DAA Lab-4

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Q-4.1) Write a program to sort a given set of elements with the Merge sort.

1)Repeat the experiment for different values of n = 500, 1000,5000, 10000 and report the time (in seconds) required to sort the elements.

2)For each of aforementioned case, consider arrays as random, sorted, and reverse-sorted and observe running time variation for different types of input for merge sort. [Provide your observation regarding sensitivity of Merge sort on the input in your lab record.]

Program:

```
/*
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Idea of the solution:
        I have first implemented the merge sort algorithm and then I created the code for random
array generation and timing analysis. For implementing the merge sort algorithm I had implement
merge_sort() function and a merge() function. The merge_sort() function breaks the array into
smaller parts, let say half of its original size recursively until one-one element is left in each sub-array
and then I called the merge() function to merge the single element arrays into an array and so on, to
form a sorted array.
*/
#include<bits/stdc++.h>
#include <stdio.h>
#include <stdlib.h>

using namespace std;
void merge(int arr[], int l, int m, int r);        //prototype for merge function
void merge_sort(int arr[], int l, int r)           //merge_sort() function defination
{                                                  //l=left index r=right index of the subarray
        if (l<r)                                   //checking left index less than right index
        {
                int m=l+(r-l)/2;                   //calculating the mid point
                merge_sort(arr,l,m);               //recursively calling merge_sort() for the 1st half
                merge_sort(arr,m+1,r);             // recursively calling merge_sort() for the 1st half
                merge(arr,l,m,r);                  //calling merge() after completion of breaking of array
        }
}
void merge(int arr[], int l, int m, int r)         //definition of merge() function
{                                                  //l=left index r=right index m=middle index
        int i,j,k,n1,n2;
        n1=m-l+1;                                  //calculating the size of 1st sub-array
        n2=r-m;                                    // calculating the size of 2nd sub-array
        int L[n1],R[n2];                           //creating the two sub-arrays
```
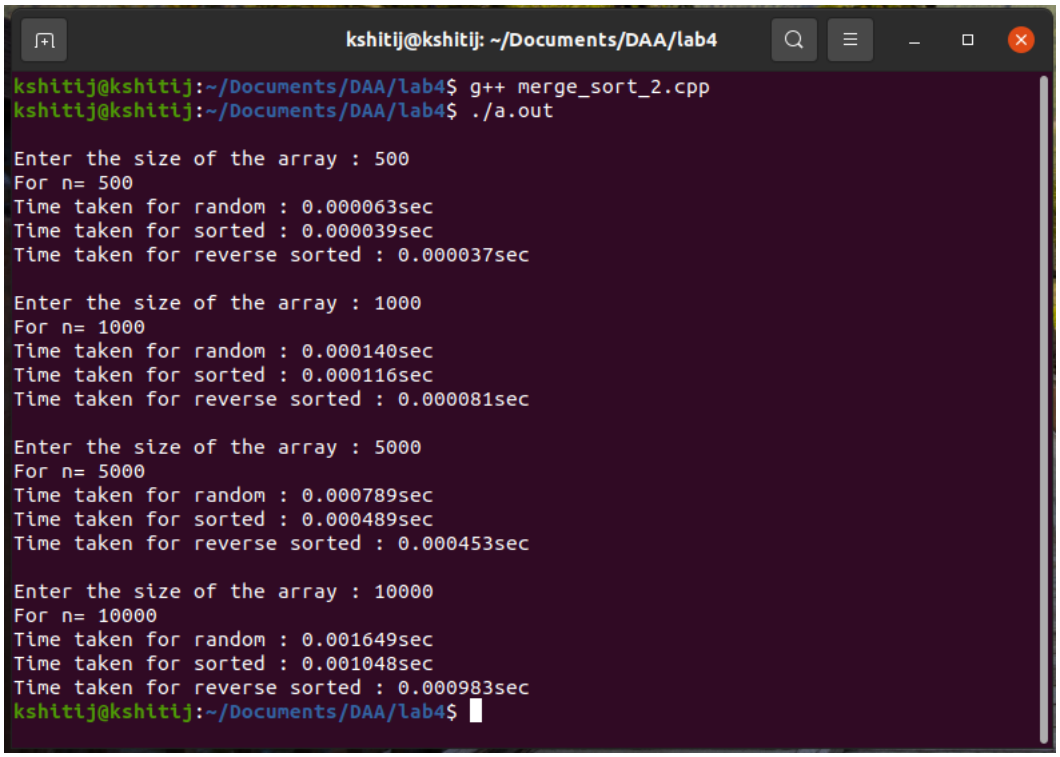
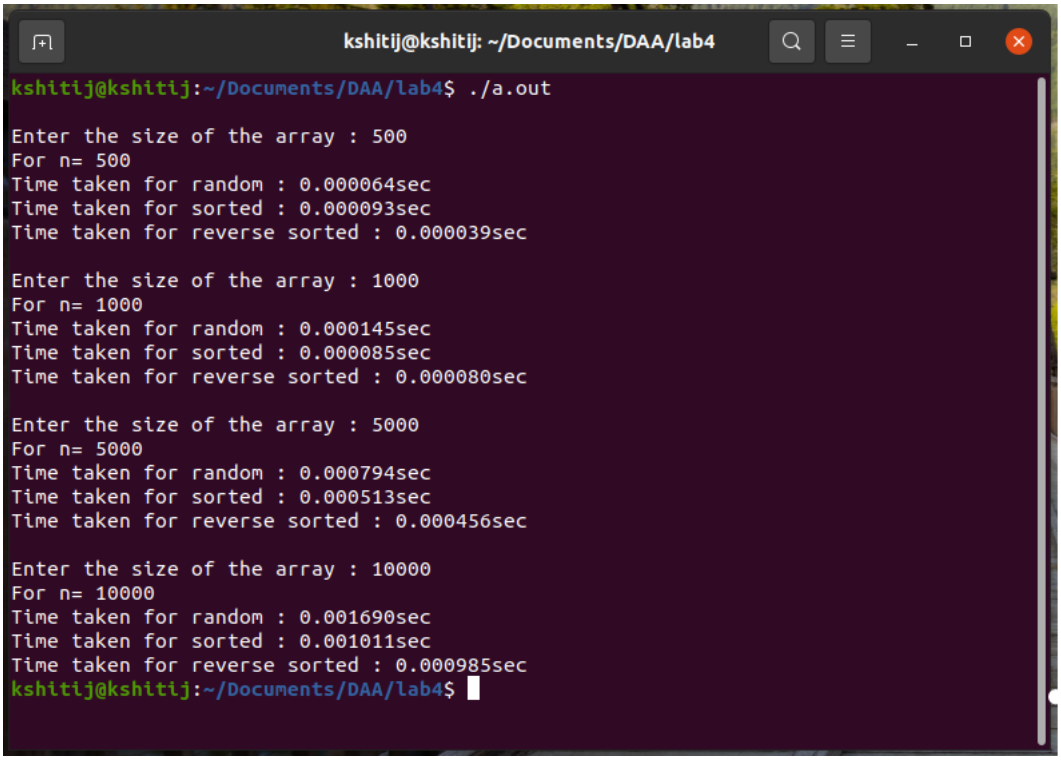

```
	for (i=0;i<n1;i++)			//initialising 1st sub-array
		L[i]=arr[l+i];
	for (j=0;j<n2;j++)			//initialising 2nd sub-array
		R[j]=arr[m+1+j];
	i=0;
	j=0;
	k=l;
	while(i<n1&&j<n2)			//loop for merging into an array in sorted order
	{
		if (L[i]<=R[j])			//checking for the larger element
		{
			arr[k]=L[i];		//inserting it to its position
			i++;
		}
		else
		{
			arr[k]=R[j];
			j++;
		}
		k++;
	}
	while(i<n1)				//inserting any left-out element from 1st sub-array
	{
		arr[k]=L[i];
		i++;
		k++;
	}
	while(j<n2)				//inserting any left-out element from 2nd sub-array
	{
		arr[k]=R[j];
		j++;
		k++;
	}
}

int main()
	{
	 int n,i,j,k;
	 clock_t start, end;			//Variables for keeping start and end time
	 double cpu_time_used;			//Variable for keeping cpu time used
	 for(i=0;i<4;i++)
		{
		cout<<endl;
		cout<<"Enter the size of the array : ";
```

