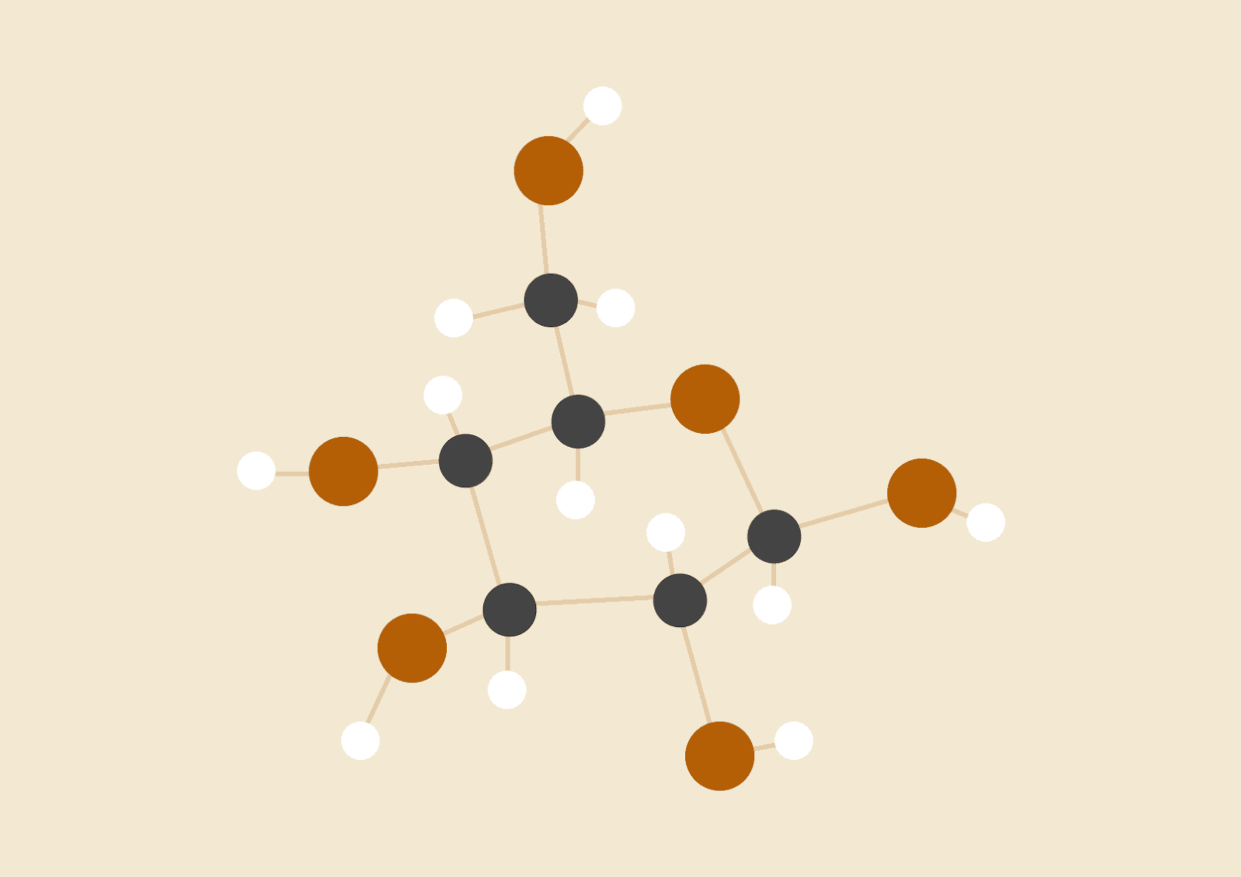
Homework Assignment 1

ICT:5102, Data Structure & Algorithm



Md.Dedarul Hasan

PGD in IT, Registration No: 0417311011
Session: April,2017

INTRODUCTION

Insertion Sort, Merge Sort & Quick Sort Algorithms.Total Comparison & Swap Count During Sort Proces. Array Sorting By Ascending, Descending & Random Order Implementations.

GIVEN INPUT ARRAY

{195, 134, 144, 141, 145, 197, 177, 101, 196, 146, 175, 173, 154, 171, 111, 136, 115, 162,165, 192,131, 142, 120, 185, 102, 181, 107, 198, 106, 176, 121, 178, 119, 128, 193, 127, 123, 143, 155, 186,191, 122, 132, 158, 129, 183, 163, 180, 103, 188, 150, 151, 172, 118, 174, 170, 104, 130, 116, 117,112, 139, 194, 147, 153, 164, 169, 199, 148, 138, 200, 190, 126, 152, 161, 179, 149, 137, 133, 110,159, 113, 140, 160, 105, 184, 182, 135, 114, 125, 168, 189, 124, 108, 187, 166, 156, 109, 167, 157};

MATERIALS

1. Code Block IDE Tools
2. GDB/CDB Debugger Tools
3. IntelliJ IDE /Netbeans IDE
4. JDK

PROCEDURE

1. C programming
2. C++ programming
3. Java programming

PROGRAM CODE IN C :

