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Group 1

Task

Implement the set type which contains integers. Represent the set as a sequence of its elements. Implement as methods: inserting an element, removing an element, returning whether the set is empty, returning whether the set contains an element, returning a random element without removing it from the set, returning the largest element of the set (suggestion: store the largest entry and update it when the set changes), printing the set

Set type

Set of values

$Set(n) = \{ a \in \mathbb{Z}^n \mid \forall i,j \in [1..n]: \nexists\, i \neq j \rightarrow a[i] = a[j] \}$

Operations

1. Inserting an element
This function asks you which element you want to add. a.InsertElement(e)

Formally: $A : Set(n) \times \mathbb{Z}$
$a \quad e$
$Pre = (a=a' \wedge e=e')$
$Post = (Pre \wedge (\forall i \in [1..n] \rightarrow a[i] \neq e) \rightarrow a:=a+e)$

This operation will check if inserted element is already existing in set or not. If such element doesn't exist, the element will be inserted. If exists then it will give error that inserted element is already in set.

2.Removing an element
When you run this function it asks you which element you want to remove. a.RemoveElement(e)

Formally: $A = Set(n) \times \mathbb{Z}$
$a \quad e$
$Pre = (a = a' \wedge e=e')$
$Post = ((\exists\, i \in [1..n] \rightarrow a[i] = e) \rightarrow a:=a-e)$

If the inserted element is not in the set it will give error message that the inserted element doesn't exist in the set.

3.Returning whether the set is empty
It will check the set, return Boolean function according to number of elements in the set.
a.isEmpty()
Formally: $A = Set(n) \times boolean$
$a \quad b$

Pre = (*a=a'*)
Post = (*Pre* ∧ b := n=0)

If it is Empty it will return the set is empty. Otherwise it will return the set is not empty

4.Returning whether the set contains an element
This operation will ask you an element you want to search for. a.isContain(c)

Formally: $A = Set(n) \times Boolean \times \mathbb{Z}$
$a \quad l \quad c$
Pre = (*a=a'* ∧ *c=c'*)
Post = (*Pre* ∧ l:= ∃ i ∈[1..n] → a[i] = c)
If the element exists in the set it will return true. On the contrary false is the answer.

5. Returning a random element without removing it from the set
This operation will return random element from the set. a.RandomElement()

Formally: $A = Set(n) \times \mathbb{Z}$
$a \quad c$
Pre = (*a=a'*)
Post = (*Pre* ∧ ∀i ∈[1..n]: a[i]=c)
If the Set is empty. It will return error message that the set is empty.

6. Returning the largest element of the set
This operation will return largest element from the set. a.LargestElement()

Formally: $A = Set(n) \times \mathbb{Z}$
$a \quad maxi$
Pre = (*a=a'*)
Post = (*Pre* ∧ maxi= $MAX_{i=1}^{i=n}$ a[i])
If the Set is empty. It will return error message that the set is empty.

7. Printing the set

This operation will print all elements from the set. a.print()

Formally: $A = Set(n)$
a
Pre = (*a=a'*)
Post = (*Pre* ∧ ∀i ∈[1..n](n>=1):e=a[i])
If the Set is empty. It will return error message that the set is empty.

Representation

There is a vector inside of set class. Only unique element exists in the vector.

