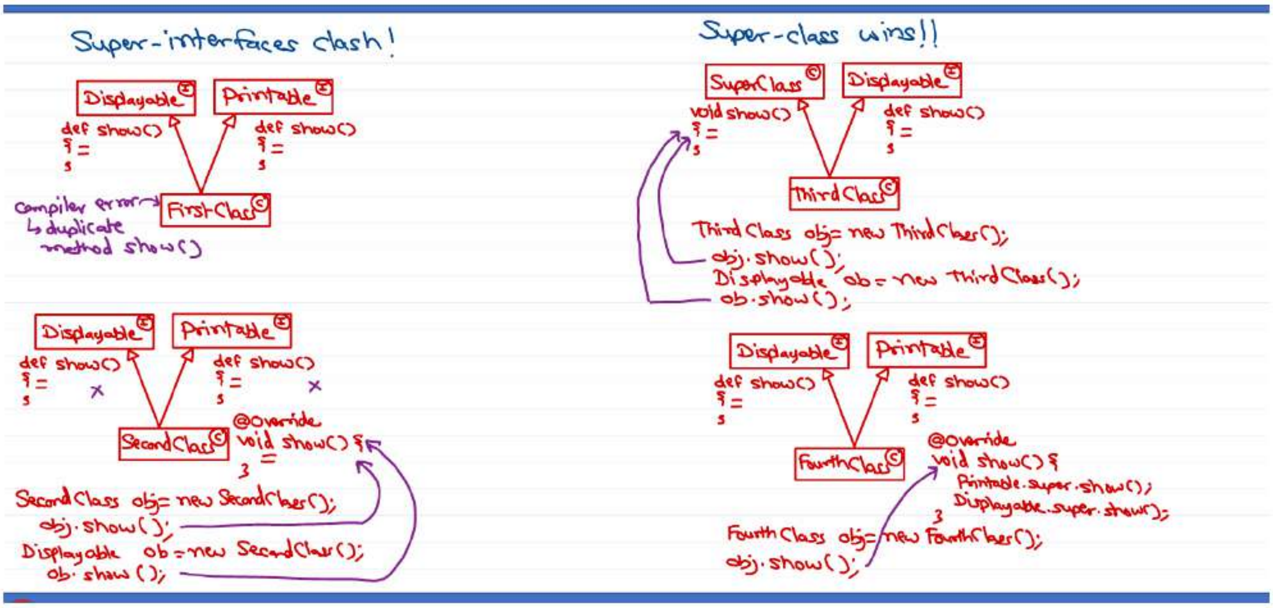
Default methods



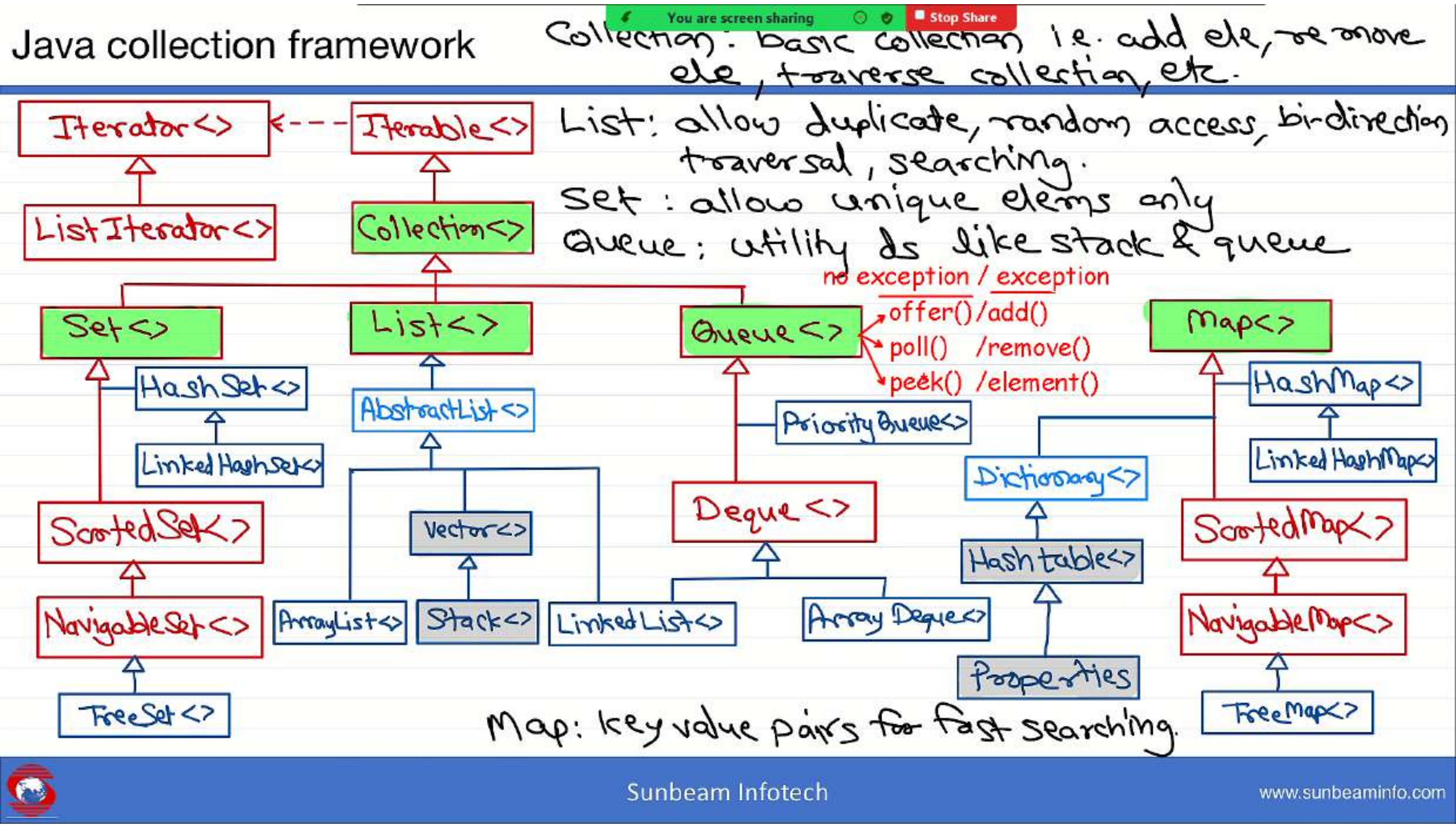
Super-interfaces clash!

```
@Override
void show() {
 =
}
SecondClass obj= new SecondClass();
  obj.show();
Displayable ob = new SecondClass();
  ob.show();
```

Super-class wins!!

```
ThirdClass obj= new ThirdClass();
  obj.show();
  Displayable ob = new ThirdClass();
  ob.show();
```

```
@Override
void show() {
  Printable.super.show();
  Displayable.super.show();
}
FourthClass obj= new FourthClass();
obj.show();
```



Java collection framework

Collection: basic collection i.e. add ele, remove ele, traverse collection, etc.

List: allow duplicate, random access, bi-direction traversal, searching.

Set : allow unique elems only

Queue: utility ds like stack & queue

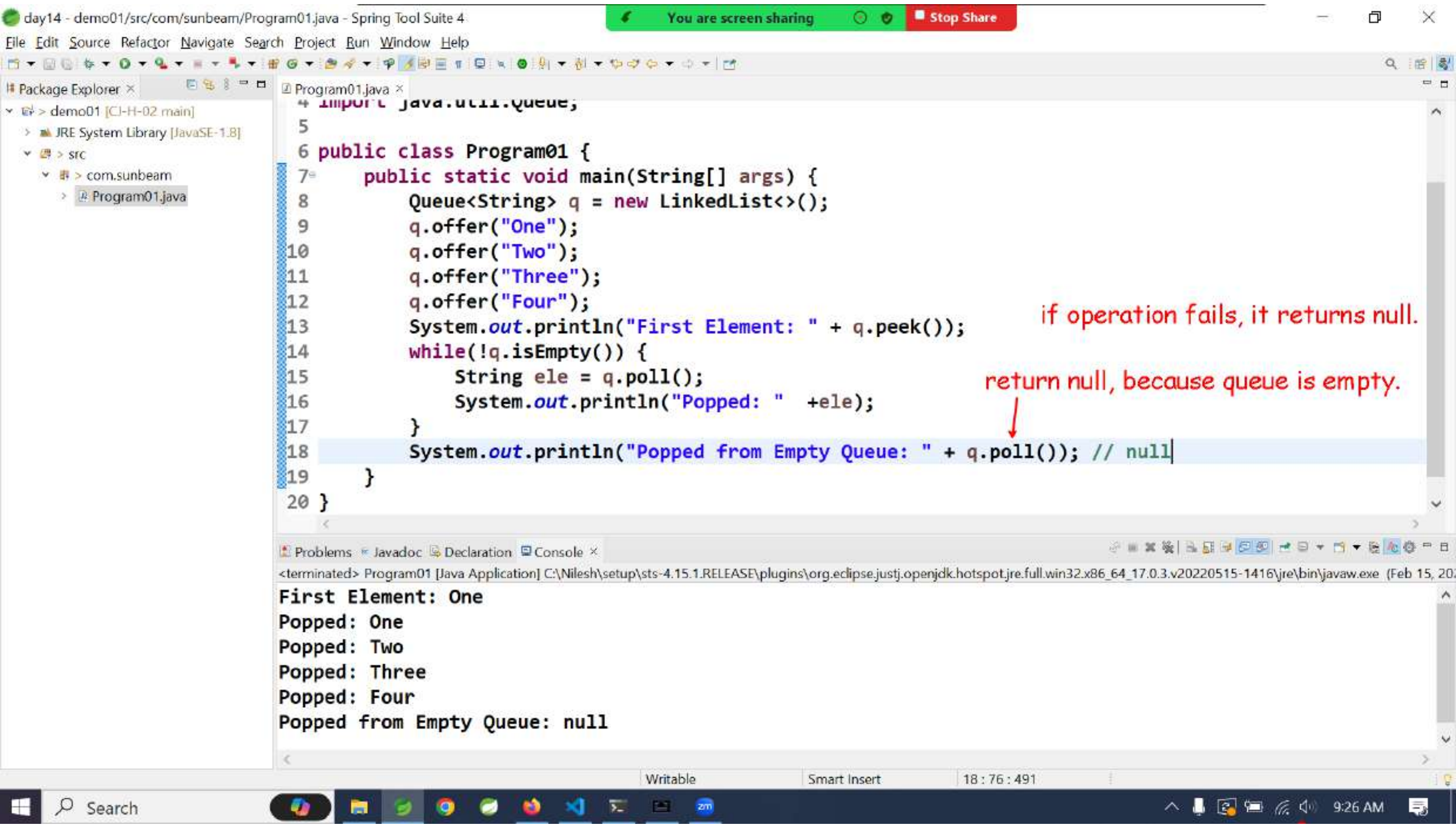
no exception / exception

offer()/add()

poll() /remove()

peek() /element()

Map: key value pairs for fast searching.

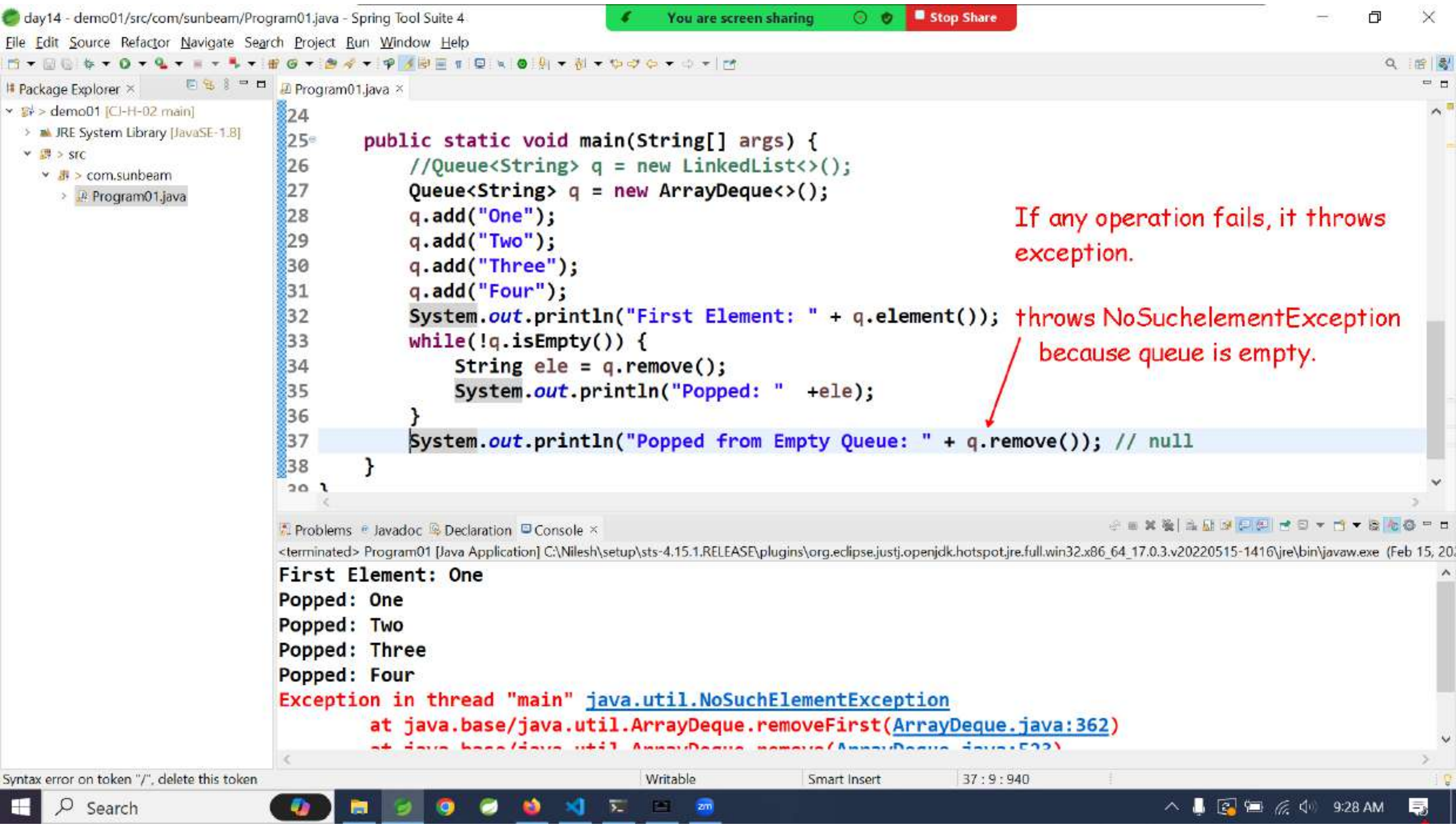


```java
import java.util.Queue;

public class Program01 {
    public static void main(String[] args) {
        Queue<String> q = new LinkedList<>();
        q.offer("One");
        q.offer("Two");
        q.offer("Three");
        q.offer("Four");
        System.out.println("First Element: " + q.peek());
        while(!q.isEmpty()) {
            String ele = q.poll();
            System.out.println("Popped: "  +ele);
        }
        System.out.println("Popped from Empty Queue: " + q.poll()); // null
    }
}
```

if operation fails, it returns null.

return null, because queue is empty.

```
<terminated> Program01 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 20
First Element: One
Popped: One
Popped: Two
Popped: Three
Popped: Four
Popped from Empty Queue: null
```



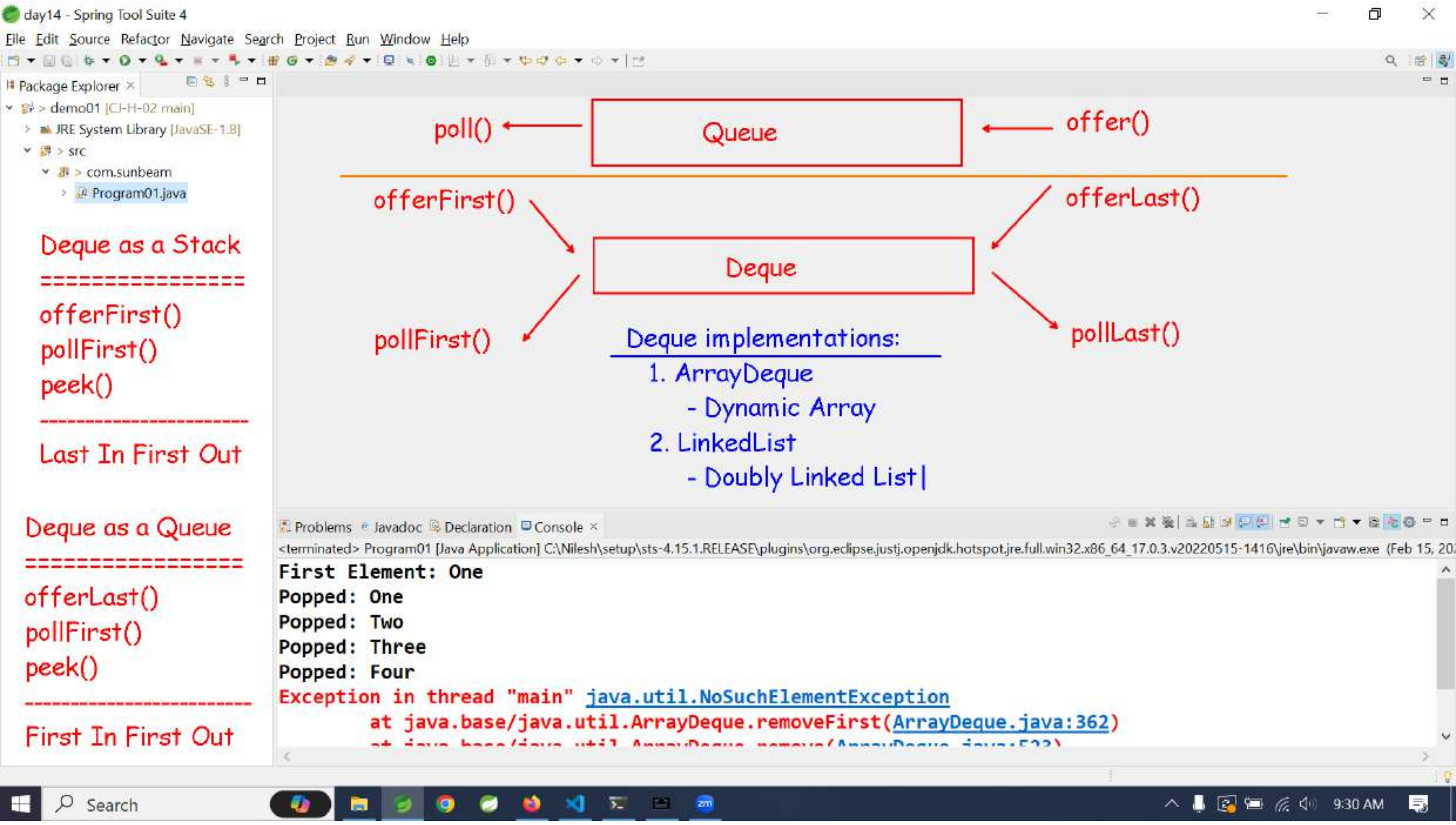
```java

    public static void main(String[] args) {
        //Queue<String> q = new LinkedList<>();
        Queue<String> q = new ArrayDeque<>();
        q.add("One");
        q.add("Two");
        q.add("Three");
        q.add("Four");
        System.out.println("First Element: " + q.element());
        while(!q.isEmpty()) {
            String ele = q.remove();
            System.out.println("Popped: "  +ele);
        }
        System.out.println("Popped from Empty Queue: " + q.remove()); // null
    }
}
```

If any operation fails, it throws exception.

throws NoSuchelementException because queue is empty.

```
<terminated> Program01 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 20
First Element: One
Popped: One
Popped: Two
Popped: Three
Popped: Four
Exception in thread "main" java.util.NoSuchElementException
        at java.base/java.util.ArrayDeque.removeFirst(ArrayDeque.java:362)
        at java.base/java.util.ArrayDeque.remove(ArrayDeque.java:523)
```

Syntax error on token "/", delete this token


day14 - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
demo01 [CJ-H-02 main]
JRE System Library [JavaSE-1.8]
src
com.sunbeam
Program01.java
Problems
Javadoc
Declaration
Console
Search
9:30 AM

poll() ← Queue ← offer()

offerFirst() → Deque ← offerLast()

pollFirst() ← Deque → pollLast()

Deque implementations:

1. ArrayDeque
   - Dynamic Array
2. LinkedList
   - Doubly Linked List|

Deque as a Stack
================
offerFirst()
pollFirst()
peek()

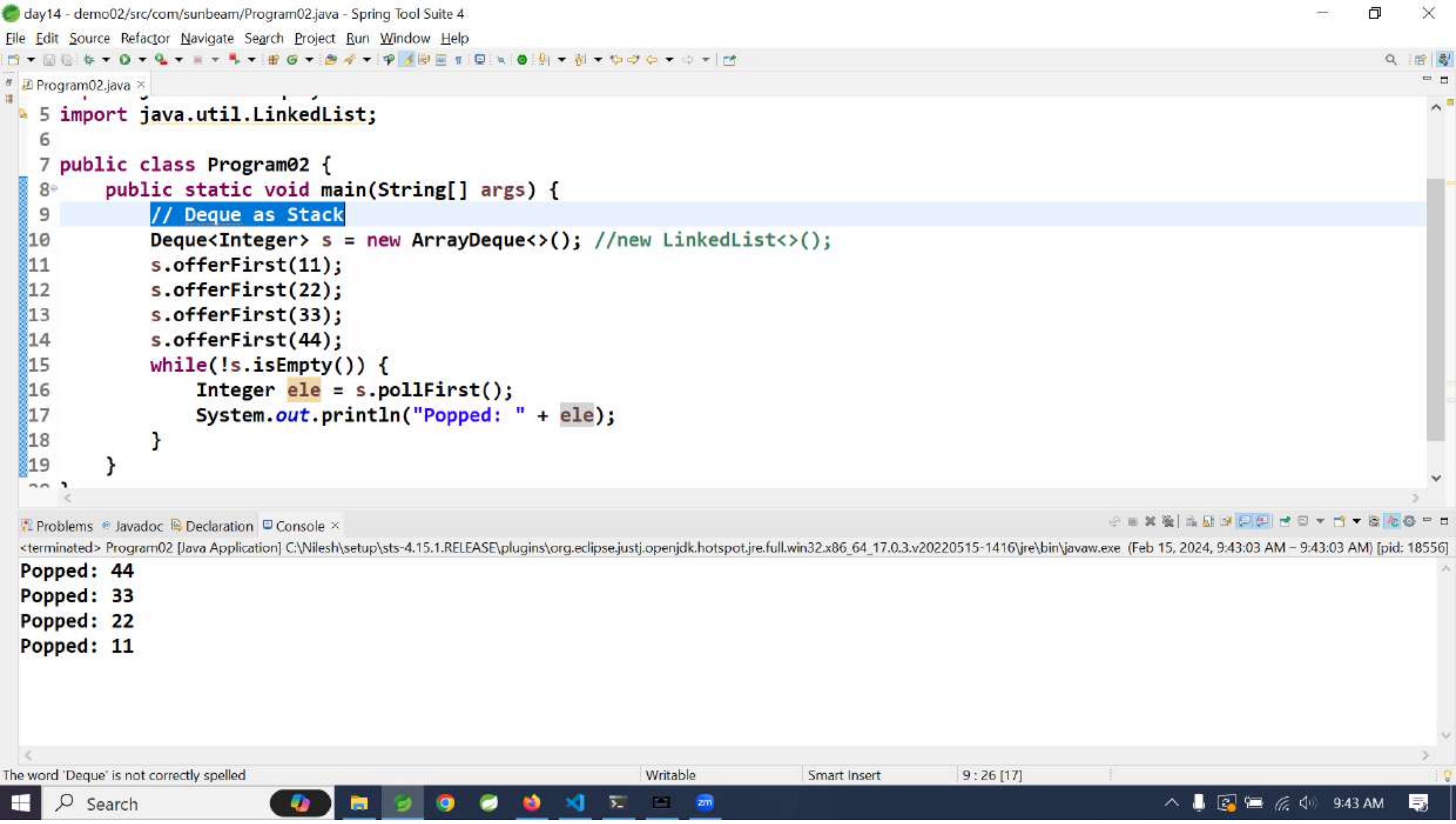
Last In First Out

Deque as a Queue
=================
offerLast()
pollFirst()
peek()

