CSP2348/CSP5243 Data Structures

Solutions to Tutorial 11: - Abstract Data Types (ADTs) (3): Sets and Maps

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Tasks:

Complete the following.

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Task 1: Set theoretical operations

Let A = {1, 2, 3, 4, 5}, B = {4, 5, 6, 7}, and C = {2, 3, 4}, attempt the following set operations:

(1) A ∪ B
(2) A ∩ B
(3) A – B
(4) B – A
(5) C – A
(6) the relationship between A and C.

Answers:

A ∪ B = {1, 2, 3, 4, 5, 6, 7}
A ∩ B = {4, 5}
A – B = {1, 2, 3}
B – A = {6, 7}
C – A = {}
A ⊇ C

Task 2: Test the Java implementation of the `TreeSet Class` given in WS1101

(Download the Java code from Blackboard)

a. Notice the invocation of `add()` `first()`, `last()`, `headSet()`, `subSet()`, and `tailSet()` methods provided by the `TreeSet Class`;
b. Execute this program and analyse the results corresponding to individual method invocations in the program.

Executed results

[Australia, Canada, China, Egypt, Greece, India, Oman, Peru, Togo, USA]
countries.first() = Australia
countries.last() = USA
countries.headSet(Australia) = []
countries.subSet(Australia,Canada) = [Australia]
countries.tailSet(Canada) = [Canada, China, Egypt, Greece, India, Oman, Peru, Togo, USA]

Task 3: Test the Java implementation of the `HashSet Class` given in WS1102

(Download the Java code from Blackboard)

a. Notice the invocation of `add()`, `contains()`, and `remove()` methods provided by the `HashSet Class`;
b. Execute this program and analyse the results corresponding to individual method invocations in the program.

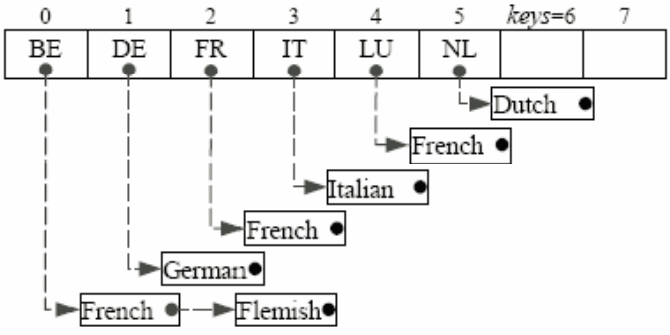
Executed results

```
7 elements: [China, USA, Peru, New Zealand, India, Australia, Canada]
set.contains(Australia) = true
countries.remove("Australia") = true
6 elements: [China, USA, Peru, New Zealand, India, Canada]
set.contains(Australia) = false
6 elements: [China, USA, Peru, New Zealand, India, Canada]
set.contains(Fiji) = false
countries.remove("Fiji") = false
countries.add("Fiji") = true
7 elements: [China, USA, Fiji, Peru, New Zealand, India, Canada]
set.contains(Fiji) = true
countries.add("Fiji") = false
7 elements: [China, USA, Fiji, Peru, New Zealand, India, Canada]
set.contains(Fiji) = true
```

Task 4: A multi-map is similar to a map, except there may be several entries with the same key. How would you represent a multi-map without storing multiple copies of the same key? Use the table given below to illustrate your representations

Country	*Language*
BE	Flemish
BE	French
DE	German
FR	French
IT	Italian
LU	French
NL	Dutch

We can represent a multi-map in the same manner as an ordinary map, except that each key is associated with a *set* of values. The following figures illustrate sorted array, sorted SLL, and BST representations of a multi-map. In each case the set of values associated with a particular key is represented by an unsorted SLL, which is adequate if it can be assumed that multiple entries with the same key will be relatively uncommon.



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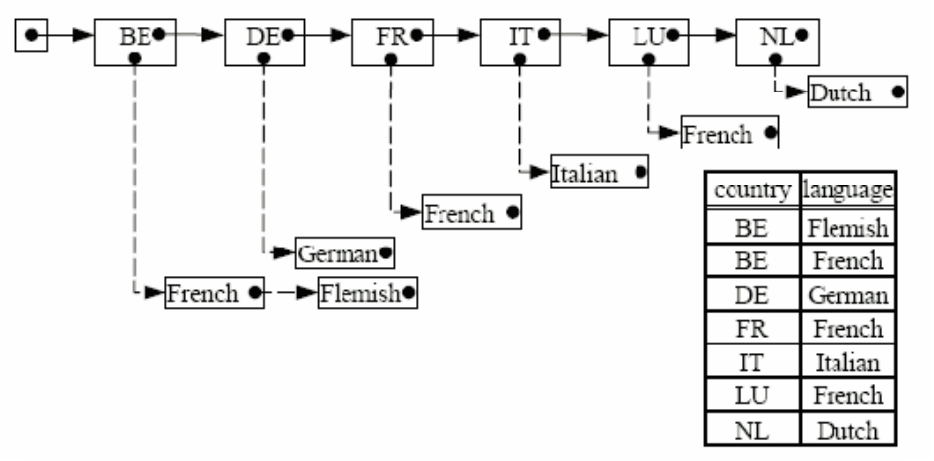

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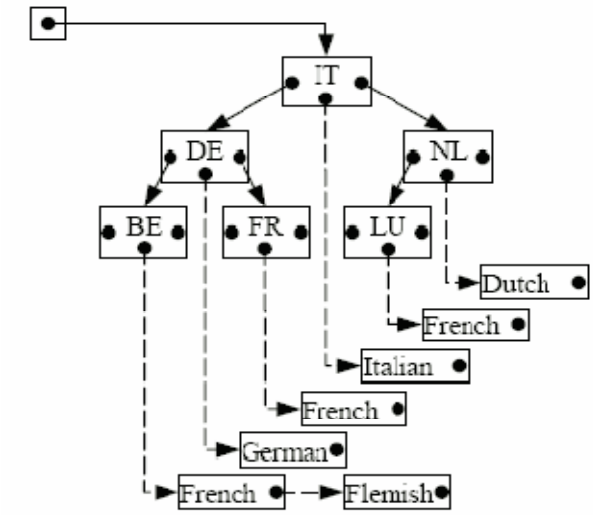

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Task 5: Test the Java implementation of the `HashMap Class` given in WS1103

(Download the Java code from Blackboard)

a. Notice how to build a dictionary using `HashMap Class`
b. Notice the order of the words in this dictionary created using `HashMap Class`.

Executed results

```
map={Tag=day, Rat=advice, counsel, Ohr=ear, Ast=gate, Ost=east, Mal=mark,
signal, Uhr=clock, Zug=procession, train, Wal=whale, Eis=ice, Hof=court,
yard, farm, Lob=praise, Tor=gate, Rad=wheel, Hut=hat, Mut=courage}
map.keySet()=[Tag, Rat, Ohr, Ast, Ost, Mal, Uhr, Zug, Wal, Eis, Hof, Lob,
Tor, Rad, Hut, Mut]
map.size()=16
```

Task 6: Test the Java implementation of the `TreeMap Class` given in WS1004

(Download the Java code from Blackboard)

a. Notice how to build a dictionary using `TreeMap Class`;
b. Notice the order of the words in this dictionary created using `TreeMap Class`;
c. Discuss the difference between the two dictionaries implemented using different classes.

Executed results

```
Ast=gate
Eis=ice
Hof=court, yard, farm
Hut=hat
Lob=praise
Mal=mark, signal
Mut=courage
Ohr=ear
Ost=east
Rad=wheel
Rat=advice, counsel
Tag=day
Tor=gate
Uhr=clock
Wal=whale
Zug=procession, train
```