Analysis and Design of Algorithms

Semester III, Year **2021-22**

Lab - 2 Date : 29-09-2021

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AIM: Implement merge sort and quick sort using iterative and recursive methods. The number of inputs elements has to be passed from command line arguments. The elements has to be generated randomly within the code.
Compute:

a. Check the performance of program by varying the number of elements.
b. Compute the time taken by each case (for particular number of inputs).
c. Plot a graph with number of inputs to time taken in seconds.
d. Compute and compare the memory taken by recursive and iteration implementation of the two sorting algorithms.

Merge Sort (Iterative):

Output:

```
Command Prompt
Microsoft Windows [Version 10.0.19043.1202]
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C:\Users\DELL>cd "OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 1"

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 1>python insertionSort.py 10
Number of Inputs : 10
Time taken :  1.0022399425506592

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 1>python insertionSort.py 100
Number of Inputs : 100
Time taken :  1.0142841339111328

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 1>python insertionSort.py 1000
Number of Inputs : 1000
Time taken :  1.0388813018798828

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 1>python insertionSort.py 10000
Number of Inputs : 10000
Time taken :  4.226747035980225

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 1>python insertionSort.py 100000
Number of Inputs : 100000
Time taken :  345.9366717338562

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 1>
```
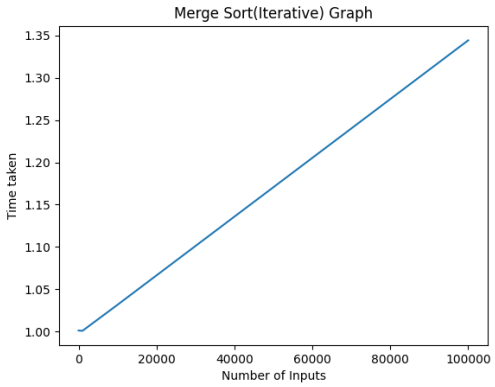

Graph:



Merge Sort (Recursive):

Output:

```
Command Prompt
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C:\Users\DELL>cd "OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2"

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python mergeSort_recursive.py 10
Number of Inputs : 10
Time taken : 1.0031836032867432
Memory used in MB : 13.98046875

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python mergeSort_recursive.py 100
Number of Inputs : 100
Time taken : 1.0021986961364746
Memory used in MB : 13.9921875

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python mergeSort_recursive.py 1000
Number of Inputs : 1000
Time taken : 1.00168776512146
Memory used in MB : 14.015625

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python mergeSort_recursive.py 10000
Number of Inputs : 10000
Time taken : 1.0482115745544434
Memory used in MB : 14.4375

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python mergeSort_recursive.py 100000
Number of Inputs : 100000
Time taken : 1.394745111465454
Memory used in MB : 17.87890625

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>
```
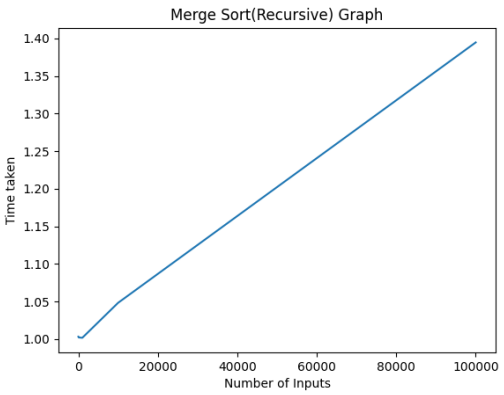

Graph:



Quick Sort (Iterative):

