K. J. Somaiya College of Engineering, Mumbai-77

(Autonomous College Affiliated to University of Mumbai)

Department of Computer Engineering

Batch: B1 **Roll No.: 1711072**

Experiment No. 1

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of the Staff In-charge with date

Title: Implementation of selection sort/ Insertion sort

Objective: To analyse performance of sorting methods

CO to be achieved:

Sr. No	Objective
CO 1	Compare and demonstrate the efficiency of algorithms using asymptotic complexity notations.
CO 2	Analyze and solve problems for divide and conquer strategy, greedy method, dynamic programming approach and backtracking and branch & bound policies.
CO 3	Analyze and solve problems for different string matching algorithms.

Books/ Journals/ Websites referred:

1. **Ellis horowitz, Sarataj Sahni, S.Rajsekaran,” Fundamentals of computer algorithm”, University Press**
2. **T.H.Cormen ,C.E.Leiserson,R.L.Rivest and C.Stein,” Introduction to algortihtms”,2nd Edition ,MIT press/McGraw Hill,2001**
3. **http://en.wikipedia.org/wiki/Insertion_sort**
4. **http://www.sorting-algorithms.com/insertion-sort**

5. **http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Insertion_sort.html**
6. **http://www.personal.kent.edu/~rmuhamma/Algorithms/MyAlgorithms/Sorting/insertionSort.htm**
7. **http://en.wikipedia.org/wiki/Selection_sort**
8. **http://www.sorting-algorithms.com/selection-sort**
9. **http://www.personal.kent.edu/~rmuhamma/Algorithms/MyAlgorithms/Sorting/selectionSort.htm**
10. **http://courses.cs.vt.edu/~csonline/Algorithms/Lessons/SelectionCardSort/selectioncardsort.html**

Pre Lab/ Prior Concepts:
Data structures, sorting techniques

Historical Profile:
There are various methods to sort the given list. As the size of input changes, the performance of these strategies tends to differ from each other. In such case, the priori analysis can helps the engineer to choose the best algorithm.

New Concepts to be learned:
Space complexity, time complexity, size of input, order of growth.

Algorithm: Insertion Sort

INSERTION_SORT (*A*,*n*)
//The algorithm takes as parameters an array *A*[1.. *n*] and the length *n* of the array.
//The array *A* is sorted in place: the numbers are rearranged within the array
// A[1..n] of eletype, n: integer

```
FOR j ← 2 TO length[A]
    DO  key ← A[j]
        {Put A[j] into the sorted sequence A[1 . . j − 1]}
        i ← j − 1
        WHILE i > 0 and A[i] > key
              DO A[i +1] ← A[i]
                 i ← i − 1
        A[i + 1] ← key
```

Algorithm: Selection Sort

SELECTION_SORT (A,n)
//The algorithm takes as parameters an array *A*[1.. *n*] and the length *n* of the array.
//The array *A* is sorted in place: the numbers are rearranged within the array
// A[1..n] of eletype, n: integer

```
FOR i ← 1 TO n-1 DO
   min j ← i;
   min x ← A[i]
  FOR j ← i + 1 to n do
     IF A[j] < min x then
        min j ← j
        min x ← A[j]
   A[min j] ← A [i]
   A[i] ← min x
```

Implementation (in Python):

```python
import random, time
import matplotlib.pyplot as plt

inc = 200
x1 = []
y1 = []
x2 = []
y2 = []

for val in range(15):

  a = random.sample(range(0,10000), 2200+(val*inc))
  b = a[:]
  tic = time.time()

  #Selection
  for i in range(len(a)-1):
    min_i = i
    for j in range(i+1, len(a)):
        if a[min_i] > a[j]:
            min_i = j
    a[i],a[min_i] = a[min_i], a[i]
```

```
  tac = time.time()

  x1.append(2200+(val*inc))
  y1.append(tac - tic)
  print("The sorted list is ", a)
  #print("Time taken for selection sort is ", 1000 * (toc - tic),"ms")

  tac = time.time()
  #Insertion
  for i in range(1, len(b)):
    key = b[i]
    j=i-1
    while j >=0 and key < b[j]:
      b[j+1] = b[j]
      j -= 1
    b[j+1] = key

  toe = time.time()
  x2.append(2200+(val*inc))
  y2.append(toe-tac)
  #print("The sorted list is ", b)
  #print("Time taken for insertion sort is ", 1000 * (tac - toc), "ms")
print(x1, y1, sep = '\n')
print(x2, y2, sep = '\n')

plt.plot(x1, y1, label = 'Selection')
plt.plot(x2, y2, label = 'Insertion')
plt.legend()
plt.grid()
plt.xlabel(' Number of Values ')
plt.ylabel(' Time taken per loop(s) ')
plt.savefig('graph.png')
```

The space complexity of Insertion sort:

Insertion sort is an O (1) space complexity algorithm, since the array is passed by reference, and all the other variables are input independent local variables. The array doesn't require extra space since its base address is available and the contents can be retrieved by iterating over it. In our example, we have i, j, key, a and n as the variables which are locally needed by the function.