vec =

a1	a2	a3	a4	a5

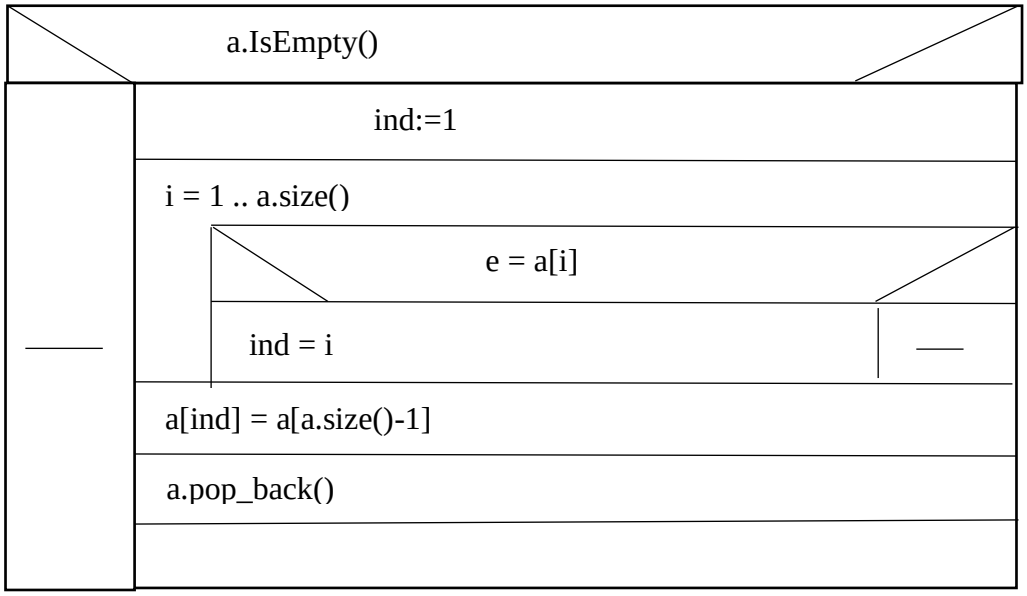
vec = < a1 a2 a3 a4 a5 >

Implementation

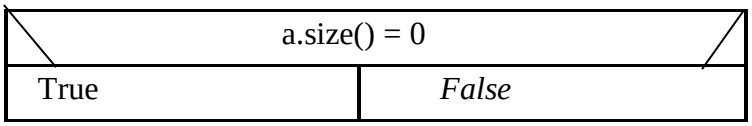
1.Inserting an element
We insert int "e" into Set a with the help of push_back function.

a.push_back(e)

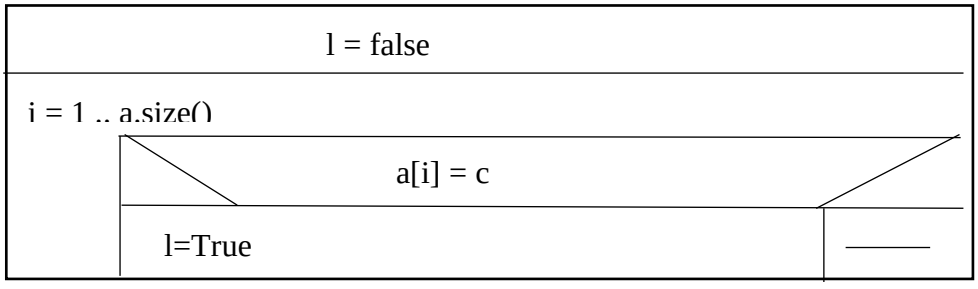
2.Removing an element
When we want to remove element "e" we first find the index of it. Then we swap it With the last element. Then remove the last place.



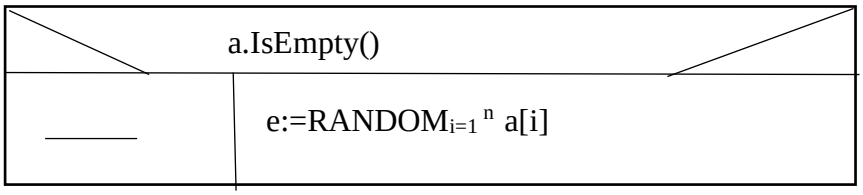
3.Returning whether the set is empty
It will return a Boolean True if a.size() is equal to zero. If not it will return False.



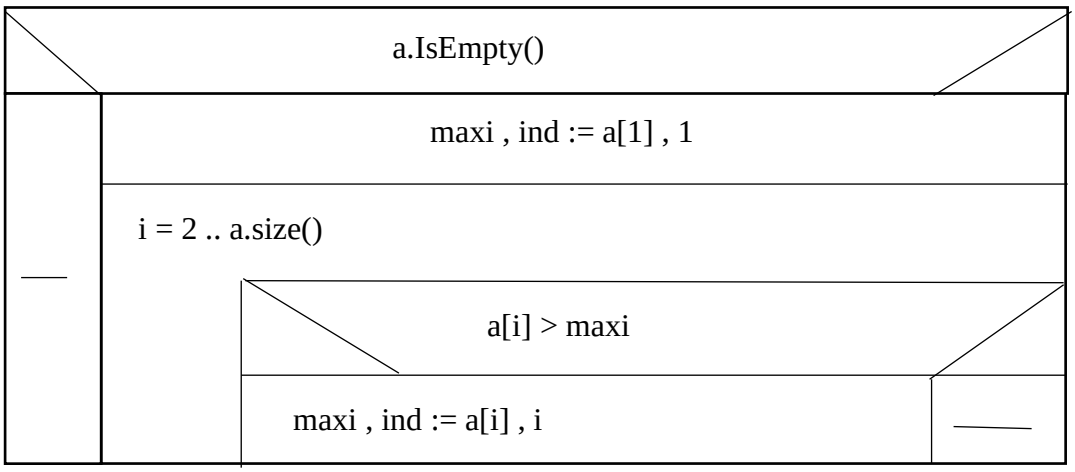
4. Returning whether the set contains an element
Through the for loop it will search for element "c" in the set "a". If it founds it will return True. On the contrary False.



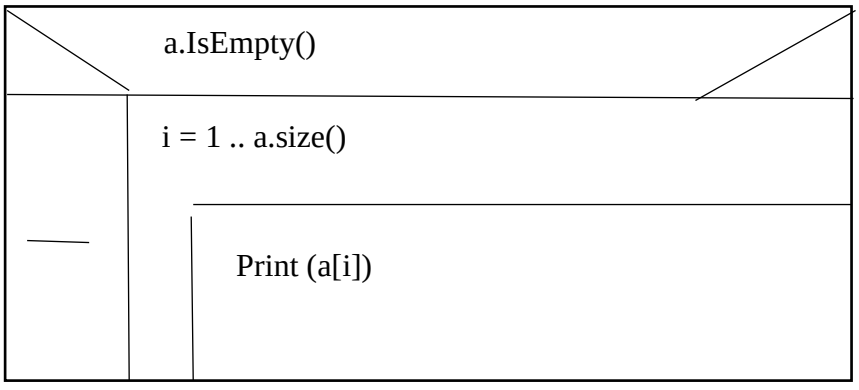
5. *Returning a random element without removing it from the set*
Firstly it will look if there is an element. If yes it will randomly return one of them. If not it will give error messega that the set is empty



6. *Returning the largest element of the set*
Firstly it will look if set is empty or not. If not It will search for the maximum element in the set. And will return that value.

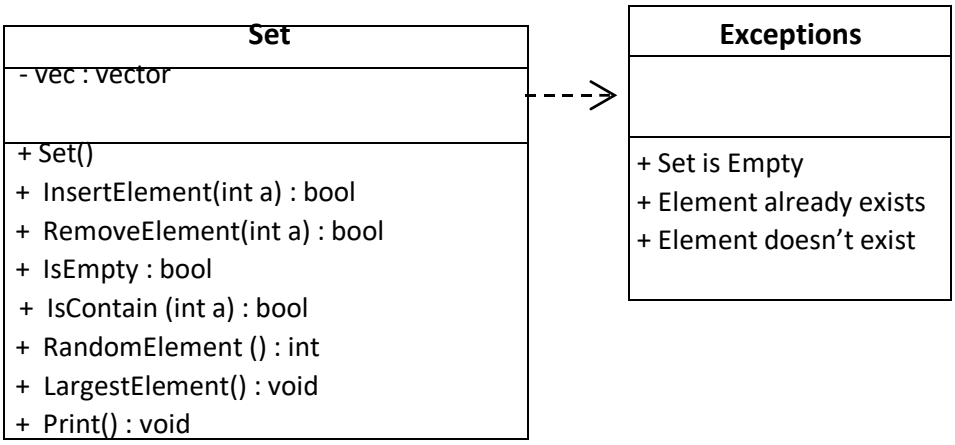


7. *Returning the largest element of the set*
It will print all elements. It will not print element if the set is empty.



Class

The Set type is worked out as a class.



The entries in the set can be represented as a vector<int> or as a dynamic array.

For error handling, three exceptions are defined. `Set is empty` is thrown when you want to remove element from empty set or return largest element when there is no element in the set.

Element already exists is thrown when you want to add element and there is such element in the set already. So you can not add that element. `Element doesn't exist` is thrown when there when you want to remove such element that doesn't contain in the set or you search for that element in the IsContain method. If such element doesn't exist it will throw that message again.

Testing

Testing the operations (black box testing)

1) Inserting element.
   a) I inserted “7” and it was inserted successfully, returned true.
   b) When I inserted “7” again. It will return false. Because such element is already existing.
2) Removing element
   a) When I tried to remove element from an empty set it returns false.
   b) I inserted element 2. And removed 2 again. It return true.
   c) I inserted 3 , but removed 4. It returns false. Because such element doesn’t exist in the set.
3) Is Set Empty
   a) I checked the set when it is empty it returns true.
   b) I inserted element and checked again it returns false
4) Is Set Contain an element
   a) I inserted element “2” and checked if that element contains or not. It gave me true.
   b) I inserted element “2” and checked if “3” contains in the set. It returned false
5) Random Element
   a) When the set is empty it will return “-1”.
   b) When I inserted element “2”, it gave me that element because that element is the only element that exists in the set

6)Largest element

a) I inserted element “22” and run this function. It gave me 22 which is true.

b)I added “33” to the set and checked this function again. The largest element in the set was shifted form 22 to 33.