Implement static methods **Partition** and **QuickSort** in class Sorting to sort an array in ascending order.

```
#ifndef SORTING_H
#define SORTING_H
#include <sstream>
#include <iostream>
#include <type_traits>
using namespace std;
template <class T>
class Sorting {
private:
    static T* Partition(T* start, T* end) ;
public:
    static void QuickSort(T* start, T* end) ;
};
#endif /* SORTING_H */
```

You can read the pseudocode of the algorithm used to in method Partition in the below image.

ALGORITHM *HoarePartition*$(A[l..r])$

```
//Partitions a subarray by Hoare's algorithm, using the first element
//        as a pivot
//Input: Subarray of array A[0..n − 1], defined by its left and right
//        indices l and r (l < r)
//Output: Partition of A[l..r], with the split position returned as
//        this function's value
p ← A[l]
i ← l; j ← r + 1
repeat
    repeat i ← i + 1 until A[i] ≥ p
    repeat j ← j − 1 until A[j] ≤ p
    swap(A[i], A[j])
until i ≥ j
swap(A[i], A[j])   //undo last swap when i ≥ j
swap(A[l], A[j])
return j
```

Implement static methods **Merge** and **MergeSort** in class Sorting to sort an array in ascending order. The Merge method has already been defined a call to method printArray so you do not have to call this method again to print your array.

```
#ifndef SORTING_H
#define SORTING_H
#include <iostream>
using namespace std;
template <class T>
class Sorting {
public:
    /* Function to print an array */
    static void printArray(T *start, T *end)
    {
        long size = end - start + 1;
        for (int i = 0; i < size - 1; i++)
            cout << start[i] << ", ";
        cout << start[size - 1];
        cout << endl;
    }

    static void merge(T* left, T* middle, T* right){
        /*TODO*/
        Sorting::printArray(left, right);
    }
    static void mergeSort(T* start, T* end) {
       /*TODO*/
    }
};
#endif /* SORTING_H */
```

The best way to sort a singly linked list given the head pointer is probably using merge sort.

Both Merge sort and Insertion sort can be used for linked lists. The slow random-access performance of a linked list makes other algorithms (such as quick sort) perform poorly, and others (such as heap sort) completely impossible. Since worst case time complexity of Merge Sort is O(nLogn) and Insertion sort is O(n^2), merge sort is preferred.

Additionally, Merge Sort for linked list only requires a small constant amount of auxiliary storage.

To gain a deeper understanding about Merge sort on linked lists, let's implement **mergeLists** and **mergeSortList** function below

Constraints:

0 <= list.length <= 10^4
0 <= node.val <= 10^6

Use the nodes in the original list and don't modify ListNode's val attribute.

```
struct ListNode {
    int val;
    ListNode* next;
    ListNode(int _val = 0, ListNode* _next = nullptr) : val(_val), next(_next) { }
};

// Merge two sorted lists
ListNode* mergeSortList(ListNode* head);

// Sort an unsorted list given its head pointer
ListNode* mergeSortList(ListNode* head);
```

Implement static methods **merge, InsertionSort** and **TimSort** in class **Sorting** to sort an array in ascending order.

merge is responsible for merging two sorted subarrays. It takes three pointers: start, middle, and end, representing the left, middle, and right portions of an array.

InsertionSort is an implementation of the insertion sort algorithm. It takes two pointers, start and end, and sorts the elements in the range between them in ascending order using the insertion sort technique.

TimSort is an implementation of the TimSort algorithm, a hybrid sorting algorithm that combines insertion sort and merge sort. It takes two pointers, start and end, and an integer min_size, which determines the minimum size of subarrays to be sorted using insertion sort. The function first applies insertion sort to small subarrays, prints the intermediate result, and then performs merge operations to combine sorted subarrays until the entire array is sorted.

```
#ifndef SORTING_H
#define SORTING_H
#include <sstream>
#include <iostream>
#include <type_traits>
using namespace std;
template <class T>
class Sorting {
private:
    static void printArray(T* start, T* end)
    {
        int  size = end - start;
        for (int i = 0; i < size - 1; i++)
            cout << start[i] << " ";
        cout << start[size - 1];
        cout << endl;
    }

    static void merge(T* start, T* middle, T* end) ;
public:
    static void InsertionSort(T* start, T* end) ;
    static void TimSort(T* start, T* end, int min_size) ;
};
#endif /* SORTING_H */
```