We have implemented one C class file with user defined method to make that insertion ,merge & quick sorting algorithm.Now ,we will see bellow with that codes:

```
#include<stdio.h>

//GIVEN INPUT
ARRAY******************************************************************************
************************************//

    int array[]=

    {195, 134, 144, 141, 145, 197, 177, 101, 196, 146, 175, 173, 154, 171, 111, 136, 115, 162,
165, 192,131, 142, 120, 185, 102, 181, 107, 198, 106, 176, 121, 178, 119, 128, 193, 127, 123,
143, 155, 186,191, 122, 132, 158, 129, 183, 163, 180, 103, 188, 150, 151, 172, 118, 174, 170,
104, 130, 116, 117,112, 139, 194, 147, 153, 164, 169, 199, 148, 138, 200, 190, 126, 152, 161,
179, 149, 137, 133, 110,159, 113, 140, 160, 105, 184, 182, 135, 114, 125, 168, 189, 124, 108,
187, 166, 156, 109, 167, 157};

    int n = sizeof(array)/sizeof(array[0]);//LENGTH OF GIVEN ARRAY

    int A[]; // TEMP ARRAY TO STORE THE COPIED FORM GIVEN INPUT ARRAY

//METHOD TO COPY array BY int
A[]**********************************************************************************
**********************//

void arrayCopy(int copied[],int n){

    int loop;

    for(loop = 0; loop < n; loop++){

            copied[loop] = array[loop];

    }

}
```

```
//METHOD TO PRINT ARRAY
ALWAYS***************************************************************************
*******************************//

void printArray(int arr[], int n){

    int i;

    for (i=0; i < n; i++)

        printf("%d ", arr[i]);

        printf("\n");

}

//METHOD TO MAKE SWAP WITH ONE ELEMENT TO
ANOTHER**************************************************************************
*************//

void swap(int *a, int *b){

    int temp = *a;

    *a = *b;

    *b = temp;

}

//METHOD TO MAKE ARRAY IN ASCENDING
ORDER*****************************************************************************
******************//

void AscSort(int arr[], int n){

    int i,j,hold,pos;

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

        hold = arr[i];

        pos = i-1;

        for(j=0;j<i;j++){
            if(hold<arr[pos] && pos>=0){

                arr[pos+1]=arr[pos];

                pos=pos-1;

            }

            else break;

            arr[pos+1]=hold;

        }

    }

}

//METHOD TO MAKE ARRAY IN DESCENDING
ORDER***********************************************************************************************
******************//

void DscSort(int arr[], int n){

    int i,j,hold,pos;

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

        hold = arr[i];

        pos = i-1;

        for(j=0;j<i;j++){

            if(hold>arr[pos] && pos>=0)

            {   arr[pos+1]=arr[pos];

                pos=pos-1;

            }

            else break;

            arr[pos+1]=hold;
        }
    }
}
//METHOD TO MAKE ARRAY SORT USING INSERTION SORT WITH ASCENDING ORDER********************************************************************//
void insertionSortAsc(int arr[], int n){
    int comparisonCount=0;
    int swapCount=0;
    int i,j,hold,pos;
    for(i=1;i<=n-1;i++){
        hold = arr[i];
        pos = i-1;
        for(j=0;j<i;j++){
            comparisonCount++;
            if(hold<arr[pos] && pos>=0){
                arr[pos+1]=arr[pos];
                pos=pos-1;
                swapCount++;
            }
            else break;
            arr[pos+1]=hold;
        }
    }
    printArray(arr, n);
    printf("TOTAL NUMBER OF COMPARISONS: %d\n", comparisonCount);

    printf("TOTAL NUMBER OF SWAPS: %d\n", swapCount);

}

//METHOD TO MAKE ARRAY SORT USING INSERTION SORT WITH DESCENDING
ORDER*********************************************************************************//

void insertionSortDsc(int arr[], int n){

    int comparisonCount=0;

    int swapCount=0;

    int i,j,hold,pos;

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

        hold = arr[i];

        pos = i-1;

        for(j=0;j<i;j++){

            comparisonCount++;

            if(hold>arr[pos] && pos>=0){

                arr[pos+1]=arr[pos];

                pos=pos-1;

                swapCount++;

            }

            else break;

            arr[pos+1]=hold;

        }

    }

    printArray(arr, n);
    printf("TOTAL NUMBER OF COMPARISONS: %d\n", comparisonCount);

    printf("TOTAL NUMBER OF SWAPS: %d\n", swapCount);

}

//METHOD TO MAKE ARRAY SORT USING MERGE SORT WITH ASCENDING ORDER******************************************************************************//

void mergeSortAsc(int arr[],int n){

    int comparisonCount=0;

    int swapCount=0;

//METHOD TO MAKE ARRAY SORT USING MERGE SORT****************************************************************************************************//

void merge(int arr[], int l, int m, int r){

    int i, j, k;

    int n1 = m - l + 1;// TEMP LEFT ARRAY SIZE

    int n2 =  r - m;// TEMP RIGHT ARRAY SIZE

    int L[n1], R[n2];/* CREATE TEMP ARRAYS */

    for (i = 0; i < n1; i++)    /* COPY DATA TO TEMP ARRAYS L[]  */

        L[i] = arr[l + i];

    for (j = 0; j < n2; j++)    /* COPY DATA TO TEMP ARRAYS R[]*/

        R[j] = arr[m + 1+ j];

    i = 0;

    j = 0;

    k = l;

    while (i < n1 && j < n2){

        comparisonCount++;
        if (L[i] <= R[j]){
            arr[k] = L[i];
            i++;
        }
        else{
            swapCount++;
            arr[k] = R[j];
            j++;
        }
        k++;
    }
    while (i < n1){
        arr[k] = L[i];
        i++;
        k++;
    }
    while (j < n2){
        arr[k] = R[j];
        j++;
        k++;
    }
}
//MERGE SORT METHOD TO IMPLEMENT***************************************************************************************
```

```
*************************//

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);

    }

  }

  mergeSort(A,0,n-1);

  printArray(A, n);

  printf("TOTAL NUMBER OF COMPARISONS: %d\n", comparisonCount);

  printf("TOTAL NUMBER OF SWAPS: %d\n", swapCount);

}

//MARGE SORT DESCENDING
**********************************************************************************************
***********************//

void mergeSortDsc(int arr[],int n){

  int comparisonCount=0;

  int swapCount=0;

// MERGE TWO SUBARRAY OF arr[].First (left) SUB ARRAY IS arr[l..m],SECOND (right)
SUBARRAY IS arr[m+1..r] ************************//

void merge(int arr[], int l, int m, int r) {

  int i, j, k;

  int n1 = m - l + 1;// TEMP LEFT ARR SIZE
int n2 =  r - m;// TEMP RIGHT ARR SIZE
int L[n1], R[n2];/* CREATE TEMP ARRAYS */
for (i = 0; i < n1; i++)    /* COPY DATA TO TEMP ARRAYS L[]  */
    L[i] = arr[l + i];
for (j = 0; j < n2; j++)    /* COPY DATA TO TEMP ARRAYS R[]*/
    R[j] = arr[m + 1+ j];
i = 0;
j = 0;
k = l;
while (i < n1 && j < n2){
    comparisonCount++;
    if (L[i] >= R[j]){
        arr[k] = L[i];
        i++;
    }
    else{
        swapCount++;
        arr[k] = R[j];
        j++;
    }
    k++;
}
/* COPY THE REMAINING ELEMENTS OF L[], IF THERE ARE ANY*/
while (i < n1){
        arr[k] = L[i];

        i++;

        k++;

    }

    /* COPY THE REMAINING ELEMENTS OF R[], IF THERE ARE ANY */

    while (j < n2){

        arr[k] = R[j];

        j++;

        k++;

    }

}

//MERGE SORT
ARRAY***********************************************************************************
**********************************//

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);

        }

    }

    mergeSort(A,0,n-1);

    printArray(A, n);
    printf("TOTAL NUMBER OF COMPARISONS: %d\n", comparisonCount);

    printf("TOTAL NUMBER OF SWAPS: %d\n", swapCount);

}

//METHOD FOR QUICK SORT IN ASCENDING
ORDER******************************************************************************
*****************//

void quickSortAsc(int arr[],int n){

    int comparisonCount=0;

    int swapCount=0;

//METHOD FOR PARTITIONING
*************************************************************************************
**************************//

int partition(int arr[], int low, int high){

    int pivot = arr[high];    // PIVOT

    int i = (low - 1);  // Index of smaller element

    int j;

    for ( j = low; j <= high- 1; j++){

        comparisonCount++;

        if (arr[j] <= pivot){

            i++;    // INCREMENT INDEX OF SMALLER ELEMENT

            swap(&arr[i], &arr[j]);

            if (i<j){

                swapCount++;

            }

        }
```

```
   }

   swap(&arr[i + 1], &arr[high]);// NO COMPARISON ONLY ONE SWAP

   if (i+1<high){

         swapCount++;

   }

   return (i + 1);

}/*END OF PARTITION()*/

//QUICK
SORT********************************************************************************
*********************************************//

void quickSort(int arr[], int low, int high){

      if (low < high){

         int pi = partition(arr, low, high);


         quickSort(arr, low, pi - 1);

         quickSort(arr, pi + 1, high);

      }

   }

   quickSort(A,0,n-1);

   printArray(A, n);

   printf("TOTAL NUMBER OF COMPARISONS: %d\n", comparisonCount);

   printf("TOTAL NUMBER OF SWAPS: %d\n", swapCount);

}

//METHOD FOR QUICK SORT
DESCENDING************************************************************************
```

```
*******************************//

void quickSortDsc(int arr[],int n)

{   int comparisonCount=0;

    int swapCount=0;

//PARTITIOON
MAKING****************************************************************************
******************************************//

int partition(int arr[], int low, int high){

    int pivot = arr[high];    // PIVOT

    int i = (low - 1);  // INDEX OF SMALLER ELEMENT

    int j;

    for ( j = low; j <= high- 1; j++){

        comparisonCount++;

        if (arr[j] >= pivot){

            i++;    // INCREMENT INDEX OF SMALLER ELEMENT

            swap(&arr[i], &arr[j]);

            if (i<j){

                swapCount++;

            }

        }

    }

    swap(&arr[i + 1], &arr[high]);// NO COMPARISON ONLY ONE SWAP

    if (i+1<high){

            swapCount++;

    }
    return (i + 1);

}/*END OF partition()*/

//METHOD FOR QUICK
SORT********************************************************************************
********************************//

void quickSort(int arr[], int low, int high){

        if (low < high){

            int pi = partition(arr, low, high);

            quickSort(arr, low, pi - 1);

            quickSort(arr, pi + 1, high);

        }

    }/*END OF quickSort()*/

    quickSort(A,0,n-1);

    printArray(A, n);

    printf("TOTAL NUMBER OF COMPARISONS: %d\n", comparisonCount);

    printf("TOTAL NUMBER OF SWAPS: %d\n", swapCount);

}

//METHOD FOR RANDOMIZE THE ARRAY
ELEMENTS**************************************************************************
*********************//

void randomize ( int arr[], int n ){

    int comparisonCount=0;

    int swapCount=0;

    int i;

    srand( time(NULL) );
```

```
   for ( i = n-1; i > 0; i--){
       comparisonCount++;
       int j = rand() % (i+1);
       swap(&arr[i], &arr[j]);
       swapCount++;
   }
   printArray(A, n);
   printf("TOTAL NUMBER OF COMPARISONS: %d\n", comparisonCount);
   printf("TOTAL NUMBER OF SWAPS: %d\n", swapCount);
}
int main(){
//PROGRAMMER INFORMATION
INDETAILS-**************************************************************************
*************************//
                const char assignmentName[200] = "                                 *** Home Work
Assignment ***";
                const char programmerName[200] = "                                  MD.DEDARUL
HASAN,IICT-BUET";
                const char registrationID[200] = "                                    REG. NO:
0417311011";
                const char sessionID[200] = "                                    SESSION: APRIL,2017";
                const char submissionDate[200] = "                                    COMPLETED:
22/02/2019";
                printf("\n %s\n", assignmentName );
                printf(" %s\n", programmerName );
                printf(" %s\n", registrationID );
                printf(" %s\n", sessionID );

                printf(" %s\n", submissionDate );

                printf("\n");

//MAIN METHOD UTILIZATION CODE STARTED
HERE*****************************************************************************************
**********//

   int chooseOption;

   printf("GIVEN INPUT ARRAY \n");

   printf("int A[]=\n{");

   printArray(array, n);

   printf("}\n");


   while(1){

       printf("TASKS TO DO:");

       printf("\n1. OPTION FOR INSERTION SORT");

       printf("\n2. OPTION FOR MARGE SORT");

       printf("\n3. OPTION FOR QUICK SORT");

       printf("\n4. OPTION FOR EACH SORT IN BOTH ORDER");

       printf("\n5. EXIT\n");

       printf("\nENTER OPTION TO VIEW:\t");

       scanf("%d", &chooseOption);

   //

       switch(chooseOption){

           case 1: arrayCopy(A,n);
```

