# Java Synchronized Collections: Introduction

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## Learning Objectives in this Lesson

- Recognize the capabilities & limits of Java's synchronized collections

| Collections Method |
|---|
| `synchronizedCollection(coll)` |
| `synchronizedList(list)` |
| `synchronizedMap(map)` |
| `synchronizedSet(set)` |

## Overview of Java Synchronized Collections

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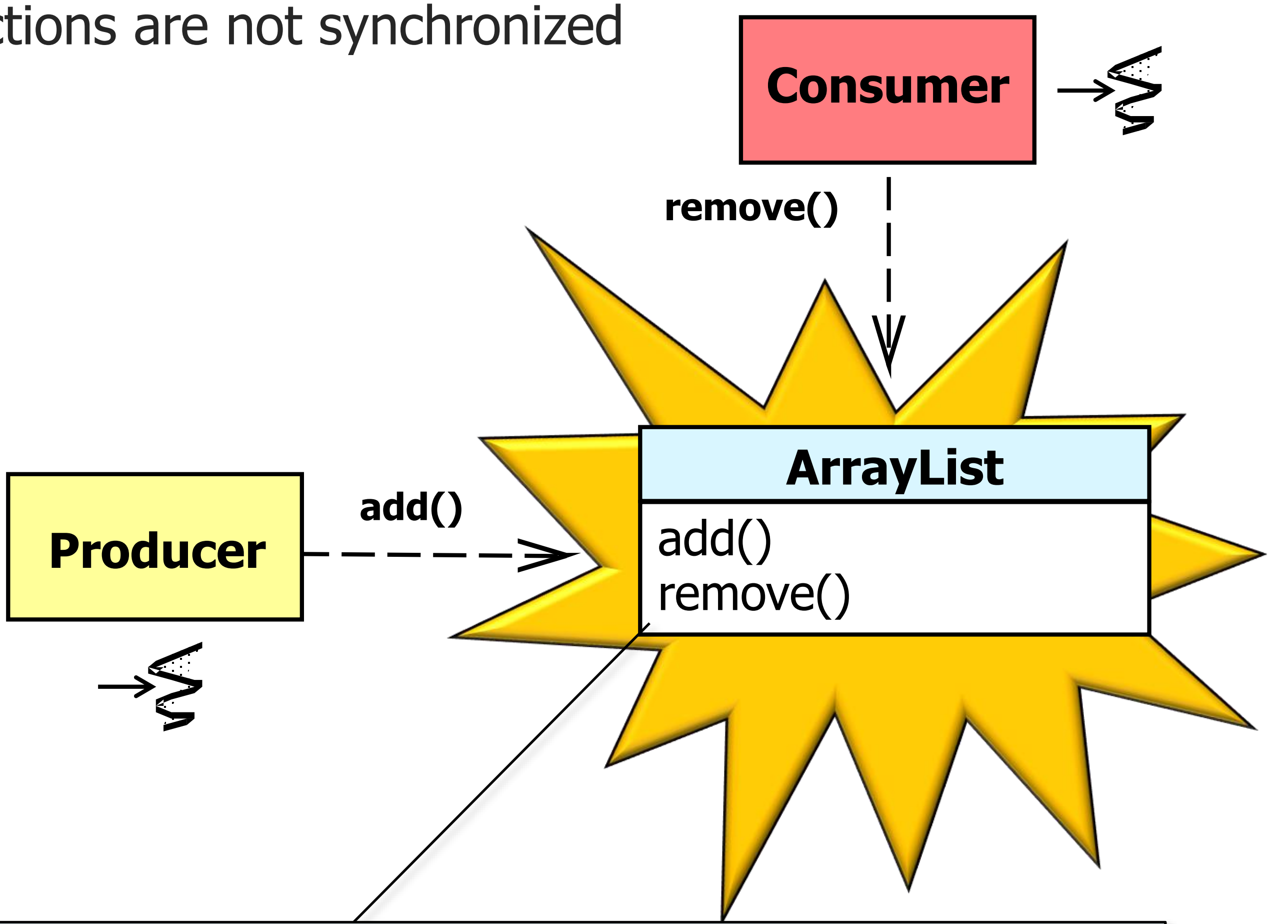
- By default, Java collections are not synchronized

