Assignment-4

Ques:

Write a C Program to analyse the time complexity (make a comparative analysis) analysis of the following sorting algorithms

· Insertion Sort

· Bubble Sort

· Selection Sort

· Merge Sort

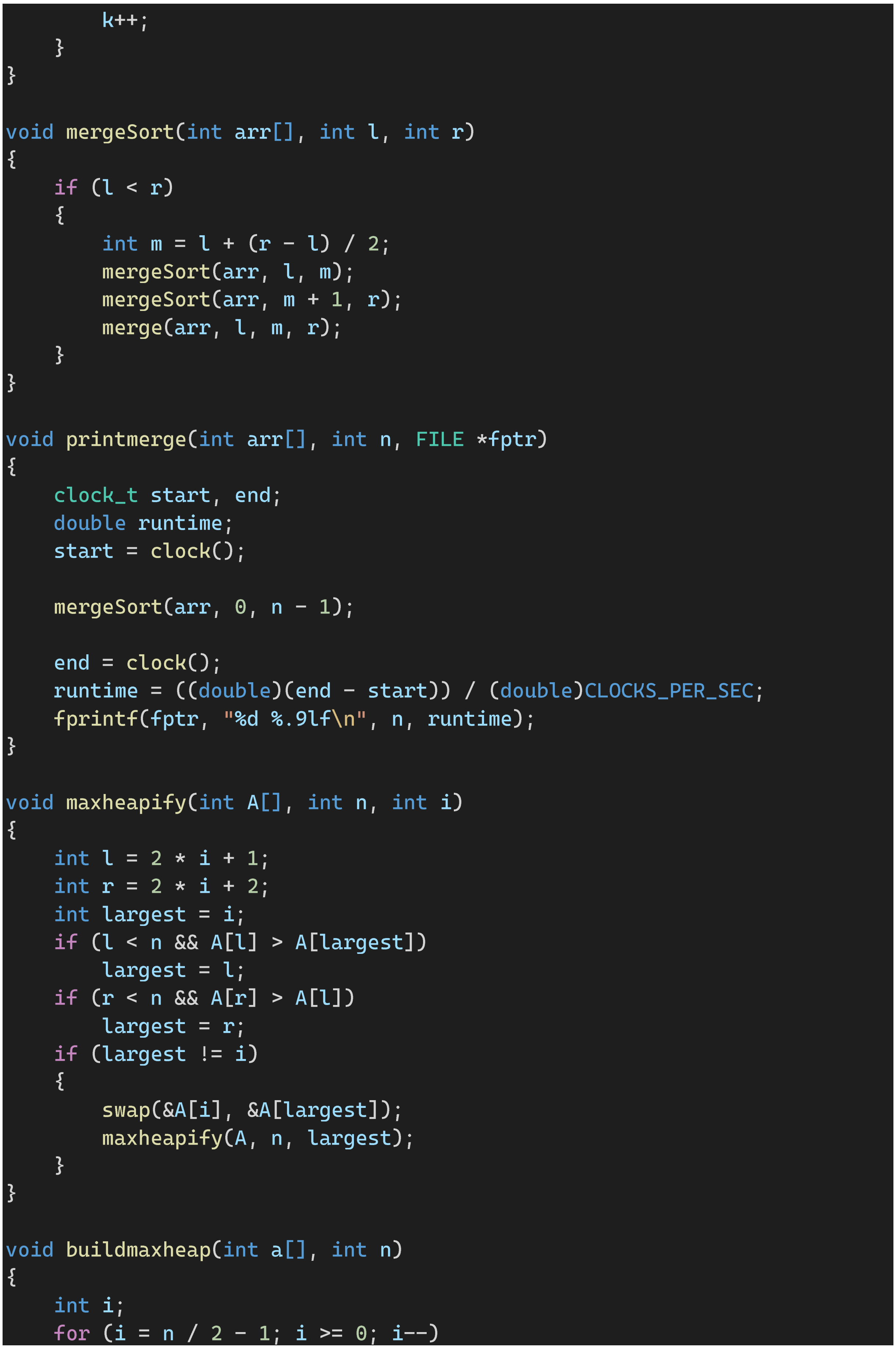
· Heap Sort

· Shell Sort

and also mention your explanation for the best sorting algorithm.