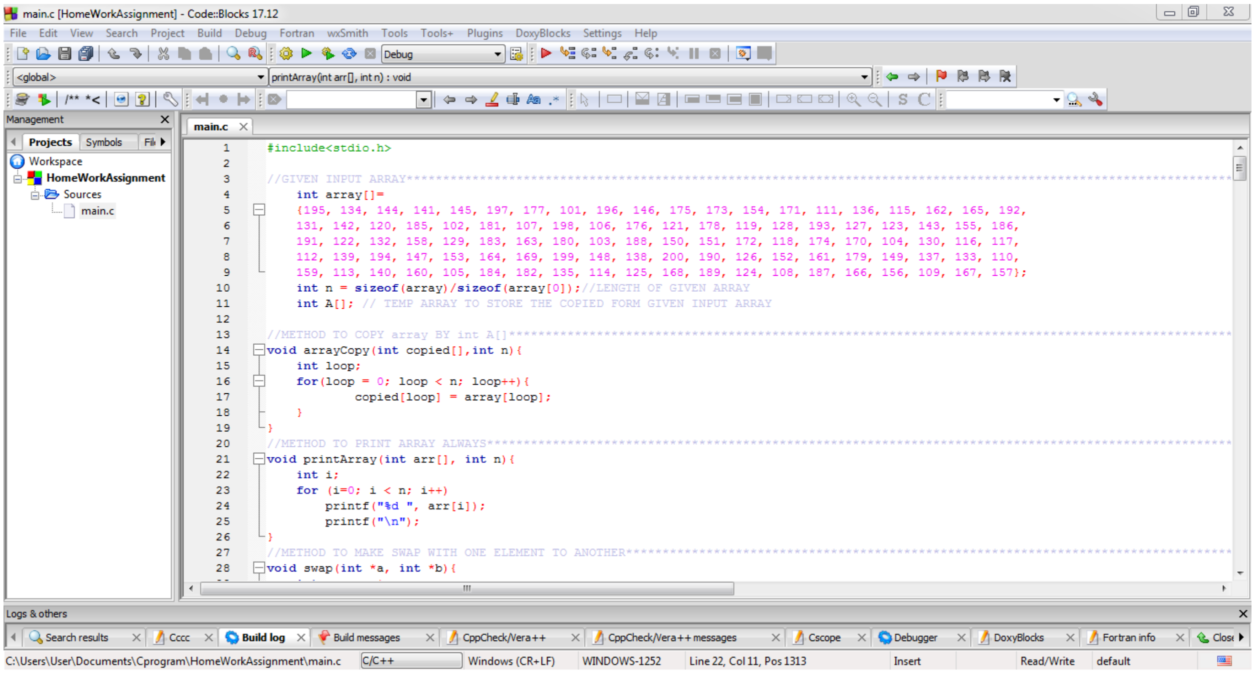
```
          AscSort(A, n);

          printf("\n1.1 INSERTION SORTED ARRAY [101-200] ASCENDING TO
ASCENDING ORDER:\n");

          insertionSortAsc(A, n);


          arrayCopy(A,n);

          DscSort(A, n);

          printf("\n1.2 INSERTION SORTED ARRAY [200-101] DESCENDING TO
ASCENDING ORDER:\n");

          insertionSortAsc(A, n);


          arrayCopy(A,n);

          printf("\n1.3 INSERTION SORTED ARRAY [101-200] RANDOM TO ASCENDING
ORDER:\n");

          insertionSortAsc(A, n);

          break;

      case 2: arrayCopy(A,n);

          AscSort(A, n);

          printf("\n2.1 MERGE SORTED ARRAY[101-200] ASCENDING TO ASCENDING
ORDER:\n");

          mergeSortAsc(A, n);


          arrayCopy(A,n);

          DscSort(A, n);

          printf("\n2.2 MERGE SORTED ARRAY [200-101] DESCENDING TO ASCENDING
ORDER:\n");
          mergeSortAsc(A, n);


          arrayCopy(A,n);
          printf("\n2.3 MERGE SORTED ARRAY [101-200] RANDOM TO ASCENDING
ORDER:\n");
          mergeSortAsc(A, n);
          break;
      case 3: arrayCopy(A,n);
          AscSort(A, n);
          printf("\n3.1 QUICK SORTED  ARRAY [101-200] ASCENDING TO ASCENDING
ORDER:\n");
          quickSortAsc(A,n);


          arrayCopy(A,n);
          DscSort(A, n);
          printf("\n3.2 QUICK SORTED  ARRAY [200-101] DESCENDING TO ASCENDING
ORDER:\n");
          quickSortAsc(A,n);


          arrayCopy(A,n);
          printf("\n3.3 QUICK SORTED  ARRAY [101-200] RANDOM TO ASCENDING
ORDER:\n");
          quickSortAsc(A,n);
          break;
```

```
case 4: printf("\nINSERTION SORTED ARRAY IN ASCENDING ORDER:\n");
        arrayCopy(A,n);
        insertionSortAsc(A, n);

        printf("\nINSERTION SORTED ARRAY IN DESCENDING ORDER:\n");
        arrayCopy(A,n);
        insertionSortDsc(A, n);

        printf("\nMERGE SORTED ARRAY IN ASCENDING ORDER:\n");
        arrayCopy(A,n);
        mergeSortAsc(A,n);

        printf("\nMERGE SORTED ARRAY IN DESCENDING ORDER:\n");
        arrayCopy(A,n);
        mergeSortDsc(A, n);

        printf("\nQUICK SORTED ARRAY IN ASCENDING ORDER:\n");
        arrayCopy(A,n);
        quickSortAsc(A,n);

        printf("\nQUICK SORTED ARRAY IN DESCENDING ORDER:\n");
        arrayCopy(A,n);
        quickSortDsc(A,n);
```

```
                printf("\nARRAY IN RANDOM ORDER:\n");

                arrayCopy(A,n);

                randomize (A, n);

                break;


            case 5: exit(0);

            default: printf("PLEASE ENTER CORRECT INPUT!\n");

        }

    }

    return 0;

}
```

