Differences between TreeMap, HashMap and LinkedHashMap in Java

Prerequisite : HashMap and TreeMap in Java

TreeMap, HashMap and LinkedHashMap: What's Similar?

TreeMap, HashMap and LinkedHashMap: What's Similar?

- All offer **a key->value** map and a way to iterate through the keys. The most important distinction between these classes is the time guarantees and the ordering of the keys.
- All three classes HashMap, TreeMap and LinkedHashMap implements **java.util.Map** interface, and represents mapping from unique key to values.

Key Points

1. **HashMap:** HashMap offers **0(1)** lookup and insertion. If you iterate through the keys, though, the ordering of the keys is essentially arbitrary. It is implemented by an array of linked lists.
   Syntax:

```
public class HashMap extends AbstractMap
implements Map,Cloneable, Serializable
```

   - A HashMap contains values based on the key.
   - It contains only unique elements.
   - It may have one null key and multiple null values.
   - It maintains **no order.**
2. **LinkedHashMap:** LinkedHashMap offers **0(1)** lookup and insertion. Keys are ordered by their insertion order. It is implemented by doubly-linked buckets.
   Syntax:

```
public class LinkedHashMap extends HashMap
0implements Map
```

- A LinkedHashMap contains values based on the key.
- It contains only unique elements.
- It may have one null key and multiple null values.
- It is same as HashMap instead **maintains insertion order**.

3. **TreeMap:** TreeMap offers **O(log N)** lookup and insertion. Keys are ordered, so if you need to iterate through the keys in sorted order, you can. This means that keys must implement the Comparable interface. TreeMap is implemented by a Red-Black Tree.
   Syntax:

```
public class TreeMap extends AbstractMap implements
NavigableMap, Cloneable, Serializable
```

- A TreeMap contains values based on the key. It implements the NavigableMap interface and extends AbstractMap class.
- It contains only unique elements.
- It cannot have null key but can have multiple null values.
- It is same as HashMap instead **maintains ascending order(Sorted using the natural order of its key**).

4. **Hashtable:** "Hashtable" is the generic name for hash-based maps.
   Syntax:

```
public class Hashtable extends Dictionary implements
Map, Cloneable, Serializable
```

- A Hashtable is an array of list. Each list is known as a bucket. The position of bucket is identified by calling the hashcode() method. A Hashtable contains values based on the key.
- It contains only unique elements.
- It may have not have any null key or value.
- It is synchronized.
- It is a legacy class.

HashMap

```
// Java program to print ordering
// of all elements using HashMap
import java.util.*;
import java.lang.*;
import java.io.*;
class Main
{
    // This function prints ordering of all elements
    static void insertAndPrint(AbstractMap<Integer, String> map)
    {
        int[] array= {1, -1, 0, 2,-2};
        for (int x: array)
        {
            map.put(x, Integer.toString(x));
        }
        for (int k: map.keySet())
        {
            System.out.print(k + ", ");
        }
    }

    // Driver method to test above method
    public static void main (String[] args)
    {
        HashMap<Integer, String> map = new HashMap<Integer, String>();
        insertAndPrint(map);
    }
}
```

Run on IDE

LinkedHashMap

```
// Java program to print ordering
// of all elements using LinkedHashMap
import java.util.*;
import java.lang.*;
import java.io.*;

class Main
{
    // This function prints ordering of all elements
    static void insertAndPrint(AbstractMap<Integer, String> map)
    {
        int[] array= {1, -1, 0, 2,-2};
        for (int x: array)
        {
            map.put(x, Integer.toString(x));
        }
        for (int k: map.keySet())
        {
            System.out.print(k + ", ");
        }
    }

    // Driver method to test above method
    public static void main (String[] args)
    {
        LinkedHashMap<Integer, String> map = new LinkedHashMap<Integer, String>();
        insertAndPrint(map);
    }
}
```

Run on IDE

TreeMap

```
// Java program to print ordering of
// all elements using TreeMap

import java.util.*;
import java.lang.*;
import java.io.*;

class Main
{
    // This function prints ordering of all elements
    static void insertAndPrint(AbstractMap<Integer, String> map)
    {
        int[] array= {1, -1, 0, 2,-2};
        for (int x: array)
        {
            map.put(x, Integer.toString(x));
        }
        for (int k: map.keySet())
        {
            System.out.print(k + ", ");
        }
    }

    // Driver method to test above method
    public static void main (String[] args)
    {
        TreeMap<Integer, String> map = new TreeMap<Integer, String>();
        insertAndPrint(map);
    }
}
```

Run on IDE

Output of HashMap:

```
-1, 0, 1, -2, 2,
// ordering of the keys is essentially arbitrary (any ordering)
```