Code:

```c
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

void swap(int *xp, int *yp)
{
    int temp = *xp;
    *xp = *yp;
    *yp = temp;
}

void bubble_sort(int v[], int n, FILE *fptr)
{
    int i, j;
    clock_t start, end;
    double runtime;
    start = clock();
    for (i = 0; i < n; i++)
    {
        for (j = 0; j < n - i + 1; j++)
        {
            if (v[j] > v[j + 1])
            {
                int temp = v[j];
                v[j] = v[j + 1];
                v[j + 1] = temp;
            }
        }
    }
    end = clock();
    runtime = ((double)(end - start)) / CLOCKS_PER_SEC;
    fprintf(fptr, "%d %lf\n", n, runtime);
}

void selection_sort(int v[], int n, FILE *fptr)
{
    clock_t start, end;
    double runtime;
    start = clock();
    int i, j, min_idx;

    for (i = 0; i < n - 1; i++)
    {

        min_idx = i;
        for (j = i + 1; j < n; j++)
            if (v[j] < v[min_idx])
                min_idx = j;

        if (min_idx != i)
            swap(&v[min_idx], &v[i]);
    }
    end = clock();
    runtime = ((double)(end - start)) / CLOCKS_PER_SEC;
    fprintf(fptr, "%d %lf\n", n, runtime);
}
void insertion_sort(int arr[], int n, FILE *fptr)
{
    clock_t start, end;
    double runtime;
    start = clock();
    int i, key, j;
    for (i = 1; i < n; i++)
    {
        key = arr[i];
        j = i - 1;
        while (j >= 0 && arr[j] > key)
        {
            arr[j + 1] = arr[j];
            j = j - 1;
        }
        arr[j + 1] = key;
    }
    end = clock();
    runtime = ((double)(end - start)) / CLOCKS_PER_SEC;
    fprintf(fptr, "%d %lf\n", n, runtime);
}

void merge(int arr[], int l, int m, int r)
{
    int i, j, k;
    int n1 = m - l + 1;
    int n2 = r - m;

    int L[n1], R[n2];

    for (i = 0; i < n1; i++)
        L[i] = arr[l + i];
    for (j = 0; j < n2; j++)
        R[j] = arr[m + 1 + j];

    i = 0;
    j = 0;
    k = l;
    while (i < n1 && j < n2)
    {
        if (L[i] <= R[j])
        {
            arr[k] = L[i];
            i++;
        }
        else
        {
            arr[k] = R[j];
            j++;
        }
        k++;
    }

    while (i < n1)
    {
        arr[k] = L[i];
        i++;
        k++;
    }

    while (j < n2)
    {
        arr[k] = R[j];
        j++;
```

