HashMap Custom implementation in java - How HashMap works internally with diagrams and full program

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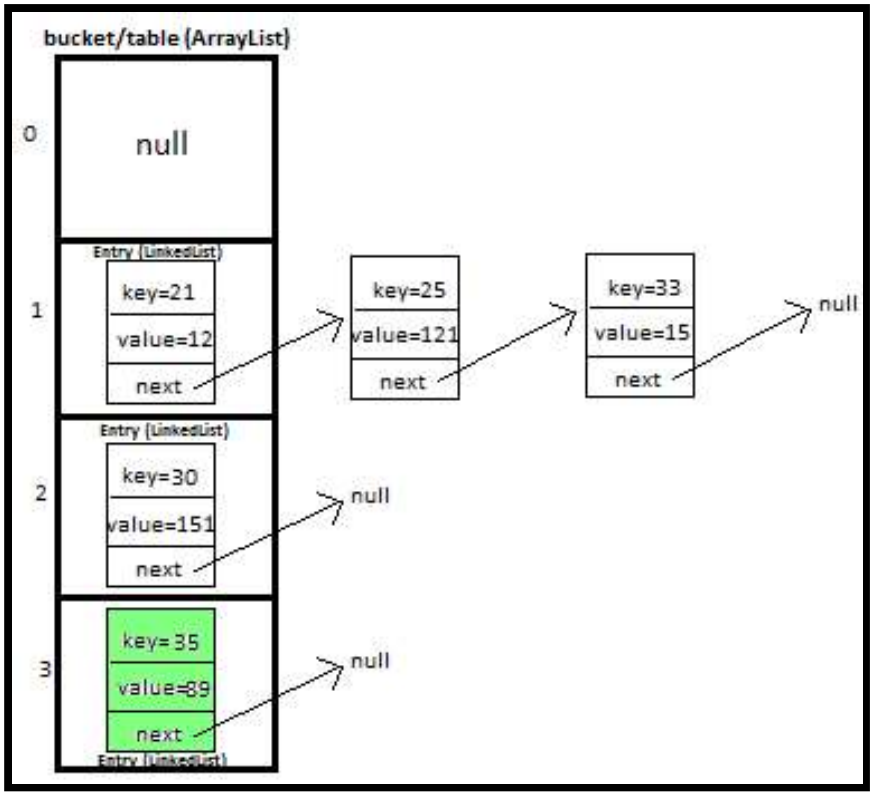
1) Custom HashMap in java >



In this tutorial we will learn how to create and implement own/custom HashMap in java with full working source code.

This is very **important** and **trending** topic in java. In this post i will be explaining **HashMap** custom implementation in lots of detail with diagrams which will help you in **visualizing** the HashMap implementation. ***This is must prepare topic for interview and from knowledge point of view as well.***

I will be explaining how we will **put** and **get** key-value pair in HashMap by overriding-
>**equals** method - helps in checking equality of entry objects.
>**hashCode** method - helps in finding bucket's index on which data will be stored.

We will maintain **bucket (ArrayList)** which will store **Entry (LinkedList)**.

2) Entry<K,V>

We store key-value pair by using `Entry<K,V>`
Entry contains

- K **key**,
- V **value** and
- `Entry<K,V>` **next** (i.e. next entry on that location of bucket).

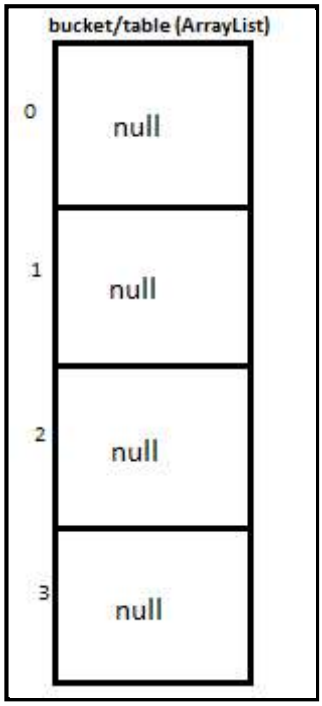
```
        static class Entry<K, V> {
```

```
        K key;
        V value;
        Entry<K,V> next;

        public Entry(K key, V value, Entry<K,V> next){
            this.key = key;
            this.value = value;
            this.next = next;
        }
    }
```

*3) Putting **5 key-value pairs in own/custom HashMap (step-by-step)** in java>*

I will explain you the whole concept of HashMap by putting **5 key-value pairs in HashMap.**

