JAVAGURU INTRODUCTION TO JAVA

LESSON 9

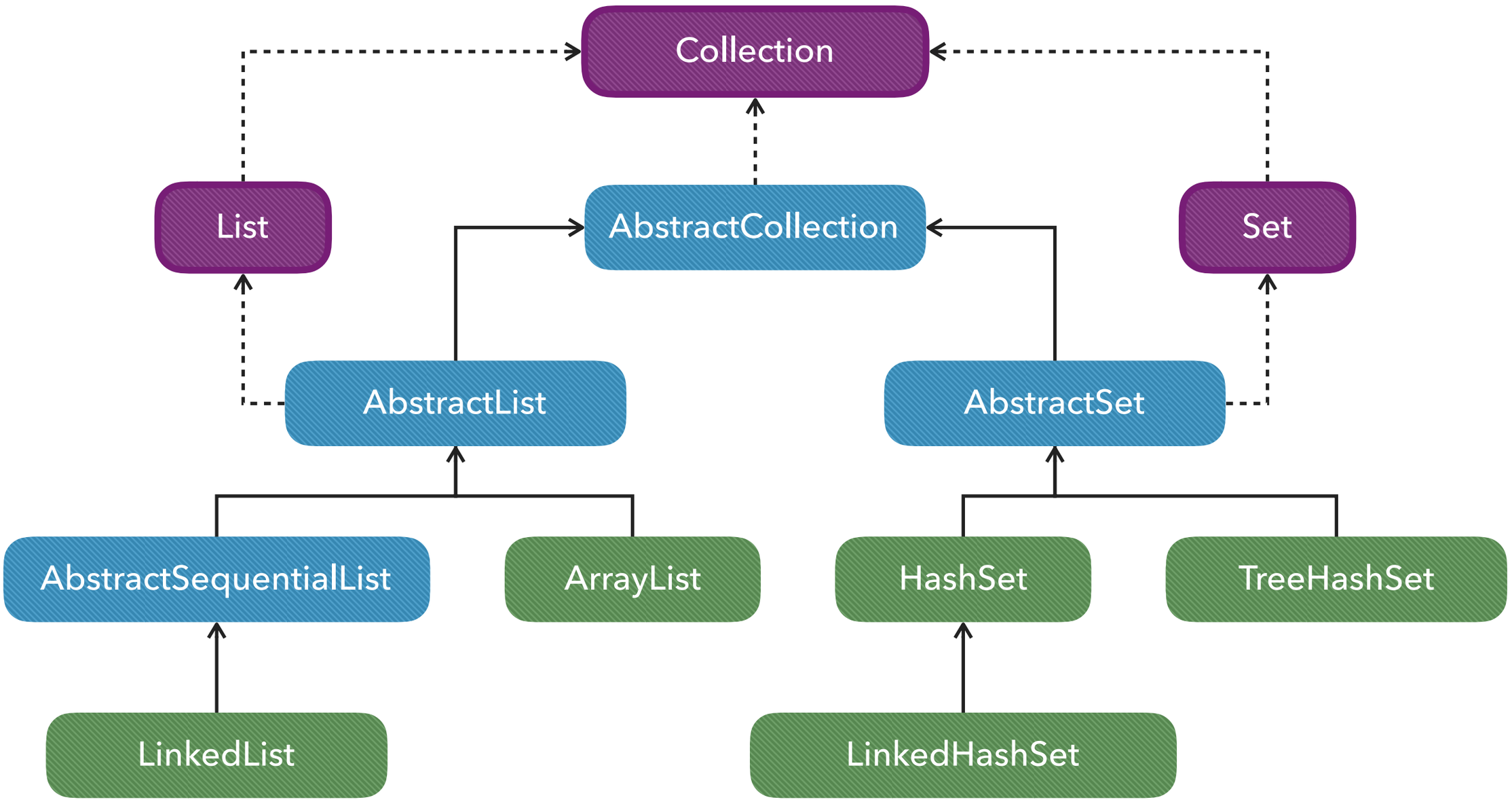
COLLECTIONS API

OVERVIEW

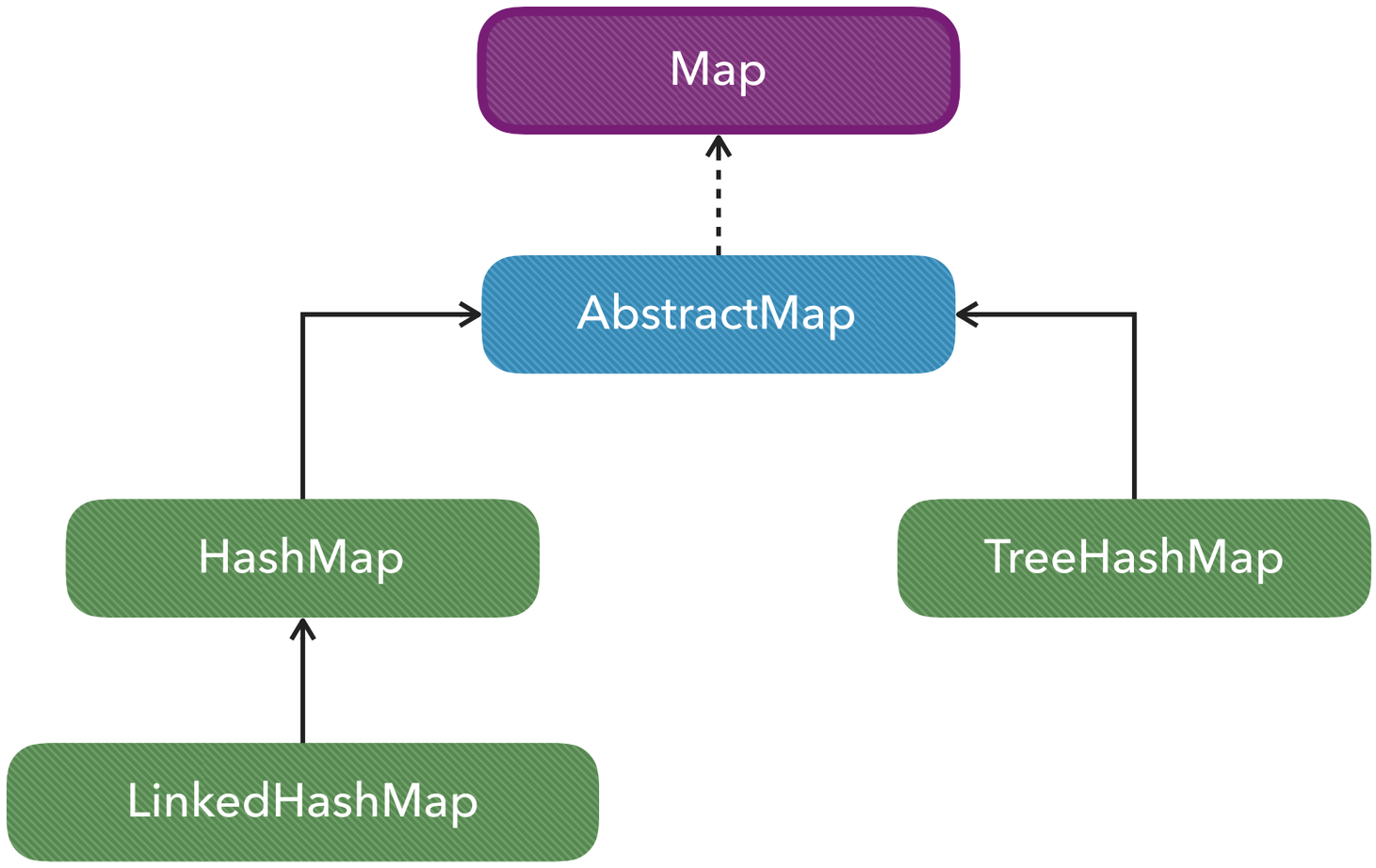
REASONING

- Plain data structures (e.g. arrays) are simple and fast, but cumbersome to work with
- Initially Java provided some tools to store and manipulate group of objects, but they lacked unifying theme
- Language developers wanted to design such framework, that would meet several goals
  - High performance
  - Support high degree of interoperability and abstraction
  - Extend and adapt collections easily

