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| **SUBJECT** | Design and Analysis of Algorithms |
| **EXPERIMENT NO:** | 2(B) |
| **AIM:** | Understanding more concepts regarding quick sort algorithm and display the swaps. |
| **Algorithm:** | **Quick Sort Algorithm**  partition (arr[], low, high)  { // pivot (Element to be placed at right position)  pivot = arr[high];  i = (low – 1) // Index of smaller element and indicates the  // right position of pivot found so far  for (j = low; j <= high- 1; j++){  // If current element is smaller than the pivot  if (arr[j] < pivot){  i++; // increment index of smaller element  swap arr[i] and arr[j]  }  }  swap arr[i + 1] and arr[high])  return (i + 1)  }  quickSort(arr[], low, high) {  if (low < high) {  /\* pi is partitioning index, arr[pi] is now at right place \*/  pi = partition(arr, low, high);  quickSort(arr, low, pi – 1); // Before pi  quickSort(arr, pi + 1, high); // After pi  } |
| **Code:** | #include <stdio.h>  #include <stdlib.h>  #include <time.h>  long SWAP = 0;  void merge(int arr[], int p, int q, int r) {  int i, j, k;  int n1 = q - p + 1;  int n2 = r - q;  int L[n1], R[n2];  for (i = 0; i < n1; i++)  L[i] = arr[p + i];  for (j = 0; j < n2; j++)  R[j] = arr[q + 1 + j];  i = 0;  j = 0;  k = p;  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);  }  }  int quicksort(int a[], int start, int end) {  int pivot = a[end];  //int pivot = a[start];  //int random = start + rand() % (end - start);  //int pivot = a[random];  //int mid = start + (end - start)/2;  //int pivot = a[mid];  int i = (start - 1);  for (int j = start; j <= end - 1; j++) {  if (a[j] < pivot) {  i++;  int t = a[i];  a[i] = a[j];  a[j] = t;  SWAP++;  }  }  int t = a[i + 1];  a[i + 1] = a[end];  a[end] = t;  SWAP++;  return (i + 1);  }  double quick(int a[], int start, int end) {  if (start < end) {  int p = quicksort(a, start, end);  quick(a, start, p - 1);  quick(a, p + 1, end);  }  }  int main() {  double qust, mest;  srand(time(0));  FILE \* fp, \* file;  fp = fopen("random.txt", "w");  for (int i = 0; i < 100000; i++) {  fprintf(fp, "%d\n", rand() % 900001 + 100000);  }  int upper\_limit = 100;  fclose(fp);  file = fopen("outputEnd.txt", "w");  fprintf(file, "Block\tMerSort\tQuickSort\tSwaps\n");  for (int i = 0; i < 1000; i++) {  fp = fopen("random.txt", "r");  int arr1[upper\_limit], arr2[upper\_limit], temp\_num;  for (int j = 0; j < upper\_limit; j++) {  fscanf(fp, "%d", & temp\_num);  arr1[j] = temp\_num;  arr2[j] = temp\_num;  }  fclose(fp);  clock\_t t;  t = clock();  mergeSort(arr2, 0, upper\_limit - 1);  t = clock() - t;  mest = ((double) t) / CLOCKS\_PER\_SEC;  clock\_t t1;  t1 = clock();  qust = quick(arr1, 0, upper\_limit - 1);  t1 = clock() - t1;  qust = ((double) t1) / CLOCKS\_PER\_SEC;  fprintf(file, "%d\t%lf\t%lf\t%ld\n", i + 1, mest, qust, SWAP);  fflush(stdout);  upper\_limit += 100;  }  return 0;  } |
| **Graphs and Observation:** | **Running time comparison for Different Pivot Positions**     * Here, we can see that the time complexity of quick sort is nearly the same even when varied pivot points are taken into account. * We can see that a quick sort when the pivot is at a random position takes longer than when the pivot is in an end position at the conclusion of execution. * Despite the fact that both executions are finished in 0.1 seconds.   **Number of swaps considering different pivot positions**     * We can see from this that fewer swaps are needed for a quick sort when the pivot is in a random position as opposed to when it is at the end. * The average number of swaps is over 500,000,000. * Throughout the entire execution, the number of swaps keeps rising. |
| **Conclusion:** | Thus, we have provided observations for different pivots for quick sort algorithms and given the swap count. |