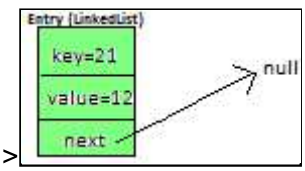
Initially, we have bucket of **capacity=4.** (all indexes of bucket i.e. 0,1,2,3 are pointing to null)



Let's put first key-value pair in HashMap-

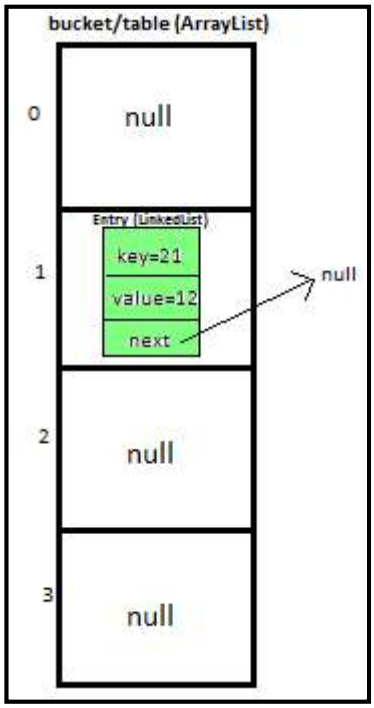
Key=21, value=12

newEntry Object will be formed like this >



We will calculate hash by using our **hash(K key)** method **-** in this case it returns **key/capacity= 21%4= 1.**
So, **1** will be the **index of bucket** on which **newEntry object** will be stored**.**
We will go to **1st** index as it is pointing to null we will **put our newEntry object there.**

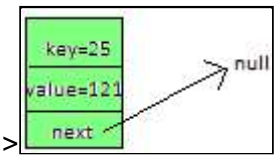
At completion of this step, our HashMap will look like this-



Let's put second key-value pair in HashMap-

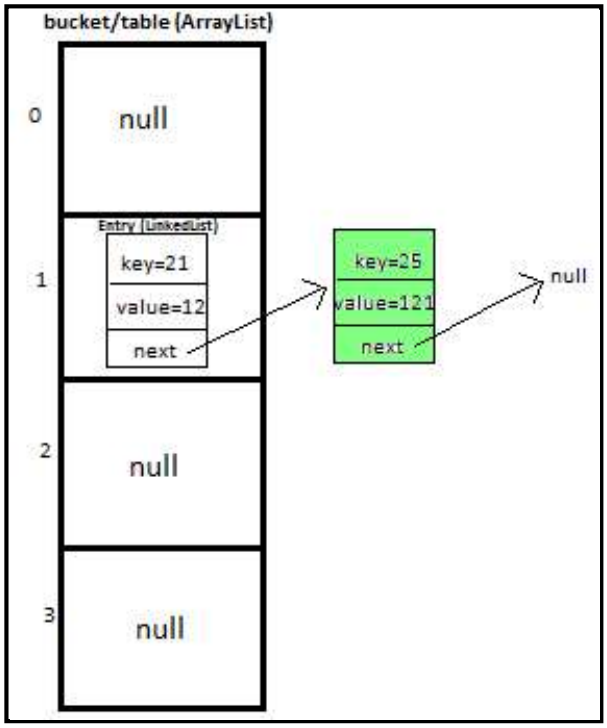
Key=25, value=121

newEntry Object will be formed like this >



We will calculate hash by using our **hash(K key)** method - in this case it returns **key/capacity= 25%4= 1.**
So, 1 will be the **index of bucket** on which **newEntry object** will be stored**.**
We will go to **1st** index, it contains **entry with key=21**, we will compare two keys(i.e**. compare 21 with 25** by using **equals method**), as **two keys are different** we check whether entry with key=21's **next is null or not**, **if next is null** we will **put** our **newEntry object** on **next.**

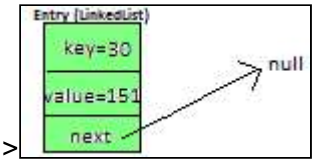
At completion of this step our HashMap will look like this-