The space complexity of Selection sort:

Selection sort is an O(1) space complexity algorithm, since the array is passed by reference, and all the other variables are input independent local variables. The array doesn't require extra space since its base address is available and the contents can be retrieved by iterating over it. In our example, we have i, j, key, min, a and n as the variables which are locally needed by the function.

Time complexity for Insertion sort:

The worst case time complexity for insertion sort is given by the following equation:

$T_{insertion}$ >= (n-1)(2 + 1 +1) + (3)(n-1)(n-2)/2 + 1 = 4n – 3 + 1.5(n^2 – 3n + 2) = 1.5n^2 - 0.5n. So,

$$\mathbf{T_{insertion} >= 1.5n^2 - 0.5n}$$

In asymptotic terms, **Insertion sort is an O (n^2) algorithm.**

In best case, let's say the sort works on an array already sorted. Then, the inner while loop will never execute and only the outer for loop runs, which gives the best case as O (n).

Time complexity for selection sort:

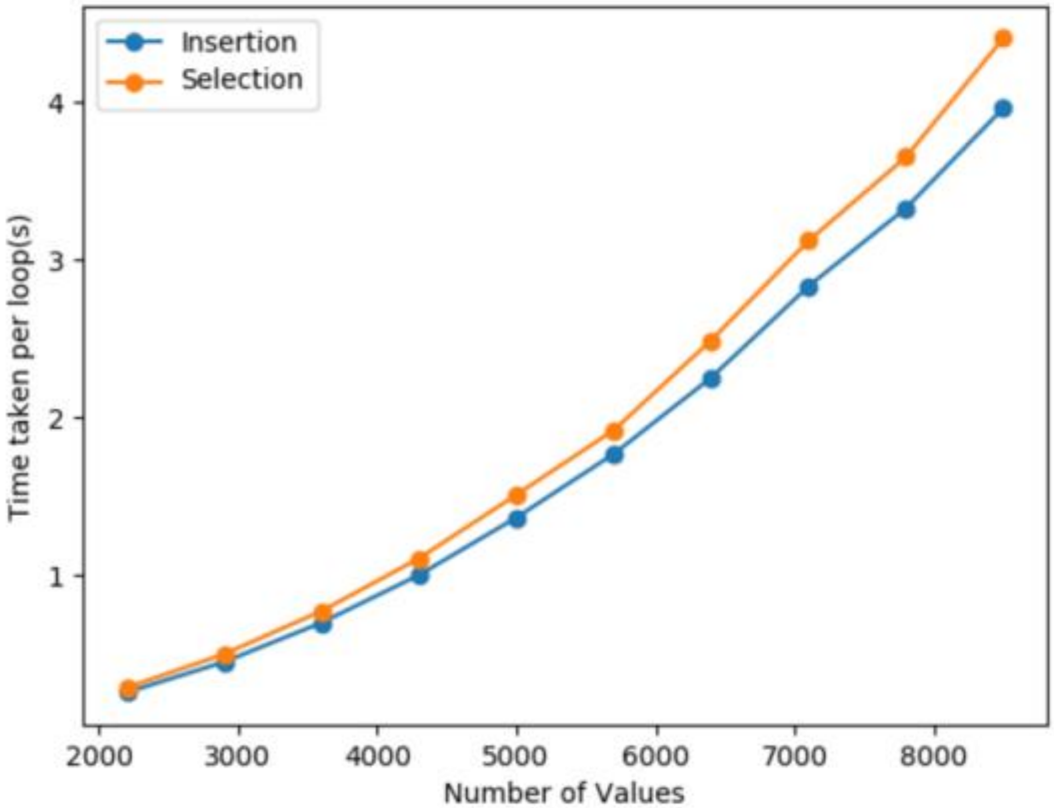
The worst case time complexity for selection sort is given by the following equation:

$T_{selection}$ >= (n-1)(2 + 2 + 1) + (4)(n-1)(n-2)/2 + 1 = 5n – 4 + 2(n^2 – 3n + 2) = 2n^2 - n So,

$$\mathbf{T_{selection} >= 2n^2 – n.}$$

In asymptotic terms, Insertion sort is an O(n^2) algorithm Even in the worst case, the sorting algorithm will run through both of its for loops, which gives the algorithm a best case running time of O(n^2).

Graphs for varying input sizes: (Insertion Sort & Selection sort) (Worst case):



CONCLUSION: Hence, insertion sort and selection sort algorithms were executed in Python and appropriate analysis of both algorithms were done using both graphical and mathematical methods.