COLLECTIONS API HIERARCHY: COLLECTION



COLLECTIONS API HIERARCHY: MAP



1. COLLECTION CHARACTERISTICS

- Ordered
  - Whether it is possible to iterate over the elements of an ordered collection in a predictable order
- Uniqueness of elements
  - Some collections do not allow duplicate elements
- Thread safety
  - Whether it is safe to work with collection in multithreaded environment

2. COLLECTION CHARACTERISTICS

- Underlying storage structure
  - Array based storage
    - Fast to access but slow to remove or insert
  - Linked-list based storage
    - Efficient at removing or inserting but slower for access
- Hash based storage
  - Reasonably efficient access
- Tree based storage
  - Efficient for searching

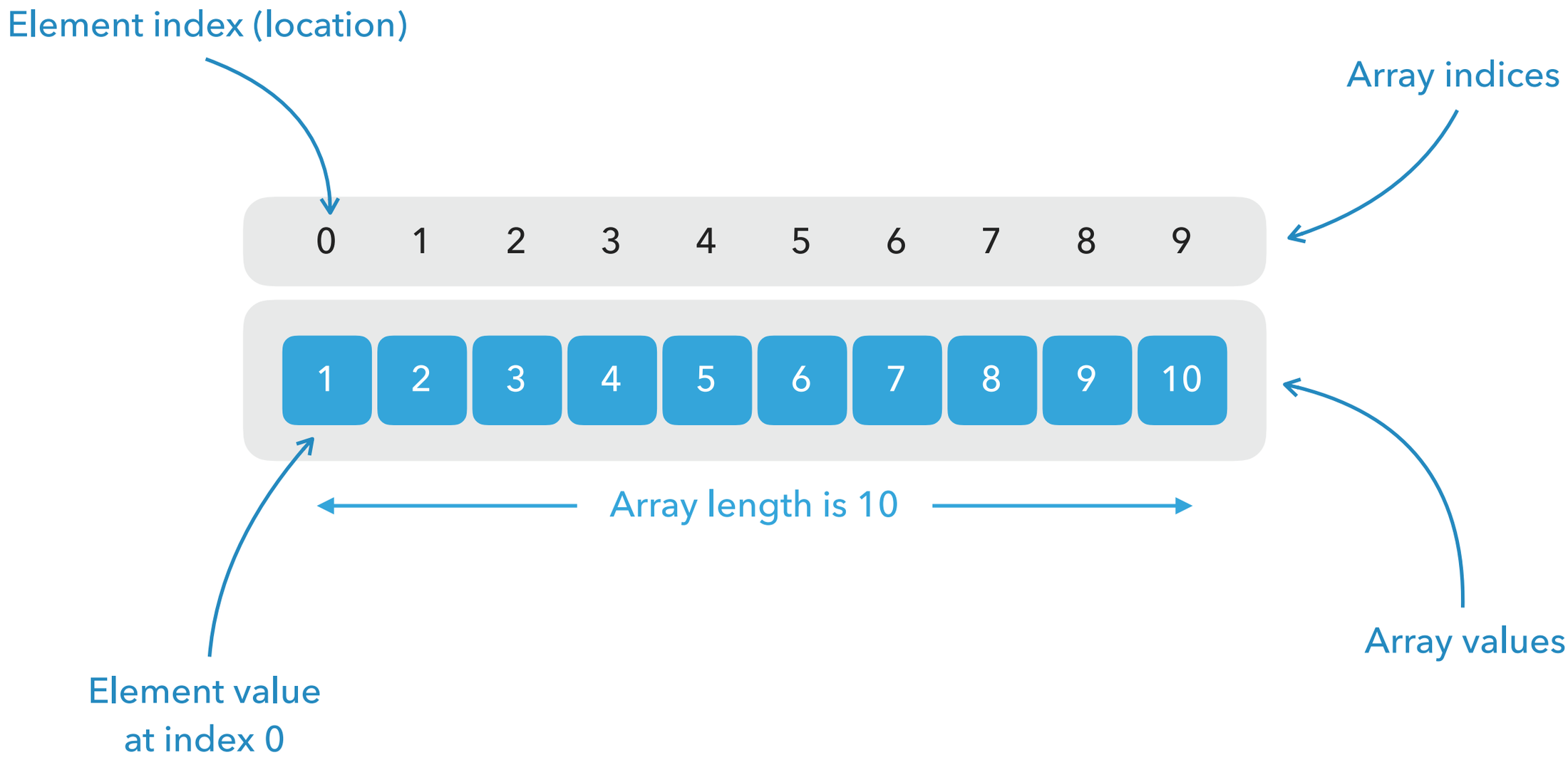
ARRAYLIST

INTERNALS

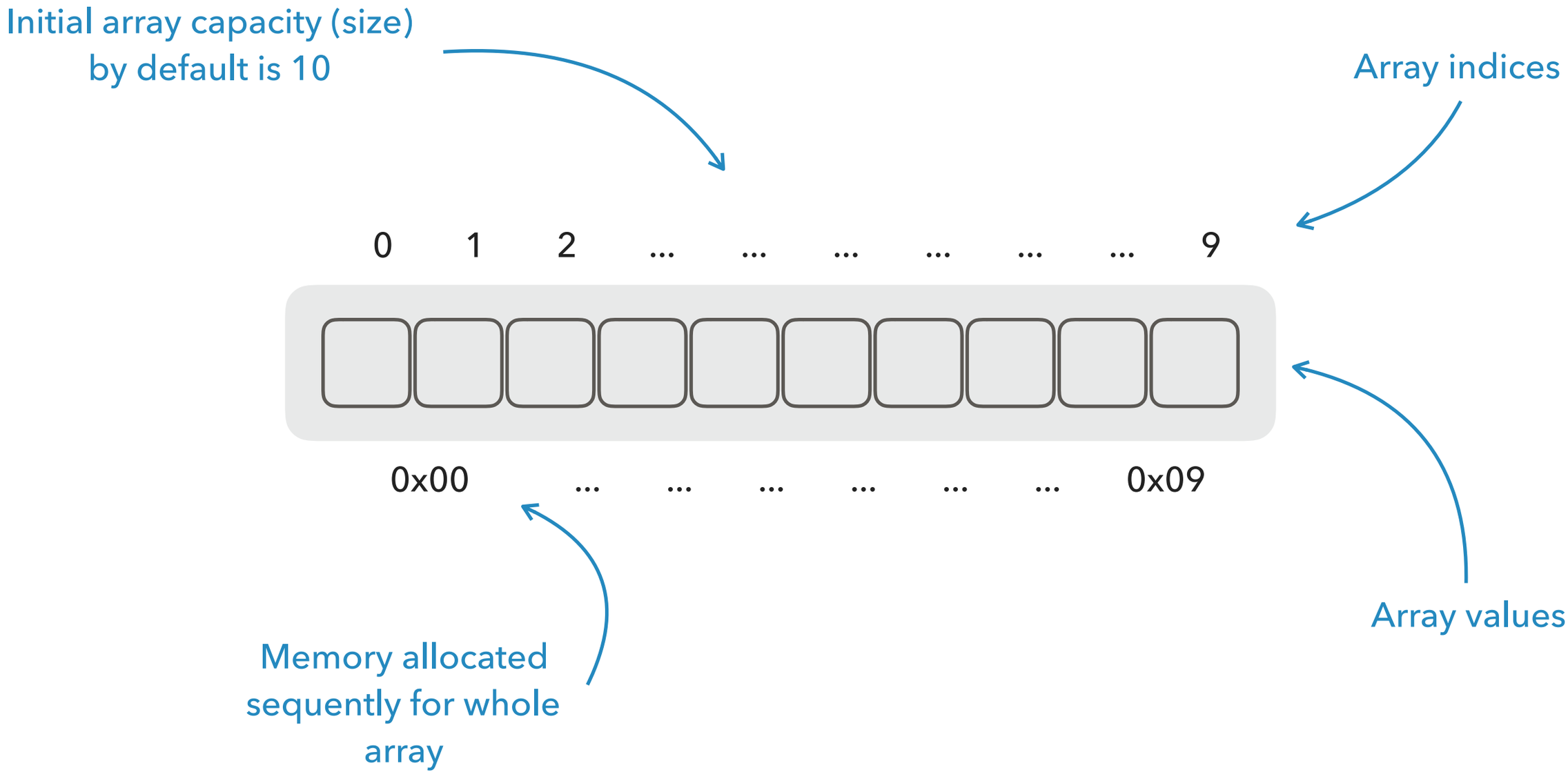
RESIZABLE ARRAY IMPLEMENTATION OF THE LIST INTERFACE

Java Documentation

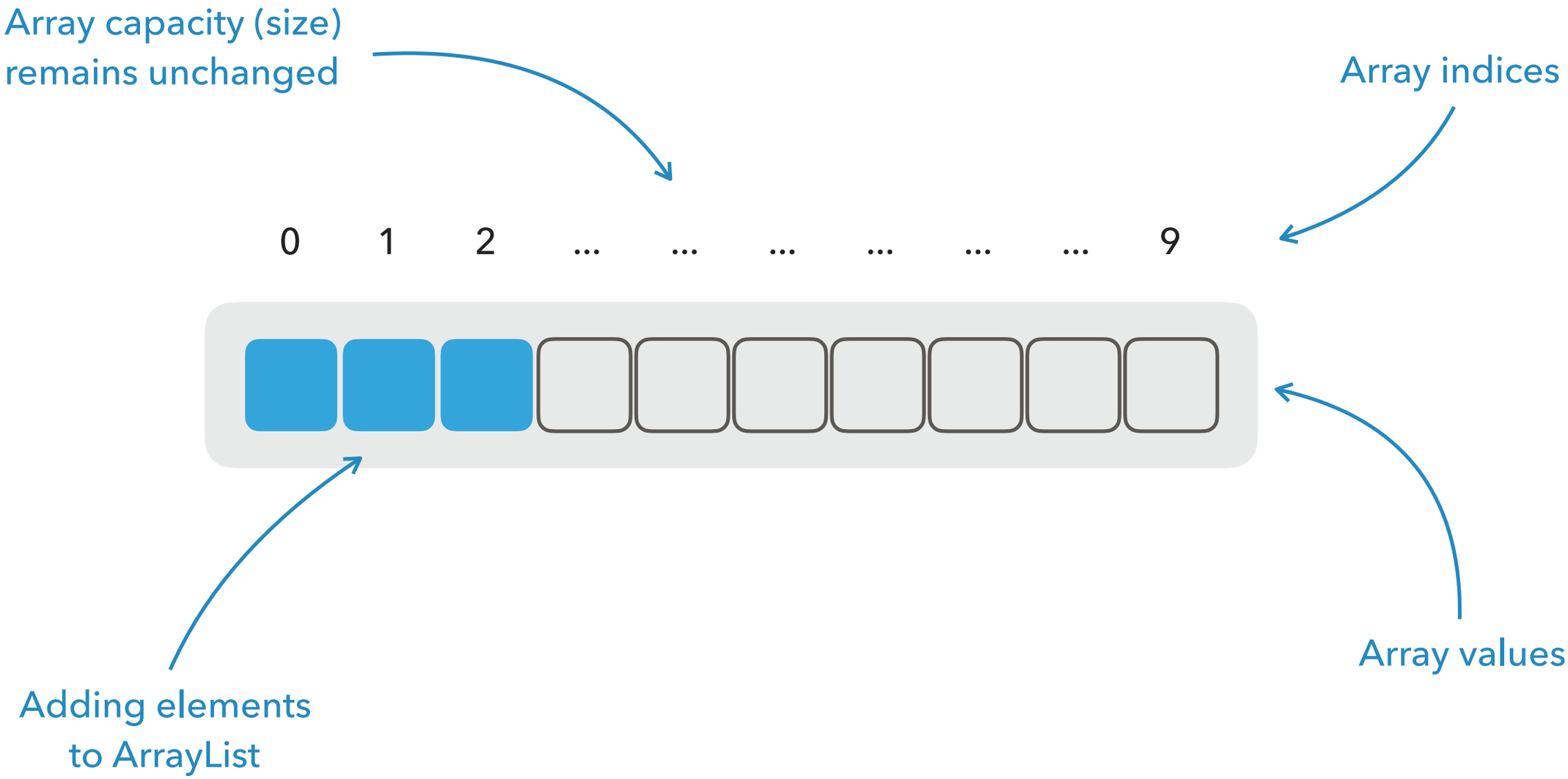
ARRAYLIST INTERNAL DATA STRUCTURE REPRESENTATION



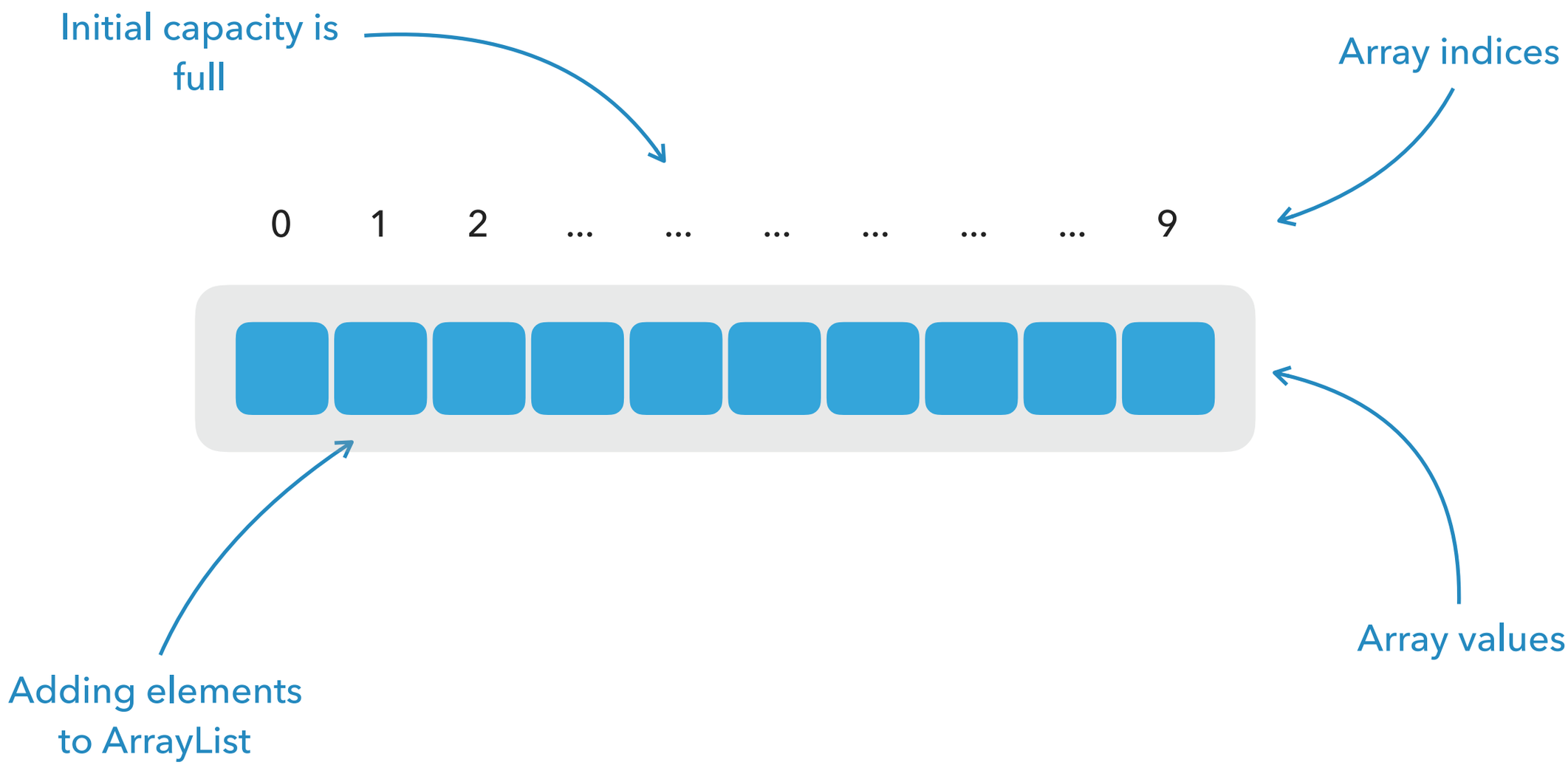
1. ARRAYLIST INSERTION PROCESS: INITIALIZATION



