BLG335E Analysis of Algorithm

Project 1

Name : Emre ÖZDİL

Number : 150120138

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Teacher : Hazım Kemal Ekenel

CRN : 11924

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ISTANBUL TECHNICAL UNİVERSITY

A - Asymptotic Upper Bound

Merge Sort is run on O(nlg(n)).
My code for Merge Sort:

```
if (lowerBound < upperBound)
       {
        int median = (lowerBound + upperBound) / 2;
        sort(unsorted, lowerBound, median);
        sort(unsorted, median + 1, upperBound);
        merge(unsorted, lowerBound, median, upperBound);
    }
```

O(1)

T(n) = 2T(n/2) + merge part

Merge Part:

```
for (int i = 0; i < leftLength; i++)
{
    Left[i] = unsorted[lowerBound + i];
}
for (int j = 0; j < rightLength; j++)
{
    Right[j] = unsorted[median + 1 + j];
}
for (int k = lowerBound; k <= upperBound; k++)
{
    if (Left[i].distance <= Right[j].distance)
    {
        unsorted[k] = Left[i];
        i++;
    }
    else
    {
        unsorted[k] = Right[j];
        j++;
    }
}
```

run (upperBound-lowerBound) times maximum so it depens n and runs on O(n)

These fors run on O(n). So it is T(n) = 2T(n/2) + O(n). It becomes finally 1 due to binary division so the result is O(n) + O(n) + … + O(n) There are lg(n) times O(n). It shows that it is O(nlg(n)).

Insertion Sort is run on O(n^2).
My code for Insertion Sort:

```
int j;
       Point temp;

       for (int i = 1; i < length; i++)
       {
              j = i;
              while (j > 0 && unsorted[j].distance < unsorted[j - 1].distance
              {
                     temp = unsorted[j];
                     unsorted[j] = unsorted[j - 1];
                     unsorted[j - 1] = temp;
                     j--;
              }
       }
```

for loop n times
while loop n times;
therefore, O(n^2)

It shows that it is O(n^2).

Linear Search is run on O(n^2).
My code for Linear Search:

```
while (j != total)
        {
                for (int i = 0; i < length; i++)
                {
                        if (unsorted[i].distance > higherDistance)
                        {
                                higherDistance = unsorted[i].distance;
                                higherIndex = i;
                        }
                }
                for (j ; j < total; j++)
                {
                        if (unsorted[j].distance < higherDistance)
                        {
                                higherDistance = unsorted[j].distance;
                                temp = unsorted[j];
                                unsorted[j] = unsorted[higherIndex];
                                unsorted[higherIndex] = temp;
                                break;
                        }
                }
        }
```

(n-k)*k complexity
Best case O(1)
Worst case O(n^2/4)=O(n^2)

