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

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Question 1.1:

1- System Requirements:

a. The class is a hash table that implements the interface KWHashMap.
b. The key values must be comparable.

2- Problem-Solution Approach:

The system uses the chaining technique to handle collisions and has a maximum load factor of 3.0. The table extends its size dynamically by finding the maximum prime number that is less than or equal to 2 times + 1 the current size of the table. The chains are from the class BinarySearchTree written in the book.

HashMapChain <K extends Comparable<K>, V>

The data fields are:

1- private BinarySearchTree<Entry<K, V>>[] table;
2- private int numKeys;
3- private static final int START_CAPACITY = 11;
4- private static final double LOAD_THRESHOLD = 3.0;

The constructors are:

1- public HashMapChain(); // Default constructor

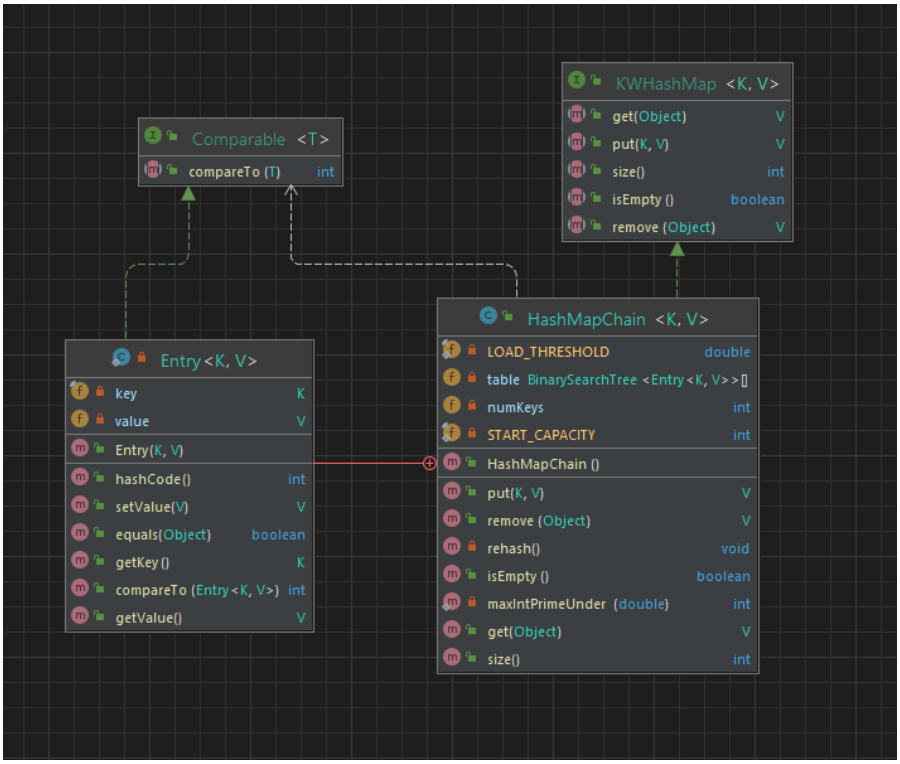
The methods are:

1- public V get(Object key);
2- public boolean isEmpty();
3- public V put(K key, V value);
4- public V remove(Object key);
5- public int size();
6- private void rehash();
7- private static int maxIntPrimeUnder(double N);

The inner classes:

1- private static class Entry<K extends Comparable<K>, V>
implements Comparable<Entry<K, V>>;

3- Class Diagram:



Question 1.2:

1- System Requirements:

a. The class is a hash table that implements the interface KWHashMap.

2- Problem-Solution Approach:

The system uses a combination of coalesced and double hashing techniques to handle collisions and has a maximum load factor of 0.75. The table extends its size dynamically by finding the maximum prime number that is less than or equal to 2 times + 1 the current size of the table. The double hashing formula is used when adding an entry to the end of a chain, and it uses the following formulas:

Hash1 = key % tablesize (10 in our case)

Hash2 = Prime_number – (key % Prime_number)

Hash function = (Hash1 + (*i* * Hash2)) % tablesize (for the *I'th* probe.)