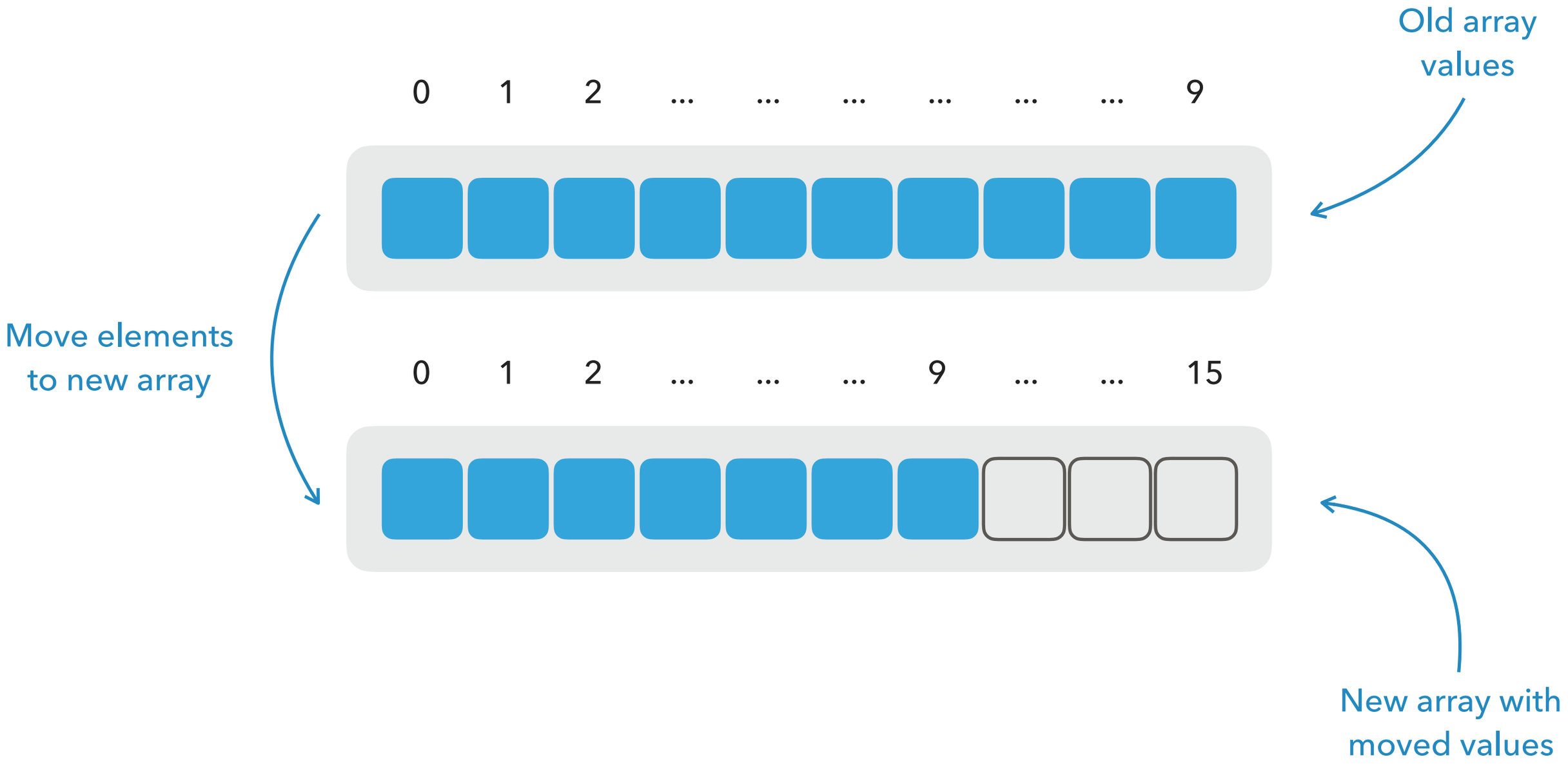
2. ARRAYLIST INSERTION PROCESS: ADDING ELEMENTS



3. ARRAYLIST INSERTION PROCESS: HIT CAPACITY CAP



4. ARRAYLIST INSERTION PROCESS: COPY TO NEW ARRAY



ARRAYLIST CAPACITY INCREMENT EQUATION

Increase capacity by roughly 50%

```
int newCapacity = (oldCapacity * 3)/2 + 1;
```

ARRAYLIST (WITH DEFAULT CAPACITY): CODE EXAMPLE

Code

```
List<String> scaryStories = new ArrayList<>();
scaryStories.add("Your browser history is public");
scaryStories.add("You didn't kill that spider");

for (String story : scaryStories) { System.out.println(story); }
```

Console output

```
Your browser history is public
You didn't kill that spider
```

ARRAYLIST (WITH SPECIFIED CAPACITY): CODE EXAMPLE

Code

```
List<String> scaryStories = new ArrayList<>(15);
scaryStories.add("Your browser history is public");
scaryStories.add("You didn't kill that spider");

for (String story : scaryStories) { System.out.println(story); }
```

Console output

```
Your browser history is public
You didn't kill that spider
```

ARRAYLIST CHARACTERISTICS: RECAP

- It is a resizable array, also called a dynamic array
- It internally uses an array to store the elements
- It allows duplicate values
- It is an ordered collection
- It can store only non-primitive values