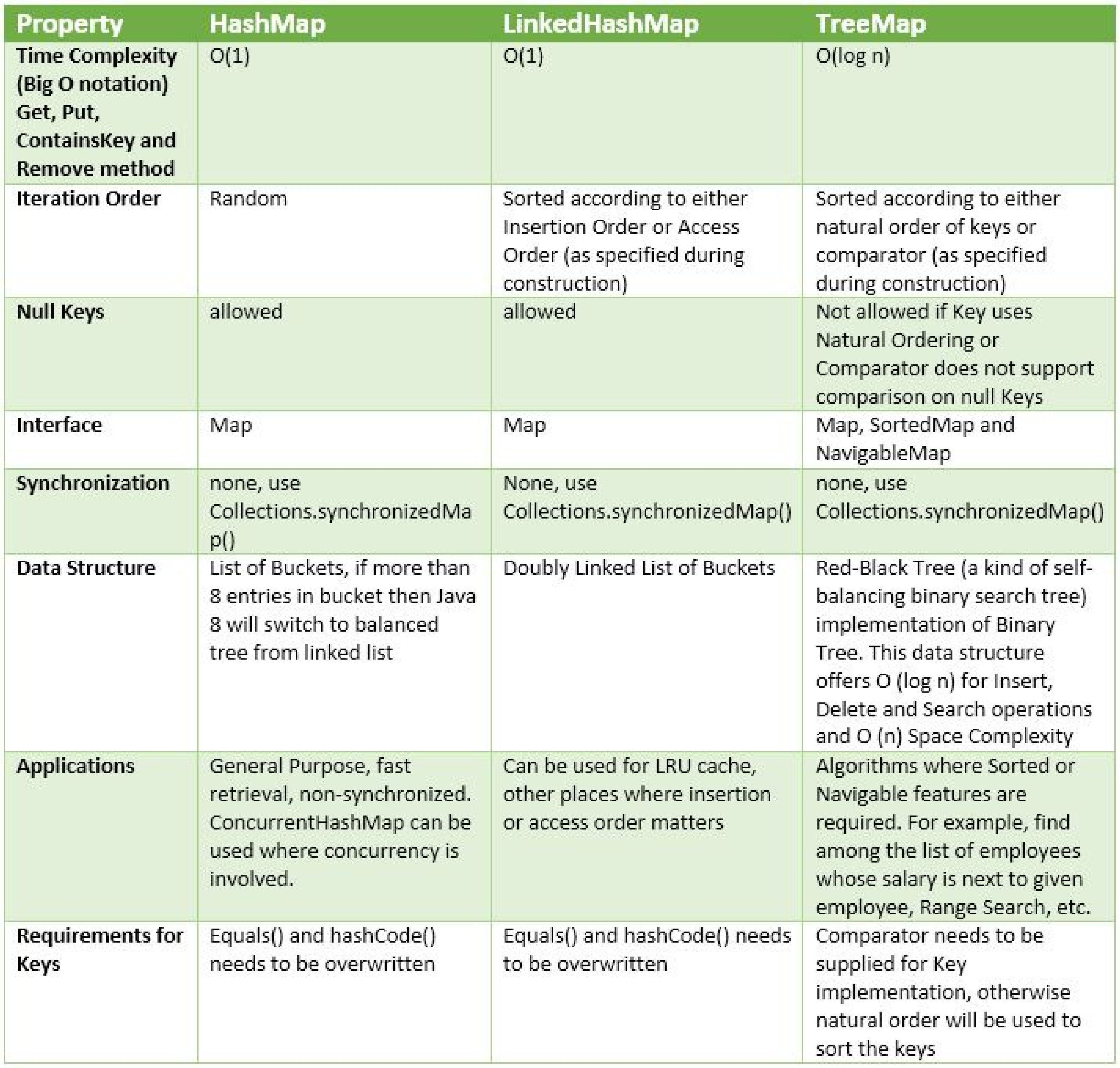
Output of LinkedHashMap:

```
 1, -1, 0, 2, -2,
// Keys are ordered by their insertion order
```

Output of TreeMap:

```
 -2, -1, 0, 1, 2,
// Keys are in sorted order
```

Comparison Table



Property	HashMap	LinkedHashMap	TreeMap
Time Complexity (Big O notation) Get, Put, ContainsKey and Remove method	O(1)	O(1)	O(log n)
Iteration Order	Random	Sorted according to either Insertion Order or Access Order (as specified during construction)	Sorted according to either natural order of keys or comparator (as specified during construction)
Null Keys	allowed	allowed	Not allowed if Key uses Natural Ordering or Comparator does not support comparison on null Keys
Interface	Map	Map	Map, SortedMap and NavigableMap
Synchronization	none, use Collections.synchronizedMap()	None, use Collections.synchronizedMap()	none, use Collections.synchronizedMap()
Data Structure	List of Buckets, if more than 8 entries in bucket then Java 8 will switch to balanced tree from linked list	Doubly Linked List of Buckets	Red-Black Tree (a kind of self-balancing binary search tree) implementation of Binary Tree. This data structure offers O (log n) for Insert, Delete and Search operations and O (n) Space Complexity
Applications	General Purpose, fast retrieval, non-synchronized. ConcurrentHashMap can be used where concurrency is involved.	Can be used for LRU cache, other places where insertion or access order matters	Algorithms where Sorted or Navigable features are required. For example, find among the list of employees whose salary is next to given employee, Range Search, etc.
Requirements for Keys	Equals() and hashCode() needs to be overwritten	Equals() and hashCode() needs to be overwritten	Comparator needs to be supplied for Key implementation, otherwise natural order will be used to sort the keys

Real Life Applications

1. Suppose you were creating a mapping of names to Person objects. You might want to periodically output the people in alphabetical order by name. A TreeMap lets you do this.
2. A TreeMap also offers a way to, given a name, output the next 10 people. This could be useful for a "More"function in many applications.
3. A LinkedHashMap is useful whenever you need the ordering of keys to match the ordering of insertion. This might be useful in a caching situation, when you want to delete the oldest item.
4. Generally, unless there is a reason not to, you would use HashMap. That is, if you need to get the keys back in insertion order, then use LinkedHashMap. If you need to get the keys back in their true/natural order, then use TreeMap. Otherwise, HashMap is probably best. It is typically faster and requires less overhead.