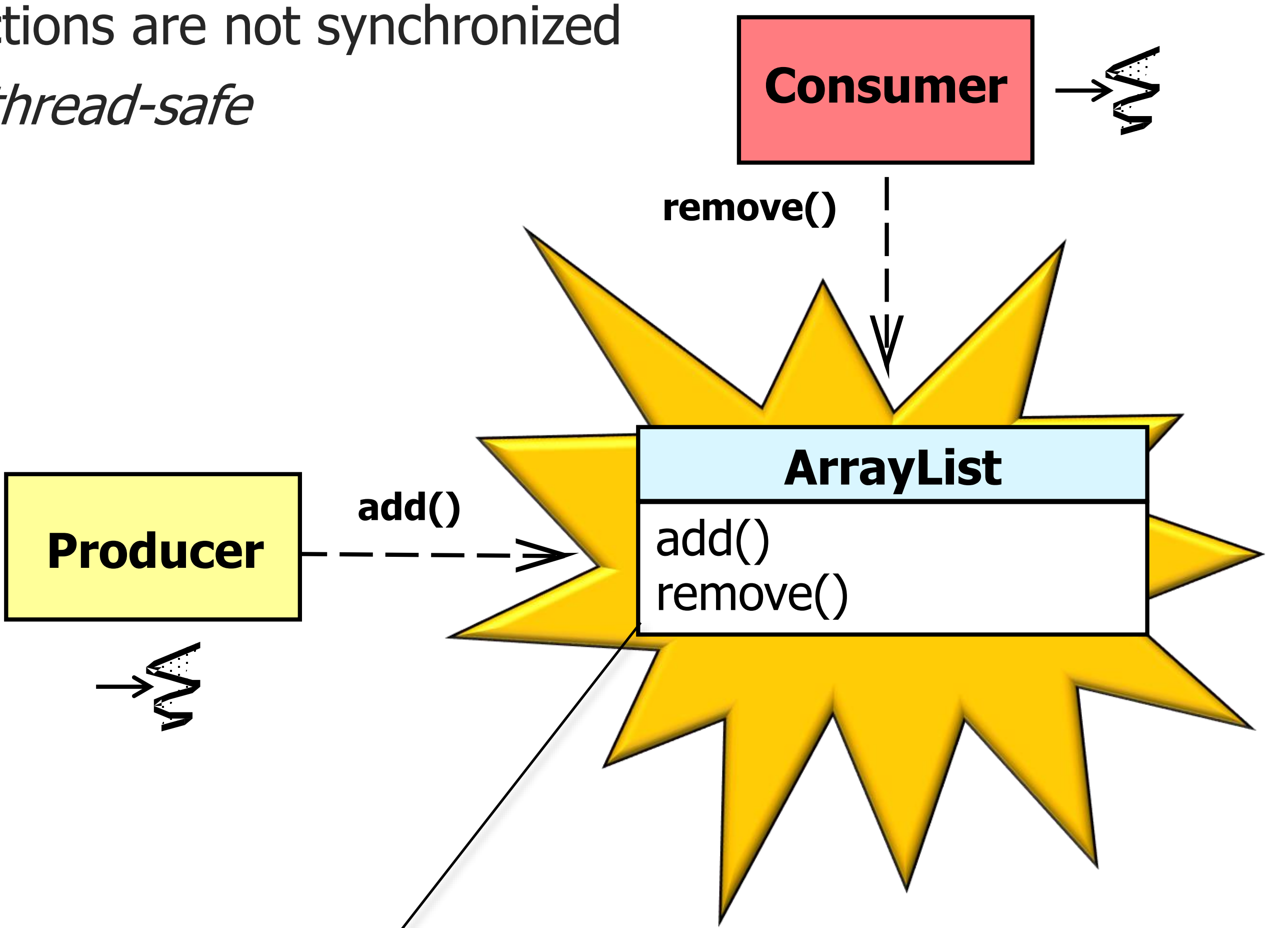


***Note that this implementation is not synchronized.** If multiple threads access an ArrayList instance concurrently, and at least one of the threads modifies the list structurally, it must be synchronized externally*

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

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- 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](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*

```
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.
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*This factory method converts a non-thread-safe map into a thread-safe map via the synchronization wrapper*

```
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);
```

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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

```
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);
    }
  } ...
```

*A synchronized collection is thread-safe & governed by one mutual exclusion lock*

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*Implemented by decorating each forwarded method in a* **`synchronized`** *statement*

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See en.wikipedia.org/wiki/Decorator_pattern

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*A single mutual exclusion lock can yield excessive contention*

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See [www.ibm.com/support/knowledgecenter/en/SS3KLZ/com.ibm.java.diagnostics.healthcenter.doc/topics/resolving.html](www.ibm.com/support/knowledgecenter/en/SS3KLZ/com.ibm.java.diagnostics.healthcenter.doc/topics/resolving.html)

## End of Java Synchronized Collections: Introduction