Let's put third key-value pair in HashMap-

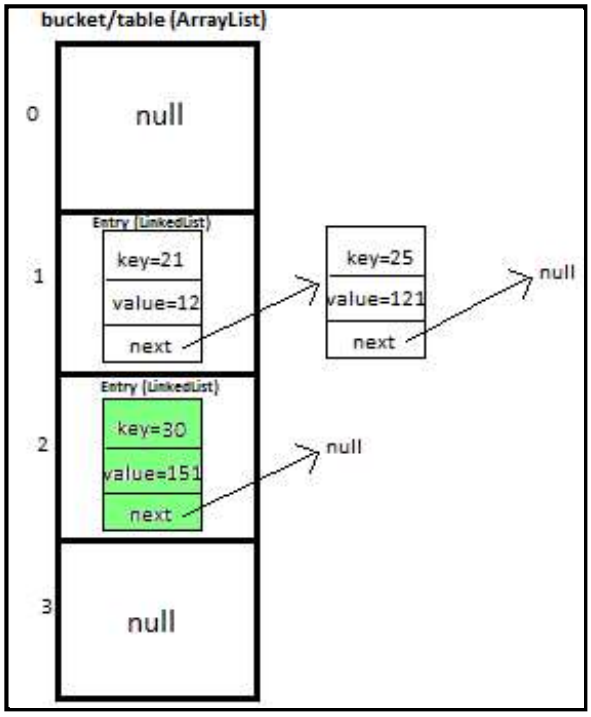
Key=30, value=151

newEntry Object will be formed like this >



We will calculate hash by using our **hash(K key)** method **-** in this case it returns **key/capacity= 30%4= 2.**
So, **2** will be the **index of bucket** on which **newEntry object** will be stored.
We will go to **2nd** index as it is pointing to null we will **put our newEntry object there.**

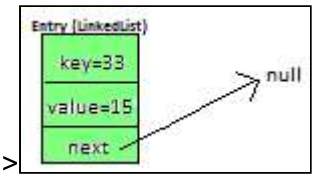
At completion of this step, our HashMap will look like this-



Let's put fourth key-value pair in HashMap-

Key=33, value=15

Entry Object will be formed like this >



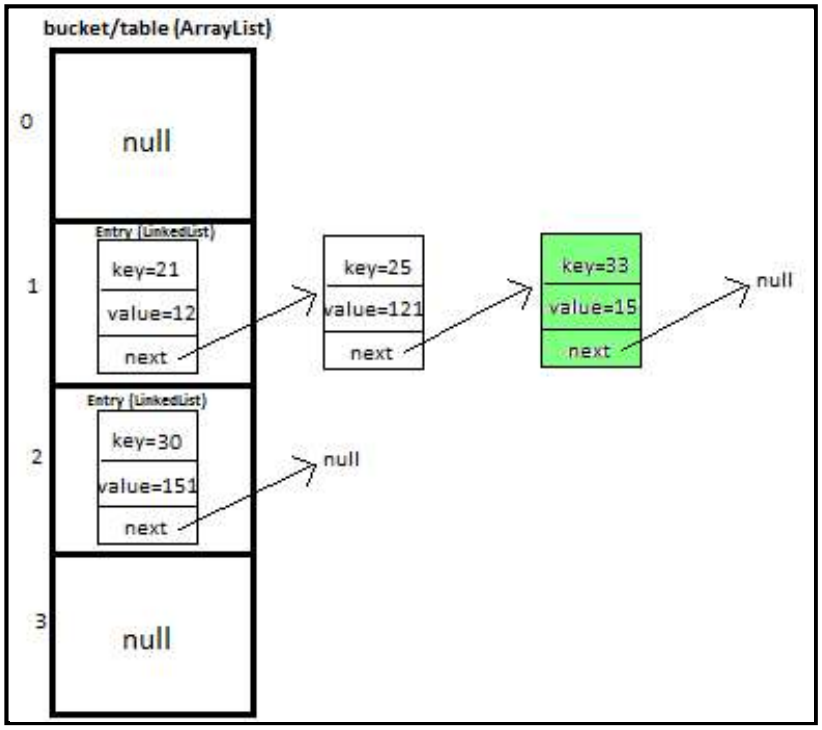
We will calculate hash by using our **hash(K key)** method - in this case it returns **key/capacity= 33%4= 1,**
So, 1 will be the **index of bucket** on which **newEntry object** will be stored.

We will go to **1st** index -

>it contains **entry with key=21**, we will **compare** two keys (i.e. **compare 21 with 33** by using **equals method**, as **two keys are different,** proceed to next of **entry with key=21 (**proceed only if **next is not null).**

>now, next contains **entry with key=25**, we will **compare** two keys (i.e. **compare 25 with 33** by using **equals method**, as **two keys are different,** now **next of entry with key=25** is pointing to **null** so we won't proceed **further,** we will **put our newEntry object on next.**