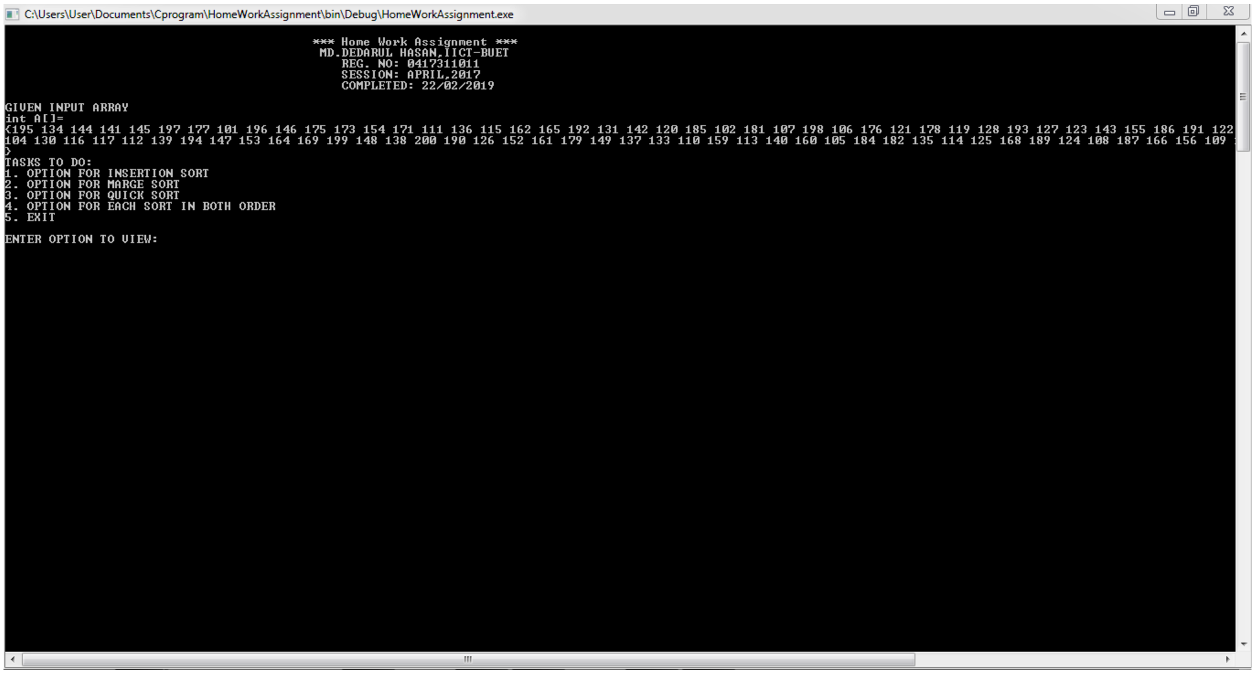
PROGRAM OUTPUT FOR THATS ALGORITHMS :

Fig :1-Code Block Project Overview


main.c [HomeWorkAssignment] - Code::Blocks 17.12
File Edit View Search Project Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help
Debug
<global>
printArray(int arr[], int n) : void
Management
Projects Symbols Fil
Workspace
HomeWorkAssignment
Sources
main.c
Logs & others
Search results Cccc Build log Build messages CppCheck/Vera++ CppCheck/Vera++ messages Cscope Debugger DoxyBlocks Fortran info Close
C:\Users\User\Documents\Cprogram\HomeWorkAssignment\main.c C/C++ Windows (CR+LF) WINDOWS-1252 Line 22, Col 11, Pos 1313 Insert Read/Write default

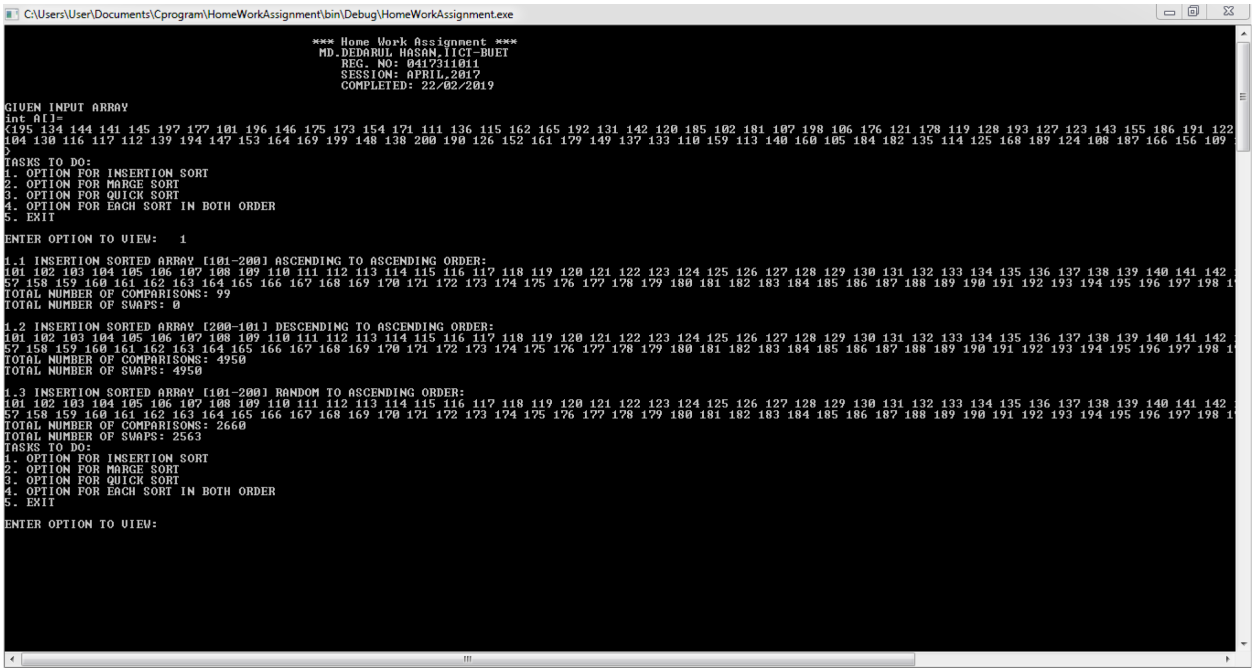
```
#include<stdio.h>

//GIVEN INPUT ARRAY*****************************************************************************************
    int array[]=
    {195, 134, 144, 141, 145, 197, 177, 101, 196, 146, 175, 173, 154, 171, 111, 136, 115, 162, 165, 192,
    131, 142, 120, 185, 102, 181, 107, 198, 106, 176, 121, 178, 119, 128, 193, 127, 123, 143, 155, 186,
    191, 122, 132, 158, 129, 183, 163, 180, 103, 188, 150, 151, 172, 118, 174, 170, 104, 130, 116, 117,
    112, 139, 194, 147, 153, 164, 169, 199, 148, 138, 200, 190, 126, 152, 161, 179, 149, 137, 133, 110,
    159, 113, 140, 160, 105, 184, 182, 135, 114, 125, 168, 189, 124, 108, 187, 166, 156, 109, 167, 157};
    int n = sizeof(array)/sizeof(array[0]);//LENGTH OF GIVEN ARRAY
    int A[]; // TEMP ARRAY TO STORE THE COPIED FORM GIVEN INPUT ARRAY

//METHOD TO COPY array BY int A[]****************************************************************************
void arrayCopy(int copied[],int n){
    int loop;
    for(loop = 0; loop < n; loop++){
            copied[loop] = array[loop];
    }
}
//METHOD TO PRINT ARRAY ALWAYS*******************************************************************************
void printArray(int arr[], int n){
    int i;
    for (i=0; i < n; i++)
        printf("%d ", arr[i]);
        printf("\n");
}
//METHOD TO MAKE SWAP WITH ONE ELEMENT TO ANOTHER***********************************************************
void swap(int *a, int *b){
```

Fig :2- Output of Assignment Class File Execution- Starting Phase


C:\Users\User\Documents\Cprogram\HomeWorkAssignment\bin\Debug\HomeWorkAssignment.exe