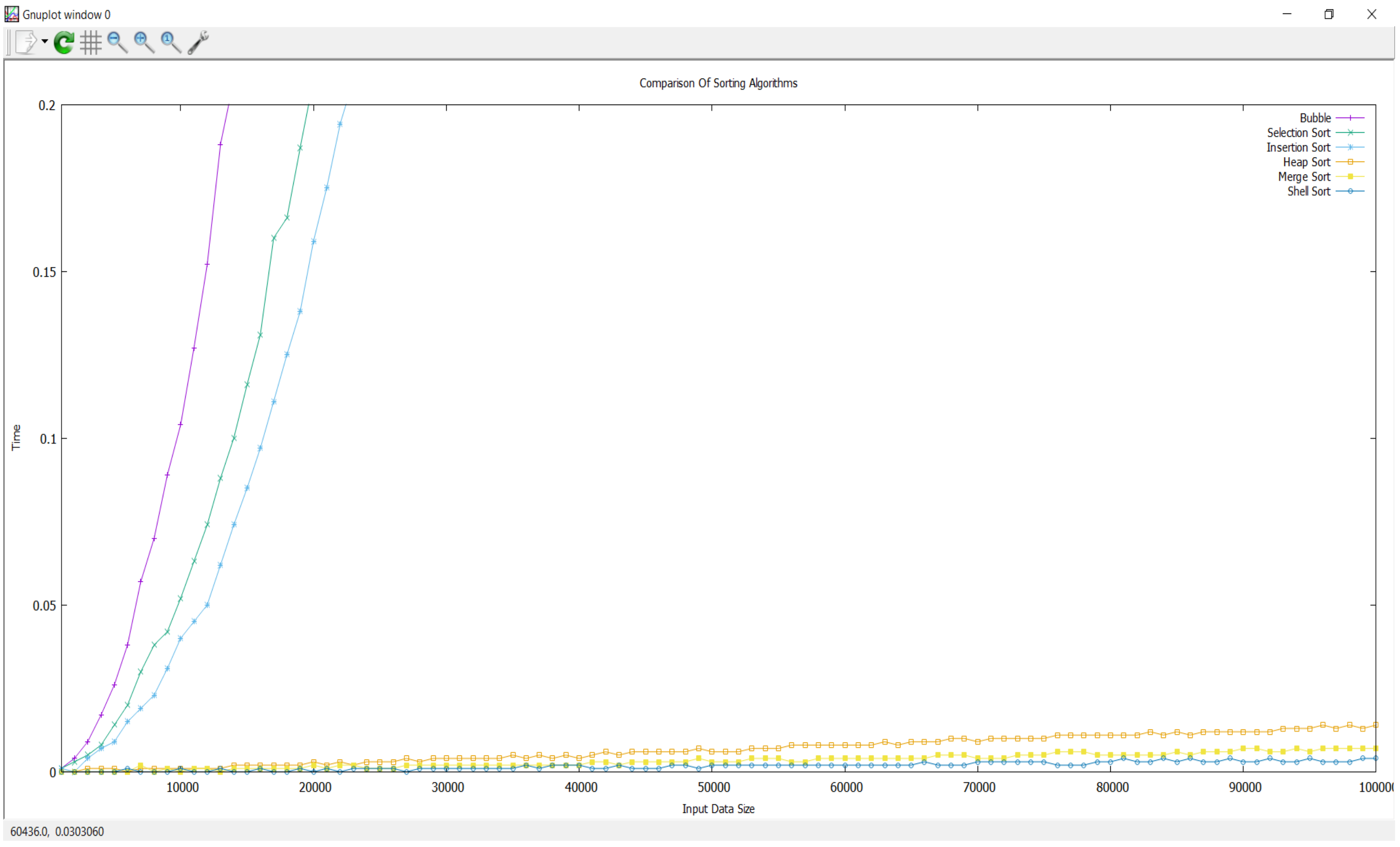


```
        k++;
    }
}

void mergeSort(int arr[], int l, int r)
{
    if (l < r)
    {
        int m = l + (r - l) / 2;
        mergeSort(arr, l, m);
        mergeSort(arr, m + 1, r);
        merge(arr, l, m, r);
    }
}

void printmerge(int arr[], int n, FILE *fptr)
{
    clock_t start, end;
    double runtime;
    start = clock();

    mergeSort(arr, 0, n - 1);

    end = clock();
    runtime = ((double)(end - start)) / (double)CLOCKS_PER_SEC;
    fprintf(fptr, "%d %.9lf\n", n, runtime);
}

void maxheapify(int A[], int n, int i)
{
    int l = 2 * i + 1;
    int r = 2 * i + 2;
    int largest = i;
    if (l < n && A[l] > A[largest])
        largest = l;
    if (r < n && A[r] > A[l])
        largest = r;
    if (largest != i)
    {
        swap(&A[i], &A[largest]);
        maxheapify(A, n, largest);
    }
}

void buildmaxheap(int a[], int n)
{
    int i;
    for (i = n / 2 - 1; i >= 0; i--)
```

```c
    {
        maxheapify(a, n, i);
    }
}

void heapsort(int a[], int n)
{
    int i;
    int t = n;
    buildmaxheap(a, n);
    for (i = n - 1; i >= 1; i--)
    {
        swap(&a[0], &a[i]);
        maxheapify(a, i, 0);
    }
}

void printheap(int arr[], int n, FILE *fptr)
{
    clock_t start, end;
    double runtime;
    start = clock();

    heapsort(arr, n);

    end = clock();
    runtime = ((double)(end - start)) / (double)CLOCKS_PER_SEC;
    fprintf(fptr, "%d %.9lf\n", n, runtime);
}

void shellSort(int arr[], int n)
{
    int gap, i;
    for (gap = n / 2; gap > 0; gap /= 2)
    {

        for (i = gap; i < n; i += 1)
        {

            int temp = arr[i];

            int j;
            for (j = i; j >= gap && arr[j - gap] > temp; j -= gap)
                arr[j] = arr[j - gap];

            arr[j] = temp;
        }
    }
```

```c
}

void printshell(int arr[], int n, FILE *fptr)
{
    clock_t start, end;
    double runtime;
    start = clock();

    shellSort(arr, n);

    end = clock();
    runtime = ((double)(end - start)) / (double)CLOCKS_PER_SEC;
    fprintf(fptr, "%d %.9lf\n", n, runtime);
}

int main()
{
    FILE *fptr1 = fopen("bubble.txt", "w");
    FILE *fptr2 = fopen("selection.txt", "w");
    FILE *fptr3 = fopen("insertion.txt", "w");
    FILE *fptr4 = fopen("merge.txt", "w");
    FILE *fptr5 = fopen("shell.txt", "w");
    FILE *fptr6 = fopen("heap.txt", "w");
    int n, i;
    for (n = 1000; n <= 100000; n += 1000)
    {
        int lb = 1, ub = 1000000;
        int arr[n];
        for (i = 0; i < n; i++)
        {
            arr[i] = rand() % (ub - lb + 1) + lb;
        }
        bubble_sort(arr, n, fptr1);
        selection_sort(arr, n, fptr2);
        insertion_sort(arr, n, fptr3);
        printmerge(arr, n, fptr4);
        printshell(arr, n, fptr5);
        printheap(arr, n, fptr6);
    }
    fclose(fptr1);
    fclose(fptr2);
    fclose(fptr3);
    fclose(fptr4);
    fclose(fptr5);
    fclose(fptr6);
}
```

Graph:



Best Sorting algorithm :

In my opinion, Heap Sort is the best sorting algorithm as it works in O(nlogn) always and doesn’t consume much extra space.