Sorting Algorithms

Topics

- Sorting Algorithms
- Bubble Sort
- Swapping Items
- Comparing Strings
- Merge Sort

Sorting

Sorting Algorithms

- **Sorting** puts elements of a list in a certain order.
- Most common orderings are **numerical** or **alphabetical**.

Why do we sort?

- Essential for **searching** and **merging.** The list must be sorted before it can be searched or merged efficiently.
- For **UIs** and user experience (ex: sort list by price low-high). Humans like to see lists arranged in ways that help them.
- For **grouping** and **decision making** (ex: Z-order)

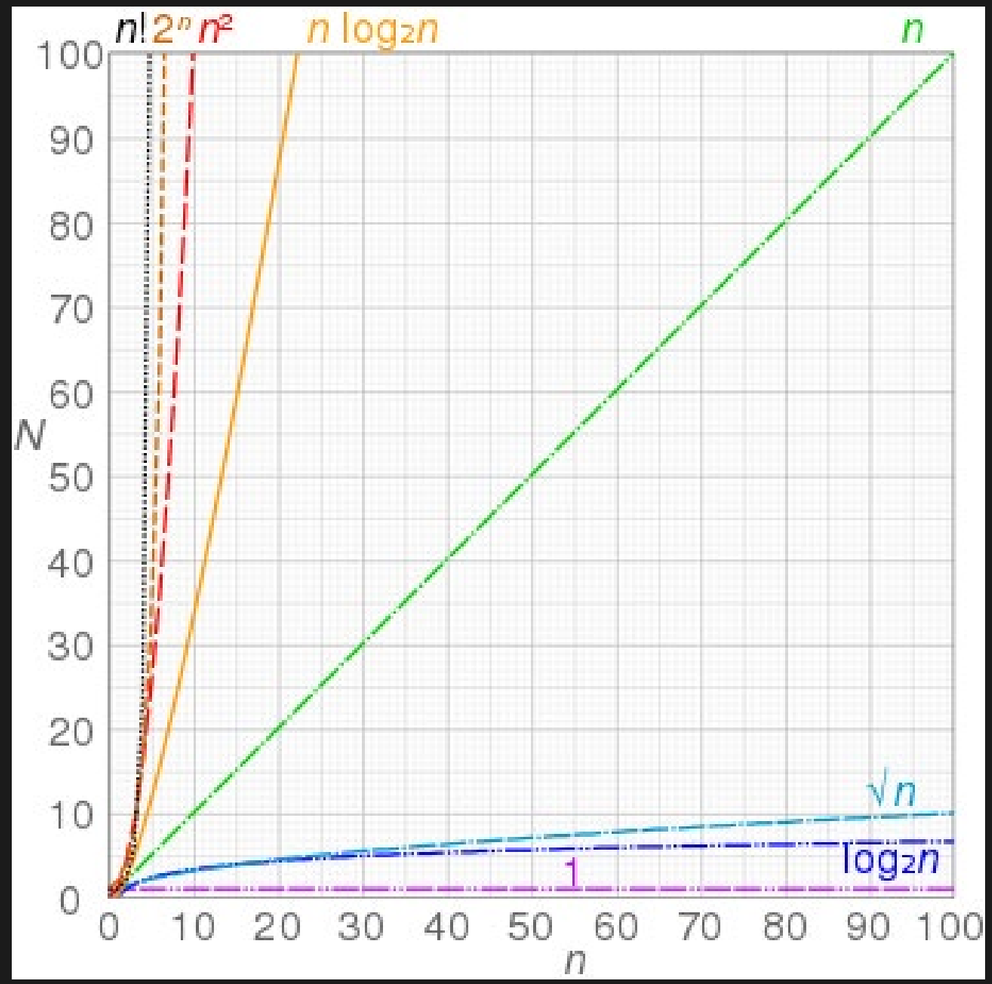
Performance

Computational Complexity

Best

O(1)	constant
O(log n)	logarithmic
O(n)	linear
O(n log n)	loglinear
$O(n^2)$	quadratic
$O(2^n)$	exponential
O(n!)	factorial