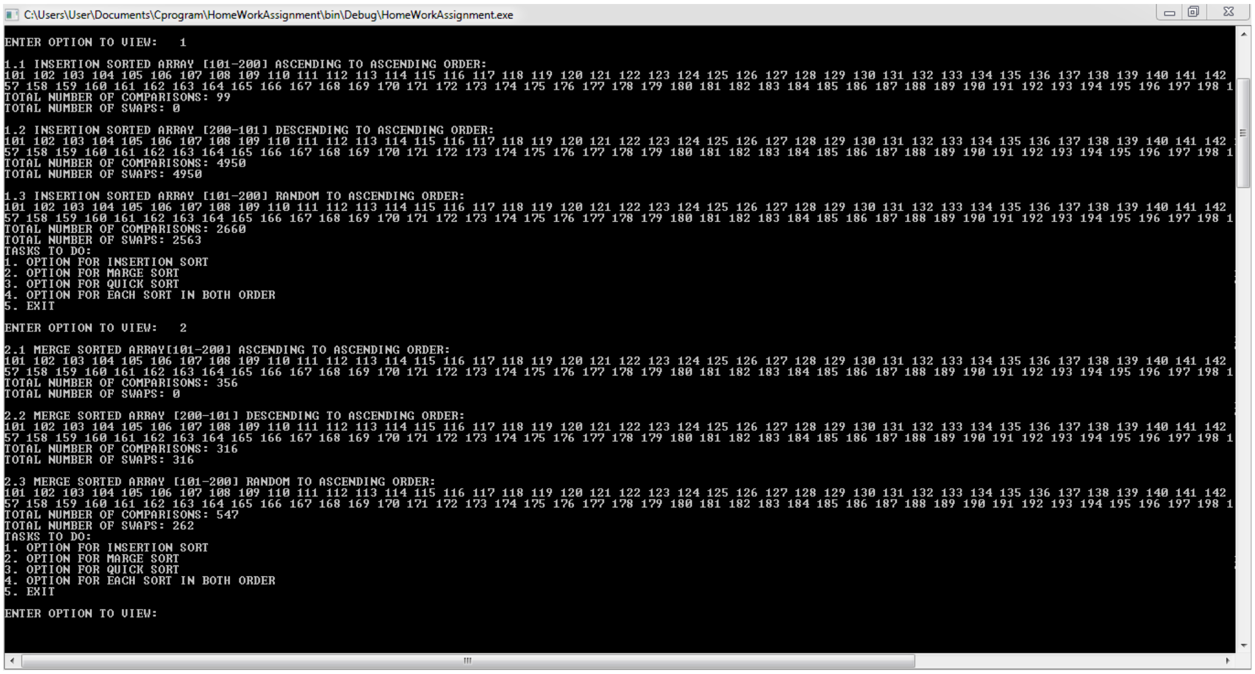
```
                                             *** Home Work Assignment ***
                                              MD.DEDARUL HASAN,IICT-BUET
                                                 REG. NO: 0417311011
                                                 SESSION: APRIL,2017
                                                 COMPLETED: 22/02/2019

GIVEN INPUT ARRAY
int A[]=
{195 134 144 141 145 197 177 101 196 146 175 173 154 171 111 136 115 162 165 192 131 142 120 185 102 181 107 198 106 176 121 178 119 128 193 127 123 143 155 186 191 122
104 130 116 117 112 139 194 147 153 164 169 199 148 138 200 190 126 152 161 179 149 137 133 110 159 113 140 160 105 184 182 135 114 125 168 189 124 108 187 166 156 109
}
TASKS TO DO:
1. OPTION FOR INSERTION SORT
2. OPTION FOR MARGE SORT
3. OPTION FOR QUICK SORT
4. OPTION FOR EACH SORT IN BOTH ORDER
5. EXIT

ENTER OPTION TO VIEW:
```

Fig :3- Entered Option 1 For Insertion Sort With Total Comparisons & Swap Count


C:\Users\User\Documents\Cprogram\HomeWorkAssignment\bin\Debug\HomeWorkAssignment.exe

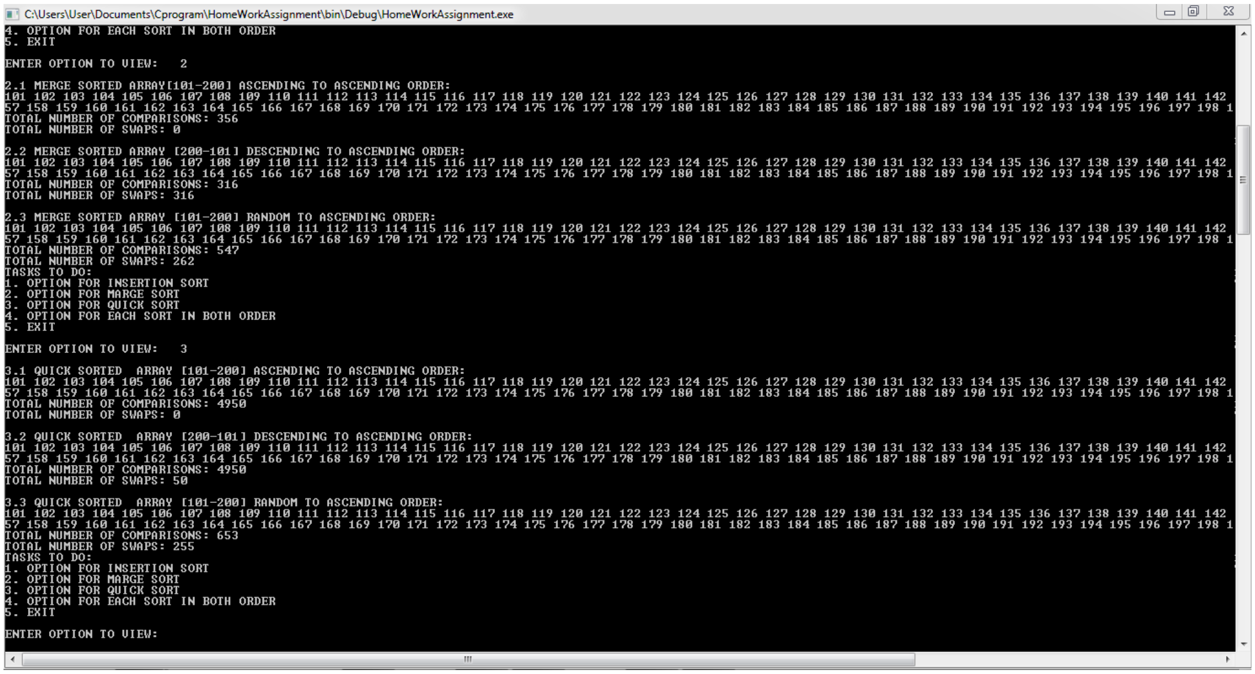
```
                                     *** Home Work Assignment ***
                                      MD.DEDARUL HASAN,IICT-BUET
                                          REG. NO: 0417311011
                                          SESSION: APRIL,2017
                                          COMPLETED: 22/02/2019

GIVEN INPUT ARRAY
int A[]=
{195 134 144 141 145 197 177 101 196 146 175 173 154 171 111 136 115 162 165 192 131 142 120 185 102 181 107 198 106 176 121 178 119 128 193 127 123 143 155 186 191 122
104 130 116 117 112 139 194 147 153 164 169 199 148 138 200 190 126 152 161 179 149 137 133 110 159 113 140 160 105 184 182 135 114 125 168 189 124 108 187 166 156 109
}
TASKS TO DO:
1. OPTION FOR INSERTION SORT
2. OPTION FOR MARGE SORT
3. OPTION FOR QUICK SORT
4. OPTION FOR EACH SORT IN BOTH ORDER
5. EXIT

ENTER OPTION TO VIEW:   1

1.1 INSERTION SORTED ARRAY [101-200] ASCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 99
TOTAL NUMBER OF SWAPS: 0

1.2 INSERTION SORTED ARRAY [200-101] DESCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 4950
TOTAL NUMBER OF SWAPS: 4950

1.3 INSERTION SORTED ARRAY [101-200] RANDOM TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 2660
TOTAL NUMBER OF SWAPS: 2563
TASKS TO DO:
1. OPTION FOR INSERTION SORT
2. OPTION FOR MARGE SORT
3. OPTION FOR QUICK SORT
4. OPTION FOR EACH SORT IN BOTH ORDER
5. EXIT

ENTER OPTION TO VIEW:
```