At completion of this step our HashMap will look like this-

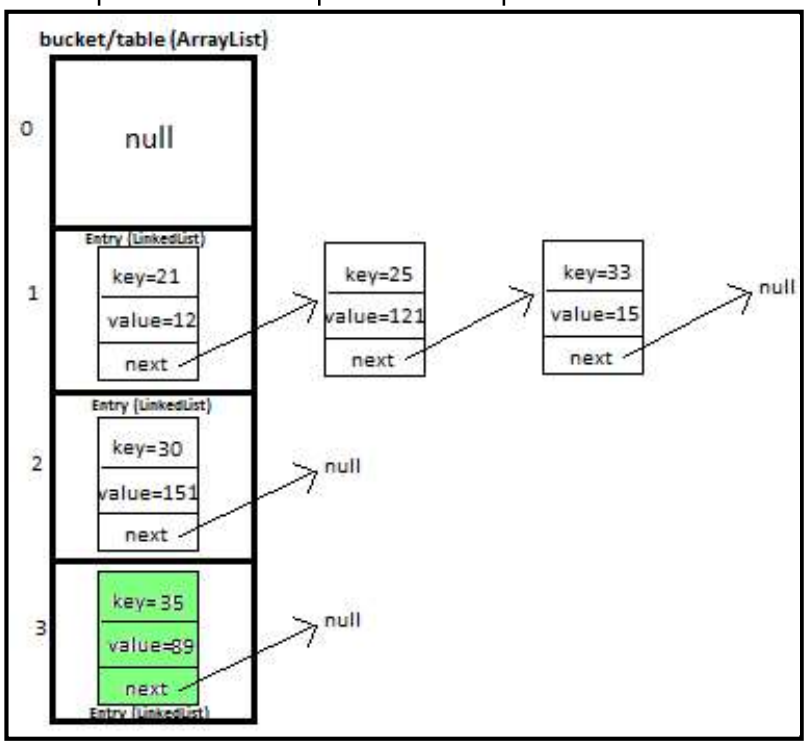


Let's put fifth key-value pair in HashMap-

Key=35, value=89

Repeat above mentioned steps.

At completion of this step our HashMap will look like this-



Must read: LinkedHashMap Custom implementation

LinkedHashMap Custom implementation - put, get, remove Employee object.

4) Methods used in custom HashMap in java >

public void **put**(K newKey, V data)	-Method allows you put key-value pair in HashMap -If the map already contains a mapping for the key, the old value is replaced. -provide complete functionality how to override equals method. -provide complete functionality how to override hashCode method.
public V **get**(K key)	Method returns value corresponding to key.
public boolean **remove**(K deleteKey)	Method removes key-value pair from HashMapCustom.
public void **display**()	-Method displays all key-value pairs present in HashMapCustom., -insertion order is not guaranteed, for maintaining insertion order refer LinkedHashMapCustom.
private int **hash**(K key)	-Method implements hashing functionality, which helps in finding the appropriate bucket location to store our data. -This is very important method, as performance of HashMapCustom is very much dependent on this method's implementation.

REFER: HashMap Custom implementation - put, get, remove Employee object.

5) What will happen if map already contains mapping for key?

If the map already contains a mapping for the key, the old value is replaced.