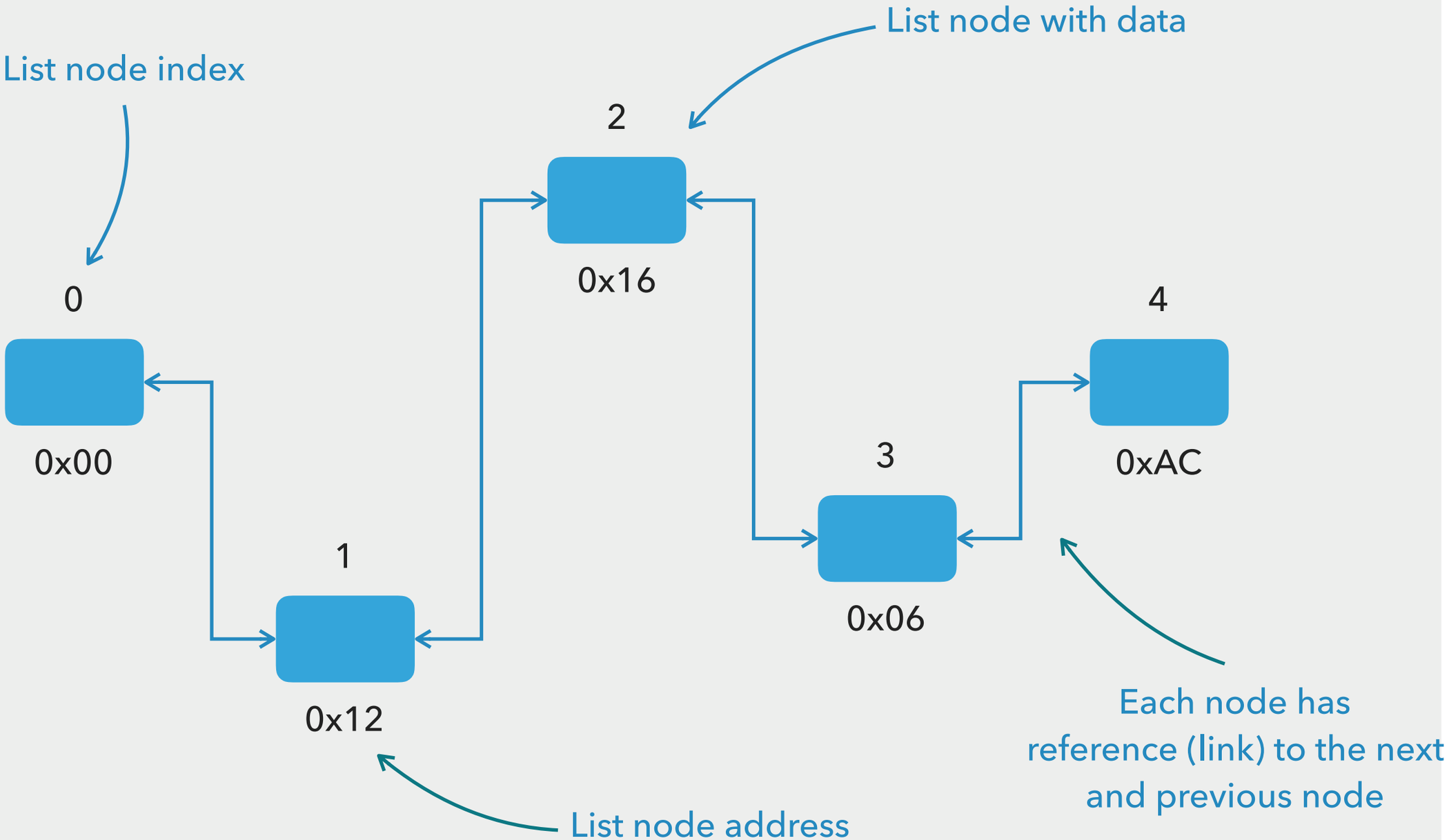
LINKEDLIST

INTERNALS

DOUBLY-LINKED LIST IMPLEMENTATION OF THE LIST AND DEQUE INTERFACES

Java Documentation

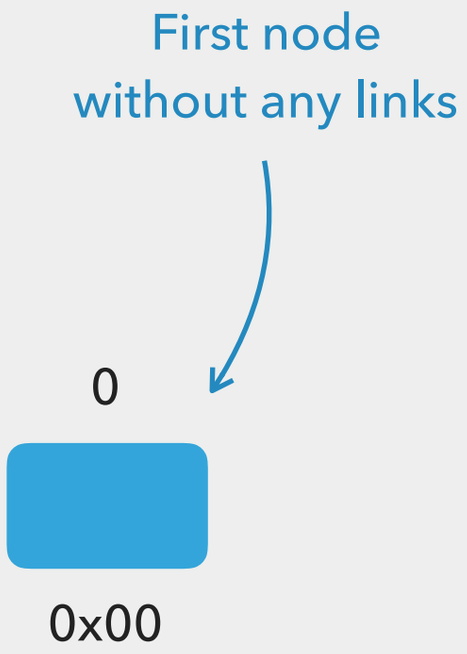
LINKEDLIST INTERNAL DATA STRUCTURE REPRESENTATION



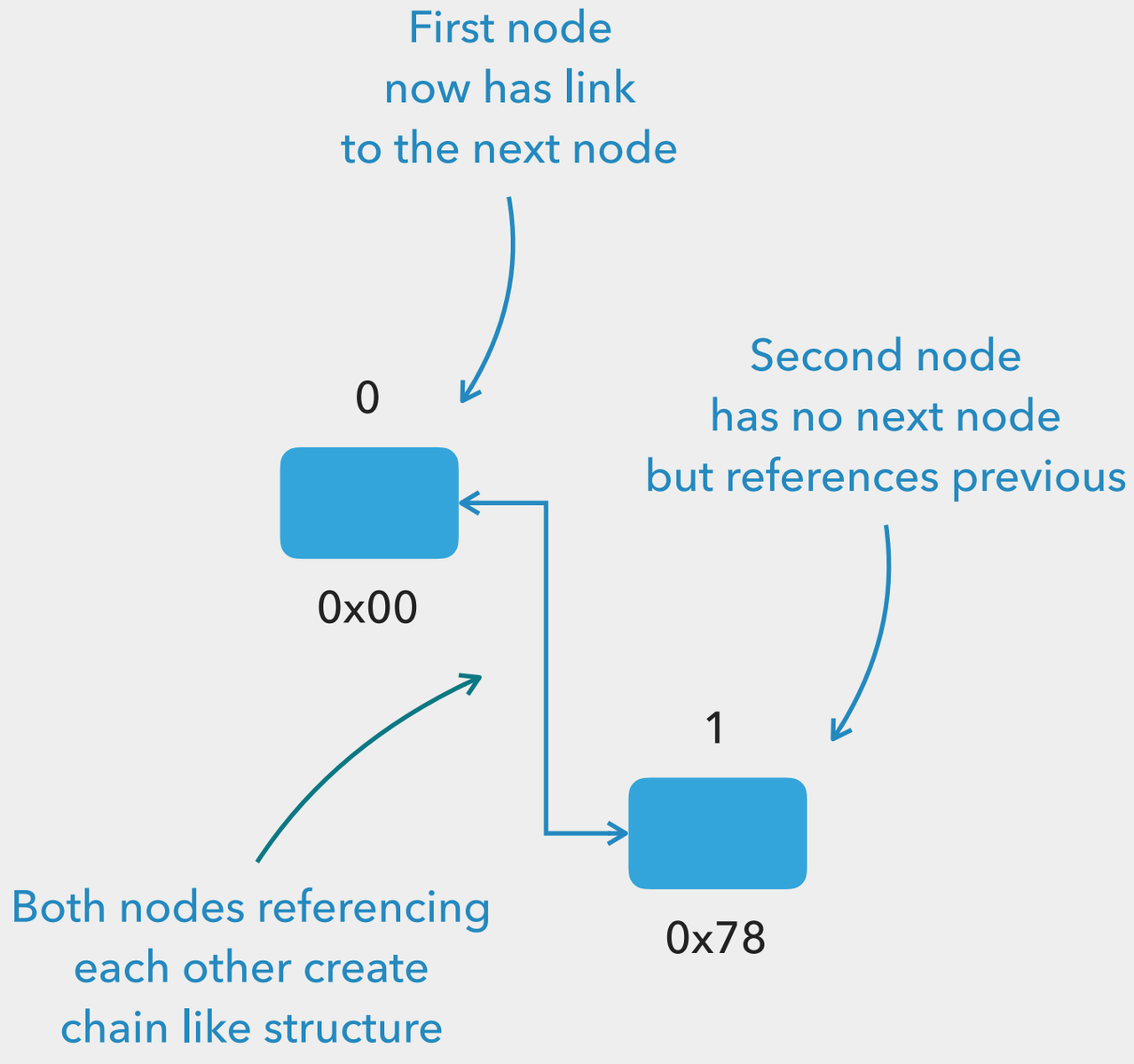
1. LINKEDLIST INSERTION PROCESS: INITIALIZATION

It starts totally empty..

2. LINKEDLIST INSERTION PROCESS: ADDING FIRST ELEMENT



2. LINKEDLIST INSERTION PROCESS: ADDING NTH ELEMENTS



LINKEDLIST: CODE EXAMPLE

Code

```
List<String> things = new LinkedList<>();
things.add("Computer");
things.add("Coffee");
for (String thing: things) { System.out.println(thing); }
```

Console output

```
Computer
Coffee
```

LINKEDLIST CHARACTERISTICS: RECAP

- Internally uses distinct objects which are referencing each other
- It allows duplicate and null values
- It is an ordered collection
- It can store only non-primitive values