Fig :4- Entered Option 2 For Merge Sort With Total Comparisons & Swap Count


C:\Users\User\Documents\Cprogram\HomeWorkAssignment\bin\Debug\HomeWorkAssignment.exe

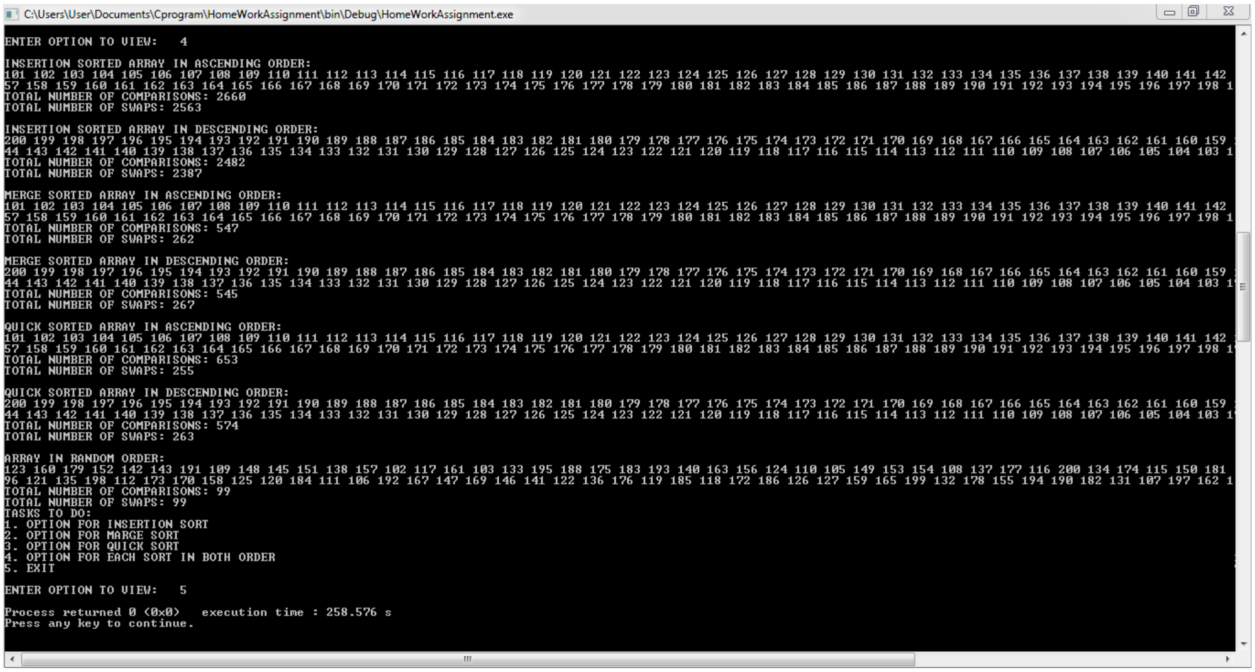
```
ENTER OPTION TO VIEW:   1

1.1 INSERTION SORTED ARRAY [101-200] ASCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 99
TOTAL NUMBER OF SWAPS: 0

1.2 INSERTION SORTED ARRAY [200-101] DESCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 4950
TOTAL NUMBER OF SWAPS: 4950

1.3 INSERTION SORTED ARRAY [101-200] RANDOM TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 2660
TOTAL NUMBER OF SWAPS: 2563
TASKS TO DO:
1. OPTION FOR INSERTION SORT
2. OPTION FOR MARGE SORT
3. OPTION FOR QUICK SORT
4. OPTION FOR EACH SORT IN BOTH ORDER
5. EXIT

ENTER OPTION TO VIEW:   2

2.1 MERGE SORTED ARRAY[101-200] ASCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 356
TOTAL NUMBER OF SWAPS: 0

2.2 MERGE SORTED ARRAY [200-101] DESCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 316
TOTAL NUMBER OF SWAPS: 316

2.3 MERGE SORTED ARRAY [101-200] RANDOM TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 547
TOTAL NUMBER OF SWAPS: 262
TASKS TO DO:
1. OPTION FOR INSERTION SORT
2. OPTION FOR MARGE SORT
3. OPTION FOR QUICK SORT
4. OPTION FOR EACH SORT IN BOTH ORDER
5. EXIT

ENTER OPTION TO VIEW:
```

Fig :5- Entered Option 3 For Quick Sort With Total Comparisons & Swap Count


C:\Users\User\Documents\Cprogram\HomeWorkAssignment\bin\Debug\HomeWorkAssignment.exe

```
4. OPTION FOR EACH SORT IN BOTH ORDER
5. EXIT

ENTER OPTION TO VIEW:   2

2.1 MERGE SORTED ARRAY[101-200] ASCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 356
TOTAL NUMBER OF SWAPS: 0

2.2 MERGE SORTED ARRAY [200-101] DESCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 316
TOTAL NUMBER OF SWAPS: 316

2.3 MERGE SORTED ARRAY [101-200] RANDOM TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 547
TOTAL NUMBER OF SWAPS: 262
TASKS TO DO:
1. OPTION FOR INSERTION SORT
2. OPTION FOR MARGE SORT
3. OPTION FOR QUICK SORT
4. OPTION FOR EACH SORT IN BOTH ORDER
5. EXIT

ENTER OPTION TO VIEW:   3

3.1 QUICK SORTED  ARRAY [101-200] ASCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 4950
TOTAL NUMBER OF SWAPS: 0

3.2 QUICK SORTED  ARRAY [200-101] DESCENDING TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 4950
TOTAL NUMBER OF SWAPS: 50

3.3 QUICK SORTED  ARRAY [101-200] RANDOM TO ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 653
TOTAL NUMBER OF SWAPS: 255
TASKS TO DO:
1. OPTION FOR INSERTION SORT
2. OPTION FOR MARGE SORT
3. OPTION FOR QUICK SORT
4. OPTION FOR EACH SORT IN BOTH ORDER
5. EXIT

ENTER OPTION TO VIEW:
```

Fig :7- Entered Option 4 For Random Sort With Total Comparisons & Swap Count


C:\Users\User\Documents\Cprogram\HomeWorkAssignment\bin\Debug\HomeWorkAssignment.exe

```
ENTER OPTION TO VIEW:   4

INSERTION SORTED ARRAY IN ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 2660
TOTAL NUMBER OF SWAPS: 2563

INSERTION SORTED ARRAY IN DESCENDING ORDER:
200 199 198 197 196 195 194 193 192 191 190 189 188 187 186 185 184 183 182 181 180 179 178 177 176 175 174 173 172 171 170 169 168 167 166 165 164 163 162 161 160 159
44 143 142 141 140 139 138 137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111 110 109 108 107 106 105 104 103 1
TOTAL NUMBER OF COMPARISONS: 2482
TOTAL NUMBER OF SWAPS: 2387

MERGE SORTED ARRAY IN ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 547
TOTAL NUMBER OF SWAPS: 262

MERGE SORTED ARRAY IN DESCENDING ORDER:
200 199 198 197 196 195 194 193 192 191 190 189 188 187 186 185 184 183 182 181 180 179 178 177 176 175 174 173 172 171 170 169 168 167 166 165 164 163 162 161 160 159
44 143 142 141 140 139 138 137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111 110 109 108 107 106 105 104 103 1
TOTAL NUMBER OF COMPARISONS: 545
TOTAL NUMBER OF SWAPS: 267

QUICK SORTED ARRAY IN ASCENDING ORDER:
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142
57 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 1
TOTAL NUMBER OF COMPARISONS: 653
TOTAL NUMBER OF SWAPS: 255

QUICK SORTED ARRAY IN DESCENDING ORDER:
200 199 198 197 196 195 194 193 192 191 190 189 188 187 186 185 184 183 182 181 180 179 178 177 176 175 174 173 172 171 170 169 168 167 166 165 164 163 162 161 160 159
44 143 142 141 140 139 138 137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111 110 109 108 107 106 105 104 103 1
TOTAL NUMBER OF COMPARISONS: 574
TOTAL NUMBER OF SWAPS: 263

ARRAY IN RANDOM ORDER:
123 160 179 152 142 143 191 109 148 145 151 138 157 102 117 161 103 133 195 188 175 183 193 140 163 156 124 110 105 149 153 154 108 137 177 116 200 134 174 115 150 181
96 121 135 198 112 173 170 158 125 120 184 111 106 192 167 147 169 146 141 122 136 176 119 185 118 172 186 126 127 159 165 199 132 178 155 194 190 182 131 107 197 162 1
TOTAL NUMBER OF COMPARISONS: 99
TOTAL NUMBER OF SWAPS: 99
TASKS TO DO:
1. OPTION FOR INSERTION SORT
2. OPTION FOR MARGE SORT
3. OPTION FOR QUICK SORT
4. OPTION FOR EACH SORT IN BOTH ORDER
5. EXIT

ENTER OPTION TO VIEW:   5

Process returned 0 (0x0)   execution time : 258.576 s
Press any key to continue.
```