6) Full Program/SourceCode for implementing custom HashMap in java >

```
package com.ankit;
 /**
 * @author AnkitMittal, JavaMadeSoEasy.com
 * Copyright (c), AnkitMittal . All Contents are copyrighted and must not be
 * reproduced in any form.
 * This class provides custom implementation of HashMap(without using java api's)-
 * which allows us to store data in key-value pair form.
 * insertion order of key-value pairs is not maintained.
 * @param <K>
 * @param <V>
 */
```

```
class HashMapCustom<K, V> {

     private Entry<K,V>[] table;   //Array of Entry.
     private int capacity= 4;  //Initial capacity of HashMap

     static class Entry<K, V> {
         K key;
         V value;
         Entry<K,V> next;

         public Entry(K key, V value, Entry<K,V> next){
             this.key = key;
             this.value = value;
             this.next = next;
         }
     }


    @SuppressWarnings("unchecked")
    public HashMapCustom(){
       table = new Entry[capacity];
    }



    /**
     * Method allows you put key-value pair in HashMapCustom.
     * If the map already contains a mapping for the key, the old value is replaced.
     * Note: method does not allows you to put null key though it allows null values.
     * Implementation allows you to put custom objects as a key as well.
     * Key Features: implementation provides you with following features:-
     *      >provide complete functionality how to override equals method.
     *  >provide complete functionality how to override hashCode method.
     * @param newKey
     * @param data
     */
     public void put(K newKey, V data){
       if(newKey==null)
           return;    //does not allow to store null.

       //calculate hash of key.
       int hash=hash(newKey);
       //create new entry.
       Entry<K,V> newEntry = new Entry<K,V>(newKey, data, null);

       //if table location does not contain any entry, store entry there.
        if(table[hash] == null){
         table[hash] = newEntry;
        }else{
           Entry<K,V> previous = null;
           Entry<K,V> current = table[hash];

           while(current != null){ //we have reached last entry of bucket.
           if(current.key.equals(newKey)){
               if(previous==null){  //node has to be insert on first of bucket.
                     newEntry.next=current.next;
                     table[hash]=newEntry;
                     return;
               }
               else{
```

```
                newEntry.next=current.next;
                previous.next=newEntry;
                return;
            }
        }
        previous=current;
          current = current.next;
      }
      previous.next = newEntry;
    }
}

/**
 * Method returns value corresponding to key.
 * @param key
 */
public V get(K key){
    int hash = hash(key);
    if(table[hash] == null){
     return null;
    }else{
     Entry<K,V> temp = table[hash];
     while(temp!= null){
         if(temp.key.equals(key))
             return temp.value;
         temp = temp.next; //return value corresponding to key.
     }
     return null;   //returns null if key is not found.
    }
}


/**
 * Method removes key-value pair from HashMapCustom.
 * @param key
 */
public boolean remove(K deleteKey){

   int hash=hash(deleteKey);

  if(table[hash] == null){
        return false;
  }else{
    Entry<K,V> previous = null;
    Entry<K,V> current = table[hash];

    while(current != null){ //we have reached last entry node of bucket.
       if(current.key.equals(deleteKey)){
           if(previous==null){  //delete first entry node.
                 table[hash]=table[hash].next;
                 return true;
           }
           else{
                 previous.next=current.next;
                  return true;
           }
       }
       previous=current;
         current = current.next;
      }
```

```
        return false;
      }

    }


    /**
     * Method displays all key-value pairs present in HashMapCustom.,
     * insertion order is not guaranteed, for maintaining insertion order
     * refer LinkedHashMapCustom.
     * @param key
     */
    public void display(){

       for(int i=0;i<capacity;i++){
           if(table[i]!=null){
                  Entry<K, V> entry=table[i];
                  while(entry!=null){
                        System.out.print("{"+entry.key+"="+entry.value+"}" +" ");
                        entry=entry.next;
                  }
           }
       }

    }
    /**
     * Method implements hashing functionality, which helps in finding the appropriate
     * bucket location to store our data.
     * This is very important method, as performance of HashMapCustom is very much
     * dependent on  this method's implementation.
     * @param key
     */
    private int hash(K key){
        return Math.abs(key.hashCode()) % capacity;
    }

}


/**
 * Main class- to test HashMap functionality.
 */
public class HashMapCustomApp {

    public static void main(String[] args) {
          HashMapCustom<Integer, Integer> hashMapCustom = new HashMapCustom<Integer, Integer>
();
          hashMapCustom.put(21, 12);
          hashMapCustom.put(25, 121);
          hashMapCustom.put(30, 151);
          hashMapCustom.put(33, 15);
          hashMapCustom.put(35, 89);

          System.out.println("value corresponding to key 21="
                      + hashMapCustom.get(21));
          System.out.println("value corresponding to key 51="
                      + hashMapCustom.get(51));

          System.out.print("Displaying : ");
          hashMapCustom.display();
```

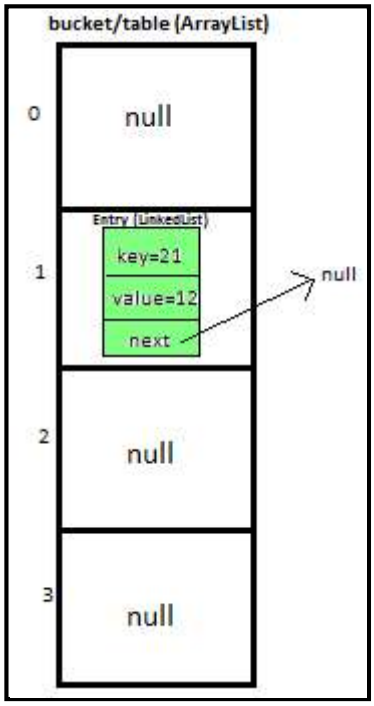
```
            System.out.println("\n\nvalue corresponding to key 21 removed: "
                        + hashMapCustom.remove(21));
            System.out.println("value corresponding to key 51 removed: "
                        + hashMapCustom.remove(51));

            System.out.print("Displaying : ");
            hashMapCustom.display();

    }
}

/*Output

value corresponding to key 21=12
value corresponding to key 51=null
Displaying : {21=12} {25=121} {33=15} {30=151} {35=89}

value corresponding to key 21 removed: true
value corresponding to key 51 removed: false
Displaying : {25=121} {33=15} {30=151} {35=89}

*/
```

7) Complexity calculation of put and get methods in HashMap in java >

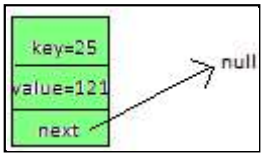
7.1) put method - worst Case complexity >

O(n).