A hotel has m rooms left, there are n people who want to stay in this hotel. You have to distribute the rooms so that as many people as possible will get a room to stay.
However, each person has a desired room size, he/she will accept the room if its size is close enough to the desired room size.
More specifically, if the maximum difference is k, and the desired room size is x, then he or she will accept a room if its size is between x - k and x + k
Determine the maximum number of people who will get a room to stay.

input:
vector<int> rooms: rooms[i] is the size of the ith room
vector<int> people: people[i] the desired room size of the ith person
int k: maximum allowed difference. If the desired room size is x, he or she will accept a room if its size is between x - k and x + k

output:
the maximum number of people who will get a room to stay.

Note: The iostream, vector and algorithm library are already included for you.

Constraints:
1 <= rooms.length, people.length <= 2 * 10^5
0 <= k <= 10^9
1 <= rooms[i], people[i] <= 10^9

Example 1:

Input:
rooms = {57, 45, 80, 65}
people = {30, 60, 75}
k = 5
Output:
2

Explanation:
2 is the maximum amount of people that can stay in this hotel.
There are 3 people and 4 rooms, the first person cannot stay in any room, the second and third person can stay in the first and third room, respectively

Example 2:

Input:
rooms = {59, 5, 65, 15, 42, 81, 58, 96, 50, 1}
people = {18, 59, 71, 65, 97, 83, 80, 68, 92, 67}
k = 1000
Output:
10

Given a list of distinct unsorted integers nums.

Your task is to implement a function with following prototype:

```
int minDiffPairs(int* arr, int n);
```

This function identify and return all pairs of elements with the smallest absolute difference among them. If there are multiple pairs that meet this criterion, the function should find and return all of them.

Note: Following libraries are included: iostream, string, algorithm, sstream

For example:

Test	Result
`int arr[] = {10, 5, 7, 9, 15, 6, 11, 8, 12, 2};` `cout << minDiffPairs(arr, 10);`	(5, 6), (6, 7), (7, 8), (8, 9), (9, 10), (10, 11), (11, 12)
`int arr[] = {10};` `cout << minDiffPairs(arr, 1);`	
`int arr[] = {10, -1, -150, 200};` `cout << minDiffPairs(arr, 4);`	(-1, 10)

Print the elements of an array in the decreasing frequency order while preserving the relative order of the elements.

Students are not allowed to use map/unordered map.

iostream, algorithm libraries are included.

For example:

Test	Result

`int arr[] = {-4,1,2,2,-4,9,1,-1};`
`int n = sizeof(arr) / sizeof(arr[0]);`
 	
`sortByFrequency(arr, n);`
 	
`for (int i = 0; i < n; i++)`
`  cout << arr[i] << " ";`
	-4 -4 1 1 2 2 9 -1

`int arr[] = {-5,3,8,1,-9,-9};`
`int n = sizeof(arr) / sizeof(arr[0]);`
 	
`sortByFrequency(arr, n);`
 	
`for (int i = 0; i < n; i++)`
`  cout << arr[i] << " ";`
	-9 -9 -5 3 8 1

Given a list of points on the 2-D plane (**points[]** with **n** elements) and an integer **k**. Your task in this exercise is to implement the **closestKPoints** function to find K closest points to the given point (**des_point**) and print them by descending order of distances.

Prototype of `closestKPoints`:

```
void closestKPoints(Point points[], int n, Point& des_point, int k);
```

Note: The distance between two points on a plane is the Euclidean distance.

Template:

```
#include <iostream>
#include <string>
#include <cmath>
#include <vector>
#include <algorithm>

using namespace std;

class Point{
   public:
   int x, y;
   Point(int x = 0, int y = 0){
      this->x = x;
      this->y = y;
   }
   void display(){
      cout << "("<<x<<", "<<y<<")";
   }
};
```