Worst



Sorting Algorithms

ALGORITHM	WORST	BEST	AVG
Heap Sort	O(n log n)	O(n log n)	O(n log n)
Quick Sort	$O(n^2)$	O(n log n)	O(n log n)
Merge Sort	O(n log n)	O(n log n)	O(n log n)
Insertion Sort	$O(n^2)$	O(n)	$O(n^2)$
Bubble Sort	$O(n^2)$ comparisons, $O(n^2)$ swaps	O(n) comps, O(1) swaps	$O(n^2)$ comparisons, $O(n^2)$ swaps

Bubble Sort

Bubble Sort

- The Algorithm
  1. Compare each pair of adjacent elements from the beginning of the array
     - If they are in reversed order, swap them
  2. If at least one swap was made, repeat step 1

```
procedure bubbleSort(A : list of sortable items)
    n := length(A)
    repeat    //this is the start of a loop
        swapped := false
        for i := 1 to n - 1 inclusive do
            if A[i - 1] > A[i] then
                swap(A[i - 1], A[i]) //you'll need swap code here
                swapped = true
            end if
        end for
        n := n - 1
    while we swapped something //this is the end of the loop
end procedure
```

Swapping Items

How Do We Swap?

EXAMPLE: swap indexes 10 and 11

int k = 10, j = 11; //indexes

1) Store **j** item in a temporary variable

```
int temp = numbers[ j ];
```

2) Copy the k item to j location

```
numbers[ j ] = numbers[ k ];
```

3) Copy the temporary variable to the k location

```
numbers[ k ] = temp;
```

Swap Method Challenge

1. Write a Swap method that will swap the items in an array at the specified indexes.
    1. Parameters to the method:
        1. The int array
        2. The first index
        3. The second index
2. Call Swap from Main.
3. Print the array.

```
int k = 10, j = 11; //indexes

int temp = numbers[ j ];
numbers[ j ] = numbers[ k ];
numbers[ k ] = temp;
```

LINKS

VIDEOS

Comparing Strings

String Comparison

- How do we compare strings?
- Equal is easy – the string class already handles equality for us.
  - Use the == operator or the Equals method
- But what about < or >?
  How do we know that one string is less than another for sorting purposes?
- Use the **CompareTo** method on string.

String Comparison

- **string1.CompareTo(string2);**
  - Returns **0** if **equal**
  - Returns **-1** if string1 **<** string2
  - Returns **1** if string1 **>** string2

- EXAMPLE:
  string str1 = “A”;
  string str2 = “B”;
- str1.CompareTo(str2) returns -1 meaning “A” is < “B”
- str2.CompareTo(str1) returns 1 meaning “B” is > “A”

Compare 2 strings Challenge

1. Create a method called CompareStrings
2. Use ReadLine to get 2 strings from the user.
3. Compare the strings using CompareTo.
4. Print a message about the strings. LESS than, GREATER than, or EQUAL to.
5. Call CompareStrings from Main

```
string s1 = "Batman", s2 = "Aquaman";
int compResult = s1.CompareTo(s2);
```