But how complexity is O(n)?
Initially, let's say map is like this -

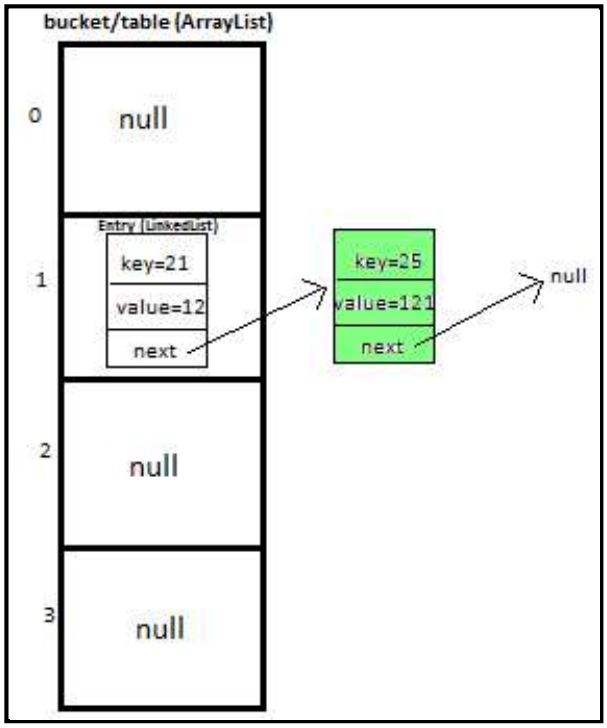


And we have to insert **newEntry Object** with **Key=25, value=121**



We will calculate hash by using our **hash(K key)** method - in this case it returns **key/capacity= 25%4= 1.**
So, 1 will be the **index of bucket** on which **newEntry object** will be stored**.**
We will go to **1st** index, it contains **entry with key=21**, we will compare two keys(i.e**. compare 21 with 25** by using **equals method**), as **two keys are different** we check whether entry with key=21's **next is null or not**, **if next is null** we will **put** our **newEntry object** on **next.**

At completion of this step our HashMap will look like this-

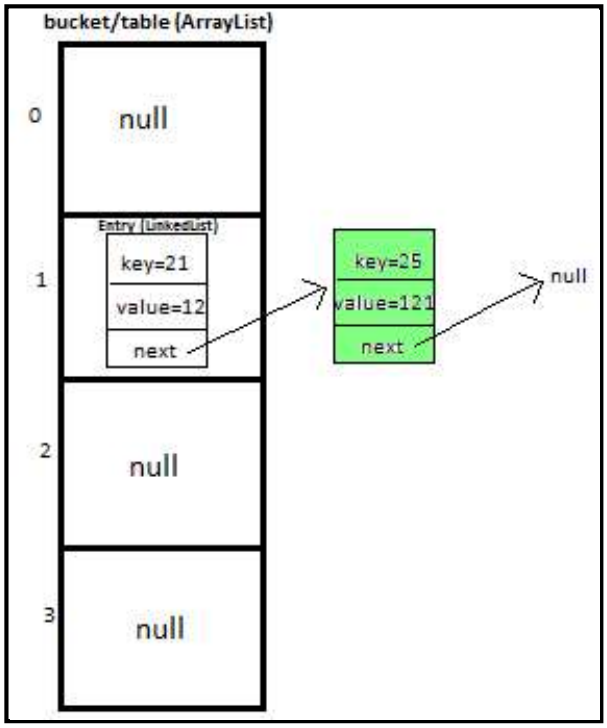


Now let's do complexity calculation -
Earlier there was 1 element in HashMap and for putting **newEntry Object** we iterated on it. Hence complexity was O(n).
Note: We may calculate complexity by adding more elements in HashMap as well, but to keep explanation simple i kept less elements in HashMap.

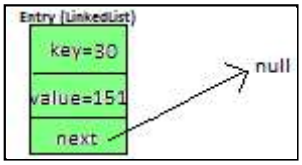
*7.2) **put** method - **best Case** complexity >*

O(1).