OUTPUT DATA REPORT FOR TOTAL COMPARISONS & SWAPS COUNT:

ALGORITHM	NO OF COMPARISONS	NO OF SWAPS
Insertion Sort		
Merge Sort		
Quick Sort		

RESULTS

We have used C programming language for that assignment completions. Which has given the ultimate result for Insertion Sort, Merge Sort & Quick Sort using their algorithm & pseudo codes. After that we have sorted the given input array [101-200] in Ascending ,Descending & also Randomize options too.

CONCLUSION

1. **Insert sort** is more efficient than bubble sort and selection sort.In this algo we divide the entire array into parts; the sorted array and the unsorted array.With every iteration we have to place the first element of the unsorted array in the correct position of the sorted array and increase the sorted list by one.

   Time Complexity:

   when elements are sorted there are no swaps and the correct position of the element in the sorted list is the current index itself.The time complexity is : **O(n**)

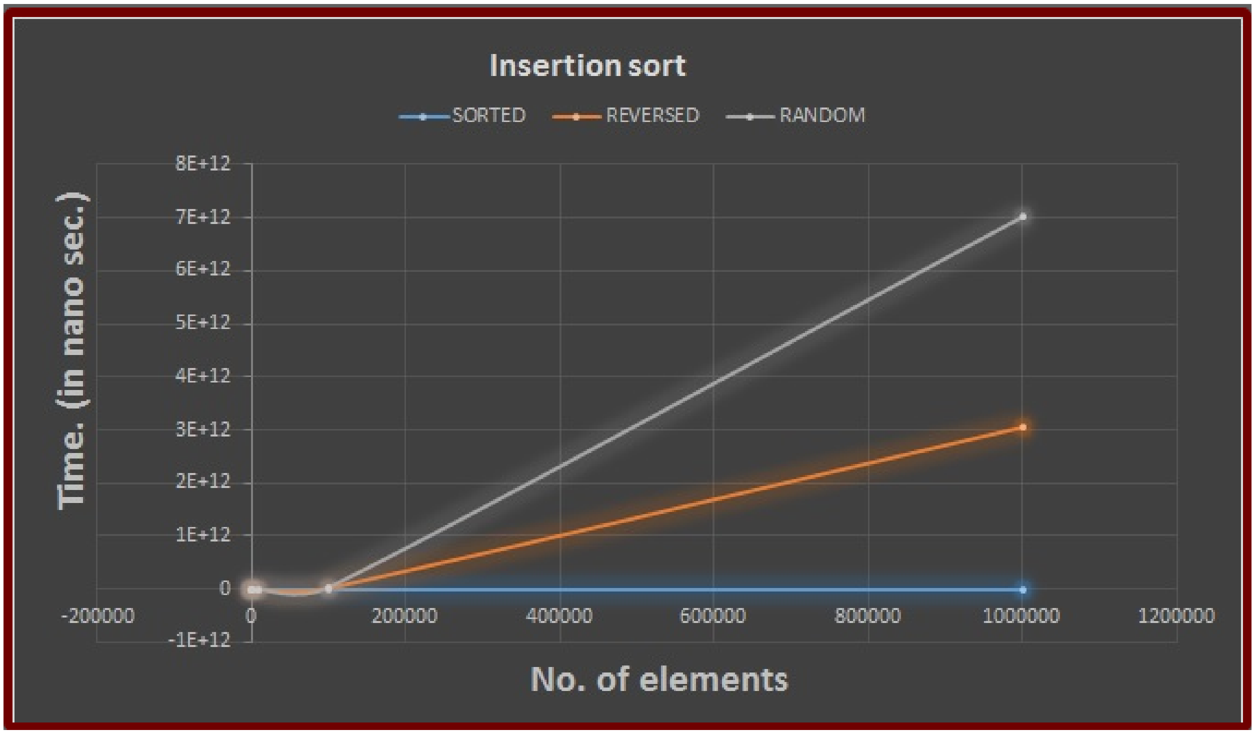
Insertion sort gets penalized if comparison or copying is slow. In other words, the maximum array size which is faster to sort with insertion sort compared to O(*n*log*n*) algorithms gets smaller if comparison or copying of the array elements is slow.

Divide and Conquer Approach-

In this approach the algorithm is divide into multiple sub-problems.Each of these sub-problems is then solved separately and the solution of each sub-problem is used to solve the original problem.

Divide and conquer technique uses recursion to solve each of the sub-problem.

Fig : Insertion Sort Time Complexity



2. **Merge sort** uses the divide and conquer approach.It is one of the most efficient algo for sorting.In this algo,we divide the list into two from the middle and keep dividing the list until the sub-problems has only one element list.

   We then merge the list and while merging the list we sort them in the ascending order.

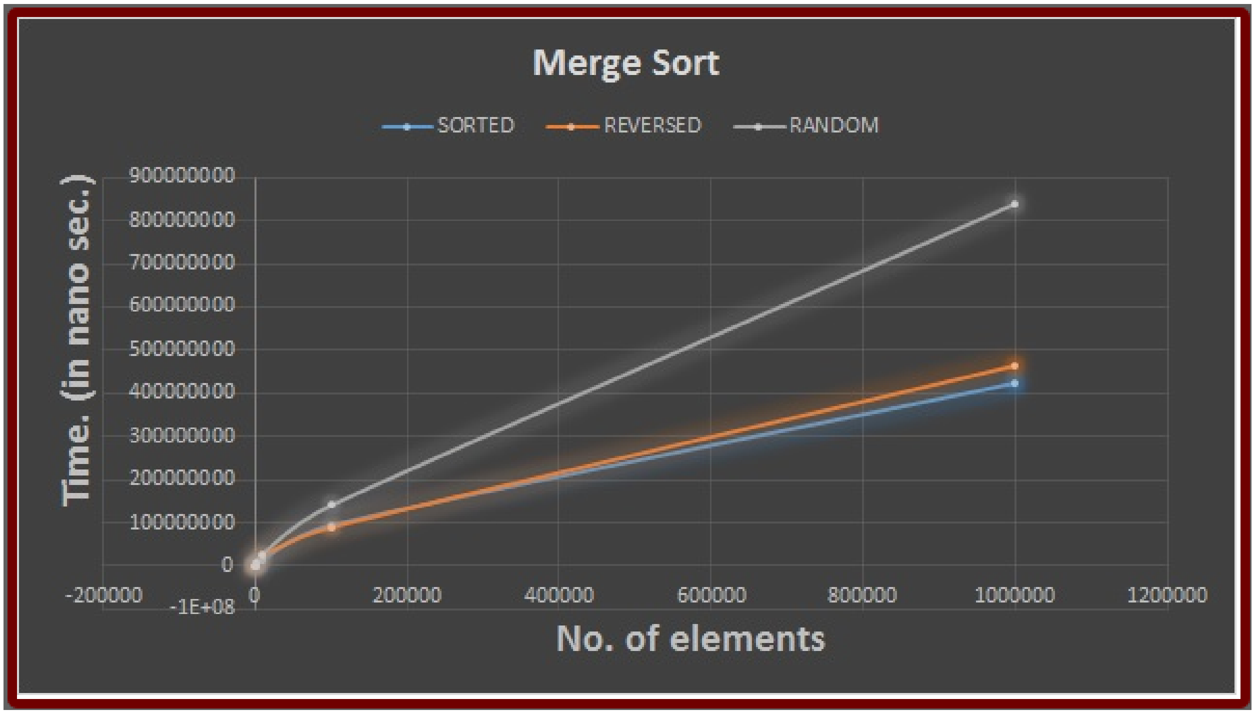
   Time complexity:

   We are dividing the list into no matter if the list is sorted or no.But if the array is sorted,while merging the list there are no swaps merging results into an array itself.Thus, the best ,average and worst case time complexity is: O(nlogn)

   Surprisingly fast, at least with the optimizations used in this test (ie. the sorting function doesn't need to allocate the secondary array each time it is called). Given that it is always O(*n*log*n*), it is a very good alternative if the extra memory requirement is not a problem.