LINKS

CompareTo

VIDEOS

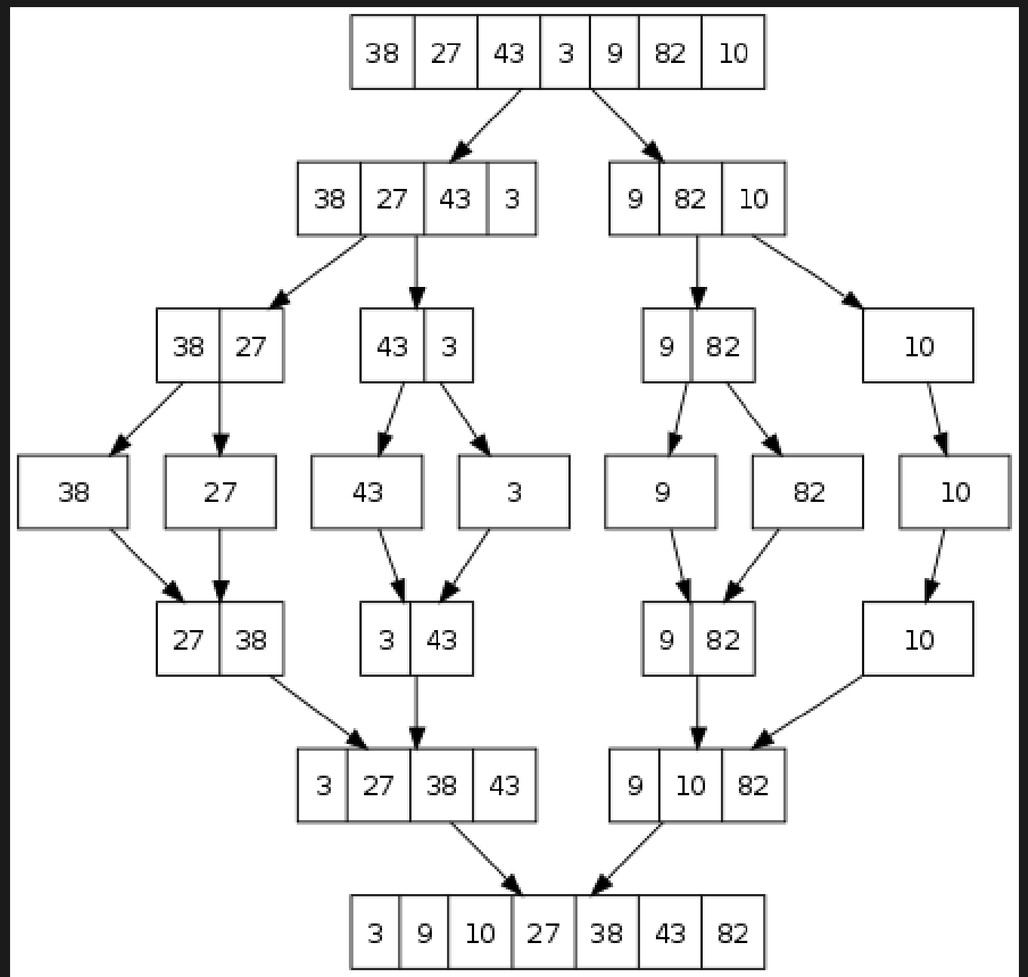
Merge Sort

Merge Sort

- The Algorithm
  1. Divide the list into n sublists that are all 1 element long.
  2. Merge the sublists to make new ***sorted*** lists.
  3. Continue merging until only 1 list remains.

Merge Sort

- https://en.wikipedia.org/wiki/File:Merge_sort_algorithm_diagram.svg



Merge Sort: Split Step

1) Split pseudocode

```
function merge_sort(list m) is

    // exit condition. A list of zero or one elements is sorted, by definition.
    if length of m ≤ 1 then
        return m

    // Recursive case. First, divide the list into sublists
    // consisting of the first half and second half of the list. This assumes lists start at index 0.

    var left := empty list
    var right := empty list

    for i = 0 to length(m) do
        if i < (length of m)/2 then
            add m[i] to left
        else
            add m[i] to right

    // Recursively sort both sublists.
    left := merge_sort(left)
    right := merge_sort(right)

    // Then merge the now-sorted sublists.
    return merge(left, right)
```

Merge Sort: Merge Step

2) Merge pseudocode

```
function merge(left, right) is
    var result := empty list

    while left is not empty and right is not empty do

        if first(left) ≤ first(right) then
            add first(left) to result
            remove first from left
        else
            add first(right) to result
            remove first from right

    // Either left or right may have elements left; consume them.
    // (Only one of the following loops will actually be entered.)

    while left is not empty do
        add first(left) to result
        remove first from left

    while right is not empty do
        add first(right) to result
        remove first from right

    return result
```

Split a List Challenge

1. Create a method called Split that takes one list of ints as a parameters.
2. In the method, split the list into 2 halves: left and right.
3. Print the left half then print the right half. Before printing each half, print a title for the list: “Left Half” and “Right Half”
4. Call Split from Main.

```
var left := empty list
var right := empty list

for i = 0 to length(m) do
    if i < (length of m)/2 then
        add m[i] to left
    else
        add m[i] to right
```

LINKS

VIDEOS