# C++ Programming: Exam Variant 2 (Exam-2017-05-28)

Solutions for each task will be submitted in the form of compressed archive (.zip) files, containing .h and .cpp files.

Please be mindful of the strict input and output requirements for each task, as well as any additional requirements on running time, used memory, etc., as the tasks are evaluated automatically and not following the requirements strictly may result in your program’s output being evaluated as incorrect, even if the program’s logic is mostly correct.

For some of the tasks in this exam you are provided with files, which the Judge system places in your submitted solution. These files are the so-called "Solution Skeleton" and, depending on the task, may require you to write specific code for your solution to work (e.g. a Solution Skeleton may contain a file with the main() function defined, in which case your task will usually be to implement a class or function in another file, for the program to work correctly). DO NOT attempt to edit the Solution Skeleton files – the Judge system overwrites any files from the skeleton you submit, so it won’t see your changes to them. Some tasks may contain additional files you can use (and edit) if you want – if so, this will be described explicitly in the task.

You can use C++03 and C++11 features in your code.

Unless explicitly stated, any integer **input** fits into int and any floating-point **input** can be stored in double.

## Task 2 – IndexedSet (E2-Task-2-IndexedSet)

You are tasked with implementing methods for an IndexedSet class. An indexed set works just like a normal std::set, but also keeps an array of the sorted elements and can access the ith element immediately. For example, to get the 5th element of a normal std::set you need to run a for loop 5 iterations from the begin() of the set – the IndexedSet supports the operator[] and you can directly ask for the 5th element, retrieving it in constant time i.e. O(1), just like with an array/vector.

To work fast, the IndexedSet doesn’t constantly update the sorted array – it does a so-called “lazy-initialization” of the sorted array, creating it only when it is needed and clearing it when the IndexedSet is modified. More formally:

* The first time operator[] is called, the sorted array is built
* If operator[] is called and the sorted array exists, it is used without being rebuilt. If it doesn’t exist (or is empty – implementations can vary), it is rebuilt and then used.
* If the IndexedSet is modified, the sorted array is cleared, so that the next operator[] call will rebuild it to match the current contents of the IndexedSet

You are given a skeleton containing the declaration of an IndexedSet class and its members. You need to implement the IndexedSet class in a new IndexedSet.cpp file:

* Fields std::set<Value> valueSet and Value \* valuesArray represent the actual set and the sorted array of the set’s elements, correspondingly
* IndexedSet() – constructs an empty IndexedSet
* IndexedSet(const IndexedSet& other) – copy-constructs IndexedSet
* void add(const Value& v) – adds an element to the IndexedSet (and clears the sorted array, so that the next call to operator[] will rebuild it)
* size\_t size() const – returns the size of the set (the number of elements)
* const Value& operator[](size\_t index) – returns a const reference to the element at the given index (and constructs the sorted array, if necessary, as described above). *Hint: don’t worry about* const*, just return the value at that position in the array*
* IndexedSet& operator=(const IndexedSet& other) – copy-assigns IndexedSet
* ~IndexedSet() – destructs IndexedSet (only necessary to clear the sorted array)
* buildIndex() and clearIndex() are intended as helper methods you can define to create and clear the sorted array – they aren’t used in external code, so you can chose whether you want to implement them

The skeleton also contains the main.cpp file, which defines the main() function. The program in main.cpp reads a series of arrays from the console, then reads a line of indices from the console. It then finds the array, for which the sum of the indices (read last from the console) of its elements – when the elements are sorted and the duplicates removed – is the maximum of the given arrays, and prints it in that form (sorted with duplicate values removed). To do that, it uses the IndexedSet.

For example, given the following arrays:  
1 1 7 2 7 3 1  
4 12 2 8 8  
5 6 5 1 1 1   
and the indices 0 and 2, the program will sort and remove duplicates from the arrays:  
1 2 3 7  
2 4 8 12  
1 5 6  
and will print the result 2 4 8 12, because that array has the maximum sum of the indices 0 and 2 (the sum is 2 + 8 = 10, which is bigger than both 1 + 3 and 1 + 6 for the other two arrays). The program uses IndexedSet to get a representation of the sorted arrays with removed duplicates.

### Input

The program defined in main.cpp reads the following input:

One or more lines from the standard input, containing the input arrays, ending with a line containing the string end. Then one more line containing the indices, which will be used for the sums for determining the output array.

### Output

The program defined in main.cpp writes the following output:

The sorted array with duplicates removed, which has the highest sum of the indices defined in the input (the sum is calculated after the array is sorted and its duplicates are removed).

### Restrictions

There will be between 1 and 50 (inclusive) arrays in the input. Each array will have no more than 2000 elements, and each of its elements will be a value between 0 and 2000 (inclusive).

There will be between 1 and 5000 indices in the input. No index will be larger than the number of elements in the smallest array after all its duplicate elements have been removed. That is, there is no need to add range checks and validation logic to the IndexedSet class.

The total running time of your program should be no more than 0.3s

The total memory allowed for use by your program is 8MB

### Submission Instructions

Submit only a single file – IndexedSet.cpp, containing the implementation of the IndexedSet class, as declared in IndexedSet.h.

### Example I/O

|  |  |
| --- | --- |
| Example Input | Expected Output |
| 5 1 3 7 9 3 2 1 4  12 10 9 8  10 100 15 2 3 4  end  0 1 2 | 8 9 10 12 |
| 1 1 1 2 3 2  1 1 3 3 3  end  1 1 1 1 | 1 3 |