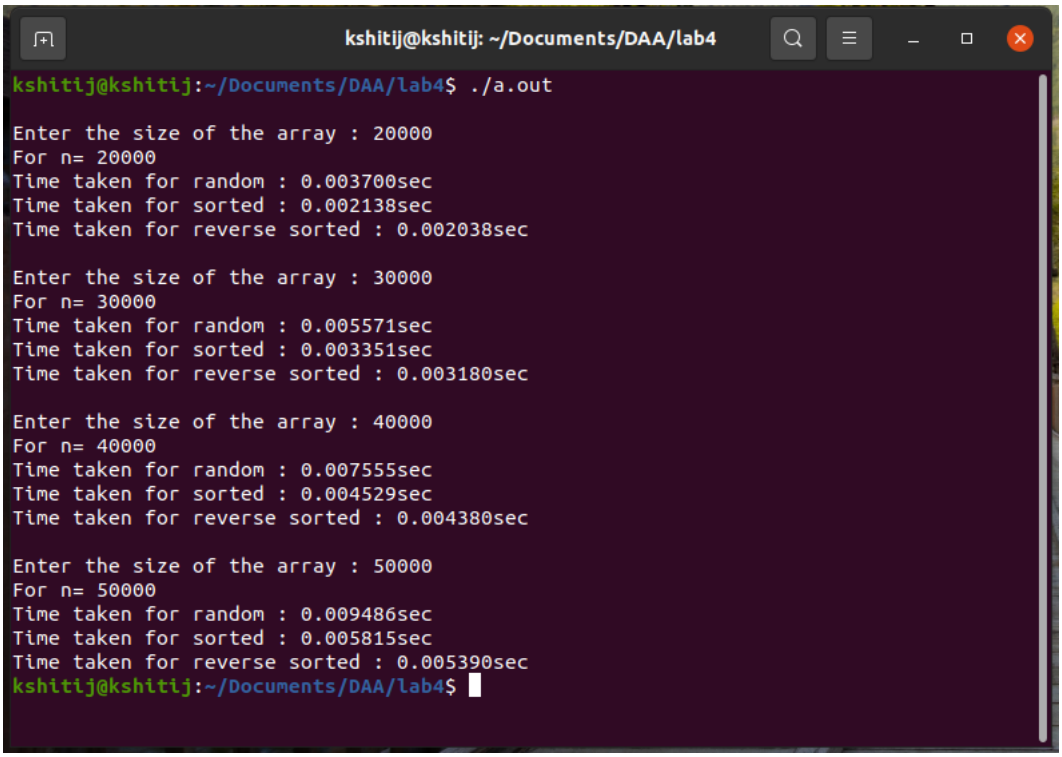
```
        cin>>n;
        int a[n];
        srand(time(0));
        for(j=0;j<n;j++)
                a[j]=rand()%1000000;            //generating the random array
        cout<<"For n= "<<n<<endl;
        start=clock();                          //keeping start time of the clock for random array
        merge_sort(a,0,n-1);                    //sorting
        end=clock();                            //keeping end time of the clock for random array

        cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
        printf("Time taken for random : %fsec \n",cpu_time_used);

        sort(a,a+n);

        start=clock();                  //keeping start time of the clock for sorted array
        merge_sort(a,0,n-1);            //sorting
        end=clock();                    //keeping end time of the clock for sorted array

        cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
        printf("Time taken for sorted : %fsec \n",cpu_time_used);

        sort(a,a+n,greater<int>());

        start=clock();                  //keeping start time of the clock for reverse sorted array
        merge_sort(a,0,n-1);            //sorting
        end=clock();                    //keeping end time of the clock for reverse sorted array

        cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
        printf("Time taken for reverse sorted : %fsec \n",cpu_time_used);
        }
}
```