HashMapCoalesced<K, V>

The data fields are:

1- private Entry<K, V>[] table;
2- private int numKeys;
3- private static final int START_CAPACITY = 11;
4- private static final double LOAD_THRESHOLD = 0.75;
5- private static long probe = 0;

The constructors are:

1- public HashMapCoalesced (); // Default constructor

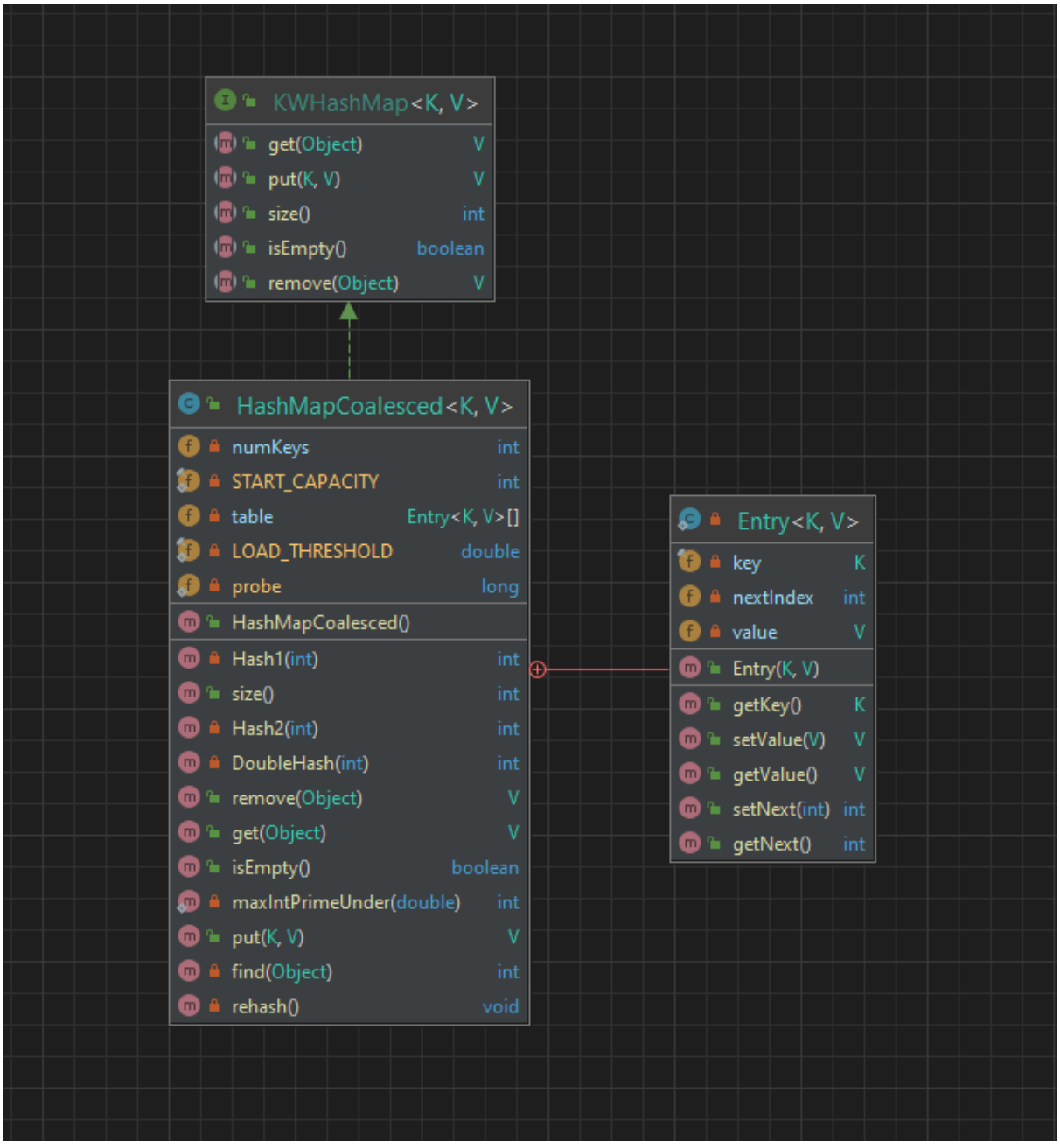
The methods are:

1- public V get(Object key);
2- public boolean isEmpty();
3- public V put(K key, V value);
4- public V remove(Object key);
5- public int size();
6- private int find(Object key);
7- private void rehash();
8- private static int maxIntPrimeUnder(double N);
9- private int Hash1(int key);
10- private int Hash2(int key);
11- private int DoubleHash(int key);

The inner classes:

1- private static class Entry<K, V>;

3- Class Diagram:



Test Cases:

100 randomly generated integer data sets are created for each of the following sizes: (small (size = 100), medium (size = 1000), and large (size = 10000)). The elements are inserted into an initially empty hash table of both types. After that multiple adding, removing, and accessing operations are performed and the results are printed on the screen.