But how complexity is O(n)?
Let's say map is like this -

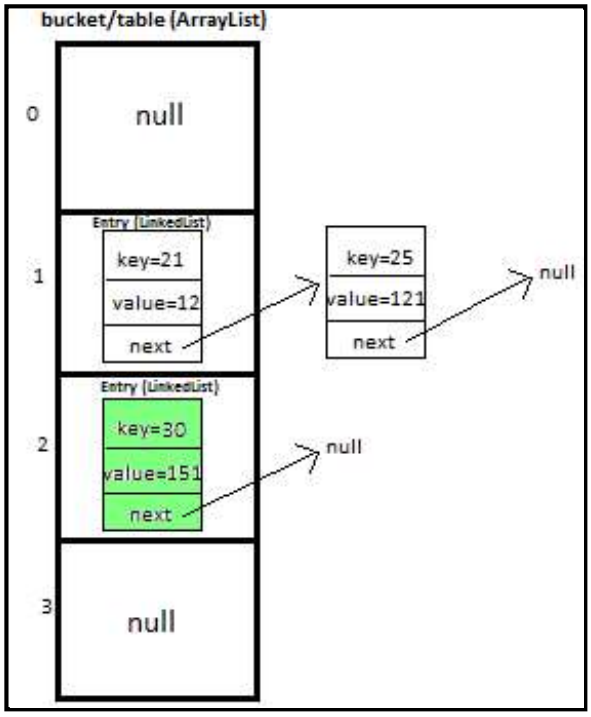


And we have to insert **newEntry Object** with **Key=30, value=151**



We will calculate hash by using our **hash(K key)** method **-** in this case it returns **key/capacity= 30%4= 2.**
So, **2** will be the **index of bucket** on which **newEntry object** will be stored**.**
We will go to **2nd** index as it is pointing to null we will **put our newEntry object there.**

At completion of this step our HashMap will look like this-

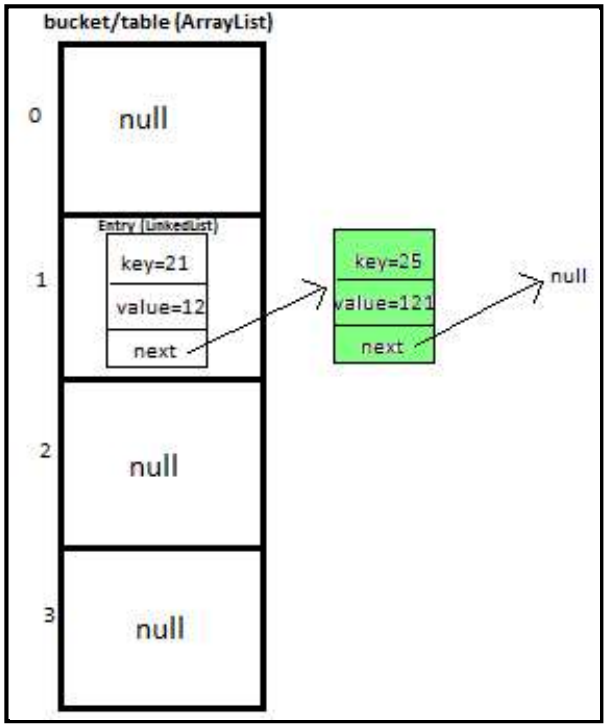


Now let's do complexity calculation -
Earlier there 2 elements in HashMap but we were able to put **newEntry Object** in first go. Hence complexity was **O(1).**

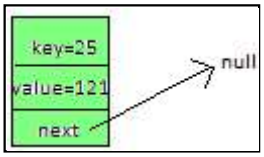
*7.3) **get** method - **worst Case** complexity >*

O(n).

But how complexity is O(n)?
Initially, let's say map is like this -



And we have to get **Entry Object** with **Key=25, value=121**



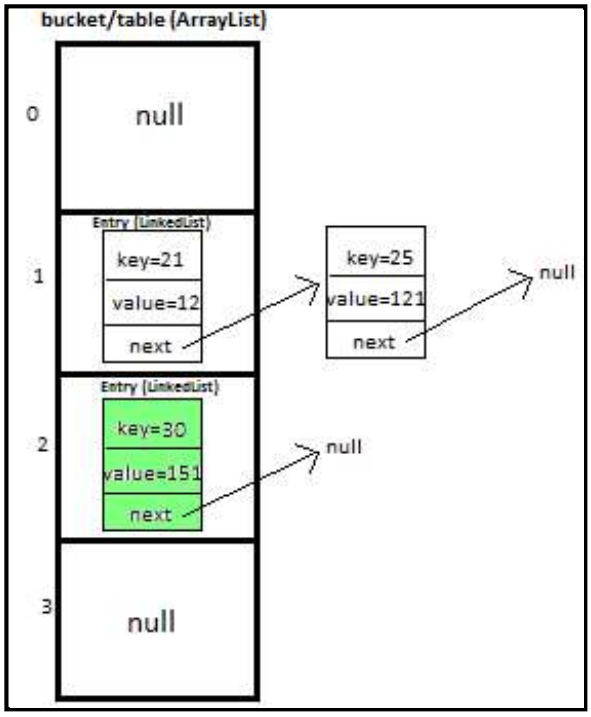
We will calculate hash by using our **hash(K key)** method - in this case it returns **key/capacity= 25%4= 1.**
So, 1 will be the **index of bucket** on which **Entry object** is stored.
We will go to **1st** index, it contains **entry with key=21**, we will compare two keys(i.e. **compare 21 with 25** by using **equals method**), as **two keys are different** we check whether entry with key=21's **next is null or not**, **next is not null** so we will repeat same process and ultimately will be able to get **Entry object**.