First In First Out

<terminated> Program01 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 20

```
First Element: One
Popped: One
Popped: Two
Popped: Three
Popped: Four
Exception in thread "main" java.util.NoSuchElementException
	at java.base/java.util.ArrayDeque.removeFirst(ArrayDeque.java:362)
	at java.base/java.util.ArrayDeque.remove(ArrayDeque.java:523)
```

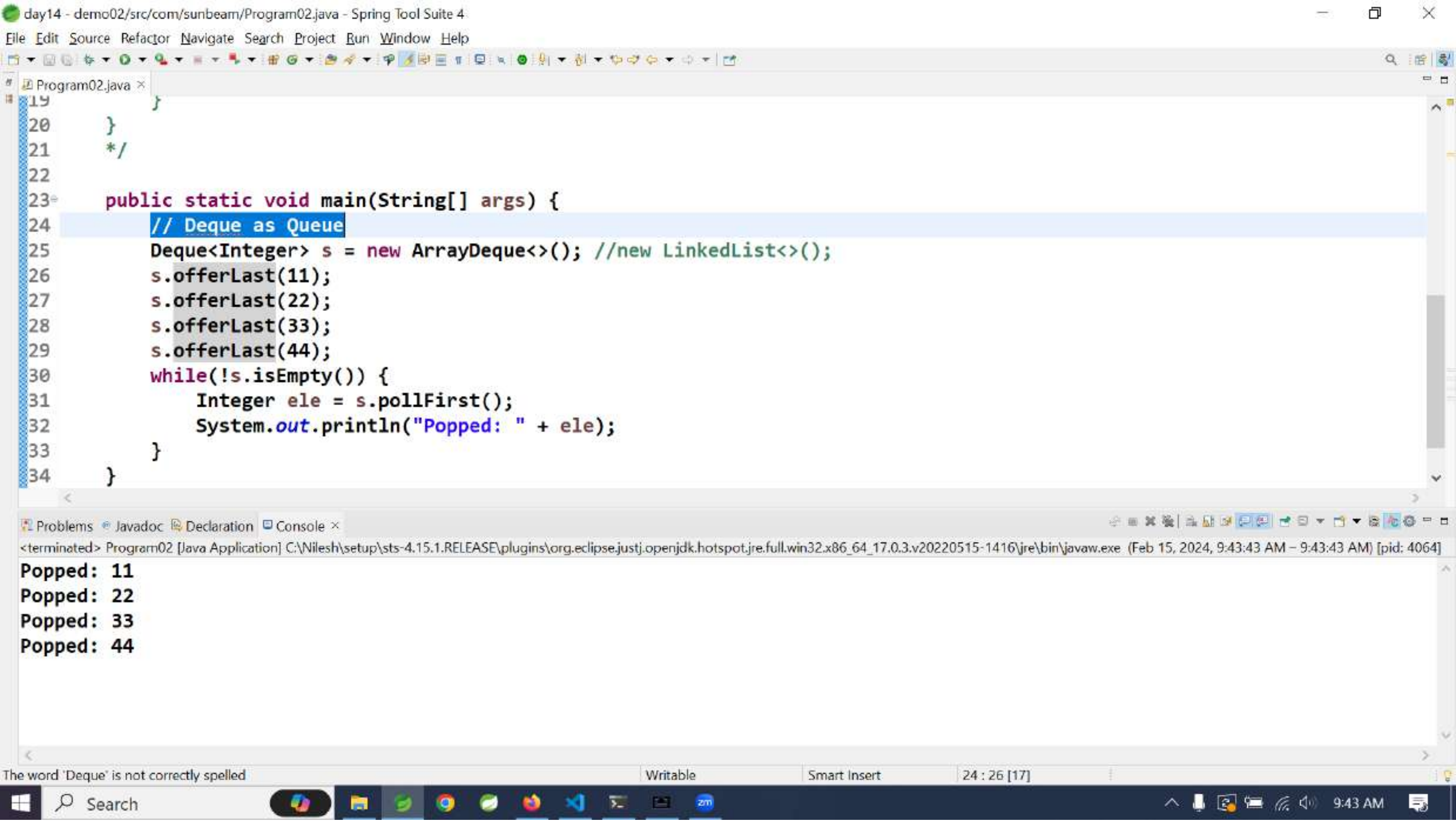

day14 - demo02/src/com/sunbeam/Program02.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program02.java
Problems
Javadoc
Declaration
Console

```java
import java.util.LinkedList;

public class Program02 {
    public static void main(String[] args) {
        // Deque as Stack
        Deque<Integer> s = new ArrayDeque<>(); //new LinkedList<>();
        s.offerFirst(11);
        s.offerFirst(22);
        s.offerFirst(33);
        s.offerFirst(44);
        while(!s.isEmpty()) {
            Integer ele = s.pollFirst();
            System.out.println("Popped: " + ele);
        }
    }
```

<terminated> Program02 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 2024, 9:43:03 AM – 9:43:03 AM) [pid: 18556]

```
Popped: 44
Popped: 33
Popped: 22
Popped: 11
```

The word 'Deque' is not correctly spelled

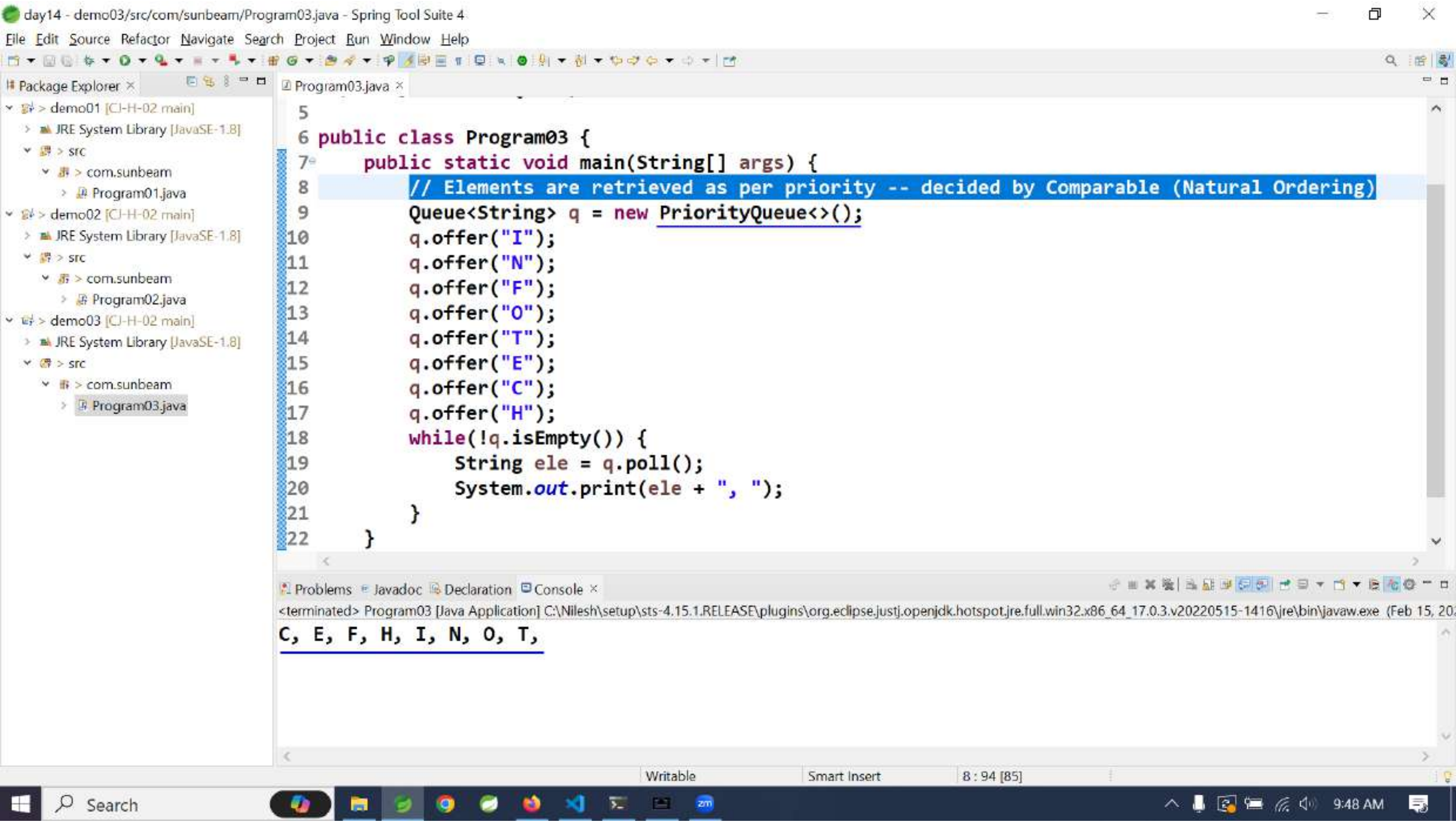


day14 - demo02/src/com/sunbeam/Program02.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program02.java
Problems
Javadoc
Declaration
Console
Writable
Smart Insert
24 : 26 [17]
Search
9:43 AM

```java
        }
    }
    */

    public static void main(String[] args) {
        // Deque as Queue
        Deque<Integer> s = new ArrayDeque<>(); //new LinkedList<>();
        s.offerLast(11);
        s.offerLast(22);
        s.offerLast(33);
        s.offerLast(44);
        while(!s.isEmpty()) {
            Integer ele = s.pollFirst();
            System.out.println("Popped: " + ele);
        }
    }
```

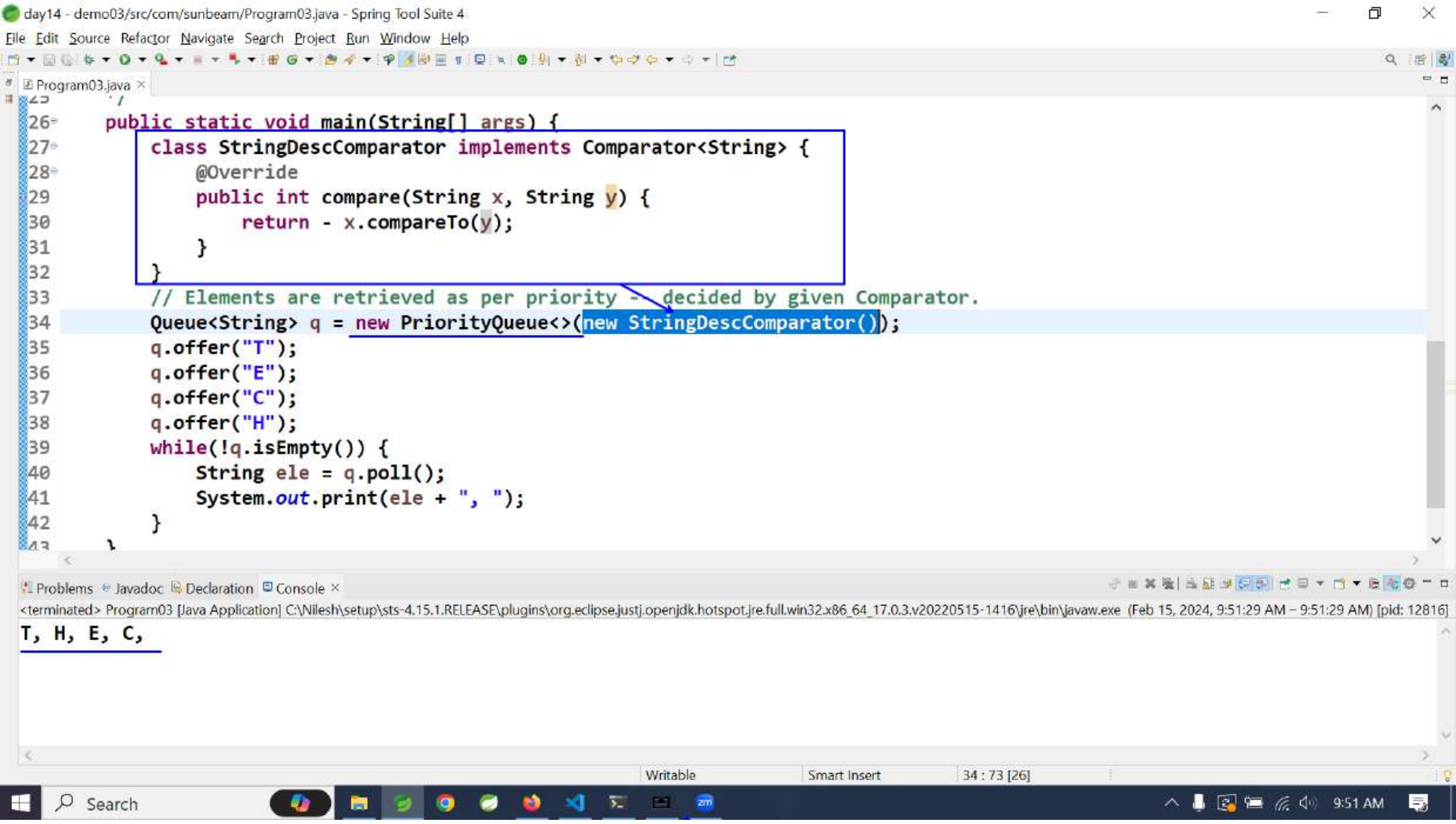
```
<terminated> Program02 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 2024, 9:43:43 AM – 9:43:43 AM) [pid: 4064]
Popped: 11
Popped: 22
Popped: 33
Popped: 44
```

The word 'Deque' is not correctly spelled



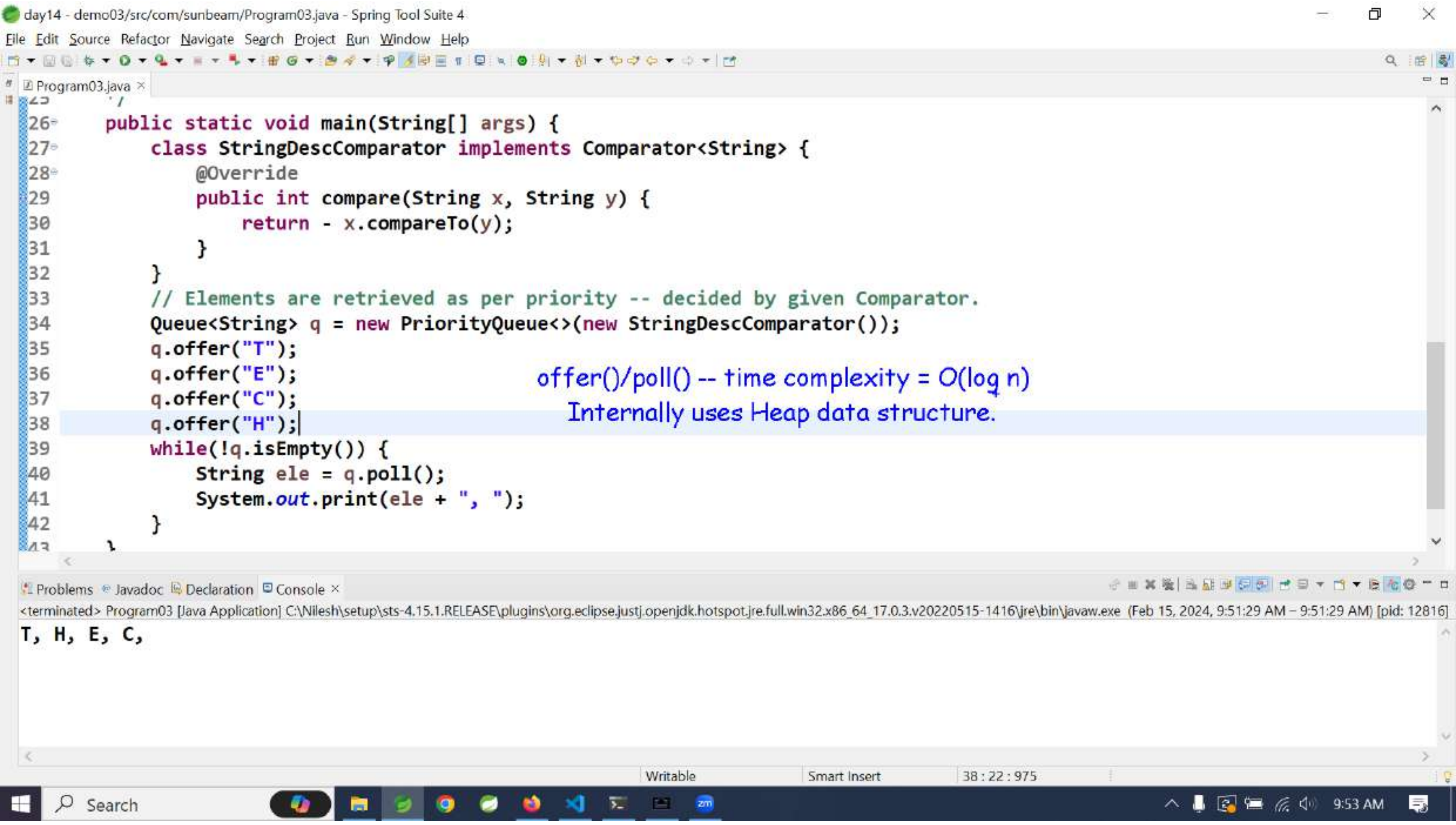
```java

public class Program03 {
    public static void main(String[] args) {
        // Elements are retrieved as per priority -- decided by Comparable (Natural Ordering)
        Queue<String> q = new PriorityQueue<>();
        q.offer("I");
        q.offer("N");
        q.offer("F");
        q.offer("O");
        q.offer("T");
        q.offer("E");
        q.offer("C");
        q.offer("H");
        while(!q.isEmpty()) {
            String ele = q.poll();
            System.out.print(ele + ", ");
        }
    }
```

```
<terminated> Program03 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 20
C, E, F, H, I, N, O, T,
```


day14 - demo03/src/com/sunbeam/Program03.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program03.java
Problems Javadoc Declaration Console
Writable
Smart Insert
34 : 73 [26]
Search
9:51 AM

```java
     */
    public static void main(String[] args) {
        class StringDescComparator implements Comparator<String> {
            @Override
            public int compare(String x, String y) {
                return - x.compareTo(y);
            }
        }
        // Elements are retrieved as per priority -- decided by given Comparator.
        Queue<String> q = new PriorityQueue<>(new StringDescComparator());
        q.offer("T");
        q.offer("E");
        q.offer("C");
        q.offer("H");
        while(!q.isEmpty()) {
            String ele = q.poll();
            System.out.print(ele + ", ");
        }
    }
```

```
<terminated> Program03 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 2024, 9:51:29 AM – 9:51:29 AM) [pid: 12816]
T, H, E, C,
```