ARRAYLIST AND LINKEDLIST KEY DIFFERENCES

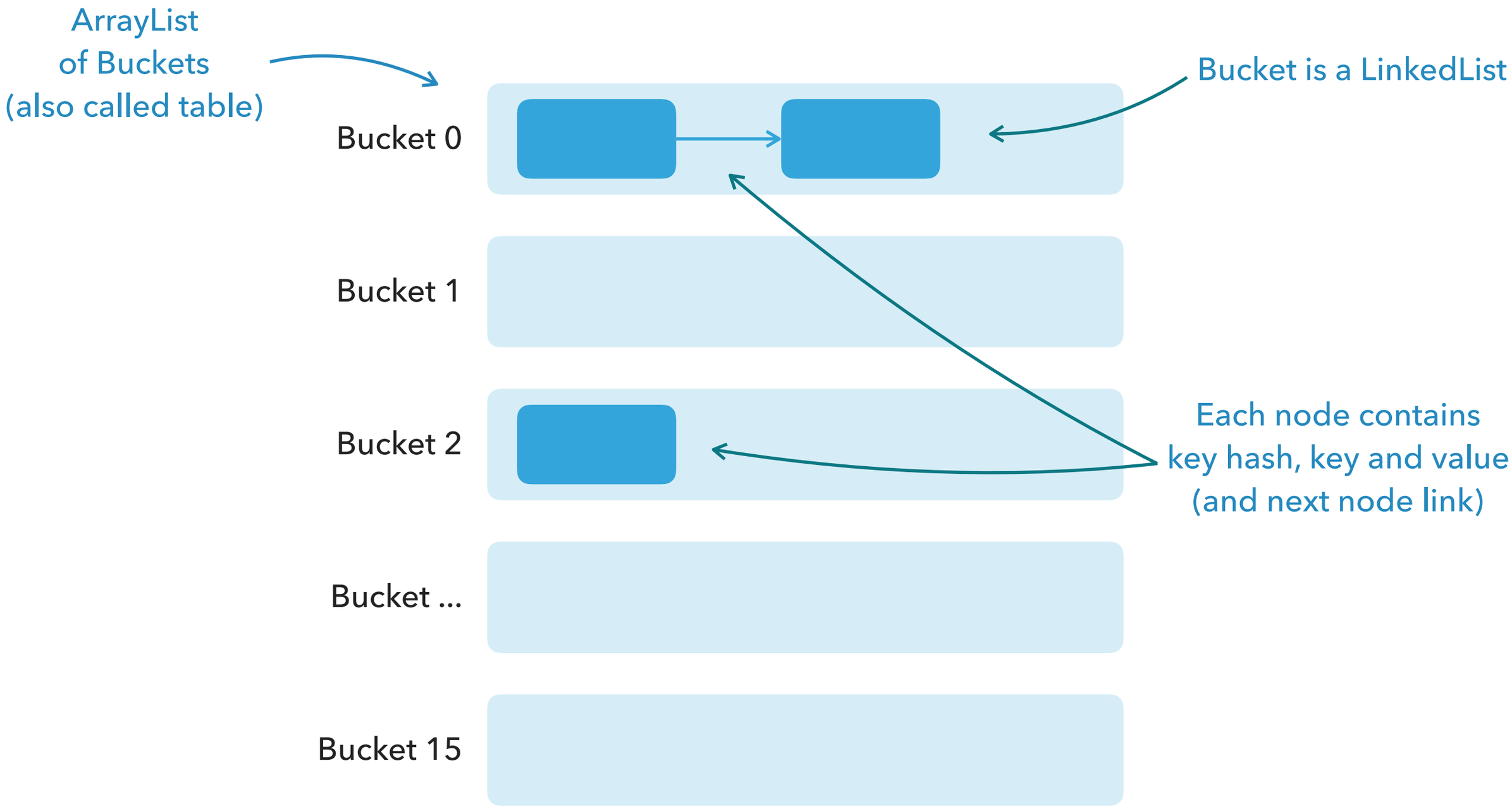
- Memory consumption:
  - LinkedList consumes more memory than an ArrayList because it also stores the next and previous references along with the data
- Accessing data:
  - An element can be accessed in an ArrayList in O(1) time (directly by index)
  - It takes O(n) time to access an element in a LinkedList (traverse to the desired element though references)
- Addition or removal:
  - ArrayList is usually slower, because the elements in the ArrayList needs to be shifted if element is added or removed in the middle (capacity changes matter as well)
  - LinkedList is faster because only references must be changed

HASHMAP INTERNALS

HASH TABLE BASED IMPLEMENTATION OF THE MAP INTERFACE

Java Documentation

HASHMAP INTERNAL DATA STRUCTURE REPRESENTATION



HASHING 101

- Hash function is a function that produces determined value
- For every argument there is unique hash produced
- Whenever hash function is invoked with the same argument more than once, the hash value is consistently the same
- Equal arguments should return equal hashes
- Whenever two different arguments return equal hashes, it is called collision
- Hash function is one way: original value cannot be obtained or calculated from hash

HASHCODE AND EQUALS CONTRACT

- Developers should override both methods in order to achieve a fully working equality mechanism
- If two objects are equal according to the *equals()* method, then calling the *hashcode()* method on each of the two objects must produce the same integer result

1. HASHCODE AND EQUALS CONTRACT: CODE EXAMPLE

```
public class Bag {

    private String brand;
    private String material;

    public Bag(String brand, String material) {
        this.brand = brand;
        this.material = material;
    }

    @Override
    public boolean equals(Object o) {
        if (this == o) return true;
        if (o == null || getClass() != o.getClass()) return false;
        Bag bag = (Bag) o;
        return Objects.equals(brand, bag.brand) &&
                Objects.equals(material, bag.material);
    }

    @Override
    public int hashCode() {
        return Objects.hash(brand, material);
    }

}
```

Overriding equals method by specifying which fields to compare

Overriding hashCode method by specifying which fields to hash

2. HASHCODE AND EQUALS CONTRACT: CODE EXAMPLE

Code

```
Bag mk = new Bag("Michael Kors", "suede");
Bag gucci = new Bag("Gucci", "leather");

System.out.println("Michael Kors = " + mk.hashCode());
System.out.println("Gucci = " + gucci.hashCode());
```

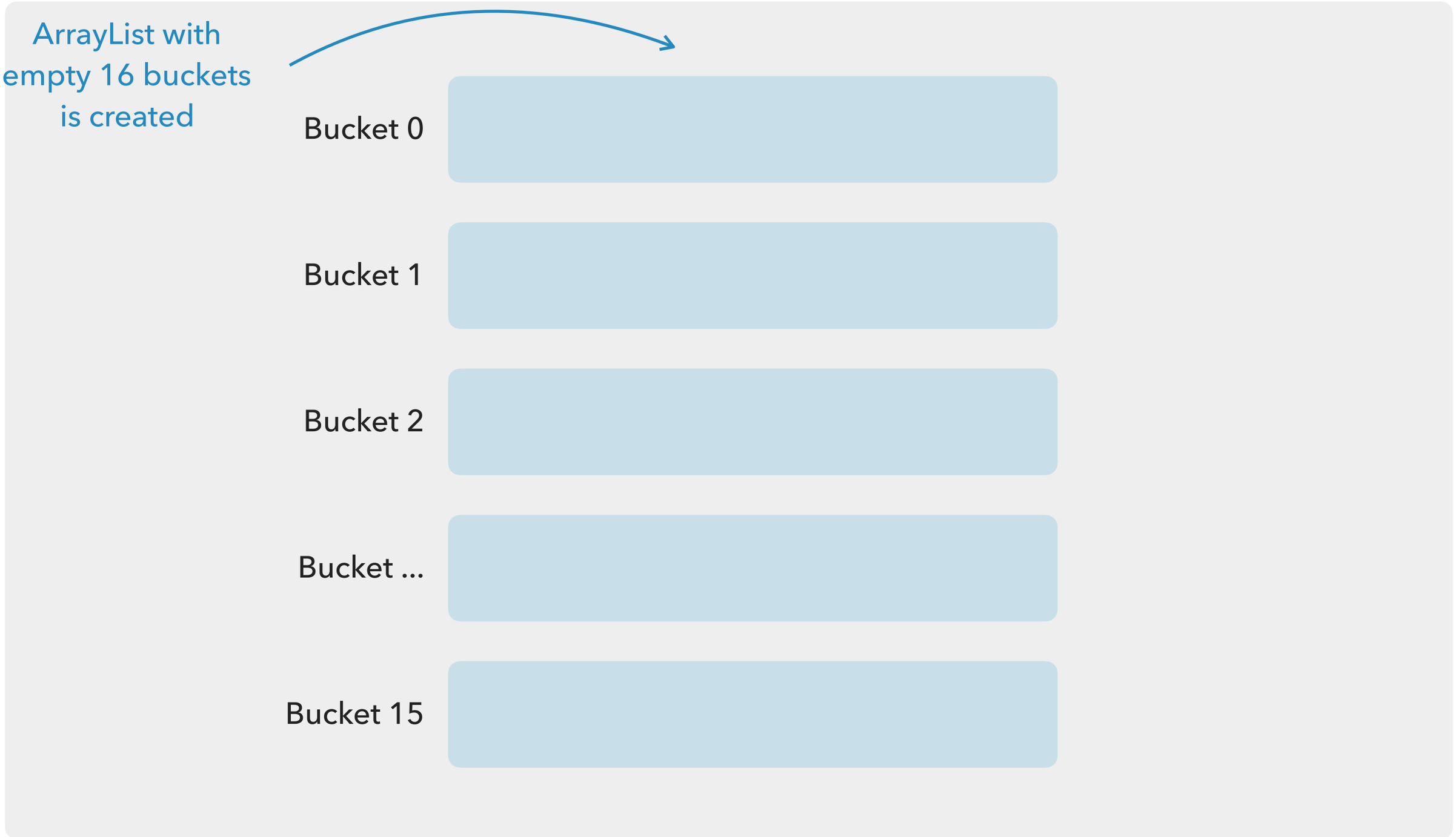
Console output

```
Michael Kors = 1944981575
Gucci = -2100362481
```

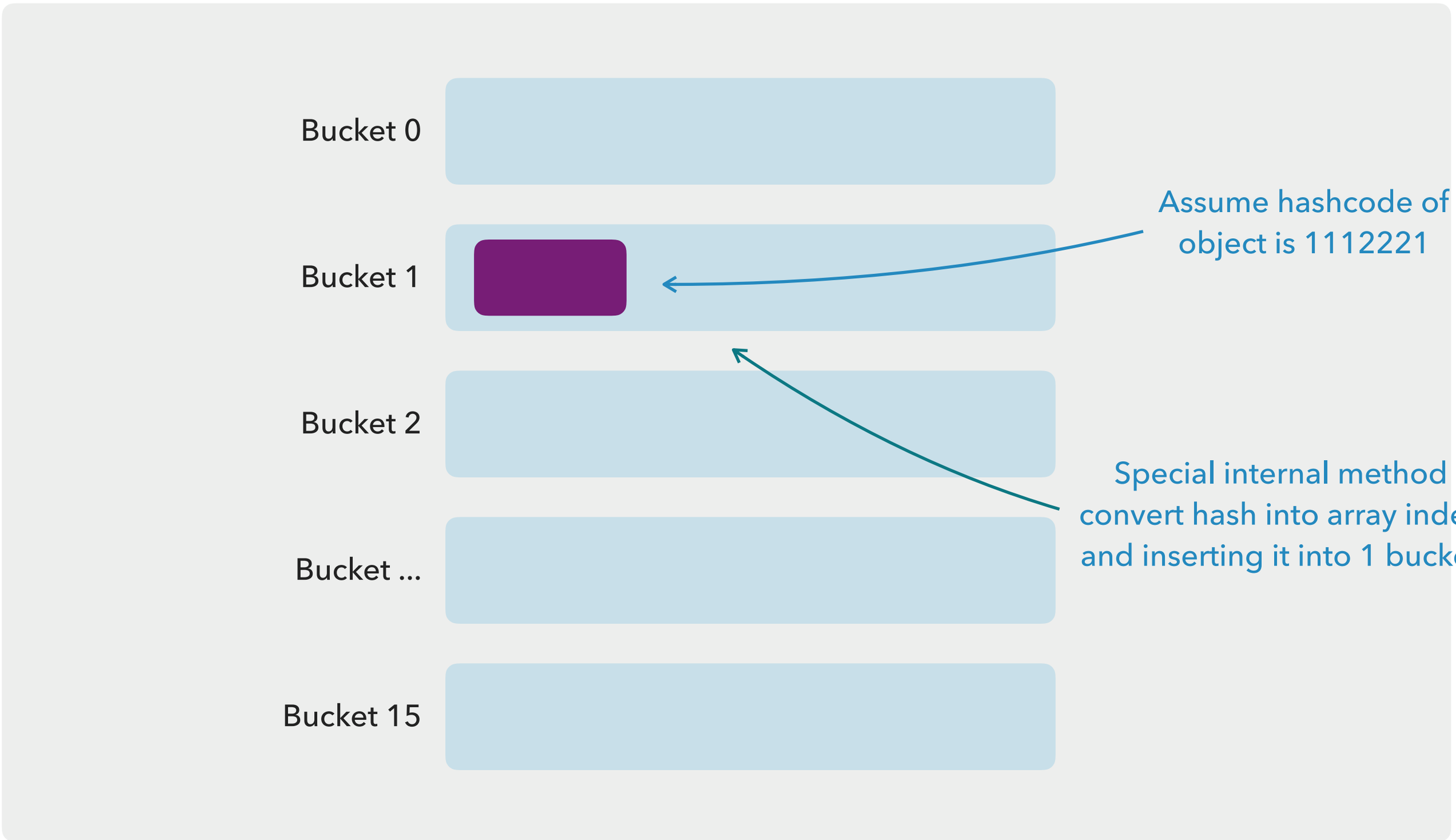
HASHMAP USAGE OF EQUALITY CONTRACT

- An object's hash allows algorithms to put objects into compartments in order to increase lookup speed
- An object's equal method allows algorithms to find exact object in that compartment

1. HASHMAP INSERTION PROCESS: INITIALIZATION



2. HASHMAP INSERTION PROCESS: ADDING ELEMENT



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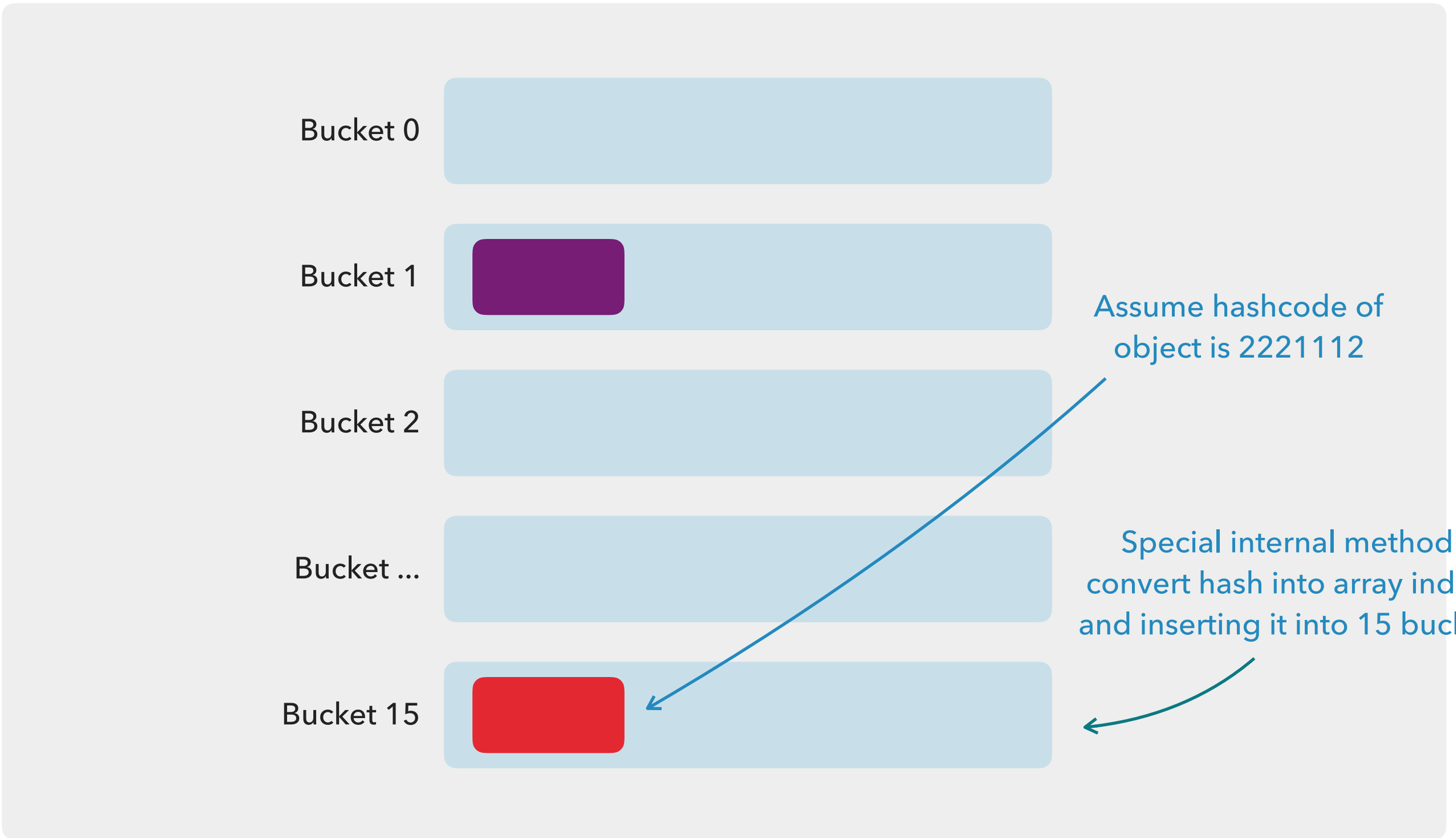

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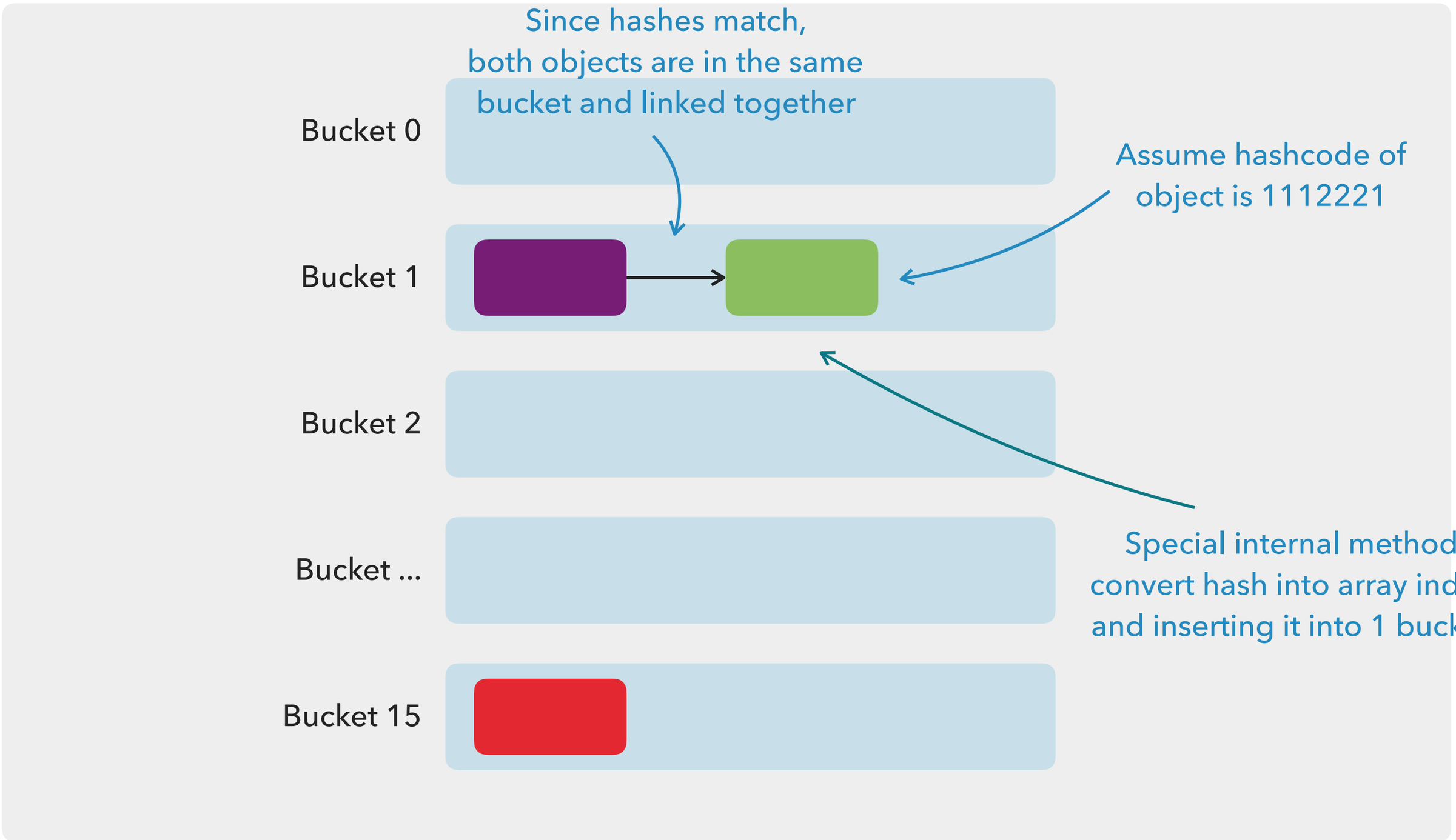


HASHMAP: CODE EXAMPLE

Code

```
Map<String, Integer> tableOfContents = new HashMap<>();
tableOfContents.put("Introduction", 3);
tableOfContents.put("Chapter 1", 15);
tableOfContents.put("Chapter 2", 48);

System.out.println(tableOfContents);
```

Console output

```
{Introduction=3, Chapter 1=15, Chapter 2=48}
```

HASHMAP CHARACTERISTICS: RECAP

- Internally uses ArrayList (with buckets as elements) and each bucket contains LinkedList
- It doesn't allow duplicate keys
- It allows single null key and multiple null values
- It is an unordered collection
- It can store only non-primitive values

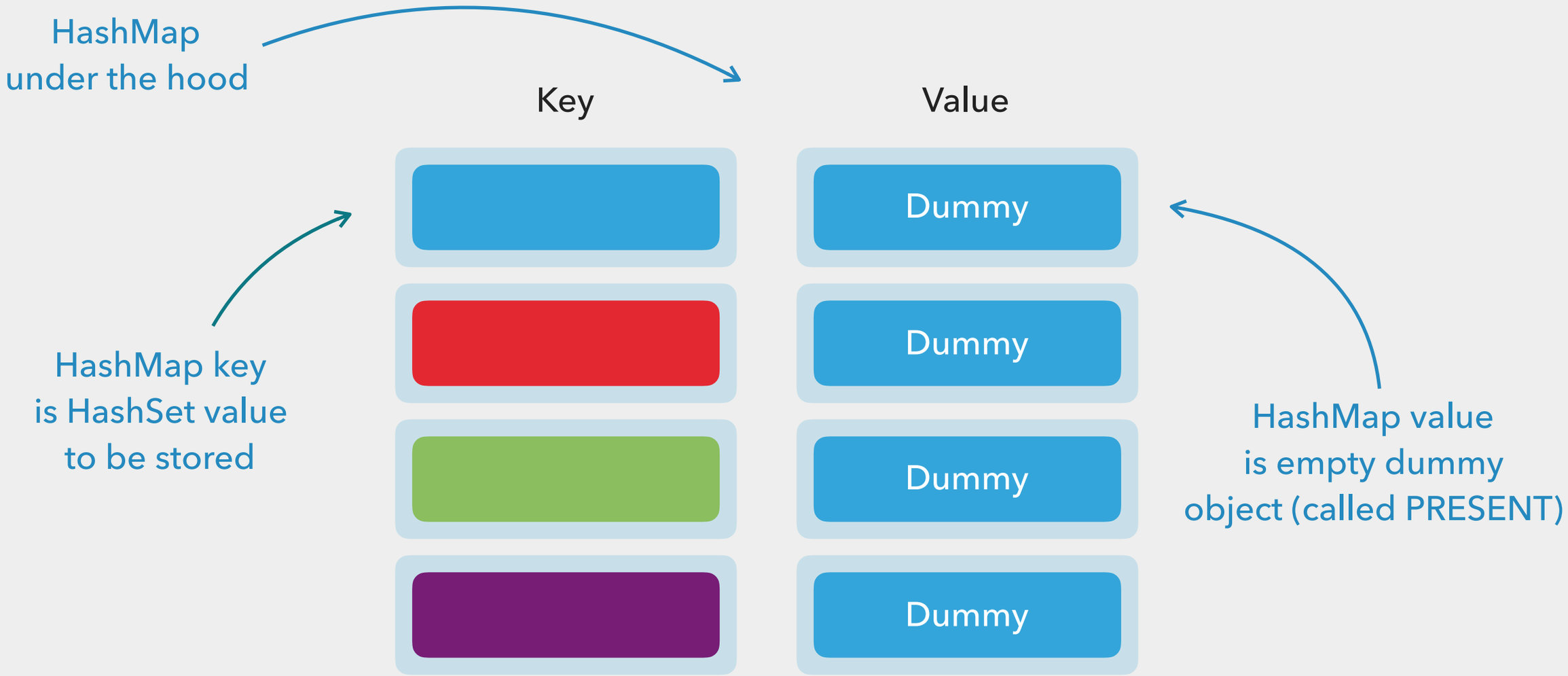
HASHSET

INTERNALS

THIS CLASS IMPLEMENTS THE SET INTERFACE, BACKED BY A HASH TABLE

Java Documentation

HASHMAP INTERNAL DATA STRUCTURE REPRESENTATION



HASHSET: CODE EXAMPLE

Code

```
Set<String> cities = new HashSet<>();
cities.add("Riga"); cities.add("Ogre"); cities.add("Riga");

System.out.println("cities = " + cities);
```

Console output

```
cities = [Riga, Ogre]
```

HASHSET CHARACTERISTICS: RECAP

- Internally uses HashMap to store its elements
- It doesn't allow duplicate values
- It allows single null value
- It is an unordered collection
- It can store only non-primitive values

REFERENCES

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