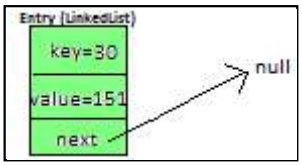
Now let's do complexity calculation -
There were 2 elements in HashMap and for getting **Entry Object** we iterated on both of them. Hence complexity was O(n).
Note: We may calculate complexity by using HashMap of larger size, but to keep explanation simple i kept less elements in HashMap.

*7.4) **get** method - **best Case** complexity >*

O(1).

But how complexity is O(n)?
Initially, let's say map is like this -





And we have to get **Entry Object** with **Key=30, value=151**
We will calculate hash by using our **hash(K key)** method **-** in this case it returns **key/capacity= 30%4= 2.**
So, **2** will be the **index of bucket** on which **Entry object** is stored.
We will go to **2nd** index and get **Entry object**.

Now let's do complexity calculation -
There were 3 elements in HashMap but we were able to get **Entry Object** in first go.
Hence complexity was O(1).

8) Summary of complexity of methods in HashMap in java >

Operation/ method	**Worst case**	**Best case**
put(K key, V value)	O(n)	O(1)
get(Object key)	O(n)	O(1)

Summary of article >

In this tutorial we learned how to create and implement own/custom HashMap in java with full program, diagram and examples to insert and retrieve key-value pairs in it.

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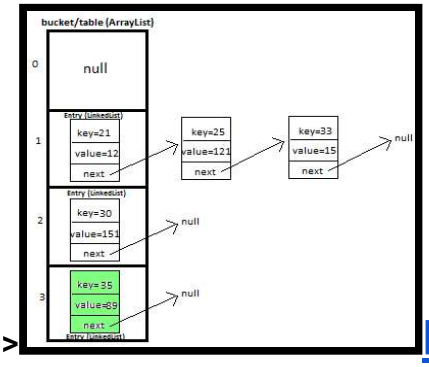
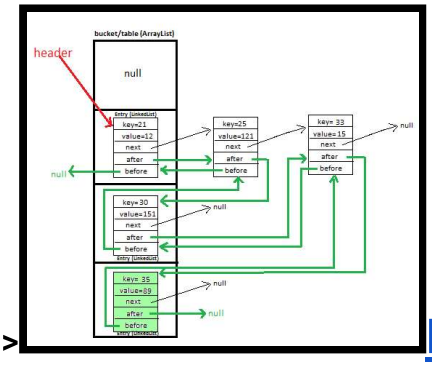
1 > 

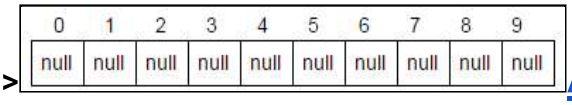
HashMap Custom implementation in java/ Develop own HashMap with full java code

>HashMap Custom implementation in java - put, get, remove Employee object

2 > 

LinkedHashMap own/Custom implementation/ with full code in java

>LinkedHashMap Custom implementation - put, get, remove Employee object

3 > 

ArrayList custom implementation in java/ Create own ArrayList with full code

>ArrayList custom implementation - add, get, remove Employee object

4 > 

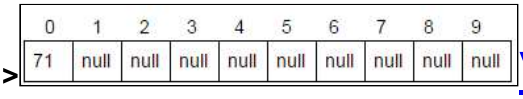
Set Custom implementation in java

>Set Custom implementation - add, contains, remove Employee object

5 > 

LinkedHashSet Custom implementation in java

>LinkedHashSet Custom implementation - add, contains, remove Employee object

6 > 

Vector custom implementation in java

HashMap and Hashtable - Similarity and Differences

Collection - List, Set and Map all properties in tabular form in java