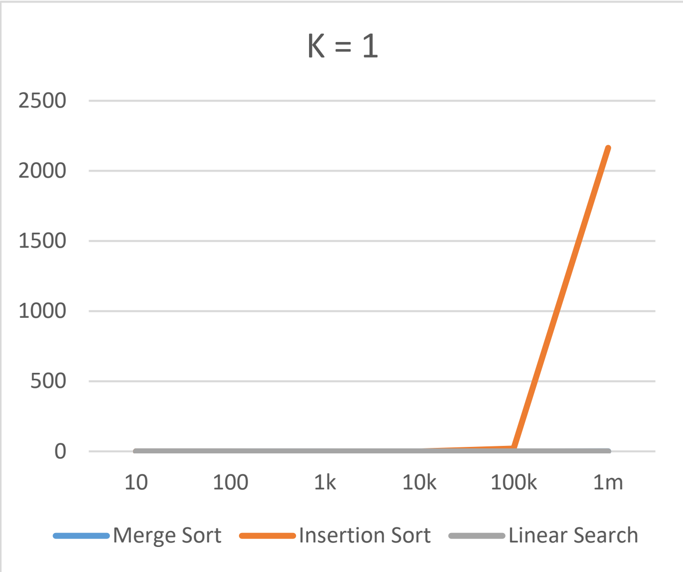
Worst case => N = 1000000, K = 500000

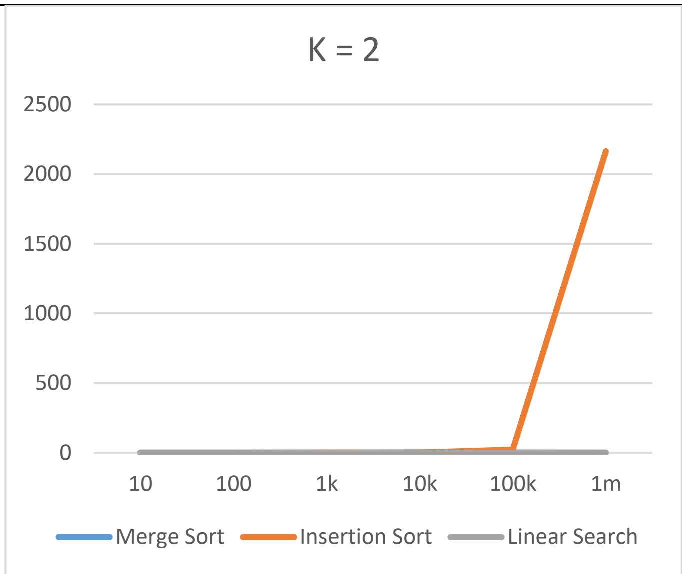
B – Calculation Times

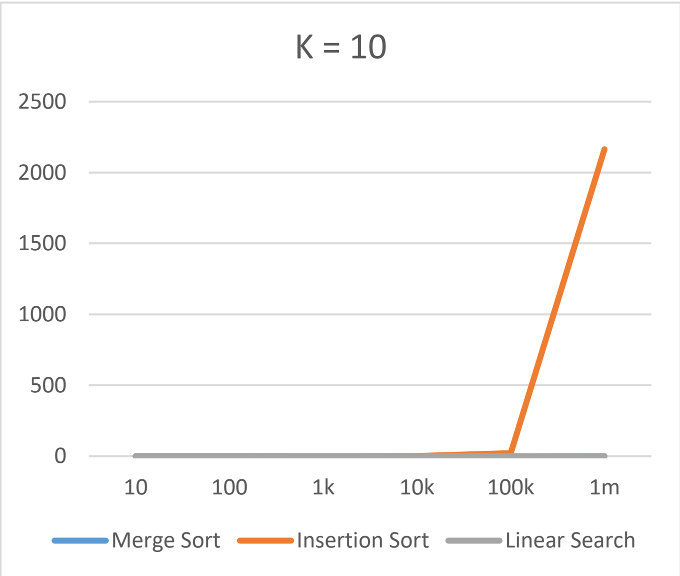
N	K	Merge Sort	Insertion Sort	Linear Search
10	1	0	0	0
10	2	0	0	0
10	5	0	0	0
100	1	0	0	0
100	2	0	0	0
100	10	0	0	0
100	50	0	0	0
1k	1	0	0.002	0
1k	2	0	0.002	0
1k	10	0	0.002	0
1k	500	0	0.002	0
10k	1	0.005	0.208	0
10k	2	0.005	0.208	0
10k	10	0.005	0.208	0
10k	5k	0.005	0.208	0.047
100k	1	0.049	20.851	0
100k	2	0.049	20.851	0
100k	10	0.049	20.851	0
100k	50k	0.049	20.851	4.696
1m	1	0.511	2164.27	0.003
1m	2	0.511	2164.27	0.003
1m	10	0.511	2164.27	0.003
1m	500k	0.511	2164.27	492.604

