.com/c/c-bubble-sort.php

Selection sort

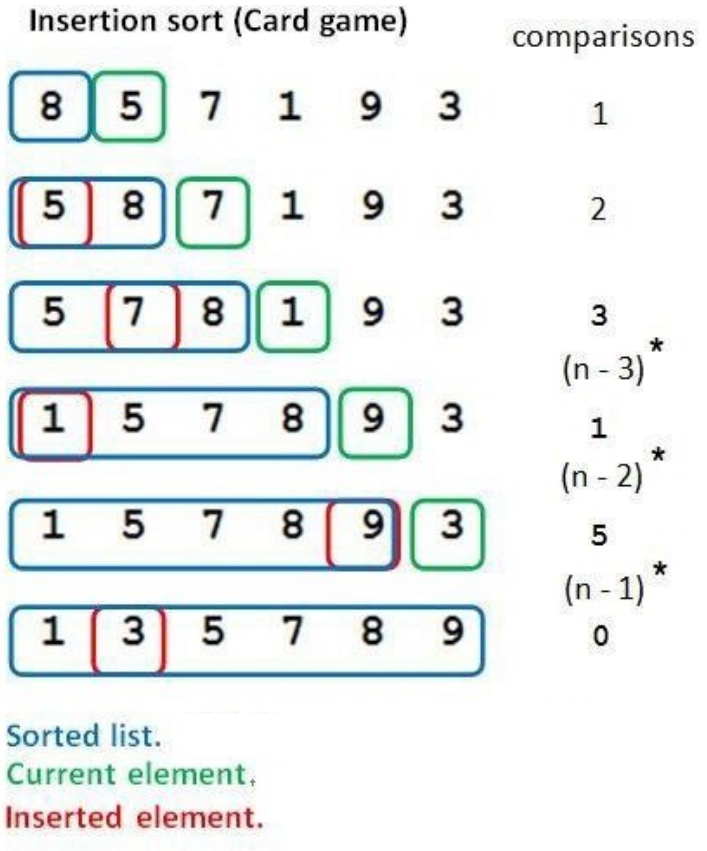
- Data has two sections
  - Already sorted
  - Remaining unsorted
- Repeatedly finds the minimum element from the unsorted portion of the data and puts it at the beginning
- Not stable by default
- Consistent runtime
- In-place, no significant extra space needed



https://cheetahonfire.blogspot.com/2009/05/selection-sort-vs-insertion-sort.html

Insertion sort

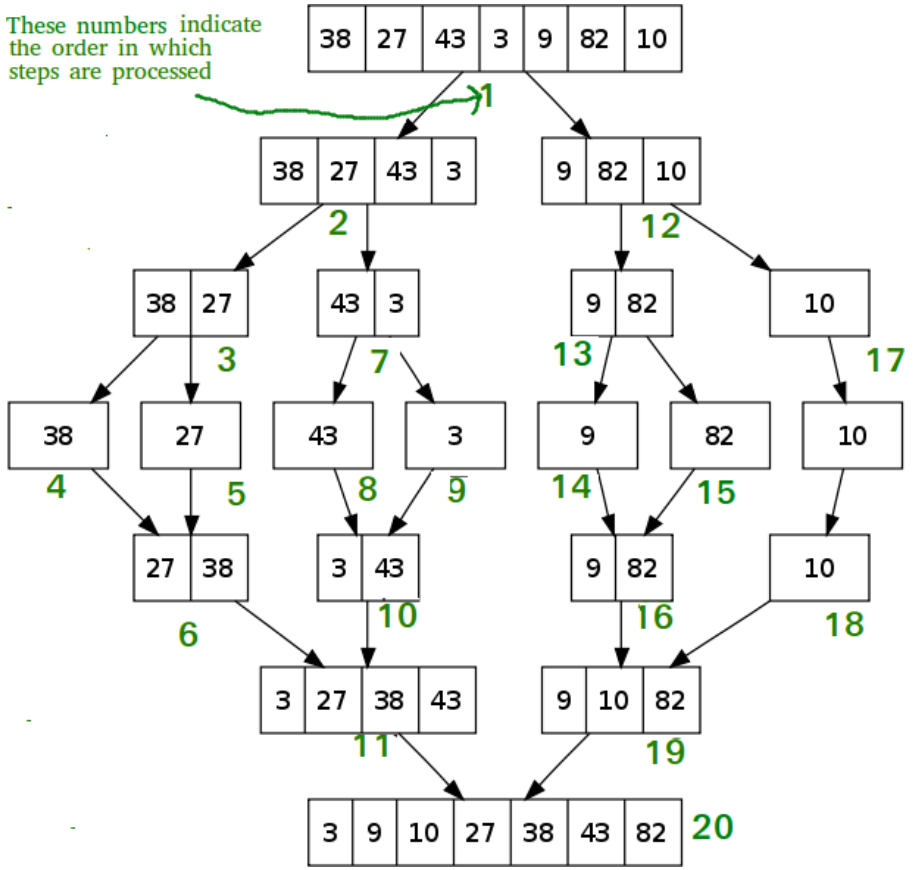
- Somewhat like selection sort…
  - Divides the data into sorted and unsorted
  - Elements in the sorted portion are only sorted with respect to each other (not the entire array)
- An unsorted element could still be inserted somewhere in the middle of the sorted portion
  - Think of how you organize a hand of playing cards
- Stable
- Best used for smaller datasets



https://cheetahonfire.blogspot.com/2009/05/selection-sort-vs-insertion-sort.html

Merge sort

- A divide and conquer algorithm
  - Divide – Break the given problem into subproblems of the same type
  - Conquer – Solve the subproblems
  - Combine – Appropriately combine the answers
- Key concepts
  - 1) When two arrays are already sorted, it is easy to combine them into one sorted array
  - 2) An array of length “1” is already sorted
- Stable
- Often used for large datasets



GeeksForGeeks.org

A note on STL Sorting

- sort() – uses hybrid algorithm called introsort (combination of quick, heap, and insertion)
- stable_sort() – preserves order of equal elements

Additional References

- Selection Sort

  https://www.geeksforgeeks.org/selection-sort/
- Insertion Sort

  https://www.geeksforgeeks.org/insertion-sort/
- Merge Sort

  https://www.geeksforgeeks.org/merge-sort/