Running and Results:

The driver code is designed to be launched by a makefile in a Linux system.

Testing Coalesced and Chaining Hashing Techniques:

Inserting the small sets to both tables.

Removing:

The entry with the key 31769 is removed from both tables.

Time taken for the operation:

Coalesced hash table: 9300

Chaining hash table: 32000

The values associated with the removed key are:

Coalesced hash table: 27848

Chaining hash table: 27848

The entry with the key 32421 is not in the table, so it can not be removed.

Time taken for the operation:

Coalesced hash table: 2400

Chaining hash table: 3100

The values associated with the removed key are:

Coalesced hash table: null

Chaining hash table: null

Accessing:

The entry with the key 18209 is sought from both tables.

Time taken for the operation:

Coalesced hash table: 5200

Chaining hash table: 4500

The values associated with the accessed key are:

Coalesced hash table: 4572

Chaining hash table: 4572

The entry with the key 32421 is not in the tables, so can not be accessed.

Time taken for the operation:

Coalesced hash table: 56500

Chaining hash table: 19000

The values associated with the accessed key are:

Coalesced hash table: null

Chaining hash table: null

Adding:

The entry with the key 7726 and value 18209 is added to the tables.

Time taken for the operation:

Coalesced hash table: 4700

Chaining hash table: 20000

The replaced values associated with the key are:

Coalesced hash table: null

Chaining hash table: null

The entry with the key 7726 is modified with the value 18440.

Time taken for the operation:

Coalesced hash table: 78600

Chaining hash table: 9700

The replaced values associated with the key are:

Coalesced hash table: 18209

Chaining hash table: 18209

Inserting the medium sets to both tables.

Removing:

The entry with the key 23844 is removed from both tables.

Time taken for the operation:

Coalesced hash table: 106500

Chaining hash table: 35000

The values associated with the removed key are:

Coalesced hash table: 23015

Chaining hash table: 23015

The entry with the key 32421 is not in the table, so it can not be removed.

Time taken for the operation:

Coalesced hash table: 68300

Chaining hash table: 32500

The values associated with the removed key are:

Coalesced hash table: null

Chaining hash table: null

Accessing:

The entry with the key 6265 is sought from both tables.

Time taken for the operation:

Coalesced hash table: 49900

Chaining hash table: 27300

The values associated with the accessed key are:

Coalesced hash table: 20664

Chaining hash table: 20664

The entry with the key 32421 is not in the tables, so can not be accessed.

Time taken for the operation:

Coalesced hash table: 51600

Chaining hash table: 33100

The values associated with the accessed key are:

Coalesced hash table: null

Chaining hash table: null

Adding:

The entry with the key 12235 and value 6265 is added to the tables.

Time taken for the operation:

Coalesced hash table: 50900

Chaining hash table: 15300

The replaced values associated with the key are:

Coalesced hash table: null

Chaining hash table: null

The entry with the key 20285 is modified with the value 21687.

Time taken for the operation:

Coalesced hash table: 21000

Chaining hash table: 11700

The replaced values associated with the key are:

Coalesced hash table: 6265

Chaining hash table: 6265

Inserting the large sets to both tables.

Removing:

The entry with the key 5261 is removed from both tables.

Time taken for the operation:

Coalesced hash table: 14500

Chaining hash table: 49900

The values associated with the removed key are:

Coalesced hash table: 19061

Chaining hash table: 19061

The entry with the key 32421 is not in the table, so it can not be removed.

Time taken for the operation:

Coalesced hash table: 64000

Chaining hash table: 10000

The values associated with the removed key are:

Coalesced hash table: null

Chaining hash table: null

Accessing:

The entry with the key 22418 is sought from both tables.

Time taken for the operation:

Coalesced hash table: 2500

Chaining hash table: 2600

The values associated with the accessed key are:

Coalesced hash table: 10304

Chaining hash table: 10304

The entry with the key 32421 is not in the tables, so can not be accessed.

Time taken for the operation:

Coalesced hash table: 1400

Chaining hash table: 3900

The values associated with the accessed key are:

Coalesced hash table: null

Chaining hash table: null

Adding:

The entry with the key 12230 and value 22418 is added to the tables.

Time taken for the operation:

Coalesced hash table: 2500

Chaining hash table: 1500

The replaced values associated with the key are:

Coalesced hash table: 4982

Chaining hash table: 4982

The entry with the key 12230 is modified with the value 22649.

Time taken for the operation:

Coalesced hash table: 2700

Chaining hash table: 1500

The replaced values associated with the key are:

Coalesced hash table: 22418

Chaining hash table: 22418