DAA Lab-7

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Q-7.1) Write a program to sort a given set of elements with the Heap sort.

1) Repeat the experiment for different values of n = 20000, 50000, 100000, 500000 and report the time (in seconds) required to sort the elements.

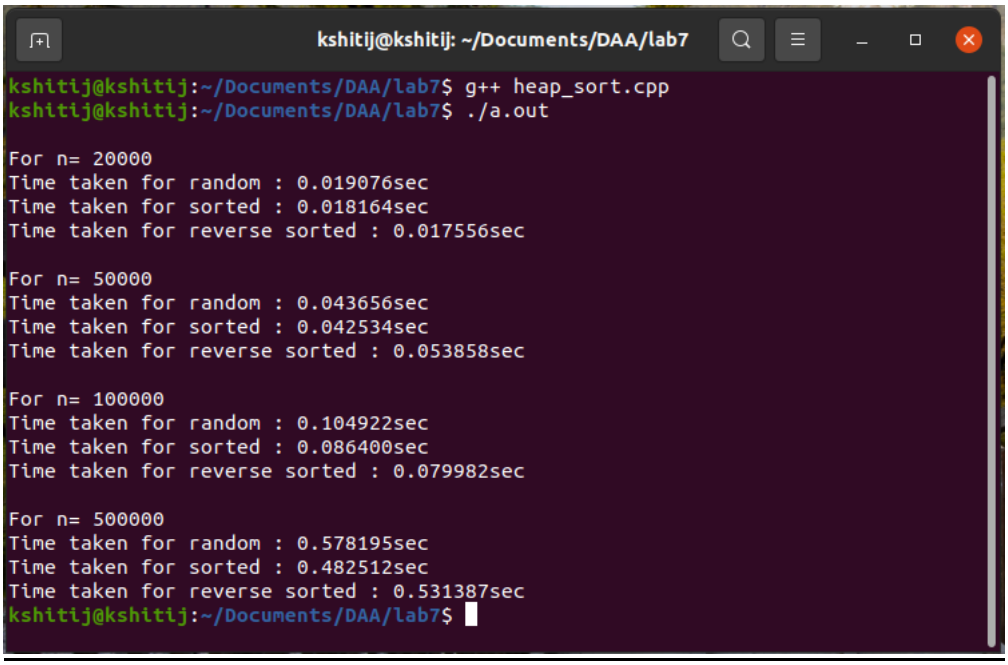
2)For each of aforementioned case, consider arrays as random, sorted, and reverse-sorted and observe running time variation for different types of input for heap sort. [Provide your observation regarding sensitivity of heap sort on the input in your lab record.]

Program:

```
/*
Written by: Kshitij Kumar Sharma                Roll No.: 1905514
Idea of the solution:
    I have implemented heapify() to convert the array into a heap data structure and generate the max heap. The heap_sort() function calls the heapify(). The idea behind the concept is that the parent node is always grater then the child nodes and that is what I have tried to implement trough this program.
*/
#include <bits/stdc++.h>

using namespace std;

void heapify(int a[], int n, int i)             //converting to heap data structure
{                                               //and max-heap generation
   int l,r,largest=i;
   l=2*i+1;                                     //left child
   r=2*i+2;                                     //right child
   if (l<n&&a[l]>a[largest])                    //checking for the largest among the three
      largest=l;
   if (r<n&&a[r]>a[largest])
      largest=r;
   if (largest!=i)
   {
      swap(a[i],a[largest]);                    //swapping
      heapify(a,n,largest);                     //recursively calling
   }
}
void heap_sort(int a[], int n)                  //heap sort
{
   int i;
   for (i=n/2-1;i>=0;i--)
      heapify(a,n,i);
   for (i=n-1;i>0;i--)
   {
      swap(a[0],a[i]);
```

```
      heapify(a,i,0);
   }
}
int main()
{
   int n,i,j,k,s[]={20000,50000,100000,500000};      //different array sizes to test
   clock_t start, end;                               //time variables for timing analysis
   double cpu_time_used;
   for(i=0;i<4;i++)
    {
      cout<<endl;
      n=s[i];
      int a[n];
      srand(time(0));
      for(j=0;j<n;j++)
         a[j]=rand()%1000000;                        //generating random array
      cout<<"For n= "<<n<<endl;
      start=clock();
      heap_sort(a,n);
      end=clock();
      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();
      heap_sort(a,n);
      end=clock();

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

Output:



Q-7.2) Compare running time (in seconds) of heap sort with insertion sort, merge sort, and quick sort on different input sizes and also for different input types (random/sorted/reverse-sorted).

Program:

```
/*
Written by: Kshitij Kumar Sharma                    Roll No.: 1905514
Idea of the solution:
        The concept of heap sort is same just adding merge sort and random quick sort which I have
did in previous labs. Included them as a header file in this program to avoid repetition of the same
code.
*/

#include <bits/stdc++.h>
#include "merge_sort.cpp"                           //merge sort header file
#include "quick_sort_random.cpp"                    //random quick sort header file

using namespace std;
                                                    //everything remains same as before
void heapify(int a[], int n, int i)
{
   int l,r,largest=i;
   l=2*i+1;
   r=2*i+2;
   if (l<n&&a[l]>a[largest])
```

```
      largest=l;
   if (r<n&&a[r]>a[largest])
      largest=r;
   if (largest!=i)
   {
      swap(a[i],a[largest]);
      heapify(a,n,largest);
   }
}
void heap_sort(int a[], int n)
{
   int i;
   for (i=n/2-1;i>=0;i--)
      heapify(a,n,i);
   for (i=n-1;i>0;i--)
   {
      swap(a[0],a[i]);
      heapify(a,i,0);
   }
}
int main()          //some changes into the main function for analysing all the algorithms together
{
   int n,i,j,k,s[]={20000,50000,100000,500000};
   clock_t start, end;
   double cpu_time_used;
   for(i=0;i<4;i++)
    {
      cout<<endl;
      n=s[i];
      int a[n];
      srand(time(0));
      for(j=0;j<n;j++)
         a[j]=rand()%1000000;
      cout<<"For n= "<<n<<endl;
      cout<<"  Random Array \n";
      start=clock();
      heap_sort(a,n);
      end=clock();
      cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
      printf("    Heap sort : %fsec \n",cpu_time_used);

      start=clock();
      merge_sort(a,0,n-1);
      end=clock();
```

```
cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
printf("    Merge sort : %fsec \n",cpu_time_used);

start=clock();
random_quick_sort(a,0,n-1);
end=clock();
cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
printf("    Quick sort : %fsec \n",cpu_time_used);
cout<<"  Sorted Array \n";
sort(a,a+n);

start=clock();
heap_sort(a,n);
end=clock();
cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
printf("    Heap sort : %fsec \n",cpu_time_used);

start=clock();
merge_sort(a,0,n-1);
end=clock();
cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
printf("    Merge sort : %fsec \n",cpu_time_used);

start=clock();
random_quick_sort(a,0,n-1);
end=clock();
cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
printf("    Quick sort : %fsec \n",cpu_time_used);
cout<<"  Reverse Sorted Array \n";
sort(a,a+n,greater<int>());

start=clock();
heap_sort(a,n);
end=clock();
cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
printf("    Heap sort : %fsec \n",cpu_time_used);

start=clock();
merge_sort(a,0,n-1);
end=clock();
cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
printf("    Merge sort : %fsec \n",cpu_time_used);

start=clock();
```

```
    random_quick_sort(a,0,n-1);
    end=clock();
    cpu_time_used=((double)(end-start))/CLOCKS_PER_SEC;
    printf("    Quick sort : %fsec \n",cpu_time_used);
  }
}
```

Output: