

**GIT Department of Computer Engineering  
CSE 222/505 - Spring 2022  
Homework 6 Report**

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## **Question 1**

## 1. SYSTEM REQUIREMENTS

### 1.1 Problem Definition

Two hash map class uses KWHashMap interface;

- chaining technique with binary search tree
- double hashing with coalesced hashing

### 1.2 Functional Requirements

Returns the value associated with the key

```
public V get(Object key)
```

Puts the key/value pair in table

```
public V put(K key, V value)
```

Remove key/value pair from table

```
public V remove(Object key)
```

Returns number of entries

```
public int size()
```

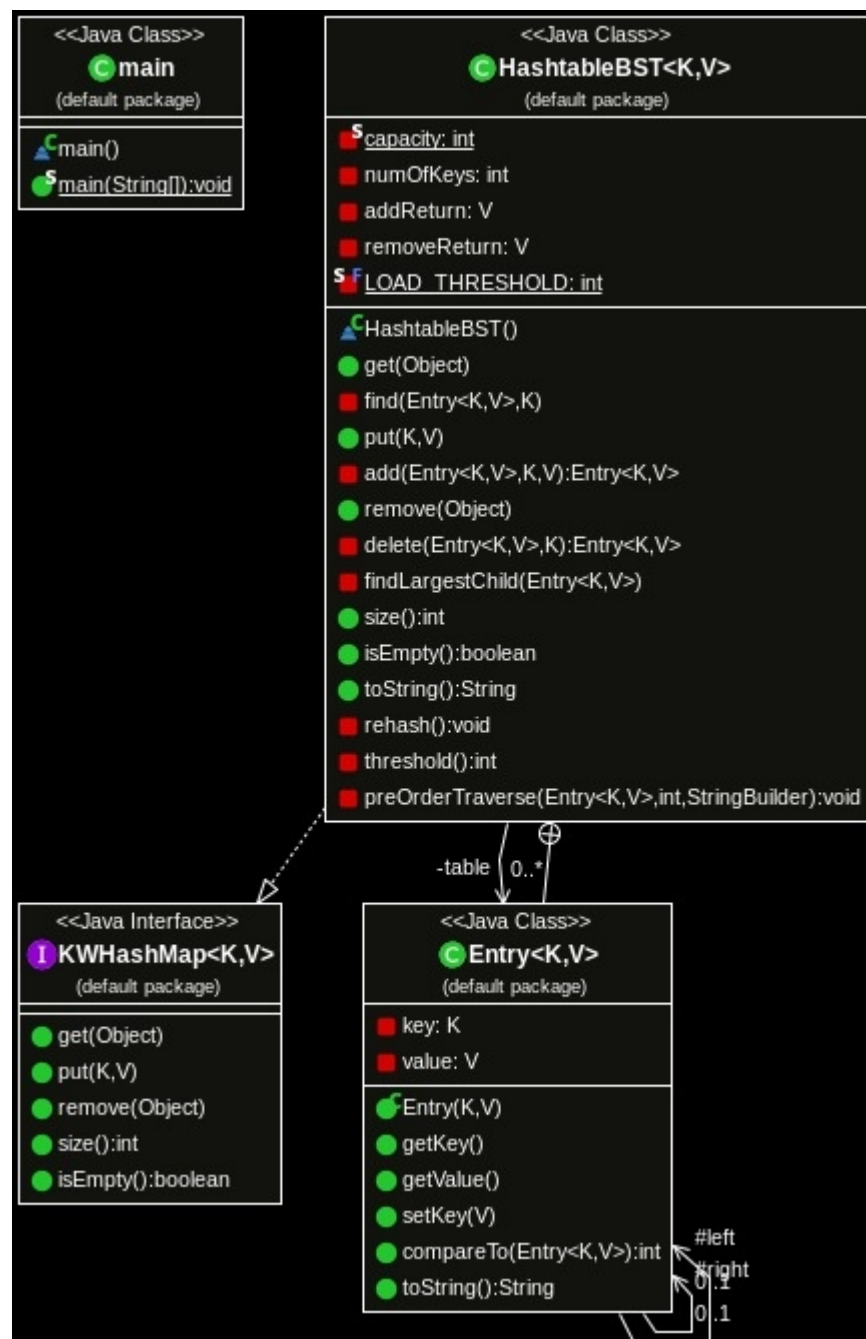
Checks if table is empty

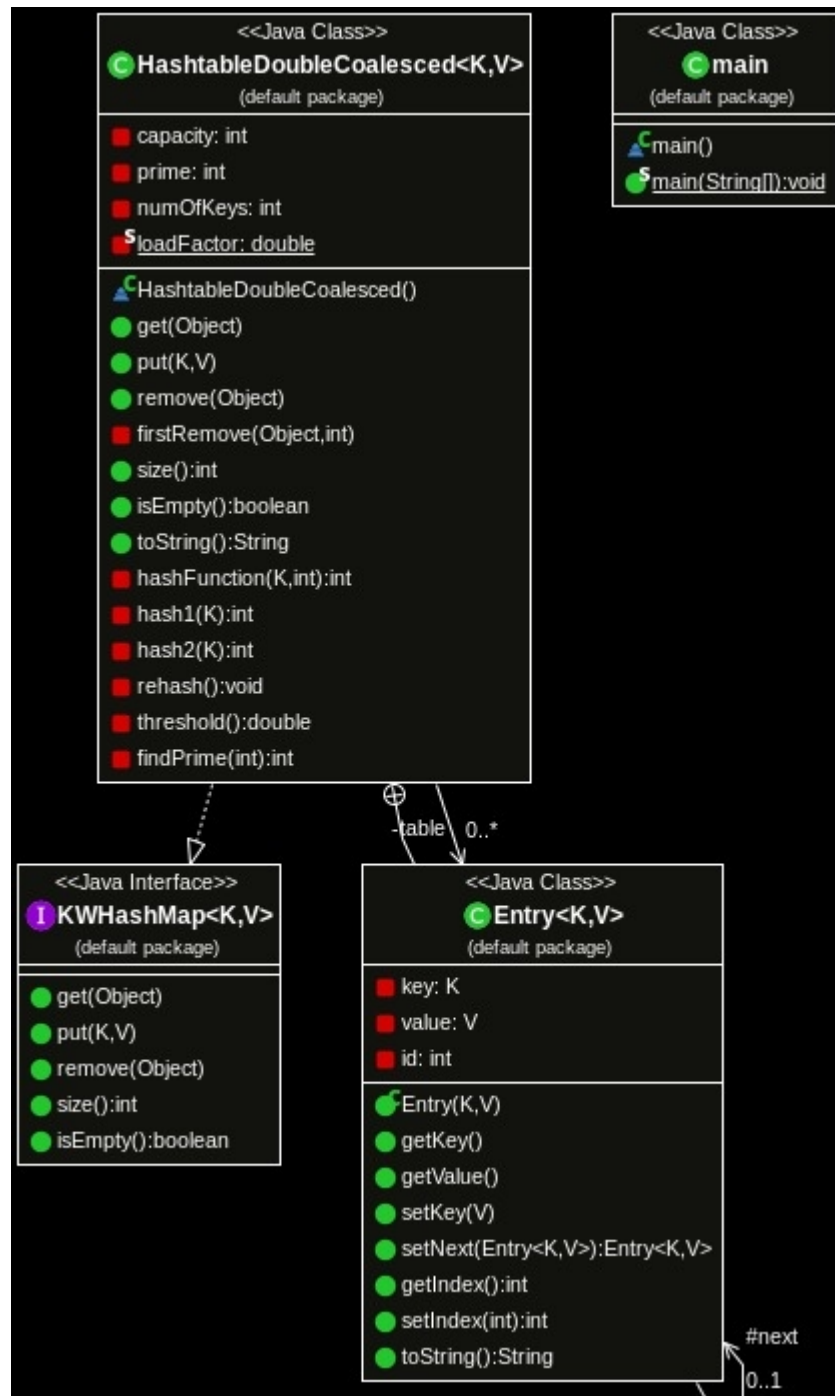
```
public boolean isEmpty()
```

Returns string format of hash table

```
public String toString()
```

## 2. CLASS DIAGRAMS





### 3. TEST CASES

| Test Case  | Expected Result                     | Pass/Fail |
|--|-------------------------------------|-----------|
| Consturct A Hash Table   | Construct A Hash Table              | PASS      |
| Put a key/value pairs  | Put the pairs in the table          | PASS      |
| Using a key on get() function to return the value associated with it | Return true value                   | PASS      |
| Using invalid key on get() function                                  | Return null                         | PASS      |
| Remove a key/pair from table using key on remove() funciton          | Remove the pair from table          | PASS      |
| Invalid table using key on remove() funciton                         | Return null                         | PASS      |
| Number of entires of table   | Return number of entires            | PASS      |
| Check if table is empty with isEmpty() function                      | Return false                        | PASS      |
| Show string representation of table                                  | Show string representation of table | PASS      |

## 4. RUNNING AND RESULTS

### 4.1 HashMapBST

#### ADD TEST

```
Add Key:1 Value: honda
null
honda
null
null
null
null
null
null

Add Key:10 Value: acura
acura
null
null
honda
null
null
null
null
null

Add Key:22 Value: lexus
acura
null
null
honda
null
null
lexus
null
null
null
null

Add Key:33 Value: mazda
acura
null
null
honda
null
null
lexus
null
null
mazda
null
null
null

Add Key:44 Value: subaru
acura
null
null
honda
null
null
lexus
null
null
mazda
null
subaru
null
null

Add Key:55 Value: mitsubishi
acura
null
mitsubishi
null
null
honda
null
null
lexus
null
null
mazda
null
null
subaru
null
null
```

Add Key:66 Value: nissan

```
acura
  null
  mitsubishi
    null
    null
honda
  null
  nissan
    null
    null
lexus
  null
  null
mazda
  null
  null
subaru
  null
  null
```

Add Key:88 Value: suzuki

```
acura
  null
  mitsubishi
    null
    null
honda
  null
  nissan
    null
    null
lexus
  null
  toyota
    null
    null
mazda
  null
  suzuki
    null
    null
subaru
  null
  null
```

Add Key:77 Value: toyota

```
acura
  null
  mitsubishi
    null
    null
honda
  null
  nissan
    null
    null
lexus
  null
  toyota
    null
    null
mazda
  null
  null
subaru
  null
  null
```



## GET TEST

```
Get 0: null
Get 11: null
Get 33: mazda
Get 8: null
Get 7: null
Get 77: toyota
```

## REMOVE TEST

```
Remove 55
  acura
    null
    null
  honda
    null
  nissan
    null
    null
  lexus
    null
    null
  mazda
    null
    null
  suzuki
    null
    null
  subaru
    null
    null
```

```
Remove 1
  acura
    null
    null
  nissan
    null
    null
  lexus
    null
    null
  mazda
    null
    null
  suzuki
    null
    null
  subaru
    null
    null
```

```
Remove 88
  acura
    null
    null
  nissan
    null
    null
  lexus
    null
    null
  mazda
    null
    null
  suzuki
    null
    null
  subaru
    null
    null
```

## 4.2 HashtableDoubleCoalesced

### PUT TESTS

```
Add Key:1 Value: honda      Add Key:22 Value: lexus    Add Key:44 Value: subaru
0 -- null -- null          0 -- 22/lexus -- null     0 -- 22/lexus -- 2
1 -- 1/honda -- null       1 -- 1/honda -- null     1 -- 1/honda -- null
2 -- null -- null          2 -- null -- null        2 -- 33/mazda -- 5
3 -- null -- null          3 -- null -- null        3 -- null -- null
4 -- null -- null          4 -- null -- null        4 -- null -- null
5 -- null -- null          5 -- null -- null        5 -- 44/subaru -- null
6 -- null -- null          6 -- null -- null        6 -- null -- null
7 -- null -- null          7 -- null -- null        7 -- null -- null
8 -- null -- null          8 -- null -- null        8 -- null -- null
9 -- null -- null          9 -- null -- null        9 -- null -- null
10 -- null -- null         10 -- 10/acura -- null    10 -- 10/acura -- null

Add Key:10 Value: acura     Add Key:33 Value: mazda   Add Key:55 Value: mitsubishi
0 -- null -- null          0 -- 22/lexus -- 2        0 -- 22/lexus -- 2
1 -- 1/honda -- null       1 -- 1/honda -- null     1 -- 1/honda -- null
2 -- null -- null          2 -- 33/mazda -- null    2 -- 33/mazda -- 5
3 -- null -- null          3 -- null -- null        3 -- 55/mitsubishi -- null
4 -- null -- null          4 -- null -- null        4 -- null -- null
5 -- null -- null          5 -- null -- null        5 -- 44/subaru -- 3
6 -- null -- null          6 -- null -- null        6 -- null -- null
7 -- null -- null          7 -- null -- null        7 -- null -- null
8 -- null -- null          8 -- null -- null        8 -- null -- null
9 -- null -- null          9 -- null -- null        9 -- null -- null
10 -- 10/acura -- null     10 -- 10/acura -- null    10 -- 10/acura -- null
```

```
Add Key:66 Value: nissan
0 -- 22/lexus -- 2
1 -- 1/honda -- null
2 -- 33/mazda -- 5
3 -- 55/mitsubishi -- 4
4 -- 66/nissan -- null
5 -- 44/subaru -- 3
6 -- null -- null
7 -- null -- null
8 -- null -- null
9 -- null -- null
10 -- 10/acura -- null

Add Key:88 Value: suzuki
0 -- 22/lexus -- 2
1 -- 1/honda -- null
2 -- 33/mazda -- 5
3 -- 55/mitsubishi -- 4
4 -- 66/nissan -- 7
5 -- 44/subaru -- 3
6 -- 88/suzuki -- null
7 -- 77/toyota -- 6
8 -- null -- null
9 -- null -- null
10 -- 10/acura -- null
```

```
Add Key:77 Value: toyota
0 -- 22/lexus -- 2
1 -- 1/honda -- null
2 -- 33/mazda -- 5
3 -- 55/mitsubishi -- 4
4 -- 66/nissan -- 7
5 -- 44/subaru -- 3
6 -- null -- null
7 -- 77/toyota -- null
8 -- null -- null
9 -- null -- null
10 -- 10/acura -- null
```

## GET TESTS

```
Get 0: null
Get 11: null
Get 33: mazda
Get 8: null
Get 7: null
Get 77: toyota
```

## REMOVE TEST

-----Remove test-----

```
0 -- 22/lexus -- 2
1 -- 1/honda -- null
2 -- 33/mazda -- 5
3 -- 55/mitsubishi -- 4
4 -- 66/nissan -- 7
5 -- 44/subaru -- 3
6 -- 88/suzuki -- null
7 -- 77/toyota -- 6
8 -- null -- null
9 -- null -- null
10 -- 10/cura -- null
```

Remove 55

```
0 -- 22/lexus -- 2
1 -- 1/honda -- null
2 -- 33/mazda -- 5
3 -- 66/nissan -- 4
4 -- 77/toyota -- 7
5 -- 44/subaru -- 3
6 -- null -- null
7 -- 88/suzuki -- null
8 -- null -- null
9 -- null -- null
10 -- 10/cura -- null
```

Remove 1

```
0 -- 22/lexus -- 2
1 -- null -- null
2 -- 33/mazda -- 5
3 -- 66/nissan -- 4
4 -- 77/toyota -- 7
5 -- 44/subaru -- 3
6 -- null -- null
7 -- 88/suzuki -- null
8 -- null -- null
9 -- null -- null
10 -- 10/cura -- null
```

Remove 88

```
0 -- 22/lexus -- 2
1 -- null -- null
2 -- 33/mazda -- 5
3 -- 66/nissan -- 4
4 -- 77/toyota -- 7
5 -- 44/subaru -- 3
6 -- null -- null
7 -- null -- null
8 -- null -- null
9 -- null -- null
10 -- 10/cura -- null
```

## REHASH TEST

```
Adding some random number
0 -- 137954437/rehash -- null
1 -- null -- null
2 -- null -- null
3 -- 5648987/rehash -- null
4 -- null -- null
5 -- null -- null
6 -- null -- null
7 -- null -- null
8 -- 77/toyota -- null
9 -- null -- null
10 -- 33/mazda -- 17
11 -- null -- null
12 -- 450109378/rehash -- null
13 -- 1658076752/rehash -- null
14 -- null -- null
15 -- null -- null
16 -- null -- null
17 -- 10/acura -- null
18 -- null -- null
19 -- 1648289568/rehash -- null
20 -- 66/nissan -- null
21 -- 44/subaru -- null
22 -- 22/lexus -- 12
```

# COMPARE

## HashtableDoubleCoalesced

```
Insert 100    random element in hash table take: 477850 nanoTime
Insert 1000   random element in hash table take: 2189291 nanoTime
Insert 10000  random element in hash table take: 19650650 nanoTime

-----
Insert a random element in hash table which have 100    element take: 868 nanoTime
Insert a random element in hash table which have 1000   element take: 791 nanoTime
Insert a random element in hash table which have 10000  element take: 383 nanoTime

-----
accessing existing items at hash table which have 100    element take: 20350 nanoTime
accessing existing items at hash table which have 1000   element take: 9222 nanoTime
accessing existing items at hash table which have 10000  element take: 1510 nanoTime

-----
remove items at hash table which have 100    element take: 2926 nanoTime
remove items at hash table which have 1000   element take: 2345 nanoTime
remove items at hash table which have 10000  element take: 2117 nanoTime

-----
accessing non existing items at hash table which have 100    element take: 1933 nanoTime
accessing non existing items at hash table which have 1000   element take: 1796 nanoTime
accessing non existing items at hash table which have 10000  element take: 1772 nanoTime
```

## HashtableBST

```
Insert 100    random element in hash table take: 509701 nanoTime
Insert 1000   random element in hash table take: 3218424 nanoTime
Insert 10000  random element in hash table take: 6430394 nanoTime

-----
Insert a random element in hash table which have 100    element take: 11098 nanoTime
Insert a random element in hash table which have 1000   element take: 8096 nanoTime
Insert a random element in hash table which have 10000  element take: 1405 nanoTime

-----
accessing existing items at hash table which have 100    element take: 3243 nanoTime
accessing existing items at hash table which have 1000   element take: 2254 nanoTime
accessing existing items at hash table which have 10000  element take: 1878 nanoTime

-----
remove items at hash table which have 100    element take: 2605 nanoTime
remove items at hash table which have 1000   element take: 2769 nanoTime
remove items at hash table which have 10000  element take: 2599 nanoTime

-----
accessing non existing items at hash table which have 100    element take: 1487 nanoTime
accessing non existing items at hash table which have 1000   element take: 1969 nanoTime
accessing non existing items at hash table which have 10000  element take: 1971 nanoTime
```

