Data Structures and Algorithms

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Data Structure and Algorithms



1

outline

Searching and Sorting

Sorting Searching Linear search Unsorted list Sorted list **Binary search** Quick sort Time complexity comparison of Heap sort Linear and Binary search



- **Bubble sort**
- **Selection sort**
- **Insertion sort**
- Merge sort

Sorting

Applications of Searching and

Searching

- Find the location of a given element in al list.
- Successful or Unsuccessful search: whether given element is to be found or not.
- Searching Methods:
 - Linear Search
 - **Binary Search**



Linear Search

Linear Search

- Sorted List:
 - See Animation of linear search on sorted list
 - See <u>source code in C++</u> of linear search on sorted list
- Unsorted List:
 - See <u>Animation</u> of linear search on unsorted list
 - See <u>source code in C++</u> of linear search on unsorted list





Binary Search

Binary Search

- Sorted List:
 - See <u>Animation</u> of binary search on sorted list
 - See <u>source code in C++</u> of binary search on sorted list



Time Complexity comparison of Linear & Binary search





Data Structure and Algorithms

Intersection of Sorted Arrays, N = 1,000,000

Sorting

- Arranging a set of data in some order.
 - Data is to be sorted in:
 - Ascending order
 - Descending order
- **Sorting Methods:**
 - **Internal Sorting:** when all the data that is to be sorted can be accommodated at a time in memory.
 - Bubble Sort
 - Selection Sort
 - **Insertion Sort**
 - Merge Sort
 - Quick Sort
 - Heap Sort

External Sorting: when the data to be sorted is so large that some of the data is present in the memory and some is kept in auxiliary memory (hard disk, floppy, tape, etc.)

Bubble Sort

Bubble Sort

- See <u>Animation</u> of bubble sort
- See <u>source code in C++</u> of bubble sort

Time Complexity:

| Algorithm | Worst Case | Average Case | Best Case |
|-------------|--------------------|--------------------|-----------|
| Bubble sort | O(n ²) | O(n ²) | O(n²) |



Selection Sort

Bubble Sort

- See <u>Animation</u> of selection sort
- See <u>source code in C++</u> of selection sort

Time Complexity:

| Algorithm | Worst Case | Average Ca | |
|----------------|--------------------|--------------------|--|
| Selection sort | O(n ²) | O(n ²) | |







Insertion Sort

Insertion Sort

- See <u>Animation</u> of insertion sort
- See <u>source code in C++</u> of insertion sort

Time Complexity:

| Algorithm | Worst Case | Average Case | Best Case |
|----------------|------------|--------------|-----------|
| Insertion sort | O(n²) | O(n²) | O(n) |



Quick Sort

Quick Sort

- See <u>Animation</u> of quick sort
- See <u>source code in C++</u> of quick sort

Time Complexity:

| Algorithm | Worst Case | Average Case | Best Case |
|------------|------------|-----------------------|-----------------------|
| Quick sort | O(n²) | O(log ₂ n) | O(log ₂ n) |



Merge Sort

Merge Sort

- See <u>Animation</u> of merge sort
- See <u>source code in C++</u> of merge sort

Time Complexity:

| Algorithm | Worst Case | Average Case | Best Case |
|------------|-------------------------|-------------------------|-------------------------|
| Merge sort | O(n log ₂ n) | O(n log ₂ n) | O(n log ₂ n) |



Heap Sort

Heap Sort

- See <u>Animation</u> of heap sort
- See <u>source code in C++</u> of heap sort

Time Complexity:

| Algorithm | Worst Case | Average Case | Best Case |
|-----------|-------------------------|-------------------------|-------------------------|
| Heap sort | O(n log ₂ n) | O(n log ₂ n) | O(n log ₂ n) |



Comparison Sorting Algorithms

Demo of comparison of different sorting algorithms:

Comparison Sorting Algorithms

Randomize Array Insertion Sort Selection Sort Bubble Sort Quick Sort Merge Sort Shell Sort Change Size



https://www.cs.usfca.edu/~galles/visualization/ComparisonSort.html



Data Structure and Algorithms

hange Size



Comparison Sorting Algorithms

Another good demo of comparison of different sorting algorithms:



https://www.toptal.com/developers/sorting-algorithms





Applications of Searching & Sorting Algorithms

Searching Applications:

- Query to document matching
- Web search engine
- Sub-string matching
- Image retrieval
- etc.
- Read more about search algorithms' applications:
 - <u>https://en.wikipedia.org/wiki/Search_algorithm</u>

Sorting Applications:

- Read about sorting algorithms' applications:
 - <u>http://algs4.cs.princeton.edu/25applications/</u>
 - <u>https://en.wikipedia.org/wiki/Sorting_algorithm</u>

Acknowledgement

Mostly Slides taken from Book: "Data Structures through C++" by Yashavant P. Kanetkar