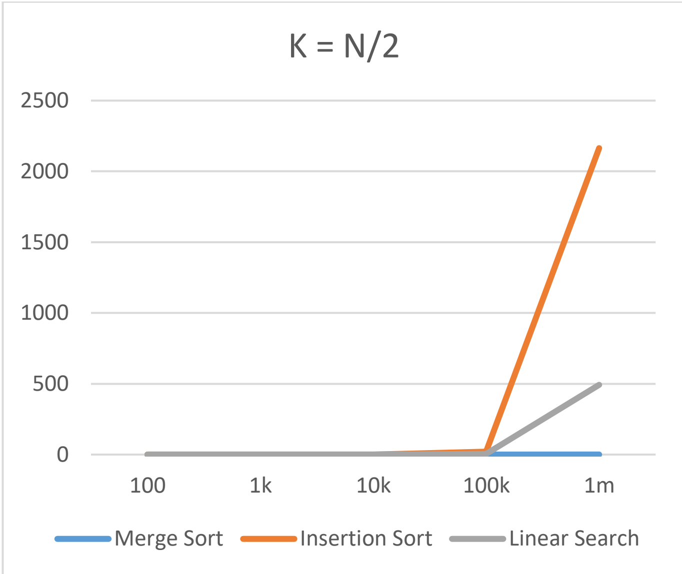
*The unit is second

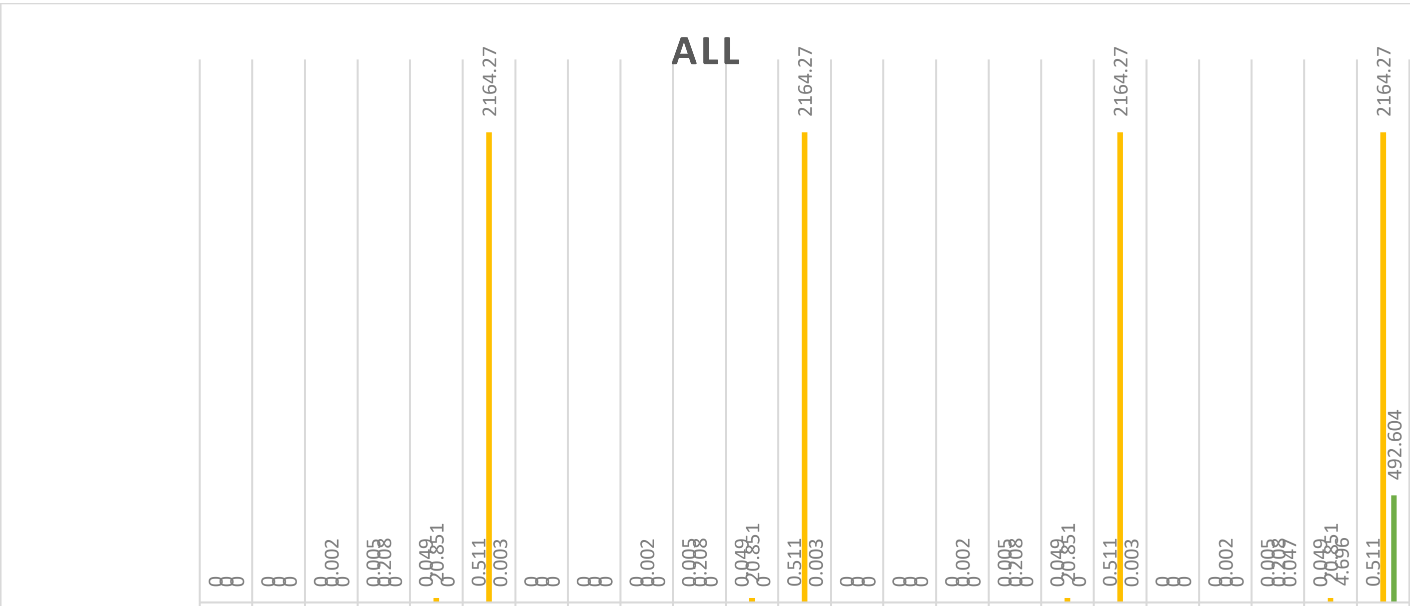
C – Graph











	10	100	1k	10k	100k	1m	10	100	1k	10k	100k	1m	10	100	1k	10k	100k	1m	100	1k	10k	100k	1m
Merge Sort	0	0	0	0.005	0.049	0.511	0	0	0	0.005	0.049	0.511	0	0	0	0.005	0.049	0.511	0	0	0.005	0.049	0.511
Insertion Sort	0	0	0.002	0.208	20.852	2164	0	0	0.002	0.208	20.852	2164	0	0	0.002	0.208	20.852	2164	0	0.002	0.208	20.852	2164
Linear Search	0	0	0	0	0	0.003	0	0	0	0	0	0.003	0	0	0	0	0	0.003	0	0	0.047	4.696	492.6

It is clearly seen that Merge Sort is better in these algorithms. Merge Sort is O(nlg(n)) because it has lower asymtotic function view on the graph.

Until N =10000 all algorithms almost have same time. K factor affects only Linear Search algorithm because Linear Search algorithm complexity depends on K factor.

If (n-k)*k is small number I select Linear Search Algorithm. Otherwise Merge Sort is better than Linear Search. Insertion Sort is worst algorithm in these algoritgms.