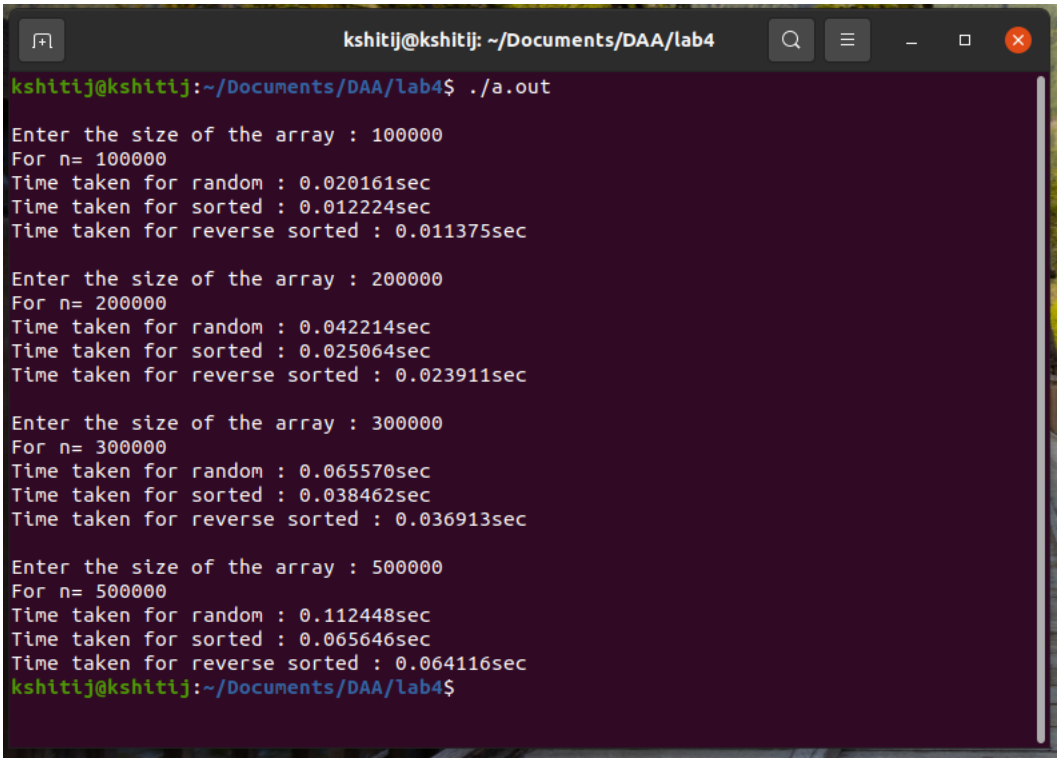
Outputs as per asked in question:





Extra outputs for analysis:





Conclusions after analysis of outputs:

1. The time taken for sorting a reverse sorted array is always less than the sorted element, random element array.
2. There is not much significant increase observed in time increase on increasing the array size.
3. It is faster than insertion sort algorithm.