Introduction to Java
Synchronized Collections

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Learning Objectives in this Lesson

• Recognize the capabilities & limits of Java’s synchronized collections

<table>
<thead>
<tr>
<th>Collections Method</th>
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<td>synchronizedCollection(coll)</td>
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<td>synchronizedList(list)</td>
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<tr>
<td>synchronizedMap(map)</td>
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<td>synchronizedSet(set)</td>
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Overview of Java Synchronized Collections
Overview of Java Synchronized Collections

- By default, Java collections are not synchronized

Note that this implementation is not synchronized. If multiple threads access an ArrayList instance concurrently, and at least one of the threads modifies the list structurally, it must be synchronized externally.

See [docs.oracle.com/javase/8/docs/api/java/util/ArrayList.html](docs.oracle.com/javase/8/docs/api/java/util/ArrayList.html)
Overview of Java Synchronized Collections

- By default, Java collections are not synchronized
- Thus, they are not *thread-safe*

**Code is thread-safe if it only manipulates shared data structures in a manner that avoids race conditions by multiple concurrent threads**

See [en.wikipedia.org/wiki/Thread_safety](https://en.wikipedia.org/wiki/Thread_safety)
Overview of Java Synchronized Collections

- Java’s synchronized collection *wrappers* are created via static factory methods

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See [docs.oracle.com/javase/tutorial/collections/implementations/wrapper.html](http://docs.oracle.com/javase/tutorial/collections/implementations/wrapper.html)
Overview of Java Synchronized Collections

- Java’s synchronized collection wrappers are created via static factory methods, e.g.
- Ensure that method calls are thread-safe

```java
public class Collections {
    public static <K,V> Map<K,V> synchronizedMap (Map<K,V> m) {
        return new SynchronizedMap<>(m);
    }
}
```

E.g., the Map parameter is simply wrapped by a SynchronizedMap
Overview of Java Synchronized Collections

- Java’s synchronized collection wrappers are created via static factory methods, e.g.
- Ensure that method calls are thread-safe

```java
Map<Integer, String> mMap = new HashMap<>();

mMap = Collections.synchronizedMap(mMap);

// Thread t1:
mMap.put(1, "Newton");
mMap.put(4, "Favre");
mMap.put(7, "Elway");
mMap.put(12, "Brady");
mMap.put(13, "Warner");
mMap.put(18, "Manning");

// Thread t2:
String s1 = mMap.get(12);

// Thread t3:
String s2 = mMap.get(13);

// Thread t4:
String s3 = mMap.get(18);
```

This factory method converts a non-thread-safe map into a thread-safe map via the synchronization wrapper
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// Thread t2:
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```

Multiple threads can thus access & update the synchronized collection
Overview of Java Synchronized Collections

- Java’s synchronized collection wrappers are created via static factory methods, e.g.
  - Ensure that method calls are thread-safe
- Synchronized collections aren’t optimized for concurrent access

A synchronized collection is thread-safe & governed by one mutual exclusion lock
Overview of Java Synchronized Collections

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Implemented by decorating each forwarded method in a synchronized statement

```java
class SynchronizedMap<K, V> implements Map<K, V> {
    // Backing Map
    private final Map<K, V> m;
    // Synchronizer object
    final Object mutex;

    SynchronizedMap(Map<K, V> m) {
        this.m = Objects.requireNonNull(m);
        mutex = this;
    }

    public V get(Object key) {
        synchronized (mutex) {
            return m.get(key);
        }
    }

    // ...
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        this.m = Objects.requireNonNull(m);
        mutex = this;
    }

    public V get(Object key) {
        synchronized (mutex) {
            return m.get(key);
        }
    }
    ...
```

A single mutual exclusion lock can yield excessive contention

End of Introduction to Java
Synchronized Collections