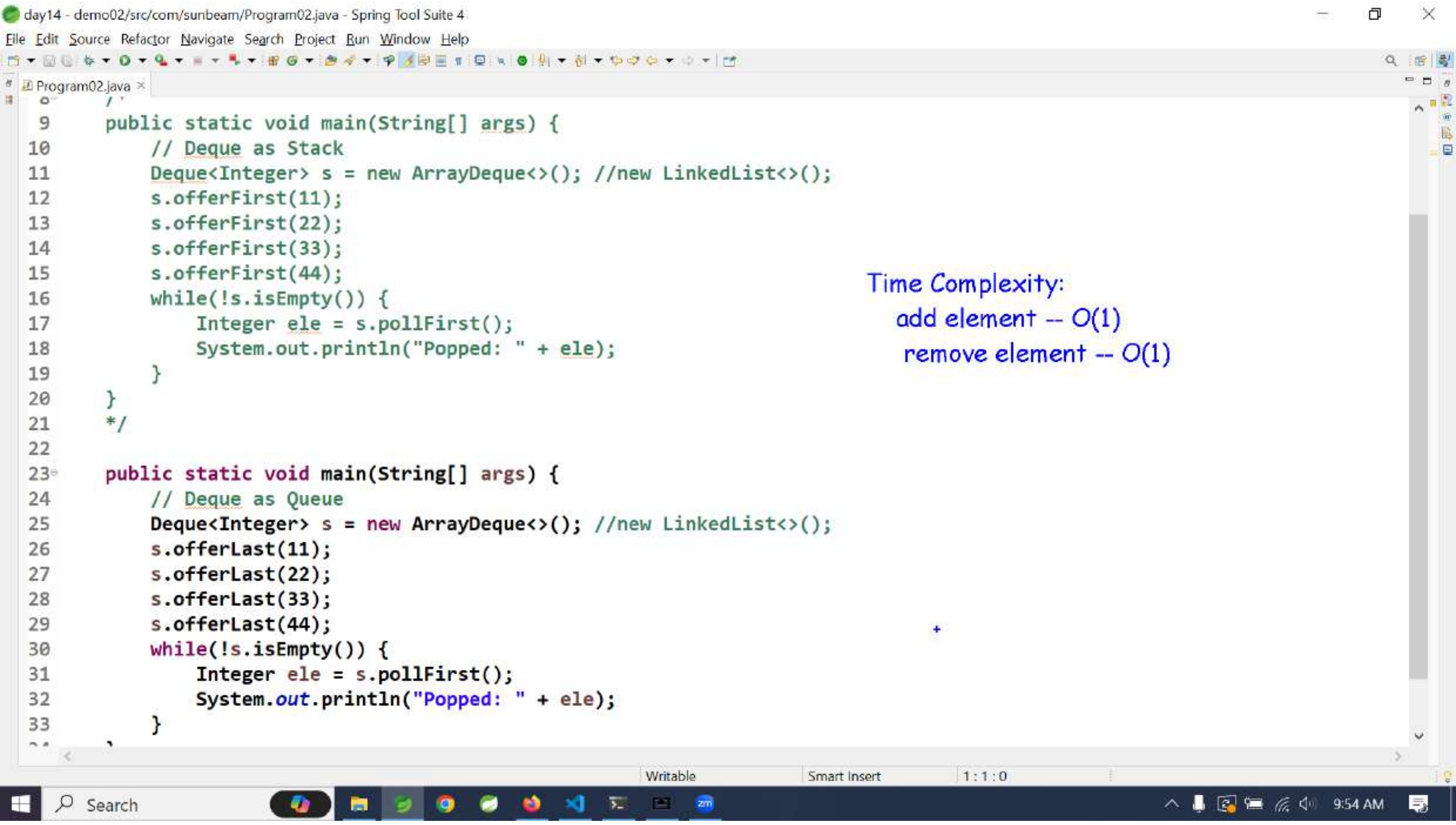

day14 - demo03/src/com/sunbeam/Program03.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program03.java
Problems Javadoc Declaration Console
Writable
Smart Insert
38 : 22 : 975
Search
9:53 AM

```
     */
    public static void main(String[] args) {
        class StringDescComparator implements Comparator<String> {
            @Override
            public int compare(String x, String y) {
                return - x.compareTo(y);
            }
        }
        // Elements are retrieved as per priority -- decided by given Comparator.
        Queue<String> q = new PriorityQueue<>(new StringDescComparator());
        q.offer("T");
        q.offer("E");
        q.offer("C");
        q.offer("H");
        while(!q.isEmpty()) {
            String ele = q.poll();
            System.out.print(ele + ", ");
        }
    }
```

offer()/poll() -- time complexity = O(log n)

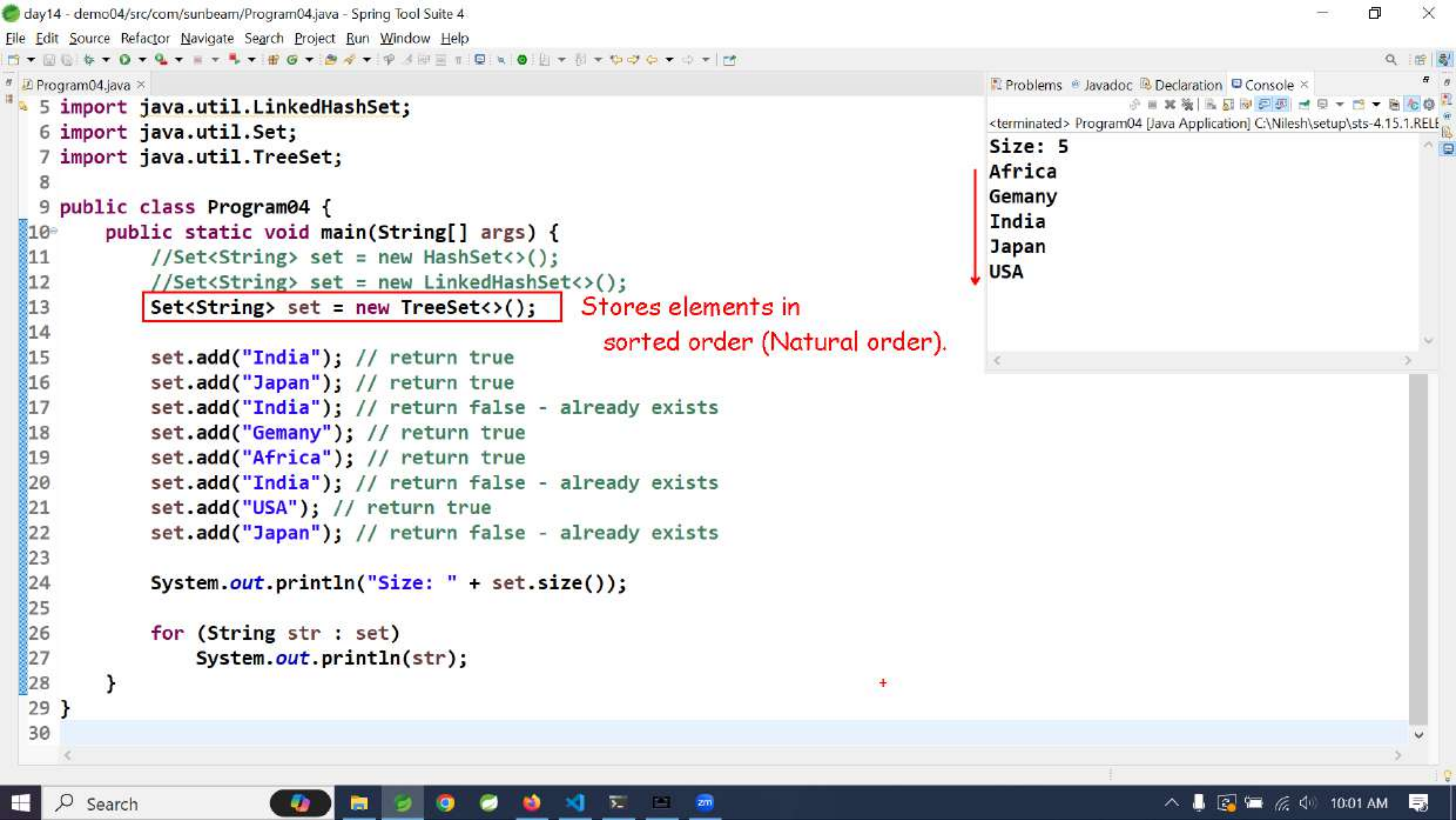
Internally uses Heap data structure.

```
<terminated> Program03 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 2024, 9:51:29 AM – 9:51:29 AM) [pid: 12816]
T, H, E, C,
```


day14 - demo02/src/com/sunbeam/Program02.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program02.java
Writable
Smart Insert
1 : 1 : 0
Search
9:54 AM

```java
    public static void main(String[] args) {
        // Deque as Stack
        Deque<Integer> s = new ArrayDeque<>(); //new LinkedList<>();
        s.offerFirst(11);
        s.offerFirst(22);
        s.offerFirst(33);
        s.offerFirst(44);
        while(!s.isEmpty()) {
            Integer ele = s.pollFirst();
            System.out.println("Popped: " + ele);
        }
    }
    */

    public static void main(String[] args) {
        // Deque as Queue
        Deque<Integer> s = new ArrayDeque<>(); //new LinkedList<>();
        s.offerLast(11);
        s.offerLast(22);
        s.offerLast(33);
        s.offerLast(44);
        while(!s.isEmpty()) {
            Integer ele = s.pollFirst();
            System.out.println("Popped: " + ele);
        }
```

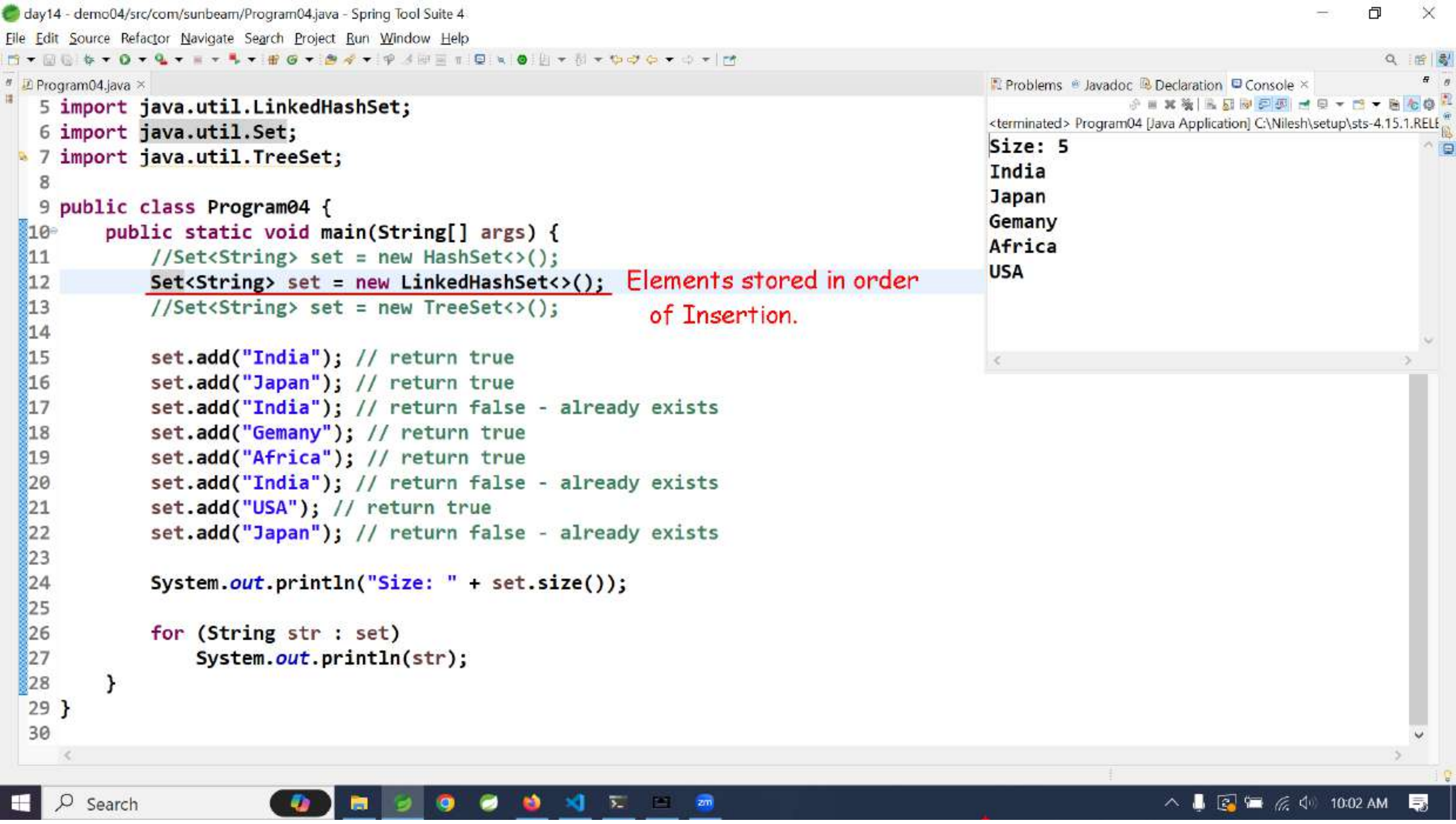
Time Complexity:
add element -- O(1)
remove element -- O(1)


day14 - demo04/src/com/sunbeam/Program04.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program04.java
Problems
Javadoc
Declaration
Console
Search
10:01 AM

```java
import java.util.LinkedHashSet;
import java.util.Set;
import java.util.TreeSet;

public class Program04 {
    public static void main(String[] args) {
        //Set<String> set = new HashSet<>();
        //Set<String> set = new LinkedHashSet<>();
        Set<String> set = new TreeSet<>();

        set.add("India"); // return true
        set.add("Japan"); // return true
        set.add("India"); // return false - already exists
        set.add("Gemany"); // return true
        set.add("Africa"); // return true
        set.add("India"); // return false - already exists
        set.add("USA"); // return true
        set.add("Japan"); // return false - already exists

        System.out.println("Size: " + set.size());

        for (String str : set)
            System.out.println(str);
    }
}
```

Stores elements in sorted order (Natural order).

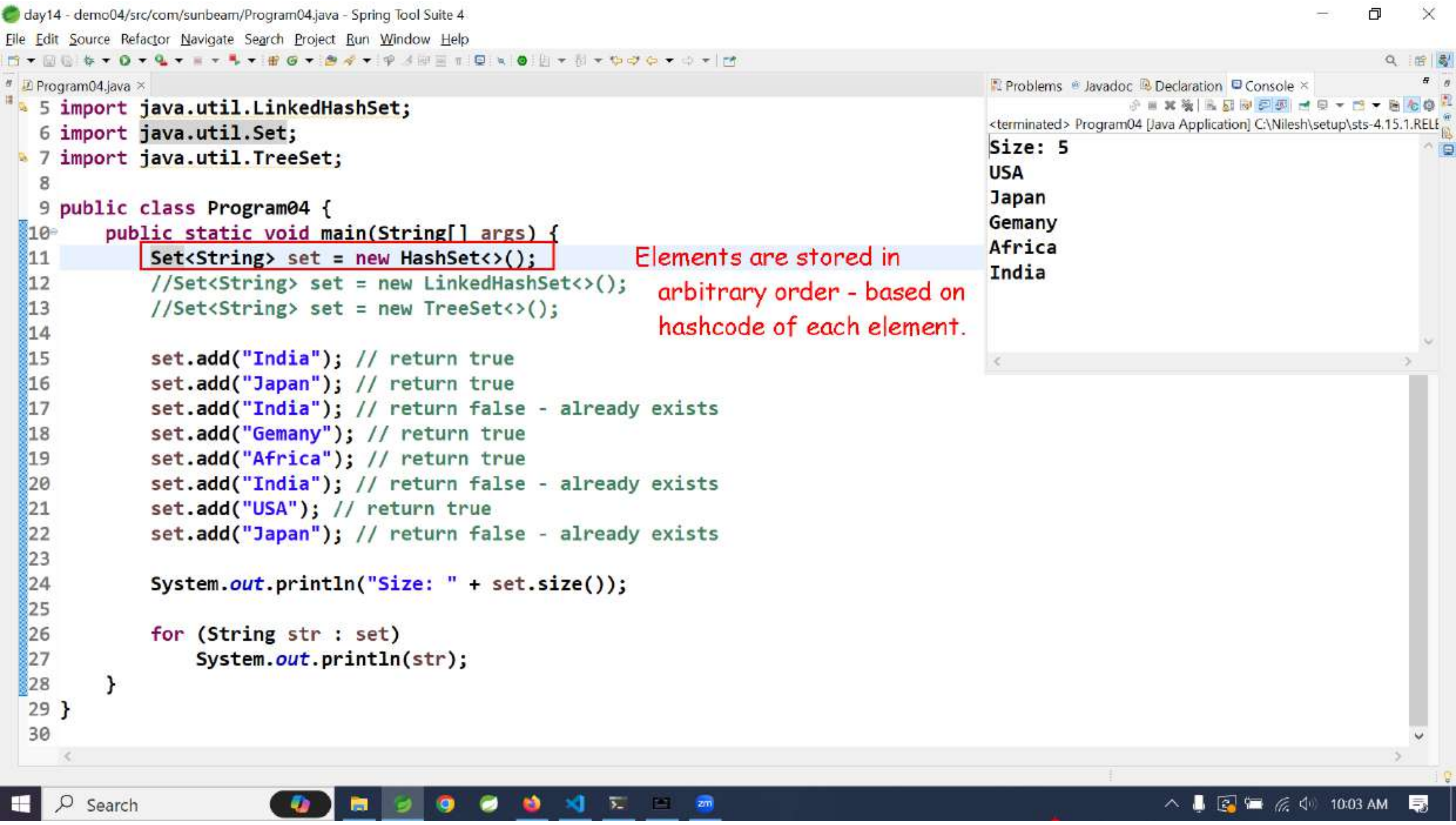
```
<terminated> Program04 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELE
Size: 5
Africa
Gemany
India
Japan
USA
```


day14 - demo04/src/com/sunbeam/Program04.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program04.java
Problems Javadoc Declaration Console
Search
10:02 AM

```java
import java.util.LinkedHashSet;
import java.util.Set;
import java.util.TreeSet;

public class Program04 {
    public static void main(String[] args) {
        //Set<String> set = new HashSet<>();
        Set<String> set = new LinkedHashSet<>();
        //Set<String> set = new TreeSet<>();

        set.add("India"); // return true
        set.add("Japan"); // return true
        set.add("India"); // return false - already exists
        set.add("Gemany"); // return true
        set.add("Africa"); // return true
        set.add("India"); // return false - already exists
        set.add("USA"); // return true
        set.add("Japan"); // return false - already exists

        System.out.println("Size: " + set.size());

        for (String str : set)
            System.out.println(str);
    }
}
```

Elements stored in order of Insertion.

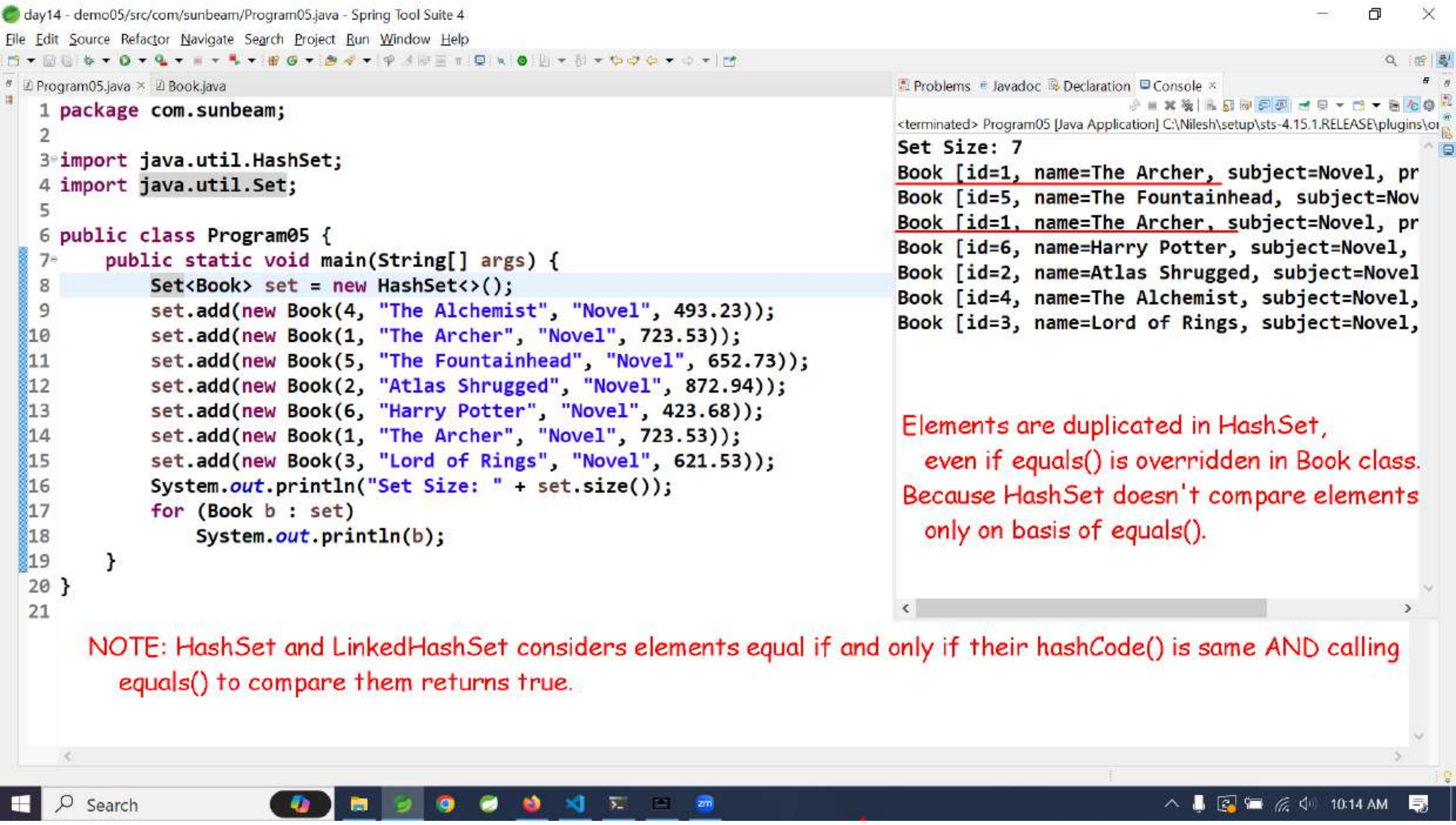
```
<terminated> Program04 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELE
Size: 5
India
Japan
Gemany
Africa
USA
```


day14 - demo04/src/com/sunbeam/Program04.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program04.java
Problems Javadoc Declaration Console
Search
10:03 AM

```java
import java.util.LinkedHashSet;
import java.util.Set;
import java.util.TreeSet;

public class Program04 {
    public static void main(String[] args) {
        Set<String> set = new HashSet<>();
        //Set<String> set = new LinkedHashSet<>();
        //Set<String> set = new TreeSet<>();

        set.add("India"); // return true
        set.add("Japan"); // return true
        set.add("India"); // return false - already exists
        set.add("Gemany"); // return true
        set.add("Africa"); // return true
        set.add("India"); // return false - already exists
        set.add("USA"); // return true
        set.add("Japan"); // return false - already exists

        System.out.println("Size: " + set.size());

        for (String str : set)
            System.out.println(str);
    }
}
```

Elements are stored in arbitrary order - based on hashcode of each element.

```
<terminated> Program04 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELE
Size: 5
USA
Japan
Gemany
Africa
India
```


day14 - demo05/src/com/sunbeam/Program05.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program05.java
Book.java
Problems
Javadoc
Declaration
Console
Search
10:14 AM