Output:

```
Command Prompt
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C:\Users\DELL>cd "OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2"

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python quickSort_iterative.py 10
Number of Inputs : 10
Time taken : 1.012416601181030 3
Memory used in MB : 13.828125

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python quickSort_iterative.py 100
Number of Inputs : 100
Time taken : 1.0135064125061035
Memory used in MB : 13.984375

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python quickSort_iterative.py 1000
Number of Inputs : 1000
Time taken : 1.0009789466685791
Memory used in MB : 14.0234375

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python quickSort_iterative.py 10000
Number of Inputs : 10000
Time taken : 1.034202575683593 8
Memory used in MB : 14.41796875

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>python quickSort_iterative.py 100000
Number of Inputs : 100000
Time taken : 1.1853516101837158
Memory used in MB : 17.85546875

C:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 2>
```
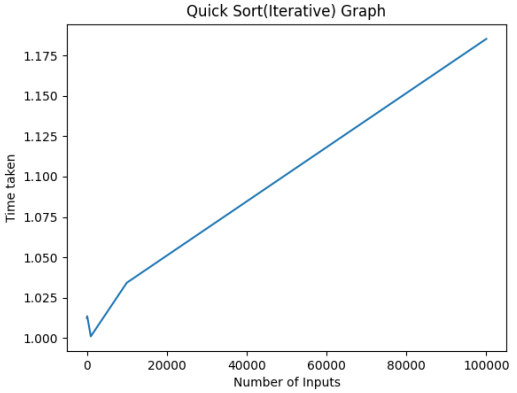
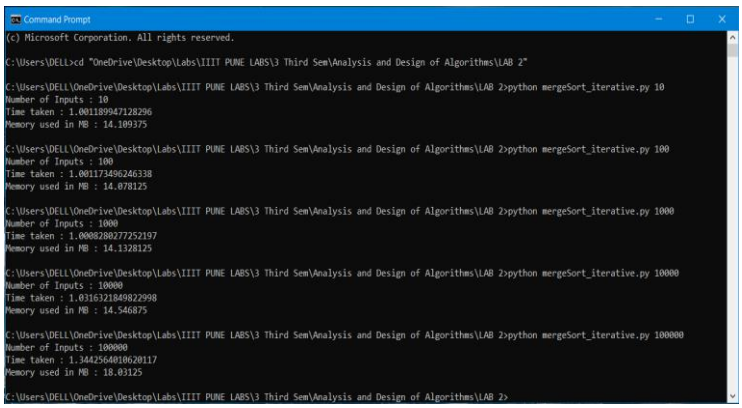

Graph:

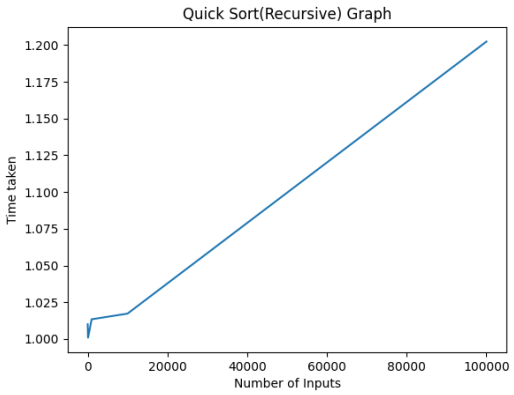


Quick Sort (Recursive):

Output:



Graph:



Result:

Here are the results obtained showing the time taken for merge and quick sort both iterative and recursive way to run different number of inputs.

Time taken for different inputs:

* All times obtained were added with one second using time.sleep(1)

Number of Inputs (To right)	10	100	1000	10000	100000
Merge Sort(Iterative)	1.001189947128296	1.001173496246338	1.0008280277252197	1.0316321849822998	1.3442564010620117
Merge Sort (Recursive)	1.0031836032867432	1.0021986961364746	1.00168776512146	1.0482115745544434	1.394745111465454
Quick Sort (Iterative)	1.0124166011810303	1.0135064125061035	1.000978946685791	1.0342025756835938	1.1853516101837158
Quick Sort (Recursive)	1.0100398063659668	1.0009138584136963	1.0134236812591553	1.0172724723815918	1.202369213104248

Average of time taken:

Merge Sort(Iterative) : 1.0758160114288
Merge Sort(Recursive) : 1.0900053501129
Quick Sort(Iterative) : 1.049291229248
Quick Sort(Recursive) : 1.0488038063049

Memory Usage**:**

* Memory in MB (Mega Bytes)

Number of Inputs (To right)	10	100	1000	10000	100000
Merge Sort(Iterative)	14.109375	14.078215	14.1328125	14.546875	18.03125
Merge Sort (Recursive)	13.98046875	13.9921875	14.015625	14.4375	17.87890625
Quick Sort (Iterative)	13.828125	13.984375	14.0234375	14.41796875	17.85546875
Quick Sort (Recursive)	13.984375	13.984375	13.96484375	14.35546875	17.7890625

Average of memory usage:

Merge Sort(Iterative) : 14.9797055
Merge Sort(Recursive) : 14.8609375
Quick Sort(Iterative) : 14.821875
Quick Sort(Recursive) : 14.815625

Conclusion:

After analysing the results obtained, I observed that in case of merge sort and quick sort memory usage during iterative implementation is larger than in recursive implementation by a little fraction. But recursive implementation uses more memory than iterative implementation. This small fraction in the result might have occurred because of random input. But when compared with same input recursive implementation uses more memory compared to iterative implementation.

Comparing the time taken to sort the elements, the iterative implementation is little faster than recursive implementation. In some cases, recursive implementation is faster than iterative implementation. On average, iterative implementation is way more bit faster than recursive implementation.