   Array elements with fast comparisons and slow copying seem to slightly penalize merge sort.

   Fig: Merge Sort Time Complexity



3. **Quick sort** uses the similar approach of divide and conquer technique

   In this technique, element is selected which is the pivot element.Now the element which are less than the pivot are placed to the left of the array and the element which are more than the pivot are placed to the right of the pivot.The index of the pivot element is then returned back to the function.The same function is called to the sub-array left to the pivot which has all the elements less than the pivot and also to the right of the sub-array which has the elements more than the pivot.

   After calling the function recursively,the resulting function will be a sorted array.

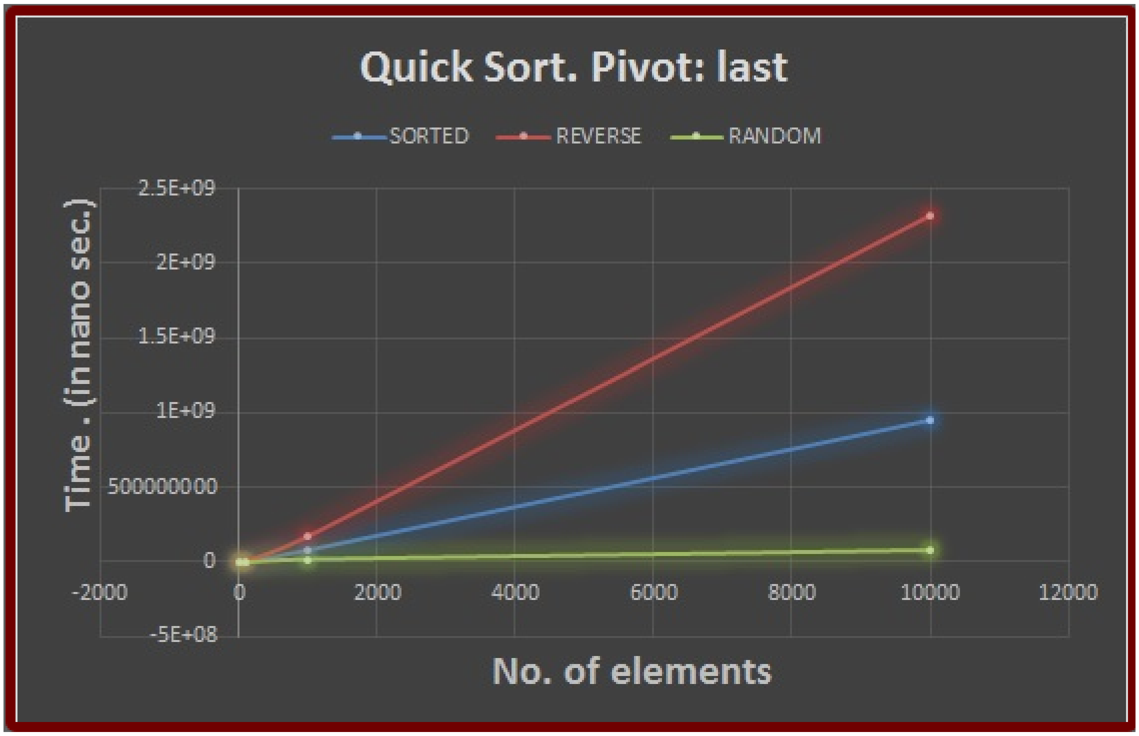
   Time complexity:

   The **best case** is when the elements are in a sorted manner. The best and average case time complexity is : **O(nlogn**)

   The **worst case** time complexity is when the elements are in a reverse sorted manner.The time complexity is :**O(n2)**

   In this Quick Sort,the last element in the list is taken as the pivot element.This Quick Sort is a bit slow as compared to other approaches of Quick Sort.

Fig: Quick Sort Time Complexity



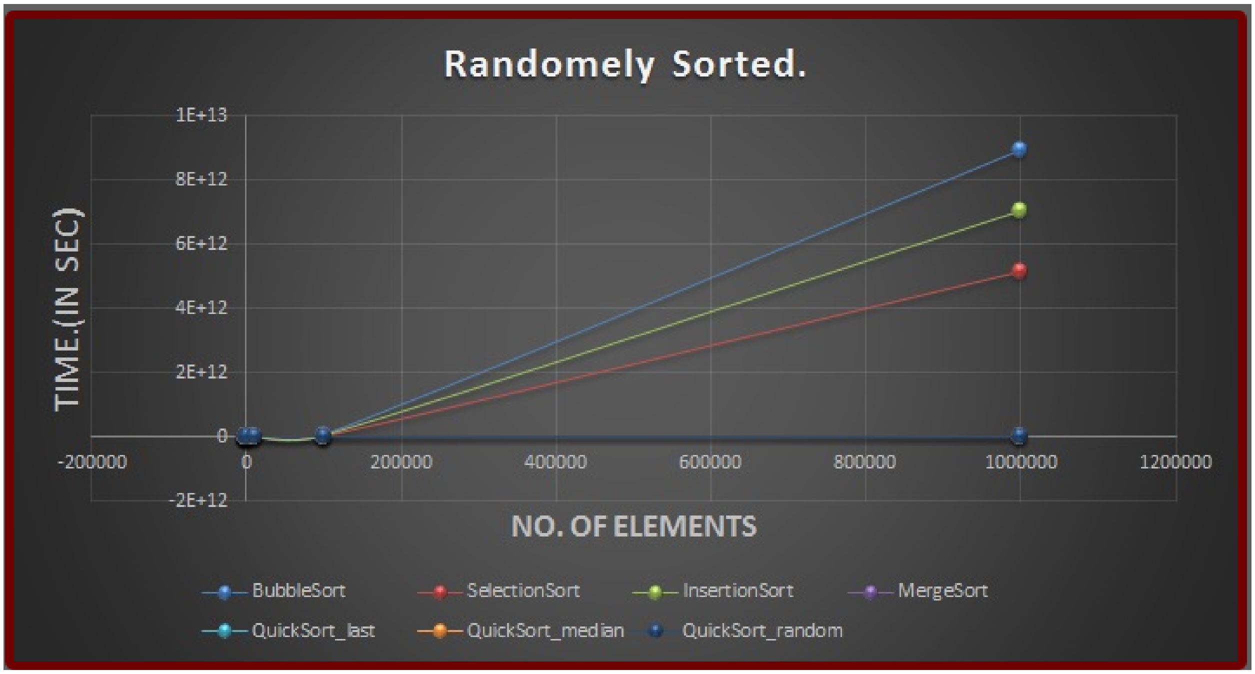
4. For **Random sort** approach,Most of the times this is going to be the approach since we are going to sort random number elements

   Other sort,should never be employed.They take hours to sort a million elements.We can see that by the readings provided in the zip file of the assignment 5 folder.

   Merge sort performs very well for this sort.It should be employed.

   Also the quick sort algorithm performs very well for a million elements.All three approaches of quick sort are pretty fast and any of them can be employed.However,if one requires very good efficiency,he should use Quicksort pivot-median approach.

Fig: Random Sort Time Complexity



REFERENCES

1. Class Lectures & Pseudo-Code
2. Stack Overflow
3. GeeksforGeeks
4. Others Blog Sites
5. Books Help