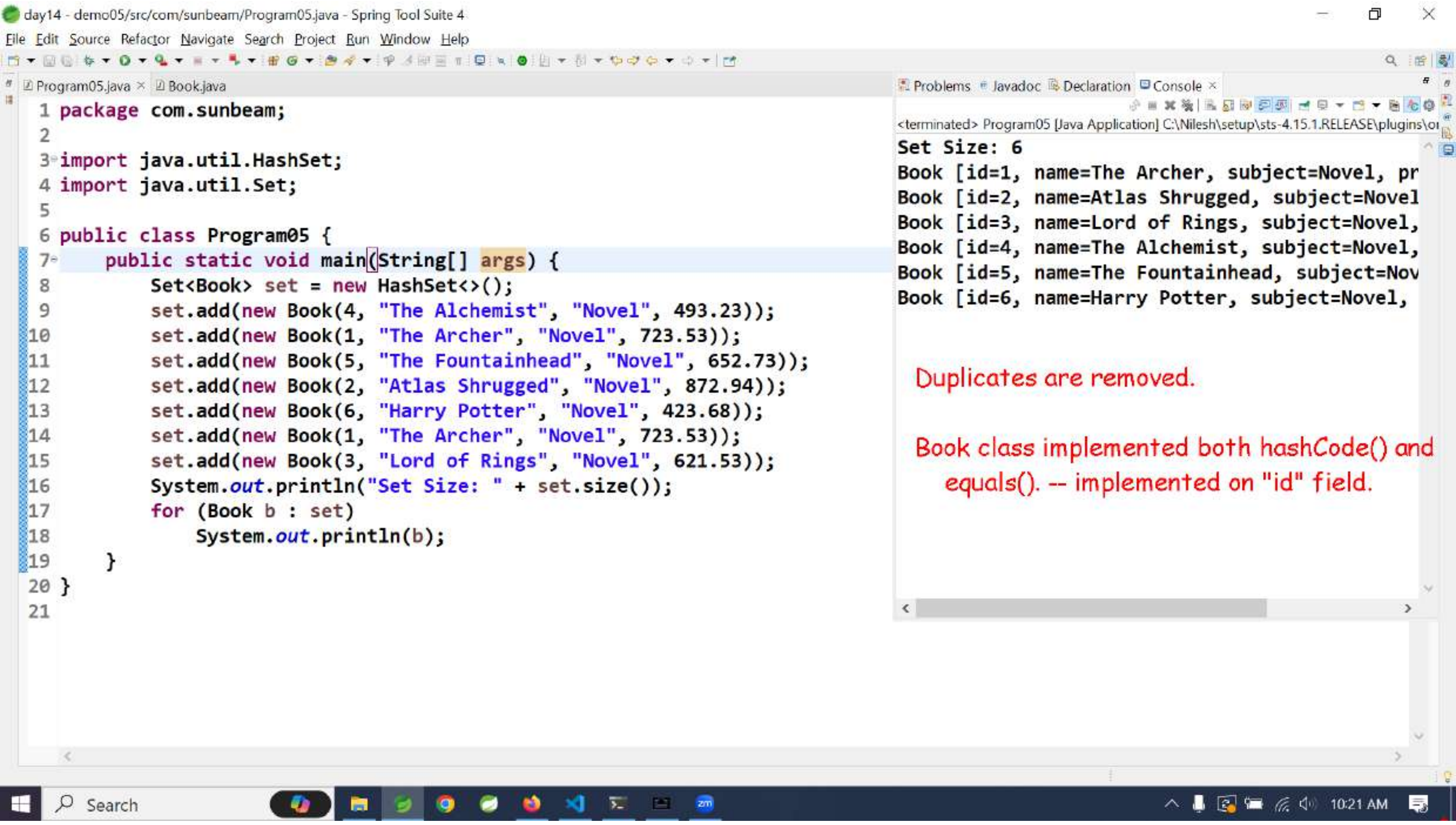
```java
package com.sunbeam;

import java.util.HashSet;
import java.util.Set;

public class Program05 {
    public static void main(String[] args) {
        Set<Book> set = new HashSet<>();
        set.add(new Book(4, "The Alchemist", "Novel", 493.23));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(5, "The Fountainhead", "Novel", 652.73));
        set.add(new Book(2, "Atlas Shrugged", "Novel", 872.94));
        set.add(new Book(6, "Harry Potter", "Novel", 423.68));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(3, "Lord of Rings", "Novel", 621.53));
        System.out.println("Set Size: " + set.size());
        for (Book b : set)
            System.out.println(b);
    }
}
```

<terminated> Program05 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\or

```
Set Size: 7
Book [id=1, name=The Archer, subject=Novel, pr
Book [id=5, name=The Fountainhead, subject=Nov
Book [id=1, name=The Archer, subject=Novel, pr
Book [id=6, name=Harry Potter, subject=Novel,
Book [id=2, name=Atlas Shrugged, subject=Novel
Book [id=4, name=The Alchemist, subject=Novel,
Book [id=3, name=Lord of Rings, subject=Novel,
```

Elements are duplicated in HashSet, even if equals() is overridden in Book class. Because HashSet doesn't compare elements only on basis of equals().

NOTE: HashSet and LinkedHashSet considers elements equal if and only if their hashCode() is same AND calling equals() to compare them returns true.


day14 - demo05/src/com/sunbeam/Program05.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program05.java
Book.java
Problems
Javadoc
Declaration
Console
Search
10:21 AM

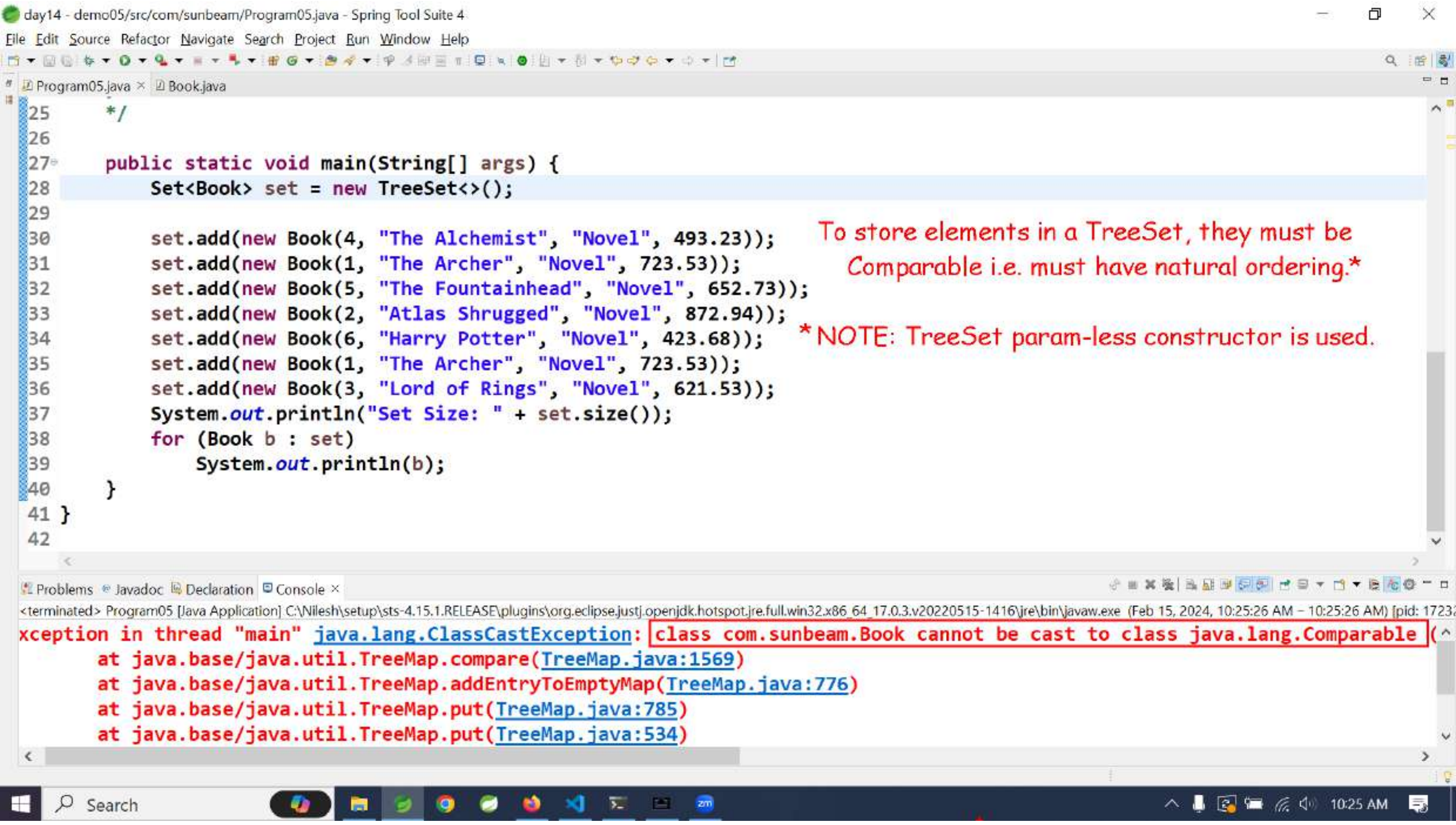
```java
package com.sunbeam;

import java.util.HashSet;
import java.util.Set;

public class Program05 {
    public static void main(String[] args) {
        Set<Book> set = new HashSet<>();
        set.add(new Book(4, "The Alchemist", "Novel", 493.23));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(5, "The Fountainhead", "Novel", 652.73));
        set.add(new Book(2, "Atlas Shrugged", "Novel", 872.94));
        set.add(new Book(6, "Harry Potter", "Novel", 423.68));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(3, "Lord of Rings", "Novel", 621.53));
        System.out.println("Set Size: " + set.size());
        for (Book b : set)
            System.out.println(b);
    }
}
```

<terminated> Program05 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\or

```
Set Size: 6
Book [id=1, name=The Archer, subject=Novel, pr
Book [id=2, name=Atlas Shrugged, subject=Novel
Book [id=3, name=Lord of Rings, subject=Novel,
Book [id=4, name=The Alchemist, subject=Novel,
Book [id=5, name=The Fountainhead, subject=Nov
Book [id=6, name=Harry Potter, subject=Novel,
```

Duplicates are removed.

Book class implemented both hashCode() and equals(). -- implemented on "id" field.



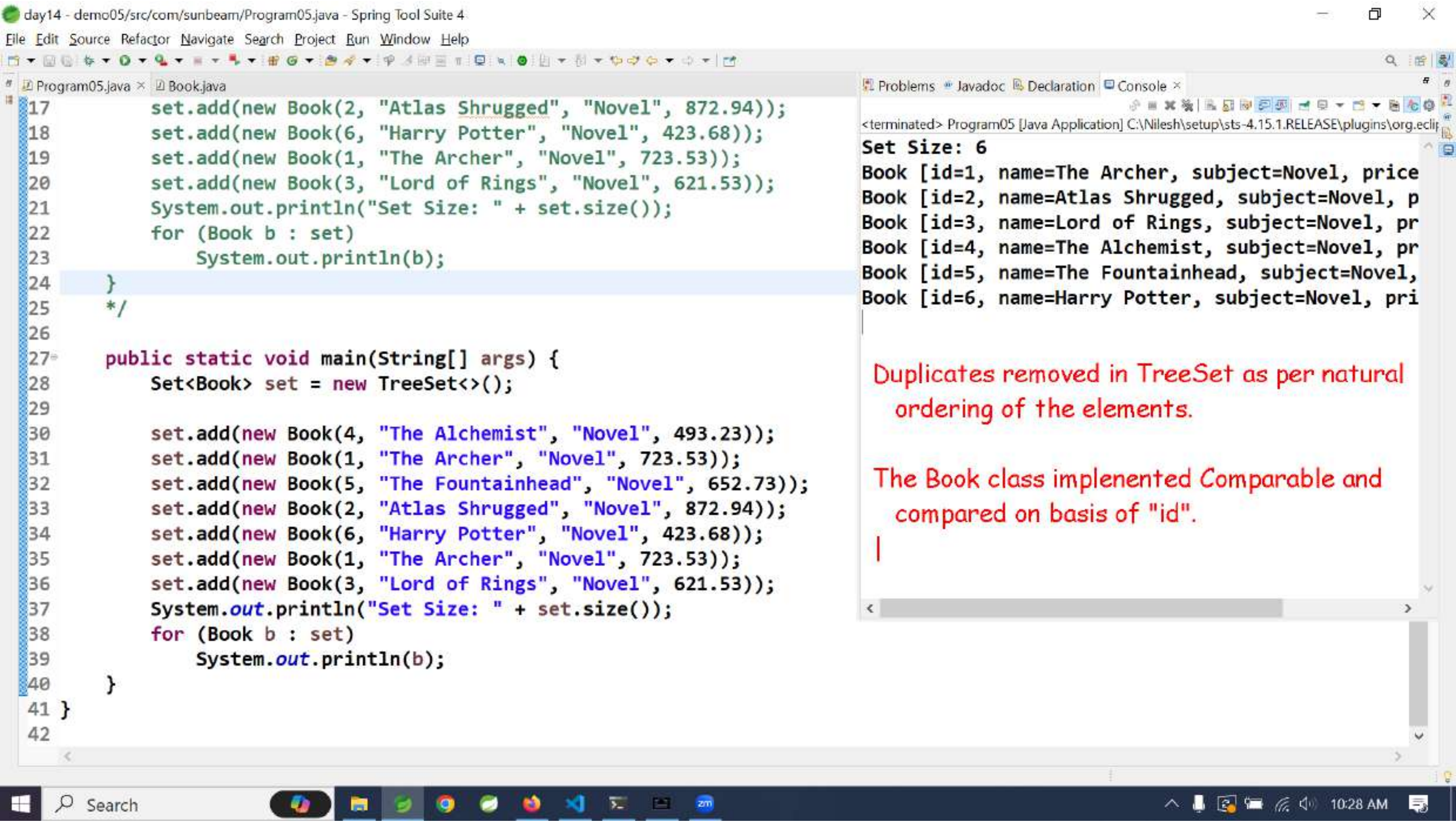
day14 - demo05/src/com/sunbeam/Program05.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program05.java
Book.java
Problems
Javadoc
Declaration
Console
Search
10:25 AM

```java
    */

    public static void main(String[] args) {
        Set<Book> set = new TreeSet<>();

        set.add(new Book(4, "The Alchemist", "Novel", 493.23));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(5, "The Fountainhead", "Novel", 652.73));
        set.add(new Book(2, "Atlas Shrugged", "Novel", 872.94));
        set.add(new Book(6, "Harry Potter", "Novel", 423.68));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(3, "Lord of Rings", "Novel", 621.53));
        System.out.println("Set Size: " + set.size());
        for (Book b : set)
            System.out.println(b);
    }
}
```

To store elements in a TreeSet, they must be Comparable i.e. must have natural ordering.*

*NOTE: TreeSet param-less constructor is used.

```
<terminated> Program05 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe  (Feb 15, 2024, 10:25:26 AM – 10:25:26 AM) [pid: 1723
xception in thread "main" java.lang.ClassCastException: class com.sunbeam.Book cannot be cast to class java.lang.Comparable (
	at java.base/java.util.TreeMap.compare(TreeMap.java:1569)
	at java.base/java.util.TreeMap.addEntryToEmptyMap(TreeMap.java:776)
	at java.base/java.util.TreeMap.put(TreeMap.java:785)
	at java.base/java.util.TreeMap.put(TreeMap.java:534)
```

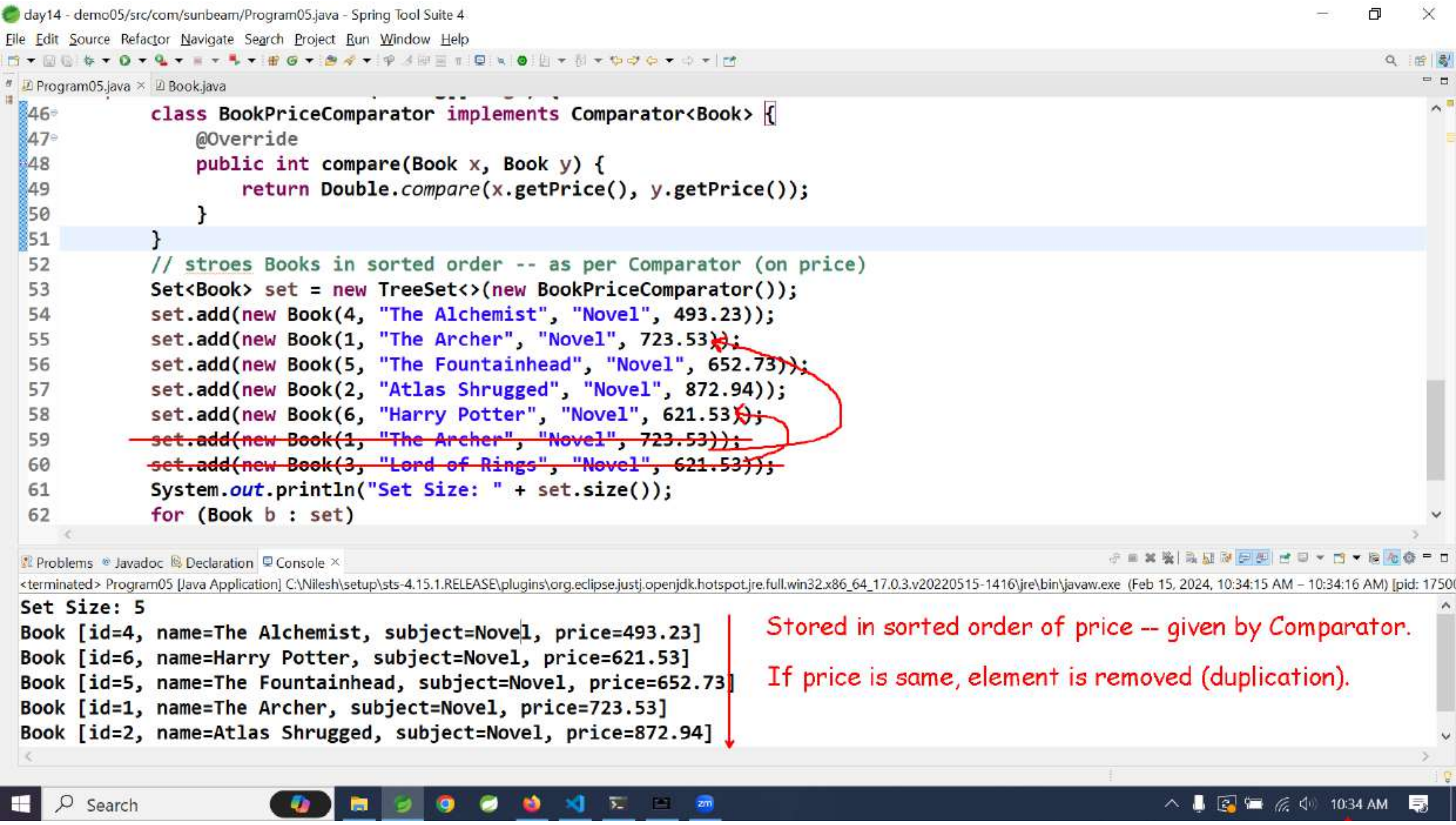

day14 - demo05/src/com/sunbeam/Program05.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program05.java
Book.java
Problems
Javadoc
Declaration
Console
Search
10:28 AM

```java
        set.add(new Book(2, "Atlas Shrugged", "Novel", 872.94));
        set.add(new Book(6, "Harry Potter", "Novel", 423.68));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(3, "Lord of Rings", "Novel", 621.53));
        System.out.println("Set Size: " + set.size());
        for (Book b : set)
            System.out.println(b);
    }
    */

    public static void main(String[] args) {
        Set<Book> set = new TreeSet<>();

        set.add(new Book(4, "The Alchemist", "Novel", 493.23));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(5, "The Fountainhead", "Novel", 652.73));
        set.add(new Book(2, "Atlas Shrugged", "Novel", 872.94));
        set.add(new Book(6, "Harry Potter", "Novel", 423.68));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(3, "Lord of Rings", "Novel", 621.53));
        System.out.println("Set Size: " + set.size());
        for (Book b : set)
            System.out.println(b);
    }
}
```

```
<terminated> Program05 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclip
Set Size: 6
Book [id=1, name=The Archer, subject=Novel, price
Book [id=2, name=Atlas Shrugged, subject=Novel, p
Book [id=3, name=Lord of Rings, subject=Novel, pr
Book [id=4, name=The Alchemist, subject=Novel, pr
Book [id=5, name=The Fountainhead, subject=Novel,
Book [id=6, name=Harry Potter, subject=Novel, pri
```

Duplicates removed in TreeSet as per natural ordering of the elements.

The Book class implenented Comparable and compared on basis of "id".


day14 - demo05/src/com/sunbeam/Program05.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program05.java
Book.java
Problems
Javadoc
Declaration
Console
Search
10:34 AM

```
class BookPriceComparator implements Comparator<Book> {
    @Override
    public int compare(Book x, Book y) {
        return Double.compare(x.getPrice(), y.getPrice());
    }
}
// stroes Books in sorted order -- as per Comparator (on price)
Set<Book> set = new TreeSet<>(new BookPriceComparator());
set.add(new Book(4, "The Alchemist", "Novel", 493.23));
set.add(new Book(1, "The Archer", "Novel", 723.53));
set.add(new Book(5, "The Fountainhead", "Novel", 652.73));
set.add(new Book(2, "Atlas Shrugged", "Novel", 872.94));
set.add(new Book(6, "Harry Potter", "Novel", 621.53));
```

~~set.add(new Book(1, "The Archer", "Novel", 723.53));~~

~~set.add(new Book(3, "Lord of Rings", "Novel", 621.53));~~

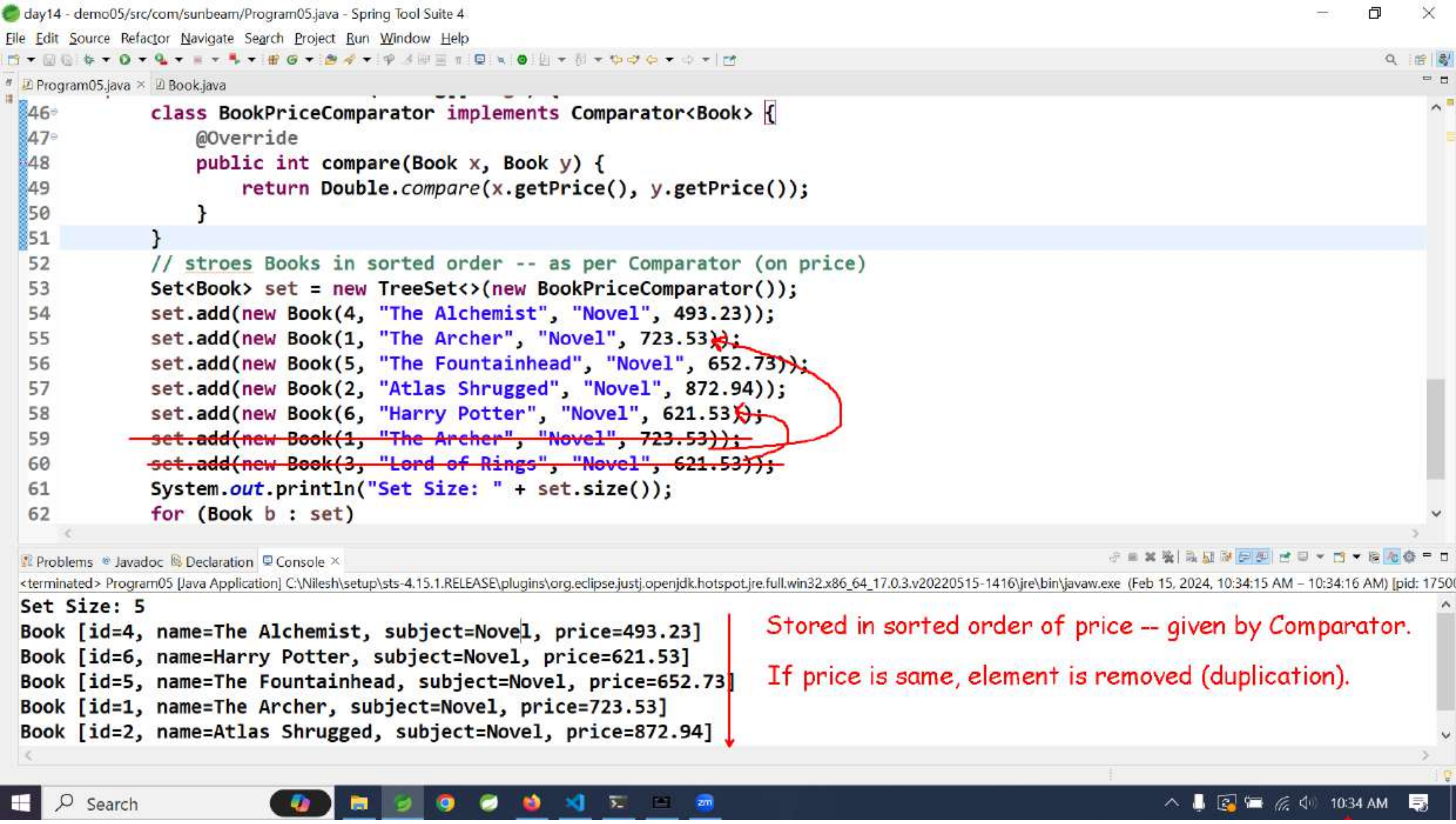
```
System.out.println("Set Size: " + set.size());
for (Book b : set)
```

<terminated> Program05 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 2024, 10:34:15 AM – 10:34:16 AM) [pid: 1750

```
Set Size: 5
Book [id=4, name=The Alchemist, subject=Novel, price=493.23]
Book [id=6, name=Harry Potter, subject=Novel, price=621.53]
Book [id=5, name=The Fountainhead, subject=Novel, price=652.73]
Book [id=1, name=The Archer, subject=Novel, price=723.53]
Book [id=2, name=Atlas Shrugged, subject=Novel, price=872.94]
```

Stored in sorted order of price -- given by Comparator.

If price is same, element is removed (duplication).


day14 - demo05/src/com/sunbeam/Program05.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program05.java
Book.java
Problems
Javadoc
Declaration
Console
Search
10:34 AM

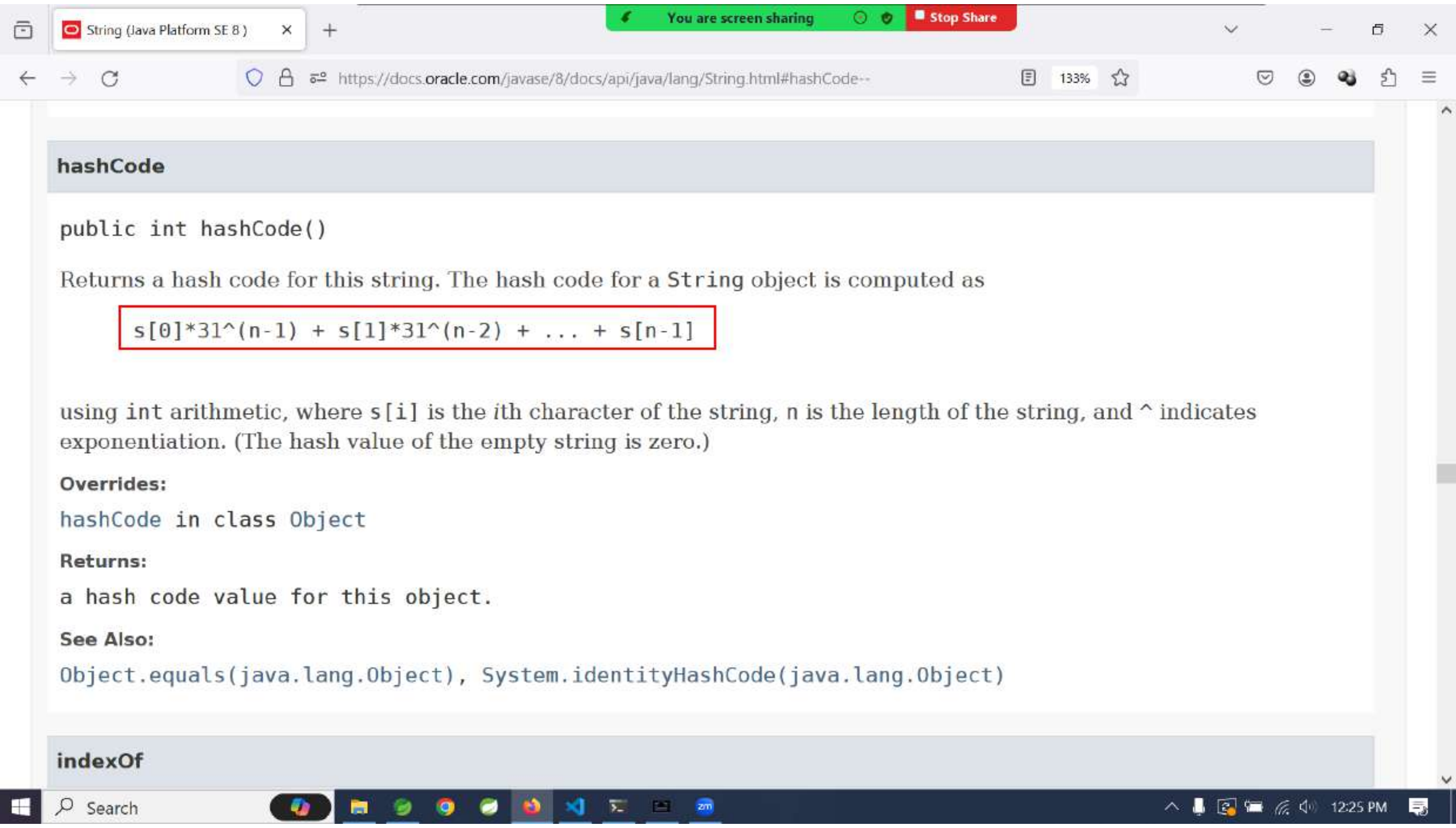
```java
        class BookPriceComparator implements Comparator<Book> {
            @Override
            public int compare(Book x, Book y) {
                return Double.compare(x.getPrice(), y.getPrice());
            }
        }
        // stroes Books in sorted order -- as per Comparator (on price)
        Set<Book> set = new TreeSet<>(new BookPriceComparator());
        set.add(new Book(4, "The Alchemist", "Novel", 493.23));
        set.add(new Book(1, "The Archer", "Novel", 723.53));
        set.add(new Book(5, "The Fountainhead", "Novel", 652.73));
        set.add(new Book(2, "Atlas Shrugged", "Novel", 872.94));
        set.add(new Book(6, "Harry Potter", "Novel", 621.53));
        ~~set.add(new Book(1, "The Archer", "Novel", 723.53));~~
        ~~set.add(new Book(3, "Lord of Rings", "Novel", 621.53));~~
        System.out.println("Set Size: " + set.size());
        for (Book b : set)
```

<terminated> Program05 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 2024, 10:34:15 AM – 10:34:16 AM) [pid: 1750

```
Set Size: 5
Book [id=4, name=The Alchemist, subject=Novel, price=493.23]
Book [id=6, name=Harry Potter, subject=Novel, price=621.53]
Book [id=5, name=The Fountainhead, subject=Novel, price=652.73]
Book [id=1, name=The Archer, subject=Novel, price=723.53]
Book [id=2, name=Atlas Shrugged, subject=Novel, price=872.94]
```

Stored in sorted order of price -- given by Comparator.

If price is same, element is removed (duplication).


String (Java Platform SE 8)
You are screen sharing
Stop Share
https://docs.oracle.com/javase/8/docs/api/java/lang/String.html#hashCode--
133%
Search
12:25 PM

hashCode

```
public int hashCode()
```

Returns a hash code for this string. The hash code for a `String` object is computed as

```
s[0]*31^(n-1) + s[1]*31^(n-2) + ... + s[n-1]
```

using `int` arithmetic, where `s[i]` is the *i*th character of the string, `n` is the length of the string, and `^` indicates exponentiation. (The hash value of the empty string is zero.)

Overrides:

`hashCode` in class `Object`

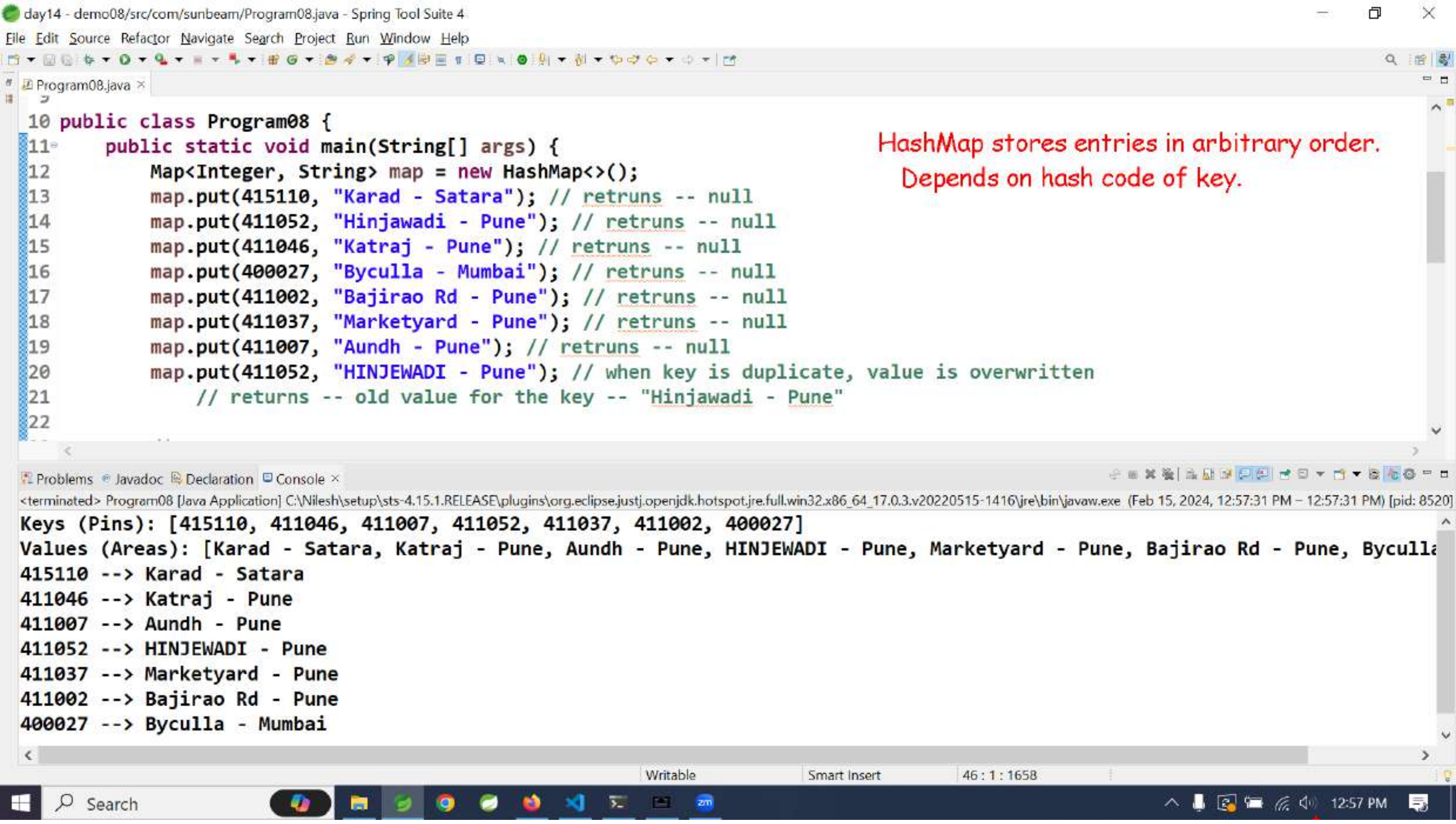
Returns:

a hash code value for this object.

See Also:

`Object.equals(java.lang.Object)`, `System.identityHashCode(java.lang.Object)`

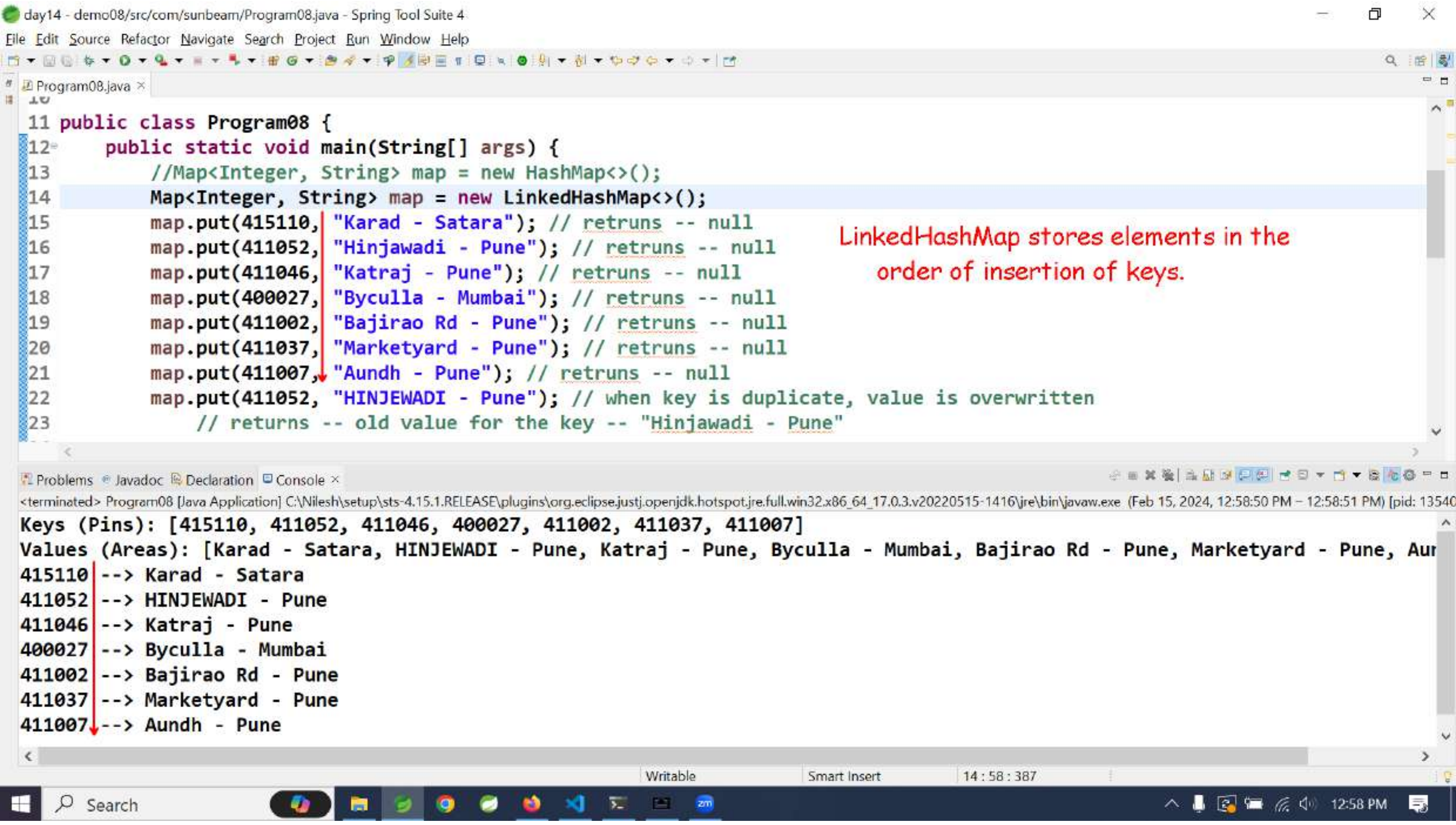
indexOf


day14 - demo08/src/com/sunbeam/Program08.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program08.java
Problems Javadoc Declaration Console
Writable
Smart Insert
46 : 1 : 1658
Search
12:57 PM

```java
public class Program08 {
    public static void main(String[] args) {
        Map<Integer, String> map = new HashMap<>();
        map.put(415110, "Karad - Satara"); // retruns -- null
        map.put(411052, "Hinjawadi - Pune"); // retruns -- null
        map.put(411046, "Katraj - Pune"); // retruns -- null
        map.put(400027, "Byculla - Mumbai"); // retruns -- null
        map.put(411002, "Bajirao Rd - Pune"); // retruns -- null
        map.put(411037, "Marketyard - Pune"); // retruns -- null
        map.put(411007, "Aundh - Pune"); // retruns -- null
        map.put(411052, "HINJEWADI - Pune"); // when key is duplicate, value is overwritten
            // returns -- old value for the key -- "Hinjawadi - Pune"

```

HashMap stores entries in arbitrary order.
Depends on hash code of key.

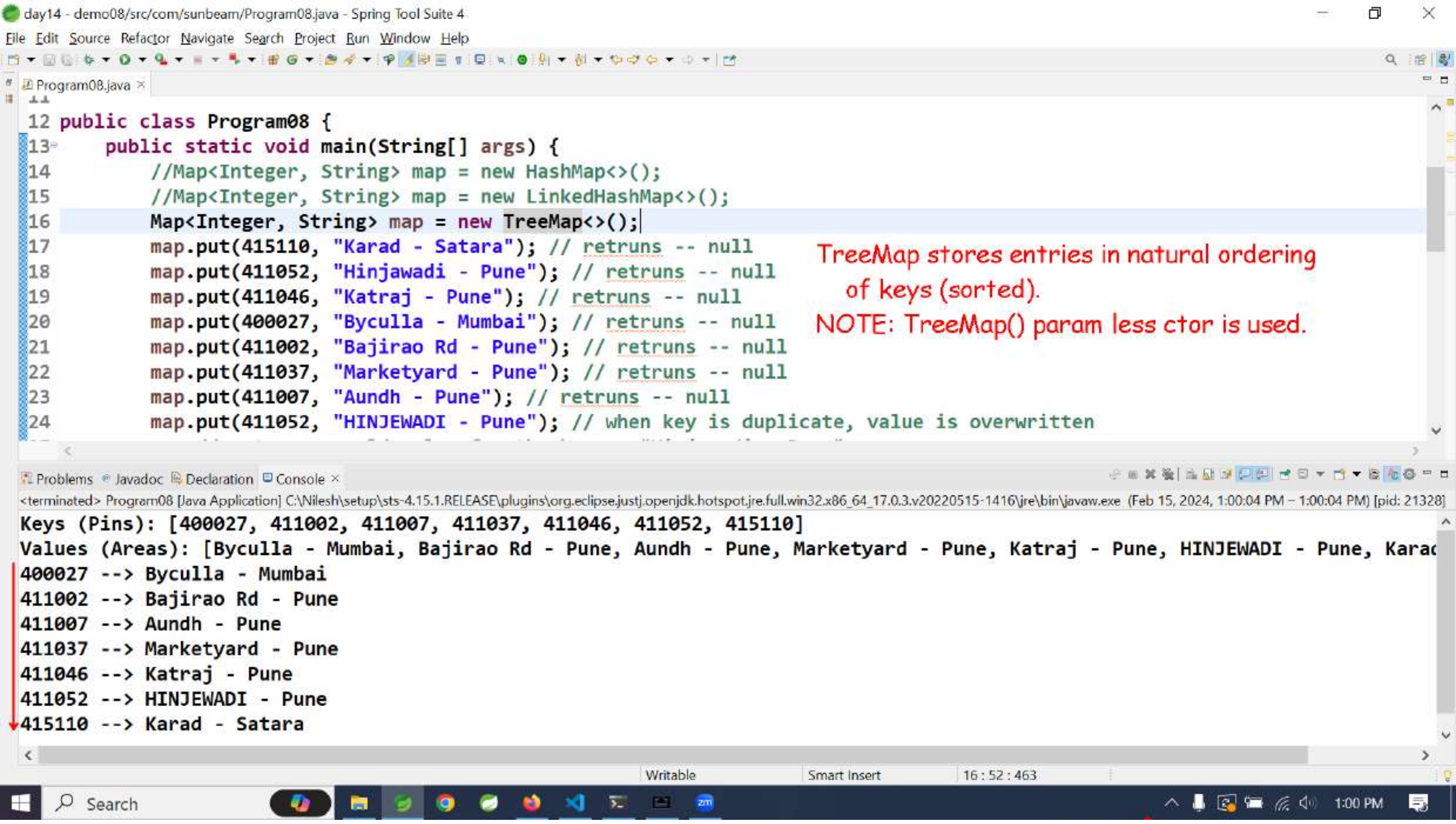
```
<terminated> Program08 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 2024, 12:57:31 PM – 12:57:31 PM) [pid: 8520]
Keys (Pins): [415110, 411046, 411007, 411052, 411037, 411002, 400027]
Values (Areas): [Karad - Satara, Katraj - Pune, Aundh - Pune, HINJEWADI - Pune, Marketyard - Pune, Bajirao Rd - Pune, Byculla
415110 --> Karad - Satara
411046 --> Katraj - Pune
411007 --> Aundh - Pune
411052 --> HINJEWADI - Pune
411037 --> Marketyard - Pune
411002 --> Bajirao Rd - Pune
400027 --> Byculla - Mumbai
```


day14 - demo08/src/com/sunbeam/Program08.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program08.java
Problems Javadoc Declaration Console
Writable
Smart Insert
14 : 58 : 387
Search
12:58 PM

```java
public class Program08 {
    public static void main(String[] args) {
        //Map<Integer, String> map = new HashMap<>();
        Map<Integer, String> map = new LinkedHashMap<>();
        map.put(415110, "Karad - Satara"); // retruns -- null
        map.put(411052, "Hinjawadi - Pune"); // retruns -- null
        map.put(411046, "Katraj - Pune"); // retruns -- null
        map.put(400027, "Byculla - Mumbai"); // retruns -- null
        map.put(411002, "Bajirao Rd - Pune"); // retruns -- null
        map.put(411037, "Marketyard - Pune"); // retruns -- null
        map.put(411007, "Aundh - Pune"); // retruns -- null
        map.put(411052, "HINJEWADI - Pune"); // when key is duplicate, value is overwritten
            // returns -- old value for the key -- "Hinjawadi - Pune"
```

LinkedHashMap stores elements in the order of insertion of keys.

```
<terminated> Program08 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 2024, 12:58:50 PM – 12:58:51 PM) [pid: 13540
Keys (Pins): [415110, 411052, 411046, 400027, 411002, 411037, 411007]
Values (Areas): [Karad - Satara, HINJEWADI - Pune, Katraj - Pune, Byculla - Mumbai, Bajirao Rd - Pune, Marketyard - Pune, Aur
415110 --> Karad - Satara
411052 --> HINJEWADI - Pune
411046 --> Katraj - Pune
400027 --> Byculla - Mumbai
411002 --> Bajirao Rd - Pune
411037 --> Marketyard - Pune
411007 --> Aundh - Pune
```

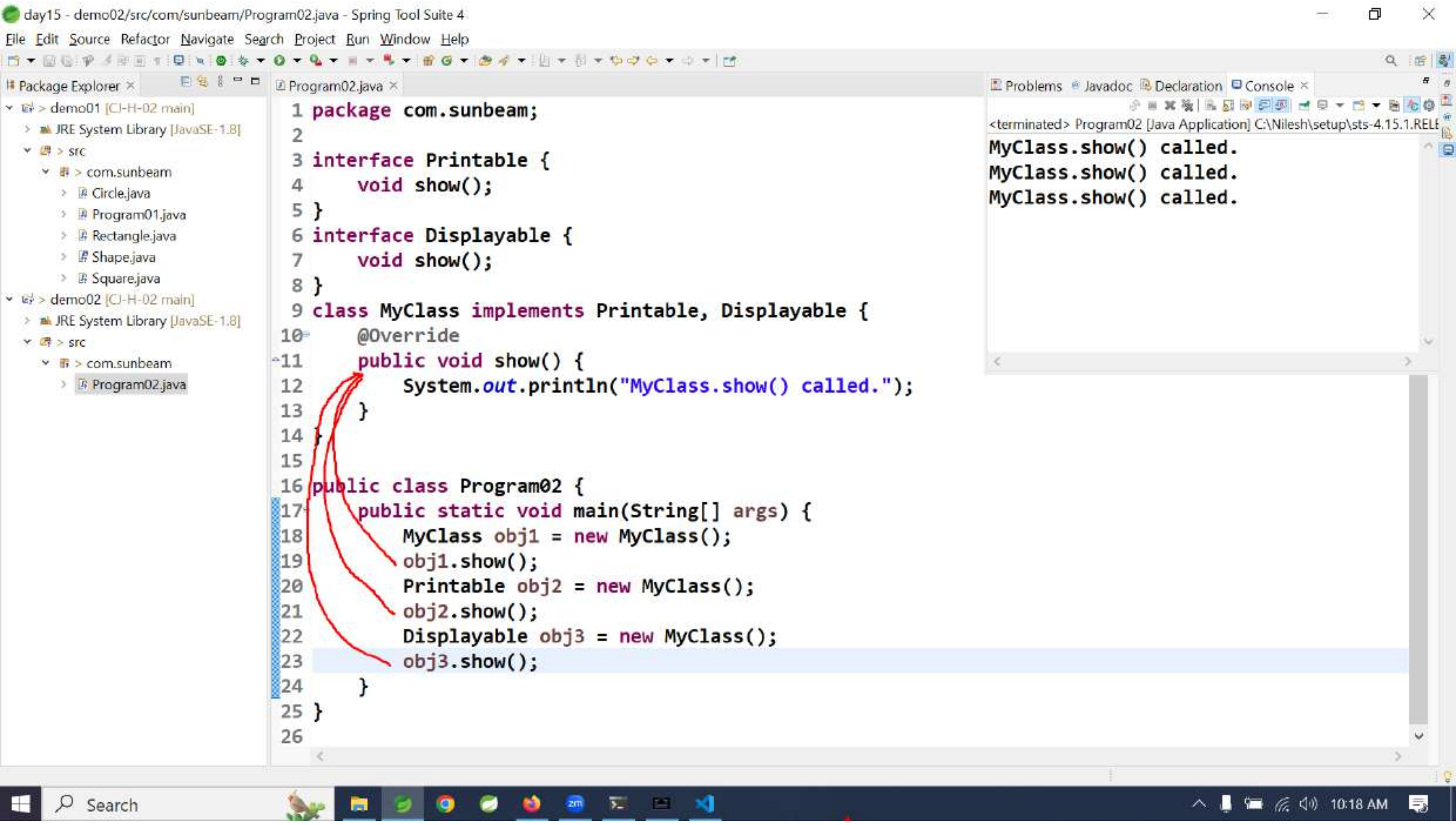

day14 - demo08/src/com/sunbeam/Program08.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program08.java
Problems Javadoc Declaration Console
Writable
Smart Insert
16 : 52 : 463
Search
1:00 PM

```java
public class Program08 {
    public static void main(String[] args) {
        //Map<Integer, String> map = new HashMap<>();
        //Map<Integer, String> map = new LinkedHashMap<>();
        Map<Integer, String> map = new TreeMap<>();
        map.put(415110, "Karad - Satara"); // retruns -- null
        map.put(411052, "Hinjawadi - Pune"); // retruns -- null
        map.put(411046, "Katraj - Pune"); // retruns -- null
        map.put(400027, "Byculla - Mumbai"); // retruns -- null
        map.put(411002, "Bajirao Rd - Pune"); // retruns -- null
        map.put(411037, "Marketyard - Pune"); // retruns -- null
        map.put(411007, "Aundh - Pune"); // retruns -- null
        map.put(411052, "HINJEWADI - Pune"); // when key is duplicate, value is overwritten
```

TreeMap stores entries in natural ordering of keys (sorted).

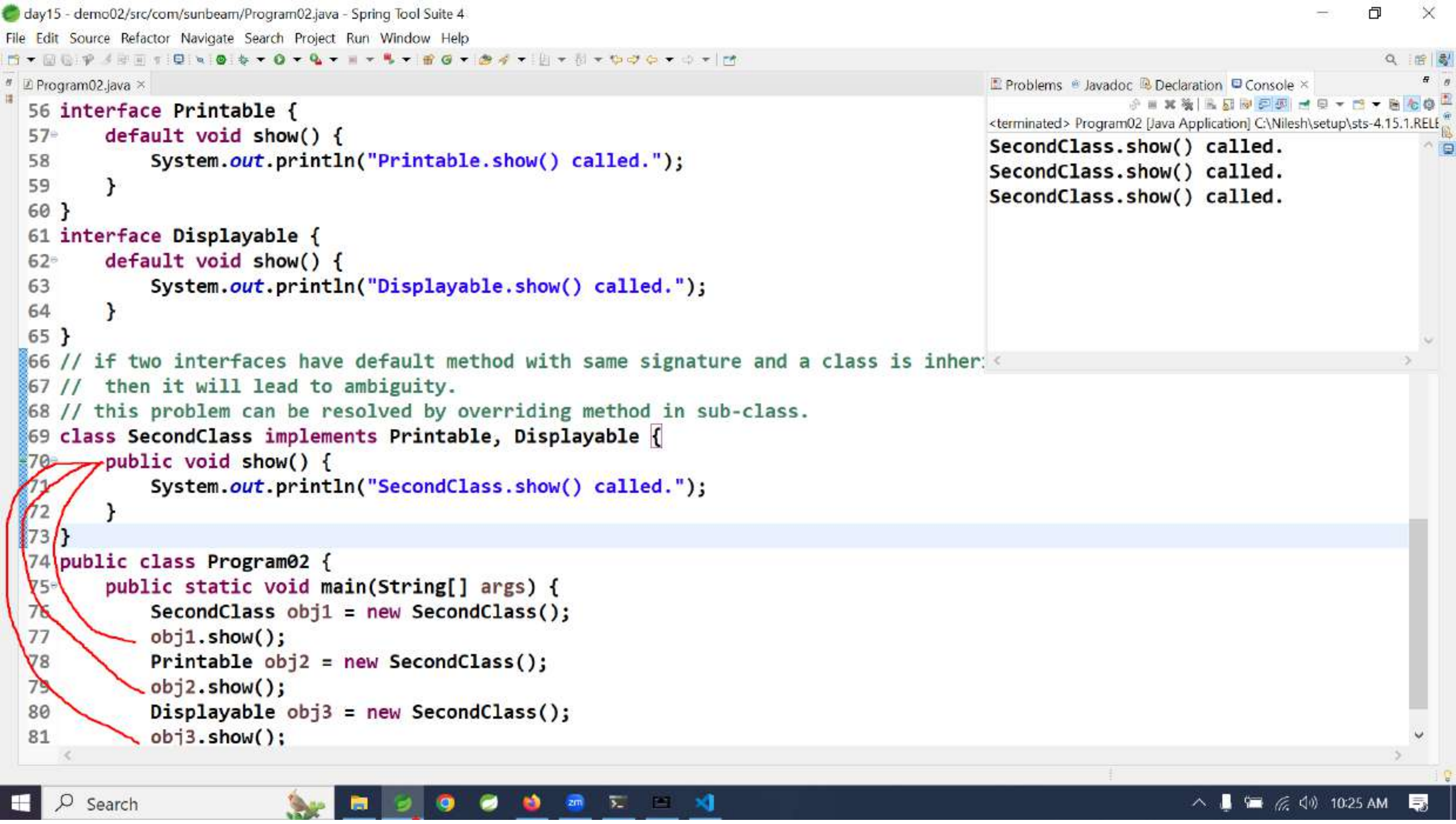
NOTE: TreeMap() param less ctor is used.

```
<terminated> Program08 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\javaw.exe (Feb 15, 2024, 1:00:04 PM – 1:00:04 PM) [pid: 21328]
Keys (Pins): [400027, 411002, 411007, 411037, 411046, 411052, 415110]
Values (Areas): [Byculla - Mumbai, Bajirao Rd - Pune, Aundh - Pune, Marketyard - Pune, Katraj - Pune, HINJEWADI - Pune, Karad
400027 --> Byculla - Mumbai
411002 --> Bajirao Rd - Pune
411007 --> Aundh - Pune
411037 --> Marketyard - Pune
411046 --> Katraj - Pune
411052 --> HINJEWADI - Pune
415110 --> Karad - Satara
```



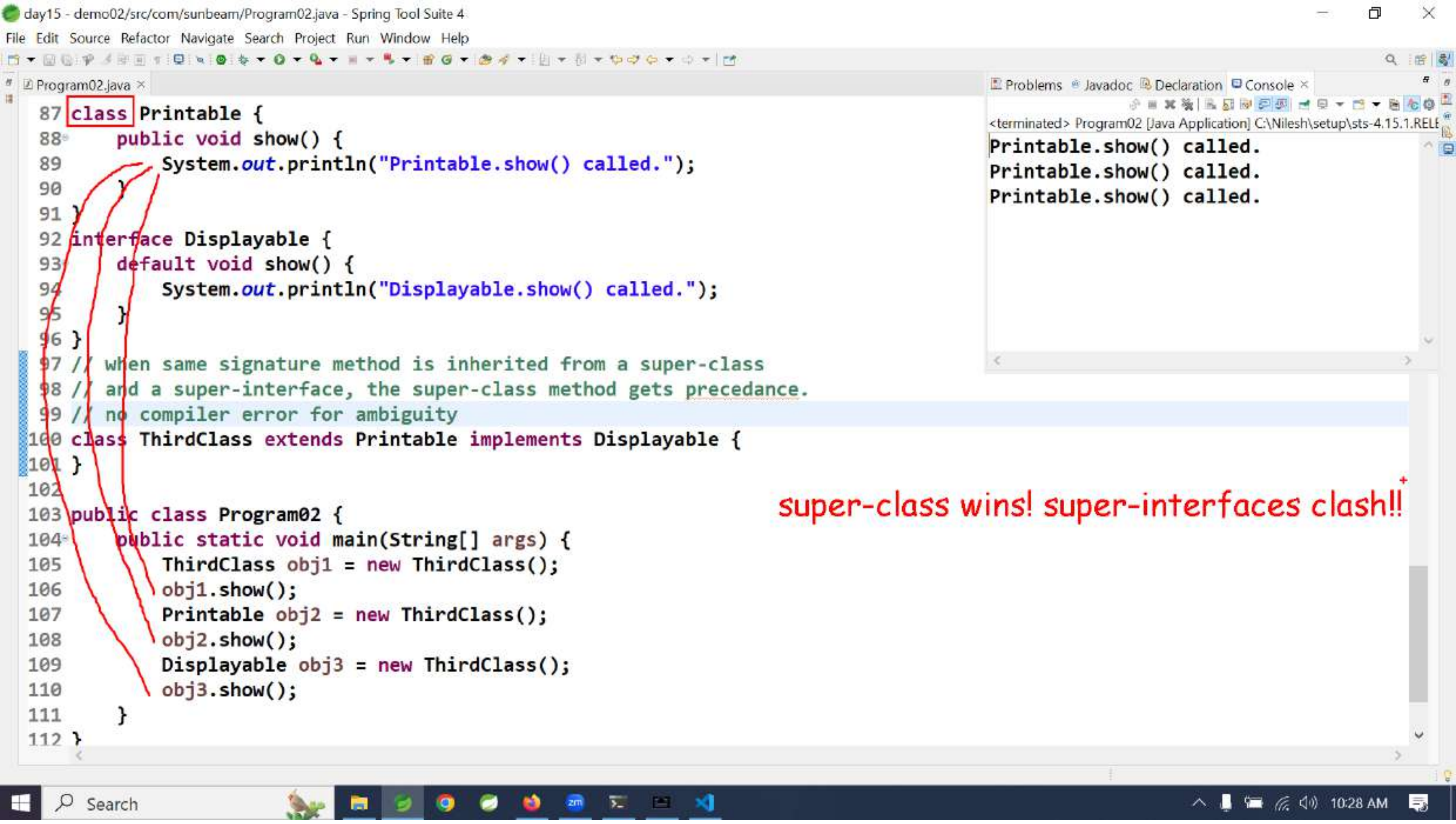
```java
package com.sunbeam;

interface Printable {
    void show();
}
interface Displayable {
    void show();
}
class MyClass implements Printable, Displayable {
    @Override
    public void show() {
        System.out.println("MyClass.show() called.");
    }
}

public class Program02 {
    public static void main(String[] args) {
        MyClass obj1 = new MyClass();
        obj1.show();
        Printable obj2 = new MyClass();
        obj2.show();
        Displayable obj3 = new MyClass();
        obj3.show();
    }
}
```

```
<terminated> Program02 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELE
MyClass.show() called.
MyClass.show() called.
MyClass.show() called.
```


day15 - demo02/src/com/sunbeam/Program02.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program02.java
Problems Javadoc Declaration Console
Search
10:25 AM

```java
interface Printable {
    default void show() {
        System.out.println("Printable.show() called.");
    }
}
interface Displayable {
    default void show() {
        System.out.println("Displayable.show() called.");
    }
}
// if two interfaces have default method with same signature and a class is inher
//  then it will lead to ambiguity.
// this problem can be resolved by overriding method in sub-class.
class SecondClass implements Printable, Displayable {
    public void show() {
        System.out.println("SecondClass.show() called.");
    }
}
public class Program02 {
    public static void main(String[] args) {
        SecondClass obj1 = new SecondClass();
        obj1.show();
        Printable obj2 = new SecondClass();
        obj2.show();
        Displayable obj3 = new SecondClass();
        obj3.show();
```

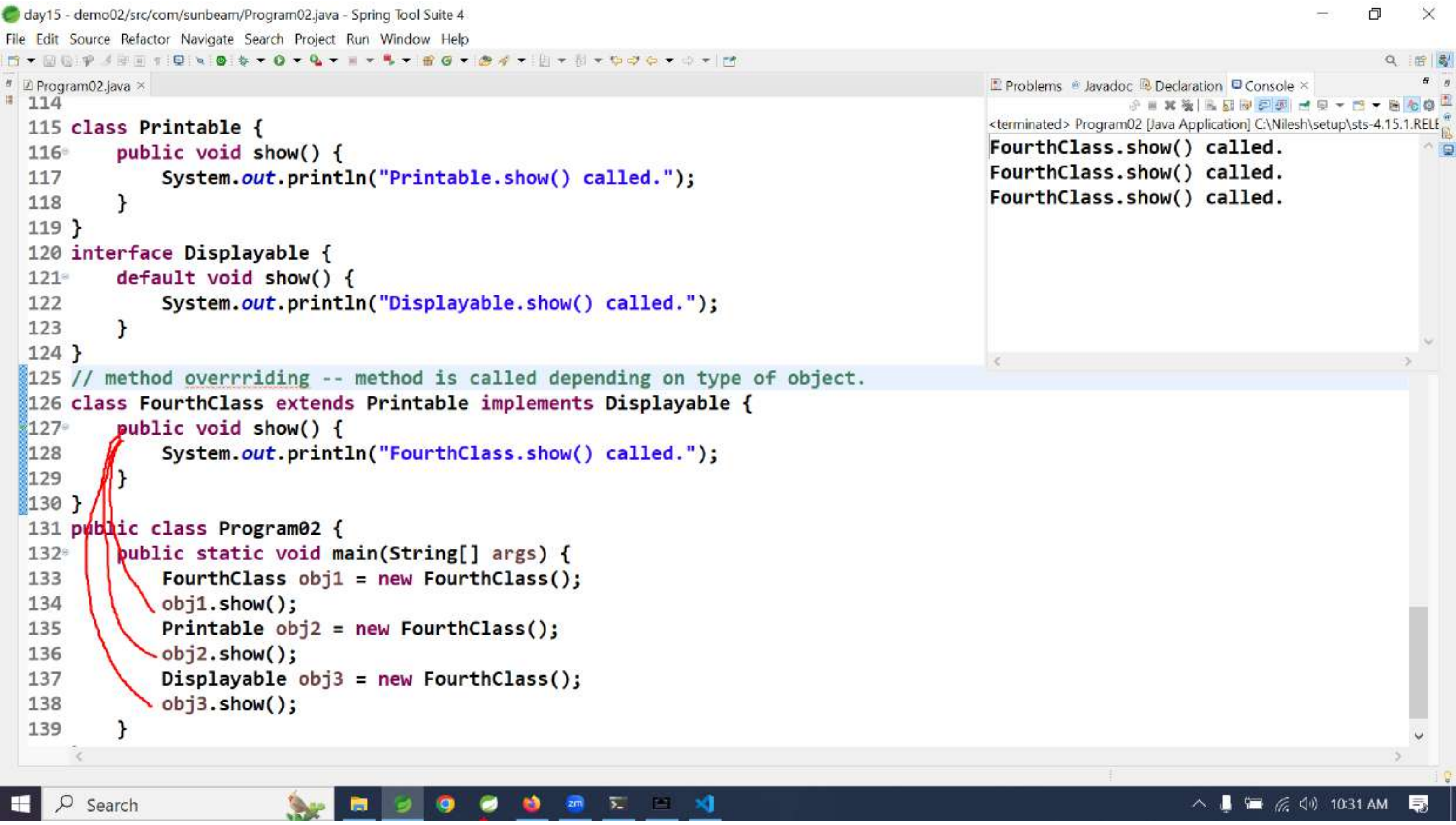
```
<terminated> Program02 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELE
SecondClass.show() called.
SecondClass.show() called.
SecondClass.show() called.
```


day15 - demo02/src/com/sunbeam/Program02.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program02.java
Problems
Javadoc
Declaration
Console
<terminated> Program02 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELE
Search
10:28 AM

```java
class Printable {
    public void show() {
        System.out.println("Printable.show() called.");
    }
}
interface Displayable {
    default void show() {
        System.out.println("Displayable.show() called.");
    }
}
// when same signature method is inherited from a super-class
// and a super-interface, the super-class method gets precedance.
// no compiler error for ambiguity
class ThirdClass extends Printable implements Displayable {
}

public class Program02 {
    public static void main(String[] args) {
        ThirdClass obj1 = new ThirdClass();
        obj1.show();
        Printable obj2 = new ThirdClass();
        obj2.show();
        Displayable obj3 = new ThirdClass();
        obj3.show();
    }
}
```

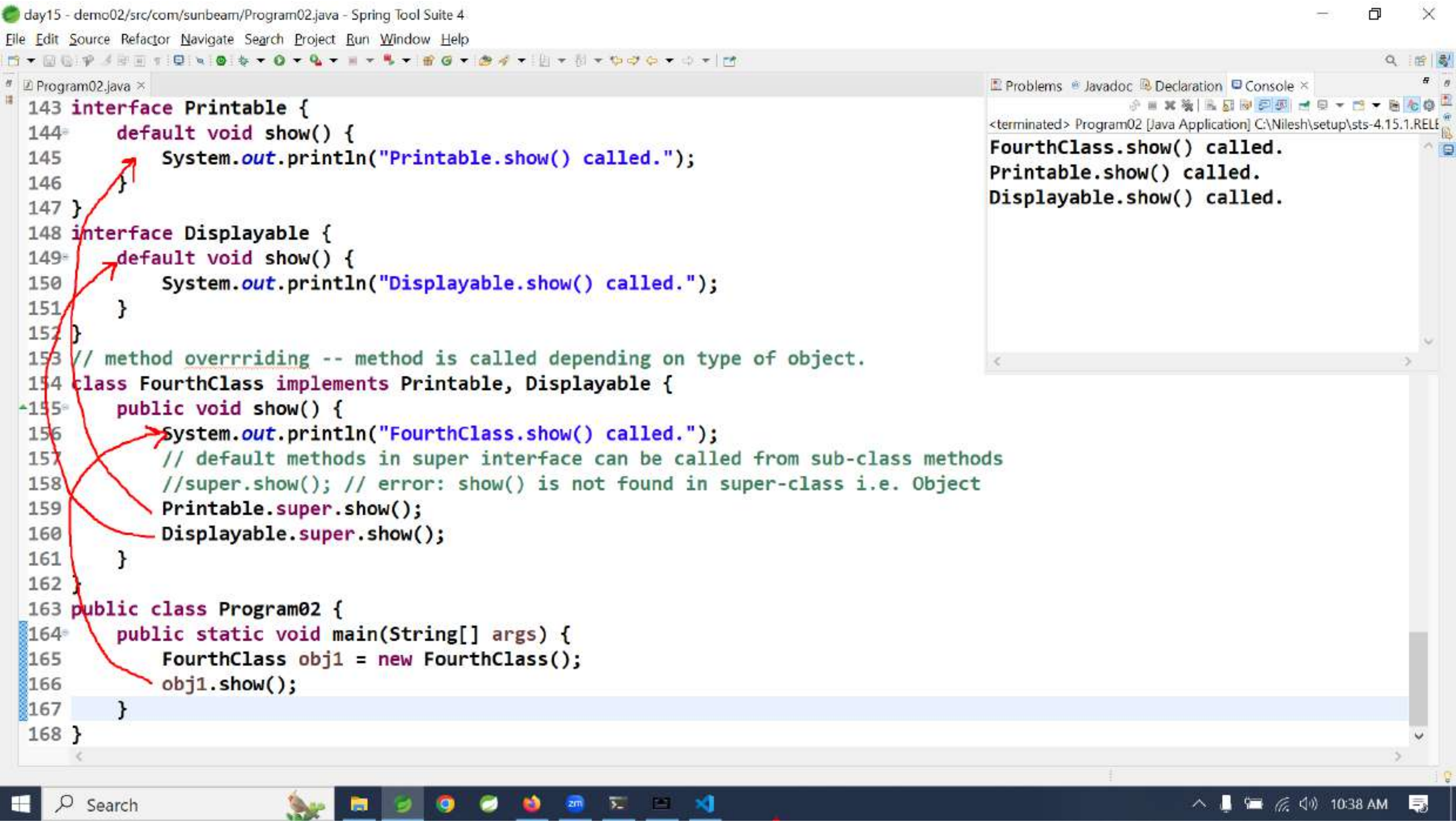
```
Printable.show() called.
Printable.show() called.
Printable.show() called.
```

super-class wins! super-interfaces clash!!


day15 - demo02/src/com/sunbeam/Program02.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program02.java
Problems Javadoc Declaration Console
Search
10:31 AM

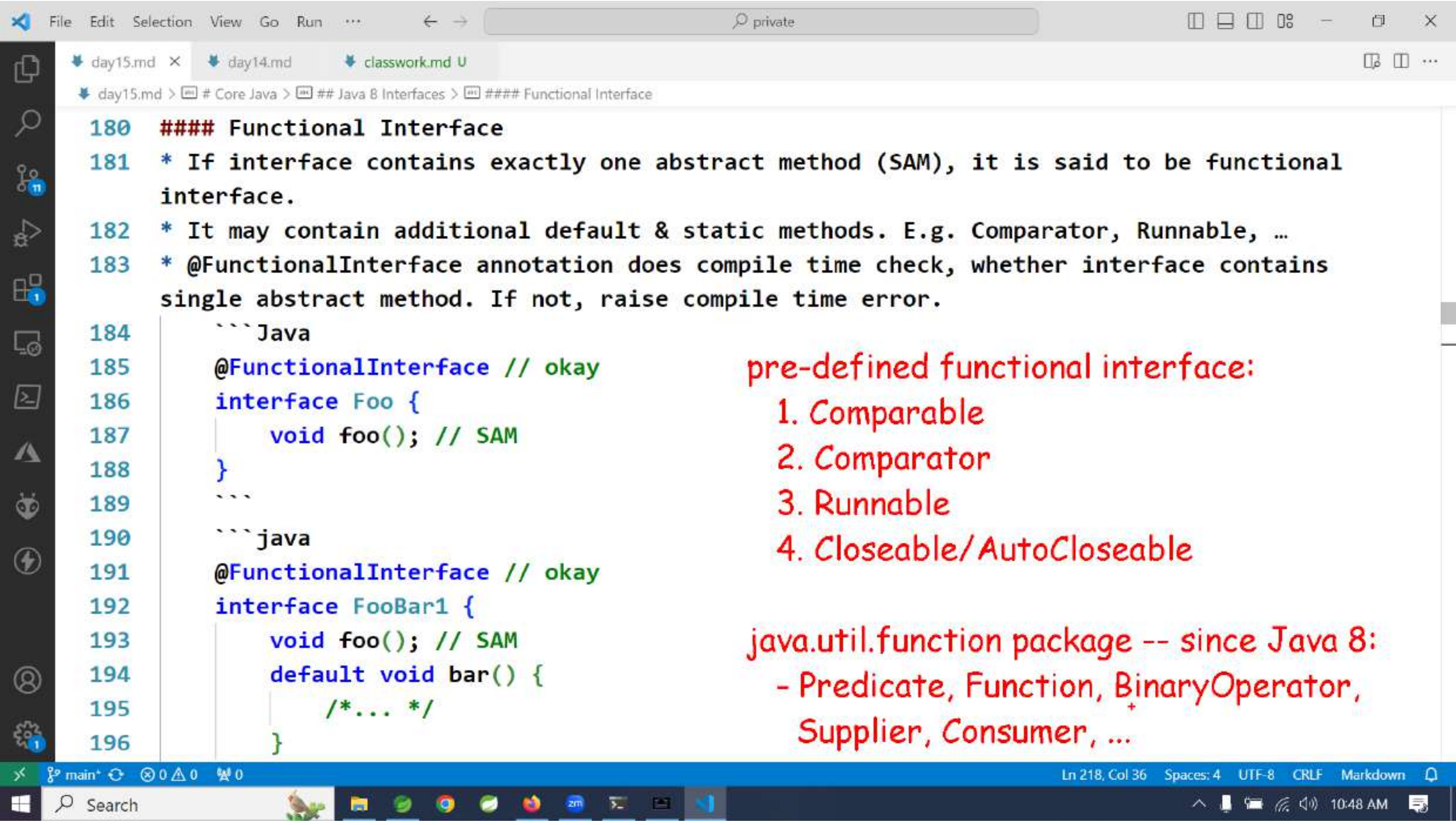
```java

class Printable {
    public void show() {
        System.out.println("Printable.show() called.");
    }
}
interface Displayable {
    default void show() {
        System.out.println("Displayable.show() called.");
    }
}
// method overrriding -- method is called depending on type of object.
class FourthClass extends Printable implements Displayable {
    public void show() {
        System.out.println("FourthClass.show() called.");
    }
}
public class Program02 {
    public static void main(String[] args) {
        FourthClass obj1 = new FourthClass();
        obj1.show();
        Printable obj2 = new FourthClass();
        obj2.show();
        Displayable obj3 = new FourthClass();
        obj3.show();
    }
```

```
<terminated> Program02 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELE
FourthClass.show() called.
FourthClass.show() called.
FourthClass.show() called.
```


day15 - demo02/src/com/sunbeam/Program02.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program02.java
Problems Javadoc Declaration Console
Search
10:38 AM

```java
interface Printable {
    default void show() {
        System.out.println("Printable.show() called.");
    }
}
interface Displayable {
    default void show() {
        System.out.println("Displayable.show() called.");
    }
}
// method overrriding -- method is called depending on type of object.
class FourthClass implements Printable, Displayable {
    public void show() {
        System.out.println("FourthClass.show() called.");
        // default methods in super interface can be called from sub-class methods
        //super.show(); // error: show() is not found in super-class i.e. Object
        Printable.super.show();
        Displayable.super.show();
    }
}
public class Program02 {
    public static void main(String[] args) {
        FourthClass obj1 = new FourthClass();
        obj1.show();
    }
}
```

```
<terminated> Program02 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELE
FourthClass.show() called.
Printable.show() called.
Displayable.show() called.
```


File Edit Selection View Go Run ···
private
day15.md
day14.md
classwork.md U
day15.md > # Core Java > ## Java 8 Interfaces > #### Functional Interface
main* ⊗ 0 ⚠ 0 0
Ln 218, Col 36 Spaces: 4 UTF-8 CRLF Markdown
Search
10:48 AM

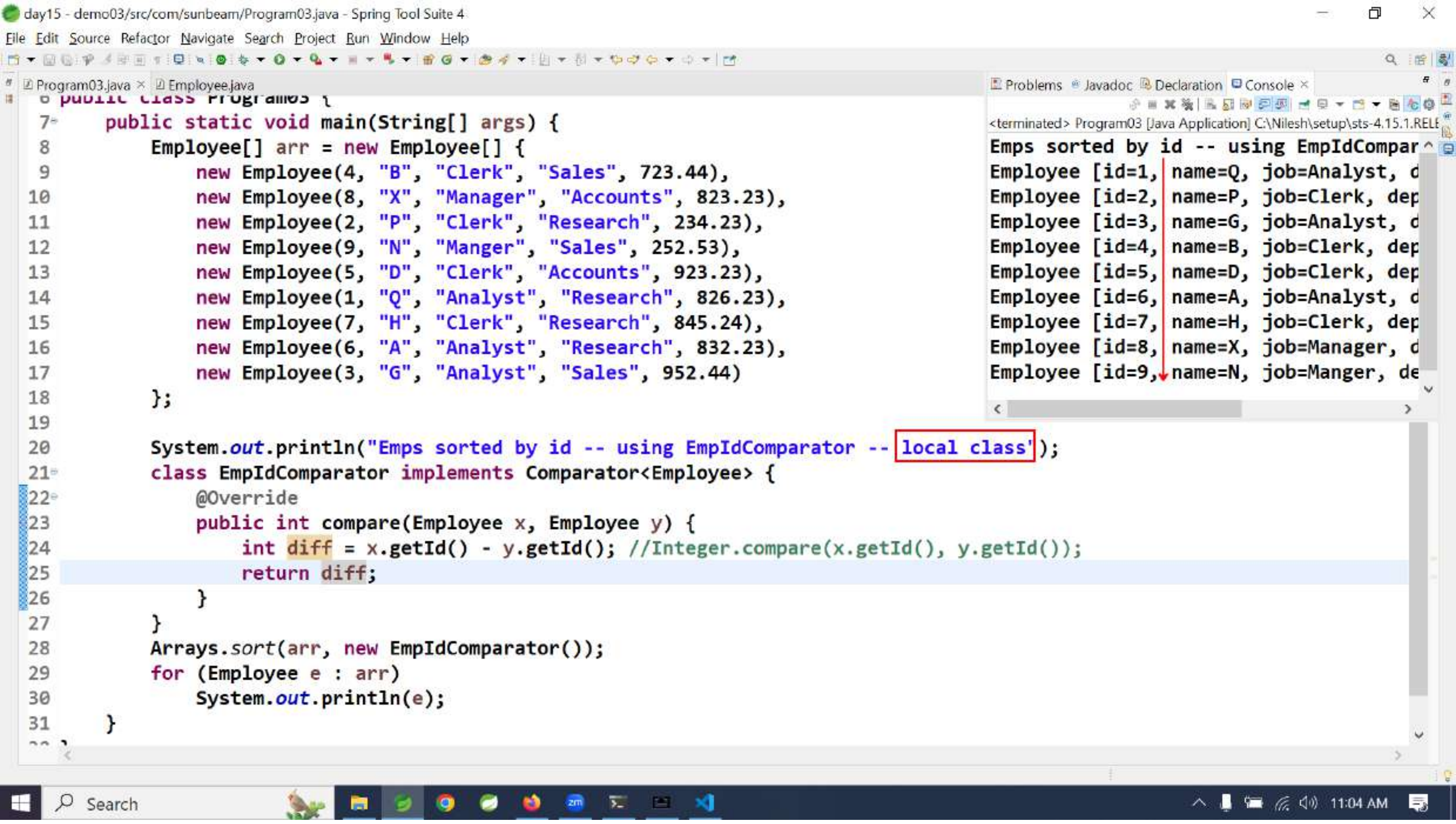
~~~
#### Functional Interface
* If interface contains exactly one abstract method (SAM), it is said to be functional interface.
* It may contain additional default & static methods. E.g. Comparator, Runnable, …
* @FunctionalInterface annotation does compile time check, whether interface contains single abstract method. If not, raise compile time error.
    ```Java
    @FunctionalInterface // okay
    interface Foo {
        void foo(); // SAM
    }
    ```
    ```java
    @FunctionalInterface // okay
    interface FooBar1 {
        void foo(); // SAM
        default void bar() {
            /*... */
        }
~~~

pre-defined functional interface:

1. Comparable
2. Comparator
3. Runnable
4. Closeable/AutoCloseable

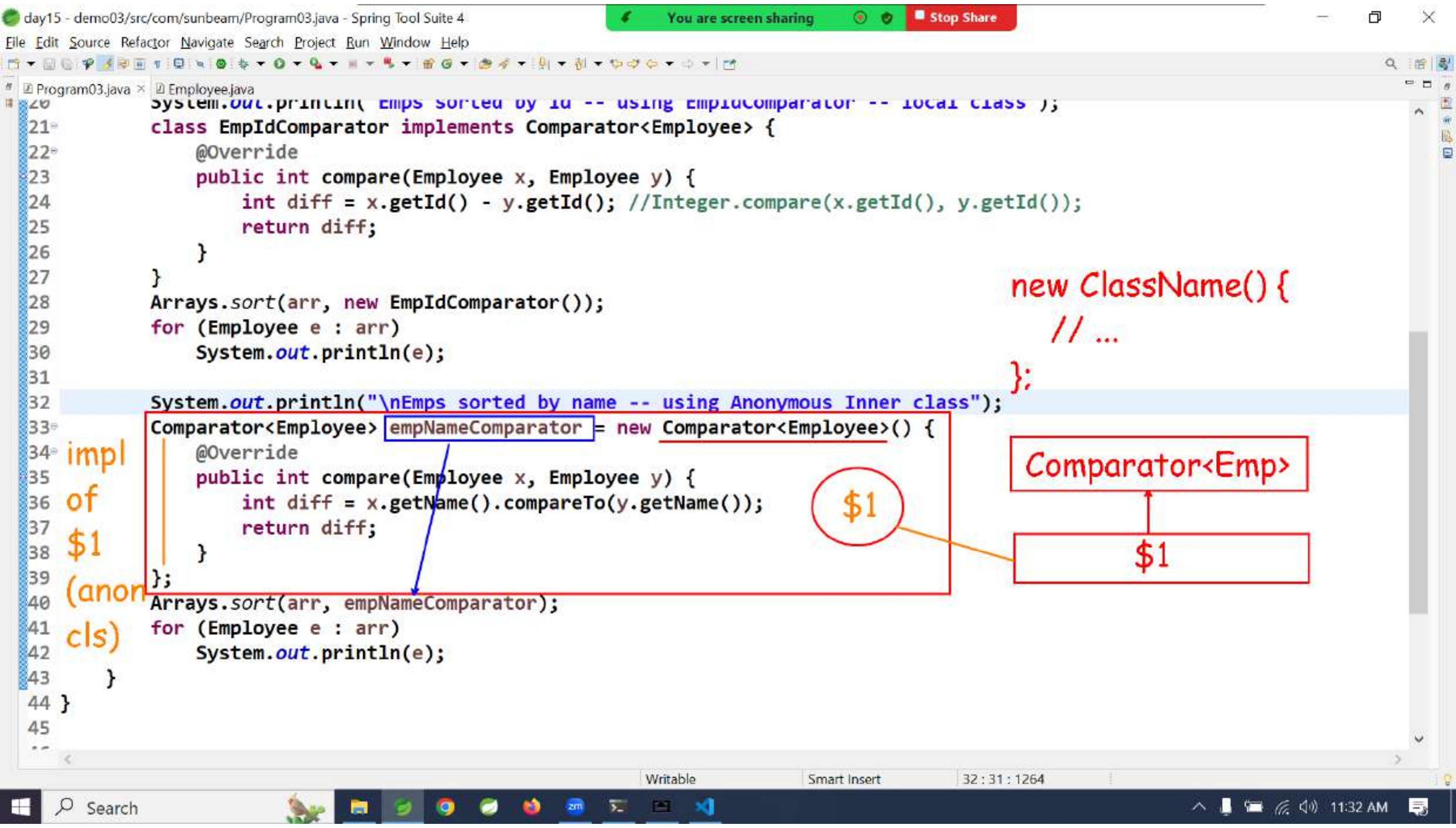
java.util.function package -- since Java 8:

- Predicate, Function, BinaryOperator, Supplier, Consumer, ...


day15 - demo03/src/com/sunbeam/Program03.java - Spring Tool Suite 4
File Edit Source Refactor Navigate Search Project Run Window Help
Program03.java
Employee.java
Problems
Javadoc
Declaration
Console
Search
11:04 AM

```java
public class Program03 {
    public static void main(String[] args) {
        Employee[] arr = new Employee[] {
            new Employee(4, "B", "Clerk", "Sales", 723.44),
            new Employee(8, "X", "Manager", "Accounts", 823.23),
            new Employee(2, "P", "Clerk", "Research", 234.23),
            new Employee(9, "N", "Manger", "Sales", 252.53),
            new Employee(5, "D", "Clerk", "Accounts", 923.23),
            new Employee(1, "Q", "Analyst", "Research", 826.23),
            new Employee(7, "H", "Clerk", "Research", 845.24),
            new Employee(6, "A", "Analyst", "Research", 832.23),
            new Employee(3, "G", "Analyst", "Sales", 952.44)
        };

        System.out.println("Emps sorted by id -- using EmpIdComparator -- local class");
        class EmpIdComparator implements Comparator<Employee> {
            @Override
            public int compare(Employee x, Employee y) {
                int diff = x.getId() - y.getId(); //Integer.compare(x.getId(), y.getId());
                return diff;
            }
        }
        Arrays.sort(arr, new EmpIdComparator());
        for (Employee e : arr)
            System.out.println(e);
    }
}
```

```
<terminated> Program03 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELE
Emps sorted by id -- using EmpIdCompar
Employee [id=1, name=Q, job=Analyst, d
Employee [id=2, name=P, job=Clerk, dep
Employee [id=3, name=G, job=Analyst, d
Employee [id=4, name=B, job=Clerk, dep
Employee [id=5, name=D, job=Clerk, dep
Employee [id=6, name=A, job=Analyst, d
Employee [id=7, name=H, job=Clerk, dep
Employee [id=8, name=X, job=Manager, d
Employee [id=9, name=N, job=Manger, de
```


day15 - demo03/src/com/sunbeam/Program03.java - Spring Tool Suite 4
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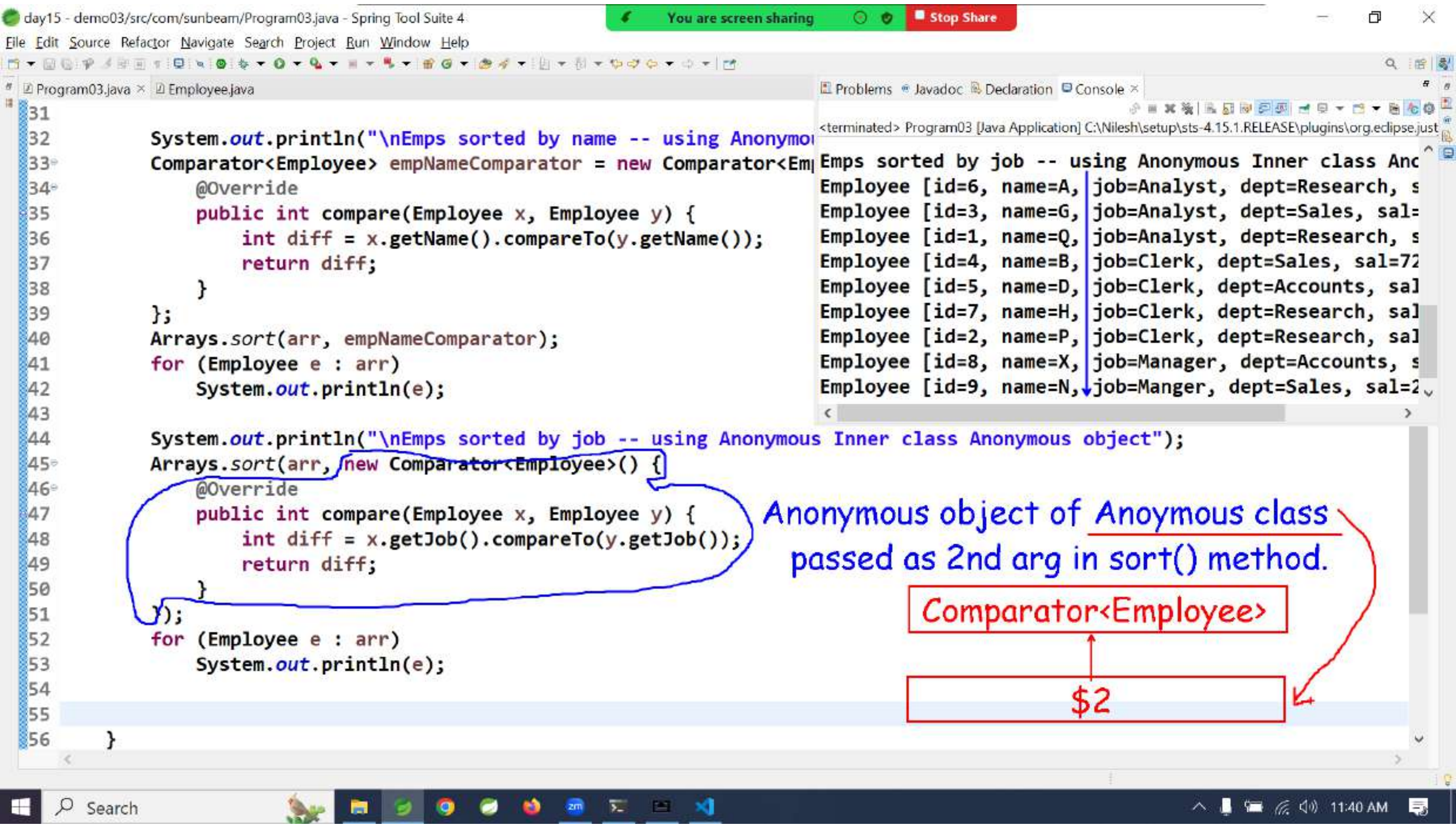
Program03.java
Employee.java
Writable
Smart Insert
32 : 31 : 1264
Search
11:32 AM

```
        System.out.println("Emps sorted by id -- using EmpIdComparator -- local class");
        class EmpIdComparator implements Comparator<Employee> {
            @Override
            public int compare(Employee x, Employee y) {
                int diff = x.getId() - y.getId(); //Integer.compare(x.getId(), y.getId());
                return diff;
            }
        }
        Arrays.sort(arr, new EmpIdComparator());
        for (Employee e : arr)
            System.out.println(e);

        System.out.println("\nEmps sorted by name -- using Anonymous Inner class");
        Comparator<Employee> empNameComparator = new Comparator<Employee>() {
            @Override
            public int compare(Employee x, Employee y) {
                int diff = x.getName().compareTo(y.getName());
                return diff;
            }
        };
        Arrays.sort(arr, empNameComparator);
        for (Employee e : arr)
            System.out.println(e);
    }
}
```

```
new ClassName() {
    // ...
};
```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File Edit Source Refactor Navigate Search Project Run Window Help
Program03.java
Employee.java
Problems
Javadoc
Declaration
Console
Search
11:40 AM

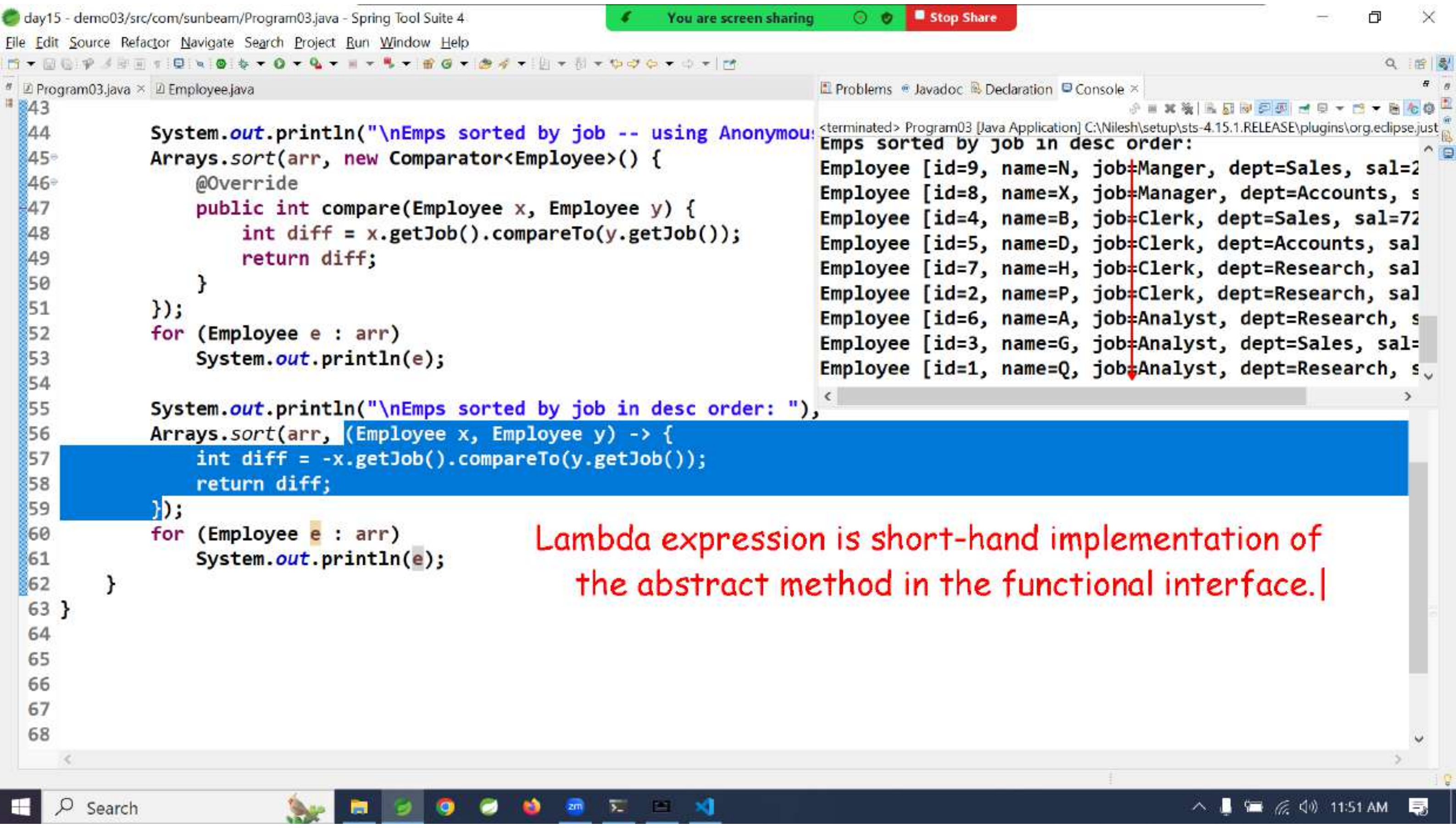
```java
        System.out.println("\nEmps sorted by name -- using Anonymou
        Comparator<Employee> empNameComparator = new Comparator<Em
            @Override
            public int compare(Employee x, Employee y) {
                int diff = x.getName().compareTo(y.getName());
                return diff;
            }
        };
        Arrays.sort(arr, empNameComparator);
        for (Employee e : arr)
            System.out.println(e);

        System.out.println("\nEmps sorted by job -- using Anonymous Inner class Anonymous object");
        Arrays.sort(arr, new Comparator<Employee>() {
            @Override
            public int compare(Employee x, Employee y) {
                int diff = x.getJob().compareTo(y.getJob());
                return diff;
            }
        });
        for (Employee e : arr)
            System.out.println(e);


    }
```

```
<terminated> Program03 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.just
Emps sorted by job -- using Anonymous Inner class Anc
Employee [id=6, name=A, job=Analyst, dept=Research, s
Employee [id=3, name=G, job=Analyst, dept=Sales, sal=
Employee [id=1, name=Q, job=Analyst, dept=Research, s
Employee [id=4, name=B, job=Clerk, dept=Sales, sal=72
Employee [id=5, name=D, job=Clerk, dept=Accounts, sal
Employee [id=7, name=H, job=Clerk, dept=Research, sal
Employee [id=2, name=P, job=Clerk, dept=Research, sal
Employee [id=8, name=X, job=Manager, dept=Accounts, s
Employee [id=9, name=N, job=Manger, dept=Sales, sal=2
```

Anonymous object of Anoymous class passed as 2nd arg in sort() method.

Comparator<Employee>

$2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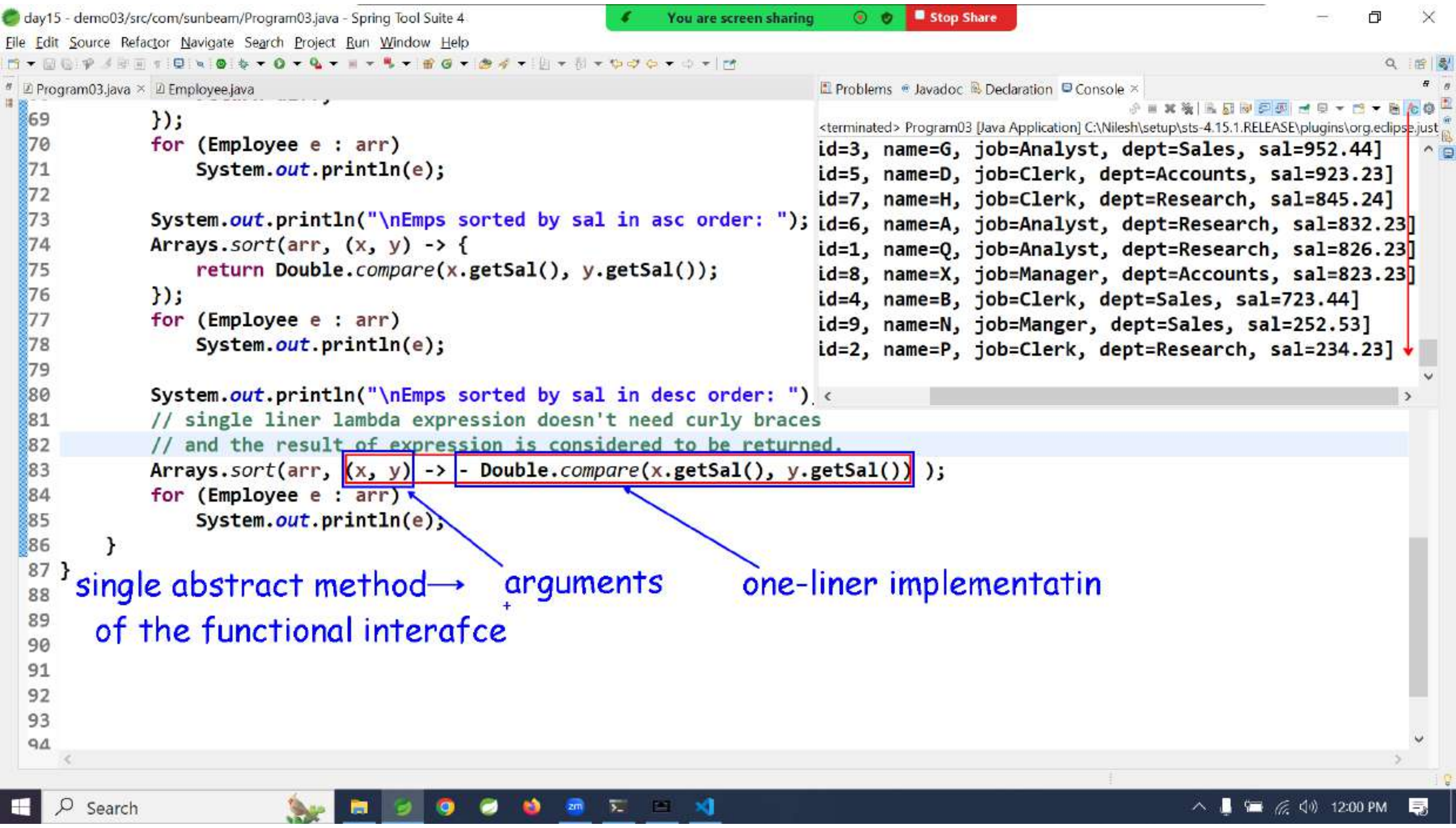
Program03.java
Employee.java
Problems
Javadoc
Declaration
Console
Search
11:51 AM

```
        System.out.println("\nEmps sorted by job -- using Anonymou
        Arrays.sort(arr, new Comparator<Employee>() {
            @Override
            public int compare(Employee x, Employee y) {
                int diff = x.getJob().compareTo(y.getJob());
                return diff;
            }
        });
        for (Employee e : arr)
            System.out.println(e);

        System.out.println("\nEmps sorted by job in desc order: ");
        Arrays.sort(arr, (Employee x, Employee y) -> {
            int diff = -x.getJob().compareTo(y.getJob());
            return diff;
        });
        for (Employee e : arr)
            System.out.println(e);
    }
}
```

```
<terminated> Program03 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.just
Emps sorted by job in desc order:
Employee [id=9, name=N, job=Manger, dept=Sales, sal=2
Employee [id=8, name=X, job=Manager, dept=Accounts, s
Employee [id=4, name=B, job=Clerk, dept=Sales, sal=72
Employee [id=5, name=D, job=Clerk, dept=Accounts, sal
Employee [id=7, name=H, job=Clerk, dept=Research, sal
Employee [id=2, name=P, job=Clerk, dept=Research, sal
Employee [id=6, name=A, job=Analyst, dept=Research, s
Employee [id=3, name=G, job=Analyst, dept=Sales, sal=
Employee [id=1, name=Q, job=Analyst, dept=Research, s
```

Lambda expression is short-hand implementation of the abstract method in the functional interface.



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Program03.java
Employee.java
Problems
Javadoc
Declaration
Console
Search
12:00 PM

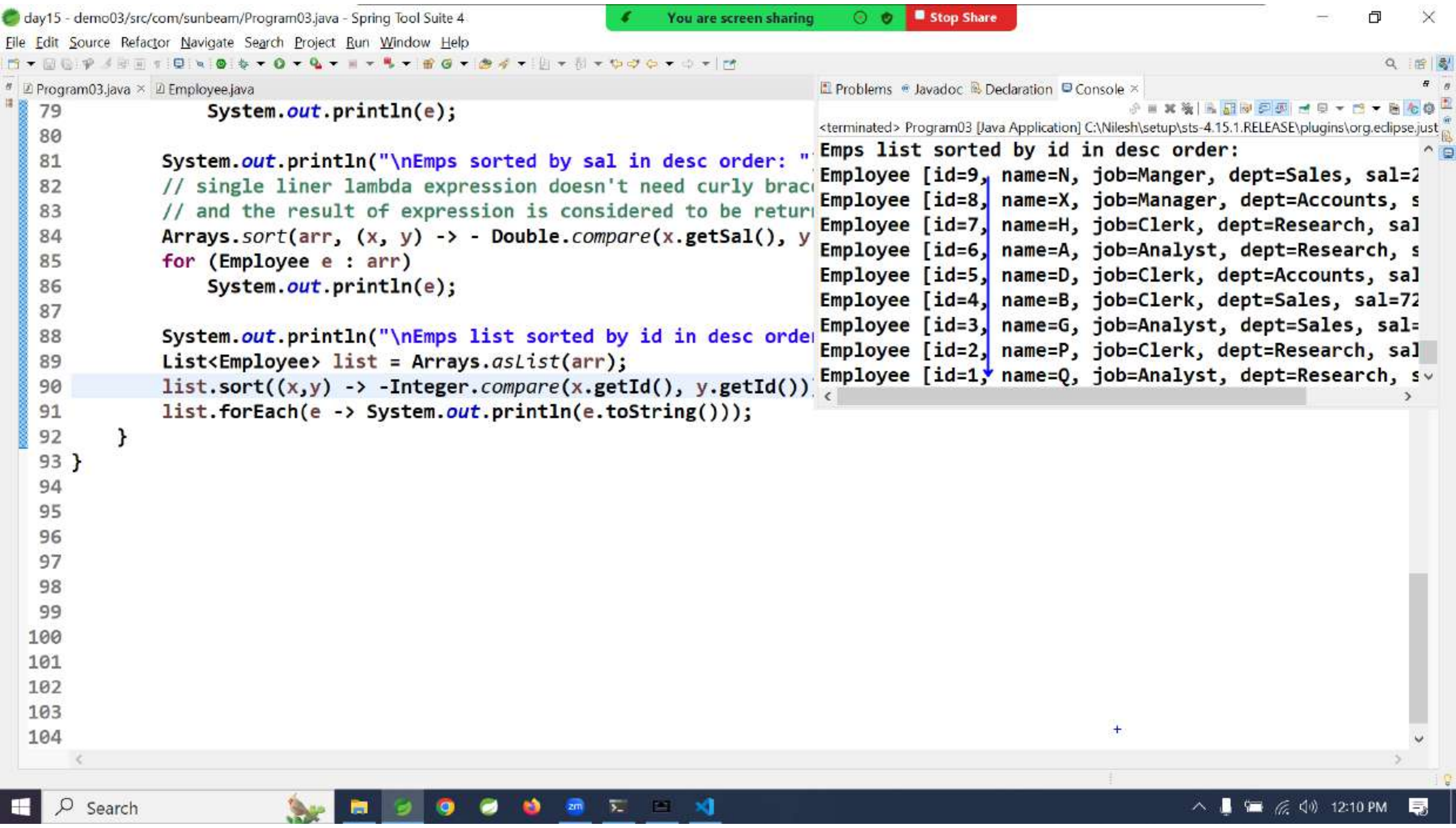
```java
        });
        for (Employee e : arr)
            System.out.println(e);

        System.out.println("\nEmps sorted by sal in asc order: ");
        Arrays.sort(arr, (x, y) -> {
            return Double.compare(x.getSal(), y.getSal());
        });
        for (Employee e : arr)
            System.out.println(e);

        System.out.println("\nEmps sorted by sal in desc order: ")
        // single liner lambda expression doesn't need curly braces
        // and the result of expression is considered to be returned.
        Arrays.sort(arr, (x, y) -> - Double.compare(x.getSal(), y.getSal()) );
        for (Employee e : arr)
            System.out.println(e);
    }
}
```

```
<terminated> Program03 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.just
id=3, name=G, job=Analyst, dept=Sales, sal=952.44]
id=5, name=D, job=Clerk, dept=Accounts, sal=923.23]
id=7, name=H, job=Clerk, dept=Research, sal=845.24]
id=6, name=A, job=Analyst, dept=Research, sal=832.23]
id=1, name=Q, job=Analyst, dept=Research, sal=826.23]
id=8, name=X, job=Manager, dept=Accounts, sal=823.23]
id=4, name=B, job=Clerk, dept=Sales, sal=723.44]
id=9, name=N, job=Manger, dept=Sales, sal=252.53]
id=2, name=P, job=Clerk, dept=Research, sal=234.23]
```

single abstract method ⟶
of the functional interafce

arguments

one-liner implementatin



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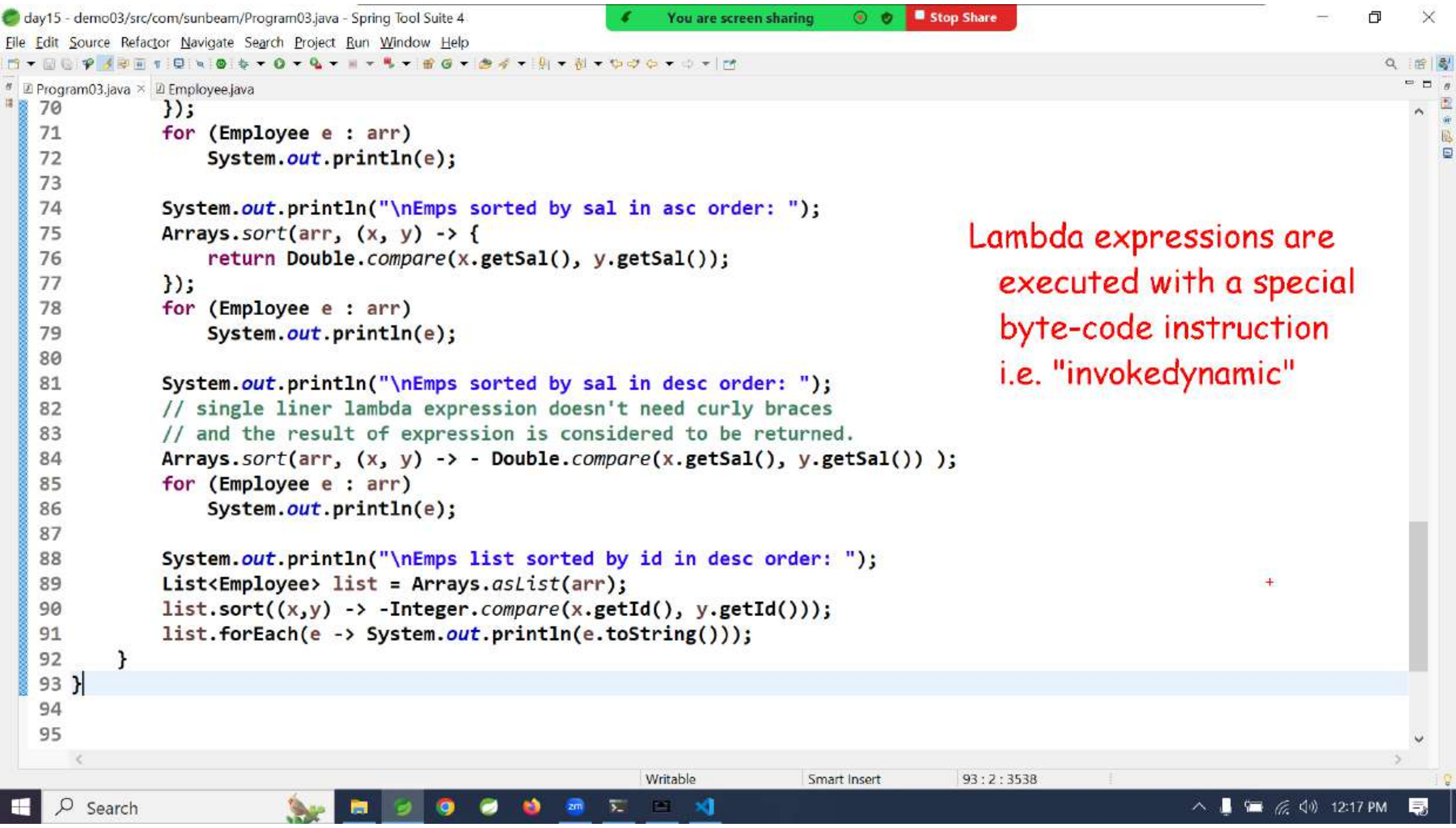
Program03.java
Employee.java
Problems
Javadoc
Declaration
Console
Search
12:10 PM

```java
                System.out.println(e);

            System.out.println("\nEmps sorted by sal in desc order: "
            // single liner lambda expression doesn't need curly brac
            // and the result of expression is considered to be retur
            Arrays.sort(arr, (x, y) -> - Double.compare(x.getSal(), y
            for (Employee e : arr)
                System.out.println(e);

            System.out.println("\nEmps list sorted by id in desc orde
            List<Employee> list = Arrays.asList(arr);
            list.sort((x,y) -> -Integer.compare(x.getId(), y.getId())
            list.forEach(e -> System.out.println(e.toString()));
        }
}
```

```
<terminated> Program03 [Java Application] C:\Nilesh\setup\sts-4.15.1.RELEASE\plugins\org.eclipse.just
Emps list sorted by id in desc order:
Employee [id=9, name=N, job=Manger, dept=Sales, sal=2
Employee [id=8, name=X, job=Manager, dept=Accounts, s
Employee [id=7, name=H, job=Clerk, dept=Research, sal
Employee [id=6, name=A, job=Analyst, dept=Research, s
Employee [id=5, name=D, job=Clerk, dept=Accounts, sal
Employee [id=4, name=B, job=Clerk, dept=Sales, sal=72
Employee [id=3, name=G, job=Analyst, dept=Sales, sal=
Employee [id=2, name=P, job=Clerk, dept=Research, sal
Employee [id=1, name=Q, job=Analyst, dept=Research, s
```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Program03.java
Employee.java
Writable
Smart Insert
93 : 2 : 3538
Search
12:17 PM

```java
        });
        for (Employee e : arr)
            System.out.println(e);

        System.out.println("\nEmps sorted by sal in asc order: ");
        Arrays.sort(arr, (x, y) -> {
            return Double.compare(x.getSal(), y.getSal());
        });
        for (Employee e : arr)
            System.out.println(e);

        System.out.println("\nEmps sorted by sal in desc order: ");
        // single liner lambda expression doesn't need curly braces
        // and the result of expression is considered to be returned.
        Arrays.sort(arr, (x, y) -> - Double.compare(x.getSal(), y.getSal()) );
        for (Employee e : arr)
            System.out.println(e);

        System.out.println("\nEmps list sorted by id in desc order: ");
        List<Employee> list = Arrays.asList(arr);
        list.sort((x,y) -> -Integer.compare(x.getId(), y.getId()));
        list.forEach(e -> System.out.println(e.toString()));
    }
}
```

Lambda expressions are executed with a special byte-code instruction i.e. "invokedynamic"